Model-Based Spectrum Management
Enabling Dynamic Spectrum Sharing

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Model-Based Spectrum Management (MBSM)

- Spectrum management (SM) based on the creation and exchange of spectrum consumption models (SCM)
  - SCM define the boundaries of spectrum use
  - SCM use 13 constructs to capture
    - The emissions radiation by transmitters
    - The tolerance of receivers to interference
    - The temporal, spatial, and spectral variations that occur as a result of their operational use and the environment
  - SCM do not reveal the details of systems
  - SCM have attendant computations for assessing compatibility among models (A common means across the entire SM system)

Legacy

Data → Tools → Decision

Judgment

VS

MBSM

Data → Tools → Models → Tools → Decision

Judgment & Intent
A Central Role for Models

- SCM capture the minimum common set of data on spectrum use that is shared among machines, systems, processes, and organizations.

A loose coupler for spectrum management systems that provides a machine readable means to communicate spectrum use and DSA policy.

A common means for the communities of the spectrum management enterprise to communicate spectrum use and collaborate in spectrum sharing.
A vision for the sharing business case

- Spectrum owners work with a database administrator (a.k.a. broker) to model spectrum they can share
- Models of available spectrum are shared across the spectrum market
- Database administrators work as brokers arbitrating the lease of spectrum and collecting commissions for the service
Ways to define spectrum available to share

- Permissive model – a model of what is available

You can use the spectrum here

- Permissive with Restrictive models

You can use the spectrum here

If you do not interfere with these uses

All methods allow the modelers to hide the details of their use of spectrum
Demonstration Scenario

- We will use this scenario to demonstrate the various ways models can be used for sharing.

A radar on the coast
Permissive Models - 1

- Build a conservative permissive models
  - Take the most sensitive detail of performance (e.g., receiver sensitivity when it is pointed at a transmitter) and create a model with transmission and location restrictions that avoid interference – A model of allowed use

- Advantages
  - It reveals nothing about the radar

- Disadvantages
  - Conservative with least sharing
  - Does not take advantage of DSA radios
Build a conservative restrictive model
- Create a model that will protect the radar but do not model the radar (e.g., a transmitter and receiver model that applies to a space rather than to a point)

Advantages
- Hides details of the radar operation
- Provides more flexibility in how the whitespace may be allocated or used

Disadvantage
- Still some sharing opportunities that are not supported

You can use the spectrum here
If you do not violate the restrictions of this model
Permissive with Restrictive Models - 2

- Capture operational aspects of the particular use in a restrictive model
  - Capture the directional nature of the radar

Less restrictive models in the bigger space are designed to prevent interference in the low gain directions

- Advantages
  - Increase opportunity to reuse spectrum
  - Flexibility in whitespace reuse

- Disadvantages
  - Reveals more about the radar
  - Still opportunity to increase sharing

Transmitter and receiver models in this space are directional and more restrictive
Permissive Models - 2

- Exploit established protocols or policies
  - Provide a model that defines allowed transmission levels and protections in the model with the addition of a policy (e.g., WiFi dynamic frequency selection) or a protocol (e.g., a mechanism that attempts to trigger emissions relative to perceived radar pulses)

- Advantages
  - Very high reuse

- Disadvantages
  - Protocol can only operate in range of radar
  - Protocol specification reveals details of radar timing

You can use the spectrum here if you use protocol x or policy y

Assumes protocols are known and trusted
Conclusion

- MBSM can enable
  - Dynamic sharing of spectrum
  - Rapid interference analysis
  - Management of coexistence
  - Abstract presentation of sharing opportunities without revealing sensitive details of spectrum use

- SCM will enable the evolution of dynamic spectrum management
  - Conservative to liberal models with
    - Confidence in management
    - Technology improvement

- I would like to make Spectrum Consumption Modeling be to spectrum management what the Internet Protocol (IP) is to the Internet, a technology that enables integration of the Spectrum Management enterprise but also allows continuous innovation.
Future Work and Learning More

- You can participate in making it a reality
  - Help standardize it in IEEE DySPAN SC 1900.5
  - To bring you up to speed
    - A manual is available for download
    - This manual is being updated and the update will be publicly released when completed
    - Tutorial classes on the details of modeling and of some algorithms at DySPAN 12 and MILCOM 12.
    - Join our MBSM Handshake site (request access by email jstine@mitre.org)

DySPAN – Dynamic Spectrum Access Networks