22 January 2016

Mr Richard Makgotlho
ICASA
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Per email: rmakgotlho@icasa.org.za

Dear Mr Makgotlho

RE: INTERNET SOLUTIONS SUBMISSION IN RESPECT OF THE DRAFT FRAMEWORK FOR DYNAMIC AND OPPORTUNISTIC SPECTRUM MANAGEMENT

Please find the attached Internet Solutions' Submission in respect of ICASAs Draft Framework for Dynamic and Opportunistic Spectrum Management 2015.

Please do not hesitate to contact the writer hereof should you have any questions.

Yours sincerely,

Zandile Gabela
Regulatory Advisor

internet solutions
A DIVISION OF DIMENSION DATA

1. Introduction

Internet Solutions welcomes the opportunity to make its written submission to ICASA in respect of the Draft Framework for Dynamic and Opportunistic Spectrum Management 2015 as published in the Gazette Number 39302 General Notice 1001 of 19 October 2015.

Internet Solutions is a division of Dimension Data Middle East & Africa, a subsidiary of Dimension Data, which is a global systems integrator. Internet Solutions is the leading African Internet Protocol-based Communications Service Provider, which strives to offer a superior client service experience for clients and partner organisations.

2. Specific Comments on the Draft Framework for Dynamic and Opportunistic Spectrum Management

Q1. Do you agree that ICASA has the appropriate legislative mandate to address the issues of dynamic and opportunistic spectrum management and TV White Spaces and to build a suitable framework? If the answer is no, please elaborate.

ICASA certainly has the mandate, even the imperative, to address dynamic and opportunistic spectrum management.

Q2. Are there any existing licensing models overlooked here?

The licensing models in general follow the somewhat archaic regime of “spectrum as property” that is bought or leased from national government. Technology has developed such that licensing and use can be substantially more flexible, with the ability to mitigate or prevent interference or other undesirable outcomes through sensing and co-ordinated use by multiple operators via autonomic systems.

Licensing can now include models based on spectrum sub-letting, sharing between primary users and secondary users,[1] and secondary users and each other (e.g. TVWS), and spectrum trading markets to allow users to buy and sell rights to use geolocated spectrum with prices driven by supply and demand,[2] as well as models to allow primary

[1] Yee Ming Chen, “Low Overhead Spectrum Allocation and Secondary Access in Cognitive Radio Networks”, Yuan Ze University; and Swastik Kumar Brahma, “Spectrum Sharing and Service Pricing in Dynamic Spectrum Access Networks”, Department of Electrical Engineering and Computer Science, University of Central Florida.
[2] Shamik Sengupta, Mainak Chatterjee and Samrat Ganguly, “An economic framework for spectrum allocation and service pricing with competitive wireless service providers”, IEEE DySpan proceedings, 2007

users that are not occupying bands efficiently to be required to give way to secondary users that pay the appropriate compensation (i.e. variants of a Coasean Bargain).[3]

Spectrum can be used at any one time as needed without affecting future availability to use that resource. Spectrum cannot be worn out through use as is the case roads, rail and other other resources. Internet Solutions submits that licensing models should be based primarily on efficiency and flexibility in use to maximise economic utility, and not exclusivity-based model oriented to ideals of business certainty and market control, as is currently the case.

Q3. Do you have any comments about these four areas of spectrum reform?

50GHz Bands: Extending license exemption in the 50GHz bands could be useful in growing use of these bands, although the high capacities make them more suitable to trunking applications such as backhaul. In this case, operator's requirement to provide service levels is a much more serious concern. As such, a light licensing regime should be adopted to ensure reliability of service.

Dynamic Spectrum Assignment: This requires urgent attention from ICASA, and the Department of Post and Telecommunications Services, as resources need to be applied to technical issues, as well as reviewing and adapting current legislation to better support spectrum sharing, reuse and trading. South Africa is in a position where it could be a global leader in driving forward a new spectrum regime that breaks with the past, and unlocks incredible economic and social benefits.

