

# ONR/PEO IWS/PEO C4I Combat System (CS)/Command and Control (C2) Limited Test Experiment (LTE) and Results: A SOA Success Story

Matthew Fisher  
Progeny Systems

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# BACKGROUND

- In September 2010, a 10-day joint limited test experiment (LTE) took place
  - Office of Naval Research (ONR)
  - Program Executive Office Integrated Warfare Systems (PEO IWS) 1, 5 and 6
  - Program Executive Office Command, Control, Communications, Computers, and Intelligence (PEO C4I)
- The experiment was a culmination of nine months effort and focused on data exchange between a simulated tactical environment, based on the AEGIS Modernization (AMOD) architecture, and a C2 environment centered around an open-source service oriented architecture (SOA).

# BACKGROUND

- The SOA was based on the JBoss SOA-P framework
- Supported data exchange through the use of Data Distribution Service (DDS) and Advanced Message Queuing Protocol (AMQP).
- A suite of services were developed and deployed as part of the experiment, including cooperation with the Space and Naval Warfare Systems Command (SPAWAR) Consolidated Afloat Networks using Enterprise Services (CANES) and Afloat Core Services (ACS) framework.
- The SOA was part of a larger C2 system design that include data decimation, data filtering, information assurance (IA) tagging, data federation across multiple platforms and optimized data exchange over disconnected, intermittent, limited (DIL) wide area networks (WANs).



# JBOSS SOA-P

## **JBOSS ENTERPRISE SOA PLATFORM**

**Registry**

**Workflow**

**Rules**

### **JBoss ESB**

Transformation, Routing, Registry

### **JBoss Enterprise Application Platform**

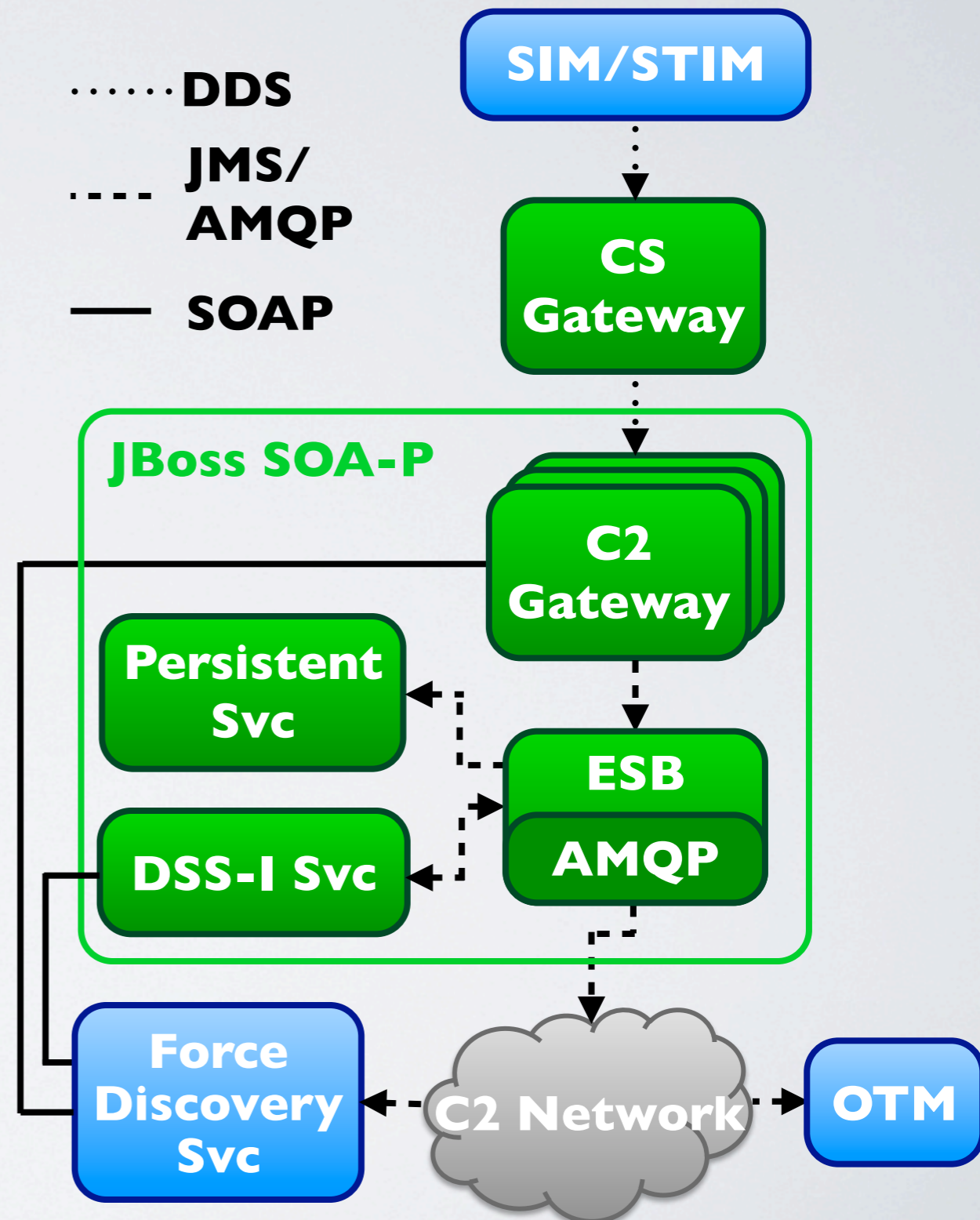
Service integration and orchestration,  
business process automation,  
rules definition, event management,  
service hosting

