GENERAL DYNAMICS

C4 Systems

A POLICY STRATEGY FOR THE SOFTWARE DEFINED RADIO ENABLING COGNITIVE RADIO TECHNOLOGY WITHIN THE TACTICAL NETWORK

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General Dynamics

C4 Systems

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Presentation Overview

- **Policy Overview**
  - What is a policy and how is it used?
- **Policy Architecture and Standards**
  - What standards do we apply?
- **Policy Model**
  - What models do we use?
- **Policy Dissemination**
  - How are policies distributed throughout the network?
- **Applicability to Cognitive Radio**
  - How do we apply policy constructs to the cognitive radio layer?
- **Policy XML**
  - PCIM-based XML storage for policies.
- **Policy Languages**
  - Beyond simple XML.
- **Spectrum Example**
  - Policy-based frequency re-assignment.
- **Conclusion**
  - How will policy-based radios help?

Policy Overview

- **Policy Framework**
  - Made up of 4 basic elements
    - Policy Management Tool
    - Policy Repository
    - PDP: Policy Decision Point
    - PEP: Policy Enforcement Point
  - External factors
    - Event trigger
    - Managed elements

Policy Overview, cont.

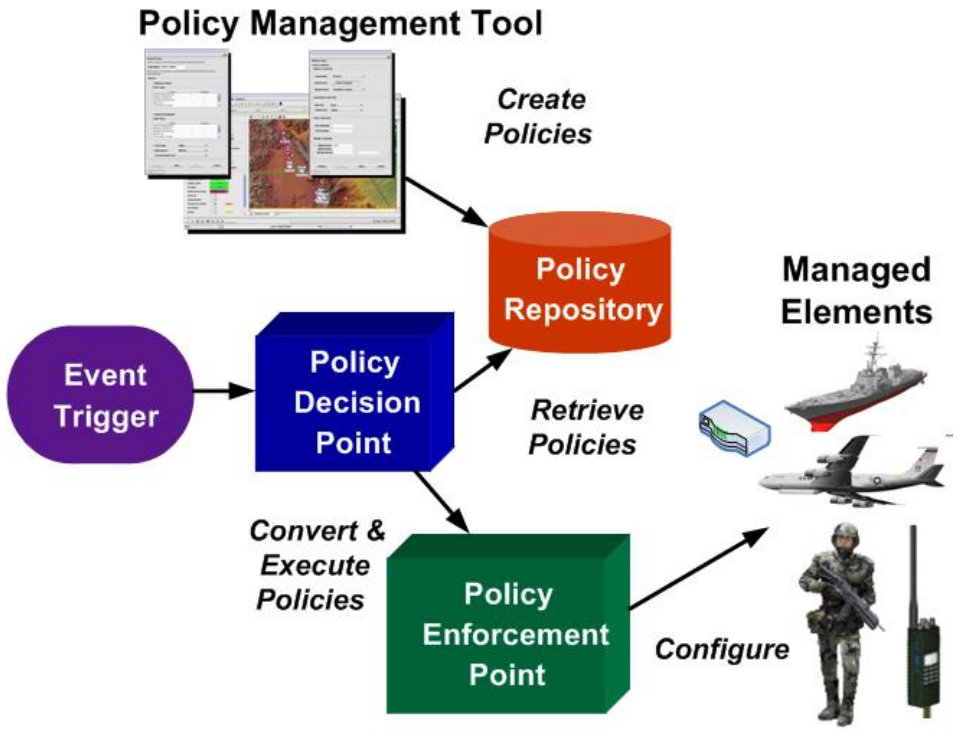
- **Policy Management Tool**
  - Generates and maintains policies
  - Persists and/or exports policies to the policy repository in format compatible with PDP
- **Policy Repository**
  - Persists policies and serves as a location for the PDP to retrieve policies
- **Policy Decision Point**
  - Responds to system events and determines if a policy must be applied
  - Retrieves policy from the repository
  - Responsible for converting the policy to a format the PEP understands. For example: from the general policy language to a specific device configuration.

Policy Overview, cont.