PLC: Internet Solutions has no particular view on this technology, albeit that the regulator ensures that PLC devices are not allowed to become interference vectors for wireless technologies as described in this Discussion Paper.

Q4. Do you favour making more licence exempt spectrum available in the 5GHz band?

Internet Solutions has a substantial and growing business providing WiFi services to consumer and enterprise customers. WiFi has also become the de facto standard for LAN connectivity in many small, medium and large enterprises. As described in this Discussion Paper, WiFi has been a "runaway success." As such, allocating additional bands would allow this success story to continue.

[3] Timothy K. Forde & Linda E. Doyle, "Exclusivity, Externalities & Easements: Dynamic Spectrum Access and Coasean Bargaining", Trinity College, University of Dublin

Q5. And in any other bands? Be specific, please, and support your recommendations.

No comment.

Q6. Do you believe that the Dynamic Spectrum Assignment approach is viable and worthwhile?

Based on a number of physical trials, not the least of which is the CSIR/Meraka trial in Cape Town (aka the "Google Trial"),[4] as well as a solid rational basis, Dynamic Spectrum Assignment is not only worthwhile, and it is a necessary requirement for efficient and effective use of spectrum in the future.

Q7. Do we have enough data about the TV broadcast transmitters to be able to model their propagation accurately?

One can assume with a fair amount of certainty that there is sufficient information about the technical parameters of the television broadcast transmitters to model propagation accurately, as there is a single operator (Sentech), which has strong technical skills. The environment is also fairly static. The techniques used for propagation modelling have proven themselves adequate, especially point-to-point Irregular Terrain Models (Longley Rice), as seen in the CSIR/Meraka Cape Town trial.[5]

However, the "open loop" nature of propagation models does not address issues around misconfiguration of equipment, human error, malicious activity or the ability to manage multiple operators. For this reason, Internet Solutions suggests examining more closely a sensor-based system that "closes the loop" on the WSDB technology that has seen so much development.

For much of the development of White Space technology, spectrum sensing has been seen as not yet being at a technical level or a practical cost point to make it integral to a framework for spectrum sharing. This view is no longer the case. A relatively modest R&D project by Internet Solutions in Johannesburg to build spectrum sensing devices with an automated back end indicates that "real time, highly distributed spectrum sensing and management" is not only very feasible, it will become a practical approach within 24 months.

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[4] Ntsibane Ntlatlape, Cape Town TVWS trial: Technical Monitoring and Evaluation Report, CSIR – CAM Networks and Media, 2013

[5] N Ntlatlape, S Song, J Carlson, A Hart, F Sibanda, J King "Suggested Technical Rules and Regulations for the Use of TVWS and Managed Access Spectrum, 2013

Internet Solutions would be delighted to share details of this project, but in short:

- Using off the shelf hardware (low cost Linux computer, consumer grade software defined radio (SDR), GPS, GPRS modem and additional IO functionality) a secure, powerful, reliable and accurate Spectrum Sensing Module (SSM) can be built for $70 per unit. This could easily be bought down to $40-$50 per unit with additional single-board component integration and volume pricing.
- A back end system that can manage the SSMs, as well as ingest and process data from them at large scale (thousands of devices) to provide real-time spectrum utilization information, both in terms of raw data (field strength) and with intelligent classification (using fingerprinting algorithm to classify common transmission types).
- A simple workflow engine to demonstrate autonomic and real-time management of channels and to identify and action processes in the case of exceptions or anomalous use.

Much work has been done in sensor-aided cognitive radio networks. The SENDORA project funded by the European Union is one such project.[6] Sensing is returning to mainstream investigation in academia and commercial research, as exemplified by the recent rejuvenation of the IEEE 802.22.3 working group (Spectrum Characterization and Occupancy Sensing (SCOS))[7]. Internet Solutions is contributing to this working group.

Q8. Does enabling the operation of TVWS contribute to the objective of ensuring efficient use of radio frequency spectrum?

