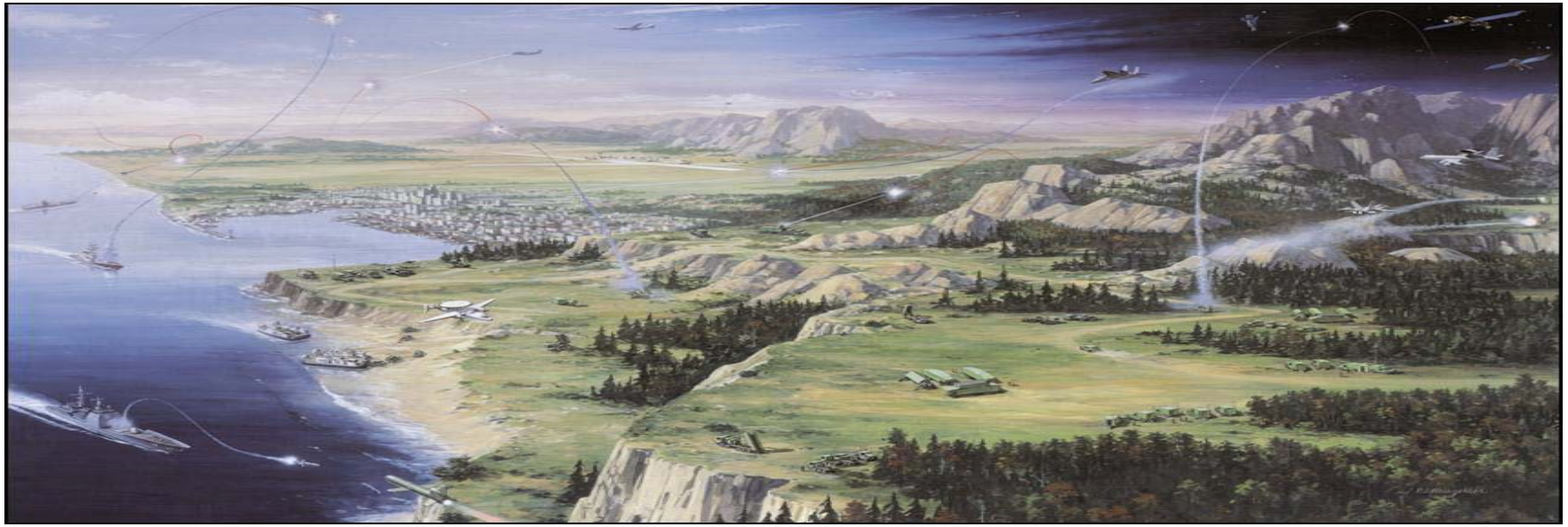
FNT-09-02 Dynamic Tactical Communications Networks (DTCN) EC Technology Overview & BAA Topics

2010 June 25



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Outline

- Major DTCN Features
  - BAA Topic Overlay
- Notional DTCN Architecture
  - Traffic Management Features
  - Edge Network and Tactical Core Factors
- Transport Layer for Dynamic C2
- BAA Topics

Major DTCN Features

Policy-Directed Traffic Management:

- Communication Requirements by Mission
  - Multiple applications
  - Criticality tiers
  - Vary by mission phase
- Aggregate along command hierarchy
  - Inter-mission deconfliction
  - Granularize at top-level

☞ Actionable, network-wide traffic management policy

Assured Information Exchange Aligned to Traffic Management Policy:

- Queuing/routing to maximize most critical IERs
  - Most critical IERs may even be flooded
- Reactive to Dynamic Network Conditions
  - Traffic, bandwidth, topology, etc.
- Multiple techniques:
  - Strict priority queuing
  - Adaptive Routing
  - Route control agent
  - *Future Performers (BAA Topic)*

General Infrastructure *(i.e., maintain degraded capability)*:

- MANET Routing Enhancements
- Radio-Router Interface
- Autoconfiguration
- Dynamic Routing Across INEs
- Linux-Based Router Platform

Address Performance Metrics:

- Network Scalability (300 nodes)
- Config/Reconfig Time (2 min/30 sec)
- Join/Leave Time (5 sec)
- Security Enclave Mobility (20 sec)

Self-Organizing Networks (SON)

Assured Information Exchange (AIE)

BAA Topics (Page 1 of 2)

Policy-Directed Traffic Management:

Tools to Manage and Monitor Coherent Application Prioritization
Develop, maintain and disseminate TM Policy which reflects and deconflicts Commander's Intent. Monitor system performance relative to this TM Policy.

Assured Information Exchange Aligned to Traffic Management Policy:

Dynamic Routing QoS Traffic Class Mechanisms
Service tiers with varying likelihood of message transfer success. Reactive to network state, TM Policy configuration, and offered traffic load. Packet duplication over independent paths is one example.

General Infrastructure *(i.e., maintain degraded capability)*:

Heterogeneous Routing Architectures
To include heterogeneous radio technologies, multiple Tactical Cores, asymmetric, and simplex links. Consistent with system-wide prioritization objectives. Self-configuring and adaptive with minimal human intervention.

Self-Organizing Networks (SON)

Assured Information Exchange (AIE)

BAA Topics (Page 2 of 2)

Assured Information Exchange (Above the Network Layer)

Serverless (Group) Communications
Either peer-to-peer or group communications that function without statically configured servers. Specific considerations include limited bandwidth, intermittent communications, ease of use.

Transport Protocols for Highly Asymmetric Networks
Asymmetry may be due to underlying network capability, or due to residual capacity for a given priority tier.

Self-Organizing Networks (SON)

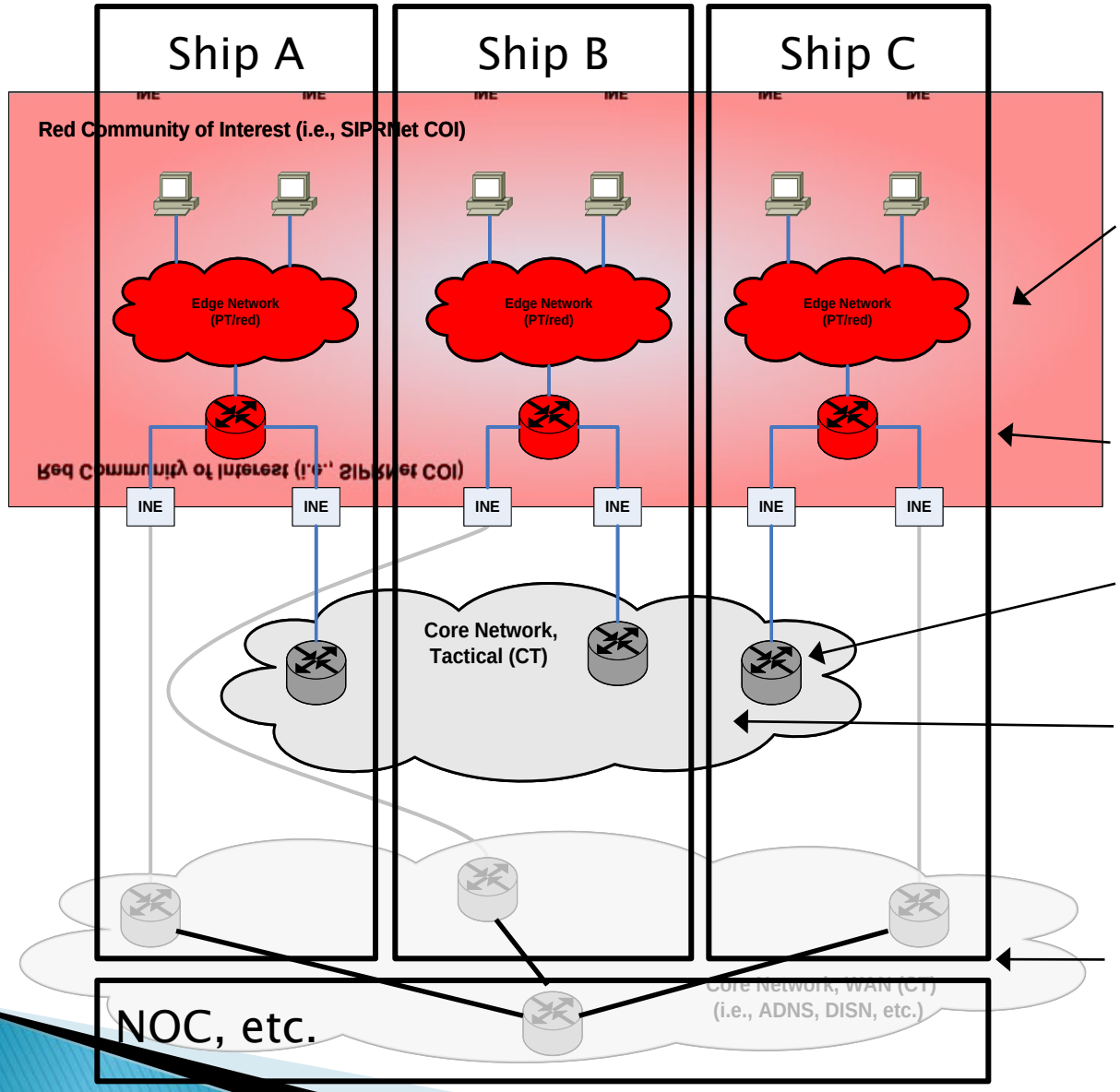
Assured Information Exchange (AIE)

