



Framework Linking Technology Risk to Mission Success

**Carol Woody, Ph. D.
Robert Ellison, Ph.D.**

Software Engineering Institute

SSTC

May 1, 2008

Desired Mission Capabilities

Real-time shared situational awareness: operational and tactical levels

Decision superiority enabling more agile and survivable joint operations

Concept of operations for an Air Operations Center: “seamless linkage of superior and subordinate elements with the Theater Air Control System, joint force, and external agencies to optimize personnel, functional, and support system capabilities.”

Desired System Capabilities

Real-time shared situational awareness: operational and tactical levels

all mission participants have access to appropriate information

Decision superiority enabling more agile and survivable joint operations

extensive range of missions with dynamically changing requirements

Concept of operations for an Air Operations Center: “seamless linkage of superior and subordinate elements with the Theater Air Control System, joint force, and external agencies to optimize personnel, functional, and support system capabilities.”

senior leadership expects immediate access to appropriate tactical information in a form appropriate to decision making

Operational Realities

Increased reliance on shared technology/services requires establishing *operational trust* among systems, software components, and services.

current mechanisms for operational trust are primitive

Reliability of mission threads can be affected by the *interactions* of software systems, hardware systems, and human operations

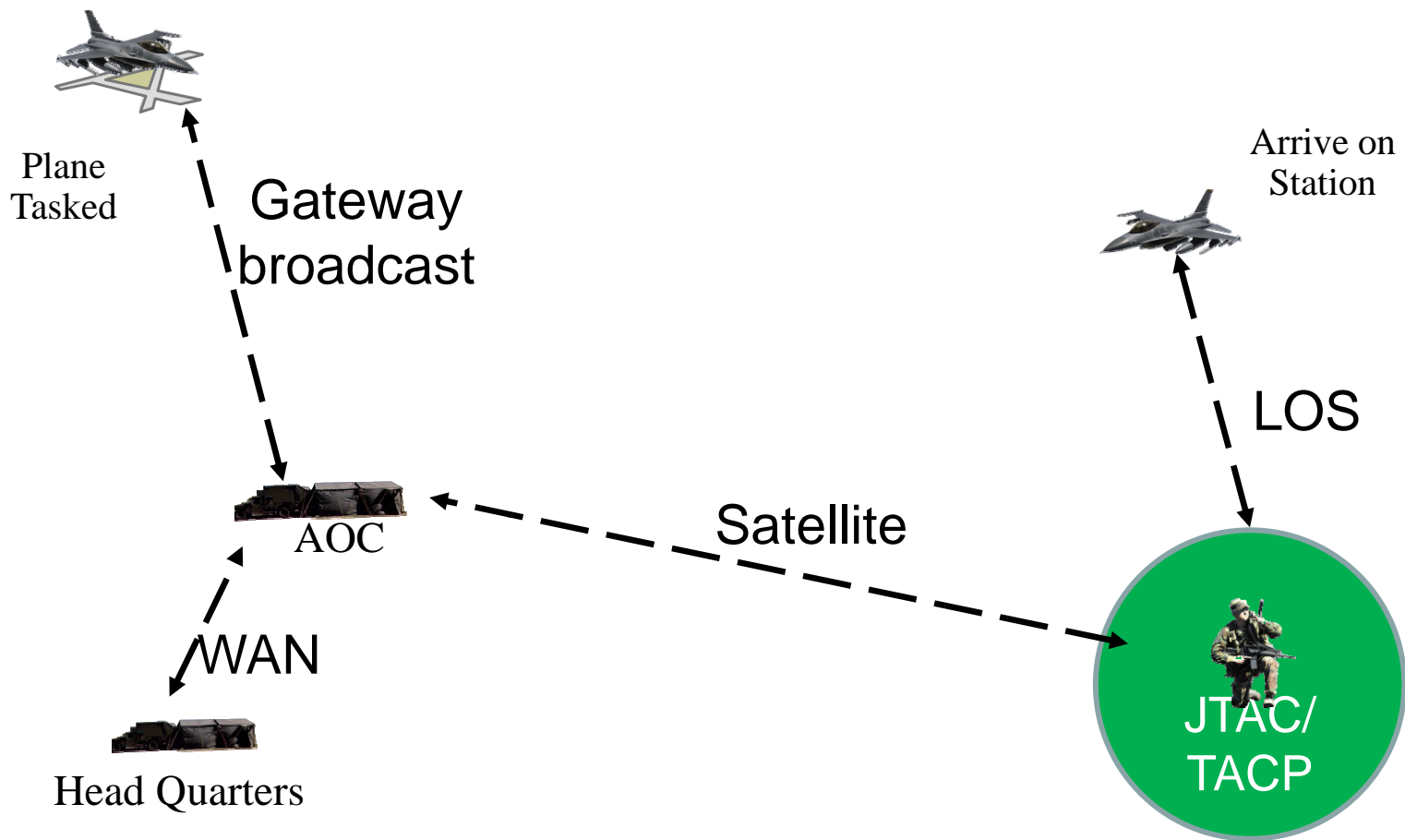
missions will be supported by a mix of legacy and new

Mission threads may be adjusted ad hoc to meet immediate critical needs. This level of *flexibility* contributes to their *fragility*.

