22 January 2016

Independent Communications Authority of South Africa

Pinmill Farm

Sandton

Attention:

Mr Manyaapelo Richard Makgotlho

E-mail: rmakgotlho@icasa.org.za

Re: Discussion Paper on the Framework for Dynamic and Opportunistic Spectrum Management

Dear Mr Makgotlho

Google Inc. (Pty) Ltd ("Google") has noted the publication by ICASA of the Discussion Paper on the Framework for Dynamic and Opportunistic Spectrum Management 2015 for consultation in terms of sections 2 (c) (d), (e), (i) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act and section 4B of the Independent Communications Authority of South Africa.

In response to ICASA's invitation to comment, please find attached Google's submissions on the Discussion Paper.

Respectfully submitted,

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Introductory remarks

Google welcomes the publication of the Discussion Paper as an important first step in implementing the use of dynamic spectrum sharing and expanding access to television white spaces (TVWS) in South Africa. As ICASA is aware, Google was one of the partners in the Cape Town TVWS Trial[1], and we are delighted that the outcomes of that Trial have assisted ICASA in initiating a rulemaking process.

In order to maximise use of TVWS spectrum, unlock its potential to connect the unconnected, and foster innovation in TV band devices, ICASA should adopt a licence-exempt, managed framework for the use of TVWS. This approach is consistent with the frameworks adopted to date in all other jurisdictions: each of the four countries that has adopted rules authorising the use of television white spaces has done so on a licence-exempt basis.[2]

Regulators in each of these countries recognised that licence-exempt access to spectrum contributes billions to the global economy, and that expanding that access will drive further economic growth.[3] For example, in South Africa technologies like Wi-Fi are expanding and improving access to broadband through municipal and private Wi-Fi networks, while saving mobile network operators billions of Rands in network deployment costs. Enabling access to TVWS will allow South Africans to take advantage of a new generation of licence-exempt technologies.

Because dynamic spectrum access has tremendous potential to help close the digital divide, Google has taken an active interest in TVWS and dynamic sharing initiatives around the world. In support of its engagement on these issues, Google participates in the Dynamic Spectrum Alliance (DSA). The group has developed a set of model rules for the use of TVWS ("**DSA Model Rules**") that are based on existing regulatory frameworks in other jurisdictions and industry best practices.[4] These rules represent a balanced framework that maximises opportunistic use of TVWS while protecting incumbent users from harmful interference, and Google refers to them in greater detail below.

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1 See www.tenet.ac.za/tvws for further information.

2 See Unlicensed Operation in the TV Broadcast Bands, ET Docket No. 04-186; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, ET Docket No. 02-380, Second Memorandum Opinion and Order, 25 FCC Rcd 18661 (2010); Industry Canada, Framework for the Use of Certain Non-Broadcasting Applications in the Television Broadcasting Bands Below 698 MHz (2012), available at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10493.html; Press Release, Industry Canada, Enhancing Wi-Fi Services in Rural Communities (Feb. 15, 2015), available at http://news.gc.ca/web/article-en.do?nid=928659; Infocomm Development Authority of Singapore, Regulatory Framework For TV White Space Operations In The VHF/UHF Bands (2014), available at http://www.ida.gov.sg/~/media/Files/PCDG/Consultations/20130617_whitespace/ExplanatoryMemo.pdf; Ofcom, Implementing TV White Spaces (2015), available at http://stakeholders.ofcom.org.uk/binaries/consultations/white-space-coexistence/statement/tvws-statement.pdf.

3 See the list of studies cited in Thanki, R. The Role of TV White Space Technology in Achieving Broadband Connectivity in South Africa [Thanki (2015)], para. 2.3.2, pp. 13-14.

4 Suggested Technical Rules and Regulations for the Use of Television White Spaces, http://www.dynamicspectrumalliance.org/assets/submissions/Suggested%20Technical%20Rules%20and%20Regulations%20for%20the%20use%20of%20TVWS.pdf.

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.***

Google agrees with the legislative and regulatory analysis set out in section 3 of the Discussion Paper and with the conclusion that ICASA has the appropriate and required legislative mandate both to address the issues raised in the Discussion Paper as well as to implement a dynamic and opportunistic spectrum management framework.

Moreover, ICASA has specifically recognised the importance of establishing "innovative approaches to technology and dynamic spectrum usage"[5] as Strategic Outcome-Oriented Goal 3 in its Strategic Plan for the fiscal years 2015-2019 and Annual Performance Plan for the fiscal year 2014-2015:

SOOG 3	**Promote efficient use of spectrum resources**
Goal statement	ICASA will develop radio frequency spectrum frameworks that support the efficient use of the spectrum for a variety of services, including broadband.
SO3.1	Establish innovative approaches to technology and dynamic radio frequency spectrum usage.

In the Plan, ICASA notes that:

The Authority is mandated to ensure the efficient management of the radio frequency spectrum resource. Rapid technological change in the ICT sector has led to the development of many new and experimental techniques in the use of the radio frequency spectrum to provide traditional connectivity services such as voice and data. These technologies may recommend new regulatory approaches to the licensing of the radio frequency spectrum.

Through this goal, the Authority will be able to introduce new licensing rules that best suit the technological capabilities of the ICT sector.

To achieve this goal, the barrier to technological innovation and introduction of secondary markets can be overcome through continuing to collaborate with research institutions to ensure delivery on agreed research topics and themes in support of ICASA priorities.[6]

5 ICASA Strategic Plan for the fiscal years 2015-2019 and Annual Performance Plan for the fiscal year 2014-2015, p22-23.
6 ibid.

In addition, the International Telecommunication Union's (ITU) rules make it clear that no ITU action is necessary to enable the use of TVWS on an opportunistic basis.[7] If they so choose, ITU Member States can pursue such policies consistent with the Radio Regulations and without waiting for further international guidance or study. Francois Rancy, the Director of the ITU's Radiocommunication Bureau, has observed that authorising dynamic spectrum access, including access to white spaces, is "essentially in the hands of national regulators in each country".[8]

Q2. Are there any existing licensing models overlooked here?

Paragraph 3.3.1 of the Discussion Paper captures all spectrum management licensing models currently used in South Africa.

Google also supports ICASA's proposal to adopt a new self-coordinated light-licensing framework for the use of the spectrum between 71 and 76 GHz and between 81 and 86 GHz (the E Band).[9] While light licensing may not provide the best framework for authorising use of TVWS, it is an important tool in enabling shared access in other bands.

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

Google supports a number of ICASA's initiatives to improve spectrum management and expand access to spectrum. Specifically, Google supports ICASA's proposal to adopt rules for the use of the E Band and V Band (57-66 GHz). As noted above, ICASA should adopt a light-licensing framework for the E Band.[10] The V Band, by contrast, is well-suited to licence-exempt use.[11]

Google also supports ICASA's efforts to make more spectrum available for licence-exempt use in the 5 GHz band and elsewhere, as discussed further below. More generally, making additional spectrum available for licence-exempt use at high, medium and low frequencies should be a priority. Enabling access to TVWS and expanding access to the 5 GHz band are both useful first steps toward achieving this goal.

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

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7 See Radio Regulations art. 4.4 (2012) (recognising that secondary and/or opportunistic use is permitted so long as such uses do not cause harmful interference to the primary user), available at https://www.itu.int/pub/R-REG-RR.

8 Keynote speech delivered at the ITU Radiocommunication Seminar for Arab Countries, RRS13-Arab Tunis, Tunisia on December 13, 2013.

9 Google Inc. Submission on the Discussion Document Regarding the Use and Licensing of the Band 57-66 GHz and the Band 71-76 GHz Paired with the Band 81-86 GHz (E Band) (collectively the "V and E Bands"), submitted to the Authority on 25 November 2015.

10 id., para. 1(a) in which Google submits that the Authority should consider pursuing light licensing for the full 10 GHz of spectrum from 71 to 76 GHz and 81 to 86 GHz.

11 id. para. 2.

Yes. Google supports efforts to make 700 contiguous MHz of spectrum – ranging from 5 150 to 5 850 MHz[12] – available on a licence-exempt basis for the provision of wireless access services and radio local area networks, subject to protection of existing users. Additional 5 GHz allocations, with large blocks of available spectrum, offer particular potential for high-capacity, short-range and long-range connections that will help to meet consumer demand for data-intensive services.