Purpose of This Notional Architecture

- Identifies discrete points where *DTCN capabilities* could be deployed so that:
  - Performers can express product value against a commonly understood architecture
  - Performers can appreciate INE implications
  - Integration discussion can proceed

- Can be varied to accommodate certain unknowns without significantly disrupting the relationship between DTCN components
  - Identify certain unknowns
  - Confirm the architectural independence to unknowns
  - Move on…

DTCN Notional Architecture



Selected Edge Networks may utilize DTCN MANET Capabilities, and may permit end-host mobility (USMC)

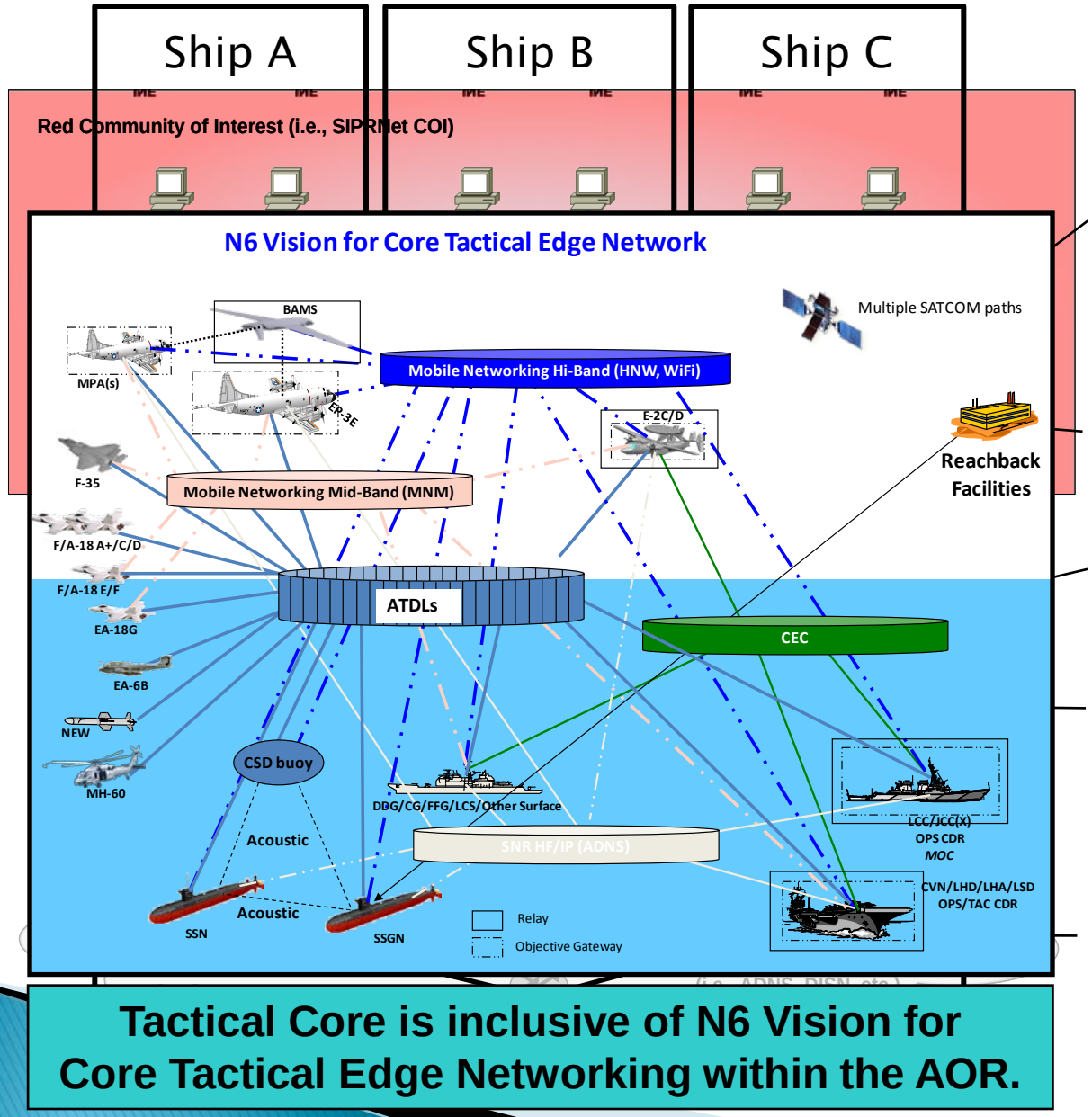
DTCN "Edge Capabilities"

DTCN "Core Capabilities"

Tactical RF Links / Subnets Throughout DTCN Core Network

DTCN Must Function Despite Loss of WAN and WAN-hosted Services.

DTCN Notional Architecture



Tactical Core is inclusive of N6 Vision for Core Tactical Edge Networking within the AOR.

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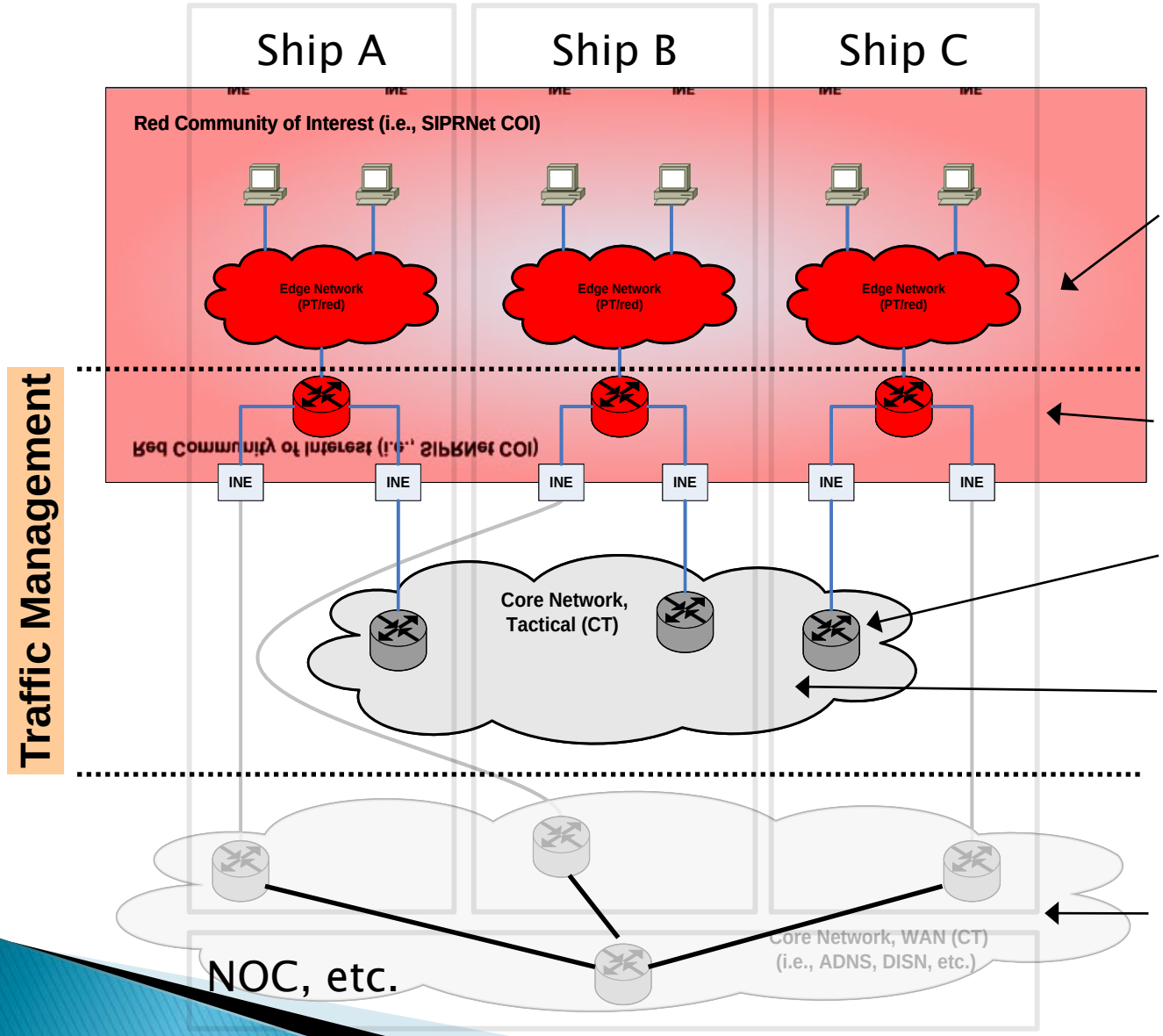

