



Fall 2014
SEI Research Review
Real-Time Mobile Applications in
Intermittently Connected Networks

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

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Report Documentation Page

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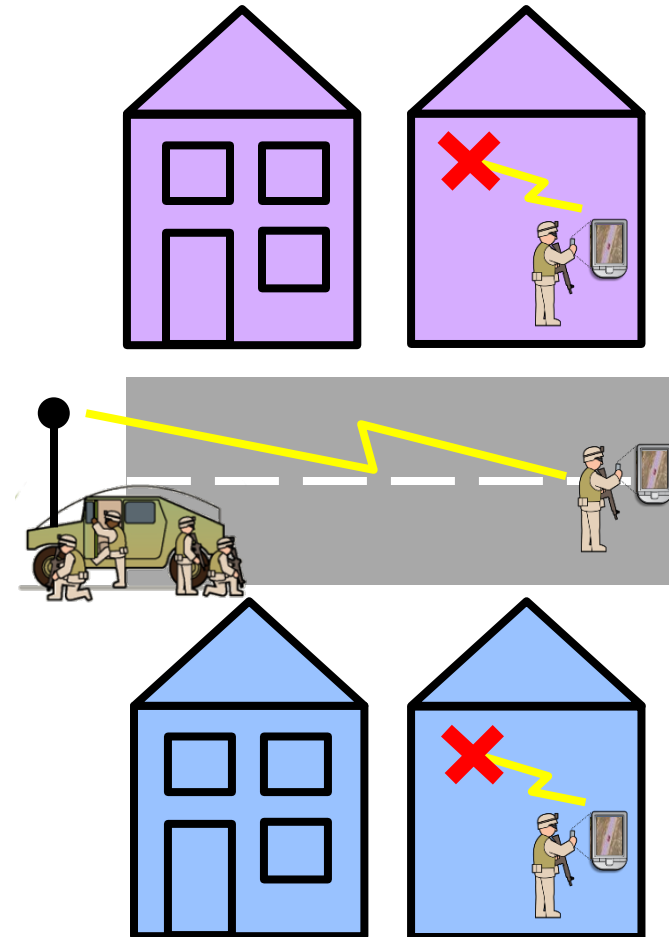
Overview

Problem

- Real-time distributed applications depend on reliable communications.
- Tactical environments are often characterized by disconnected, intermittent and low-bandwidth (DIL) communications.

To address this problem, we developed methods that

- Enable real-time shared group context in a DIL environment.
- Keep information synchronized in real time despite communication outages.
- Apply group context to make these more effective.



Approach: Keep network users productive

Our approach is to consider three communication states:



<p>Maintain shared group context Make best use of available bandwidth</p>	<p>Applications continue to function Predict state where possible</p>	<p>Re-establish shared group context as quickly and accurately as possible</p>
<p>Pre-cache data likely to be relevant later in the mission</p> <p>Delay transmission of noncritical data</p>	<p>Predict location of teams based on mission plan</p> <p>Provide connectivity map to help the user reconnect</p>	<p>Prioritize synchronization of critical messages</p> <p>Eliminate redundant messages</p>



