This research is sponsored by the ASD(R&E) Network Communication Capability Program

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TRUSTED COMMUNICATIONS...AWARENESS TO ACTION

Automating Joint Planning to Policy-Based Network Management

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Dynamic Policy Management (DPM)
Team: SSC Pacific, CERDEC, JPL

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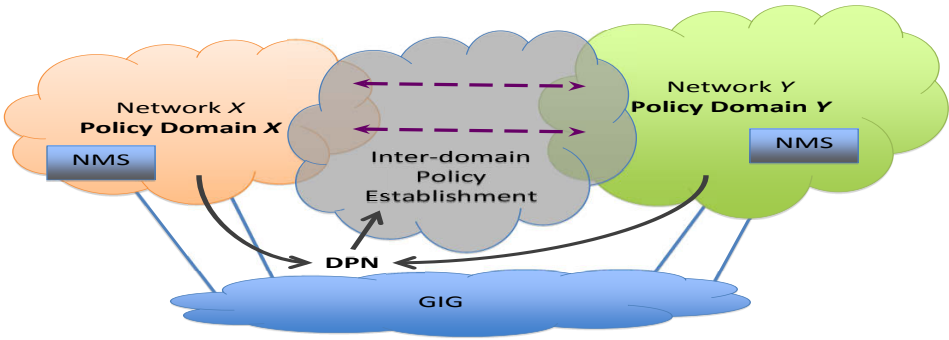
MOTIVATION

- **Today, an inter-force inter-domain Service Level Agreement (SLA) is established manually through time-consuming pre-planning processes:**
  1. **Establish overall operational traffic management policy.**
  2. **Develop and test of technical configurations.**
  3. **Iterate until acceptable performance**
- **Complexity of Communication & Networks is increasing**
  - **Management burden for force C&N is heavy**
  - **Management burden for inter-force C&N is emerging**
  - **Multiple COCOM IPLs for Comm & Network improvements**

PICTURE



Dynamic Policy Management

TECHNICAL IDEAS

- *Develop algorithms and software to enable Dynamic Policy Negotiation (DPN) between disparate forces.*
- *DPM project will leverage proven JPL policy negotiation research and addresses critical SLA, privacy, and deadlock negotiation issues for JTEN environments.*
  - *Defeasible Logic technology used in NASA Deep Space Network.*
  - *Integrated into SHINE Policy Based Network Manager*
- *Prototype software demonstrated to NCCP on 19 Apr 2011*

PAYOFF

- *DPN transforms manual SLA process to an automated inter-domain machine-to-machine negotiation process*
  - **Enables <u>ad-hoc</u> interoperable communications in the battlefield between force domains, <u>without pre-planning.</u> Current force laydowns are static in the field.**
  - **Enables rapid <u>re-negotiation</u> of SLAs based on <u>dynamic</u> battlefield conditions: seconds instead of weeks. Not attempted in the field today.**
  - **Reduced dependence upon 'white coats' in the field, currently necessary to support complex systems.**
- **ROI: Increased utilization of technology investment and reduced technical field support**

