Policy-Based Remote Spectrum Coordination

Constantin Serban, Telcordia
Thaddeus Konicki, Lockheed Martin

The Problem

- **Increasing spectrum shortage due to proliferation of wireless devices in various bands**
- **Increasing use of radio communication by tactical networks produces overcrowding in specific bandwidths**
- **Existing tactical radios are capable of operating in multiple frequency bands, however:**
  - Configuration/reconfiguration is mostly static and manual

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Our Objectives

- **Optimize spectrum allocation for a number of radio networks deployed in the same area**
- **Provide a robust way of collecting observations throughout network, thus improving the information base for making spectrum assignment decisions**
- **Make autonomous, policy-based decisions for reconfiguring the radio devices based on a wide array of conditions**

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Approach

CJSMPT

Spectrum
Management
Planning
Assignment
Interference Mitigation

DRAMA

Policy-based network
Management
Configuration
Re-configuration
Autonomous
Distributed

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DRAMA (1)

Management hierarchy is self-forming and self-healing

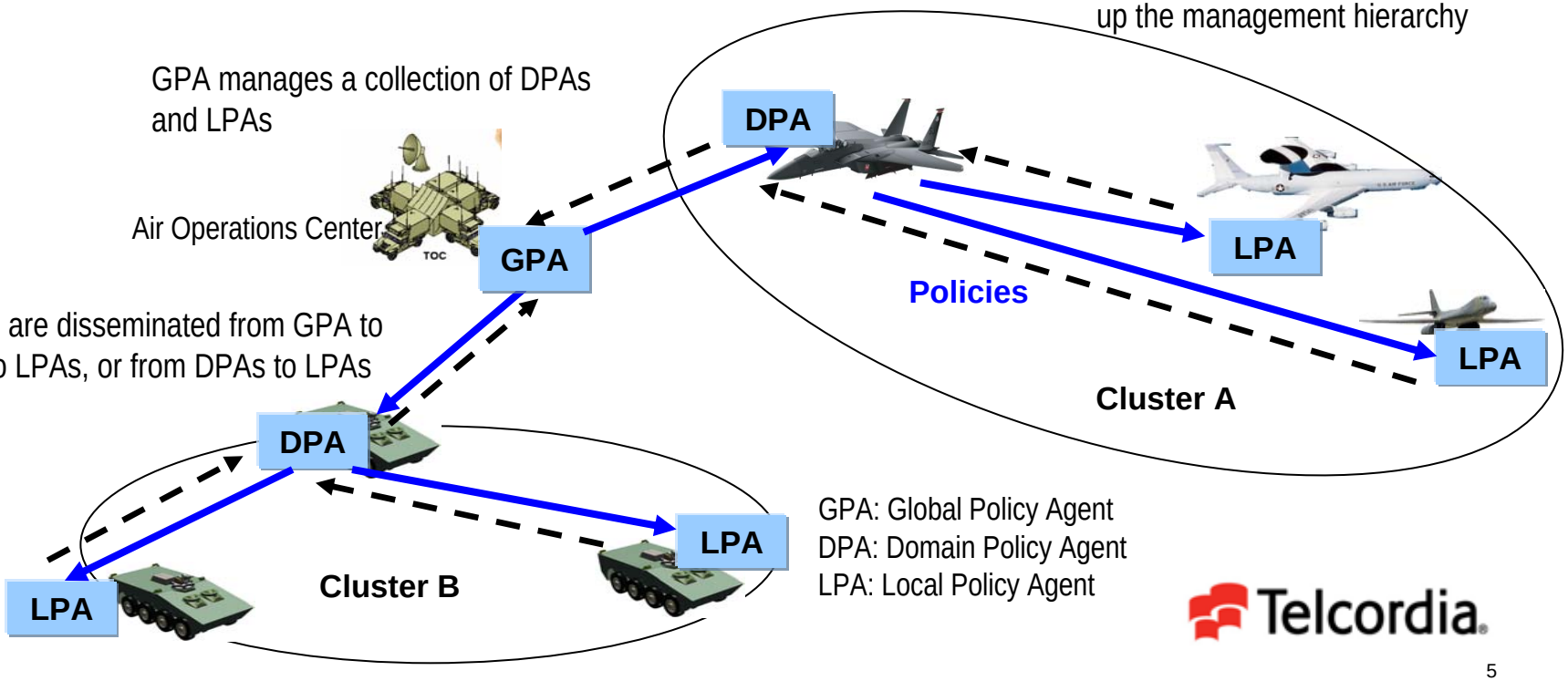
Nodes perform local policy-controlled configuration, monitoring, filtering, fault diagnosis, aggregation, and reporting, thus reducing management bandwidth overhead

Any node can dynamically take over the functionality of another node to ensure survivability

Flexible agent infrastructure allows dynamic insertion of new management functionality

