Model-Based Spectrum Management
Enabling Dynamic Spectrum Sharing

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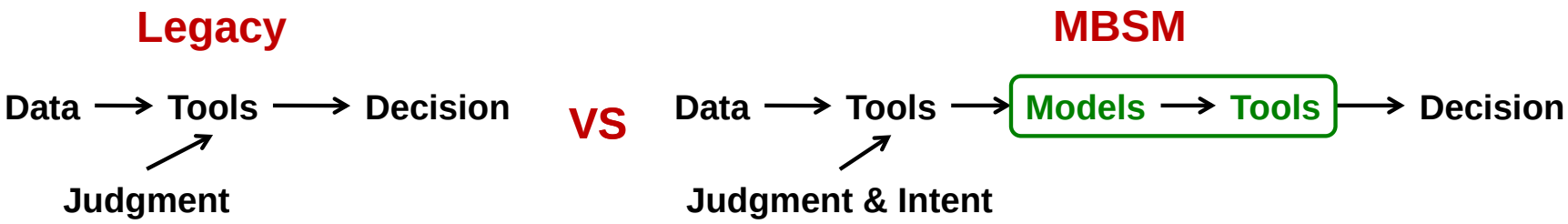
Model-Based Spectrum Management (MBSM)

- **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)**



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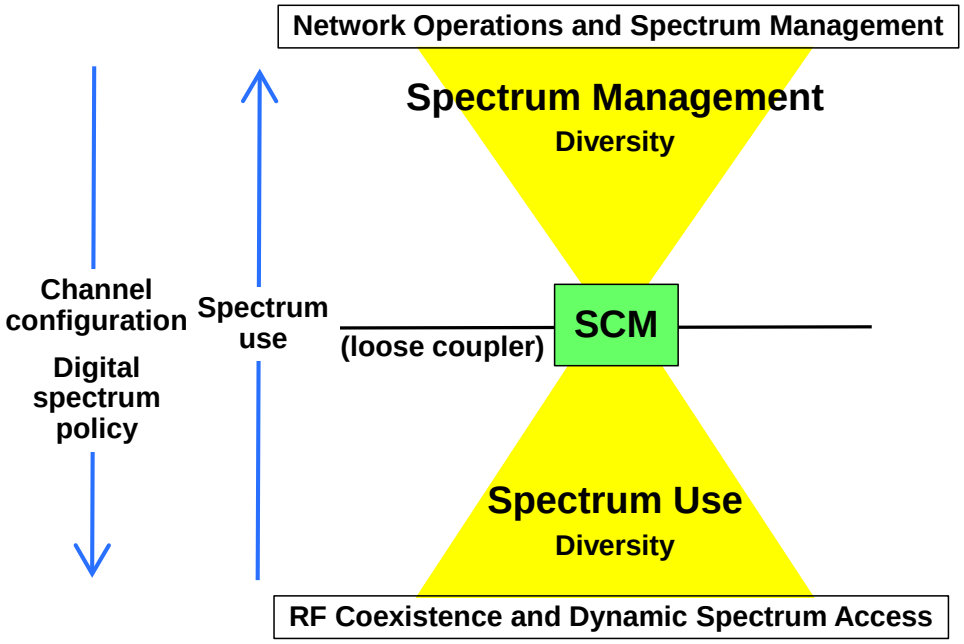
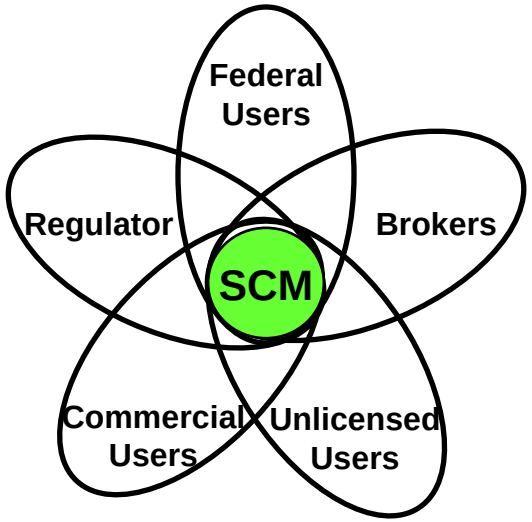
A Central Role for Models

