

Military licence exempt spectrum - the need and challenges?

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"Intelligently using the Spectrum"

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Acknowledgment

This work is based, in part, on research undertaken for Dstl.

Spectrum aggregation and regulation opportunities/constraints

- What is fragmentation?
 - What are the civil and military drivers?
 - Will it get worse?
 - Recommend a way forward
-
- **Military ISM Band – LE spectrum for future Military applications**
 - What is an ISM / LE band ?
 - What are the benefits?

The conclusions of this presentation are not UK MoD, Dstl or QinetiQ policy but reflect the views of the author

Overview

- **Military spectrum use and drivers**
- **What is the challenge?**
- **What is the concept?**
- **Why do we need it ?**
- **What is the evidence of needing it ?**
- **What would be the benefits ?**
- **What's the unique approach?**
- **What's the next step ?**

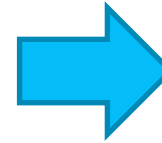


Military spectrum use and drivers

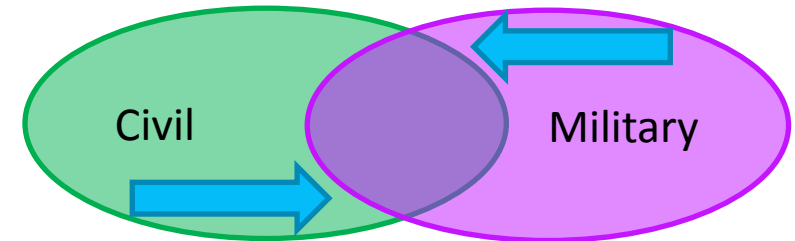
- **Spectrum from LF to mm-wave is critical for military operations, training and R&D**
 - Underpins over £14bn/yr UK's procurement budget
- **Spectrum from LF to mm-waves is critical for civil applications and economic growth**
 - (Worth over £40bn to the UK economy)
- **Increasing pressure to maximise /share the use of the limited resource**
 - UK Government 2016 strategy is to release 750MHz of valuable public sector spectrum under 10GHz by 2022 (which 500MHz will be made available by 2020)
- **Budgetary constraints of developing / delivering new capabilities and technologies**
 - Increasing use of COTS equipment



New applications, concepts and tests constantly being developed (UXS, dismounted soldiers, etc)



New applications and concepts constantly being developed (5G, IoT, Transport - sensors)



