**Before the**
**Federal Communications Commission**
**Washington, D.C. 20554**

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| Amendment of the Commission's Rules with Regard to Commercial Operation in the 3550-3650 MHz | ) | GN Docket No. 12-354 |

**COMMENTS OF**

**SPECTRUM BRIDGE, INC.**

## Executive Summary

Spectrum Bridge, Inc. ("Spectrum Bridge") strongly supports the FCC's goal to provide access to additional spectrum through sharing in the 3550-3650 MHz band. In our endeavors as a certified TVWS database provider, we have gained significant experience in the development and operation of spectrum sharing solutions (e.g. the TVWS database) and the development and certifications of radios. We have also acquired a comprehensive understanding of how users desire to deploy TVWS and other wireless solutions that rely on unlicensed and shared spectrum access and believe that multi-tiered spectrum sharing in this band is technically feasible and will provide considerable utility and economic advantages for all stakeholders. In our response, we focus on the necessary capabilities and requirements of the Spectrum Access System (SAS).

Expanding upon the functionality currently implemented in the TV bands (for TVWS) to enable three (3) tier access is well within the technical capabilities of an SAS.

While some aspects of the SAS must be different from the TVWS database, we firmly believe that spectrum sharing in TVWS has demonstrated the capability, flexibility and adaptability to do so. Hence, we strongly support the FCC's desire to move forward in a deliberate and conservative fashion, while fully understanding that the policies and regulations can be adapted as experience is gained.

Despite significant progress in spectrum sharing, some misconceptions remain regarding the mechanisms and operation of a TVWS database. This first is that an SAS required to service the proposed 3.5 GHz rules will be very complex when compared to a TVWS database. Although it is true that a majority of the incumbents in TVWS are fixed broadcast transmitters, they vary significantly in their operational attributes – transmit power, antenna parameters, protection thresholds, how they are affected by terrain and the dynamic and temporal nature of protection. In addition, there are a variety of other incumbent types that must also be tracked and protected, such as cable head-ends, public safety systems (LMR), and radio astronomy sites, peripatetic wireless microphones, the national borders and a host of other similar and unique conditions that the SAS must consider. In all, the list of incumbents in the TVWS database is diverse collection of more than 10,000 entities, which vary significantly. While the systems deployed to enable their protection, amongst secondary and dynamic spectrum use, should serve as a foundation and provide confidence for deploying similar spectrum management systems in other bands.

We hope that our experience and perspectives regarding the development and deployment of systems designed to support dynamic spectrum access is useful. We have compiled our responses in the table below and look forward to supporting the FCC's on-going efforts in this area and would be delighted to provide additional details on any area of interest.

/s/ Peter Stanforth July 14, 2014

CTO

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# Responses to areas in which the Commission seeks comment:

| Para. | Topic | comments | notes |
|---|---|---|---|
| 22 | | No comment | |
| 23 | | No comment | |
| 25 | | No comment | |
| 26 | common carrier or non common carrier basis | The SAS can enforce specific rules based on tier type if necessary. | |
| 27 | frequencies | No comment | No impact on the SAS |
| 31 | spectrum split by tier | The amounts/percentages of spectrum allocated by tier does not affect the SAS, as long as limits, constraints and availability are defined unambiguously. | The proposed 50/50 split is a good starting point which can be adjusted over time via the SAS. |
| 34 | dynamic channel assignment | 10 MHz non-contiguous (between tiers) fixed assignments would be very straightforward to implement, but least flexible.<br>Dynamic assignment would be the most flexible, but significant additional rules and/or information is required to minimize fragmentation. A practical, intermediate step could be dynamic allocation with a fixed channel plan. | See also paragraph 48, 91 and 103.<br>Coordination, conflict resolution and priority, both within an SAS and between SAS must be addressed.<br>What triggers channel reassignment? (ref: paragraph 48) |
| 35 | flexible allocations | Assuming that the channel allocation constraints contemplated in paragraph 34 are adequately defined, this is a simple implementation with minimal cost to the SAS and is already supported by the IETF PAWS protocol. | |
| 37 | GAA access to unused PAL | We suggest the “in use” triggering event should be registration by licensee, similar to the TVWS protected registration process; ”in use” should not be determined by a PAL channel request, because this does allow a current GAA user adequate time to vacate.<br><br>Once the SAS is notified of “in use”, a GAA can/will vacate at +10+1 minutes per 96.36©(1) rules. Transition to “in use” can be managed by either the FCC or the SAS. An FCC update is nominally once per day, while SAS interoperability (modeled based on the TVWS update process) can be ~15 minutes, therefore the SAS would be aware of an “in use” event more quickly than from SAS interoperability than an FCC update | For SAS “registration”, licensee validation info must be made available by FCC.<br><br>Rules should require registration far enough (minimum = 15 minutes; maximum = 24 hours) in advance of PAL channel request to ensure a GAA device has time to vacate.<br><br>The SAS should publish “in use” registrations for review, similar to TVWS public data. |
| 38 | exclusion zones | The SAS can easily apply exclusion zones | |
| 39 | earth stations | The SAS can easily apply protection for earth stations | |
| 40 | international borders | The SAS can easily apply rules for international borders | |
| 42 | license process | No comment | |
| 43 | PAL | We agree with the proposed definitions. | |
| 46 | census tracts | The SAS can easily manage census tracts as the prescribed unit of geography defining PAL usage. Census tract data is well defined and readily available. There is also an inherent correlation between ideal entity size, demographics and usage parameters.<br>Finer grained pixels will significantly increase the complexity and data management requirements, with diminishing and no obvious improvement in spectral efficiency. | Standard census tract shape-files are freely available from US Census Bureau |
| 47 | 10 MHz channels | The SAS can support any channel size | 10 MHz channels size are of a practical size for broadband applications and fully implementable. |

