An Architecture for Web-Services Based Interest Management in Real Time Distributed Simulation

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Presentation Overview

- Background: XMSF and Web Services
- Web Service Issues
- Interest Management Project
- WSIM Architecture
  - Area of Interest Management
  - Aggregation Interest Management
  - Role-Based Access Control
- Streaming Delivery Issues
- Conclusions

XMSF Motivation

- Transformational technologies are needed to scale up defense modeling/simulation to meet real-world needs
- Web technologies provide a common framework:
  - Dynamic capabilities, open standards, Web business model provide lift to support government and commercial success
  - Easy use and open extensibility for developers and users, fueling rapid growth of interoperable simulations
  - Bring defense modeling/simulation/tactical support into mainstream of enterprise-wide best-business practices

XMSF Precepts

- **Web-based technologies** can provide an extensible modeling and simulation architecture, to support a new generation of interoperable applications
- Simulation support is needed for operational warfighting capabilities
- XML-based architecture can provide a bridge between emerging rehearsal/reality/replay requirements and open/commercial Web standards
- Particularly promising for C4I-Simulation interoperation
- Web = best tech strategy + best business case

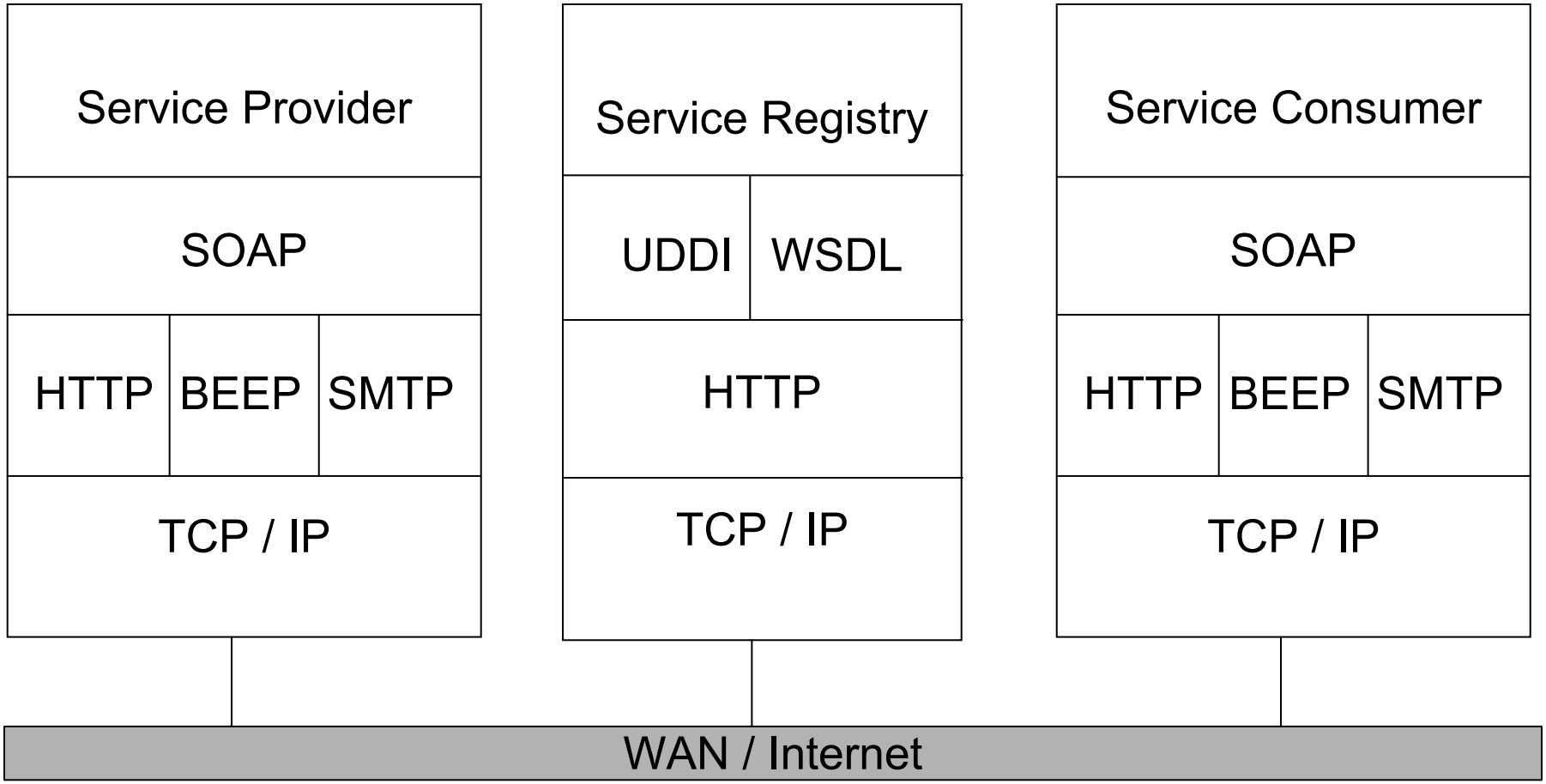
What Does XMSF "Look Like?"

