# OTF CCSDS Mission Operations Prototype Directory and Action Service Phase I Exit Presentation

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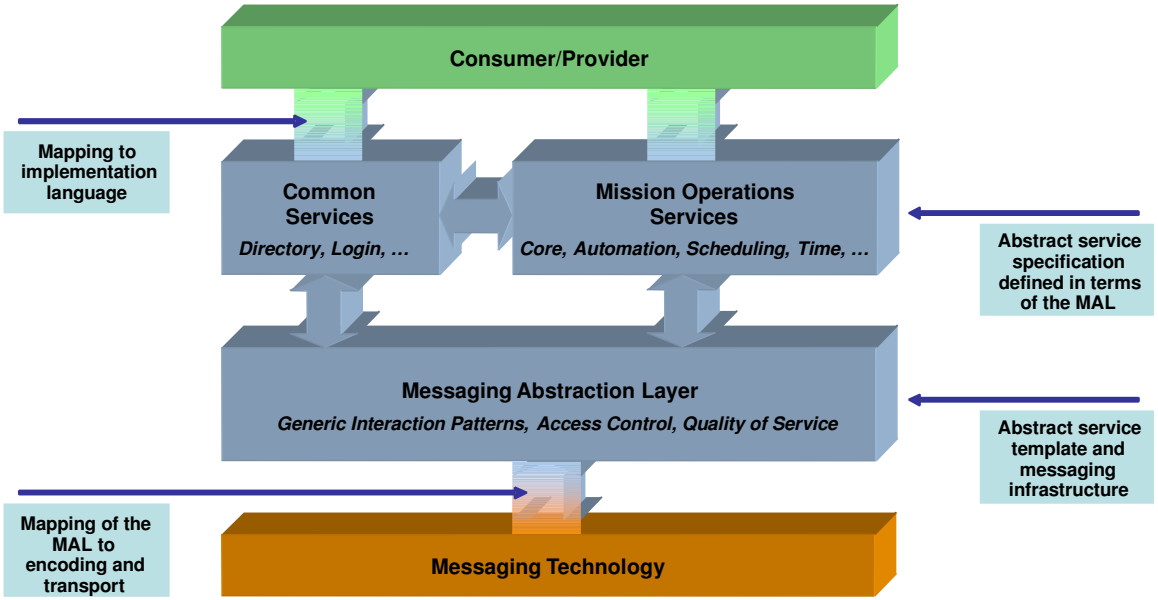
# Introduction

- Mission Operations
  - Primary goal is to increase level of interoperability among Agencies



# Project Goals

- Demonstrate the use of Mission Operations standards to implement Directory and Action Services
- Investigate Mission Operations language neutrality
- Investigate C3I XML interoperability concepts
- Integrate applicable open source technologies in a Service Oriented Architecture

# Project Benefits

- Investigate the viability of the Mission Operations standards
- Provide feed back to the Mission Operations Working Group and NASA management
- Concrete implementation of a Service Oriented Architecture (SOA)
- Multi-center cooperation
  - GSFC : MAL Implementation
  - JPL: AMS (Asynchronous Message Service) Transport Layer
- Introduction of new technologies

# Project Scope

- Does not address security concerns
- Does not implement Common Model operations
- Implements minimum MAL capabilities

# Project Definition

- Mission Operations Interoperability Constraints
  - Directory Service
    - A. Language Mapping: C, C++, Java and Python
    - B. MAL Specification: July 2007 Red Book
    - C. Service Specification
      - Common Services: September 2007 Red Book
    - D. Transport Mapping:  HTTP Transport / XML encoding
  - Action Service
    - A. Language Mapping: C++ and Java
    - B. MAL Specification: July 2007 Red Book
    - C. Service Specification:
      - Common Services: April 2008 Red Book
      - Core Services: May 2008 Red Book
    - D. Transport Mapping:  AMS Transport / XML Encoding


# Methodology

- Created XML schemas for MAL, Common and Core constructs
- Used XML tool kits to generate object to XML (OXM) mapping code from schemas
- Implemented the most common execution paths with reasonable error checking

