Optimising Spectrum Use in the Public Sector

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Outline of Presentation

- Overview of Public Sector spectrum use by Sector and Application
- Technology Evolution in the Public Sector
- Technical initiatives to promote efficiency
- National and international regulatory initiatives
- Future Opportunities for sharing and spectrum release

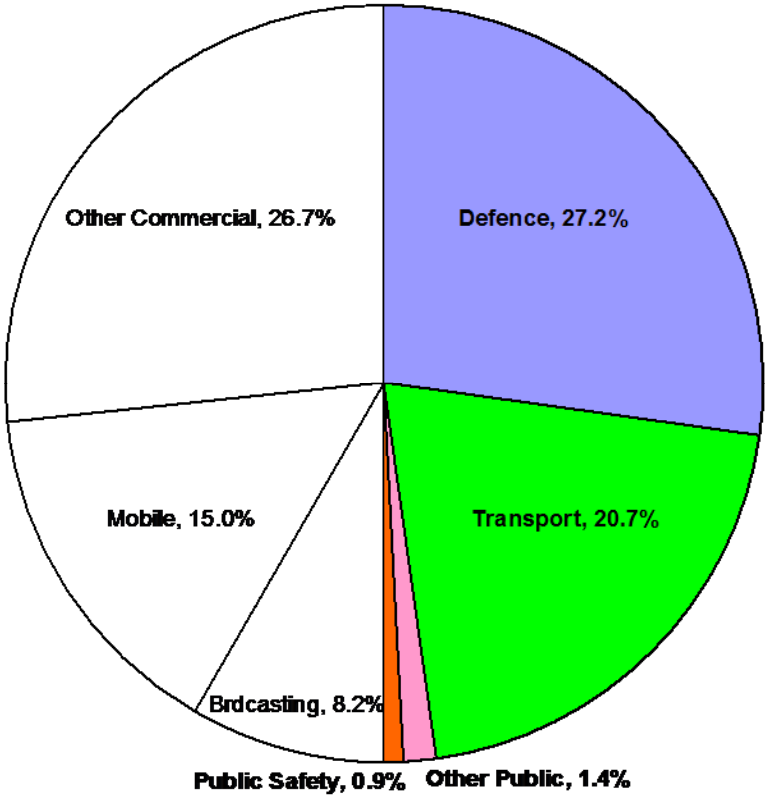
Acknowledgement

- The material that follows benefits from our involvement in a recent study for the European Commission, under the leadership of WIK Consulting (Germany)
- Thanks are due to my colleagues on the study:
  - Scott Marcus (WIK Consulting)
  - Phillipa Marks, Plum Consulting
  - Frédéric Pujol, IDATE
  - Prof. Martin Cave, Warwick Business School

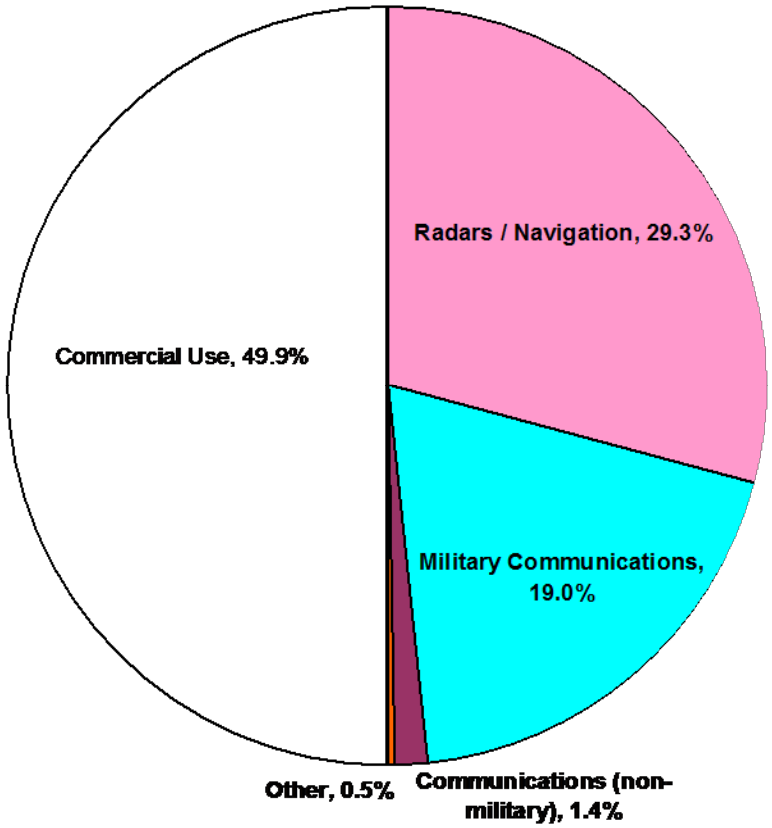
- Materials from the study final presentation can be found on the WIK web site http://www.wik.org
- The study final report will shortly be available on the European Commission web site at http://ec.europa.eu/information_society/policy/radio_spectrum/activities/studies/index_en.htm