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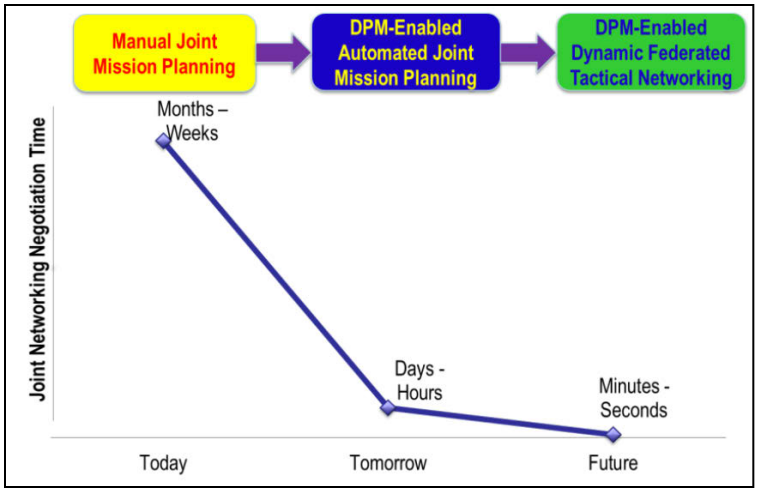
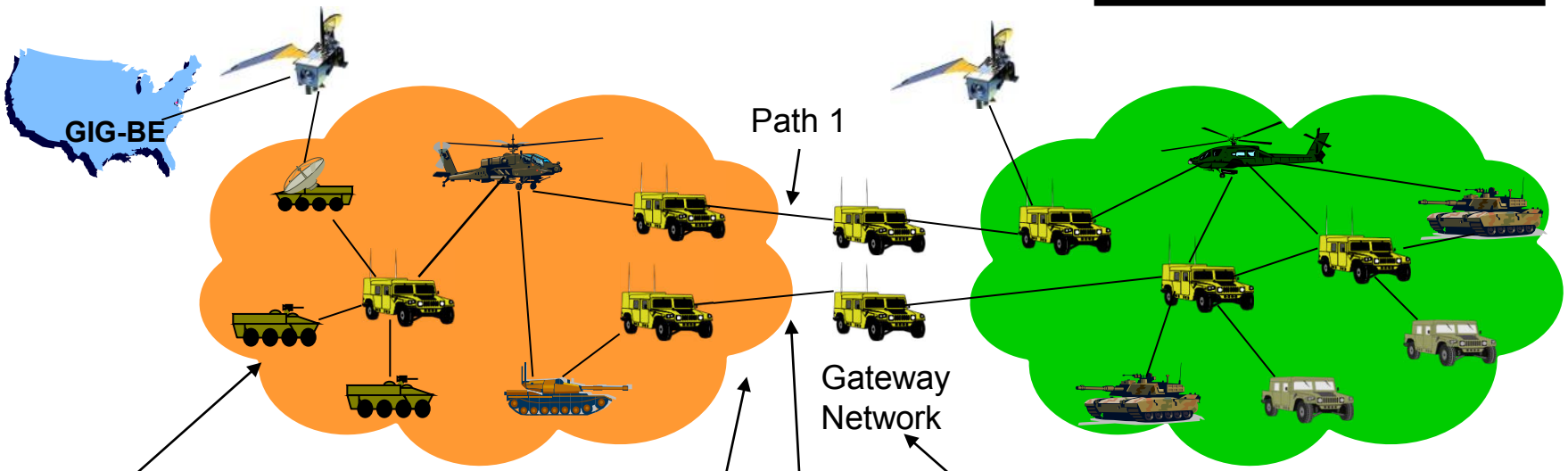
The Problem Space

- Current planning processes take 20 weeks (Army input)
  - Manual process
  - Forces work their resource requests with Higher
  - Rely on Higher to facilitate inter-force resource allocations

- Introduction of DPM enables
  - Each Force + Higher to actively plan in conjunction
  - Monte Carlo self and inter-force resources
  - Results in optimal combined allocations
    - Each force meets their and joint needs
    - Minimum resources utilized
  - Overall planning timelines greatly reduced



Isolated Connection Mode Policy Requirement Examples



Mission Application Capacity Requirements

3 x 1.2MHz + 1 x 5MHz Channel from Pick List

Mission Reliability Requirements

Redundancy Examples:

-1 R/T -> 2 IP Addrs -> IP Block of 4

-3 R/T -> 3 IP Addrs -> IP Block of 8

Traffic Policy Requirements

Examples:

-Force 1 does not allow reach back traffic from Force 2

-Force 2 does not allow route back traffic from Force 1

* R/T: Receiver / Transmitter

Deafeasible Logic Policy Editor

Introducing Rules

Name

3 Types of Rules: Strict, Deafeasible, Defeater

Introducing Variables

Defeasible Logic Policy Interface

File Mode Policy View

Policy Title:

Rule Definition

Add Blank Rule

Rule: R0

Conditions:

Relationship: will be

will be
would like to be
don't want to be

Result: using A_Satisfied_Policy

oxes to select how the conditions ult, and what that result should be.

Left: The conditions for the rule are displayed here as a list of predicates which will be ANDed together. Use the buttons below the box to add conditions from the list of

Add Positive

Add Negative

Add an item to this box to use it as a condition or result.

A_Satisfied_Policy

New Item:

<--Type in an item here and hit ENTER to add it to the list above

Priority Definition

Superior Rule: R0 > Inferior Rule: R0

Add Priority

Policy Definition

Rules:

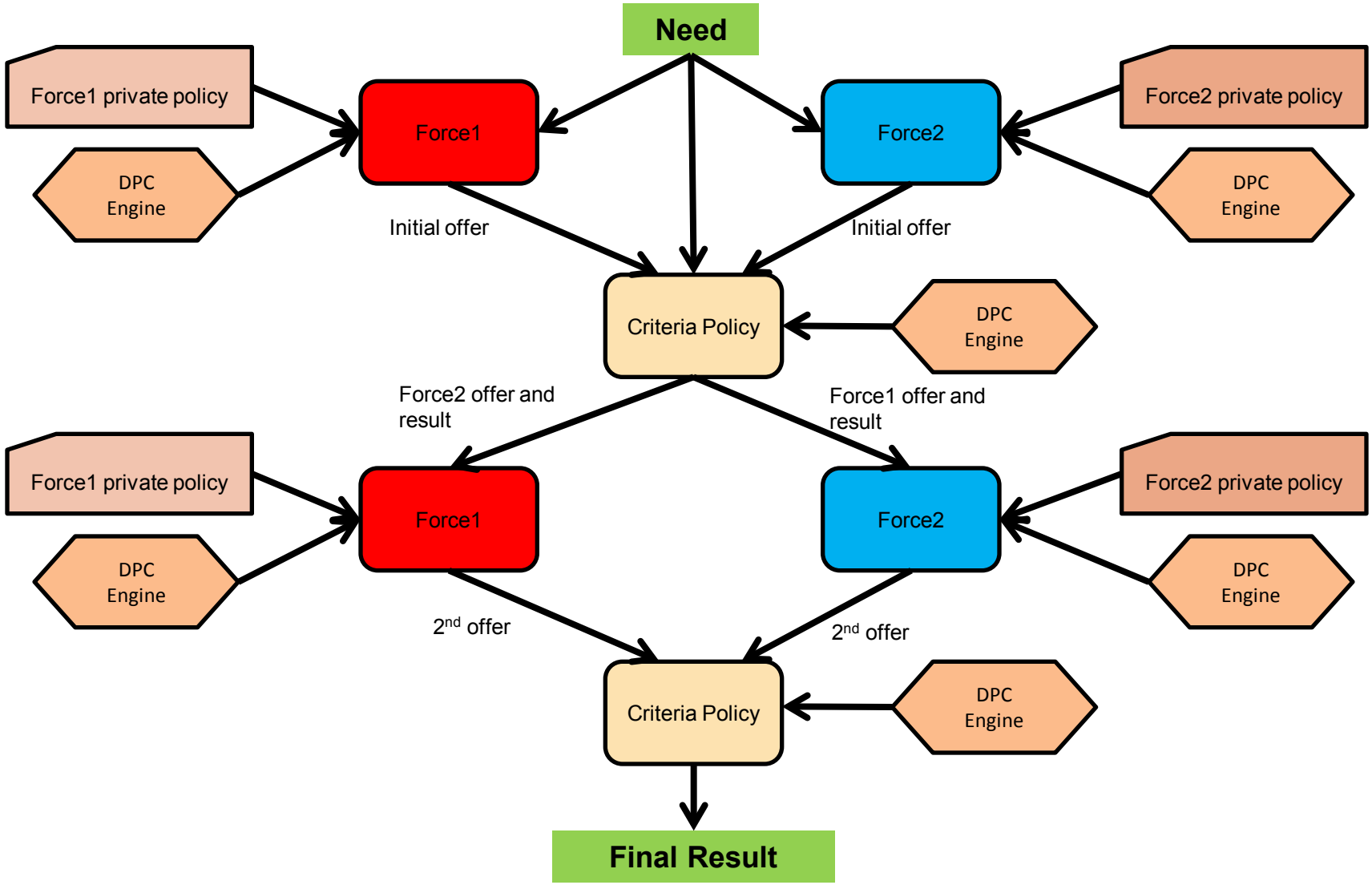
R0: will be using A_Satisfied_Policy.

Priorities:

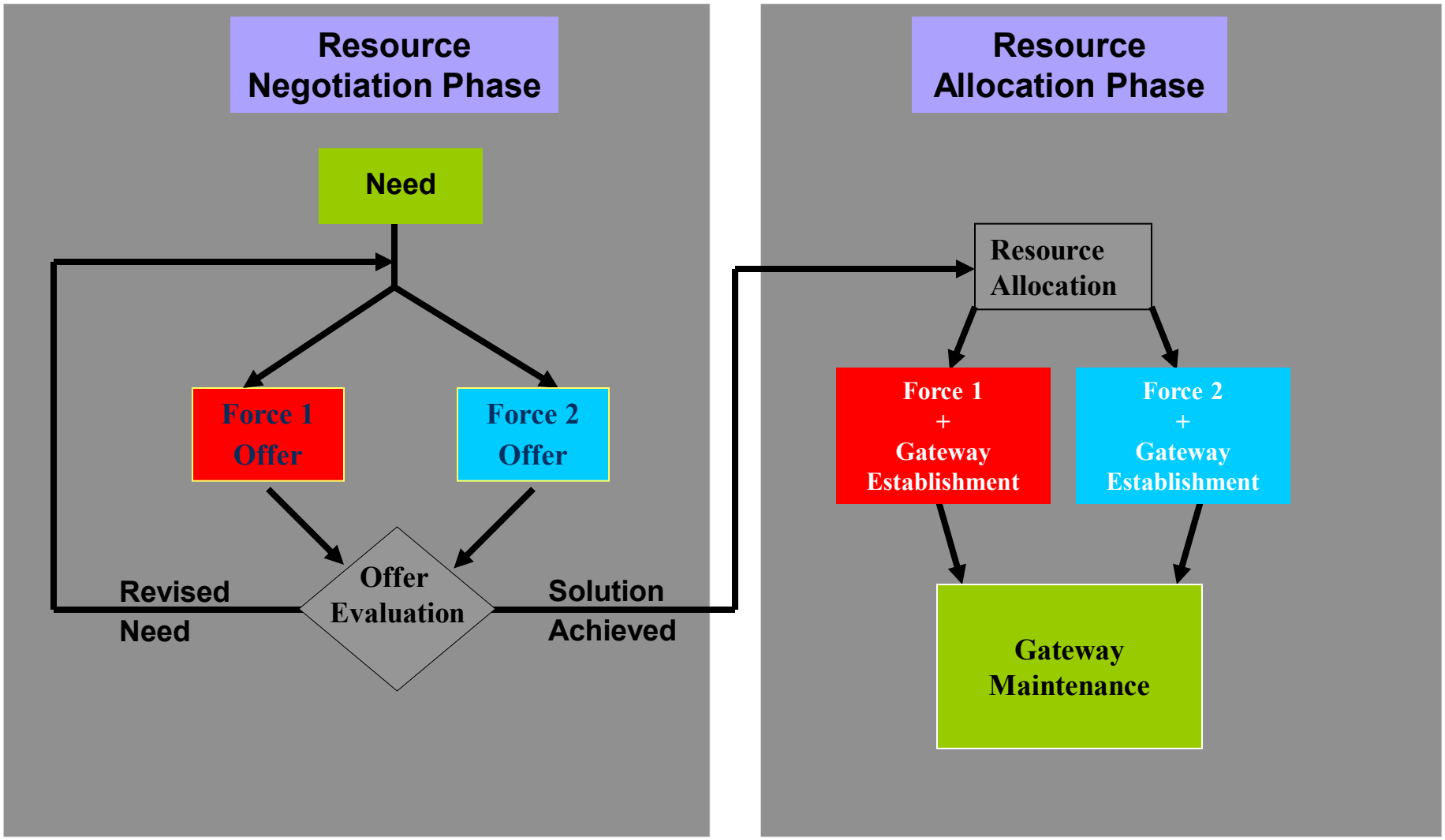
Introducing Priority Relations

Pseudo-English Form of Rules

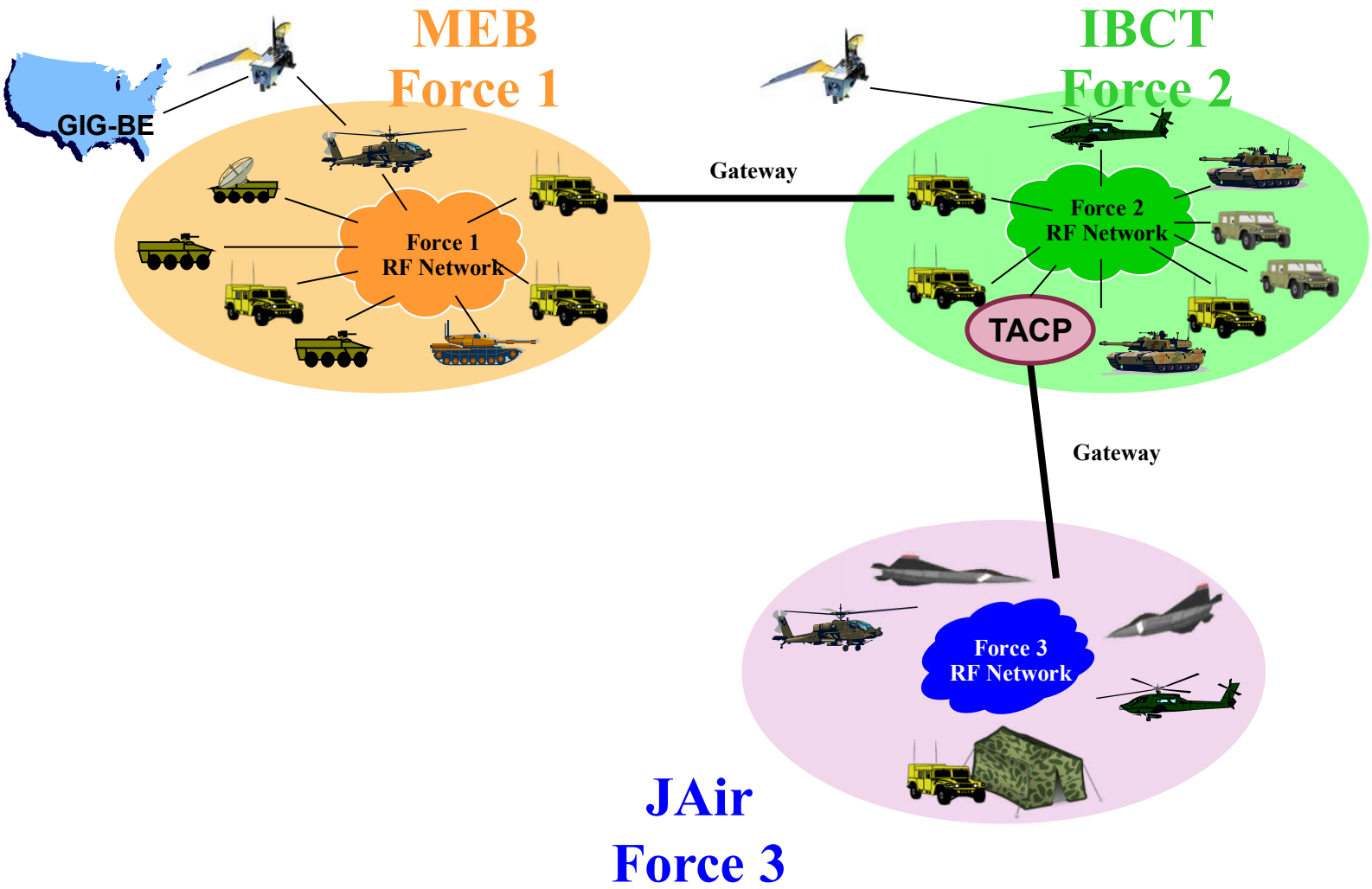
Multi-Round Resource Negotiation



Resource Phases: The DPM Process



Multi-Force Resource Planning Use Case



Multi-Force Planning of Tactical Services

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Force 1

MEB (Marine Expeditionary Brigade)

- Command Element (CE)
- Ground Combat Element (GCE)
- Aviation Combat Element (ACE)
- Logistics Combat Element (LCE)

- **Tactical Services**
  - Voice
    Video
    Blue Force Tracking
    FIRES
    COTP
    Reachback, Routeback

Force 2

IBCT (Infantry Brigade Combat Team)

- Infantry Battalion
- Infantry Battalion
- Cavalry Squadron (RS&TA)
- Fires Battalion
- Brigade Special Troops Battalion
- Brigade Support Battalion
- AF attached Tactical Air Control Party (TACP)

- **Tactical Services**
  - Voice
    Video
    Blue Force Tracking
    FIRES
    COTP
    Reachback, Routeback