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

Google supports a balanced spectrum policy that provides robust access for both licensed and unlicensed uses of spectrum in high, medium, and low frequency bands. At this time, adding licence-exempt access in the 5 GHz and TV broadcast bands is an appropriate priority for ICASA to pursue.

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

Yes. See additional discussion below. Google's answers to Questions 7, 12, 16, 30, 36, 39, 41, 44, 48, 57, 58, 61 and 63 address the feasibility of adopting a dynamic sharing approach. The answers to Questions 8, 9, 10, 13, 15, 26 and 32 highlight the benefits of doing so.

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

Yes. The Cape Town TVWS Trial demonstrated that available information regarding both broadcast television operations and terrain in the vicinity of transmitters, when used with a standard terrain-based, point-to-point propagation model, enabled effective protection of broadcast operations. Cape Town was specifically selected as a trial venue because it has the most intensive broadcast spectrum use in South Africa, complex topography and a representative mix of population densities. ICASA also will be able to draw on experience with TVWS deployments in the United States and United Kingdom and associated research by the Federal Communications Commission and Ofcom.

12 Noting that this can potentially be expanded to 5 925 MHz taking into account the resolution made at the World Radiocommunication Conference 2015 to authorise studies concerning Wireless Access Systems including radio local area networks in the frequency bands between 5 150 MHz and 5 925 MHz: (RESOLUTION COM6/22 (WRC-15)) available at http://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.11-2015-PDF-E.pdf pp430-433.

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

Yes. By authorising use of spectrum that is otherwise lying fallow, enabling the operation of TV band devices unquestionably improves spectrum utilisation. This was a clear learning from the Cape Town TVWS Trial. The principle has also been established through a number of trials, pilots and commercials deployments around the world.[13]

Within the South African electronic communications industry, there is widespread support for the expansion of spectrum sharing strategies:

Telkom: *[W]here appropriate, and supported by a fully-functioning spectrum regulator (i.e. with up to date spectrum databases and the ability to manage interference issues), Telkom supports the concept of spectrum sharing between primary and secondary users.*[14]

MTN: *The current processes used to allocate and monitor spectrum usage, both within South Africa and throughout the world, can result in poor utilisation of significant portions of the spectrum, especially when that utilisation is measured across a large geographical area.*

Dynamic spectrum management (DSM) would offer the Authority the means to efficiently allocate spectrum within a given geographic area, while ensuring that the spectrum is actually used within that area.[15]

South African Broadcasting Corporation (SABC): *The availability of TV White Spaces (TVWS) technology is an opportunity for broadcasters to meet the demands of converged platforms. The technology could be exploited for better delivery of universal service at an affordable connectivity rate to the public at large. Furthermore, in terms of section 2(e) of the Electronic Communications Act of 2005, as amended, the Authority should promote and ensure efficient use of the radio frequency spectrum. Thus, in the interest of efficient usage of radio frequency spectrum, the SABC seeks to venture into other platforms in order to improve its competitive edge and to fairly compete with new media services.*[16]

Internet Service Providers' Association (ISPA): *Disruptive technologies [such as those allowing access to TVWS] will continue to provide opportunities for competition and the role of the regulator should be to facilitate this process or at least not to impede it.*[17]

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13 See list of commercial deployments, pilots, and trials list at http://www.dynamicspectrumalliance.org/pilots/.

14 Notice of Public Inquiry into the State of Competition in the Information and Communications Technology Sector March 2014 (General Notice 229 of 2014, GG 37456, 20 March 2014) ("**ICT Competition Inquiry**"), Telkom submission, 23 June 2014, p17.

15 ICT Competition Inquiry, MTN submission, 23 June 2014, pp27-28.

16 ICT Competition Inquiry, SABC submission, 23 June 2014, para. 7.4.2.

17 ICT Competition Inquiry, ISPA submission, 23 June 2014, p10.

In addition, the following local service providers, service provider associations and research institutions were partners in the Cape Town TVWS Trial and recognise the potential for spectrum sharing strategies to improve overall spectrum utilisation:

- The CSIR Meraka Institute;
- The Tertiary Research and Education Network of South Africa (TENET);
- The e-Schools Network;
- The Wireless Access Providers' Association (WAPA); and
- Comsol Wireless Solutions (Pty) Ltd.

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

Yes. Enabling access to TVWS, especially on a licence-exempt basis, will foster innovation and investment in new and existing wireless technologies – all with no loss of broadcasting capabilities. See further discussion below in response to Questions 10 and 26.

Local operators also agree that enabling access to TVWS will stimulate innovation and investment in the wireless sector. Vodacom, for example, in its submission on the ICT Competition Inquiry stated:

TV White Spaces play in an important role in facilitating an economic and competitive environment. They also facilitate the introduction of improved, more economical wireless broadband and Internet services to consumers in areas that are currently unserved or underserved. This could foster a competitive market environment that would encourage further experimentation and innovation. This, in turn, could help to minimize deployment costs and enhance the provision of broadband services, which should lead to better Internet access and the availability of innovative consumer products and services.

The use of these technologies for applications such as rural broadband, wide-coverage hotspots, bridging between small networks, sensor networks and cellular off-loading, all of which would take advantage of these bands' superior propagation characteristics. These new technologies will help to address the capacity and spectrum shortage challenges facing the wireless communications industry.[18]

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

Google agrees with ICASA that making TVWS available will:

18 ICT Competition Inquiry, Vodacom submission p38, 23 June 2014.

- help meet the SA Connect broadband connectivity targets and the objective set out in the National Development Plan to reach the 2030 vision of "widespread use of ICT by all", with particular reference to:
  - The implementation of a service and technology-neutral flexible licensing regime to allow flexible use of resources in dynamic and innovative sectors, especially for spectrum that should be made available urgently for next generation services;
  - freeing up spectrum for efficient use, to drive down costs and stimulate innovation; and
  - adjusting the market structures and removing legal constraints to enable full competition in services.[19]
- Facilitate meeting the need to cater for demand for spectrum arising out of the growth of Machine to Machine (M2M) or Internet of Things (IoT) connectivity.[20]

Google agrees with ICASA that the following objects of the Electronic Communications Act 36 of 2005 ("**the ECA**") will be advanced through TVWS and dynamic spectrum assignment:

- ensuring efficient use of the radio frequency spectrum (section 2(e));[21] and
- encouraging investment, including strategic infrastructure investment, and innovation in the communications sector (section 2(d)).[22]

The Discussion Paper and these responses also demonstrate that TVWS and dynamic spectrum assignment can advance the following further objects of the ECA:

- promoting universal provision of electronic communications networks and electronic communications services and connectivity for all (section 2(c));[23]
- promoting the interests of consumers with regard to the price, quality and the variety of electronic communications services (section 2(n));[24]
- promoting competition within the ICT sector (section 2(f));[25] and
- developing and promoting SMMEs and cooperatives (section 2(p)).[26]

Enabling dynamic spectrum access will also create opportunities to increase engineering knowledge and competence in South Africa. This, in turn, will:

- encourage research and development within the ICT sector[27]; and

19 Discussion Paper, p25.
20 id., p26.
21 Discussion Paper, p14.
22 ibid.
23 id. p18 and see response to Question 32 below.
24 id. p18, p32 and see response to Question 15.
25 id. p25 and see excerpts from submission to the ICT Competition Inquiry set out in Questions 8 and 9.
26 See response to Question 15 below.
27 ECA, Section 2(i).

- provide assistance and support towards human resource development within the ICT sector[28].

Further benefits of authorising licence-exempt, managed use of TVWS are included in responses to other relevant questions.

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

Provided that ICASA's framework establishes reasonable protections for higher priority users, Google sees no disadvantages to enabling opportunistic access to TVWS. The Cape Town TVWS Trial and other deployments around the world have demonstrated that TV band devices can operate without causing harmful interference to protected entities.

Q12. Do you foresee any risks?

None that reasonable TVWS rules would fail to address. As noted above, the Cape Town TVWS Trial and other deployments around the world have validated that wireless devices can use TVWS without causing harmful interference to protected entities.