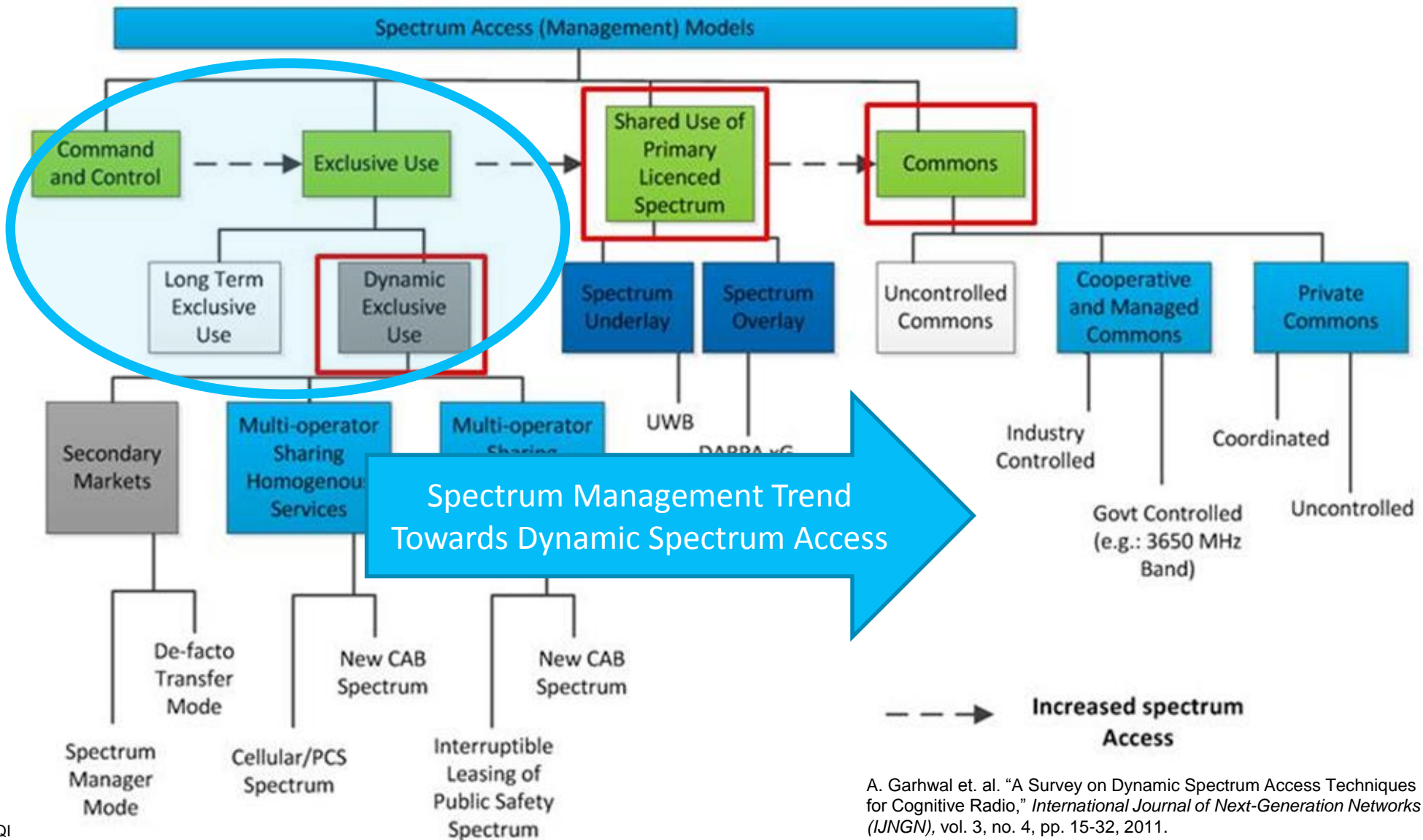
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Challenge

- Can the increasing civil pressure to maximise /share the limited spectrum resource be used for *military benefits*?
- How do military users leverage mass market to develop systems that we want?
- Can we use Spectrum - Our Unique Selling Point is valuable spectrum which “military” control?
- Is a Military Licence Exempt Spectrum a way forward?



Spectrum Management Regimes



A. Garhwal et. al. "A Survey on Dynamic Spectrum Access Techniques for Cognitive Radio," *International Journal of Next-Generation Networks (IJNGN)*, vol. 3, no. 4, pp. 15-32, 2011.

Licence Exempt Spectrum Applications, Benefits Drawbacks

- **What is LE spectrum**

- Spectrum that can be used without the need for prior authorisation. (Not “licence free” – is it controlled by hardware boundary conditions)

- **Applications**

- Applications across the whole of society such as: healthcare, transport, entertainment, banking, utilities and security

- **Civil benefits of LE devices**

- Civil LE bands has resulted in an ecosystem e.g. 2.4 GHz Wi-Fi
 - Absence of frequency assignment and licensing procedures,
 - Short time-to-market and
 - Market size and affordable chips.
- Efficient spectrum (low power only create local interference)



[http://www.stagesuperstore.co.uk/ekins-shops/stage-superstore/images/trantec-s5.3-rack-n-ready-uhf-radio-microphone-system-\[5\]-1093-p.jpg](http://www.stagesuperstore.co.uk/ekins-shops/stage-superstore/images/trantec-s5.3-rack-n-ready-uhf-radio-microphone-system-[5]-1093-p.jpg)



Drawbacks

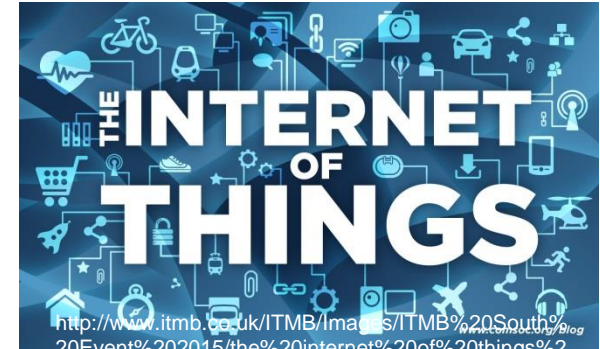
- Its popularity, open access, security
- Military have exploited LE spectrum and devices which demonstrates their willingness to accept the drawbacks.