Public Sector Spectrum use by Sector and Application (108 MHz – 6 GHz)

Sectors



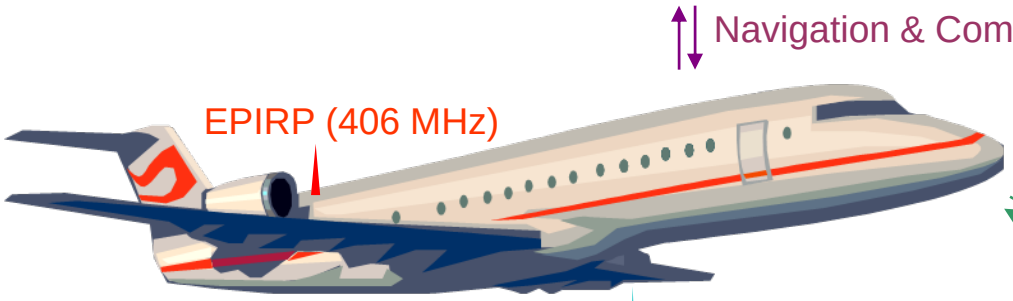
Applications



Aeronautical and Maritime Spectrum

- Nature of business necessitates global planning
  - Largely managed by ICAO / Eurocontrol and IMO
  - ICAO / Eurocontrol specify performance requirements and in some cases technical standards for aeronautical communications and navigation – are also active in ITU defending spectrum allocations
  - Frequency Bands generally harmonised globally
- SOLAS regulations specify maritime distress frequencies and carriage requirements for communications and radar equipment
  - e.g. all merchant ships above 3,000 tonnes must carry S-band and X-band radar
- Increasing use of satellite systems (navigation and communications), shared with other users
  - But continued terrestrial needs for capacity and backup

Aeronautical Systems and Spectrum



Navigation & Communication Satellites

EPIRP (406 MHz)

Weather radar (C band)

Air/Ground Comms (HF/VHF)

En-route surveillance
(L-Band, to 450 km)

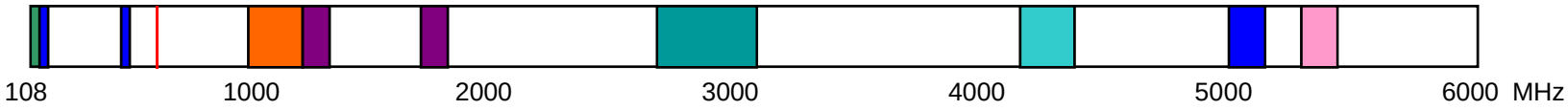
Altimeters
(C band)

Airport surveillance
(S-Band, to 80 km)

