Radio ZS

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Radio ZS

The Journal of the South African Radio League
Die Tydskrif van die Suid-Afrikaanse Radioliga
"Advancing the Spirit of Amateur Radio Through Innovation"

YOU are the SARL!

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In this issue

On the Cover.
Op die Voorblad.

South African Radio League
Suid-Afrikaanse Radioliga
Founded 20 May 1925 / Gestig 20 Mei 1925
The National Body for Amateur Radio in South Africa and Member Society of IARU Region 1
Die Nasionale Liggaam vir Amateur Radio in Suid-Afrika en Lidvereniging van IARU Streek 1
https://mysarl.org.za/

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What you doing in July?

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
28 Ham Radio FNH and the ARRL Field Day	29 	30 International Asteroid Day and the end of the 2025/26 SARL Financial Year	1 Start of the 2026/27 SARL Financial Year 	2	3	4 the SARL Newbie QSO Party 
5 the ZS5 QSO Party	6	7	8	9	10	11 IARU HF Championships and WRTC 2026
12 IARU HF Championships and WRTC 2026	13	14	15	16	17	18 the North American RTTY QSO Party and the SARL Winter QRP Contest
19 the NA RTTY QSO Party and the ZS2 QSO Party	20 International Moon Day 	21 Provincial Schools open 	22	23	24	25 the IOTA Contest and the SARL Saturday 40 m Club Contest
26 the IOTA Contest and the ZS1 QSO Party	27	28 Delta Aquarids Meteor Shower 	29 Delta Aquarids Meteor Shower and the Power Hour Tech Talk	30	31	1 AMSAT SA Space Symposium; the Pretoria Boot Sale and the North American CW QSO Party

They shall grow not old, as we that are left grow old,
Age shall not weary them, nor the years condemn.
At the going down of the sun and in the morning
We will remember them.

Hulle word nie oud soos ons wat bly vergrys,
Die jare sal hulle nie raak nog die tyd se eis.
En, soos die son sak of die more ontvou,
Eer hul herinnering - Ons sal onthou.

Angus Christie, ZS5AHC
Joseph (Joe) Katzman, ZS6TB

Amateur Radio News

First 24 GHz EME QSO into Africa

On Sunday 14 June 2026, the first ever 24 GHz EME contact is made with the African Continent. John, ZS6JON and Hans, PE1CKK made a two-way contact via the moon. This QSO had a long preparation, John contacted Hans a year ago and asked if he had some parts to make a 24 GHz setup. Parts are very hard to find in South Africa for 24 GHz.

After lot of e-mail and chat contact, John had the system up and running last Sunday. Right at the first TX cycle, John had a decode from Hans and the QSO was finished. The setup will stay for some time in SA, so John is open for skeds. Working conditions are a 1,8 m Dish, a Wavelab transverter, RW1127 twt 25W and DU3T lna.

The IARU Intruder Watch Service

The IARU Intruder Watch Service (formerly the IARU Monitoring System - IARUMS) is a worldwide service authorized by the IARU Administrative Council. It is served by dedicated volunteers As per the IARU Intruder Watch Service Terms of Reference, the primary objective of the IARU IWS is the search classification, identification and initiation of steps leading to the removal from amateur bands of radio signals of non-amateur stations causing harmful interference to the amateur services, contrary to ITU International Telecommunications Union and national radio regulations. Typical intruders include Broadcasters, Over the Horizon Radars, illegal operators on the bands including taxi-cabs and fishermen on various bands, various military modes and many more types of unwanted signals.

Visit our website at https://www.iaru-r1.org/about-us/committees-and-working-groups/iarums/

The SARL has a vacancy for an IWS Coordinator, James, ZS6NS has stepped down after many years of service. Contact the SARL Secretary if you are interested.

Book now for the 2026 AMSAT SA Space Symposium

Registration for the 2026 AMSAT SA Space Symposium opened on Sunday 28 June. The symposium will be presented on the AMSAT SA video conference platform on Saturday 1 August 2026 from 10:00 CAT (08:00 UTC). The programme features local as well as international speakers covering a wide range of topics. The registration link and more details can be found on www.amsatsa.org.za

The SARL represented at the NPWG

On Thursday 25 and Friday 26 June, the SARL was represented at the NWPG, the National WRC Preparatory Group at the CSIR Conference Centre in Pretoria. The meeting discussed the various items on the agenda for the World Radio

(Continued on page 6)

(Amateur Radio News from page 5)

Conference WRC-27 which will be held from 11 to 15 October in Shanghai, China.

The SARL was resented full time by James Archibald, ZS6NS and part time on the first day by Hans van de Groenendaal, ZS6AKV. James will report back to SARL Science and Technology Work group next week as well as on next week's SARL News.

While WRC-27 does not include agenda items directly affecting amateur allocations it remains important to be vigilant on new services on adjacent bands which could cause interference.

At WRC-27 much attention will focus on science communication in particular with respect to communication on and around moon and support structures on the earth. South Africa has a particular interest as SANS will be supporting the US Artemis to the moon project. The issues are monthly concerned about protection against interference and mitigation.

The Second Africa Scout Moot 2026

The second Africa Scout Moot will be held from 1 to 8 August 2026 at Arrowe Park, 5 Ebenezer Street in Benoni hosted by Scouts SA and the Africa Region.

A Rover Moot is an international or regional gathering organized for young adults and leaders in Scouting, typically aged 18 to 25. Derived from an Old English word meaning "assembly," these events are designed to promote leadership development, outdoor adventure, and intercultural exchange. The concept functions similarly to a Scout Jamboree, but with distinct features geared toward young adults.

Amateur radio forms part of the programme for this Moot. The East Rand ARC, ZS6ERB will be active with ZS6ERB and mainly with ZS9YOTA on Sunday 2 and Monday 3 August from Arrowe Park. There will be 4 sessions over the two days from 09:00 to 21:00 CAT on both days.

The objective is to promote Amateur Radio as both a hobby and a service to the Rover Moot, a gathering of Rover Scouts from 35 countries coming to Arrowe Park. SARL Hamnet will also be demonstrating digital communications as part of the Community Service of their demonstration. We will allow Rovers to make radio contacts primarily

on HF across South Africa and on the QO-100 if available to countries covered by the satellite. Part of their activities will also take them to Soweto, where they will participate and learn about community service.

So, listen out for ZS9YOTA on Sunday 2 and Monday 3 August and make a QSO with the Rover Scouts at Arrowe Park.

TERA

Stu Phillips, K6TU has announced the public release of TERA (Terrain Evaluation for Radio Applications), a next-generation HF antenna terrain analysis tool for the amateur radio community. TERA is now available at no charge to registered users at https://k6tu.net. K6TU.NET is an online service for the amateur radio community. The platform has provided HF terrain analysis tools, antenna modelling support and propagation resources since 2012. The interactive deployment of TERA on K6TU.NET was made possible through a generous grant from the Northern California DX Foundation, which funded a significant upgrade to the compute infrastructure.

Working Groups and Coordinators

Amateur Radio Today: Hans van de Groenendaal, ZS6AKV artoday@sarl.org.za.
ART Relays: Louis Veldkamp, ZR4DJL and Andy Cairns, ZS6ADY
Awards: Tjerk Lammers, ZS1J
Contest WG: Johan Bezuidenhout, ZS6JBZ; Gerhard Coetzee; ZS3TG; Phillip van Tonder, ZS6PVT; Phillip Fischer, ZS6FY; Danie Schnetler, ZS6DPS
Database: Colin de Villiers, ZS6COL
Forum: Bradley Phillips, ZS5Z; Roger Conroy, ZR3RC and Andy Cairns, ZS6A
IARUIWS: Vacant
QSL Manager: Gert du Plessis, ZR6GRT
RAE and Training: Donovan van Loggerenberg, ZS2DL rae@sarl.org.za
Regulatory WG: Hans van de Groenendaal, ZS6AKV; Leon Lessing, ZS6LMG; James Archibald, ZS6NS and Peter Leonard, ZS5PL
Reno Faber Station: Philip van Tonder, ZS6PVT
Repeater Co-ordination:
SARL Beacon Project Manager: Brian Jacobs, ZS6YZ
SARL Hamnet: Brian Jacobs, ZS6YZ; Michael Taylor, ZS1MJT; Andrew Gray, ZS2G; Rickus de Lange, ZS4A; Keith Lowes, ZS5WFD; Gert Botha, ZS6GC and Leon Lessing, ZS6LMG
SARL/ICASA Liaison: Hans van de Groenendaal, ZS6AKV; Nico van Rensburg, ZS6QL and Colin de Villiers, ZS6COL
SARL News/SARL Nuus: Dennis Green, ZS4BS; Dave Reece, ZS1DFR; Rory Norton, ZS2BL; Andy Cairns, ZS6ADY; Vivian Dold, ZS6VD; Herman Erasmus, ZS6CTA; Paul Johnson, ZS1S; Irene Myburg, ZS6IEA; Deon Erwin, ZS1ZL; Christo de Witt, ZS3CDW, Hannes Enslin, ZS6JDE and Kevern Burger, ZR2BK
SARL VHF and Above Records: Paul Smit, ZS6NK
Swap Shop: Rassie Erasmus, ZS1YT
Youth/Jeug: Vacant

Radio ZS Awards

The Gary Immelman RA Heritage Award Floating Trophy awarded by the SARL Council for the best article of a historic nature describing an event that occurred more than five years previously or an interesting personality that has played an important part in the development of Amateur Radio in years gone by. Donated by Gary 1993.

The JJ Pienaar Trophy awarded by the Editor for the best article published in Radio ZS during the past year.

The Radio ZS Shield awarded by the Editor to a South African Radio League affiliated Club or member who best supported Radio ZS during the year. Donated by the Port Elizabeth Branch in 1966.

Radio ZS

Radio ZS is a forum for South African Radio League members to share their amateur radio experiments, experiences, opinions and news. Manuscripts with drawings and/or photos are always welcome and will be considered for publication. Articles on e-mail are especially welcome. Material may be submitted in MS Word, Open Office or rtf format, using Calibri 12 pt and English (South Africa). Material may be e-mailed to radiozs@sarl.org.za. The League cannot be responsible for loss or damage to any material. https://mysarl.org.za/radio-zs-archives/.

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Such approval shall not unreasonably be withheld. Material taken for other Member Societies' publications in this way shall have a source and originator acknowledgement included on publication.

SARL News Bulletins / SARL Nuus Bulletins

The South African Radio League, ZS6SRL broadcasts a news bulletin every Sunday in Afrikaans and English at 08:15 and 08:30 Central African Time respectively, on HF and various VHF and UHF repeaters around the country. The bulletin is relayed on EchoLink and AllStar Node 53511 by Johan, ZS6JPL. Audio bulletins can be downloaded from https://sarlnews.podbean.com, while the text bulletin is available at https://mysarl.org.za/sarl-news/.

We invite clubs and individuals to submit news items of interest to radio amateurs and shortwave listeners, in both English and Afrikaans where possible, by uploading the news item at https://mysarl.org.za/news-inbox/ and/or by sending items to news@sarl.org.za no later than Friday morning preceding the bulletin date.

You are welcome to join us every Sunday morning for the weekly radio programme Amateur Radio Today at 10:00 CAT. The programme can be heard on VHF and UHF repeaters countrywide and is relayed on 7 115 kHz lower sideband by Louie, ZR4DJL.

In Bloemfontein, you can listen on the 145,7625 MHz repeater at 08:15 and again at 10:00 CAT.

In Cape Town, you can listen at 10:30 CAT on the 145,700 MHz repeater, with EchoLink to ZS1DCC-R by Dave, ZS1DFR.

A rebroadcast by Andy, ZS6ADY, can be heard on Monday evenings at 19:30 CAT on 3 620 kHz.

The weekly SARL News Bulletins

Subscribe at
sarlcommunications+subscribe@groups.io
Get a copy https://mysarl.org.za/radio-zs-archives/

The weekly HF Happenings Newsletter

Subscribe at HFHappenings+subscribe@groups.io
Get a copy https://mysarl.org.za/hf-happenings/

Die Suid-Afrikaanse Radioliga, ZS6SRL saai elke Sondag 'n nuusbulletin uit in Afrikaans en Engels om onderskeidelik 08:15 en 08:30 Sentraal-Afrikaanse Tyd, op HF en verskeie VHF- en UHF-herhalers regoor die land. Die bulletin word deur Johan, ZS6JPL, op EchoLink en AllStar Node 53511 herlei. Oudio bulletins kan afgelaai word vanaf https://sarlnews.podbean.com, terwyl die teks bulletin beskikbaar is by https://mysarl.org.za/sarl-news/.

Ons nooi klubs en individue uit om nuusitems van belang vir radioamateurs en kortgolfluisteraars in te dien, waar moontlik in beide Engels en Afrikaans, deur die nuus item op te laai by https://mysarl.org.za/news-inbox/ en/of deur items na news@sarl.org.za te stuur nie later nie as Vrydagoggend voor die bulletin datum.

Jy is welkom om elke Sondagoggend by ons aan te sluit vir die weeklikse radioprogram Amateur Radio Today om 10:00 SAT. Die program kan landwyd op VHF- en UHF-herhalers gehoor word en word op die 7 115 kHz laer syband deur Louie, ZR4DJL, herlei.

In Bloemfontein kan jy om 08:15 en weer om 10:00 SAT op die 145,7625 MHz-herhaler luister.

In Kaapstad kan jy om 10:30 SAT op die 145,700 MHz-herhaler luister, met EchoLink na ZS1DCC-R deur Dave, ZS1DFR.

'n Heruitsending deur Andy, ZS6ADY, kan Maandagaande om 19:30 SAT op 3 620 kHz gehoor word.

Die weeklikse SARL Nuusbulletins

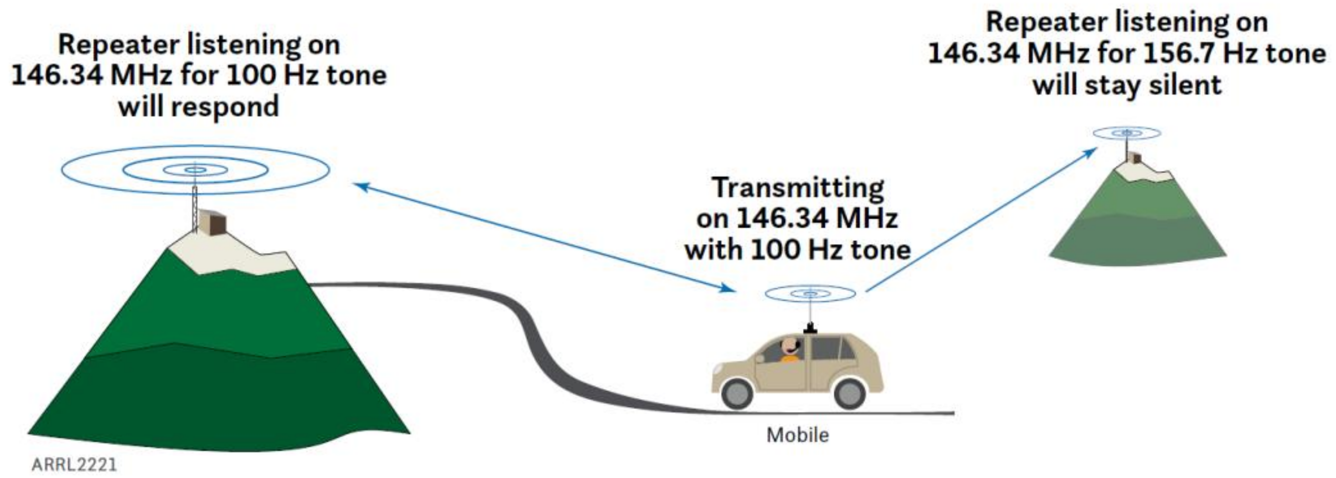
Teken in by
sarlcommunications+subscribe@groups.io
Kry 'n kopie https://mysarl.org.za/radio-zs-archives/

Die weeklikse HF Happenings Nuusbrief

Teken in by HFHappenings+subscribe@groups.io
Kry 'n kopie https://mysarl.org.za/hf-happenings/

Repeater Tones and How to Use Them

Scott Freeberg, WA9WFA First published in On the Air, March/April 2026



Though this mobile amateur is in a location where he could reach both repeaters that are listening on 146,340 MHz, he has programmed his radio to reach the repeater listening for a 100 Hz tone. (Now before you get your coax in a knot, amateurs in IARU Region 2 (the Americas) have access to 144 to 148 MHz, whereas we in IARU Region 1 have 144 to 146 MHz. Ed.)

Many of us have experienced the frustration of hearing a repeater but being unable to access it. The repeater seems to be happily repeating other stations, but it does not seem to hear you at all. Most likely, your signal is missing a special tone the repeater needs to hear before responding to your transmission — without the tone, you simply cannot get into the repeater.

Repeaters like this are utilising an interference reduction feature called Continuous Tone Controlled Squelch System, or CTCSS for short and while the feature name and abbreviation sound complicated, it is very easy to understand and implement.

About the Tones

The mysterious CTCSS tone is simply a low-frequency (67 Hz to 254,1 Hz) audio tone that is sent out with your transmission every time you press your radio's push-to-talk button. You may not hear it, these tones are very low in audio frequency and amplitude, but can be perceptible to the human ear. Thankfully, most repeaters filter out the tone from the voice audio. Otherwise, you might hear an annoying hum in the background when people are talking.

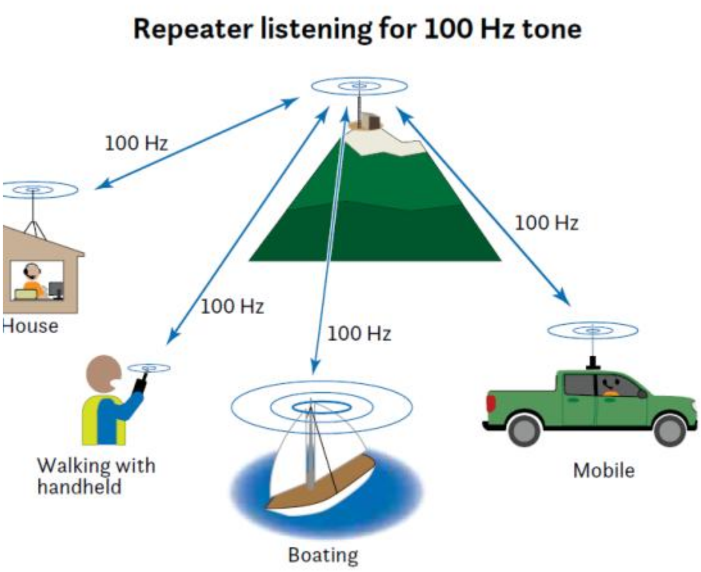
The tone's primary goal is to prevent stations from simultaneously activating (*keying up*, in amateur slang) multiple repeaters that are operating on the same frequency. Normally repeater frequencies are coordinated so that repeaters using the same frequency are located far away from each other. However, in certain propagation conditions, these distant repeaters may be able to hear each other and there may be a risk of more than one repeater being keyed up by users, resulting in confusion. But if CTCSS tones are required to access those repeaters — perhaps one uses a tone of 100 Hz, another uses 151,4 Hz and another uses 171,3 Hz — only the desired repeater will be keyed up.

How Tones Work

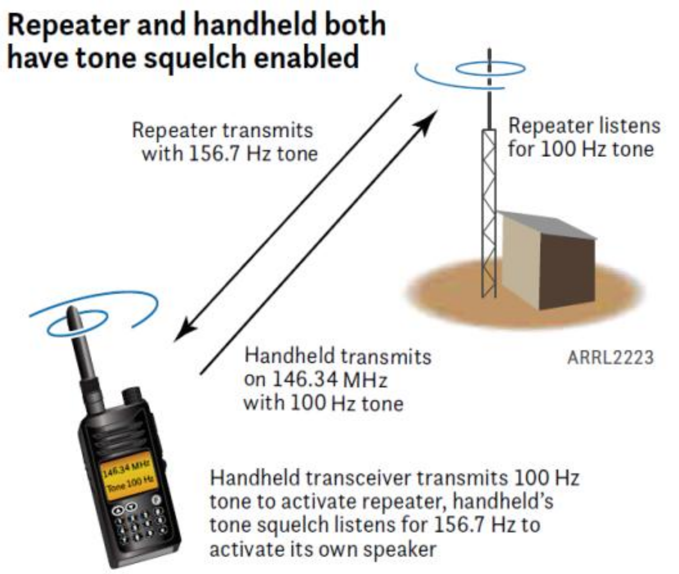
Repeaters have squelch circuits that keep your radio's speaker quiet when the repeater does not hear any signals. When an amateur transmits on the repeater input frequency with the correct tone, the repeater's receiver detects that signal and opens the squelch, signalling the repeater to start transmitting the signal it has heard - repeating it, as repeaters are meant to do. When that amateur stops transmitting, the squelch closes and the repeater transmitter turns off.

There are two types of repeater squelches — carrier-operated relay (COR) and CTCSS tone. When a repeater uses carrier-operated squelch, any FM signal the repeater "hears" on its input frequency will cause the squelch to open and the

(Continued on page 10)



Various repeater users, accessing a repeater that uses a 100 Hz tone



A handheld transceiver and a repeater, both using CTCSS tone squelch to reduce interference

(SARL Awards and Trophies from page 9)

transmitter to turn on. COR squelch allows any signal heard on the repeater's input frequency to be retransmitted. When CTCSS tone squelch is used, signals need to have the proper tone riding on the carrier for the repeater to respond. If there is no tone heard, the repeater will remain silent.

Many repeaters also transmit a tone on the same or a different frequency that your radio's tone squelch will use to turn on your radio's speaker only when the correct tone is heard. This feature comes in handy if you are hearing a distant repeater operating on the same frequency as your intended repeater during a propagation opening. Rather than have to listen to the other repeater, you can enable the receive tone squelch in your radio and only hear the repeater you want to listen for.

While a tone squelch prevents unintended repeater activation or key-up, it does not prevent interference when multiple signals are heard on the receiver input and one is transmitting the correct tone. The tone will hold the repeater open, so the receiver hears everything that is on the input. Once the signal with the proper tone stops transmitting, the repeater will shut off, regardless of other signals coming into the repeater.

Help with Programming Tones

There are 50 CTCSS tones for a repeater to choose from. Each radio manufacturer has its own specific memory channel programming technique and no two are alike. Consult your radio's user manual for the programming procedure and check YouTube for a "how-to" video on programming tones into your particular radio.

Basically, your radio will have you select an empty memory channel, then programme in the repeater's specific information, including repeater output frequency, the +/- transmit offset and the tone squelch frequency. If you are still unable to access the repeater after programming your radio with that information, consult your radio's manual to find out if the CTCSS tone generator needs to be enabled for that repeater memory channel.

Despite the scary name and abbreviation, repeater CTCSS is easy to implement, especially now that you have some background on what it is and how it works. Most modern transceivers and handhelds already have the tone generator built in, so you just have to find out which tone your repeater is using, program it into your radio's memory, enable the tone feature and then start using that repeater.

67,0	69,3	71,9	74,4	77,0	79,4	82,5	85,4	88,5	91,5
94,8	97,4	100,0	103,5	107,2	110,9	114,8	118,8	123,0	127,3
131,8	136,5	141,3	146,2	151,4	156,7	159,8	162,2	165,5	167,9
171,3	173,8	177,3	179,9	183,5	186,2	189,9	192,8	196,6	199,5
203,5	206,5	210,7	218,1	225,7	229,1	233,6	241,8	250,3	254,1

The IARU HF World Championship

https://www.arrl.org/iaru-hf-world-championship

Contest Objective

To support amateur self-training in radio communications including improving amateur operating skills, conducting technical investigations and intercommunicating with other amateurs around the world, especially IARU member society headquarters stations.

Contest Period: Second full weekend in July. Begins 12:00 UTC on Saturday 11 July and runs through to 11:59 UTC on Sunday 12 July. There is no operating time restriction for stations in any category.

Log Deadline: Upload your log at contest-log-submission.arrl.org no later than **SEVEN (7)** days after the contest is over at 11:59 UTC. Paper log forms are available at the IARU HF Championship web page.

Bands and Modes: Use only the 160, 80, 40, 20, 15 and 10 metres. Both phone and CW may be used. Contact stations only once per band and mode.

Categories: Single operator and Single operator unlimited stations in any power category can also enter as mixed-mode, CW-only, or phone-only. Multi-operator stations may only enter as mixed-mode. See the Special Rules and Entry Categories sections for details.

Contacts: All stations may contact any other station. Stations may be contacted once per band on each mode.

Exchange: All stations send a signal report and ITU zone. Headquarters stations operated by an IARU National Society send the abbreviation for their society instead of zone. (i.e. ZS0HQ sends SARL). Stations operated by the IARU Administrative Council and the three IARU regional Executive committees send “AC,” “R1,” ”R2” and “R3” as appropriate. A link to the ITU zone maps is at ITU Zone Map from EI8IC.

This is a typical contest contact:
CQing Station: CQ test from ZS3I
Answering Station: G3BJ
CQer: G3BJ 59 59 (*South Africa is in ITU Zone 59*)
Answer: 59 27
CQer: Thanks, CQ test from ZS3I

Or
CQing HQ Station: CQ TEST DE ZS9HQ
Answering Station: N1SFE
HQ station: N1SFE 599 SARL
Answer: 599 8
HQ station: TU ZS9HQ

As the answering station, it is not necessary to send the CQing station's call before the exchange unless you think there might be some confusion about which station you are responding to.

Scoring: The QSO point value of a contact depends on the location of the station — see the special scoring rules for complete information. To calculate your final score, multiply the total QSO points by the number of ITU zones and official IARU stations as described in the Special Rules.

Feedback about the contest: Send us your stories and photos! Tell us what fun you had, how you did and what challenges you faced at the ARRL Contest Programme’s “**Soapbox**” page. All contest queries should be directed to contests@arrl.org.

The rules allow for 12 stations using ZS9HQ at the same time during the contest - ZS9HQ CW 160; ZS9HQ SSB 160; ZS9HQ CW 80; ZS9HQ SSB 80; ZS9HQ CW 40; ZS9HQ SSB 40; ZS9HQ CW 20; ZS9HQ SSB 20; ZS9HQ CW 15 m; ZS9HQ SSB 15; ZS9HQ CW 10 m and ZS9HQ SSB 10 m.

The World Radio Sport Team Championship

The World Radio Sport Team Championship, known as WRTC will take place from 8 to 13 July 2026 in the East Anglia region of the United Kingdom. The 50 teams will be located in the counties of Suffolk, Norfolk and Cambridgeshire and they will participate in the 2026 IARU HF World Championship on 11 and 12 July. The call signs to be used by these stations will be drawn on Saturday morning 11 July.

Media Statement: BACAR-14 Skybridge launch date moved to 17 October 2026

The BACAR-14 Skybridge launch date has been moved from 10 October to Saturday 17 October 2026, weather permitting. (BACAR = BAlloon Carrying Amateur Radio)

The date change has been made to avoid a clash with the SARL Radio Amateur Examination test day for new amateur radio candidates on 10 October 2026. BACAR-14 fully supports the development of new radio amateurs and the revised date allows candidates, assessors, clubs and supporting radio amateurs to focus on the examination weekend without conflict.

BACAR-14 Skybridge is a high-altitude amateur radio balloon project focused on exploring how affordable, recoverable communications hardware can support SARL HAMNET, search-and-rescue and disaster communications from the stratosphere.

Project objective

The project objective is to test practical airborne communications support, including:

- 2 m APRS digipeater capability;
- 70 cm LoRa-APRS digipeater capability;
- crossband FM voice repeater capability between 2 m and 70 cm;
- ground-station participation and message relay;
- SSTV or SSDV "eye-in-the-sky" image transmission;
- tracking, recovery and post-flight data analysis; and
- lessons for future emergency communications deployments.

Call for community payload suggestions

BACAR-14 also invites the amateur radio and technical community to propose additional payloads, experiments and support systems that can add value to the mission without compromising safety, RF discipline or recovery.

A current example of a useful contribution is a dedicated 2 m APRS tracker payload. The project team has APRS and LoRa-APRS concepts in the plan, but a stand-alone 2 m APRS tracker payload is still required and would strengthen redundancy, tracking visibility and recovery support.

Suggested payload ideas may include communications experiments, telemetry sensors, camera systems, recovery aids, education payloads, ground-station tools, or other lightweight experiments suitable for a high-altitude balloon mission. Proposed payloads should include a short description, owner, expected mass, power source, frequency/mode if transmitting and what the payload will demonstrate.

High-level phase plan

The announcement phase has now been completed. The project will move through the following high-level phases:

(Continued on page 13)

Phase	Focus	High-level output
1	Brainstorm and RF selection	Refine the mission concept, confirm payload ideas, select RF modes/frequencies and agree on ground-station requirements.
2	Build and test	Build, bench-test and document payloads, trackers, digipeaters, image systems and ground-station equipment.
3	Integrated test and readiness	Test the payload train, RF systems, ground stations, tracking links and recovery arrangements together before launch.
4	Tune-up and travel	Complete final configuration, packing, launch logistics, weather monitoring, flight prediction and participant instructions.
5	Launch	Launch BACAR-14 Skybridge on Saturday 17 October 2026, weather permitting.

(BACAR-14 from page 12)

AMSAT SA webinar

A detailed BACAR-14 presentation will also be shared during the AMSAT SA webinar on Saturday 1 August 2026. The presentation will cover the mission background, payload concepts, RF plan, participant roles, preparation timeline and the areas where community participation is requested.

Invitation to participate

BACAR-14 invites amateur radio operators, ground-station builders, experimenters, students and communications volunteers to participate in the project, receive transmissions, test equipment and contribute to the learning around resilient emergency communications.

Further updates, technical details and participant guidance will be communicated as the project progresses toward the 17 October launch date.

Issued by

BACAR-14 Skybridge Project Team
Contact: Christo Kriek, ZR6LJK by e-mail at christo.kriek@live.co.za use subject BACAR and/or by WhatsApp only please to 082 907 9685.

Open sleeve vertical antenna as an add-on for a multiband vertical antenna

Daniel Romila, VE7LCG

With several small components bought from amazon.com, aliexpress.com and many other sites, one can make a multi-band vertical antenna.

In the set there is a 5,6 metres telescopic antenna (I had the surprise in a newer set to be 6,2 metres long!), a fixed pointed cylindrical metal piece and a red cylinder in which is screwed on the upper side (M10) the telescopic antenna, on the lower side (M10) it is screwed the part that will enter into the soil/ ground and on 90 degrees it is installed a big cable connector (SO-239, female UHF) for the antenna's cable. Some kits also have radials.

You can see the assembled vertical antenna in the hand of AA3K. He posted a YouTube video about at https://www.youtube.com/watch?v=h4EdM7GJxUw. You can see LB0FI pushing the assemble into the ground in his garden and/or in a park, as it would be used for POTA https://www.youtube.com/watch?v=whaL-ricSSw.

This vertical antenna will work OK for frequencies in the 10 to 54 MHz range. It is possible to adapt it with fixed coils or with an adjustable coil for lower frequencies, but this would continuously require modifying the antenna for various radio bands.

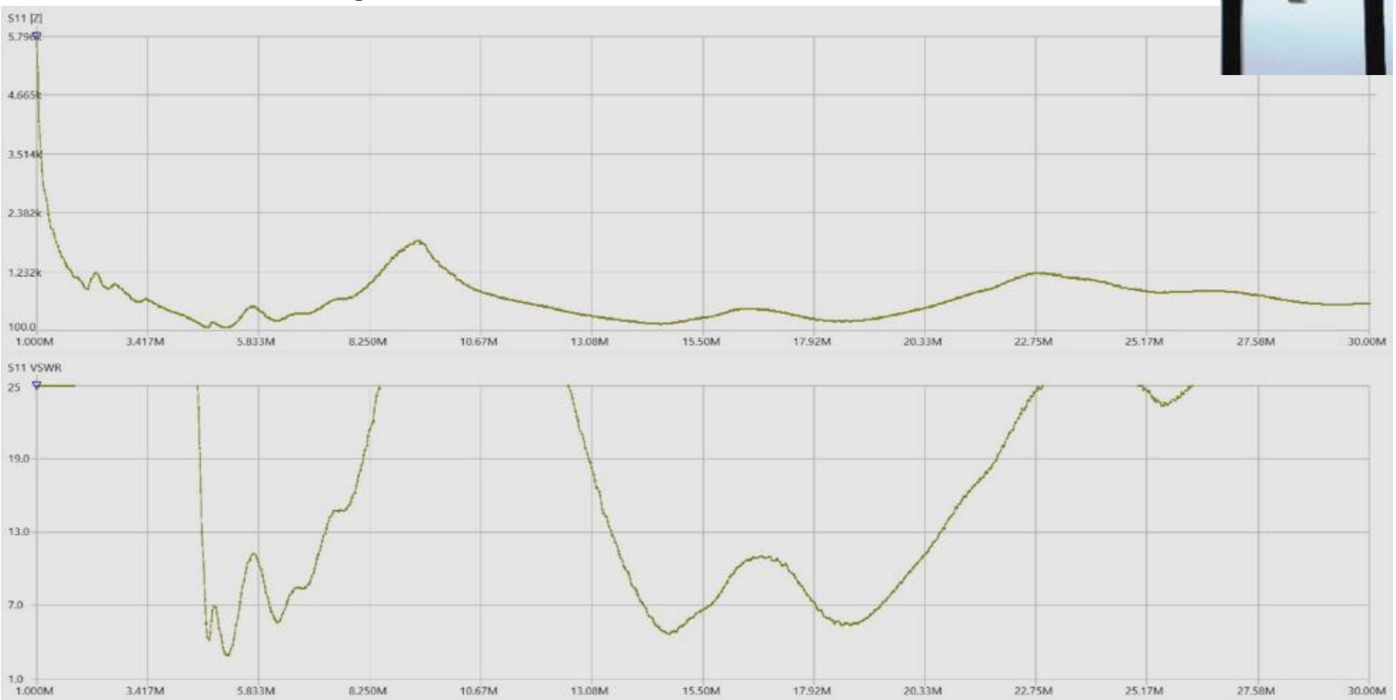
From the operation point of view, the easiest antenna to use would be an antenna that can be tuned in an as large as possible span of frequencies, no switching, no modification – no

(Open sleeve vertical antenna from page 14)

Such a vertical antenna can also be installed on a balcony rail/patio rail

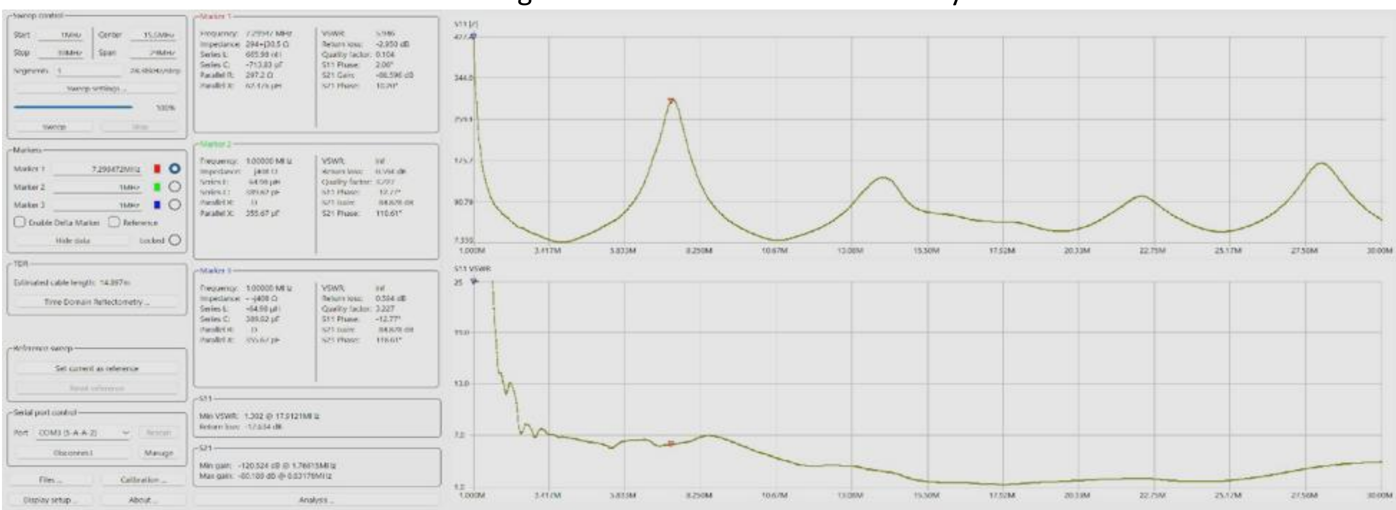
touching. But let us measure first with a NanoVNA what kind of antenna characteristics we obtained for the simple whip/telescope screwed into the red connecting cylinder and pushed into the ground (eventually with radials or having a patio/balcony rail as radial).

I obtained the following:



This does not look great at all. In my case, having a Yaesu FT-710 transceiver, the impedances for various bands of frequencies that the internal auto tuner can handle would be nicer if they would be ¼ from what it is shown in the above graphic. I use a 4:1 balun, an autotransformer having only 2 spirals (explanation down the text!), with a tap at 1 spiral for the antenna coax cable. The ratio of the spirals is 2:1 primary/secondary and the ratio of the transformation of the impedances is 4:1 (the square of spirals ratio).

I measured again with NanoVNA v2, after the balun and the cable, because exactly at the entrance of the transceiver is where I am interesting to find out the whole antenna system characteristics.

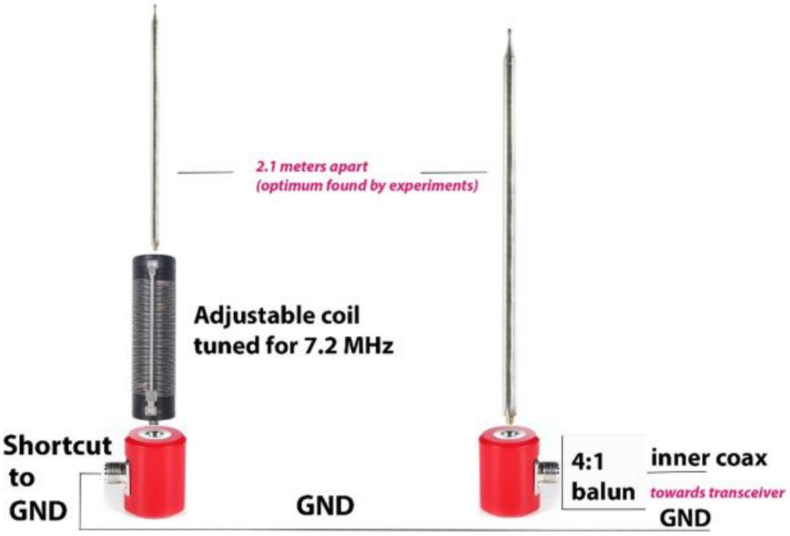


In the 40-metre band the SWR is almost 6. This is just a little too much for my Yaesu FT-710 transceiver to tune. The Yaesu specification says I can tune even an antenna with 5:1 bad SWR and it practically works above this limit, but 6 is not a safe value.

(Continued on page 16)

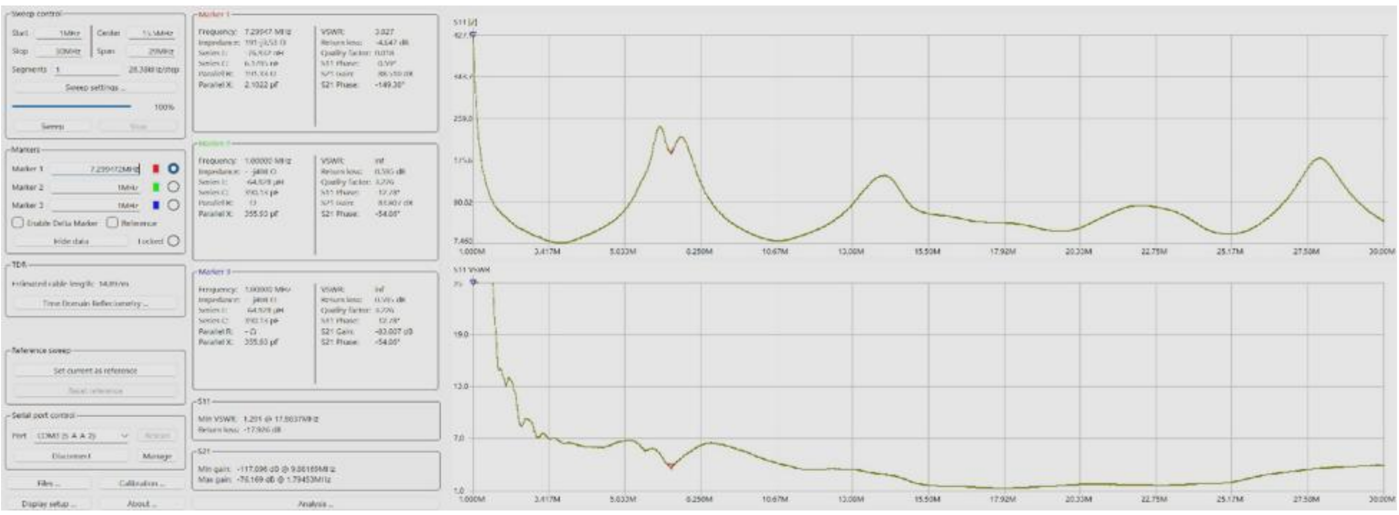
(Open sleeve vertical antenna from page 15)

The idea was to make the following system, by adding a passive open sleeve antenna, compose from a 5,6 metres telescope, an adjustable coil and the connecting red cylinder. There is no second cable for a second antenna, since I wanted everything to be as simple as possible, one antenna directly into the transceiver, no switch.



The open sleeve antenna's connector should be shortcut to the ground. Forgetting to do the shortcut will make the system not to work. Verified, measured … it does not work.

The result:



As you see, the presence of the open sleeve second antenna created a downing in the SWR value for the 40-metre band.

Observations

Many people buy already made baluns and they do not design and build them themselves. Nothing wrong with that, if it matches your needs. Already made baluns usually have complicated configurations, not simple auto transformers. Most probably your real configuration of the antenna, GND, connector to the antenna will shortcut parts of the balun and in the end, you will get anyhow at an auto transformer, with very different characteristics than what it was initially designed by the manufacturer.

There is a temptation to put many spirals. I tested many configurations. A lot of trial and error. According to my results, the more spirals a balun has, the more chances there are that that balun will start to resonate at various frequencies and those resonances (unwanted) will compromise and even

(Continued on page 17)

(Open sleeve vertical antenna from page 16)

damage your transceiver (high voltages thrown back to the transceiver's antenna connector).

Yaesu FT7-10 almost did not need an open sleeve antenna. The internal auto tuner was capable of tuning in all 40 metre band, with some high values (for my taste, that is above 2!) on some frequencies. If you have a different transceiver, a different environment where you place your telescopic antenna, you might need to place the open sleeve antenna a little closer than 2.1 metres away from the main vertical telescopic antenna. A comparison between the Yaesu FT-710 internal auto tuner and ICOM IC-7300 internal auto tuner can be found at https://www.youtube.com/watch?v=C8lrZsX3WyQ.

The Amateur's Code

CONSIDERATE…

Never knowingly operates in such a way as to lessen the pleasure of others.

LOYAL…

offers loyalty, encouragement and support to other amateurs, local clubs and the South African Radio League, through which Amateur Radio in South Africa is represented nationally and internationally.

PROGRESSIVE…

with knowledge abreast of science, a well-built and efficient station and operation above reproach.

FRIENDLY…

slow and patient operating when requested; friendly advice and counsel to the beginner; kindly assistance, cooperation and consideration for the interests of others. These are the hallmarks of the amateur spirit.

BALANCED…

radio is an avocation, never interfering with duties owed to family, job, school or community.

PATRIOTIC…

station and skill always ready for service to country and community.

Die Amateur se Kode

BEDAGSAAM...

Die amateur is 'n ware heer. Hy sal nooit bewustelik of moedswillig die radiogolwe op so 'n wyse vir sy eie genot aanwend om daardeur die genot vir ander te bederf nie.

LOJAAL...

Die Amateur is lojaal teenoor die Suid-Afrikaanse Radioliga en bied sy ondersteuning aan. Hy lê hom neer by die onderneming wat die SARL aan die owerheid beloof het.

PROGRESSIEF...

Die Amateur is progressief en sy stasie is in tred met die wetenskap. Sy bedienings praktyk is netjies en ordelik.

VRIENDELIK...

Die Amateur is vriendelik en verdraagsaam wanneer aan hom 'n versoek gerig word. Hy verstrek geredelik raad aan alle amateurs en verleen hulp en samewerking in die gees van amateur radio.

EWEWIGTIG...

Die Amateur is ewewigtig en laat nie toe dat sy stokperdjie met sy gesinslewe, werk of gemeenskap inmeng nie.

PATRIOTIES...

Die Amateur is patrioties, sy kennis en stasie is altyd vir sy land en gemeenskap beskikbaar.

A Personal Space Weather Station (PSWS)

Stewart Clark, ZR1WT

What is a PSWS and what can it do?

“Space weather” describes how the Sun interacts with Earth - solar flares, geomagnetic storms and the resulting effects on the ionosphere. As radio amateurs we experience this directly every time a band opens or suddenly dies. With relatively simple, low-cost equipment, we can move beyond casual observation and actually collect meaningful data about these effects.

Instead of just asking "why is 20m dead today?" a PSWS lets you start answering: is it D-layer absorption, is the F-layer moving, or is there geomagnetic activity - and you can record and analyse this over time.

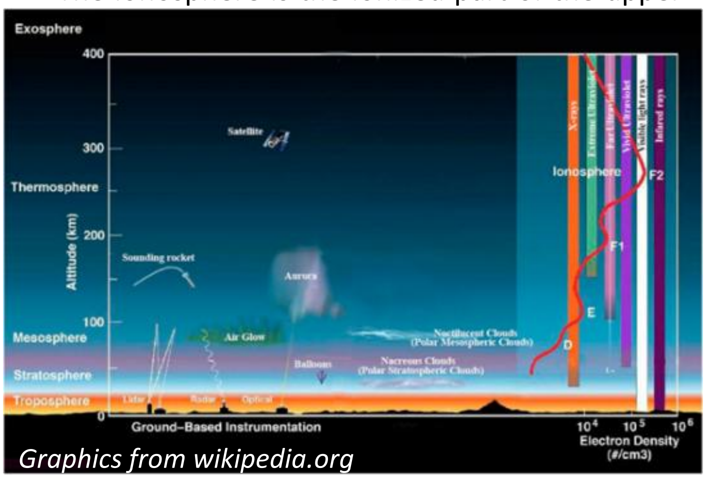
A PSWS typically consists of four components, each looking at a different part of the system. Together they give a layered view of space weather: VLF watches the D-layer, HF Doppler tracks F-layer dynamics, WSPR shows overall propagation and a magnetometer measures the geomagnetic driver itself.

For example, when a solar flare occurs: VLF shows an immediate disturbance, HF Doppler shows a shift in path length and WSPR shows band degradation. When a geomagnetic storm arrives: the magnetometer shows strong activity, HF propagation becomes unstable and WSPR paths become erratic.

Best of all, a PSWS can be built with affordable, off-the-shelf components widely available to South African amateurs. For example, Raspberry Pi, RTL-SDR and PNI RM3100 sensor (Magnetometer).

Summary of the various layers in the Atmosphere

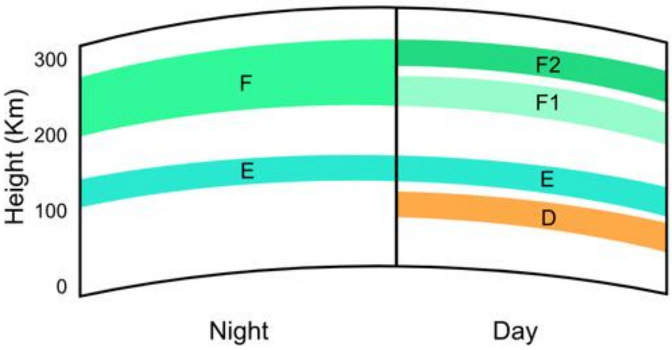
The ionosphere is the ionized part of the upper



Graphics from wikipedia.org

atmosphere of Earth, from about 50 to 800 km above sea level, a region that includes the thermosphere and parts of the mesosphere and exosphere. The ionosphere is ionized by solar radiation.

At night the F layer is the only layer of significant ionization present, while the ionization in the E and D layers is extremely low. During the day, the D and E layers become much more heavily ionized, as does the F layer, which develops an additional, weaker region of ionization known as the F1 layer. The F2 layer persists by day and night and is the main region responsible for the refraction and reflection of radio waves.



The four components of a PSWS

1. HF Doppler Monitoring (GRAPE)

A GRAPE-style receiver monitors very stable HF transmitters such as WWV, WWVH and CHU (the latter discontinued in June 2026). These stations transmit extremely accurate carriers. If the ionosphere were perfectly stable, the received frequency would stay constant - but the ionosphere is constantly expanding, contracting and shifting, which changes the effective path length and produces a tiny Doppler shift on the received carrier.