- A set of profiles rather than a single architecture
  - Formal technical specifications for interoperability of Web based technologies in support of modeling and simulation
  - A profile may define a new capability or define interoperability between two or more existing capabilities
- XMSF profiles will include
  - Applicable Web technologies, protocol standards, data and metadata standards
  - A tailoring of the set of selected standards
  - Recommendations and guidelines for implementation

Web Services

Repositories Where approved services reside	**Administrative** Exemplar: DoD XML Registry
Services Discovery Publish, search capabilities	**UDDI, LDAP** Universal Description, Discovery Integration Lightweight Directory Access Protocol
Services Description Detailed methods, parameters	**WSDL, BPEL4WS** Web Services Description Language Business Process Execution Language for Web Services
XML Messaging Simple XML encoding/decoding	**XML-RPC, SOAP, XMLP** Remote Procedure Calls, XML Protocol
Service Transport Move messages between apps	**HTTP, SMTP, FTP, BEEP** Transfer is independent of messages

Web Services Protocol Stack



XC2I Viewer

- US JFCOM experimentation environment
  - Complex and rich
  - Basically a very large LAN-based NVE
  - 100k objects in hybrid HLA/DIS system
- Desirable to extend access over WAN
  - View a subspace
  - Control object behavior

WSIM Motivation
XC2I Potential Information Flow Estimate

- Viewers
  - Each potentially has 10000 objects viewable
  - 100 different simultaneous views maximum
  - Viewers may or may not overlap
  - A viewer that zooms out uses aggregation service such that there are no more updates per second from the service than when zoomed in
- Federates
  - 250 processors
  - 5000 objects per processor
  - Average update period 2.5 seconds
- Worst-case aggregate flow:
  400 K updates/s (~100 bytes each)
  40 MBytes/s = 320 Mb/s => not feasible on WAN
  (sensitive to the viewable objects and max views)

