



A Plug-in Transport with Dissimilar ORBs and a Connectionless Network

Nathan Scandella

OMG Embedded Object-Based Workshop

19 January, 2001

Santa Clara, CA

Honeywell

 **Washington**
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of **verizon**

 **BOEING®**



Plug-in Transports for CORBA

- Introduction to DARPA/Air Force Project
- Design Motivators
 - system architecture
 - description of our transport
- CORBA Solution
- How to Plug In a Transport
- Lessons Learned
 - recommendations for RT CORBA

Honeywell

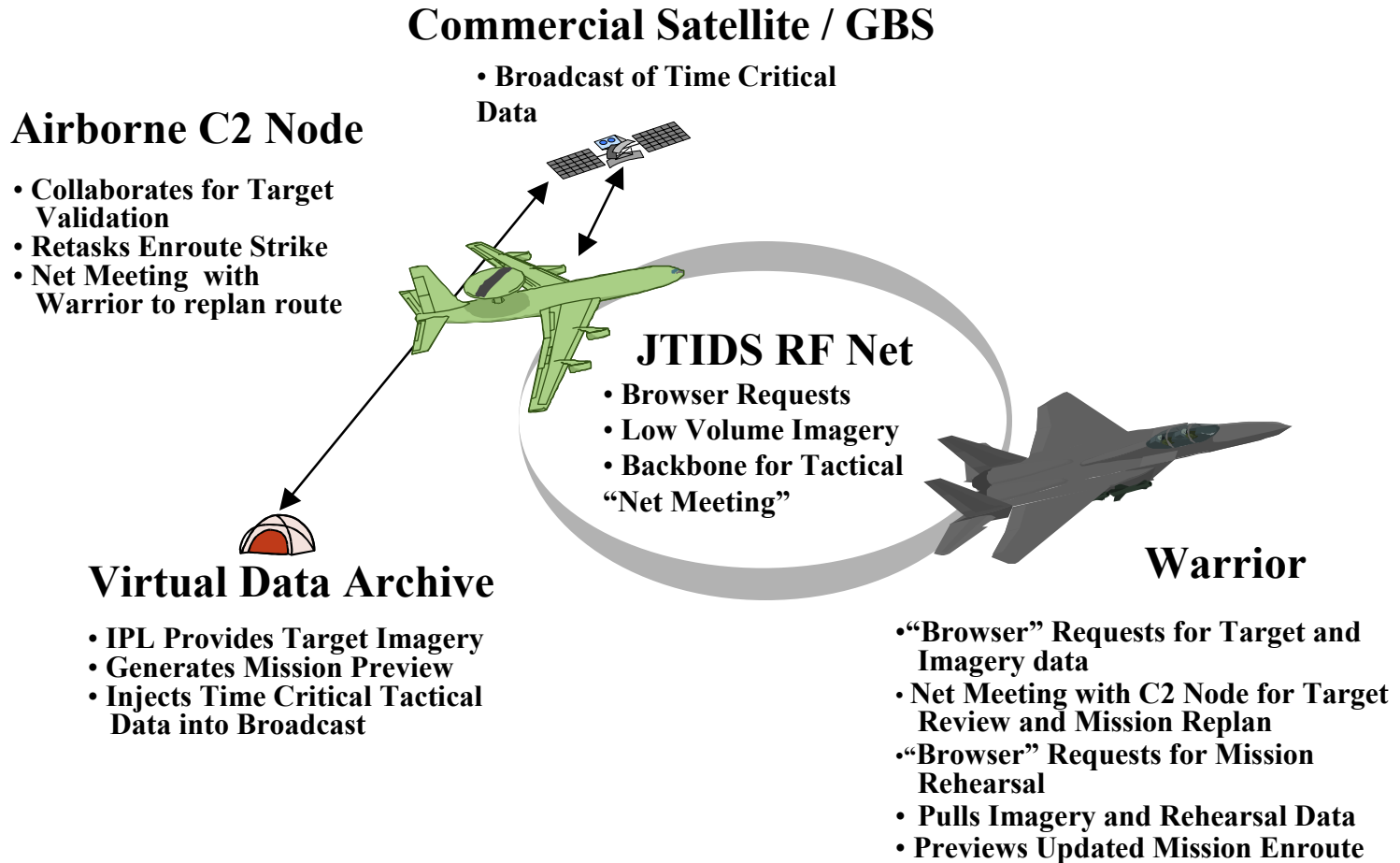
 **Washington**
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of **verizon**