This is a phase-coherent measurement, detecting changes corresponding to just metres of path change over thousands of kilometres. By tracking the Doppler shift, we can detect travelling ionospheric disturbances, solar flare effects and wave-like structures moving through the ionosphere.

It is important to note that precision Doppler

(Continued on page 19)

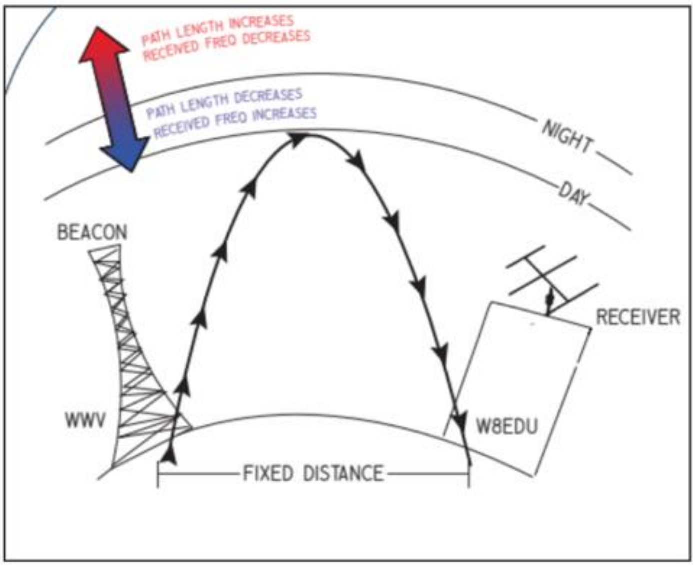


Figure 1. A simplified illustration of the relationship between rate of change in ionospheric layer height and received frequency shift. Precision frequency standards are required at both beacon and receiver to make an effective comparison. Frequency variation is generally on the order of ±1 Hz. Multi-hop propagation (multiple reflections between ionosphere and ground), Pedersen modes (internal ionospheric reflections), asymmetric paths and other factors impacting path length are not shown. Reproduced from [Collins et al. (2022)](#).

measurements require excellent frequency stability. A GPS-disciplined oscillator (GPSDO) is therefore highly recommended for both the beacon and receiving station.

The catch for South Africa: WWV, WWVH and CHU are all in North America or Hawaii. From here the signals arrive via long, multi-hop paths and are often weak, unstable and subject to heavy fading - not reliable enough for continuous precision Doppler work.

In South Africa, we can possibly use the ZS6DN located in Vereeniging (grid square KG33xi) which is part of the IARU/NCDXF International Beacon Project (IBP). It is a multi-band HF propagation beacon transmitting on the standard IBP frequencies: 14,100 MHz (20 m), 18,110 MHz (17 m), 21,150 MHz (15 m), 24,930 MHz (12 m) and 28,200 MHz (10 m).

The beacon should be roughly 600 – 800 km from the GRAPE receiver. The ZS6DN beacon is ideal for PSWS located outside Gauteng, e.g. in the Cape, KZN, Limpopo, etc. However, for a PSWS located in Gauteng, there could be a collaborative project for few remote amateur buddies to build their own GPS-disciplined HF beacons and GRAPE receivers, with each monitoring each other's distant beacon. A simple low-power carrier (5 – 20 W), locked to a GPSDO, gives a known, stable signal over a controlled path.

(Before building that beacon, read the article on page 22. Ed.)

(Continued on page 20)

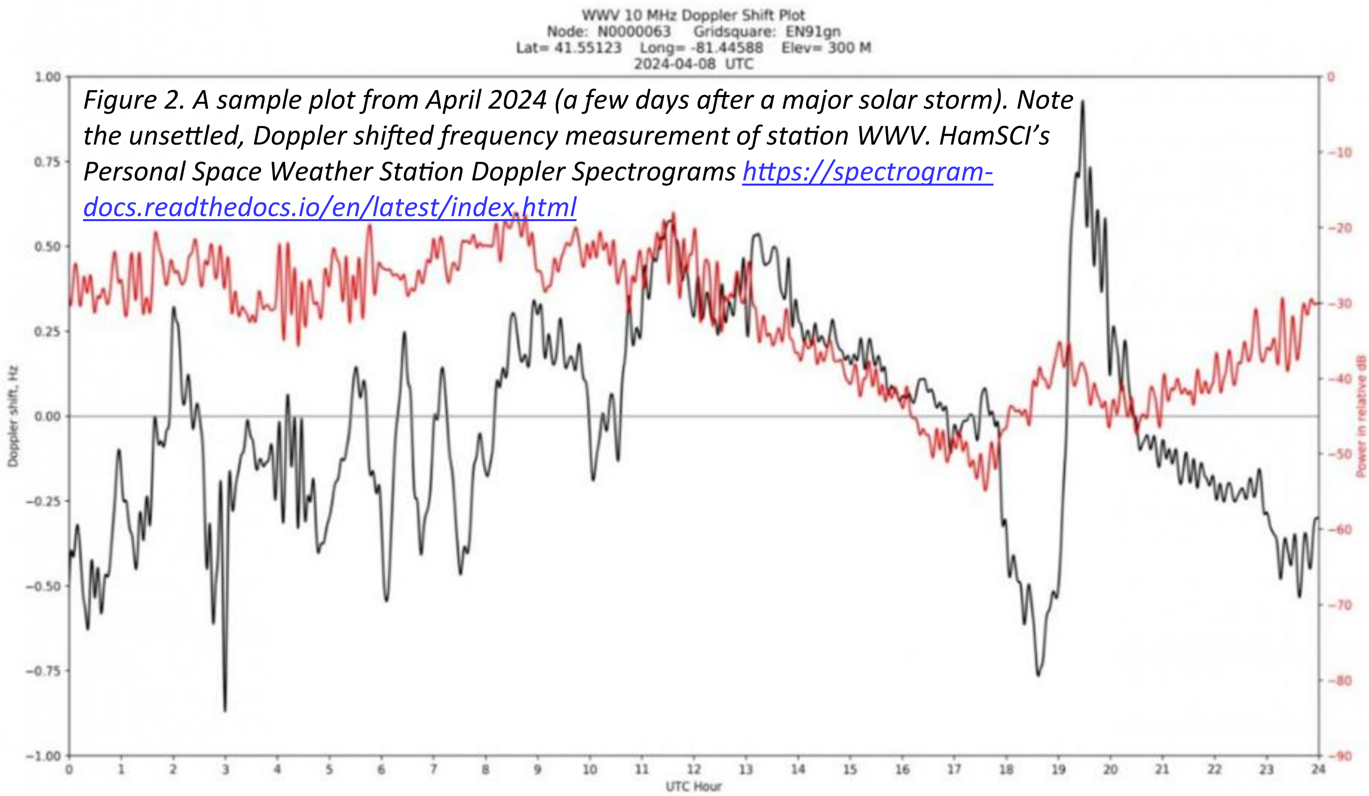


Figure 2. A sample plot from April 2024 (a few days after a major solar storm). Note the unsettled, Doppler shifted frequency measurement of station WWV. HamSCI's Personal Space Weather Station Doppler Spectrograms https://spectrogram-docs.readthedocs.io/en/latest/index.html

(The PSWS from page 19)

2. WSPR Monitoring

The second component uses the WSPR system, which many of you already run. It gives a completely different type of data: signal-to-noise ratio, frequency drift and which paths are open or closed.

Unlike GRAPE, which is very precise but along a single path, WSPR is global, distributed and statistical - it shows what is happening across the entire ionosphere, not just along one path. For example, a sudden drop in WSPR activity across a band can indicate increased D-layer absorption and changes in reported frequencies can hint at ionospheric motion. It is less precise than Doppler, but far broader in coverage.

3. Ground Magnetometer

The third component is a ground-based magnetometer, measuring tiny changes in the Earth's magnetic field - typically in the nanotesla range.

This matters because space weather is ultimately driven by the interaction between the solar wind and Earth's magnetosphere. When a geomagnetic storm hits, currents flow in the upper atmosphere, magnetic fields fluctuate and your magnetometer picks this up directly. This is different from the previous two systems: GRAPE and WSPR measure effects in the ionosphere, while a magnetometer measures the underlying driver.

4. VLF Receivers

The fourth component is a VLF (very low frequency) receiver, operating in the 3 – 30 kHz range and monitoring powerful transmitters or natural signals. VLF signals reflect off the D-layer, the lowest part of the ionosphere, which reacts very quickly to solar radiation. A VLF receiver can detect solar flares almost instantly, sudden ionospheric disturbances and day-night transitions - it is often the earliest warning system in your station.

Best VLF transmitters for South Africa

From Southern Africa, you sit in a good global VLF "window" between the North Atlantic (USA/ Europe), Europe and the Indian Ocean/Asia region (weaker but present).

Tier 1 (strongest, most reliable):

- **DHO38 (Germany), ~23,4 kHz** - one of the best VLF signals globally, excellent for SID detection. Reception in George/JHB: very strong by day, extremely strong at night.
- **US Navy transmitters (Cutler/NW networks), ~24 – 26 kHz** (varies by schedule). Reception: George strong to very strong, JHB strong.
- **Indian Navy VLF (INS Kattabomman region), ~18 – 25 kHz** (varies). Reception: Western Cape and Johannesburg, moderate to strong.

Tier 2 (regional / condition-dependent):

- **Russian VLF network, 15 – 30 kHz** (multiple transmitters). Reception: Western Cape moderate (often better at night), Johannesburg moderate.

Putting It All Together

The true strength of a Personal Space Weather Station emerges when all four instruments operate together.

Consider a solar flare:

- VLF immediately detects a D-layer disturbance
- HF Doppler measurements show path-length changes
- WSPR reports degraded propagation

Or consider a geomagnetic storm:

- The magnetometer records magnetic activity
- HF Doppler measurements become unstable
- WSPR paths become erratic

Each instrument monitors a different layer of the system:

- VLF → D-layer response
- HF Doppler → F-layer dynamics
- WSPR → overall propagation conditions

(Continued on page 21)

Sensor	Best for	Typical sampling
GRAPE HF Doppler	Rapid ionospheric motion and disturbance	1–10 s
WSPR	HF propagation quality over many paths	2 min
Magnetometer	Geomagnetic storms and substorms	1–10 s
VLF	D-region ionosphere and sudden ionospheric disturbances	1 s or faster

(The PSWS from page 20)

- Magnetometer → geomagnetic activity

Together they provide a layered view of the Sun-Earth environment.

Instead of simply knowing that propagation has changed, you begin to understand why it has changed.

User Interface

Using, for example, a Raspberry Pi 4/5 as the central collector and dashboard host.

Python services ingest data from each sensor and write to a local time-series database, for example **InfluxDB**. The following data will be collected and stored with a NTP or GPS timestamps. Accurate timestamps are critical to the data analysis.

Inputs

1. HF Doppler (GRAPE) (Frequency shift of a stable HF carrier path)
2. WSPR monitor (Decodes spots and extracts SNR, drift, distance and path availability)
3. Ground magnetometer (Measures local geomagnetic field variations (H, D, Z or total field))
4. VLF receiver (Monitors amplitude/phase of VLF transmitters)

For the presentation, **Grafana** will provide a polished local web UI. InfluxDB is a good fit on a Pi. But if you are already know/prefer SQL, maybe start with SQLite + Grafana SQLite Plugin. It gets you operational quickly, lets you leverage your SQL knowledge and avoids learning a new database ecosystem. If the project grows substantially later, the schema and SQL concepts transfer easily to MariaDB or a time-series database.

PSWS low-cost construction suggestions

One of the attractions of the PSWS concept is that it can be assembled almost entirely from inexpensive, readily available components. A realistic PSWS could be built up in stages:

WSPR receiver - easy and many amateurs already run this.

VLF receiver - a simple wire antenna feeding a SDR capable of 3kHx to 30kHz (eg SDR Play)

Magnetometer - increasingly available as DIY modules, such as the PNI RM3100 magneto-inductive sensor

Doppler monitoring – require an SDR that can be stabilized with a GPSDO (e.g., Pluto SDR, HackRF, LimeSDR etc)

Along with PSWS Receiver, a remote **GPS stabilized beacon** is required as the source. If there is not a beacon at a suitable distance from your PSWS, a GPSDO can be set up with a small RF Power Amp at the QTH of an amateur buddy.

In a future article, I intend to detail the exact constructional steps in implementing a working PSWS, which will be based on my own research and experience.

Useful Links

HamSCI Approach to PSWS https://hamsci.org/psws-overview

HF WSPR Daemon Receiver https://github.com/HamSCI/PSWS_Documentation/wiki/HF-wsprdaemon-Receiver

WSPRDaemon SDR - Overview, Specifications, Sourcing https://hamsci.org/wsprdaemon-sdr-overview-specifications-sourcing

HamSCI Grape v1 Personal Space Weather Station Plotting Tools https://pypi.org/project/hamsci-psws/?utm_source=chatgpt.com#files

HF beacon list https://hfbeacons.wordpress.com/wp-content/uploads/2026/05/iaru-hf-beacon-list-21-may-2026.pdf (from https://hfbeacons.wordpress.com/hf-beacons/)

IBP Beacons https://www.ncdxf.org/beacon/beaconlocations.html

Transmission Schedule https://www.ncdxf.org/beacon/index.html

Where to get certain components (for those eager to get started)

Raspberry-Pi https://www.pishop.co.za/store/raspberry-pi-boards

3-Axis Magnetometer Breakout Board https://www.robotics.org.za/; https://www.giga.co.za; https://www.aliexpress.com/item/1005006411162519.html

SDRs https://www.giga.co.za/ocart/index.php?route=product/search&search=SDR

GPSDO https://radiowinkel.co.za/product/progrock2-programmable-crystal/

See https://qrp-labs.com/progrock2.html for detailed description

IARU Region 1 HF Beacons - a Guide to Good Practice

REC/96/TVI/C4.10

Beacon transmissions have long been used as guides to the presence of HF openings and have contributed significantly to our knowledge of propagation. However, the number of HF beacons is steadily increasing and the amount of spectrum available is under pressure. It is more important than ever that beacon operators are aware of the technical parameters required, the reasons for them and the procedure to be followed to obtain an agreed frequency. This is particularly important in respect of bands with narrow beacon allocations.

It is not the intention of this document to prescribe the exact purpose of any beacon, its power level or the number of beacons in any country. It is also not intended to be applied rigorously to experimental or special-purpose beacons. It should, however, apply to the vast majority of HF beacons for propagation monitoring.

1. Coordination Procedure

The beacon proposal should be agreed within the national society (with consultation with neighbouring societies where appropriate) and a provisional frequency chosen. The proposed frequency should be submitted to the IARU regional HF beacon coordinator to check for potential interference problems.

2. Transmission Mode

In the interests of spectrum economy the preferred transmission mode at HF is A1a CW. If F1a is used the shift should not exceed 250 Hz, with MARK on the nominal frequency and SPACE on the lower. Care must be taken to ensure that the transmission has the lowest possible levels of spurious signals, key clicks and phase noise.

3. Frequency Accuracy and Spacing

All beacons should operate within the IARU-designated sub-bands. Additionally, solo beacons should avoid frequencies assigned by the IARU to frequency-sharing networks. Frequencies are currently assigned either on an exact kHz (e.g. 28 205.0) or a half kHz (e.g. 28 205.5). (However, if beacon numbers continue to grow 100 Hz spacing may be introduced.) Beacons should normally be capable of operating within +/- 25 Hz of their nominal frequency.

4. Message

As beacons are often heard at very low signal levels, often among spurious signals, it is important that their message be simple, unambiguous and repeated frequently. It is also necessary to have a short period of carrier for frequency checking and strength measurement purposes, and to make it easy to distinguish the mark frequency where FSK is used.

The message should therefore consist of 5 - 10 seconds of carrier followed by the call sign and (if required) the grid locator at 10 - 12 words per minute. Nothing more. No gaps in transmission.

5. Power

To avoid inefficient use of spectrum and presenting an unduly pessimistic impression of propagation conditions a minimum [maximum] power of 10 watts E.R.P. is recommended at HF. Other than this there are no recommendations as to power or antennas other than suitability for purpose and the need to minimise interference.

6. Operation

Operation should be 24-hour continuous. (This does not preclude beacons that switch to different frequencies or beam headings on a regular basis.)

Beacon operators must try to ensure that the operational parameters of their beacons remain as stable as possible and that non-operational time is kept to a minimum.

7. Status

It is important that the operational parameters and status of all beacons be widely known. This information should be sent to the Region 1 HF beacon coordinator via the local beacon coordinator or spectrum manager at least once a year or whenever the operational parameters are changed.

(Continued on page 23)

(HF Beacons - a Guide to Good Practicefrom page 22)

Beacons on Bands Below 14 MHz

The amateur beacon service has for many years provided a valuable role in offering amateurs and short-wave listeners indicators of the availability of particular paths and a base for propagation studies. In recognition of this, certain frequencies are reserved for beacons in the IARU band plan for the bands between 14 and 28 MHz.

No such allocations are made for bands below 14 MHz, with the exception of 7 MHz in sub-equatorial Africa, where special circumstances apply. However, the general view of national societies in IARU Region 1 is that beacons in continuous unattended operation on bands between 1,8 and 10 MHz are unnecessary and, even where they run low power, they can be a cause of harmful interference to normal operating and of annoyance to operators on these bands.

In recent years a number of beacons have started operation on these bands. They have no clearly defined purpose and are not part of any coordinated programme of development. The bands concerned are fully occupied and their propagation characteristics are already very well established and fairly predictable.

This matter was discussed at the 2005 Conference of IARU Region 1, which adopted a motion from the Danish national society, EDR, that beacon operation on 7 and 10 MHz was 'discouraged.' This is now the official policy of IARU Region 1. Member societies are requested to use their best efforts to ensure it prevails. Individuals are strongly urged to refrain from reporting the signals of unauthorised beacons or spotting them on the web cluster.

The exception to this general rule is for beacons used in connection with a propagation research project endorsed by the relevant national society and the HF beacon coordinator and subject to review by the subsequent triennial regional conference. Normally any such project would be for a limited period.

The conference agreed an exception to the general rule, in the case of DK0WCY's transmissions on 3,5 and 10 MHz. There is a possibility of extending the DK0WCY service by time-sharing its frequencies to provide (say) near-real-time MUF data from other locations. Anyone wishing to explore the possibility of such a development should contact the DK0WCY team leader), Ulrich, DK4VW.

While the decision of the conference did not specifically refer to 1,8 and 3,5 MHz, my personal understanding is that beacon operation should also be discouraged on those bands. An earlier Region 1 resolution stated that long-running beacons should not be established on 137 kHz.

If you are interested in designing or operating beacons, there are other possibilities on other bands. In particular:

(1) The construction of beacons for countries which are not currently covered and where local operators are not in a position to build a beacon.

(2) Beacons that share a frequency (similar to the existing IBP/NCDXF network), thus economising spectrum.

(3) Designing and constructing more technically advanced beacons to replace an earlier generation of beacons. We should always recognize that there are already many beacons, our frequencies are limited. Accordingly, we have always to ask ourselves, before beginning a new project, what is its purpose and what will it add to our hobby.

It is recommended that HF Beacons may be established on the 1,8; 3,5 and 7 MHz band in the regions of Africa south of the Equator. (REC/99/LH/C4.1 - Lillehammer 1999)

If you want to operate a HF beacon in South Africa, please provide the HF Beacon Coordinator with the following information: permission from the SARL HF Manager, the beacon frequency and call sign, QTH and grid square, the power output, the antenna and antenna direction, and the mode and hours of operation.

Contact the Region 1 HF Beacon Coordinator, Dennis Green, ZS4BS on e-mail hf_beacon@iaru-r1.org.

Got the Time?

Rich Moseson, W2VU

First published in On the Air, March/April 2026

The ways in which amateurs note time can be confusing. Here is some background to help you make sense of things when amateurs talk about UTC, GMT and Zulu (spoiler alert: they all mean the same thing!)

The British Royal Observatory in Greenwich, England, was the first source of accurate time information for mariners and is the home of Greenwich Mean Time, or GMT.

Accurate timekeeping is important to amateurs, from scheduling nets on repeaters or knowing when a satellite will come into view, to confirming contacts with fellow amateurs halfway around the world. The worldwide reach of amateur radio makes keeping track of time more complicated than looking at our phones or watches.

For local activities, such as scheduling a Club meeting or a net on a repeater, using local time is fine, although amateurs often use 24-hour, or military time, to avoid AM/PM confusion. For example, if a net is scheduled at 21:00 hours, or 9:00 PM, you will not accidentally show up at 9:00 AM, or 09:00 hours.

Things get a little more complicated when you are operating on the HF bands or making satellite contacts, as it is likely you will be communicating with people in different time zones. To avoid confusion, amateurs use a worldwide time system called Coordinated Universal Time, which is abbreviated as UTC (a compromise between the English and French abbreviations). It is based on the time at the zero-degree longitude meridian separating the eastern and western hemispheres (the prime meridian). Britain's Royal Observatory in Greenwich, England is built directly on the prime meridian and has been a centre of astronomy, navigation and timekeeping for centuries.

Greenwich time became a worldwide standard and some old-timers in amateur radio still refer to UTC as GMT, or Greenwich Mean Time (*mean* meaning the average of local times across a given time zone).

And then there is Z, or Zulu, which is often used as a shorthand for UTC, especially in print. That came from a map called the "Standard Time Zone Chart of the World" that was originally produced by the US military. On that map, time zones were identified by letter, starting with "A" one zone east of the prime meridian and continuing east to "M" at the International Date Line, then starting over again at the prime meridian, going west from zones "N" through "Y." The Greenwich time zone itself, centred on the zero meridian of longitude, was designated zone "Z." When spoken rather than

(Continued on page 25)

(Got the time from page 24)

written, this time zone is referred to as "Zulu," which is the word substitute for "Z" in the phonetic alphabet.

But What Time Is It?

Now that we know what all the abbreviations stand for — and that they all basically stand for the same thing, how do we use this knowledge to figure out what time it is in Paris when it is 9:00 PM on your clock? The beauty of UTC is that it doesn't matter. All you need to know is how to translate your local time into UTC. When the amateur in Paris does the same thing for local time there, you will both be "speaking the same language," timewise. Here is the key.

All of the continental US is west of the prime meridian and since the Earth rotates from east to west, it is always earlier here than it is in Greenwich. So we add hours to our local time to arrive at UTC. For example, Newington, Connecticut, is in the US Eastern time zone, which is 5 time zones west of Greenwich. So, when it is 7:00 AM in Newington, add 5 hours and you will find that it is 12:00 noon UTC.

When it is 7:00 AM in Chicago (in the US Central time zone), UTC is 6 hours later, so it is 1:00 PM or 13:00 UTC.

Note that UTC does not change for Daylight Saving Time, so when DST is in effect, we have to shift our calculations backwards by an hour. Eastern Daylight Time is 4 hours behind UTC instead of 5 (12:00 UTC is 8 AM EDT) and Central Daylight Time is UTC -5 instead of -6 (making 12:00 UTC 7 AM CDT).

One other thing to remember — evening times in the US are frequently early the next day in Europe. So 10:00 PM Monday EDT (UTC-4) is 02:00 Tuesday UTC.

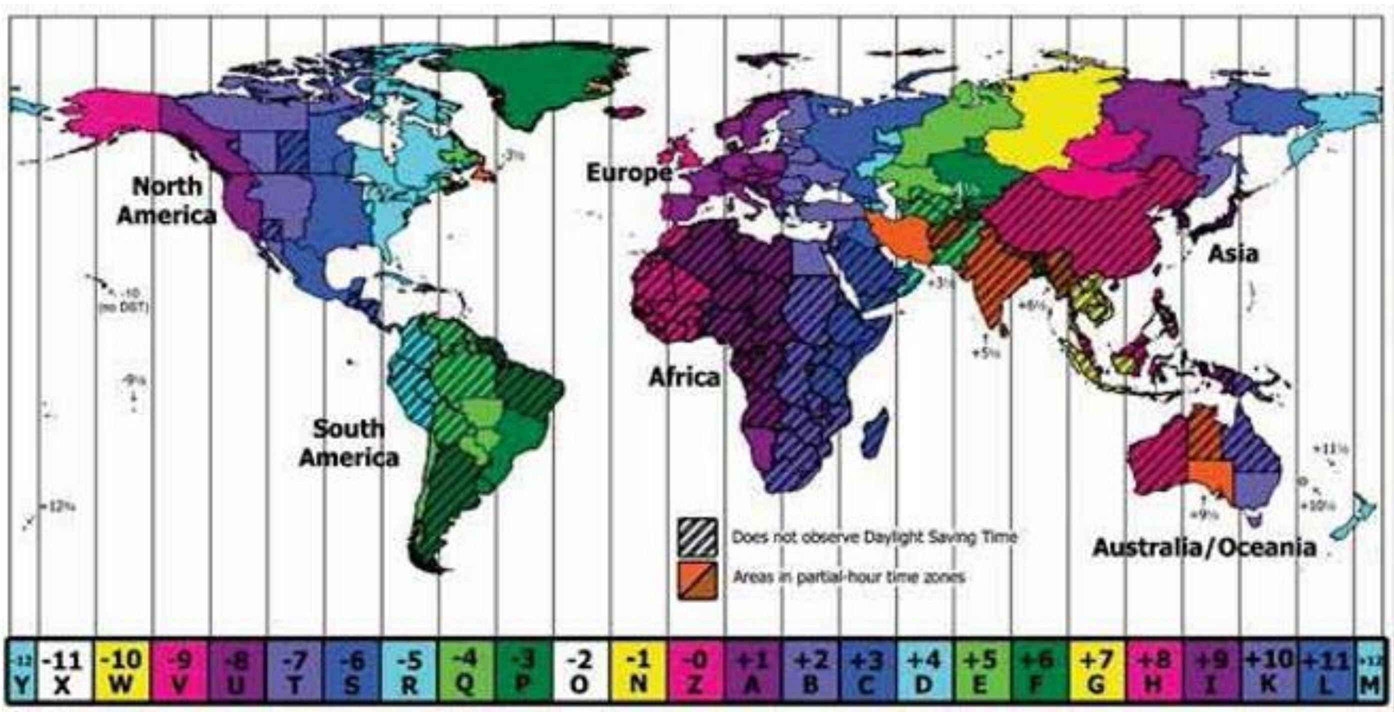
Once you have determined the difference between your local time zone and UTC, you can "set it and forget it" (a separate UTC clock in your shack is a good idea). It is up to the amateur in Paris to do the same thing, so when the two of you make a *sked*, or scheduled contact, you both use UTC and everyone will be on time!

And in South Africa?

South Africa is east of the prime meridian and thus later than Greenwich, 2 hours later.

Local time is known as SA Standard Time (SAST), Central African Time (CAT) or Bravo Time for the military.

So to determine UTC time, we need to subtract two hours from local time. 10:00 CAT is 08:00 UTC.



This world time zone map from the National Institute of Standards and Technology (NIST), shows each time zone identified by letter, which is where we get "Zulu" time. [Map courtesy of NIST Time and Frequency Division]

The DX Code of Conduct

- I will listen and listen and then listen again before calling
- I will only call if I can copy the DX station properly
- I will not trust the DX cluster and will be sure of the DX station's call sign before calling
- I will not interfere with the DX station or anyone calling and will never tune up on the DX frequency or in the QSX slot
- I will wait for the DX station to end a contact before I call
- I will always send my full call sign
- I will call and then listen for a reasonable interval
- I will not call continuously
- I will not transmit when the DX operator calls another call sign, not mine
- I will not transmit when the DX operator queries a call sign not like mine
- I will not transmit when the DX station requests geographic areas other than mine
- When the DX operator calls me, I will not repeat my call sign unless I think he has copied it incorrectly
- I will be thankful if and when I do make a contact
- I will respect my fellow radio amateurs and conduct myself so as to earn their respect

Die DX Gedragskode

- Ek sal luister, luister en nog luister
- Ek sal alleenlik roep indien ek die DX hoor.
- Ek sal nie die DX Kluster blindelings vertrou nie en eers seker maak van die DX se ware roepsein voordat ek roep
- Ek sal nie steurings veroorsaak vir die DX of enigeen wat hom roep nie en ook nie opstem op die DX of die QRX frekwensie nie
- Ek sal wag totdat die DX klaar is met sy kontak voordat ek roep
- Ek sal altyd my volle roepsein stuur
- Ek sal roep en redelike periode wag
- Ek sal nie aanhoudend roep nie
- Ek sal nie uitsaai wanneer die DX 'n ander roepsein as myne roep nie
- Ek sal nie uitsaai indien die DX 'n roepsein bevraagteken wat nie soos myne klink nie
- Ek sal nie uitsaai indien die DX 'n ander Geografiese area roep nie
- Indien die DX my roep, sal ek nie my roepsein herhaal behalwe as ek dink hy het dit verkeerd gehoor nie
- Ek sal dankbaar wees indien ek die kontak gemaak het
- Ek sal my mede Amateurs respekteer en myself handhaaf om sodoende hulle respek te verdien.

Vertaal deur en met dank aan Raoul, ZS1C

The Autumn Leg of the 2026 SARL QRP Contest Series

The Sandton ARC

The second leg of the 2026 QRP contest took place over the Easter weekend on Saturday 4 April and what a great event with a super turnout in pretty good conditions.

Several of the contestants were out of town enjoying the long weekend with their families and judging by the QSOs achieved and logbooks submitted, they were not going to miss the QRP contest and had taken their radio and antenna with them, which is something you can easily do with QRP.

Odette, ZS2OD and friends enjoying Easter together

Peet, ZS3PL with Esmarie, ZS3EL behind the camera

At this point I must mention of Trevor ZS1PIG. Trevor was getting married the following weekend, but this did not deter him from setting up a field station and participating.

Congratulations Trevor, wishing you both everything of the best and many happy adventures together, with or without your radio.

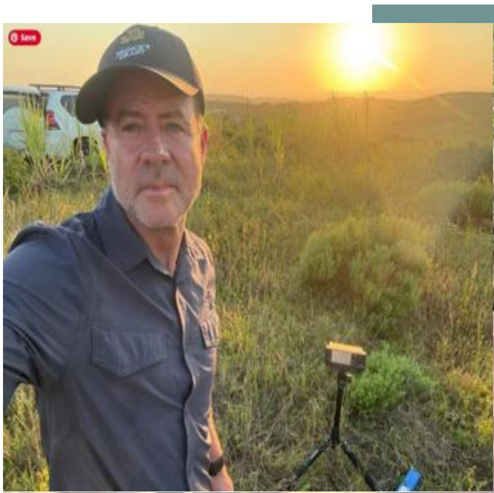
Trevor, ZS1PIG - What a beautiful location

QRP radio gear can be packed away into a small package that can travel with you everywhere, even on the back of a bike. Batteries last a long time when running QRP.

Stuck at home, no worries, QRP Amateur Radio also enjoys operating from the shack...

Left. Sid, ZS5AYC with Adele, ZS5APT behind the camera. Right. Alec, ZS3AJ

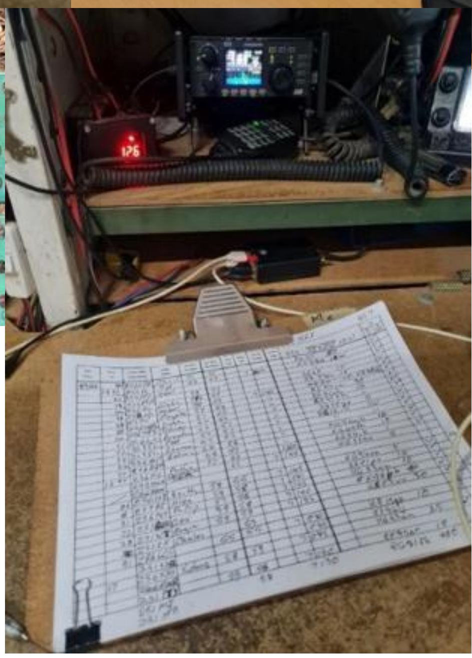
(Continued on page 28)











Top row. Brandon, ZS6LZ; Odette, ZS2OD and Luke, ZS6LUK
Middle row. Matthew, ZS6MDV; Martin, V51MJ and the Pretoria ARC, ZS6PTA
Bottom row. ZS6MDV's radio; Christie, ZS4CGR and SP, ZS1SPB

Many locations, radios and antenna's saw action over Easter!

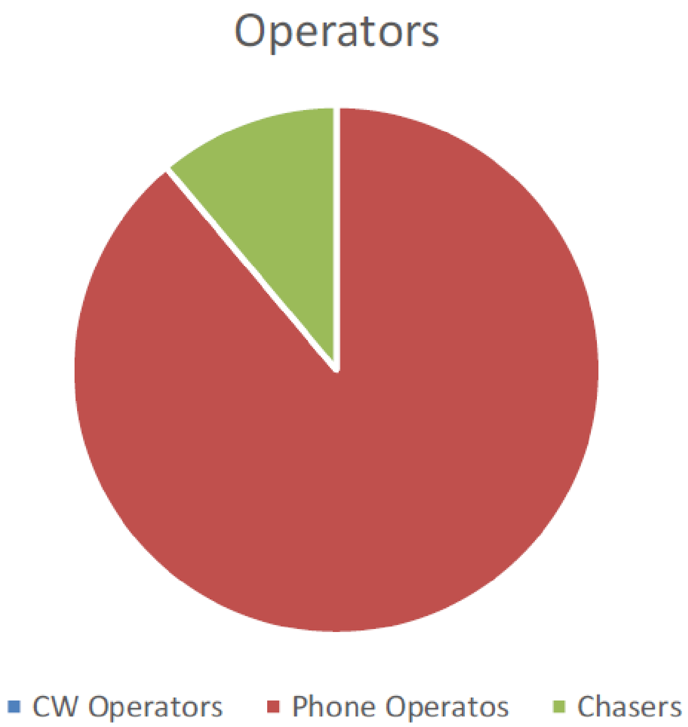
The final two legs of the SARL 2026 QRP contest series take place as follows:

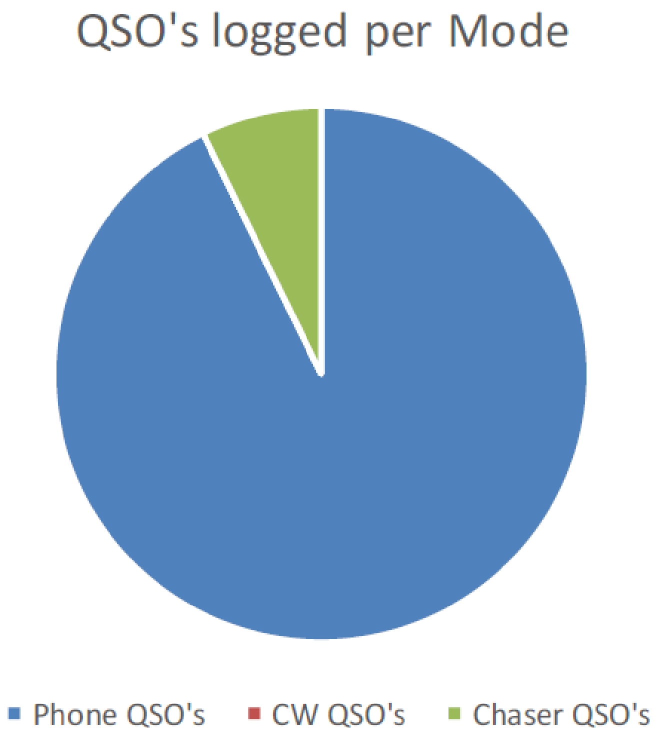
The Winter Leg from 07:00 to 09:00 UTC on Saturday 18 July.

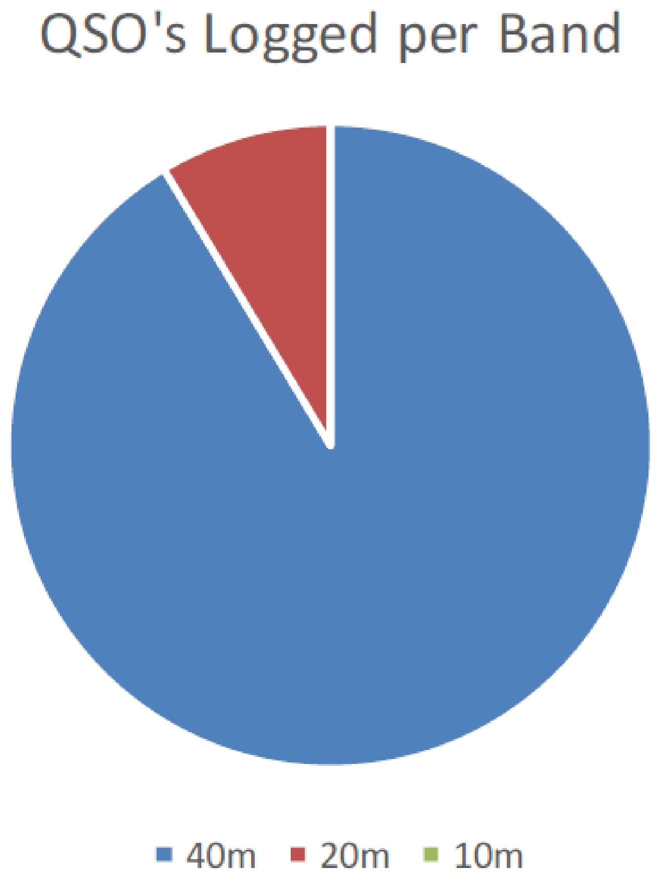
The Spring Leg from 13:30 to 15:30 UTC on Saturday 7 November.

You are invited to join in the fun and experimentation, whether running QRO or QRP. Let us see just how efficient your station can be?

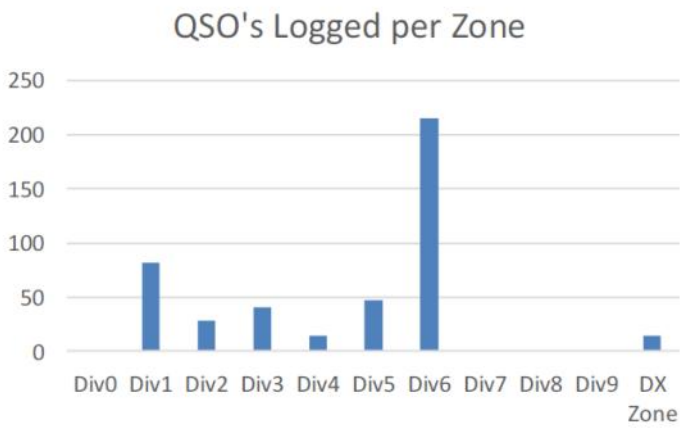
QRP
Amateur Radio
wherever you may be







Total QSOs Logged: 441
Total log sheets received: 26
Average QSOs per log sheet: 17
Operator count by mode: 27
CW Operators: 0
Phone Operators: 24 or 92%
Chasers: 3 or 12%



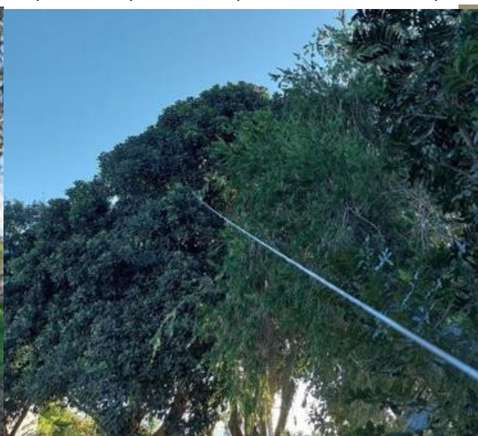
Total qualifying QSOs logged: 440
Phone QSOs: 408 or 93%
CW QSOs: 0
Chaser QSOs: 32 or 7%
Qualifying QSO count by band: 440
40 m: 402 or 91%
20 m: 38 or 9%
10 m: 0
Logged QSOs by division: 441
Div 0: 0
Div 1: 82 or 19%
Div 2: 28 or 6%
Div 3: 41 or 9%
Div 4: 14 or 3%
Div 5: 47 or 11%
Div 6: 215 or 49%
Div 7: 0
Div 8: 0

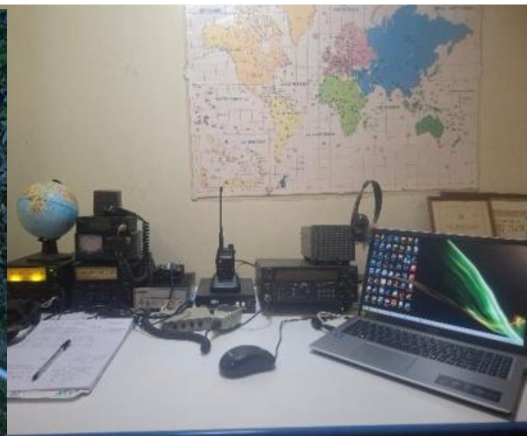
(Continued on page 30)

(Autumn QRP Contest from page 29)
Div 9: 0
DX: 14 or 3%

Maximum distance achieved: 1 670 km by Dieter, ZS1DWH
Top QSO count per hour: 18

Phillip, ZS6FY; the station of Jacobus, ZS1JDJ; Stewart, ZR1WT and Lee, ZR6LC





Radio and antenna of Dieter, ZS1DWH; Theunis, ZS2EC; Odette, ZS2OD; Luke, ZS6LUK and antenna of Brandon, ZS6LZ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Establishing a County-Wide Simplex Emergency Network

Mike Levine, N9HEL First published in QST June 2026

This Florida club built 21 VarAC stations — with plans for future enhancements — to keep their county connected.

The main concern of the Nassau County (Florida) Amateur Radio Society (NCARS), W4NAS, which often works in conjunction with the Nassau County Amateur Radio Emergency Service® (ARES®), has been hurricanes. High winds can disrupt cellular services and the power grid, easily damaging HF antennas.

We have three analogue and two digital repeaters and those repeater antennas are vulnerable to hurricane-force winds. We created a system to pass emergency traffic across the entire county, logging messages that do not rely on the power grid, the internet, antennas, or repeaters. To conserve power and be inclusive to most people, we made the minimum equipment requirement a VHF/UHF handheld radio and a laptop.

Figure 1. A stealth magnetic-mount mobile antenna on a metal roof vent with caulk around the mount for extra strength.

Creating the System

We initially evaluated five different systems to meet our goals: FM simplex, near vertical incidence skywave, digital mobile radio simplex, Automatic Packet Reporting System and Meshtastic. I started testing VarAC, which is a real-time chat system for HF, VHF and UHF that relies on VARA high-speed weak-signal digital modem software. This was the glue that we needed to build a countywide simplex network.

During a Florida Winlink drill, Dave Hopson, KO4CKW and I discussed creating a county-wide simplex group and gave a presentation to NCARS. Buddy Price, W4AHP, created an introduction describing the importance of off-grid communications in a disaster. Dave and I set up a demonstration using AnyTone AT-D878UVIIs and Digirig digital interfaces and laptops to show what can be done using low power and minimal equipment. The presentation was a success and more than 25 people signed up for a class that followed. With the help of Dave, Buddy and Doug Evans, N4AFV, we got them started.

VarAC offered us the following features:

- Station beacons
- Ability for any station to be a relay station and the relay is transparent to the relay station operator
- Group messaging/chat (with or without alert colours/ sounds)
- One-on-one chats
- V-mail with store and forward with relay notifications and multiple recipients
- External e-mail gateway with store and forward and multiple recipients
- Relay (up to two hops) through any station
- Pathfinder, which shows relay station paths to an unseen station
- Incident Command System (ICS) form capability
- Compressed file and photo transfers

(Continued on page 33)

(Simplex Emergency Network from page 32)

- Canned messages
- All events, chats and broadcast messages are logged
- Operation of HF, VHF and UHF sessions simultaneously with a shared mailbox
- A special emergency mode, which offers automatic polling of stations on the air to replace check-ins

We like using Digirigs as the digital interface component of our VarAC stations. Although the SignaLink interface works well, Digirig is less expensive and smaller and offers a huge variety of radio connection cables. Most of us use Digirig Mobile (logic level), which offers an audio port and a serial CAT port, so it can be switched to HF transceivers, if needed. There is also Digirig Lite, which is less expensive and offers audio for only handheld transceivers and VHF/UHF mobiles.

Equipment and Coverage

Armed with AnyTone AT-D878UVIIs, AT-D578UVIIIs and AT-778UVs; Baofeng's (UV-5RMs are popular and inexpensive); Yaesu FT-991As; Digirig digital interfaces and laptops, we started to build the net. We overcame antenna installation restrictions with some ingenuity; mobile antennas became our go-to, clipped to gutters and installed on metal roof vents using magnetic mounts (see Figure 1).

Gutters and downspouts are great coaxial cable concealers and Comet CTC-50M window feed-through jumpers allow you to lock the window. These antennas are surprisingly hard to notice and look like lightning/static arrestors. The advantage of these stealth roof-mounted antennas is that stations can cover a radius of more than 14 km running 7 – 10 W with the help of VARA's weak-signal capabilities.

Dave, Buddy and I decided it would be a good idea to have some stations running for 24 hours for testing, general messaging and e-mail. We initially had four stations:

- Mike Levine, N9HEL — AT-D878UVII, Digirig, magnetic-mount antenna on a roof vent
- Dave Hopson, KO4CKW — AT-D578UVIII, Digirig, Diamond X50A antenna on a 9 m pole
- Buddy Price, W4AHP — Retevis RT95, Digirig, second-story mobile antenna
- Matt Drahzal, N4MRD — AT-D878UVII, SignaLink, magnetic-mount mobile antenna on the roof

Now, we have 10 stations running 24 hours and about 21 stations total. Based on our coverage map (see Figure 2), all of Nassau County and part of Duval County are covered.

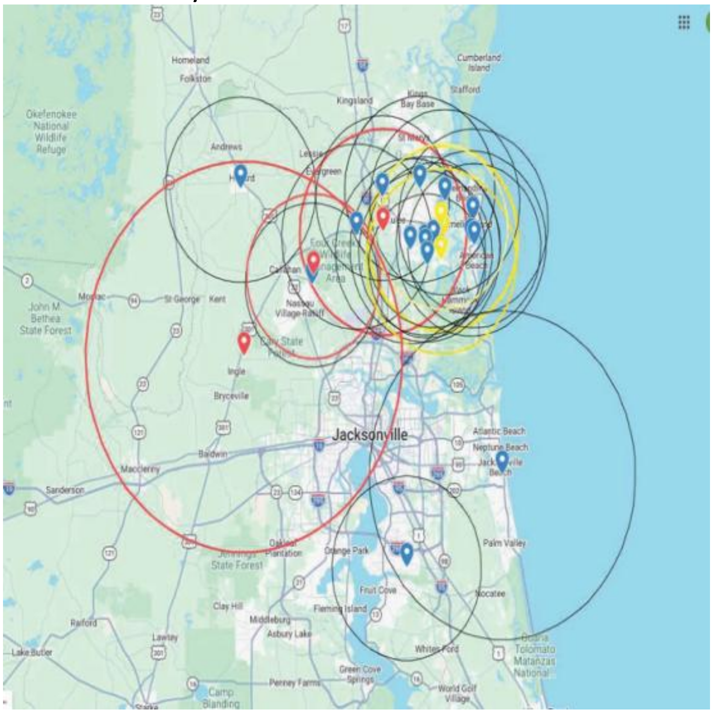


Figure 2. NCARS ARES VarAC simplex station coverage.

Most of our operators are on the east side of Nassau County, but we relay through a station in the centre of the county to connect the east and west areas. Our relay station is based in the Nassau County Emergency Operations Centre (EOC), which includes 911 services. That station runs 24/7 and is always staffed. All stations can reach the Nassau EOC directly or via one relay. Due to the importance of the EOC station as a relay, we are installing a remote station close to the EOC, which will give us a backup for any east or west relays.

Many of our stations are VarAC email gateways (e-mail to and from outside sources to individual VarAC stations) when they have internet connections. We have practiced sending e-mails to Winlink HF stations and having those e-mails returned to the initiating VarAC FM station. We also have two of what we call hardened stations, because they have 24/7 automatic generators and continuous Starlink internet connections. Both stations act as e-mail gateways to the outside world when everything else is down.

(Continued on page 34)

(Simplex Emergency Network from page 33)

We run a monthly check-in net using VarAC Broadcast with standardised messages and alert tags to simulate an emergency net startup. In the future, we plan to practice moving off the calling frequency for person-to-person chats, ICS form completion/transfer and passing traffic. Because 10 stations are constantly running and the other stations come and go, we use VarAC Broadcast chats and the internal V-mail quite a bit for information transfer.

Visit www.youtube.com/watch?v=g7SAx6rytyo to watch a VarAC net held by Nassau County ARES.