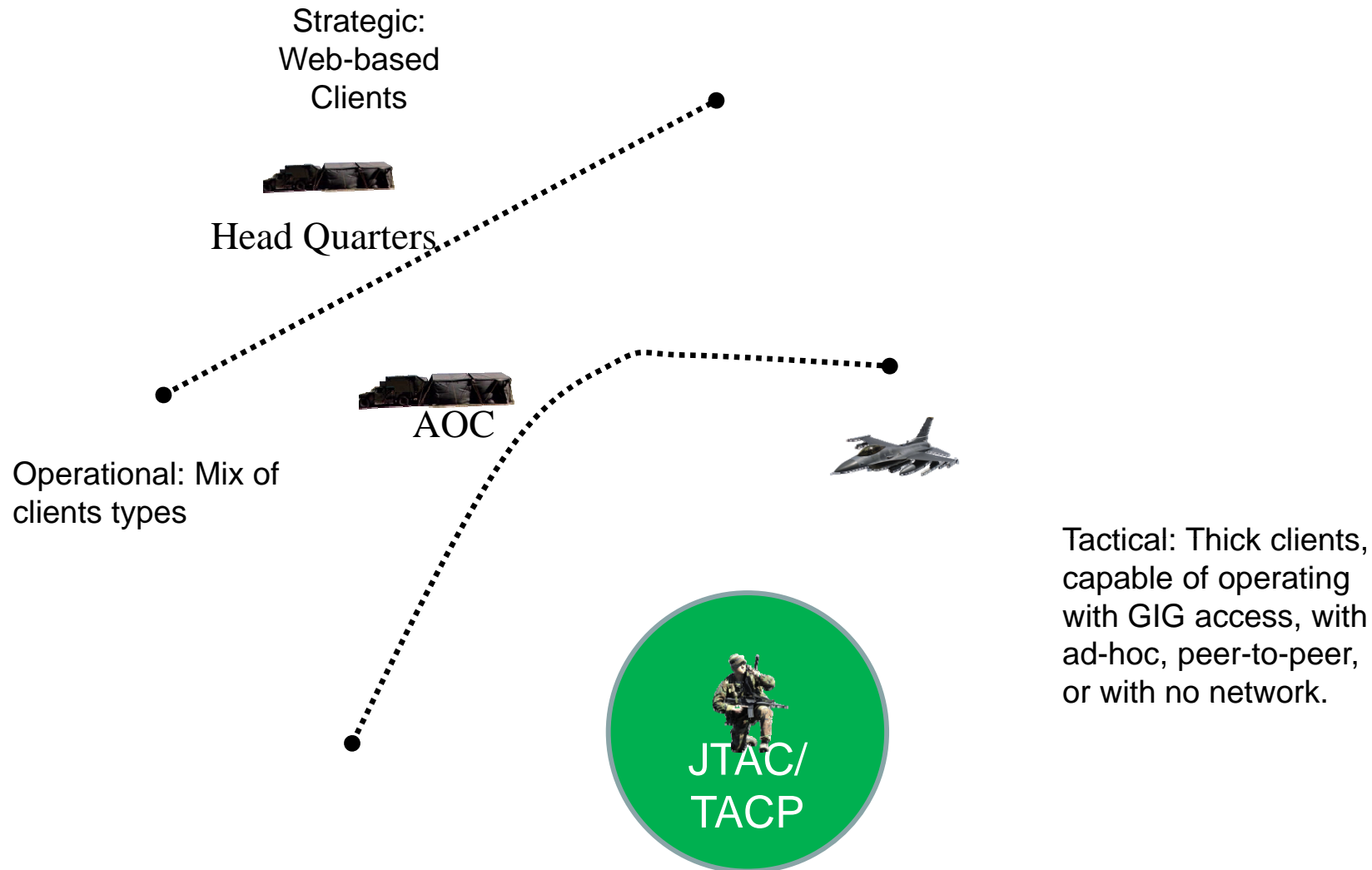
change is coming from all directions (mission, hardware, systems and software) as interoperability and modernization expands

Mission Critical Communication Links

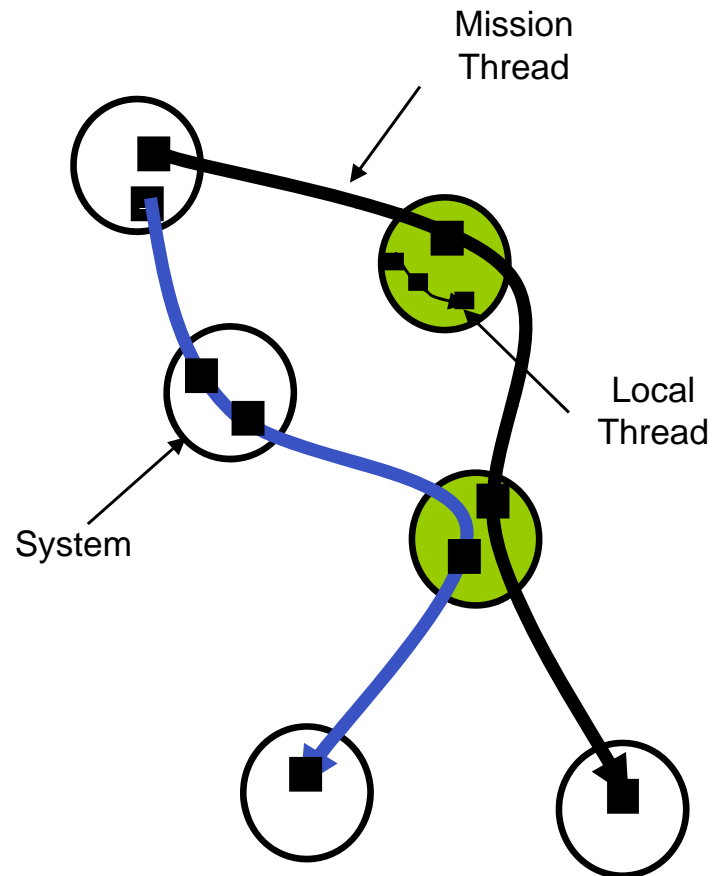
Close Air Support and Time Sensitive Targeting