In its response to the Notice of Public Inquiry into the State of Competition in the Information and Communications Technology Sector March 2014 ("**ICT Competition Inquiry**"),[29] Telkom identified a number of concerns, each of which is set out and addressed by Google below:

- **Telkom** asserts that trials have been conducted in analogue white spaces and there remains a need to ascertain the viability of the use of TVWS in Single Frequency Networks (SFNs).[30]

While there will be a reduction in the available white space during and after the migration to Digital Terrestrial Television (DTT) and the subsequent digital-to-digital migration necessary to ensure optimal usage of the Digital Dividends to be assigned, there will still be a substantial amount of spectrum unused at any given location. This is the case even if a Single Frequency Network (SFN) is implemented.

Equally importantly, enabling use of TVWS does not need to be tied to the digital migration process. TVWS technology can be utilised before, during and after digital migration. TVWS devices work in unused TV broadcast band spectrum, so by definition TVWS operations do not depend on current TV broadcast technology. Database technology can direct devices to use whichever TVWS channels are available at the time, even as television broadcast stations are being relocated. Under a

28 ECA, Section 2(l).

29 General Notice 229 of 2014, GG 37456, 20 March 2014, in which one of the questions raised by ICASA for response was: "What role will new disruptive technologies such as TV White Spaces play in making our ICT sector more competitive?"

30 ICT Competition Inquiry, Telkom submission p17, 23 June 2014.

licence-exempt, managed model, channels do not need to be contiguous in order to be used by TVWS devices and these devices do not require access to a static set of channels to operate. The database is able to update channel availability very quickly, allowing white space devices (WSDs) to function notwithstanding an ongoing DTT process.

- Telkom asserts that there continues to be a need to determine the impact of the use of TVWS on secondary users "specifically SAB/SAP (Services ancillary to broadcasting and program making)".[31]

  It is the purpose of a rulemaking approach of this nature to take heed of the concerns of other affected secondary users and accommodate them. Moreover, deployments across the world have shown that TV band devices can operate successfully without causing interference to broadcasting and a variety of other protected services.

- Telkom argues that while it is common cause that TVWS will be utilised on a non-interference and non-protection (NINP) basis, "possible claims to access rights in the long run should be addressed (operating commercial services for many years may establish perceived i.e. access rights to such spectrum)".[32]

  A rulemaking process can and should make it clear to TVWS users that they will have no expectation of interference protection and that they will not establish access rights superior to other users through long-established use.

- Telkom believes that the ability of database technology to manage use of TVWS through allowing access to a database of primary users in an area remains unproven.[33]

  Database technology has been shown in a number of jurisdictions to have the necessary functionality to enable dynamic spectrum access in TVWS without causing harmful interference to primary users and while accommodating affected secondary users. Several databases have been qualified by the United States Federal Communications Commission. It is not reasonable to describe the technology as "unproven".

- Telkom argues that while there have been a "few" technical trials on use of TVWS, "many technical and regulatory matters still need to be addressed before it can be taken to market".[34]

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31 ibid.
32 ibid.
33 ibid.
34 ibid.

The regulatory and technical landscape for authorising TVWS is well-developed. Indeed, four separate jurisdictions have successfully adopted rules for the opportunistic use of TV spectrum. There have been a large number of trials and commercial implementations of TVWS[35]: while the technology continues to develop, its application is not theoretical.

- Telkom believes that developments in cognitive radio will make it "almost impossible to police issues related to spectrum interference and users will be able to hop around the frequency bands looking for free channels, and identifying sources of interference will be virtually impossible".[36]

  Adoption of cognitive radio technologies will not make it "almost impossible" to manage interference issues. In fact, reliance on a database will likely make it easier to track non-compliant devices because a database will be able to help identify their locations.

- Telkom argues that if access to TVWS is allowed, then "the regulatory playing field would need to be levelled". Where operators are using TVWS on a licence-exempt basis and are therefore not paying annual spectrum licences fees or assuming universal service obligations, there must be a reduction of the fees payable and obligations assumed by licensed operators "as competition reduces the profitability of operators from which they are expected to cross subsidize any obligations".[37]

  TVWS made available on a licence-exempt, managed basis will be equally available to and for the potential benefit of both incumbent operators and new entrants and will not unfairly advantage new entrants. The value of licence-exempt spectrum to incumbent operators has already been established.

  In short, the risks identified by Telkom are wholly unsubstantiated by experiences with TVWS to date. Nor do they have independent merit. Neither the Cape Town TVWS Trial, nor any other trial in South Africa exhibited any of the "critical shortcomings" discussed by Telkom.[38] Rather, Google expects that enabling access to TVWS in South Africa will – as it has been shown to do elsewhere – enable substantial benefits and create minimal risks. Developments in other jurisdictions have already established the usefulness and viability of this technology while providing ICASA with substantial guidance on the regulatory and technical framework to be developed in this country.

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

35 A list of pilots, trials and commercial deployments from around the world is available at www.dynamicspectrumalliance.org/pilots/.
36 ibid.
37 ibid.
38 ibid.

As noted in paragraph 3.3.3 of the Discussion Paper, the South Africa Connect Policy specifically requires that spectrum be "managed efficiently in order to optimise its potential to provide broadband access". Section 12 of this Policy recommends prioritising "approval of spectrum sharing" and "dynamic spectrum allocation".[39]

Thus, the policy unequivocally encourages ICASA to adopt rules enabling dynamic access to TVWS.

More generally, enabling use of TVWS will expand broadband connectivity in both rural and urban areas. These benefits are discussed in greater detail in the responses to Questions 26 and 32.

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

See response to Question 33 below.

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

Yes. Licence-exempt managed use of TVWS can contribute to:

- increasing broadband penetration, particularly in rural areas;[40]
- creating an enabling environment for innovation;[41] and
- reducing the cost to communicate through more efficient utilisation of spectrum and by enabling affordable access to spectrum.[42]

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

As noted above in the response to Question 12, dynamic access technologies will work before, during and after the transition to digital terrestrial television (DTT). While there may be a reduction in the available spectrum during and after the migration to DTT, users will still have access to substantial spectrum at any given location, especially if broadcasters implement a single frequency network after the transition.

As a result, enabling dynamic access to TVWS is compatible with and complementary to DTT transition and any subsequent auction in the 700 MHz band.

39 See also the response to Question 10 above.

40 See response to Question 32 below.

41 See response to Question 9 above.

42 See response to Question 26 below.

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

White spaces should be made available pursuant to a regulatory authorisation providing for licence-exempt, managed access. See response to Question 26 below.

Q18. Should there be rules for such usage?

Yes. See response to Question 26 below.

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

Yes. See responses to Questions 9 and 10 above.

Q20. Blank question – left in to ensure numbering consistency between submission and Discussion Paper.

Q21. Is there a space for licence-exempt, unmanaged use of TVWS?

No. See response to Question 26 below.

Q22. Is there a space for licence-exempt, managed use of TVWS?

Yes. Google supports this approach for the reasons set forth in the response to Q26 below.

Q23. Is there a space for licensed use of TVWS?

A licence-exempt approach will best support innovation and investment in the TV band. A balanced spectrum policy has fuelled the mobile connectivity revolution: licence-exempt technologies such as Wi-Fi have completed licensed wide-area networks in meeting growing demands for wireless data. However, most low frequency spectrum is allocated for licensed, rather than licence-exempt use. By enabling licence-exempt managed access to TVWS, ICASA can further the balanced policy that has been so successful to date. Of course, as noted above in response to Question 12, mobile operators that have access to licensed spectrum will be able to use TVWS, just as mobile devices today often rely on the 2.4 GHz band for Wi-Fi offload.

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

As noted above, Google supports enabling access to TVWS on a licence-exempt managed basis. As such, no comment is offered on licensing fees.

Q25. Does the combination give us the best of both worlds?

