

Wireless Internet Service Provider Association
of Australia Inc

**Response to: Spectrum sharing
Overview and new approaches**



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Thank you for the opportunity to provide a response to the ACMA “Spectrum sharing Overview and new approaches” Discussion paper. The Association represents a broad range of carriers in Metropolitan and Regional areas, typically smaller operators who have limited or no access to spectrum.

The Wireless Internet Service Provider Association of Australia (WISPAU) membership are strongly in favour of the implementation of a Dynamic Spectrum Licensing Management (DSLIM) system. We consider this current discussion paper as a significant step forward and commend the Authority for a well-researched and thorough paper.

The Government by nature is a centralised organisation and lacks the granular knowledge to make small incremental decisions on precisely how spectrum should be used, and by whom, in what geographic areas to maximise the highest value use (HVU).

The ACCC recognises the problems associated with market concentration, primarily driven by access to spectrum and the detrimental effect this has on the Australian community: “Australia already has a very concentrated mobile services market, with the three network operators, Telstra, Optus and Vodafone, having over 87 per cent share. Similarly, the fixed broadband market is concentrated, with Telstra, TPG and Optus having approximately 85 per cent share.”

“Broadband services are of critical importance to Australian consumers and businesses, across both fixed and mobile channels,” ACCC Chair Rod Sims said.” Extract from <https://www.accc.gov.au/media-release/accc-opposes-tpg-vodafone-merger>.

Spectrum is a national resource, the most important stakeholders being the public on whose behalf the spectrum is purported to be managed. The most efficient way to arrange this resource is through a licensing framework that allows maximum flexibility, allowing providers

and consumers to decide through free market processes how the spectrum is used, in what areas and by whom.

The optimal way to achieve maximum flexibility and accommodation of both incumbent users and new access seekers is through the implementation of a DSM System. WISPAU's responses to this discussion paper will be in line with this approach.

Elements of Spectrum Sharing

As outlined in the preamble of the ACMA's paper, spectrum sharing is the interplay between four elements, frequency, geography, time & technology (signal sharing). As these elements form the basis for the ACMA's view on sharing it's important for us to clarify our understanding of each and identify strengths and weaknesses.

- **Frequency domain sharing:** *Defined as the separation of uses/users based on operating frequency (including in-band and out-of-band emissions). This is implemented through varying combinations of planning segregation and technology, for example, through filtering radiocommunication transmissions (to constrain the transmitted level of out-of-band emissions—'leakage rejection') and/or receivers (to constrain the received level emissions from other frequency-adjacent transmitters—'selectivity').*

The distinction between uses and users is important. Designating one band for a single use can restrict other users, for example 915 MHz may be suitable for Smart Meters in metropolitan areas and broadband internet access in regional areas. The current highly prescriptive designation of "Uses" by the ACMA should be relaxed to allow band use to be specified by the licensee and paid for accordingly. This will foster innovation through greater flexibility and allow future technologies to be authorised for user in much shorter time periods.

- **Geographic domain sharing** - *geographic separation of different devices spatially through site selection (distance separation), environmental shielding (for example, terrain and other clutter such as buildings, trees) and diversity of the radiated signal through controlling parameters such as transmission power and antenna characteristics (including height, directivity and azimuth).*

The historical size of geographically defined areas typically found in apparatus and spectrum licensing is too large. Large areas including Australia Wide allocations restrict access to potential users and create an environment where spectrum is not utilised, despite it being a finite public resource. We acknowledge the recent work conducted by the ACMA to recognise this via the Area Wide Apparatus licensing concept. We endorse this approach and encourage the ACMA to significantly reduce the size of license allocations to a more efficient level, to encourage optimal use.

Large regional wide licenses is akin to selling milk by the megalitre or food by the tonne, units this large can only be purchased by the dominant market operators and will typically lead to wasted resources.

- **Time domain sharing** - *Separation of different uses/users by time (users are permitted to transmit only at certain time intervals).*

The duration of a typical apparatus license is 1 - 5 years, with spectrum licenses typically

extending from 10 - 20 years. There are a range of issues that arise from allocations of this duration;

- **Technological Change** - The pace of technological change is such that any new use for spectrum in a band would necessarily have to wait until the existing licenses have expired before approval for use can be sought or granted. As the duration of licenses can be decades this creates a potentially stifling effect on emerging players and innovative technology. Serious negative effects on productivity follows, as new more efficient technologies cannot be adopted in a reasonable timeframe. This is particularly so where large carriers are focused on a business model reliant on population density.
- **Market Domination** - Long license durations allow dominant carriers to acquire large amounts of spectrum for long periods of time and simply lock competitors out of certain markets. A prime example is Australia wide PMTS licenses that are not available to smaller operators even in remote areas.
- **Flexibility** - Restricting certain types of itinerant use like additional mobile capacity for large sporting or music events means that this market need can only be served by dominant MNO's and a reduction in supply leads to an increase in price.
- **Certainty** - It is important to address one of the most common concerns raised by mobile network operators (MNO) related to spectrum access duration. The argument is that without 10-year license periods, MNO's would lack the certainty of continued access to spectrum to make the investment required.
There are several flaws in this argument that require further examination:

- Certainty of access to spectrum can be obtained by purchasing a Priority Access License. These licenses could span multiple years, with the incumbent having a right or option to renew (like commercial real estate leases). Should an incumbent be challenged for right of renewal they are obliged to enter into a competitive arrangement and pay the current market price for the resource. What MNO's are asking for is protection from future competition.
- Given the current pace of technological change Priority Access Licenses could be multi-year allowing for significant time to recoup investments.
- New radio technology is multi and wide band. Operators now have far greater flexibility to change frequencies and aggregate multiple carriers.

- **Signal sharing** - the use of signal characteristics and other technology-aided techniques to enable the use of the same spectrum by different uses/users (for example, spread spectrum techniques). CSMA-CD is an example.

These types of technologies work well when the mechanisms form part of the underlying protocol, for example Carrier-sense multiple access with collision avoidance (CSMA/CA) part of the 802.11 or Wi-Fi standard. This technique for sharing is best used in an unprotected public park or opportunistic use environment.

Issues for Comment

1. *Given the current momentum in international markets and opportunities for other sharing models offered by 5G technologies, is it timely to develop a more detailed consideration of spectrum sharing opportunities in Australia?*

Yes, the Wireless Internet Service Providers Association of Australia (WISPAU) have been lobbying for the introduction of a Dynamic Spectrum Access (DSA) system since 2016. We have written several papers on the subject and have consistently called for the ACMA to review the merits of such a system. We consider it most timely to consider spectrum sharing opportunities across the country and our members offered to participate in a spectrum sharing trial at the recent Tune Up event, an offer which is standing and supported by both operators and vendors.

2. *Are there recent developments in sharing techniques that industry and the ACMA should be aware of?*

Our view is that the ACMA has produced an excellent discussion paper. The quality content provides a solid foundation for meaningful progress. There have been important advances of the CBRS in the United States with the official launch of commercial services occurring in September 2019. Commonly referred to as “The Innovation Band”, the 3.5 GHz CBRS band opens the door to a huge market opportunity for enterprises and the broader U.S. economy, paving the way for network densification, IoT, neutral host networks, private LTE networks and more yet to be identified innovation.

3. *What are the (potentially new) use cases that might benefit from secondary or tertiary access to spectrum and who benefits?*

There are several potential responses to this question:

- 3.1. The first is to simply list some of the existing developments seen in other countries that have taken the lead on spectrum management and fostered innovation. These include:
- 3.1.1. **Education:** High performance reliable secure LTE networks allow students to learn in an immersive digital world and staff and faculty to securely access the administration network.
 - 3.1.2. **Hospitality:** deliver guaranteed quality of service in event venues, eliminate “dead zones” in hotel lifts, car parks etc.
 - 3.1.3. **Medical:** Over 70% of commercial buildings (including hospitals) have insufficient mobile coverage indoors. Access to properly coordinated spectrum improves wireless coverage and capacity, making it ideal for wireless needs in a world where spectrum is limited, but data demand is not. Connected medical devices can lead to greater efficiency in hospitals, and detailed patient monitoring through automation, giving an improved health outcome for patients and lower costs.
 - 3.1.4. **Home Automation:** Private LTE networks support improved security, more reliable broadband services, improved energy consumption through smart meters and home automation.
 - 3.1.5. **Enterprise Office:** Private robust high-speed networks are critical for modern office environments to function efficiently - access to spectrum would allow improved security and performance.
 - 3.1.6. **Entertainment venues:** including sports stadiums, arenas, concert halls, theme parks, are looking for enhanced fan engagements using better wireless coverage and capacity that is secure and cost-effective.
 - 3.1.7. **Neutral Host Business Models:** Neutral host infrastructure comprises a single, shared network solution provided on an open access basis to all MNOs to resolve poor wireless coverage and capacity inside large venues or other busy locations. They are usually deployed, maintained and operated by a third-party provider and designed to support the full range of MNO technologies.
<https://www.techuk.org/insights/opinions/item/13533-is-neutral-host-infrastructure-the-way-forward>