What new military applications could use a LE band?

New emerging military applications

- **Autonomous vehicles**
 - Micro air vehicles (MAV) and MAV swarms,
- **Welfare**
 - Biomedical applications
- **Telemetry and tracking**
 - Wireless logistics
 - Spares
- **Intelligent transport**
 - Autonomous vehicles
 - Impact of (short) loss of data considered low

Military

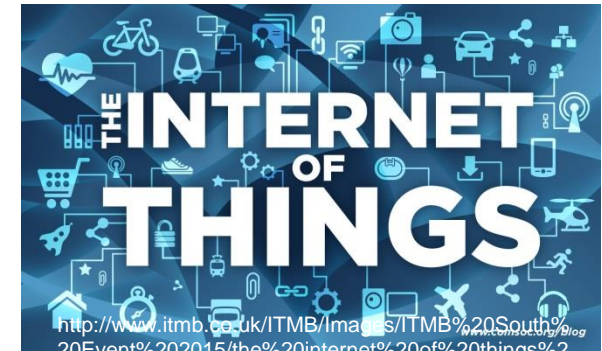


Benefits of military LE spectrum

What benefits could accrue from a bespoke Military LE band?

- Majority of the benefits accrued by the Civil sector **(except the military market size)**
 - Absence of frequency assignment and licensing procedures
 - Rapid deployments
 - Coalition operations
 - Short time-to-market
 - Innovation and new applications and business models
 - **Reduces spectrum fragmentation**
 - **Spectrum saving**

