

# Concerns for the continued Military use of HF over Potential Increases to the Background Noise Level



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# Military Assignments in the HF Band

- HF band for these purposes taken as 1.6MHz to 30MHz.
- Military usage of frequencies is almost always shared with other users, e.g.: the Maritime bands are common user.
- One exception is the 'aeronautical off-route bands' which are not used by non-Military users.

# Military use of the HF Band

- Many uses of the HF band including:
  - Fixed point-to-point links
  - Fixed point/mobile links
  - Broadcast to mobiles
  - Nets (for transfer of data)
  
- Uses may be from NVIS paths to long-range paths.
  
- Mobiles may comprise:
  - Manpacks
  - Transportable shelters
  - land vehicles
  - aircraft (both fixed and rotary wing)
  - ships

# Why Military dependence upon HF?

- Historically, Military use of HF was expected to decrease with the advent of satcoms (which usually provides higher data rates where it can be fitted)
- Not all military users can use satcoms
- Military use of HF is increasing as higher data rates become practical
- Very low cost per bit of information (as relay medium is free)
  - Per message costs hundreds of times lower than using commercial satcoms
- Need to have some systems independent of any relay mechanism
- Sometimes the only system that will operate on very short paths using NVIS
- Coverage to aircraft (for example) needs to be at all ranges

# Why are HF Military Systems so Sensitive to any Noise Increase? (1)

- Some mobiles have very lossy antennas -
  - small aircraft may have -50dBs of antenna gain at the lower frequencies due to physical limitations i.e.: entire airframe is a small fraction of a wavelength
- Received signal may be very low level indeed and resulting S/N is often therefore one of the most critical parameters determining availability.
- For Military use, availability is needed 24 hours per day, 7 days per week.

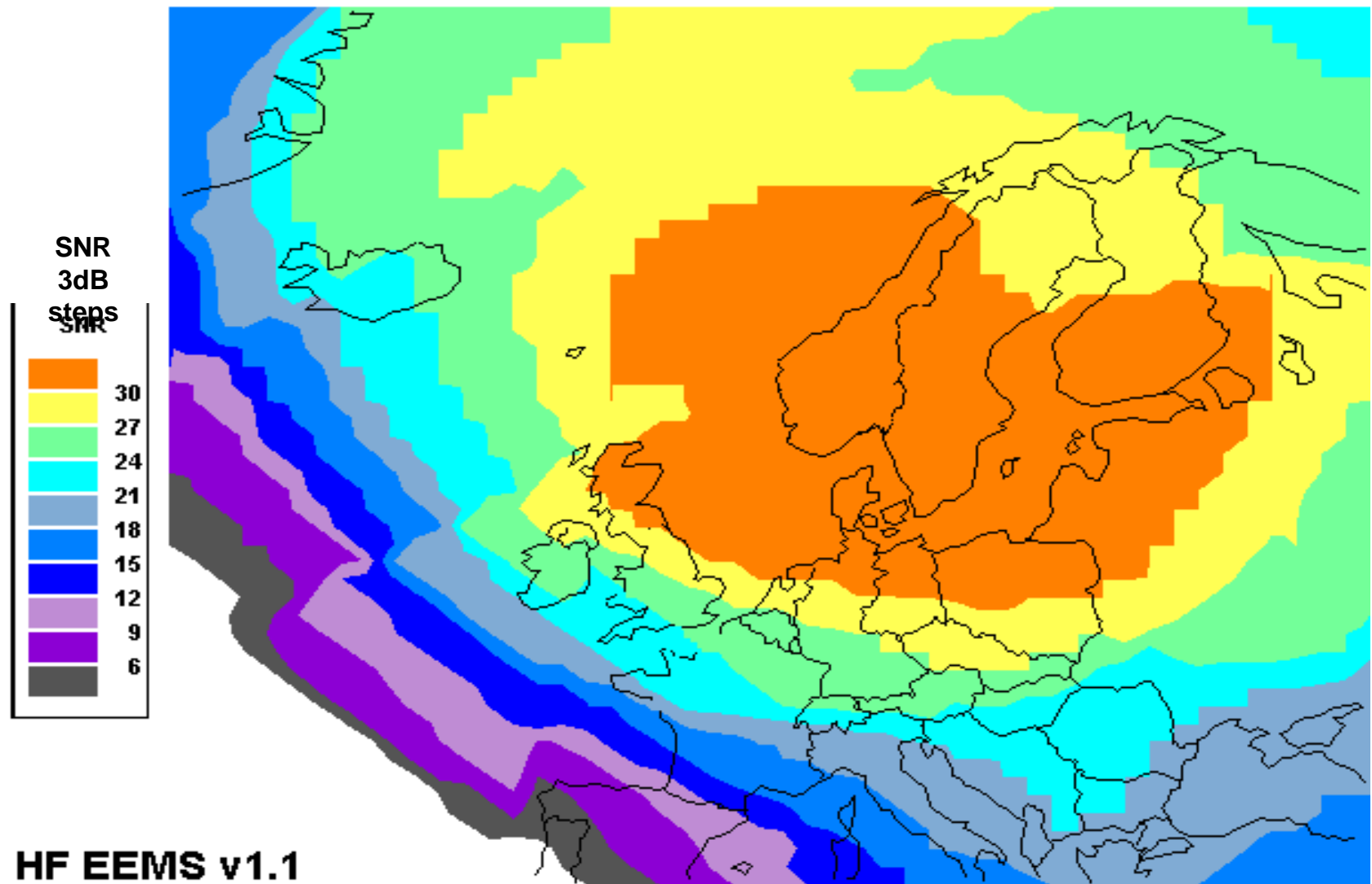
# Why are HF Military Systems so Sensitive to any Noise Increase? (2)