The operation of TVWS is a good first step, and is necessary. However, it is not sufficient to address the imperative to allocate and assign spectrum more efficiently. TVWS is merely the easiest case to address, as in South Africa, there is a single national TV signal distributor, and TV transmission and transmitters are known.

Putting in place a regulatory regime that takes the concept of Dynamic Spectrum Access (i.e. multiple opportunistic users of particular channels) as a departure point will allow vast amounts of other spectrum that is currently poorly utilised to be unlocked.

[6] Pal Grønsund, Ole Grøndalen, “Performance of a Sensor Network Aided Cognitive Radio System”, University of Oslo
[7] https://standards.ieee.org/develop/project/802.22.3.html

Q9. Do you believe that it will also further objectives of encouraging investment and innovation in the electronic communications sector?

This is a reasonable assumption.

Q10. What are the benefits that could be expected from making TVWS available?

First, it will be the availability of spectrum to allow lower cost rollout of broadband access in under-serviced and developed areas. Second, it will create a dramatically more competitive landscape in telecoms services.

Q11. What are the disadvantages that could be expected from making TVWS available?

There are no significant disadvantages, either because none exist, or possible disadvantages can be mitigated (e.g. interference with primary users).

Q12. Do you foresee any risks?

There are four fundamental barriers to spectrum sharing: poor actual usage information, market reluctance, technology challenges and regulatory barriers. Regulatory barriers are discussed in other sections of this submission, and must be addressed as a prerequisite to any other impediment.

The first barrier mentioned above – poor information on actual spectrum usage – is the most significant risk factor.

Currently, actual spectrum usage data is gathered in three ways:

- Inferred from national radio plans, and the nature and location of the transmitters used by the respective license holders. In some cases actual usage is given more specificity through the use of propagation models (e.g. WSDB), or more generally, spectrum is assumed "in use" because of national or regional exclusivity conferred by a particular license.
- Spectrum audits, usually done by a national regulator. These can be periodically scheduled, or reactively when there is an interference complaint by a licensee.
- By base stations and CPE devices as part of their technical implementation. This information is generally held by the operator of the network equipment, and is not shared with other operators or the regulator.

Without accurate and current knowledge of actual spectrum usage (rather than assigned rights, or expected usage), occupancy cannot be reliably known in real time or in near-real time.

Q13. Does it support SA Connect goals regarding the deployment and adoption of broadband?

It does.

Q14. What mechanisms should be put in place for dynamic spectrum assignment in meeting future demand for spectrum?

Considerable work has been done on efficient, fair or most profitable spectrum sharing models where Secondary Users can opportunistically take advantage of spectrum for short periods. In most cases, the underlying thinking is that spectrum opportunities would generally be localised (i.e. within footprint of a single base station) and assigned over short periods of hours, days or perhaps weeks.

The current pilots of TVWS networks have been single vendor, single operator, and have as a basis assumption that the WSDB is operating correctly (with correct information on transmitters). This is a somewhat unrealistic view, assuming that the radio environment is ideal. It does not take into account human or technology errors, mis-configuration of equipment, malicious actions (e.g. deliberate interference, etc.) or inter-operator conflict.

Also, the work done in TVWS pilots typically does not address how, irrespective of the method used to allocate channels, administration would practically be done, given the ideal assignment timeframes of minutes (which would allow high levels of opportunistic use).

It is important at this early stage of Dynamic Spectrum Access technology development that coordination and management strategies and tools must be developed in tandem with radio technology and regulatory strategy.

Unless spectrum administration and management is done programmatically by intelligent systems in near real-time (i.e. at least minutes or hours), the enormous promise that Dynamic Spectrum Access has to solve the spectrum scarcity issue are largely obviated. Modern networks need to be able to spin up or release capacity rapidly, on demand, in minutes or hours, with some level of service assurance.

In particular, DSA administration and management tools need to address the two fundamental elements of effective regulation: *ex ante* enforcement (attempting to prevent interference) which requires effective channel allocation, re-allocation and smart scheduling, as well as *ex post* regulation (remediation after the fact) which requires proof of negligent or malicious activity – what kind of interference happened, when and where – and if possible, the nature of the interfering signals.