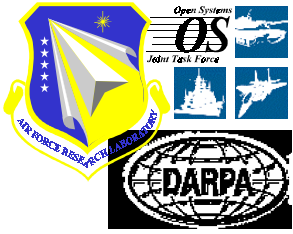
 **BOEING®**



WSOA Project Concept



C2 = Command & Control (e.g. AWACS)



WSOA Introduction

- Case Study - DARPA/Air Force sponsored flight demonstration project
- Weapons System Open Architecture (WSOA)
- Standards-based middleware desired
- Secure tactical datalink available between aircraft

punch line:

- TAO and ORBexpress real-time ORBs chosen
- Datalink transport plugged-in to ORBs

Honeywell

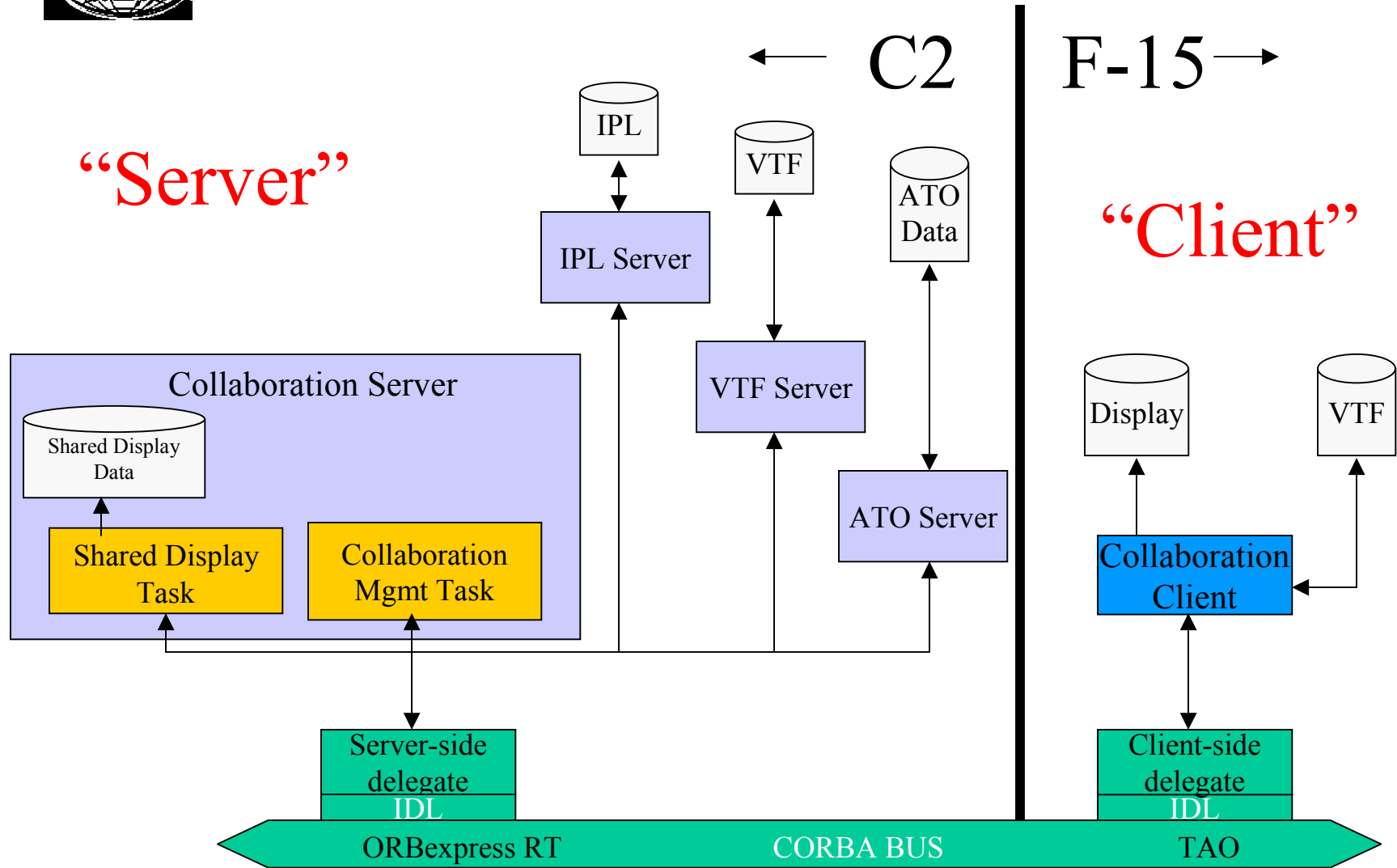
 **Washington**
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of **verizon**