- Whilst some very robust waveforms at very low data rates (75bps) have been developed to operate below the existing ambient noise floor, users require higher data rates for many purposes:
  - data rates up to 9.6kbps already standardised within NATO in the usual 3kHz HF SSB allocations
  - higher data rates are being developed, some with the use of non-contiguous multiple SSB allocations
- S/N is critical and demanding at these higher data rates to provide availability
  - where availability is that percentage of the time when an acceptable error rate (e.g.: <1 in 1000) can be realised

# Why are HF Military Systems so Sensitive to any Noise Increase? (3)

- When working to mobiles, the skywave reflection point(s) may be in areas of ionospheric disturbance, causing adverse propagation effects including sometimes severe absorption, resulting in:
  - working with very weak signals indeed in both directions, (exacerbated by the inherently poor antennas on the mobile)
  - reduction of data rate and usage of very robust systems
- Even with data rate reduction to the limit, the most sophisticated modem techniques still only allow satisfactory operation at around -8db S/N in a 3 kHz noise bandwidth
  - the S/N is still critical

# Communications Coverage Example



HF EEMS v1.1

Sky-wave Map - SNR

17UT Mar 1998 6.0MHz

**DERA**

# Importance of HF Communications

- As stated previously, HF is sometimes the only communications system available e.g.:
  - NVIS situations
  - very high latitude mobiles
- Passage of operational material may be vital
- ATC information has safety of life implications
- Airfield weather reports have safety of life implications

# DERA Cobbett Hill



# DERA Cobbett Hill

## ■ LOCATION

- Receive site : Cobbett Hill, Normandy, nr. Guildford, Surrey
- Transmit site : Cove, Farnborough, Hampshire
- (transmit site unmanned and remotely controlled from Cobbett Hill)

## ■ FACILITIES

- Modern two site station supporting up to four concurrent HF circuits
- HF/VHF/UHF air ground communications
- Wide selection of HF, VHF and UHF frequency allocations for trials use
- Calibrated measurement range for evaluation of aircraft HF antennas
- Mobile field strength measurement capability
- Spectrum occupancy measurement capability

## ■ SPECIAL ROLES

- 24 hr / 7 days HF service for BA Speedbird
- Split site 1kW ALE installed - use for ALE trials, etc.