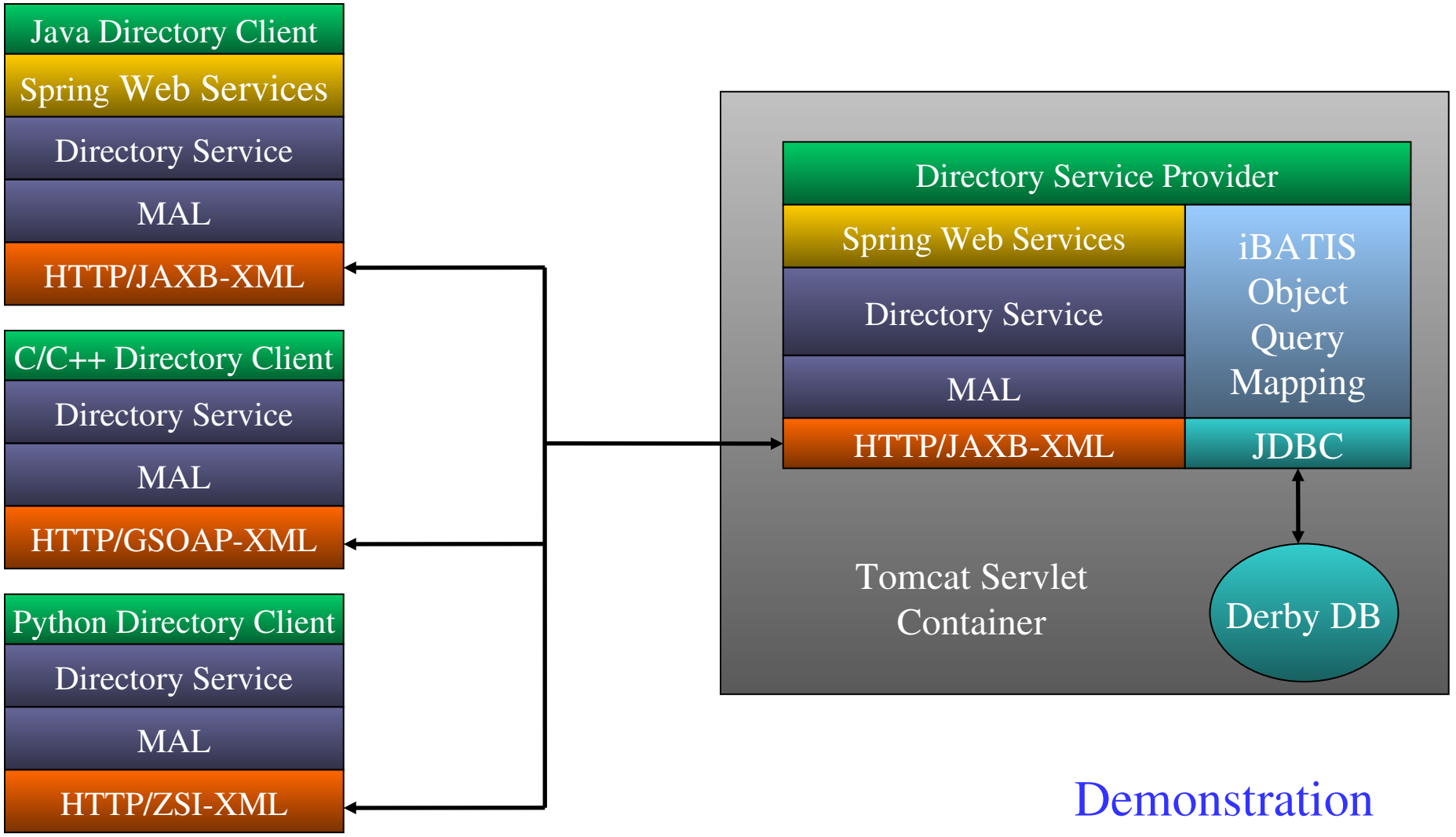

# Directory Service Provider

- Implemented Methods
  - Lookup: Consumer searches for qualifying services
  - Publish: Provider advertises availability
  - Withdraw: Provider indicates service is no longer available
- Java Application
- Integrated Open Source Projects
  - Spring Web Services: www.springframework.org/spring-ws
  - Tomcat Servlet Container: tomcat.apache.org
  - Derby embedded database: db.apache.org/derby
  - iBatis Object Query Mapping (OQM): ibatis.apache.org
  - JAXB Object XML Mapping (OXM): jaxb.dev.java.net
  - JUnit: www.junit.org
    - Automated unit and regression tests


# Directory Service Clients

- Java Client
  - Wicket Web Framework: wicket.apache.org
  - Spring Web Services: www.springframework.org/spring-ws
  - JAXB OXM: jaxb.dev.java.net
- C / C++ Client
  - gSOAP OXM: www.cs.fsu.edu/~engelen/soap.html
- Python Client
  - Zolera Soap Infrastructure OXM: pywebsvcs.sourceforge.net

# Directory Service Interfaces




Demonstration

# Action Service Provider

- invokeAction
  - Execute actions (commands)
  - Implemented only actions without arguments
- preCheckAction
  - Boolean return indicating if action would succeed
  - Not implemented
    - Not supported by COTS Command and Telemetry System
    - No MCC equivalent capability for Command