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| 48 | PAL channel assignment | Proposed functionality:<br>- SAS is permitted to assign specific frequencies upon request when available.<br>- SAS should endeavor to assign contiguous frequencies across geographic boundaries.<br>- SAS should make reasonable efforts to assign adjacent frequencies to multiple channels in a single census tract.<br>Responses:<br>-spectrum efficiency: This would have little effect as only a best effort can be made to ensure optimal frequency assignments. Over time frequency assignments may become fragmented and different SAS providers may use different algorithms to optimize allocations.<br>-simplify or complicate: This objective will clearly increase the complexity of the system, but not significantly or in an unwarranted way.<br>-effect on predicting interference: There will be little to no effect the ability to predict interference. | See also paragraph 34 on coordination, conflict resolution and priority, both within an SAS and between SAS.<br><br>NOTE: interference prediction will require a propagation model; see also paragraph 78. |
| 52 | license term | Minimal impact to SAS | Allocating channels indefinitely will not promote fair market value and may encourage hoarding. The ability to aggregate several consecutive years of licenses through competitive bidding is certainly a compromise, but perhaps a bit excessive. However, it is understood that some ability to acquire licenses for a specified term, longer than one (1) year through renewal and competitive bidding may be necessary to justify capital investment. |
| 53 | license term | No comment | |
| 54 | assignment of licenses | No comment | |
| 55 | aggregate limit | No comment | 20 MHz appears to be a practical starting point when mutual exclusivity exists. This limit can be modified as the system matures and data is gathered. |
| 57 | GAA licenses | No comment | |
| 61 | contained access | The SAS system is scalable to support a virtually unlimited number of CAF venues. However, it may be more pragmatic to treat CAF usage as a PA tier user, with the ability to acquire access to spectrum with additional defined constraints and an alternate currency (status or type of user). If the CAF users are treated as PA users (exclusivity with holding limits) then the equal (50/50) sharing schema, ensures the GAA tier is not unduly encumbered.<br><br>Registrations in TVWS, can be monitored by the FCC, should be included in public data for review. | |
| 63 | geo-location accuracy | ±3 meters (vertical) accuracy is realistic, assuming antenna heights are reported as AGL and antenna ASL is derived from terrain data. ±50 meters (horizontal) accuracy is practical and reasonable. These limits have proved sufficient for mitigating interference to incumbents in TVWS. | We suggest that the CBSD should be able to report location uncertainty (similar to Ofcom/ETSI/PAWS) to allow/support devices that cannot fix to this accuracy (or indoor or have no geo-location).<br>The SAS would apply the uncertainty when determining available channels. |
| 64 | channel interoperability | The SAS can support devices with differing capabilities.<br>Device capability could be pre-provisioned in the SAS, or reported by the CBSD via the communication protocol. This will allow lower cost devices to be offered to consumers, even though this may limit the ability of the CBSD to receive channels. | Operation across the entire band is well within the capability of existing technology. In fact, It is in the best interest of radio OEMs to manufacture standards based radios capable of operating over the entire band to achieve interoperability and economy of scale. |