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DTCN "Edge Capabilities"

DTCN "Core Capabilities"

Tactical RF Links / Subnets Throughout DTCN Core Network

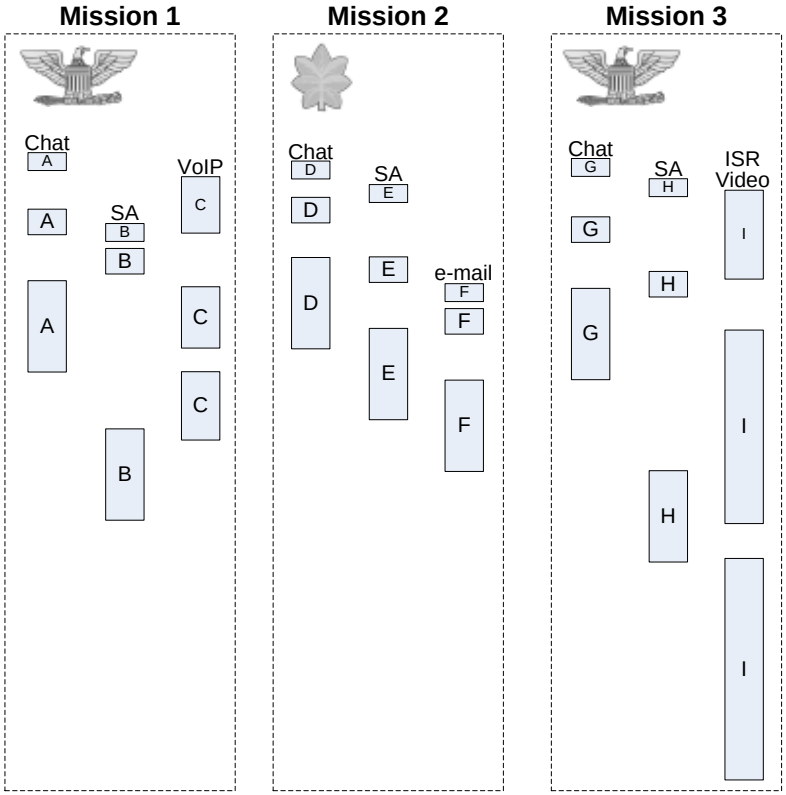
DTCN Must Function Despite Loss of WAN and WAN-hosted Services.

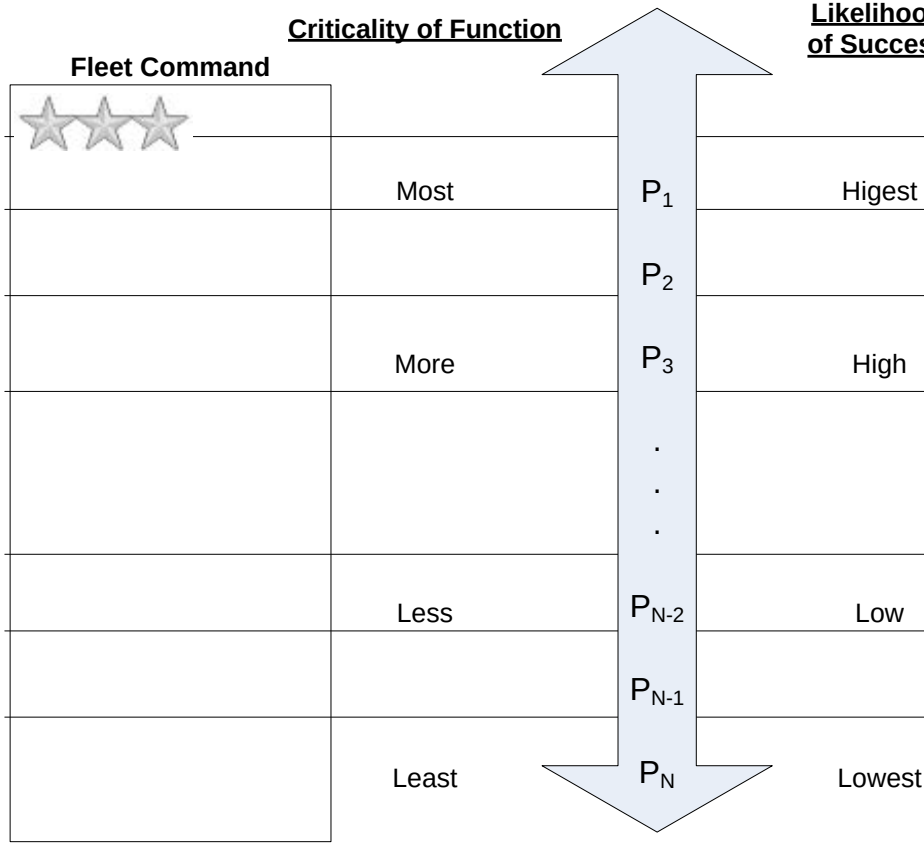
Architectural Features: AOR-Wide Traffic Management

- Queuing/routing(*) to maximize highest priority IERs
  - Highest priority IERs may even be flooded
- Each mission IER is broken into tiers:
  - Traffic flow bounds
  - Abstract priority level
  - "Mission Impact" statement
- Aggregate per Commander's Intent:
  - Cross-mission priority mapping (i.e., deconfliction)
  - Result: AOR-wide network flow prioritization
- Performance monitoring indicates "Mission Impact"
- Mission-phase dependent

(*) Includes load-balancing.

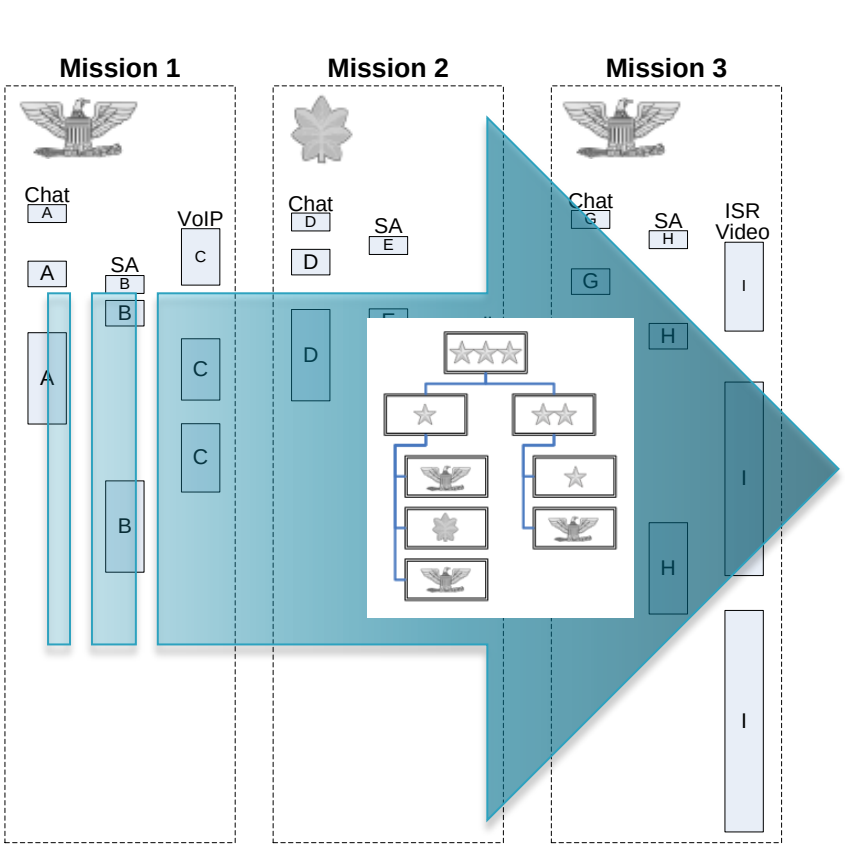
Architectural Features: AOR-Wide Traffic Management