- **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



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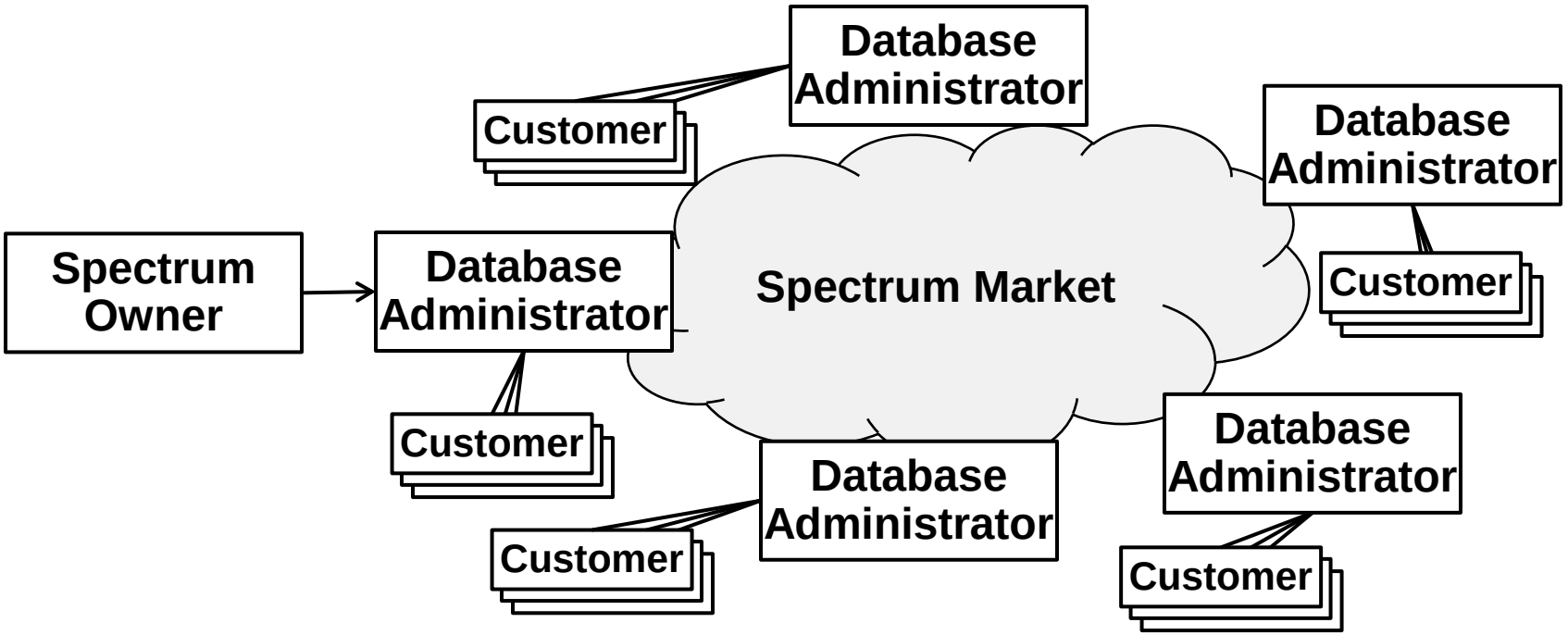
A vision for the sharing business case