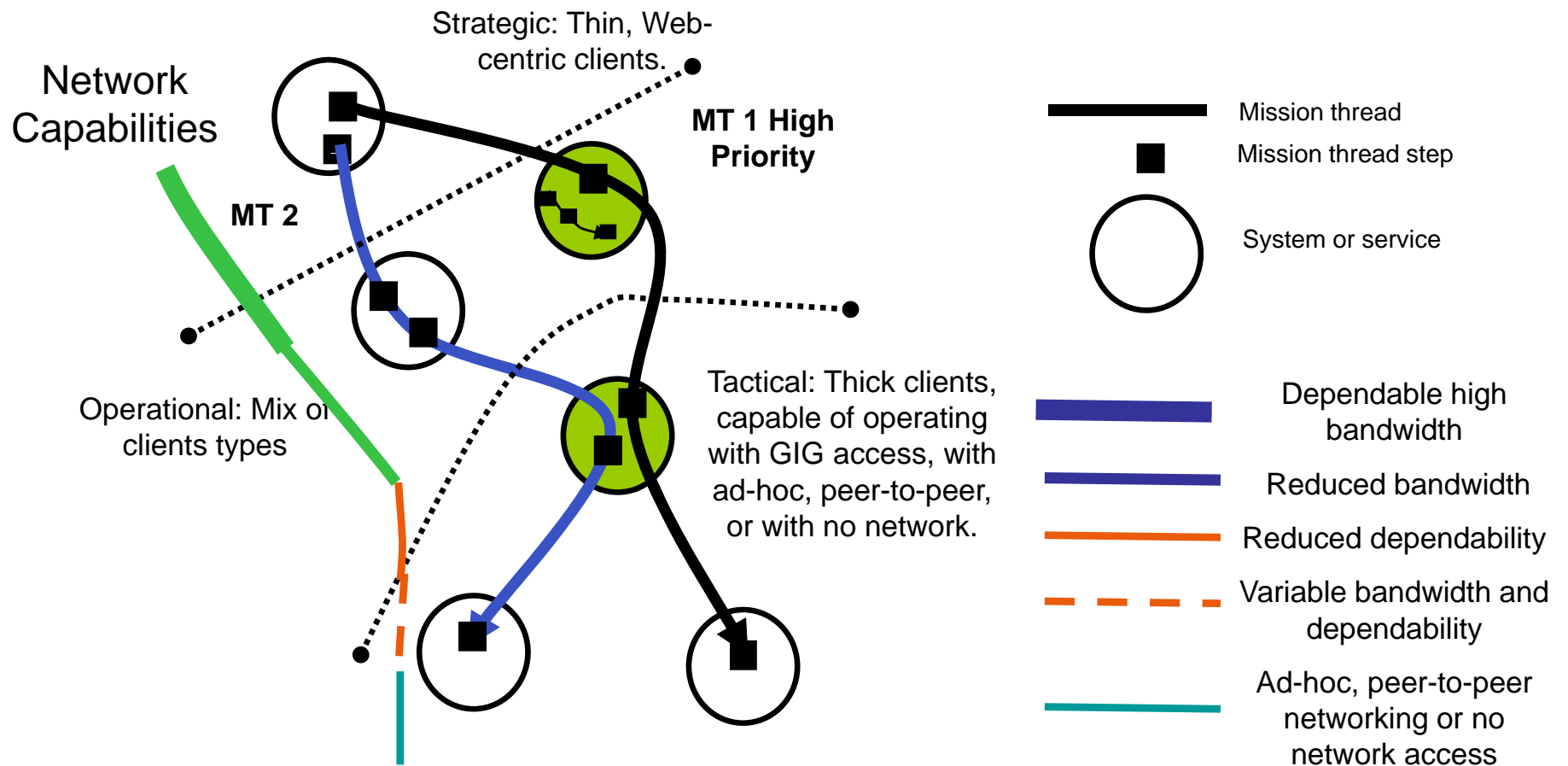
Mission Threads Communication Context



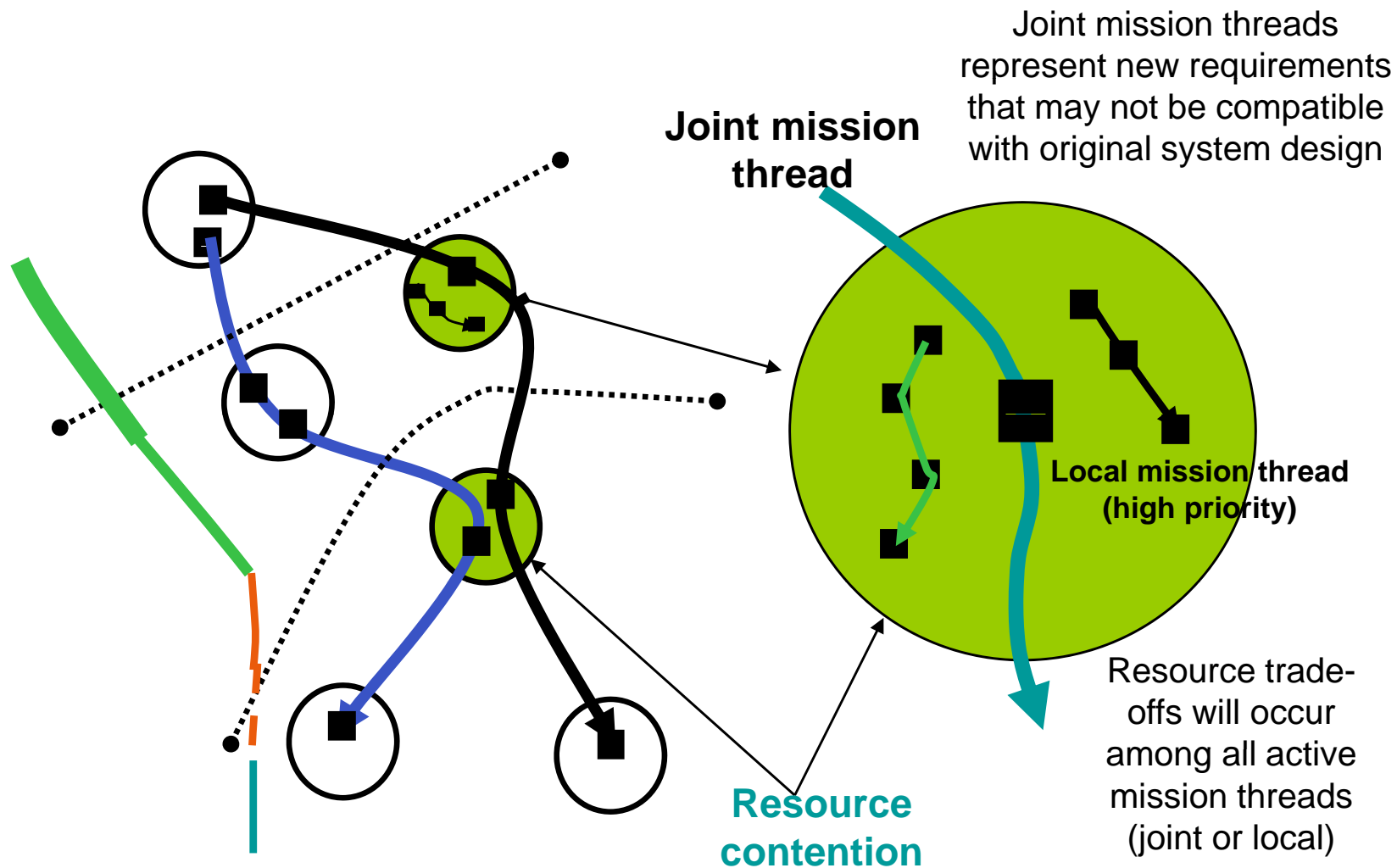
Mission Threads and Constraints



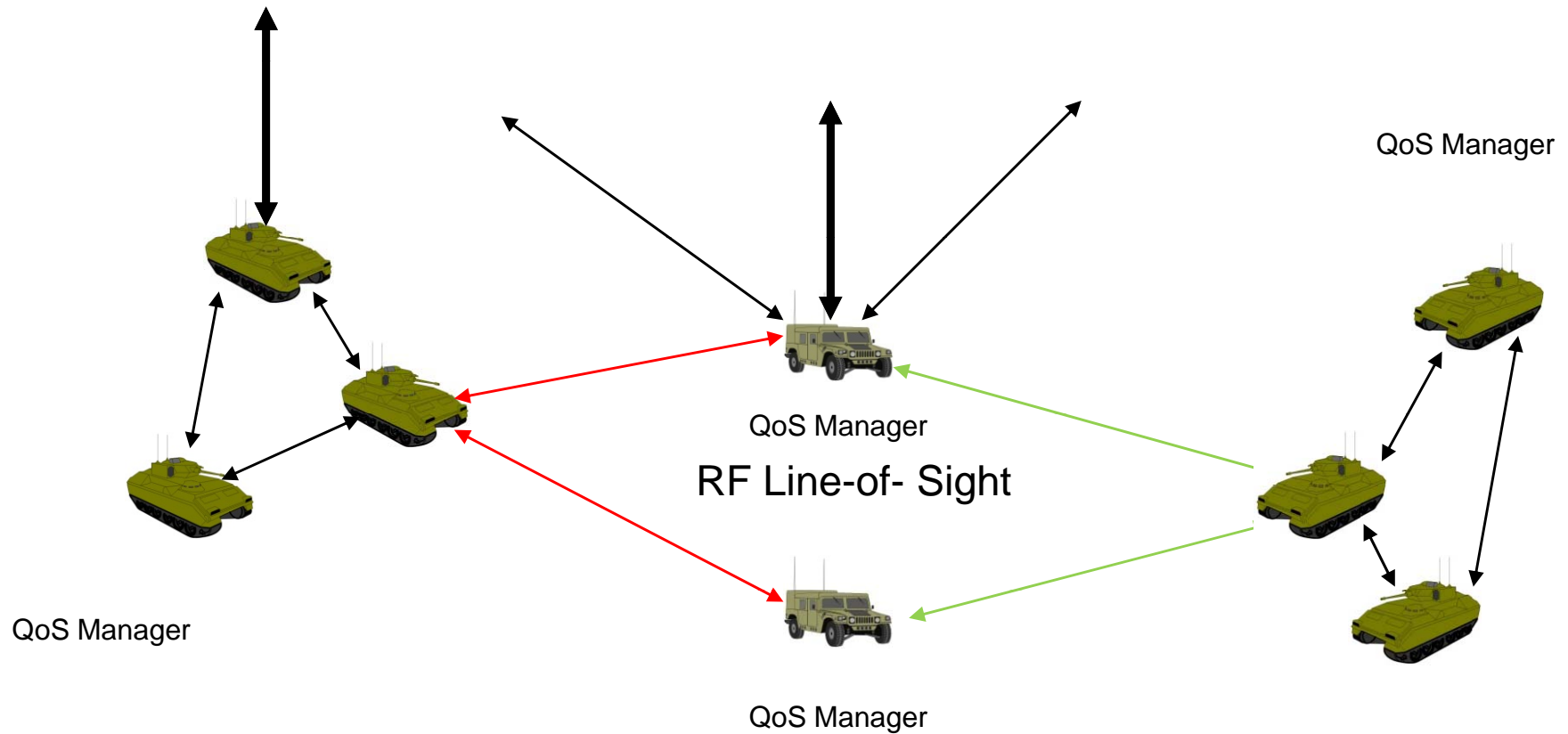
Mission Threads and Constraints



Merging Joint and Local Threads

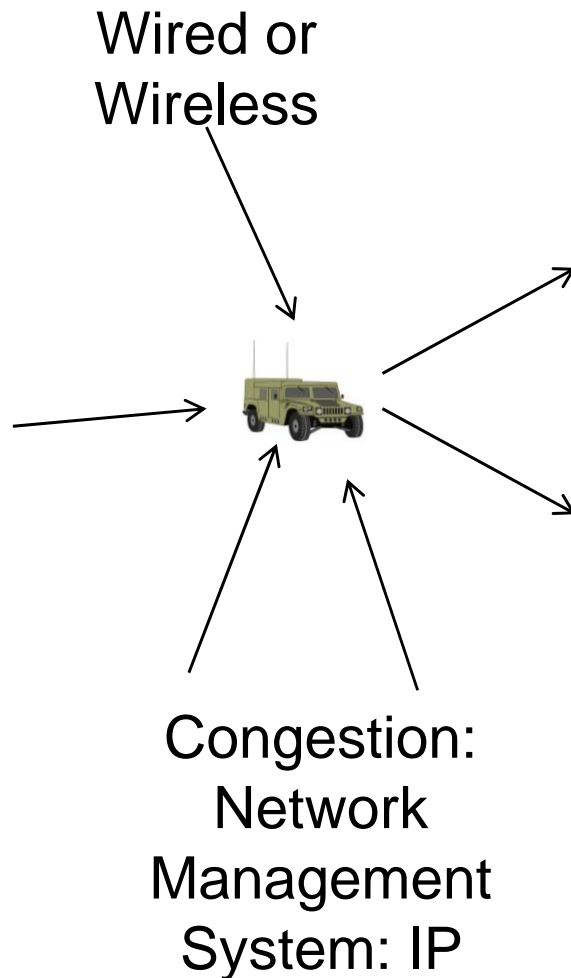


Tactical Wireless Network: Quality-of-Service

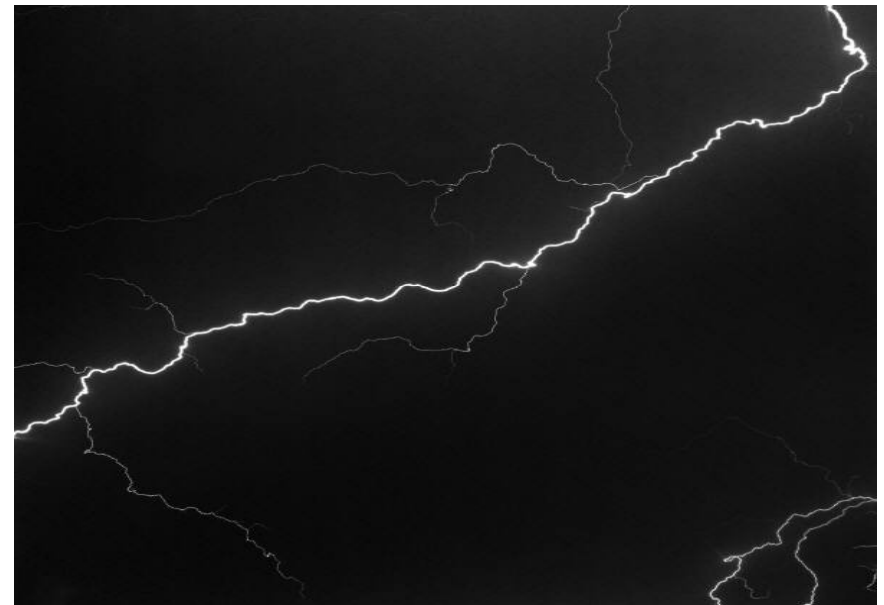


**Distributed QoS Management
Multiple Missions Supported
by Single Resource**

