ENAMS 2 – securing a history of electromagnetic noise measurements for the HF Bands

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The invention of the thermometer (Galileo) and the barometer (Torricelli) in the early 1600's paved the way for mankind to make accurate measurements of temperature and pressure in different places. It might be generous to assume that those recording these early measurements did so because it would allow comparisons of climatic change in time and place to be available to their successors. Irrespective, their initiative established records that can be relied upon to gauge weather and climate patterns for over 300 years and help to improve our lives.

Amateurs have long understood that the quality of radio communications depends on a having a satisfactory signal-noise ratio. Man-made interference is not our friend. So, like our climatic forebears, we too need to measure man-made interference and know the extent to which it is degrading the quality of our spectrum – more particularly in the HF Bands where our reach is global.

Radio Regulations generally prohibit others from interfering with the primary user of allocated spectrum. However, most amateur spectrum is retained on a secondary basis and we are not permitted to create interference and must tolerate any that we receive! In the short term, this may be convenient for primary spectrum users, but rising levels of interference from consumer appliances and other sources will eventually erode the quality of everyone's spectrum. Regulators no longer routinely record background interference levels and instead must rely on complaints to trigger their involvement.

In 2021, the German regulators ceased measuring background interference and this motivated the German Amateur Radio Club (DARC) to develop ENAMS-1 – an automatic noise measuring system for the HF spectrum that was calibrated in accordance with International Telecommunications Union Radio Standards (ITU-R P.372).

ENAMS is a reliable appliance that measures the HF spectrum on a regular basis, sends its data to a server in Germany where calibration factors (Antenna, etc) and averaging techniques are applied to populate a database that anyone can access (www.enams.de) . There are 69 units in the field – one of which is in New Zealand. DARC is committed to supporting the ENAMS database for the foreseeable future.

Figure 1 shows the ENAMS system. The receiver (essentially a highly accurate Software Defined Radio) is linked, via the internet, to a server in Germany.

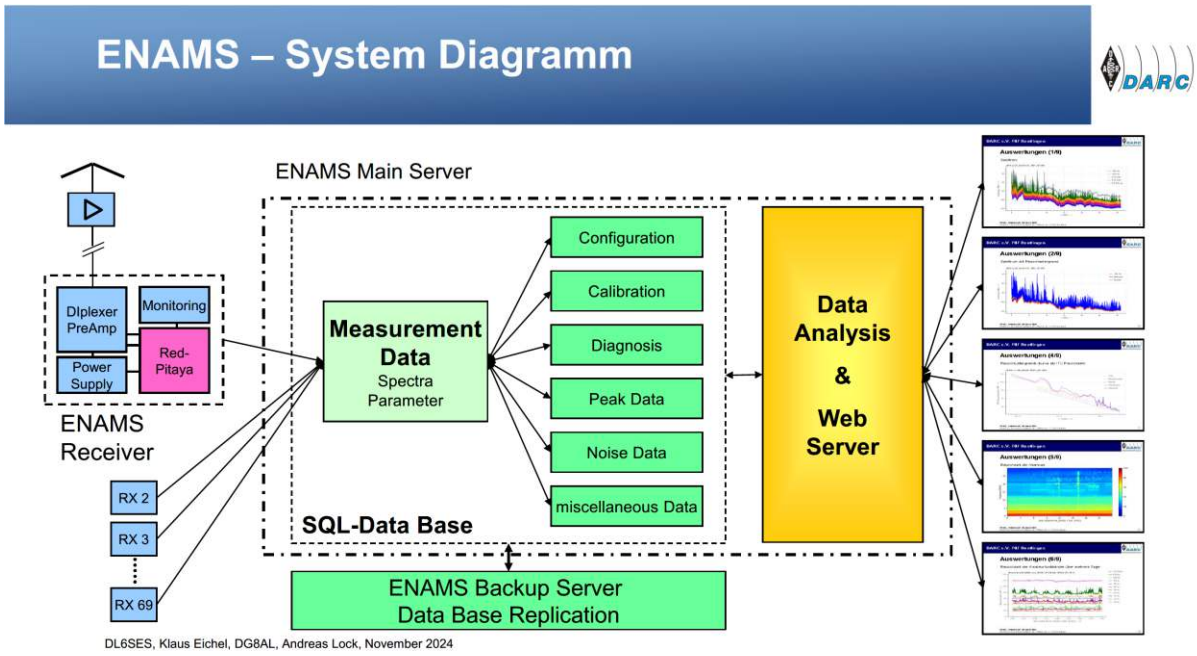

Figure 1 ENAMS System

ENAMS 1 has been in operation in New Zealand since 2022. It was established here on behalf of all NZ amateurs by Remote DX Inc on the recommendation of ZL2JPM - a member of both Remote DX and the IARU-R1 EMC Committee. Remote DX devolved into NZART Branch 50 which is committed to ongoing support of ENAMS. Through the generosity and foresight of these two organisations, there are already many gigabytes of spectrum measurements on file for future reference.

IARU R1's EMC Committee has been actively promoting ENAMS throughout other Regions. The Committee's Chairman, Wolfgang Mahr, OE1MHZ, and ENAMS Designers, Klaus, DL6SES and Andreas, DG8AL have conducted online seminars and there have been some attendees from Region 3. This paper supports their efforts.

Although ENAMS 1 has been successful, its geographic coverage remains relatively modest. All but one of these units are in the northern hemisphere and the majority are in Germany. The IARU, led by Region 1, now seeks to extend coverage into other IARU Regions and this triggered a re-design of ENAMS 1 – known as ENAMS 2.

So, what is different and what do you get from an ENAMS 2 investment?

