RF noise and interference within the ITU bands
the ACORN experience

Simone Cosoli
School of Civil, Environmental and Mining Engineering
The UWA Oceans Institute
The University of Western Australia
Outline

• ITU WRC-12 and ACMA prerequisites

• Australian Coastal Ocean Radar Network – ACORN

• Critical points: interference issues

• Mitigation efforts
ACORN

- Australian Coastal Ocean Radar Network (ACORN) is a facility of the Integrated Marine Observing System (IMOS)
- James Cook University (2007–2014)
- University of Western Australia (2014-)
- Primary application is to study dynamics of the major Australian current systems
- Free public access to HF radar data through the IMOS Ocean Portal
- 12 HF radar stations arranged in pairs at 6 sites around the coast
- Network includes both SeaSonde & WERA
- Expansion in NSW region (2-4 SeaSonde)
WRC-12: Agenda Item 1.15 (1)

- Oceanographic Radars (ORs) provide information on current, wave and wind conditions over coastal maritime areas, afford societal benefit via improved understanding of issues such as coastal pollution, fisheries management, search and rescue, beach erosion, maritime navigation and sediment transport.

- to consider possible allocations in the range 3–50 MHz to the radiolocation service for oceanographic radar applications, taking into account the results of ITU-R studies, in accordance with Resolution 612 (WRC-07)

- Very little alignment on proposed bands and bandwidths between administrations let alone between regional groups going into WRC-12.

- APT proposal comprised 21 separate ASPs of which 18 referred to frequency bands, and three to regulatory provisions.

- Australia supported only four of the band-related ASPs and abstained on four, as well as supporting the three regulatory provisions.

- ITU-R studies have shown that sharing is not straightforward due to significant sky-wave propagation issues.

- Most proposed bandwidths were larger than that required for an Oceanographic Radar to operate effectively in a given band and for its intended application.
WRC-12: Agenda Item 1.15 (2)

Outcome

- The Australian position was re-assessed and modified throughout the drafting process.

- Agreement was reached on a mix of either secondary or primary allocations with footnotes requiring protection of the fixed and or mobile services.
Interference issues

ACORN radars operate within the ITU frequency bands – however with secondary-type licenses

• Major leakage outside the licensed band for SeaSonde systems

• Primary users may use the band 1 week / year: band use and sharing must be negotiated with each individual user

• Major problem for WERA radar systems

• ACMA issuing breach complaints (3KD/day fine + 1-y jail)

• RF Common issue reported in various areas (i.e., Mediterranean Sea)
Interference issues

Radio frequency scans from CWI WERA radar shows clear intensification in the band-averaged power level after the frequency change. ACMA strongly “discourages” operations at previous non-ITU frequencies.
Interference issues

Radio frequency scans from CWI WERA radar shows clear intensification in the band-averaged power level after the frequency change.

ACMA strongly “discourages” operations at previous non-ITU frequencies.
Response of the WERA radar systems is variable:
- may be significantly affected – major artifacts in the radial current field
- may be not affected at all – directivity in the RX array filters the noise
- directivity in the main TX lobe (~90dB front/rear att; ~ 50-60 dB att ~60°)
- low TX power (4W / ant)
- and short-term bursts (5 min on / 5 min off)
- ensure minimum propagation over land

Interference issues (13.5 – 9.33 MHz)
Interference issues (4.338-4.488 MHz)

Origin and impacted users vary

e.g. SA BONC radar node – data used for upwelling and salmon fishery industry

- broad-band noise from the power line: may be local or distant source –
  transmission line may act as a long-wire antenna
- complete loss of Bragg across all ranges
- difficult to deal with – apparently correlated with rain
Standard practices: RT monitoring, calibrations
Interference issues (4.338-4.488 MHz)

Origin and impacted users vary
e.g. SA BONC radar node – data used for upwelling and salmon fishery industry

Impacted bands:
4467.0kHz (center, RX), 3kHz BW, 10KW pY TX

4373.5kHz (center, RX), 3kHz BW, 10KW pX TX

Not site-specific but AU-wide frequency band allocated to Defense

Temporary operating settings – negotiated with ACMA but still under monitoring:
4.453MHz, 11kHz BW, 12dB att (~4W TX)

Roadmap for mitigation measures and strategies plus quarterly updates to ACMA as for its implementation
Interference issues (4.338-4.488 MHz)

Temporary operating settings – negotiated with ACMA:
4.453 MHz, 11 kHz BW, 12 dB att (~4W TX)

Should not extend outside
4.438-4.463 MHz

Leakage up to 4.430-4.470 MHz still impacts a primary band (AF)

Mitigation steps:
a, modification of the SS chirp (via hardware / software)
b, improve directionality
b, decrease power and BW
c, installation of an improved design of the SS twin-TX (simulated)
d, systems relocation
Interference issues (4.338-4.488 MHz)

Increased attenuation (12dB) and decreased BW (11kHz)

Good SNR / range coverage up to 200km

1\textsuperscript{st}-order Bragg up to 30dB

Pros: No need of high TX power at lower frequencies
Interference issues (4.338-4.488 MHz)

SS Twin TX setup improves directionality through phase offset between front-rear TX antennas
Interference issues (4.338-4.488 MHz)

- SS Twin TX setup to improvement – site specific simulations that account for skywave propagation (ionopheric reflection)
- Different antenna spacing and front-rear phasing offset to minimize skywave propagation:
  - Simplified but realistic far-field physics, ground conditions, …
Interference issues (4.338-4.488 MHz)

Default twin-TX config

Proposed twin-TX config
Interference issues (4.338-4.488 MHz)
Summary

• HFR are considered important tools for research, monitoring of coastal maritime areas, fisheries management, search and rescue, beach erosion, maritime navigation and sediment transport.

• Specific frequency bands have been allocated internationally in the range 3–50 MHz, in accordance with Resolution 612 (WRC-07).

• Issued HFR licenses are either primary or secondary, with no protection from primary uses; most of the time negotiation with primary users is required for operations.

• RF is a common issue at a global level within the HFR community.
  – RF can affect the HFR operations to primary users.
  – HFR operations can affect other licensed primary users.

• Mitigation measures are needed and required for ACORN radars to operate.
  – Decreased TX and BW but with severe limitations in range resolution.
  – Improvement of