CCSDS SM&C Mission Operations Interoperability Prototype

Space Ops 2010

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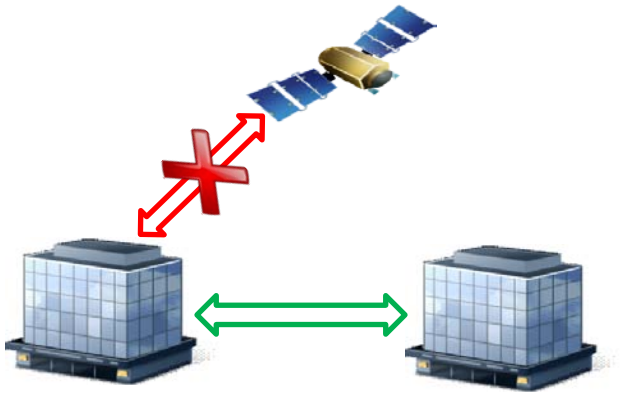
Introduction

- Future manned missions present unique challenges:
  - Require interoperability among space agencies
  - Reduced budgets for operations and development
- Mission Operations identifies two benefits of interest:
  - Increase interoperability among space agencies
  - Reduced cost of mission-specific deployment
- Interoperability Prototype covers three main topics:
  - Validation of the Mission Operations Protocol
  - Integration of legacy systems in an SOA
  - Exploration of the Data Distribution Service