Management status is reported up the management hierarchy

GPA manages a collection of DPAs and LPAs



Policies are disseminated from GPA to DPAs to LPAs, or from DPAs to LPAs

GPA: Global Policy Agent
DPA: Domain Policy Agent
LPA: Local Policy Agent

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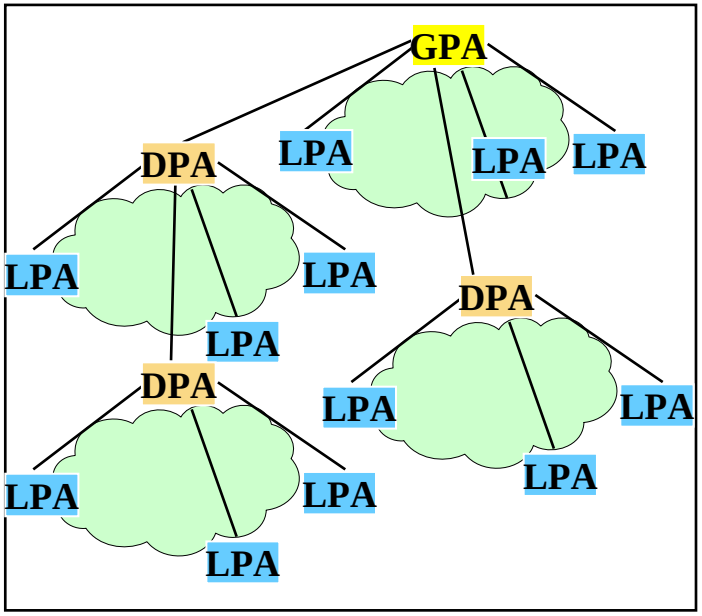
DRAMA (2)



- DRAMA management paradigm is based on a hierarchical policy dissemination and management information reporting structure
- Why not make network management completely local?
  - Sometimes faults need to be correlated across nodes and therefore a larger than local view may be necessary
  - Commander may need an aggregated Common Network Picture
  - → Some management information needs to be propagated out of the managed node

- Why have a management hierarchy?
  - → *Scalability*: Cannot have hundreds of nodes reporting to one central management station
    - Need to limit the number of nodes managed by any one manager
    - Need to aggregate/filter information as it is reported back up

DRAMA Policies

- **High-level concept: A policy rule is composed of *events, conditions, actions***
  - Zero or more events
  - Optional condition
  - One or more actions

When (events) if expression → action

- **When the events of a rule occur, the conditions are evaluated; if they evaluate to *true,* the actions are executed**
- **Policies represented using XML notation**

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CJSMPT Top Level Capabilities

- **Define Electromagnetic Battle Space (EMB)**
  - Define forces, nets, equipment, location, movement
  - Define your AOR, maps, terrain
- **Gather Spectrum Requirements**
  - Aggregate requirements via data collaboration with components
- **Spectrum Summary**
  - Recommend required allotment based on modeling and simulation of EMB
- **Nominate and Assign Frequencies**
  - Suggest specific frequencies for nomination and assignment taking into account user defined and/or host nation allocation tables
- **Perform EW Deconfliction**
  - Predict incidents of tactical Interference prior to mission execution
- **Resolve/Report Interference**
  - Suggest modification to spectrum plan to mitigate/minimize interference
- **Collaboration**
  - Exchange data via the SKR Data Exchange
  - Generate formatted reports

