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A Potential Alliance for World-Wide Dynamic Spectrum Access

DSA as an Enabler of National Dynamic Spectrum Management

*By Preston F. Marshall**

I. INTRODUCTION

Dynamic Spectrum Access (DSA) Systems are one of the most promising technologies available to increase the range and efficiency of spectrum dependent services. DSA systems locate unused spectrum, and organize their users to operate within the spectrum they have identified. DSA systems ensure no interference to other users by scanning and sensing the environment, as the Defense Advanced Research Projects Agency (DARPA) NeXt Generation spectrum sharing field tests have established, or through pre-existing knowledge, such as the geolocation database proposed for unlicensed access to TV band white space, or a combination of both. Reported experimental results to date have shown that the promises from DSA technology are realistic and achievable.

WIRELESS FUTURE PROGRAM

If the dialog for Dynamic Spectrum Access was less about "taking spectrum from DoD" (in the United States), and more about "increasing flexibility of world-wide spectrum access," advocates could form a common interest with the military that could accelerate DSA throughout the world.

Additionally, recent research has shown that DSA has significant benefits, for both licensed and unlicensed users, even if a service has more than sufficient spectrum. These advantages derive from improvements in network scaling, increased density and, potentially, actual reductions in the cost of equipment, compared to equivalent performing, non-DSA systems. Even with relatively unlimited spectrum, there are strong advantages to using DSA; therefore advocacy for DSA need not be constrained to only those who seek additional spectrum access. For example, there are strong reasons to believe that DSA technology can address the intractable problems of co-site interference, such as those driving the NEXTEL spectrum relocation. Denser, more crowded spectrum will likely make these situations more common.

In summary, DSA affords two benefits:

- It provides for increased density, better system management, and inherent in-channel and co-site interference resolution; and,
- It enables opportunistic access to the spectrum for uncoordinated sharing of spectrum on a non-interference basis.

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A number of communities are advocating for DSA in order to leverage the technology to introduce a variety of new services or products in what appears to be underutilized and potentially shareable spectrum. Not surprisingly, incumbent spectrum users have been generally hostile to the introduction of shared devices within spectrum they are dependent on for services, operations, or revenue. Therefore, they have been hostile to regulatory acceptance of DSA.

There have been several preconceptions about DSA that appear to have become a "conventional wisdom" and which run through the dialog regarding how to best achieve acceptance and deployment of DSA Systems. Belief in these preconceptions may cause advocates of DSA to overlook potential partners in advocating for the technology. In particular, while there is tension between the advocates and military authorities in considering sharing spectrum within the United States, there may be mutual interest in obtaining access for DSA devices internationally. Similarly, while public safety interests might fear the introduction of DSA devices within "their" spectrum, demonstration that DSA offers increased performance, responsiveness, and density to public safety networks may make DSA a desirable technology to these communities.

II. COMMON PRECONCEPTIONS OF THE CONVENTIONAL WISDOM

Common preconceptions about the likely deployment of DSA include:

- That DSA is an alternative to, and will replace spectrum management as practiced today,
- That unlicensed applications will lead the way,
- That this is a "Zero-Sum", and we need to get spectrum from someone, and,
- That the U.S. regulations are the first step to DSA.

It is worthwhile to examine each of these further, since they have dictated the alliances that have evolved to advocate or oppose policies favorable to DSA, and have also driven the issue, as framed, to the regulatory community.

1. Does DSA replace spectrum management, or should it be argued that it does?

Many in the DSA community have made arguments that the use of DSA supplants the classical spectrum management functions such as making frequency assignments, or setting power limits. It is both an untrue and an unnecessary argument. It alienates the very community advocates that would like to embrace DSA technology, and it oversimplifies and trivializes real engineering, technology, and policy issues. This is the equivalent of walking up to a hornet's nest and hitting it with a stick – unnecessarily agitating key spectrum users and constituencies.

A more nuanced approach would be to make the argument that DSA does not supplant spectrum management. It provides spectrum managers with powerful tools to resolve otherwise intractable problems of variable propagation, co-site and adjacent channel interference, and policy enforcement, among others. It enables additional services to be added to the spectrum, without directly removing existing uses. Re-

cent research is demonstrating that DSA can be used to resolve interference and co-existence issues, even with a single band. The spectrum management community should be on our side of this policy discussion, if we can avoid rhetoric that alienates them before all of the facts and science are on the table.

DSA can be viewed as synergistic to the regulators' goal of aligning and balancing spectrum needs and resources. We should not put ourselves as opponents of regulation or of those that license spectrum; we should be emphasizing the common interest in dynamic management that can meet both needs. There is certainly an argument that DSA can improve reliability for both protected and opportunistic users. That perspective is missing in much of the current dialog.