Force3

Joint Air Assets

- Rotary Wing
- Fixed Wing

- **Tactical Services**
  - Voice
    Video
    Blue Force Tracking
    COTP

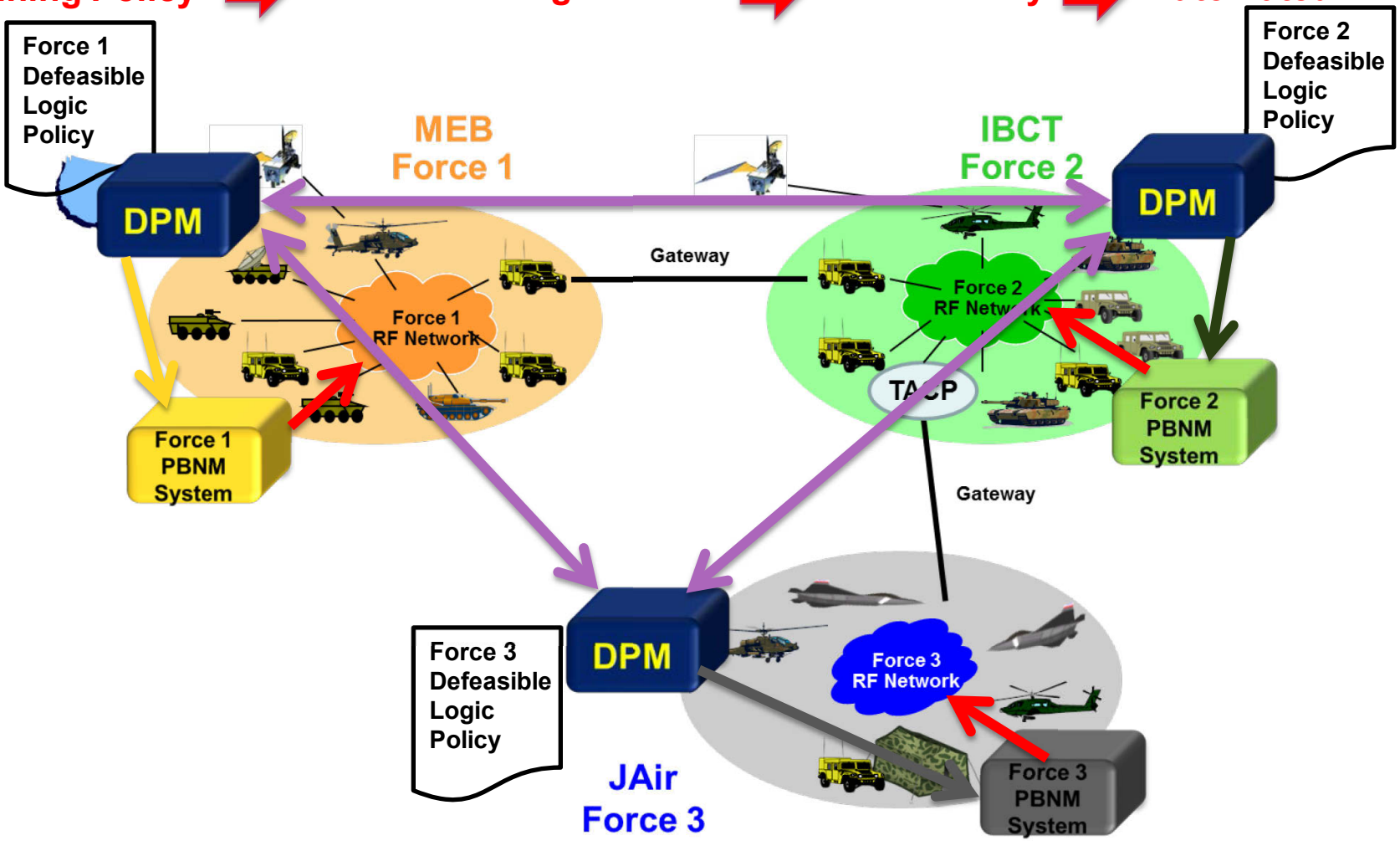
Challenges and Approach

- Challenges
  - Extend two party negotiation to multi-party negotiation
  - Incorporate Tactical services into the negotiation process
  - Automate the entire Planning-to-Network Management end-to-end process

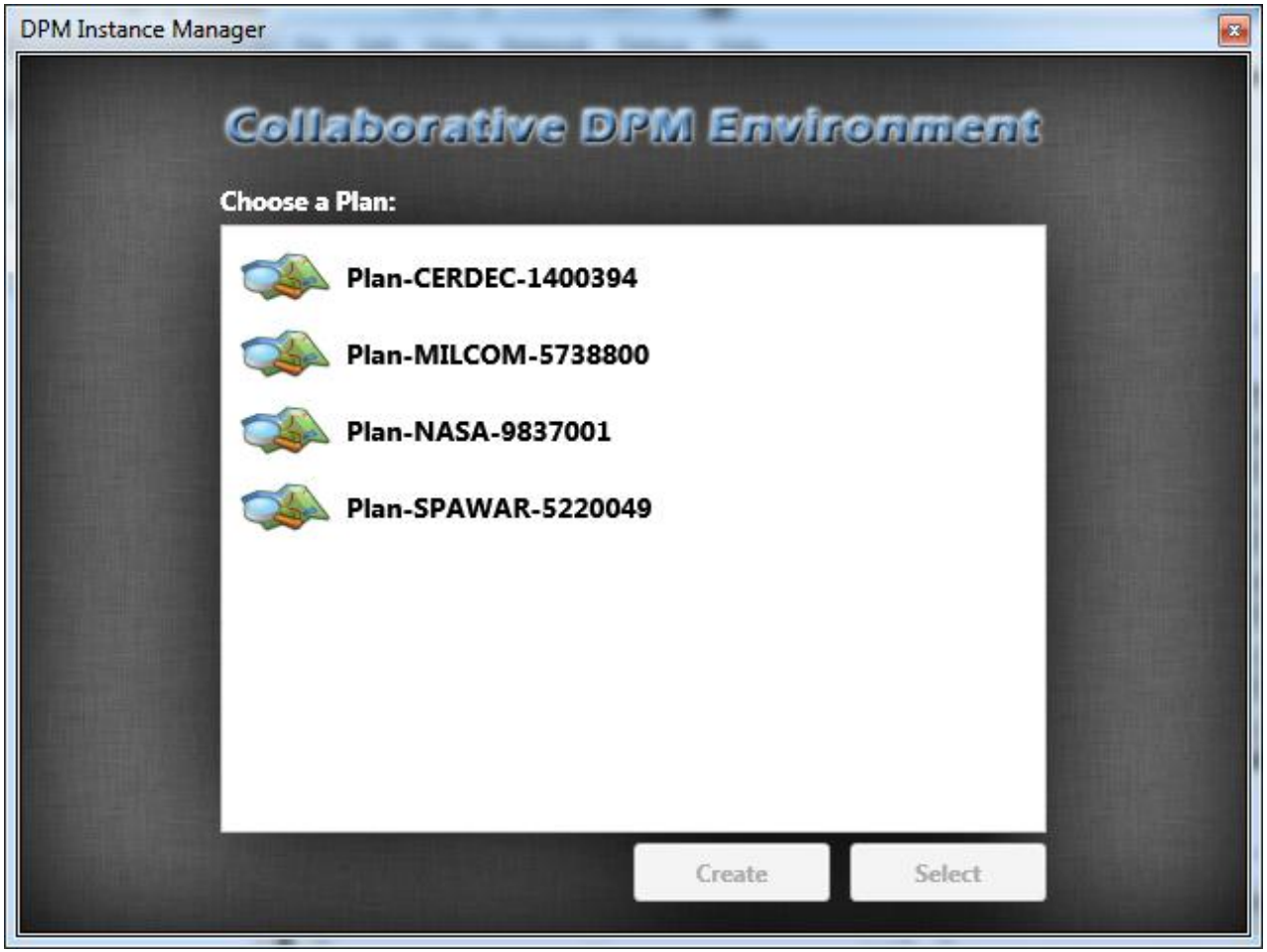
- Approach:
  - Develop Multi-Party Negotiation Algorithm
  - Develop greater complexity Use Cases with various Tactical services
  - Develop distributed multi-party collaborative DPM user interface software
  - Develop software to automatically convert DPM policies output to PBNM policies.