 **BOEING®**



WSOA Software Architecture



Honeywell

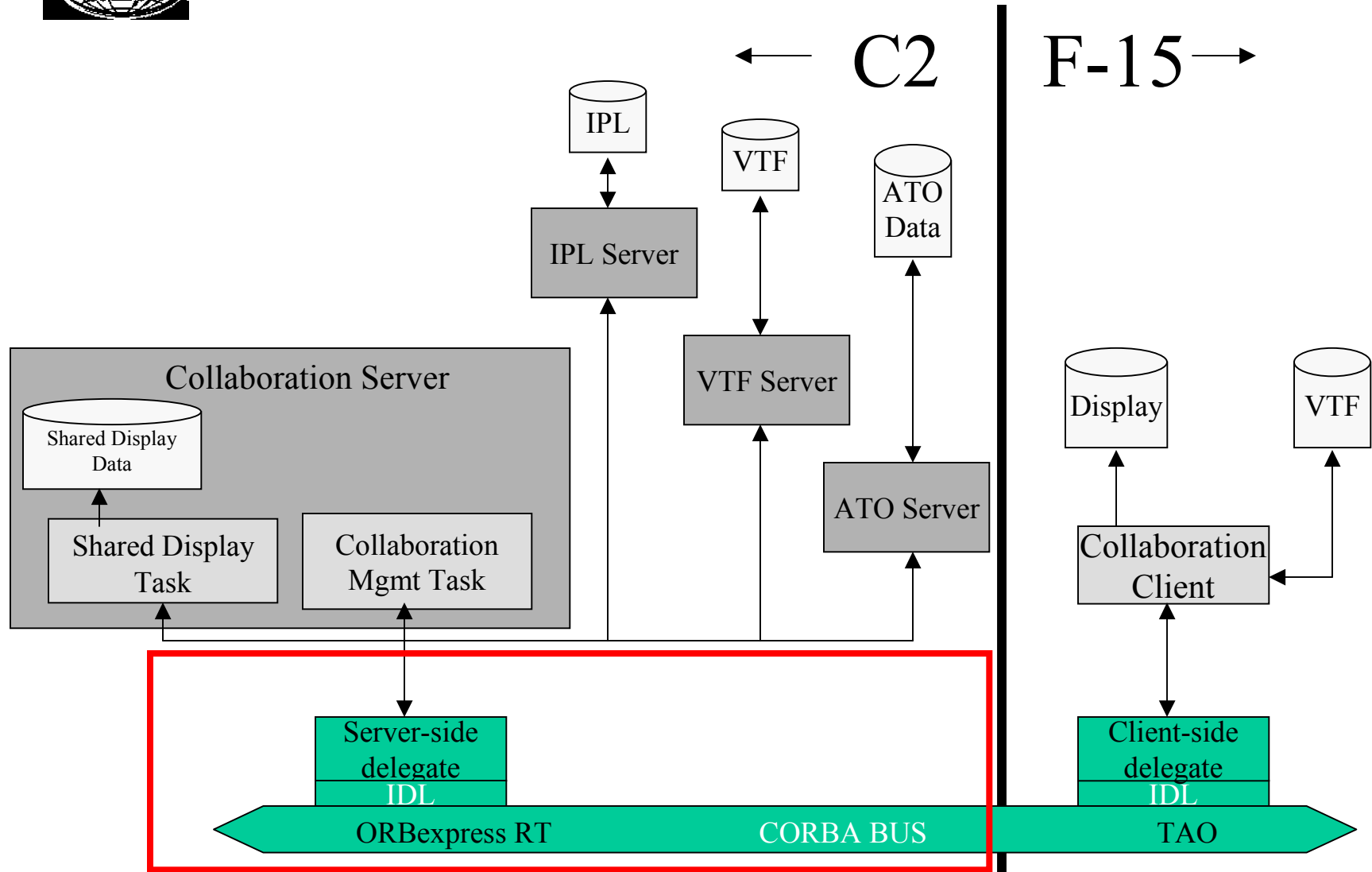
Washington
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of verizon