Multi-tier sharing regimes hold great promise in increasing spectrum utilisation and meeting the demands for additional wireless capacity. However, they are just being developed now, and they are more difficult to implement than a two-tiered access system that establishes geographic boundaries for the secondary service in order to protect the primary service. In the case of TVWS, ICASA will be best served to follow the simpler course already charted by other administrations that have considered the issue and authorise two tiers of users--protected entities, such as television broadcasters, and opportunistic users. Using such an approach, the use of licence-exempt spectrum will complement exclusive assignments of spectrum, allowing South African users to take advantage of the best licensed and licence-exempt technologies.

Q26. Which of the licensing regimes do you favour? Why?

Enabling licence-exempt access to TVWS frequencies is key to unlocking their potential.

- Licence-exempt access has been demonstrated to foster innovation and investment in the wireless sector. Innovators can move quickly to introduce new products and services without delays occasioned by obtaining licensing, resulting in many advancements in efficiency of use being originated in the licence-exempt bands. Examples of innovation in licence-exempt bands include Wi-Fi, Bluetooth, cordless phones, RFID and Zigbee.
- As noted above, a balance of access to licensed bands and licence-exempt bands, is optimal in meeting the needs of different providers and different users. In South Africa, there currently is little licence-exempt spectrum available below 1 GHz.
- The benefits of licence-exempt access accrue to incumbent operators as well as new entrants. For instance, licence-exempt spectrum has already been shown to complement both mobile and landline connectivity through Wi-Fi offload and the provision of backhaul connectivity to support last-mile fixed wireless connections.
- Licence-exempt access to low-frequency spectrum will become increasingly important as demand for machine-to-machine and other non-broadband technologies grows. Applications include wireless healthcare, smart grid communications, inventory management, access control, mobile payments and fleet management.

In addition to the work cited in the Discussion Paper, Richard Thanki has also released an analysis of the role of TVWS technology in achieving universal broadband connectivity in South

Africa.[43] He identifies affordability as being the key barrier to increased Internet connectivity in South Africa and argues that access to TVWS will reduce the cost of connectivity in South Africa.[44]

Thanki points to the following "substantial economic benefits" that will flow from enabling licence-exempt use of TVWS in South Africa:[45]

- ***Increased affordability of broadband services:*** Thanki shows that delivering broadband at a monthly cost of USD 6 would bring access within the affordability of a further 10% of the South African population.[46]
- ***Economic benefits from greater broadband penetration:*** Thanki creates low, medium and high-impact scenarios flowing from the authorisation of the licence-exempt use of TVWS in order to illustrate how this technology could add between 500 000 and 2.5 million additional broadband users by 2025. The positive relationship between broadband penetration and GDP growth is recognised in the NDP and the SA Connect National Broadband Policy.[47]
- ***Economic benefits from machine-to-machine applications:*** Thanki identifies the capabilities provided by longer-range and more reliable WLANs and sensor and control networks as being of significant value to, inter alia, the mining and agricultural industries, as well as to the protection of natural resources and the fight against poaching.[48]

Applying the ITU guideline to assessing affordability – that a bundle of communications should cost no more than 5% of an individual's income – against the reasonable assumption that 80% of South Africa's population earn less than US$10,000 per year and 40% earn less than US$2,000, and noting US$8.18 as the price of a Vodacom 500MB[49] prepaid data bundle, Thanki demonstrates that just under 40% of the South African population is not able to afford mobile broadband services (as indicated by the intersection of the lines in Figure 1 below).

43 Thanki (2015). See https://lastingparties.wordpress.com/2015/12/11/tv-white-spaces-in-south-africa/. As noted in the paper, Google provided financial assistance towards the completion of this work, but the views are the author's own.
44 id. para. 3.3, pp32ff.
45 id. para.4.3, pp39ff.
46 id. para 4.3.1., p39.
47 id. para 4.3.2., p40.
48 id. para 4.3.3., pp42-43.
49 As noted by Thanki (p34) this reflects the size of bundle the ITU uses in its discussions of affordability.

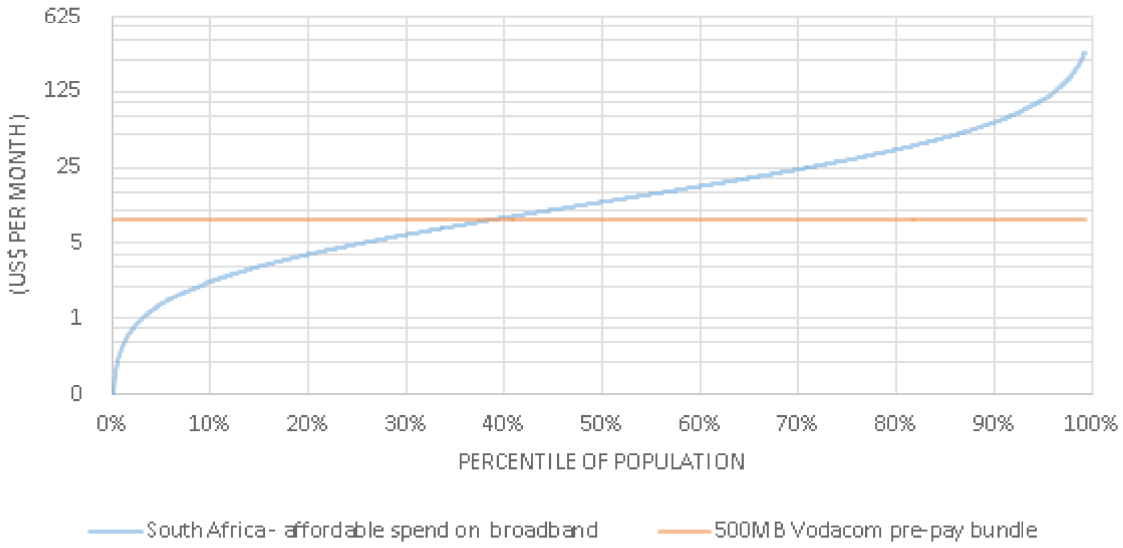

Figure 1: Telecommunications services affordability curve for South Africa

(Source: Thanki (2015), p34)

The South African Government has long-recognised the need to reduce the cost of broadband. This is captured in the NDP, SA Connect, the Cost to Communicate Programme and other initiatives. As recently as November, the Minister of Telecommunications and Postal Services published a draft policy direction to ICASA relating to increasing competition in the provision of broadband services and the reduction of broadband prices.

Because South Africa has sufficient international submarine capacity and well-developed national and regional fibre networks, the major cost to the consumer subsists in the "last mile". Thanki's conclusion is that TVWS is "a very promising candidate technology" for reducing the cost of the access component of the broadband delivery chain in South Africa because it effectively complements existing broadband delivery technologies.[50]

Thanki also identifies the following benefits resulting from authorising licence-exempt radio applications:[51]

- ***Innovation:*** licence-exempt service provision has enabled the introduction of new radio techniques as well allowing the use of wireless technology in new applications. Thanki shows that many major radio innovations have originated in the licence-exempt bands before being broadly adopted by cellular networks using licensed frequencies.

50 Thanki, R, op. cit. fn. 3, p35.

51 Thanki para. 2.3.2, pp11-15.

> These technologies have enabled substantial improvements to the range, capacity, reliability and cost-effectiveness of wireless communications, benefiting both consumers and businesses. The trend of wireless innovations being first introduced in licence-exempt spectrum is likely to continue. The open nature of the licence-exempt bands permits experimentation by large and small firms and allows them to sell their products directly to a large number of end users, avoiding both the delays associated with the licensing process and the time required to negotiate with licence-holding intermediaries.[52]

- ***Growth in the device market:*** Thanki demonstrates that the ubiquitous adoption of services provided over licence-exempt networks is reflected in device sales: the sale of devices using licence-exempt bands significantly exceeds combined sales of licensed band equipment.

> The growth in shipments of devices incorporating wireless connectivity has been pronounced since 2008. However, the growth has been substantially greater in devices equipped with Wi-Fi and Bluetooth connectivity (494% and 230% respectively) than in those capable of cellular connection (66%). This additional growth is largely driven by the innovation and diversification described above.[53]

- ***Economic benefit:*** Thanki cites a list of studies which have attempted to quantify the economic value of use of licence-exempt spectrum, concluding that the "scale of benefits, even from a small subset of licence-exempt uses, can be measured in the many tens of billions of dollars annually".[54]

In jurisdictions around the world, wireless broadband operators and other service providers have used this spectrum to offer a number of applications which boost consumer value and social and economic inclusion, including:

- delivering broadband in rural or hard-to-serve areas;[55]
- last mile access to augment city or community-wide[56] or wide-area data networks;
- data offload from mobile networks;
- machine-to-machine communications, including smart grid and health-care applications;

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52 Id. para. 2.3.2.1, p11.