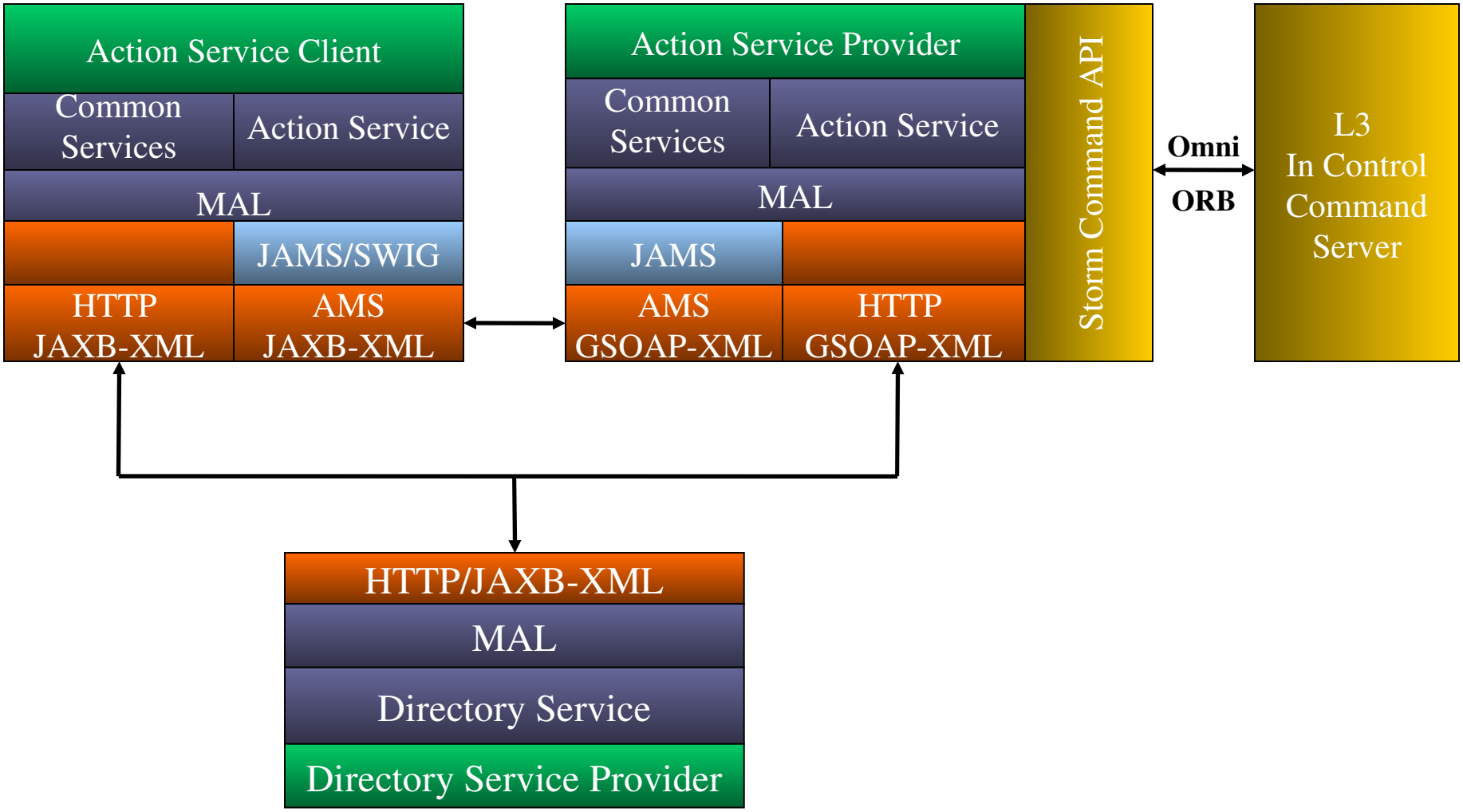
# Action Service Provider

- C++ Application
- Integrated Open Source Projects
  - OMNIORB CORBA ORB: omniorb.sourceforge.net
  - ACE TAO CORBA ORB: www.cs.wustl.edu/~schmidt/TAO.html
  - gSOAP OXM: www.cs.fsu.edu/~engelen/soap.html
  - Boost C++ Libraries: www.boost.org
- Dependencies
  - L3 InControl Command Server
    - Vendor permitted continued evaluation after trade study
  - AMS (Asynchronous Message Service)
  - JAMS (JSC Front End to AMS)