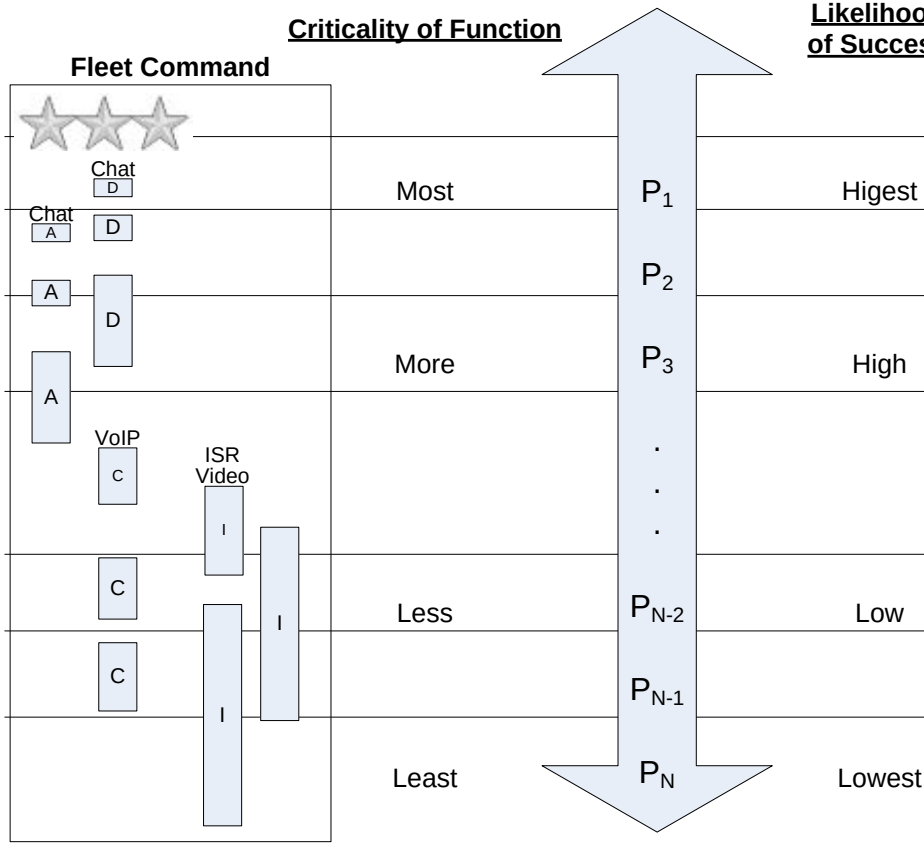




Note: 10 to 30 priority classes.

Architectural Features: AOR-Wide Traffic Management





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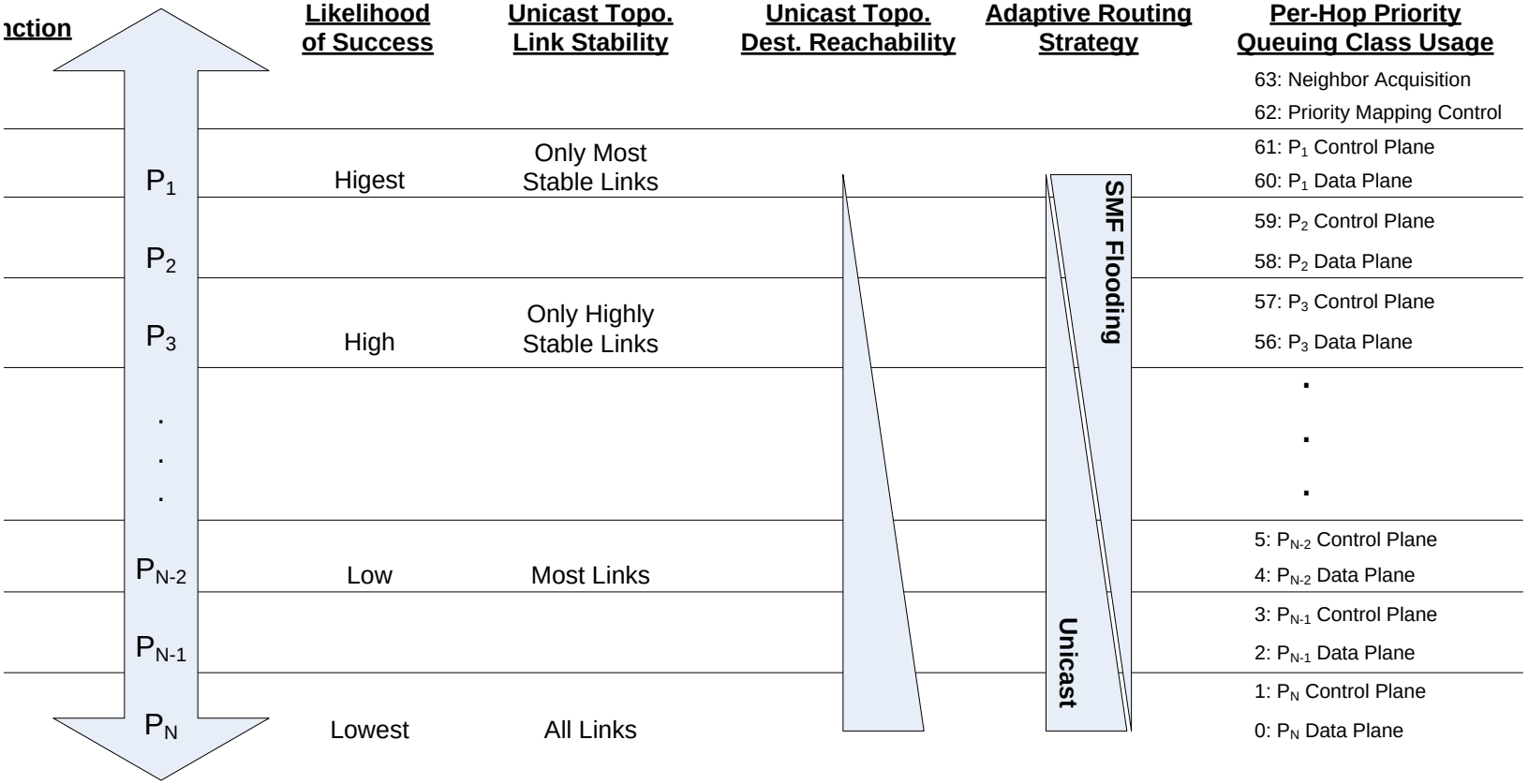

