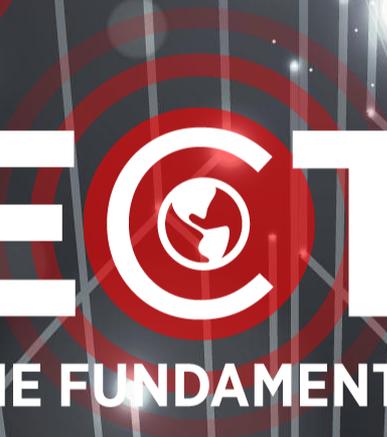


SPECTRUM

THE FUNDAMENTAL ELEMENT OF MOBILE





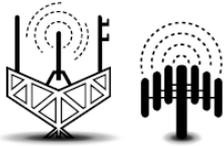
Spectrum sharing

Eur Ing Laurent Bodusseau BEng(Hons) CEng MIET
Senior Spectrum Director – GSMA

Licensing regimes impacting mobile access

Exclusive Licensed Spectrum

Auctions of cleared spectrum for 3G/4G



Exclusive use

Mobile industry's top priority - commercially proven, harmonised, quality of service, mobility and control

Shared Licensed Spectrum

Licensed Shared Access (LSA), CBRS-model, TVWS etc



Exclusive use (at times/ places) or shared use

Access and sharing conditions impact investment, commercial viability and QoS. Often used when band cannot be cleared entirely or usage gaps

Unlicensed Spectrum

Multiple technologies (Wi-Fi, LTE in unlicensed, BT & others)



Shared use

Unpredictable QoS and ideal for hotspot access. Opportunistic use for mobile broadband is rising



Unlicensed spectrum use and applications

Also known as **General Authorisation and Licence exempt spectrum**

Establishes use of radio devices without individual authorisation

- Suitable for radio services/devices that have self-containable interference potential
- Some conditions are imposed to minimise interference (e.g. listen before talk)
- **Important developments in this space:**
 - Mobile operators have launched 4G in unlicensed
 - Mobile operators already using carrier Wi-Fi increasingly
 - 5G likely to have an important unlicensed/shared component
 - Sub-1GHz unlicensed use for IoT
 - WRC-19 to consider extending 5 GHz band
 - 5.9 GHz for safety in connected cars

Wi-Fi is increasingly important for mobile

- **Most mobile traffic uses Wi-Fi**
 - More mobile device traffic offloaded to Wi-Fi than remained on cellular in 2016
 - But “reverse migration” means offloading is not always the case
- **Wi-Fi calling is growing and will likely expand more with VoLTE**
 - Same core network elements can support both technologies
 - Many operators support Wi-Fi calling today



Cellular data traffic is rising again in Korea



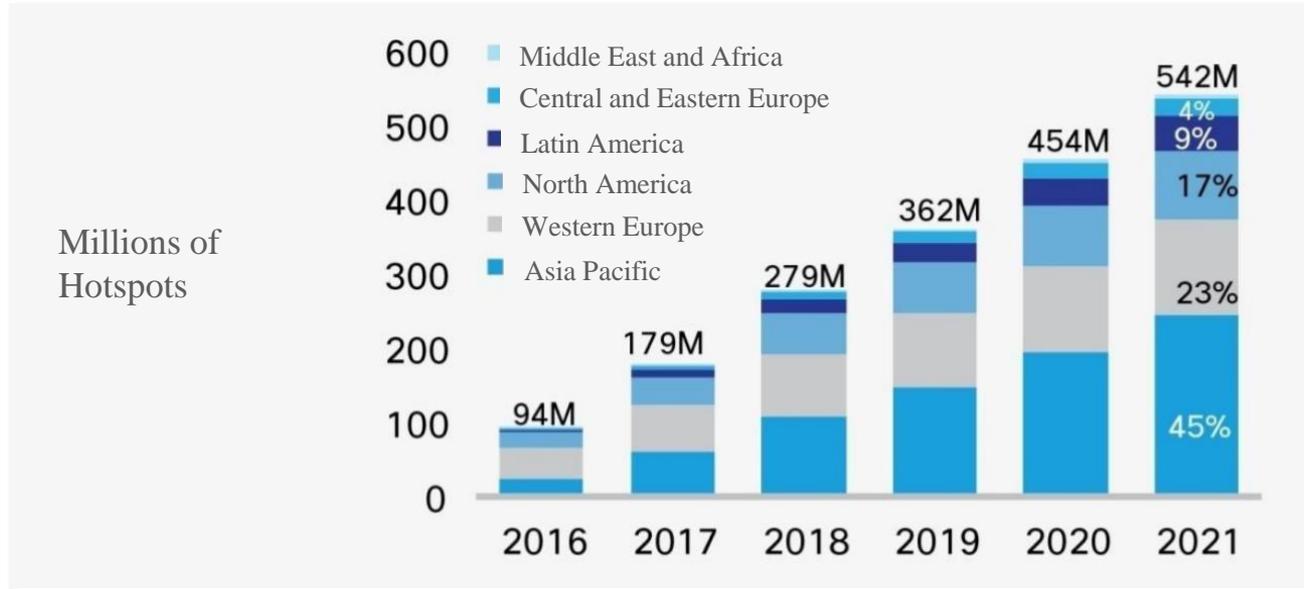
Numerous US stadiums say most traffic is now cellular