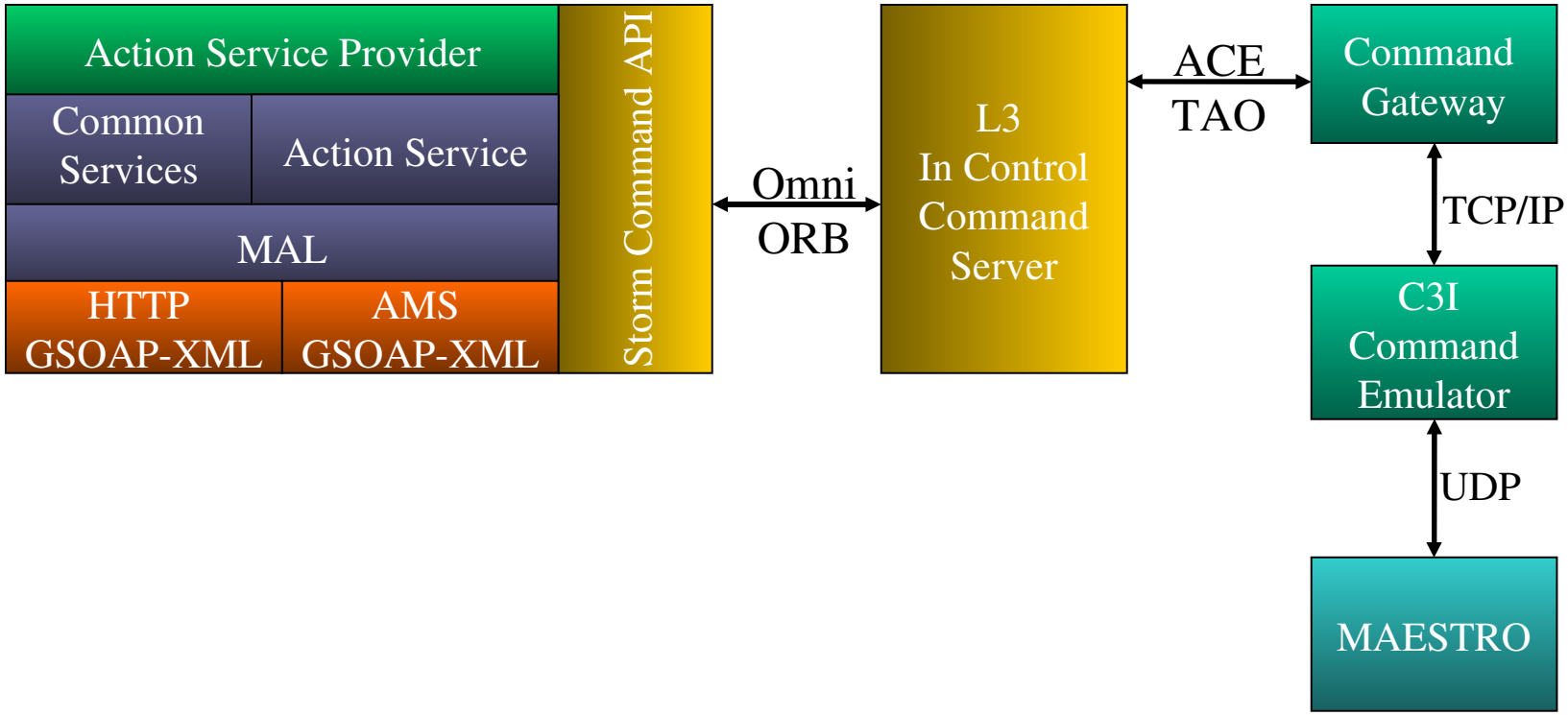
# Action Service Client

- Browser Based User Interface
- Integrated Open Source Projects
  - Java Language
  - Tomcat Servlet Container: tomcat.apache.org
  - JAXB OXM: jaxb.dev.java.net
  - Web Application Framework: wicket.apache.org
  - SWIG C/C++ Wrapper: www.swig.org
- Dependencies
  - AMS (Asynchronous Message Service)
  - JAMS (JSC Front End to AMS)