2. Is unlicensed access likely the first DSA adopter?

Unlicensed access to unused spectrum capacity is certainly an attractive model. And, it is likely that TV band white space, which the FCC recently decided to open for low-power unlicensed sharing, will be an attractive candidate in some places. However, if advocates want to achieve acceptance of DSA, then consideration should be given to working with current license holders to assist in "re-farming" current licensed spectrum. If we initially argue for DSA under the principle that the benefits of any increased access or efficiencies are transferred to some external community, such as unlicensed use, then there is little incentive for cooperation. On the other hand, if allowing DSA within these bands demonstrates additional capability, reduced interference, and practical device operation, than there is a precedent for expansion of DSA into more regions of the spectrum, both within the United States, and throughout the world. The license holder would obtain flexibility to improve service, reliability and capability, and other uses of the band (such as opportunistic access) would be permitted; benefitting all participants.

Additionally, we need to understand that, other than some of the proposed TV white space devices, early DSA devices will likely be more expensive than current mass market, unlicensed technologies, such as Wi-Fi. Adding DSA to a $3,000 radio may not significantly impact its cost; adding it to a $10 one certainly will. Wi-Fi did not just appear as ten-dollar cards for PC's; it was built on decades of investment by licensed communications applications. If Wi-Fi is the model for an eventual DSA deployment, we should consider the licensed applications as initial adopters, investors in technology maturation, and co-advocates for the regulatory changes that are needed. For example, if public safety "pooled" individual channels and selected them dynamically, it is likely that all participants in the pool would have more surge capacity when needed, since fire, storm, flood, famine, civil disruption, war, and pestilence are unlikely to occur simultaneously in the same place! This is a direct DSA benefit to public safety license holders.

3. Should proponents of DSA have a "Zero-Sum" mentality?

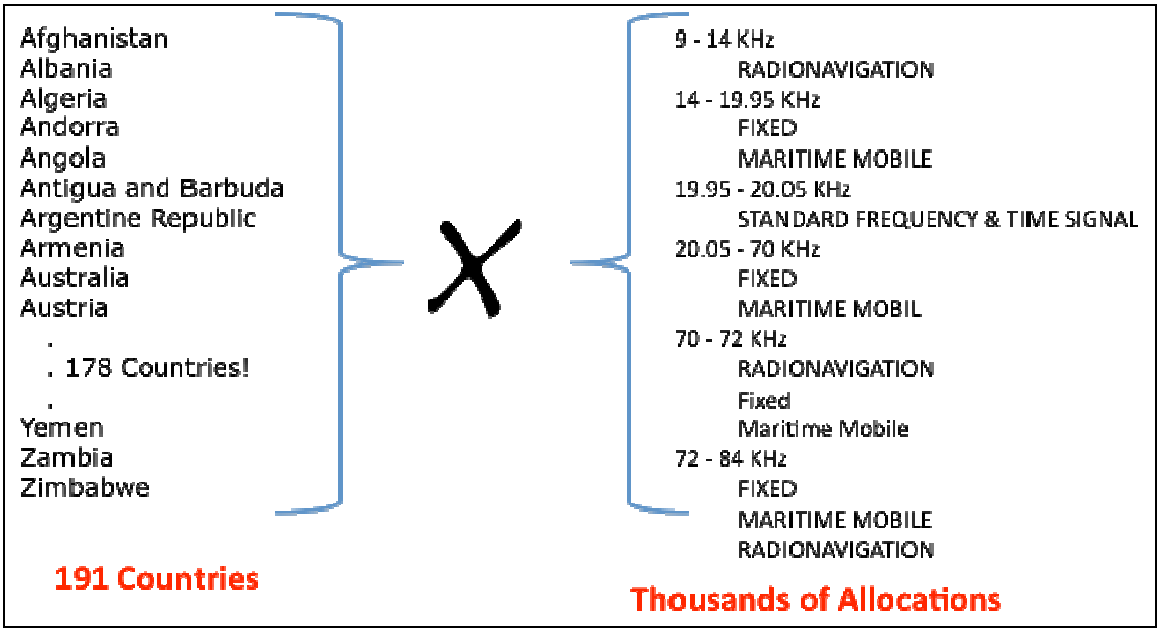
Much of the DSA advocacy creates an inevitable pushback from current stakeholders, because today we have an ownership mentality of spectrum resources that will not be immediately overcome. In fact, many DSA/unlicensed proponents are really saying, "what's yours is ours, and what's mine is still mine!" Even DSA advocates tend to take a "real estate model" towards spectrum access themselves. Moving spectrum from current exclusive use, to DSA provides dynamic access, but it does not provide dynamic management; it is still tied up for a single technology and user community, just a different one. Since so much of the spectrum is tied up in licensed applications, it is reasonable that

we look for DSA arguments that are supportive of, and beneficial to, licensed users. "Owners" of spectrum may have the most vested interest in the flexibility provided by DSA. They need not be enemies of DSA, if they are not threatened by the use of the technology.