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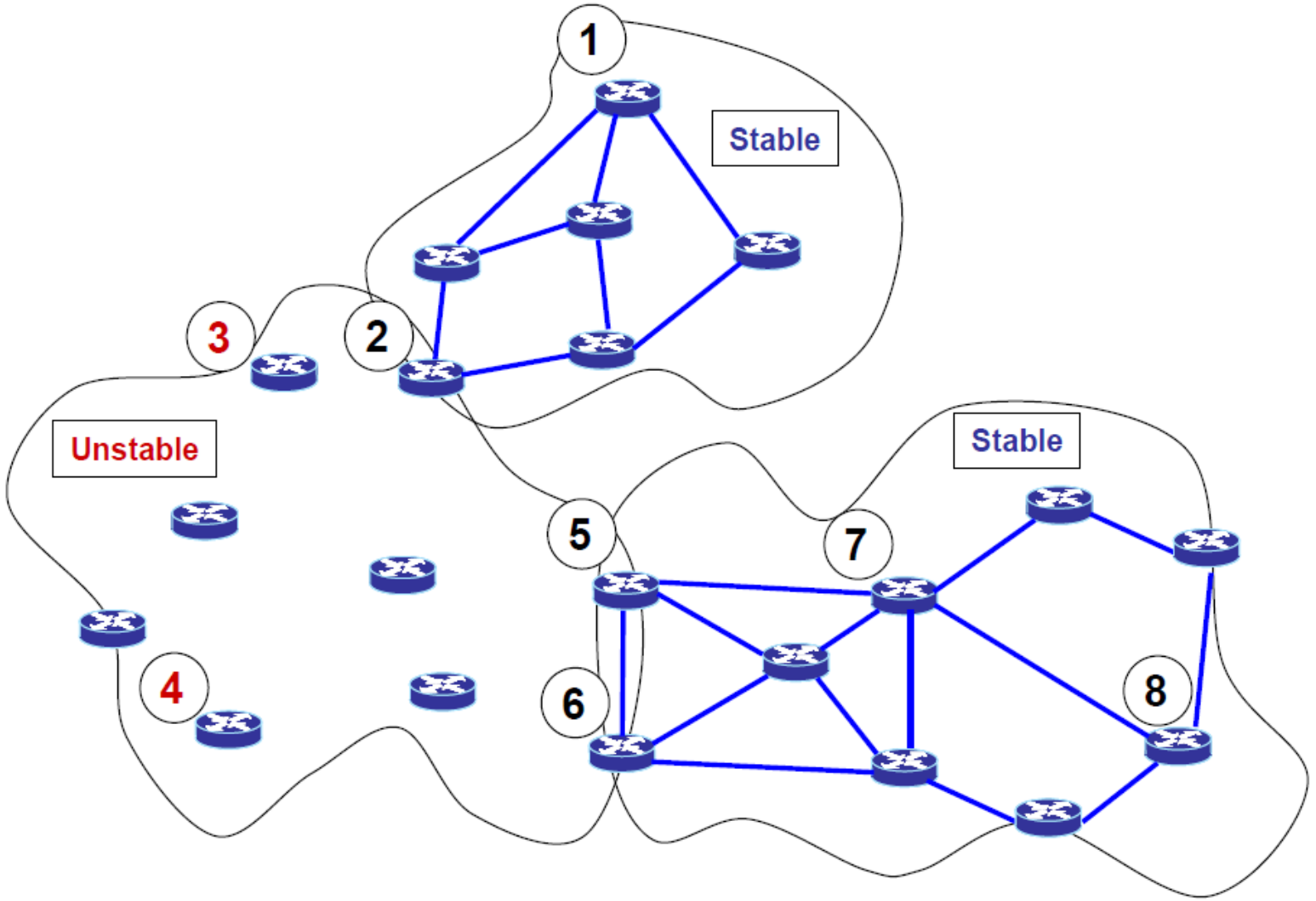
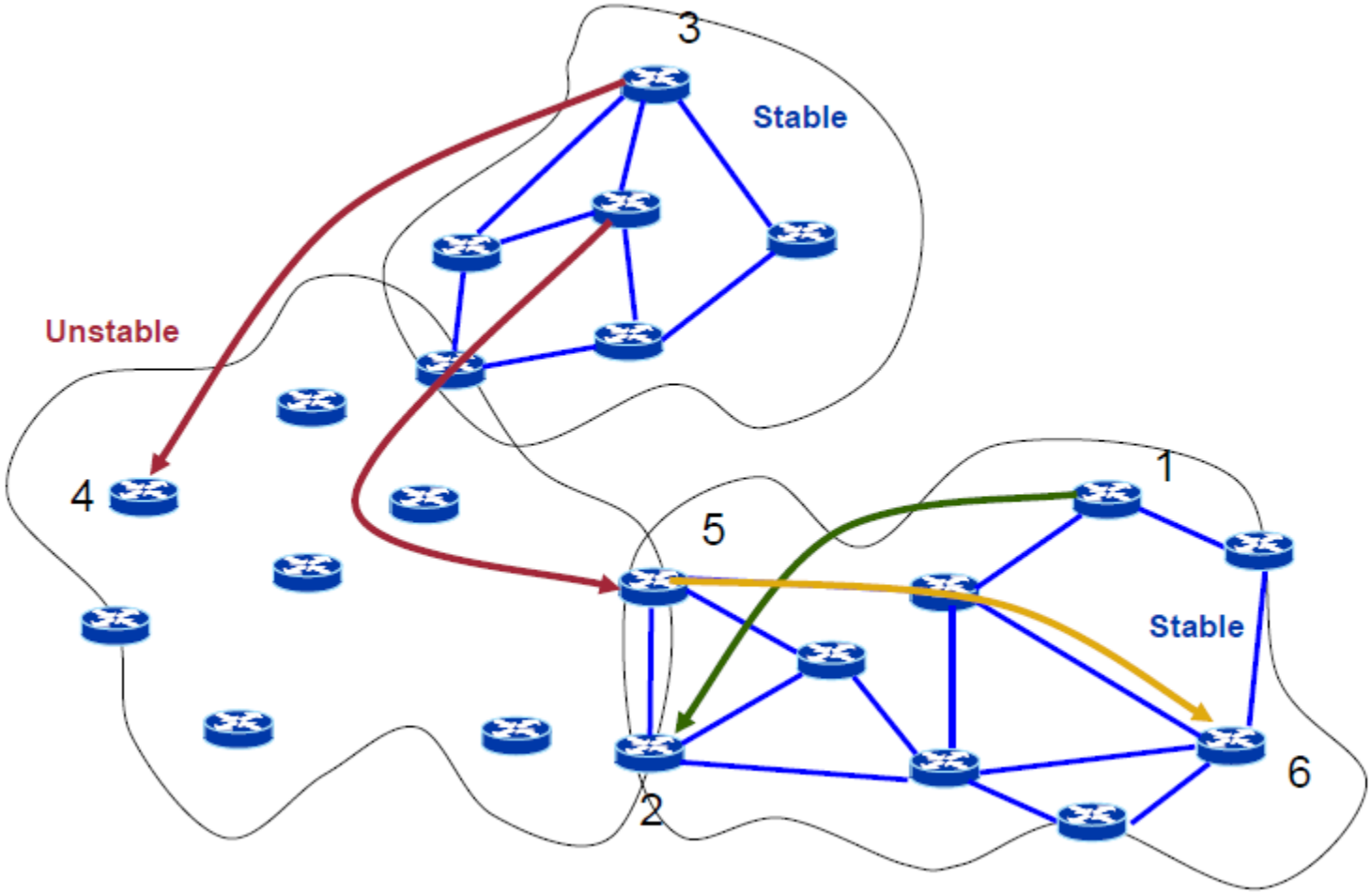
A Challenging Environment



SOURCE: Boeing "Self-Configuring Adaptive MANET Final Technical Report" (April 2010)

Adaptive Routing



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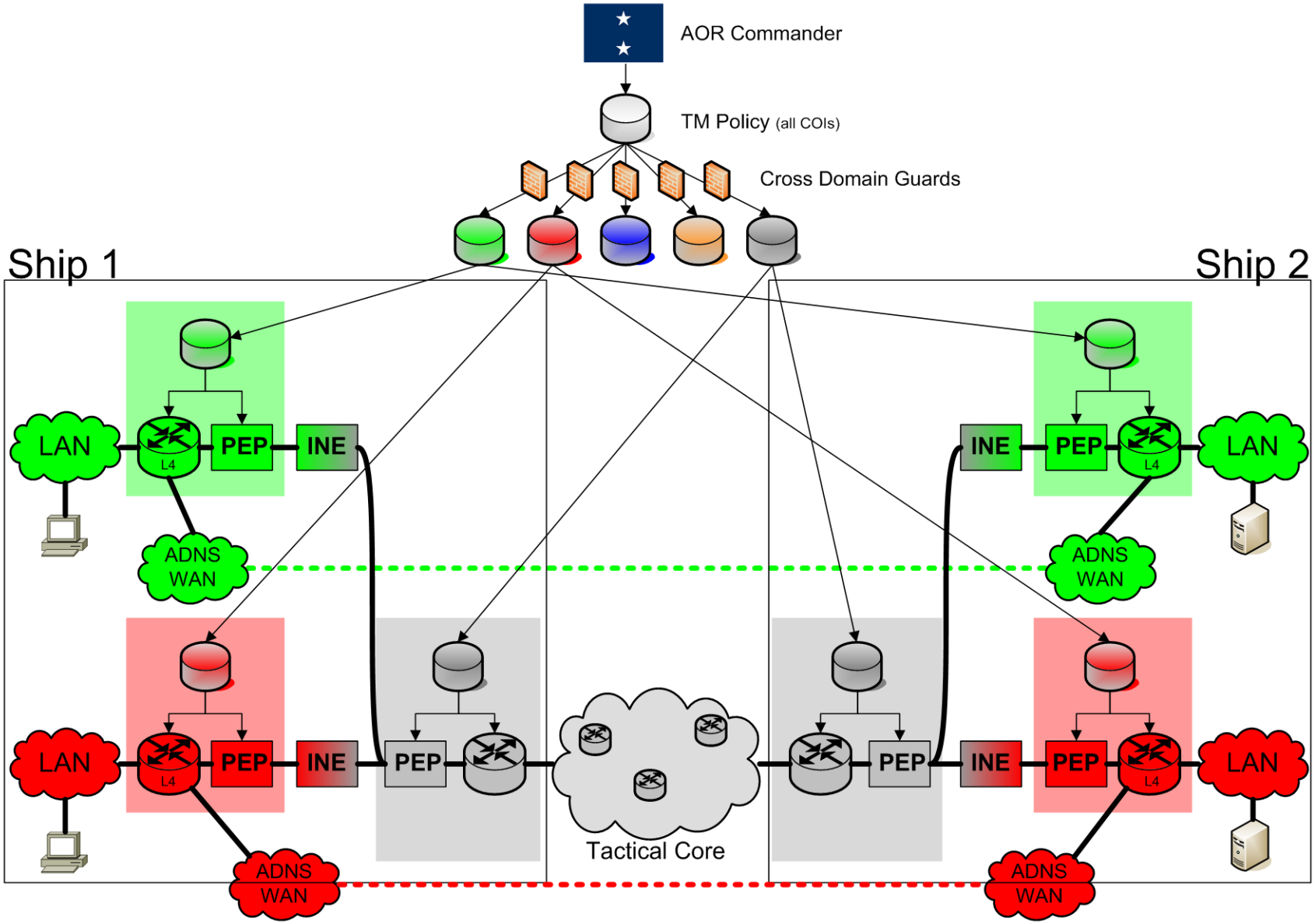


TM – Traffic Management L4 – Layer 4 Router INE-- Inline Network Encryptor
PEP – Policy Enforcement Point (Traffic Policer and Marker)

Architectural Features: Edge Network Edge Router (ENER)