- COTS-Based solution (RedHat)
- Components also available through JBoss.org
- Built on JBoss Application Server plus:
  - Deployable archive (similar to RAR, EAR, WAR)
  - Enterprise Service Bus + Transports (e.g. JBoss Messaging)
  - Services
  - Service Registry
  - Service Workflow/Chaining/Orchestration
  - Configuration Files

# BASE ARCHITECTURE

Unidirectional Flow of CS tracks, readiness data to C2

- SIM/STIM - provides simulated AMOD track and readiness data
- CS Gateway performs data filtering, CS→C2 mediation and decimation
- C2 Gateway mediates from DDS to ESB Messages
- Persistent Service records all traffic to a MySQL Database
- DSS Instrumentation (DSS-I) Service is a browser-based UI for viewing C2 traffic and data collection. Also connects AMQP brokers to remote platforms
- AMQP is the C2 transport
  - Consumers/Producers only know of a JMS-based transport
- Open Track Manager, OTM, is a C2 track consumer
- Force Discovery Service is a web-based registration and discovery application, to assist with cross-platform federation



# BASE ARCHITECTURE

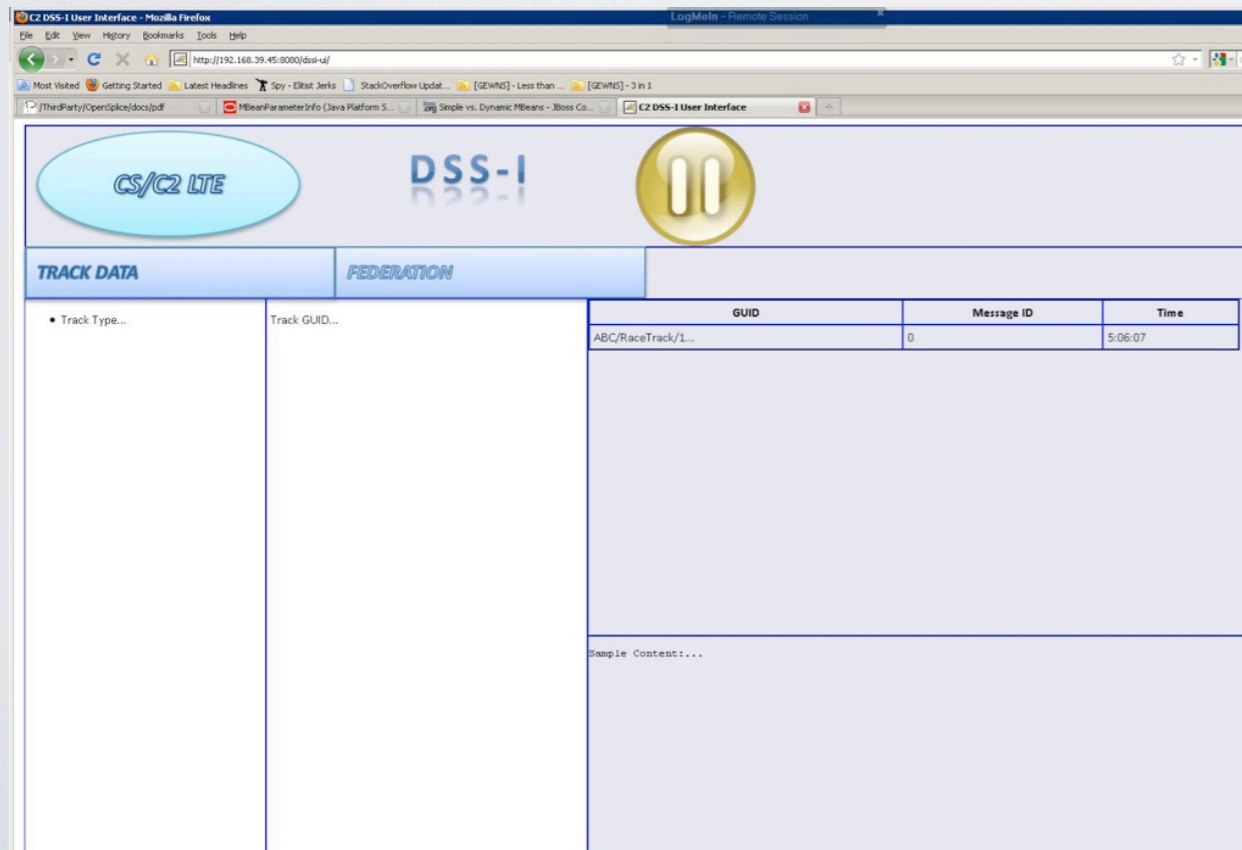
**DSS-I Svc**

**ESB**

**AMQP**

- Visual tool to verify CS data communicated end-to-end and support data collection

- Producers and consumers are able to send messages via JMS or ESB



The screenshot displays the DSS-I User Interface in a Mozilla Firefox browser. The interface includes a header with 'CS/C2 LTE', 'DSS-I', and a pause icon. Below the header, there are two tabs: 'TRACK DATA' and 'FEDERATION'. The 'TRACK DATA' tab is active, showing a table with the following data:

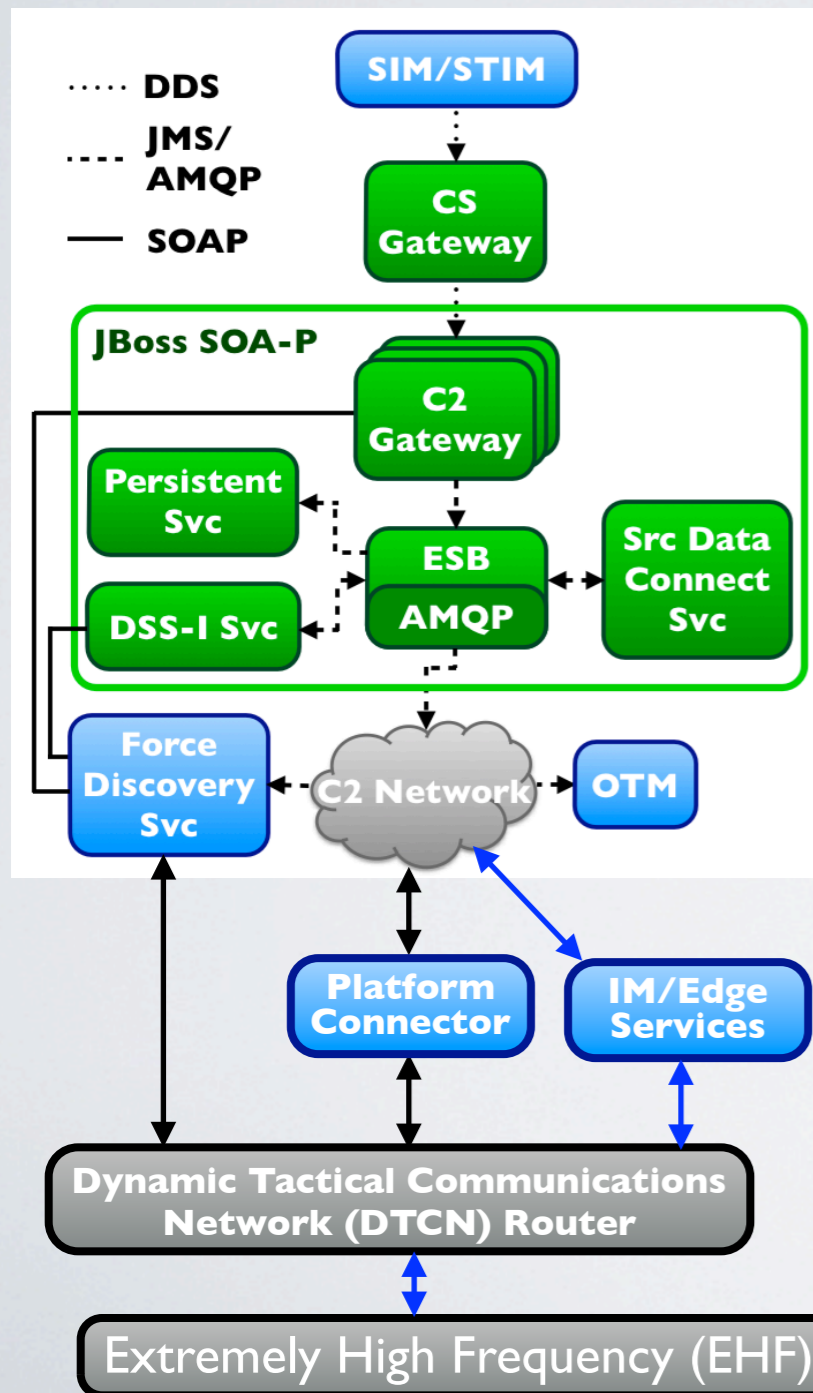
GUID	Message ID	Time
ABC/RaceTrack/1...	0	5:06:07

Below the table, there is a section labeled 'Sample Content:...'.