Future Upgrades

We believe there is more room to grow with this digital simplex network and we will be entertaining the following things in the future:

- When everything is down, the Community Emergency Response Team (CERT), using FRS or GMRS radios, would have difficulty connecting to the Nassau EOC unless they are close. VarAC simplex network station operators could monitor these bands and act as a relay to the EOC to activate an emergency service. This would also leave a paper trail to be submitted to the ICS.
- Neighbourhood watch groups could use the same system as CERT to activate an emergency service.
- We are not comfortable having only one gateway between the east and west portions of the county. One of our digital group members has a business that is geographically close to the centre of the county and is willing to set up a station there to act as a backup gateway. We are still in the process of designing and installing the hardware. We could also use the HF station to send e-mails to Winlink through VarAC HF e-mail gateways and receive responses through the same gateway.
- VarAC can run an FM station in parallel with a VarAC HF station on the same computer and cluster so that they share a V-mail/e-mail mailbox. Although HF antennas are vulnerable, we would still like to find a way of including VarAC HF in our emergency network as a backup.
- Live one-on-one training will ensure everyone's VarAC skill set is complete. We are starting this training in the Nassau County EOC.
- An updated demonstration will attract more opera-tors to the VarAC simplex network.

If you have not looked at VarAC yet, consider downloading it, it is free (www.varac-hamradio.com). The same features from VHF/UHF exist on HF. Also, the HF feature to move you off the calling frequency for a chat is automatic and something to see, you never touch the dial!

All photos provided by the author.

Thank you to Dave Hopson, KO4CKW; Buddy Price, W4AHP and the rest of the Nassau County (Florida) VarAC simplex team: Rick Whelan, AB1L; Carman Pagano, AC4SP; Harlin Silvers, K1JAX; Tom Tice, K4BTT; Bill Brumund, K4GGY; Jason Maddox, K4JMX; Red Jentz, KE8EZM; Scotty Ratcliffe, KK4JMW; James Knox, KN4UJW; Steve Mooney, KR4DQV; Chris Moore, KR4GEC; Marvin Webb, KS4UG; Mike Carey, KX4YD; Rick Shaw, N3RBS; Matthew Drahzal, N4MRD; Jim Miller, N4SDN; John McClane, W4LTY and Kent Shafer, W5XQM.

Mike Levine, N9HEL, is 77 years old and has been an Amateur Extra-class amateur for 40 years. He is a member of Nassau County Auxiliary Communications in Florida, is a Nassau County Florida ARES Assistant Emergency Coordinator and is an ARRL Volunteer Examiner. Mike enjoys operating CW, SSB, RTTY, FT8, VarAC HF and FM, analogue, DMR, YSF, NXDN and AllStarLink. He can be reached at rottytoo@gmail.com.

From the Cape to New Zealand: Amateur Radio at the Bottom of the World

Correspondent from down Under - Greg Van Der Reis, ZL1GUD - Formerly ZS1GD

My association with radio spans more than four decades. I received my amateur licence in 1990, entering the hobby as ZR1XZT before progressing to ZS1GD — a call sign that would accompany me through some of the most formative years of my operating life.

Those early years were spent embedded in the vibrant amateur community of Cape Town. I held membership with the Cape Town Branch, the Cape Radio Group and the Oakdale Amateur Radio Club and threw myself into the practical side of the hobby with considerable enthusiasm. Providing communications support on motor rallies alongside Davey and Bernie and participating in search and rescue exercises, gave me a grounding in the real-world utility of the bands. Before long, however, it was HF and the pursuit of DX that truly captured my imagination — and never let go. Some of you might remember the first DXpedition I organised to Dassen Island.

A Chance Remark That Changed Everything

Twelve years ago, I found myself seated in a tour guide training course — an occupational detour from my professional life as a quantity surveyor, during which I was running adventure travel excursions. The course facilitator posed a seemingly casual question: “Do you know anyone in New Zealand?” It was, as these things sometimes are, an entirely accidental catalyst. New Zealand had never featured in my thinking. But the follow-up remark stopped me cold: “You’re a quantity surveyor. Why don’t you simply go?”

That offhand suggestion set an entirely new course in motion. We began making preparations and, in due course, departed South Africa for a fresh chapter on the other side of the world. The amateur radio dimension of the transition proved refreshingly straightforward: I submitted a copy of my South African licence to the New Zealand authorities and within 48 hours a reciprocal licence bearing the callsign ZL1GUD was in my hands. The continuity of the hobby, at least, required no adjustment period whatsoever.

Amateur Radio in New Zealand

New Zealand is a small country and its amateur radio community reflects that scale. The licensed

(Continued on page 36)

Keeping the bugs at bay!

(From the Cape to New Zealand from page 35)

population stands at approximately 6 500, yet active operators number considerably fewer — perhaps 200 on any given day. During my first eight years on the North Island, I confess that I engaged with the hobby only intermittently.

That changed entirely when I relocated to the South Island three years ago. The community here is notably warmer and more welcoming and I wasted little time in joining two local clubs. It was here, too, that I first encountered the phenomenon that has since fundamentally reshaped my relationship with the hobby: Parks on the Air (POTA).

POTA has quite simply taken the New Zealand amateur radio scene by storm. Most weekends now find me departing the farm in the pre-dawn chill — ice still glazing the paddocks — to rendezvous with Phil, ZL3PAE at some improbable location: a remote beach, a dry riverbed, a mountain pass that tests both vehicle and nerve. The appeal lies in seeking out sites that have never been activated, or that demand genuine expedition-level effort to reach. A typical weekend activation yields upwards of 29 confirmed contacts spanning New Zealand and across the Tasman to Australia. I am, without qualification, thoroughly addicted.

I believe POTA and its sibling programme SOTA (Summits on the Air) have done more for the hobby's appeal to younger operators than almost any other development in recent memory. When amateur radio intersects with hiking, four-wheel driving, camping and wilderness navigation, it ceases to be a solitary pursuit at a desk and becomes something altogether more dynamic. By my estimation, some 80 per cent of newly licensed operators in New Zealand now engage with POTA or SOTA activations as a primary mode of participation.

(Continued on page 37)

"POTA has transformed the hobby, drawing a new generation of operators who pursue activations with the same spirit of adventure as any outdoor expedition."

(From the Cape to New Zealand from page 36)

The Ham Shack: Filling a Market Gap

Remarkably, until recently New Zealand had no dedicated amateur radio retail presence — not a single specialist supplier serving the entire country. Identifying this gap, I established The Ham Shack, which now serves as the New Zealand agent for Sotabeams (United Kingdom), Spiderbeam (Germany), Alinco (Japan) and Guohetec (China). Given the size of the local market, it is very much a hobby enterprise rather than a commercial operation in the conventional sense — but it is enormously satisfying and I would not have it any other way.

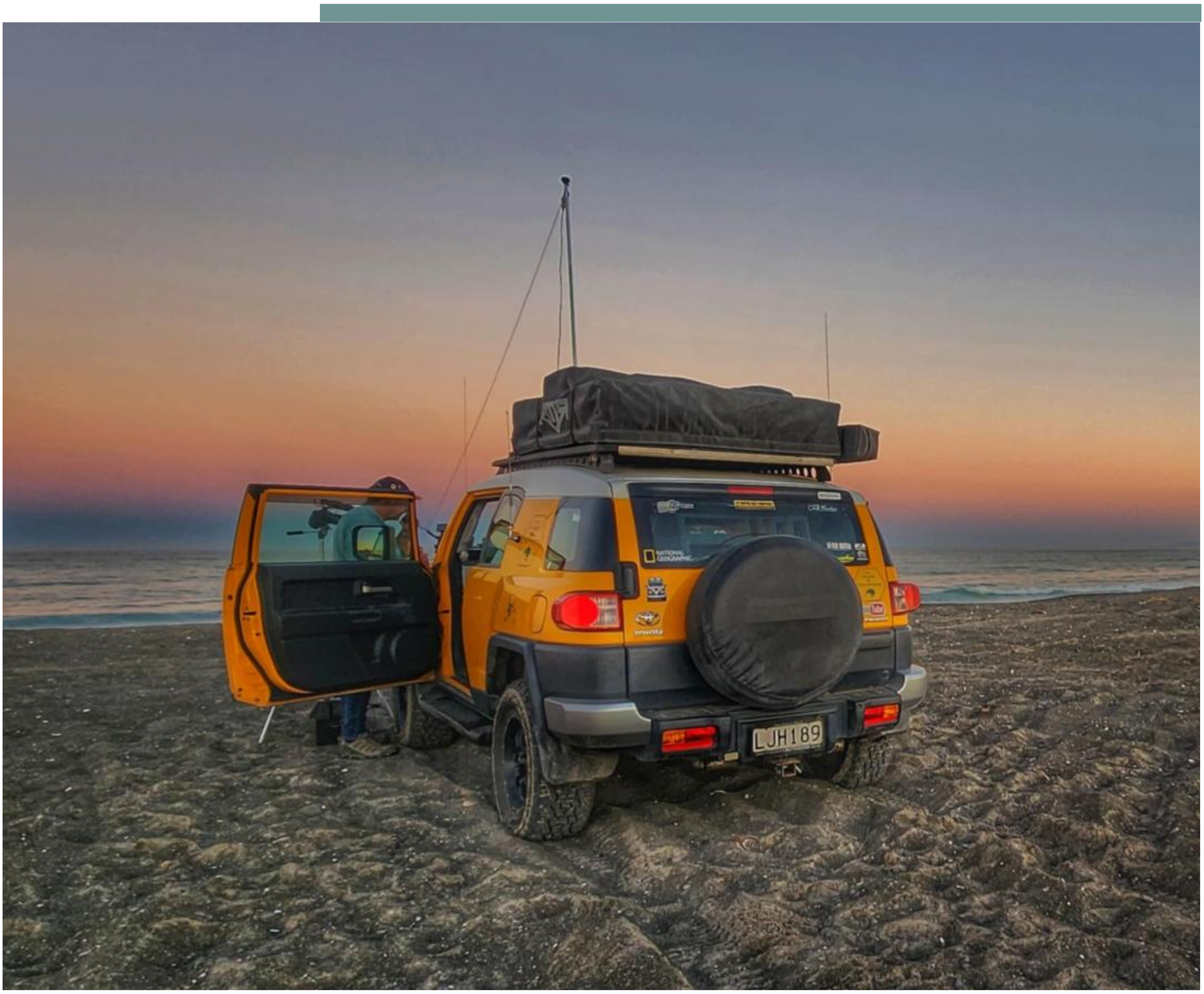
A Magazine for the Trans-Tasman Community

Writing has been a constant thread through my life. I have authored three books and the impulse to document and communicate eventually found a natural outlet in amateur radio publishing. What began as a modest electronic club newsletter has evolved into a substantive 60-page monthly publication — the NZ and Australian Amateur Radio Magazine — distributed free of charge to every club in New Zealand and Australia and read by amateur operators around the world. The readership continues to grow and the breadth of the audience never ceases to surprise me.

Life on the South Island

New Zealand and South Africa share far less than one might initially suppose. The climate on the South Island is emphatically its own: it snows, it rains and midwinter mornings regularly dip below freezing. A midsummer high of 22°C feels genuinely warm here. I live on a small farm where the creek has frozen solid in winter and snow is an unremarkable seasonal feature. And yet — the light is extraordinary, the landscapes are humbling and the people are among the most straightforward and hospitable I have encountered anywhere in the world. I spend considerable time

(Continued on page 38)



(From the Cape to New Zealand from page 37)

in Australia as well, where my daughter has settled; the crossing is a brief and inexpensive flight from the South Island.

Working DX from this part of the world demands a certain recalibration of expectations. The time zone arithmetic is unforgiving and productive propagation windows often require either rising before dawn or remaining at the key well past midnight. Neither inconvenience has proved sufficient to deter me.

Equipment: Antennas and Radios

The antenna farm at the farm has grown into a respectable installation. Current antennas include a Diamond 8010 dipole, a broadband military antenna sourced from South Africa covering 2 – 150 MHz, a TH3 yagi and a Spiderbeam five-band Yagi fitted with a 40 m extension — a combination that keeps most HF bands accessible without compromise.

The station is anchored by a Yaesu FTDX101D — a radio that continues to reward. For POTA activations in the field, I rely on the PMR 171, a Chinese-manufactured all-mode HF/VHF/UHF transceiver with a maximum output of 20 W. There is something pleasingly practical about its form factor and robustness that calls to mind the military field radios I operated during my South African service days — an association that lends the unit a certain nostalgic authority, quite apart from its merits as a portable station.

Until next month — totsiens en groete.

Greg van der Reis, ZL1GUD, formerly ZS1GD
South Island, New Zealand

July is a busy month for contests, both local and international. There are six local contests and three international contests.

All the new radio amateurs from the May RAE are invited to participate in the first leg of the SARL Newbie QSO Party from 11:00 to 16:00 UTC on Saturday 4 July. It is a phone only contest on 40 and 20 metres.

Then on Sunday 5 July, everybody works ZR5, ZS5 and ZU5 stations during the ZS5 QSO Party. The QSO Party runs from 14:00 to 15:00 UTC with CW and phone activity on 40 metres.

The IARU HF Championships runs from 12:00 UTC on Saturday 11 July to 11:59 UTC on Sunday 12 July, with CW and phone activity on 160, 80, 40, 20, 15 and 10 metres. Here is your chance to work the world. The exchange is a RS or RST report and your ITU Zone, for South Africa, that is Zone 59. IARU Member Societies will give an RS or RST report and the Society abbreviation, e.g., 59SARL. Find the rules at www.arrl.org/iaru-hf-world-championship.

The World Radio Teamsport Championship (WRTC) takes place the same weekend from England and there are awards available for working these stations. Find out more at www.wrtc2026.org/wp-content/uploads/2025/02/WRTC-2026-competition-rules-final.pdf.

The third leg of the SARL QRP Contest, the Winter leg, runs from 07:00 to 09:00 UTC on Saturday 18 July with CW and phone on 40, 20 and 10 metres.

On Sunday 19 July, everybody works ZR2, ZS2 and ZU2 stations during the ZS2 QSO Party. The QSO Party runs from 14:00 to 15:00 UTC with CW and phone activity on 40 metres.

If you enjoy working RTTY, then take part in the the North American RTTY QSO Party from 18:00 UTC on Saturday 18 July to 05:59 UTC on Sunday 19 July. Get the rules at https://ncjweb.com/NAQP-Rules.pdf.

The third leg of the SARL Saturday 40 m Club Contest runs from 15:00 to 16:00 UTC on Saturday 25 July with CW, phone and RTTY activity. The aim is to work as many Clubs and grid squares in that hour.

On Sunday 26 July, everybody works ZR1, ZS1 and ZU1 stations during the ZS1 QSO Party. The QSO Party runs from 16:00 to 17:00 UTC with CW and phone activity on 40 metres.

To close off July, there is the Islands on the Air Contest which runs from 12:00 UTC on Saturday25 July to 12:00 UTC on Sunday 26 July with CW and phone activity on 80, 40, 20, 15 and 10 m. The exchange is a RS or RST report and a serial number, with stations on islands will send their IOTA reference number, e.g., 59 21 AF064 or 599 10 AF085. AF064 is Robben Island and AF085 is Elephant Rock. Get the rules at www.rsgbcc.org/hf/iota.shtml.

For the local contests, consult your copy of the 2026 Contest Manual or visit https://mysarl.org.za/contest-resources/

The Power Connector Adapter Hub

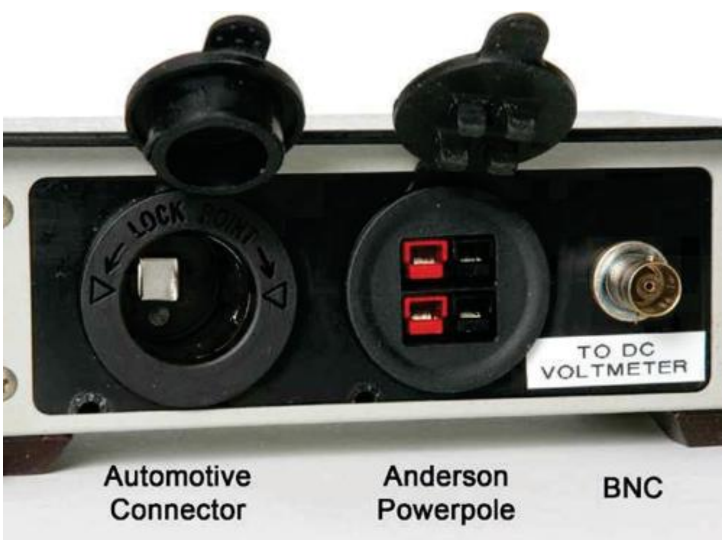
Donald "Don" Whiteside, WA8QMV first published in QST, July 2025

When you want to attach a device to a power source, the connectors are often incompatible; WA8QMV has a solution.

The PCAH in use

When I need to make power connections to my devices under test, I often end up with a scattered array of wires with alligator clips connected to power jacks, resistors, test leads, etc. So, I created a solution that has several different jacks and connectors all in one place. The result is the Power Connector Adapter Hub (PCAH), a simple box featuring multiple power jacks of various types. As seen in the lead photo, the front of the PCAH has two sets of dual banana binding posts and two dc power jacks, which are the standard size of 5,5-millimetre outer diameter (OD) × 2,1-millimetre inner diameter (ID). The rear of the PCAH, shown in Figure 1, has an automotive cigarette lighter jack (with cover), a housing with two pairs of Powerpole® connectors (with cover) and a BNC connector for attaching an oscilloscope, a digital volt-meter (DVM), or other test equipment.

The PCAH permits easy interconnection of devices for temporary testing purposes. For example, you can plug an ac/dc adapter into one of the jacks, a DVM into the BNC connector or banana jacks and a load resistor into the banana jacks. You can easily insert a dc ammeter in series with the load resistor. Similarly, you can connect a mobile radio or a handheld with a Powerpole or cigarette-type connector to the applicable jack. You can attach a power supply to the banana jacks and a DVM to the BNC to monitor the voltage.

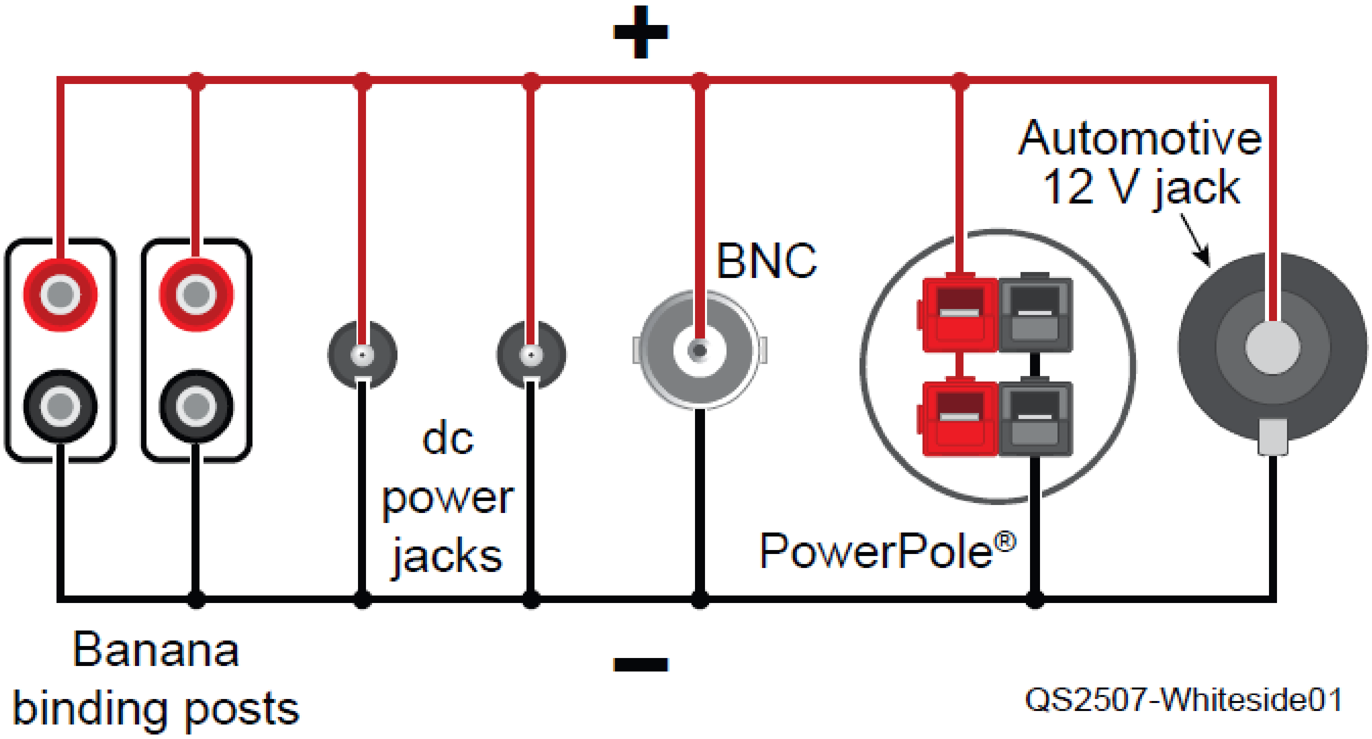


Build the PCAH As Is

Assembly is straightforward. As you can see in

(Continued on page 41)

Figure 1 - The rear view of the PCAH.



(The PCAH from page 40)

Figure 2, the connectors are all wired in parallel. You can find the needed components at electronic parts supply retailers such as Powerwerx, which has the Power-pole connectors (SKU# PanelPole2) and the cigarette lighter jacks (SKU# PanelCIG). Amazon, Jameco Electronics, Mouser Electronics and DigiKey can provide dc power jacks, BNC jacks and banana jacks.

Modify for Your Situation

You can make changes to suit your needs. You may use larger-gauge wire and connectors with higher current ratings. You may also desire different dc connectors, such as a 5,5-millimetre OD × 2,5-millimetre ID connector (used on some portable transceivers), or even a USB-C or USB 3.0 connector. While my dc jacks are wired with positive voltage centre pins, some applications may require a negative voltage centre pin. If needed, you can add a polarity-reversing switch for a specific jack or reverse-wired connectors. An LED that indicates reverse voltage might be a good addition in such cases.

Of course, always double-check your dc polarity before connecting any equipment. You will want to select a case size based on the type and number of connectors you will be using. You may choose either a metal or plastic enclosure, such as those sold by Hammond Manufacturing and other companies. If you use metal, I suggest insulating the connectors from the housing to avoid potential short circuits.

For those who do a lot of bench testing, the PCAH can simplify your dc interconnect setups — it certainly did for me.

All photos provided by the author.

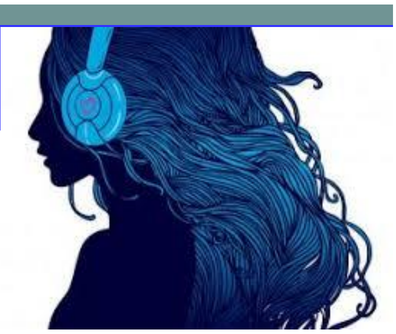
Donald “Don” Whiteside, WA8QMV, licensed since 1965, holds an Amateur Extra-class license and an FCC commercial General Radiotelephone license. He received BBA and MBA degrees from the University of Michigan-Flint and he possesses various professional certifications.

Don is retired from biomedical engineering, healthcare management and state government careers. He is now an author, podcaster and the founder of CareerLantern.com, a career-oriented website. When not on the radio or spending time with his family and wife of 50+ years, Don enjoys playing guitar with a blues/rock band at charity events.

He may be reached at wa8qmv@gmail.com.

The YL.Beam

Heather Holland, ZS5YH



YL SOTA Special Event Weekend ‘Queens of the Mountains’

The Third Annual QoM event started at 00:00 UTC on Saturday 14 June and ended at 23:59 UTC on Sunday 14 June 2026. YLs from around the world activate summits during the weekend. YL to YL DX QSOs will be recognized with a WWW-World Wide Women's certificate.

The Queens of the Mountains was created with the intention of bringing YLs together to foster camaraderie, inspire women to try SOTA and shine light on how supportive and welcoming amateur radio, particularly SOTA, is to women.

It was inaugurated in June 2024. The QoM Liz Burns K1LIZ Award is given to the YL whose participation captures Liz’s indomitable spirit to let no obstacle stand in her way.
The 2024 Recipient: Lorene Samoska, W6LOR
The 2025 Recipient: Adele Tyler, ZS5APT

What and why SOTA

Eva Kelemen Gajdo, YO6EVA, reached a thousand points in May 2018 becoming the first YL Mountain Goat in Romania. To understand why Eva, YO6EVA should have been transmitting radio signals from the highest peak in the Alps and what activation means we need to introduce the radio sport called SOTA. The acronym comes from Summits on the Air. Launched in 2002 by radio amateurs who combined their passion for radio with mountaineering. It is a fun and challenging activity that encourages portable operation in mountainous areas. SOTA has been designed to make participation possible for everyone – you do not have to be a mountaineer! The peaks score between 1 and 10 according to their height.

There are awards for activators (those who hike to the summits) and chasers (those who operate from home, a local hilltop, or another summit). After earning a thousand points (1 000), the competitor is awarded the title 'Mountain Goat' and receives a trophy. There are no fees and you can participate on your own schedule.

SOTA has hundreds of participants in Associations across the World, all sharing the same award ethos and infrastructure. Note that SOTA is an award programme not a club or society; as such you cannot be a "Member" of SOTA but you can certainly be a participant! More information can be found at https://www.sota.org.uk.

Adele, ZS5APT a two times Mountain Goat from South Africa says, “There is still nothing quite like setting up a portable station on a summit, calling ‘CQ SOTA’ and hearing someone answer your call.”

Getting started on SOTA made easy

Register at http://sota.org.uk/, choose an easy summit nearby (check SOTAwatch or SOTLAS), start with existing gear — a handheld on 2 m is enough for a first activation, announce your activation on SOTAwatch so chasers are ready and then climb the summit, operate and enjoy SOTA is one of the most rewarding activities in amateur radio. You are outdoors in nature, getting exercise and operating amateur radio at the same time. The combination of mountain hiking and radio creates experiences you would never have sitting at a desk. And the view from the summit comes free of charge.

73 – your oeradio.at editorial team https://oeradio.at/en/sota-in-austria-operating-from-summit-to-summit/.

From Skirts to Summits - Julia Kursten

Editorial note: The following story has nothing to do with radio, but I was impressed by the attitude of these women from Bolivia and hope you will be too. Climbing Cholitas, a group of Indigenous women are on a mission to reclaim their power. One climb at a time, they endure tough routes at extreme altitudes, all while wearing traditional pollera skirts as an act of resistance. Mountains do not discriminate and neither do radio-waves. You do not have to climb the highest

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peaks, just head for your local hill-top in a frilly frock, sprinkle some sparkles on your radios and call CQ. Please share your stories and pictures on Social Media and with me. Have fun. 33 Heather ZS5YH

The Cholita Climbers of Bolivia, or Las Cholitas Escaladoras Bolivianas, are a group of Indigenous, Aymara, women mountaineers who climb peaks in Latin America. They do not wear modern mountaineering clothing, preferring instead their traditional costumes including polleras, brightly coloured, full, pleated skirts with many under skirts. They do wear helmets and boots and use crampons, ice picks and ropes but carry their equipment on their backs in traditional shawls.

The group was founded in 2015 by local women including Cecilia Llusco Alaña. The women are part of a tight knit community who work and live in the mountains. Their most notable expedition was on 23 January 2019 when they became the first Aymara women to summit Aconcagua, the highest mountain in the Americas.

History

The Cholita climbers live in the cities of La Paz and El Alto and so are accustomed to high altitude conditions. The women range from 24 to 50 years old. Many of them have family or work connections to mountaineering. For example, Cecilia Llusco Alaña started helping her father, a trekking guide, at the age of eight. Others in the group have partners who are climbers or have themselves worked as porters or high mountain cooks on climbing expeditions.

In 2015, eleven Cholitas Escaladoras, led by mountain cook Lidia Huayllas Estrada, made it to the summit of Huayna Potosí, a 6 088 metre high peak in Bolivia, in a single attempt. They then decided to climb mountains all over Latin America, despite the fact that it was judged by many to be inappropriate or impossible for women in their community to be mountaineers.

The word Cholita has been used pejoratively to refer to Aymara women. They have also been ridiculed for wearing their traditional costumes and have been discriminated against in public spaces and in employment opportunities. To challenge these negative connotations, this group of mountaineers climb in their traditional attire. After Huayna Potosi, the group climbed Acotango, a mountain between Bolivia and Chile, Parinacota, Pomarapi, Illimani and Bolivia's highest mountain, Sajama de Oruro, all peaks higher than 6 000 meters above sea level. Individuals in the group now accompany tourists on their climbs as regular guides.

On 23 January 2019, they made history by reaching their highest summit so far; they climbed

(Continued on page 44)

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Aconcagua (6 968 meters - LUM/PH-001) in Mendoza, Argentina, the highest summit in the western hemisphere. The climb was sponsored by the Ministry of Culture and Tourism of Bolivia and the expedition is now detailed in a documentary film called 'Cholitas' that premiered in Spain. https://www.youtube.com/watch?v=41NdWRsGfN8 3,11 mins English

Great job, Elvira IV3FSG!

On Sunday 17 May 2026, at the Dayton Hamvention, Elvira Simoncini, IV3FSG was inducted into the DX Hall of Fame, considered the "Nobel Prize" of the DX world.

The International DX Association (INDEXA) Foundation selected her among many world-class DXers, recognizing her extraordinary contribution to the DX community through her numerous DXpeditions, most of them carried out solo.

Only two women are members of the DX Hall of Fame and Elvira is the first one inducted exclusively for her DX operating achievements.

Elvira Simoncini, IV3FSG most recently 3X3A, has been inducted into the CQ DX Hall of Fame. Elvira has been an enthusiastic DX explorer who has operated from 34 different DXCC entities since 1990, often with a strong humanitarian focus, including her association with "IT WITHOUT BORDERS."

In a world constantly facing new digital challenges, this association seeks to reduce the digital divide through the intelligent, supportive and sustainable use of technology, implementing non-profit projects in emergency and marginalized situations worldwide. It also promotes innovative IT initiatives for people with disabilities. After a professional life dedicated entirely to teaching, this volunteer work provided her with numerous opportunities to travel and engage in amateur radio, almost always independently, while continuously optimizing her portable equipment. This volunteer work often included introducing

(The YL.Beam from page 44)

young students to amateur radio through courses and demonstrations.

Radioaficionadas YL Salta (Argentina)

YL: Walkers of the Invisible Voices

The women walkers, the YL, advance along the trails of Salta with firm steps, as if the mountains themselves were inviting them to discover hidden secrets. Their backpacks carry more than provisions and warm clothing; they carry with them the magic of radio, that gateway to invisible paths where voices meet faceless, yet soulful.

The fresh mountain air mingles with the crunch of leaves under their boots. They stop in a clearing, where the sun bathes the hills in golden hues and the wind whispers ancient stories. With an almost sacred ritual, they set up their equipment. They adjust antennas, turn knobs and the silence of the place fills with the murmur of static, as if the universe were holding its breath.

“CQ CQ CQ,” one of them says, her voice serene yet expectant, floating in the air like a silken thread. The radio crackles, there's a pause and then it arrives: a distant response, a voice caught in the waves that has travelled miles to find them. They don't know the face behind that voice, but it doesn't matter. It's an invisible friend, a companion crossing the void to share a part of themselves. They talk about everything and nothing. About the approaching rain, the steps they still must take, the moon that will soon light their way back. The words are simple, but they fill the space like a bridge between worlds, a reminder that they are not alone, neither on the trails, nor in life.

Some laugh, others remain silent, each lost in their own thoughts as twilight paints the sky purple. The contacts are not just a game of frequencies; they are an act of faith, a leap into the unknown that always finds an echo. The voices in

(Continued on page 46)

(The YL.Beam from page 45)

the air gift them stories, improvised poems, sometimes just a "thank you" that resonates deeper than any long conversation. When the sun sets and shadows embrace the mountains, the YLs pack up their equipment, but they don't turn off their radios. They continue walking under the stars, accompanied by the voices of their invisible friends, weaving dreams along the trails.

Each step is a heartbeat, each touch a connection that transcends time and space. They are more than hikers; they are weavers of invisible threads, guardians of a world that lives on the airwaves, where every voice has a place and every silence, a promise of reunion.

Jorge Tisera LU9OTA (4 January 2025)

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yl.beam news: Editor Eda (Heather), e-mail zs6ye.yl@gmail.com

The Newsletters can be found at https://wrarc-anode.blogspot.com/; the Italian Radio Amateurs Union: QTC URI www.unionradio.it/qtc-la-rivista-della-unione-radioamatori-italiani/; the West of Scotland Amateur Radio Society https://wosars.club/category/yl-news/; the YLs-Amateur Radio Ladies-Portugal www.facebook.com/CT2ISX and Ham YL www.facebook.com/ham.yls.

The South African Maritime Mobile Weather Net

The Maritime Net is on the air daily at 06:35 UTC [08:35 CAT] and 11:35 UTC [13:35 CAT] on 7,120 MHZ LSB and 14,316 MHZ USB.

The 06:35 UTC and 11:30 UTC transmissions are for High Seas METAREA 7 which covers from Ascension Island down to Madagascar East and Marion Forties on 14,316 USB.

The coastal weather and general sails are on 7,120 MHz LSB after the main weather broadcast.

The team is Peter, ZS1CH; Marjoke, ZS5V; Woody, ZS3WL and Johan, ZS6WZ.

The IARU Intruder Watch Service (formerly the IARU Monitoring System or IARUMS) is a worldwide service authorised by the IARU Administrative Council. It is served by dedicated volunteers.

A monthly IWS Newsletter is published and can be downloaded from https://www.iaru-r1.org/spectrum/monitoring-system/iarums-r1-newsletters/

The Silence between the Stars

Charl Marais, ZS1ZZ first published in Ragchew May 2026

Somewhere in the vast emptiness of the Northern Cape, roughly 90 km north of the small town of Carnarvon, sixty-four white dishes stand in the red Karoo dust and listen. Not for voice. Not for CW. Not for the warble of FT8 crossing an open band. They listen for the universe itself for the faintest whisper of hydrogen atoms spinning in galaxies billions of light-years away, for the dying shriek of neutron stars colliding in the dark, for signals so extraordinarily weak that a single badly shielded laptop in a farmhouse twenty kilometres away could drown them out entirely. To hear those signals, South Africa did something unprecedented: it silenced an area larger than England.

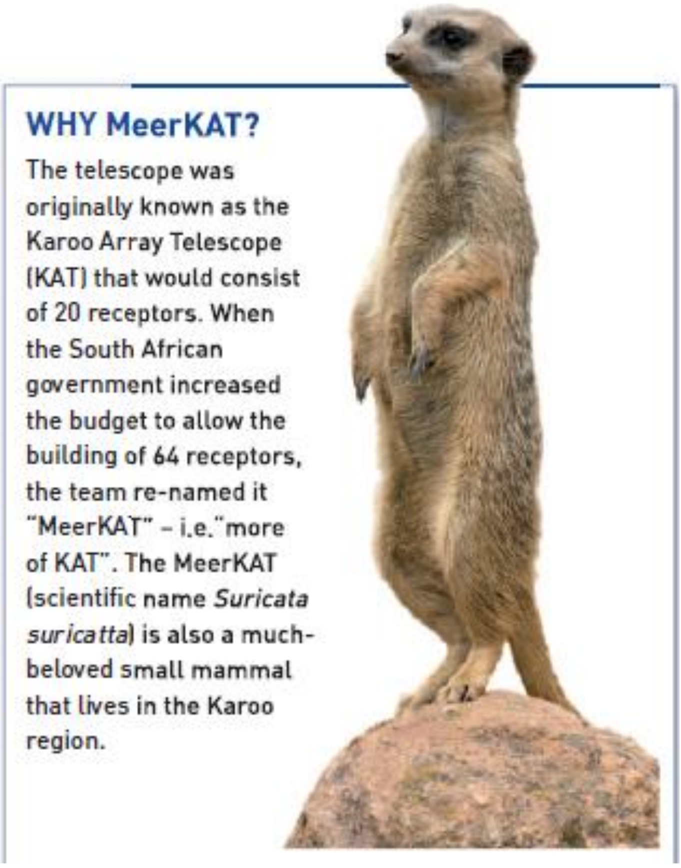
Welcome to MeerKAT, one of the most remarkable scientific instruments ever built on African soil and the centrepiece of a radio quiet zone that holds a Guinness World Record.

What is MeerKAT?

MeerKAT is a radio telescope array operated by the South African Radio Astronomy Observatory (SARAO), a national facility of the National Research Foundation. It consists of 64 individual dish antennas, each 13,5 metres in diameter, spread across an area of roughly 8 km in the Karoo semi-desert of the Northern Cape. Inaugurated on 13 July 2018 by then Deputy President David Mabuza, it is currently the most sensitive radio telescope array of its kind in the southern hemisphere. The name itself has a pleasing history. The original design was called KAT — the Karoo Array Telescope. When the South African government significantly increased the funding and doubled the number of planned dishes from 20 to 64, the project was renamed MeerKAT: literally *more of KAT.* In Afrikaans, *meer* means more. It is, in every sense, a very South African telescope.

Each dish is a marvel of precision engineering. The reflector surface must maintain its shape to within a fraction of a milli meter across its full width regardless of temperature, wind loading, or the angle at which it is pointed. The receivers mounted at the focus of each dish are cooled to within a few degrees of absolute zero colder than deep space itself to minimise thermal noise and achieve the extraordinary sensitivity the instrument requires.

The 64 dishes do not operate independently. Their signals are combined by a powerful correlator a specialized supercomputer that processes the data from all dishes simultaneously, effectively creating a single virtual telescope up to 8 km in diameter. This technique, known as aperture



(MeerKAT from page 47)

synthesis interferometry, is the same principle that makes arrays like the Very Large Array in New Mexico so powerful and it is a principle that every amateur radio operator who has thought about antenna arrays will find intuitively familiar.

A Child of South Africa

What makes MeerKAT particularly remarkable is that it was designed and built almost entirely by South African engineers and scientists. The hardware, the software, the signal processing systems the vast majority of it was conceived, developed and manufactured within South Africa. For a country that sometimes underestimates its own scientific and engineering capability, MeerKAT is a powerful reminder of what is achievable.

The telescope is not a standalone project. It was conceived from the outset as the South African precursor instrument to the Square Kilometre Array, the SKA an international megaproject that will, when complete, become the largest and most powerful radio telescope ever constructed. MeerKAT is both a world class scientific instrument in its own right and a proving ground for the technologies and techniques that the SKA will depend on.

The World's Biggest Radio Silence

The Karoo Central Astronomy Advantage Area — 106 306 km² of mandated silence

Every radio amateur understands RFI. We have all hunted interference the switched-mode power supply next door that puts noise across 40 m, the solar inverter that kills a quiet band, the laptop charger that raises the noise floor at exactly the wrong moment. Now imagine scaling that problem up to the point where you need to hear a signal so faint it carries less power than a single snowflake landing on your antenna. That is the world MeerKAT lives in and it is why South Africa did something no other country had ever done on this scale.

A Guinness World Record in Silence

The Karoo Central Astronomy Advantage Area (KCAAA) is officially the largest radio quiet zone on Earth, a fact confirmed by Guinness World Records. It covers approximately 106 306 square kilometres an area roughly three times the size of the previous record holder, the United States National Radio Quiet Zone around Green Bank, West Virginia, which covers approximately 33 670 square kilometres. To put it another way: the KCAAA is larger than the entire country of Portugal, or about the size of South Korea.

The legal framework behind this silence is the Astronomy Geographic Advantage Act (Act 21 of 2007), passed by the South African parliament on 17 June 2007, more than a decade before MeerKAT's first dish went live. The regulations came fully into effect in December 2021, establishing a tiered protection system with different levels of restriction depending on distance from the telescope core.

How the Zones Work

The protection area is not a single uniform zone. It operates in concentric layers, with the most stringent restrictions closest to the telescope core located 90 km north of Carnarvon and

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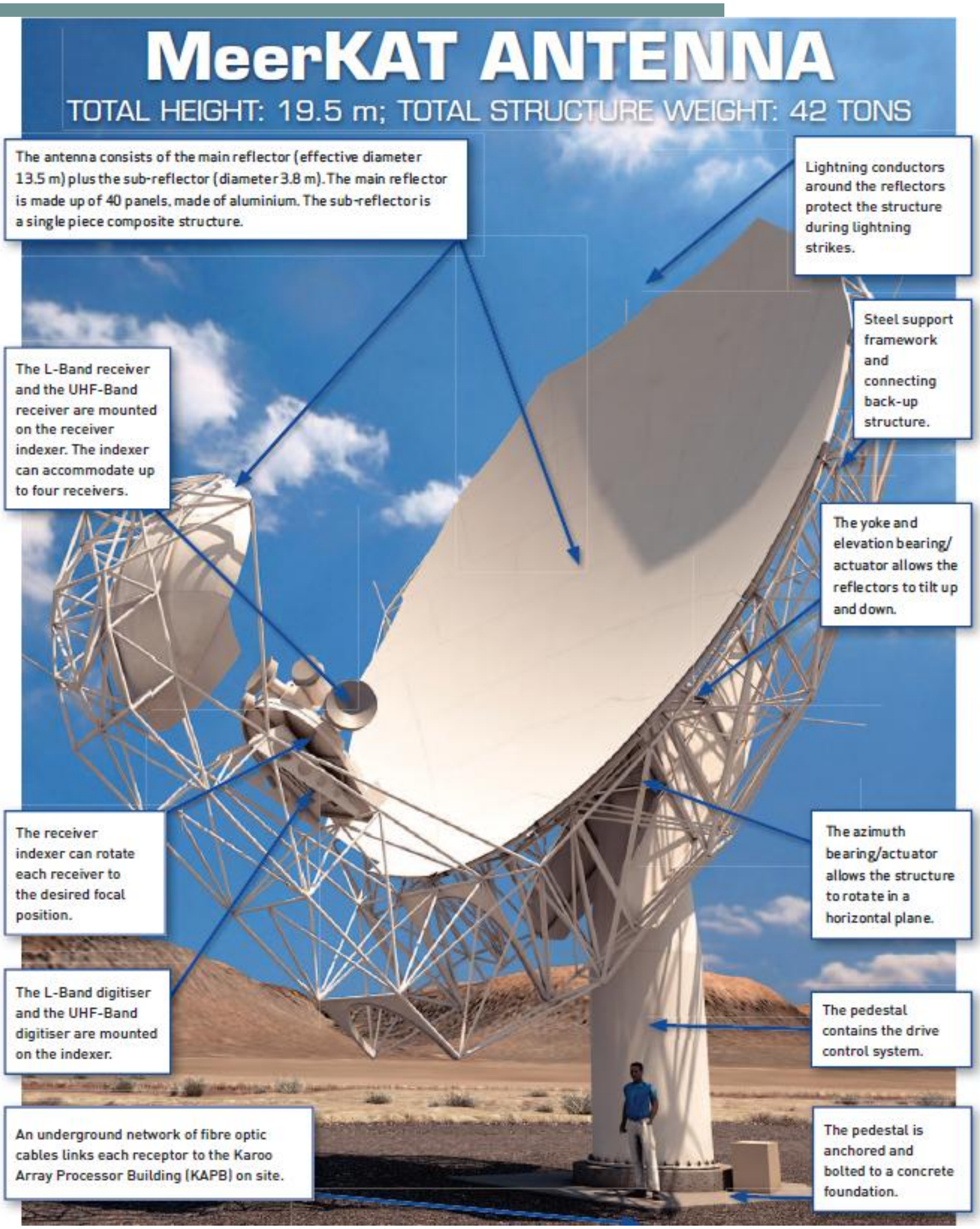
Zone	Radius	Key Restrictions
Core / SKA infrastructure territory	10 km spiral arms	Virtually all radio-frequency devices prohibited. No Wi-Fi, no mobile phones, no spark-ignition engines without special shielding.
Inter protection area	20 km radius	Spectrum from 100 MHz to 25,5 GHZ restricted. All transmitting devices require assessment and permit.
50 km permit zone	50 km radius	ICASA-exempted devices (Wi-Fi, DECT phones, public mobile radio, meter reading) requires a permit from the Astronomy Management Authority.
Outer KCAAA	Full 106 306 km^2	All spectrum use and transmissions must be assessed. Restrictions apply proportionally to proximity and signal strength



(MeerKAT from page 48)

progressively more relaxed conditions toward the outer boundary.

What is Actually Banned?

The primary target of the regulations is the radio frequency spectrum from 100 MHz to 25,5 GHz which covers virtually every frequency band of interest to radio astronomers and, not coincidentally, almost every wireless device in modern life. Within the core zones, the following are either prohibited or tightly controlled.

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Devices Prohibited or Restricted:

- Mobile phones and smartphones
- Wi-Fi routers and access points (802.11 any band)
- DECT cordless telephones
- Bluetooth devices
- Microwave ovens (leak on 2.4 GHz)
- Solar panel inverters and charge controllers
- Switch-mode power supplies of all kinds
- LED lighting drivers (switching electronics)
- Variable-speed motor drives
- Spark ignition petrol engines (unshielded)
- Wind turbines within 50 km (require permit)
- Amateur radio transmitters
- CB radio
- All broadcast transmitters (TV, FM, AM)
- Radar and navigation transmitters
- Drone remote control systems

Why Each One Matters

The common thread connecting every item on that list is unintentional or intentional radio frequency emission. To a radio astronomer, it does not matter whether a device is designed to transmit only whether it radiates energy in the protected spectrum. A microwave oven leaks on 2,45 GHz right in the middle of an important hydrogen line. A switching power supply generates broadband hash from kilohertz to gigahertz. A solar inverter, converting DC to AC at high switching frequencies, radiates across much of the spectrum. An LED driver dims its light by rapidly switching the current and that switching generates radio noise.

In the core zone, even the power supply for the telescope itself must be specially engineered and shielded to prevent self-interference. The SKA construction team is currently testing prototype remote solar power stations specifically designed to meet the electromagnetic emission requirements of the radio-quiet site.

Farmers within the 50 km radius who wish to use Wi-Fi on their properties, or operate public mobile radio equipment, or install smart electricity meters, must apply for a permit from the Astronomy Management Authority. Those who need a permit to continue existing operations had to register and apply once the regulations came into full effect in December 2021.

What Meerkat Hears

Discoveries from the radio heart of the cosmos

In 2023, the Royal Astronomical Society presented MeerKAT's team with its Group Achievement Award — one of the most prestigious honours in British astronomy for what it called 'spectacular advances in radio astronomy' achieved in a remarkably short period of operation. It was a fitting recognition for an instrument that has, in just a few years, rewritten parts of our understanding of the universe.

The Bubbles at the Heart of the Milky Way

MeerKAT's most iconic discovery came in

(Continued on page 51)

Location	Karoo Northern Cape - 90 km north of Carnarvon
Dishes	64 antennas, each 13,5 m in diameter
Array diameter	Approximately 8 km
Inaugurated	13 July 2018
Operator	SARAO / NRF, South Africa
Frequency range	580 MHz to 3,5 GHZ (multiple receivers)
Award	Royal Astronomical Society Group Achievement Award 2023
Role	SKA precursor — will integrate with SKA-MID

(MeerKAT from page 50)

September 2019, with the very first scientific result from its complete 64-dish array. Pointing toward the centre of our own galaxy, astronomers discovered two enormous balloon-like radio-emitting structures towering hundreds of light-years above and below the plane of the Milky Way. These radio bubbles, stretching roughly 1 400 light-years across the galactic centre, had been completely hidden from previous telescopes by the blinding glare of radio emission from the galactic plane itself.

The structures are believed to be the remnant of a phenomenally energetic eruption that occurred near Sagittarius A* the four-million solar mass black hole lurking at the centre of our galaxy several million years ago. Whether triggered by a burst of star formation that sent shockwaves through the galactic centre, or by a feeding frenzy as the black hole devoured vast quantities of gas and dust, the bubbles stand as a monument to an event of almost incomprehensible violence in our galaxy's past. The result was published in *Nature* and made headlines worldwide.

60 New Cosmic Structures — and Counting

In work published in early 2026, MeerKAT researchers identified 103 diffuse radio sources in galaxy clusters, 60 of which had never been detected before by any instrument. These findings illuminate how galaxy clusters the largest gravitationally bound structures in the universe evolve, interact and redistribute energy across cosmic scales. Each new structure is a clue to the forces shaping the universe's large-scale architecture.

Giants in the Deep

MeerKAT has proved to be an exceptional hunter of giant radio galaxies enormous structures formed when supermassive black holes at the cores of galaxies launch jets of plasma that travel millions of light-years into intergalactic space, lighting up as they go. In January 2025, a team from the University of Cape Town published results revealing new giant radio galaxies discovered with MeerKAT, with co-author Kathleen Charlton noting that the number of such discoveries had 'absolutely exploded' in the preceding five years thanks to MeerKAT's sensitivity.

Neutron Stars, Pulsars and Gravitational Waves

MeerKAT has been a powerful tool for pulsar science the study of rapidly rotating neutron stars that emit beams of radio waves with clockwork precision. By monitoring arrays of pulsars spread across the galaxy, astronomers can use them as a detector for gravitational waves ripples in space-time caused by the most violent events in the cosmos. MeerKAT contributed to the detection of radio afterglow from a neutron star merger event, earning the RAS Group Achievement Award mention as one of the instrument's headline breakthroughs.