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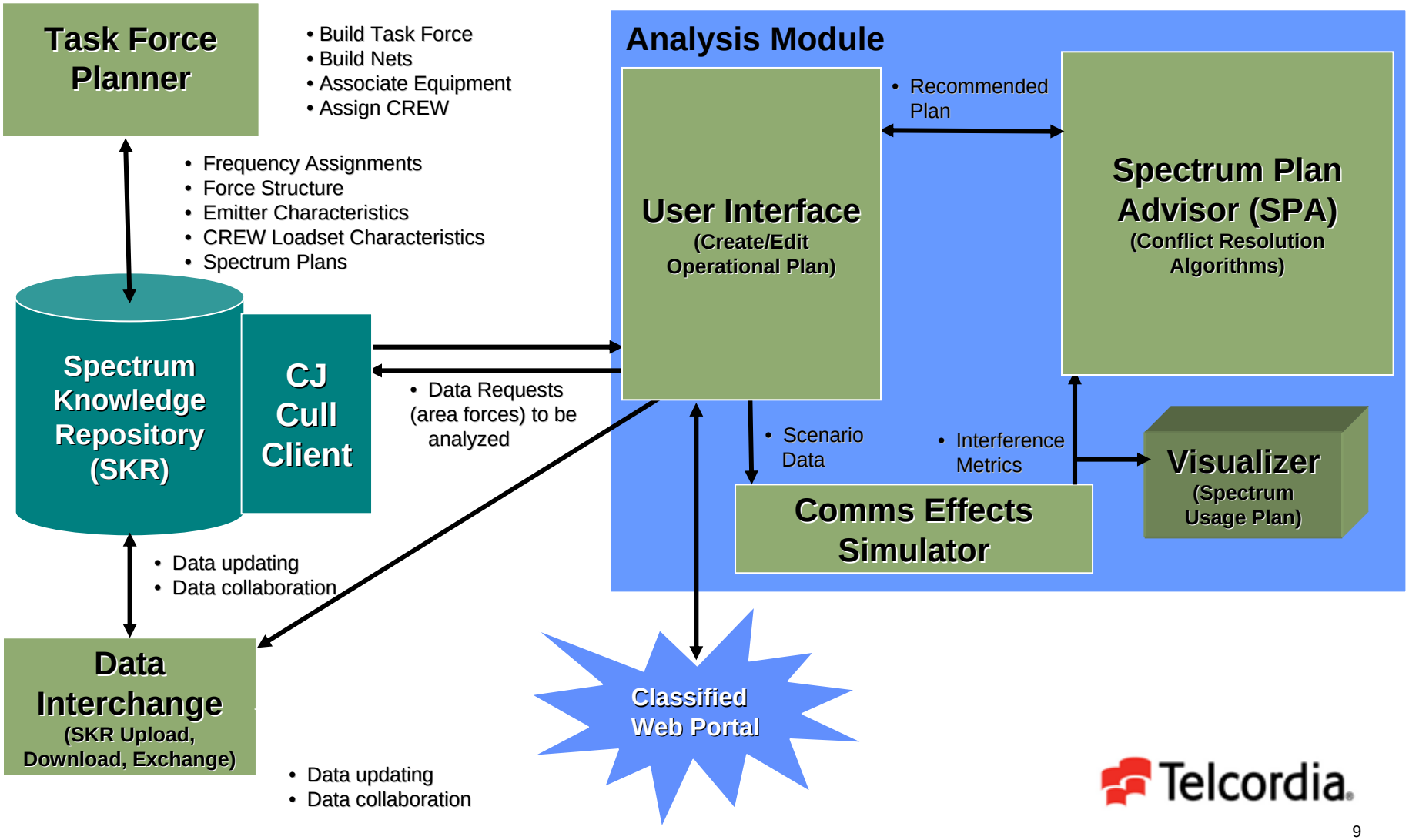
CJSMPT Client Architecture

Plan, Simulate, and Manage Operational EMB



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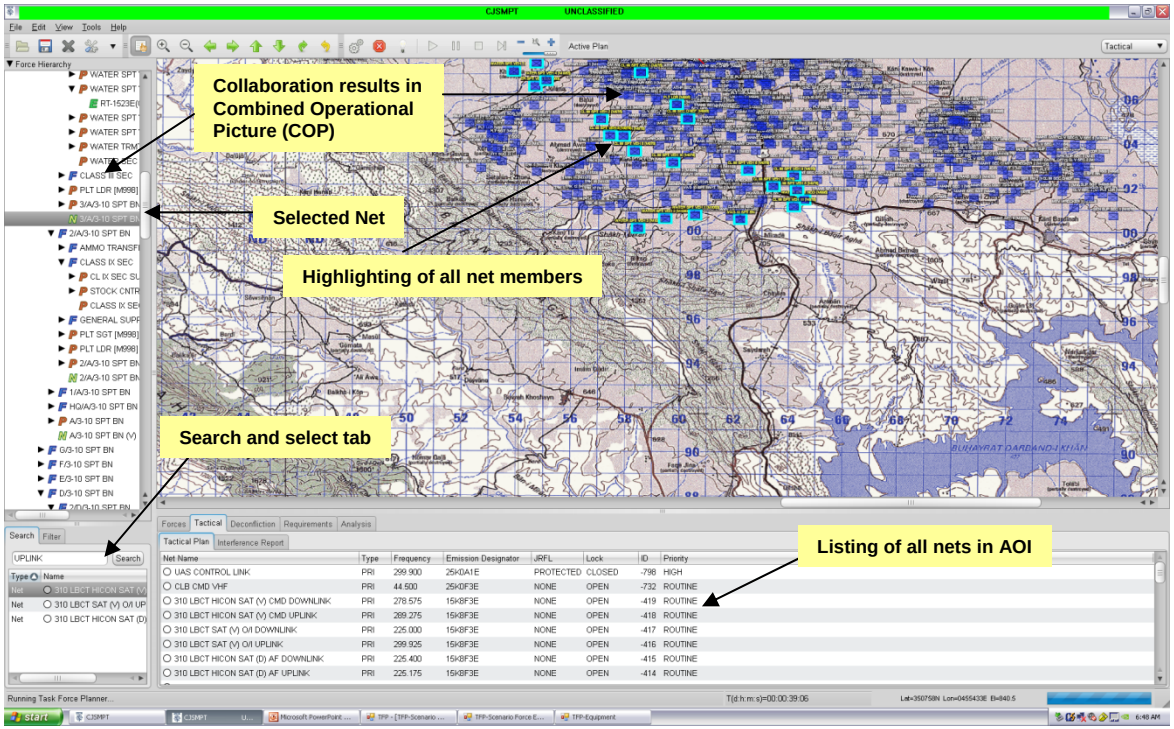
Analysis Module

