Audio PMSE sharing in the 960 – 1164 MHz band

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Access to 700 MHz band

2013 - impact assessment of loss access to 700 MHz band

- Identified peak demand events and events where spectrum access is challenging
- With data from event organisers and an indicative post-700 MHz DTT plan had external PMSE expert ‘re-plan’ each event
- Assessed impact on a 5 point scale – minimal, slight, substantial, severe, critical
- Large negative impact on a broad range of events although most events not affected – 93% of events use fewer than 24 audio channels
- Mitigation – work harder/smarter, equipment performance but **alternative spectrum** would be required

Alternative Spectrum – criteria for spectrum sharing

5 criteria that spectrum options would have to satisfy

- Not already allocated to mobile – risk of interference to audio PMSE
- Not identified as a candidate mobile band – risk of reallocation, cannot provide long term security of access
- Incumbent use of the candidate band is harmonised at least Europe wide – provides opportunity for sharing option to be adopted by other countries
- Must provide a substantial block of contiguous spectrum – fragmented spectrum supply not viable for PMSE users
- Must be below 2 GHz – higher frequencies not appropriate for audio PMSE

In addition to the above we also recognised that the spectrum would have to be usable by audio PMSE

Alternative Spectrum – options

We looked at all bands from 790 MHz to 2 GHz

- Coexistence studies indicated two candidate sharing bands:
  - 960 to 1164 MHz (sharing with aeronautical services); and
  - 1525 to 1559 MHz (sharing with mobile satellite services)

- The 960 to 1164 MHz band provides the best sharing option against our criteria
  - The band is not used by Mobile not identified for future Mobile
  - The incumbent use is **globally** harmonised – sharing option could be adopted globally
  - Provides a significant amount of contiguous spectrum interleaved with aero use
  - The band is close in frequency to currently available audio PMSE equipment

Compatibility assessment

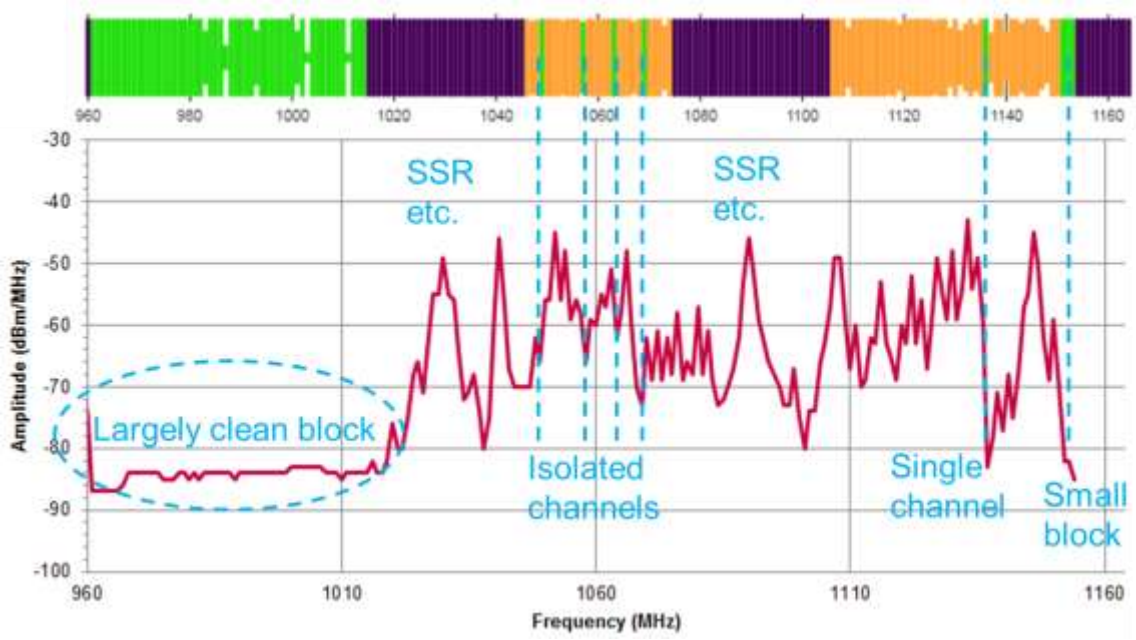
We carried out theoretical and practical compatibility studies