- 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

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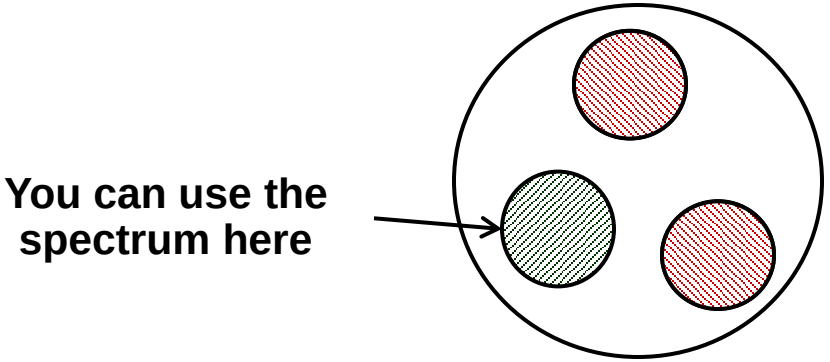
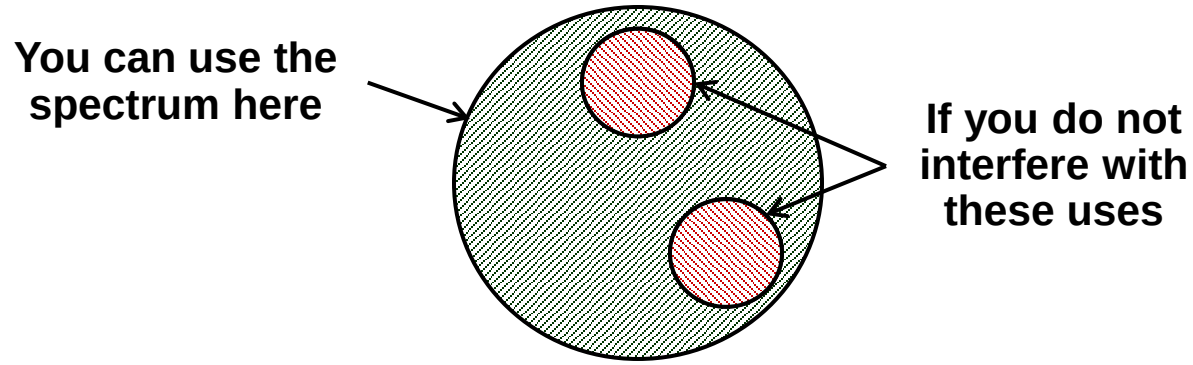
Ways to define spectrum available to share

- **Permissive model – a model of what is available**



- **Permissive with Restrictive models**



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

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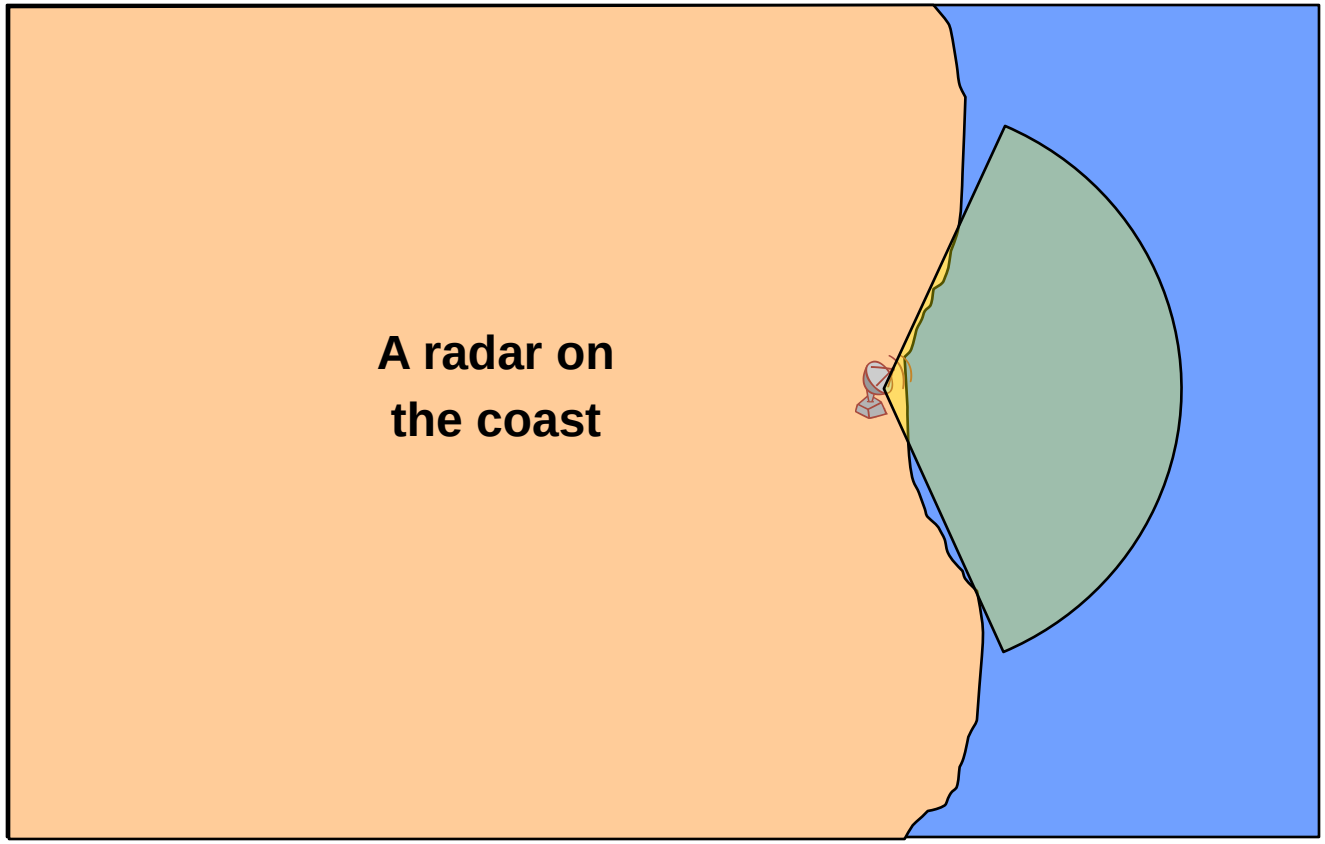
Demonstration Scenario