- **Force Structure Panel**
  - Hierarchical list of forces, platforms, equipment, and Nets
  - Linked to details panel and visualizer
- **Filter/Search Panel**
  - Filters and searches by user defined parameters
- **Details Panel**
  - Force, net, equipment and CREW
  - Tactical interference report
  - Deconfliction
  - Spectrum requirements
  - Terrain analysis
  - Tabs oriented to selected item
- **Main Visualizer Panel**
  - 2D and 3D visualization of EMB
  - Forces, Net members and routes
  - Interference, signal and EW
  - All NGA products “skinned” over DTED



Requirements Analysis, Tactical Deconfliction, and Interference Mitigation

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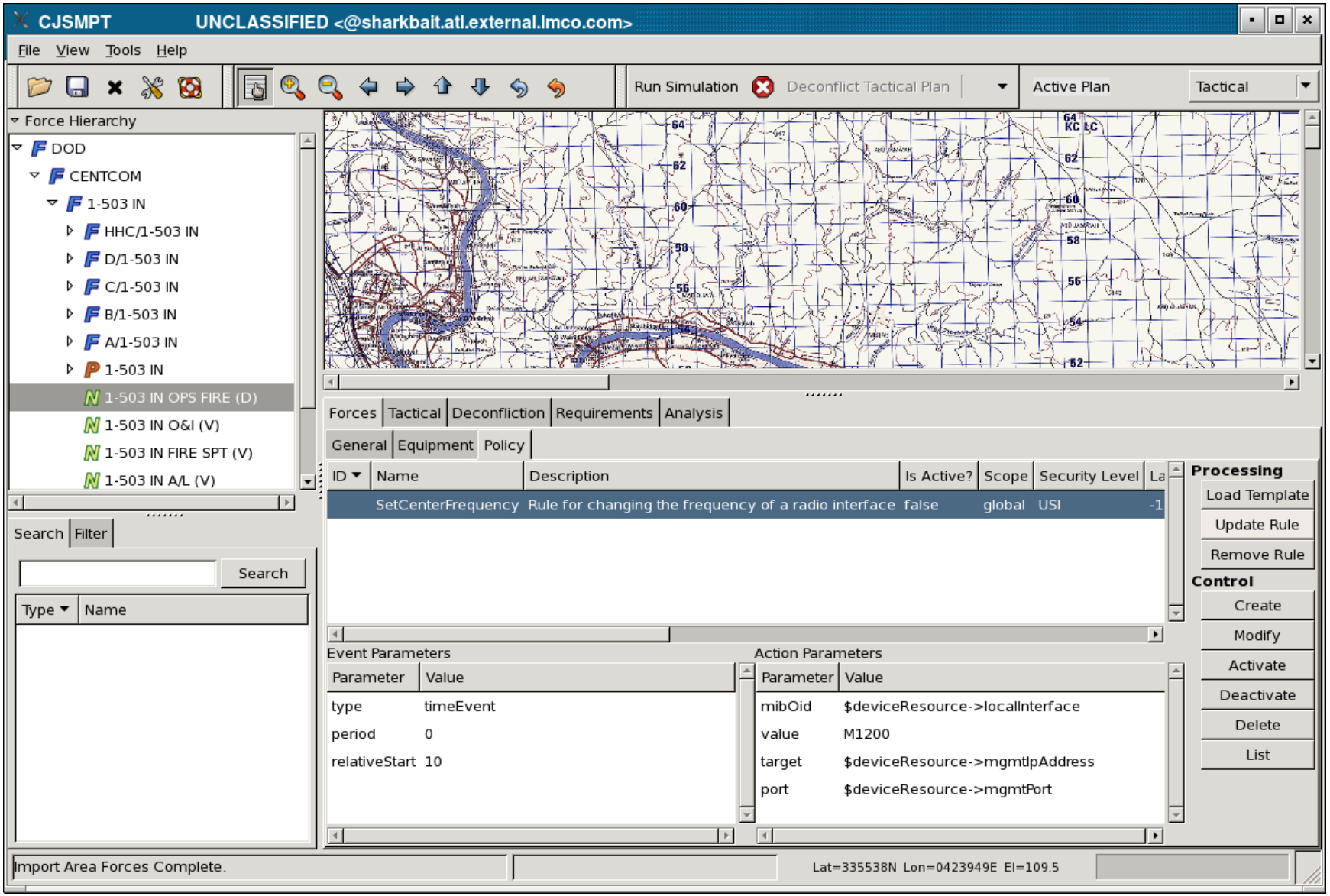
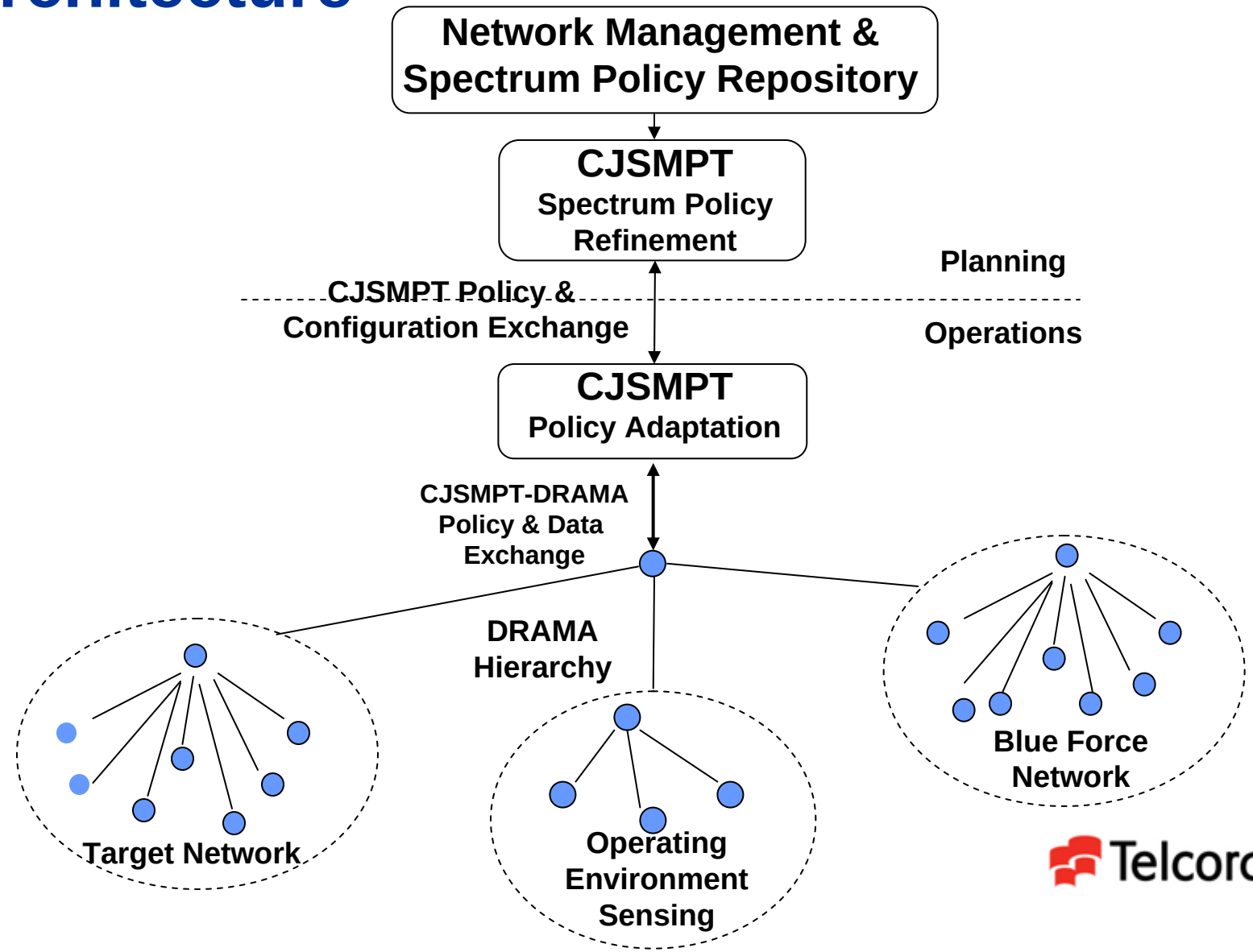
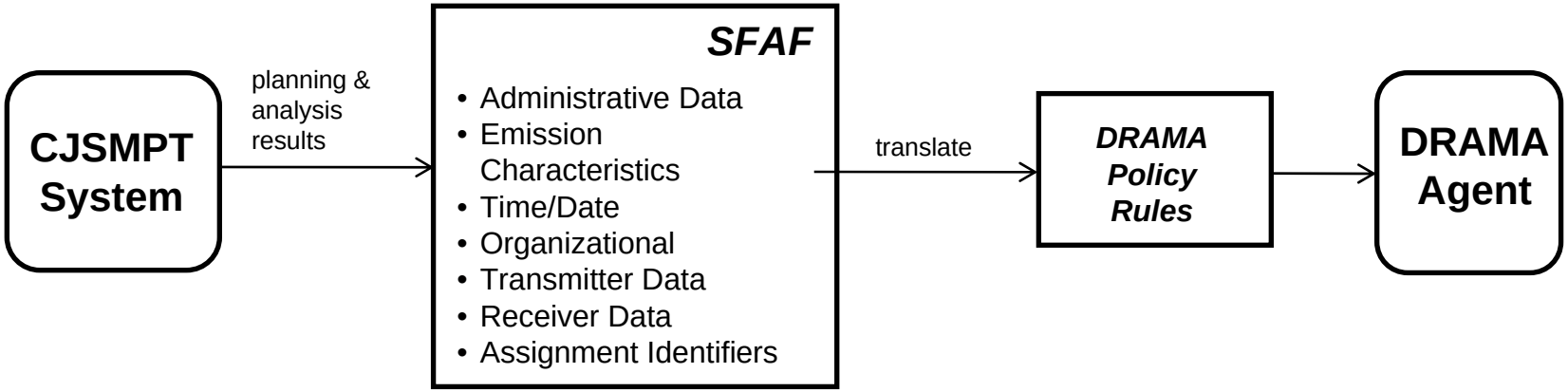
Policy Rule Processing and Control