- **Policy Enforcement Point**
  - Responsible for executing the policy
    - Reconfiguring devices
    - Re-routing network traffic
    - Blocking network traffic
  - Could be combined with the PDP
- **External Factors**
  - Event trigger
    - Any event that triggers the execution of a policy.
  - Managed elements
    - The pieces of the network that the policy will effect
      - Radios
      - Network elements
        - Routers
        - Gateways
        - Etc.

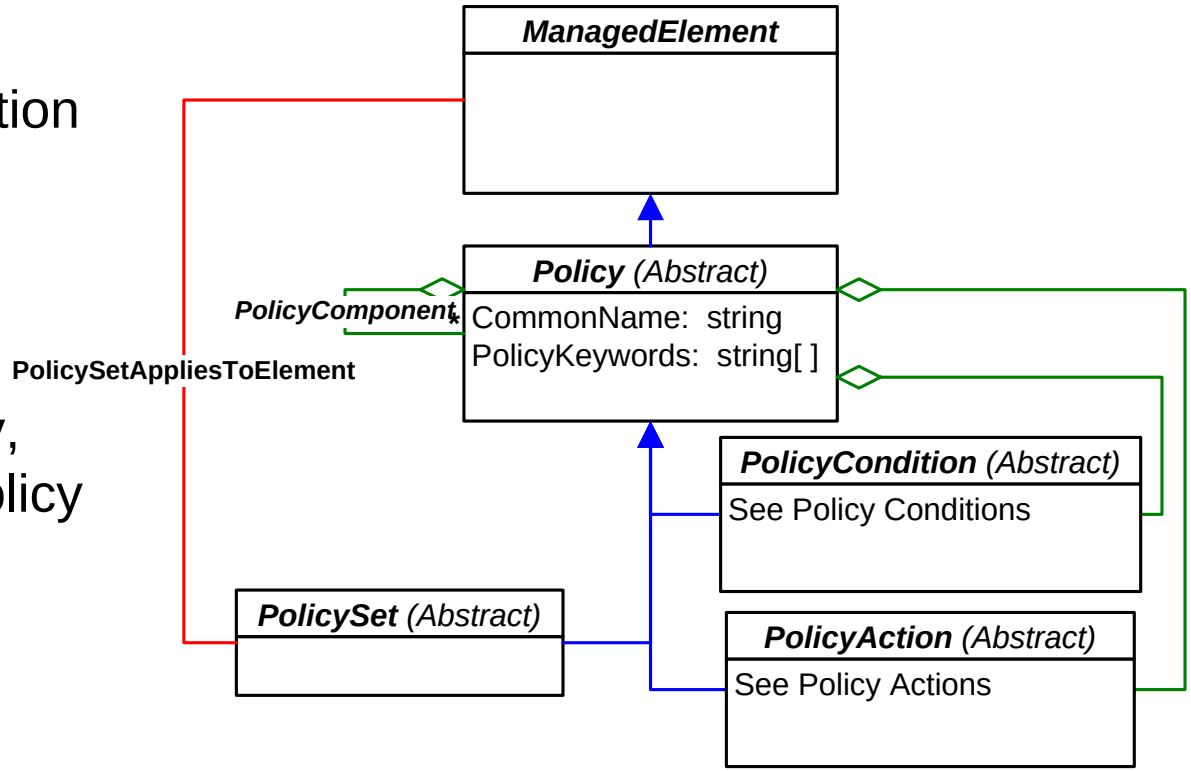
Policy Architecture and Standards

- Need a policy definition for disparate networks and diverse types of network equipment.
- The key to creating a flexible and usable policy implementation is to start with standards based policy architecture and data model.
- Policy architecture is described in a variety of models; the most common model is heavily influenced by the CIM-based IETF (Internet Engineering Task Force) Policy Core Information Model (PCIM), which is defined by the IETF Policy Framework Working Group.