- Desk based analysis and practical coexistence measurements showed sharing is possible
- Measurements provide interference thresholds into aero systems and coexistence criteria for satisfactory PMSE operation
- DME channels are 1 MHz wide
- No airborne DME transmissions below 1025 and above 1150 MHz
- C/I (to degrade audio quality) is less than 2 dB (para 13.6.1 of JCSys report)
- Offsetting PMSE frequency by 300 kHz from DME centre frequency gives additional 20dB+ of isolation (para 13.6.2 of JCSys report)

Spectrum monitoring

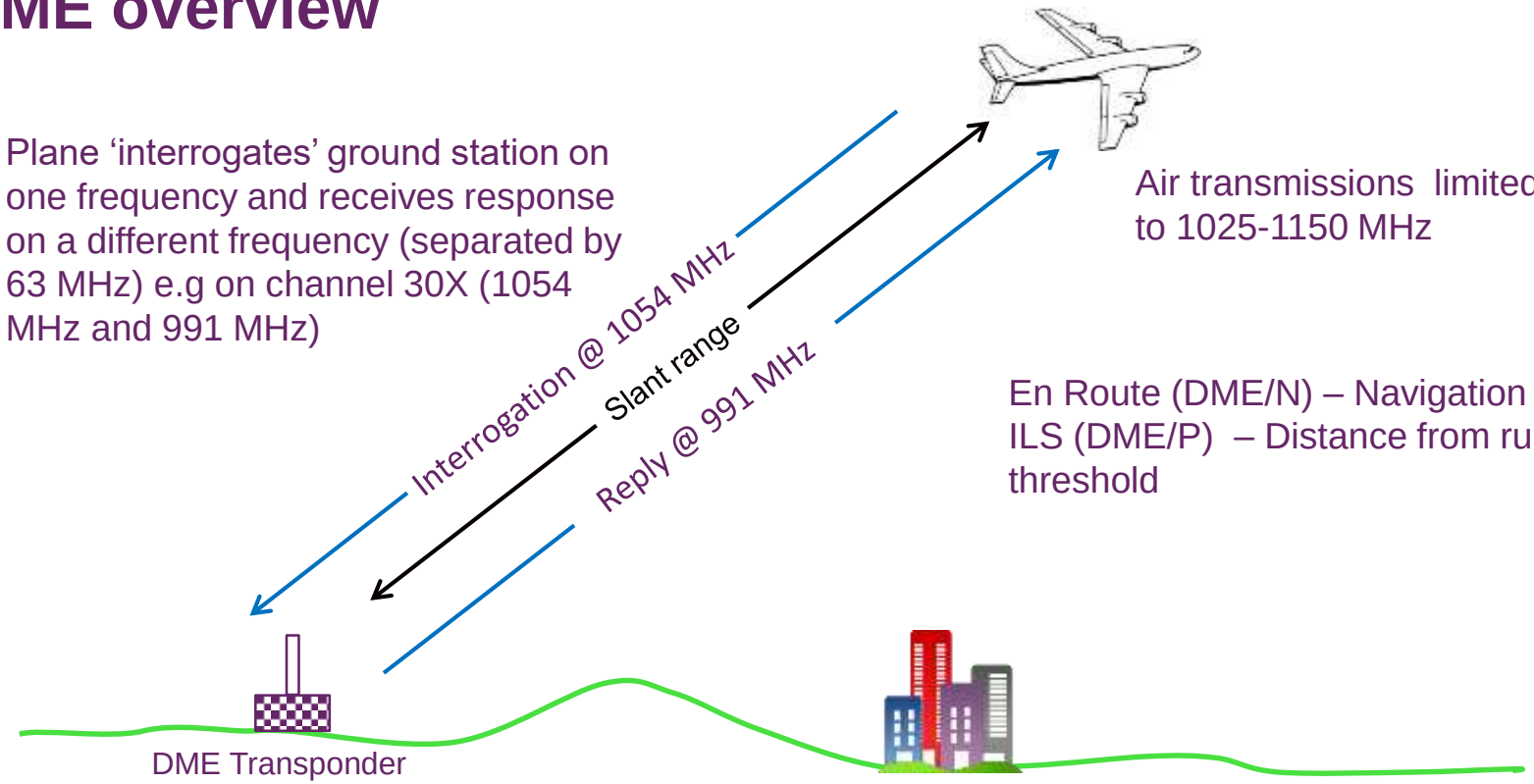
Spectrum monitoring at Cambridge Theatre and Baldock