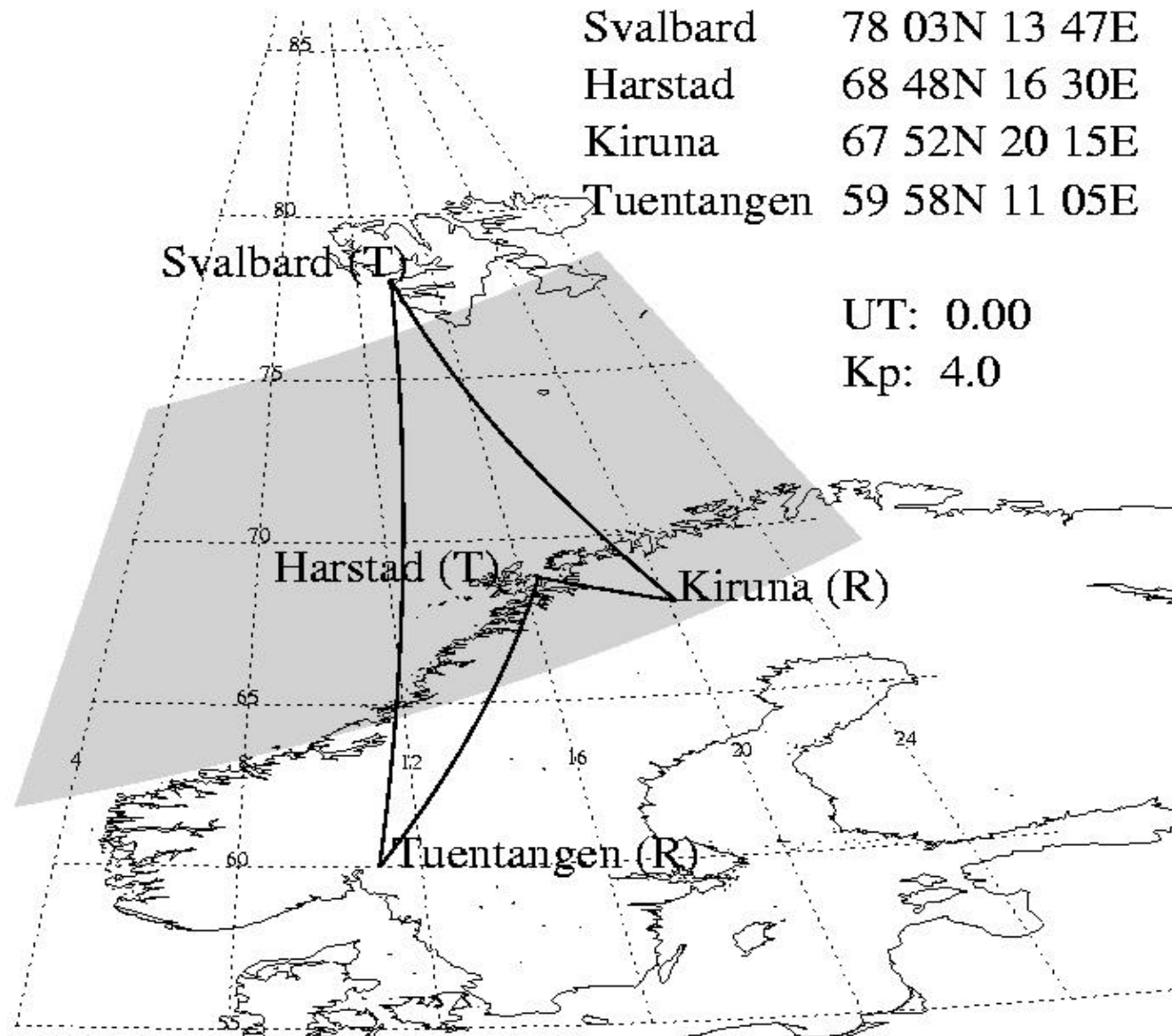
# DAMSON Project

- International programme to characterise the HF channel from a communications perspective
- Doppler And Multipath Sounding Network
- International collaboration
  - Defence Evaluation & Research Agency (DERA), UK
  - Communications Research Centre (CRC), Canada
  - Defence Research Establishment (FFI), Norway
  - Defence Research Establishment (FOA), Sweden

# DAMSON System

- 2-30 MHz
- Pulse compression sounder
- PC based
- Extensive Digital Signal Processing (DSP)
- Originally 3 kHz channels, saving power scattergram
- Currently operating in 12 kHz channels with I & Q saving