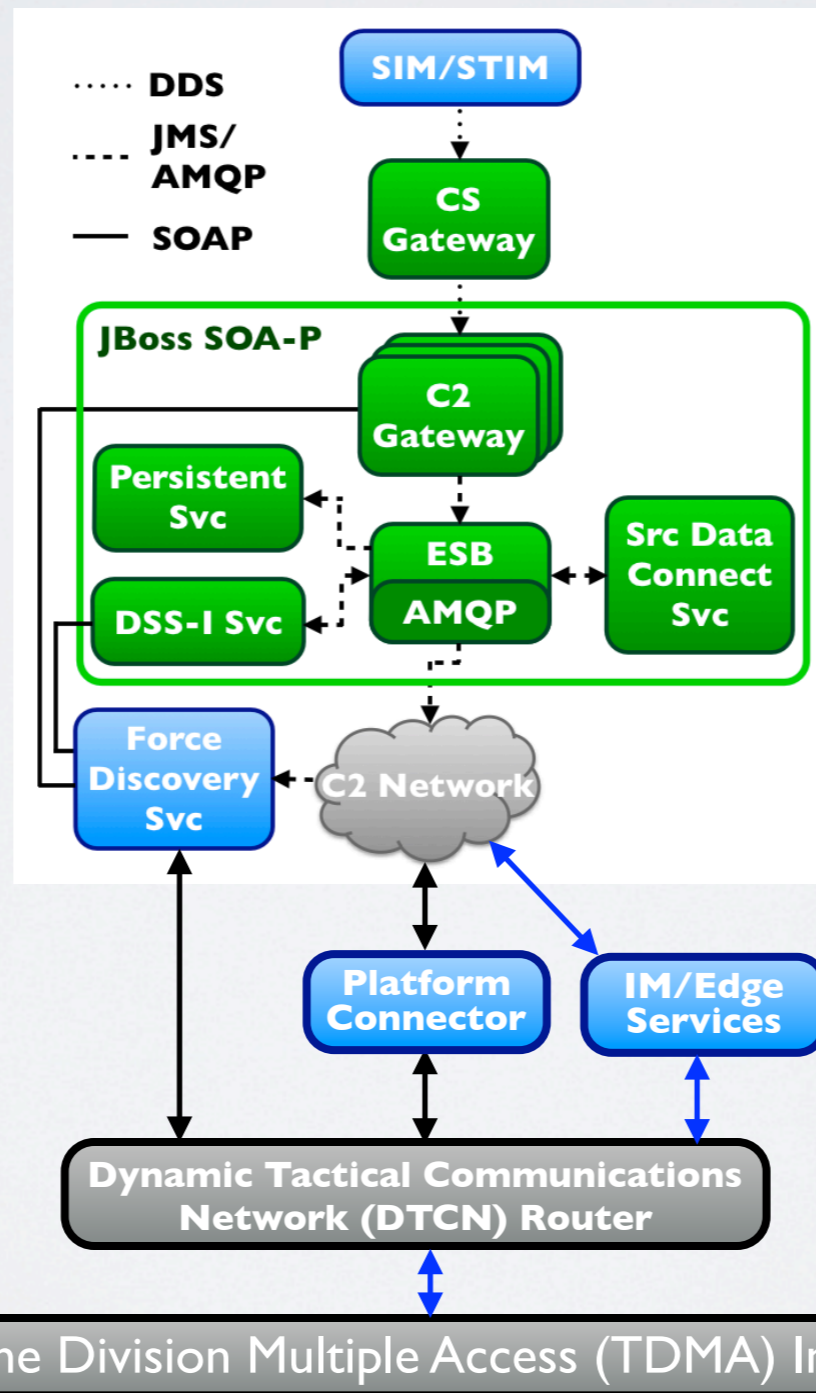
- Existing systems used JMS (legacy transport)
- New systems used ESB for flexibility, maintainability