- To determine if DME is used as expected – it is
- Levels and spectrum availability compare favourably with modelled results
- Stakeholder workshop in April to demonstrate our work in detail



DME overview

Plane ‘interrogates’ ground station on one frequency and receives response on a different frequency (separated by 63 MHz) e.g on channel 30X (1054 MHz and 991 MHz)



Air transmissions limited to 1025-1150 MHz

En Route (DME/N) – Navigation information
ILS (DME/P) – Distance from runway threshold

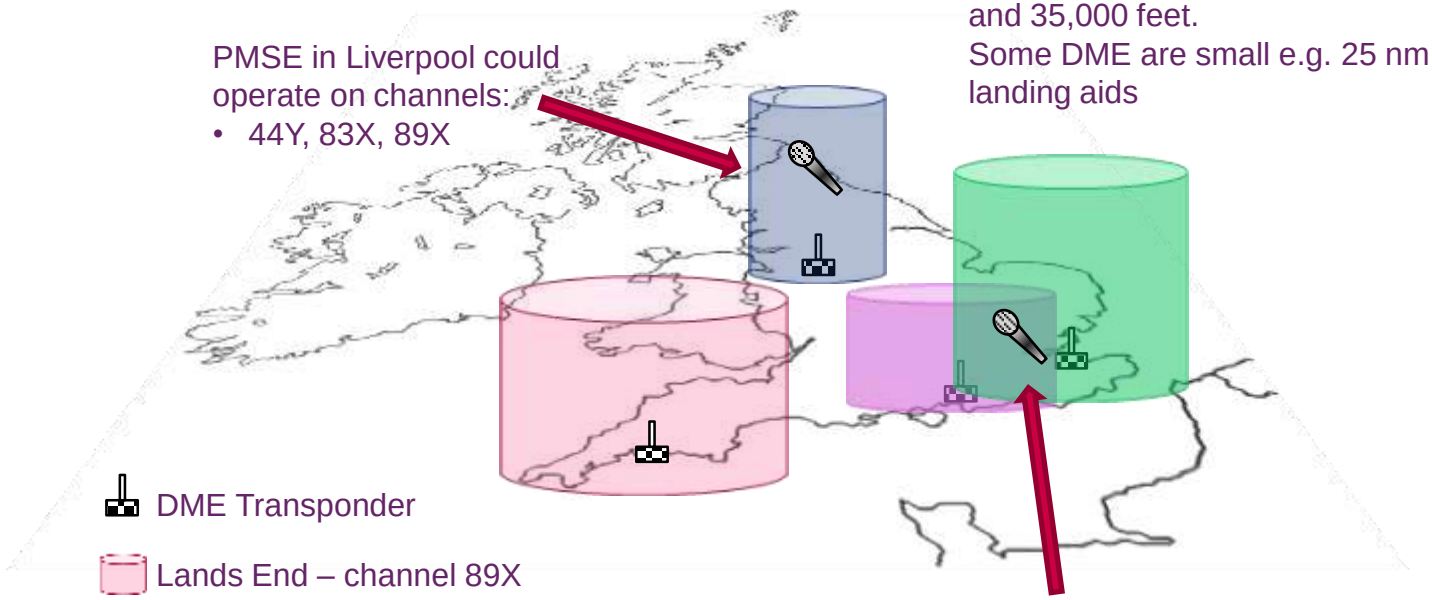
Time taken for the signal to get from the plane to the transponder and back is used to provide accurate indication in the cockpit of the slant range distance from a station

DME overview - coverage

The coverage area (DOC) of a DME ground station is defined as a cylinder of airspace with distance in nautical miles and height in hundreds of feet e.g. 100/350 would be 100 nautical miles and 35,000 feet.
Some DME are small e.g. 25 nm when used for landing aids

PMSE in Liverpool could operate on channels:

- 44Y, 83X, 89X



DME Transponder

Lands End – channel 89X

London – channel 83X

Southampton – channel 44Y

Liverpool – channel 54Y

PMSE in London could operate on channels:

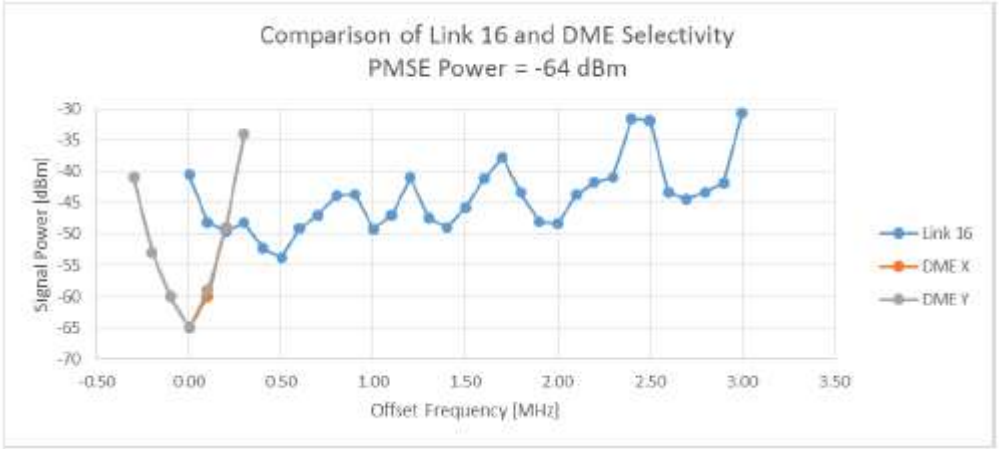
- 54Y and 89X but not 44Y or 83X due to overlapping coverage areas

DME overview – how we apply DOC

Beacon	Remarks	Com3	DOC applied
Dover VOR	VOR/DME DOC: 80 nm/50000 ft (**200 nm**/50000 ft in Sector R015º-075º).	200 NM	200 NM
Biggin VOR	VOR/DME DOC: 60 nm/50000 ft (**125 nm**/50000 ft in Sector R286º-046º and 100 nm/50000 ft in Sector R046º- 136º) Due to terrain, coverage at low level is reduced in Sector R116º-221º. In addition DME unlocks may occur in Sector R006º-041º at ranges between 15 nm and 25 nm	125 NM	130 NM (FOM:2)
Bovingdon VOR	VOR/DME DOC: **60 nm**/50000 ft	60 NM	130 NM (FOM:2)
London City ILS	DME freq paired with ILS LST and LSR. Zero range is indicated at THR of Runways 09 and 27. RWY 27: Intermittent DME unlocks may be experienced at ranges in excess of 7 nm.	25 NM	25 NM (FOM:0)

JTIDS – Joint Tactical Information Distribution System

- JTIDS is a frequency hopping, spread spectrum communication system
- Transmission is encoded as a series of pulses and each pulse is allocated to one of 51 transmission frequencies
- Coordination agreement between CAA[1] and MOD[2] limits its use near aircraft and airfields
- MOD state use is mostly above 10,000 ft and in remote areas – but not exclusively
- Airborne transmission power is less than DME

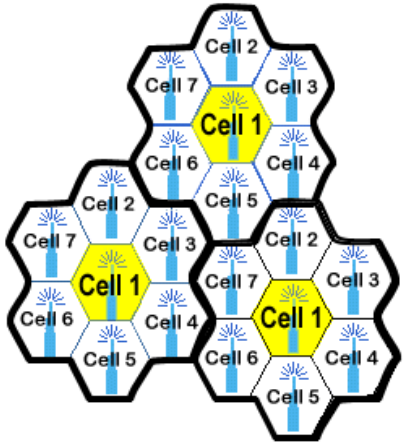


[1] CAA = Civil Aviation Authority the UK's aviation statutory regulator

[2] MOD = UK's Ministry of Defence

L-DACS

- Similar to mobile radio system – based on cellular point-to-multipoint concept – airspace segmented into cells
- Cell size between 60 and 120 nm
- Ground station always on, aircraft within the cell communicate with that ground station as required
- FDD system with 500 kHz channels
- ~100 base stations to cover whole of Europe
- Standards and Recommended Practices (SARPS) expected by 2020
- First deployments by mid-2020s

