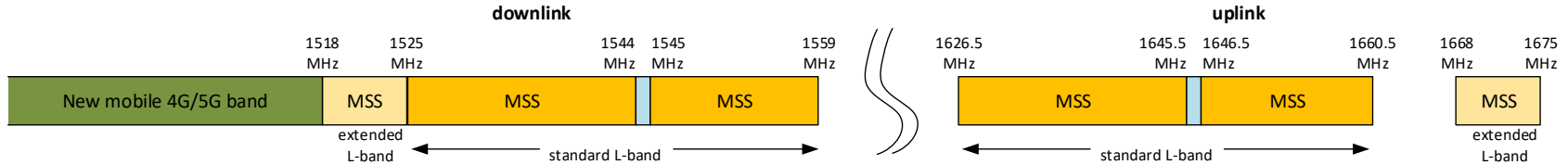




# IMT-MSS coexistence in L-band

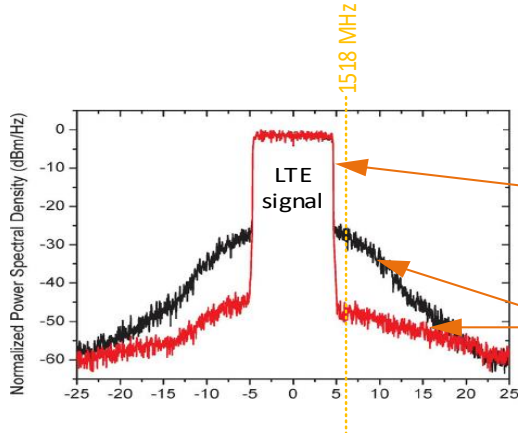
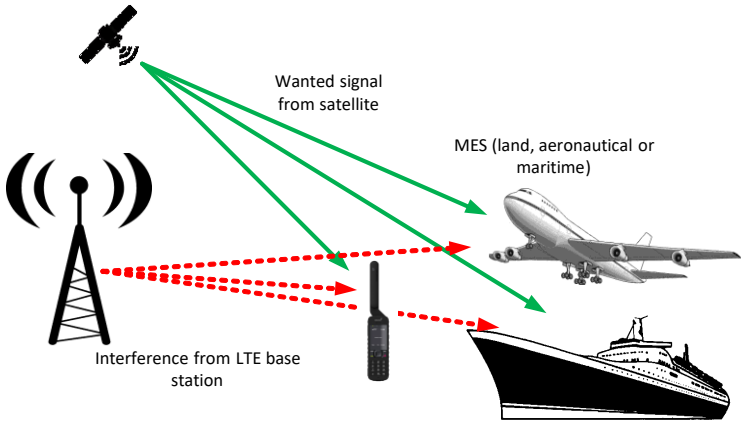
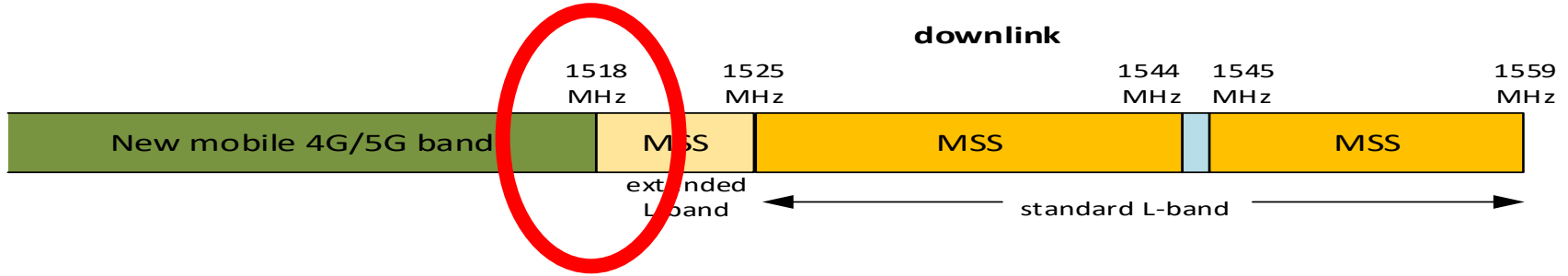
Paul Deedman, Inmarsat  
ASEAN Workshop - 19 October 2021

