**Mission Thread Workshop (MTW): Preparation and Execution**

**Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, 15213**

**Software Engineering Institute (SEI) Architecture Technology User Network (SATURN) Conference, 29 Apr - 3 May 2013, Minneapolis, MN.**

**Approved for public release; distribution unlimited**

**Abstract**

Same as Report (SAR) 31
Outline

- MTW and our experience base
- Three phases for conducting an MTW
- How MTWs fit into system-of-systems (SoS) architecture development and analysis
Conceptual Flow of the MTW

- **SoS Drivers and Capabilities**
- **SoS Architecture Plans**
- **Mission Threads and Vignettes**
  - OV-1
  - OV-4
  - OV-6c
- **Legacy Systems**
- **SoS Quality Attributes**
- **Quality Attribute Augmentation and Analysis**

**SoS Challenges**

**SoS Drivers and Capabilities** impacts into **SoS Architecture Plans**

**Mission Threads and Vignettes** distilled into **SoS Quality Attributes**

**Architectural Issues**

**Engineering Issues**

**Capability Issues**
Mission Thread Workshop

- Present Results
- Present the MTW
- Present the Business and Mission Drivers
- Present the Architectural Plan
- Review the Vignette
- Analyze Remaining Mission Threads
- Discuss Overarching QA Considerations
- Consider Extensions to Mission Thread
- Augment the Mission Thread

Steps:
1. Step 1
2. Step 2
3. Step 3
4. Step 4
5. Step 5
6. Step 6
7. Step 7
8. Step 8
9. Step 9
## Mission Thread Workshops – Experiences

<table>
<thead>
<tr>
<th>Client</th>
<th>Description</th>
<th>MTWs</th>
<th>Vignettes</th>
<th>Mission Threads</th>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>IRAD New Platform/Capability</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>New Naval Ship</td>
<td>13</td>
<td>17</td>
<td>37</td>
<td>&gt;200</td>
</tr>
<tr>
<td>C</td>
<td>Battle Command</td>
<td>6</td>
<td>3</td>
<td>4</td>
<td>&gt;100</td>
</tr>
<tr>
<td>D</td>
<td>Maritime Detection</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>30</td>
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<tr>
<td>E</td>
<td>NSF</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>15</td>
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<td>F</td>
<td>Air Force Program</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>G</td>
<td>DHS</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>H</td>
<td>Other Govt Agency</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>12</td>
</tr>
</tbody>
</table>

- Identifies SoS architecture gaps, overlaps, and challenges
- Identifies issues for constituent legacy systems and software architectures
- Overcomes organizational stovepipes and facilitates stakeholder communication
Three Phases of an MTW Engagement

- **Preparation**: Up to 6 weeks
- **Conduct the Workshop**: 1–1.5 days
- **Follow-on**: Up to 2 weeks

MTW Timeline
Preparation Phase

- Review the MTW process
- Develop SoS mission and business drivers
- Develop SoS architecture plans
- Develop the vignettes, mission threads, and appropriate quality attributes
- Identify participating stakeholders
- Select MTW team
- Settle on logistics
SoS Mission and Business Drivers and Architecture Plans

Overview presentation of the SoS mission and business drivers

- 1–2 slides on the business drivers; more if agreed it’s needed
- Identify business/programmatic context, high-level functional requirements, high-level constraints, high-level quality attributes, plan for development, and the program’s goals and objectives

Overview presentation of the SoS architecture plans

- 1–2 slides on the vision for the architecture; more if agreed it’s needed
- Identify legacy systems being considered, high-level constraints, high-level quality attributes, and the plan for development
- Visio/PowerPoint

Need to establish the scope of the mission thread analysis effort

- 70–80% functionality
Vignettes

A vignette has two parts:

1. Vignette description
2. Graphical description of the vignette, such as an DoD OV-1 or context diagram.

## Name of Vignette

Protect Fleet Assets Against Cruise Missile Attacks

## Vignette (summary description)

Two ships (Alpha and Beta) are assigned to air defense to protect a fleet containing two high-value assets. A surveillance aircraft and four UAVs (two pairs) are assigned to the fleet and controlled by the ships. A pair of UAVs flying as a constellation can provide fire-control quality tracks directly to the two ships. A two-pronged attack on the fleet occurs:
- five aircraft-launched missiles from the southeast
- three minutes later, seven submarine-launched missiles from the southwest

The fleet is protected with no battle damage.