Connecting with the World

In January 2025, MeerKAT was successfully integrated for the first time with the European VLBI Network (EVN) the world's most sensitive network of radio telescopes using very long baseline interferometry. The combined system produced the highest resolution images of a distant black hole jet ever achieved from the southern hemisphere, opening new possibilities for international collaboration and pointing toward what the SKA era will make routine.

Growing the Array — MeerKAT+

MeerKAT is not standing still. The MeerKAT+

(Continued on page 52)

Key Discoveries at a Glance

2019: Giant radio bubbles at the Milly Way's galactic centre, caused by emption near Sagittarius A* millions of years ago - published in Nature.
2021: Multiple giant radio galaxies discovered, with UCT researchers among the lead authors.
2023: RAS Group Achievement Award for breakthrough observations including neutron star merger afterglow.
2025: Final integration with the global EVN network, producing highest-resolution images from the southern hemisphere.
2026: 60 previously unknown cosmic structures identified in galaxy clusters.

(MeerKAT from page 51)

expansion project, jointly funded by SARAO and Germany's Max Planck Society with support from Italy's Istituto Nazionale di Astrofisica, is adding 14 new dishes to the array. The first dish was delivered in February 2024 and by late 2025, five additional SKA Mid dishes had joined the array alongside the 64 MeerKAT dishes, bringing the total to 83 antennas. This expanded array, designated SKA-Mid AA1.0, is already delivering improved sensitivity and survey speed a preview of what the full SKA will achieve.

Why This Matters To Us

The connection between MeerKAT, the SKA and the amateur radio community

We Share These Frequencies

If you have ever hunted interference in your own shack, you already understand MeerKAT's fundamental challenge at a human scale. We all know the frustration of a noise source that raises the floor on 40 m, or a switching supply that puts hash across a quiet band. Radio frequency interference RFI is to radio astronomy exactly what light pollution is to optical astronomy: invisible to those who cause it, catastrophic to those trying to observe through it.

MeerKAT listens on frequencies we use. The hydrogen line at 1 420.405 MHz one of the most important frequencies in radio astronomy, used to map the structure of galaxies including our own sits in the middle of the 23 cm amateur band. The telescope's receivers span from around 580 MHz to 3,5 GHz depending on the feed installed, covering portions of spectrum that amateur allocations share or adjoin.

The Karoo's radio quiet zone is not a comment on amateur radio in particular it applies to everything equally. But it is a vivid demonstration of just how sensitive modern radio receivers can be and a reminder that our frequencies carry far more than our signals. Every switching power supply, every solar inverter, every LED driver we use radiates into the same spectrum we spend so much effort trying to use cleanly.

The Same Ionosphere

There is a deeper connection too. The ionosphere that MeerKAT must account for when it observes at certain frequencies the layer of charged particles that refracts and absorbs radio waves is the same ionosphere, we rely on for DX. The physics of propagation that lets your FT8 signal reach Japan on 10 m is the same physics that limits what MeerKAT can observe and when. Radio astronomy and amateur radio are, at a fundamental level, two activities built on the same physical foundation.

Radio astronomy has, in fact, given back to amateur radio in practical ways. The development of low-noise amplifiers for radio telescope front ends has influenced receiver design across the industry. Wi-Fi itself now ironically banned in the Karoo quiet zone owes its development partly to radio astronomy research conducted in Australia. The technologies flow in both directions.

Pride in Our Backyard

For South African amateurs, there is a particular reason to pay attention to MeerKAT: it is ours. Designed here, built here, operated here by South

(Continued on page 53)

(MeerKAT from page 52)

African scientists and engineers and now recognised as one of the most productive radio telescopes in the world. The Royal Astronomical Society does not hand out Group Achievement Awards to instruments that are merely good. MeerKAT is genuinely exceptional.

And the best is still to come. MeerKAT will eventually be absorbed into SKA-Mid a 197-dish array centred on the same Karoo site, incorporating the 64 MeerKAT dishes alongside new SKA dishes built to even more exacting specifications. Construction is actively under way. By January 2026, the first SKA-Mid dishes had achieved 'first fringes' the moment when two dishes first worked together as an interferometer, the equivalent of a first QSO for a new station. First science data from a 64-dish SKA Mid array is expected by early 2027.

Closing Thought

The next time you are on 40 m late at night, spinning the dial through the mix of signals and noise that populates a busy band, spare a thought for sixty-four dishes in the red Karoo dust. They are doing what we do listening to what the radio spectrum has to tell us but at a scale and sensitivity that makes our most sensitive receivers look almost crude by comparison. They are listening to the universe. And to do it, South Africa silenced an area the size of Portugal. That is something to be proud of.

References

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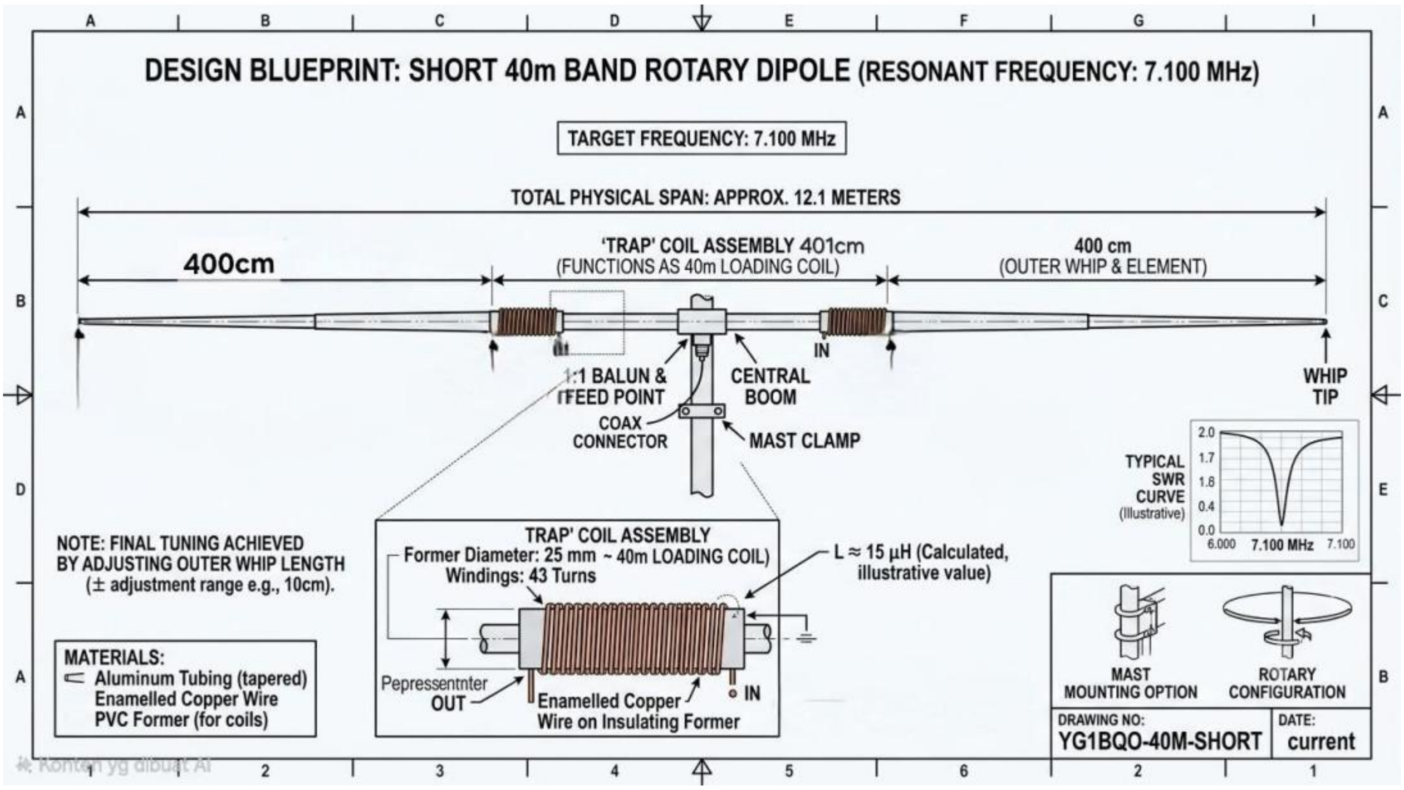
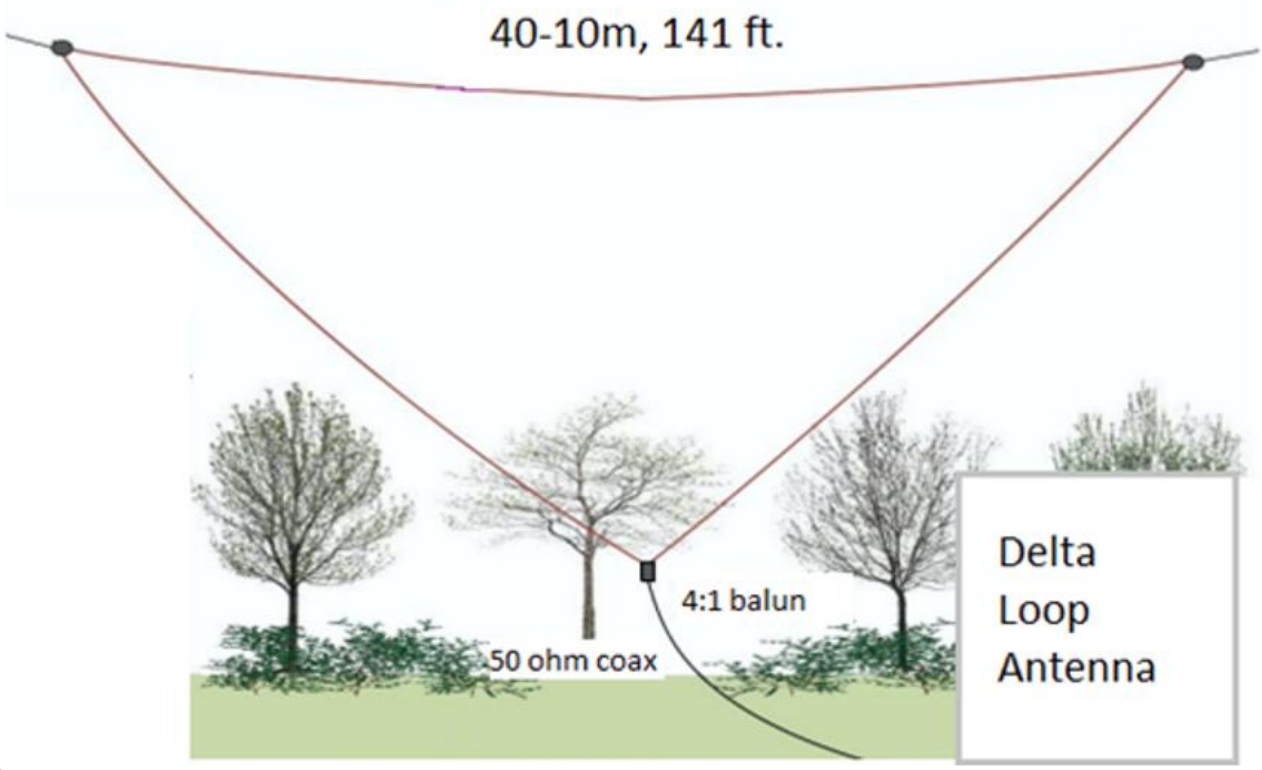


In the Loop: Delta Loop Antennas

Mark Haverstock, K8MSH



Looking for a wire antenna that is inexpensive, easy to build and works great for DX above 40 m? A delta loop and its variants can make an effective single-band or multiband antenna. The larger dimensions of the loop increase radiation efficiency as compared to the typical half-wave dipole.

Shape Shifting

For those with limited space, the delta loop antenna offers a compact and space-efficient design. Its triangular shape allows it to fit into smaller areas, making it suitable for installations in urban environments or where space constraints are a concern. The delta with the point down is convenient for a rigid top support or strung between two trees like a dipole and only requires a short feed line to reach the ground. For shorter supports, the delta with the point up can be used.

A full-size delta loop, fed in the bottom corner, is a good low angle radiator and is a DX dream. This antenna can have up to a 3 dBi gain over a ½ wave centre fed dipole, depending on height. It is not only a great transmitting antenna but also a low-noise receiving antenna. The direction of radiation is broadside to the antenna - if the base wire of the antenna goes from north to south, the direction of gain will be east and west.

This simple broadband antenna is easy to construct, has gain similar or better than a dipole and is generally tolerant of nearby objects. It can be erected in almost any configuration, provided the wires are well separated.

The Build

Using the formula 1,005 /freq (MHz) gives the total size in feet. This is usually divided among the three sides, forming an equilateral triangle. When the antenna is horizontally polarized, it should be mounted as high as possible, but it can work well at low heights of 10 - 30 feet. They are quieter than a dipole or vertical, have a broader bandwidth and slightly outperform a dipole antenna.

Delta loop wire lengths at mid-band

10 metres: 34,84 feet
12 metres: 40,29 feet
15 metres: 47,35 feet
17 metres: 55,47 feet
20 metres: 70,55 feet
30 metres: 97,19 feet
40 metres: 140,56 feet (IARU Region 2 has 7,000 to 7,300 MHz)
75/80 metres: 269,80 feet (IARU Region 2 has

(Continued on page 55)

(Delta Loop Antennas from page 54)

3,500 to 4,000 MHz)

160 metres: 528,9 feet (IARU Region 2 has 1,800 to 2,000 MHz)

The feed point impedance of a delta loop in free space is approximately 100 - 120 ohms. When installed close to ground in the real world, the feed point impedance can vary from 50 - 240 ohms depending on configuration, orientation and choice of feed point. Because of this, a feed point matching system is required for multiband operation.

There are multiband delta loop designs available that use an equilateral triangle with apex up or down and feed points on the bottom, side and corner. Each variation changes the characteristics slightly regarding the impedance, gain, polarization, pattern and, from the DX point of view, the take-off angles.

When using coaxial cable, a 4:1 balun is added for a multiband antenna. Sometimes ladder line is used at the feed point in addition to a ladder line matching stub on the opposite end. Tuners, either at the base of the antenna or in your ham shack, can also be used.

Monoband delta loops are also an option. They can tune up on its second harmonic at a higher frequency: 160 m loop on 80 m, 80 m loop on 40 m, 20 m loop on 10 m. The Bushcomm Delta Diamond is made for 60 m but can be adjusted for other bands.

Perhaps the biggest decision is which polarization to use. The below image shows the typical feed points for horizontal and vertical polarization. Vertical polarization is preferred for working DX.

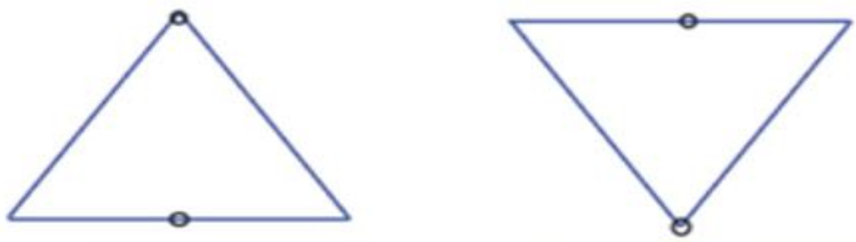
Shortened Delta Loop

A 40 m delta loop measures roughly 140,5 feet, making each side about 46,8 feet. Several articles about delta loops mention that a reduction to 0,75 wavelength can be done while still maintaining good results. Given these figures, it could be reduced to a total length of about 105 feet, with each side 35 feet long.

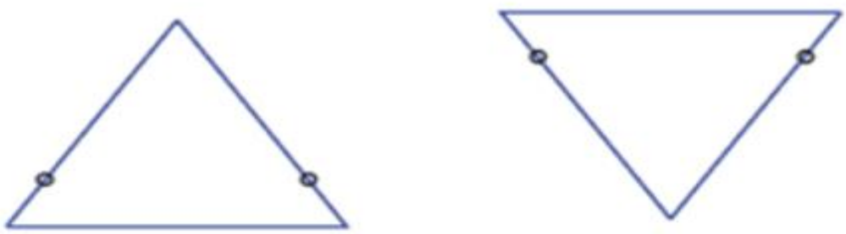
Searching the DX Engineering catalogue for commercially-made delta loops, I found two that had compact versions. The first was Chameleon's Tactical Delta Loop, a portable antenna incorporating a matching transformer and tuneable from 3,5 to 54,0 MHz with an ATU. EAntenna's HF Rotatable Delta Loop has 1- and 3-kW models intended for base station use and include a matching unit at the antenna mount. They are tuneable from 30 to 6 metres - wide range tuners also provide operations on 40 metres.

Shape of Things to Come

Delta loops are good performers, cheap, simple, sometimes portable and one more option to get on the air. Put the force of the delta loop behind your signal.



Delta Loop--Horizontal polarization feedpoints



Vertical polarization feedpoints

Hanging a Treetop Antenna with a Drone

Michael Shanblatt, W3MAS and Joseph Warwick, KB3ZED first published in QST March 2018

Whether you throw a weighted line into a tree or use a slingshot or air launcher to get your antennas aloft, these methods suffer from two problems: accuracy and the broad arc of the launch line.

Hanging the line by drone overcomes these issues, as it allows the line to be dropped straight down through the tree, allowing almost pinpoint accuracy.

We retrofitted a radio-controlled release mechanism onto a drone to enable us to drop a heavy-duty monofilament fishing line while the drone, or UAV (Unmanned Aerial Vehicle), was hovering. The line was weighted with a tennis ball and the other end was released by spool from the ground near the base of the tree. Several accurate drops were made from a height of about 100 feet over some very tall trees in a densely wooded area.

At the end of the day, we replaced the fishing line with ¾-inch double-braided Dacron line and raised a very high Carolina Windom antenna. We used a second drone to guide the positioning of the drop drone and to record the event from above.

Figure 1. The drop drone, a OJI F550 Flamewheel Hexacopter, in pre-flight position.

Our Drones of Choice

The most common UAV on the market is a basic quadcopter - a drone that is lifted and propelled by four rotors.

We chose a OJI F550 Flamewheel Hexacopter (which we will refer to as the "Hexacopter" or "drop drone") to carry and release the load and a OJI Phantom 3 Professional Quadcopter for sighting and recording the event.

The Hexacopter is a hobby-oriented UAV with six rotors. It can carry a heavier load and is easily modified for experimental use. Basic drone operation requires a minimum of five channels. Additional channels on the Hexacopter allow for the selection of its various flight modes and are available for user-modified tasks - in our case, the release of the fishing line by servo control.

The OJI Phantom 3 is a professional-quality UAV quadcopter designed to carry a high-quality camera and maintain efficiency for longer flight times. Its design usually limits additional pay-load and it is more difficult to modify.

The Hexacopter used a simple video camera and onboard transmitter (200 mW), while the Quadcopter carried a 4K camera. Both drones transmitted live video back to the ground station to guide the pilot for positioning the drop line over the targeted point.

How We Did It

The underlying concept was simple: fly a drone carrying a tag line, with a small weight attached, up over a tree and have a mechanism to release the line when the drone is in place.

For the tag line, we used lightweight monofilament fishing line (10-pound test), dispensed by fishing reel from the take-off point. Because the drone has obvious lifting capabilities, the person in charge of the tag line was responsible for assuring that it remained loose and ran freely off the reel. Once the drone was positioned and hovering at the drop point, the base of the tag line (fishing reel end) was walked to the desired pull-up point for the antenna.

The Hexacopter's onboard camera was used to position the drone at the vertical point above the tree where the weighted line was to be dropped. To provide more accuracy for a precise vertical drop and - perhaps more importantly - to film the event, the Quadcopter with the high-resolution camera was positioned to hover at a safe distance over the drop drone. This allowed us to determine when the drop drone was exactly vertical to the point where we wanted the weight to land. Video taken during the process is available at

(Continued on page 57)

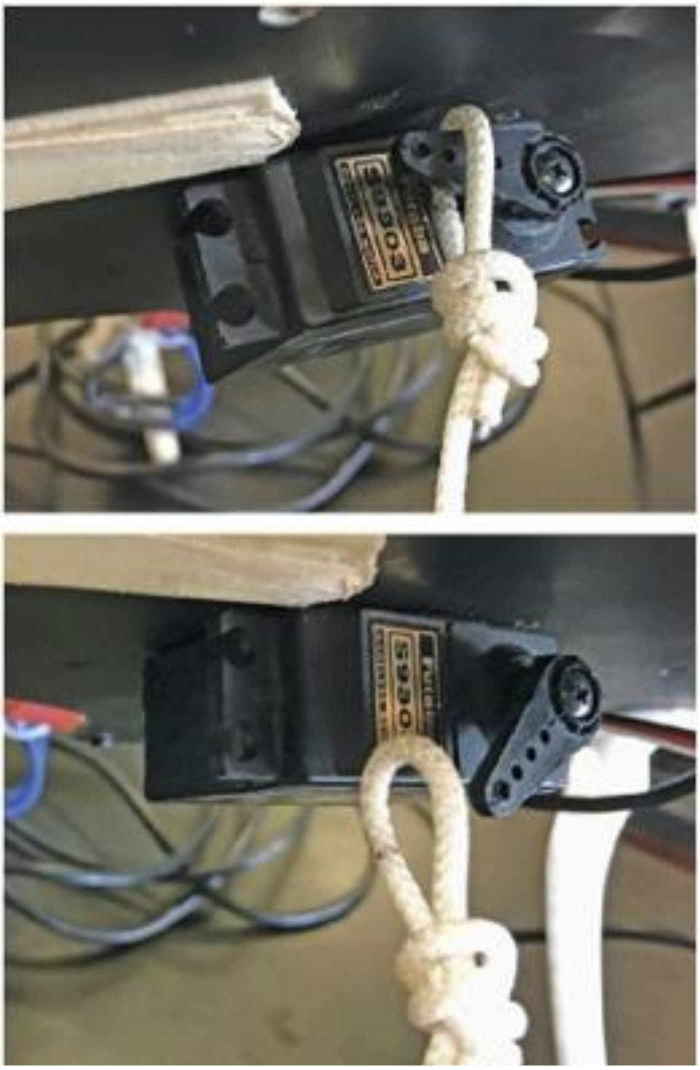
(Using a Drone from page 56)
[www.youtube.com/watch?v=wtxfbSYeXE0.](www.youtube.com/watch?v=wtxfbSYeXE0)

Figure 1 shows a picture of the Hexacopter in its pre-flight position. A bright-coloured tennis ball was used as the weight on the dropped end of the line. Figure 2 shows the Hexacopter after take-off, with tennis ball weight hanging freely. The 10-pound fishing line is attached to the tennis ball through the release mechanism and is too thin to show up in the photograph.

Having a second drone for positioning and photography was a convenience, but not a necessity. In conjunction with the Hexacopter's onboard camera, one could have a few friends positioned around the tree to sight the vertical point by visual triangulation. Moreover, even a drop drone without a camera could be positioned by sight triangulation and still provide far more accuracy than a slingshot or air launcher.

Figure 2. The drop drone, a OJI F550 Flamewheel Hexacopter, after liftoff. Note that the trailing line is too thin and translucent to show up in the photograph.

Figure 3. Close-ups of the servo release arm. A small arm on the upper-right corner of the mechanism pivots downward. A small nook (barely visible) in the arm held the drop line. For clarity, white cord was used in place of the fishing line for these photos.



Release Mechanism

The release mechanism was the only non-standard component of our drone setup. The control system between the handheld joystick and the drone's onboard microcontroller provides for several user-defined signals to be transmitted to the drone for flight control and a variety of user-designed applications.

The Hexacopter requires a minimum of five channels to operate: throttle, rudder, aileron, elevator and flight mode. The flight mode is a three -position switch selecting one of three modes: **GPS HOLD, NO GPS HOLD** and **EMERGENCY RETURN** to home.

Depending on the type of controller, one or more extra channels are available for user-defined functions. In our case, we programmed a sixth channel to operate a simple standard servo (44 oz-in of torque) for the release mechanism. The servo limits were set to just above horizontal position to a vertical position. When the sixth channel switch was thrown, the servo arm moved from the above horizontal position (holding position) to the vertical position (release position). A simple plastic arm was fitted on the servo axle to hold the fishing line (see

(Using a Drone from page 57)

Figure 3).

The side face of the servo was simply glued to the under frame of the aircraft using quick-set epoxy. With the fishing line attached to the centre underbody of the aircraft, it was a little tricky to keep the line out of the way of the propellers during take-off. Keeping the string slightly taut and a quick take-off prevented any problems with tangling, or with the line getting pulled into the propellers.

Issues We Encountered

We had to wait for a calm day to fly the drones - wind is also an issue when using slingshots and air launchers to raise antennas. Finally, a calm day came.

On our first attempt, the fishing line was tied to a small metal ring from a keychain and hooked over the servo arm. This failed on the first try after the ring slid down the arm and over the centre shaft of the servo. Our simple solution was to remove the metal key ring and simply tie a loop with a very small radius at the end of the fishing line. The loop was small enough not to advance up on the slightly tapered release arm and yet small enough to slip off when released. After this simplification, the release mechanism worked as planned and the fishing line, with the tennis ball weight, fell on command without fault. We were able to drop two lines quickly and accurately.

With a bit of practice, anyone can use this method to raise their antennas - and might find themselves picking up a new hobby in the drones themselves.

Getting Started with UAVs

Just like Amateur Radio, the UAV hobby can be entered at various levels. Entry-level fly-ready kits (including the controller) are available for as little as a few hundred dollars. Higher-priced systems offer greater stability, camera/video, video transmission and range of operation.

Fly-ready drones and DIY kits are available everywhere, from mall kiosks to local hobby stores to web retailers that can be located with a simple online search for "drone kits," "quadcopters," or the like. One of our favourite retailers, www.dronenerds.com, is located in Florida and caters to recreational and professional UAV pilots around the country.

And, just as in Amateur Radio, someone interested in UAVs as an in-depth technical hobby may choose to build a custom Quad or Hexacopter. A good starting point is to contact a local Drone User's Group at droneusergroup.net. You will meet experienced builders and pilots to help you get started. Because you will be playing with fragile, lightweight, often expensive equipment, it is best to learn to fly from an experienced pilot.

Safety and Legal Considerations

Before jumping on the UAV bandwagon, one must be aware of both safety and legal issues. In August 2016, the FAA created Part 107 to regulate commercial sUAS (small Unmanned Aerial Systems) operations. Our pilot, Joe Warwick, has since taken his Remote Pilot Exam to qualify for his license to fly UAVs commercially. The FAAs rules define sUAS as either hobby or commercial. "Hobby" is defined by the FAA as, "Flying for enjoyment and not for work, business purposes, or for compensation or hire." For more information about the FAA and sUAS, go to https://www.faa.gov/uas/faqs/.

The fundamental safety rules that all must be

(Continued on page 59)

Our Basic Equipment, with Approximate Prices	
Hexacopter (drop drone)	
OJI F550 Hexacopter Kit	$299
Spektrum OX6 transmitter and receiver	$160
Standard servo for line release	$20
Venom 5,000 mAh LiPo 4S battery with charger	$103
5,8 GHz, 200 mW AV transmitter with 5,8 GHz receiver	$33
FPV (first-person view) camera	$30
Quadcopter	
OJI Phantom 3 Professional (4K Camera) with extended battery	$999

(Using a Drone from page 58)

aware of include:

- Do not fly over people who are not participating or aware of the activity.
- Understand the risk of getting the UAV caught up in tree branches.
- One pilot per UAV - one person is not permitted to simultaneously operate multiple drones.
- Make sure you are not in controlled airspace (Classes B, C, D, or E); you typically need to be 5 miles away from any airport to fly. Notifying the control tower is required if you are in controlled airspace.

The FAA now requires a Remote Pilot License (under FAA Part 107) for an individual to perform commercial operations with drones.

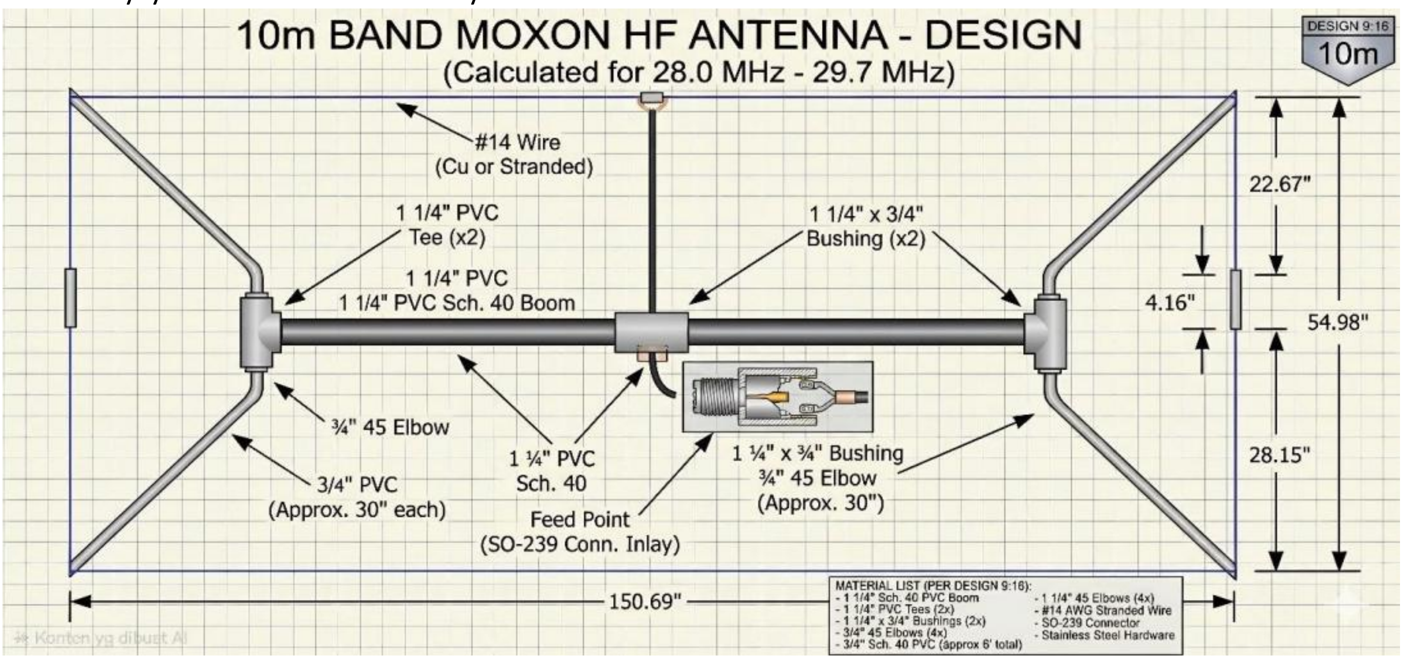
It takes 10 - 20 hours to prepare for this licensing exam and the exam cost is $150. Test preparation material is available online at sites such as www.uavcoach.com. An individual hobbyist should consult knowbeforeyoufly.org for details on current rules and regulations for recreational users.

In South Africa - https://www.caa.co.za/industry-information/uas/

All photos by the authors.

Michael Shanblatt, Ph.D., W3MAS, is Professor Emeritus of Electrical and Computer Engineering at Michigan State University. He has been involved in radio experimentation and repair since high school. For many years he was the faculty advisor to the MSU Amateur Radio Club, W8SH. Since retiring he resides in Bucks County, Pennsylvania, where he is an active member of the Warminster Amateur Radio Club. Michael can be reached at w3mas@arrl.net.

Joseph Warwick, KB3ZED, has been teaching physics for 26 years in the Council Rock School District and currently serves as the science department coordinator for Council Rock High School South. He earned his BS in Physics and minor in Mathematics at Virginia Tech and a Masters in Science and Math Education at Lehigh University. He has been involved with remote control aircraft for 30 years and created a summer programme for children, Physics and Flight STEM Camp, which is in its thirteenth year and teaches the physics of flight outside of the traditional classroom using remote-control model airplanes and drones. In the early days of UAVs, Joe and five of his students were required to earn their amateur radio license in 2012 in order to fly long-range drones under a local grant. Joe and his colleagues later set up a station at their school in order to participate in NASA's ARISS programme. Joe is currently training law enforcement and other public safety organizations to create UAV Units in their departments in compliance with the FAA. He has flown crime scenes to record evidence with photography and to create 3D models. He can be reached at runwarwick@gmail.com.



The Cape Infanta Lighthouse

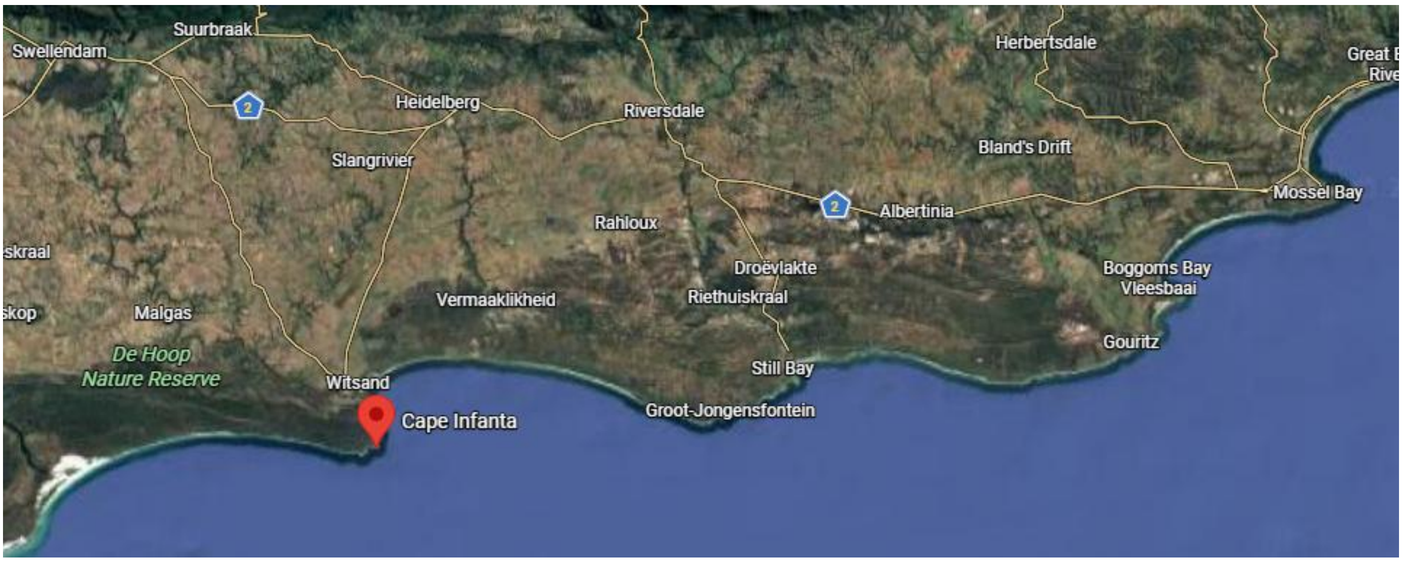
The deputy assistant lighthouse keeper

Infanta is a settlement in the Overberg District Municipality in the Western Cape. It is a seaside resort at the estuary of the Breede River, at St Sebastian Bay, some 80 km south-east of Swellendam. It takes its name from Cape Infanta several kilometres to the south, and from its situation on the Breede River. The cape was in turn named after Captain João Infante, who commanded the *São Pantaleão* (named after Saint Pantaleon), one of Bartolomeu Dias's caravels during the voyage around the Cape of Good Hope in 1487/1488.

The Lighthouse

The Cape Infanta lighthouse is inside the De Hoop Nature Reserve (ZSFF-0098), so special arrangements had to be made to access the site. The De Hoop personnel were very helpful and we were permitted to travel on a sand and limestone track for 2 hours (37 km) to reach the lighthouse. The last few kilometres are heavily overgrown with

(Continued on page 61)



(Lighthouses from page 60)

rooikrans (*Acacia cyclops*.) The first view was thus a relief.

The lighthouse is actually sited on Uiterstepunt which is west of Cape Infanta. This was originally privately owned property, which was expropriated by Armscor, later Denel. The land is still owned by Denel, but custodianship has been granted to Cape Nature. The actual Cape Infanta point is very close by and was photographed in the afternoon sun.

The Cape Infanta Lighthouse, located in the Western Cape near the San Sebastian Private Nature Reserve and overlooking the rugged Uiterstepunt, is a 15-metre-tall triangular skeletal (lattice) tower. Commissioned on 15 March 1979, this active beacon flashes white three times every 20 seconds and remains a key navigational guide for ships passing the shallow, sandy coastline.

The Technical Stuff

Commissioned: 15 March 1979
Construction: Aluminium lattice tower
Height: 15 meters
Focal plane: 53 metres above sea level
Day markings: White tower with a red lantern room
Range: 24 nm or 44 km
Flash pattern: Group flashing, 3 flashes per 20s, flash 0,5s, eclipse 2s, white.
Co-ordinates: 34 28,1921 S 20 50,7738 E
Grid square: KF05KM

International Lighthouse/Lightship number: ZA0002
Amateur Radio Lighthouse Society number: SAF-036

Sources

https://lighthouses-of-sa.blogspot.com/2016/12/no-16-cape-infanta-lighthouse.html; www.lightphotos.net/photos/displayimage.php?album=126&pid=22853; ILLW; ARLHS; Wikipedia

The 29th International Lighthouse/Lightship Weekend (ILLW) runs from 00:01 UTC on Saturday 15 August to 23:59:59 UTC on Sunday 16 August 2026 and you can participate for the full 48 hours or part thereof.

What is the ILLW? Is it a contest?

The event is NOT a contest. There are no prizes, certificates or other enticements to participate and therefore, participation is free. Each station's operators decide how they will operate their station regards modes and bands while complying with their amateur licence. Participants are not committed to being on the air during the entire period - only as much as they can. There are no restrictions on aerials or power. We wish operators to enjoy themselves and have fun whilst contacting as many amateur radio stations as possible. We request that stations take time to work other lighthouses or lightships as well as the slow operator, or the newly-licensed or QRP stations.

How close to the Lighthouse do I have to be?

As most available space in many lighthouses is usually filled to capacity, our activity does not have to take place inside the tower itself. Field day type set-up at the light or other building next to the light is OK. *Our guidelines require that the station must be AT or ADJACENT to the light. Adjacent means next to or as close as possible. The intention behind this requirement is that the station should have a visible presence to the passing public who may be visiting the lighthouse over the weekend*.

Permission to operate from a lighthouse/ lightship should be obtained from the relevant authorities. Operation from faux or false lighthouses, lights on poles, etc., is discouraged as they are not within the spirit of the event.

What is regarded as a Lighthouse for this event?

Generally regarded as a structure which is or has been listed officially as an aid to navigation in a recognised publication such as the British

(Continued on page 63)

(ILLW from page 62)

Admiralty List of Light and Foghorns and which falls into the classic concept of a lighthouse. For example, a substantial tower having an internal staircase, a revolving Fresnel lens and had or has a designated lighthouse keeper. Also permitted are lighthouses which have been moved to a museum for historic reasons. As stated in the previous paragraph, the lighthouse should also be visible to and visited by the passing public where possible.

The fact that a light has been listed in official documents does not automatically qualify the structure for this event such as range lights, channel markers and break wall lights. Examples of some lights which have been submitted for the event, but which have been rejected can be seen on this web page.

The increase in the popularity of the ILLW has also seen an increase in the number of entries for lights which do not comply with the guidelines or the spirit of the event. It is important that entrants appreciate and understand the concept of the ILLW which is to promote public awareness of lighthouses and lightships and their need for preservation and restoration and at the same time to promote amateur radio and to foster International goodwill as well as remembering the dedication of those who served as lighthouse keepers. This is why there are fairly strict guidelines as to the definition of acceptable lights for the event.

The Australian Maritime Safety Authority has this to say about aids to navigation - Lighthouses and other aids to navigation can be used to help mariners in determining their position or safe course whilst warning them of fixed dangers or obstructions to navigation. They assist the mariner at sea to make landfall, safely navigate along the coast, avoid (by marking) certain objects and shoals that may be classified as a potential danger or obstruction to navigation and assist in moving through other waterways. What is the main difference between a lighthouse and an Aid to Navigation. A lighthouse - the principal structure of a light station, generally made up of a lantern, balcony and tower. An aid to navigation can be a lighthouse but also includes lit and unlit buoys, lit or unlit beacons, radio navigation aids such as radar transponders (RACON) and Automatic Identification Systems (AIS), fog signals, etc.

In other words, all lighthouses are aids to navigation but not all aids to navigation are lighthouses.

Lightships: Similarly, these are those lightships which are or have been listed officially as floating aids to navigation. Lightships that are currently being used as restaurants or other commercial operations are not acceptable for this event.

Faux Lights: Faux or false lighthouses are those which have never been an active aid to navigation and never listed officially as such. They are usually replicas, miniatures or other structures constructed for decorative purposes to satisfy some person's whimsy. Their use in this event is discouraged as they are not within the spirit of the event.

Having said that, it should be borne in mind that the ILLW organisers cannot prevent any amateur from operating at any lighthouse, but faux lights will generally not be listed on the official entrants list.

The onus is on operators to act within the spirit of the event, the object of which is to have a visible presence at or near the lighthouse because the event is used to obtain maximum exposure for our hobby. We invite the press and, QTH permitting, also the public and try to underline the obvious parallel between the international aspect in lighthouses, lightships and amateur radio.

What frequencies and modes can I use?

Because it is NOT a contest you may operate on any authorised frequency and mode as per your licence. It is not possible to specify particular frequencies as there are over 50 countries involved in this event and each has a different band plan so what is legal in one country may be illegal in another. Licence conditions also vary from one level to another and we are also dependent on propagation.

How do I call "CQ"?

To assist other stations, we request that participating CW stations add LT for lighthouse or LS for lightship, other stations add LIGHT, LGT, LIGHTHOUSE or LIGHTSHIP after their call. Some stations obtain a call sign with the letter L in the suffix to assist other stations identifying them as a

(Continued on page 64)

(ILLW from page 63)

participating station in the event.

Why is there a list of numbers for lighthouses at https://wllw.org

The ILLW organisers have compiled a list of lights which have participated in the event for the purpose of allocating an identifying number to each lighthouse/lightship. These numbers are simply there for use when conditions make it difficult for the name of the lighthouse to be clearly understood over the air waves.

The list will gradually be expanded but it will never attempt to be a definitive list of every lighthouse in existence. It will assist operators in difficult conditions to issue a contact number in lieu of the lighthouse name. The list thus far is here. If your lighthouse is not listed, do not worry just enter and leave the number field blank. A number will be allocated after your entry is received providing the structure complies with our guidelines. Our numbers are primarily for use during the event. You may, of course, use any other reference number if you so desire, for example if your contact is chasing an award and requires a qualifying number appropriate to that award.

Who do I contact if I have any other questions?

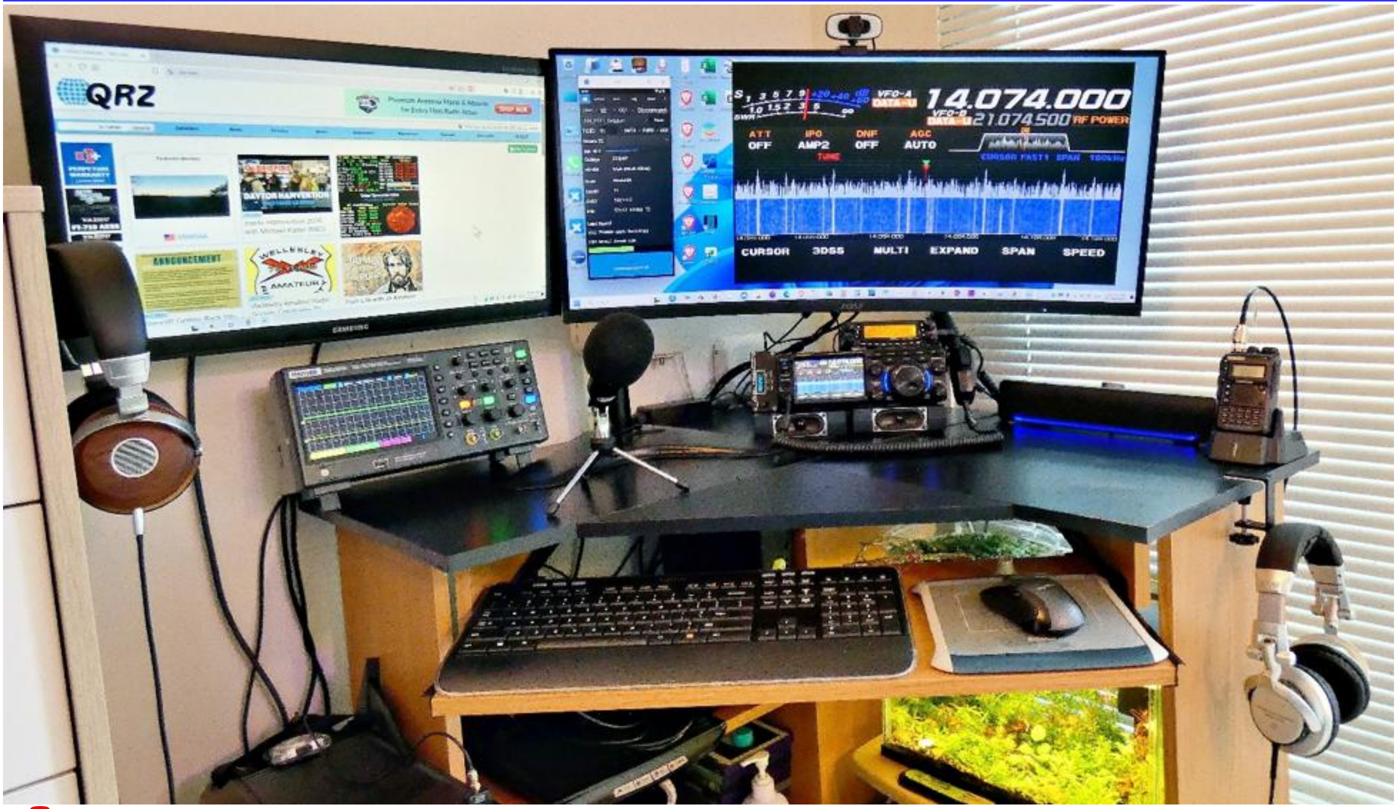
Finally, if you have any questions at all about the event or how to enter, please contact Kevin, VK2CE the organiser and webmaster using this link.

The Southern African lighthouses that are registered at the time of publication.

Lighthouse	ILLW no	ARLHS no	Operated by
Hondeklip Bay Lighthouse	n/a	SAF-049	Pierre, ZS6PS/3
Doringbaai Lighthouse	ZA0020	SAF-044	The Bo-Karoo ARC, ZR3VDK/1
Cape Columbine Lighthouse	ZA0001	SAF-034	The Boland ARC, ZS1BK
Roman Rock Lighthouse	ZA0027	SAF-024	The Roman Rock ARC, ZS0RR
Green Point Lighthouse	ZA0006	SAF-047	The Cape Town ARC, ZS1CT
Cape Point Lighthouse	ZA0014	SAF-007	The Cape Radio Group, ZS1CRG
Slangkop Lighthouse	ZA0015	SAF-026	Peter, ZS1PZ
Cape Hangklip Lighthouse	ZA0010	SAF-005	The Winelands ARC, ZS1WRC
Danger Point Lighthouse	ZA0005	SAF-012	The Overberg ARC, ZS1OAR
Cape Agulhas Lighthouse	ZA0011	SAF-004	The Boland ARC, ZS1BAK
Ystervark Point Lighthouse	ZA0009	SAF-073	The Eden ARC, ZS1ERZ
Cape St Blaize Lighthouse	ZA0026	SAF-010	The Southern Cape ARC, ZS1SKR
Cape Seal Lighthouse	ZA0033	SAF-038	The Cape Coast ARC, ZS1CCR

Knock on wood - headphones with wooden cups

Daniel Romila, VE7LCG



I am an advanced licensed radio amateur (maximum I can have in Canada), so I got a corner desk with some transceivers, walkie-talkies that I use in my radio activity. While modest, it looks like this.

Many things from the above picture were received as gifts, sometimes even without knowing exactly who was the person that made the gift. Anyhow, the above picture has some equipment in it and which element do you think attracts the attention the most?

The headphones that you see on the left of the picture, next to my corner desk, those semi-open, with wooden cups. I got them almost as a gift. I noticed them on Facebook Marketplace; I knew what they were and the owner wanted 10 CAD for them. I contacted the guy (a nice Korean man, a Ph.D. student at UBC Vancouver, Canada) and – believe it or not – I told him that I want the headphones (which were already posted for many weeks) and that the value of such new headphones (he sold them as new, with case and cable) is more than 10 CAD and to think if it is not better to keep them, or sell them to me for a higher price. But he really wanted to get rid of them and he wanted only 10 CAD (R116.)

The earpads indeed smelled of chemicals so strongly that my roommate did not allow me to keep them without fixing them; I spent 5 days washing them and yes, you read correctly, I washed

(Knock on wood from page 66)

the earpads with water and soap 5 days again and again.

What you see in the picture as headphones are either SIVGA SV004 or a knock-off kit for do-it-yourself. It is not clear if the DIY kit is the original or the knock off.