Further, the *locus of adjudication* question is a critical. The adjudicator must be trusted by primary and secondary users, and must have jurisdiction to adjudicate interference events. This requires that the regulatory framework be updated, but also that a new class of data gathering and administration tools can be bought to bear.

Q15. Could TVWS provide increased consumer value and/or improved social and economic inclusion?

An enormous amount of research has shown that reducing cost of broadband and increasing availability of broadband has clear and measurable impacts on consumer value (market competitiveness) and economic inclusion.

Q16. What impact is the digital switchover expected to have on the use and availability of TVWS?

There is no direct impact. As with digital switchover, old analogue TV bands are to be released. According to the ICASA roadmap of IMT use in 700 and 800MHz,[8] old analogue TV bands would no longer be available to TVWS use. As such, the planned use of TVWS technology in the DTT bands would continue to be pursued.

Q17. Do you believe white spaces should be utilised without authorisation or licensing?

While Wi-Fi has demonstrated that bands can be used with little or no regulation, it could be regarded as a special case, in that the technology is homogenous (IEEE 802.11 standards). This means that its Carrier Sense/Collision Avoidance systems work well, even with little or no coordination of users.

This is largely due to historical reasons on the basis that the technology was widely adopted because it was technically effective and had wide vendor buy-in to implement it in user devices. There was a perfect storm of factors. It was the right technology, at the right time, when no other viable contenders were present.

In the case of white spaces, this happy set of circumstances may not exist, and a variety of standards may develop with the additional rider that some technologies will be more suitable to certain frequencies, or certain use cases, e.g. broadband/Internet access vs narrowband/IoT use. The very nature of White Space devices is that there is coordination

[8] ICASA, Draft IMT Radio Frequency Spectrum Assignment Plan, 2014

of use, which makes the ability to effect authorisation or licensing a consequence of the technology. If done correctly, this ability to coordinate (as well as police) usage is very desirable.

Q18. Should there be rules for such usage?

Several international examples of “ultra-light” regulation exist where the regulation comes down to a simple rule: “no interference with Primary User, Secondary Users have no recourse”. This is probably overly simplistic, as it opens the door to any number of unwanted behaviours, from malicious activity (blocking access to other secondary users by “squatting” on channels) to carelessly configured equipment.

At the least, light regulation can be done in terms of maximum transmit power, Primary and Secondary Users only transmitting when there is actual data to move (i.e. not holding a channel by transmitting empty traffic). This last point is important to address through regulatory intervention (e.g. charging licence fees per time use to disincentivise operators “squatting” on channels), but also through technical means such as advanced statistical techniques[9] to identify actual occupancy of highly-modulated transmission types, which may appear to be in use because of noisy protocols, such as 3G mobile. These techniques can identify actual occupancy without demodulating transmissions, which may fall afoul of a primary user’s licence rights.

Q19. Does the advent of TVWS have the potential to remove the existing “spectrum scarcity”, at least in some bands?

It does, by the simple expedient of increasing available spectrum for use by telecommunications operators.

Q21. Is there a space for license-exempt, unmanaged use of TVWS?
Q22. Is there a space for license-exempt, managed use of TVWS?
Q23. Is there a space for licensed use of TVWS?

All three regimes have viable use cases, and would depend on where they would be used, and how. In a rural area with few potential operators, license-exempt, unmanaged use would be viable. In higher contention areas, license-exempt, managed use would be preferable, and so on. Hence, it would be critical that these options are catered for in any regulatory changes which allow TVWS, as it is likely that usage patterns or usage consequences would only become known over time.

[9] S.D. Barnes, B.T. Maharaj, Prediction based channel allocation performance for cognitive radio, University of Pretoria 2013

Q24. If so, should licensed users pay the minimum annual fee, or a fee proportionate to use?