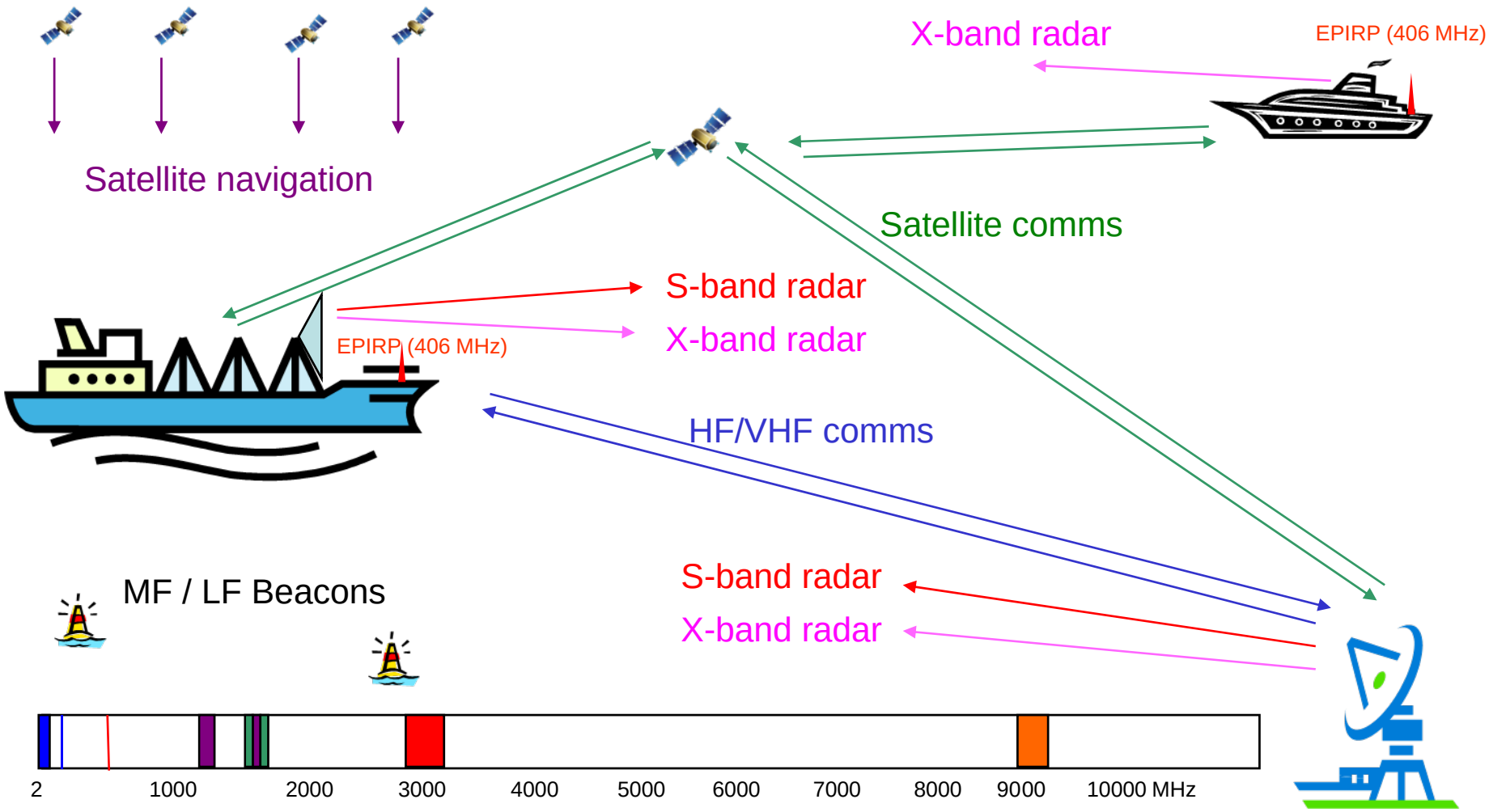
Landing systems (VHF/UHF/C-band)

Note:

This diagram illustrates the diversity of aeronautical spectrum use but is not intended to cover all applications. Various additional frequencies above 6 GHz are also deployed, e.g. for short range airport surveillance, surface monitoring and airborne navigation aids.