4. Should we assume that DSA will be deployed in the United States first?

Regulators in the United States, through efforts such as the FCC's Spectrum Policy Task Force, and the TV white space decision, have shown the most readiness to consider spectrum sharing. That is true, but the also has some very unique characteristics that make it both atypical, and challenging. The United States has vast regions with very low population, such as the Western deserts. It not only has a large standing military, but also has devoted large spaces (square miles) and large segments of the spectrum to use, exclusively by the military. Lastly, it has a unique view of the role of its national security apparatus, in particular the likelihood of expeditionary military operations, far from its own domestic communications infrastructure. Additionally, it has a century of building out spectrum-dependent infrastructure that perceives DSA as a threat to its reliability, viability, or economics. Lastly, the United States has successful and effective communications services, and thus the perceived benefits of an advanced, but potentially disruptive technology, are not as strong as in regions that are massively underserved by their current fixed and mobile infrastructures.

The scope of a country-by-country and band-by-band approach to DSA is quite extensive. There are currently 191 countries in the ITU, and thousands of individual spectrum bands allocated. Consider the effort that has gone into the recent progress on access to the TV white space. We want to avoid a "One-Country, One-Band" at a time approach. If we argue that *this band in this country* is a special case, then have we not undercut the more general arguments for spectrum sharing? There is synergy amongst the countries and amongst the bands that is lost when they are addressed outside the context of a general framework. Further, it forces advocates of DSA to argue for a single business model that is limited to one country, and to the sharable resources in just one spectrum band.



IV. STRONGER ARGUMENTS FOR REGULATORY ACCEPTANCE OF DSA

There has been a tendency to view DSA as inherently a form of "spectrum redistribution" that benefits the "spectrum poor community" at the cost of the "spectrum rich community." This might have been a correct a few years ago. However, our understanding of DSA technologies has increased and our appreciation of the systemic benefits of it has emerged. We can now frame the advocacy of DSA as having benefits to both current and prospective spectrum users, even if some of the current spectrum users have yet to, or are only beginning to, understand the benefits to themselves. Regulatory acceptance of DSA would both improve current spectrum usage, as well as enable opportunistic spectrum services.

V. SUGGESTIONS FOR THE FUTURE: TURF BATTLES OR A COMMON GROUND CAMPAIGN?

There exists some (unexploited) common ground between the proponents of DSA and existing users of spectrum in the United States. Many DSA proponents have looked to military spectrum as a ripe target for sharing and DSA technology. The pro- or anti- positions of employing DSA in current military spectrum obscures a natural mutual interest between advocates of DSA and the military; dynamic access to spectrum on a world-wide basis. Although there is a tendency to think of military spectrum usage in a combat context, the bulk of the Department of Defense (DoD) spectrum usage is for test and training, and non-combat operations.

Recently, there has been extensive DoD involvement in disaster assistance, necessitated by events, such as hurricanes, typhoons, earthquakes, and tsunamis. These situations are tailor made for the advantages of DSA; lack of time for performing conventional spectrum assignments, a wide range of technologies in close proximity, shortage of on-site technical expertise, dynamic and evolving operational footprint, and likely lack of pre-planning.

If the dialog for DSA was less about "taking spectrum from DoD" (in the United States), and more about "increasing flexibility of world-wide spectrum access," advocates could form a common interest with the military that could accelerate DSA throughout the world. Further, there is a win here for licensed users. When licensed users wanted 25 kHz channels, there was no need for flexibility, or surge, since these were fixed regardless of usage context. The future is not channels; it is networks. With networking, there is much more flexibility to expand and contract spectrum usage. There can be peaks and valleys in demand. While DSA offered little to the owner of one hundred 6.25 kHz channels, it could offer immeasurable advantages to the owner of an emergency network that will see surges in traffic, and thus spectrum demand. These stakeholders have not joined the DSA discussion, but they should and must be a fundamental part of the dialog. Introduction of networking changes the spectrum management problem from providing a single clear channel (which still dominates our thinking) to providing assured access to at least a certain amount of spectrum. Pooling spectrum resources is in every participant's interest.

VI. CONCLUSIONS

If DSA arguments focused on the benefits to all, rather than the redistribution of current allocations, there would be a much larger and diverse community to support Dynamic Spectrum Access. We can frame the arguments for DSA to acquire significantly more partners in advocating the technology.

From a regulatory perspective, this would imply that DSA should be approached with a perspective of the following:

- **Focus on World Wide Flexibility**. While addressing a single band in a single country is convenient, it will not offer other stakeholders significant benefits, and yet it mobilizes opposition under the appearance of a slippery slope, eventually spreading to other spectrum bands.

- **DSA is a Technology to Enhance Spectrum Management.** The objective is not to supplant spectrum management, but to automate the decision-making. DSA provides mechanisms to enhance the national regulation of spectrum through policy controls. DSA offers the flexibility to resolve interference without regulatory intervention. While it reduces the frequency management functions, it empowers the spectrum management ones.

- **DSA is agnostic as to the use in licensed (exclusive) or unlicensed applications**. While the initial arrival of DSA was associated with the introduction of what was assumed to be unlicensed users into licensed bands, this view offers no systemic benefit to licensed users. It must be stressed that in fact the principles of DSA are not linked to any particular regulatory status.

- **The objective for all users is the need for "spectrum on demand."** Rather than a different partition of spectrum, DSA can enable a transition from a regulatory commitment of a fixed block of spectrum to a commitment to at least a minimum level of spectrum access.

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