Automated Planning-to-Network Management Architecture

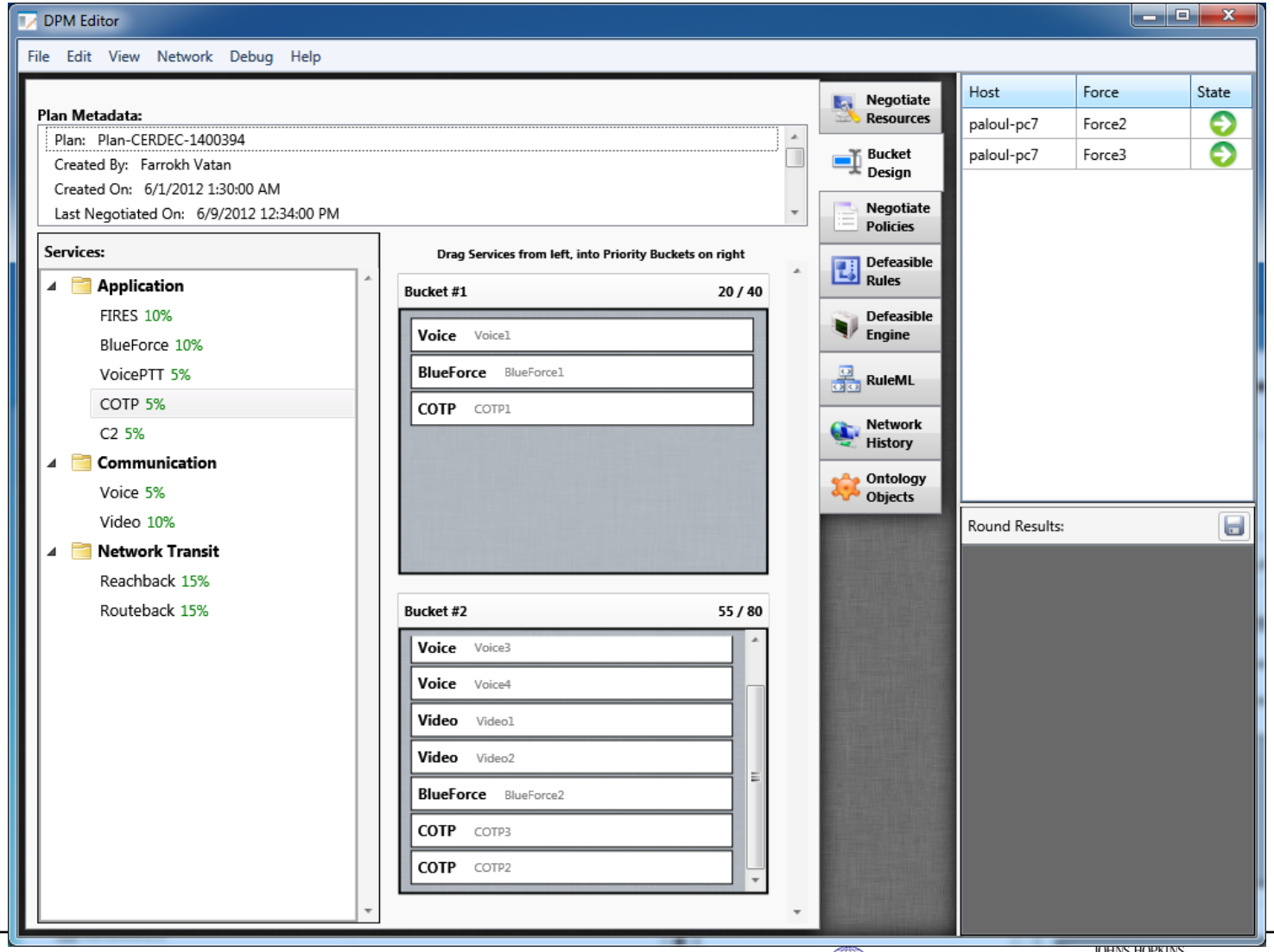
Planning Policy → Multi-Point Negotiation → PBNM Policy → Automated PBNM