Maritime Systems and Spectrum



AEGIS systems limited

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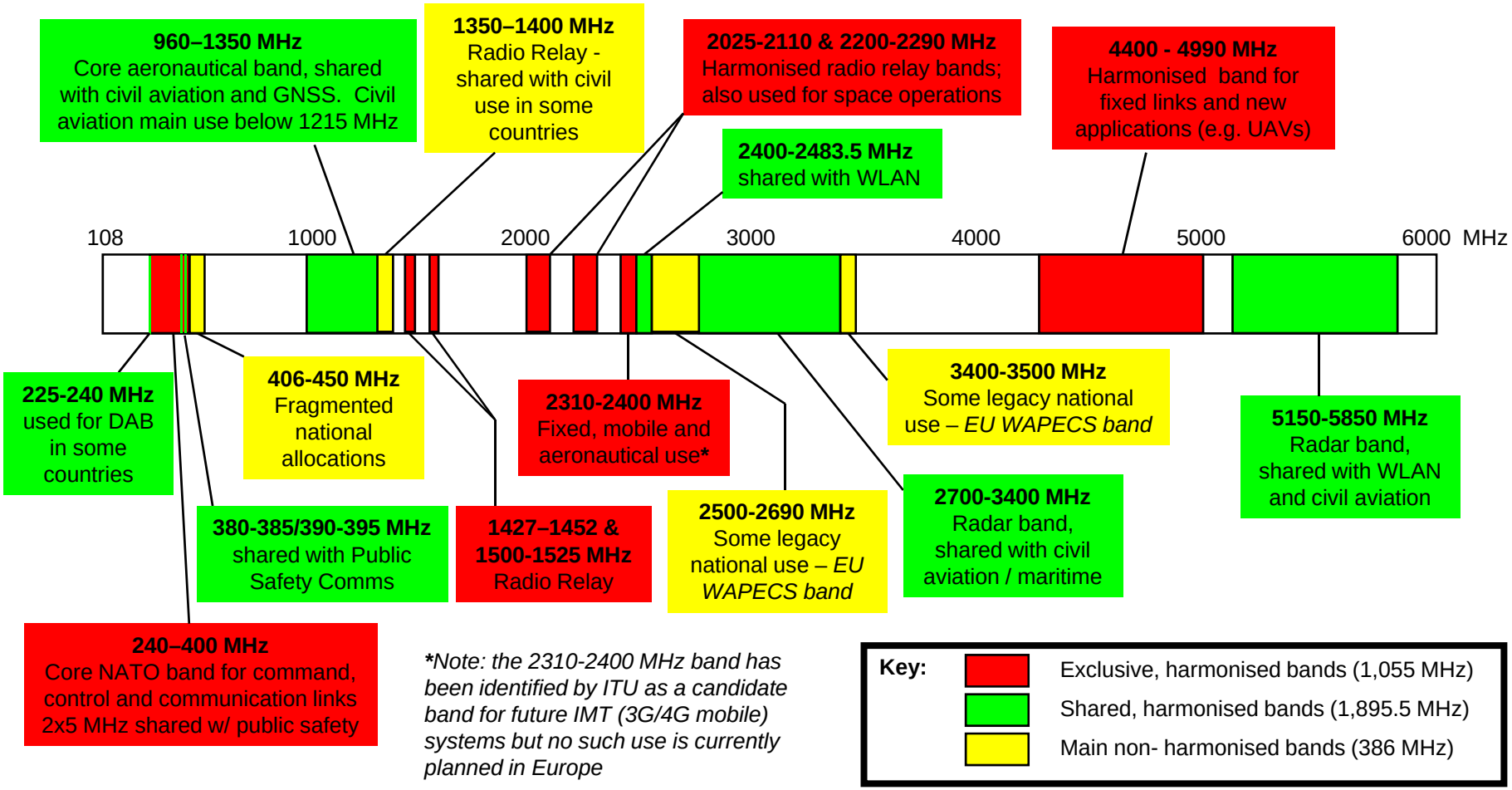
A brief note on Radars

- Primary Radar relies on passive reflections from the target
  - Needs very high transmit powers and very sensitive receivers
  - Bandwidth largely a function of range resolution (specified by ICAO)
  - Large interference potential – requires large geographic and/or frequency separation
  - System is self-contained (no remote terminals or transponders)
- Secondary Radar relies on a transponder mounted on the target to send a return signal
  - Much lower transmit powers and higher link budget
  - Greater scope for signal processing
  - Relies on compatible transponders on all target craft (may be tens or hundreds of thousands in use)
- Primary radar requires more spectrum but more scope for improvement (as numbers involved are smaller)