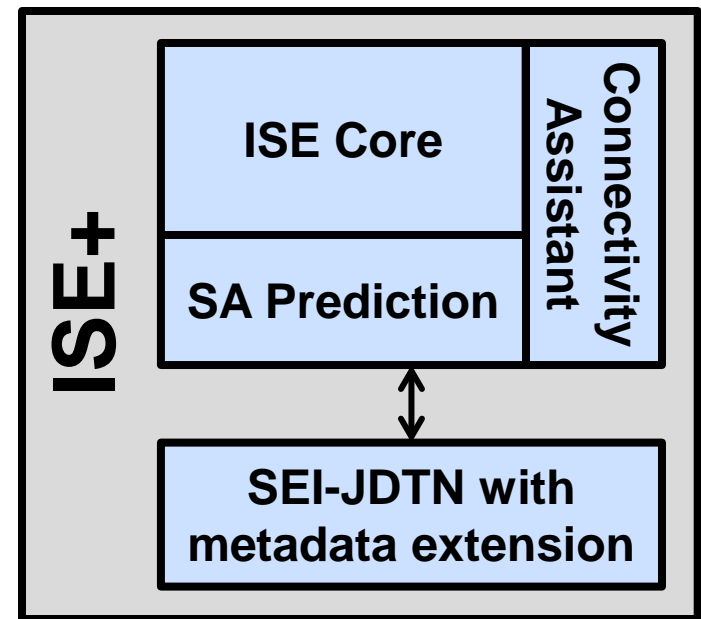
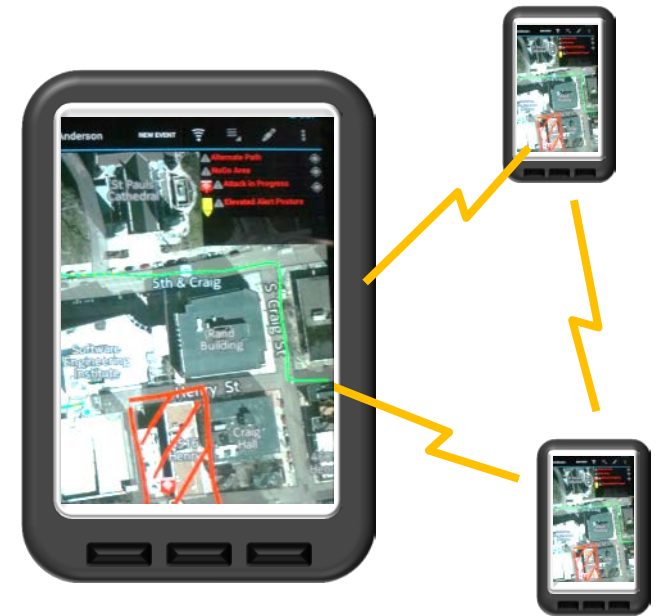
Implementation

ISE (Information Superiority to the Edge)

- Group-context aware middleware
- Wireless data synchronization

ISE+ (Enhanced Version)

- DTN (Delay Tolerant Networking) bundle protocol used for message delivery
 - Modified open-source implementation
- DTN Metadata Extension Blocks
 - Filtering of irrelevant or obsolete data
 - Prioritization of messages
- SA prediction for disconnected operation
- Dynamic connectivity map construction
- Pre-caching of mission-relevant data



Metadata Supports Forwarding Decisions

Use DTN metadata extension block to attach key-value pairs to bundles

- Time and location
- Priority
- Type of payload (image, voice, video, text, ...)
- Set of tags describing the payload content (selected from a mission-specific tag set configured in ISE)
 - E.g., building, crowd, fire, protest, injured person, etc.

DTN nodes are configured with scheduling and discard policies to

- Determine the priority order in which to forward bundles, some bundles may not be forwarded at all but held back until the end of the mission
- Detect duplicate bundles that should be de-prioritized or discarded
- Decide which bundles to delete in case the node runs out of memory

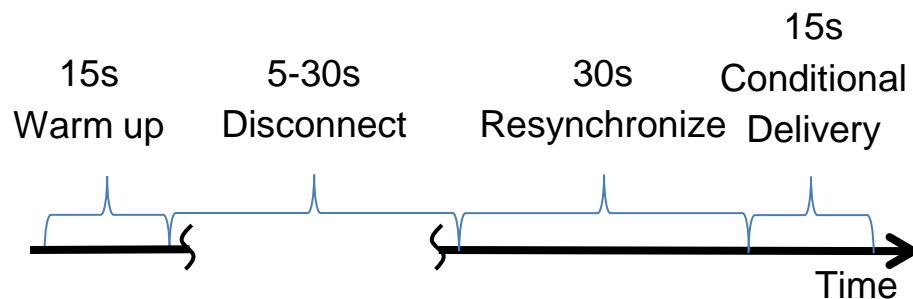


Metadata Experiments

Goal: Show reduction in transmission of redundant messages and reconnection time after a disconnection.