Wooden cups headphones look good, like a nice piece of furniture. Do they sound good? If I asked Google, the Artificial Intelligence version, I obtained the answer, "*Wooden cup headphones are prized for their natural acoustics, aesthetic appeal and reduced resonance compared to plastic or metal housings."*

The DIY kit that I got (or SIVGA SV004) have two versions: one with 50 mm drivers and one with 40 mm drivers and eventually two adapters for those smaller drivers. I found that 40 mm drivers do have their advantage over 50 mm drivers, when it is about clarity, especially for radio amateur communications. Let us not forget that the legendary SONY MDR-7506 headphones, that we still see in many recording studios, have 40 mm drivers.

All those being said, my personal preference usually goes towards 50 mm drivers (not 40, not 70).

Since there is a big debate out there if the wooden cups indeed make a big difference or not, I will not come with graphics, measurements and figures, because 50% of them say wooden cups are better and 50% of them say they are not better in any way.

Instead of this kind of partizan talk I would like to mention some models of such wooden headphones and some prices, in May 2026.

SIVGA Audio is a Chinese manufacturer. The M300 model is sold with around 92 USD and the Nightingale Pro 14,5mm Planar Magnetic Driver IEM is 417 USD. The declared Frequency response is 20 Hz - 40K Hz and the sensitivity 107 dB +/- 3 dB.

It is a very expensive piece of equipment, more expensive than many transceivers.

The nowadays over the head model, SV021, closed back with 50 mm driver, is around 252 USD. If it is only about looks, I prefer the older models, like the SV004 I got.

(Knock on wood from page 67)

For a little more money, this meaning $2 000, one can buy Meze Audio POET, a compact planar-magnetic headphones, capable of reproducing audio between 4 Hz and 96 KHz. It is shown in the last picture of this article. Being capable of reproducing high frequency allows a clean signal in the human hearing range and the total harmonic distortion is declared as being under 0,05%. It is a kind of heavy headphones, 405 grams.

JBL does not currently manufacture headphones with wooden earcups.

Sony does not currently manufacture or sell any mainstream or flagship headphones with wooden ear cups. But SONY created one of the most legendary wooden-cupped headphones of all time, Sony MDR-R10 (1989)

Sony MDR-Z1R do not feature wooden cups, they use an engineered aluminium housing designed to mimic the resonance and natural acoustics of wooden chambers. They can reproduce 120 KHz.

Other popular wooden headphones are FiiO FT1 – $150. They have 32 mm drivers.

FOSTEX does wooden headphones and I let you search and find models.

In my modest opinion, I would not spend on the headphones more money than on the transceiver itself. I can make a comparison between what I have in my use. SIVGA SV004 has very comfortable thick earpad that can be kept on the head hours and hours. The sound is OK. It is a pleasant sound, which does not excel in anything. OK clarity, OK separation, OK lack of muddiness, OK spatiality. They do not match my SONY MDR-V700, 50 mm drivers, which press on the head like hell and are not comfortable. I can say this for both the original SONY, marked as SONY and the various Chinese exactly looking models, most probably being exactly SONY MDR-V700 (my opinion, no proof!), exactly made on the same Chinese manufacturing line and just branded differently and sold at different price.

If you can get from somewhere cheap wooden headphones – as I did, with 10 CAD – do it! After such purchase most probably everybody will notice only the headphones and not your transceivers.

Water, jy het dit tot jy dit nie meer het nie

SafariNuus Junie 2026

As jy uitgaan om ‘n SOTA, POTA, HOTA, IOTA te aktiveer of RaDAR of Velddag of die QRP kompetisie daar in die veld, het jy al jou toerusting ingepak, maar wat van water en kos. Water is baie belangrik as jy op so ‘n uitstappie gaan. **Dink aan die water!**

Kom ons wees eerlik. Wanneer ons 'n kamp-reis beplan, spandeer ons baie meer tyd daaraan om oor die lekker goed te dink as wat ons oor water dink.

Watter tent gaan saam? Is die yskas vol? Het ons genoeg hout? Waar gaan ons kamp opslaan? En iewers tussen al die beplanning word die water sommer vinnig as vanselfsprekend aanvaar.

Tot die dag wat dit nie meer daar is nie.

(Vervolg op bladsy 69)

(Dink aan die Water vanaf bladsy 68)

Want daar is min dinge wat jou maag so vinnig laat draai soos wanneer iemand die kraan oopmaak en... niks gebeur nie.

Nie 'n druppel nie. Net stilte. Skielik begin die vrae kom. Hoeveel water het ons nog oor? Wanneer is die naaste plek waar ons kan hervul? Hoe ver is dit? Is dit veilig om hierdie water te drink?

En as jy diep in die bos, in die Kalahari, die Richtersveld of êrens op 'n grondpad is waar die naaste winkel twee uur se ry ver is, raak daardie vrae baie vinnig belangrik. Want water is nie soos hout wat jy dalk kan gaan optel nie. Dis nie soos ys wat jy dalk by die volgende vulstasie kan koop nie. Wanneer die water klaar is, is dit klaar. Ons het n gesegde wat sê: “Water is belangriker as brandstof.”

Vir sommige mense werk 'n paar waterkanne perfek. Gooi hulle vol, laai hulle in en ry. Vir ander maak 'n permanente watertenk baie meer sin. Veral as jy gereeld toer, lang afstande aanpak of daarvan hou om vir 'n paar dae heeltemal onafhanklik van kampterreine te wees.

Die belangrike vraag is egter nie net hoe jy die water bêre nie. Dis hoeveel jy nodig gaan hê.

En hier onderskat mense hulself gereeld. 'n Volwassene benodig maklik 5 liter water per dag net vir drink en basiese gebruik. Voeg kook, skottelgoed en hande was by, en jy kyk vinnig na 10 tot 15 liter per persoon per dag.

Maar as jou voertuig of kamp opstelling oor 'n stort beskik, verander die prentjie heeltemal. Selfs 'n vinnige kampstort kan tussen 10 en 20 liter water gebruik. Nou vat 'n gesin van vier wat vir drie dae kamp, en die getalle begin vinnig optel. Voor jy jou oë uitvee, het jy nie meer 50 of 60 liter nodig nie – jy kan maklik 100 tot 400 liter water deur 'n langnaweek gebruik, afhangend van hoe jy kamp.

Dis hoekom ervare “overlanders” amper altyd meer water saamneem as wat hulle dink hulle gaan nodig hê. Want wanneer dinge volgens plan verloop, het jy ekstra water oor. Wanneer dinge nié volgens plan verloop nie, kan daardie ekstra water die verskil maak tussen 'n klein ongerief en 'n groot probleem.

Dan is daar nog die vraag van waterkwaliteit. Want nie alle water wat helder lyk, is noodwendig veilig nie. Daardie mooi stroompie wat deur die kamp vloei lyk dalk perfek, maar jy weet nie wat 'n paar kilometer stroomop gebeur het nie.

Dis waar 'n goeie water suiweraar sy geld werd raak. Vir sommige mense is 'n eenvoudige filter genoeg. Vir ander wat gereeld afgeleë gebiede besoek, is 'n meer gevorderde suiwering stelsel een van die slimste beleggings wat hulle kan maak. Want die laaste ding wat jy wil hê wanneer jy op jou droom-avontuur is, is om siek te word van die water wat jou veronderstel was om aan die gang te hou.

Die waarheid is eenvoudig: Niemand het al ooit by die huis gekom en gesê, “Ek wens ek het minder water saamgebring.” Maar baie mense het al die teenoorgestelde gesê.

So wanneer jy volgende keer jou voertuig pak, moenie net dink aan die roete, die kampterrein of die bestemming nie.

Dink aan die water.

Want wanneer die son bak, die stof hang en jy ver van enige hulp af staan, verander water van iets wat lekker is om te hê... na die belangrikste ding in jou hele voertuig.

Heritage on the Air from Langebaanweg

Roy Walsh, ZS1YR

We were lucky enough to be able to register the Langebaanweg Air Force Base as a HOTA site. It was registered as AF0002 and was activated on the 20 June 2026 by Esme, ZS1YE and Roy, ZS1YR. We made all the necessary contacts to be able to activate the site. We also displayed the West Coast Amateur Radio Club banner. The Harvard in the photo is one of the Harvard's that were used in the Second World War.

A Delta Loop for 160 Meters

This linear-loaded antenna radiates well at low elevation angles

Ted Algren, KA6W First published in the March 2018 issue of QST

First-place winner in the 2017 QST Antenna Design Competition, 160 Metres and Lower Frequencies category

My passion for DXing on 160 metres left me searching for an effective low-angle radiating antenna for that band. Vertically polarized monopoles and vertical arrays with good ground systems are effective, but their size and real estate requirements are prohibitive for most of us. A reduced-height, vertically polarized loop might be an alternative antenna because a ground system is not required.

Square, triangular and circular loop configurations are well documented,[1] however, the vertical heights required for those configurations are restrictive at my location. I realized that the height of an isosceles triangle can be less than that of an equilateral triangle, so I designed a 160-metre -band isosceles triangle loop. Reducing the size of this 160-metre full-wave vertical triangular loop was the next goal.

The Vertical Loop

I was aware of loop resonant impedances and their matching requirements from past experience. An isosceles triangle with vertical sides of 0,293 wavelength and a base of 0,414 wavelength and polarized loop with a resonant impedance close to 112 Ω. If you start with an inverted V, which is two quarter-wavelength wires and connect a single wire between each low point to create an isosceles triangle, the resulting loop would require a base wire length twice the height of this isosceles triangle to yield the desired 112 Ω feed-point impedance. Although this loop would indeed be an isosceles loop, it would not be a full-wave antenna. Additional wires would be required to force the loop to resonate in the 160-metre band. The addition of linear loading using open-wire line (ladder line) to obtain loop resonance would create the desired resonant loop (see Figure 1).

A 75 Ω quarter-wave matching stub is required to match a 50 Ω coax line to the 112 Ω loop resonant impedance. Winding this matching stub into a common-mode choke (see Figure 2) completes the needed corner feed configuration.

The addition of a length of open-wire line connected at the apex of the loop (see Figure 3) would set the loop resonant frequency within the

(Continued on page 72)

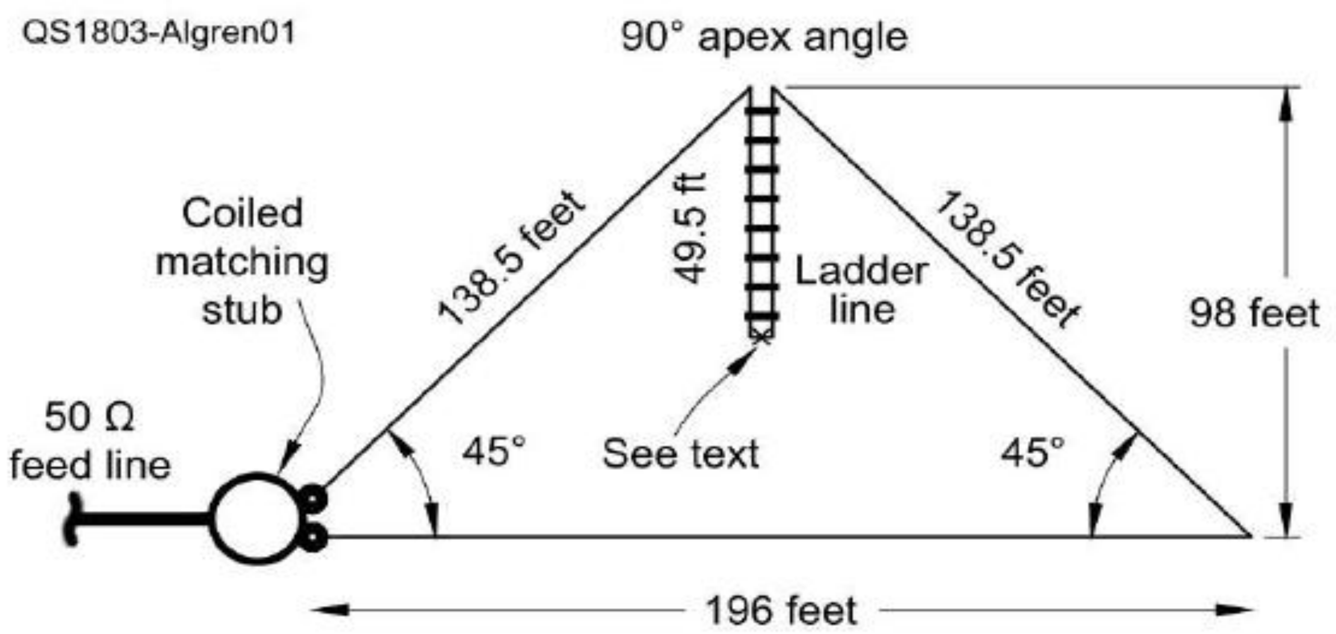


Figure 1. This KA6W 160-metre vertical isosceles delta loop is resonant at 1,830 MHz. The side lengths are a quarter wavelength each. The height of the loop is 98 feet from the apex to the bottom wire, which is 1½ feet above ground. Poly rope, not shown, holds the ladder line down.

Figure 2. The matching stub is an 88-foot, 8-inch-long piece of RG-11 75 Ω coax, wound tightly into a choke configuration and held in place with wide nylon zip ties.
Figure 3. View of the loop apex with attached open-wire line used for linear loading.

(Delta Loop for 160 from page 71)

160-metre band; for me, the lower CW portion of the band. Lengthening the open-wire line lowers the resonant frequency, while shortening the open-wire line raises the resonant frequency.

The New and Improved Design

I selected the *EZNEC+ version 6.0* software[2] to prove the concept and predict the performance of

(Continued on page 73)

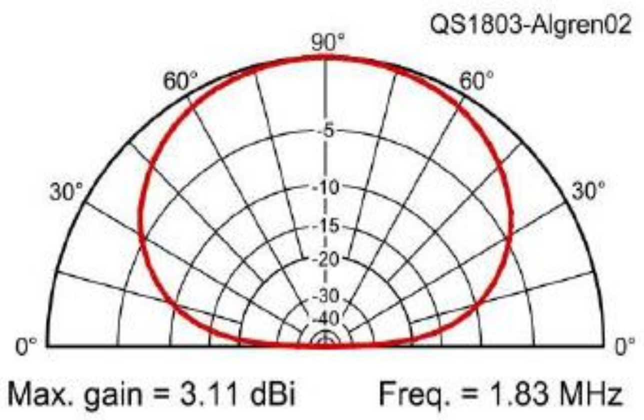


Figure 4. EZNEC elevation pattern of an inverted V antenna over a medium ground (conductivity of 0,005 S/m and a relative dielectric constant of 13). The inverted V is horizontally polarized, with its apex 0,185 of a wavelength high, hence the peak gain is at 90' elevation - not very useful for DXing.

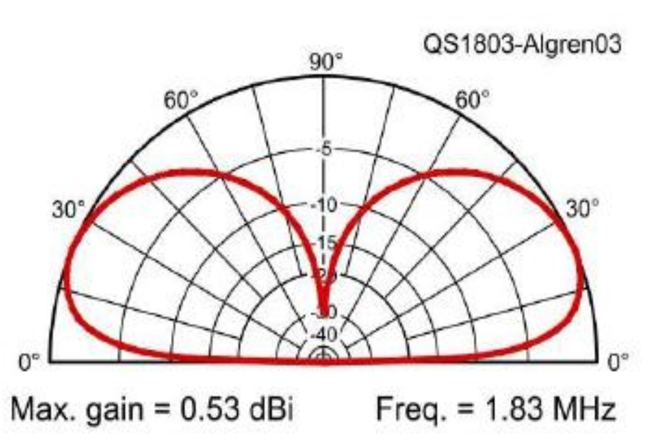
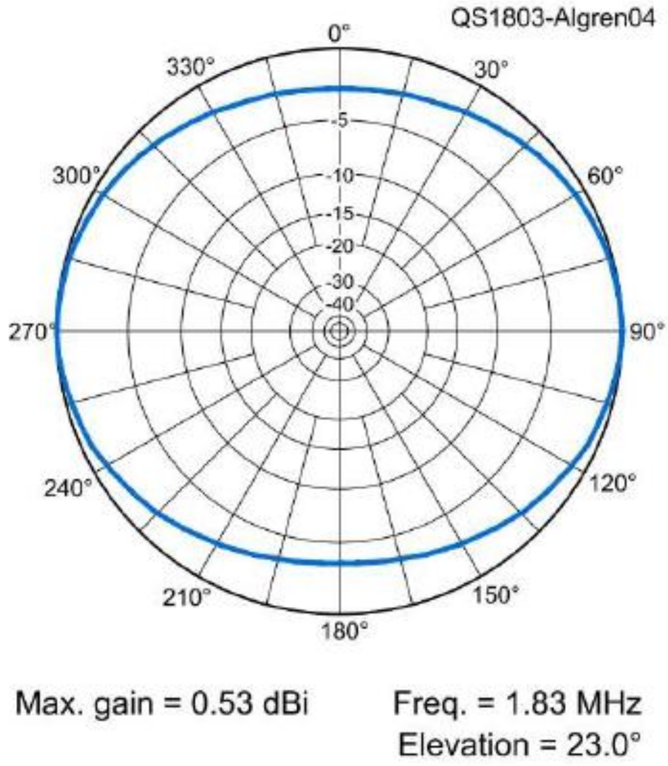


Figure 5. EZNEC elevation pattern of the vertically polarized KA6W loop antenna over medium ground has a peak at an elevation angle of 23°. At the more important elevation angles of 5° to 10°, the loop has more than a 3 dB advantage over the inverted V.



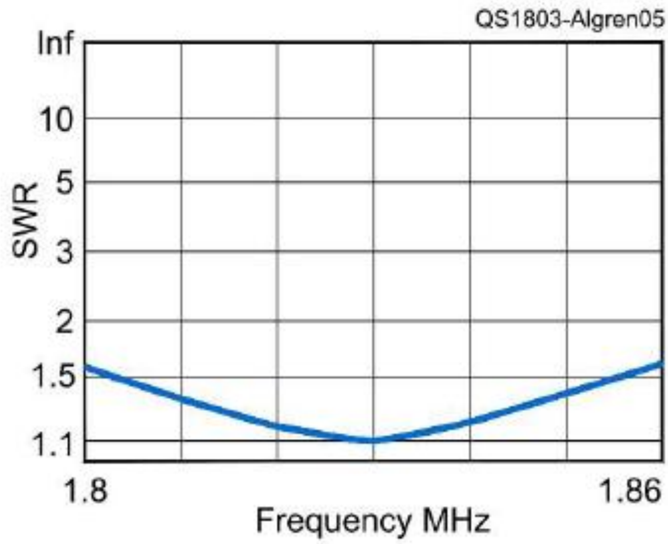


Figure 6. *EZNEC* azimuth pattern of KA6W loop antenna over medium ground at its peak gain elevation angle of 23°. While it is not quite omnidirectional, there is useful radiation at all azimuth angles.
Figure 7. SWR of the loop over medium ground, predicted using *EZNEC.*

(Delta Loop for 160 from page 72)

my loop design. Many amateurs use inverted V antennas on 160 - 40 metres. Figure 4 shows the elevation pattern of a horizontally polarized inverted V with the apex at 99½ feet. By comparison, Figures 5 and 6 show the elevation and azimuth patterns of my vertically polarized isosceles loop design - the loop has a lower signal launch angle. It also has very good SWR performance (see Figure 7). Further simulations of the loop model have shown that removing the jumper wire at the bottom of the open-wire line in Figure 1 results in an improved, more symmetrical radiation pattern. The computer simulations presented here are *without* jumper wire. Raising the loop so that the bottom wire is more than 1½ feet above ground is desirable. Of course, the gain of the loop is directly affected by the conditions of the ground over which the loop is mounted.

Putting It into Action

I have had very satisfying results while DXing over many years using various vertically polarized isosceles triangle loops. I had a linear-loaded, low-angle radiating 80-metre loop (see the sidebar, 'The Linear-Loaded Delta Loop for 80 Metres') that performed extremely well as a DXing antenna. It allowed me to contact more than 120 CW and phone DXCC entities. Many were long-path contacts radiating southwest from California during pre-sunrise hours. Using a full-size 160-metre isosceles loop, I was able to contact 198 DXCC entities on CW from a previous location. One of those entities was very special. In March of 2004, Eric Scace, K3NA, operating at 3B9C, answered my early morning reply to his "CQ up 5!"

It is my hope that future DXpeditions operating near salt water locations will use linear-loaded loops to enhance their signal performance. These loops do not require the installation of a ground plane, so DXpedition antenna set-up time and effort might be reduced.

It should be evident that wire loops have become my favourite HF antennas. Winning the 160 Metre and Lower category in the 2017 ARRL Antenna Design Competition for this design was entirely unexpected and is gratefully accepted. My sincere thanks to the ARRL individuals who spent time and effort judging all contest entries. Additional thanks go to Joel Hallas, W1ZR, for showing me how to configure *EZNEC+* to accurately

(Continued on page 74)

"Further simulations of the loop model have shown that removing the jumper wire at the bottom of the open-wire line results in an improved, more symmetrical radiation pattern."

(Delta Loop for 160 from page 73)

model my designs and suggesting the 80-metre loops described in the sidebar.

Notes

[1]The ARRL Antenna Book, 23rd Edition. Available from your ARRL dealer or the ARRL Bookstore, ARRL Item no. 0444. Telephone 860-594-0355, or toll-free in the US 888-277-5289; www.arrl.org/shop; pubsales@arrl.org.

[2]Several versions of *EZNEC* antenna modelling software are available from developer Roy Lewallen, W7EL, at www.eznec.com.

Bill of Materials for the 160-Metre Loop

- Approximately 485 feet of #12 or #14 AWG wire for the loop
- Approximately 65 feet of open-wire 600 Ω #18 AWG transmission line for the linear loading, from Larry Plessinger, AL7LW, at https://www.ebay.com/itm/LADDER-LINE-600-OHM-18-AWG/131390905037
- 88 feet, 8 inches of RG-11 75 Ω (or RG-59 75 Ω if running low power) 66% velocity factor coax for 1,830 MHz matching section and common-mode current choke
- Three to six insulators, at the builder's option, to use at wire ends
- ¼-inch poly rope to hang the loop and to hold open-wire line down
- PL-259 plug and PL-258-barrel coax connectors
- Black liquid electrical tape for application to all exposed solder connections
- Waterproof electrical tape to wrap PL-259 connectors

Ted Algren, KA6W, was first licensed in 1953 as WN0QYE, then W0QYE in 1954 and Amateur Extra-class in 1958. He entered college that year and earned BSEE and MSEE degrees separately at the University of Minnesota and Santa Clara University in California. Ted retired in 1998, leaving previous careers in Electronic Warfare Engineering and owning an Electronic-Systems Sales Representative firm. His hobbies include skiing, golf, chasing DX, casual Amateur Radio contesting efforts, building HF amplifiers and designing antennas. His favourite communication mode is CW. He and his wife, Kim, have two children and five grandchildren. You can reach Ted at ka6w@arrl.net.

The Linear-Loaded Delta Loop for 80 Metres

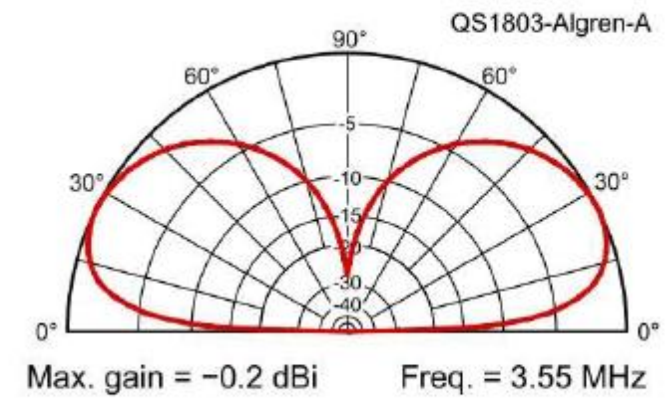
The dimensions for two 80-metre linear-loaded loop designs are listed in Table A. Start with an inverted V set to your desired resonant frequency. Then add the base wire, the open-wire line and matching stub as described in the text.

The resulting linear-loaded loop will launch a vertically polarized low-angle signal that the horizontally polarized inverted V will not produce.

Two sets of dimensions for this loop are shown in Table A. The original design has a height of 51½ feet; however, alternate dimensions are shown for those wishing to use a 40-foot fiberglass mast for support.

Figure A shows the EZNEC-predicted elevation

(Continued on page 75)



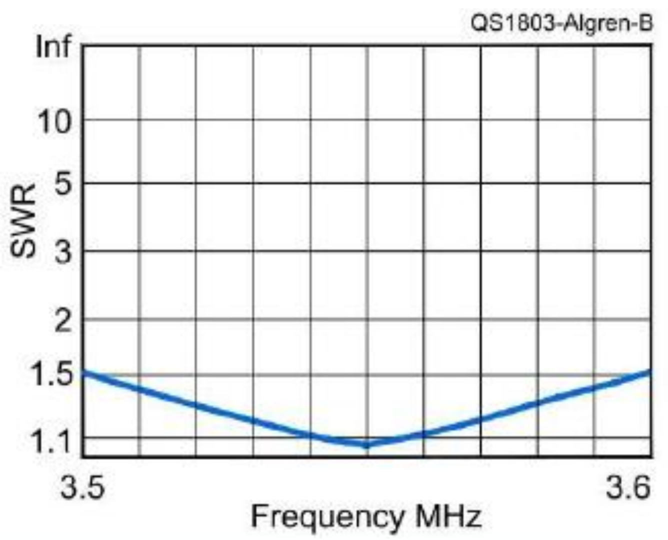


Figure A. EZNEC elevation plot of the 51 ½-foot-high 80-metre loop antenna in the direction of maximum radiation.
Figure B. SWR of the 51 ½-foot version of the 80-metre loaded loop, predicted using EZNEC.

(Delta Loop for 160 from page 74)

pattern and Figure B shows the predicted SWR for the original design.

Table A. Dimensions (feet) for two versions of an 80-metre linear-loaded loop antenna. The smaller loop does not require a 75 Ω matching stub because its geometry yields a 68 Ω impedance that can be fed directly with 50 Ω coax. A common-mode choke should be created by coiling several feet of this coax line or adding ferrite cores on the line, which is then placed at the loop feed point.

Support Height	Sides	Base	Linear Loading	75Ω Stub
51,5	70,6	100	31	45,74
40	61,75	96	38,5	N/A

HF Update

Dennis Green, ZS3I

The All-Africa Award

Morocco, CN. Pascal, F8NQV is active as CN2NQV until 11 July from Sidi Rahal Chatai on 40, 20, 17, 15 and 10 metres.

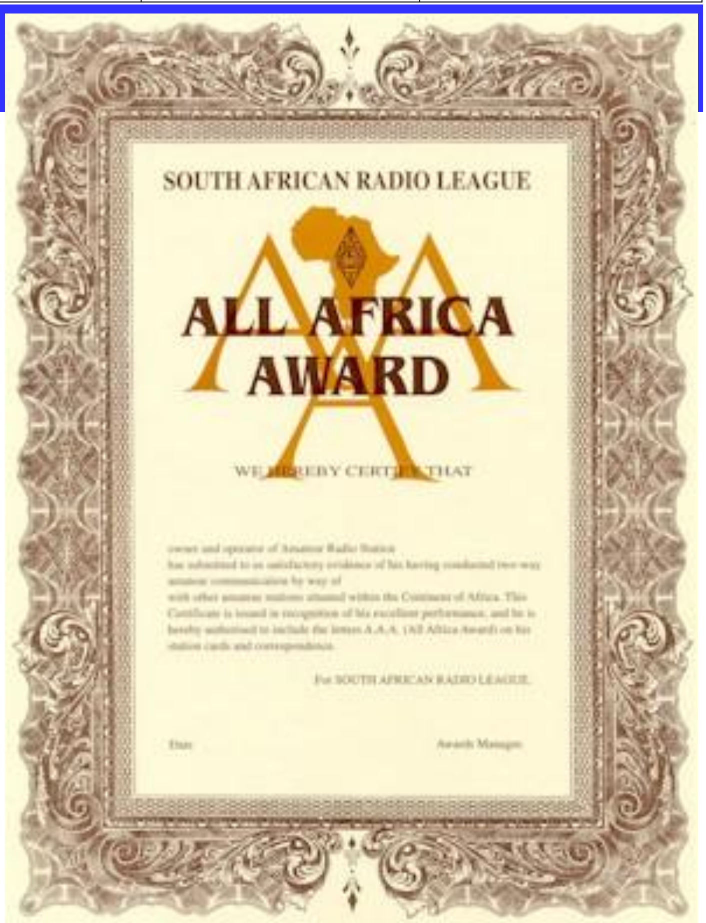
Benin, TY. Red, DL1BUG will once again be active as TY5FR from 7 July until 4 August with activity from 160 to 10 metres using CW and SSB. QSL via home call direct.

Tanzania, 5H. With dates not yet certain, Dov 4Z4DX and Eyal 4X1RE plan to be active from Tanzania as 5H2DX (CW and SSB) and 5H2RE (SSB) sometime in August or September 2026. They hope to activate different National Parks within the country. Updates to follow.

DR of Congo, 9Q. The Mediterranean DX Club will be active as 9T0MD between 30 September and 11 October. The 9T prefix has never been used before. Operation from 160 to 6 metres using CW, SSB and digital. Also, on QO-100 and EME. www.mdxc.support/9t0md/

Mozambique, C9. The Czech DXpedition group will be active as C8K between 10 and 19 November. Active from 160 to 6 metres using CW, SSB and digital with several stations. Satellite QO-100 also. Club Log livestream, QSL via OQRS or via OK6DJ. https://www.cdxp.cz/

The Gambia, C5. Lui, YT3PL and Luc, F5RAV will once again be active as C5R from near Banjul from 1 October to 4 November. Their humanitarian work is ongoing – so far, they made 3 new classrooms for WILCOS school for children aged 3 to 5 years old. All the money that is donated will be invested in this project – they already spent €7 500 but still need to make new toilets and add new tiles to make new floors. You can donate via here.



African Islands

Cameroun, TJ. Darek, TJ1GD (TL8GD, TN8GD and TT1GD) is once again active as TJ1GD/p from Mondoleh Island (AF-095), Cameroun until 15 July. See qrz.com for QSLing instructions.

Seychelles, S7. Kasimir, DL2SBY will again be active as S79/DL2SBY between 11 and 21 September with activity from 80 to 6 metres using CW, SSB and digital. QSL via home call or LoTW.

Sao Tome, S9. Francisco, CT7AKS will be active as S9R with EC7R, D2ACE, CT1BOL, D2IM, CT1BZG and CT3MD between 17 and 31 October. They will be active with 3 stations from 160 to 6 metres using CW, SSB and digital. https://s9r.viacom.ao/

(Continued on page 76)

(HF Update from page 75)

Rodrigues Island, 3B9. Kazu, M0CFW will once again be operating as 3B9KW during the CQ WW SSB contest (24 and 25 October) and during the CQ WW CW contest (28 and 29 November). Operation before and after the contest as 3B9/M0CFW between 20 and 28 October and between 22 November and 2 December. QSL via LoTW.

Seychelles, S7. Rudi, OLK2ZA and David, OK6DJ will be active as S79/OL1T between 28 December and 8 January 2027. Operation on various bands and modes. More to follow. QSL via LoTW.

The 13 Colonies Special Event

The 13 Colonies Special Event, now in its eighteenth year, will take place from 1300 UTC on Wednesday 1 July to 04:00 UTC on Tuesday 7 July.

Amateur radio operators can make contacts with stations in each of the 13 colonies plus three bonus stations in Great Britain, France and Philadelphia. 2A (New York), K2B (Virginia), K2C (Rhode Island), K2D (Connecticut), K2E (Delaware), K2F (Maryland), K2G (Georgia), K2H (Massachusetts), K2I (New Jersey), K2J (North Carolina), K2K (New Hampshire), K2L (South Carolina), and K2M (Pennsylvania), plus 'bonus stations' WM3PEN from Philadelphia (the city where the US independence was declared), GB13COL from England (QSL direct, see qrz.com for instructions) and TM13COL from France (QSL via F5OGL).

This year, the event ties into the America250 celebration, with stations marking locations where the Declaration of Independence was first read. Across the original colonies, cities and towns are hosting events tied to pivotal moments in American history. Portsmouth, New Hampshire, commemorates its role in the 1774 Paul Revere ride. Lexington and Concord, Massachusetts, are highlighting their locations as the birthplace of the Revolution, with reenactments and the Freedom Trail. Cities in other former colonies, including Augusta, Georgia, and Charleston, South Carolina, are also part of the national celebration, offering historic sites and authentic experiences.

Information about call signs, frequencies, special certificates, and QSL cards can be found online at The Annual 13 Colonies Special Event https://13colonies.us/.

Other DX

Peter 1 Island, 3Y0. The 3Y0L DXpedition is scheduled for February 2027. A team with 19 operators will spend approximately 20 days in the vicinity of the island. https://3y0l.com/#Peter-I-DXpedition

New Zealand, ZL. The New Zealand Association of Radio Transmitters (NZART) was founded on 16 August 1926. To celebrate their centenary, NZART members are encouraged to use the ZM prefix during the 2026 year; in addition, individual operators and NZART branches can apply to use special ZL100 call signs (e.g. ZL100AA, ZL100AM, ZL100C, ZL100MVL, ZL100TUX). QSOs made with ZL100 stations between 1 June and 31 August count towards the ZL100 Award https://nzart.org.nz/centenary/.

Poland, SP. Special call signs 3Z100LKK, HF100LKK, SN100LKK, SO100LKK, SP100LKK, SP0LKK and SQ100LKK celebrate the 100th anniversary of the Lviv Shortwave Club, from 18 June to 31 December. The Club was founded in 1926 as Lwowski Klub Krotkofalowcow (LKK). The cradle of Polish Amateur Radio, LKK was one of the largest clubs in Europe before World War II. See https://radiodyplom.pl/ses/282 for the commemorative certificate.

Canada, VE. Pierre, VE3KTB will again be active as VY0ERC from the Eureka Amateur Radio Club, Ellesmere Island, NA-008 during mid-June to mid-July 2026. He will be active on the HF bands using CW, SSB and digital as well as the satellites when time permits as the main purpose of his trip is work related at the Polar Environment Atmospheric Research Laboratory (PEARL). There is a chance VY0ERC may also be active from Cornwall Island,

(Continued on page 77)

(HF Update from page 76)

EU-009 on the way to Eureka.

Franz Josef Land, R1/F. After two years of planning the RUDXT are proud to announce a DXpedition to the northern-most DXCC in the world – Franz Josef Land. Team of 6 operators will be active from Heiss island (FJL) during 15 days in late August/early September 2026. www.rudxt.org/ri1fjl

French Polynesia, FO. Didier, F6BCW is once again active from Tikehau Atoll, Tuamotu as FO/F6BCW until mid-July. He is active on 80 to 6 m using CW and SSB. QSL via LoTW

Marshall Islands, V7. John, WA4IYB is currently residing on Kwajalein Atoll doing contract work and mentions that he is not entirely sure how long he will be there, but it could be up to a year. When time permits look for V73RJ on 40 to 10 m SSB using the island club station. QSL via LoTW and eQSL.

Cook Islands, E5. Steve, ZL2KE and Steve, ZL4CZ will once again be active as E51CZZ and E51KEE between 22 July and 14 August for E51KEE (CW, SSB) and between 26 July and 6 August for E51CZZ (SSB) from Rarotonga. QSL via IK2DUW.

Solomon Islands, H44. A team with 9A2NA, 9A3MR, 9A3CJY, 9A4WY, 9A7Y and DK8ZZ will be active from Guadalcanal as H49A between 9 and 21 October. Operation on HF and perhaps 6 metres. 'H49A call sign has been issued for our expedition, honouring 15 years of charity work of Croatian Sisters of Charity of St Vincent de Paul in Buma, Malaita Island, OC-047. Our special call sign itself symbolises ties between Solomon islands and Croatia. Part of amateur donations for the expedition will be redirected to charity work in the mission.'

Sardinia, IS0. Jose, EA5UJ will be active as IS0/EA5UJ/QRP with a campervan from different locations. Operation between 16 and 27 July. Jose works only SSB from 80 to 10 metres and will try to activate some POTA references. QSL via LoTW, home call and OQRS.

Corsica, TK. Alex, OE5AUH and David, OE5DDJ will be operating as TK/calls from 9 to 22 August. They plan to hike the GR2O trail. Low power station with 10 W.

Sweden, SM. Look for OZ0J, OZ3ACB and OZ9U as SM/OV2E between 23 and 27 July from Ven Island (EU-137). An entry in the IOTA contest is included. Outside the contest, they will be active on HF using CW, SSB and digital. QSL via LoTW, Club Log or OZ0J.

Greenland, OX. Emil, DL8JJ will once again be active as OX/DL8JJ between 3 and14 July with activity during his spare time using CW from a base camp on Tasiilaq.

Bermuda, VP9. Look for Al, K7AR; Ron, WJ7R and Lee, N7NU as VP9/calls between 23 and 27 September. An entry in the CQ WW RTTY contest is included. Before and after the contest on other bands as conditions allow.

Andaman Islands, VU4. Look for VU4R between 22 and 26 July with activity on HF using SSB and digital with an entry in the IOTA contest. This is a test in anticipation of the main event between 17 and 30 December alongside the 49th SEANET convention. https://www.dxindia.in/VU4R

Andaman Islands, VU4. The World DXpedition team will be operating during November 2027 from 3 POTA locations. A team with 11 operators (Dave, WJ2O; Nick Maslon, K1NZ; William "Savo" Savacool, K2SAV; Jeff Briggs, K1ZM; Miriam Briggs, N1QV; Steve Keithahn, W0ZB; Kyle Snavely, K3PT; Emily Snavely, KD0IVB; Krassy Petkov, K1LZ; Sarath Rayaprollu, VU2RS and Van Herridge N4VGE) will be active with 5 stations 24/7. Team support members are XYL's Judi Savacool and Vicki Herridge. https://worlddxpeditions.org/andaman/

South Shetland Islands, HF0PAS. Rafal, SQ4O informs that all going well, he will try to be active as HF0PAS from the Henryk Arctowski Polish Antarctic Station, King George Island, South Shetland Islands He will remain there until October 2026. News updates will posted on the HF0PAS QRZ page.

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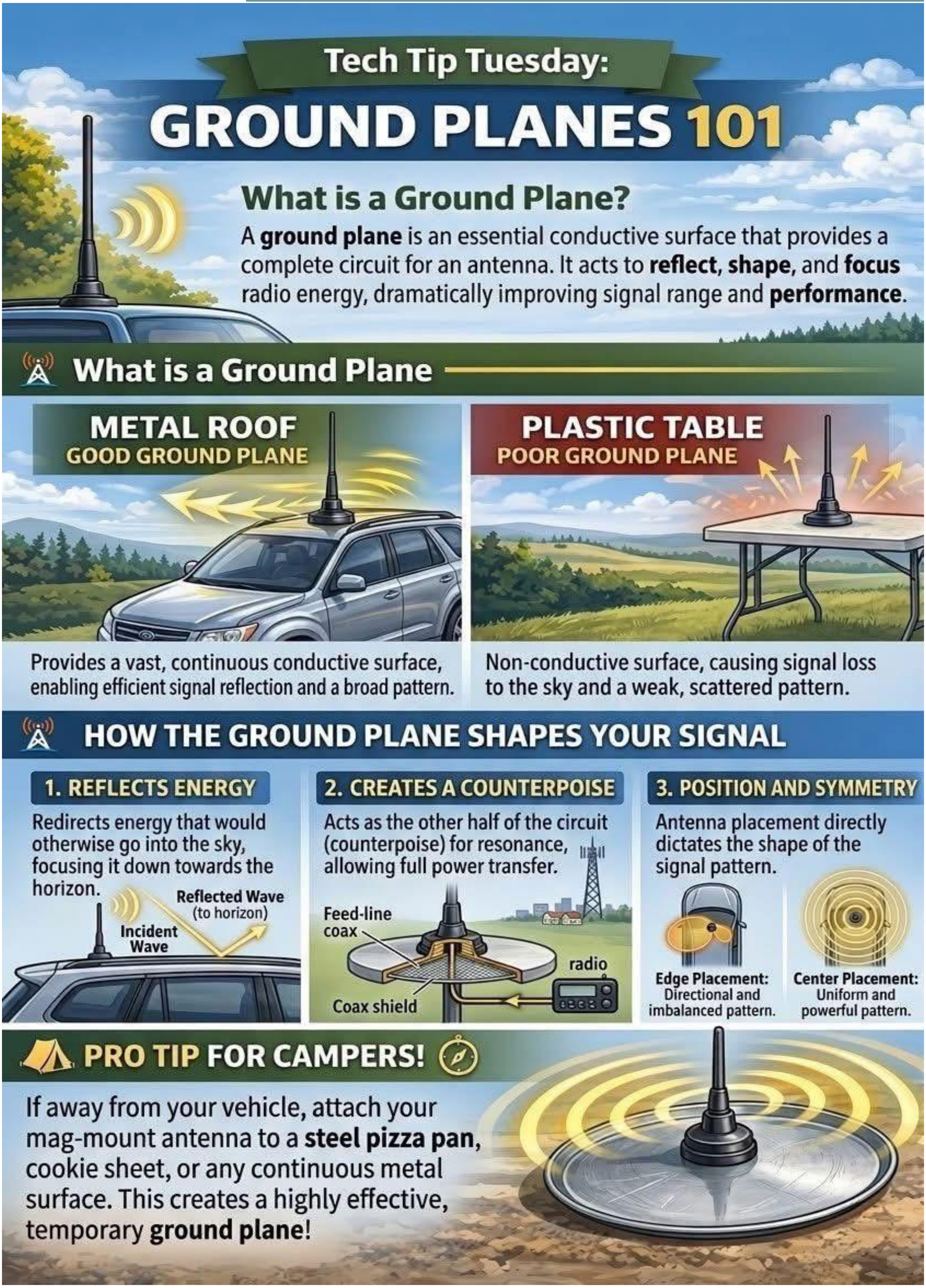
Tech Tip Tuesday:
GROUND PLANES 101
What is a Ground Plane?
A ground plane is an essential conductive surface that provides a complete circuit for an antenna. It acts to reflect, shape, and focus radio energy, dramatically improving signal range and performance.
What is a Ground Plane
METAL ROOF
GOOD GROUND PLANE
PLASTIC TABLE
POOR GROUND PLANE
Provides a vast, continuous conductive surface, enabling efficient signal reflection and a broad pattern.
Non-conductive surface, causing signal loss to the sky and a weak, scattered pattern.
HOW THE GROUND PLANE SHAPES YOUR SIGNAL
1. REFLECTS ENERGY
Redirects energy that would otherwise go into the sky, focusing it down towards the horizon.
Reflected Wave
(to horizon)
Incident
Wave
2. CREATES A COUNTERPOISE
Acts as the other half of the circuit (counterpoise) for resonance, allowing full power transfer.
Feed-line
coax
radio
Coax shield
3. POSITION AND SYMMETRY
Antenna placement directly dictates the shape of the signal pattern.
Edge Placement:
Directional and imbalanced pattern.
Center Placement:
Uniform and powerful pattern.
PRO TIP FOR CAMPERS!
If away from your vehicle, attach your mag-mount antenna to a steel pizza pan, cookie sheet, or any continuous metal surface. This creates a highly effective, temporary ground plane!

Two Clandestine Radios of WWII

Replicating the prison camp radio and the Paraset spy transceiver

Hiroki "Hiro" Kato, AH6CY

(This article first appeared in the November 2012, issue of Electric Radio.)

War is a tragedy, no matter the cause or the scale. Yet, the more difficult the existential challenges brought about by war, the more human ingenuity seems to surface. For us radio aficionados, two radios, one from the Pacific theatre and the other from the European theatre of WW II, exemplify such ingenuity. These are the radios which would not likely have been built had it not been for the war. They have beauty of their own because of their simplicity and elegant solution to meet the needs. These are a product of a rather different philosophy from that of the designs for the radios with which we are familiar today; they did not have any bells and whistles, nor did they even try to incorporate the state-of-the-art technology of the time. They were produced solely to meet the given objectives with minimum necessary components and technology.

1. A one-tube receiver in the Philippines POW camp

The early WW II battles fought in the Philippine islands were not in favour of the US military. After Corregidor fell to the Japanese, the captured American soldiers were moved to and were kept in Japanese prison camps in most miserable conditions. The infamous Bataan March was the most memorialized incident from that era.

In one of the war histories compiled by the US Army, the following passages appear, accompanied by a drawing of a radio, "Nor was concealed radio activity by Signal Corps men in the Philippines confined to the guerrillas. There was at least one incident of it in prison, involving a radioman, William D. Gibson, who had received his commission as a lieutenant in the Signal Corps only a few hours before the fall of Corregidor. A former US "amateur" working in Manila as a civilian radio technician, he had offered his services to the Army on Corregidor after the enemy invasion began. But his commission had been delayed till the last hours of his freedom because the medical officers, busily treating wounded men, had not given him the required physical examination. Subsequently, a prisoner in the Cabanatuan concentration camp, he came into the possession of a 1-tube regenerative radio receiver improvised by an officer of the Engineer Corps, Capt. Russell J. Hutchinson, who had built it of scrap parts and placed it inside a GI canteen. Hutchinson, on being shifted out of the prison, left it with Gibson. But the set no longer worked. Its single amplifying tube, a 12SK7, had burned out. Obtaining a different type of amplifier tube, a 6J7, stolen by an American sailor who had a prison job in a Japanese shop, Gibson, rewired the set to accommodate the tube; a cauterizing iron from the prison hospital served as a soldering iron. Looking like any ordinary canteen, the radio was kept hanging at the lieutenant's bed. Japanese inspectors passed it by, suspecting nothing. Its antenna was a No 22 wire woven inconspicuously into a rope clothesline. Only the headphones had to be secreted separately. The prisoners furtively operated the receiver in the evening, using battery power, which was available in the prison hospital. The little set brought in radio programmes emanating from Saigon, Tokyo and San Francisco. Best of all was the Voice of Freedom broadcast from the Apache after the Leyte Campaign began. This treasured radio receiver was left behind when the lieutenant, suddenly freed with other prisoners departed in the pell-mell of the daring Cabanatuan raid, 30 January 1945."

One of the most intriguing questions to me was how Hutchinson obtained the parts to assemble the original 12SK7 radio. Here is a glimpse of how this was accomplished according to an eye witness account of the Cabanatuan camp, "One group of Corregidor prisoners, before first entering the camp, had each hidden a piece of a radio under their clothing, to later be reassembled into a working device." (http://en.wikipedia.org/wiki/Raid_at_Cabanatuan, taken from Breuer, William B. (1994). The Great Raid on Cabanatuan. New

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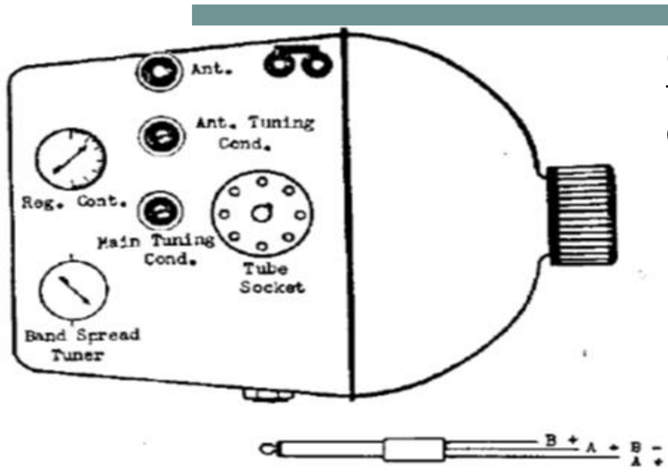

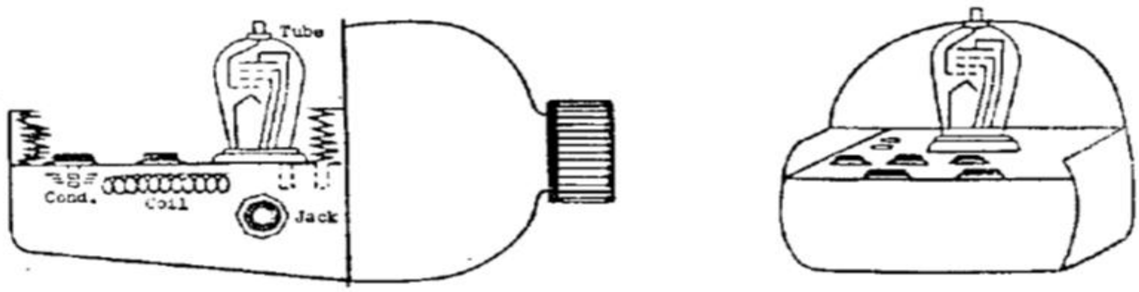

(United States Army in WWII, The Technical Services, The Signal Corps: The Outcome, US Government Printing Office, 1966, pp 274 - 275)

(The Museum Column from page 80)

York: John Wiley & Son's, p. 75)

There is another war time record I have come across that makes a mention of the prison radio in the Cabanatuan prison camp. It offers additional details of the method of securing parts.