The basis of ENAMS 2 has not changed: it provides the same accurate measurements as its predecessor. However, ENAMS 2 now features local storage and processing. Storage for up to 5 years of data and better computation capability with its Raspberry Pi 5. This means that ENAMS-2 can now be operated off-line and synchronised periodically – as opposed to continuously, with ENAMS 1. An improved antenna design together with the ability to recalibrate existing ENAMS -1 measurements means that historical and new measurements will be equally accurate.

The necessity for ENAMS has only increased: spectrum interference (which is on the rise) cannot be challenged unless there is evidence to either support a complaint or advocate for strengthened standards (set by bodies such as IEC, CISPR, etc).

Certification of ENAMS as a valid ITU-R measuring technique is being pursued by IARU R1. There has been resistance from others – mainly appliance manufacturers - who prefer an measuring protocol that accommodates existing equipment – some of which are evidently noisy. The IARU's concern is

that the cumulative effects of increasingly popular appliances (such as some barely or even non-compliant wireless power transfer (WPT) devices and LED controllers) may contribute to significant interference throughout the HF band.

Historical comparisons are very important in standard-setting as there has been a tendency to prioritise growth in appliance manufacture and use (Wireless Power Charging (WPT), Photovoltaic optimisers, vehicle management systems, Home Solar DC/AC converters, etc) over the risk of accumulated interference. The attitude has been that if a new appliance is tested in isolation and emits modest interference near the current limits – then it complies. As mentioned earlier, insufficient recognition has been given to the potential for the accumulated effects of thousands of such appliances located throughout whole neighbourhoods (such as in-garage WPT and solar optimisers). European experience appears to indicate that the accumulated effects of appliance-generated inference is already degrading the HF spectrum. ENAMS easily measures the accumulated effects of interference over time and its results add credibility to IARU advocacy to reconsider the limits of allowable interference from new mass-produced appliances.

Figure 2 is an ENAMS plot of a noisy Photovoltaic Installation in Europe.

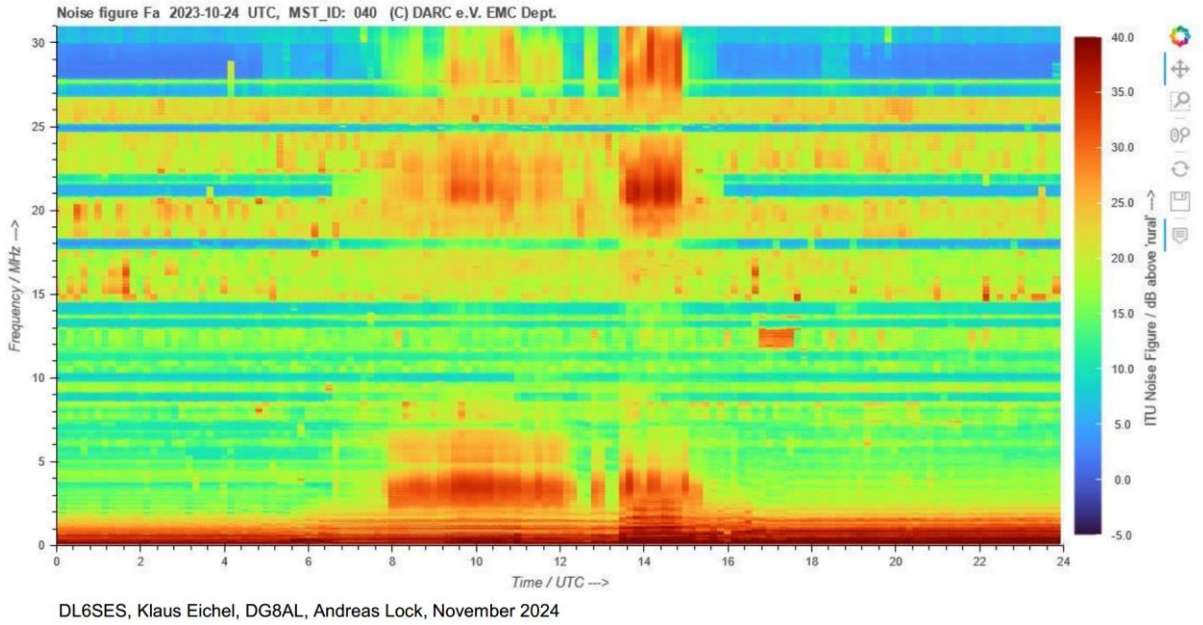

Figure 2 ENAMS Heatmap

The bright red areas (between 0800 and 1600 UTC) show excessive interference up to 5MHz and from 18MHz through 30MHz. 30dB levels of interference above ITU Rural levels would be experienced as 5 additional S units of noise on top of what would, for most of us, normally be about S5. S9+ noise is untenable. Complaints, in the absence of proof, are unlikely to succeed. Note also that the bright red line across the bottom of the chart represents high-level noise on the power distribution network.

Readers may access www.enams.de and examine the results for any of 69 stations (including New Zealand – where the receiver is located in Horowhenua).

In conclusion, ENAMS 1 has proven itself as a very reliable window on the state of electromagnetic interference on the HF band. By comparison with the opening example of temperature and pressure

measurements, our ENAMS electromagnetic noise measurements, are comparable to those pioneers in the early 1700's. We have a long way to go.

The IARU needs more ENAMS units out there and it is in our best interests to invest in the future preservation of amateur spectrum. The IARU is contacting every National Society to ask that they consider purchasing (for about $4,500) and maintaining an ENAMS-2 system to join the original 69 sites and help establish a global electromagnetic interference measuring system. Enquiries may be made via the IARU R3 Secretariat (Secretary@iaru-r3.org).