## Nodes/actors

Alpha and Beta ships, two high-value assets, surveillance aircraft, UAVs, missiles

## Assumptions

Sea state is Level 1
Etc.
Ballistic Missile Defense (BMD) OV-1 Example

Protect Forces Afloat
Defend High-Value Assets
Example of a Context Diagram for a Wireless Emergency Alerts Message

First Responders
Local govt
Emergency Management Organization
Citizen calls 911

CMSP Gateway
Message Recipient

Citizen calls 911

EAS
Social media

IPAWS
Integrated Public Alert and Warning System
www.fema.gov/emergency/ipaws
## Mission Thread Snippet

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
<th>Engineering Considerations, Issues, Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A large truck carrying pesticide goes through an intersection with a “RED” traffic light and is hit broadside by an SUV. Both vehicles burst into flames.</td>
<td>1.</td>
</tr>
<tr>
<td>2</td>
<td>Several citizens in cars that were approaching the intersection stop and call 911 to report the accident. Others rush to assist the accident victims.</td>
<td>1. 911 call center starts receiving calls but is quickly overwhelmed with the volume 2. Calls start rolling to neighboring 911 call centers 3. Begin initial assessment</td>
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<td>3</td>
<td>Driver from SUV is pulled from vehicle and placed on a nearby lawn.</td>
<td>1. Fire, police, EMS are dispatched to accident 2. No information provided to public yet. (should any be?) 3. A smoke plume begins drifting toward residential area.</td>
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# Quality Attributes

<table>
<thead>
<tr>
<th>Quality Attribute</th>
<th>Considerations</th>
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<tbody>
<tr>
<td>Performance</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td></td>
</tr>
<tr>
<td>Usability</td>
<td></td>
</tr>
<tr>
<td>Resilience</td>
<td></td>
</tr>
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</table>
Wrap-up of Preparation Steps

Identify participating stakeholders
- Need to elicit architectural and engineering considerations for the mission threads
- Experience of stakeholders largely determines quality of the results

Select MTW team
- Consists of three or more people who fill the four MTW roles (lead, facilitator, scribe, and analyst)
- Experienced architects with good facilitation skills and related quality attribute knowledge

Logistics of the MTW
- Room, equipment
Conduct Workshop Phase

- Present the MTW
- Present the business and mission drivers
- Present the architectural plan
- Review the vignette
- Augment the mission thread
- Consider extensions to the mission thread
- Discuss overarching quality attribute considerations
- Analyze remaining mission threads
## MTW Agenda

### Day 1: XX XXX 2009
- **08:00–08:15** Welcome/Introductions/Opening Remarks (name, SEI)
- **08:15–08:30** MTW Overview (SEI)
- **08:30–08:45** Business Drivers and Quality Attributes (name)
- **08:45–09:00** Architecture Plan (name)
- **09:00–09:30** Vignettes and OV-1 Descriptions (name)
- **09:30–09:45** Break
- **09:45–12:00** Augmentation of Mission Threads (SEI facilitated)
- **12:00–13:00** Lunch
- **13:00–17:00** Augmentation of Mission Threads (SEI facilitated)

### Day 2: XX XXX 2009
- **08:00–12:00** Augmentation of Mission Threads (SEI facilitated)
- **12:00–13:00** Lunch
- **13:00–16:30** Augmentation of Mission Threads (SEI facilitated)
- **16:30–17:00** Summary/Wrap Up
Mission Thread Workshop