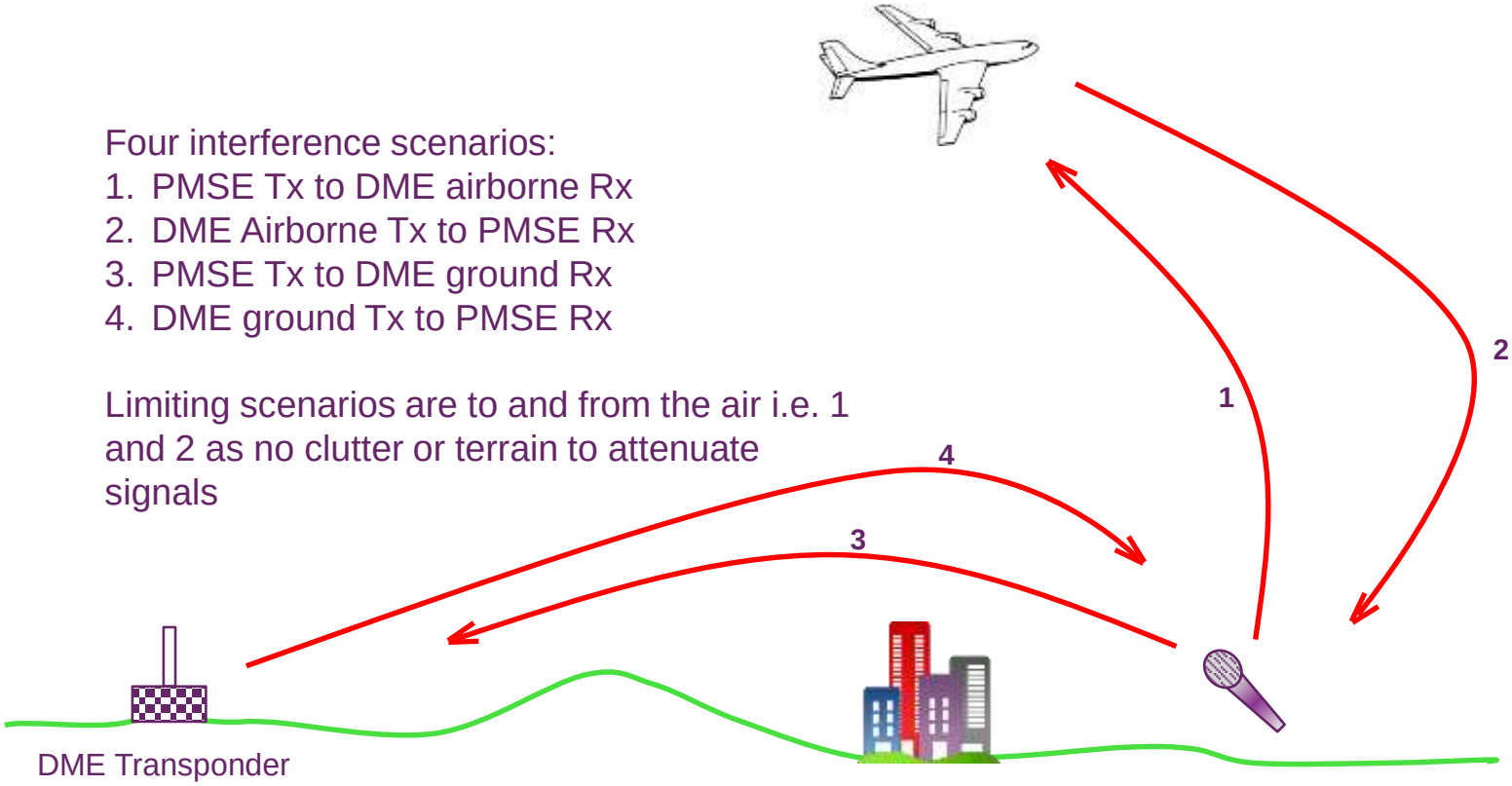


Modelling - Interference scenarios

Four interference scenarios:

1. PMSE Tx to DME airborne Rx
2. DME Airborne Tx to PMSE Rx
3. PMSE Tx to DME ground Rx
4. DME ground Tx to PMSE Rx

Limiting scenarios are to and from the air i.e. 1 and 2 as no clutter or terrain to attenuate signals