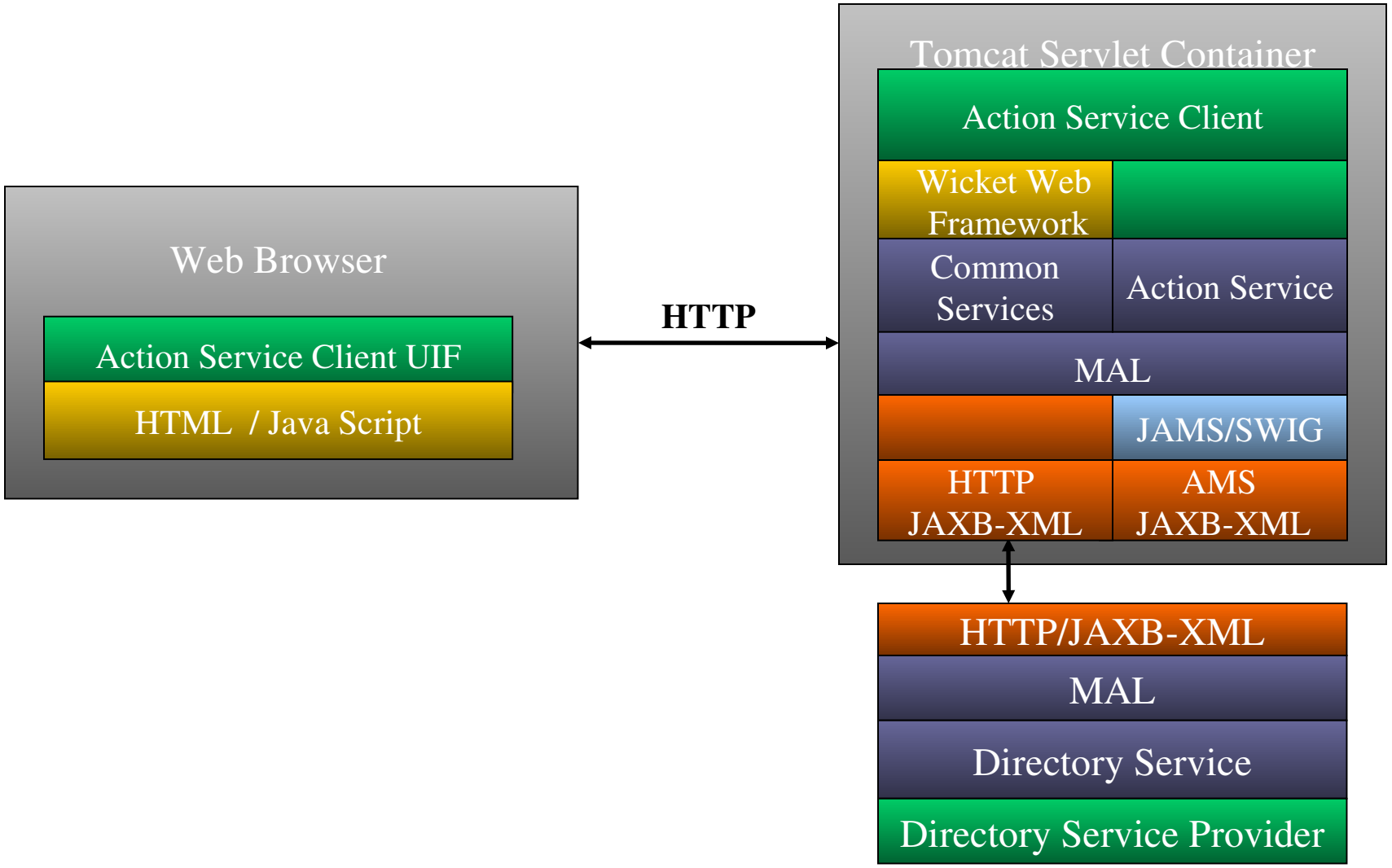
# Action Service Interfaces



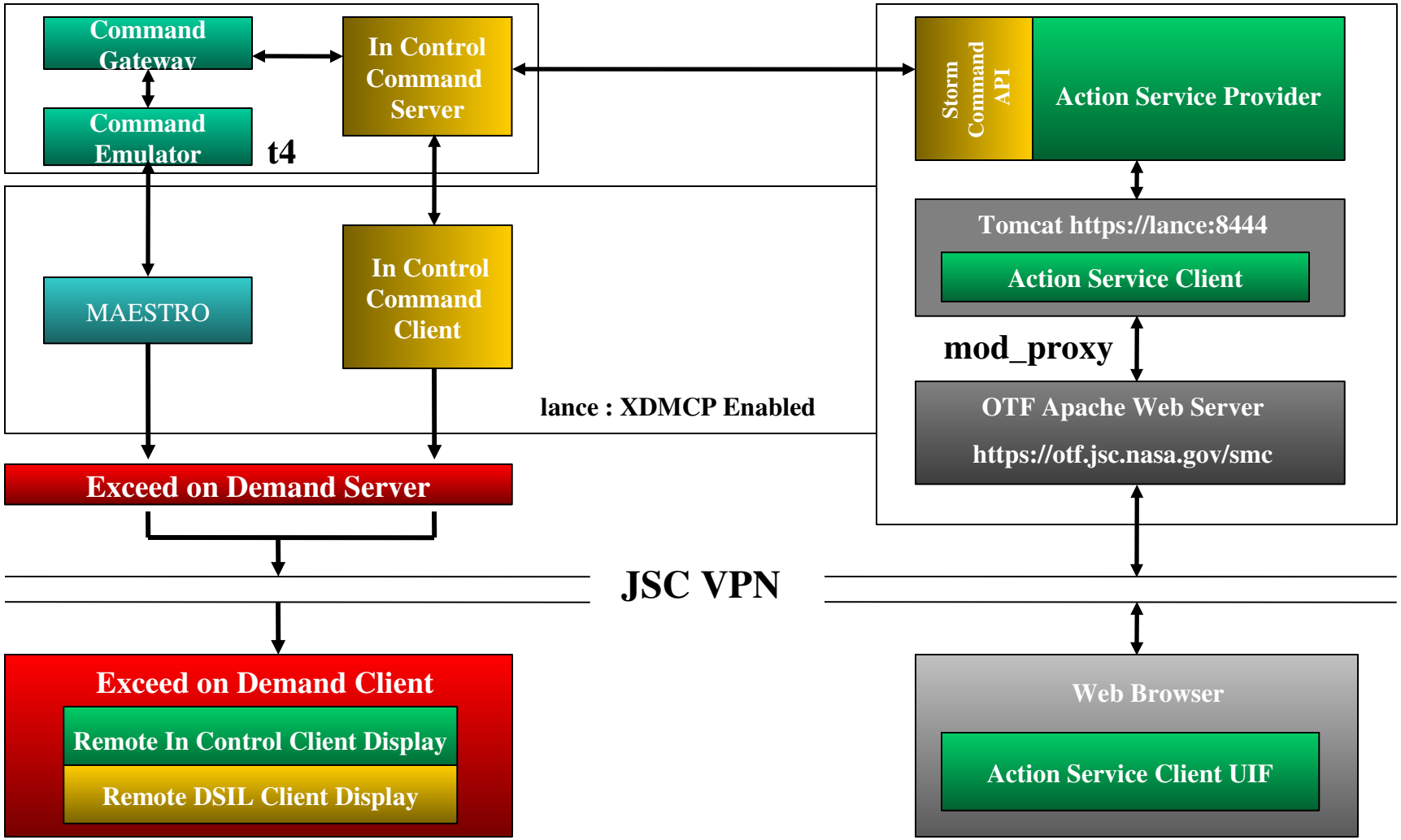
# Action Service Proxy



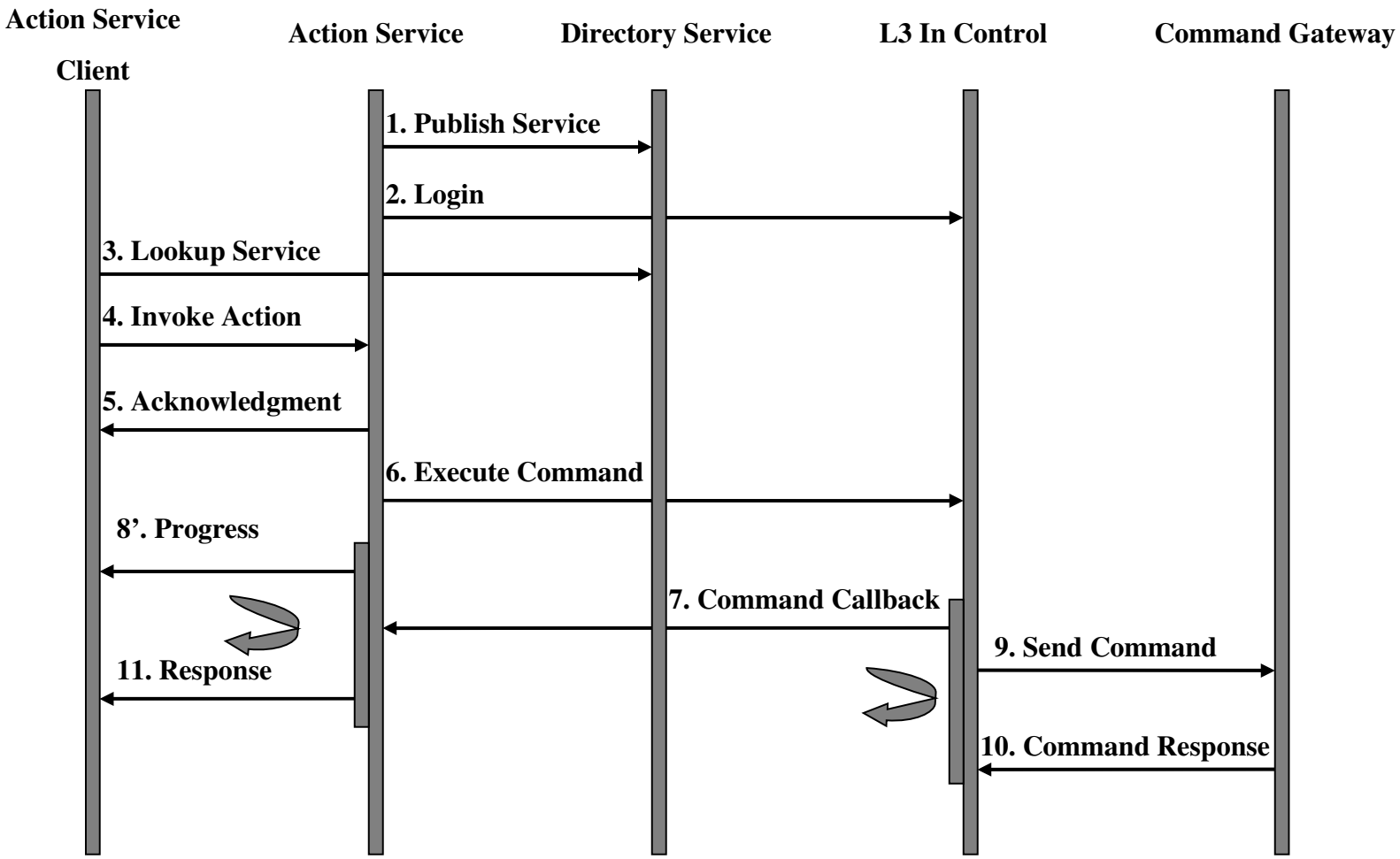
# Action Service Client



# Demonstration Architecture



# Demonstration Flow



# Results

- Identified modifications to implement manned spaceflight requirements (separate presentation)
- Eighteen (18) RIDS against Directory Service
- Seven (7) RIDS against Action Service
- Validated MO interoperability in regards to language neutrality
- Validated C3I XML interoperability concepts

# Results Continued

- Specification defers many data format issues to the service configuration which is outside the scope of the documents
  - No discovery mechanism for the available commands with parameters
  - Interface for command uplink provides only an argument list for parameter values.
    - No parameter type
    - No engineering units
    - No operational limits

# Results Continued

- Service Oriented Architecture (SOA) requires long term investment
  - Interfaces must be negotiated and designed for reuse
  - Software developer training
- Mission Operations does an excellent job defining the interfaces and service specifications
  - Provides business requirements to drive the architecture
  - Potential to absorb up front cost of interface design
  - Specifies defendable and versionable interfaces


# MO Lessons Learned

- Necessary to write a blue book specifying the schemas for the Mission Operations data structures
  - The consumer and provider schema must be in agreement for interoperability


# XML Lessons Learned

- Sufficient tool support for XML encoding
- Support varies by language
  - C/C++ require large amounts of generated code
