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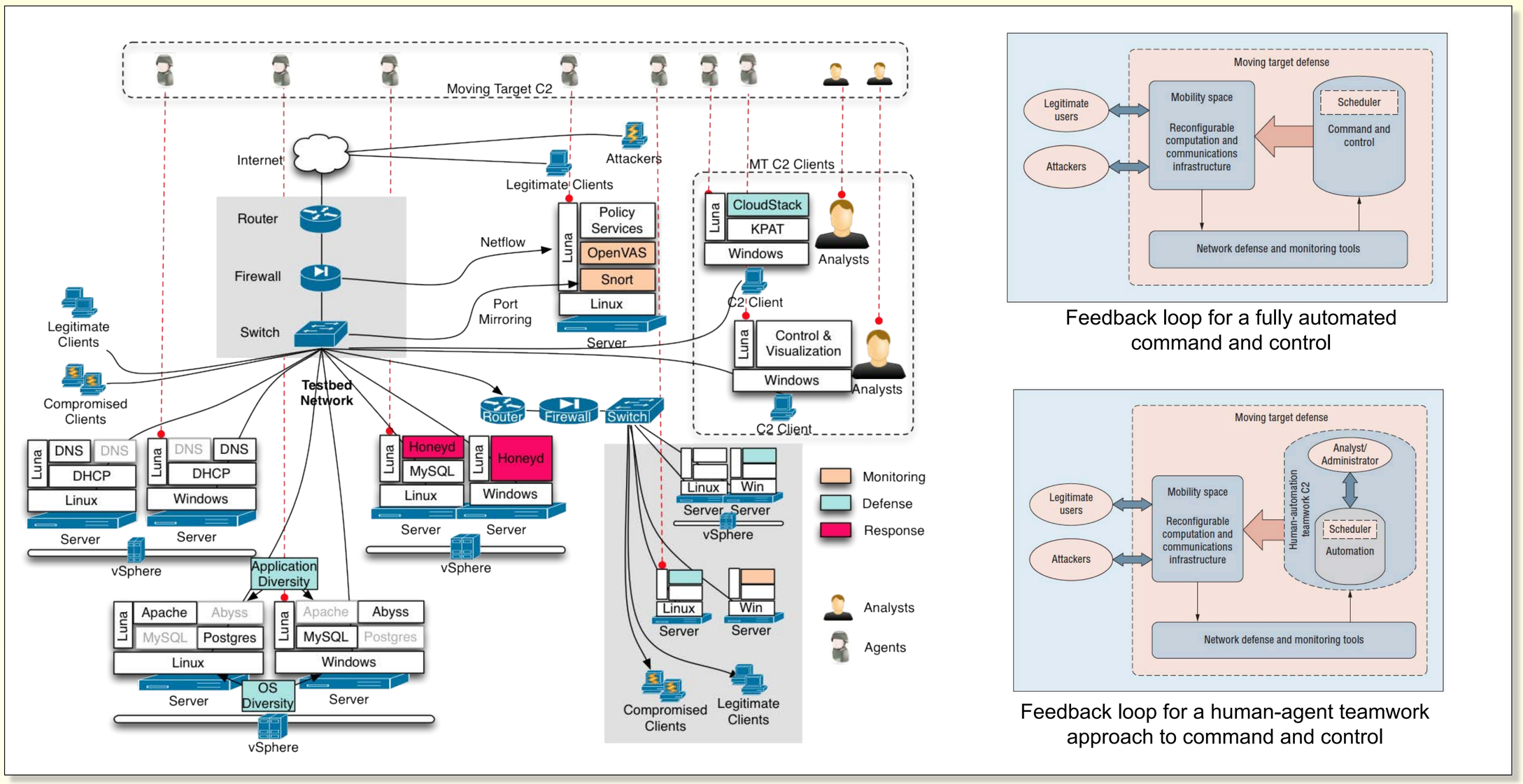
A Human-Agent Teamwork Approach to Moving Target Defense Command and Control

Objective: A command and control (C2) framework for moving target defense (MTD) management and coordination that embodies the principles of human-agent teamwork.