# SIMPLIFIED CROSS-PLATFORM ARCHITECTURE

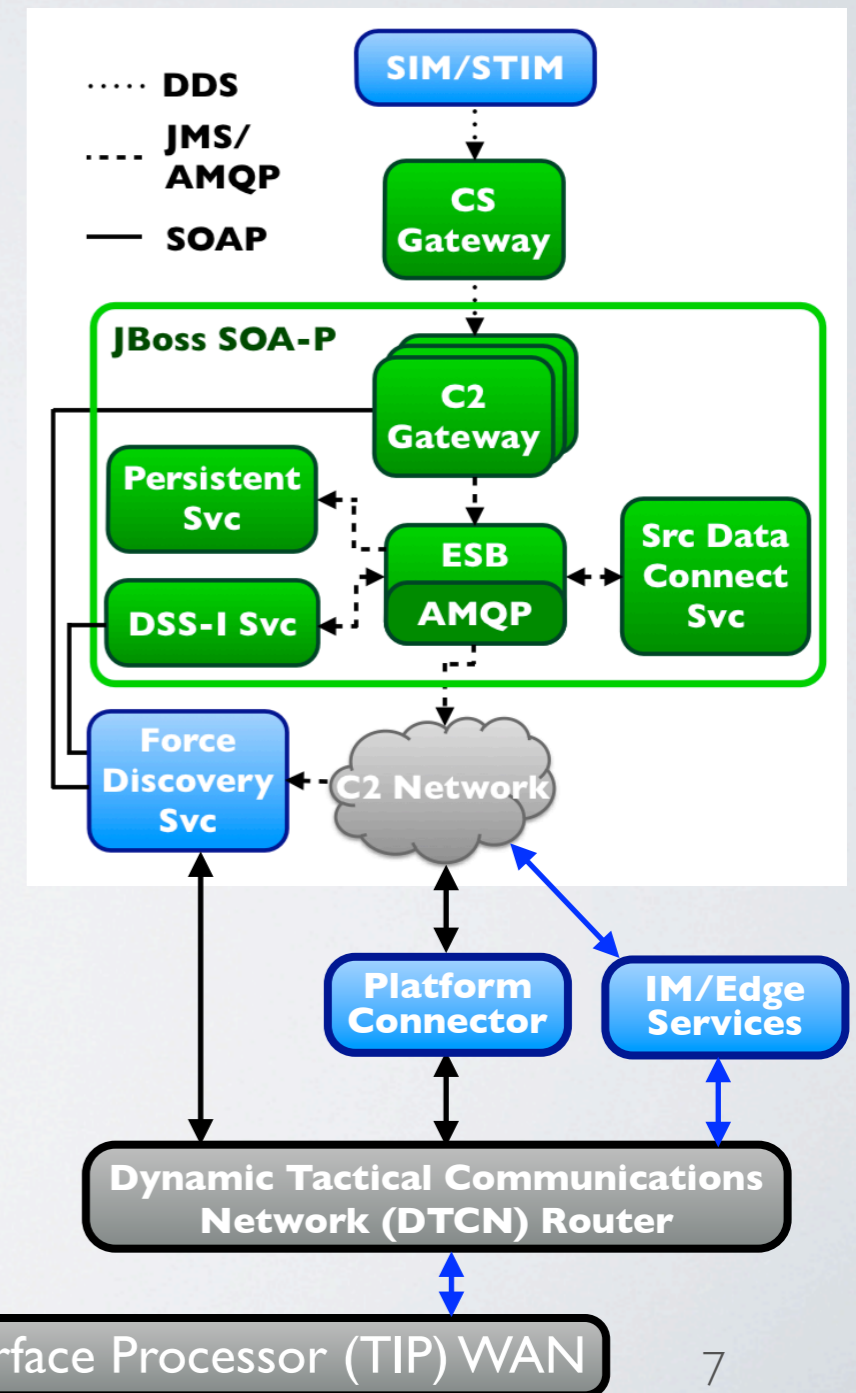
CVN



DDG1



DDG2



# SOA ADVANTAGES

- Services were not dependent on transport
  - Today :AMQP, tomorrow...?
- Services were reusable, reading/writing ESB Messages
- Services didn't care where CS data originated, protocol & data agnostic
- Architecture could be deployed within CANES environment
  - Services were the only custom-coded components inside JBoss
- Leverage existing SOA capabilities
  - Workflow, registry, load balancing, configuration-based deployment