Step 1
Present the MTW

Step 2
Present the Business and Mission Drivers

Step 3
Present the Architectural Plan

Step 4
Review the Vignette

Step 5
Augment the Mission Thread

Step 6
Consider Extensions to Mission Thread

Step 7
Discuss Overarching QA Considerations

Step 8
Analyze Remaining Mission Threads

Step 9
Present Results
Follow-On Phase

- Scrub the augmented mission threads
- Reference each comment with a unique identifier
- Produce a group of challenges
- Develop a briefing to summarize the challenges
- Complete the Mission Thread Description Document
Augmented Mission Thread

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# Scrubbed, Augmented Mission Thread

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<tr>
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<td>MT1-1-1.</td>
</tr>
<tr>
<td>2</td>
<td>Several citizens in cars that were approaching the intersection stop and call 911 to report the accident. Others rush to assist the accident victims.</td>
<td>MT1-2-1. 911 call center starts receiving calls but is quickly overwhelmed with the volume MT1-2-2. Calls start rolling to neighboring 911 call centers MT1-2-3. Begin initial assessment</td>
</tr>
<tr>
<td>3</td>
<td>Driver from SUV is pulled from vehicle and placed on a nearby lawn.</td>
<td>MT1-3-1. Fire, police, EMS are dispatched to accident MT1-3-2. No information provided to public yet MT1-3-3. A smoke plume begins drifting toward residential area.</td>
</tr>
</tbody>
</table>
## Challenge Area Grouping

### Initial Grouping

<table>
<thead>
<tr>
<th>Category</th>
<th>Mission Thread Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert severity levels</td>
<td>Assumptions, MT5-10-5</td>
</tr>
<tr>
<td>911 call center overload</td>
<td>MT2-4-1, MT2-4-2, MT4-4-3, MT4-5-4, MT5-9-1, MT5-9-2, MT5-9-14, MT5-10-6, MT5-10-10</td>
</tr>
<tr>
<td>Public education – alert awareness</td>
<td>MT3-4-5, MT4-9-2, MT4-9-16, MT5-11-2, MT5-11-6, MT5-11-11</td>
</tr>
<tr>
<td>Role of a communications manager</td>
<td>MT1-4-7, MT1-9-2, MT1-9-7, MT1-9-8, MT2-10-6, MT2-11-6, MT2-11-11</td>
</tr>
<tr>
<td>Tool features</td>
<td>MT3-4-9, MT5-1-5, MT5-1-11</td>
</tr>
<tr>
<td>Coordination and jurisdiction</td>
<td>MT2-4-11, MT2-5-1, MT4-6-2, MT4-9-5, MT4-11-1</td>
</tr>
<tr>
<td>Future information inputs</td>
<td>MT3-5-3, MT3-9-6, MT3-9-13, MT3-9-16</td>
</tr>
<tr>
<td>Operator training</td>
<td>MT2-9-3, MT2-9-6, MT2-9-16, MT2-10-6</td>
</tr>
<tr>
<td>Mutual aid agreements / awareness</td>
<td>MT1-5-4, MT1-9-5, MT1-9-6, MT1-9-8, MT4-6-3, MT4-6-4</td>
</tr>
<tr>
<td>Operators’ procedures</td>
<td>MT2-4-2, MT2-6-2, MT3-9-1, MT3-9-16, MT4-4-6, MT4-4-10</td>
</tr>
<tr>
<td>Scenario planning</td>
<td>MT1-9-1, MT1-9-9, MT1-9-10, MT3-3-2, MT3-3-9, MT3-3-11</td>
</tr>
<tr>
<td>Public’s expectations</td>
<td>MT1-4-12, MT1-9-2, MT1-9-16, MT1-11-2, MT1-11-6</td>
</tr>
<tr>
<td>When to send an alert</td>
<td>MT1-4-3, MT2-6-2, MT2-6-3, MT2-6-4, MT3-9-7, MT4-2-4, MT4-3-5</td>
</tr>
<tr>
<td>Communication channels</td>
<td>MT1-4-1, MT1-4-10, MT3-5-3, MT3-6-2, MT4-9-1, MT4-9-2, MT5-3-6</td>
</tr>
<tr>
<td>Security</td>
<td>Sec-2, Sec-4, Sec-5</td>
</tr>
</tbody>
</table>