Quality-of-Service: Manage Congestion



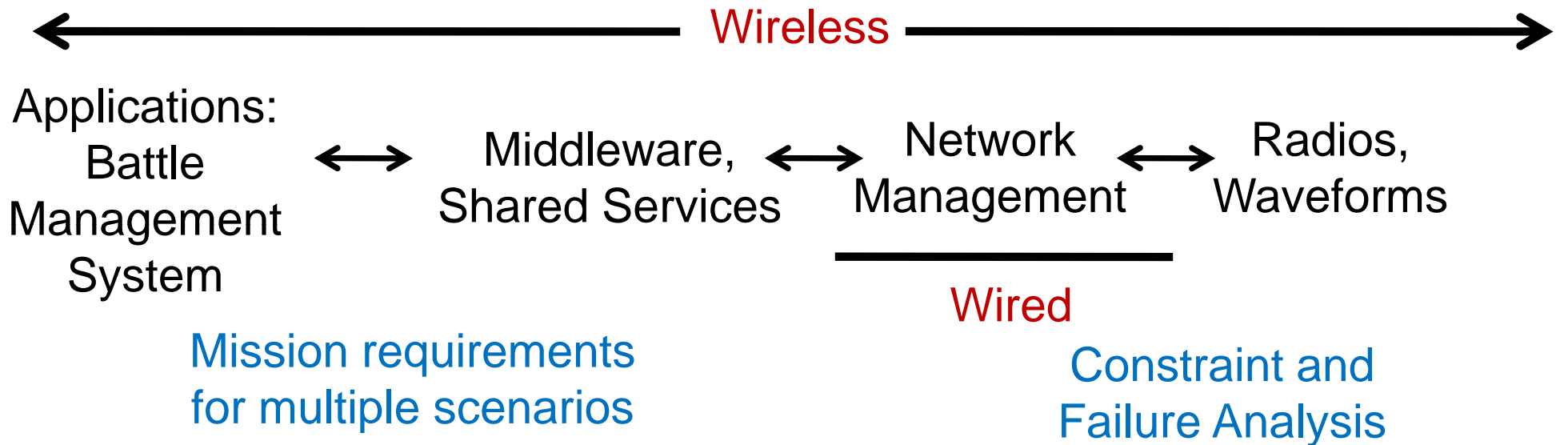
Wireless: Distinguish Congestion from Link Failures



Wireless: Dynamic changes in usage and link state

Link Failures: Detected by Radio

End-to-End Quality-of-Service



Analyze and characterize application operational capability under various levels of capacity constraints. Cannot hide constraints and failures from applications

SAF: Tie Technical Trade-off Analysis with Mission Analysis Trade-offs among Missions