Military Spectrum in the UK and Europe

- Largely planned at international level
  - NATO plays a key role
    - EDA (European Defence Agency) and CCEB (Combined Communications Electronics Board) also have a role in UK
  - Extensive sharing, especially with civil aeronautical and maritime apps – but still significant exclusive use
- Most spectrum harmonised, but still significant national variation in some bands
- Small, fragmented allocations at national level can constrain re-farming options
- Some important mobile / wireless bands still used by military in some countries
  - e.g. 2500-2690 MHz, 3400-3500 MHz

Main European Military Frequency Bands



*****Note: the 2310-2400 MHz band has been identified by ITU as a candidate band for future IMT (3G/4G mobile) systems but no such use is currently planned in Europe*

Public Safety Spectrum Use

- Mainly voice and narrow band data but growing interest in broadband mobile – more spectrum sought
- Legacy analogue services migrating to harmonised digital trunked radio band (380 – 400 MHz)
- Relatively small user of spectrum relative to military and transport
- National use plus occasional need for cross-border interoperability (natural disasters, terrorist incidents).
- Additional harmonised band sought (up to 2x15 MHz) for broadband mobile

Other key Public Sector Uses

- Land Transport
  - Dedicated spectrum for railways (e.g. GSM-R) and road traffic telematics
- Meteorology
  - Harmonised international bands for weather radars, satellites and other meteorological aids
- Scientific Research (e.g. Radio Astronomy)
  - Generally harmonised bands, though some only used in relatively few countries
  - Certain bands reserved globally for extra-terrestrial research

Spectrum Sharing in the Public Sector

- Spectrum can be shared between Public Sector users…
  - Many radar bands are shared between civil (especially aeronautical and maritime) and military uses
  - Ground based aeronautical radars and Shore based marine radars can co-exist
- …or between Public and Commercial users
  - Geographic sharing has taken place in TV broadcast and GSM bands
  - Dynamic Frequency Sharing between radars and WLANs at 5 GHz
- Some public sector systems have evolved to serve both sectors
  - e.g. GPS, Inmarsat

Technology Evolution in the Public Sector

- Technology evolves more slowly than *some parts* of the commercial sector
  - Typical upgrade cycle 15 – 25 years
  - Slow compared to cellular but comparable to broadcast transmission or telecoms backbone networks
- Limiting factors include:
  - Low market volumes
  - High unit costs
  - Demanding performance requirements
  - Need for global interoperability (e.g. aircraft / ships)
  - Tendency for professional equipment to be re-used by private users (e.g. general aviation, leisure craft)
  - Lack of incentive to upgrade (often spectrum is free)

Technical initiatives to improve efficiency

- Aeronautical Communications
  - More allocation flexibility – accommodate new data communication systems in radio-navigation bands
  - Joint initiative by FAA & Eurocontrol to develop new communications technology
    - Replace current analogue technology with CDMA or TDMA technology
    - Mobile WiMax technology (5 GHz) for short range comms
    - Planned implementation by 2020
    - In meantime big improvements achieved with analogue technology (down from 25 kHz to 8.33 kHz)
    - Details at www.eurocontrol.int/nexsat/gallery/content/public/Library/AP17_Final_Report_v10.pdf

Technical initiatives to improve efficiency

- Military Communications
  - Cognitive and Software Defined Radio can deliver greater flexibility and sharing potential
    - e.g. NATO JTRS (Joint Tactical Radio System) provides frequency agility (2 MHz – 2 GHz) and uses over the air software upgrades to adapt to local needs
  - Increasing scope for pre-emptive sharing of military spectrum with commercial users
  - Greater use of commercial technology
    - e.g. DARPA WAND project (Wireless Adaptive Network Development) aims to deliver frequency agile battlefield radios using adapted commercial hardware

Radars present biggest opportunity for spectrum savings but also greatest challenge

- Radar spectrum largely driven by range/resolution req'ts
  - Typical Operational Bandwidths (Primary Radar) up to 20 MHz
  - Out-of-band emissions extend well beyond these limits and can "overspill" into adjacent bands
  - High transmit powers and highly sensitive receivers require large frequency and/or geographic separation between radars and limit scope to coexist with other systems
  - Many radars use valve technology (Magnetrons, TWTs)
- But improvements are being made
  - New tighter out-of-band limits have been developed by CEPT and ITU
  - Recent solid state radars significantly improve out-of-band performance