Motivation

- Common exchange format between NASA control centers is necessary

- Investigating ground-to-ground standardization

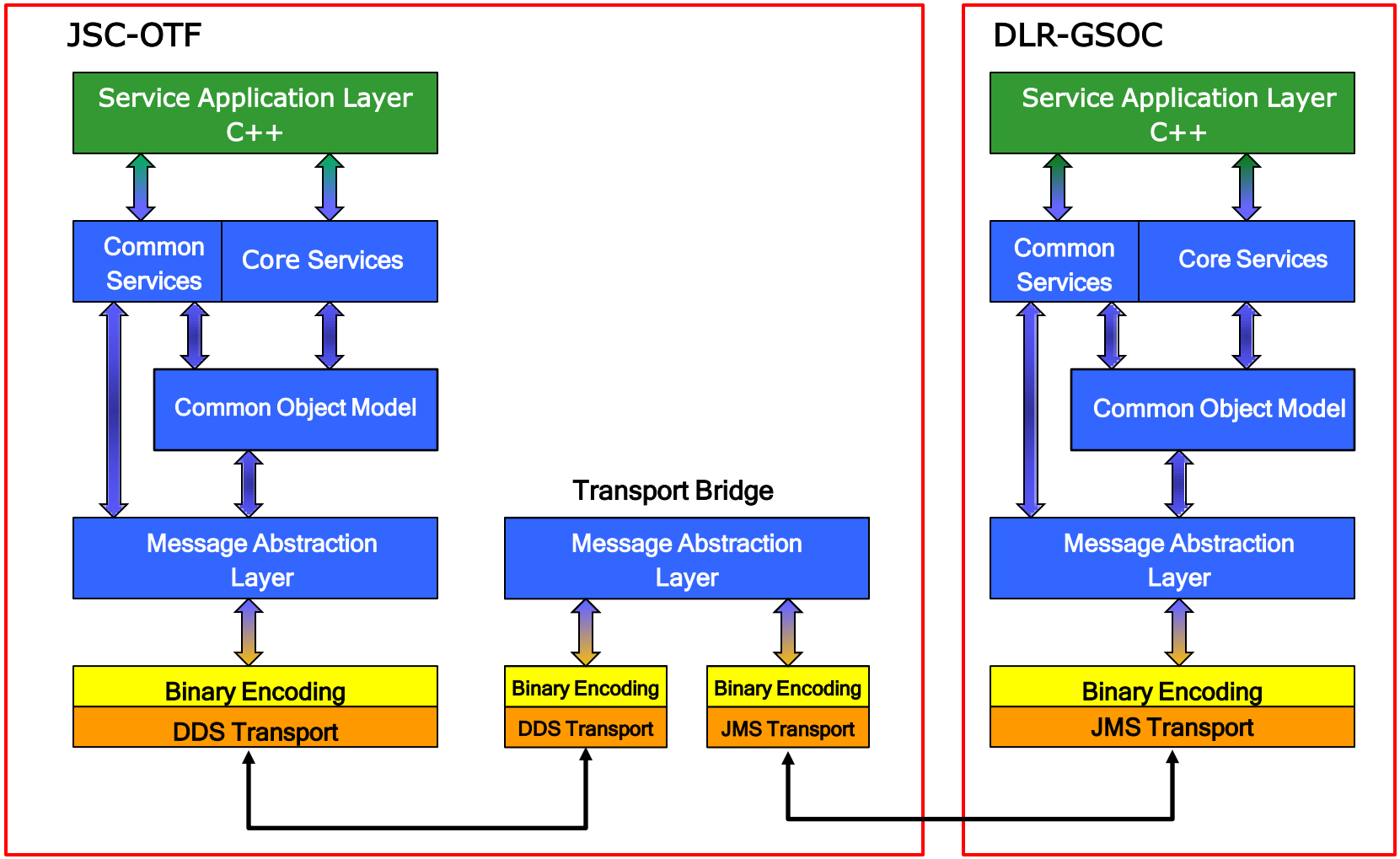


- Negotiation of an data exchange format between control centers can be challenging.

