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Responses and Comments to Notice of Intent (NOI)

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SPECTRUM MONITORING PILOT PROGRAM

Presented to

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NATIONAL TELECOMMUNICATIONS & INFORMATION ADMINISTRATION

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LS telcom Inc. is located in Bowie MD and we design and develop software and system solutions and services for the spectrum management and wireless telecommunications market.

LS telcom is widely recognized as an international market leader of spectrum management software, consultancy and system integration. Our portfolio includes hardware and software solutions for spectrum monitoring, capture, storage, analysis and display. Our monitoring system can be deployed to stand alone, networked to give national coverage, or connected into LS telcom back office products to give full, detailed analysis of spectrum usage, licensing revenue return and more. The flexibility of the system architecture allows the use of your existing monitoring hardware, or the use of LS telcom provided hardware. The hardware can be scaled according to the operational requirement and as such the cost of the project can be managed, but allow for future expansion or enhanced capabilities.

A variety of factors affect the ideal measurement system such as the location, signal strength, signal type, etc. In addition, there are a lot of types of data that can be measured, such as frequency, field strength, bandwidth, location, etc. This depends on the goals that have to be achieved. In most cases, a tradeoff between features and costs has to be made. It can be two approaches, one general purpose system dealing with the full frequency spectrum or a mix of specific devices each focusing on a particular frequency band or radio service. The second approach gives the best performance but the cost is high.

We recommend that a system that follows the first approach by integrating a variety of RF front ends to cover the different requirements that different locations and frequency bands will require. Not every location will require a high end RF front end while others will. A system which can utilize different RF front ends that meet the situation with little to no custom engineering required will ensure that the monitoring requirements are met while keeping budget to a minimum.

During the Pilot Program, many bands will be under consideration as potential candidates for reallocation for the purpose of mobile broadband and other uses. As we are not a direct stakeholder in any band, we do not have any specific recommendation for frequency bands that would be most important to monitor initially. Our LS Observer is not a product that operates on a band by band basis. The system records the full data within the pass band of the RF front end in use. Based on the relative importance of different bands, different RF front ends would be recommended for use with LS Observer. Measuring the full spectrum will be beneficial for the pilot program as a guide for locations and bands that need to be looked into more closely.

With regard to the specification of monitoring parameters, in practical terms it is less important to have an RF front end device specification and more important to specify how can data from multiple sources be aggregated and displayed side by side in a statistically reliable and meaningful way. Using different RF front ends from different manufacturers on their own would result in data that is incompatible due to different specifications of input factors and output factors that would need to have some conversion to correlate between the different front ends. LS telcom has already resolved this incompatibility within the LS Observer system. It is the only such system that can aggregate data from different RF front ends and display them in a meaningful and reliable way side by side. The data collected by LS Observer is stored according to the specifications of the ITU Handbook on Spectrum Monitoring.

Crowded metropolitan areas will provide the most useful data for the pilot program. Such areas will be the most difficult and complex areas to engineer a monitoring solution but this will make a stronger case for a full rollout if the pilot program is successful. Crowded areas are where the most RF problems will occur, such as interference or unauthorized emitters. Real world data about spectrum usage will come from monitoring these problems and will be a better guide to future spectrum allocation than using current licenses and allocations as they are today. Metropolitan areas will also be the areas with the economic activity to drive rollouts of new systems if any are developed as a result of this program.

Three types of measurement units can and should be part of this initiative. Low footprint fixed measurement units can provide continuous measurement where infrastructure allows. Vehicle mounted mobile measurement units that can travel to areas where infrastructure is limited or site access for a permanent installation cannot be obtained can augment coverage. Finally, handheld portable units can be used to fill in the gaps where even vehicles cannot reliably access. A system which can accommodate these form factors and provide a unified interface would be ideal for this program.

LS Observer provides low footprint units that can be deployed virtually anywhere. The only infrastructure constraints are power and internet connectivity. Coverage and site acquisition are other constraints which require careful preplanning. By using public buildings for the sites of monitoring units, the cost and access issues related to site acquisition can be mitigated. Using propagation modeling software to analyze coverage estimates will assist during the site selection process to optimize coverage. This is also a good way to choose a geographic location for the pilot program: use propagation modeling software to choose which metropolitan area can provide the best coverage from units placed on public buildings and structures.