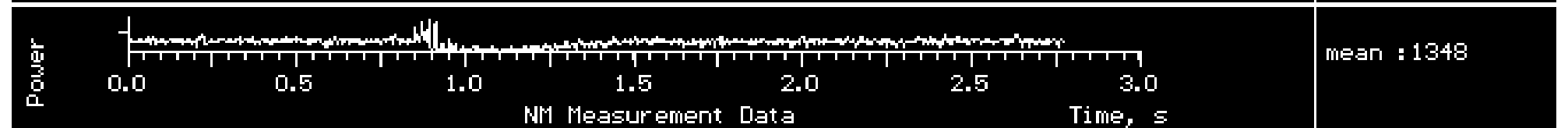
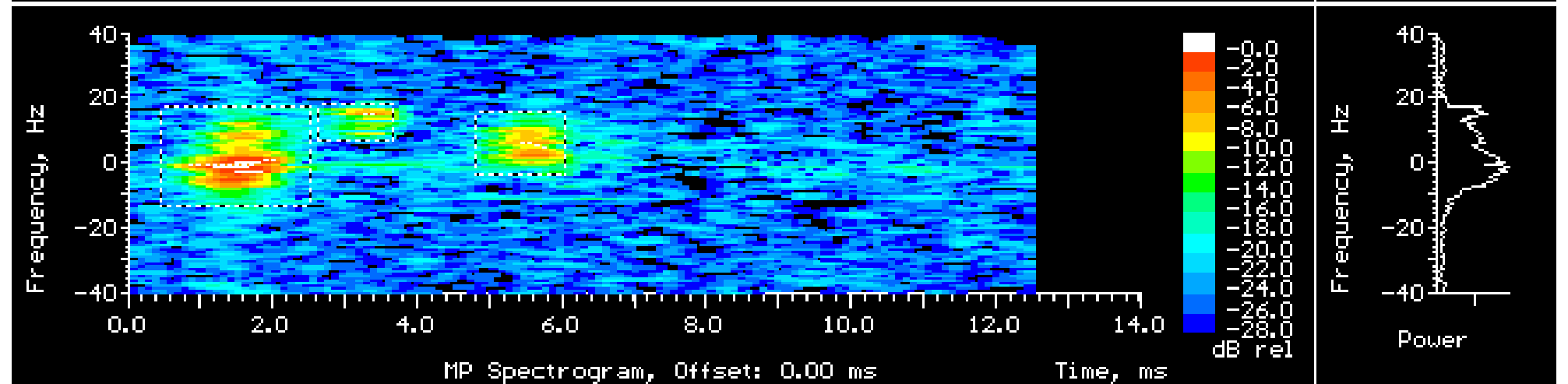
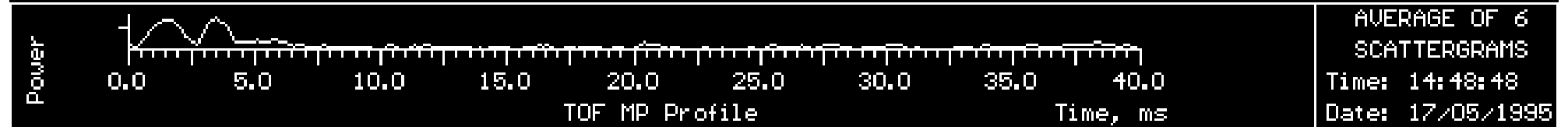
# DAMSON Station Locations



TX: Harstad(68.48N, 16.30E) RX: Kiruna(67.84N, 20.40E)

Frequency: 06.7 MHz  
Status: Waiting for choice

<P> = GOOD; <Q> = BAD; <SPACE> = DIFFICULT.  
<Z> = PAUSE; <ESC> = ESCAPE.