# 1. Spectrum Overview



- ITU WRC-15 identified the 1427-1518 MHz for LTE/IMT ■
- Standard L-band: 1525-1559 MHz (DL) and 1626.5-1660.5 MHz (UL) ■
- 1544-1545 MHz & 1645.5-1646.5 MHz, for SAR application and used by Cospas-Sarsat ■
- Extended L-band: 1518-1525 MHz (DL) and 1668-1675 MHz (UL) ■
- Extended L-band is today used by Inmarsat (Alphasat covering Europe, Middle East and Africa). Will also be used by Inmarsat-6 (2 satellites currently being built by Airbus), first launch planned for end of 2021. Will allow for near global coverage of extended L-band and standard L-band.
- MSS bands are used for land, maritime and aeronautical MESS, including for safety (GMDSS, AMS(R)S, disaster relief)

# 2. Interference issue (1)



Blocking interference (LTE signal received by MES on adjacent frequencies, including terminals operating above 1525 MHz)

Out-of-band emissions (LTE OOB emissions received by MES within the MSS band)

Improved terminal receiver design cannot mitigate against OOBE problem

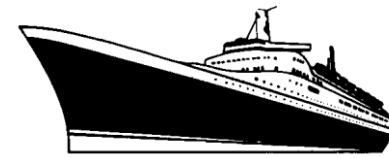
## 2. Interference issue (2)

### Minimum separation distances from LTE base station for **current land terminals**

- All distances from ECC Report 263
- Blocking limit = -60 dBm for older MESs, -40 dBm for newer MESs
- Distance for OOB emissions based on -10 dB I/N.
- Assumes 58 dBm/5 MHz EIRP from base station, rural area (4m high obstruction in path)

	Older MES terminals		Newer MES terminals	
	Land Low gain	Land High gain	Land Low gain	Land High gain
<b>Minimum distance for blocking</b>	3,650m	5,620m	700m	1,100m
<b>Minimum distance for OOB emissions 1518-1520 MHz</b>	5,000m	6,100m	5,000m	6,100m
<b>Minimum distance for OOB emissions above 1520 MHz</b>	60m	600m	60m	600m





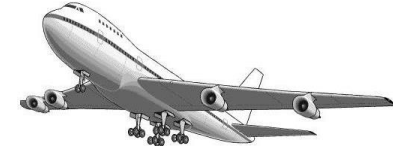
## 2. Interference issue (3)

### Minimum separation distances from LTE base station for **current maritime terminals**

- All distances from ECC Report 263
- Blocking limit = -60 dBm for older MESSs, -40 dBm for newer MESSs
- (Note subsequent testing shows Inmarsat-C blocking actual blocking value = -76 dBm).
- Distance for OOB emissions based on -10 dB I/N
- Assumes 58 dBm/5 MHz EIRP, non-obstructed path

	Older MSS terminals		Newer MSS terminals	
	Maritime Low gain	Maritime High gain	Maritime Low gain	Maritime High gain
<b>Minimum distance for blocking</b>	7,700m	8,000m	1,200m	1,300m
<b>Minimum distance for OOB emissions 1518-1520 MHz</b>	13,200m	13,600m	13,200m	13,600m
<b>Minimum distance for OOB emissions above 1520 MHz</b>	600m	700m	600m	700m

## 2. Interference issue (4)



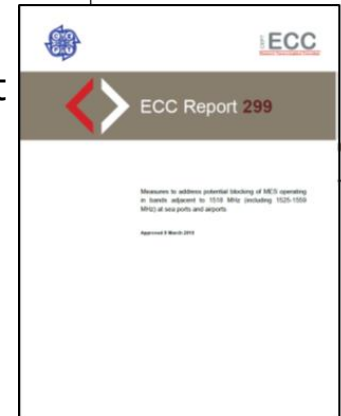
### Minimum separation distances from LTE base station for **current aeronautical terminals**

- All distances from ECC Report 263
- Blocking limit = -60 dBm for older MESs, -40 dBm for newer MESs
- Distance for OOB emissions based on -10 dB I/N
- Assumes 58 dBm/5 MHz EIRP, non-obstructed path

	Older MSS terminals		Newer MSS terminals	
	Aero Low gain	Aero High gain	Aero Low gain	Aero High gain
Minimum distance for blocking	7,700m	10,785m	1,300m	2,000m
Minimum distance for OOB emissions 1518-1520 MHz	13,400m	16,500m	13,400m	16,500m
Minimum distance for OOB emissions above 1520 MHz	600m	1100m	600m	1100m