It would be preferable that users pay a fee proportionate to use to disincentivise "spectrum squatting" by a particular operator.

Q25. Does the combination give us the best of both worlds?
Q26. Which of the licensing regimes do you favour? Why?
Q27. Rank the licensing regimes in order of preference with reasons for your preferred order.
Q28. Do you see this as possible? Why / why not?

Q25. License-exempt, managed use.

Q26. Suggested model: licensed use, paid for on-demand via online market, autonomically provisioned.

Q27. License-exempt, unmanaged use.

Q28. Licensed use

Note that our suggested model in response to Q26 is licensed use, but paid via an online market to reduce friction. Licensed use unless carefully designed would create undesirable barriers to entry, both in terms of costs to start-up operators, as well as administration overhead. If the fundamental objective is for a Dynamic Spectrum Assignment regime to drive the principles of SA Connect, licensing could obviate the benefits of opening spectrum for secondary use.

At the same time, the paying of licence fees (however small) can create a rational market where the value of utilisation of spectrum is recognised, allowing a balance to be struck between supply and demand, and reducing "tragedy of the commons" types of abuse (e.g. 'spectrum squatting').

Whether or not spectrum should be licensed, it should be at least managed. Ad hoc and on-demand management used to be impossible in a granular or case-by-case basis because of technology limits and administrative challenges in the past. Hence, exclusive national or regional licenses. With modern sensing and management systems, light management actually becomes a consequence of the technology needed to assign channels in a DSA system.

Q29. Does this provide a significant improvement on the status quo?

It does, as licence fees (utilisation fees) can then be driven by market forces, or light regulatory intervention to find the most economically efficient balance.

Q30. If some form of this approach is adopted, how should TVWS databases and TVWS database service providers be managed?

It is important at this early stage of Dynamic Spectrum Access technology development that coordination and management strategies and tools must be developed in tandem with radio technology and regulatory strategy. The most important part of this is that TVWS databases should be closed loop – i.e. that sensing is used to validate propagation models and detect anomalous use of spectrum. Further, the allocation of channels should be done through automated systems.

The key to an operationally viable DSA network is what we describe as a "White Space Management Engine" (WSME), the back end that allows automation of time-critical administration and management activities.

The requirements include:

- Verifying WSDB assignments against actual channel usage through mass-deployment of spectrum sensing devices.
- Design of these sensing devices to identify the nature of channel allocation errors or collisions and communicate reliably and securely to a back end system for trouble-shooting or regulator intervention.
- Intelligent back end that interprets sensing information and applies a set of rules to trigger automatic processes to identify administration errors, technology failures or misconfiguration, or malicious activity.
- Definition of major processes and the interface requirements to allow this management system to interact with authoritative and regulator-certified spectrum databases, and with the operational systems of any relevant network operators.

Q31. From a South African perspective what will be the socio-economic benefits of TVWS?
Q32. Will TVWS be of the most benefit to rural or urban areas? Please provide reasons – technical and socio-economic

The benefits of improved access to telecommunications technologies by all sectors of society have been widely studied.

Q33. Please provide proposals on the regulatory framework (including none at all) for TVWS.
Q34. What are the advantages and disadvantages of different methods?

This is addressed in response to Q23-28.

Q35. How should South Africa define TVWS?

The definition is inherent to the technology – the utilisation of unused channels in the TV broadcast range, whether by geographical location, by time-based sharing or by noise-floor underlay.

Q36. How will the rules for non-compliance apply?

Non-compliance can easily be enforced by remotely disabling a White Space transmitter since White Space devices need to get assigned channels by a central database.

Q42. What additional measurements should be adopted for greater accuracy?
Q43. Should the Authority allow – or require - sensing as an option at this time?

Sensing should be a key part of any DSA strategy. Sensing technology used to be extremely expensive, difficult to sense and monitor spectrum usage in real time, and over enough sample points to be useful for anything other than attempts to monitor compliance in the case of complaints.