Ways to Reduce Network Impact of Viewer

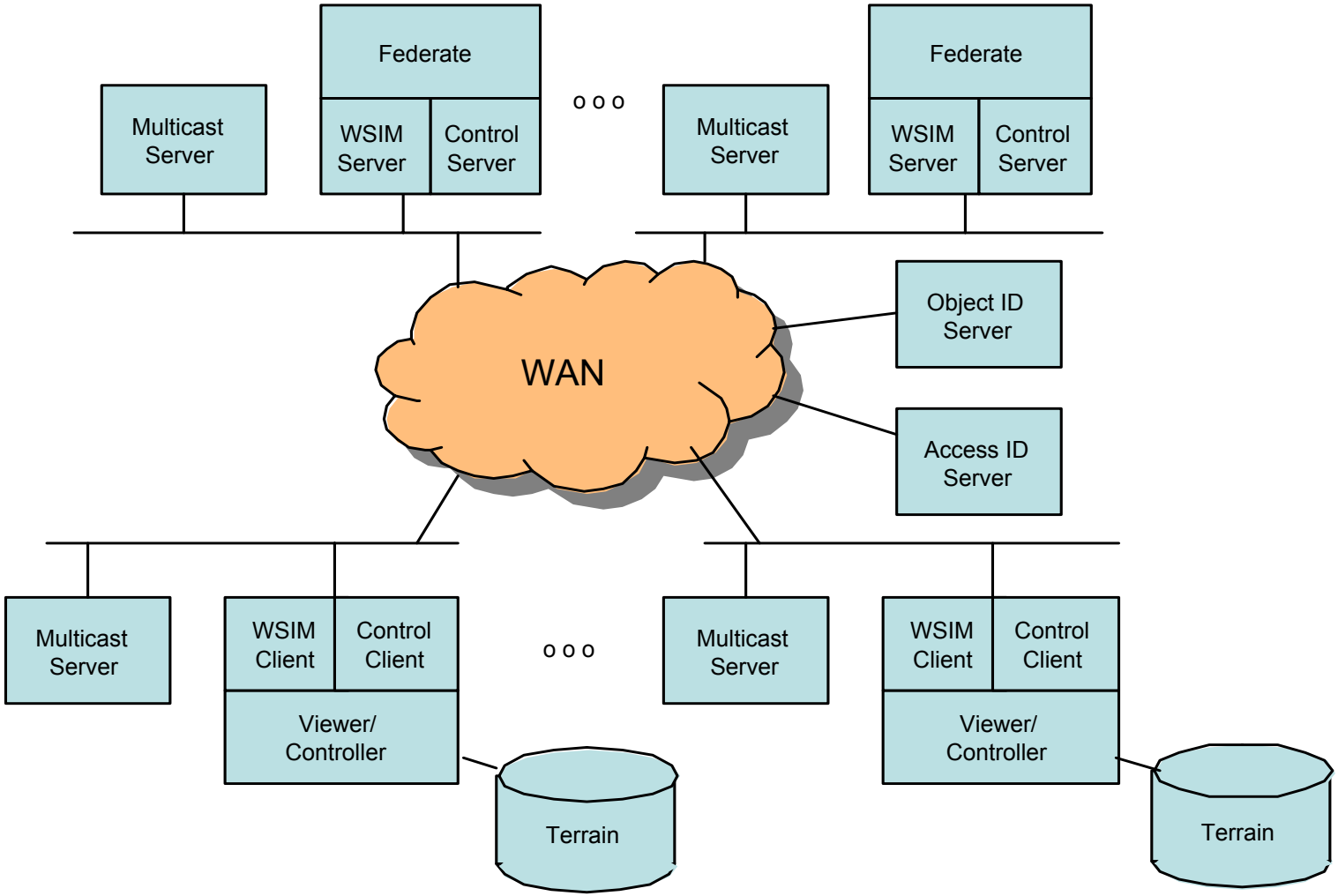
- Limit scope in geographic and other dimensions
- Aggregate objects at server
- Don’t transmit movements too fine to be seen
- Decrease the viewer refresh rate to preclude network overload
  - statically as startup parameter
  - or dynamically as necessary during execution
- Use streaming multicast for high-volume flows

WSIM Overview

The user subscribes to types of entities in a geographic region using a GUI

- Make the process as easy and visual as possible
  - Point & click
  - Drag & drop
- Insulate the user from the details of the Interest Management (IM) protocol and underlying, native IM mechanisms
  - Mapping is handled at layers beneath the viewer
- A user can only subscribe to entities in the current viewbox
  - If an entity of interest moves out of the viewbox (“out of scope”), its updates won’t be delivered again until it’s back in scope, but the subscription will remain in effect
  - This is enforced by the viewer, not by the IM protocol