- 3.1.8. **Rural and Remote Connectivity:** Access to coordinated licensed spectrum will allow smaller carriers (WISP's) to provide high quality broadband services to rural and remote communities on par with what is offered in larger more urban areas. It truly opens the communications market to smaller players on a level playing field and fosters genuine competition which will reduce prices and improve outcomes for customers.
- 3.1.9. **Network Densification:** As demand for bandwidth increases network operators must increase the density of their networks to maintain performance. Estimates put this at as much as a tenfold increase in today's network density. The introduction of licensed spectrum through a DSA system will allow smaller operators to compete in this market, without which only carriers with spectrum holdings will be legally allowed to operate. They will be unable to keep up with demand leading to extremely poor outcomes for consumers.
- 3.1.10. **Industrial Automation:** Competitiveness is everything to manufacturers and much-needed gains in efficiency and profitability will have to be achieved through new process innovations. This includes, for example, the continued automation of robots and warehouse transportation and cutting cables to become truly flexible. 5G and IoT will be key to enhancing and enabling these advances in manufacturing. 5G networks offer manufacturers and telecom operators the chance to build smart factories and truly take advantage of technologies such as automation, artificial intelligence, augmented reality for troubleshooting, and the Internet of Things (IoT).
<https://www.ericsson.com/en/networks/trending/insights-and-reports/5g-for-manufacturing>
- 3.1.11. **Internet of Things (IoT):** The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems.
https://en.wikipedia.org/wiki/Internet_of_things
- 3.1.12. **Agribusiness:** Secure reliable communications are required to support the next generation of farming technologies including self-driving tractors and swarms of autonomous drones, used for fertilizer and pesticide delivery.
- 3.2. Another response to this question is “no one knows”. Without a flexible framework the current prescriptive license allocation “uses” will stifle innovation. It's not possible for anyone to predict what technologies will be developed or implemented in the future - we cannot predict what entrepreneurs may invent. However, we contend inflexibility creates an environment where innovation is stifled.

The current licensing regime is incredibly restrictive, in terms of the uses, users, duration, geography, time, and cost (monetary). We advocate for the implementation of a framework flexible enough to accommodate future uses without the need to engage in “refarming” processes that can take years to progress through, favours one type of use and disrupts incumbent users.

4. *What are the potential challenges/impediments to the introduction of DSA in Australia—technical, industry capability, licensing and regulatory frameworks?*

- 4.1. **Regulatory:** We see the regulatory environment as the greatest challenge to the adoption of a DSA framework, primarily due to the existing regulations that exist including incumbent licensees, and a vested interest to preserve the status quo. Regulators necessarily tread a fine line - between creating a new more dynamic innovative environment that will benefit all Australians and fear of retribution from incumbents adamant to preserve the status quo and their perceived “rights” of access to a national resource.
- 4.2. **Technical:** A considerable amount of the technical challenges that may arise have been addressed already by the United States and its implementation of the CBRN system. Australia is a small market - it is very unlikely that large equipment manufacturers are going to tailor protocols to suit the small number of carriers that may purchase their equipment, instead we would be far better served through global standardisation.
- 4.3. **Industry capabilities:** As noted above, the technical capabilities already exist. Our concerns reside not in the lack of capability but in a lack of will to change and adapt. Conventional Mobile Network Operators MNO's benefit greatly from the current spectrum licensing regime. We anticipate a plethora of barriers will emerge or be created in order to preserve the status quo. This can only be addressed by good leadership from the ACMA and the Government more broadly.
- 4.4. **Licensing:** The existing wide area spectrum licenses with long durations are the greatest impediment to the implementation of DSM and necessitate the construction of a three-tiered system with incumbent users taking priority over all others.

5. *Facilitating spectrum access (e.g. monitoring, control, reporting, assignment) logically necessitates involvement from both government and industry. Are there any early thoughts on what an appropriate industry/government balance might look like? How might the ACMA facilitate shared spectrum access? How might the ACMA address this?*

The link below shows the current CBRS Network Architecture - this article explains the Spectrum Access System (SAS) Interface and Operation. Australia must adopt a similar system.

<http://www.techplayon.com/cbrs-network-architecture-and-spectrum-access-system-sas-operation/>

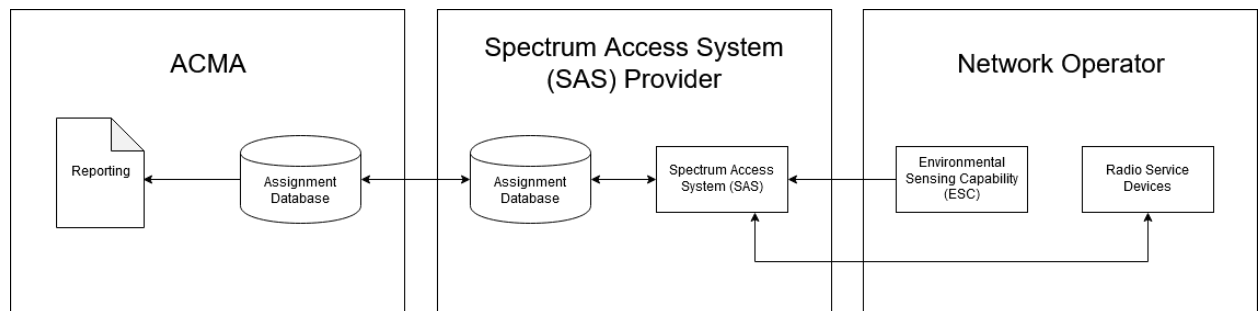


Diagram Above is a simplified illustration of the components required to maintain a DSM system:

- **ACMA** - Provides regulatory framework including database structure, assignment rules, and reporting which can include tax payable by the Spectrum Access System Provider or Network operators.
- **Spectrum Access System (SAS) Provider** - develops and maintains the assignment systems in accordance with the regulatory framework, updates the assignment database which in turn synchronises with the ACMA and other SAS operators, they can also be involved in tax collection for smaller operators.
- **Network Operators** - As a condition of obtaining a license, network operators can be required to deploy and maintain Environmental Sensing equipment, the radio service devices deployed would register with the SAS, then request spectrum resources and maintain a heartbeat to ensure continued operation.
- **Assignment Database** - This database should be constructed by the ACMA and distributed via secure blockchain technology to all SAS providers.

5.1. **Monitoring:** Provided by SAS providers

5.2. **Control:** Maintained by SAS providers in line with ACMA regulations

5.3. **Reporting:** ACMA would have access to its own version of up to date database for reporting purposes.

5.4. **Assignment:** All assignments are handled by the SAS in accordance with ACMA regulations and existing assignments within the assignment database.

6. *What is the relevance of DSA examples such as the US Citizens Broadband Radio Service (CBRS) arrangements to the Australian spectrum environment? Are there other or lower cost alternatives to help inform access control and assignment systems of incumbent usage in a timely manner?*

As the CBRS Model in the United States has demonstrated, with properly structured regulation a majority of systems required to build and maintain a Dynamic Spectrum Management system can be provided by free enterprise. This takes place in Australia already - we have spectrum brokerage firms ideally suited to maintain assignment databases and build systems that can manage and maintain license assignments in real time.

The ACMA's involvement would be kept to a minimum and therefore costs associated with development and maintenance are borne by the users, all the way down to the customer level, "User Pays" system.

7. Under a multi-tier DSA approach

- 7.1. Tier 1 (highest priority or incumbent) users would be expected to share spectrum with lower tier users when not being utilised. Are there any specific licensing and/or regulatory arrangements that might incentivise the tier 1 users to release unutilised spectrum for lower-tier access?

Yes, The Tier 1 carriers have purchased spectrum licenses that covered a large geographic areas, the fact that they are not utilising spectrum across the entire geographic coverage implies one of two things, either they were forced to pay for spectrum they didn't want or need at the time OR they wanted the spectrum to prevent others from accessing it and competing with them.

In the case of the former where the Tier 1 operator was forced to pay for spectrum not required, tax collected from Tier 2 users to operate within this band could be rebated to the Tier 1 operator on a pro rata basis over the timeframe granted to the Tier 2 operator. With a properly constructed Dynamic Licensing System taxation for spectrum occupation could be measured in hours, allowing for Tier 2 operators to pay costs directly proportional to their spectrum occupation.

Where the purchase of spectrum is left underutilised to block competitors, it would be significantly harder to convince Tier 1 operators to participate. The ACMA may consider regulating on a 'use it or share it' approach.

- 7.2. *Tier 2 and 3 users need to vacate spectrum (regardless of their service type or communication urgency) for Tier 1 users to operate seamlessly. Do we see potential services/service types in Australia who would fit the criteria of second or third tier users? What are the incentives to adopt a conditional (lower priority) spectrum than an unconditional (full access) spectrum?*

Itinerant Access - Groups that run large sporting or musical events could deploy networks on a short-term basis. In emergency situations where conventional mobile network operator networks are damaged or non-operational due to extended power outages, DSM would allow temporary networks to be stood up and operate for the duration of the outage. Examples are Hurricane Katrina in the United States where all MNO's were knocked out for weeks and communications were supplied by smaller operators running equipment off generators and batteries.

Supplementary Bandwidth - Tier 2 and Tier 3 access could be used to increase throughput where available and assist in increasing the performance for users. Technologies such as LTE Advanced Carrier Aggregation allow for multiple frequencies to be used simultaneously. Wireless Internet Service Providers WISPs could opportunistically use bandwidth to provide improved services in areas with low risk of Tier 1 utilisation.

Lack of alternatives - The motivation to use spectrum as a Tier 2 operator may be as simple as lack of alternatives, in which case the choice is to take a calculated business risk and operate within a market or choose to not operate at all.

Economics Risk Calculation - Serve low margin users at a profit by utilising spectrum that is unlikely to be used by the Tier 1 carrier due to economic viability.