A small handheld could be used in a car but its features would be limited in term of RF characteristics of the receiver (e.g. scanning speed). We are able to integrate better receivers in a car, which won't fit into our handheld unit because of their bigger form factor. This also has also a clear advantage when it comes to antennas. We are able to integrate more and bigger antennas in a vehicle than a person could carry.

The handheld form factor would augment the data collected in situations where neither a fixed or vehicular monitoring unit is able to reliably be used. One such scenario would be when measuring higher frequency signals experience greater atmospheric path loss and thus require the measurement unit be closer to the transmitter in order to see it. It would be prohibitively expensive to cover even a small fraction of a city with fixed or mobile units scanning these high frequencies. It would also be possible to carry out a short term monitoring campaign for a specific purpose with less planning and coordination needed using a handheld monitoring unit. Within the LS Observer ecosystem, we supply all three of these form factors.

The data in LS Observer is normalized and can be integrated from all sensors. No matter whether the data comes from a fixed or portable unit, the data is compatible and can be used to supplement or as a comparison for other data sources.

There is an incremental cost associated with the acquisition of multiple fixed units within a community but this comes with the advantage of much greater coverage and statistical reliability of the data collected. Within the frequency bands of interest of this monitoring program, the path loss and propagation effects of buildings, trees, cars, etc. would limit the radius that a single unit would be able to see. Coverage of an entire metropolitan area would be challenging and to mitigate this issue we suggest using several monitoring receivers placed in areas considered most statistically relevant taking into account maximum nodes transmission coverage and that will be seen by the monitoring unit.

In addition to number of nodes, the temporal dimension is a factor to consider with regard to data accuracy. A measurement unit which has a very long scan time might be too slow to notice some signals which have a very short duration. The length of time for the measurement campaign is also dependent upon frequency to a degree. The reasons for this are the long term temporal issues, varying propagation due to season, differences in spectrum use on weekdays versus weekends or at different times of the month and statistical reliability. While any data is better than none, the less you have the higher the probability of inaccuracy. To put a rough figure on the length of any particular measurement campaign, the system should be monitoring a location for a matter of months, not days, and ideally it would be able to run for at least a full year. More data collected will always be more useful. This is why the our LS Observer system is designed so that each monitoring unit can store 30 days of raw data and 2 years of statistical data such as occupancy. This data is stored at the site of the monitoring unit and can be accessed remotely to retrieve the data.

For each location a pre-evaluation of the site should be taken into account to determine the node density, location probable coverage and so on. This allows the monitoring network to be established correctly and to understand what can be monitored before committing resources to installation. This can be done by propagation modeling or by undertaking some trial monitoring exercises at the selected area and examining the results.

The detection thresholds used to measure and characterize the patterns of incumbent systems is complex and depends upon the band and technology used. In general a system of evaluating the average noise floor of a given frequency/location and then identifying a percentage time above that noise floor for a given transmission would equal a valid signal being recorded. This is the basis of frequency channel occupation (FCO). It scores a frequency in use when there is a transmission on frequency for over a certain amount of time, as interference is usually transitory it does not score a hit. Of course ultimately this is the complexity of automated systems; various factors can come into play and cause the appearance of a frequency to be occupied when, in fact, it is not.

This why we promote FCO as the best analysis of spectrum utilization measured in different time increments, i.e. percentage of time a signal is seen in 5 minute increments, 15 minute increments, etc. The FCO is a very useful tool in order to control the spectrum usage, seeing which percentage of the time a frequency is used. A 0% use means that the frequency is free, and without interference. A 100% use means that the frequency is always used, typical for broadcast frequencies. Using different time basis it is quick and easy to find free frequencies and frequencies that could be licensed for a limited time, e.g. week/week-end, day/night.