PRESS <I> TO DISPLAY AN ISOMETRIC PLOT

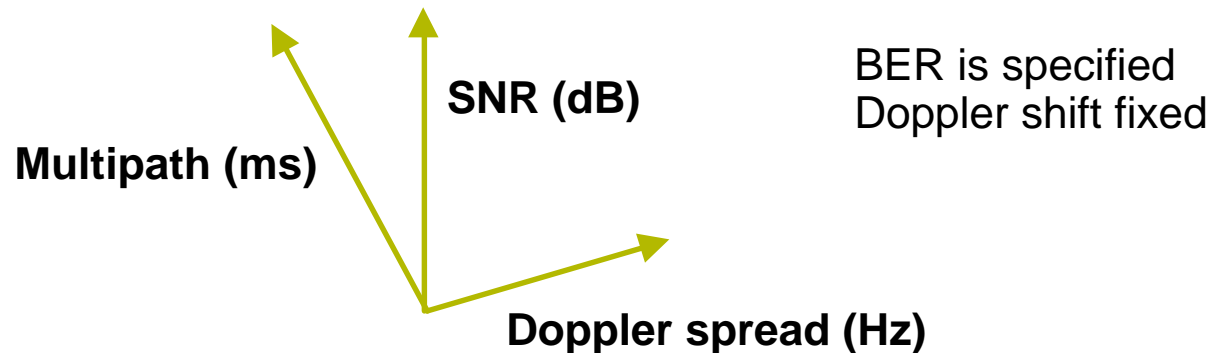
# HF Modem Characterisation

## ■ Measurement technique ...

- Specify : BER
- Fix : Doppler shift
- Vary : Multipath
- Vary : Doppler spread

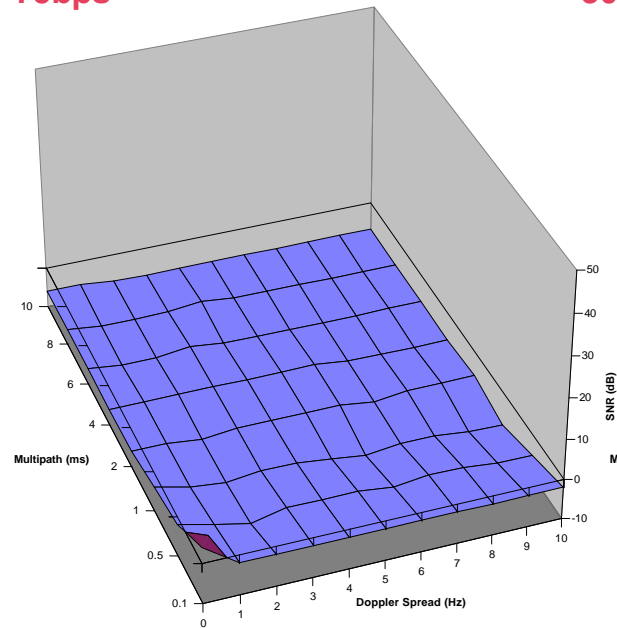
Search for SNR  
to give required BER

