VT Wireless Symposium

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Title of Proposed Tutorial: **The IEEE 1900.5.2 Standard for Spectrum Consumption Modeling**
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Abstract:

Model-Based Spectrum Management (MBSM) is spectrum management based on the creation and exchange of spectrum consumption models (SCMs). SCMs define the boundaries of spectrum use so that the compatibility of uses can be arbitrated objectively. SCM can describe a range of spectrum access constraints as simple as a traditional frequency assignment to more complex spectrum etiquettes for DSA. SCMs are machine-readable and are complemented with standard algorithms to compute compatibility. SCM can enhance spectrum management and reuse in several ways:

In regulation, regulators can use SCMs to define a user's spectrum usage rights.

In commerce, markets can use SCMs to capture the quanta of spectrum that are traded.

In technology, SCMs can convey spectrum assignments and spectrum policy to RF systems and RF systems can use SCMs to autonomously collaborate in spectrum reuse.

In operations, distributed managers can use SCMs to collaborate in the dynamic management of spectrum.

The IEEE Dynamic Spectrum Access Networks Standards Committee (DySPAN SC) is standardizing spectrum consumption modeling in the standardization project 1900.5.2. This project was just authorized in 2013 and a first draft has been written. This tutorial will present the current details of the draft standard with the intent of preparing attendees to participate in the standardization and to anticipate future applications of using the standard.

Motivation:

SCMs are well suited for two important contemporary visions in spectrum management. Since they define spectrum use boundaries they are a natural choice for defining the harm claim thresholds that the Receivers and Spectrum Working Group of the FCC Technical Advisors Committee currently recommend for improving spectrum management. SCMs are perfectly suited for database managed spectrum sharing. They solve several of the challenges of building a national Spectrum Access System (SAS) as proposed in the 2012 PCAST report. They enable incumbents to reveal their spectrum use in a manner that obfuscates sensitive information about systems and missions and still allow determination of compatible reuse.

Tutorial Content:

The following is the proposed course outline.

- The role of spectrum consumption models
  - Definition of a loose couple and examples
  - Use of loose couplers to enable highly effective systems
- Overview of use cases of MBSM
  - Spectrum management
  - Managing coexistence and sharing
  - Creating policy for DSA systems
  - Dynamic spectrum management
  - Spectrum brokering
- Overview of the draft standard organization
- Constructs of spectrum modeling
  - The 12 constructs of modeling
  - The Spectrum Consumption Modeling Markup Language (SCMML)
  - Modeling phenomena
    - Frequency
    - Power
    - Propagation
    - Directionality
    - Location and space
    - Time
    - Intermodulation
    - Behaviors
  - Modeling Systems
    - Radio networks
    - Satellites
    - Unmanned aerial systems
    - Radars
    - Sensors
    - Jammers
    - Listening systems (e.g., radio telescopes and signal intelligence systems)
- Algorithms
  - Arbitrating compatibility of models
  - Measuring spectrum use
- Conclusion

Intended Audience:

The primary target audience is engineers, computer scientists and whitespace database administrators who are interested in: spectrum management, spectrum sharing, dynamic spectrum management, dynamic spectrum access (DSA) and whitespace database systems.

This topic should be very interesting to companies developing spectrum sharing database systems and to researchers and radio manufacturers developing radios to operate as part of these systems. It is relevant to regulators who seek an approach to define usage rights that account for all aspects of system performance. It is relevant to researchers and entrepreneurs who seek a method to commoditize spectrum.

Novelty:

The basic concept of modeling is not new; it was the subject of a 2007 DySPAN best paper and is described in a chapter of Bruce Fette's book, *Cognitive Radio*. The true novelty is that it is so timely to the issues of today. If MBSM were used in licensing spectrum, there would not have been the conflict that occurred in the Lightsquared/GPS conflict in the United States. Models would have revealed the conflict prior to any decisions and in the worst case could have provided a very objective approach to arbitrating the conflict. The methods of MBSM are a means to overcome many the hurdles of government and commercial sharing of spectrum. SCM provide a means for government owners of spectrum to identify spectrum they can share without revealing how they are using the spectrum. It provides a means to expand the concept of whitespace database management beyond the TV bands and into any band and for managing any type of RF spectrum use.

Past Tutorials:

A similar tutorial was presented at DySPAN 2012. There were between 20 and 30 attendees. This tutorial differs from the previous in its intended objective. Rather than introducing and promoting the vision for spectrum consumption modeling, it will seek to make the audience knowledgeable of the content and use of the 1900.5.2 standard. This tutorial has also been updated to match the changes that have been made in modeling since the last presentation.

Biography:

Prior to joining MITRE, John served 20 years as an engineer and as an ORSA in the U.S. Army. He served in all company level leadership positions and in battalion, brigade, and division staff positions. He taught electrical engineering at the United States Military Academy. He was the coordinating analyst in the Army's first tactical networking experiments. He is currently the Head of MITRE's Operations Research and Systems Analysis Department. In his twelve years at MITRE, he has led internally funded research in mobile ad hoc networking, consulted with the DoD on spectrum management issues authoring "Spectrum Management 101," consulted with Army analysis agencies on modeling and analysis of tactical networks specializing in operational effectiveness, and is currently leading a research project to enable more dynamic spectrum management by exploiting models of spectrum consumption. John has authored numerous papers on wireless networking, spectrum management, dynamic spectrum access and network modeling and evaluation and has patents and patents pending in wireless mobile ad hoc networking and spectrum management. He received the OPENTWORK Distinguished Paper Award in 2005, IEEE Dynamic Spectrum Access Networks Conference best paper award in 2007, and the International Test and Evaluation Association's annual publication award for 2007.

Dr. Stine received a Bachelor of Science degree in General Engineering from the United States Military Academy at West Point, Master of Science Degrees in Electrical Engineering and in Manufacturing Systems Engineering from the University of Texas at Austin and a Doctorate in Electrical Engineering from the University of Texas at Austin. He is a senior member of the IEEE and was registered as a professional engineer in the State of Virginia.

Logistics:

This course is a lecture. The room should be equipped with an overhead projector. Students should be able use their computers. I anticipate that course slides will be provided in an electronic form. I would also like to provide the students with the latest draft of the standard in electronic form for reference during the class.