Sprint reported Wi-Fi offload dropped from Q1-Q4 2016



Growing number of public Wi-Fi hotspots



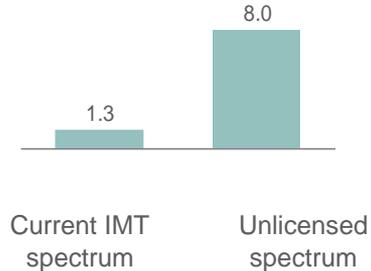
* Middle East and Africa represents 1 percent of global public Wi-Fi hotspots by 2021
Source: Maravedis, Cisco VNI Mobile, 2017

Significant amount of unlicensed spectrum

Lots of unlicensed spectrum...

...but most is focused in mmW

Current spectrum availability
(approximate theoretical average*, GHz)



*identified IMT spectrum and unlicensed spectrum varies significantly by country and region

Key unlicensed bands

- Small amount **sub-1 GHz**: IoT use (Sigfox, LoRa)
- **2.4 GHz and 5 GHz**: Fast services (Wi-Fi, LTE-U)
- **57-66/71 GHz** Superfast services (WiGig & 5G)

Coverage and Usage

- Mostly not suited to wide area coverage
- More well suited to urban hotspots & inside buildings
- Usage conditions apply but do evolve (e.g. FCC 5GHz)



Unlicensed-centric cellular technology standards

Tech	Body	Status	Spec
LAA	3GPP	Specification is ready for downlink. 3GPP test plan for Rel-13 ongoing. Rel-14 WI for eLAA will add uplink.	Release 13
LWA	3GPP	Completed – Aggregation is supported for downlink in Rel-13 (and for uplink in Rel-14). 3GPP test plan for Rel-13 ongoing.	Release 13
LWIP	3GPP	Completed. 3GPP test plan for Rel-13 ongoing. Rel-14 will add flow control and WLAN metrics	Release 13
LTE-U	LTE-U Forum	Specification developed by a set of companies and already available. Wi-Fi Alliance has developed a coexistence test plan	Available (v1.3)
MuLTEFire	MuLTEFire Alliance	Research phase, initiating work with the ecosystem to develop industry-wide specifications for this technology. Presented current draft to 3GPP in September, 2016	Release 1 specification in December 2016

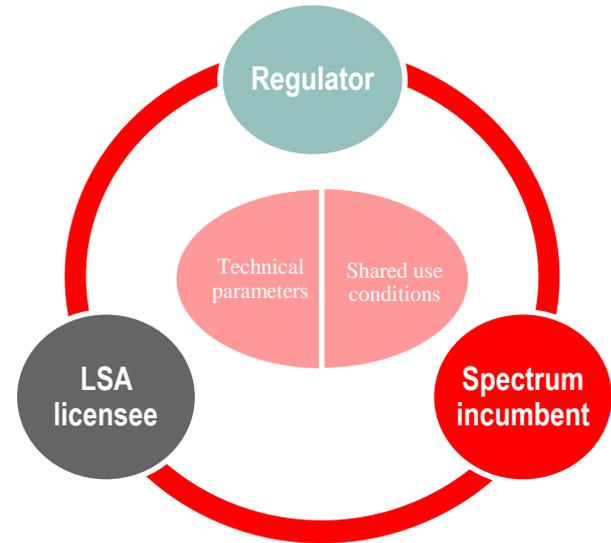
Sharing licensed: Licensed Shared Access (LSA)

Licensed Shared Access is a voluntary sharing method where an incumbent can share spectrum with another user – typically on a commercial basis

- Access can be guaranteed assuring QoS
- Can support existing low cost devices
- Encourages spectrum efficiency