Technology has developed quickly, and it is now possible to sense spectrum usage cheaply and accurately. Internet Solutions has developed prototype devices that can accurately and reliably sweep sub-GHz bands, do quite advanced processing, and communicate findings to a powerful back-end visualisation, analytics and workflow-capable back end. Devices can currently be built for less than $70 each, and potentially $30-$40 at scale.

It is our belief that a new era of wireless communications is dawning, where spectrum resources are used extremely efficiently by combining White Space Database (WSDB) type occupancy prediction techniques with a White Space Management Engine (WSME) that uses a combination of highly distributed, real-time sensing and intelligent autonomic systems for "on demand", responsive channel assignment and management.

Without investing resources into developing these real-time autonomic systems, efficiency of spectrum use through sharing may see an increase, but will not bring a radical improvement through addressing the underlying spectrum regime, which is based on turn-of the century "spectrum as property" regulation.

Q44. What mechanisms should be put in place to ensure that database providers obtain information required to protect incumbent operations (e.g. location of TV transmitters)?

Currently, there is an emphasis on spectrum utilization information in the footprint of signal distributor radio transmitters. More importantly, the focus should be on spectrum occupancy at CPE locations where interference is actually the problem. The radio environment at both network operator and service customer need to be known, otherwise hidden node/exposed node problems will not be addressed, where interference affects the CPE.

Q45. What mechanisms should be put in place to ensure that broadcasters and/or signal distributors provide the Authority and database operators with accurate updated information?

This is an administrative issue that can be dealt with through existing mechanisms.

Q46. What parameters should the Authority set forth for TVWS databases?

- Band characteristic: band harmonization information, power/propagation characteristics to inform geographic separation.
- Use characteristics: defined for Primary and Secondary Users in terms of allowed transmit power, geographic coverage, transmit time information, minimum receive noise floor (e.g. white space underlay sharing), nature of user (e.g. for emergency services or disaster management).

Other parameters and technical requirements have been widely studied, and a comprehensive view can be found in reference 6 on page 2 of this submission.

Q47. What criteria should be used to certify, recognise, or authorise TVWS databases?

Criteria here would relate to:

- Technical capability;
- Internal processes that are transparent and auditable; and
- Track record in providing related services.

Q48. How should the Authority approach issues such as non-discrimination, security, and quality of service?

Non-discrimination

A great deal of the concerns around non-discrimination could be addressed by making the assignment of channels, and the fees paid per usage, transparent and autonomic, set by rules-based systems informed by supply and demand. The fees should be set at a basic rate, increasing as demand increases.

Security considerations

It is useful to consider two types of adversaries in a security model – those having the same technical capabilities as the benign secondary users (bad players); and those with extraordinary technical capability, such as massive transmit powers and physical modification (so called “aggressive interloper”).[10]

The following “good player” rules are assumed:

- Secondary Users do not to intentionally create unacceptable interference to licensed primary users;
- Secondary Users not to prevent other secondary users from using available bands, for either selfish or malicious objectives; and
- Secondary Users disseminate correct state information timeously to regulator and other Secondary Users management systems.

Attacks by “bad players” can be categorised into three major groups:

1) Jamming of the Control Channels;
2) Primary (or Secondary) user emulation attack; and
3) Byzantine attacks (modification/fabrication).

Whatever the “bad player” mechanism, these attacks would play out in the following ways:

a) Attacks on Spectrum Sensing and Sharing where the attacker transmits into open channels, or spoofs Secondary Users and causes interference.
b) Attacks on Spectrum Mobility by interfering with handoff process as a radio moves from one channel to another.
c) Attacks on Spectrum Management by falsifying spectrum use information to WSDB systems.
d) Attacks against the Learning Engine by direct interference with or tampering with management systems.

Most of these attacks can be addressed through standard network security techniques (digital signing, transmission encryption, etc.) that protect transmissions between elements.

In the case of an “aggressive interloper”, a WSDB with sensing capability could pick up exceptional activity, such as massive amounts of transmission activity, or radio/sensing nodes not responding correctly.