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



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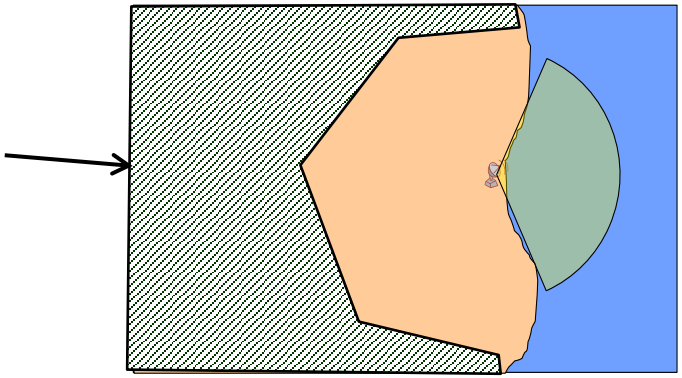
Permissive Models - 1

- **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**

You can use the spectrum here



  - **Advantages**
    - **It reveals nothing about the radar**
  - **Disadvantages**
    - **Conservative with least sharing**
    - **Does not take advantage of DSA radios**

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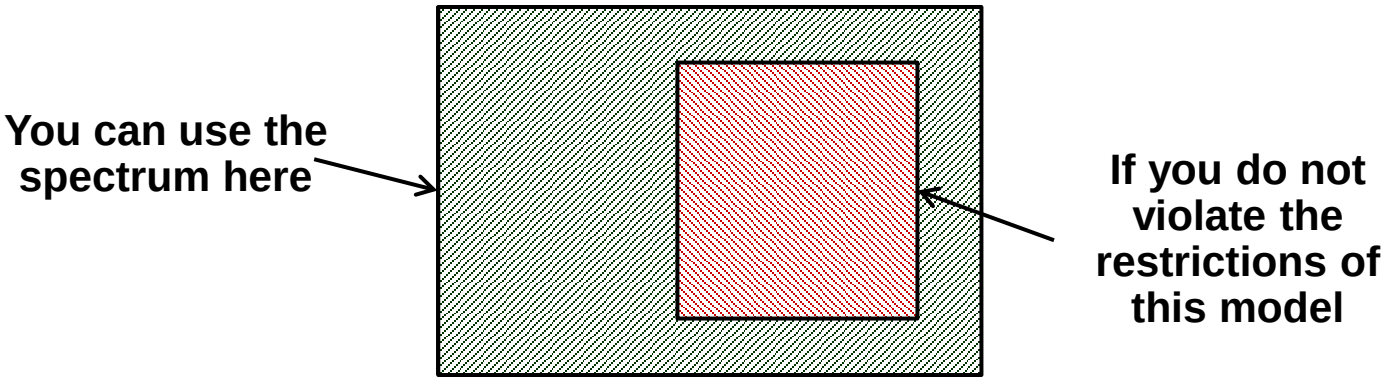
Permissive with Restrictive Models - 1