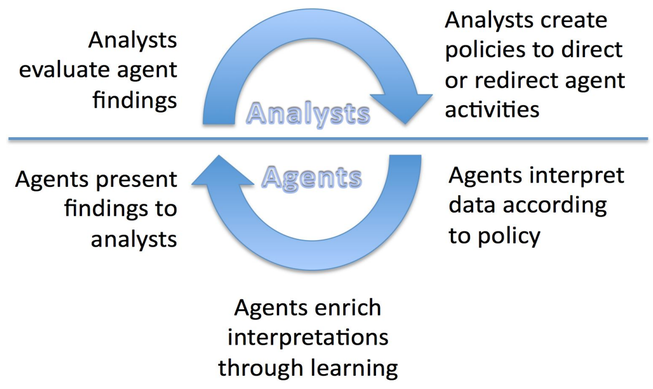
A Distributed Agent-Based Approach to MTD C2



Feedback loop for a fully automated command and control

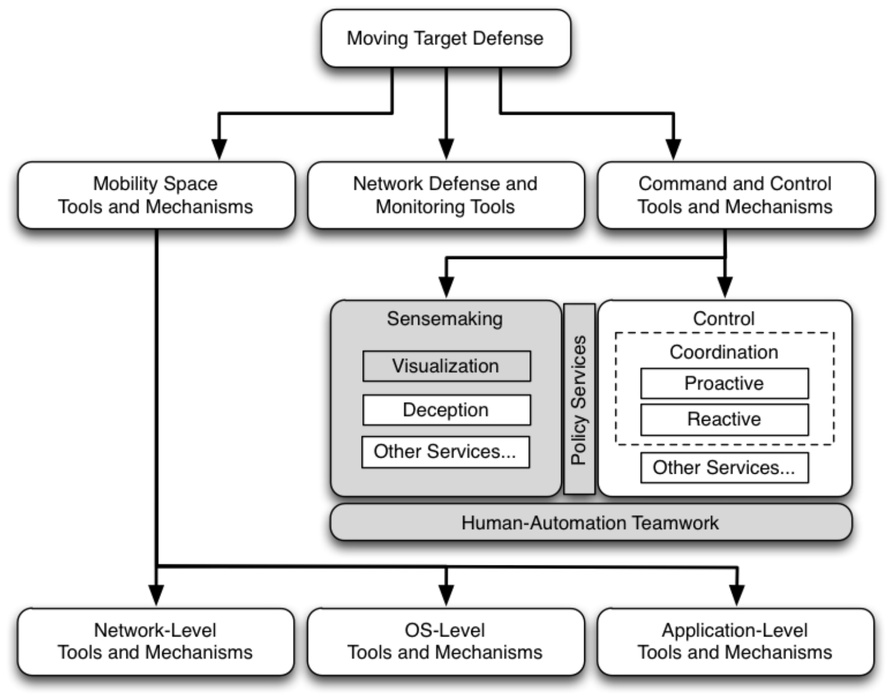
Feedback loop for a human-agent teamwork approach to command and control

Coactive Emergence in Human-Agent Teamwork



- Coactive emergence describes the process whereby useful interpretations of data are created through the interplay of interdependent sensemaking activities by analysts and agents.
- First-order emergence of interpretive patterns arises from problem-space constraints currently expressed within policies and tool configurations.
- Second-order emergence arises from dynamic changes to the problem-space constraints by agents and analysts.

Sensemaking, Teamwork, Policies, and Visualization



Sensemaking: Theory-informed approach to enable awareness, anticipation, and effective action within distributed teams.

Human-Automation Teamwork: Collaboration among analysts and software agents working together on interdependent activities. Relies on the unique capabilities of the *Luna Agent Framework* to support observability, directability, interpredictability, learning, multiplicity, and fine-grained policy governance of agent behavior.

Policy Services: Ability to direct defense strategies and system behavior through dynamic, declarative, context-sensitive policies. Relies on the unique capabilities of the OWL-based *KAoS Policy Services Framework* and the *VIA Cross-Layer Communications Substrate*.

Visualization: Leverages knowledge about human perception, cognition, and collaboration to enhance human performance in complex, real-time work.

Organic Resilience and Collective Obligation Policies

- MTD resilience is achieved through (1) on demand creation of self-organizing capabilities for problem mitigation and recovery; (2) engaging the adaptive capabilities of humans.
- Organic resilience builds on a biological analogue (inter-cell signaling and differentiation) to enable agent self-organization.
- Collective obligation policies represent duties of a group of agents without specifying in advance who must do what.
- Properties enabling organic resilience include:
  - self-organization and adaptation at all levels, and including both analysts and agents.
  - plasticity and redundancy of agents and operations.
  - feedback cycles for agents and analysts that allow the ongoing evaluation and correction of operations.

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