Framework Linking Technology Risk to Mission Success

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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.”
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

Plane Tasked

Gateway broadcast

AOC

WAN

Head Quarters

Arrive on Station

LOS

JTAC/TACP

Satellite

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Mission Threads Communication Context

Strategic: Web-based Clients
Head Quarters
Operational: Mix of clients types
AOC
Tactical: Thick clients, capable of operating with GIG access, with ad-hoc, peer-to-peer, or with no network.
Mission Threads and Constraints
Mission Threads and Constraints

Network Capabilities

Strategic: Thin, Web-centric clients.

Tactical: Thick clients, capable of operating with GIG access, with ad-hoc, peer-to-peer, or with no network.

Operational: Mix of clients types

MT 1 High Priority

MT 2
Merging Joint and Local Threads

Joint mission threads represent new requirements that may not be compatible with original system design.

Local mission thread (high priority)

Resource trade-offs will occur among all active mission threads (joint or local).

Resource contention
Tactical Wireless Network: Quality-of-Service

Distributed QoS Management
Multiple Missions Supported by Single Resource
Quality-of-Service: Manage Congestion

Wired or Wireless

Congestion: Network Management System: IP

Wireless: Dynamic changes in usage and link state

Wireless: Distinguish Congestion from Link Failures

Link Failures: Detected by Radio
End-to-End Quality-of-Service

Applications: Battle Management System

Middleware, Shared Services

Network Management

Radios, Waveforms

Wired

Mission requirements for multiple scenarios

Constraint and Failure Analysis

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

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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)

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)

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)
Close Air Support (CAS) Thread

1. CAS planes assigned
2. ASR
3. JTAC notified
4. Dis/Approval
5. Aircraft notified
6. JTAC notified
7-8. CAS 9-Line Update Message
9. Lead-In Clear to Attack
10. Egress

ASOC

Target

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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

<table>
<thead>
<tr>
<th>Step 8</th>
<th>Aircraft arrive on station</th>
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</thead>
<tbody>
<tr>
<td><strong>Precondition</strong></td>
<td>Communications established between JTAC and aircraft</td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>JTAC provides lead detailed target area Situational awareness, targeting, and attack information (“9-line”)</td>
</tr>
<tr>
<td></td>
<td>Lead acknowledges receipt of 9-line via “read-back”</td>
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<tr>
<td></td>
<td>JTAC notify lead of “marking” arrangements</td>
</tr>
<tr>
<td><strong>Post-Condition</strong></td>
<td>Aircraft begins ingress to target</td>
</tr>
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</table>
## Describing a Specific Step

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

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