  - C/C++ require hand written memory allocation logic
  - Java / Python have basic XML support available as libraries or packages

# XML Lessons Learned

- Investigation to determine bandwidth issues for large amounts of XML data is necessary
- Schemas to define data formats must be defined and agreed upon for C3I to succeed


# Conclusions

- Additional commanding capabilities are needed for manned space flight
- Validated MO interoperability in regards to language neutrality
- Validated C3I XML interoperability concepts
  - Contingent upon schema definition
- SOA is a long term investment

# Contacts

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# Thank You

- Questions

# SOA SLOC Matrix

| Components | Language | SLOC Count | COCOMO Estimate (Months) |
|---|---|---|---|
| Directory Web Service | Java | 2,028 | 3.91 |
| Directory Web Service Client | Java | 1,569 | 3.75 |
| | C | 366 | 0.84 |
| | Python | 212 | 0.52 |
| Action Service | C++ | 6,370 | 16.30 |
| Action Service Client | Java | 1,519 | 3.72 |
| | | **12,064** | **29.04** |
| **Generated Components** | | | |
| OXM Services | C++ | 14,443 | 39.59 |
| | C | 9,887 | 26.93 |
| | Java | 1,512 | 3.70 |
| | Python | 430 | 0.99 |
| OQM Services | Java | 1,579 | 3.88 |
| MAL SWIG Interface to JAMS | Java | 75 | 0.16 |
| | C | 298 | 0.67 |
| | | **28,224** | **75.92** |
| | | | |
| | | ***40,288*** | ***104.96*** |

Return

# Directory Service RIDS

- Distributed nature of directory service is not hidden from the clients
  - Client performs iterative lookup to resolve URI
  - Client performs addition of external links
- Publish service is not specify action to take if node does not exist
- Extra information attribute not used to aid problem resolution for errors