53 Id. para. 2.3.2.2, p12.

54 Id. para. 2.3.2.3, p13.

55 Thanki at p38 identifies the potential for licence-exempt use of TVWS in South Africa to enable local wireless Internet service providers (WISPs) to provide a low-cost broadband service in rural areas. While many of these WISPs use licensed backhaul spectrum they do provide access services using licence-exempt spectrum, particularly in the 5 GHz range. According to Thanki, access to TVWS on a licence-exempt basis "will enable these companies, as well as start-ups and established communications companies, to expand this cost effective delivery model into rural and remote areas where terrain and distances would not permit the use of existing frequencies".

56 There are also indications that spectrum sharing can help empower communities. Communities that have access to spectrum can invest on a community-level in the development of a local access network. The Rhizomatica Community Base-Station initiative is an example of GSM spectrum-sharing being used to empower communities. (http://rhizomatica.org/projects/community-basestation/).

- in-building media distribution;
- local government and public safety applications; and
- services to educational and health facilities.

Q27. Rank the licensing regimes in order of preference with reasons for your preferred order.

As noted above, Google supports a licence-exempt regime, with access to spectrum managed by databases.

Q28. Do you see automated licensing as possible? Why / why not?

As noted above, Google supports a balanced allocation of licence-exempt and exclusively licensed spectrum and recommends that ICASA designate TVWS for licence-exempt use. As such, Google does not believe that licensing – whether automated or otherwise – is appropriate for these frequencies.

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

Please see the response to Question 28.

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

TVWS databases should be authorised using a certification process developed by ICASA. The certification process should evaluate database providers' ability to meet certain basic obligations, and service providers should remain accountable to ICASA for meeting these obligations on an ongoing basis.

In other jurisdictions[57], database service providers typically must fulfil the following obligations:

- demonstrate that their databases can operate with the criteria established by a regulatory authority to protect incumbents from harmful interference;
- provide services to all TVWS devices on a non-discriminatory basis;
- establish reasonable fees for the provision of database services;

57 47 C.F.R. § 15.703(n); Industry Canada, *Application Procedures for White Space Database Administrators (WSDBAs)*, CPC-4-1-01 Issue 1 (2015) (Application Procedures), *available at* https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/CPC-4-1-01-issue1.pdf/$file/CPC-4-1-01-issue1.pdf ; Industry Canada, *White Space Database Specifications*, DBS-01, Issue 1 (2015) (Database Specifications), *available at* https://www.ic.gc.ca/eic/site/smt-gst.nsf/vwapj/DBS-01-Issue1.pdf/$file/DBS-01-Issue1.pdf ; http://stakeholders.ofcom.org.uk/spectrum/tv-white-spaces/databases/.

- share information in a secure manner where necessary for effective interference protection; and
- Where required to do so by the regulator, restrict operation of a device that is registered with it that is causing harmful interference to a protected service.

The DSA Model Rules impose the following responsibilities on database administrators:[58]

§ 5 Database Administrator

(a) Database administrator responsibilities. [Regulator] will designate one public entity or multiple private entities to administer geolocation database(s). Each geolocation database administrator designated by [Regulator] shall:

(1) Maintain a database that contains information about incumbent licensees to be protected.

(2) Implement propagation algorithms and interference parameters issued by [Regulator] pursuant to § 4 to calculate operating parameters for WSDs at a given location. Alternatively, a database operator may implement other algorithms and interference parameters that can be shown to return results that provide at least the same protection to licensed incumbents as those supplied by [Regulator]. Database operators will update the algorithms or parameter values that have been supplied by [Regulator] after receiving notification from [Regulator] that they are to do so.

(3) Establish a process for acquiring and storing in the database necessary and appropriate information from the [Regulator's] databases and synchronizing the database with current [Regulator] databases at least once a week to include newly licensed facilities or any changes to licensed facilities.

(4) Establish a process for the database administrator to register fixed WSDs.

(5) Establish a process for the database administrator to include in the geolocation database any facilities that [Regulator] determines are entitled to protection but not contained in a database maintained by [Regulator].

(6) Provide accurate information regarding permissible frequencies of operation and maximum transmit power available at a master WSD's geographic coordinates based on the information provided by the device pursuant to §3(c). Database operators may allow prospective operators of WSDs to query the database and determine whether there are vacant frequencies at a particular location.

(7) Establish protocols and procedures to ensure that all communications and interactions between the database and WSDs are accurate and secure and that unauthorised parties cannot access or alter the database or the list of available frequencies sent to a WSD.

58 DSA Model Rules § 5.

(8) Respond in a timely manner to verify, correct and/or remove, as appropriate, data in the event that [Regulator] or a party brings a claim of inaccuracies in the database to its attention. This requirement applies only to information that [Regulator] requires to be stored in the database.

(9) Transfer its database, along with a list of registered fixed WSDs, to another designated entity in the event it does not continue as the database administrator at the end of its term. It may charge a reasonable price for such conveyance.

(10) The database must have functionality such that upon request from [Regulator] it can indicate that no frequencies are available when queried by a specific WSD or model of WSDs.

(11) If more than one database is developed for a particular frequency band, the database administrators for that band shall cooperate to develop a standard process for providing on a daily basis or more often, as appropriate, the data collected for the facilities listed in subparagraph (5) to all other WSD databases to ensure consistency in the records of protected facilities.

(b) Non-discrimination and administration fees.

(1) Geolocation databases must not discriminate between devices in providing the minimum information levels. However, they may provide additional information to certain classes of devices.

(2) A database administrator may charge a fee for provision of lists of available frequencies to fixed and personal/portable WSDs [and for registering fixed WSDs].

(3) [Regulator], upon request, will review the fees and can require changes in those fees if they are found to be excessive.

Google urges ICASA to authorise multiple commercial entities to offer database services. Competition in the database services sector encourages database providers to compete in improving database technology, offering value-added services, developing resilient and robust infrastructure and setting reasonable prices.

Q31. From a South African perspective, what will be the socio-economic benefits of TVWS?

The principal socio-economic benefits of enabling licence-exempt access to TVWS are discussed in response to Questions 15 and 26. In addition, Google agrees with Richard Thanki's 2012

analysis of the economic benefits of enabling opportunistic use of TVWS,[59] cited in the Discussion Paper.

Q32. Will TVWS be of the most benefit to rural or urban areas? Please provide reasons – technical and socio-economic.

Access to TVWS spectrum will benefit both rural and urban areas.

In South Africa, a mix of fixed (fibre, copper, wireless) mobile and satellite technologies deliver broadband services to end users, and each of these have advantages and disadvantages in different environments and across different applications. While deepening mobile penetration in particular has resulted in significant progress in availability of access to the Internet, there remains a challenge in providing high-capacity, low-cost services in both urban and rural environments.

Thanki argues that TVWS technology has the potential to act as a "powerful complement" to these other methods of broadband delivery, particularly in rural areas where incomes are low and populations widely scattered.[60] As the distance between households increases in areas with lower population density, network infrastructure is shared among fewer users, and the amount of network equipment required to serve each user increases due to the longer distances involved in connecting to the network. As a result, network deployment costs per user in the last mile are inversely proportional to population density: as the population density increases, the cost per user decreases. TVWS on a licence-exempt, managed basis represents an opportunity to provide affordable access to sparsely-populated areas using a resource – fallow spectrum – which is particularly underutilised in these areas.

In short, TVWS connectivity shows significant promise in helping South Africa meet its aggressive broadband penetration targets in the South African Connect National Broadband Policy, especially in the rural areas that are expensive and technically challenging to connect.

Urban areas, too, will benefit from improved connectivity offered by TVWS. For example, the Cape Town TVWS Trial established the case for the use of TVWS to provide a broadband service to schools within an urban environment. Other urban applications include smart city technologies such as traffic monitoring, public safety and municipal service delivery enhancements. And more ubiquitous connectivity will boost productivity and social welfare throughout the country.