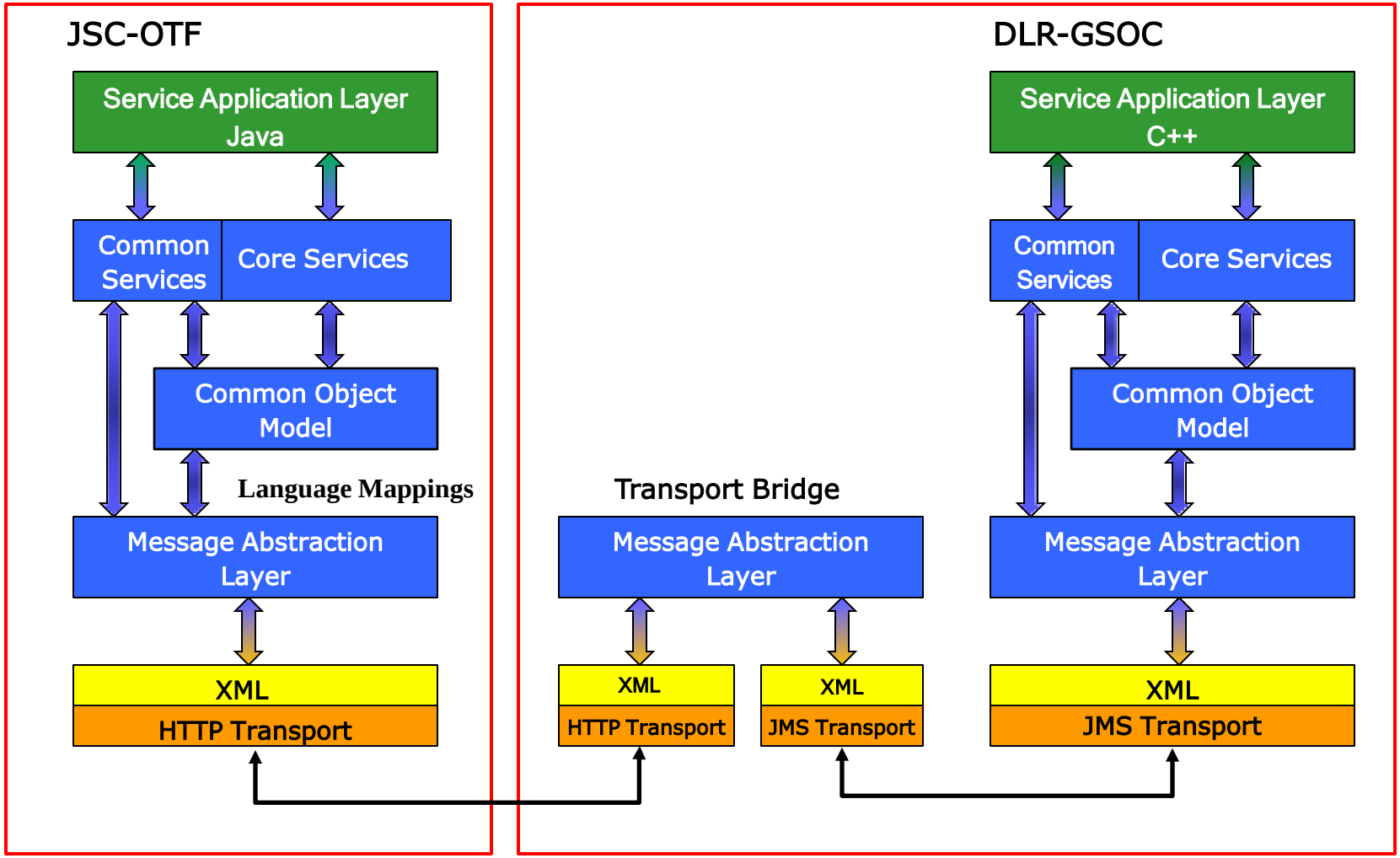
Validation of MO Protocols

- Collaborate with the German Space Operations Center (DLR) to implement an interoperability prototype
  - Prototype implements five MO services:
    - Action Service
    - Parameter Service
    - Alert Service
    - Directory Service
    - Login Service (internal access control)
- Identify additional capabilities for the services to meet human spaceflight operations concepts

Action, Alert and Parameter Service Architecture



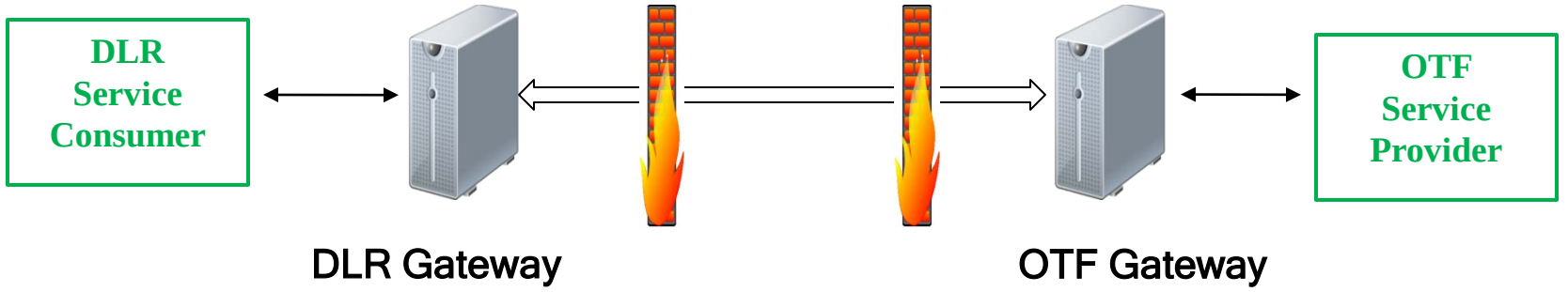
Directory Service Architecture



Encoding Specifications

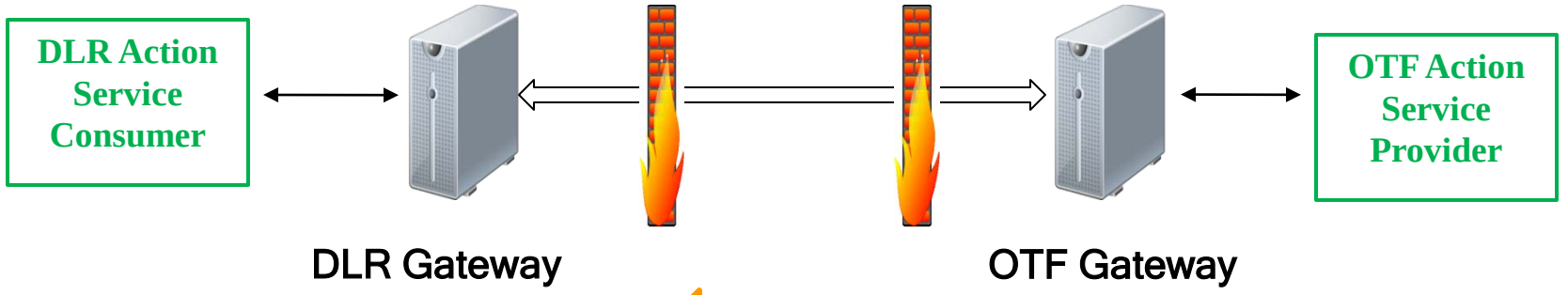
- Encoding is currently mission implementation specific
- Developed a BNF like grammar to describe a binary encoding with emphasis on simplicity
- Developed an XML schema for encoding of the data structures necessary for the Directory Service

