What is spectrum management

Why manage spectrum?

- Recall: if GNSS signals share frequencies with high power terrestrial systems, eg mobile phones, GNSS reception would not be possible
- To avoid interference, the **Radio Regulations** separate different service types (eg terrestrial mobile, satcoms, TV) into different frequency bands or "**allocations**", eg,
  - mobile at 900MHz
  - TV at 600MHz
  - satcoms at 1650MHz
  - GNSS at 1575MHz

How do you avoid interference?

- By separating systems that expect to receive very different signal levels, interference can be minimised
- typically satellite systems are kept well separated from terrestrial systems
  - however, systems using highly directional antennas sometimes share frequencies, eg point to point links
- radio frequency filters are used in transmitters and receivers to avoid frequency overlap

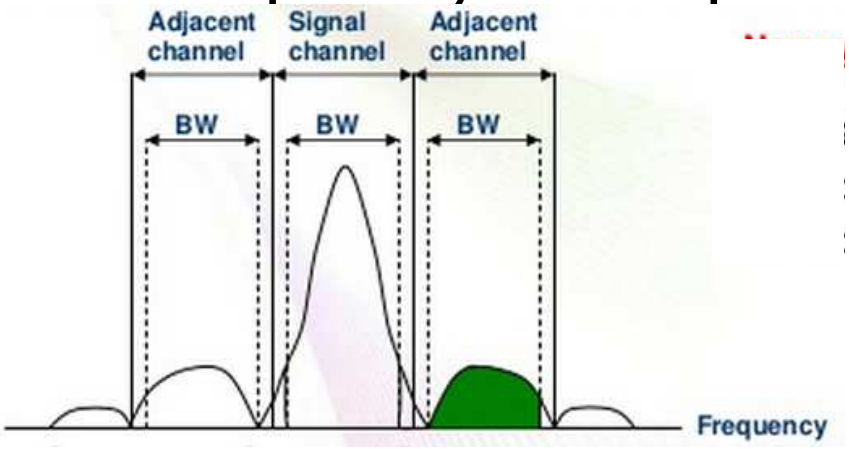
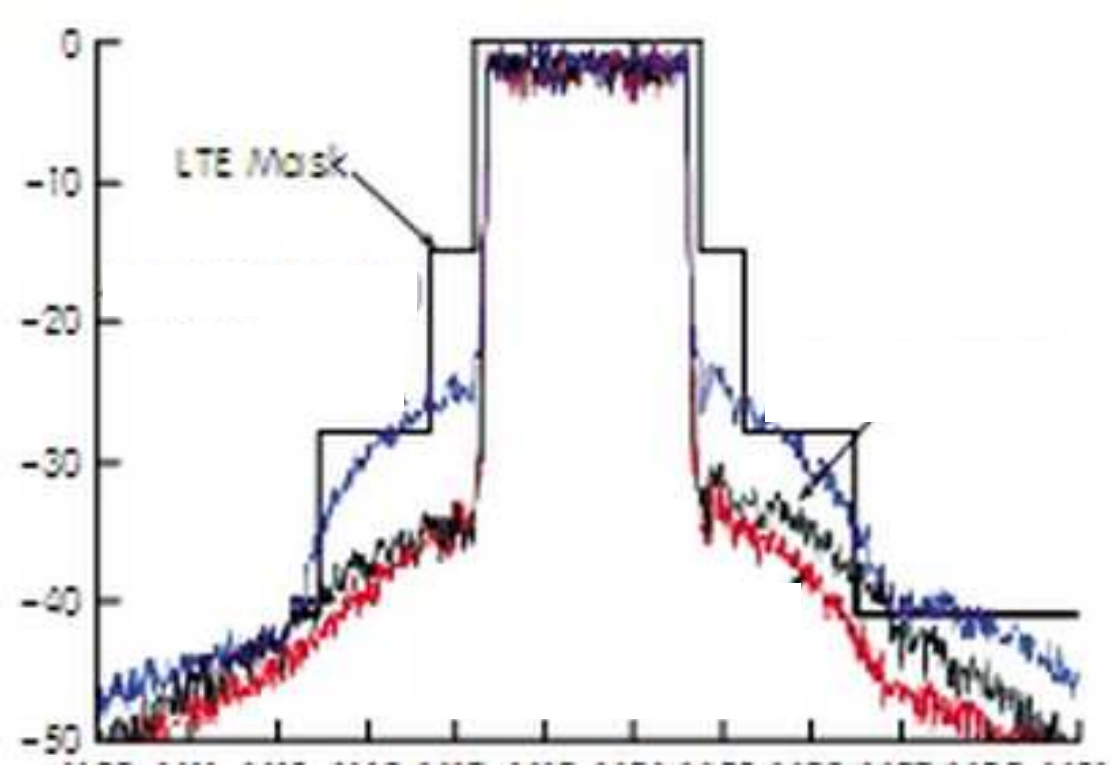


image from TI Inc

Adjacent frequency systems

- The problem is, frequency filters are not perfect, there is some overspill, both for transmitters and receivers