- **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**

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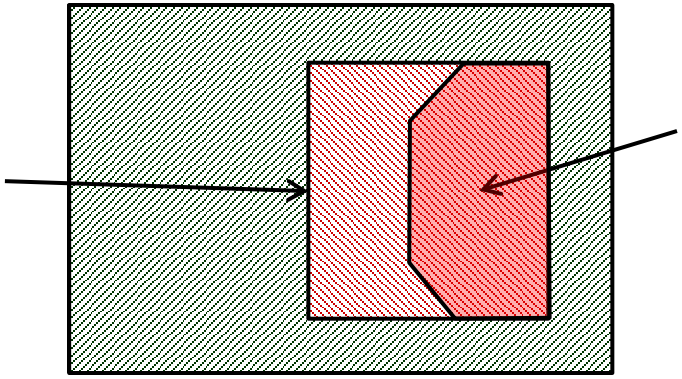
Permissive with Restrictive Models - 2

- **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



Transmitter and receiver models in this space are directional and more restrictive

  - **Advantages**
    - **Increase opportunity to reuse spectrum**
    - **Flexibility in whitespace reuse**
  - **Disadvantages**
    - **Reveals more about the radar**
    - **Still opportunity to increase sharing**

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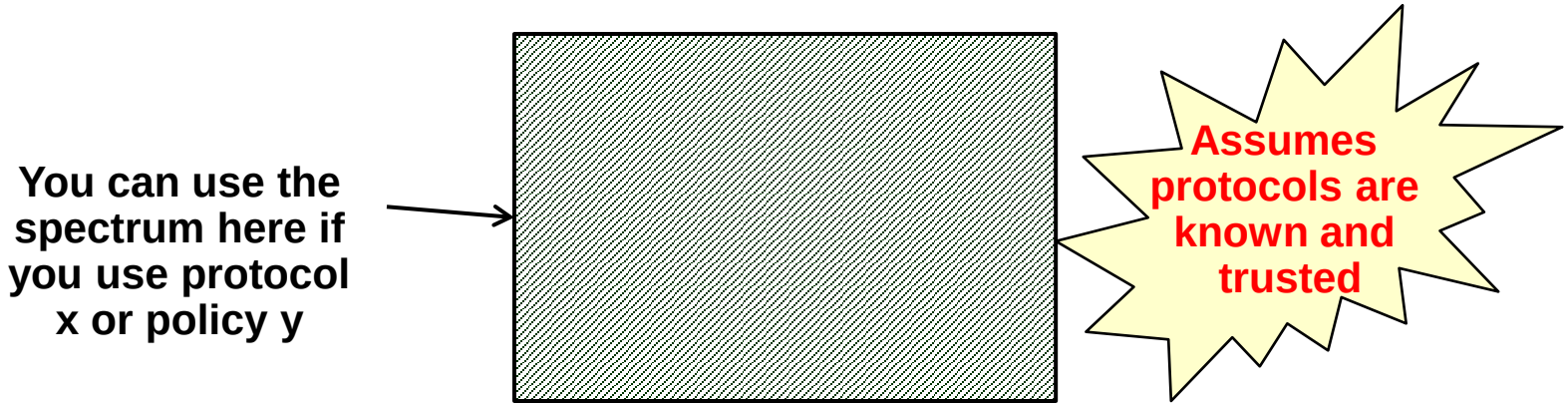
Permissive Models - 2

- **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**

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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

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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

      http://www.mitre.org/work/tech_papers/2011/11_2071/11_2071.pdf
    - This manual is being update 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)

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