Bridging System Domains



- Use an “in care of” address to specify the routing information
  - otf-service-uri@otf-gateway-uri
- The Message Header URI contains the complete routing sequence similar to USENET addresses

In Care of Address Example



URI to ddsbin:action-service@ jmsbin:otf-gateway@ jmsbin:dlr-gateway
URI to jmsbin:action-client
URI from jmsbin:action-client
URI from ddsbin:action-service@ jmsbin:otf-gateway@ jmsbin:dlr-gateway

URI to ddsbin:action-service@ jmsbin:otf-gateway
URI to jmsbin:action-client@ jmsbin:dlr-gateway
URI from jmsbin:action-client@ jmsbin:dlr-gateway
URI from ddsbin:action-service@ jmsbin:otf-gateway

URI to ddsbin:action-service
URI to jmsbin:action-client@ jmsbin:dlr-gateway@ ddsbin:otf-gateway
URI from jmsbin:action-client@ jmsbin:dlr-gateway@ ddsbin:otf-gateway
URI from ddsbin:action-service

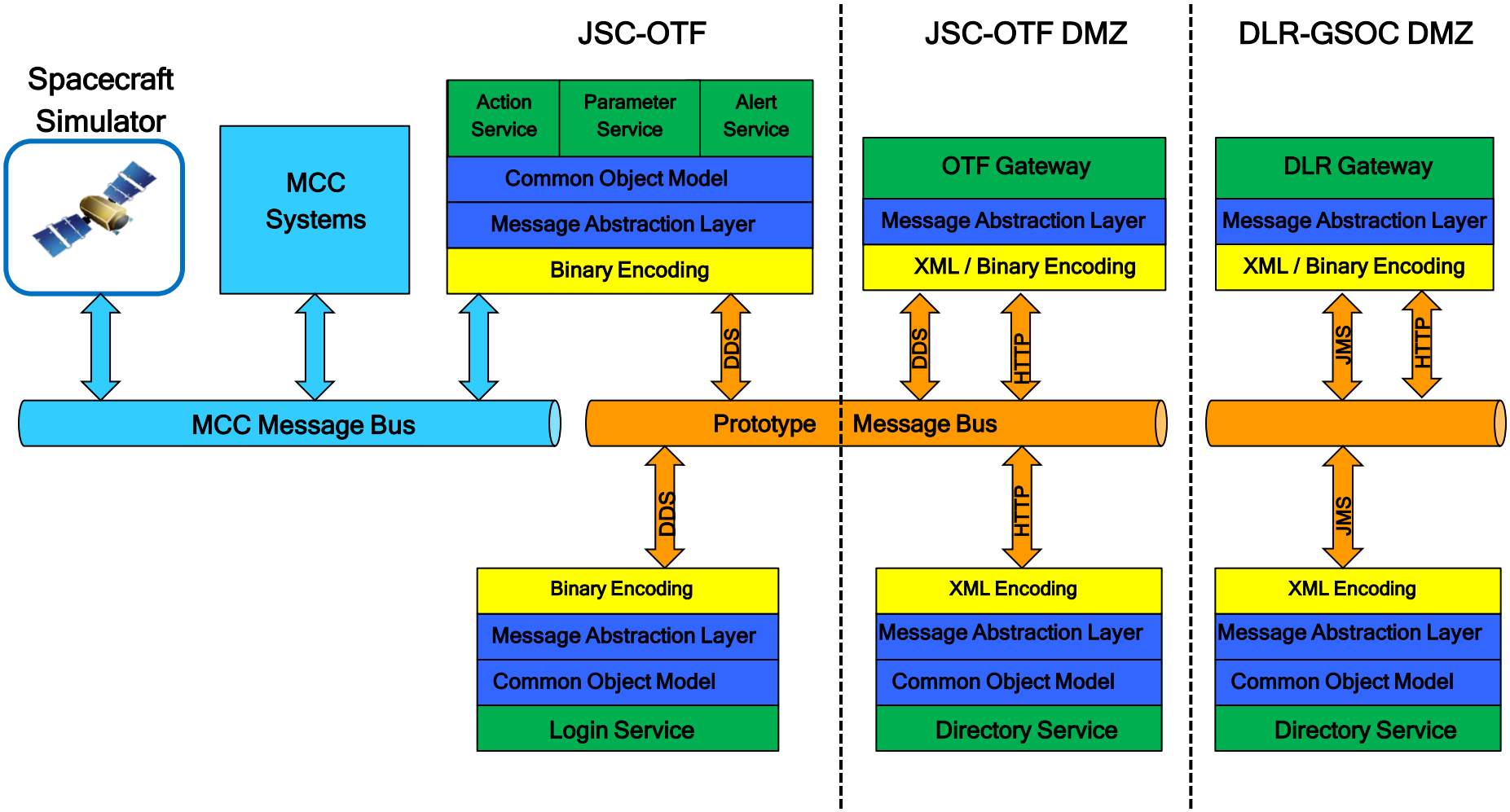
Additional Capabilities

- Human spaceflight requirements for Action Service
- Significant departure from traditional unmanned environment:
  - Control a few number of resources with a large number of people
  - Consequences of sending the incorrect command are more serious when humans are aboard
  - Provides a distributed work environment to allow flight controllers and operators to collaborate
  - Maintain a dynamic and shared command repository