Q33. Please provide proposals on the regulatory framework (including none at all) for TVWS

59 Discussion Paper, para 5.3 on pp31-32 citing "The Economic Significance of Licence-Exempt Spectrum to the Future of the Internet" by Richard Thanki, http://www.wirelessinnovationalliance.org/index.cfm?objectid=DC8708C0-D1D2-11E1-96E9000C296BA163.

60 Id. para 4.2, p38.

Google supports a regulatory framework for TVWS that includes the following elements:

- ***Licence-exempt use:*** As set forth at length above, licence-exempt use will complement existing technologies, help meet the challenge of connecting the unconnected and drive innovation.
- ***Database-based methods of enabling dynamic access:*** Trials and commercial deployments have demonstrated that TVWS databases constitute an effective technology for the protection of incumbent users from harmful interference. Use of a point-to-point terrain-modelling propagation model maximises spectrum utilisation while ensuring accurate protection of incumbent users.
- ***Commercial database provision:*** Allowing multiple entities to offer database services drives competitions, innovation and greater resilience in database management. Database provision is discussed in greater detail in response to Questions 36, 39 and 48.
- ***Sensing:*** Spectrum sensing should be permitted either as a stand-alone solution or as a potential complement to database-enabled sharing. As sensing technology develops further, it has the potential to further enhance the utility of dynamic spectrum sharing.
- ***Flexible, reasonable technical rules:*** Technical rules should establish distinct categories of devices (fixed and mobile, as well as master and client) and mandate compliance with out-of-band emissions limits that track either the European Telecommunications Standards Institute (ETSI) or United States Federal Communications Commission (FCC) standards. As stated above, Google supports the DSA Model Rules as a set of flexible and reasonable technical rules.

Q34. What are the advantages and disadvantages of different methods?

As noted in greater detail in the response to Questions 8,9,10, 13, 15, 26 and 32, licence-exempt, dynamic access to TVWS has several benefits:

- ***Increased spectrum utilisation:*** Re-using the same spectrum hundreds or even thousands of times over, in many small areas, means that spectrum is no longer “scarce”.
- ***Immediate access:*** TVWS can be made available for wireless use without having to wait for the finalisation of the DTT transition and restacking processes.
- ***Increased innovation and increased investment:*** improved broadband technologies and services will drive corresponding socio-economic benefits.

By contrast, clearing UHF and VHF spectrum and then assigning it through a competitive process is both complex and costly. This process will also – unlike licence-exempt, managed use – delay the use of available spectrum until after the DTT transition is complete. Moreover, a licence-exempt approach harmonises well with the approaches of other regulators who have authorised wireless users in the UHF and VHF bands, enabling South African users to take advantage of a global market for devices.

Q35. How should South Africa define TVWS?

TV broadcast channels should be defined as available for TVWS use if a TVWS device can operate on the channel in a particular location without causing harmful interference to incumbent broadcast users. Determinations regarding channel availability should be based on a point-to-point terrain-based model that predicts the propagation of signals from individual television transmitters.

ICASA should define TVWS as channels available for opportunistic use in both the UHF *and* VHF broadcast bands. Although the Discussion Paper does not specifically discuss the VHF band, ICASA's final rules should include these frequencies. Expanding access to the VHF bands would improve spectrum utilisation and make additional spectrum available for broadband transmission, and Google is not aware of any unique technical or policy considerations that preclude inclusion of the VHF band in ICASA's TVWS framework.

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

ICASA will retain ultimate authority for compliance with its rules, but databases can be used to facilitate compliance both prospectively – to ensure that devices access only authorised channels – and retrospectively, to identify and shut down non-compliant devices. The database facilitates compliant operation by providing a list of available channels and corresponding maximum power levels based on a master device's location and other relevant operational parameters of the device (e.g. out-of-band emissions characteristics). In calculating channel availability, ICASA should follow the methodology set forth in the Appendices of the DSA Model Rules.[61] Database providers can also facilitate enforcement, assisting ICASA in identifying non-compliant devices, as suggested in the DSA model rules.[62]

Q37. On what basis should white space use in the 470–694 MHz band be authorised?

As set forth more fully in Google's response to Question 33, ICASA should adopt a licence-exempt, managed access approach to use of TVWS.

Q38. Do the benefits of adopting a licence-exempt, managed assignment approach apply?

Yes. See the response to Question 26 and the sources cited in footnote 2 for a list of countries which have authorised use of TVWS on a licence-exempt, managed basis.

61 See DSA Model Rules, Annex C: Calculation of Available TV White Space Frequencies and Power Limits, para. 3.2.

62 DSA Model Rules, § 5(a)(10).

Q39. If a licence-exempt, managed assignment approach is adopted, what registration requirements, if any, might apply?

Google supports the registration requirements set forth in the DSA Model Rules. In particular, fixed devices should register the following information with a TVWS database:

- a unique alphanumeric code supplied by the manufacturer that identifies the make and model of the device/type approval number;
- manufacturer's serial number of the device;
- device's geographic coordinates (latitude and longitude);
- device's antenna height above ground level or above mean sea level;
- name of the individual or business that owns the device;
- name of a contact person responsible for the device's operation;
- address for the contact person;
- email address for the contact person; and
- phone number for the contact person.[63]

It should be the responsibility of the named individual or business to ensure that the database contains the most recent information.

As discussed in greater detail in the response to Question 50 below, Google also supports a rule allowing fixed devices to provide location information manually.

Q40. Do you think that licensed use of TVWS requires the operator to have an ECNS licence?

As noted above, Google support licence-exempt, managed use of TVWS. Accordingly, Google expresses no view on this question.

Q41. Should the white spaces database approach be adopted or is there an alternative system?

Google support the adoption of database-based protection. More specific views on database provision are set forth in response to Questions 36, 39 and 48.

The Discussion Paper includes definitions of two different types of databases: 1) a reference geolocation database, and 2) a secondary geolocation database. ICASA proposes to define a reference geolocation white space database as:

a master database that performs baseline calculations for the country-wide maps of available television white space ("TVWS") channels and their corresponding maximum allowed

63 DSA Model Rules § 3(e)(3).

power levels for WSDs. The maps are to be utilised as regulatory limits by the authorised secondary geolocation white space database administrators.[64]

Secondary geolocation white space databases are defined as:

databases that utilise TVWS availability maps and corresponding power levels calculated by the reference geolocation white space database for the purpose of providing services to end users. Secondary geolocation white space databases are allowed to perform their own calculations for available TVWS channels and corresponding maximum allowed power levels of WSDs provided that their results are identical to or do not exceed the results produced by the reference geolocation white space database.[65]

Although the Discussion Paper defines these two types of databases, it does not specify whether commercial providers will be permitted to offer both types of databases, or explain how the certification processes for the two types might differ. ICASA should clarify how it proposes to use these two definitions. As noted above, allowing multiple commercial database providers to offer all types of database services will best foster advances in database technology and allow database operators to compete in offering value-added services. Google looks forward to learning more about ICASA's proposal to establish two types of databases, rather than one type as has been the international norm, and responding further as necessary.

Q42. What additional measurements should be adopted for greater accuracy?

As noted above in response to Question 33, Google supports allowing the use of spectrum sensing as an alternative or as an optional enhancement to database-enabled sharing.

Q43. Should the Authority allow – or require – sensing as an option at this time?

The Authority should permit but not require the use of sensing as a method of interference avoidance. See responses to Questions 33 and 42.

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)?

Ensuring that databases use the most accurate information regarding incumbent operations is a joint responsibility of ICASA, incumbent service providers, and database operators. ICASA should work with incumbents to ensure that it has access to up-to-date, accurate and complete information regarding incumbent operations. During the certification process, database providers should

64 Discussion Paper, p13.
65 ibid.

demonstrate that they have the ability to consistently and accurately retrieve the information made available by ICASA and incorporate that information into their calculations.

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?

It is appropriate for ICASA to require incumbents to provide technical information necessary for protection of their operations. Moreover, it plainly benefits protected entities to provide accurate information: without it, interference protection will suffer.