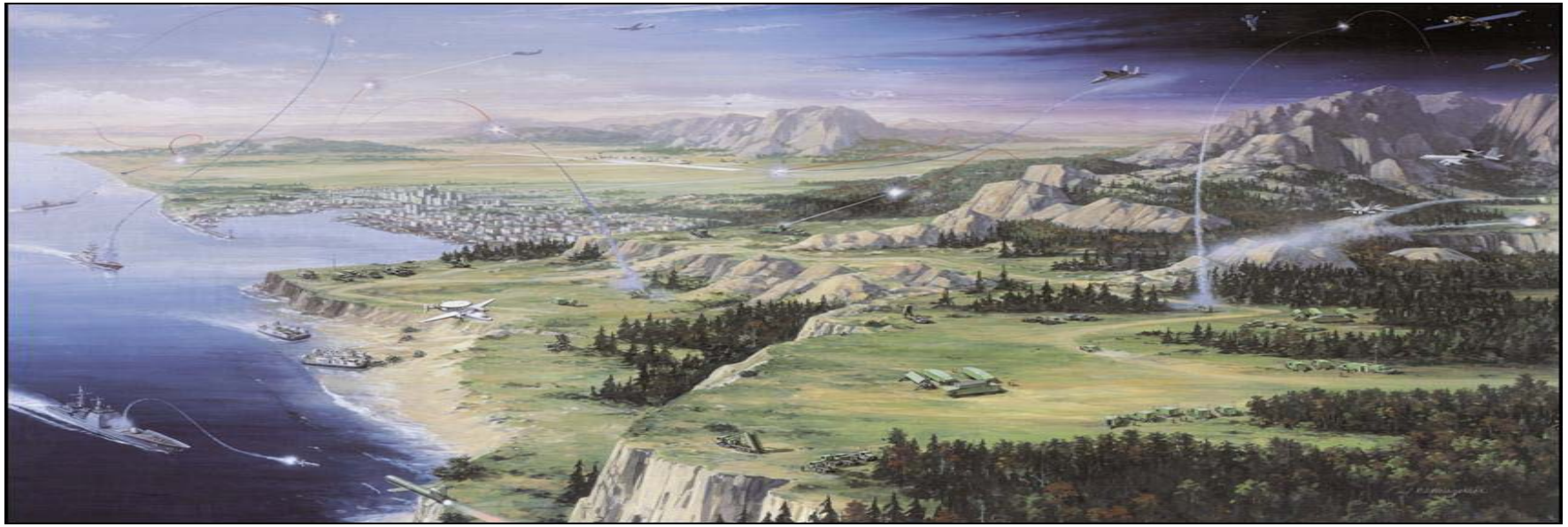
- Tactical Core Reachability
- INE PT/CT Address Mapping
- Policy Enforcement Points
  - Traffic Policing and Remarking

Architectural Features: Tactical Core

- Tactical RF links interconnect routers
- Priority queuing by DSCP value
- Routing to maximize likelihood of high priority traffic flows' delivery
- Independent of WAN
  - Operation
  - Design
- Likely operated at SECRET
  - Communication Requirements (TM Policy)
  - Mission phase
  - DSCP bypass
  - Type 1 link encryption likely required

FNT-09-02 Dynamic Tactical Communications Networks (DTCN) EC Transport Layer Efforts (with FNT-09-04 EC)

2010 June 25



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FNT 09-02 Inter-EC Coordination (Transport Layer Efforts)

- C2 Transport Layer (priority-enhanced NORM)
  - Priority-Queued Application Messages
  - Multi-level Network QoS/Priority Marking

- C2 Video Transport
  - Adaptive to C2 Network Dynamics
  - Multi-layer fidelity encoding
  - Encoding aligned to network QoS/Priority Marking

Notional C2 Priorities: Tracks

Information Priorities	
High	1
Medium	2
Low	3

Classification \ Type	*Surf*	*Sub*	*Air*	*UNK*
Friend	2*	1	2**	NA
Neutral	3	NA	3	NA
Suspect or Hostile	1	1	1	NA
Unknown or Pending (within OPAREA)	2	1	2	2
Unknown or Pending (outside OPAREA)	3	1	3	3

*Priority = 1 if track age > 30 minutes

**Priority = 1 if track age > 10 minutes

Source: Dynamic C2 EC "Information Priorities."
Intended for experimental evaluation use only.

Notional C2 Database with Transport Layer Control & Status

track_id	x	y	z	type	rowid	update_ time	tx_ priority	tx_ time	ack_ time
123	X1	Y1	100	blue	101	10425	200	10600	9500
345	X2	Y2	120	blue	102	10210	200	10300	10500
567	X3	Y3	15000	blue	103	9985	200	10100	10200
789	X4	Y4	75	wht	104	10320	300	9010	8500
432	X5	Y5	-1000	blue	107	10321	200	10450	10600
654	X6	Y6	50	red	109	10322	100	10390	10550
876	X7	Y7	-500	red	111	11050	100	11075	-