Development and Operational Context

Understanding of degradation

Wide spectrum of failure potentials

Wider spectrum of stakeholders (with potentially conflicting needs)

Changes from all directions

Multiple systems and their interactions (composition and failure modes)

Survivability Analysis Framework (SAF) -1

Connecting mission and technology risks:

- Identify a mission thread-specific example
- Describe critical steps required to complete the process (end to end) - sequenced activities, participants, and resources
- Select one or more critical steps within the mission thread for detail analysis.
- Identifying the mission critical resource(s)
- Identify stresses relevant to critical resources within the context of this mission
- Evaluate threats relevant to the selected mission critical resource

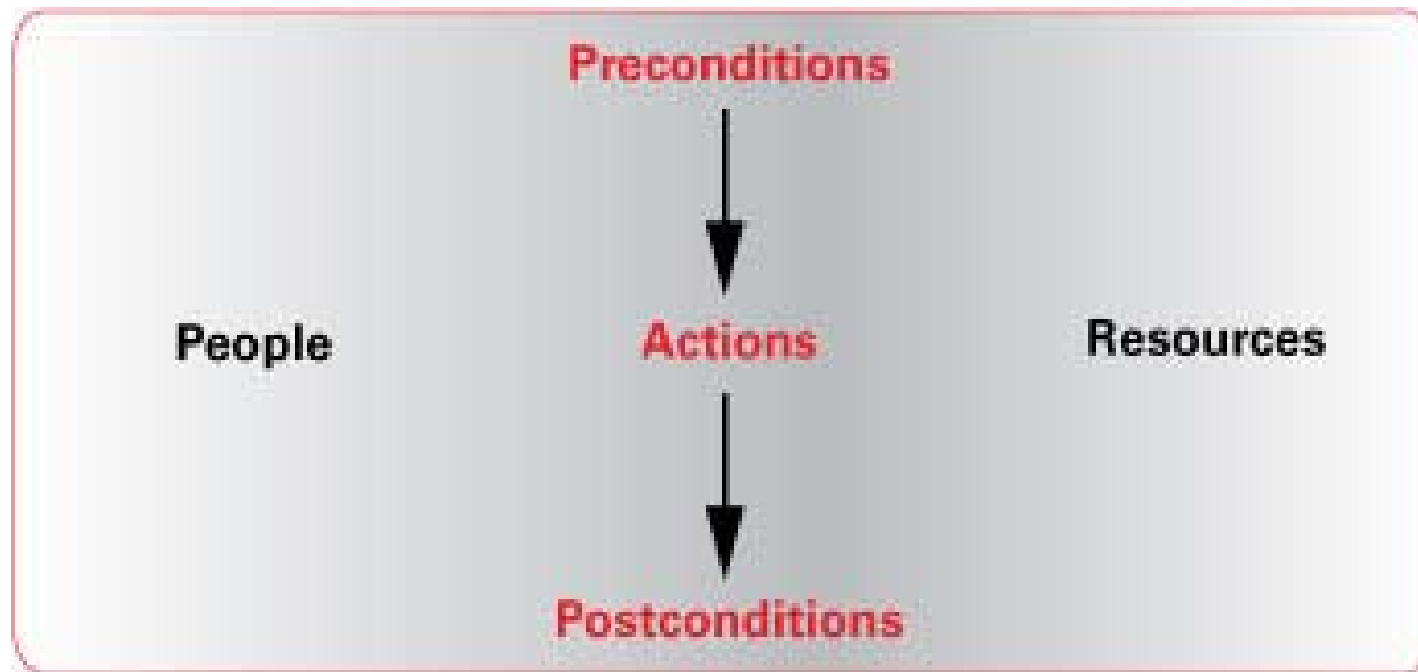
Survivability Analysis Framework (SAF) -2