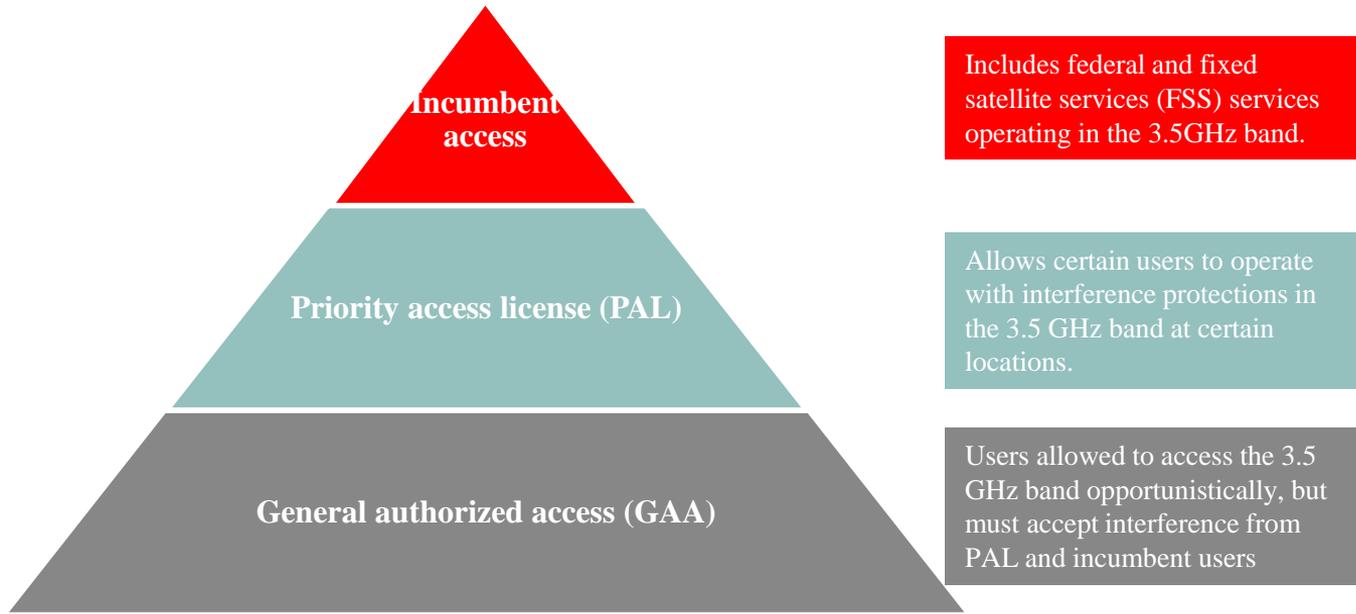
But....

- Contract length must justify investment
- Spectrum must be available in right bands, at right times and places, for the right price





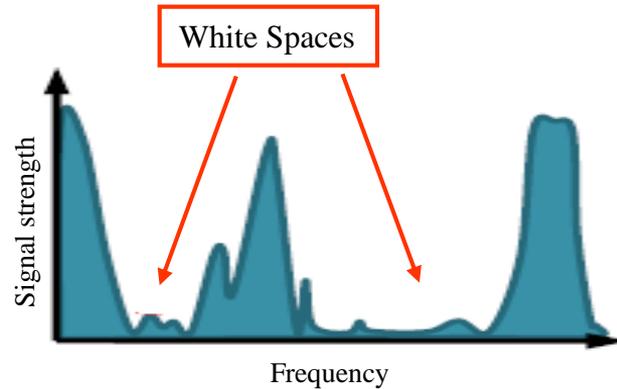
Sharing licensed: Citizens Broadband Radio Service (3.5 GHz)



Source: Ruckus Wireless

Sharing licensed: TV Whitespace

TV Whitespace has not yet gained major commercial traction



- TVWS employs broadcast TV spectrum that is unoccupied in certain areas
- This means availability is limited
- Normally available on unlicensed basis, so quality of service is not guaranteed
- The digital dividend reduces the amount of TVWS spectrum available



A middle way: light licensing

Non-exclusive licences – lower cost, simpler to manage, but less QoS control

Light licensing can have varying rights/protections	
Stronger rights/ protections	Weaker rights/ protections
Individual frequency planning / coordination	No individual frequency planning / coordination
Simplified procedure compared to individual licensing	Registration and/or notification
Limitations on user numbers	No limitations in the number of users nor coordination

- Quality of service protections range from relatively strong to relatively weak
- Not currently used in mobile access – due to QoS concerns – but used for some backhaul



Shared spectrum vs Exclusive spectrum

- Could offer some opportunities – case by case
- Sharing would often reduced the usefulness and the economic benefits of the spectrum
- Increase complexity
- Impact on investment
- Long term visibility can be difficult to achieve
- Conflict resolution could be lengthy and difficult to resolve
- Possible lack of harmonisation