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| 65 | Registration with SAS – channel switch time | Once informed by the SAS the device should be able to switch channels almost immediately. The latency for the SAS to be aware of the need and communicate the need to the device will be in the order of 15 minutes, as defined by the channel allocation validity period. | The statement "as directed by SAS within a reasonable time" is reasonable, assuming the SAS can 'contact' or 'find' the device. A shorter response period could be imposed, but it is our experience that shorter times may not always be feasible as communication will be subjected to the quality of wireless and internet connections, notwithstanding the computation and query time the SAS requires under heavy load. |
| 66 | Interference reporting – signal measurement | Reporting measured signal strength is problematic due to variations in receivers, antennas, location, elevation, shading, dwell time, etc. Therefore standardizing the measurement technique is going to be difficult, especially without affecting the cost of devices. Quality of measurements will also be a significant issue. Nevertheless, PSD measurements at RBW = 100 KHz would most likely be sufficient. | |
| 67 | security | TVWS serves as a practical and realized model for security.<br>The SAS can support industry standard protocols, e.g. https.<br>Bi-directional authentication may be required to validate CBSDs, but this requires advanced provisioning at the SAS | Security measures will be quite different depending on whether the SAS is reporting spectrum availability (e.g. TVWS) or authorizing spectrum use (e.g. cellular)? |
| 68 | master/slave | We agree with the proposal. | |
| 69 | digital modulation | We agree with the proposal. | |
| 78 | power limits | The SAS can support flexible power limits. However the SAS must know the CBSD capabilities and requires standardized environmental parameters. | Interference prediction will require a propagation model. See also paragraph 79.<br>Rural and non rural areas need to be well defined. Area could be defined by census block and revised as conditions change. |
| 79 | signal limits | Ideally signal strength limits will be defined at the boundary or border of a license area, as it is defined in other bands. Measurements using a RBW of 100 KHz is practical and sufficient. It is reasonable to assume that the specified signal level would need to be met at all points along the PA license service boundary at a reasonable distance above ground level (~3m) with some level of confidence as prescribed and implemented in accordance with a propagation model such as the extended Hata model. This can be achieved by calculating offset distances between the radio and various points of the boundary as a function of the desired radio operating parameters such as HAAT and EIRP. | |
| 80 | emission limits | These limits have proven to be adequate in many other bands. | |
| 81 | OOBE | More stringent limits are not compatible with OFDM modulation and other digital modulation technologies commonly used for broadband applications. Excessive OOBE have been a significant impediment to the adoption of TVWS. | |
| 83 | OOBE | No comment | |
| 84 | OOBE | No comment | |
| 85 | reception limits | TVWS rules were initially established with simple co-existence rules that enabled early adoption. A similar concept would enable operation in the 3.5GHz band. More specific co-existence rules, for more efficient spectrum use by more capable devices can be added to the SAS over time based on experience and device capabilities. | |

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| 87 | GAA power adjustments | The SAS can manage power adjustments in accordance with the time frames defined in the rules. | Currently CBSDs are required to query at 10 minute intervals per 96.36©(1), and execute within 60 seconds. |
| 88 | additional comments | No comment | |
| 91 | multiple SAS | SAS interoperability will be similar to that currently implemented in TVWS. Industry has demonstrated the ability, in TVWS, to accurately and consistently calculate and apply protections, and synchronize data in near real-time. We suggest the FCC define "what" and allow industry to propose "how". | We support the multiple SAS model. However the FCC should establish reasonable expectations to participate in the SAS certification process, require demonstrated competence, active participation in working groups and set a limited timeframes to complete certification requirements.<br><br>In several sections of the FNPRM (examples, paragraphs 34 and 48) procedures are described in the context of a single SAS. The concurrent operation of multiple SAS will add complexity that must be clearly addressed. |
| 97 | SAS operations | In principle we support the proposed requirements. However, there is a significant amount of additional detailed information that will be required before implementing a complete solution. For example:<br>- How will the SAS determine maximum allowable TX power?<br>- What propagation model will be used to determine required separations?<br>- How will the SAS protect PAL users from GAA users? | We suggest that the most practical model to use is the extended HATA model. It strikes an excellent balance between accuracy and computational complexity. |
| 98 | SAS coordination | Multiple SAS operation is readily achievable. However, we suggest that the definition of methods and protocols for interoperability be imposed on an industry consortium for further definition and optimization. | Specific requirements (beyond what has been adopted for TVWS) would promote increased cooperation and promote greater operational consistency.<br><br>We suggest automated periodic testing to ensure consistency among SAS providers. |
| 99 | | No comment | |
| 100 | federal zones | Establishing a separate database to store sensitive federal information and instruct registered SAS's regarding the availability of certain spectrum is feasible and practical. | |
| 101 | spectrum sensing | Sensing has the potential for enabling useful enhancements to SAS operation. Specifically, dedicated sensors could be useful in addressing some of the issues outlined in paragraph 100 without directly affecting the operation of the SAS. However there are many challenges in achieving reliable CBSD sensing, e.g. how the devices are calibrated, how they are deployed (accuracy), impact of increased cost/complexity of devices. | 96.36(d) is unclear on CBSD interference reporting capabilities, and how an SAS defines a limits and thresholds. We have concerns regarding how this will be implemented in a CBSD in a consistent and cost effective manner.<br><br>Another concern is how the correlation is made between what an SAS asks for and what a CBSD can provide. |
| 102 | validate CBSD operation | SAS can validate CBSD identity. | |
| 103 | frequency assignment | It is feasible for the SAS to dynamically manage frequency assignments. The SAS will "take into consideration any channel requests submitted by CBSDs as well as geographic and spectral efficiency considerations" | Frequency coordination/synchronization across multiple SAS's must be considered. |
| 104 | security | See comments on paragraph 67 | |