Terrestrial transmitter next to a GNSS receiver

- Imagine a GNSS receiver operating a short distance from a base station or mobile phone
- the terrestrial signal levels could be many billion times larger than the GNSS signals
- if the frequency separation is insufficient, there is a real risk that overspill tails from the terrestrial system will swamp the GNSS receiver
- the ITU spends many years working out the appropriate frequency separations to reduce interference
- and, to prevent interference between systems, national regulators apply ITU recommendations

Radio Regulation Allocations

- The result of decades of compatibility studies

Allocation to services		
Region 1	**Region 2**	**Region 3**
1 525-1 530 SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Mobile except aeronautical mobile 5.349 5.341 5.342 5.350 5.351 5.352A 5.354	**1 525-1 530** SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	**1 525-1 530** SPACE OPERATION (space-to-Earth) FIXED MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A Earth exploration-satellite Mobile 5.349 5.341 5.351 5.352A 5.354
1 530-1 535 SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.353A Earth exploration-satellite Fixed Mobile except aeronautical mobile 5.341 5.342 5.351 5.354	**1 530-1 535** SPACE OPERATION (space-to-Earth) MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.353A Earth exploration-satellite Fixed Mobile 5.343 5.341 5.351 5.354	
1 535-1 559	MOBILE-SATELLITE (space-to-Earth) 5.208B 5.351A 5.341 5.351 5.353A 5.354 5.355 5.356 5.357 5.357A 5.359 5.362A	
1 559-1 610	AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.208B 5.328B 5.329A 5.341	

services are either:

- PRIMARY

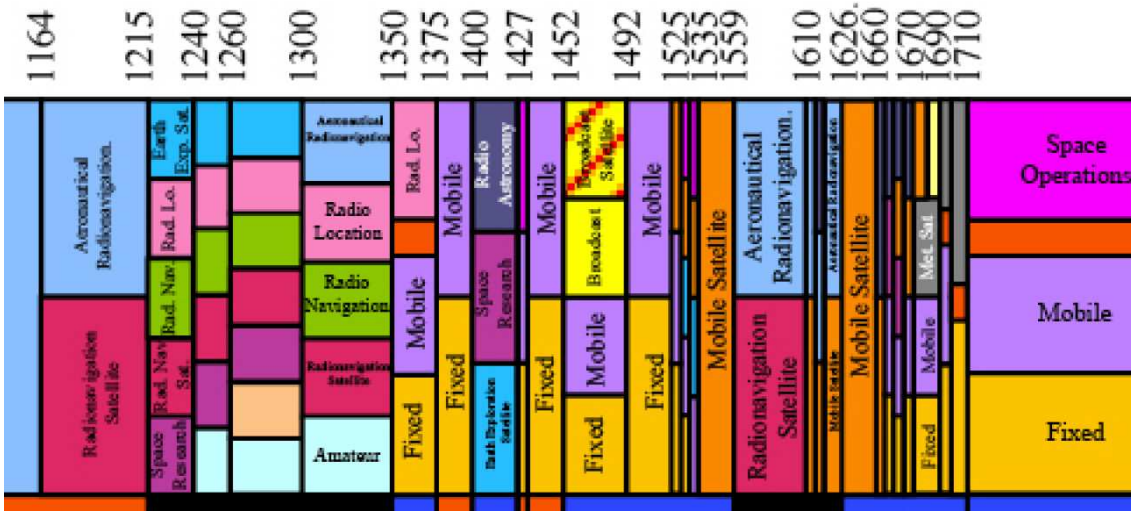
or

- secondary

  (must not cause interference to primary)

Typical National Allocations

- National implementations usually align with, or mirror, the Radio Regulations
- Aligning with the RR helps minimise interference between neighbouring countries and services
- Also allows countries to benefit from harmonised spectrum use, lower equipment costs, etc
- Chart below shows UK allocations around the GNSS L-bands



Minimise interference, maximise benefits

- The Radio Regulations are the results of many decades of compatibility studies
- Experts at the ITU consider the specific characteristics and operational aspects of systems
- the experts evaluate whether systems can either share the same frequencies or use frequencies adjacent to each other
  - these are the **radio compatibility studies**
- the experts also define recommendations to facilitate harmonious use of the spectrum
- The Radio Regulations generally work!