Benefits of reduced radar emissions

- Work undertaken for Ofcom suggests up to 63% reduction in required frequency separation between two S-band radars at 45 km distance if latest solid state technology used to replace existing TWT based radars*
- Average reduction anticipated to be about half this (32%)
- Suggests ability to “pack” more radars into existing frequency bands without compromising performance
- Longer term possibility to re-plan the bands and maybe reduce overall bandwidth
- But this would require all existing TWT / magnetron radars to be upgraded on an internationally co-ordinated basis

* see “Study into Spectrally Efficient Radar Systems in the L and S Bands - Short Report for Ofcom Spectral Efficiency Scheme 2004 – 2005, by BAe Systems, July 2006

Regulatory initiatives to promote efficiency

- EC Working Group on Public Use of Spectrum (under Radio Spectrum Policy Group remit)
  - seeking to identify and promote best practice
  - details at http://rspg.groups.eu.int/doc/documents/meeting/rspg16/rspg08225_progressreport_pus.pdf
- USA Federal Strategic Spectrum Plan
  - aims to provide access to spectrum for Government and non-Government users on an increasingly dynamic basis
  - details at www.ntia.doc.gov/ntiahome/press/2008/SpectrumPlan_080320.html
- Australia, Netherlands, Sweden, UK, US have undertaken reviews of public sector spectrum and proposed improvements to promote efficiency.

Key findings of national reviews include:

- Need to improve information on spectrum use – e.g. through EFIS (European Frequency Information System) or national frequency tables
- Improve understanding by users of current spectrum use and appreciate value of spectrum holdings
- Scope for more intensive use and/or release of spectrum, partly through application of new technology
- Potential to provide incentives (financial and otherwise) for more efficient public sector use

But implementing change will take time :

- Technical work is needed to exploit spectrum sharing and release opportunities so security and safety are not compromised
- Equipment replacement and procurement cycles cause delay
- New institutional and licensing arrangements may be required.
- Public sector budget constraints apply.

Recent developments in the UK

- Independent audit of spectrum holdings commissioned by Government (2005) www.spectrumaudit.org.uk
  - Identified 23 bands as possible candidates for sharing or release
  - Proposed shift to market based management of some public sector spectrum (tradable usage rights)
- Ofcom consultation on new spectrum framework for the public sector (2007) www.ofcom.org.uk/consult/condocs/sfrps/summary
  - Proposed licensing changes to facilitate sharing and release of spectrum by public bodies
- More extensive audit by MoD and consultation on possible release or sharing of spectrum (2008) www.mod.uk/NR/rdonlyres/8B9CFFD1-6C36-476A-A6C3-8A3E5635DC55/0/dsm_consultation_report.pdf
  - Initially 406 - 430 MHz and possibly 3410 to 3600 MHz
  - Other bands may follow over next four years

Other countries favour a different approach

- Whilst UK and US have favoured a market based approach to incentivise efficiency, some have preferred an administrative approach to promote efficiency
  - e.g. Netherlands holds periodic reviews of public sector allocations and requires users to justify their access to spectrum
- Both approaches can be effective
  - Depends on national circumstances
  - Key requirement is to ensure users appreciate value of their spectrum resources

Future opportunities for sharing and release

- Greater use of “Smart” Radio technologies could enhance ability to share spectrum
  - Many military systems are designed for “hostile” RF environments hence should be able to co-exist with commercial uses
- Some applications could migrate to higher, less congested bands
  - e.g. line-of-sight communication links
- Future requirement for some existing allocations is uncertain
  - e.g. some ILS / MLS functionality could be replaced by satellite systems enabling re-farming to support new applications
- Pre-emptive access to spectrum could cater for unpredictable emergency requirements
  - But need to be sure spectrum available when needed and learn lessons from US “Band D” auction

Summary

- Public sector accounts for around 50% of spectrum
- Radars and Military Communications account for bulk of public sector spectrum use
- Demand for aeronautical and defence spectrum is growing but should mostly be met in existing bands by
  - Upgrading technology to improve spectrum efficiency
  - Greater sharing, both within the public sector and between public and commercial users
- Regulatory initiatives can provide incentives to more efficient use and promote sharing or release of spectrum
  - Either market based (financial incentives) or administrative (justification of spectrum assignments)