Generate ISE messages of varying types

- Location Updates (expire)
- Comment added to event (data replacement)
- Multiple photos of same target (redundancy elimination)
- Important but not mission relevant (conditional delivery)

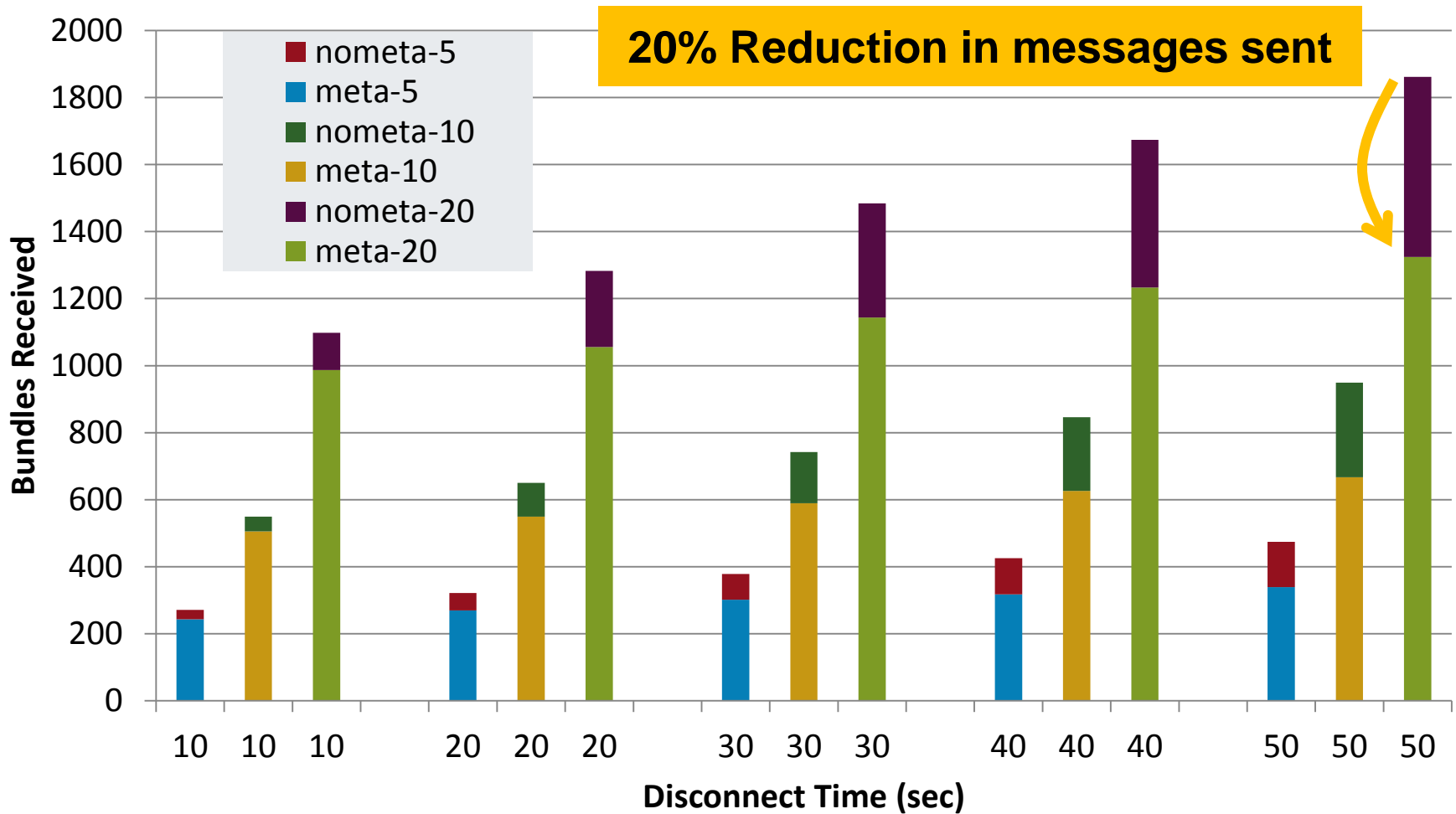


Independent Variables:

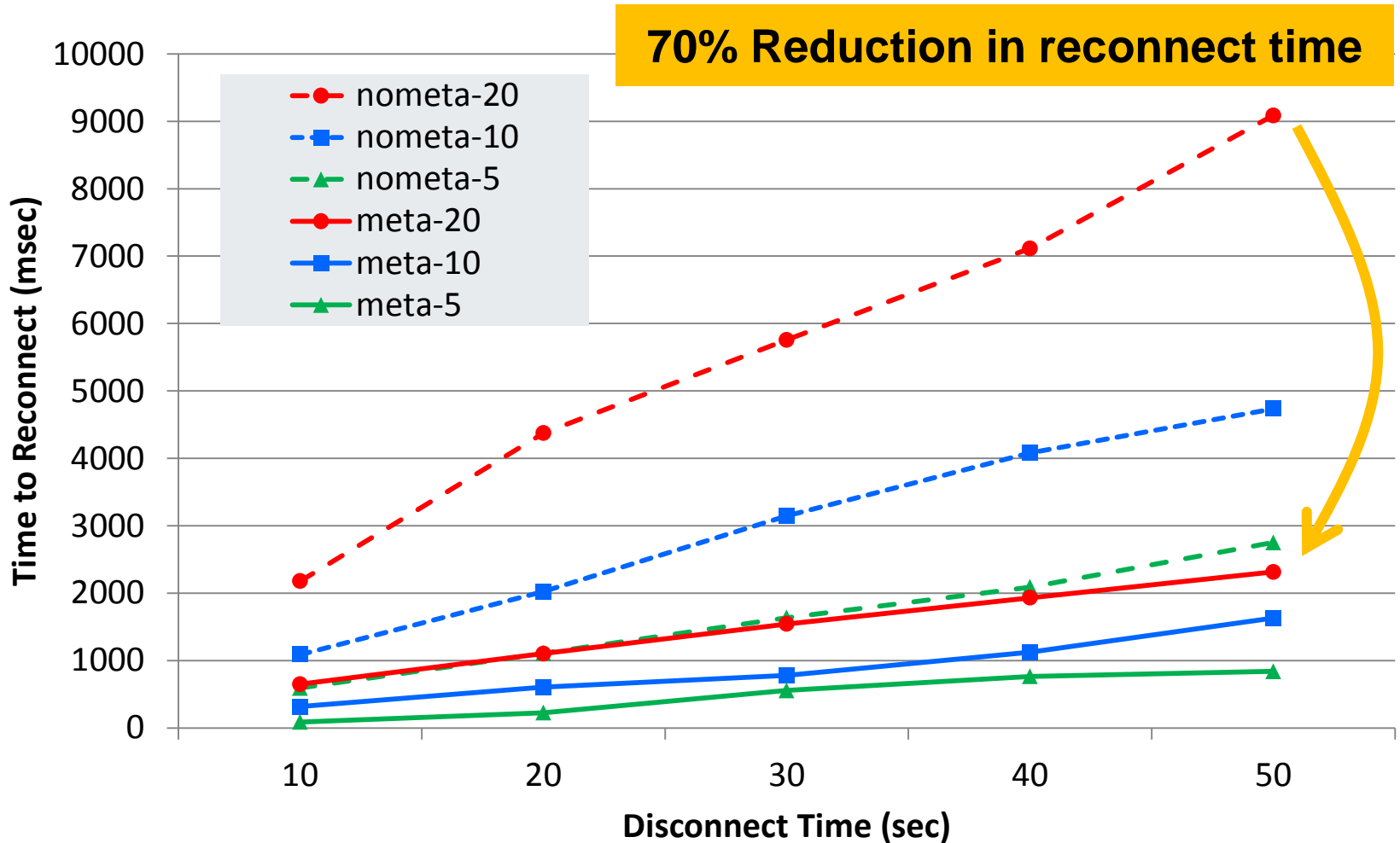
- Metadata extensions: disabled, enabled
- Disconnect time (sec.): 10, 20, 30, 40, 50
- Messages per second: 5, 10, 20



Message Reduction with Metadata



Reconnect Time with Metadata



Impact

Improve operational capabilities for soldiers/first responders in DIL environments

- Ability to operate without fully connected network.
- Faster and lower energy synchronization of most relevant mission data.
- Increased mission time capability.

Stakeholders include

- Mitre, USMC (TID and CIO reps), DHS First Responder's Group, SOCOM S&T

Demonstrated effectiveness of metadata enhancements

- 20% reduction in traffic load after disruption.
- 70% reduction in time to reestablish group context after disruptions.

Incorporated DTN technologies into ISE

- ISE to continue with DTN enhancements in FY15 EETS project



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