BOEING



WSOA Software Architecture

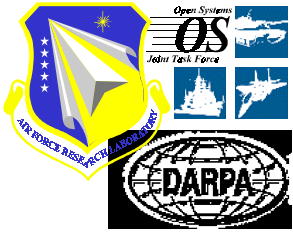


Honeywell

Washington
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of verizon

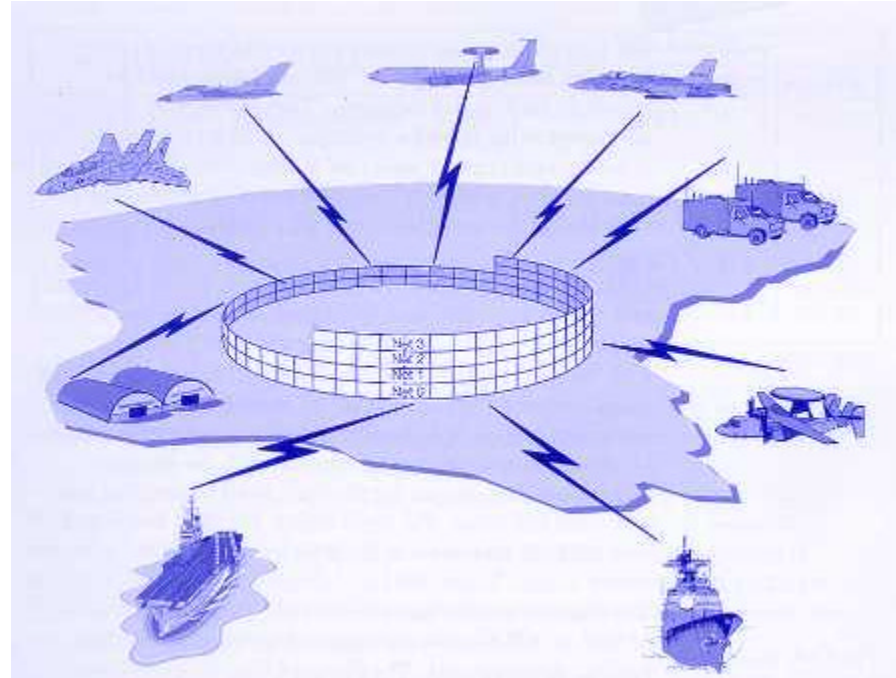
BOEING®



Link 16 Transport

Mil-Std-6016 Tactical Digital Information Link - Joint Tactical Information Distribution System (JTIDS)

- Time Division Multiple Access (TDMA)
- Nodeless
- Message and Transmission Encryption
- Frequency Hopping
- UHF, L_X Band
- Line of Sight





Link 16 Transport

- Secure RF broadcast network
 - no connections!
- Reliable delivery, error detection and correction
- Most messages are content specific, except JTIDS free text message
 - this message used to transmit secure digital voice data
 - compressed imagery not tolerant of transmission errors
- Free text (~byte stream) effective data rate < 16kbps
- “Transport” is really a network application
 - GIOP could be tunneled thru JTIDS messages, though