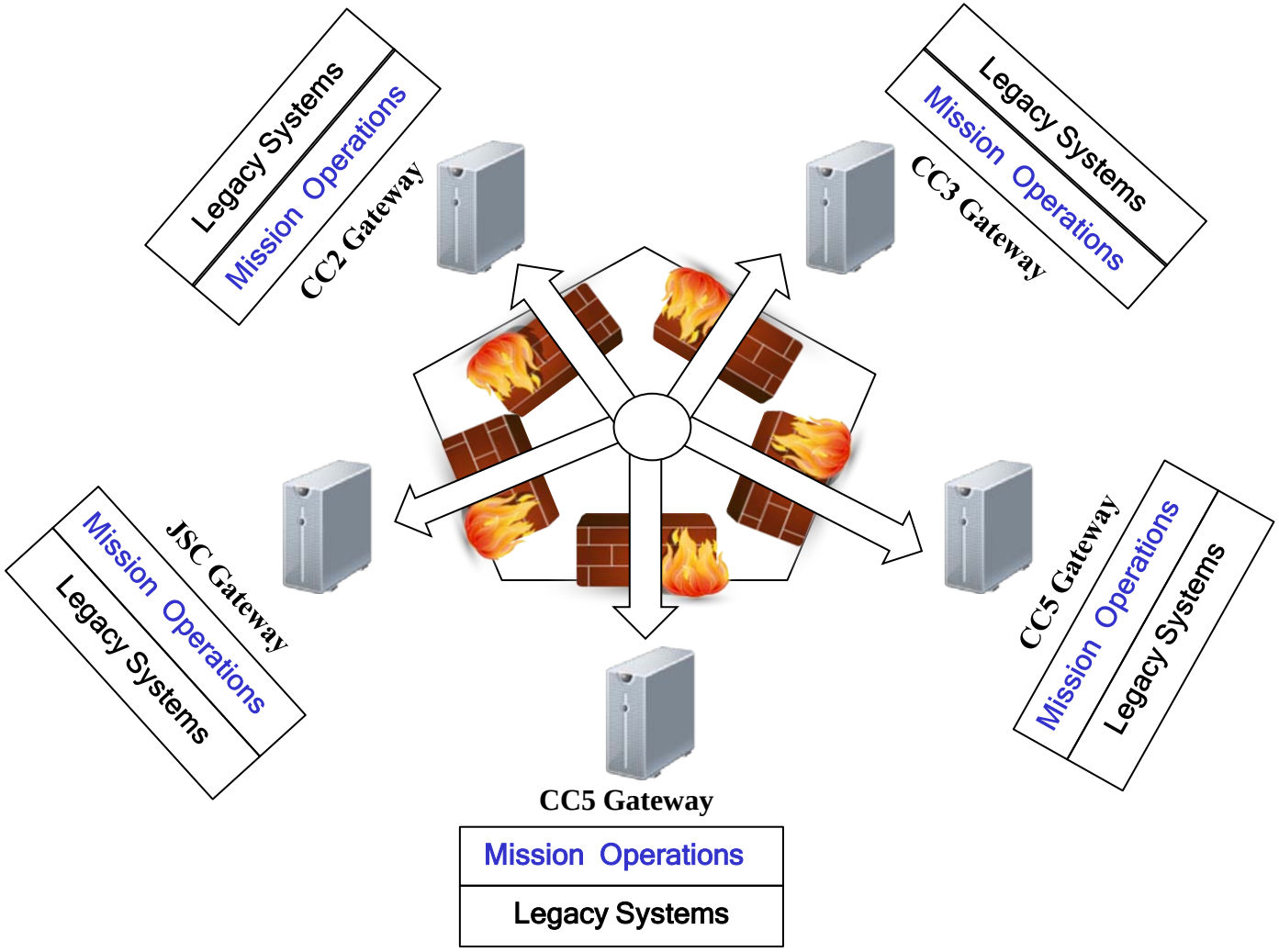
Integrating Legacy Systems

- Action Service interfaces with the ISS Command Server
  - Treated as just another client
  - Identified a set of eleven Station commands
- Parameter Service interfaces with the telemetry distribution system for ISS and the Space Shuttle
  - Identified a set of twenty corresponding ISS telemetry parameters
- Alert Service interfaces with the advisory service for ISS and the Space Shuttle.