## ■ Presentation of results ...

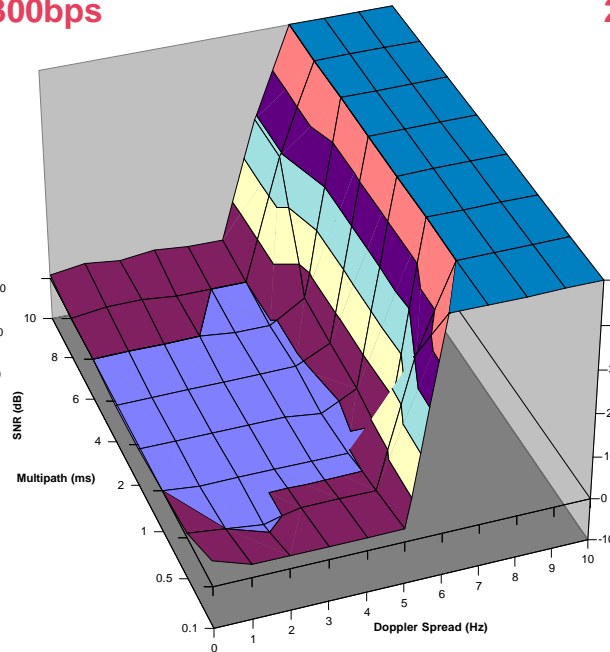


# Example Characterisations (serial-tone waveform)

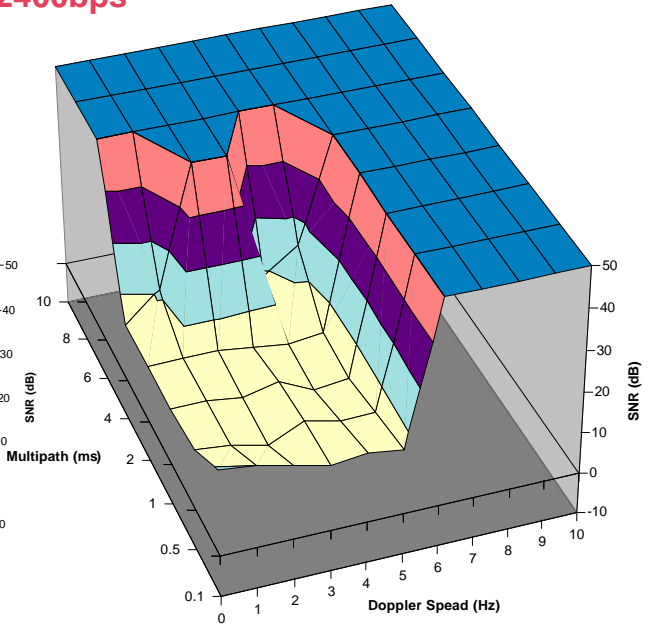
75bps



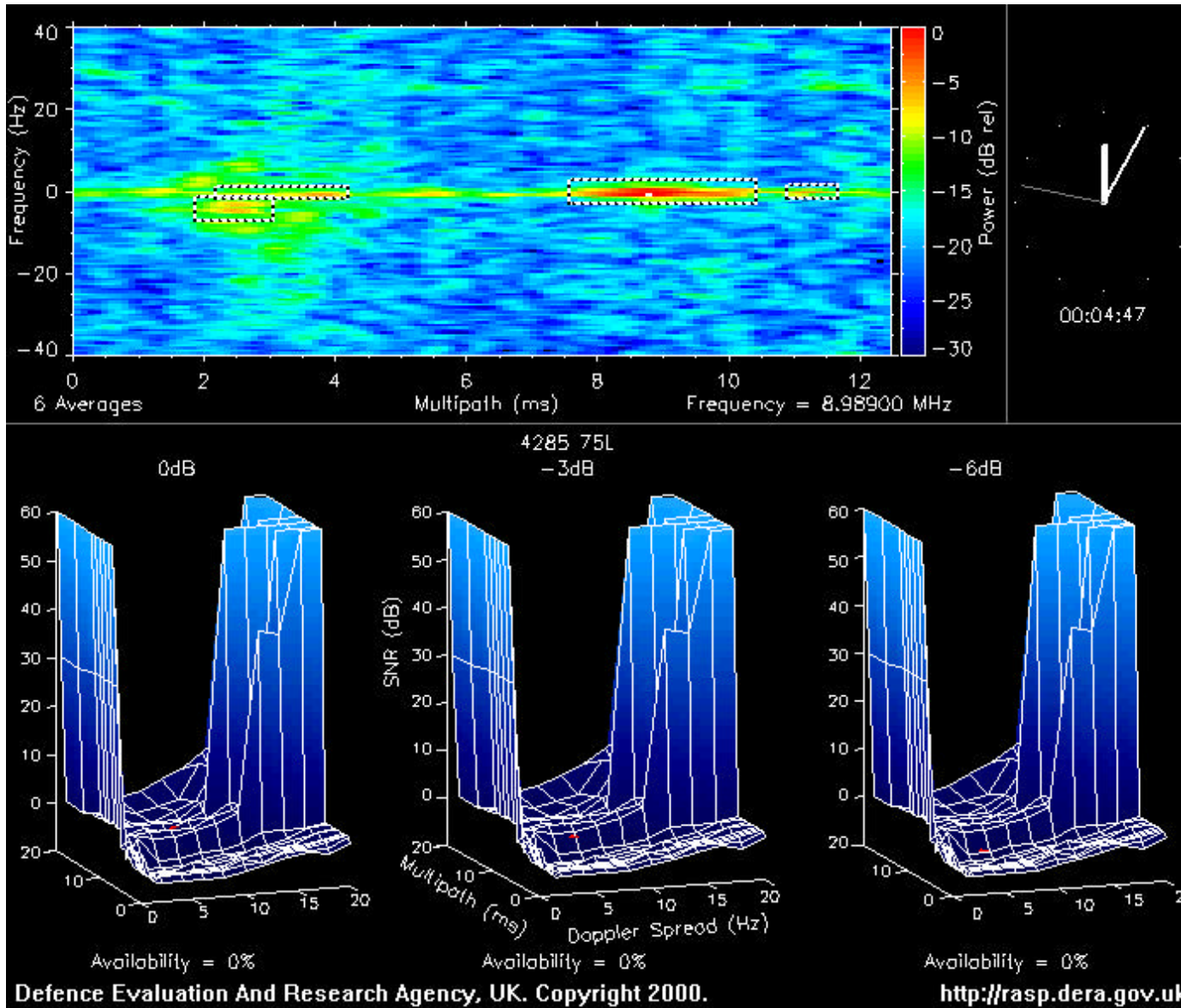
300bps



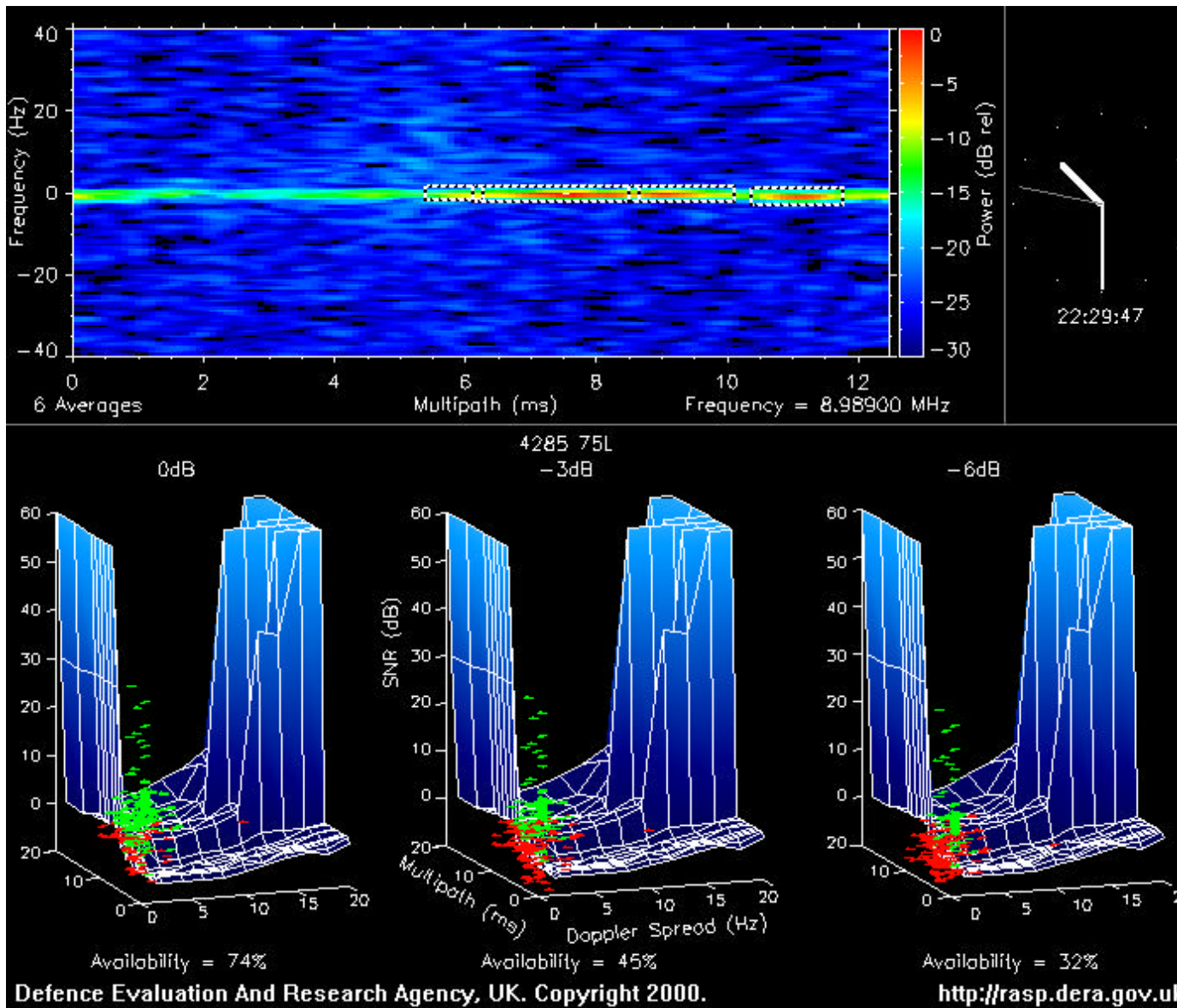
2400bps



# Cobbett Hill - St Ives



# Cobbett Hill - St Ives



# Conclusions

- HF communications are vital to the Military, in both UK & NATO
- Availability limiting factor is usually S/N
- Even an increase of 3dBs over the existing noise floor is likely to cause severe problems
- Users (including mobiles) may be anywhere in the UK, above the UK, or outside the UK