Honeywell

 **Washington**
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of **verizon**

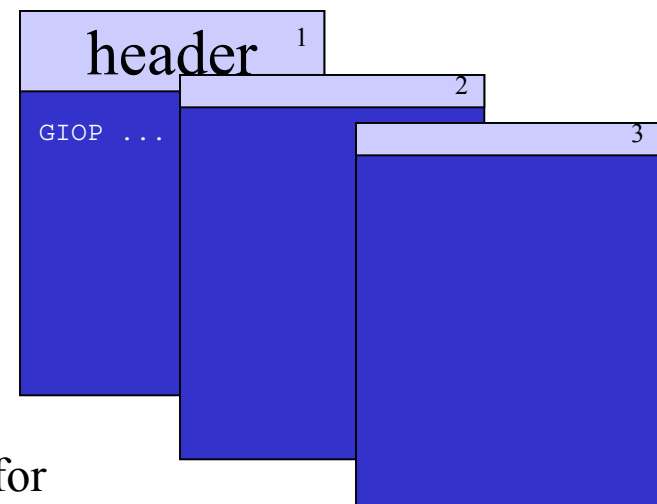
 **BOEING®**

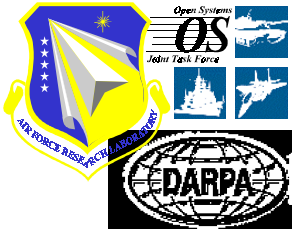


Free Text Message Transport Layer

- message sequence number
- **subaddress**
 - ala TCP “port”
 - currently, no host identifier
- message status
 - start, during, end
- message byte count
- **overhead**
 - approx. 4 bytes per GIOP message + 2 bytes for each 54 bytes of GIOP message length
- compatible with other free text data applications

`"link16://00041:12"`



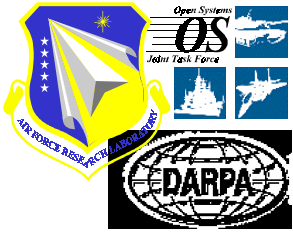


Aside: Why Else to Replace TCP/IP?

TCP/IP Feature	Protocol or Mechanism	Drawbacks and Limitations
Connection-Oriented		Unsuitable, or at least inefficient, for use in multi-point communication.
Reliable, Ordered	Acknowledgements	Unsuitable or inefficient for simplex, half duplex, or multipoint communication media. Inefficient for high-latency communication connections.
	Retransmission after time-out	Ignores limited time value of some data, e.g. audio, video, track updates
	Source quenching flow control	Unbounded blocking of source may result in unbounded priority inversions
Stream-Oriented		Limits preemption to account for priority

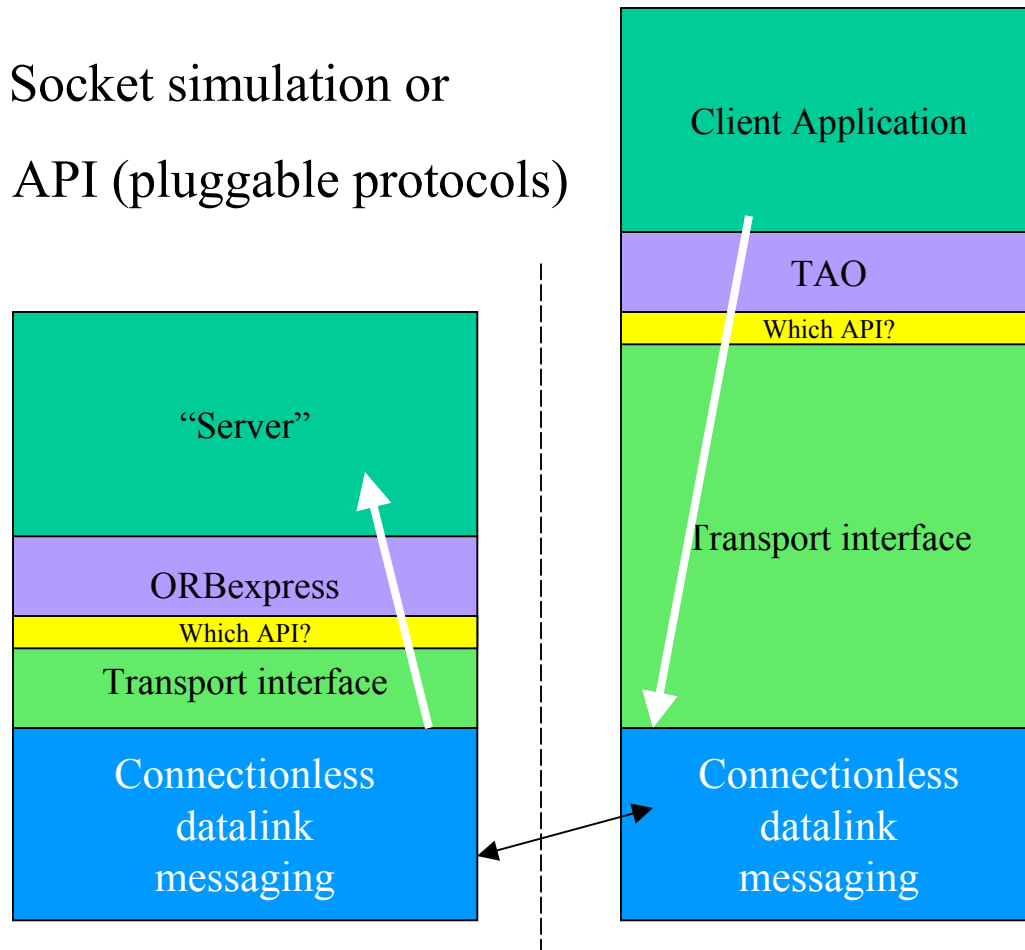
From OIS, CORBA Programming with ORBexpress in Ada 95