“Former POW James Hildebrand recalled how the prisoners tricked the Japanese into helping them build their secret radio: [The guys] were fixing Japanese radios and they would take certain parts out and tell the Japanese those parts needed replacing and it was up to the Japanese to get those parts. Well, the Japanese never asked for

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those parts back and if you get enough parts, you can make a radio and that's exactly what they did. They fooled the Japanese." (http://www.pbs.org/wgbh/amex/bataan/peopleevents/e_atrocities.html)

In the past few years, I have come across several recreations of this radio built by amateurs, each with some variations. I have recently decided to build one myself. Fortuitously, I met Al Klase, N3FRQ, a curator of the Radio Technology Museum in Wall, New Jersey and Ted Carr, N1VE, a collector of WW II era radios, who were two of such re-creators and from each learned a great deal about building the radio. Here is Al's replica and the schematic drawn by him. Ted followed Al's design but substituted a 6SK7 for the 12SK7. These tubes are essentially the same only with a different heater voltage. I have heard that a 6SJ7 would work with this schematic equally well.

As you can see, this is as simple a schematic as one can think of for a one-tube regenerative receiver with a minimum number of parts. Hutchinson et al in the POW camp apparently reproduced the schematic from memory. The radio works with as low a voltage for the plate as 12 V. Other than the canteen itself, I had all the necessary parts in my junk box, mostly from 1940's and 50's to build a replica except that I used a small variable capacitor taken from a transistor radio from the 1960's as I did not have a small enough old capacitor on hand with large enough value to cover the desired frequency range. I found a canteen on eBay. It has the date "1942" embossed and, judging from the badly beaten condition, it was well used and most probably saw combats. I must confess that, when I was cutting out the portion with a hack saw where the "guts" of the radio would be inserted, I could not help but stand in awe and keep imagining what the original owner of this canteen might have gone through in war.

The aluminium wall that I cut out was used to make a "chassis" of the radio as the photo shows. I drilled a hole for an octal tube socket and bent it so that it could be bolted inside the canteen at two points. My design goal was to build a working receiver with the minimum of hardware work with no concern for aesthetics as the original builder of the one tube radio might have faced. Unlike Al and Ted's versions, I placed a phone jack inside the mouth of the canteen, using a cork cap from a wine bottle. The headphone is of WW II vintage with 2 000-ohm impedance. The RF coil was wound on a 1" OD PVC pipe. Al's version places a metal 12SK7 tube perpendicular to the canteen's side wall as in the drawing in the Army publication. Ted's and mine place the tube horizontally. I find that doing it this way requires fewer hardware pieces. What surprised me was how cavernous the canteen is. It is not impossible to place more than one octal tube, let alone a couple of miniature tubes and add a transmitter section to build a transceiver all contained in a canteen. I am tempted.

My version as presented here covers 3 mc to 10 mc and works surprisingly sensitive. With a 30 feet long wire I can pick up many international short-wave stations just above the 40-metre amateur

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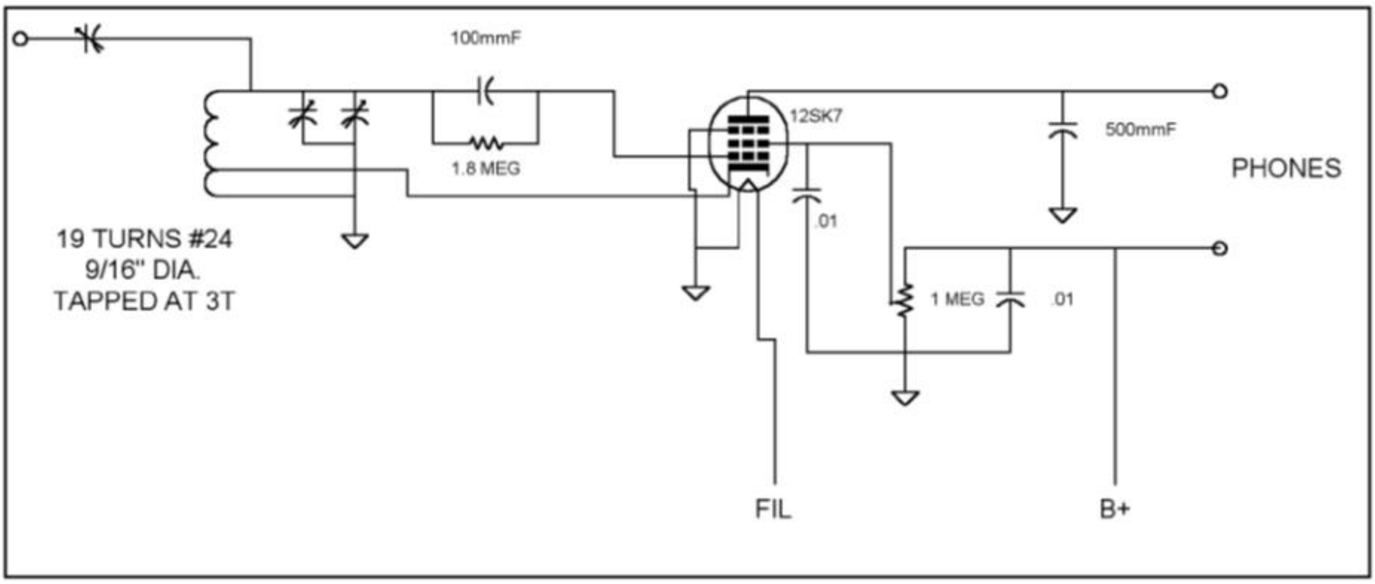
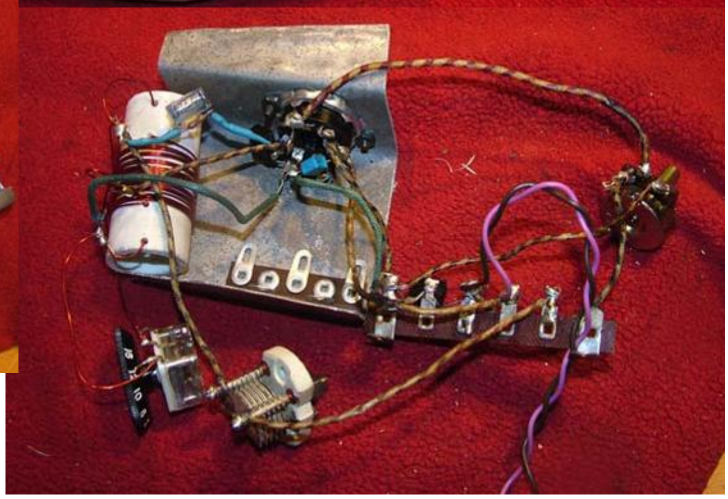


(The Museum Column from page 82)

band at night. I use two 12 V gel cell battery in series to produce 24 V DC to supply the plate voltage and get 12 V for the heater from one of them. I have tried wall-warts power supply with 18 V for the B+ voltage which works equally well.



II. The Paraset spy transceiver in Europe

In the European war theatre, the Nazi's successful invasion and occupation of many countries spawned the resistance movement and the Allied clandestine field operatives were sent into these countries via sea route or dropped from planes to obtain information on Nazi troop and ship movement as well as to report on weather, the important real time information needed as there was no weather satellite then. The Royal Signals Communications Unit developed several kinds of radios and they were constructed by the Secret Intelligence Service (MI6, i.e., Military Intelligence, Section 6) in the workshops at first at Barnes in London, then from 1940 at Whaddon Hall and from 1942 onwards at Little Horwood, both in north Buckinghamshire. One of the radios, a small three-tube transceiver was first built in 1941 and was officially called the Whaddon Mark VII (other radios were designated as Whaddon Mark I, II, III etc. Mark I and II were also known as B1 and B2) but when these sets were issued to the Special Operations Executive, it was nicknamed "Paraset" as many SOE agents parachuted into Nazi-controlled area with the radio and some sets were dropped by parachute to the Resistance groups in France, Belgium, Netherland and Norway. There were several versions of the Paraset with slight variations; early sets were contained in a wooden box which may or may not be carried inside a leather suitcase and many sets later in a metal "cash" box.

Only a few original sets survive today as Winston Churchill ordered complete disposal of the radio equipment and related information for fear that they fall into Soviets' hands as Cold War began[3].

According to Geoffrey Pidgeon, the author of *The Secret Wireless War: The Story of MI6 Communications 1939-1945*, who worked at Whaddon Hall in his youth and was involved in the production of the Whaddon Mark VII and who was assigned to Calcutta, India, toward the end of WWII, the order to destroy the communication equipment was far reaching. He writes, "I received about eight large crates from Tom Kennerley who was in charge of our station at Kunming [China]. When I unpacked them, I found twelve Whaddon MkVII sets in leather cases, some B2 wireless sets

(Continued on page 84)

(The Museum Column from page 83)

and a large collection of wireless spares of all kinds… I asked Mike Vivian what should be done with it all and he told me to 'lose' all the wireless sets – without indicating how that could be achieved. That night, a couple of friends rowed me out into the middle of the lake [Lake Dhakuria] and the wireless sets were dropped quietly over the side into what we guessed was its deepest part.” [4]

David White, G3ZPA, who worked for MI6 in the 1940's, writes, in his communication with the *QRP Quarterly* publication, “I was one of 4 people sent to the old Poundon (SOE) radio station 36 years ago to close it down and in one of the rooms there were dozens of B1, B2 and MK7 Paraset radios. When we returned, we were given sledgehammers and told to destroy them all. Well, I kept a B1, a B2 and 3 of the MK7 sets and the rest were destroyed.”

“I display two of them at [the radio museum of] Bletchley Park and keep one at home.[5]

Besides these sets at Bletchley Park, I am aware that there are at least one original set in the Imperial War Museum, London and another at the Norway's Resistance Museum (also known as the Norwegian Home Front Museum (*Norges Hjemmefrontmuseum*) in Oslo and two more sets in private hands.”

The display at the Imperial War Museum states that the production date of the Whaddon MkVII was “1939,” which is at odds with the statements made by Pidgeon and White who place the production date in 1941. Possibly, this discrepancy indicates that the design/prototype work began in 1939, but the production did not actually commence until 1941. I have not been able to ascertain from any official records exactly how many Parasets were produced by the end of WWII, except that various sites on the Internet mention a few thousands.

The history notes accompanying the IWM display tells how the Paraset was used in one instance in Norway, “Olaf Reed-Olsen was a famous MI6 agent who operated in his native Norway, 1943 - 1944, particularly in the Kristiansand area and reporting on German shipping. He communicated with London using his MkVII transceiver. He operated three times in Norway before making his final escape to Sweden in December 1944. The Mark VII, also known as the 'Paraset', is a self-contained miniature transceiver. This version is mounted within a suitcase, for disguise and portability.”[6]

Displayed at the Imperial War Museum in London.

The Paraset is a three-tube transceiver, two tubes used for the receiver and a single tube for the transmitter section. The transmitter is crystal controlled and can transmit CW only. The set was designed to work from 3 to 8 mc and could produce about 5 watts, depending on the power supply voltage. Some sets were used with an AC power supply and others with battery power source. The transceiver was sufficient to maintain reliable contact with the Whaddon site, which, of course, had a powerful transmitter and good antenna (some sources say they used Rhombic, but I have not confirmed if it was really the case). I do not know if the designer of the Paraset took into account the sunspot cycle situation, but one lucky thing, whether it was known or not, for those involved in the design and use of this veritable “QRP” rig, was that WWII coincided with a high sunspot cycle, peaking in 1945.

Three features, other than the simplicity of the schematic calling for the minimum use of parts, stand out in the design:

- The CW key is imbedded in the transceiver's body itself. The operating knob looks like

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other control knobs and does not protrude any more than they. This obviously increases portability and risk of losing the key would be eliminated.

- It used two small flashlight bulbs to tune the transmitter and for antenna coupling. There is no panel meter, which would have been the most standard way to tune transmitters in those days. A panel meter would have added to the overall size and weight. Also, the use of easily available bulbs made it easy to replace them if necessary.
- It used a simple "vernier" dial made of a shaft pressing against the edge of a circular panel, serving as a dial, to turn the receiver tuning capacitor. It requires a delicate touch to operate, but again, this solution, though crude, is a simplest possible approach to do the job. It allows the elimination of an extra small variable capacitor or a standard vernier for fine tuning. It, too, saved space and weight.

One of the practical problems of operating the Paraset in clandestine situations is the power source. As tube radios go, the Paraset was very frugal in power consumption compared with most of the radios of the time but operating it from battery required frequent charging and the use of AC source presented its own kind of danger. Pidgeon writes:

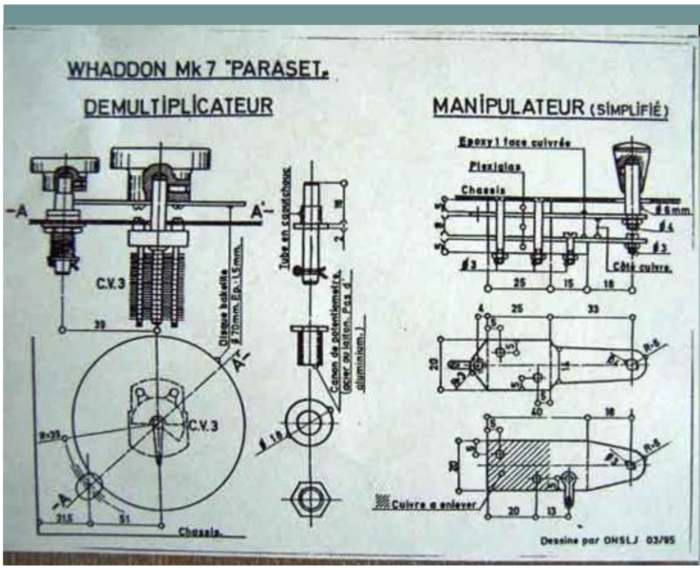
"Electrical power for clandestine equipment was always a problem. Some depended on AC mains supplies although this imposed extra hazards. Some depended on 6V vehicle batteries in conjunction with electro-mechanical vibrator units or dynamotors for higher powers. A few Onan petrol-electric generators were deployed in the field, despite their bulk and noise. Many batteries were charged using stationary bicycles with generators clamped to the pedal-driven wheel. More exotic devices were also used including steam-driven generators and thermos-generators that could be fired by charcoal braziers."[7]

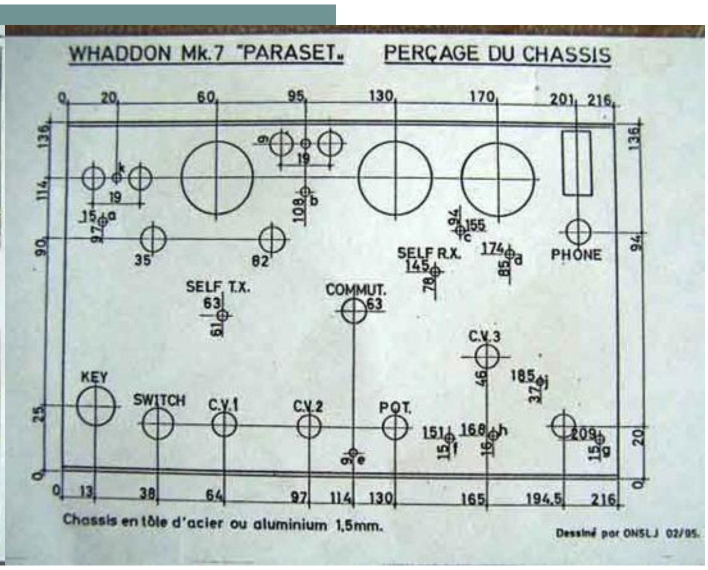
One of the methods the Nazis employed to detect the radio being operated from the AC mains is to cut off power supply section by section in a given town, narrowing the search area.

Above. Discovered in a Belgian flea market in 1988. It was used by the Belgian resistance group (www.paraset.co.uk)
Below. Original owned by a French amateur, Patrick Giraud, F4SMX. (www.paraset.nl)

Difficulties of frequent charging of batteries were depicted this way in one account, "The constant charging of heavy car batteries on a near daily basis meant transporting them to a safe charging place. Being caught with a heavy battery in your back pack meant instant arrest with all the associate danger that went with it. In an effort to reduce this danger several ideas were put into

(Continued on page 86)





(The Museum Column from page 85)

operation resulting in steam, hand and bicycle driven generators being introduced. You had to be fit if the hand generator was your only means of charging as its maximum charging rate was 3 amps, so several hours were needed in a typical charging session."[8]

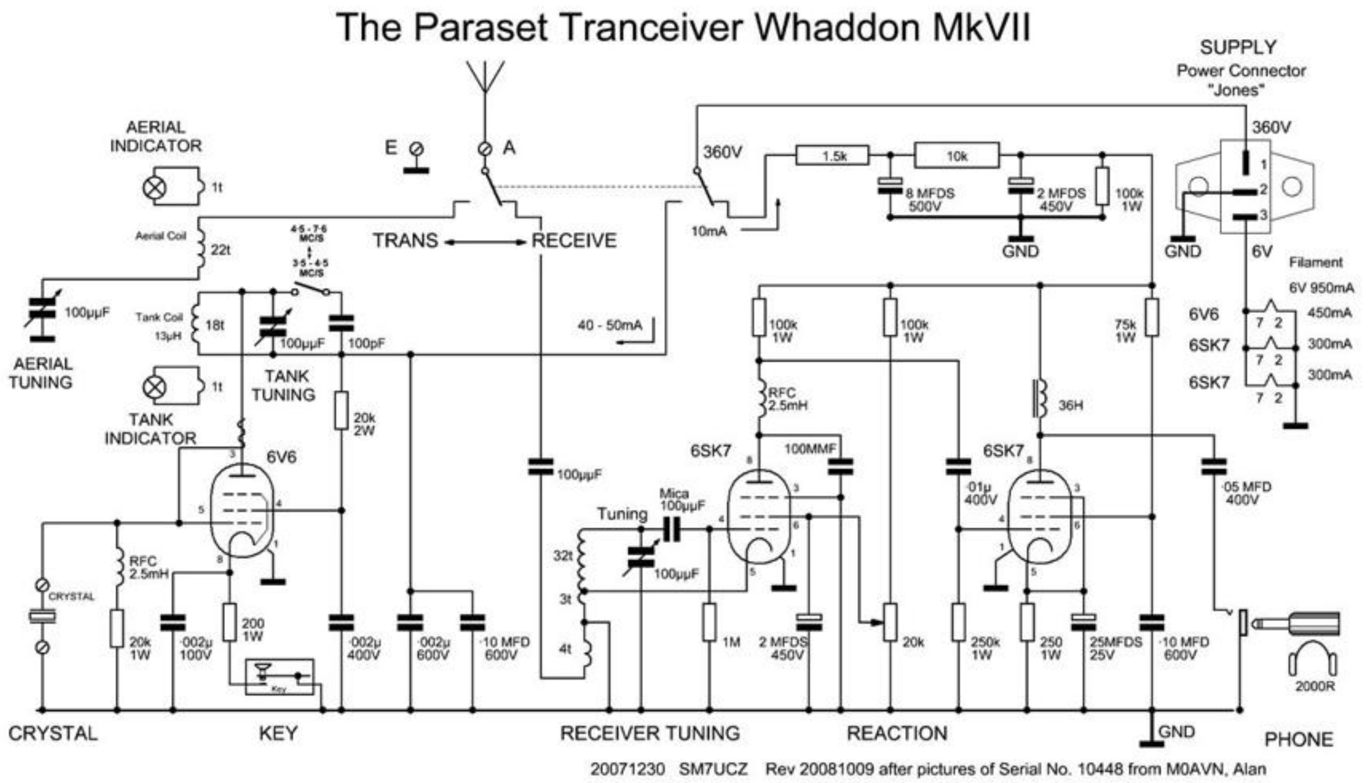
Information on the almost forgotten Paraset for over 40 years, due to the paucity of the surviving sets and information, was brought to a wide attention of amateurs by a Belgian amateur named Joseph le Suisse, ON5LJ (SK) in 1990 who made the first schematic and mechanical drawing from an original Paraset.

Since then, many amateurs have replicated the set, some adding their own improvement and modifications. There is even a group of amateurs solely dedicated to building and preserving the Paraset memory based in the United Kingdom with many international members. You can come across many websites about the Paraset by simply Googling it today.

Here is my version of the Paraset replica built in a re-repurposed shoebox. Like many old-time amateurs, I have been accumulating a lot of vintage junk over the years for which I have not had much use. Building the Paraset replica was exhilarating for me as I see my old junk come alive once again. Not only my own junk box, but those of my friends were also tapped. I shared the building process with them as it progressed and they offered me much good advice. I am especially indebted to Rich Bonkowski, W3HWJ, who provided me with some perfect WWII era parts in addition to his expert advice on the regenerative receiver. He had built many regenerative receivers himself.

I followed the original schematic as reproduced here, except that I adopted VE7SL's excellent suggestion regarding isolating the B+ voltage from

(Continued on page 87)



Original schematic redrawn by SM7UCZ

(The Museum Column from page 86)

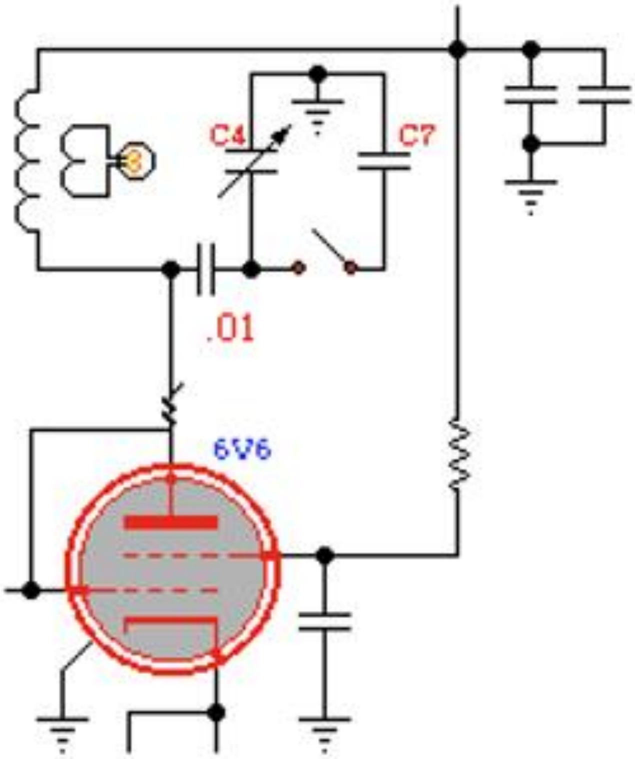
the variable capacitor for the transmitter section as you see below. The original schematic calls for connecting the B+ voltage to both the rotor and stator sides of the capacitor which runs the risk of inadvertent electric shock.

Most of the parts were relatively easily available even today thanks to the Internet market if any reader of this article wants to roll his/her own Paraset. Many amateur swap meets also are still a good place for finding parts. One item which I have found difficult to obtain is a small 36 Henry audio choke. I have substituted a small speaker output transformer for it, using only the primary side of winding.

III. Final words

Unlike the collection and restoration of vintage radios I have done for many years, building the replicas of the two radios was an unexpectedly emotional experience for me. As I researched historical background of the radios, I could not help but relive, albeit vicariously, the hardships and challenges the builders and users must have faced.

Readers of this article may have more historical and technical information on the two radios than I have uncovered. I would love to hear from anyone who does and would welcome any comment and questions.



VE7SL's modified circuit for transmitter

Footnotes

[3] General Douglas MacArthur, as the Supreme Commander of the Allied Forces in Japan ordered destruction of Japanese military equipment when

(Continued on page 88)

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the Allied occupation of Japan began in 1945. This is the reason why it is rare to see Japanese military radios from WW II, unlike American war surplus radios.

[4] The Secret Wireless War: The Story of MI6 Communications 1939 - 1945 p.343

[5] http://www.sm7ucz.se/Paraset/Paraset_e.htm

[6] http://www.iwm.org.uk/collections/item/object/30005321

[7] The Secret Wireless War, p. 95

[8] Horndean and District ARC Journal, June/July 2009, p. 17

Replica by IK5FUZ

Replica by VE7SL

Replica by LA5MT

Replica by G3YVF

Continuing Saga of the Paraset

In my last article, I noted an unverified comment on the type of antenna that was used at a receiving and transmission site of the SOE headquarters in England. Since then, I came across the following posting on the Internet by Gary Giles, KF9CM.

"The base stations in the UK, were usually a 250 -watt transmitter with a 15 KW backup. The antenna array was a large curtain array for receive and a half wave doublet high in the air for transmission. With this system, Parasets had no problem transmitting and receiving. The operator would transmit up to 75 code groups and then must wait till the code people deciphered the message and send back the "message OK" signal. The field operative would have to wait up to an hour, sometimes more with his or her sidearm at the ready, looking down the road for the DF people. Then if everything was received and decoded successfully, the base station would send back the OK. If not, the field operative would have

(Continued on page 89)

(The Museum Column from page 88)

to try to send it again. We're talking a lot of stress."[1]

I have not independently established the accuracy of the information contained in this posting. My effort to reach Gary to find out the source of his information was not successful. The advent of the Internet has vastly expanded our ability to do research on practically everything, including information on historical radios. However, the ease of disseminating information and so-called democratization of media (i.e., anyone at any time can create, duplicate or circulate information, correct or false, at a minimal cost and effort) have created many perils for authenticating the reliability and accuracy of information. So much information floating in cyberspace has no reference to the source or offers a way of independently verifying its accuracy. Thus, we sometimes see a "manufactured fact" or a fruit of someone's imagination masquerading as a fact and being repeated again and again. We have earlier seen that the antenna used at the SOE transmitting base was rhombic, but now we have different information as you have just seen.

Mike Murphy, WU2D an enthusiast of WWII era equipment who built his own Paraset replica, wrote to me and related the following in-credible story. "… [operating my own Paraset replica on] 27 February 2009, when I boldly made a CQ on 3 520 kHz at 10:30 PM and Bruno, DL1EV came back from Germany. I was using a 36 m inverted L and we had a clear frequency. We QSO'd for about 20 minutes. It turned out that he was a radio operator in the Wehrmacht in WWII and actually hunted Parasets with his DF Van."

Mike Murphy's Paraset replica

German Mobile DF Radio Van used in hunt for Paraset Radios

German DF Radio

Another interesting story he relates is when Mike was on a business trip to London in 2003, he

(Continued on page 90)

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"... [had] an exclusive dinner at the very exclusive Special Forces Club... This place was amazing. All the agents who were in the SOE had pictures on the wall and a story of how they had been operatives, captured, tortured [and] let go and recaptured by the Gestapo etc… most of the pictures on the wall were of women. Upstairs in the bar, there were a few actual agents, little old ladies, to be sure from WWII."

One of the SOE agents' photos on the wall is that of the famous "spy princess," Noor Inayat Kahn, a brilliant Indian French woman, who was captured in France and tortured and perished in the Nazi concentration camp in Germany. She was known to have the best "fist" among the SOE agents who studied Morse code with her in the spy training school in England and without doubt the Paraset she carried on her mission in France was most efficiently operated.[2]

The Canteen Paraset - The Ultimate "Retro" QRP transceiver?

When I was building a replica of the single-tube canteen receiver I noticed how cavernous the water canteen was and wondered if it would be possible to build a two-tube transceiver inside a canteen.

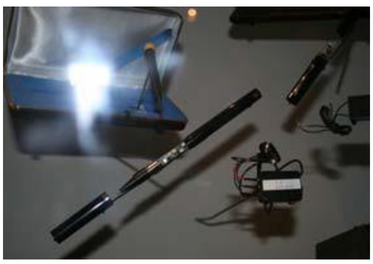
Unlike what the POWs in the Philippines faced, procuring the necessary parts or using a work-bench with a drill press and a metal cutting tools was not a great problem for me but con-taining all the WWII era size components inside a canteen did turn out to be a much greater challenge than I had expected. Nonetheless, after a few months of tinkering, I now have a working two-tube canteen transceiver. In terms of the circuitry, it is sort of a hybrid of the original canteen receiver and the transmitter section of the original Paraset. The tube complement is a 12SK7 and a 12A6 (12 v heater equivalent of the 6V6). This transceiver is tunable for the 40-metre band only at the moment, but it is possible to make it useable for both the 40- and 80-metre bands by adding (and finding a place for) a switch to add 100 pf capacitor parallel to the variable capacitor for the tank circuit.

Instead of using two flashlight bulbs like the original Paraset, one as a tank tuning indicator and the other as an aerial matching indicator, I decided to use one bulb for the tank tuning only. I learned while operating my Paraset replica that a tank tuning indicator can also serve as the antenna tuning indicator. By tuning the capacitors for both to obtain the spot where the bulb shines the brightest you can tune both the tank circuit and match the antenna impedance. I operated this transceiver for the Straight Key Night, January 1, 2013. My signal has slight chirp, but the radio was perfectly useable.

Author's two-tube canteen transceiver

Personal Note

In early October 2012, I had an opportunity to visit the Imperial War Museum in London and was able to see one of the original Parasets in person. This is a magnificent museum, excellently curated and very informative. I highly recommend that anyone visiting London to spend some time there. It is located well within easy walk from London's major touristic sites, such as the Westminster and the National Gallery. I do not know a comparable museum in the world in terms of comprehensive inclusion of artifacts and historical exhibits of one nation's history of involvement in armed conflicts from the 19th century to the present. In the section where the Paraset is exhibited, one can trace how secret communication equipment has evolved over time, including a transceiver hidden in a pen which was used during the Cold War period. (I am, naturally, tempted to replicate that one.)



Cold War Pen Radio

In November 2012, two of my amateur friends and I went camping and for outdoor QRP operating

A Paraset

The author at Jalama Beach with his Paraset

at Jalama Beach, near Santa Barbara, California. One of my goals for that trip was to simulate a "real world" situation to operate my own Paraset replica. We were of course off grid. The first QSO was on 7 199.7 kc with W7UDA in Barstow, California, about 200 miles away, using only a 20 feet long thin wire antenna flung over nearby bush, invisible to most bystanders. Power source was AC generated by a Honda generator. Our QSO was done with armchair (er… picnic bench chair) copy ease. As I tapped the key, I was imagining what it may have been like to operate one of those behind the enemy lines, perhaps from a little barn near the beach in Normandy. Of course, I had no fear of being hunted and arrested or worse by the Wehrmacht for my operation.

I wish to thank all those amateurs who wrote to me. There is no more pleasure for an author than to hear from the readers with their insights and comment.

Notes

[1] Re: Paraset are (sic.) not transceivers!!! Tuesday 6 November 2007

[2] For her biography, see Shrabani Basu, *Spy Princess: The Life of Noor Inayat Khan*, Omega Publications, 2007

The Tinus Lange 7066 Technical Excellence Award

Do you enjoy building pieces of equipment to use in or outside the Shack? Or software to use for amateur radio? Well then how about entering for the Tinus Lange 7066 Technical Excellence Award?

The award is bestowed annually on the League member who submits a technical project in any of the following categories – a) the design and/or construction of projects such as a pre-amp, SWR bridge, patching unit, automatic ID'er, practical antenna ideas, mast, portable gear, power supplies, etc., or b) any software for use in Amateur Radio.

The submission must include the actual items (if size and mass allow) or photographs (particularly in the case of antennas, masts, etc.) And a complete write-up in article form with illustrations/pictures, ready for publication in Radio ZS.

The Award is a framed certificate and a cash award of R1 000. The closing date for entries is midnight on Sunday 31 January 2027 and must be sent to secretary@sarl.org.za.

eSSB (wider bandwidth SSB)

Daniel Romila, VE7LCG

I wanted to write a longer article, but this subject ended so fast for me, according to several identical experiences. Let me tell you the last one.

It was Sunday late evening and I was exploring the 40-metre band on my Yaesu FT-710 SDR transceiver. I made the procedure for being allowed 4 kHz maximum bandwidth (you can look for it on the Internet, something with entering the service menu!) I was looking on the band scope, which is repeated on a bigger monitor, so it was very easy to see the waterfall and how much bandwidth is occupied by each station. Utah webSDR also has a nice band scope and allows adjusting of the received bandwidth. I stopped on 7,196 MHz and listened to an American station.

It was not the first time I had QSO with his group. He was fading in and out. I saw on the waterfall he has 6 kHz bandwidth, constantly, so it was eSSB, a kind of SSB transmission in which the hardware of the transceiver was modified to allow more than 3 kHz audio bandwidth to be transmitted. I jumped into the conversation.

He told me he was indeed using eSSB, this meaning he was transmitting SSB (lower side band, in the 7 MHz band), but not with only 3 kHz bandwidth, but with 6 KHz. He did not sound good, but it had moments when his signal came clear. My receiver was still set for 2,7 kHz bandwidth, totally independent of his 6 kHz wide transmission and all stations transmitting normally, with some 100 Watts and 3 kHz sounded better and more constant in my receiver. I enlarged the Rx bandwidth to the maximum I could, that was 4 kHz for Yaesu FT-710 and eliminated the cut off audio filters. In that

moment I started to have problems understanding him, because I started to hear all the

noise from the building from the fans, the high frequency equipment used by the nearby restaurants against rodents and some LED installation my neighbour has.

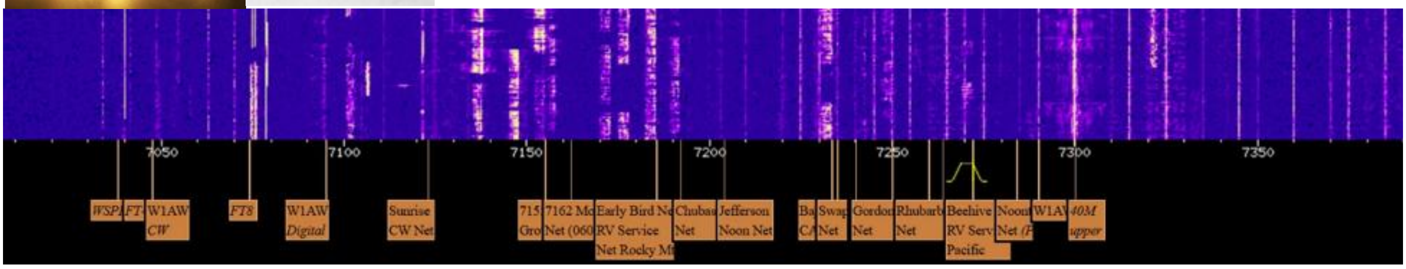
I told the American station, transmitting with 6 kHz bandwidth and to a second station, who transmitted with 4 kHz, that their audio (no! not their audio, but the audio that got to me, after a little more than thousand kilometres) is not so good. They told me they have some kilowatt transmission power. The radio amateur with a lower bandwidth, just 4 kHz instead of 6 kHz, sounded a little better. My receiver was wide open at 4 kHz. Having problems in understanding them, I moved back to my 2,7 kHz Rx setting and the conversation became again OK, still not as OK as with their colleagues having only 100 Watts, but all that hundred watts concentrated in 3 kHz bandwidth or less and the microphone audio settings dedicated to the normal bandwidth, not forced into 4 kHz or 6 kHz bandwidth, which are meant to be heard and understood in a matching Rx wide bandwidth, not the normal narrow one.

If I was across the street from the eSSB guys, most probably I would have appreciated their enhanced audio quality, enhanced audio quality gained by increasing their audio transmitting bandwidth. By the way, none of them started to sing, so they did not generate more than the usual male voice.

When adopting commercial radio bandwidth, you start having commercial radio problems.

The commercial radio station Voice of America

(Continued on page 93)



(eSSB from page 92)

transmits with power between 100 kilowatts and 1,5 megawatts. Radio France International has 10 megawatts transmitters. But we, the radio amateurs, are limited in the maximum power we can use. The beautiful eSSB signal, originating nicely from the eSSB transmitter and spread all over a wide bandwidth must reach me thousand kilometres away, not across the street and to cover all my local radio noise that I have in a high-density urban area. The more I enlarge the Rx bandwidth, the more noise I have.

Unfortunately, the eSSB kilowatt spread all over and required to cover my local noise from all over does not penetrate and is not more understandable than 100 Watts focused on 3 kHz or less bandwidth for my reception, in my location, with my hardware.

This ended the eSSB subject for me. Nothing wrong with experimenting, but eSSB is not for me. Those in country side, those in wilderness where the radio noise is lower might have better results with eSSB. I underline that this is my own experience, in my location which is a small apartment in an apartment building, with plenty of electrical noise from simply living in a high-density area.

I already raised the issue with the 2 radio amateurs practicing eSSB, in an e-mail, too, not only in the conversation, that ***a radio communication chain has 2 parts, the Tx and Rx***; they take care of Tx and they push better quality out. But it is required the Rx to have the same bandwidth, for them to be heard with the intended quality. If they set their Tx for 6 kHz and I set the reception for 2,7 kHz it is already worse than if we have the full chain 2,7 - 3 kHz matched Tx with Rx.

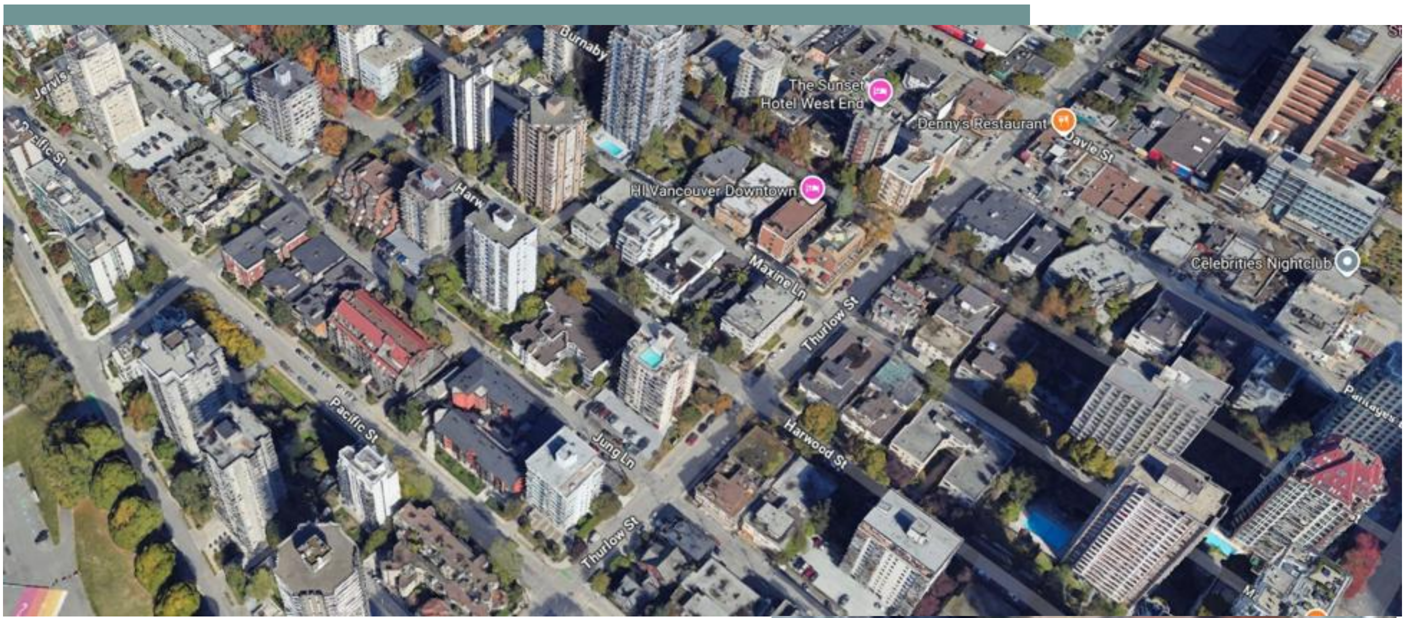
At the moment I want to increase the bandwidth of my Rx; to take advantage of their wider Tx, I largely open the door to all the noise the building and urban surrounding generates, stronger than whatever still comes from their 1 Kilowatt. Not only that I do not have a better quality of signal coming from them, but I have problems in understanding them. The experience of other radio amateurs with eSSB might be different and the result is very dependent on the location and the radio noise from that location.

The two colleagues did not give me yet any answer, about the Rx needing to match the Tx bandwidth and that increasing the Rx bandwidth degrades the quality of their signal, not increases the quality of their signal. They cannot come with megawatts, like the commercial stations do, to solve the Rx problem.

I was disappointed again by eSSB, although I really wanted to like it and I felt pressure from the eSSB group to say the quality of their audio was way better than the normal SSB. It was not the case in any of the eSSB transmissions I heard, neither on my transceiver, nor in any of the webSDRs that I was listening to. The additional noise collected by the receiver after extending the possible audio bandwidth always hindered whatever quality increase would have been gained by increasing the transmission audio bandwidth from 3 kHz to 4, 6 or even 8 KHz. To be honest, all transmissions I heard came from male voices, so there was not much more to be transmitted above 3 kHz, anyhow.

Somehow, I remember that exactly because of this Rx noise issue we arrived at the solution of using SSB communication and we arrived at having

(Continued on page 94)

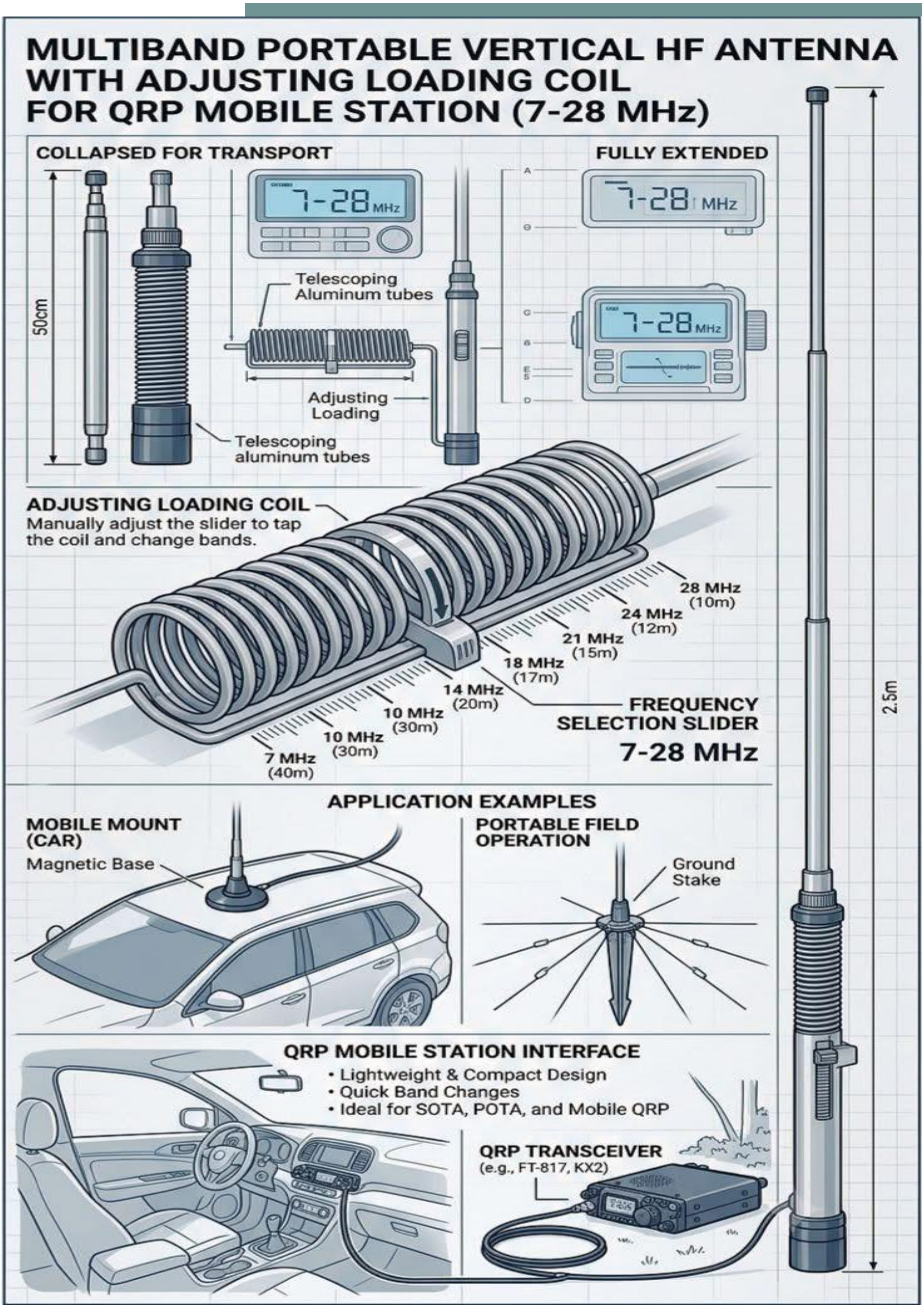


(eSSB from page 93)

2,7 and 2,4 kHz filters. But never mind, I will not insist more; experiments are fine, I do not have anything against them and there are very few radio amateurs in any bands, so there is plenty of room for everybody, with eSSB or not. My particular experience, of living in an apartment building, in a noisy environment, does not allow me to have much interest for eSSB. Most people, nowadays, are in the same situation with me.

It would be more attractive to write about ISB. *Independent Sideband (ISB) stereo is an AM stereo technique that transmits the left audio channel on the Upper Sideband (USB) and the right channel on the Lower Sideband (LSB) of a single carrier. Primarily championed by Leonard Kahn in the 1980s, it allows high-fidelity, independent information on each sideband. While theoretically sound, it faced challenges with receiver availability and stereo separation at high frequencies." – quoted from Google AI search*

For those still wanting to learn more about eSSB, the website essb.us is a good source. ***As a word of caution, radio amateur transceivers always worked better, safer and more reliable as their manufacturers designed and intended, not modified.***


MULTIBAND PORTABLE VERTICAL HF ANTENNA
WITH ADJUSTING LOADING COIL
FOR QRP MOBILE STATION (7-28 MHz)
COLLAPSED FOR TRANSPORT
FULLY EXTENDED
50cm
7-28 MHz
Telescoping
Aluminum tubes
Adjusting
Loading
Telescoping
aluminum tubes
2.5m
ADJUSTING LOADING COIL
Manually adjust the slider to tap
the coil and change bands.
28 MHz
(10m)
24 MHz
(12m)
21 MHz
(15m)
18 MHz
(17m)
14 MHz
(20m)
10 MHz
(30m)
10 MHz
(30m)
7 MHz
(40m)
FREQUENCY
SELECTION SLIDER
7-28 MHz
APPLICATION EXAMPLES
MOBILE MOUNT
(CAR)
Magnetic Base
PORTABLE FIELD
OPERATION
Ground
Stake
QRP MOBILE STATION INTERFACE
• Lightweight & Compact Design
• Quick Band Changes
• Ideal for SOTA, POTA, and Mobile QRP
QRP TRANSCEIVER
(e.g., FT-817, KX2)

Extreme NVIS Antennas — How Big Can We Go?

Examples of NVIS antennas with descriptions and gain figures

John Stanley, K4ERO first published in QEX March-April 2025

NVIS (Near Vertical Incidence Skywave) antennas are something that many are talking about these days. YouTube is full of advice and results videos. Some of these are useful and some not so much. *QST* articles and the Wikipedia NVIS article are a better source than most of the videos.

In my amateur and professional career, I have often needed an antenna that would produce a strong HF signal at a high angle.

I have made contacts on 1,8 to 14,35 MHz that were in the distance range of 160 – 480 kilometres, consistent with skywave propagation and thus NVIS. In my professional career, I have designed several shortwave broadcast antennas used to cover a range out to a few hundred kilometres and these called for the use of the 90, 60, 49 and 41-metre bands (3,2 to 7,4 MHz) and an NVIS antenna. I worked on and with a large NVIS array at the HIPAS (High Power Auroral Stimulation) ionospheric lab near Fairbanks, Alaska, which was used on frequencies below 7 MHz to "heat" the ionosphere. This was operated by the Plasma Physics Lab at UCLA and conducted many experiments on ionospheric modification. We also used ionosondes which used special NVIS antennas to study the results of those experiments.

I have designed, built and used NVIS antennas all the way from a simple dipole close to the ground, up to a large array of 8 dipoles with a gain of 13 dBi. Some of these "extreme" NVIS antennas may be only of passing interest to amateurs who use NVIS for shorter range net operations or just general operating, but amateurs may want to try some of the less extreme ones. I will give examples of some of these antennas along with some physical details and gain figures. I can provide more details to prospective builders.

A list of NVIS antennas I have designed, built, operated, or been involved with.