Policy Model

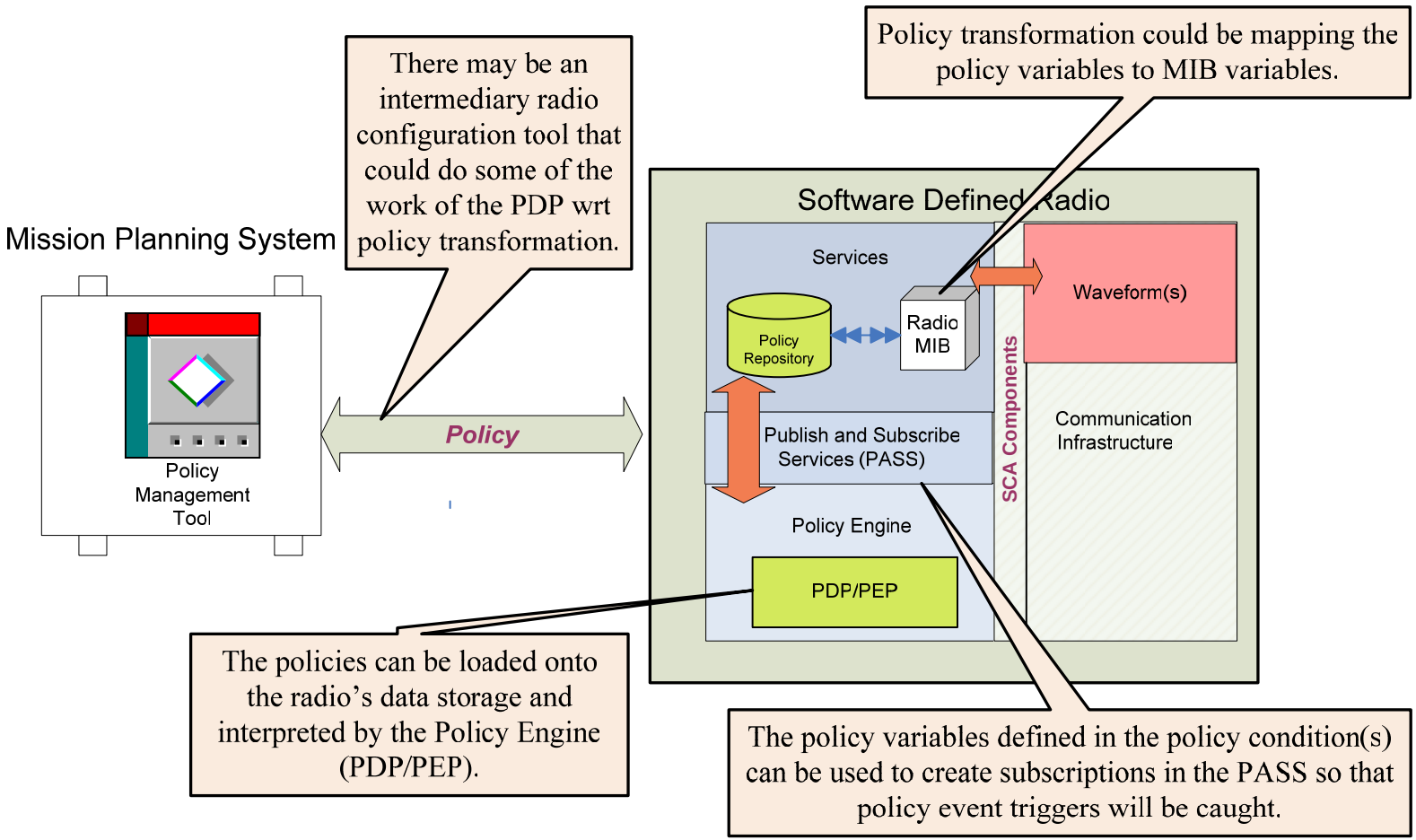
The CIM Policy Model emphasizes the definition of general event-condition-action semantics. These semantics are represented abstractly, independent of any policy language or implementation.