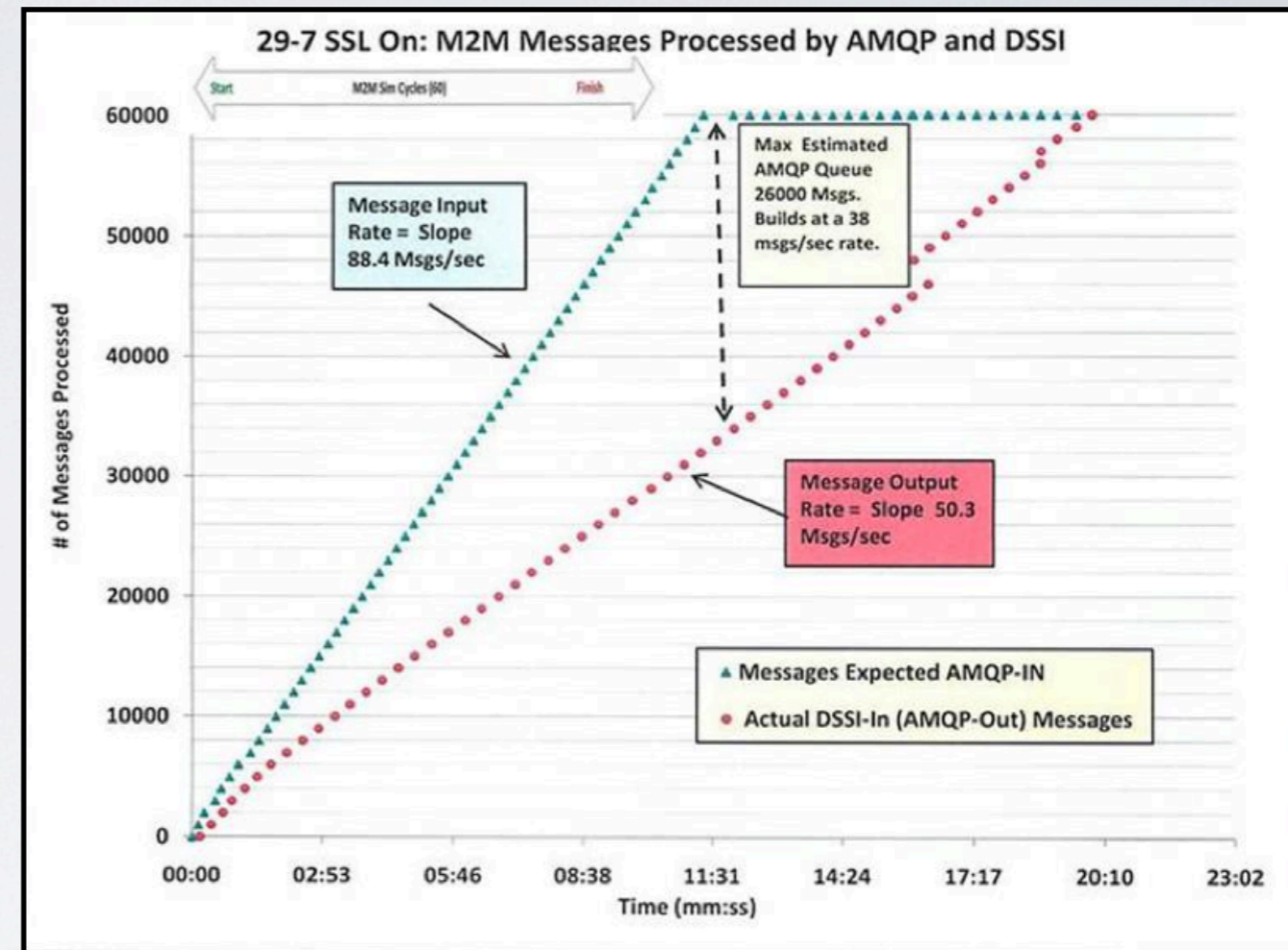