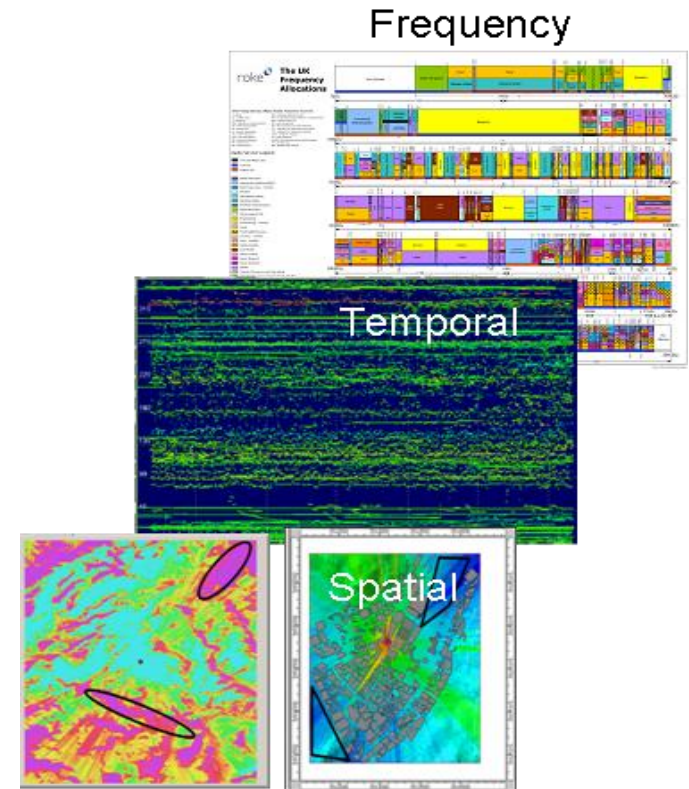
Military



Spectrum Fragmentation need for LE spectrum

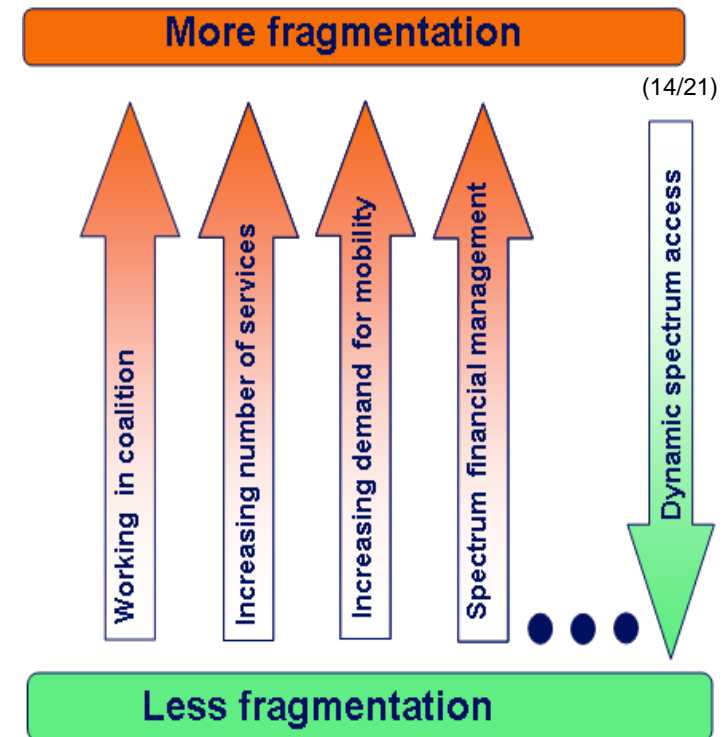


- **Is there a fragmentation definition? - No**
 - It can occur in frequency, space and time,
 - In the military domain there is an expectation of higher temporal and spatial rates of change than civil domain
- **Can fragments be identified? - Difficult**
 - The lack of mature spectrum databases and suitable analysis tools makes fragment identification difficult
 - However specific examples of fragmentation were identified
- **Are civil and military drivers the same? - No**
 - Differences between military and civil include:
 - The wider range of radio systems that military operations have to contend with (i.e. civil, coalition, etc.)
 - The highly dynamic nature of military operations (e.g. sorties, campaigns)
 - The slower technological refresh rate



Spectrum Fragmentation need for LE spectrum

- **Will it decrease?**
 - Both civil and military domains concluded that, generally, fragmentation would increase
- **Will it be a problem?**
 - Yes,
 - No clear fragmentation benefits could be identified.
- **Will civil research solve it?**
 - Not completely, civil systems are not as “dynamic”, but military should leverage civil techniques and policy initiatives being developed such as:
 - Reconfigurable Radio Systems (RRS), cognitive radios, white space radios, context aware radios, HetNets (Heterogeneous Networks)
 - Dynamic spectrum management and policy initiatives
- **Minimise congestion from new systems.**
 - Examine the novel concept of “**military unlicensed spectrum**” to: promote innovation and reduce hardware costs, reduce spectrum congestion from new radio applications



Spectrum savings – using LE spectrum

Hypothetical question was posed;

“Are there (UK based) systems that currently use licensed spectrum that could have used a military licence exempt band if it existed with the right conditions”

- **How many systems are < 2 watts EIRP (~33dBm)**
 - Between 30 – 300MHz
 - Between 300 - 3000 MHz
 - Between 3000 - 6000 MHz
- **How many systems 2 - 25 watts EIRP (~33 - 44dBm)**
 - Between 30 – 300MHz
 - Between 300 - 3000 MHz
 - Between 3000 - 6000 MHz

Numerous  MLE

- **(Caveat – did not look at the applications in detail)**

Challenges of a Military LE band?

- **Interference, inability to control applications, inability to reclaim spectrum**
 - Don't know where systems are used
- **Need for harmonised spectrum**
 - Creates market size
 - Cost of system higher than current LE devices but could be cheaper than licenced systems
- **Would the military use LE spectrum**
 - Military have already exploited commercial LE devices, which demonstrates willingness to accept the drawbacks
- **Could military use Civil LE (ISM) bands more**
 - Yes but
 - Low radiated power could be contributing to its lack of use
 - Lack of control could be contributing to its lack of use



What could a military LE band look like - concept

Use a tiered approach to maximise the market size

- **No databases**
- Bands have higher EIRPs than current LE bands
 - Increased range, building penetration – what user want
- Devices would be more expensive

- **Challenge** - how does the military leverage the mass market to develop systems that we want.
- **Our USP** is valuable spectrum which we control

Tier 1 - Military use (highest cost devices)