Collaborative DPM Environment
- Supports Multi-Mission, Multi-Force Planning



Collaborative DPM Environment - Tactical Service-Based Priority Planner



DPM-PBNM Modeling Environment for Policy Validation

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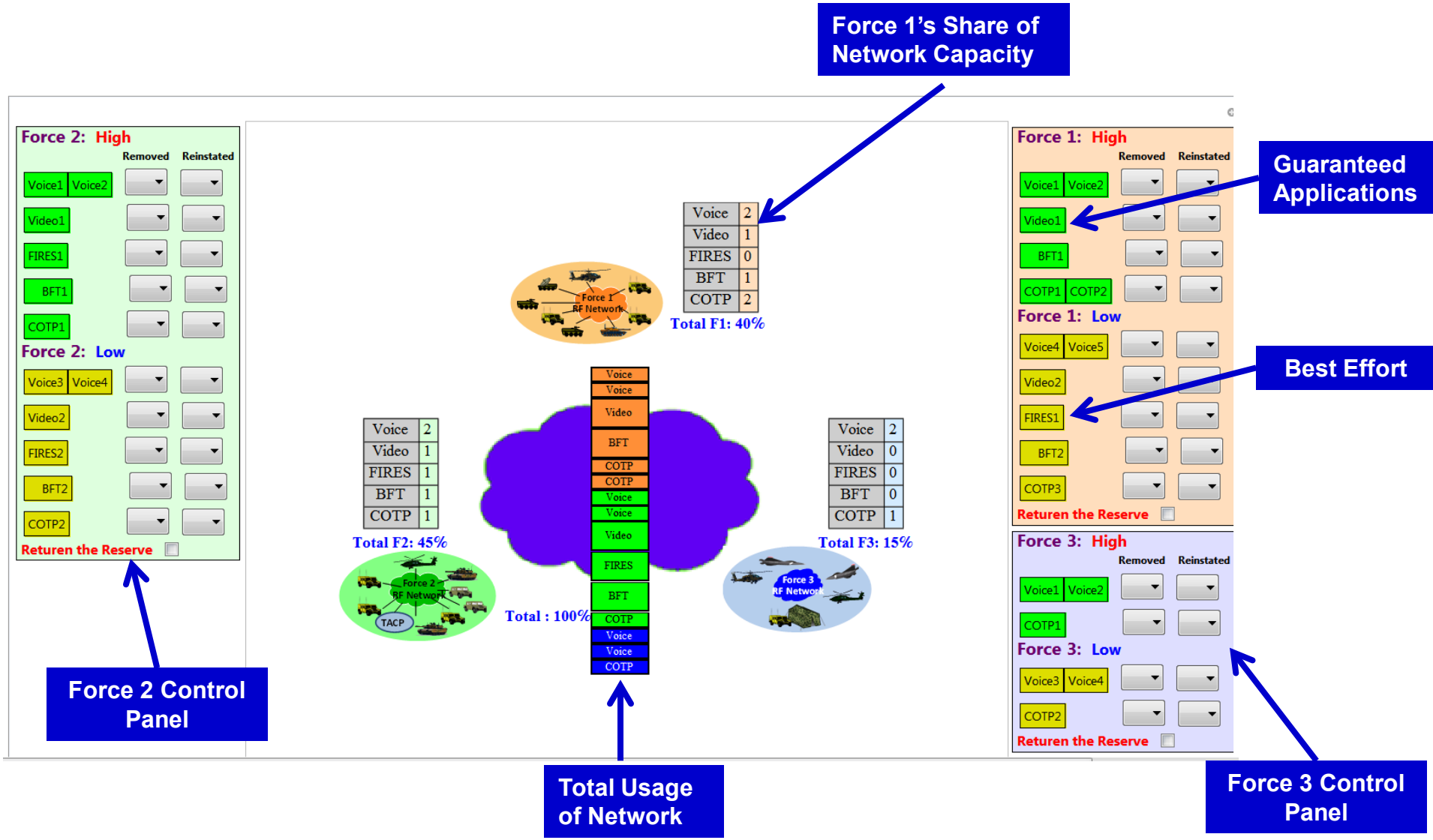

- Our team successfully:
  - Developed Multi-Party Negotiation Algorithm
  - Developed greater complexity Use Cases with various Tactical services
  - Developed distributed multi-party collaborative DPM user interface software
  - Developed software to automatically convert DPM policies output to SHINE and DRAMA PBNM policies.
  - Developed PBNM Modeling Environment to validate Use Cases
  - Validated DPM output on PBNM Modeling Environment.

Demonstrated Feasibility of End-to-End Planning-to-Network Management in seconds