Policy Dissemination

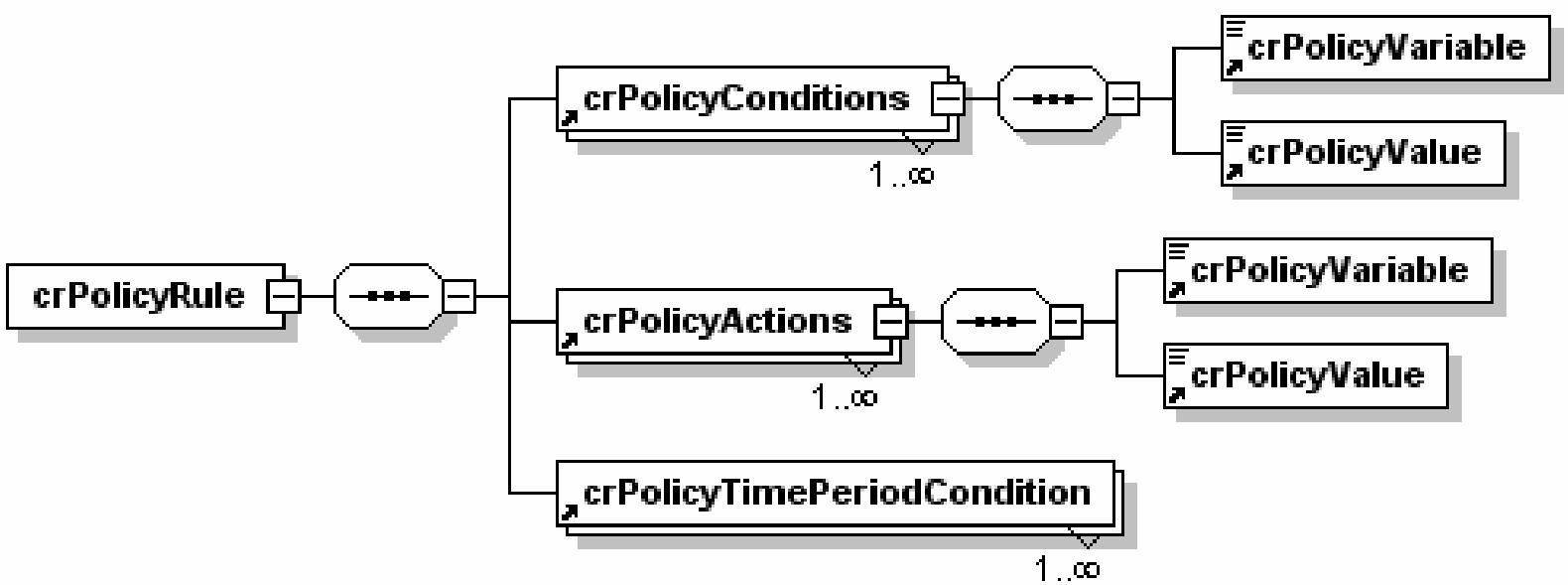
- **Three most commonly used methods of policy persistence and dissemination involve:**
  - Databases
    - More suited for volatile data (i.e.: more write operations than read operations)
    - Much better lookup performance than a directory service
    - Less robust data synchronization
  - Directories
    - More suited for stable data (i.e.: more read operations than write operations)
    - Built in replication scheme enables near real-time policy distribution
    - Not really feasible at radio level
  - Files
    - Low overhead; Files are generally small and don't require special software.
    - XML over SOAP
    - "Sneaker-net"
- **Answer is more likely a combination of solutions based on levels of deployment.**

Applicability to Cognitive Radio



Policy XML

- **PCIM-based XML schema**
  - Policy variables are based on an object-oriented information mode.
  - Eases transfer of policies between planning systems, host platforms, radios and devices.
  - Eases transformation between vendors.