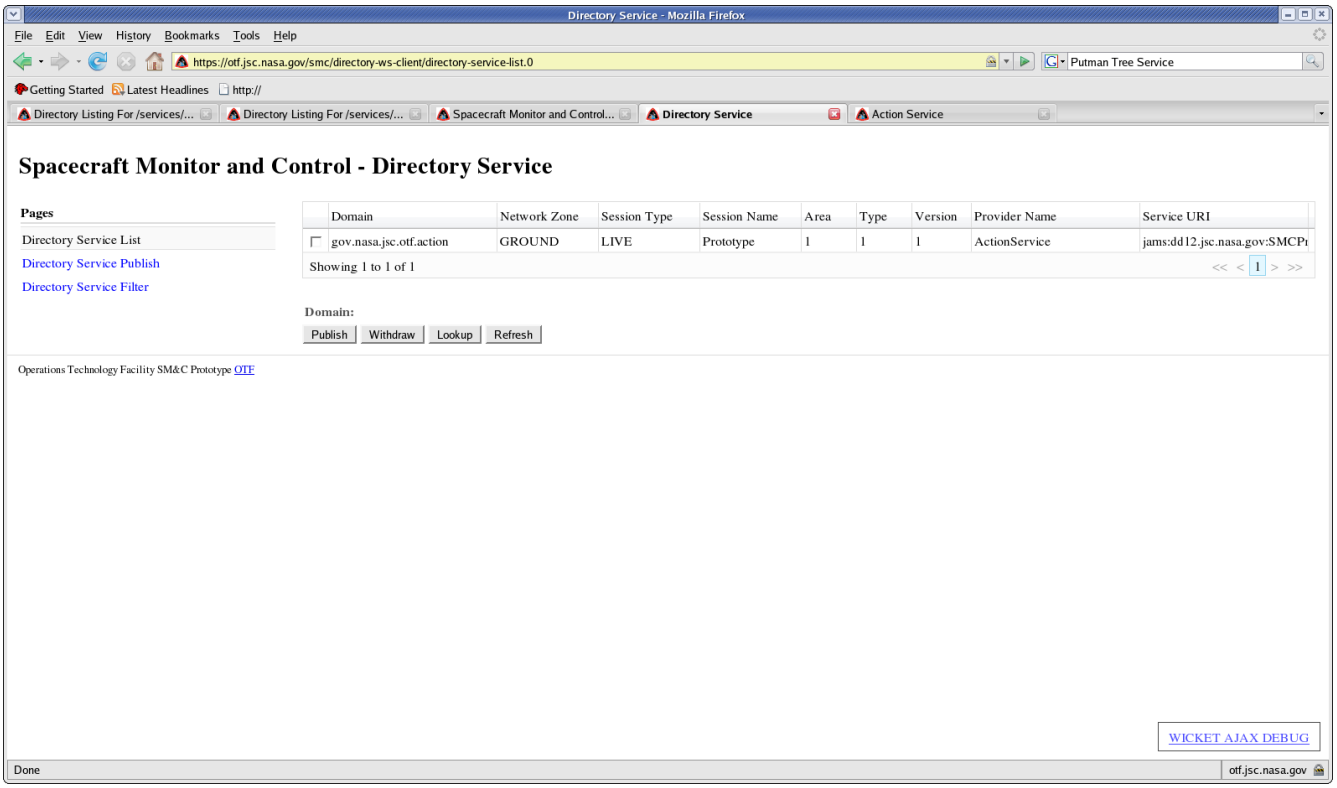
# Action Service RIDS

- Information mismatch between progress updates and data archived in the Common Model
- Time triggered actions not specified
- Extra information attribute not used to aid problem resolution for errors