DSA framework

Dynamic spectrum access requires a set of rules and a decision-making process that can operate rapidly with little or no intervention by the regulator. While there are various specific implementations of the DSA concept, each requires a framework that identifies a: hierarchy of spectrum users (and in some case a mechanism to determine/allocate rights to be part of the various hierarchical layers) set of rules articulating the rights and responsibilities of those users in a hierarchy mechanism(s) to determine actual spectrum use (as opposed to authorised/licensed) that is, a way to understand the current spectrum environment dynamic feedback or control system to implement changes to spectrum use by users based on the rules and the current spectrum environment.

License Allocation Mechanisms

Is it important to distinguish between issues that arise in addressing legacy licensing models and the way a system may function without the need to accommodate elements like multi decade Australia wide spectrum licenses. Strict multi-tier hierarchies are only required when access to spectrum resources have been determined by Government through price manipulation, leading to misallocations of resources to providers that leave them idle.

Basic Principles of Supply and Demand

To better understand the illustrations to follow it is important to have a clear understanding of the economic principles of supply and demand. https://en.wikipedia.org/wiki/Supply_and_demand

Supply and demand - in economics, relationship between the quantity of a commodity that producers wish to sell at various prices and the quantity that consumers wish to buy. It is the main model of price determination used in economic theory. The price of a commodity is determined by the interaction of supply and demand in a market. The resulting price is referred to as the equilibrium price and represents an agreement between producers and consumers of the good. In equilibrium the quantity of a good supplied by producers equals the quantity demanded by consumers. <https://www.britannica.com/topic/supply-and-demand>

Price - So long as they are not artificially controlled, prices provide an economic mechanism by which goods and services are distributed among the large number of people desiring them. They also act as indicators of the strength of demand for different products and enable producers to respond accordingly. This system is known as the price mechanism and is based on the principle that only by allowing prices to move freely will the supply of any given commodity match demand. If supply is excessive, prices will be low, and production will be reduced; this will cause prices to rise until there is a balance of demand and supply. In the same way, if supply is inadequate, prices will be high, leading to an increase in production that in turn will lead to a reduction in prices until both supply and demand are in equilibrium.

Of course, a totally free and unfettered price mechanism does not exist in practice. Even in the relatively free market economies of the developed Western world there are all kinds of distortions—arising out of monopolies, government interference, and other conditions—the effect of which reduces the efficiency of price as a determinant of supply and demand. In centrally planned economies, the price mechanism may be supplanted by centralised governmental control for political and social reasons. Attempts to operate an economy without a price mechanism usually result in surpluses of unwanted goods, shortages of desired products, black markets, and slow, erratic, or no economic growth. <https://www.britannica.com/topic/price-economics>

Effects of Price controls on supply and demand of spectrum

The current pricing regime implemented by the ACMA can only be described as Government price controls, these are practically implemented in two ways;

1. **Direct Price Controls** - This is implemented through the apparatus licensing fee schedule <https://www.acma.gov.au/theACMA/About/Making-payments/Apparatus-licence-fees/apparatus-licence-fees-acma>
2. **Indirect Price Controls** - This is implemented through onerous conditions placed on the sale of spectrum licenses that restricts the ability of smaller operators to participate in auctions. These conditions include large geographic areas and long duration licenses, which in turn lead to high lot prices that are out of reach for most operators, giving monopolistic market access to a small number of operators and higher prices and reduced access to services for consumers through limited competition.

Spectrum Licensing & Effects on Supply and Demand

We need to examine how the presence of incumbent spectrum licenses assigned in wide geographic areas to large mobile network operators effects supply and demand of services in various markets.

Current Spectrum Licensing Regime			
Spectrum Resource	Spectrum Suitable for deployment of 4G / 5G Broadband Services		
License Allocation via Auction	Australia Wide Spectrum License (Granted for 10 - 15 Years)		
Spectrum Rights Mobile Network Operators	Spectrum License Holder (s)		
Geographic Areas	Metropolitan	Regional	Remote
Spectrum Utilisation MNO(s) Supply	90% Used	40% Used	10% Used
Secondary Access Seekers WISPs	Complete Restriction		
Consumer Demand (Supply / Demand / Substitution)	Demand almost equal to supply	Demand exceeds supply	Demand Significantly higher than supply