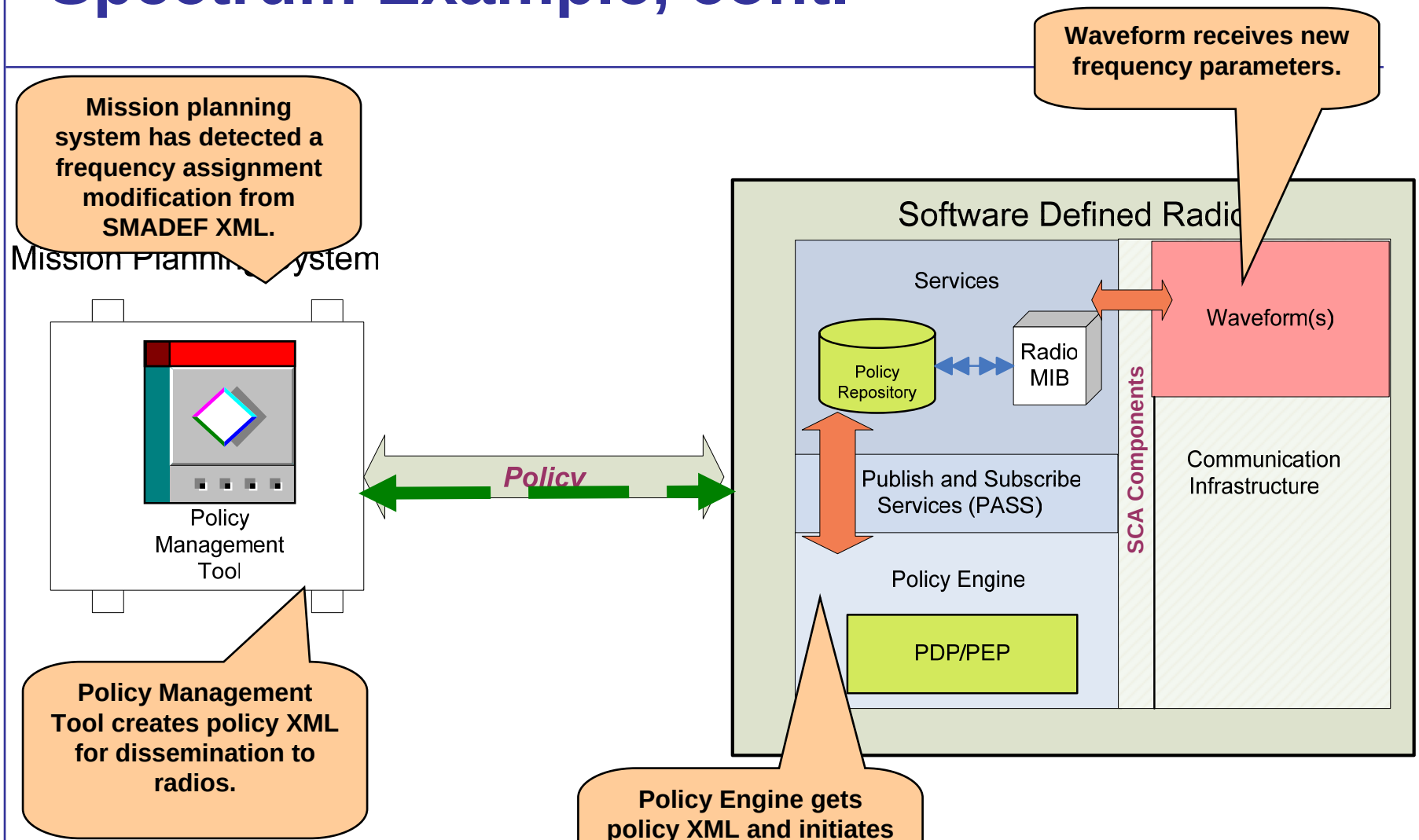
Policy Language

- The policy engine using one of the standard policy languages (PONDER, XACML, CIM-SPL, etc) would be more scalable to a full set of network devices.
- The policy engine could be a subset of the overall cognitive engine, it seems logical to map the policy language to the ontology language used for the cognitive engine.
- There is a great deal of research proposing these mappings.
  - Framework for constructing a CIM ontology based upon previous research that identified mappings from UML constructs to ontology language constructs.
  - XML based ontology language that maps Web Ontology Language (OWL) constructs to CIM elements.

Spectrum Example

- Scenario
  - **Network Management tool has received frequency assignment via SMADEF-XML interaction.**
    - SMADEF-XML is the North Atlantic Treaty Organization (NATO) approved format used to exchange information related to the spectrum management process defined in Military Communications Electronics Board (MCEB) Publication 8.
  - **Policy Management tool has subscribed for the receipt of frequency changes and converts it into policy XML for distribution.**

Spectrum Example, cont.



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Conclusion

- **Communication links are vital to mission success, as such they need to be maintained.**
- **Policy-based radios provide more reliable communication links.**
  - Policy-based radios remove the human aspect of monitoring the communication environment and push that responsibility onto the radio itself.
  - As the communication environment changes, policies can be enforced to seamlessly and transparently maintain communications links in an ad-hoc mobile tactical environment.
- **Enabling software defined radios with policy architecture is one step closer to a true cognitive radio.**