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

Google supports the establishment of the database requirements set forth in the DSA Model Rules.[66] These requirements are also discussed in additional detail in response to Questions 36, 39 and 48.

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

As noted above and in response to Question 30, Google recommends that the Authority utilise the criteria set out in the DSA Model Rules.

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

Google recommends that the Authority utilise the criteria set out in the DSA Model Rules,[67] specifically the following:

- Geolocation databases should not discriminate between devices in providing the minimum information levels. However, they may provide value-added services at their discretion.
- For purposes of obtaining a list of available frequencies and related matters, master WSDs shall be capable of contacting only those geolocation databases operated by administrators authorised by ICASA.

66 DSA Model Rules, § 6.
67 § 5 (b)(1), § 3 (h).

- Communications between WSDs and geolocation databases are to be transmitted using secure methods that ensure against corruption or unauthorised modification of the data; this requirement also applies to communications of frequency availability and other spectrum access information between master devices.
- Communications between a client device and a master device for purposes of obtaining a list of available frequencies shall employ secure methods that ensure against corruption or unauthorised modification of the data. Contact verification signals transmitted for client devices should be encoded with encryption to secure the identity of the transmitting device. Client devices using contact verification signals shall accept as valid for authorisation only the signals of the device from which they obtained their list of available frequencies.
- Geolocation database(s) shall be protected from unauthorised data input or alteration of stored data. To provide this protection, a database administrator shall establish communications authentication procedures that allow master devices to be assured that the data they receive is from an authorised source.

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

Only fixed master devices should be required to register with databases. Mobile master devices should be required to automatically report their information to a database but not to register with it. Providing location information to a database will allow a database to provide mobile master devices with channel availability in a device's particular location. Client devices should not be required to register with a database or provide their location information to a database. They will receive channel availability from master devices and will not be able to transmit without affirmative permission from a master. Because they operate under the control and within the range of a master, no location information is needed. This approach to registration and geolocation tracks the approach in the United States and other jurisdictions.[68]

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

68 Unlicensed Operation in the TV Broadcast Bands, ET Docket No. 04-186; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band, ET Docket No. 02-380, Second Memorandum Opinion and Order, 25 FCC Rcd 18661 (2010), 47 CFR 15.713 available from http://www.ecfr.gov/cgi-bin/text-idx?SID=c84b44bb6450f82fcf137a7049ca80e9&mc=true&node=se47.1.15_1713&rgn=div8; Industry Canada Framework for the Use of Certain Non-broadcasting Applications in the Television Broadcasting Bands Below 698 MHz, para. 7.1 available at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10494.html#sec7.1; Infocomm Development Authority of Singapore, Regulatory Framework For TV White Space Operations In The VHF/UHF Bands (2014), para 83, available at https://www.ida.gov.sg/~/media/Files/PCDG/Consultations/20130617_whitespace/ExplanatoryMemo.pdf.

The purpose of distinguishing between fixed and mobile devices is to address the different risks of causing harmful interference by the two device types and to allow for flexibility in establishing different rules for different device types. In particular, ICASA may wish to authorise fixed devices to operate at higher power levels both because they present a lower risk of interference and because offering fixed broadband is an important use case for improving broadband coverage in rural areas.

In addition, Google urges ICASA to allow manual geolocation of fixed devices. These fixed devices are likely to be installed by a professional installer well-versed in the ICASA's rules, and once installed, they are unlikely to be moved. As a result, allowing manual provision of geolocation is appropriate.

Q51. What rules should be attached to each type of device?

Google supports adoption of the technical parameters for fixed and mobile devices set forth in the DSA Model Rules and looks forward to providing feedback on ICASA's proposed rules when they are published.

Q52. Should operating parameters differ by device type or technology?

Please see the response to Question 51 above.

Google encourages the use of existing type approval procedures for certification of both fixed and mobile devices. New standards adopted should be recognised in the official list of Regulated Standards for Technical Equipment and Electronic Communications Facilities.

Q53. Should transmit power levels be different for different device types?

Google supports higher power levels for fixed TVWS devices as opposed to mobile devices. Allowing these higher power levels will enable the provision of last-mile access in rural areas.

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

In addition to adopting overall maximum power limits (e.g. 10W for fixed devices), ICASA should adopt variable power limits depending on the presence of protected entities in the vicinity of TVWS operations. Transmitter power levels should be determined and limited by the database based

on three things: 1) TVWS device locations and technical characteristics; 2) incumbent locations and technical characteristics; and 3) models that calculate propagation on a point-to-point basis, taking into account terrain effects. Establishing variable power limits will increase efficiency of use while maintaining protection for primary users.

Google also agrees with ICASA that transmission power higher than 4W should be allowed where there are no TV broadcasters in adjacent channels.[69]

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

ICASA should adopt a maximum power level of at least 10W. This level will allow substantial fixed wireless service, especially in rural areas, but is not so high that it creates coexistence challenges among TVWS devices.

Google notes that there is already a substantial amount of equipment designed to operate below this threshold.

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

As noted above, Google supports a licence-exempt, managed approach for use of TVWS. Accordingly, Google has no comment on this question.

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. Allowing a database to select unused channels – even if those channels are adjacent to broadcast transmitters – increases the amount of spectrum available for secondary use and, provided that a database establishes appropriate protection, does not result in harmful interference. The Cape Town TVWS Trial operated in channels adjacent to channels used by TV broadcasters, and in some cases, between two channels used by TV transmitters (i.e. adjacent on either side to the TVWS channel). The results of this Trial, provided to ICASA, showed that operation did not cause harmful interference to incumbent users.

69 Discussion Paper, para. 5.9.2.1, p37.

As noted in paragraph 11 of the Discussion Paper, the learnings and recommendations document arising from this Trial[70] were cited by the FCC as a reason for adopting modifications of the technical rules for TVWS in the USA to allow greater utilisation of white spaces in adjacent bands.[71]

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

No. As long as databases calculate channel availability based on established protection criteria, there is no reason to believe that adjacent channel operation causes a greater risk of harmful interference to incumbent operations. The DSA Model Rules incorporate protection criteria that are sufficient to protect incumbent broadcast operations while still allowing healthy use of white space spectrum.

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?

The Authority should adopt out-of-band emissions rules. Google recommends that ICASA require devices to comply with either the ETSI or FCC out-of-band emissions limitations. Mandating compliance with either of these frameworks will allow TVWS users in South Africa to take advantage of devices developed for the global market. Moreover, both ETSI and the FCC have adopted an approach that allows devices with better emission characteristics access to additional spectrum, thereby creating incentives for manufacturers to improve emissions performance.

As demonstrated in the Cape Town TVWS Trial, devices that conform to FCC emissions masks[72] can operate without causing harmful interference and will be able to access many available channels.

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

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70 Recommendations and Learnings from the Cape Town Television White Spaces Trial ("Cape Town Trial Recommendations"), available from http://www.tenet.ac.za/tvws/recommendations-and-learnings-from-the-cape-town-tv-white-spaces-trial.

71 In the Matter of Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37, and Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap, ET Docket No. 14-165; Promoting Spectrum Access for Wireless Microphone Operations, GN Docket No. 14-166; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, GN Docket No. 12-268, Notice of Proposed Rulemaking, 29 FCC Rcd 14781, ¶ 40 (2014) (Part 15 NPRM). https://www.fcc.gov/document/part-15-nprm.

72 Test results available from FCC can be found at https://drive.google.com/open?id=0B_0gyzoUN4hcdWZ1ZDVJYXJVQlk.

The choice of a propagation model is important to ensure accurate protection of incumbent users and maximise use of white spaces.

Whether or not a specific model is mandated, ICASA should require database providers to rely on point-to-point, terrain-based models. The benefits of point-to-point, terrain-based models are discussed in further detail in response to Question 61 below.

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

Today, point-to-point, terrain-based models provide the most accurate basis for propagation modelling for database providers due to their greater sensitivity to the terrain in which transmitters are situated.

Such models do the following:

- maximise spectral efficiency relative to contour-based propagation models by more accurately capturing the effects of terrain on incumbent transmitter signal distribution; and
- offer the best protection for incumbent operations by using more input data to create greater accuracy in predictions of which channels can be utilised without causing harmful interference.[73]

See further discussion in response to Question 63 below.