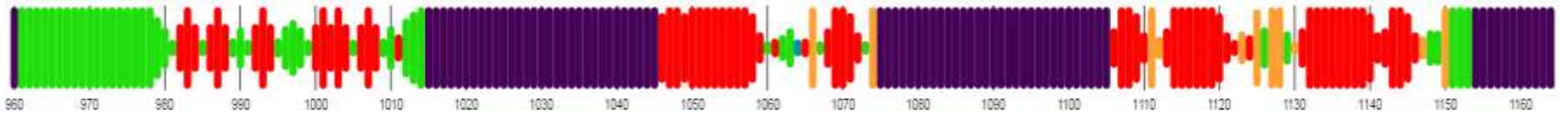
Spectrum availability modelling

- We have created a dedicated new tool with graphical interface
- Applies the spectrum management rules agreed by the CAA (and detailed in our Statement)
- Model is conservative using peak power and minimum coupling loss.
- Model implies large margins to protect aeronautical over and above what is expressed
- We can illustrate any location in Europe using DME assignment plans
- CAA to provide updates on DME assignments
- Spectrum availability and quality dependent on location

DME spectrum availability

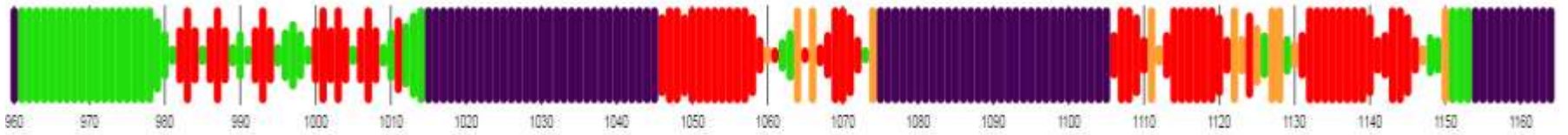
Glasgow - SECC

74 Guard Band	19 PMSE to DME (Aircraft)	0 PMSE to DME (Ground)
91 Available to PMSE	21 DME (Aircraft) to PMSE	0 DME (Ground) to PMSE



Sky studios

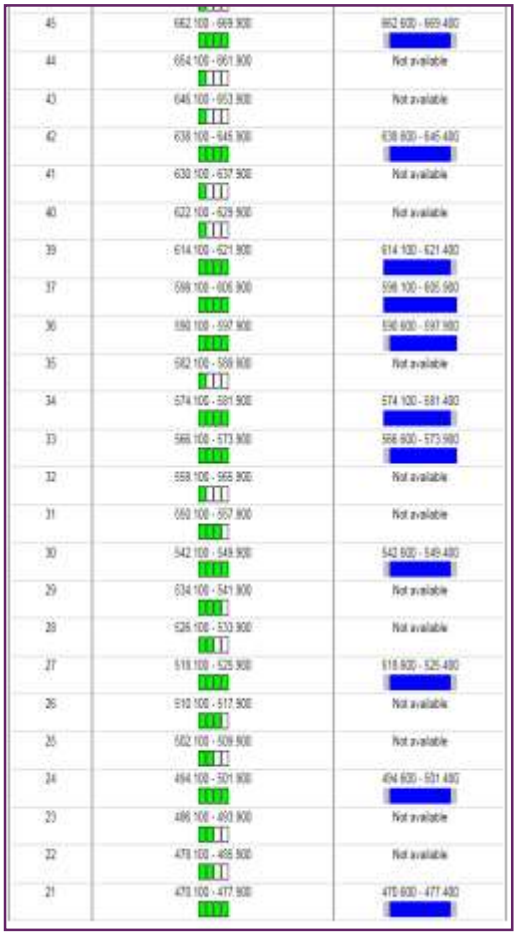
74 Guard Band	71 PMSE to DME (Aircraft)	1 PMSE to DME (Ground)
48 Available to PMSE	11 DME (Aircraft) to PMSE	0 DME (Ground) to PMSE