In terms of monitoring off air, location, field strength and occupancy are the most immediately relevant information when evaluating potential sharing compatibility. Technically, the modulation schema and licensing regime are useful in determining sharing compatibility. In terms of practicality most wireless broadband systems are license free and can pop up and go at any time in any location they are the least likely candidate target for sharing unless it needs or want to share in an LPI/LPD environment (Low Probability of Intercept / Low Probability of Detection) unless co-sharing a technical level within the modulation (or expected modulation) envelope.

By having a set of real world data rather than the licensing view greater accuracy of sharing can be considered and more use made of natural or opportunistic spectrum availability. Ultimately this can feed into a comprehensive dynamic spectrum allocation system, maximizing the use of available spectrum.

The foundation of efficient spectrum management and allocation is accurate data in the license database. To make sure your license data is as correct as possible you need to compare it to long-term real spectrum occupancy data. This is why spectrum monitoring “on its own” is not enough. It is essential to compress and store long-term “historic data” on a permanent basis to be able to analyze the spectrum use at any time and for any frequency range that needs analysis.

A key to efficiency is to connect the spectrum management system and the monitoring system together. Management and monitoring are traditionally segmented in different organizations and different systems making communication slow and common work inefficient. Connecting management (database, licensing, etc.) and monitoring together opens speeds up traditional processes like preparing and sending monitoring orders from the management department to the monitoring department, reporting monitoring results, etc. Moreover, it opens new and powerful possibilities like automated analysis and correlation between theory based on database information and simulations and real world based on monitoring measurements and automated violation detection. For these purposes, LS telcom offers Observer as a monitoring solution, MONITORplus as the interface between the monitoring and management system and SPECTRAemc for the planning of both transmitter and monitoring system locations.

The key differentiator of our LS Observer compared to conventional monitoring systems is its unique data compression and storage capacity as well as its integrated intelligent software for spectrum analysis. LS Observer in combination with the SPECTRA spectrum management system allows for automated comparison of spectrum data in the license database with real world spectrum occupancy data, which makes this Combined System Solution the real enabler for truly efficient spectrum allocation and usage.

MONITORplus represents the interface between the frequency license database and radio monitoring systems such as Observer for the control of the spectrum use. It allows not only direct control of several monitoring devices, but is the tool for administration and analysis of monitoring measurement data. It supports the typical monitoring tasks of a regulatory authority such as monitoring of the usage of the spectrum and correlation analysis between recorded data and license data.

Technical analysis and basic planning may be performed in SPECTRAemc. This tool allows visualizing the existing stations, creating and placing new stations, embedding them into an existing network, calculating coverage and interference between the existing stations and the new component or network and finally assigning also frequencies.

Another advantage of our LS Observer is that provides easy automated analysis of spectrum usage, automated license and channel validation, report generation and quick identification of illegal use or interferers always monitoring the entire frequency spectrum and capturing everything at all the times. Whatever monitoring data is needed, it is available in the system and can be retrieved easily for instant intelligent decision. LS Observer is a self-contained monitoring system, whose scanning and storage options will be set by means of an external PC, but can be run in fully independent and unattended mode.

Observation of wide frequency ranges (in accordance with receiver specifications) and carry out detailed analysis on raw spectrum data is stored. LS Observer stores raw data up to 30 days, compressed spectrum data up to two years. The system automatically compresses and stores the entire observed spectrum throughout the tuning range of the attached RF front, while noise is being removed. Costly external storage systems are not required, because LS Observer stores all data within the confined monitoring system.

From the radio frequency front end with LS Observer you can “observe” the complete frequency range and carry out detailed analysis on raw spectrum observation data that is stored for about 30 days. The system then automatically compresses and stores the entire observed spectrum throughout the tuning range of the attached RF front end, while noise and zero occupancy are removed. In the standard version of LS Observer, compressed data is saved in the RMU for up to two years.