Prototype Architecture



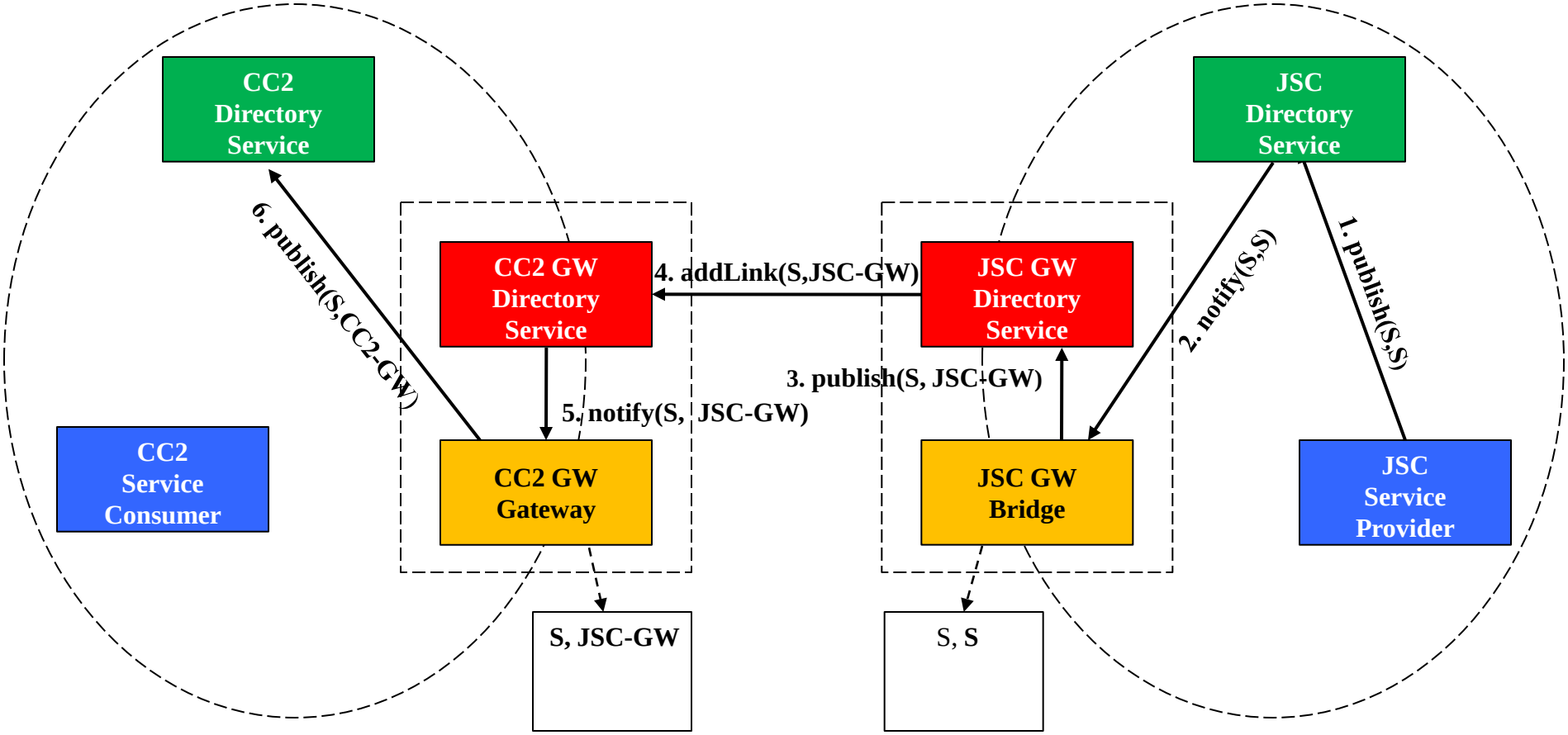
Bridging Control Centers



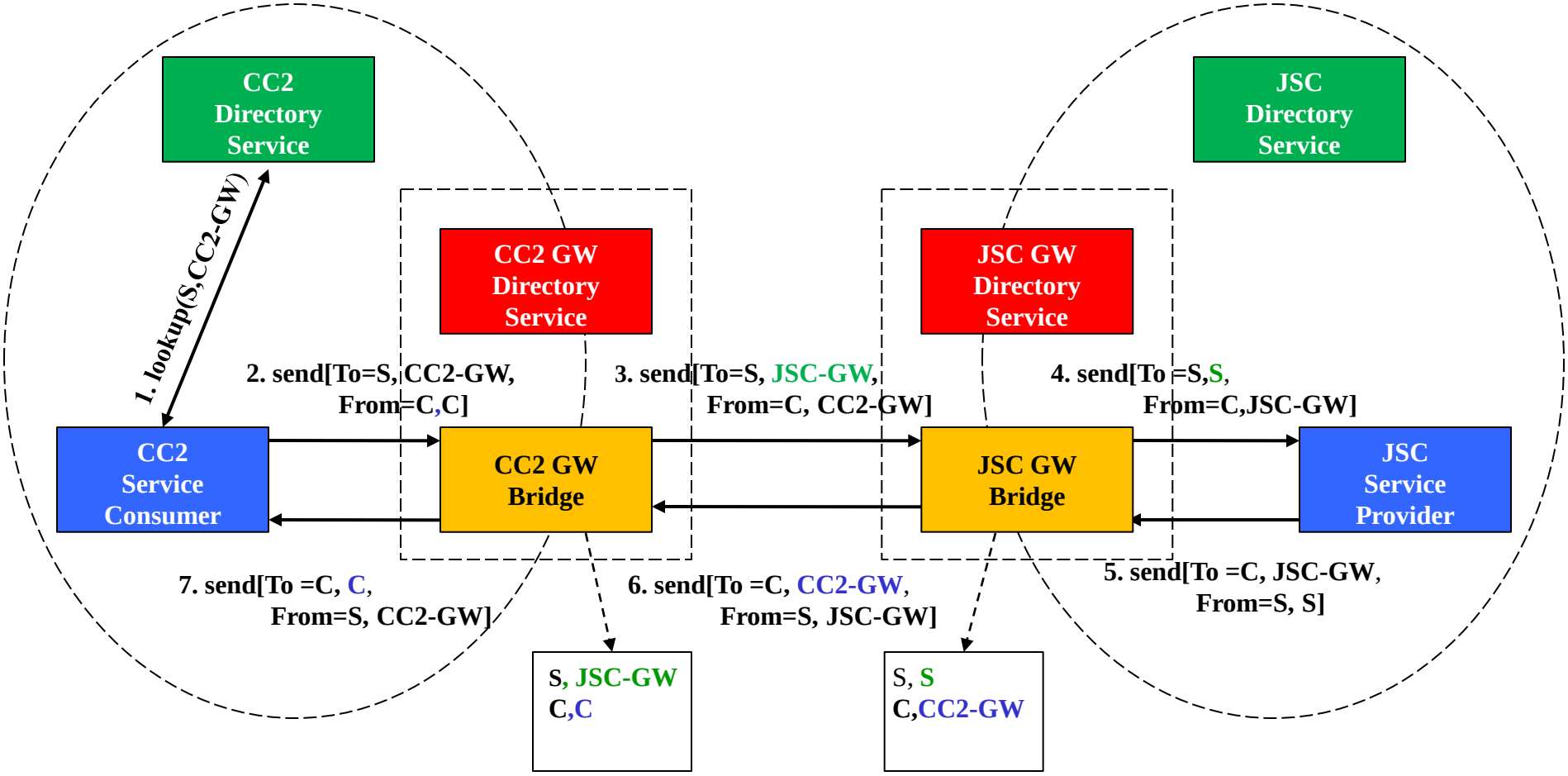
Extend Prototype Bridge

- Prototype bridge solution requires knowledge of complete routing sequence
- Extend solution to accommodate an arbitrary number of gateways.
- Maintain only the next hop routing information in the URI