- Low dipole, the often-recommended low NVIS antenna. It "works" but not very well.
- Higher dipole, a half wave dipole at 0,2 λ above ground, optimum transmit height for NVIS. An inverted V, 0,2 λ above ground at the centre is essentially the same thing.
- An end-fed half wave is identical at its fundamental, but not good for NVIS at harmonics.
- Full-wave loop, a "lazy quad," full-wave loop either square or triangular.
- Extended double Zepp, a 1,2-wavelength doublet, centre fed with ladder line.
- Two collinear dipoles, separately fed at the centre of each.
- Two parallel dipoles, separately fed at the centre of each.
- Double full wave delta loop, two delta loops spaced 1 λ centre to centre.
- "Very lazy" H, 4 dipoles, spaced end to end and side to side.
- Double lazy H, 8 dipoles, 4 dipoles in parallel with another set end to end.
- HIPAS, a circular array of 8 crossed dipoles, 7 in a circle and one at the centre.
- HAARP (High-frequency Active Auroral Research Project) with the same total transmitter power as HIPAS, but slightly higher ERP due to its more closely packed 48-element antenna array. HAARP can be continuously tuned between 3,1 – 9 MHz, gain is a function of frequency. It can be considered the king of NVIS antennas

(The Jicamarca array in Chile has even more gain, but operates at around 49,9 MHz, well above the normal NVIS frequencies. The main antenna is a dual polarized antenna array that consists of 18,432 half-wavelength dipoles occupying an area of 1000 × 1000 feet. With 6 MW of transmitter power beamed directly upwards it produces reflections from the overhead atmosphere, even though only a tiny fraction of the power is reflected. Other "radio telescopes" produce even more gain but are typically operated well above the NVIS frequencies. They can aim their very narrow beam straight up or at lower angles.)

What is "Slewing"?

More complex NVIS antennas can be "slewed."

(Continued on page 97)

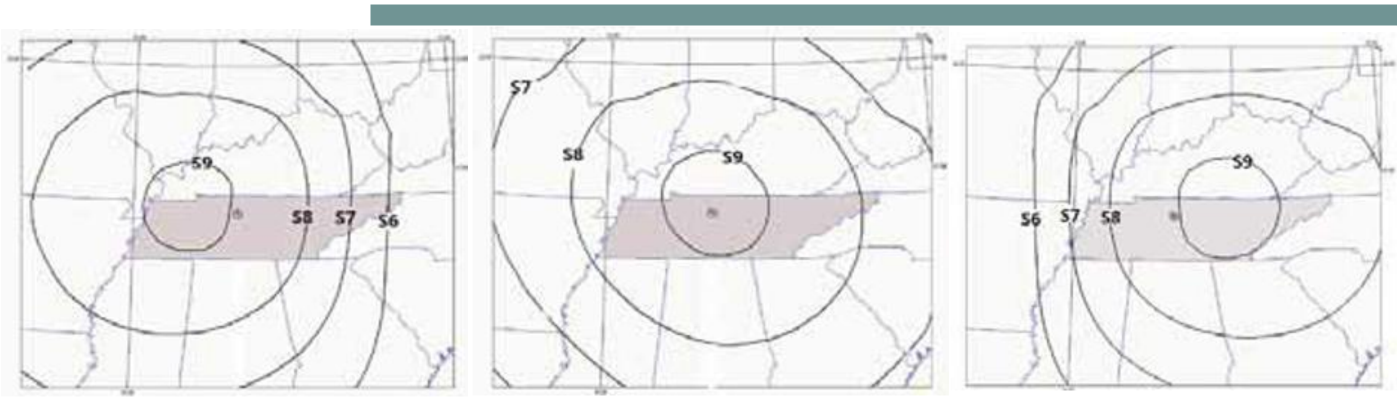


Figure 1a. Nashville antenna slewed west. Figure 1b. Nashville no slew in antenna. Figure 1c. Nashville antenna slewed east
Figure 1. Coverage footprints for a double dipole on 80 metres on a late afternoon in spring. At night the patterns would be much larger but show a similar shifting of coverage due to slewing the pattern. The greater the gain (narrower NVIS lobe), the more important slewing becomes. You do not have to aim a flood light, but you do have to aim a spotlight. Of course, the spotlight is much brighter. The contours show relative S meter values based on 6 dB per S unit. Actual values will depend on power levels and time of day.

(Extreme NVIS Antennas — How Big Can We Go? from page 96)

Slewing an antenna pattern means aiming it in a direction either side of the normal beam by changing the phase to two or more parts of the antenna. On HF typically slewing is limited to steering the beam up to 30 degrees. With NVIS this moves the area on the ground that is covered to one side or the other. Figure 1 shows coverage patterns of an unslewed and a slewed antenna. A station near Nashville could shift its NVIS coverage to favour the east-ern or western half of Tennessee by throwing a switch.

How is this accomplished?

This example, Figure 2, uses an antenna consisting of two half wave dipoles spaced a half wave apart. If they are fed in phase, they produce a very round pattern. Looking at the vertical pattern from the end of the dipoles, we can see that the pattern is very clean and the maximum signal is straight up.

If we feed one of the dipoles 90 degrees out of phase, the vertical pattern can be seen to be shifted to one side. See Figure 3 and Figure 4. The coverage contours of the two cases are in Figure 1. The coverage shifts toward the side of the delayed dipole. This could be very useful in a case where the transmitter is not located in the exact centre of the area that we desire to cover.

Slewing can also be useful in preventing interference from an undesired area, both in transmit and receive.

Relative Size of Various NVIS Antennas

The HAARP array is not shown. It would be too large to fit on this page. All of these are shown as viewed from above, that is a "bird's eye" view. Height above ground is a constant 0,2 wave-length unless otherwise noted. See Figure 5.

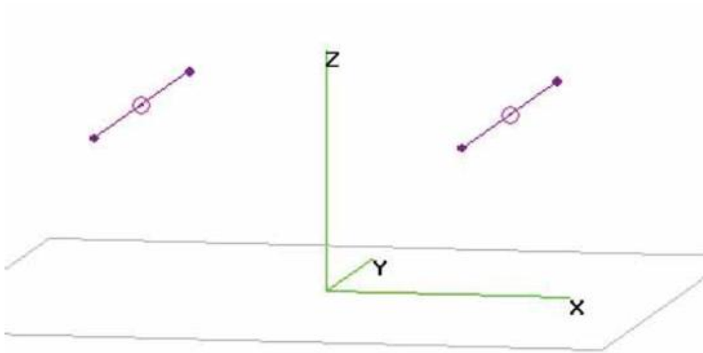


Figure 2. Two half wave dipoles separately fed.

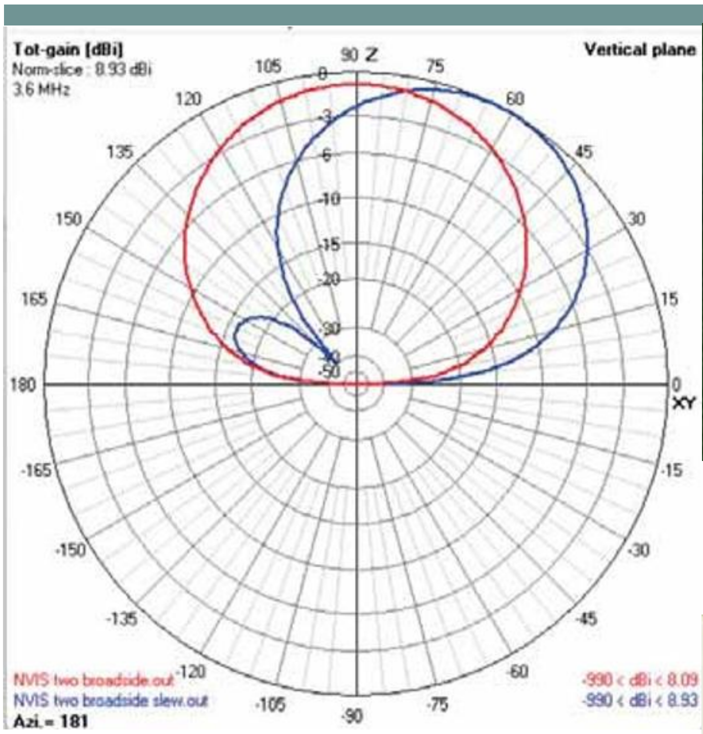
Propagation Factors in NVIS Operation

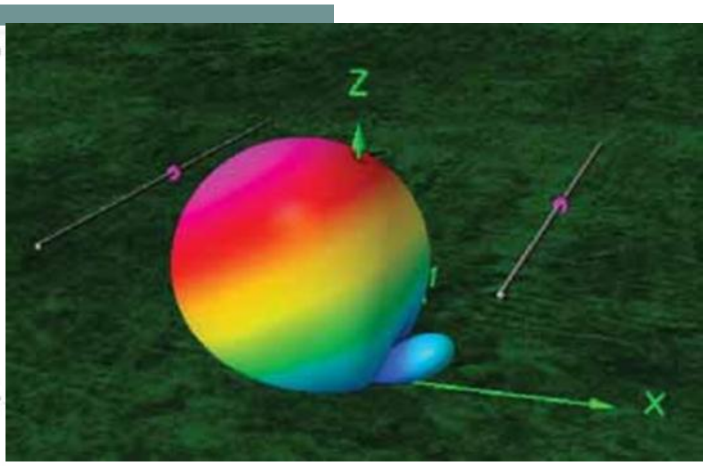
Some presentations on NVIS underplay the most important part of NVIS operation, that is, the effect of the ionosphere. Yet NVIS is utterly dependent on the ability of the ionosphere to reflect the waves that go up at Near Vertical Incidence (the NVI in NVIS).

If the high angle waves are either strongly absorbed, or simply pass though into space without reflection, *no* antenna will produce NVIS contacts. On the other hand, on the frequencies where the absorption is relatively low and the ionization sufficient to reflect the vertical incidence (high angle) waves, NVIS always occurs.

You simply cannot prevent it. You can use an antenna that has very little high angle radiation, such as a vertical quarter wave, but even then,

(Continued on page 98)





Left. Figure 3. Slewed and unslewed patterns
Above. Figure 4. A 3D view of the slewed pattern
Below. Figure 5 – Relative size of various NVIS antennas. (Birdseye view.)

(Extreme NVIS Antennas — How Big Can We Go? from page 97)

some NVIS will occur. The answer to the question "Have you ever operated using NVIS?" is "Yes, I have used frequencies below 10 MHz." So, for those who think that NVIS is hard to use, I want to say that no; rather NVIS is hard to avoid, unless you never use the lower bands. The amateur bands most useful for NVIS are 3,5 to 7,3 MHz. The best band will depend on time of day, sunspots and seasonal factors. 2, 10 and 14 MHz may occasionally be useful as well.

*Low Dipoles

Many have advocated dipoles only a few feet above ground as the best NVIS antenna. Yet extensive studies by the Army[1] and a Dutch research group[2] have shown that the low dipole has a lot of loss compared to one at 0,15 to 0,25 wavelengths, about 12 to 19 m for 80 metres, or 6 to 10 m for 40 metres. An antenna used on both bands should be 9 to 12 m up. The loss on receive is not as important as both signal and noise drop down. That contacts can be made with these very low antennas proves nothing except that NVIS signals can be strong enough so that even putting 90% of your power in the dirt will still provide communications. So, while in a hastily set up portable station, the dipole only six feet off the ground may "work," for any permanent site every effort should be made to get the antenna up to the optimum height to avoid extreme ground losses. This also prevents danger from the radiation and touching a working antenna and getting RF burns. We should characterize these low antennas not as cloud burners, but as dirt burners and worst-case people and pet burners. They are a serious compromise.

**Crossed Dipoles

You will see that the HIPAS antenna uses crossed dipoles. This allows the upgoing wave to be circularly polarized. While the experiments done at HIPAS benefited from this ability, it is not recommended for ham use. When other stations are using a dipole, transmitting using circular polarization can enhance your signal by 3 dB, but can reduce received signals by up to 20 dB. Changing the "sense" from left to right hand circular polarization will reverse these effects. Furthermore, sometimes when the X mode (extraordinary ray) predominates, a further reversal takes place. Thus, one might need to switch the sense between receive and transmit and even for different stations in a round table or net. Even then it will not be optimum for every station and time. I have used this technique on the 60-meter band and concluded that 3 dB is not worth all the switching. But if you are adventurous, go

(Continued on page 99)

Relative Size of Various NVIS Antennas			
Type of Antenna	Size for 80 Metres	Pattern and Slewing – see text for discussion	Relative Gain
Low ½-wave dipole end or centre fed	36,5 m, 7 feet high See Birdseye 1	Nearly round. No slewing.	–10dB*
High ½ wave dipole straight or inverted V end or centre fed,	36,5 m, 15 m high at centre. See Birdseye 1	Nearly round No slewing	0 dB (Reference)
Full wave loop, (lazy quad)	18 by 18 m, 15 m high See Birdseye 2	Very round No slewing	0,6 dB
Extended double Zepp	85 m long, 15 m high See Birdseye 3	Oval, long axis broadside No slewing	2.5 dB
Collinear dipoles individually fed	85 m long, 15 m high See Birdseye 4	Oval, long axis broadside Slew along the short axis	3 dB
Hourglass	15 by 67 m, 15 m high See Birdseye 5	Oval, along long side No slewing	2 dB
Two parallel dipoles	36,5 m by 36,5 m See Birdseye 6	Nearly round Slew broadside to dipoles	2.5 dB
Double delta loop	21 by 54 m See Birdseye 7	Oval, long axis along line Slew along long axis	3 dB
Lazy H, (four dipoles)	36,5 m by 73 m See Birdseye 8	Very nearly round Slew along short axis	5 dB
Double Lazy H, (8 dipoles)	109 by 73 m See Birdseye 9	Very round Slew in any direction	8 dB
HIPAS Array - 16 dipoles, crossed dipoles in pairs	152 m diameter circle See Birdseye 10	Very round Slew in any direction	9 dB**
HAARP array - 240 dipoles	16 hectares full of dipoles, too big to be shown	Very round Slew in any direction	18 dB

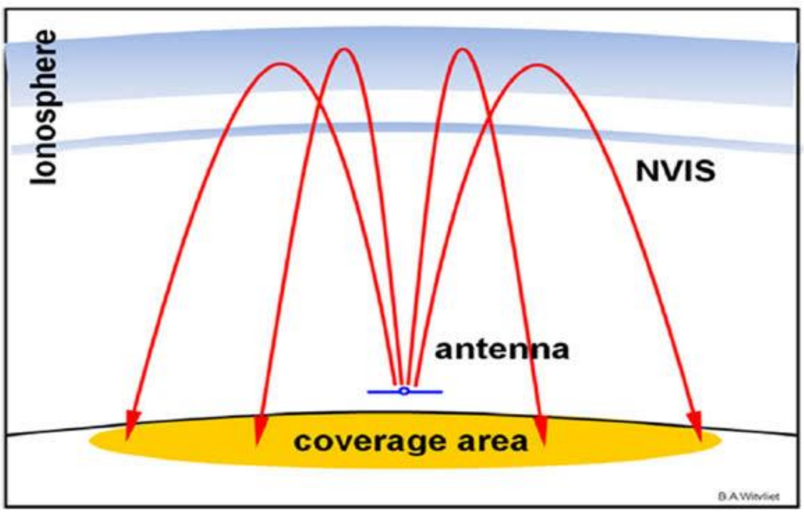
(Extreme NVIS Antennas — How Big Can We Go? from page 98)

ahead and try it.

References

[1] https://arrl-ohio.org/wp-content/uploads/2024/08/G0TJD_NVIS_Communication.pdf

[2] https://ris.utwente.nl/ws/portalfiles/portal/12174288/2014_Witvliet_NVIS_Research_in_The_Netherlands_summary_URSI_Benelux.pdf



Vir ons Afrikaanse lesers - 'n vis! Ek weet net nie of hy gaan resoneer nie.

Extremely Low Frequencies

J. B. Crawford - Computers Are *Bad*, a newsletter

https://computer.rip/2026-05-09-extremely-low-frequencies.html

The submarine is a surprisingly ancient technology - at least in its early, primitive forms. The idea is quite simple, that a well-enough-sealed boat ought to be able to submerge and resurface. It is the practicalities that make the whole thing difficult. It is generally considered that the US Civil War was the first use of submarines in combat; these were primitive machines with very limited operating endurance and navigational capabilities. These submarines were more like torpedoes: you pointed them in the right direction and hoped they went straight.

The First World War benefited from tremendous advances in submarine technology. Several experimental designs during the 19th century had built practical experience, especially in Germany and the Germans apt use of the first modern "U-boats" had a significant military impact. British and US designs made similar advances and submarine warfare was born.

The chief advantage of the submarine is its ability to submerge and manoeuvre while hidden. WW1 submarines were diesel-electric or gasoline, so their submerged endurance was limited by the power supply stored onboard. Still, these submarines could operate underwater longer than any before, long enough to establish the submarine sneak attack as a key part of naval warfare.

It was also long enough to expose one of the trickiest challenges of underwater defence: communications. Water, especially seawater, is dense and conductive. This is very bad for radio wave propagation: by the first world war it had already been discovered that seawater effectively blocked radio communications. HF radio, the main form of communications at sea (and, in the WW1 era, in general) might only penetrate seawater for a few meters in real-world That meant that submarines had to surface in order to communicate, another de facto limitation on their endurance while submerged.

The Navy had been evaluating electronic communication aboard ships since 1887, when they demonstrated a simple and "radio-adjacent" technology using conduction of waves through the seawater itself. This scheme never worked very well but was saved by the development of modern wireless transmitters late in that century. Marconi himself demonstrated radio to the Navy in 1899 and in 1903 the Navy bought its first radio sets. Tactical reports from conflicts elsewhere on the globe, like the Russo-Japanese war, reinforced the idea that radio would serve a key role in naval combat.

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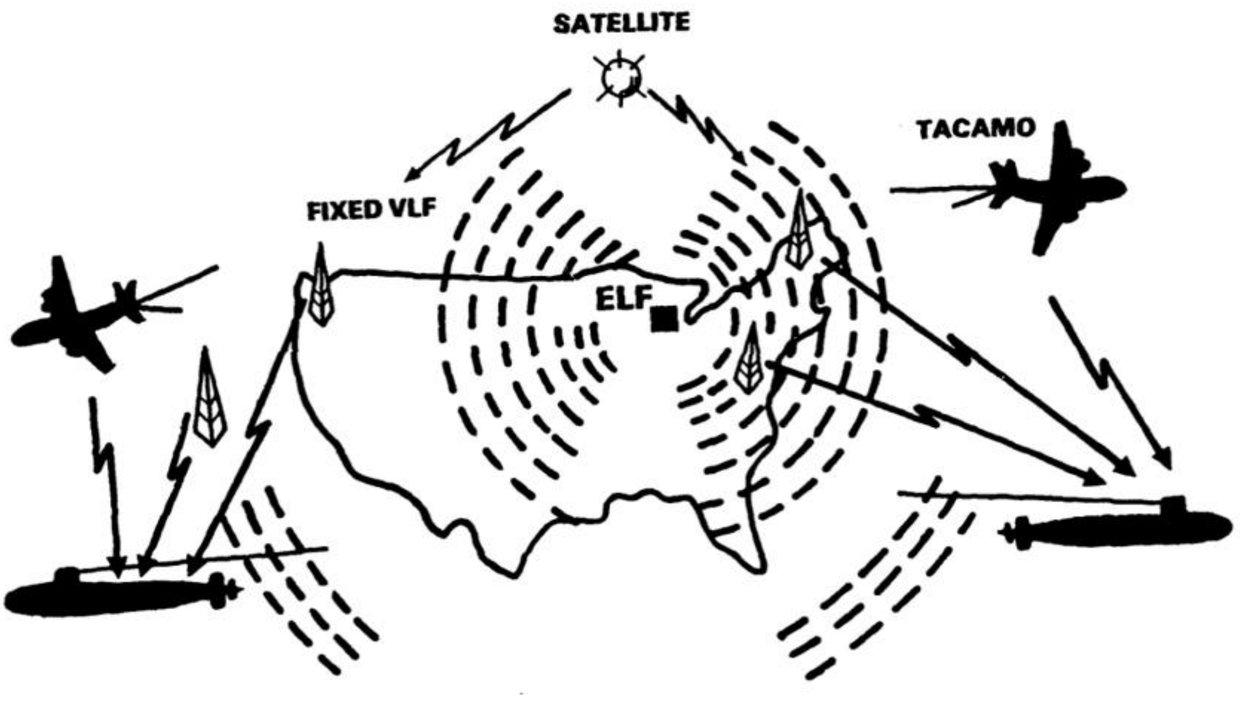

(Extremely Low Frequencies from page 100)

When C-class submarines Stingray and Tarpon and D-class Narwhal, launched in 1909, they were immediately given duties including the evaluation of radio equipment. In a classic tale of early technology, the evaluations went poorly. Tarpon ran into mechanical trouble that prevented its planned trial voyage, so the radio set was never installed. Stingray received a cutting-edge quenched spark gap transmitter and receiver set, but the transmitter turned out to be DOA. Still, Stingray was able to demonstrate its receivers, copying a message from the nearby Boston Navy Yard while surfaced.

Narwhal's mission was more ambitious: underwater communication. A test was made on the same direct conduction technology, using brass plates suspended below the ships, demonstrated in 1887. It similarly failed to perform. A repetition of those experiments, done the next year and with improved equipment aboard Narwhal's sister ship Grayling, produced better results. The system provided reliable communications with the “antenna” plates submerged as much as two feet below the water... and no deeper. Frustrated Navy engineers concluded that it was possible to get radio signals through seawater, but not practical.

Through the First World War and following decades, engineers focused on ways to get the antenna to the surface without having to bring up the entire submarine. Around 1915, the Navy adopted a floating antenna buoy that a submarine could "winch up" towards the surface on a cable. Putting anything at the surface was less than ideal, but the anti-submarine technology of the era the small antenna buoy was still very difficult to detect at long range. Submarines just had to make sure it was retracted back to the submarine's deck before attempting anything where stealth was key. These floating buoys were not reliable during WW1, but they could work and the technology has continued to develop to this day.

Still, there were other ideas about underwater communications. The most important development came from two engineers of the National Bureau of Standards (NBS), or at least, that is what a court ruled after a patent dispute between two sets of supposed inventors. John Willoughby was employed by the NBS, which would later be known as the National Institute of Standards and Technology (NIST), to investigate new types of radio receivers. In the summer of 1917, he was arranging various types of coil antennas at a receiver test site on the Chesapeake Bay when he accidentally dropped one of the antennas into the water. Strangely enough, the radio receiver connected to the antenna continued to provide good reception even as it sank into the bay.

NBS management was not especially enthusiastic about this accident, but Willoughby was. He knew that the Navy was investigating means of communication with submarines and that seawater seemed to block radio waves, all of which suggested that he might have stumbled on an important discovery. Lacking NBS support for further research, he took the idea to gifted radio inventor and NBS colleague Percival Lowell [1]. In a fine tradition of innovation, the two took to Willoughby's basement for a series of experiments that illuminated the underlying phenomenon: Willoughby had been experimenting with unusually low radio frequencies, below 30 kHz where wavelengths become too long for most antenna designs and coils become the best receivers. These lower frequencies were significantly less affected by water than higher, more conventional frequencies and Willoughby and Lowell built a successful prototype for what they called "long-wave" radio between two coils.

The NBS remained surprisingly uninterested, but Willoughby had a contact in the Navy who felt quite differently. In 1918, Willoughby and Percival joined Lt Cdr H. P. LeClair, then running the Navy's experimental radio programme, at submarine base New London (so named after New London, Connecticut, across the Thames River (Connecticut) from the base). They made a hurried and rough installation of their equipment on submarine D-1 and a surface support vessel. Not everything went perfectly, but they proved the idea: Willoughby, Lowell and LeClair listened attentively to their radio sets as the D-1 submerged and continued to come in loud and clear.

Within a matter of a few years, the Navy accepted long-wave radio as a standard technology for submarine communications. The various jury-rigged installations at New London showed that

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coil antennas could easily be integrated into a submarine's rigging and even better, the Navy had found that long-wave radio propagated over the surface as well as under it. Long-wave communications would serve the entire Navy and a transmitter site was already underway.

Long-range communications had become a top concern throughout the military in the early 20th century and a series of meetings between US military branches and between the US and UK led to a scheme of “High Power” radio stations. The first of these, NAA, went up near Arlington, Virginia in 1913. Over the following years, similar stations were built in the US and Europe, facilitating the first direct communications between the two and the first transatlantic voice communication in 1915. The construction and operation of these stations also led to considerable advances in radio technology generally, especially powerful transmitters. NAA was one of the early stations to be equipped with Poulson arc transmitters, almost two times more efficient than earlier designs and well-suited to long-wave operation.

Around the same time as the Willoughby/ Lowell experiments, Navy engineer Lt Cdr Albert Taylor found similar results with long-wire antennas shallowly under the water. These experiments offered another design for concealed submarine antennas (which could be stored onboard in reels and let out with floats that kept them just under the surface) and demonstrated that long-wire antennas could be buried for transmit use.

Five years later, in 1918, construction was underway on NSS - a new high-power station in Annapolis, Maryland. Unlike those before, NSS was specifically designed for long-wave signals. Two 500 kW Poulson arc transmitters driving an antenna 122 m square and suspended between four 152 m tall towers [2]. The long-wave capability at Annapolis was not originally intended for submarine communications, but it quickly fell into that niche. During the 1920s, NSS became a key station for submarine command and control of submarines.

NSS itself remained in service until 1996 and it was joined by VLF transmitters at Cutler, Maine; Jim Creek, Washington; Lualualei, Hawaii; LaMoure, North Dakota; and Aguada, Puerto Rico; besides sites in Europe operated with allied militaries. Each of these stations is its own interesting story. The 367 m VLF antenna tower at Aguada remains the tallest structure in the Caribbean. LaMoure was originally built in the 1960s for a long-wave navigation system called Omega and was repurposed for submarine C2. Jim Creek went into service in 1952 as the most powerful radio transmitter in the world, using a fascinating antenna that draped from one ridge to another across a mountain valley.

Let us focus, though, on Cutler. VLF Transmitter Cutler is the spiritual descendant of the Navy's original High-Power programme, symbolized in its inheritance of the call sign NAA. Cutler was part of a Cold War expansion of the VLF system, going into service in 1961. Many other VLF sites received upgrades around the same period, but Cutler was a completely new design. Cutler's two antennas, for redundancy, are each supported by 13 towers. The centre tower is about 304 m tall and the other 12 make up two concentric rings of about 274 m height. The complete antenna is over 1 828 m across, or nearly 2 km. Between the tower tops stretches a web of tight horizontal wires, each 2,54 cm copper, that form an enormous capacitor. The capacitor's other plate is the ground, electrically reinforced by many miles of buried ground plane wires. The radiating elements are vertical wires, hanging down from the upper horizontal mesh.

In Maine's harsh winters, the wires accumulate ice until their weight threatens the towers. Each antenna is alternately switched into a de-icing mode in which it is turned into a 3 MW heating element... just for long enough that the ice melts off. Outer towers are supplemented by short, stout structures that allow the 220-ton tension weights to move up and down on tracks. “Helix houses” at the feedlines of the two antennas sheltered enormous inductors; walls lined with copper served as insulation and to ground the occasional arcs that made the helix houses and transmitter rooms unsafe to enter during operation.

The two antennas were driven by a transmitter complex designed and built by Continental Electronics. The 11 MW on-site power plant supplied the AN/FRT-31 transmitter, custom to this

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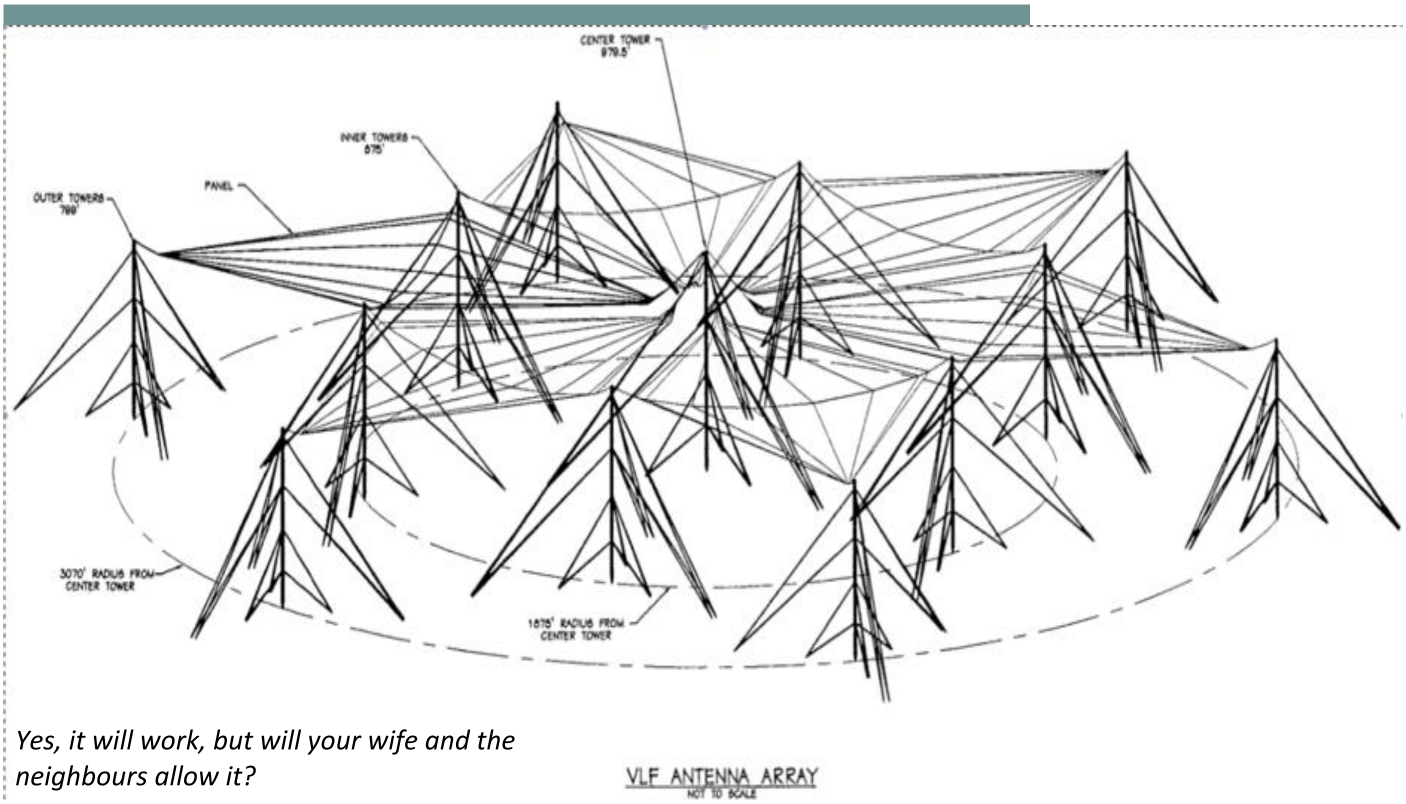

Yes, it will work, but will your wife and the neighbours allow it?

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installation, consisting of four parallel units of eight ML-6697 transmitter tubes. The transmitter's control room rivalled that of many power plants, as did its output: the military required at least 1 MW, Continental rated the transmitter for just over 2 MW and it still operates today at powers as high as 1,8 MW. There are several reasons that the "most powerful radio station in the world" is now difficult to pin down, but NAA Cutler is certainly in the running.

That is the end of the VLF story, in that it has not ended. The original 1910s and 1920s VLF sites are mostly decommissioned, but only because they have been replaced by more modern equipment, sometimes on the same site. Cutler, Jim Creek, Lualualei and Aguada are all still in service. LaMoure may be in some kind of mothballs state but is definitely capable of operating, it has recently seen some use for propagation experiments. VLF is still a key technology in the Navy's C2 and nuclear reprisal plans. So, we can say that VLF has achieved one of the great feats of technical history: it has outlived its replacement.

First, though, we should spend some more time on the theory. In modern parlance, "VLF" describes the band from 3 - 30 kHz. Most Naval VLF stations operate at around 24 kHz, but some stations support lower frequencies as well and other stations have operated as high as 40 kHz (still considered VLF by the Navy for practical purposes). These wavelengths pass through seawater well because of a basic trait of radio waves that was becoming experimentally apparent in the 1920s and received a thorough theoretical underpinning later. Radio waves attenuate as they pass through materials in proportion to the number of wavelengths in the material. In other words, as a rule of thumb, a radio wave with a 12 m wavelength (~24 MHz) will experience about 1 000 times the attenuation of a signal with a 12 000 m wavelength (~24 kHz). This is true of water or air or any other material, but the attenuation rate in saltwater is so high that the effect is extremely apparent in the sea.

This brings us to our first property of VLF: because of the long wavelength of VLF signals, they pass through water with relatively little attenuation. Still, there is a limit. The details of submarine communications are mostly classified, but from open materials it is realistic for a submarine to receive a VLF transmission up to about 30 m below the surface. This depth is already far better than what is achievable with HF and far superior to deploying a floating buoy. Still, intuition dictates that even lower frequencies could be even better and the Navy did not go without noticing

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that possibility.

Second, we should revisit the antennas. One of the key insights of early experimenters like Willoughby and Lowell is that coil antennas create an asymmetry in radio communications. Antennas become more efficient as they reach the wavelength of the signal, or multiples thereof. That means that lower frequencies and longer wavelengths, require larger antennas—thus the 1 828 m wide cobwebs at Cutler and more than one regional height record set by VLF antenna towers. On the other hand, coil antennas, or more specifically magnetic loop antennas, can be very small compared to the wavelength they receive.

Unfortunately, the physics trick that makes magnetic loop antennas work so well (magnetic coupling) is basically one-way. Magnetic loop antennas are relatively inefficient but usable for reception; they're completely useless for transmitting. VLF is effectively a one-way technology and some of the traffic carried by the Navy's VLF network consists simply of orders for submarines to surface or deploy a buoy for more advanced communications.

Finally, we should observe that the capacity of a radio channel to carry information is proportional to its bandwidth and that the use of lower frequencies and longer wavelengths makes the usable bandwidth of given radio equipment much smaller (we can intuitively understand this by noting that larger antennas are, simply due to scaling, more precisely tuned to their intended wavelength than smaller antennas). VLF transmitters are only capable of very narrow transmissions, functionally limiting them to continuous wave (Morse code) operation or simple digital schemes at very low speeds.

We probably all realize, as did the Navy, that pushing to yet lower frequencies and longer wavelengths would produce better penetration of the seawater, at the cost of basically every other property becoming worse: larger antennas, less efficient transmitters and receivers, narrower bandwidths. The possibility of going even further - from Very Low Frequency to Extremely* Low Frequency - was just a solution in wait of a problem. The military had a lot of those and the Cold War was one huge problem.

The idea of a nuclear-powered submarine is almost as old as the nuclear programme and a collaboration between the Navy; the Atomic Energy Commission and famed Admiral Hyman Rickover led to the 1954 launch of nuclear-powered submarine Nautilus. The next decade gave the Electric Boat Company new meaning, as nuclear propulsion displaced diesel in the US submarine

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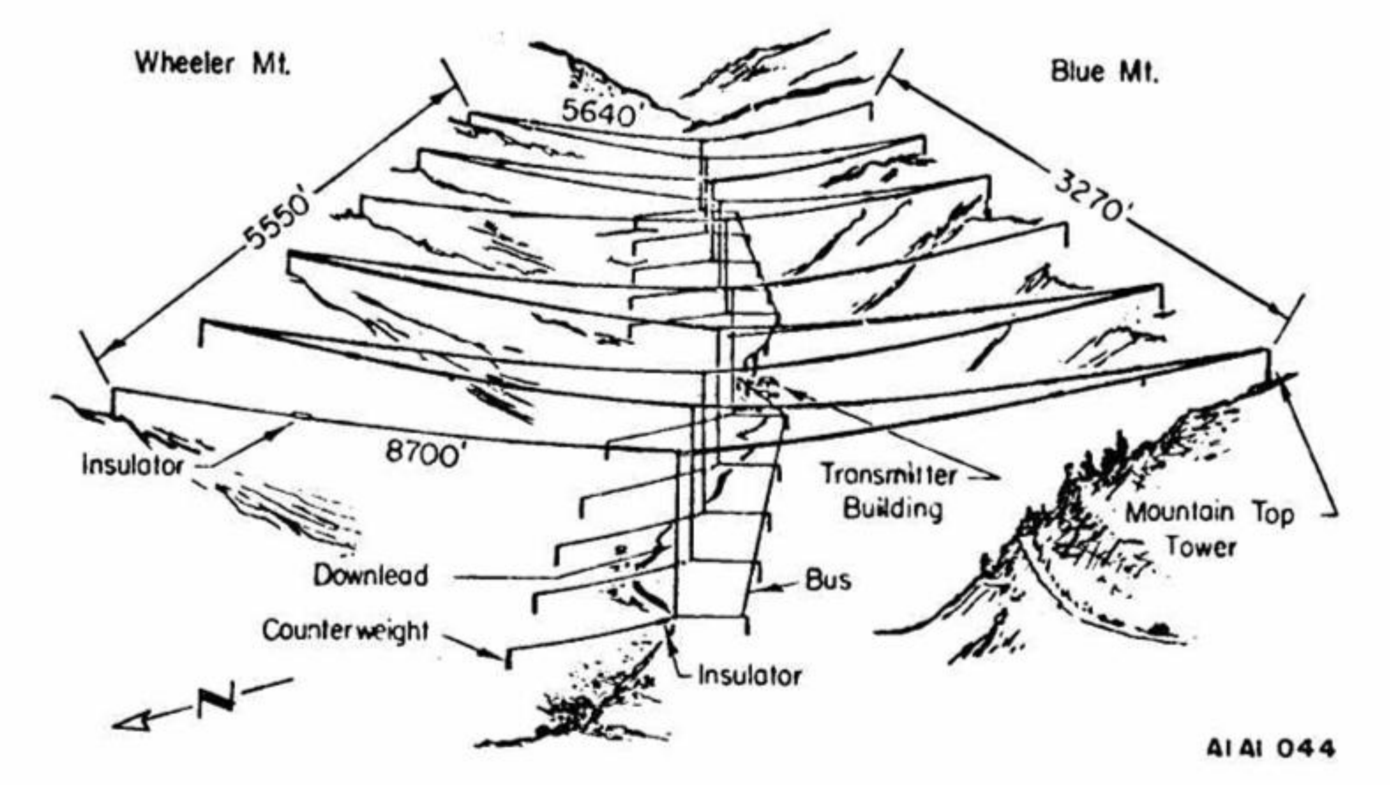

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fleet and fundamentally changed the strategy of submarine warfare. Nuclear submarines, unlike those using diesel-electric or gasoline propulsion, can be set up to remain submerged almost indefinitely. The reactor does not require air and provides plentiful power for life support equipment that mitigates the fresh air requirement for everything else. This created a generational change: by some definitions, all pre-nuclear submarines were merely submersibles, ships designed to submerge only temporarily. The nuclear submarine was a new kind of creature, one that not only visited the depths but could live there.

Add in the development of submarine-launched ballistic missiles (SLBMs), which enabled a submarine to direct nuclear weapons at targets on shore with shorter travel time than any other means of delivery. Every submarine became a portable missile silo, one that could not only hide but actively evade detection. Their ideal mission was to lurk, undetected, for extended periods of time.

Of course, this new potential for submarines further stressed communications infrastructure. A nuclear submarine might spend weeks submerged in water that is ostensibly controlled by another nation, making stealth critical. Such a submarine does not want to remain close to the surface, which makes detection by all means easier and also does not want to deploy floating buoys or antennas that are easily detected by modern radar. On the other hand, for it to have any value as a nuclear deterrent, the Navy needs some way to deliver a launch order without having to wait for the next duty rotation.

The military spent the early Cold War developing a dozen different systems for survivable delivery of nuclear war orders, things like the High Frequency Global Communications System (HFGCS) and TACAMO (Take Charge And Move Out) that solidified the concept of short, simple, one-way Emergency Action Messages to direct nuclear forces. The Navy needed a way to deliver EAMs to submerged submarines and that provided the impetus to investigate lower frequencies than ever before.

The lowest generally recognized radio band, ITU band 1, is Extremely Low Frequency or ELF. There is some historic complexity around the definition of ELF and the modern range of 3 - 30 Hz does not exactly match the way the Navy has used the term. In general, though, we can consider ELF to refer to the very bottom end of the usable radio spectrum. The extreme lower edge could be said to fall around 7 Hz, where the wavelength of a radio signal matches the circumference of the earth. This leads not only to complex interference problems due to constructive and destructive interactions, but it also produces a very high noise floor as global lightning storms trigger perturbances that resonate on and on. Balancing the desire for the lowest possible frequency against the practical challenges of ELF, the Navy settled on the range of 72 - 80 Hz as the most promising window for submerged submarines.

The history of Naval ELF development is not simple to research. First, the Navy conducted much of its ELF research in secrecy, a result of typical Cold War paranoia and an awareness that the Soviet Union was pursuing a similar idea. Second, much like GWEN, ELF became the locus of fervent public opposition grounded in general anti-war sentiment, demands for nuclear disarmament and the safety of electromagnetic radiation. Many of the readily available sources on ELF history today come from "electrosensitive" advocates or newsletters, a still-strong movement founded on the mostly unscientific premise that EM fields pose a danger to human health. While mostly factually accurate, these sources require some caution since they tend to mix their historical narrative with observations about EM and RF safety that are now broadly considered pseudoscientific. Still, this frustration leads to two positive outcomes: first, it helps to place the development of ELF radio within a broader cultural context of uncertainty about both war and new technology, emphasizes the unknowns involved in the push to ELF and makes the ELF stations an interesting focus of the anti-war movement. Second, it leads to a personal connection that likely contributed a great deal to my interest in military communications.

There are rumours, even scant evidence, that the Navy initiated classified experiments with ELF in the late 1950s. There is very little that I can say

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about this first part of ELF history, besides that the experiments must have had promising results. In 1968, the Navy adopted a full-scale ELF communications plan called Project Sanguine.

The original Sanguine proposal was truly an artifact of the Cold War, remarkable in its scale and doomed to obsolescence before construction even began. The Sanguine ELF station would actually be over one hundred independent transmitting stations, operating in synchronization as a form of hardening. The loss of a subset of those stations, say due to nuclear attack, would only reduce power rather than disabling the entire facility. Of course, to maximize survivability of the individual transmitters, they would all be installed in hardened underground bunkers, each with a set of 5 cm antenna cables extending 64 or more kilometres in four directions. The overall layout of stations and antennas created a grid with antenna elements spaced every 5 – 8 km, covering a total of some 16 834 square km. That is larger than Connecticut, but smaller than New Jersey. Perhaps more apropos, it is about 1/10 the area of Wisconsin, the state where the Navy planned to install the system [3].

This underscores a fundamental problem with ELF: antenna sizes. At 80 Hz, the wavelength of a radio wave is 3 700 km, or about one quarter of the diameter of the earth. Take, for example, a half-wave dipole antenna - a very common antenna design in most bands. For ELF, the antenna would need to stretch from Albuquerque to Portland. Clearly, then, any practical ELF antenna needs to be “electrically short” or, in the relative sense of RF engineering, a small antenna. Small antennas are inefficient and the smaller they get the less efficient they are. Complicating things further, practical ELF propagation over the surface of the earth requires vertically polarized waves. That means a vertically polarized antenna and there is simply no way to construct a tower that is hundreds of miles tall.

Sanguine proposed and most later ELF projects adopted, a style of antenna called a ground dipole. A ground dipole is basically two different electrodes, or grounding rods, driven into the ground a great distance apart and connected by feedlines. The power from the transmitter goes through the electrodes into the ground, where it flows as ground current from one end of the antenna to the other. The ground dipole thus forms a loop, with the feedlines as one side and the ground as the other. The actual RF emission results from the magnetic field between the feedlines above ground and the current flowing beneath, somewhat like the VLF antenna at Annapolis if half of it was buried beneath the ground.

Ground dipoles, like a typical dipole antenna, are directional. They emit RF most strongly in the same axis as the antenna, with strong lobes extending away from the ends of the two feedlines. By installing a second antenna on a perpendicular axis and shifting the phase between the two, you can create a steerable antenna with its strongest lobes pointed in the direction of your choice. That is why the Sanguine proposal and most ELF transmitters after, have used two ground dipoles in a crosswise layout.

During the 1960s, the Navy performed a series of poorly documented experiments to establish the feasibility of Sanguine. These included a Wyoming power transmission line that was temporarily disconnected for use as an ad-hoc 64 km antenna and a power-line-like 177 km antenna built by RCA in North Carolina and Virginia. The details of this RCA experiment, part of Project Pangloss, have become obscure. It appears that RCA was contracted to evaluate several different communications options for the Navy, including the use of other planets in the solar system as passive repeaters, but most of them did not work out. The VLF transmitter for the project was located at Ararat, North Carolina and the two electrodes at Algoma, Virginia and Lake Lookout, North Carolina. A 1963 test successfully got a message from the test antenna to a submarine submerged 45 m and 836 km from the transmitter.

Like most of the military's ambitious plans in the late 1960s, Project Sanguine did not happen. The reasons are complex, or at least several. Sanguine was unpopular with the public: besides specific concerns around safety, the late '60s saw a rising anti-nuclear campaign and a general lack of interest in enormously expensive military undertakings. The fact that Sanguine needed a massive amount of land meant that it was pretty

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much impossible to site it somewhere that wouldn't generate local opposition, so like ICBM fields, Sanguine was kicked around like a football. Originally planned for Wisconsin, it later shifted to Texas and Texas did not like it that much either (although by that point the antenna field had been downsized to just 4 144 to 8 288 square km). And, of course, the technology was struggling to keep up with the threat landscape. The hardened design of Sanguine relied mostly on the idea that the Soviet Union could not possibly nuke most of the transmitters distributed over 16 834 square km, a reassurance that the development of multiple independent re-entry vehicles (MIRVs) seriously undermined.

As public opposition formed, a health and safety review commissioned by the Navy resulted in a noncommittal report that did little to reassure the public (and lawmakers) that the plan was safe. Last of all, but certainly not least, the budget projections for Sanguine were formidable and Congress did not have the appetite for the spending.

Sanguine made it far enough that, during 1968, the Navy and RCA built a scaled down transmitter and antenna in the Chequamegon National Forest of Wisconsin. This came to be known as the Wisconsin Test Facility and it was used as a transmitter for a series of jamming tests in the late '60s and early '70s. During this period, the Navy also considered the use of a BPA transmission line from The Dalles, Oregon to Los Angeles as an ELF transmitter - the plan being to actually modulate messages onto the 60 Hz AC power carried by the line, which was incidentally radiated due to the line’s largely straight 1 367 km span. This plan was called PISCES and it is unclear if it ever went anywhere, although an interesting rumour holds that it was operational for a short period and used as the "jammer" transmitter for jamming susceptibility testing of the Wisconsin transmitter.

The results of these tests were mostly positive, but that was not enough to save an unpopular plan. Sanguine faded away, perhaps replaced by a scaled -down system called Super Hard ELF or SHELF. There is very little information on SHELF today. The idea seems to have been to install an ELF antenna in deep underground shafts (potentially over a mile below the surface) using hard-rock mining techniques. Work on SHELF apparently continued through the 1970s, but it probably never got beyond the feasibility stage.

Instead, the Navy shifted its focus to Project Seafarer. Seafarer was clearly a direct descendant of Sanguine but addressed many of its biggest problems through a stripped-down design. Seafarer transmitters, for example, would be located in surface buildings instead of underground. Still, the same basic antenna design remained, a grid on 5,6 km spacing requiring about 12 127 square km. The Nevada Test Site was considered as a location, as was White Sands Missile Range and forestland in the Upper Peninsula of Michigan. Michigan was ultimately selected, a result of favourable ground conditions and the lack of frequent large explosions. Seafarer construction was expected to begin in 1977, but instead it ended. The governor of Michigan shot the idea down; Congress didn't like it all that much and President Carter signed the order ending work on not only Seafarer but ELF in general. In 1977, after roughly two decades of R&D work across multiple experimental sites, the ELF Programme was in mothballs.

The Navy was not so easily dissuaded. Later in 1977, they proposed "Austere ELF," a plan to throw together an ELF transmit site more or less from spare parts. A transmitter at Sawyer AFB in Michigan's Upper Peninsula would feed 51, 72 and 85 km-long antenna elements and via a leased telephone line the AFB would also control the inactive Wisconsin Test Facility transmitter. Even this basic, partially spare parts plan fell afoul of the public and congress. It failed to address most of the original health and environmental concerns and still cost too much.

Serious resumption of the ELF programme would have to wait for President Ronald Reagan. Reagan was a fan of big, expensive, technically sophisticated solutions to Cold War programmes and ELF sure was one of those. Reagan approved "Project ELF," itself a scaled down version of Austere ELF. Project ELF used the existing Wisconsin Test Facility, supplemented by an identical 90 km antenna in Michigan's Escanaba State Forest. Both would be operated by Sawyer AFB.

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The Wisconsin Test Facility from Project Sanguine, after 20 years, came to be known as Navy Radio Transmitter Clam Lake: the first operational ELF transmitter. The Michigan site, known as Navy Radio Transmitter Republic, quickly joined it.

It is amusing that a temporary test facility ultimately became the final product, but the Navy had already invested a huge amount of effort in the Wisconsin transmitter. Everything from the strength of the EM field produced by the transmitter to its location in a National Forest had posed complications.