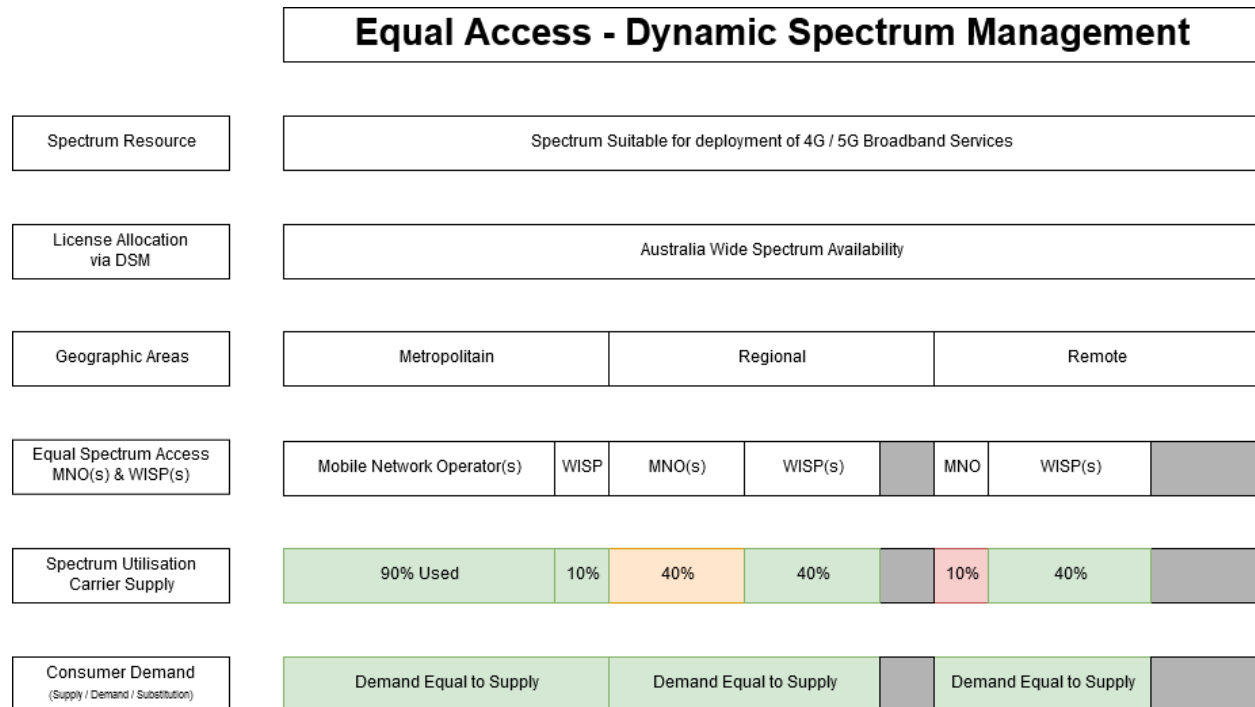
**** Note:** All figures used are for illustrative purposes only.

- **Spectrum Resources** - Demand for a particular band comes about then consumers desire a product or service, in this example 4G / 5G Mobile Broadband Services.
- **License Allocation via Auction** - Spectrum is allocated in large lots for long durations via Government Auction, in this example an Australia Wide Licenses.
- **Spectrum Rights Mobile Network Operators** - Exclusivity is granted to one operator Australia wide for a duration of 15 years.
- **Geographic Areas** - The operator intends to provide services in markets where the predicted return on investment is sufficient to make a profit, after operating expenses. The less efficient the operator, the higher the operating costs and the greater the return required to justify supplying services.
- **Spectrum Utilisation MNO(s) Supply** - The requirement for a positive Return on Investment (ROI) causes the MNO to supply services to:
 - 90% of the population in Metropolitan Areas leaving 10% of the market unserved
 - 40% of the population in Regional Areas leaving 60% of the market unserved
 - 10% of the population in Remote Areas leaving 90% of the market unserved
- **Secondary Access Seekers WISPs** - Due to the current spectrum licensing practises secondary access seekers are not able to operate, despite disused spectrum resources and unsatisfied consumer demand.
- **Consumer Demand (Supply / Demand / Substitution)**
 - **Metropolitan** - Due to the population density the ROI for an MNO will typically justify enough investment to cater for most of the demand, only a small subset of users is not catered for typically in apartment or office blocks with poor signal.
 - **Regional** - As population density diminishes the opportunities for a positive ROI too decrease, this leads to major population centres being well covered and sparsely populated regional areas largely left unserved.
 - **Remote** - These areas tend to have such low population density that MNO's will only provide services when incentivised by Government grants like the Mobile Blackspot program, where taxpayer funds allow for positive ROI's in unprofitable areas.

Equal Access Licensing & Effects on Supply and Demand

Now assume that geographic allocations are small, time durations are based on the licensee's time preference and pricing is allocated through market forces with genuine competition.

The diagram below is an illustration of equal carrier access to licenses.