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[10] Saman T. Zargar, Martin B. H. Weiss, Carlos E. Caicedo, “Security in Dynamic Spectrum Access Systems: A Survey”, University of Pittsburgh, 2009 (submitted)

Quality of Service

If an autonomic system is used for channel management based on sensing devices and an intelligent management platform, some of these security issues can be addressed by applying several information sets to be able to isolate and give weighting to possible security incidents.

At a basic level, it applies trust metrics to sensing devices, based on:

- Class of device (as per SSM sensing data definitions).
- Age of device (how long has it been giving reliable information).
- Corroboration of sensing information from any nearby devices.
- expected channel occupancy based on historical data, and from authoritative WSDB

With the expectation that a White Space environment would be somewhat co-ordinated (i.e. managed by a national regulatory authority, or White Space network operators sharing sensing and usage information), the back end spectrum management engine would also compare actual usage against expected usage by other operators/users. Where these deviate, an exception would be thrown to alert the operator's support team, and/or the enforcement section of the national regulator.

Q49. Should the Authority require the registration of some or all devices? If only some, which devices?

Since Base Stations would require registering with a WSDB to be allowed to use assigned channels, registration with the Authority would be desirable to ensure the WSDB base station behaved as required (or at least, if it did not, that the Authority would know who was operating it to have recourse).

Q50. Should mobile devices be obliged to have geolocation determination capability? How should the regulatory framework differentiate among devices types?

Q51. What rules should be attached to each type of device?
Q52. Should operating parameters differ by device type or technology?
Q53. Should transmit power levels be different for different device types?

Transmit power levels for mobile devices would certainly need to be managed differently to static devices, which could be fitted with directional antenna to reduce probability of interference with other users.

It is desirable that transmitter/receiver pairs be able to negotiate a suitable power level, similar to that of WiFi's automatic power control (Auto-RF). This ensures that only minimum necessary radio activity is created, as a pre-emptive measure against RF pollution as network activity and contention grows[11].

Q54. Should the Authority consider a variable power limit which could increase the utility of spectrum for devices?

This should absolutely be the case, as the fundamental requirement is to have effective data communications that do not interfere with other/Primary Users. As long as there is no interference, power limits should be set at whatever is technically optimum.

Q55. Should there be a maximum power output and what maximum power level should the Authority consider?

The maximum power level would be case dependant (e.g. rural or urban use, possibility of interference, etc.).

Q56. Should licensed devices be allowed a higher power limit than licence-exempt devices?

This would be a reasonable rule as mitigating interference can be done on a case by case basis, where a licensed device operator could be required to reduce output power or lose their licence.

Q57. Recognising that allowing adjacent channel use would significantly improve spectrum utilisation and increase the amount of spectrum available for use by TVWS devices, should the Authority permit TVWS devices to operate in channels adjacent to incumbent operations? Please substantiate

Yes, if they do not cause interference.

Q58. Are there any substantiated concerns regarding harmful interference associated with adjacent channel operation?

This would be difficult to predict until there is a greater deployment of devices.

Q59. Should the Authority establish out of band emissions limits in order to improve spectral efficiency? If so, what are your recommendations to protect incumbent operators? What out-of-band emissions rules will best improve spectral efficiency and protect incumbent operations?

Internet Solutions does not have a view on this yet.

Q60. Should the Authority mandate a particular propagation model for database providers?

Propagation model should be chosen based on real world effectiveness only (i.e. accuracy of prediction).

[11] M McHenry, D Roberson, Robert J, “Electronic Noise Is Drowning Out the Internet of Things”, IEEE Spectrum 2015

Q61. Which propagation model or models are most accurate for this application?

So far point-to-point terrain based models, specifically Longley-Rice, has proven effective, but other models by supersede it.

Q62. Which model or models maximise spectral efficiency?

Internet Solutions does not have a view on this yet.

Q63. Which models best protect incumbent operations?

Internet Solutions does not have a view on this yet.