Application Data

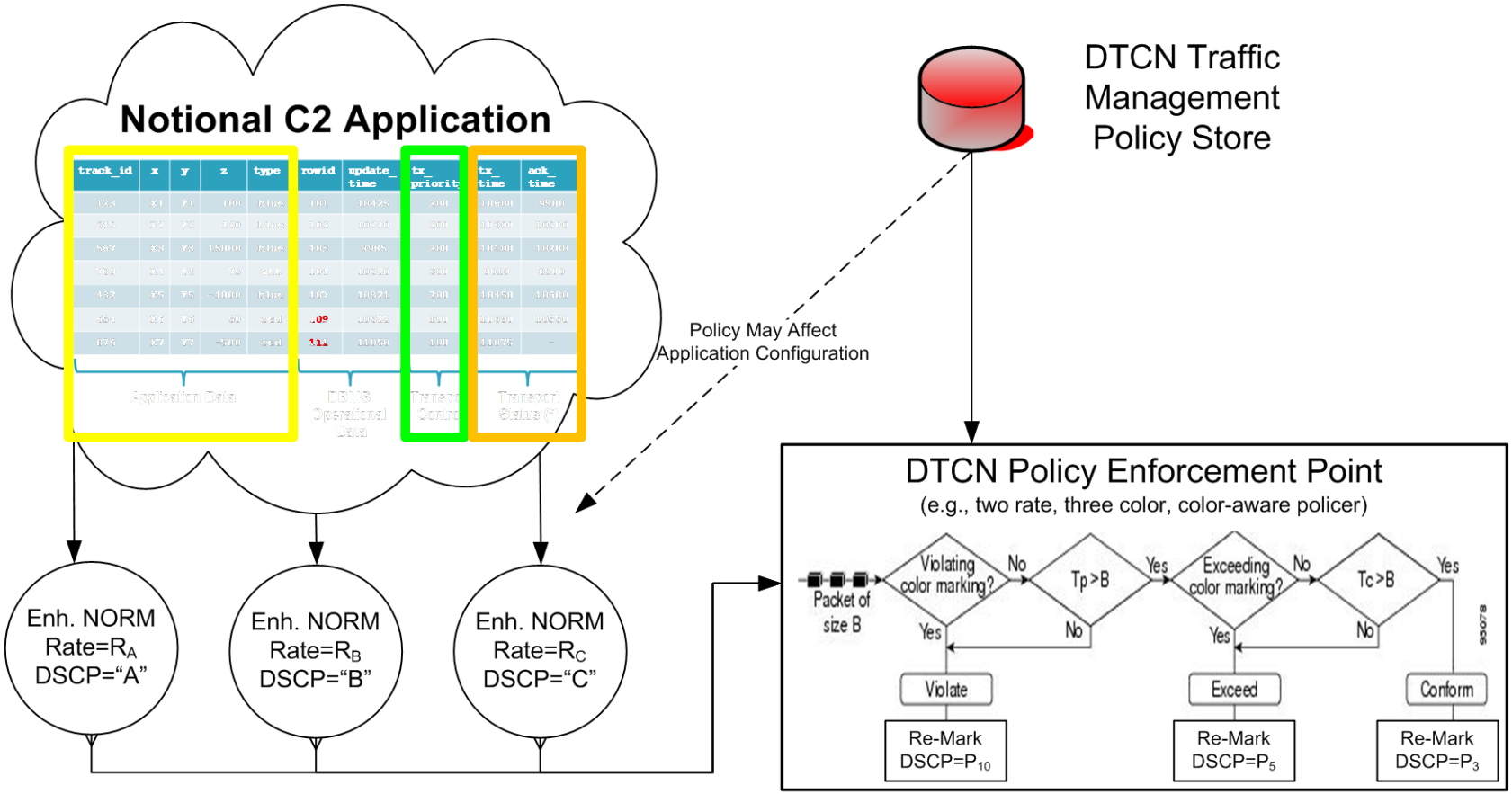
DBMS Operational Data

Transport Control

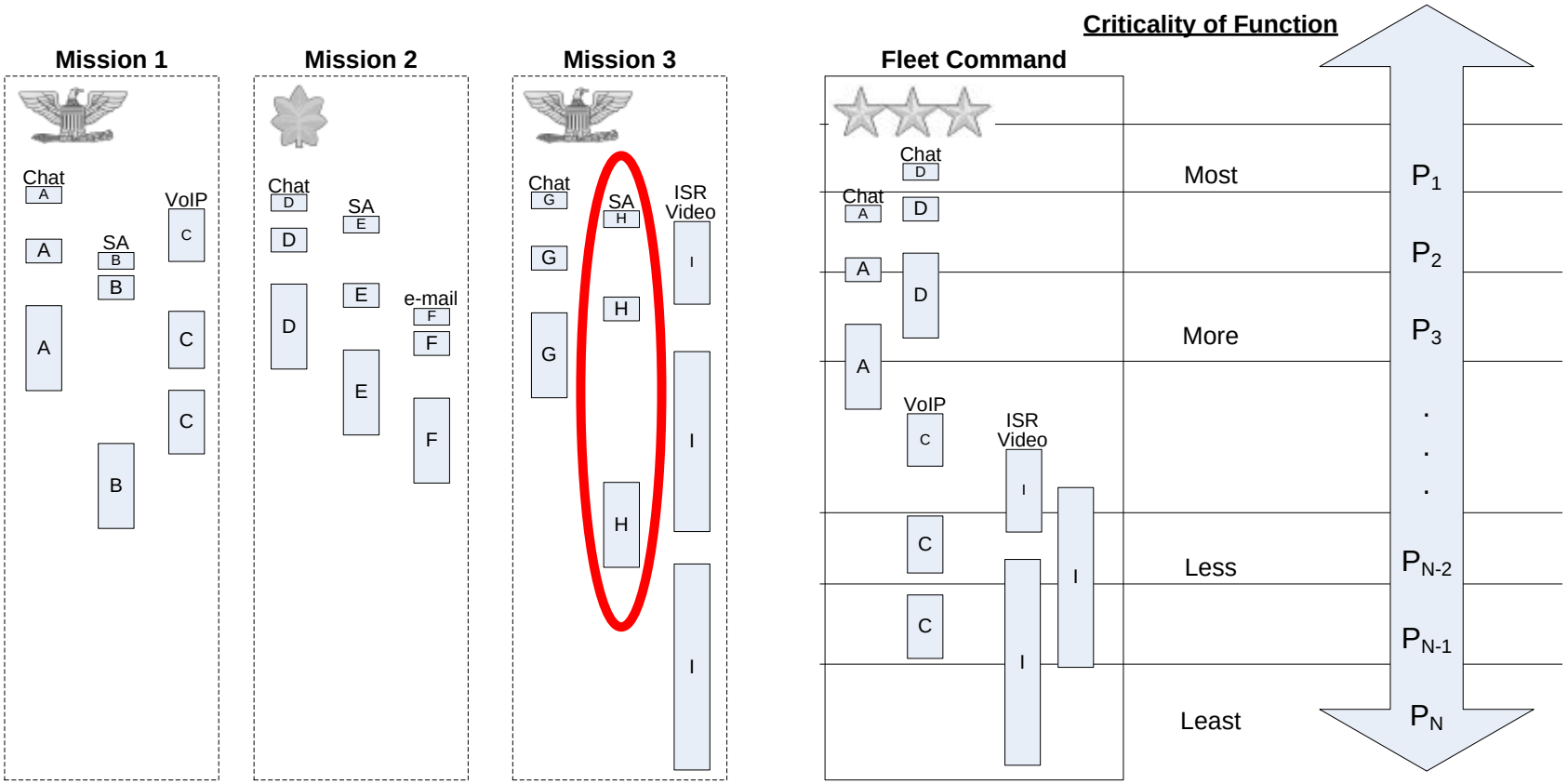
Transport Status (*)

(*) Transport Status should be multi-valued to reflect Application Data versions.