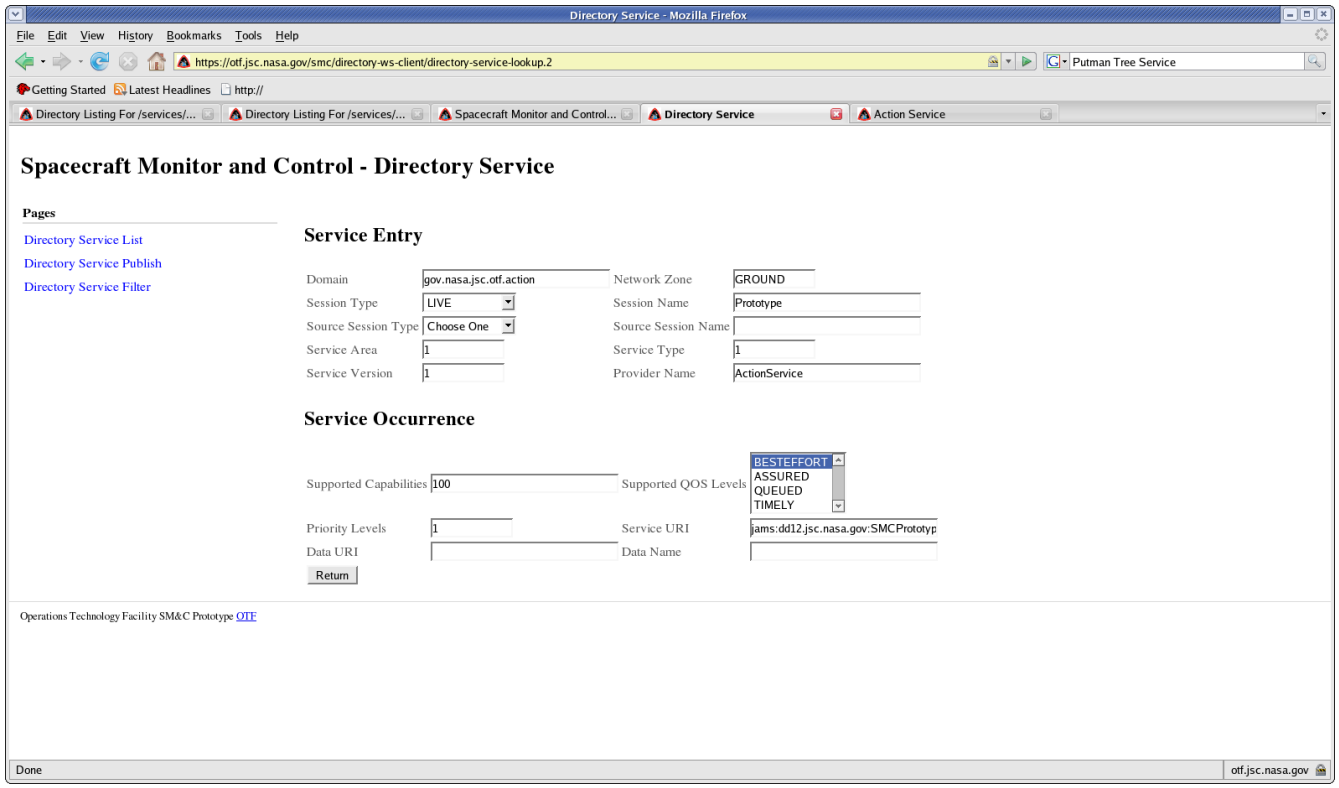
CCSDS Mission Operations
Directory Service Demonstration

Screen Shots

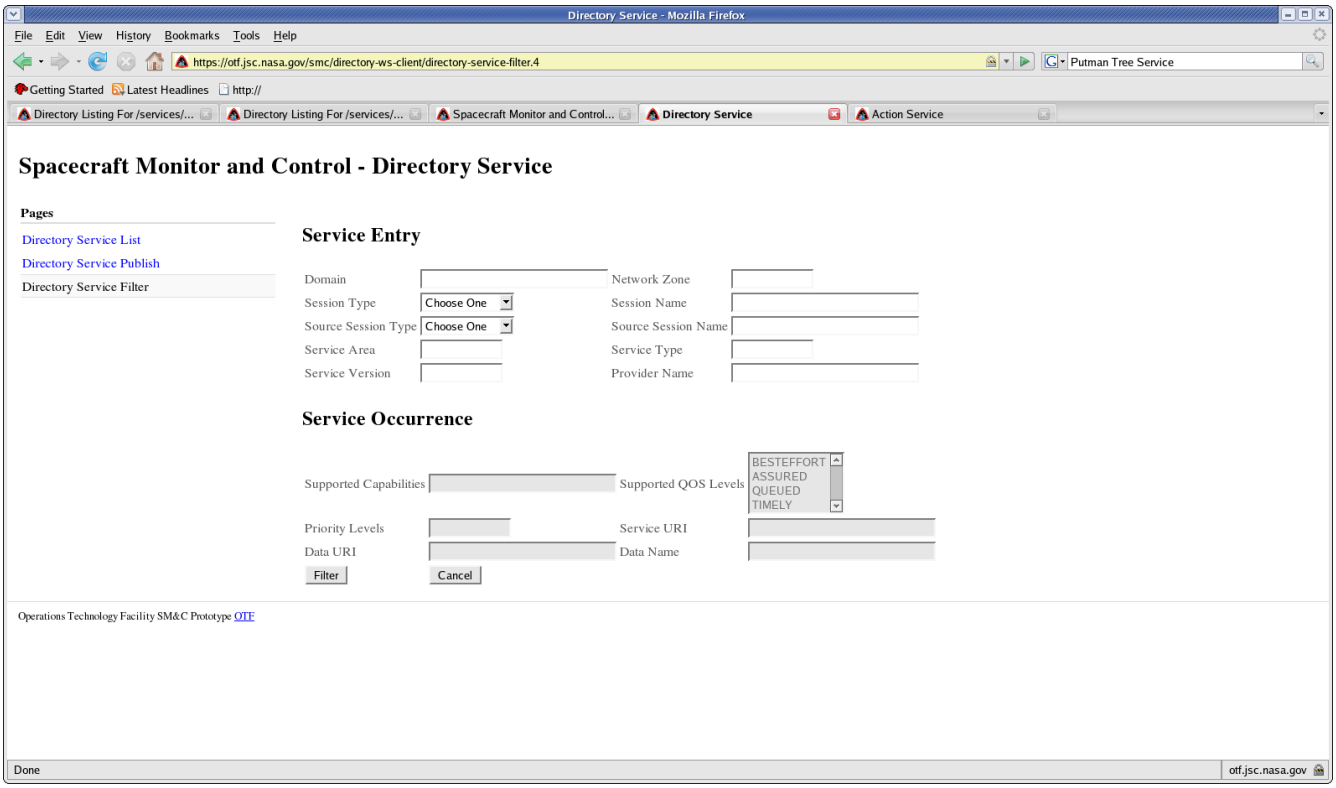
1. Directory Service Home Page



2. Directory Service Lookup



3. Directory Service Filter



4. Directory Service Withdraw