Q64. Overall, what is the appropriate method of determining the required protection from authorised users in the TV bands?

Internet Solutions does not have a view on this yet.

Q65. On balance, do the potential benefits of permitting licence-exempt managed assignment TVWS devices outweigh any potential risks?

This question is impossible to answer as real world utilisation and user/operator behaviour is still largely unknown.

Q66. Do the techniques discussed above adequately mitigate any interference potential?

Currently, the approach to prevent Primary User interference is to focus on detecting or modelling for primary transmitters. This approach, however, is conservative, potentially leading to overlooked opportunities. Low-cost sensors, deployed close to primary receivers, allows for efficient secondary user spectrum opportunity detection.

In conjunction with a White Space management platform, they also allow for coordination between multiple secondary users, reducing collisions and hence improving end user experience. Real-time sensing and radio device provisioning can therefore lead to on-demand radio use in conjunction with on-demand spectrum assignment, where small licence fees reduce the possibility of “spectrum squatting”.

How many sensing devices are needed is a key question if a mass, national deployment is envisaged. In this project, we assume that mobile phone base stations are a good analogue of both human telecommunications activity and population density. With this in mind, if one counts the operators base stations from 2014 annual reports and media reports: Vodacom 14,000 (4,000 shared), MTN 12,000, Cell 4,100 Telkom Mobile 2,500. Sentech (national signal distributor) has 627 TV plus 742 radio transmitters.

This gives around 28,000 sites in a country the size of South Africa – a realistic upper limit for the number of spectrum sensing modules that would need to be deployed for a very high percentage of radio-using areas. This would translate into a total cost of $1.12-million for devices only – an eminently reasonable figure for a national regulator to budget for, considering the revenues possible if a secondary market for spectrum was implemented.

Q67. Should we oblige every device to have GPS location capability?

Certainly every base station should have GPS location capability, as well as any sensing-only device. CPE devices would only usefully need GPS location capability of they had sensing functionality (e.g. in IEEE 802.20)

Q68. In the US model, only latitude and longitude was required of GPS location. Is there any reason why we shouldn't demand full 3D location?

Full 3D location is desirable as radio propagation is fundamentally dependant on terrain characteristics.

Q69. What about the situation where a fixed device is professionally installed with an external antenna and an internal unit. Should we accept the location details provided by the installer? Using what mechanism?

This is certainly a viable option that extends the ability of the Authority to gather good data without needing additional internal resources. The licensing of professional installers would allow a trust relationship.

Q70. Do you believe that Dynamic Spectrum Assignment should be applied to other bands, beyond the proposed TVWS operation? Please provide reasons?

Dynamic Spectrum Assignment should absolutely be applied to other bands, beyond the proposed TVWS operation. As noted before, TVWS is the easiest case for application of DSA. There are numerous other bands, both sub-GHz and in higher bands that are very inefficiently utilised. Many of these are historical assignments, such as for radio astronomy, meteorology, and municipal radio links.

If one examines this waterfall of sensing data gathered in North Riding, Johannesburg in November 2015 (using one of IS' prototype sensing devices), it is clear that large amounts of spectrum are barely used at all.

Q71. If so, which bands should be considered next?

Earth-satellite links are almost by definition geolocation dependant, and are likely bands for secondary use. These include bands in 1.4-1.6GHz. There is possible opportunistic use of bands in 400MHZ, 850MHz that are currently assigned for local government links and up for reassignment in the draft IMT radio plan.

Q72. Are the study questions above the most relevant?

Yes.

Q73. Are there additional study questions that you would propose?

None.

Q74. Are there any additional devices or services in the 470-698 MHz UHF DTT band that should be considered in authorising use of TVWS?

Internet Solutions does not have a view on this yet.

3. Conclusion

Finally, we would like to thank ICASA for the opportunity to make our written submission on the Draft Framework for Dynamic and Opportunistic Spectrum Management. Internet Solutions would appreciate an opportunity to make an oral presentation in respect of this inquiry.