### Challenge Areas

<table>
<thead>
<tr>
<th>Category</th>
<th>Mission Thread Reference</th>
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<tbody>
<tr>
<td>Alert severity levels/When to send an alert</td>
<td>Assumptions, MT5-10-5, MT1-4-3, MT2-6-2, MT2-6-3, MT2-6-4, MT3-9-7, MT4-2-4, MT4-3-5</td>
</tr>
<tr>
<td>Tool features/Future information inputs</td>
<td>MT3-4-9, MT3-5-3, MT3-5-11, MT3-5-3, MT3-9-6, MT3-9-13, MT3-9-16</td>
</tr>
<tr>
<td>Coordination and jurisdiction/Mutual aid agreements/Awareness</td>
<td>MT2-4-11, MT2-5-1, MT4-6-2, MT4-9-5, MT4-11-1, MT1-5-4, MT1-9-5, MT1-9-6, MT1-9-8, MT4-6-3, MT4-6-4</td>
</tr>
<tr>
<td>Operators’ procedures/Operator training</td>
<td>MT2-4-2, MT2-6-2, MT3-9-1, MT3-9-16, MT4-4-6, MT4-4-10, MT2-9-3, MT2-9-6, MT2-9-16, MT2-10-6</td>
</tr>
<tr>
<td>Scenario planning/911 call center overload</td>
<td>MT1-9-1, MT1-9-9, MT1-9-10, MT3-3-2, MT3-3-9, MT3-3-11, MT2-4-1, MT2-4-2, MT4-4-3, MT4-5-4, MT5-9-1, MT5-9-2, MT5-9-14, MT5-10-6, MT5-10-10</td>
</tr>
<tr>
<td>Public’s expectations/Public education – alert awareness/Role of a communications manager</td>
<td>MT1-4-12, MT1-9-2, MT1-9-16, MT1-11-2, MT1-11-6, MT3-4-5, MT4-9-2, MT4-9-16, MT5-11-2, MT5-11-6, MT5-11-11, MT1-4-7, MT1-9-2, MT1-9-1, MT1-9-8, MT2-10-6, MT2-11-6, MT2-11-11</td>
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<td>MT1-4-1, MT1-4-10, MT3-5-3, MT3-6-2, MT4-9-1, MT4-9-2, MT5-3-6</td>
</tr>
<tr>
<td>Security</td>
<td>Sec-2, Sec-4, Sec-5</td>
</tr>
</tbody>
</table>
Example of a Challenge

Challenge: What civil emergencies are worthy of a WEA message?

Category grouping: Operational procedures, governance

Supporting info
- MT5-10-5
- MT2-6-2, MT2-6-3, MT2-6-4
- MT4-3-5

Recommendations
- Continue to identify and develop civil emergency scenarios that can be discussed with first responders and partnering communities to develop a consistent approach for determining when to issue WEA messages.
- Continue to host meetings with NWS, FEMA, DHS, and the state to share information about when it is appropriate to send a WEA message.
Contents of the Mission Thread Description Document

Inputs

• Presentations
  – MTW process
  – Business and architecture drivers and plans
• Tailored vignette(s) and mission threads

Outputs

• Mission threads augmented with quality attributes
• Analysis methods
• Challenges
How MTWs Fit into SoS Architecture
Development and Analysis
Overview
Overview
Overview
backup
SoS Architecture Quality Attribute Specification and Evaluation Approach

- Early elicitation of quality attribute considerations
- Early identification and addressing of architecture challenges
- Early identification and mitigation of architectural risks

Diagram:
- SoS Business / Mission Drivers
  - Warfare Vignettes
    - Mission Threads
    - SoS Architecture Plans
- Mission Thread Workshop
- Quality Attribute Augmented Mission Threads
  - SoS Architecture Challenges
- SoS Architecture Evaluation
  - SoS Architecture Risks
    - Problematic systems identified with the augmented mission threads
- System ATAM
  - System & S/W Architecture
    - Sys & S/W Arch Risks
- SoS and System Architecture(s) Acquisition / Development
Contact Information

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