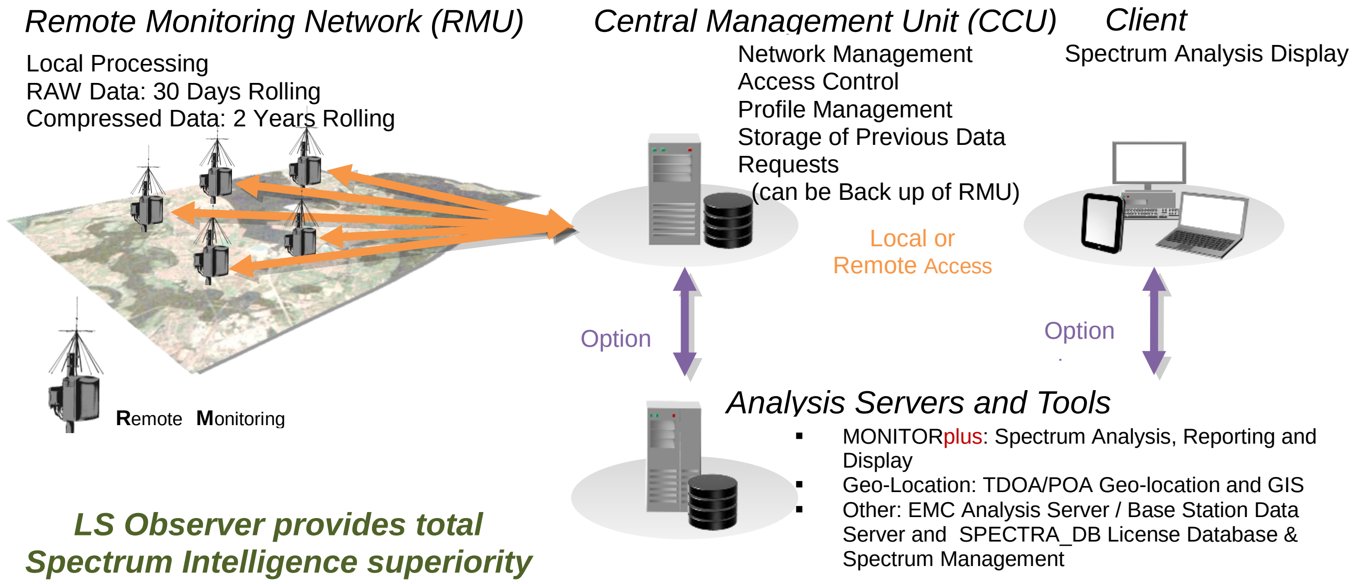
Intelligent software will sort out the necessary information and only the data required for analysis is transferred from the radio frequency unit to the central server. You can retrieve exactly the data you need with the help of search filters. This is why only little infrastructure is needed to connect to the RF front end device. In addition, the transferred data is stored on the central server and, if needed once more, does not have to be retrieved again from the monitoring unit.

This method saves huge costs on the backhaul infrastructure between the monitoring units and the central database, and opens up a large number of possibilities for monitoring unit locations.

Any system which is storing and collecting sensitive data should have user role management built in to ensure that sensitive data does not end up in the wrong hands. The government should consider whether or not frequency channel occupation data to be classified and sensitive. If spectrum monitoring data is made publicly available and certain bands are excluded, this would only highlight the fact that these bands are in use for classified means. Perhaps dummy data could be added to the occupancy statistics for these bands to obfuscate the classification of the bands. Perhaps some data like occupancy statistics would not be considered classified while other data such as location information is, thus requiring that the system sort out which data must be restricted to authorized users and which can be considered publicly accessible. For some emissions, the signal content is classified but information about the signal level is not sensitive. For the purpose of this program and the protection of classified information and the privacy of citizens, signal content should never be collected, stored or distributed.

LS Observer provides user role management so that if occupancy data is classified, only authorized users will be able to initiate a measurement of classified signals or access occupancy data from prior measurements. LS Observer also does not measure or store signal content as this is not relevant to the purpose of a spectrum management system. Occupancy, level data and location information provide enough information to make decisions regarding spectrum usage for the planning of future spectrum allocations.

Our LS Observer system represents an integrated platform for spectrum collection, spectrum visualization and spectrum analysis. Please find below system overview.



…and bridges the gap between spectrum management systems and monitoring systems