Mission completion is affected by stresses that individually or collectively strain the operational resources.

The following stresses linked to survivability were characterized:

- Interaction (data): missing, inconsistent, incorrect, unexpected, incomplete, unintelligible, out of date, duplicate
- Resources: insufficient, unavailable, latency, inappropriate, interrupted
- People: information overload, analysis paralysis, distraction, selective focus, diffusion of responsibility, lack of skills or training
- Mission/participants/configuration flexibility

Survivable Analysis Framework (SAF)



Stresses

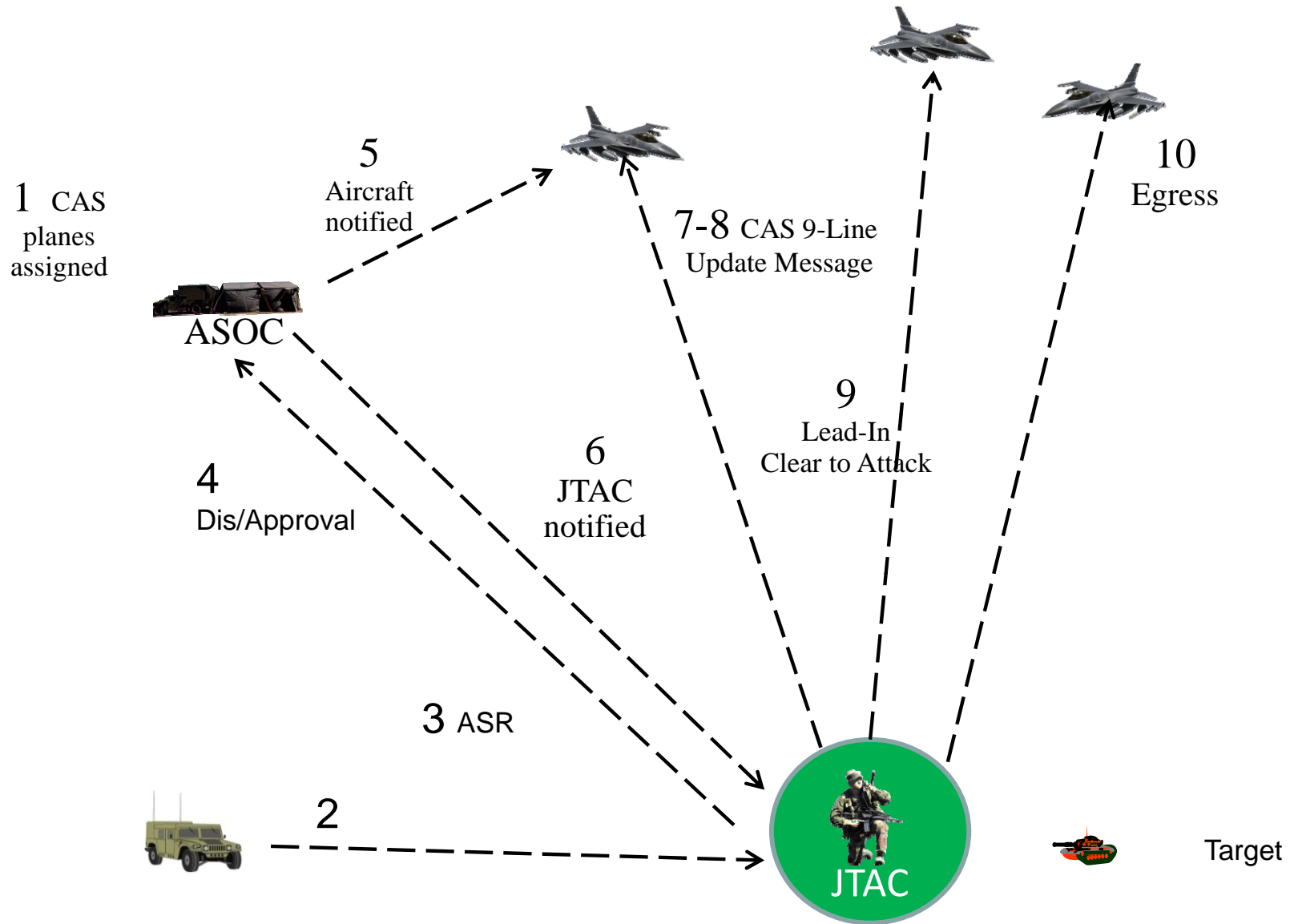


Acceptable
Outcomes

Analysis

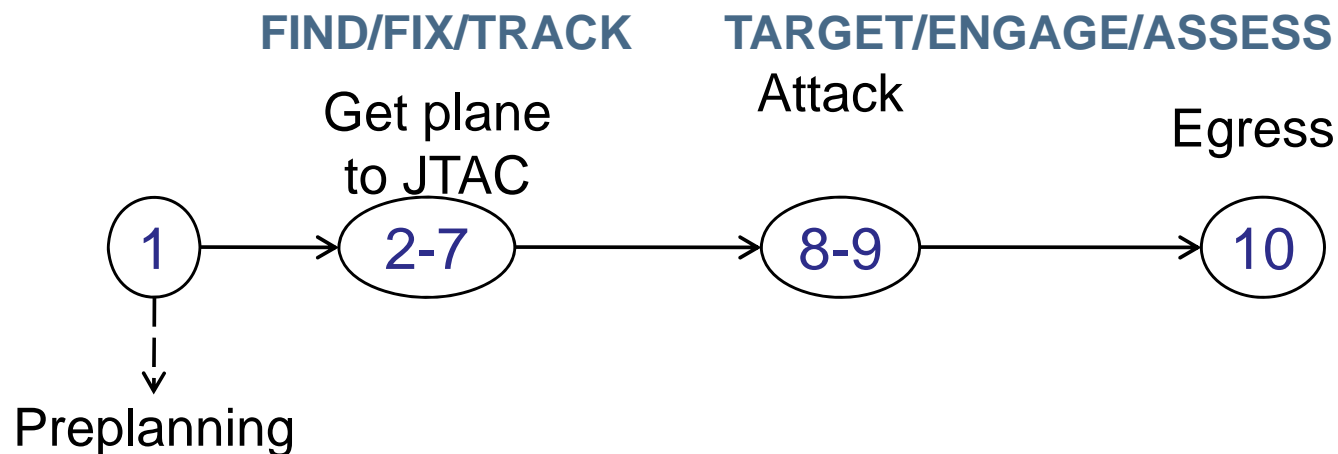
- *Potential Failure Conditions*
- *Likelihood of error conditions*
- *Impact of occurrences*
- *Recovery strategies*

Close Air Support (CAS) Thread



CAS Thread

- 1) Assignment of planes to CAS
- 2) Army communicates target to JTAC
- 3) ASR initiated
- 4) ASR reviewed and approved/disapproved
- 5) Plane notified of assignment (initial 9-line)
- 6) JTAC notified of arriving plane
- 7) CAS assets transit to control point
- 8) JTAC updates 9-line for plane, provides Situational Awareness
- 9) Target attacked
- 10) Egress and status communication to Command & Control



Describing a Specific Step

Step 8	Aircraft arrive on station
Precondition	Communications established between JTAC and aircraft
Action	JTAC provides lead detailed target area Situational awareness, targeting, and attack information (“9-line”) Lead acknowledges receipt of 9-line via “read-back” JTAC notify lead of “marking” arrangements
Post-Condition	Aircraft begins ingress to target

Describing a Specific Step

Step 9	Target Attack
Precondition	Communication between JTAC and aircraft established Target, friendlies, etc are “marked” appropriately