Top-Level Architecture With WSIM



WSIM Functions
Area of Interest Management

The IM protocol is focused on C2 viewers

- Not as general as HLA DDM because it explicitly includes geographic location and entity type
- But broader than JFCOM JUO
  - Tailoring is handled in one of the mapping layers
- The same protocol can be used with other federations by changing only the bottom mapping layer

WS Interest Management Layers

Generic	JFCOM J9 JUO
User's IM language/interface	GUI: user selects lat/lon/alt, entity (or aggregation) type
Mapping between user's IM & IM protocol	Mapping between GUI inputs & IM protocol
IM protocol	XML Interest Expressions (some tags derived from C2IEDM)
Mapping between IM protocol and native IM	Mapping between IM protocol, and JSAF POB & RTI regions
Native IM	JSAF POB & RTI regions

Not necessarily a one-to-one mapping to physical architecture components

WSIM Functions
Aggregation Interest Management

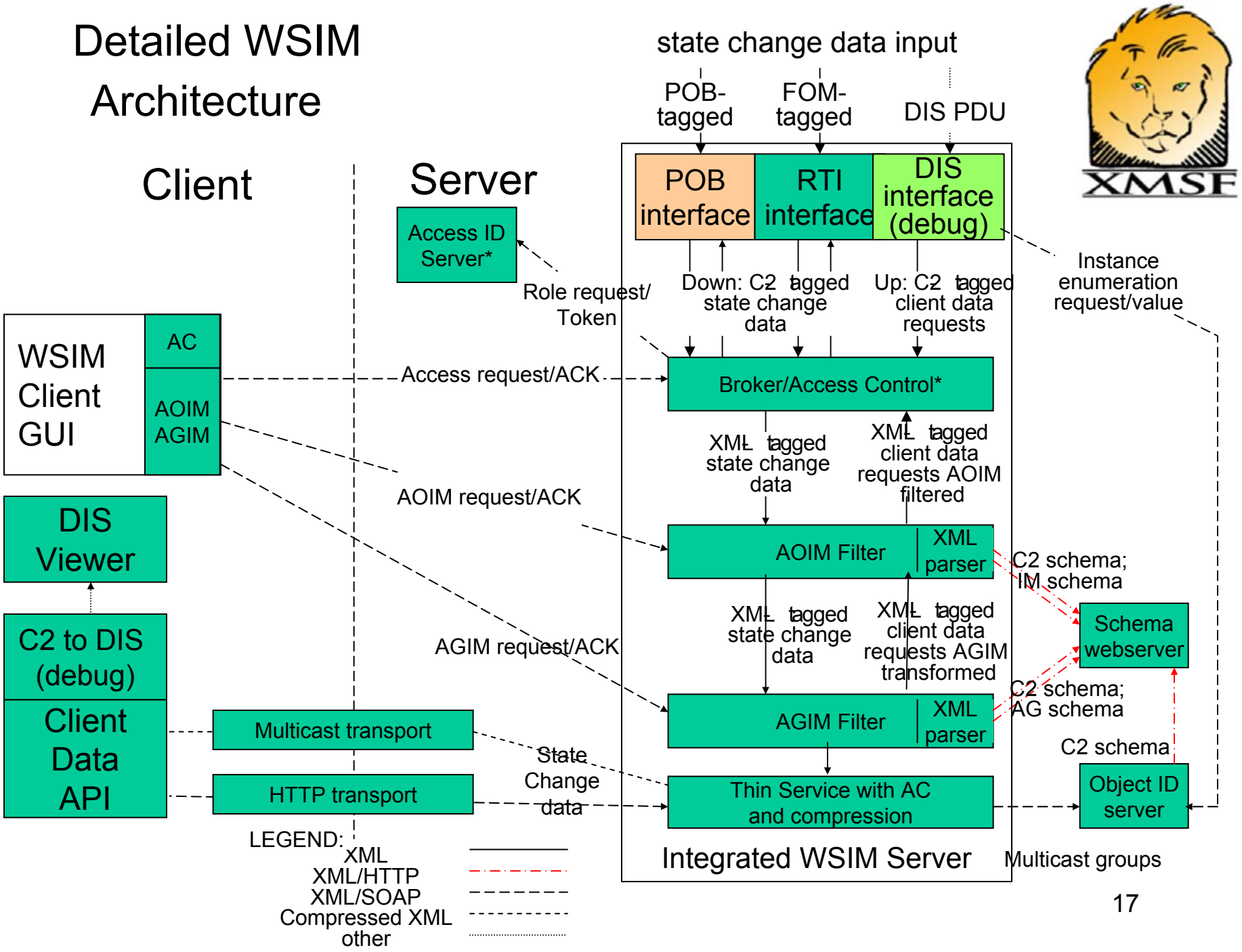
Aggregation:

- "the ability to group entities while preserving the effects of entity behavior and interaction"
- type driven: based on the organization types of the simulated platform and entities established in the military order of battle
- instance driven: based on specific user requirements, *e.g.* "show these three objects as one icon"
- Instance driven overrides type driven
- Applicable to generic military command & control

WSIM Functions
Role-Based Access Control

- Participants have defined access rights
- Don’t send viewer data that will not be displayed
- Combined with latest Web security
  - Globally unique signed certificate
  - Distributed identity management, *e.g.* LDAP
  - GUI for role selection (within user’s prescribed rights)

Detailed WSIM Architecture



Web Service Overhead (~3000%)

Pure Web service

Connect	- 136 Bytes
HTTP Request Seg 1	- 1500 Bytes
Client Ack 1	- 40 Bytes
HTTP Request Seg 2	- 120 Bytes
Client Ack 2	- 40 Bytes
HTTP Response Seg 1	- 833 Bytes
HTTP Response Seg 2	- 40 Bytes
Client Ack for seg 1	- 40 Bytes
Client Ack for seg 2	- 40 Bytes
Response 1	- 40 Bytes
Ack 1	- 48 Bytes
Response 2	- 48 Bytes
Ack 2	- 40 Bytes

Total Per Computation : 2829 Bytes

Grand Total = 136 +350 * 2829

= 990286 Bytes

Web service plus multicast

Connect	- 136 Bytes
HTTP Request Seg 1	- 1500 Bytes
Client Ack 1	- 40 Bytes
HTTP Request Seg 2	- 175 Bytes
Client Ack 2	- 40 Bytes
HTTP Response Seg 1	- 835 Bytes
HTTP Response Seg 2	- 40 Bytes
Client Ack for seg 1	- 40 Bytes
Client Ack for seg 2	- 40 Bytes
Response	- 40 Bytes