Q62. Which model or models maximise spectral efficiency?

As noted above, today, point-to-point, terrain-based models provide the most accurate representation of interference potential. As such, they also maximise both protection and spectrum utilisation.

Q63. Which models best protect incumbent operations?

Several point-to-point models provide accurate incumbent protection. For example, the Longley-Rice model takes into account of terrain effects, resulting in extremely accurate protection. Another point-to-point, terrain-based propagation model cited in the DSA Model Rules is the ITU Radiocommunication Sector Recommendation P-1812 (ITU-R. P-1812). Like Longley-Rice, ITU-R. P-1812 is a path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands.[74]

73 As detailed in the Cape Town Trial Recommendations, the Cape Town TVWS Trial utilised the Longley-Rice model to determine channel availability - including channels adjacent to those being used by broadcasting transmitters - without any harmful interference being recorded. See further the response to Question 57.

74 Further detail regarding ITU-R. P-1812 is available from https://www.itu.int/rec/R-REC-P.1812-3-201309-I/en.

The F(50,50) curves propagation model – which calculates a circular contour around each incumbent installation, in and around the installation location – is not preferred. Reliance on this method leads to both over-protection and under-protection. Over-protection typically occurs because the approach does not take into account the fact that broadcast signals cannot pass over mountainous territory.[75] Under-protection occurs when terrain is flat and signals travel further than the model predicts.[76]

The model adopted by Ofcom, using a localised propagation model based on the calculation of the level of background noise which can be tolerated by a television receiver,[77] is not suitable for use in South Africa. The implementation of this model by Ofcom is enabled by a database of registered television users, a resource which is not available in South Africa.

The Cape Town TVWS Trial utilised the Longley-Rice propagation model to minimise coupling loss. No interference was caused by the use of TVWS during the Trial.

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

Google supports the use of point-to-point, terrain-based models for the reasons set forth above.

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

Yes. As set forth more comprehensively in the remainder of this questionnaire, as well as demonstrated by the experience in Cape Town and by TVWS implementations across the globe, licence-exempt, managed access to TVWS will improve connectivity and drive innovation in South Africa, which will, in turn, promote economic development and opportunity.

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

Yes. As set forth more comprehensively in responses to Questions 30 and 44 above, databases or sensing can protect incumbent entities from harmful interference. The Cape Town TVWS Trial and a number of other trials, pilots and commercial deployments in Africa and around the globe have further confirmed that broadband can be delivered over TVWS without causing harmful

75 Cape Town Trial Recommendations at 39, 41.
76 Id.
77 See http://stakeholders.ofcom.org.uk/binaries/consultations/white-space-coexistence/summary/white-spaces.pdf paras. 5.26 ff.

interference to protected entities using white space databases and point-to-point terrain-based propagation models.

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

No. Google supports an automated geolocation requirement for portable devices. But ICASA should not establish a mandate dictating the precise technology to be used in determining geolocation. Such specificity will limit the ability of TVWS users to take advantage of technological developments in the field of geolocation. Moreover, GPS – the primary method of obtaining outdoor location data today – often works poorly indoors, so it may be of limited utility in geolocating indoor devices. As a result, the Authority should permit devices to report their location using GPS, but it should not be designated as the *only* permissible method.

Equally importantly, in order to deal with varying degrees of location accuracy among devices, the Authority should require devices to provide their location capabilities as an input to a database, rather than requiring all devices to meet a fixed geolocation accuracy target. The database can then use this accuracy parameter as an input for calculating available spectrum in the vicinity of the device. Thus, a device with poorer location-accuracy capabilities may have access to a lesser number of channels, while a device with more precise location-accuracy capabilities could gain access to additional channels. Both the FCC and Ofcom have recently adopted a similar rule for licence-exempt devices operating in their television bands.[78]

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

The US model strikes an appropriate balance: it requires height information for fixed devices but not portable devices. Fixed devices often operate at higher power and are more likely to interfere with incumbents than portable devices. Equally importantly, their heights can be supplied by a professional installer, so FCC requires fixed device operators to provide height information to a database. Portable devices are lower power and less likely to be operated at high elevations outdoors; as a result, they are less likely to cause interference. Equally important, it is often difficult to automatically determine the height of these devices using today's technology. As a result, the FCC does not require 3D location of portable devices. Instead, it has established the protection criteria

78 Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap, and Channel 37 (ET Docket No. 14-165), and Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 600 MHz Duplex Gap Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions (GN Docket No. 12-268). para. 77 ***https://www.fcc.gov/document/amendment-part-15***; Ofcom, Implementing TV White Spaces (2015), available at http://stakeholders.ofcom.org.uk/binaries/consultations/white-space-coexistence/statement/tvws-statement.pdf. Para. 7.59ff.

that ensure interference is very unlikely, even if portable devices are operating at a significant height above ground level. ICASA should also adopt this course.

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?

A fixed device with an external antenna should be treated similarly to all other fixed devices: a professional installer should be permitted to provide location information on the device itself, which can then transmit such information to the database.

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

Yes. Wherever it can be applied, dynamic spectrum sharing should be the norm rather than the exception. Dynamic spectrum access is, in principle, a spectrum management model that increases efficiency of use in any band in which there is underutilised spectrum that be used on a secondary basis without causing harmful interference to protected entities.

ICASA should commission studies to identify candidate spectrum bands for this mode of spectrum sharing, taking into account international developments in this regard.

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

If ICASA's rules for the use of TVWS are initially limited to the UHF band, ICASA should move expeditiously to expand the framework to the VHF band. Beyond the broadcast bands, Google suggests that examining sharing the 3400-3800 MHz band would also be beneficial.

The FCC has recently adopted rules enabling spectrum sharing between federal (government) incumbent users, fixed-satellite stations and wireless services in the 3550 - 3700 MHz band.[79]

The 3400-3600 MHz band is allocated for international mobile telecommunications in South Africa, setting the stage for sharing with other uses, but Google does not have complete information regarding the use of the 3600-3800 MHz portion of this band within the country. The latest usage

79 Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550- 3650 MHz Band, GN Docket No. 12-354, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 (2015) (Report and Order and Second FNPRM).

spreadsheet from ICASA[80] reflects the entire band from 3600-4200 MHz as being available for satellite services coordinating with existing legacy terrestrial services provided by Telkom.

If the band is in fact being used for fixed satellite services, it would be an appropriate candidate for sharing: like broadcasting operations, satellite services are delivered from known, fixed locations that can be protected through the use of a databases or spectrum access system. There is a developing ecosystem around the use of this band for backhaul and small cell applications and new technologies being developed to ensure protection of primary users from harmful interference.

Moreover, the US experience in sharing between fixed satellite services and terrestrial wireless operations will provide useful learnings as ICASA considers a framework for dynamic access to this band.

Q72. Are the study questions above the most relevant?

The proposed questions collectively address the relevant issues.

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

Not at this time. Google encourages ICASA to take a broad view in defining and evaluating the potential value or benefits to be derived from allowing dynamic access to additional bands.

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?

None other than stated above.

80 https://www.icasa.org.za/LegislationRegulations/EngineeringTechnology/RadioFrequencySpectrumManagement/FrequencySpectrumUsageandAvailability/tabid/394/ctl/ItemDetails/mid/1288/ItemID/4044/Default.aspx.

Conclusion

In developing a framework for the use of TVWS, ICASA should adopt the following core principles:

- determine protection requirements that are sufficient to avoid harmful interference while allowing maximum usage;
- consider multiple TVWS device profiles for fixed and mobile devices and for master and client devices;
- promote an internationally harmonised approach to TVWS device characteristics and certification to take advantage of economies of scale;
- encourage the development of multiple databases and promote competition to drive down costs and spur innovation;
- consider regional coordination when establishing a licence-exempt managed access spectrum framework and conformance regimes for the equipment; and
- recognise the value of spectrum sharing and promote its use as part of a forward-looking approach to managing spectrum more efficiently.

Google looks forward to working with ICASA and other stakeholders as ICASA refines a framework for the use of wireless devices in vacant TV spectrum.