Policy-Based Spectrum Coordinator: Architecture



Policy Rule Definition for CJSMPT/DRAMA Integration



- The Standard Frequency Action Format (SFAF) is used for frequency proposals, assignments, and modifications.
- A final SFAF file resulting from planning and analysis activities represents policy rule parameters for a given situation

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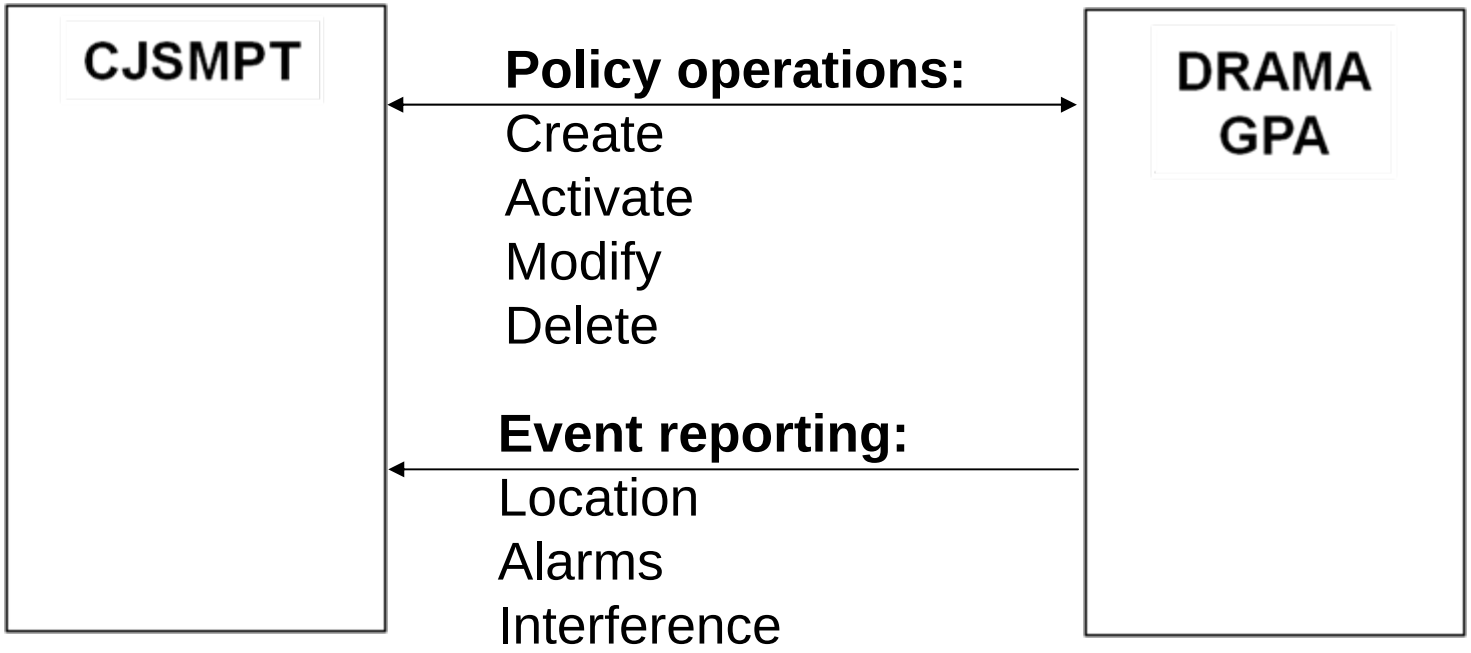
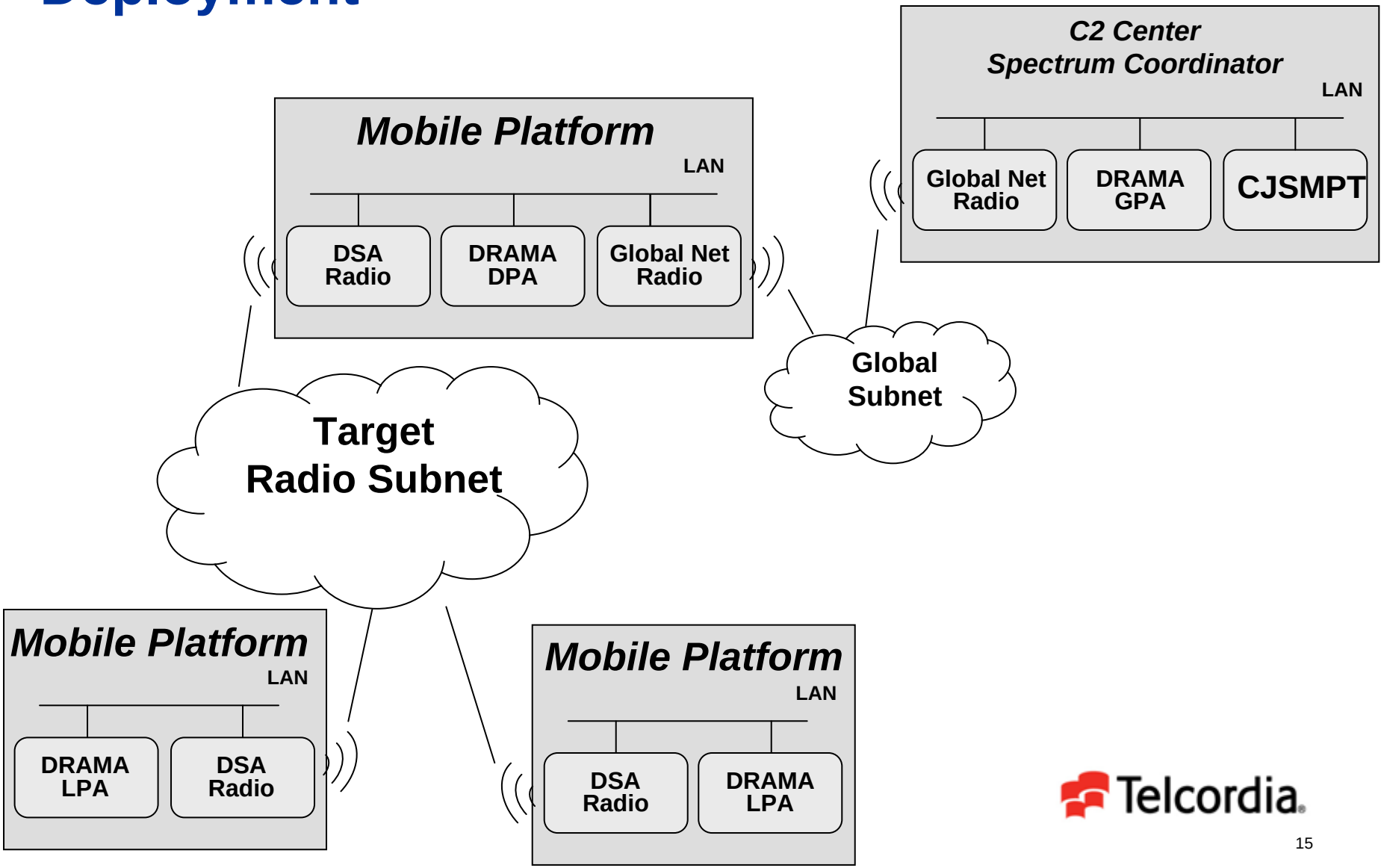
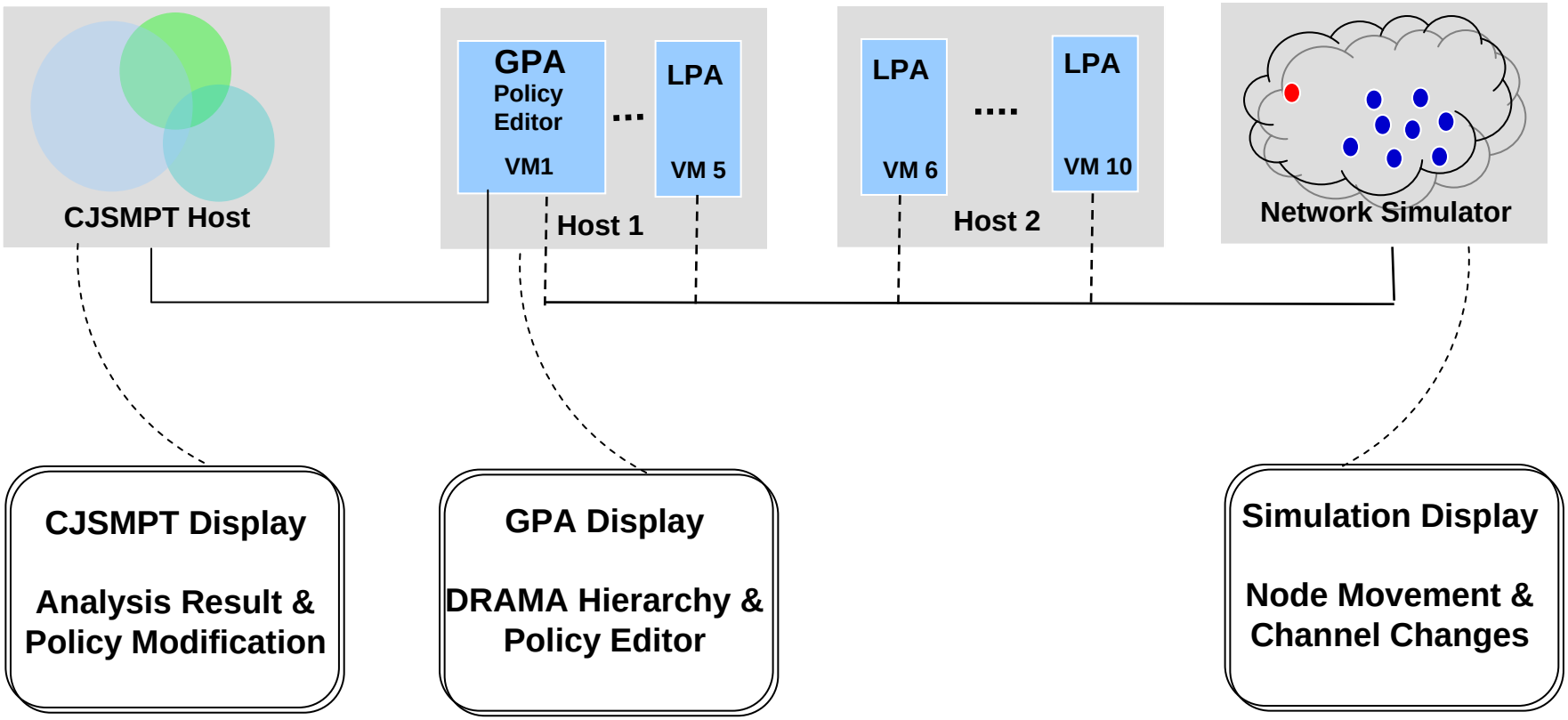
Policy-Based Spectrum Coordinator: Details