Action	Army approval: The supported army ground unit provides approval to the JTAC to release the weapons. Synchronization of target identification JTAC provides correction to aircrews as needed JTAC clears or aborts aircraft to attack
Post-Condition	Target is attacked

Mission Critical Resource

Selected Resource

- JTAC and Aircraft establish secure communications

Resource Context – changes over time

- Initially Voice, Line of site (LOS)
- Enhanced to Text and voice
- Expanded to image sharing
- Further enhanced to video
- All participants share all information – full situational awareness

Critical Resource Stress Evaluation

Stress Evaluation Criteria:

- High: mission abort, mission errors with fratricide, wrong target
- Medium: mission delays; insufficient attack power; loss of IA for mission (exposure)
- Low: future mission potential (too many variables to worry about these)

Stress Categorization for JTAC to Aircraft communication (voice, LOS)

- Interaction – medium to high
- Resources – high
- People – low (automated connectivity process required)
- Flexible mission/participants/configuration - high

Critical Resource Threat Evaluation

Threat (example developed using OCTAVE® Threat Trees)

Outcome for resource of threat realized (disclosure, modification, loss/destruction, unavailable)

Impact on mission of compromised resource

Impact rating (high, medium, low)

Stresses relevant to threat

Level of risk (high, medium, low)

Mitigations

Mission impact of mitigations

Response strategy (accept, monitor, mitigate)



Acronyms

AOC	Air Operations Center
ASOC	Air Support Operations Center
ASR	Air Support Request
CAS	Close Air Support
GIG	Global Information Grid
IP	Internet Protocol
JTAC	Joint Tactical Air Controller
LOS	Line of Sight
OCTAVE	Operationally Critical Threat, Asset, Vulnerability Evaluation
QoS	Quality-of-Service
SAF	Survivability Analysis Framework
TACP	Tactical Air Control Party
WAN	Wide Area Network