- Spectrum Resources** - Demand for a particular band comes about when consumers desire a product or service, in this example 4G / 5G Mobile Broadband Services.
- License Allocation via DSA** - Licensing is allocated through a price mechanism to determine the primary user. Carriers can specify geographic area, bandwidth and license duration. This would foster a competitive bidding environment in the event of competing interests and where no competition exists the price of spectrum would be kept to a minimum, allowing for less expensive services to be delivered to consumers.
- Geographic Areas** - Geographic area definitions can be completely abolished as they would be defined by carriers through license applications and prices set by supply and demand, however for the purposes of this illustration they have been kept to show the increase in efficiency of treating all carriers as equals.
- Equal Spectrum Access MNO(s) & WISP(s)** - In this example the concept of an Australia Wide Spectrum License granted to one MNO for long durations has been dispensed with. Instead all carriers are required to bid against each other for access to spectrum in areas defined by licensees. The effect of this is most visible in Regional and Remote markets where spectrum that was previously restricted by spectrum license

conditions is now available to any operator. This will allow smaller, more operationally efficient operators, to secure spectrum on terms that allow them to achieve a positive ROI and serve consumers previously deemed unviable, improving outcomes for consumers.

- **Spectrum Utilisation Carrier Supply** - Utilisation of spectrum will increase as more operators are able to gain access to markets, this will be most visible in regional and remote areas where the supply of services is significantly lower than the demand.
- **Consumer Demand (Supply / Demand / Substitution)** - Consumer demand will be best served by a more competitive environment, allowing smaller agile operators to serve markets not deemed as viable by conventional MNO's.

Tiered Hierarchical Access

As the example above illustrates a system with three tiers is only required if the regulator preserves the existing Spectrum Licensing regime and maintains the concept of an "Incumbent user" with rights that supersede all others.

If equal access was granted to all carriers, there would only be a need for a two-tiered system, license holders and opportunistic users.

- **Spectrum Licensing Regime** - Three tiers required (Incumbent Priority, Secondary Protected, Tertiary Unprotected)
- **Equal Access Market** - Priority Access License Holder, Opportunistic User.

These elements influence when a DSA approach may make sense. Some key considerations are:

1. *Is there a viable hierarchy of spectrum users that are complementary to each other? For example, is one use/user infrequent and/or itinerant basis on one of the users in the hierarchy?*
 - 1.1. Three tiered - to accommodate existing spectrum licenses (priority access)
 - 1.2. Two tiered - that will allow for licensed access to be dynamically assigned, on the basis of use (multiple uses allowed), bandwidth (variable size), Geography (allow specific areas to be selected (including radio propagation), and duration (allow where available for short or long duration licenses (longer duration = higher cost)

Priority Access User - Protection from both Licensed and opportunistic

Licensed User - Protection from Opportunistic non-interference basis for PAL

Opportunistic - No protection

2. *How is hierarchical status determined? In other words which user is the higher tier user?*
In a two-tiered system the user with the highest priority is the one with a valid license to operate. In the event two operators require the same license this can be decided through a competitive bidding process, potentially a reverse Auction.

In a three tiered system implemented to accommodate legacy spectrum assignments the Tier 1 users would be the spectrum license holders, Tier 2 users would be secondary access seekers willing to purchase licenses and Tier 3 users are opportunistic and only permitted to operate on a non-interference basis with no protection.

3. *What rights do each tier of user have? For how long does a lower tier operator have to switch off or change their operation to permit the higher tier user access? Should there be a limit to how often and for how long a user has to 'yield' to a higher user?*

Three Tier Model

- 3.1. Tier 1 - Fully Protected from Tier 2
- 3.2. Tier 2 - No Interference to Tier 1 & Protected from Tier 3
- 3.3. Tier 3 - No Interference to Tier 1 or 2 & No Protection

Two-Tiered Model

- 3.4. Tier 1 - Fully Protected from Tier 2
- 3.5. Tier 2 - No Interference & No Protection

Authorisation to operate can be maintained through a heartbeat with an interval of say 5 minutes, meaning it would take a maximum of 5 minutes for spectrum to be vacated in the event of a higher tiered user signaling occupancy or being detected by the sensor network.

Higher tiered users should have absolute rights to use the spectrum, with no limits placed on how often lower tiered users should yield.

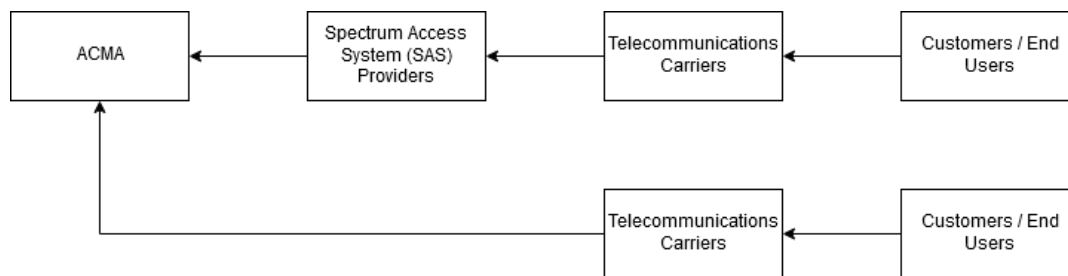
4. *How is the system made aware of actual spectrum usage? For example, different options such as spectrum sensing and geolocation reporting/databases, are available.*

A combination of spectrum sensing network and direct reporting by radio equipment on a 5 minute interval will be sufficient to maintain an accurate awareness of spectrum usage.