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| 108 | SAS authorization | The proposed rules do not unambiguously establish appropriate qualifications for SAS Administrators. Expand on the TVWS example. Be more specific about how an SAS provider would qualify and remain qualified.<br><br>We suggest stricter requirements on calculation accuracy (similar to WSDBA group efforts or Ofcom requirements for Database Administrators).<br><br>Automated access for test scenarios to ensure continued accuracy. | The process should not be open ended, qualification should be completed in a reasonable timeframe. |
| 109 | SAS fees | Competition will dictate an acceptable fee structure within each, including the ability to offer differentiated services, and whether users, licensees or manufacturers are charged. Limiting fees to Priority Access Licensees will not effectively promote diverse and innovative use of the GAA service tier. In fact this may have the opposite effect as there is no incentive to innovate and manage services for the GAA tier. | |
| 110 | additional rule changes | No comment | |
| 115 | licensing | No comment | |
| 116 | incumbents | No comment | |
| 118 | competitive bidding | No comment | |
| 119 | competitive bidding | No comment | |
| 121 | competitive Bidding | No comment | |
| 123 | Bidding process | No comment | |
| 125 | Bidding process | No comment | |
| 126 | Bidding process | No comment | |
| 127 | Bidding process | No comment | |
| 128 | Bidding process | No comment | |
| 130 | Bidding process | No comment | |
| 132 | Bidding process | No comment | |
| 133 | Bidding process | No comment | |
| 135 | secondary market | An annual auction process coupled with a healthy secondary market in which the FCC assumes a passive role, as opposed to current requirements in Section 310(d), will promote a more dynamic secondary market. An effective secondary market will not be successful in the 3.5-3.7 GHz band if transactions are impeded by the existing Section 310(d) rules. The Section 310(d) review process is lengthy (months) and complex (typically requires legal counsel) and transfers are subject to Commission approval, which requires significant cost. To attain efficiency, secondary market transactions in this band (conducted between auctions) should be conducted and executed entirely between the two interested parties, without the need for legal counsel or FCC approval. An appropriate methodology would be analogous to how the stock exchange conducts securities transactions in accordance with government rules and oversight, but without direct intervention. The FCC should retain audit and oversight of the process to ensure its integrity. | |

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| 142 | dynamic access | The SAS approach offers tremendous flexibility in implementing policies to mitigate the potential for interference in exclusion zones.<br><br>Operation within exclusion zones can be facilitated by the SAS when interference can be managed. | We support the concepts of geo-fencing, and co-channel operation where the SAS is managing co-existence. We believe this addresses a demonstrated need (agriculture, transportation) and has significant benefits to improve spectrum use.<br>Today, in TVWS, co-channel operation is prohibited, we suggest this be allowed as a managed co-existence function executed within the SAS between the affected parties. |
| 143 | CBSD protection | No comment | |
| 144 | incumbent interference | No comment | |
| 150 | calculate earth station protection | The SAS approach offers tremendous flexibility in implementing policies to mitigate the potential for interference to FSS earth stations. | |
| 151 | calculate earth station protection | The SAS approach offers tremendous flexibility in implementing policies to mitigate the potential for interference. Protection criteria could be specified by rule (e.g., specific receive protection area) or by industry standard/multi stake-holder groups (WSDBA) with the FCC as final arbiter. | |
| 159 | ground station equations | No comment. | |
| 160 | look angle | No comment | |
| 161 | additional mitigation | No comment | |
| 162 | enforcement and interference mitigation | Transparency and availability of data by the SAS to industry can aid enforcement and improve confidence in the systems. For example, TVWS license holders are able to use public data to verify that WSDBs are providing correct protection. | |
| 168 | grandfathering | The SAS is an excellent means of facilitating a transition process that incorporates the 3650-3700 MHz band into the regulatory scheme described in this FNPRM. Additional or unique incumbent protections can be provided in the interim, with time limits. | |
| 169 | allocation | A 50%/50% split among PA and GAA tiers seems reasonable and promotes a healthy symbiotic relationship between tiers and operators. | |
| 176 | IRFA | No comment | |
| 178 | Alternatives | We believe the proposal is innovative, while remaining realizable in the relative short term. Alternative schemes with an emphasis on static assignments would be a retrograde step. | |