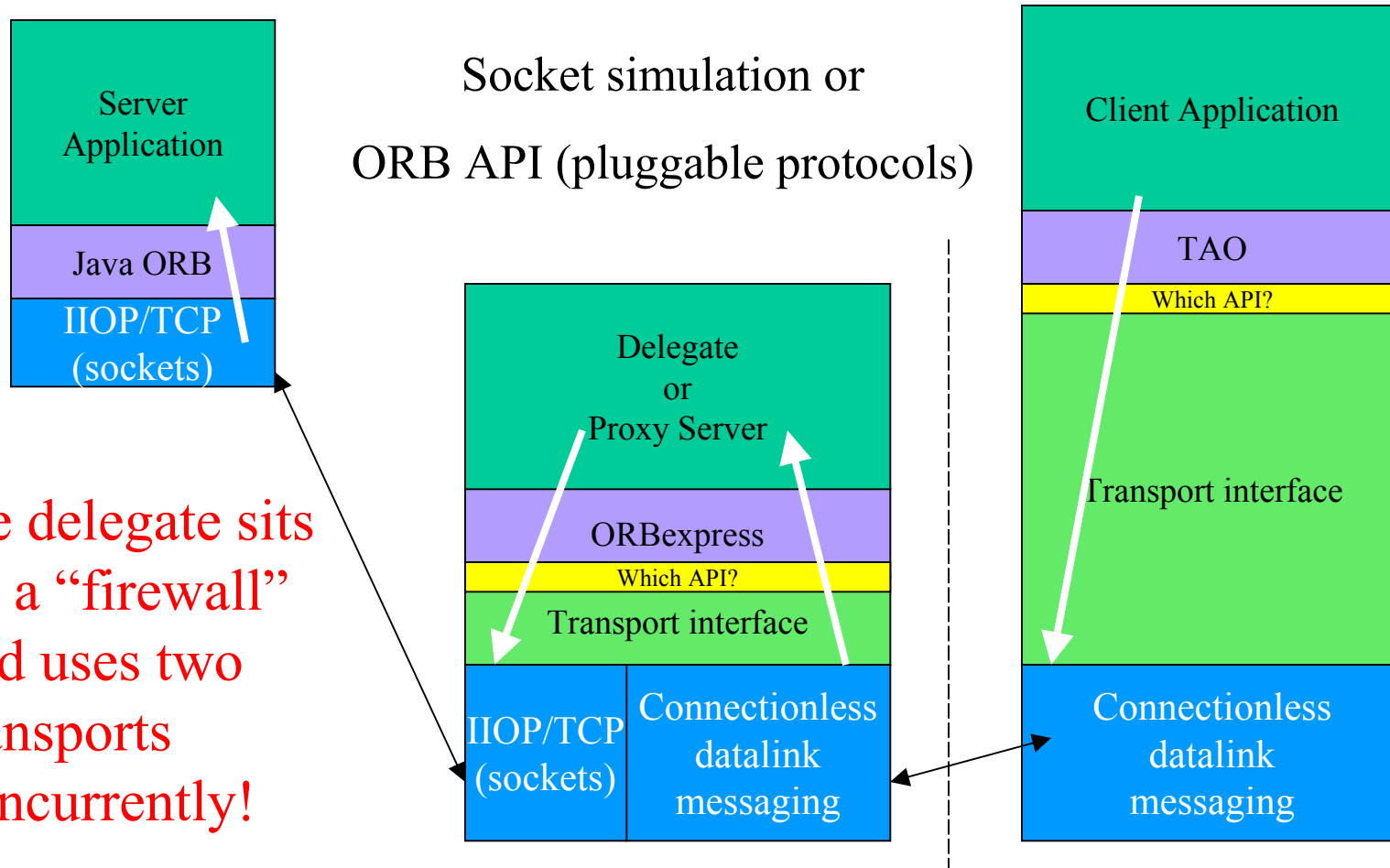
CORBA Implementation - Inline Bridge

Socket simulation or
ORB API (pluggable protocols)

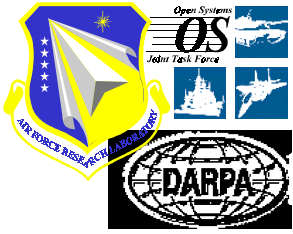




CORBA Implementation - Inline Bridge

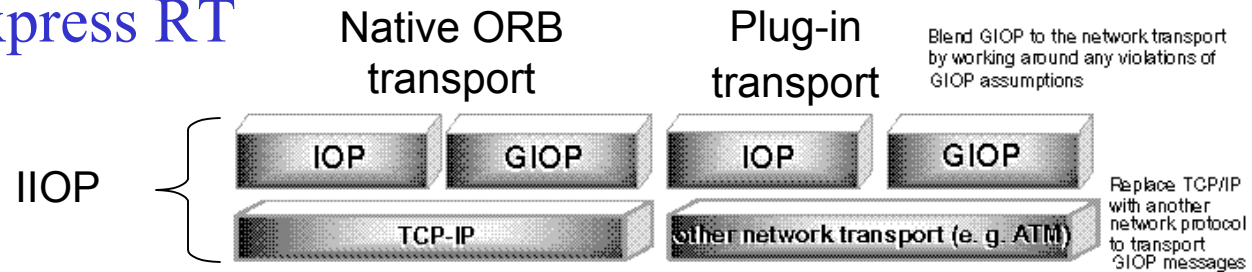


the delegate sits on a “firewall” and uses two transports concurrently!



CORBA Implementation - Transport

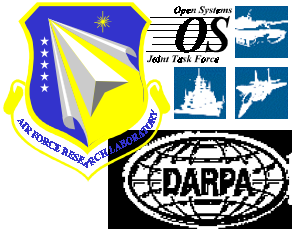
- Pluggable transport protocol between TAO and ORBexpress RT



Resulting implementation specializes several ORBexpress APIs and plugs into the ORB network

- Each ORB has unique transport interface
- Future CORBA specification should standardize this

From OIS, CORBA Programming with ORBexpress in Ada 95



CORBA Implementation - Inline Bridge

Which Network API?

- **ORB Pluggable Protocol**

- CORBA recommended method for inline bridging
- in CORBA spec in the future?
- uses GIOP
- clean integration into ORB
- multiple transports OK

- simple high level API for ORBexpressRT

- experience with this method

- **Socket API**

- standard network interface for other network apps

- uses IIOP (GIOP over ~TCP)
- requires namespace resolution for using real IPC sockets AND socket emulation