Total for setup: 2886 Bytes

Multicast Packet Size average - 88 Bytes

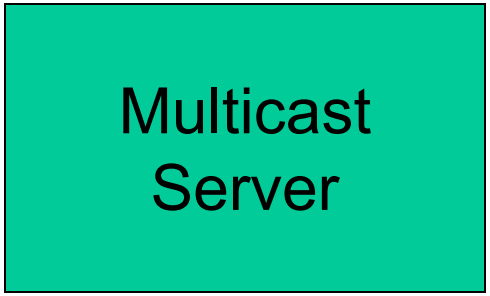
Grand Total = 2886 + 350 * 88

= 33686 Bytes

Web Services for XC2I

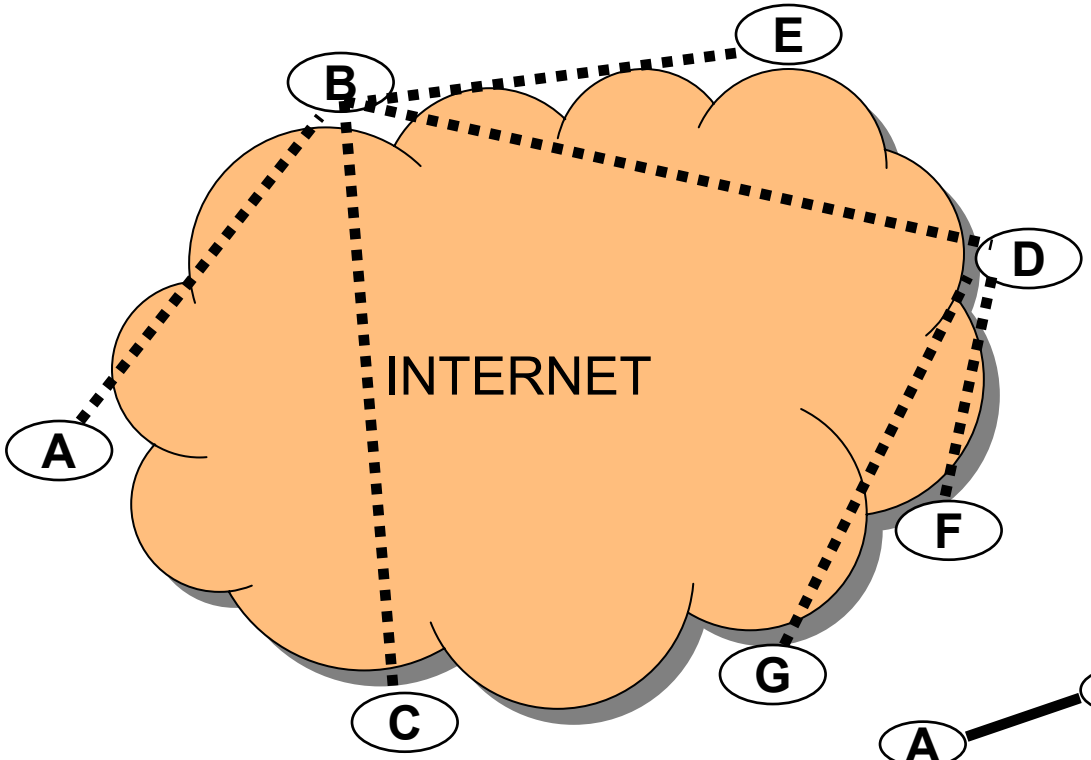
- Pro:
  - Easy to create
  - Easy to interface
  - Easy to compose
  - Use everywhere data volume is low
- Con:
  - Significant overhead
  - Don’t use for massive data flows

Multicast Server (XOM)

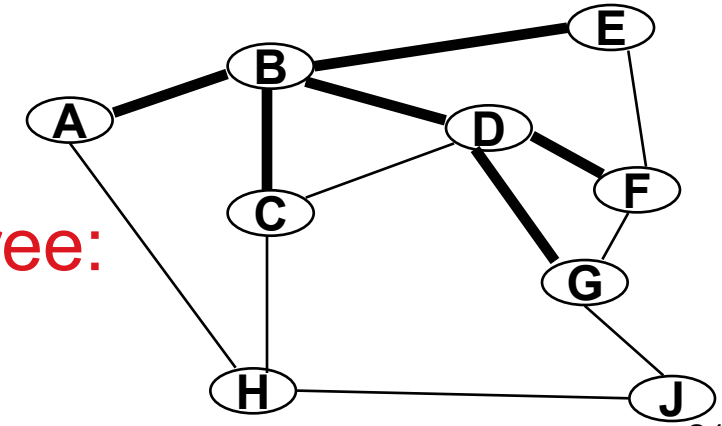


- Provides multicasting service over WAN
  - Couples to IP multicast on LAN
  - Minimizes traffic using optimal transfer tree
- See companion paper