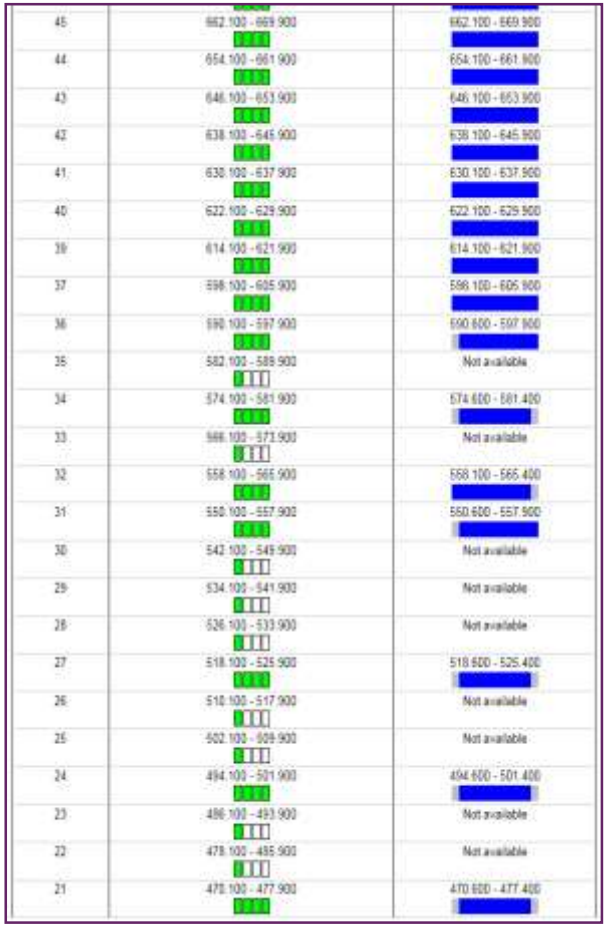
Cambridge Theatre

74 Guard Band	71 PMSE to DME (Aircraft)	0 PMSE to DME (Ground)
46 Available to PMSE	14 DME (Aircraft) to PMSE	0 DME (Ground) to PMSE

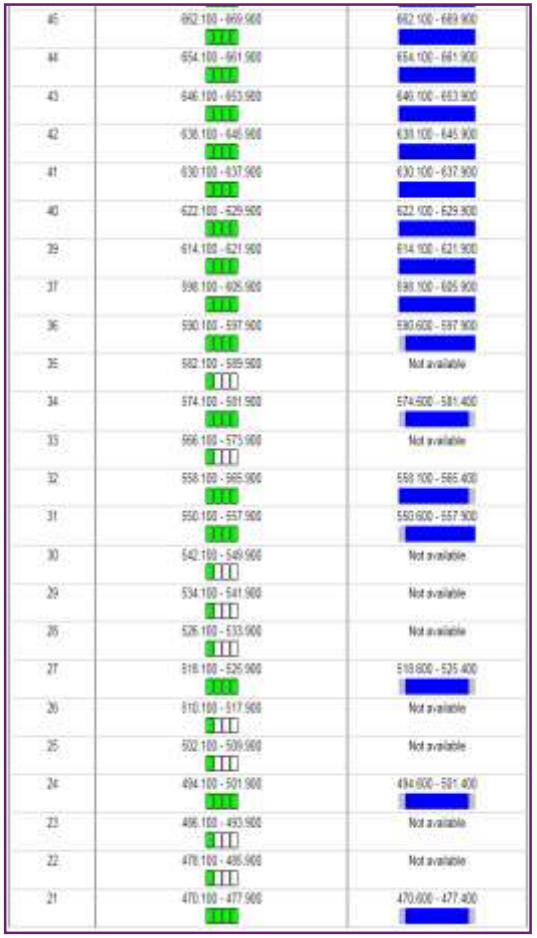
DTT spectrum availability



Glasgow - SECC



Sky



Cambridge Theatre

Current work

- Additional data gathering on SSR and associated systems e.g. TCAS, ADS-B etc, GMDSS to refine and review guard bands
- Associated tasks such as developing base line safety case
- Developing procedures for management and updating of the spectrum management rules (SMRs), for example incorporating changes to aeronautical deployments or additional technical analysis
- International engagement – primarily bilaterally but presented to ECC in June (ECC instructed WGFM to consider further)
- Developing licensing system and incorporating spectrum availability tool
- One manufacturer and major PMSE user to carry out trials in the summer