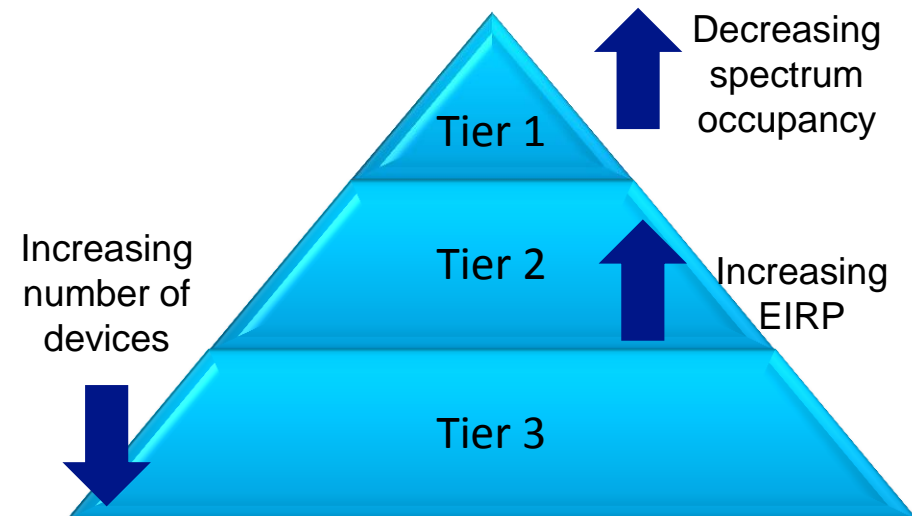
- High powers cause interference to Tier 2 and 3
- Small market and small spectrum occupancy (e.g. military training)

Tier 2 - Military and other security related users

- Medium power cause interference to Tier 3 and accepts interference from Tier 1
- Medium market size and medium spectrum occupancy (e.g. emergency services)

Tier 3 – Military, other security users and civil users

- Low power but accept interference from Tiers 1 and 2
- Mass market but variable spectrum occupancy



What boundary conditions could be used

Traditional boundary conditions including:

- Fixed power, duty cycle etc.

Use new technical parameters such as:

- Out of band emissions
- Dynamic channel bandwidth allocation
- Antenna patterns
- Adaptive power control could be stipulated

Additionally “soft” boundaries:

- Hierarchical / prioritisation / risk rules
- Digital social rules such as changing frequency based on location

What technologies:

- Spectrum sensing
- Intelligent antennas
- GPS/INS



Summary

- **Military spectrum use and drivers ?**
 - Demand, congestion and sharing
- **What is the challenge?**
 - How do we leverage civil mass market
- **What is the concept?**
 - Can we use our USP of spectrum access – MLE?
- **Why do we need it ?**
 - Rapid development of new capabilities
- **What is the evidence of needing it ?**
 - Military use LE and civil systems, some low power devices licenced
- **What would be the benefits ?**
 - Cost reduction, spectrum management
- **What's the unique approach?**
 - Tiered (no database) approach to usage



Study Recommendations - next steps ?

1. Military Technologists should:

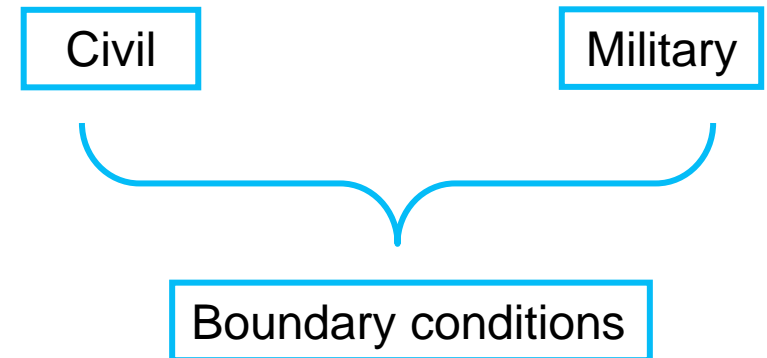
- Design, simulate and field test, exploiting both current military and civil radio capabilities the concept of a Tiered Military LE boundary conditions

2. Civil Market / Users should:

- Co-investigate the boundary conditions for Tiered Military LE spectrum.

3. Regulators should:

- Develop long term (2015) regulatory strategy for a tiered Military LE band
- Highlight barriers and standardisation opportunities both nationally and internationally across NATO



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