Although Sanguine was intended as a hardened, underground system, burying antennas was a lot of work and the Wisconsin Test Facility had originally been temporary. Instead of buried cables, it used 1,27 cm aluminium wires strung above ground on utility poles for the two antennas. The voltages on the antenna wires required isolation from the surrounding environment, so as with power lines, trees were cleared to make a right of way for the antenna cables. The Forest Service, concerned about aesthetic impact on the forest's recreational areas, required that the antenna routes avoid some parts of the forest and take right-angle jogs near roads so that it was not possible to see a considerable distance down the antenna ROW when driving past (which would make the existence of the cleared ROW much more obvious). The transmitter site and antenna ROWs are still clearly visible today. At each of the four ends, about seven miles from the transmitter building, around 3 048 m of buried copper wire make up the electrode.

Trickier were the electrical problems. The ELF antennas could induce a significant potential in parallel electrical lines and the use of ground return meant a lot of interference on telephone lines. When transmitting, which was ultimately the case 24/7, the 2,6 MW transmitter induced a current of about 300 A in the cables and ground. Understanding these impacts of ELF transmitters was actually one of the original purposes of the Wisconsin Test Facility and the Navy had built model power and telephone lines parallel to the antenna elements. The ELF system was found to cause problems ranging from flickering light bulbs to phantom telephone ringing and the Navy installed additional grounding and filtering on public utilities throughout the area at its own expense - even reimbursing the utilities for administrative costs related to customer complaints. Still, the interference problems were not fully solved during the test operations and no doubt contributed to the public's less than enthusiastic support.

The former Wisconsin Test Facility, as Clam Lake, became operational in 1985. Its sister site, Republic in Michigan, went online in 1980. Republic was new construction, not an old experimental facility, but for cost and expediency reasons it was a virtually identical design to Clam Lake with above ground wires to buried electrode screens. Because of geographical constraints, the Republic antenna is not in a straightforward cross configuration. Instead, it is more of an "F" shape, electrically equivalent but with the feedlines placed differently. From 1989 on, the two sites operated in synchronization, with their total 2,6 MW operational transmitter power producing a radiated power of about *eight* watts.

Yes, even at 22 km in length, ELF ground dipoles are extremely inefficient. This remained a key problem with ELF. Early Navy ELF plans, like Project Sanguine, had assumed the use of extremely high transmit powers to produce a usable signal. ELF propagates very well, but at the paltry 8 W achieved by the Project ELF transmitters, practical reception still required extracting the transmitted signal from a noise floor that was just about as loud. That meant reducing the practical bandwidth of the system even further and thus its speed. Project Sanguine would probably have been able to transmit EAMs directly to submarines; Project ELF was not. Even the compact format of EAMs was too long for a system with an effective symbol rate of about one letter per five minutes, or fifteen minutes to transmit the three-letter code groups used by the Navy.

This reduced ELF capability was basically a very fancy pager network. The Navy has not disclosed the details of the scheme, but it is probably something like this: each submarine has a three-letter code group assigned to it. When its ELF receiver detects that specific code group, the

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submarine crew know that there is a message waiting for them and they must move at least close enough to the surface for VLF to find out what that message is. The Navy often referred to this as "bell ringing:" ELF messages were like the ringing of a telephone. As a means of supervision, so that submarines knew they could receive a message, "idle" code groups were transmitted 24/7.

For how hard the Navy had fought to build it, Project ELF did not have a long life. The Navy's ELF submarine communications system was conceived around 1958, became operational over 30 years later in 1989 and shut down in 2004 after just 15 years of service. "The Nuclear Register," an anti-nuclear-weapons newsletter, put it like this: "A surprise Navy announcement signalled the end of 36 years of first local, then global, opposition to the Navy's giant transmitter system."

ELF overcame formidable political odds. Besides Congress's lack of interest in the expense and federal policy concerns around health and the environment, a statewide ballot referendum in Michigan had attempted to prohibit construction and legislation prohibiting ELF transmitters was perennially introduced in the federal congress. Activist groups opposed to the transmitters staged regular demonstrations and, as Project ELF proceeded despite their objections, protests gave way to civil disobedience. Utility poles supporting the ELF cables were cut on numerous occasions and the transmitter buildings vandalized. "The Nuclear Register" wrote:

Nukewatch said the Navy's closure announcement, while welcome, raises more questions than it answers. The Navy said, "improved technologies" and "changing requirements of today's Navy" made ELF obsolete. However, "very-low-frequency (ELF) [sic] alternatives to ELF have been around for 30 years and the 'changing requirements' refer to the end of the cold war that happened 14 years ago," LaForge said.

Indeed, it is hard for me to see the undignified closure of the Navy's ELF programme as anything other than an admission of failure. The basic technical concept of ELF appears sound, but the transmitters are large, disruptive and costly to operate. It is not clear that the advantages of ELF, namely the greater depth at which it can be received, outweigh its downsides or compare well to VLF.

VLF is still used by the US Navy today. ELF is not: the US has had no ELF capability since the 2004 closure of Clam Lake and Republic. China, India and Russia are the only other nations to have constructed ELF transmitters. The Russian system, ZEVS, operates at 82 Hz from ground dipole antenna in place since at least the early 1990s. It is a candidate for the most powerful radio transmitter in the world, although the exact specifications have not been made public. India's INS Kattabomman gained an ELF transmitter in the 2010s and while few details are known, China is believed to have constructed an enormous ELF transmitter in Huazhong during the 2010s.

It is, of course, interesting that China and India have both built an ELF capability after the US abandoned the technology. One wonders what made an ELF capability so hard to sustain here, even after the Clam Lake and Republic sites were built. Well, there is an inertia to politics: the organized opposition to ELF, once energized, did not go away. Area residents and politicians continued to organize for the closure of the Wisconsin and Michigan transmitters until their final days.

Opponents of the ELF sites got plenty of help from both science and popular culture. Preliminary research linking ELF radiation to leukaemia has not held up to modern scrutiny, but as with broader EM/RF cancer links this is an area of ongoing controversy. Extensive research by the Navy, mostly on the Clam Lake Site, has not found evidence of ecological disruption due to the ELF transmitter. Still, there is ongoing controversy and one of the reasons for Project ELF's long and torturous construction process was a series of lawsuits and appeals under the National Environmental Policy Act, contesting the thoroughness of the environmental research.

As usual, these possible connections to health and environmental impacts have given way to conspiracy theories. In the more shadowy corners of the internet, ELF is associated with everything from strange sensations to mind control. And that is where I first became involved.

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The X-Files episode "Drive" (S06E02) sees Fox Mulder cornered, practically carjacked, by a man who insists that if he does not drive West then his head will explode. The episode aired four years after the release of *Speed* and no doubt owes inspiration to that film (Mulder even makes a joke about it in the episode), but it attributes the bizarre scenario to a very different cause. The hapless victim, portrayed by Bryan Cranston, gained his head-exploding illness as a result of some sort of military experiment involving long antennas secretly buried beneath his house. Vince Gilligan wrote the episode and while there were several influences, the final episode is a direct reference to Project ELF and the surrounding controversy. Years later, because of their collaboration on "Drive," Vince Gilligan cast Cranston as the lead in his show *Breaking Bad.*

In the episode, Cranston does not make it to the West Coast. Mulder and Scully hatch a plan to puncture his inner ear and relieve the pressure building in his brain somewhere on the California coast, but Mulder just cannot drive fast enough. Cranston's head explodes.

Over the lifespan of the Project ELF facilities, police issued 636 trespass citations to demonstrators. Congressional representatives introduced legislation and amendments to end the ELF programme multiple times. At least a half dozen ELF transmitter concepts were cancelled, each one less ambitious than the ones before it. ELF is an interesting technology, but in a way, it's more interesting as a case study in military acquisition.

Take a concept that is expensive, politically unpopular and questionably superior to systems already in service - but if the military wants it, they tend to eventually get it. After thirty years, the military wears resistance down and gets something pushed through. Fifteen years later, the Navy shrugs, calls it obsolete and shuts it down. What is left is a 22 km-across "X" in the forests of Wisconsin, a legacy of controversy that still echoes and a pretty good episode of The X-Files.

1. Unrelated to astronomer Percival Lowell, although there are enough moments of intersection between the two that you wonder if they might have met.

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2. Many of the fine details of the original NSS installation have become confused, probably because the Navy upgraded the equipment several times in its first decades and the specifications of different eras have become confused. Here are some notes: some sources give the transmitters as 350 kW, others as 500 kW. A Navy history explains that improvements to the antenna design allowed for raising the power after the site was originally designed, so 500 kW is indeed what was installed but we know where the 350 number came from. Some sources give the original towers as 152 m tall and others (including Wikipedia) 182, I think the 152 m number is more reliable as it agrees with the Navy history. I am not quite sure where the confusion comes from, though.
3. Some sources, such as Wikipedia, give a number of 58 274 square km and ⅖ the area of Wisconsin. This was the very top end of a preliminary estimate that was revised down to 16 834 during planning. The 58 274 number still frequently appears, probably just because it's the more absurd figure, which is an example of the challenges of historical research when most information comes from activist groups opposed to the thing you're researching. Of course, we must temper that criticism with the fact that some anti-Sanguine sources use the 16 834 figure, especially older ones. The shift towards the more attention-grabbing 58 274 might have happened later as Sanguine was discussed more by people without original knowledge of the programme.


When digital systems fail
An expert report on the hidden risks of our digital world
SciencesPo
Technology & Global Affairs INNOVATION HUB
UNDRR
UN Office for Disaster Risk Reduction
ITU

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Foreword

As digital systems become ever more central to our lives, the risks that threaten them increasingly transcend sectors, institutions and borders. Critical digital disruptions, whether driven by natural hazards, infrastructure failure, or systemic interdependencies, can spill over at a speed and scale that existing governance frameworks are not yet designed to manage.

This report confronts a growing paradox. While digital infrastructure has brought extraordinary efficiency, connectivity and resilience to everyday life, it has also created new forms of systemic vulnerability. They unfold quietly, across interdependent systems, until critical functions suddenly stop working, often when they are needed most.

Developed through a co-creation process with international experts, this report makes visible the hidden dependencies and knock-on effects that standard risk assessments tend to overlook. Its aim is not prediction, but preparedness: to support a shared understanding of critical digital risks before disruption occurs.

The report reflects a joint effort by the International Telecommunication Union (ITU), the United Nations Office for Disaster Risk Reduction (UNDRR) and Sciences Po Paris School of International Affairs to convene and facilitate a collaborative process, bringing together technical, policy, disaster-risk and academic expertise to examine these challenges.

As digital interdependence deepens faster than our ability to govern it, collaboration is no longer optional. It is the foundation of digital resilience.

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Executive summary

What if, tomorrow, mobile phones and the internet stopped working, payments failed, hospitals lost patient data and emergency alerts never arrived? What may sound like science fiction could become reality. A large-scale, escalating failure of critical digital systems, a ‘digital pandemic,’ is a plausible scenario that current management frameworks are not yet designed to address.

Modern society runs on critical digital infrastructure: From electricity, finance and transport to healthcare, communication and government services. Everything depends on deeply connected systems that are more fragile than they appear and whose risks remain largely overlooked.

A solar storm of the magnitude that narrowly missed Earth in 2012 could have knocked out power grids and communications across entire continents. Growing space debris already threatens to push low-Earth orbit toward failure, jeopardizing satellite navigation, financial networks and weather forecasting all at once. Extreme weather, which is growing more violent with climate change, has already shown its capacity to sever digital infrastructure entirely, turning disasters into humanitarian crises.

This report shows that digital disruptions rarely remain isolated events. They cascade. What begins with a local failure can rapidly spread across sectors and borders. In fact, up to 89% of digital disruptions from natural hazards are caused by secondary spillover effects rather than the initial damage[1]. The number of people ultimately affected can be up to ten times higher than those initially exposed to the initial event[2]. Digital risks often remain invisible until they reach a critical threshold. Systems simply stop working while our physical world is seemingly unaltered. This may delay crisis response when action matters the most.

Meanwhile, our ability to cope without digital systems has eroded. Across sectors, analogue skills and fallback options have disappeared or are no longer tested. When systems fail at scale, manual alternatives often cannot replace them. However, the severity of this challenge varies significantly across contexts: countries with more limited infrastructure redundancy, including small island developing states and least developed countries, face distinct and in some cases more acute vulnerabilities.

Finally, a critical gap persists in how risks are understood. Cyber threats attract significant attention, but non-intentional disruptions of material infrastructure follow different dynamics. The knowledge exists, but we are not paying sufficient attention. And even when we do, we lack the necessary frameworks, standards and coordination capacities needed to turn that knowledge into preparedness.

Addressing these risks requires action across six priorities, identified through a co-creation process with senior expert practitioners spanning international organ-isations, national authorities, academic institutions and the private sector:

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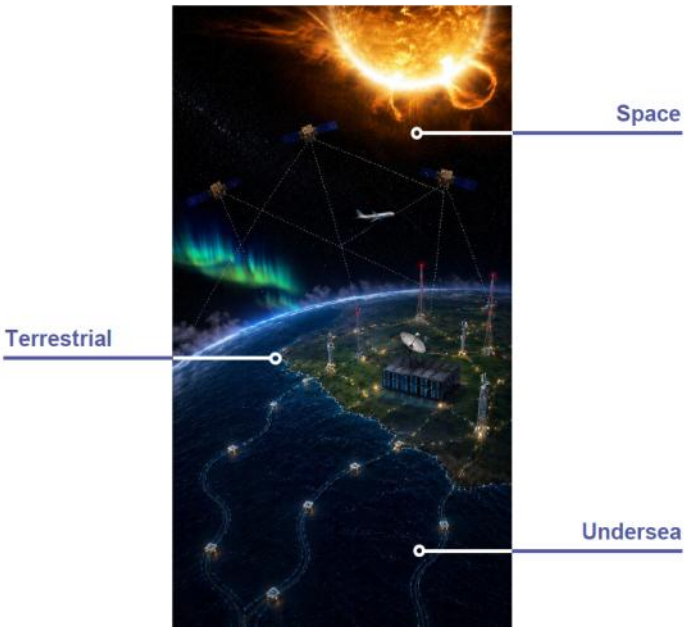
1. building the knowledge base to identify critical risks, model chain reactions and map cross-sector dependencies;
2. updating risk management frameworks to recognize non-intentional digital disruptions as a core risk;
3. strengthening international standards for resilience, encouraging cooperation for analogue fallback capacity and joint scenario planning;
4. ramping up proactive coordination on the most acute risk vectors; enhancing societal capacity to absorb and recover from digital disruptions;
5. building the trust, shared situational awareness and
6. global collaboration needed to translate early warnings into collective action.

Scenarios of critical digital failures

The scenarios that follow translate abstract risk into concrete terms.

Grounded in documented hazards, empirical evidence and cross-sector expertise spanning telecommunications, digital infra-structure governance, natural hazards, risk management, cybersecurity and critical systems resilience, the scenarios in this section were developed through a collaborative process. Senior experts from international organizations, national authorities, academic institutions and the private sector contributed to their design. The scenarios trace plausible chains of events through tightly coupled systems. They are not exercises in forecasting. Instead, they were attempts to make explicit what is usually left implicit: the dependencies that never appear in risk registers and the moments at which a digital system crosses, without warning, into a large digital disruption. Their purpose is to provide policymakers and practitioners with a shared tool to work from. The severity and nature of impacts will vary substantially across regions, depending on levels of digital integration, infrastructure ownership and national regulatory capacity.

The data and timelines presented in the three scenarios are illustrative. They are grounded in scientific literature, expert knowledge and documented past events, but they are not probabilistic predictions: real-world disruptions unfold under conditions of uncertainty and complexity that no model fully captures and their actual effects may differ significantly from those described here. The scenarios are intended to render visible the structural dynamics of systemic failure and not to prescribe how any specific event will unfold.



Space

In September 1859, a solar storm, an extraordinary burst of energy and charged particles from the sun, struck Earth. Telegraph operators in Europe and North America received electrical shocks. Sparks flew from telegraph equipment, setting some offices alight. Auroras were visible even at tropical latitudes. The event entered history as the Carrington Event, named after the British astronomer who observed it. At the time, the telegraph was the internet. Although the damage was severe, the infrastructure was relatively easy to rebuild and broader societal functions continued largely unaffected. Probabilistic estimates of a Carrington-class event vary widely across the literature, reflecting different methodological approaches and datasets. Estimates for the next decade range from under 2% to approximately 12%, depending on the statistical model applied[3]. A 2013 Lloyd's of London assessment estimated the North American impact alone at between 0,6 and 2,6 trillion US dollars[4]. Crucially, no event of this magnitude has occurred within the lifetime of any

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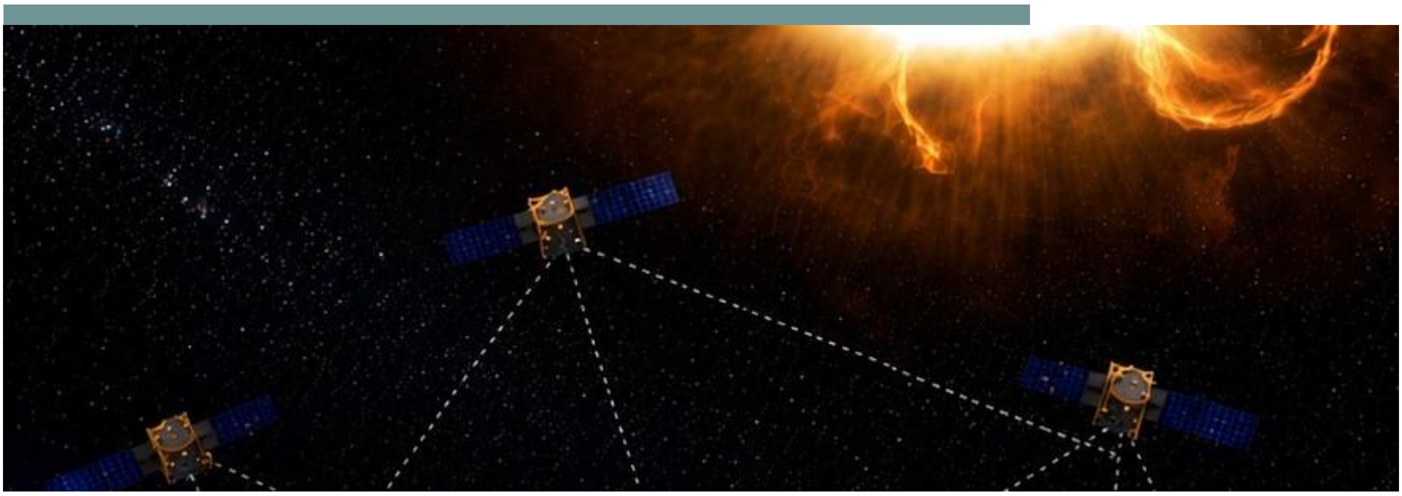

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digital system. Yet a near miss in 2012 had a similar strength to the Carrington event. The following scenario illustrates how a similar event would unfold if it were to strike today.

T-18 to T-0 hours: the warning window

Space weather monitoring detects a large coronal mass ejection on an Earth-impact trajectory. The warning window is 16 to 20 hours: sufficient for some protective measures, but insufficient for most. Three power utilities in northern latitudes reduce transformer loads. Airlines begin grounding polar routes, where navigation and communications are most vulnerable to solar interference. A major cloud provider suspends high-latitude operations.

Most organizations do not act. The decision-makers who receive the warning have never experienced anything similar and the systems they manage have never been tested against it. This is not negligence. It is a structural feature of risk management built on historical data and the historical record contains only one major entry.

T+2 hours: navigation disappears

Global Navigation Satellite Systems (GNSS) rely on radio-frequency signals from satellites to provide precise position, velocity and time worldwide. When these signals become globally unreliable, aircraft must revert to fixed flight procedures rather than live radar, slowing traffic to a fraction of normal capacity. Maritime navigation slows. Emergency services lose dispatch routing. Autonomous cars stop. Precision agriculture also halts, affecting food supply. Financial infrastructure does not merely use digital networks for transactions; it uses satellite timing to synchronize them. This timing failure is particularly consequential: When the timestamps become unreliable, clearing systems cannot determine the order of precedence. Transactions are rejected.

T+4 to T+8 hours: The wave of blackouts

Geomagnetically induced currents can cause transformer failures in national grids. The failures do not occur simultaneously: they move with the storm front, creating a travelling wave of outages that exhausts restoration capacity before any grid can fully recover. Initially, blackouts are managed. By hour eight, a number of grids have lost central dispatch capability. Data centres begin exhausting backup power. The disruption accelerates as backup systems reach their limits. Transformer replacement requires twelve to eighteen months per unit under normal manufacturing conditions. There is no strategic reserve and no established international protocol for the coordination of recovery currently exists.

T+12 to T+72 hours: The failed assumption

Every business continuity plan rests on an assumption that is rarely stated: that manual procedures can substitute for digital systems in case of failure. At scale, under sustained disruption, this assumption is tested and in even the most advanced economies, it fails. Hospital staff trained exclusively on electronic health record systems cannot locate patient information. Bank branches without cash reserves cannot serve customers. Traffic management in digitized urban centres fails. The skills required for analogue fallback are either absent or have not been rehearsed. Coordination

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depends on capacities that have been decommissioned or reduced.

The analogue skills problem can be described through the lens of aviation: GNSS navigation has so thoroughly replaced traditional piloting skills that specific training programmes now exist to maintain the capacity to fly without GNSS when disruptions occur. This principle applies across every sector.

Beyond 72 hours: The long silence

The duration of the disruption is determined not by the storm, but by the transformer replacement. When grid restoration requires components manufactured in a few facilities globally, the recovery is measured in months. The scenario does not end with a dramatic event, but with a slow, inequitable process of rebuilding infrastructure whose vulnerability

What this scenario reveals

Space weather is not integrated into national disaster risk registers in most countries. The Carrington benchmark is scientifically well-established; the probability estimates are credible; the engineering vulnerabilities of high-voltage transformers are well-documented. What is absent is a mechanism that systematically connects this knowledge to coordinated preparedness action across the organizations, jurisdictions and sectors concerned. The scenario does not require a failure of a warning system or a human error. It requires only not to change our current way of dealing with this risk.

In 2003, weather forecasts on high temperatures were largely accurate, warnings were issued across Western Europe and civil protection authorities sent heatwave advisories. The guidance matched the risk, as it was well understood, but the chain of consequences was not. The mechanism to translate a meteorological signal into a public health mobilisation was missing, which resulted in over 70 000 excess deaths across Western Europe. Meanwhile, the heat lowered river levels and raised water temperatures, forcing power plants to cut output just as demand peaked[5]. Although this strained electricity supply, digital infrastructure was not yet deeply embedded in critical systems, so its failure did not cause widespread and systemic disruption. The event would play out differently today.

Days 1 - 2: Below every threshold, everywhere at once

Several large data centre clusters in the region begin reporting cooling stress on the first morning. Electricity consumption across the grid reaches 97% of capacity by the afternoon. A regional transmission operator, following standard procedure, applies precautionary load-balancing, producing micro-outages of 8 to 12 minutes in suburban and industrial zones. Each of these events falls below the formal alert threshold for its respective system. No emergency is declared. No cross-sector coordination is triggered.

This is how cascading failures begin: not with a dramatic event, but with a convergence of tolerable pressures that no individual operator is positioned to see as a whole.

Terrestrial

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Day 3: The first cascade

Some data centres switched to a degraded mode, suspending non-critical services in anticipation of backup generator fuel shortages caused by reduced river traffic during the heatwave that noticeably affected the navigability of rivers. Mobile network latency increases by 180%. A major operator's traffic management system, itself hosted in one of the affected centres, begins throttling automatically. Several thousand base stations lose active cooling. A regional cloud provider suspends services and reroutes traffic to northern European nodes, creating congestion on transnational links that have not been designed to absorb the load.

In a meeting room in another country, engineers at a telecommunications company are looking at dashboards that show a problem they had not anticipated: their traffic management decisions were now entangled with the cooling capacity of buildings they did not own, in a city experiencing a weather event they had not included in their resilience planning.

Days 4 - 5: Health and financial systems learn they are dependent on a server room

An Uninterruptible Power Supply, a form of backup power, continues operating but no longer fully provides backup power or protection at one data centre during a 14-minute grid micro-outage. Recovery takes 31 hours. During this window, the national health authority's patient data exchange system, used for real-time bed availability and ambulance routing, becomes inaccessible. Three hospitals revert to telephone coordination. Emergency response times increase by 34% in the affected area.

The dependency has not appeared in any standard risk register. The health authority had not been consulted when the data exchange platform migrated to cloud infrastructure eighteen months earlier. No one has asked what would happen if the data centre hosting it overheated during a heatwave. The question has not seemed necessary.

A financial clearing system used by regional retailers fails to settle transactions for 19 hours. Smaller merchants suspend electronic payments and close. On the fourth day of a heatwave, in a city where temperatures have reached 42 degrees, many shops are shut not because of the heat but because their card terminals cannot connect to a server that has overheated.

Day 6: The alert that could not be sent

On the final day of the heatwave, a second data centre experiences a cooling failure simultaneously with a peak-load grid event. Mobile connectivity in the core urban area drops to 12% of normal capacity for four hours. The regional cell-broadcast infrastructure, designed to operate independently of data networks, relies on base station transmitters, several hundred of which have been without active cooling since Day 3. The civil protection authority attempts to issue a new emergency public alert, but the primary alert dissemination platform is also down. Radio and analogue systems are activated. Still, a significant proportion of the population does not receive the alert.

What this scenario reveals

The heatwave is forecasted. The data centre stress is measurable. The dependencies, power grid to cooling to cloud to health system to civil alert, have all been documented somewhere, by someone. What does not yet exist is a shared mechanism to view these dependencies together, or any protocol that treats a sustained thermal event as a digital infrastructure emergency. The absence of a visible trigger, no explosion, no cyberattack, no dramatic failure, means that each organization waits for someone else to declare the crisis. By the time anyone does, the alert system that would have reached the public is already offline.

Undersea

On 15 January 2022, the Hunga Tonga-Hunga Ha'apai volcano erupted 40 kilometres north of the Tongan capital. It shredded 80 kilometres of the single submarine cable connecting the archipelago to the rest of the world. The nearest repair ship was stationed in Papua New Guinea, more than 4 200 kilometres away. Tonga went dark for five weeks[6]. The domestic inter-island cable, buried under volcanic debris, took eighteen months more to

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repair. Tonga carried little global traffic. Had the same cable geography applied to a major routing hub, a choke point where dozens of systems converge, the outage would not have been a footnote of a volcanic eruption. It would have been a financial and logistical crisis measured in continents.

Hour 0 - 6: The rupture and the governance vacuum it exposes

Several cables are severed immediately. Others sustain damage that instruments will not detect until day eight, when they fail completely, eliminating the residual connectivity. In the first six hours, satellite backup absorbs approximately 8% of normal traffic. Within 90 minutes, even that capacity is overwhelmed.

The affected cables are owned by a consortium of private operators from a number of countries. Repair vessel mobilization requires commercial negotiation and approvals from coastal States, including routing authorisations across three exclusive economic zones. The fastest available cable repair vessel is nine days away. A second is identified but requires 18 days to reach the severed cables. The whole Pacific is covered by a few ships.

Emergency requests to redirect satellite capacity trigger competing national claims on available bandwidth. No agreed protocol for prioritization currently exists, nor a shared definition of what level of connectivity constitutes a humanitarian minimum. This reflects the distributed nature of responsibilities across national authorities, international organizations and private operators.

Days 2 - 7: Cascading into economies and bodies

Financial clearing for the region is suspended after 48 hours of degraded connectivity. Businesses can not settle import payments. Port operations slow by 60% as logistics software, dependent on cloud services, becomes inaccessible. A regional central bank declares a connectivity emergency. Health facilities that had migrated patient records to cloud platforms lose access to clinical histories. A doctor treating a patient in a rural clinic has no record of the patient's medications or previous diagnoses.

This is the moment when a system that appeared to be about information management reveals itself to be a system of medical safety. The cloud migration has been efficient, but it created a hidden interdependency to be taken into account.

Days 8 - 21: Three weeks without the internet

The region reverts to operating on high-frequency radio and physical document transport. A generation of administrators, health workers, teachers and traders who had never worked without digital connectivity discover, under stress, that analogue fallback requires skills that have been lost, equipment that has been decommissioned and institutional memory that had not survived the transition to digital systems.

Misinformation spreads rapidly to fill the information vacuum. With verified information sources unavailable, speculations fill the vacuum. Rumours about the cause of the outage, about when connectivity would return, about which banks had cash reserves and which did not, circulate and are amplified. The information disruption is no longer a secondary effect of the

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cable rupture; it becomes a crisis of its own.

What this scenario reveals

Submarine cables carry over 99% of international internet traffic. Yet, there are only a few hundred globally. Repair capacity is commercially contracted and geographically limited. While bodies such as the International Cable Protection Committee that include private and public actors, coordinate cable protection and facilitate repair operations, this capacity operates without a strategic reserve requirement or any public international governance framework adequate to a major multi-cable event. In this scenario, every relevant institution, national governments, international organisations, cable operators, satellite providers and financial regulators have a partial role. However, no actor has the authority required to match its responsibility. The crisis is not only caused by an eruption; it is mainly caused by an architecture in which no single actor holds both the authority and the operational capacity required to match the scale of its responsibilities.

Shared patterns of systemic digital risks

Despite their different triggers, critical digital risk scenarios tend to follow a common set of structural patterns.

Notably, different critical digital risk scenarios are equally possible. A prolonged drought could affect the river systems used for data centre cooling. A major volcanic eruption along a submarine cable corridor could replicate and amplify the governance vacuum the undersea cable scenario exposes, while adding atmospheric disruption that degrades satellite backup simultaneously. A major hurricane could level the mobile towers and poles carrying communications fibre of island nations. A progressive collapse of collisions in low Earth orbit makes large numbers of communications satellites inoperable and generates debris fields dense enough to render key orbital shells unusable for decades. Unlike the other scenarios in this report, the scenario, known as the Kessler effect, would leave no immediate recovery path.

Read each scenario should therefore be read as a question: not 'could this happen?' but 'what would we do if it did?'

What do those three scenarios share?

These disruptions are preceded by warnings. In each case, the information required to anticipate the disruption existed. The probability of a major solar event was published. The heatwave was forecast. The cable corridor's vulnerability was mapped. What was absent in each case was not knowledge but the architecture to translate knowledge into coordinated action across the organizations, jurisdictions and sectors that a disruption would cross. Yet this architecture must also extend to risks that have not yet been named: building the capacity to surface unknown unknowns as the vulnerabilities that exist before they appear in any forecast or risk register remains an equally pressing challenge.

They are invisible until they are not. None of these crises announces itself with a single dramatic event. Instead, they accumulate through thresholds that no individual organization is positioned to see in aggregate. By the time the crisis is legible as a crisis, the window for the most effective interventions has already closed.

They expose a specific kind of dependency: the hidden kind. Financial transactions depend on satellite timing. Transport systems depend on real-time data, GNSS navigation and digital traffic management. Health systems rely on cloud platforms. Emergency alerts depend on the same data centres as everyday services. These dependencies were created through individually rational decisions, by people who were not asked and had no mechanism to assess what those choices meant for the system as a whole.

Finally, digital risks do not depend simply on how digitalised a country is. The global digital divide, leaving about one quarter of the world offline, creates distinct vulnerabilities: in some Small Island Developing States, connectivity might depend on a single submarine cable, with critical data infrastructure often lying beyond national jurisdiction[7].

The second part of this report examines the analytical foundations that explain why these patterns recur and what a management response

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adequate to their scale would require.

Understanding critical digital risks

The scenarios described in the first part of this report are not hypothetical curiosities. They are plausible projections of a risk landscape that has been systematically documented across technical literature, empirical studies of recent infrastructure failures and the expert co-creation processes on which this report is based. This second part steps back from the narrative level to examine what we actually know about critical digital risks: how they are conceptualized, what structural conditions produce them, where our frameworks remain inadequate and what forms of management could begin to match the scale of the challenge.

Contemporary digital infrastructure is simultaneously more robust and more fragile than ever before. This is not a contradiction but a structural feature of how large-scale networked systems evolve. Decades of investment in redundancy, load balancing and distributed architecture have made digital systems increasingly resilient to routine and localized failures. A single server outage, a cut fibre link, a software bug: these events can be absorbed by systems designed to handle such failures. Yet this same architecture, tightly coupled, deeply interdependent, optimized for efficiency over slack, creates conditions in which a sufficiently large initial shock can propagate across systems with a speed and scope that no single operator controls or even anticipates.

The literature describes this as the transition from additive to exponential failure dynamics. In traditional risk models, two concurrent hazards produce roughly the sum of their individual impacts. In a tightly coupled digital infrastructure, concurrent stresses interact nonlinearly: the failure of one system removes a redundancy that another depends upon, which in turn overloads a third, triggering cascading collapse across sectors that were never explicitly connected in any operator's risk register. Empirical evidence confirms that this is not just a theoretical concern. Studies of observed outages show that up to 89 per cent of digital service disruptions caused by natural hazards result not from direct physical damage but from these secondary ripple effects. The number of people ultimately affected is estimated to be up to ten times higher than those exposed to the initial event[8].

This paradox has a second dimension that expert discussions have brought into sharp relief: digital risks are invisible. Unlike floods, earthquakes, or industrial accidents, digital infrastructure failures frequently produce no visible physical signal. Populations and organizations may wake to find nothing altered in their surroundings, yet critical systems have ceased to function. This invisibility delays recognition of severity and postpones activation of response mechanisms precisely when timely action proves most consequential. The 2011 Fukushima nuclear accident illustrates the principle: the multi-sector breakdown from earthquake to tsunami to nuclear crisis created critical information gaps that were themselves a secondary disaster. When the information infrastructure fails, the capacity to assess damage, coordinate response and communicate guidance is destroyed simultaneously with, or even before, the physical systems it depends on.

Four infrastructure domains and their interdependencies

The core expert group on critical digital risks identified four critical infrastructure domains whose interdependencies constitute the material architecture of digital risks. These are not independent categories but layers of a single ecosystem, each depending on the others in ways that are only partially mapped.

Power grids as the foundational layer

Power grids serve as the foundational layer of digital infrastructure. Every other digital system, telecommunications networks, data centres, payment systems, navigation services and mobile infrastructure, as well as satellite earth stations, depend on a reliable electricity supply. Power grid failures, therefore, ripple immediately across the entire digital ecosystem. The critical implication is that power infrastructure must be assessed in three phases: preventing failure, maintaining degraded operations during disruption and

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restoring service within timeframes that prevent dependent system collapse.

Historical analysis shows that restoration delays produce sequential failures:

- The 2003 European heatwave triggered power grid stress, which contributed to cascading failures across interdependent systems.
- The 2021 OVHcloud fire in Strasbourg was responsible for the disruption of ~3.6 million websites from a single physical facility failure.
- The Oregon heatwave in 2021 caused data centre outages at multiple cloud providers.
- In 2022, the Oracle and Google Cloud failures in London were linked to cooling capacity during a heat event.
- The 2025 blackout in Spain involved the sudden loss of 15 gigawatts of power, triggering cross-sector failures and knocking out telecommunications across Spain and Portugal. Internet, mobile and messaging services were widely disrupted, with knock-on effects reaching Morocco and remote villages in Greenland.

Submarine cables as the connectivity backbone

Submarine communication cables transmit over 99 per cent of international internet traffic, yet their critical role remains poorly understood in public discourse and risk governance frameworks. Submarine cables are fragile and easily severed by natural hazards or commercial fishing activities. What makes these events particularly severe is the repair timescale: specialized cable repair vessels exist in limited numbers globally and restoration can require several months, during which traffic is rerouted through alternative paths, degrading service across the wider network.

The vulnerability of undersea cables to natural hazards is well documented:

- The 2006 Hengchun underwater earthquake severed eight cables simultaneously, degrading connectivity across several Asian countries for weeks.
- The 2022 Hunga Tonga volcanic eruption isolated an entire island nation from global communications.
- In 2022, a single cable failure on the Shetland Islands isolated communities for several days.
- The 2024 Red Sea cables disruption consisted of multiple cables cut within weeks, with 25% of traffic between Asia and Europe disrupted.
- Multiple precedents of repair timelines of 3 - 6 weeks in international waters.

Satellite systems and space weather impact

Scientific literature on space weather has extensively documented the power grid vulnerability. Geomagnetically induced currents produced by major solar events can cause half-cycle saturation in high-voltage transformers, leading to permanent damage with replacement timescales measured in months. As the scenario of a Carrington-class event shows, a triggered network-wide effect would potentially destroy transformer infrastructure faster than global manufacturing capacity could replace it. This is not a marginal scenario; it is a credible planning horizon for which current preparedness frameworks are structurally inadequate.

Satellite systems face complementary vulnerabilities from space weather events, with implications for GNSS navigation, financial transactions, transport and communications. The Kessler syndrome is a chain reaction of space debris collisions that can sustain itself. It is a longer -horizon risk, with some orbits already becoming dangerously crowded. It would unfold across years, creating a sense that it can be managed, while quietly moving past the point of no return.

Despite the singularity of the Carrington event, there are precedents of space weather disruption:

- In 1989, a geomagnetic storm, known as the Quebec blackout, caused a nine-hour total blackout affecting six million people.
- The 2003 Halloween storms led to satellite failures, aviation disruption, power grid stress across Northern Europe.

Data centres as the hidden concentration risk

Despite their centrality to financial services, healthcare, supply chains and public administration, data centres constitute what the

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literature identifies as a significant blind spot in critical digital risk scholarship. As of early 2024, the total number of data centre facilities globally, including hyperscale, colocation and enterprise sites, exceeded 11 800, with the United States alone accounting for around 40% of that total. Growth is accelerating sharply: the sector added 137 new hyperscale facilities in 2024 alone and AI and cloud computing are projected to drive a 14% compound annual growth rate through 2030[9]. By 2030, global data centre electricity demand is expected to more than double, from 415 terawatt-hour in 2024 to approximately 945 terawatt-hour, approaching 3% of total global electricity consumption[10].

Geographic concentration amplifies vulnerability. Industry-led standards address some of these risks at the facility level, though they do not cover cross-facility cascade dynamics. Clusters mean that a single extreme weather event affecting a regional hub can simultaneously disrupt cloud computing platforms, content delivery networks, enterprise systems and tele-communications infrastructure. The 2021 European floods and multiple hurricane events in the United States of America provide recent empirical examples. Flooding causes immediate and irreversible damage to electrical and cooling systems, while extreme heat events can trigger emergency shutdowns that escalate through interconnected data centre networks as workload redistribution overloads remaining facilities.

Data centre failures, each with the risk of knock-on effects, are not uncommon:

- In 2009, a heavy rainstorm flooded the Vodafone data centre in Istanbul in just eight minutes, destroying equipment and causing a major customer outage.
- The 2012 Hurricane Sandy in New York led to several data centres in lower Manhattan going offline. Operators had to pump out flooded basements and generator rooms and replace damaged switchgear before restoring service.
- The 2015-2016 flooding of the Vodafone facility in Leeds, due to River Aire bursting its banks, caused an outage lasting several days and disrupting mobile services across the region.
- Multiple US hurricane seasons (notably 2017) during the costliest hurricane season on record led to widespread generator failures, power outages and data centre shutdowns across the Gulf Coast and East Coast.

Compound risks and the limits of current frameworks

Most risk planning today assumes that one problem happens at a time, lasts for a short period and can be fixed using well-rehearsed procedures. This is how most emergency plans, risk registers and business continuity strategies are designed.

But critical digital disruptions rarely work like that.

In reality, several pressures often hit at the same time, interact with each other and last longer than backup systems were designed to handle. A heatwave may coincide with high electricity demand. A cable cut may occur while networks are already under strain. In such situations, failures do not stay confined to one system or sector. They spread.

Two common patterns explain why impacts quickly become much larger than expected.

- In some cases, one single event affects many systems at once. For example, a major solar storm, an extreme weather event, or damage to a key submarine cable can simultaneously disrupt electricity, communications, data centres and financial services, even though these systems are often treated as separate.
- In other cases, the timing of events is the problem. One incident stretches backup systems and redundancies; a second, otherwise manageable event, then pushes the system beyond its limits. What would have been recoverable on its own becomes a serious disruption because the safety margin is already gone.

In both situations, systems that usually work reliably become fragile because they rely on each other in ways that are not always visible or fully understood.

These failures are hard to manage not only because they spread, but because they often begin out of sight. This becomes clear when contrasted

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with cyber threats, where the problem is usually visible, even if its consequences are not.

Cyber incidents usually announce themselves. When systems are hacked or hit by ransomware, it is clear that an attack has taken place, even if the details are not yet known. Non-intentional digital infrastructure failures are different. When they occur, the cause is often invisible to the people experiencing the disruption. Systems simply stop working. Payments fail. Data is unavailable. Alerts do not arrive without any obvious explanation.

For physical digital risks, the problem may lie far away: an overheated data centre, a damaged submarine cable, a power disturbance, or a satellite disruption. But from the user's perspective, there is no clear starting point. The failure looks local, temporary, or technical, even though it is part of a much larger system breakdown. This invisibility is what makes these risks so dangerous. Time is lost searching for the wrong causes, while failures quietly spread across sectors and borders. By the time the real source becomes clear, if it ever does, the disruption has already escalated.

This distinction is analytical, not hierarchical. Cyber and non-intentional risks are increasingly interconnected: a physical disruption can create vulnerabilities that malicious actors exploit, while a cyberattack can trigger cascading physical failures. Both dimensions warrant attention and their interaction constitutes an additional layer of systemic risk.

Finally, the economic impacts of large digital disruptions are still poorly understood. While available estimates suggest that even a single day of mobile network failure can cause very large economic losses in highly digitalized economies, most analyses focus only on direct effects, such as missed transactions or service outages.

They rarely capture the wider knock-on effects: supply chains that stall, businesses that cannot operate, public services that fail to coordinate, or the longer-term damage to investor confidence and public trust. We still lack economic models that reflect how deeply modern societies depend on digital infrastructure and that could be reliably used for planning at the organisational, national, or international level.

Conclusion and recommendations

Critical digital risks are real, documented, systemic and largely underestimated. They do not unfold as isolated incidents, but as disruptions across sectors and borders. While many of the risks are already understood in expert communities, they remain insufficiently recognized and acted

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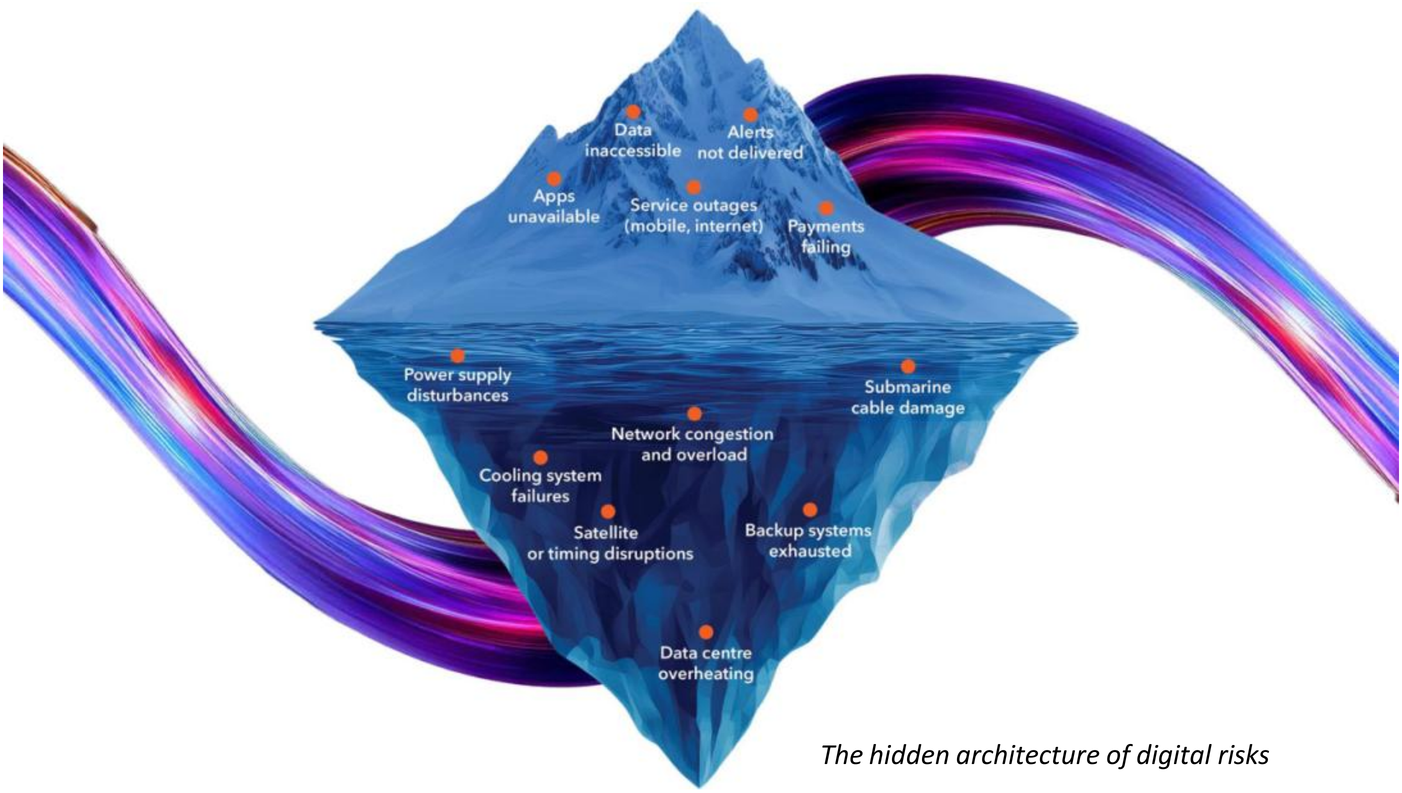

The hidden architecture of digital risks

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upon.

Drawing on a co-creation process with senior expert practitioners spanning international organizations, national authorities, academic institutions and the private sector, this report highlights six priorities for action:

Build knowledge:

- Identify critical digital risks
- Cross-sector dependency mapping adapted to different national contexts, including low- and middle-income countries where infrastructure data availability is more limited and digital integration follows distinct patterns
- Model probabilistic chain reactions

Update management:

- Recognise non-intentional digital disruptions as a core risk
- Clarify legal definitions
- Revise disaster risk frameworks
- Establish incentives for preparedness

Consider strengthening international standards:

- Ensure analogue fallback capacity
- Conduct joint scenario planning for energy, finance, telecommunications and emergency management domestically (local + national), regionally and even globally

Ramp up proactive coordination on critical risks, especially:

- Space weather
- Submarine cables
- Satellites
- Data centres

Strengthen societal resilience:

- Upkeep of analogue skills across professional and public contexts
- Build societal capacity to absorb and recover from digital disruptions

Build trust:

- Build capacity for national authorities, local governments and vulnerable communities
- Convenecommunities and stakeholders, including private operators across sectors and borders
- Foster shared situational awareness and mutual accountability
- Whether these risks remain manageable or escalate into systemic crises will also depend on how these priorities are translated into action.

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Glossary

Critical digital risks. Large-scale catastrophic threats to digital infrastructure that could trigger cascading failures across interconnected systems. These risks are larger than the direct physical impact of a disaster.

Critical digital infrastructure. Vital technological and material systems that support essential social functions like financial services, healthcare, emergency response and communications.

Digital networks. Interconnected systems of digital technologies that transmit, process and store information. These networks function as "networks of networks" where the operation of one system depends on the continued functioning of others.

Digital systems. Cyber-physical systems where digital control, material infrastructure and communication networks work together to deliver critical services.

Data centres. Critical facilities housing server hardware, storage systems and network equipment that process and store digital information. Essential to financial transactions, telecommunications, healthcare, supply-chain logistics and public administration.

Space weather. Solar phenomena, including

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coronal mass ejections, solar flares and geomagnetic storms that can damage electronic systems, disrupt communications and induce dangerous currents in power grids.

Carrington event. The most intense geomagnetic storm in the instrumental record (September 1859), causing widespread telegraph system failures. Used as a reference point for worst-case space weather scenario planning.

Kessler effect/syndrome. A self-sustaining cascade of collisions between orbital objects generating exponentially increasing space debris that could render low-Earth orbit unusable. Occurs when debris density reaches a critical threshold where collision rates exceed natural debris removal.

Cascading failures. Sequential failures where initial disruption in one system component propagates through interconnected systems, causing progressive collapse.

Hidden interdependencies. Undocumented or unexpected pathways through which failures in seemingly unrelated systems propagate. Difficult to predict and prevent, representing blind spots in risk.

Compound risks. Scenarios where multiple stress factors occur simultaneously or in close succession, interacting to amplify systemic failure beyond individual impacts.

Perfect storm scenarios. Situations where different technologies are affected simultaneously, either through a single cause affecting multiple systems or coincidental timing of independent failures that overwhelm redundancy mechanisms.

Network topology. The structural arrangement of nodes and connections in a network. Key properties include degree distribution, clustering coefficients and path redundancy, which determine how failures propagate.

Tightly coupled systems. Systems with strong interdependencies where failures propagate rapidly and deterministically between networks, creating higher risks of collapse.

Infrastructure hardening. Strengthening specific components against known risks through physical reinforcement, protective measures and enhanced resistance to stressors.

Disclaimer

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