Spectrum Access System providers may also wish to construct a portal for manual entry in the event Tier 1 users wish to clear usage before an impending deployment.

5. *How is the feedback loop implemented? For example, different options such as direct human intervention and automated, computer access systems, are possible.*
Automated computer access systems are provided on a commercial basis by Spectrum Access System's providers (SAS). These SAS providers will be required to maintain a replicated database that keeps all participating providers records in synchronization.
6. *Who pays for the system? Governments? Regulators? Users? A third-party spectrum access broker/facilitator?*

Costs would be borne by all participants; these could be either direct or indirect costs for maintaining the system.



- **Consumers -- \$ --> Carriers:** Customers would pay for the use of spectrum indirectly through the purchase of services from the carriers.
- **Carriers -- \$ --> SAS Providers:** Carriers that utilise SAS providers could pay the SAS provider who in turn remits the funds to the ACMA
- **SAS Providers -- \$ --> ACMA:** SAS providers remit any tax collected to the ACMA on behalf of the carriers
- **Carriers -- \$ --> ACMA:** Larger carriers may wish to maintain internal compliance spectrum access systems and would therefore directly remit tax to the ACMA based on usage.
- **ACMA** - Through the use of blockchain and distributed ledger data bases the ACMA would have full visibility and be capable of cross referencing any tax collected on its behalf and verify the accuracy of all payments, similar to the Australian Taxation Office (ATO) single touch payroll system recently implemented.

System Maintenance Costs

- **ACMA** - The ACMA would be required to fund the initial construction of the database, this could be constructed in consultation with the SAS providers, they would then be required to maintain a copy of the database as well as any required reporting.
- **Spectrum Access System** - Spectrum Access System providers would be required to cover all costs associated with their operations; they would be run on a commercial for-profit basis.
- **Radio and Sensor Network** - Carriers wishing to participate in the DSM system would be required to cover all costs associated with the use of Spectrum Access System provider services as well as deploying and maintaining the sensor and radio network.

7. *Is this approach, on balance, economically viable? Costs might not be just monetary; they could also come in the form of administrative burden, reduced certainty and/or flexibility for users and reduced spectrum utility for lower tier or users. In some case a more traditional sharing model might make more sense.*

Economic viability can likely only be determined through market forces; arguments can be made both for and against. However, the true determination is the construction and implementation of the system and subsequent utilisation, assuming artificial barriers to entry are not created in the process - for example spectrum tax pricing set by Government fiat as opposed to supply and demand.

The true cost of anything is not the price paid but the alternative uses of the same resources, for example the cost of spectrum sitting idle is not the price paid by the carrier to the Government. It is the forgone opportunity cost of alternative uses the spectrum could have been put to that are not been realised. These costs by their nature are typically unquantifiable.

DSA System Considerations

Issues that need to be considered when implementing this type of approach include:

Responsibility for the development and deployment of the system

- ACMA - Develops and provides the regulatory framework including database structure, assignment rules, and reporting which can include tax payable by the Spectrum Access System Provider or Network operators.
- Spectrum Access System (SAS) Provider - develops and maintains the assignment systems in accordance with the regulatory framework, updates the assignment database which in turn synchronises with the ACMA and other SAS operators. They can also be involved in tax collection for smaller operators.

- Network Operators - As a condition of obtaining a license, network operators can be required to deploy and maintain Environmental Sensing equipment, the radio service devices deployed would register with the SAS, then request spectrum resources and maintain a heartbeat to ensure continued operation.
- Assignment Database - This database should be constructed by the ACMA and distributed via secure blockchain technology to all SAS providers.

Degree of automation or human decision making in the system

The system should be fully automated, except for manual notifications which should only be permitted by existing holders of priority access licenses through a Spectrum Access System portal.

Financial management and ongoing system support

Ongoing system support should be provided by Spectrum Access Service providers, they would be funded by carriers directly in return for provision of brokerage services.

Quality standards, to ensure priority 1 users can always be protected

SAS providers should be accredited by the ACMA to ensure quality standards are met and maintained. In the event they are not the SAS provider would risk losing accreditation and the ability to operate.

Thank you for the opportunity to respond to this paper, we sincerely hope our contributions have been valuable and encourage the ACMA to commence a trial of this type of licensing system.

Regards,

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