Notional C2 App. With DTCN

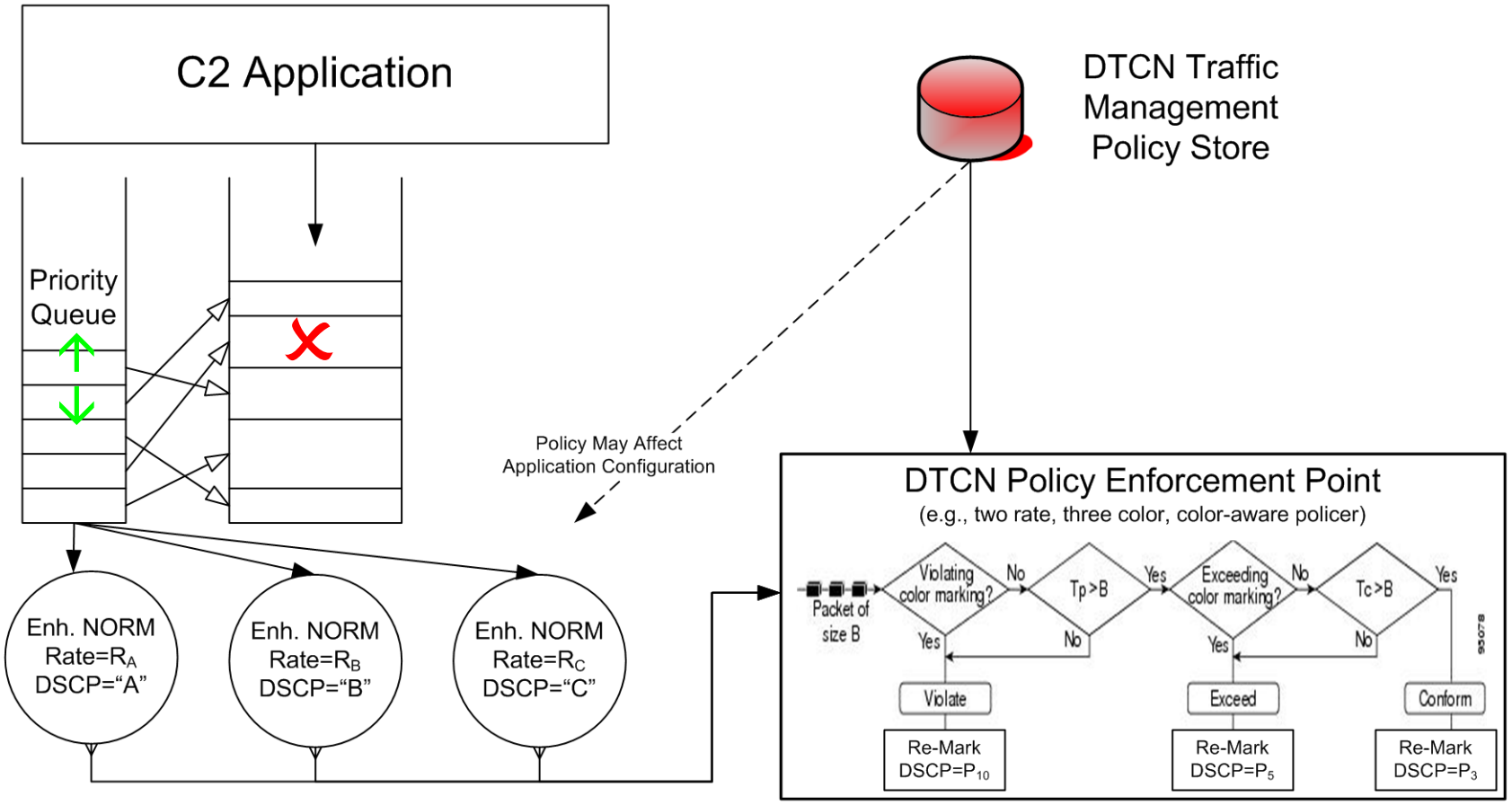


Enhanced NORM for C2: Fits into DTCN Prioritization Tiers



Note: 10 to 30 priority classes

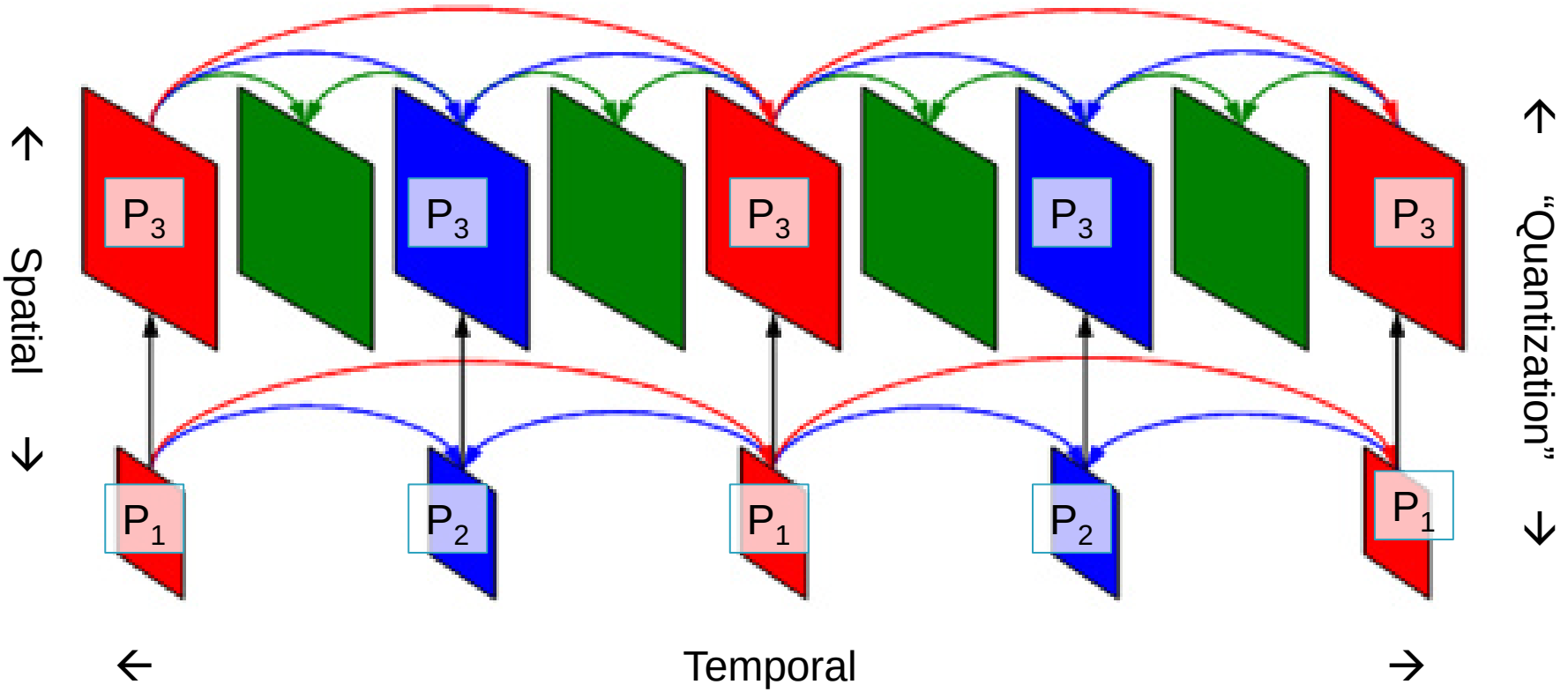
Enhanced NORM for C2 App.



Cancel Messages

Reprioritize Messages

Example C2 Priorities: H.264/Scalable Video Coding

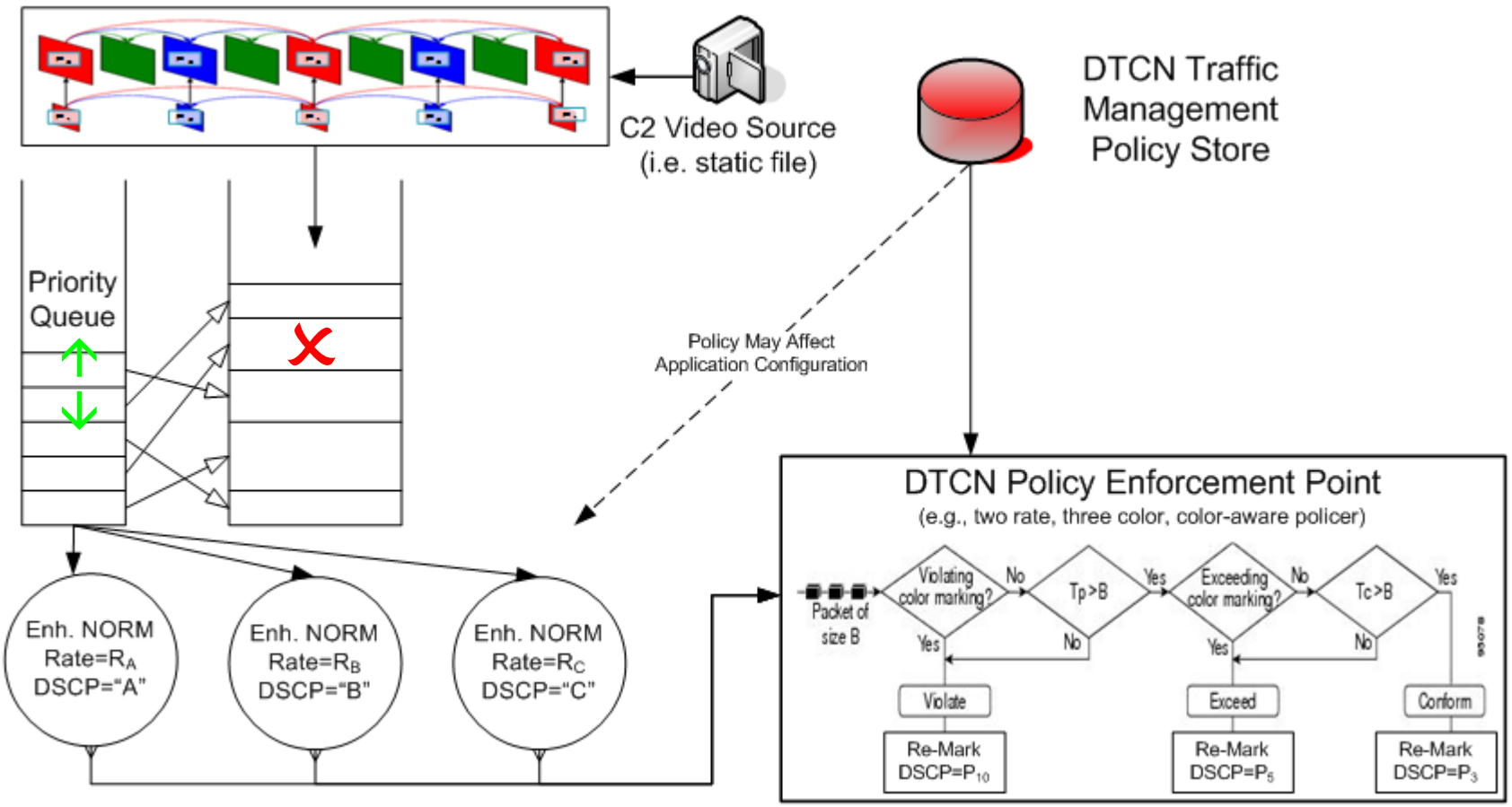


H.264/SVC Video Example

- See video outside of PowerPoint
  "Vidyo vs. Legacy H.264 comparison video (HD).mp4"

- Note, packet loss is unbiased in video. In our LTE thread (and in DTCN), packet loss will be biased toward less-critical data tiers.

C2 Video with Enhanced NORM



✕ Cancel Messages

↑↓ Reprioritize Messages

BAA Topics

Assured Information Exchange (Above the Network Layer)

Serverless (Group) Communications

Transport Protocols for Highly Asymmetric Networks

Policy-Directed Traffic Management:

Tools to Manage and Monitor Coherent Application Prioritization

Assured Information Exchange <u>Aligned to Traffic Management Policy:</u>

Dynamic Routing QoS Traffic Class Mechanisms

General Infrastructure *(i.e., maintain degraded capability)*:

Heterogeneous Routing Architectures

Self-Organizing Networks (SON)

Assured Information Exchange (AIE)

SON Topic 1: Tools to Manage and Monitor Coherent Application Prioritization

- DTCN Goal: Maximize the delivery of mission critical IERs over an unpredictable and highly dynamic environment to meet Commander's Intent.

- Traffic Management (TM) Policy represents:
  - Accurate and actionable mission requirements
    - Multiple applications
    - Broken down by priority tiers
    - Mission impact statements per-tier
  - Multiple concurrent missions
  - Multiple mission phases (per mission)
- TM Policy…
  - Must be disseminated over the network
  - Is the optimization objective for components & overall system
- Performance monitoring is relative to TM Policy
  - E.g. alerts cite “mission impact statements”

SON Topic 2: Heterogeneous Routing Architectures

- Enrich our *Tactical Core* capabilities with respect to:
  - Hierarchal networks
  - Network interconnection
  - Asymmetric link technologies, including:
    - Simplex datalinks
    - Split-IP SATCOM
    - EMCON
- While enriching capabilities, maintaining focus upon:
  - System-wide prioritization objectives
  - Minimal human intervention

AIE Topic 1: Dynamic Routing QoS Traffic Class Mechanisms

- "Routing Protocol Class" solutions to create service tiers
  - Varying likelihood of message transfer success
  - Different resource costs
  - Different network stability requirements
- Dynamic and reactive to:
  - Network state
  - TM Policy configuration
  - Mission phase
  - Offered traffic load
- Packet duplication over independent paths is one example.

AIE Topic 2: Transport Protocols for Highly Asymmetric Networks

- Asymmetry may be due to underlying network capability, or due to residual capacity for a given priority tier.

AIE Topic 3: Serverless (Group) Communications

- Either peer-to-peer or group communications that function without statically configured servers. Specific considerations include limited bandwidth, intermittent communications, ease of use.