# 3. CEPT studies (1)

- All CEPT studies based on use of SDL (IMT downlink only) and hence did not consider interference from IMT user terminals.
- ECC Report 263 (2017):
  - Focussed on compatibility with **land** MSS.
  - Concludes that **1 MHz separation** leads to excessive interference, while **3 MHz and 6 MHz separation** may be feasible in some circumstances and with other mitigations
  - Provides in-band and out-of-band EIRP limits for base stations
  - Recommends that next generation *land* MSS terminals should be more resilient to LTE interference; to the level -30 dBm
  - Notes that additional measures are required at ports/airports
- ECC Report 299 (2019):
  - Recommends additional protection measures required for ports and airports through the application of PFD limits on base stations
  - Recommends that next generation *maritime* and *aeronautical* terminals should be more resilient to LTE interference, to the level of -30 dBm
  - Timing for upgrade of ships/aircraft to be determined in consultation with the user community



# 3. CEPT studies (2)

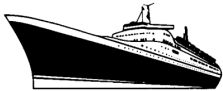


## Land Terminals

- Existing land terminals are not usable in the same areas as LTE deployed. Even for next generation terminals, parts of the MSS band cannot be used in any areas where LTE is deployed.

## Maritime Terminals

- Existing maritime terminals will suffer interference from LTE base stations deployed within maximum 13km of a port/harbour, unless base stations are restricted.
  - Ship operators could be unable to use Inmarsat terminals at port, including testing of safety-related communications and receiving safety-related information. Impacts commercial shipping, fishing and some leisure vessels.
  - Actual distance is higher for some terminals, not analysed by CEPT



## Aeronautical Terminals

- Existing aircraft terminals will suffer interference from LTE base stations deployed within maximum 16km of an airport unless base stations are restricted. Impacts majority of commercial airlines.





# 3. CEPT studies (3)

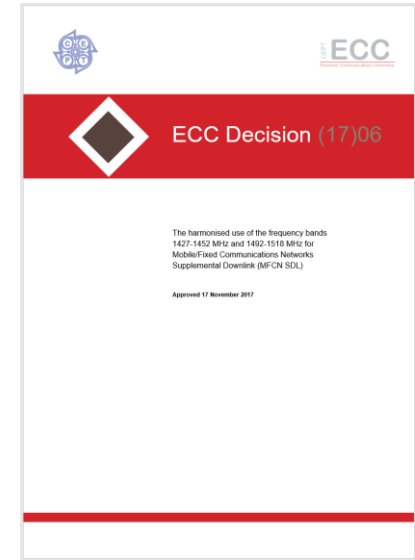
- CEPT compatibility solution consists of:
  - PFD limits to be applied by administrations at ports and airports
  - In-band EIRP limits for base station
  - Out-of-band emission limits for base station
- Does not address protection of current land MESSs and provides only partial protection to next generation land MESSs
- Measures so far adopted by only a handful of countries, due to lack of demand from operators
- Currently no commercial LTE/IMT services in operation in Europe

Table 12: PFD limits on MFCN BS transmitting a single channel

Phase	Phase 1			Phase 2		
	PFD limit for BS emissions in the band 1492-1502 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1502-1512 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1512-1517 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1492-1502 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1502-1512 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1512-1517 MHz (dBW/m <sup>2</sup> )
Ports and waterways	-60.9	-75.9	-83.9	No limit required	-27.9	-37.9
Airports	-32.9	-42.9	-58.2	No limit required	-27.9	-37.9

Table 13: PFD limits on MFCN BS transmitting multiple channels

Phase	Phase 1		Phase 2	
	PFD limit for BS emissions in the band 1492-1512 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1512-1517 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1492-1512 MHz (dBW/m <sup>2</sup> )	PFD limit for BS emissions in the band 1512-1517 MHz (dBW/m <sup>2</sup> )
Ports and waterways	-74.9	-85.9	-30.9	-40.9
Airports	-53.5	-63.4	-30.9	-40.9