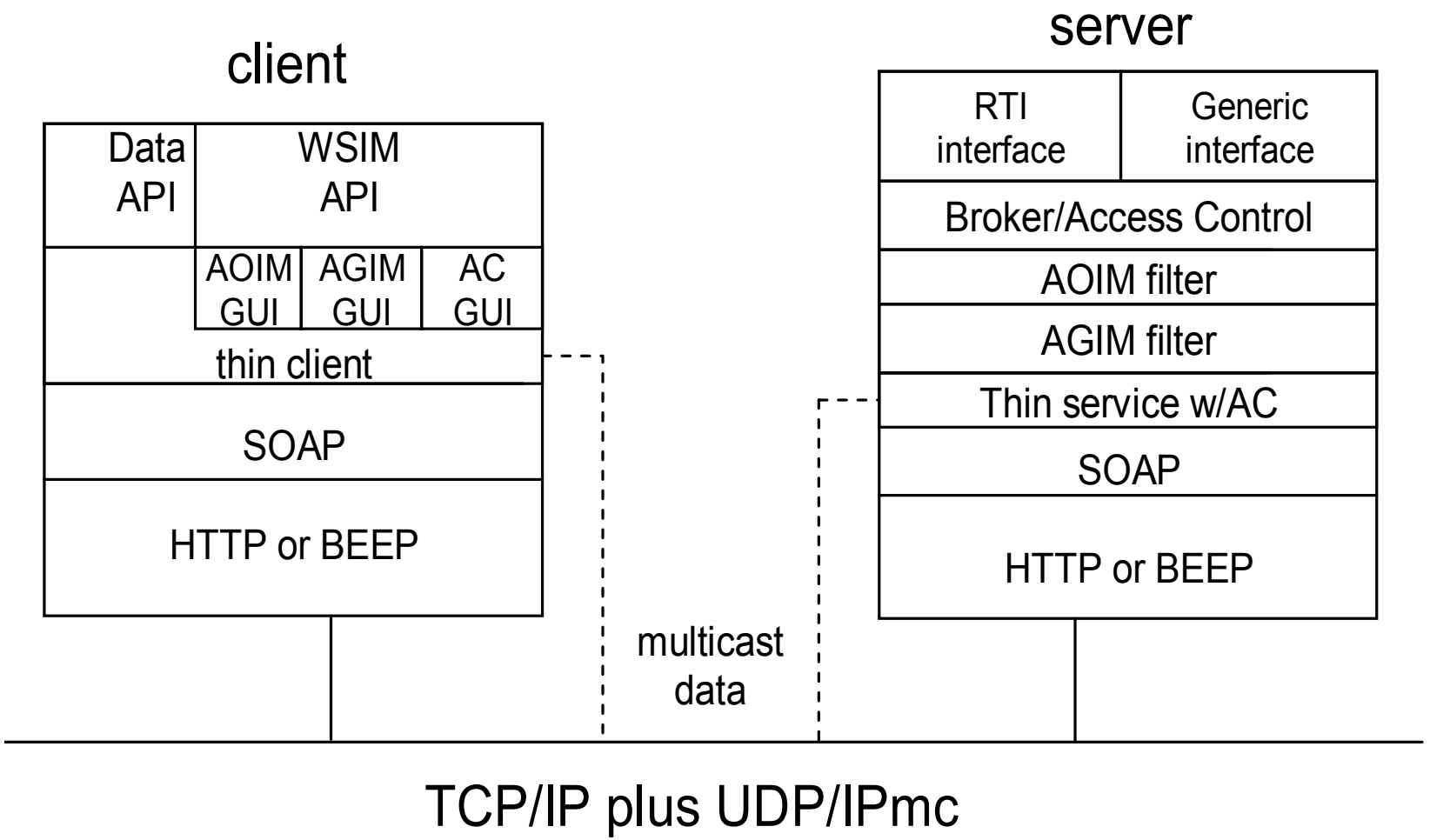
Overlay Multicast Tree



IP Multicast tree:



WSIM with Streaming Multicast



Conclusions

- The XMSF approach is showing great promise as a basis for distributed software interoperation
  - In particular, distributed simulation
- We have developed an architecture for generic Web-service interest management
  - Prototype now running
- However, we have found some limitations in the approach
  - Web services need to be extended for high performance systems
  - We used streaming multicast for the extension