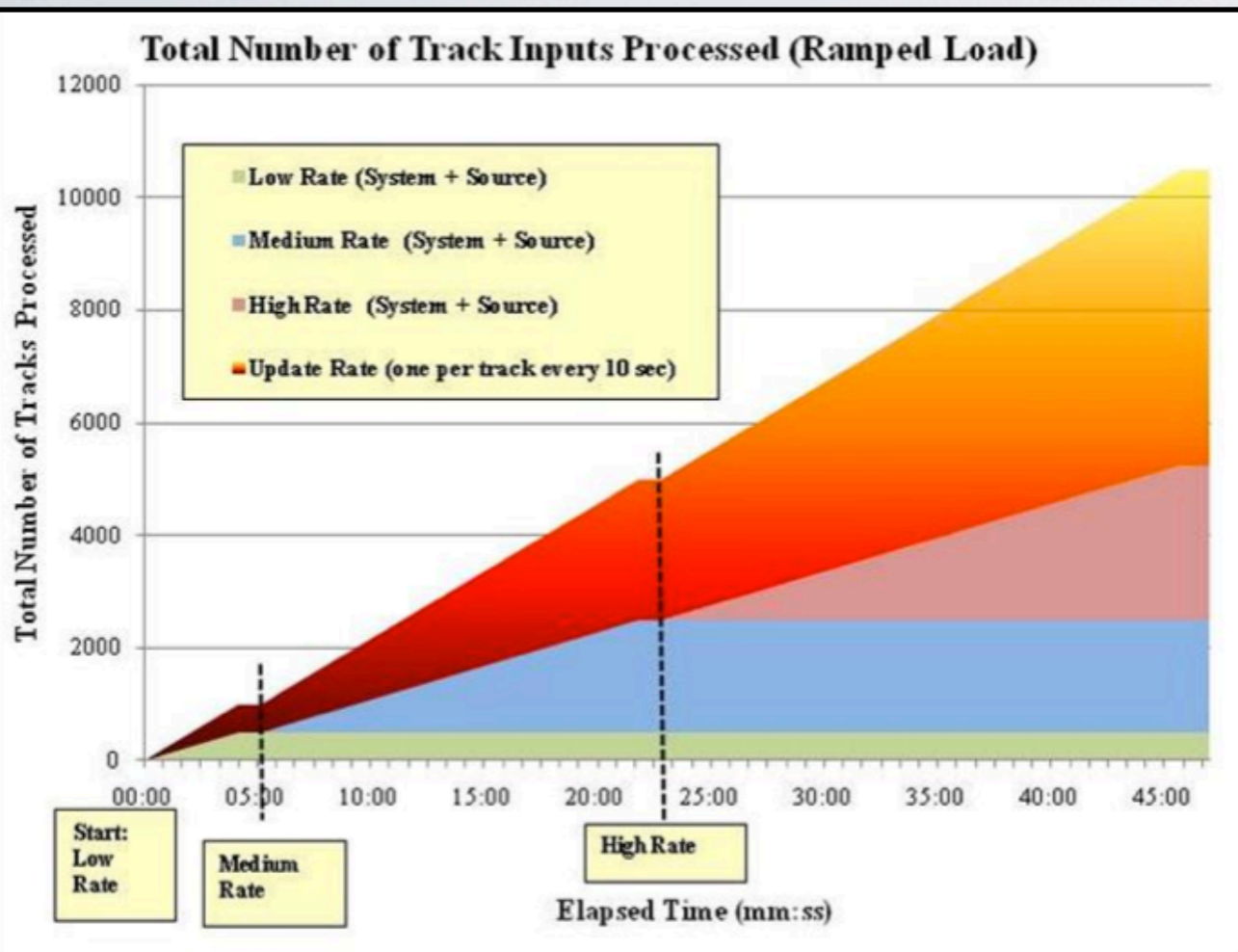
# LTE RESULTS



