Policy-Based Command & Control
In Federated Systems

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Outline

• Thesis
• Federated C2 Systems
• C2 Space - Policy Domains
• C2 Actors
• C2 Services
• C2 Timing - Completion Time Requirements
Thesis

• Effective governance of large-scale federated enterprise systems requires policy-based “inter-” and “intra-enterprise” C2
• Effective enterprise C2 (EC2) in federated (collaborative, interoperable, interactive) enterprise systems requires higher degrees of automation (tools) of traditional social and ad hoc C2 activities
• Automation of ad hoc C2 activities requires a more formal EC2 model and associated set of tools (services)
• Key EC2 services include policy-based
  – Situation Assessment
  – Plan Generation
  – Plan Execution
Ex. DoD C2 Enclaves

USJFCOM

USSTRATCOM

GIG NOC

NASA Shuttle
C2 Space: Federated Policy Domains

- An enterprise is **accountable** to the degree it operates in an authority, command or asset chain hierarchy
- An enterprise is **federated** to the degree it operates in a **policy domain** with other enterprises
- An enterprise is able to **collaborate** to the degree the policy domain supports **interoperability**
Policy Frameworks

Joint C2 Strategy

Policy Categories

L0  L1  L2  L3  L4  L5

Enterprise Level

Tactical  Operational  Strategic

External  Internal
Federated C2 Systems

• A given enterprise may participate in multiple federations (systems of systems)
• Each federated entity is considered a command, or value production unit
• A command is a four port object operating in a lattice or mesh interconnected by a
  - Command Axis (superior-subordinate)
  - Service Axis (client-server)

Federation members are
  - Uniquely Identifiable
  - Self Directed (Semi-Autonomous)
  - Freely Associative, and
  - Mutually Interdependent
The Processes of EC2

Federated enterprise management has two simultaneous objectives:
- Maintaining command chain commitments (viability, homeostasis)
- Maintaining supply chain commitments (service level agreements)

Automation of core processes (autonomic controls) is a proven means of improving performance (yield, quality, etc.).
The Principal EC2 Actors

Enterprise (Command)
EC2 Enclave Applications

Visual Commons

Model Manager

Policy Manager

Core C2 Services

Scenario (Plan) Manager

Performance Manager

Resource Manager
# Core C2 Services

<table>
<thead>
<tr>
<th>SID</th>
<th>SERVICE Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS</td>
<td>Filter Service (Subscription Management)</td>
</tr>
<tr>
<td>TS</td>
<td>Triage Service (Event Detection, Correlation &amp; Prioritization)</td>
</tr>
<tr>
<td>AS</td>
<td>Analysis Service (Situation Detection &amp; Response Proposals)</td>
</tr>
<tr>
<td>PS</td>
<td>Policy Service (Condition Detection &amp; Risk Assessment)</td>
</tr>
<tr>
<td>RS</td>
<td>Resource Service (Asset Management &amp; Allocation)</td>
</tr>
<tr>
<td>CS</td>
<td>Command Service (Plan Sequencing &amp; Authorization)</td>
</tr>
<tr>
<td>ES</td>
<td>Execution Service (Plan Execution, Coordination &amp; Abort)</td>
</tr>
</tbody>
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Policy-Guided Tasking Orders

- Plans (tasking orders) comprise **policy-constrained** task steps.
- Policies are defined by rules and measures of risk related to rule violations.
- A plan’s **value** to an enterprise is a function of its **effects** and **completion-time** semantics.
- \[ \Rightarrow \] A task’s **value** to a plan is a function if its **effects** and **completion-time** semantics.
Within a Service Oriented Architecture (SOA) a “policy service” is defined by six specifications:

- Policy Service
- Policy Service Advertisement
- Policy Service Description
  - Policy Service Data Model (Policy Template)
  - Policy Service Use Policy
  - Policy Service Contract
Federated C2 Policy Management

SOA C2 Policy Service
“c2policy.osd.mil” or “c2policy.domain.net” ...
Policies Govern Timeliness

TPPU: task, publish, process, use

- Real-time => Meeting completion time requirements
- Grid-based => IP connected with publish-subscribe services
C2 Service Time
Completion-Time Semantics

- Plans (tasking orders) have completion time requirements
- A plan’s value (utility) to an enterprise is dependent on its completion
- A plan’s completion is dependent on its ability to obtain resources
- Effective (timely) resource management is a critical EC2 management objective
C2: The Evolution of Plans

Plan State Evolution

- Situation → Scenario
- Scenario → COA
- COA → ps()
- ps() → POA
- POA → rs()
- rs() → POR
- POR → cs()
- cs() → TO
- TO → es() → Action

- SDB scenario update
- SDB plan performance update

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Utility Accrual Model
In Summary...

EC2: From Policies to Coordinated Effects
Thank You.

Are there any questions?