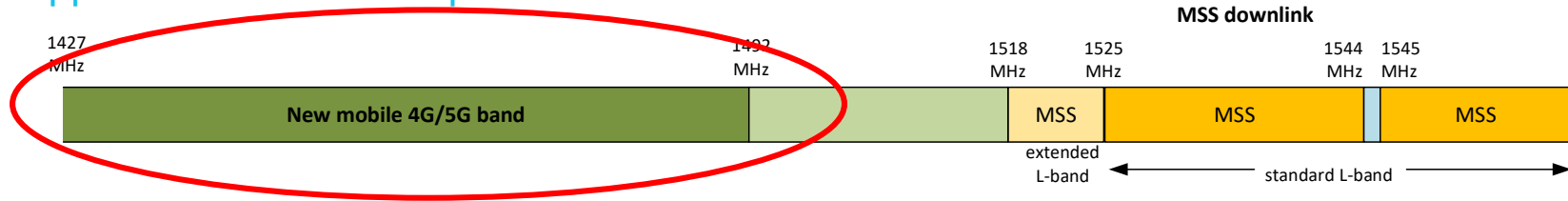
## 4. MES receiver

- CEPT has established new receiver blocking requirement: MES blocking level of **-30 dBm at the terminal input, with respect to LTE in the band 1512-1517 MHz**
- Requirement is now included in ETSI and other equipment standards.
- However...
  - Wanted satellite signal level at same reference point may be as low as -140 dBm, i.e. 110 dB lower than the IMT signal.
  - Requirement is very challenging to meet technically, especially for small terminals such as Satellite IoT devices
  - Manufacturers are beginning to bring resilient terminals to the market, in particular for aviation and maritime.
  - Timeframe for widespread introduction of new terminals is primarily driven by replacement period for aircraft and ships (circa 20-25 years).
  - ICAO and IMO have expressed concern over the feasibility of a shorter timeframe.
  - Improved receiver resilience does not avoid the need for protection measures



# 5. Compatibility measures for ASEAN (1)

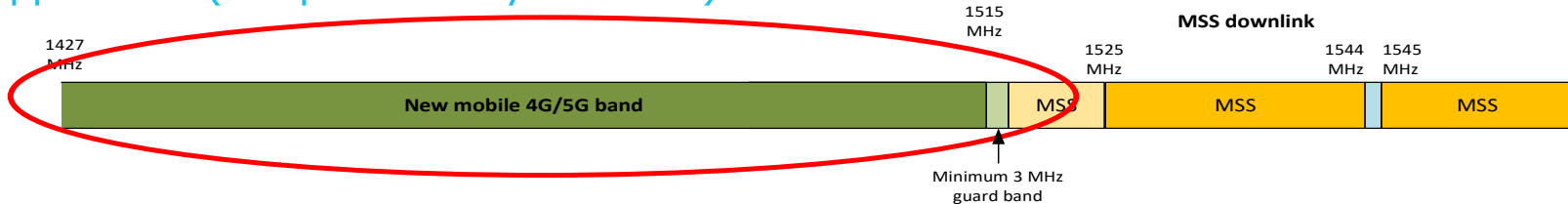
## Approach 1 – Inmarsat preferred solution



- **Limit IMT deployment to the band 1427-1492 MHz (reserve 1492-1518 MHz for lower power and/or low density applications)**
- The only approach that provides compatibility with all MSS operations
- Requires no protection measures for ports and airports. OOB emission limits should be trivial.
- Has been implemented by several European countries (Germany, Netherlands, Malta, Romania).
- LTE Equipment is available today for the band 1452-1492 MHz

# 5. Compatibility measures for ASEAN (2)

## Approach 2 (Not preferred by Inmarsat)



- **IMT deployment to the band 1427-1515 MHz (retain minimum 3 MHz guard band with respect to MSS)**
- Requires OOB emission limits on IMT base stations – Inmarsat recommends -41 dBm/MHz EIRP which is achievable with 3 MHz guard band.
- Requires additional protection measures for ports and airports, i.e. PFD restrictions on base stations.
- Land MSS operations remain vulnerable to interference from base stations - may require additional restriction on IMT base stations in some areas.
- If TDD is considered, OOB emission limits required on user equipment.

## 6. Summary

1. Compatibility measures are necessary, complex to implement and the demand for L-band spectrum is uncertain.
2. Best solution is to limit IMT use to 1427-1492 MHz for the time being, which gives 65 MHz additional mid-band spectrum.
3. Use of the upper band for IMT (1492-1518 MHz) requires more complex compatibility measures, which cannot in any case address all compatibility issues.
  - As a minimum, requires PFD limits for ports/airports and OOB emission limits on base stations
  - Would not protect current land MESs used in ASEAN countries