Bridge Publish Availablity



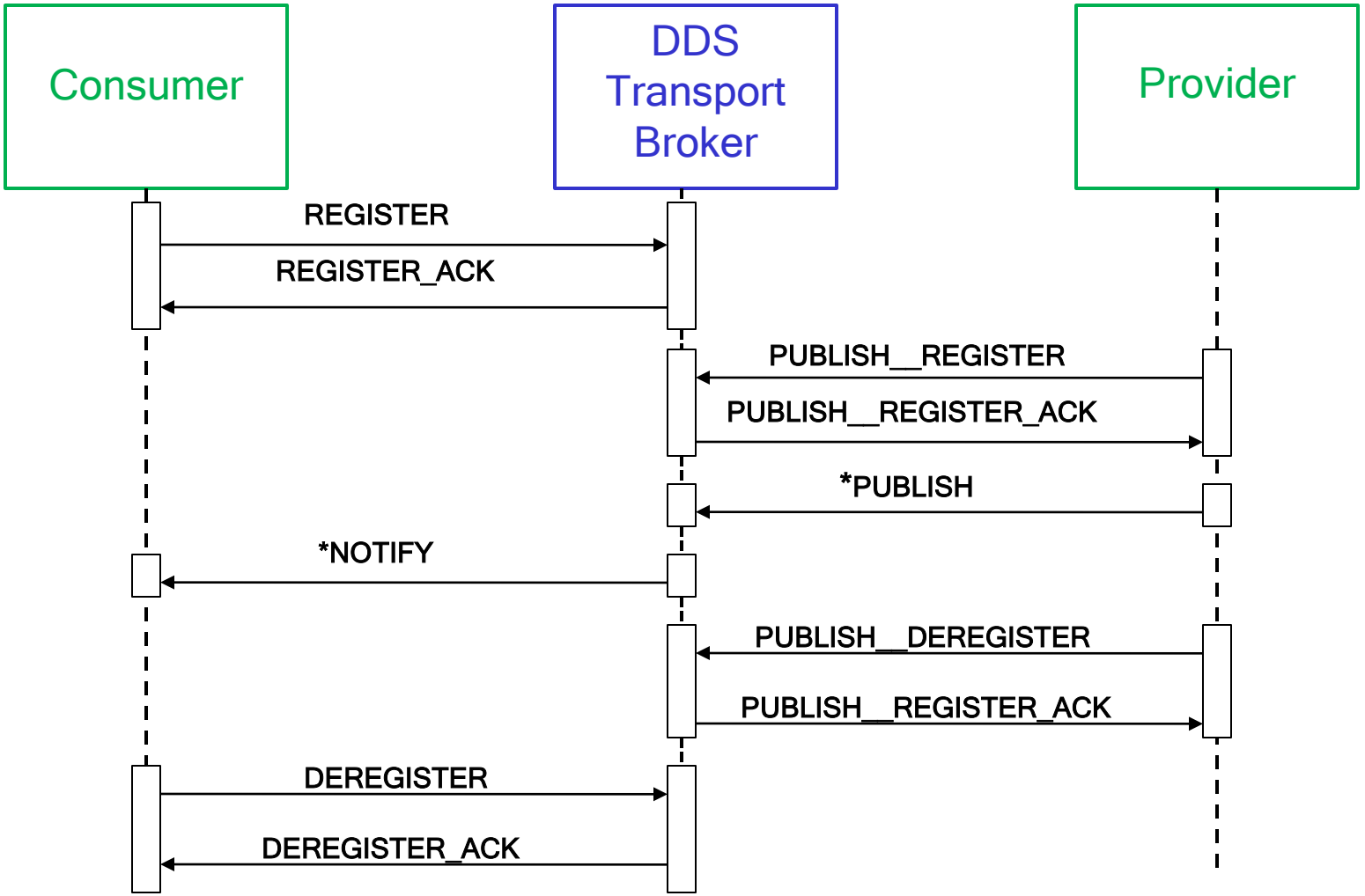
Bridge Request / Reply



Data Distribution Service

- Prototype uses for bulk data transfer
- Plan to perform benchmark comparisons against legacy telemetry distribution system
- Investigate structured data messages

Transport Broker



Conclusion

- Specifications are sufficiently robust to allow NASA missions to collaborate
- Specifications are not yet capable of replacing existing systems
- Encourage NASA space centers to participate in the working group and propose capabilities necessary for mission support

Thank You

- Questions