- *“The LTE results validated configurable Combat to C2 gateway design that will facilitate transition into PEO IWS FYI 2/FYI 4 Advanced Capability Builds (ACBs) and PEO C4I Consolidated Afloat Networks and Enterprise Services (CANES) core services targeted for CVN 78. This will eliminate multiple, static, point-to-point Combat to C2 legacy interfaces.”*
- *“Thread 7 [DIL WAN communications] successfully demonstrated ‘proof of concept’ for this approach to achieve mission- critical communications in a DIL environment...”*
- *“The LTE analysis of Thread 2 indicated successful proof-of-concept for the ACS federation capabilities.”*
- *“In general, security controls were applied successfully with minimal impact on performance.”*
  - Note: performance impact is possible with two-way data flow

**Quotes are from the LTE final report**

# LTE AREAS OF IMPROVEMENT



- AMQP operated as fast as the slowest consumer
  - Requires patterns and practices to govern consumer use of a shared enterprise resource
  - Believed to be configuration issue; queue backups were not infrequent
- Track and readiness messages were dropped before making it onto the ESB
  - Complex, multiple issues: in-band communications using AMQP, use of Hypersonic database, AMQP unique node IDs

**Results are very condensed from full report, our focus is on SOA**

# UXV APPLICABILITY

- UxV control systems could use protocol and data mediation services inherent in SOA stack
- UxV data interfaces could bypass the need for code changes when interfaces change (e.g. version upgrade, communicating with new type of UxV)
  - Dependent upon interface being well-documented
- UxVs could take advantage of both C2 and CS data for missions

# LTE NEXT PHASE

- Currently working on Phase B, LTE
- Targeted for September, 2011
- Dual data flow; C2 to CS
- Expanding effort to include other DoD branches
  - Navy, Army, Air Force
- Support for additional data types
  - ATOs, EW Database, Dynamic Air Space Management (DASM), others
- Use of COTS Rules Engine
  - JBoss Drools is under investigation

Thank You

Matthew Fisher  
[mfisher@progeny.net](mailto:mfisher@progeny.net)



# ACRONYMS

- AMOD: AEGIS Modernization
- AMQP: Advanced Message Queuing Protocol
- ATO: Authority To Operate
- C2: Command and Control
- CS: Combat System
- DDS: Data Distribution Service
- DIL: Disconnected, Intermittent and Limited
- EAR: Enterprise Archive File, defined by the Java EE spec
- ESB: Enterprise Service Bus
- EW: Electronic Warfare
- LTE: Limited Technology Experiment
- OTM: Open Track Manager
- RAR: Resource Archive File, defined by the Java EE spec
- SAR: Service Archive File
- SOA: Service Oriented Architecture
- WAR: Web Archive File, defined by the Java EE spec