Policy-Based Spectrum Coordinator: Deployment



Network Simulation



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Evaluation

- **PBSC deployed and evaluated on the VAN Testbed**
  - **Simulation-In-The-Loop testbed**
  - **High fidelity network simulation model**
    - WNW model (Local and Global) (JTRS)
  - **Management and control software executes on virtual machines with full OS environment**
    - DRAMA and CJSMPT execute in a native environment
  - **Frequency change enacted through SNMP**
    - Local DRAMA agents issue *snmpset* operations for changing the operating frequency of local radio

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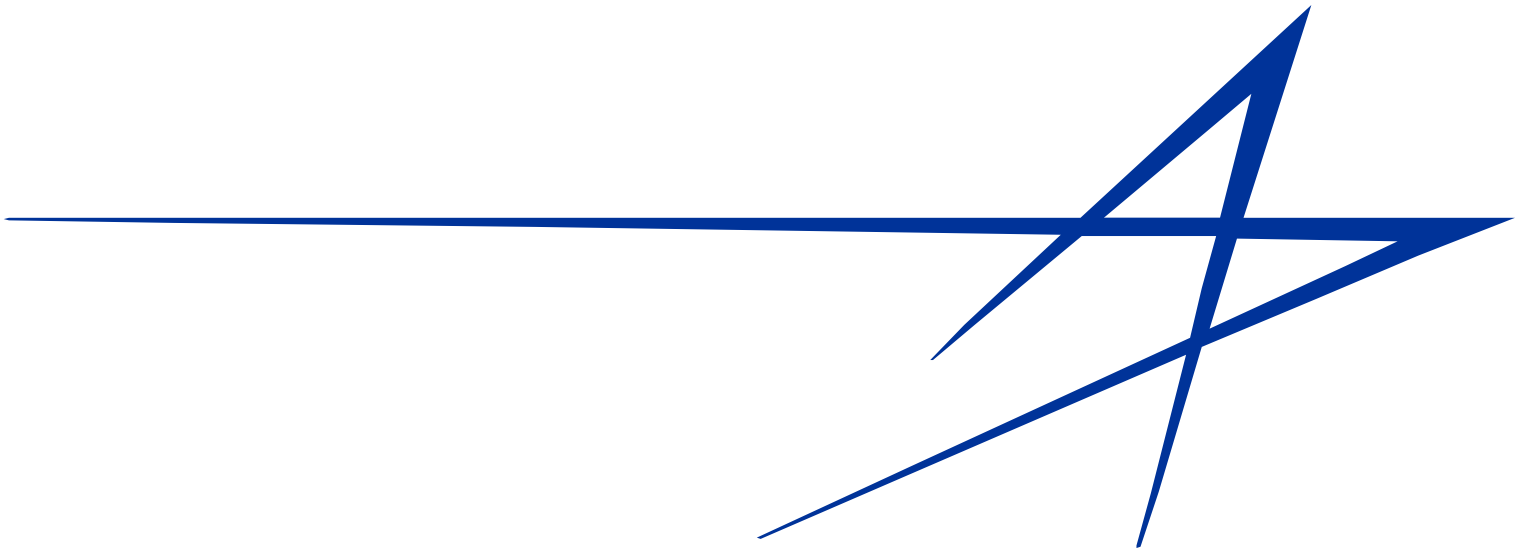
Performance

- **Policy distribution based on DRAMA hierarchy**
- **Build in tolerance to communication disruption**
  - Timeout-and-retry, store-and-forward
- **Policy distribution DPA to LPAs typically ~120ms**
  - Current grace period at about 1-5s
- **Rendezvous and logical control channel implementations through frequency hopping (FHSS) (work in progress)**

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