- may have complex system calls to emulate true POSIX sockets

- experience with this method

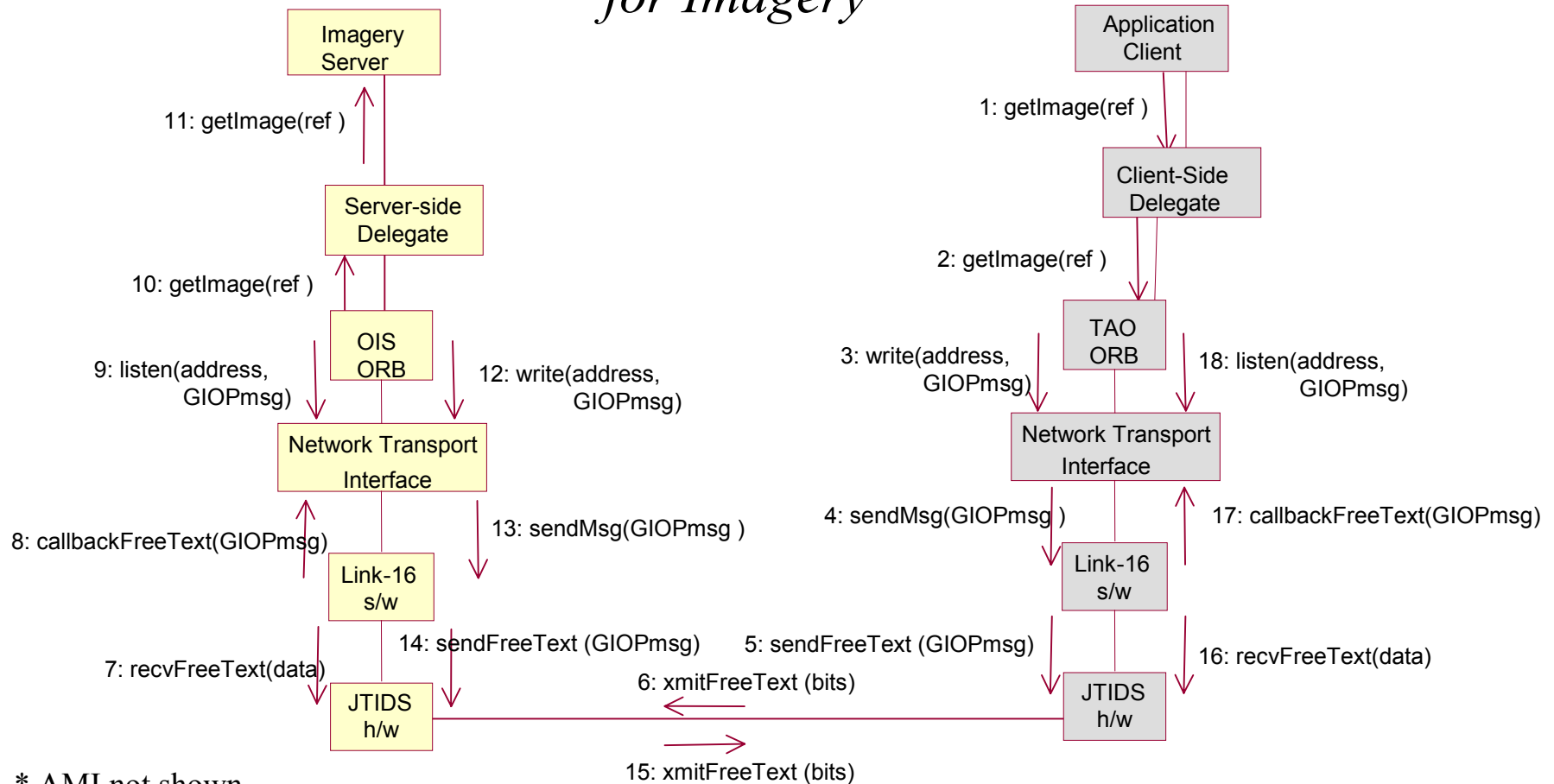


CORBA Implementation

C2

Client-Server Request for Imagery

F-15E



* AMI not shown

Honeywell

Washington
WASHINGTON UNIVERSITY IN ST. LOUIS

BBN Technologies
a part of **verizon**

BOEING



GIOP Transport Requirements

Requirement

Comments

- Connection-oriented

- Wrap Link-16 addressing info into transport messages.

- Reliable

- Transport includes orderly delivery.

- Stream-based

- Implemented by free text transport layer.

- Notification of connection-loss

- Asynchronous messaging used to avoid timeouts.

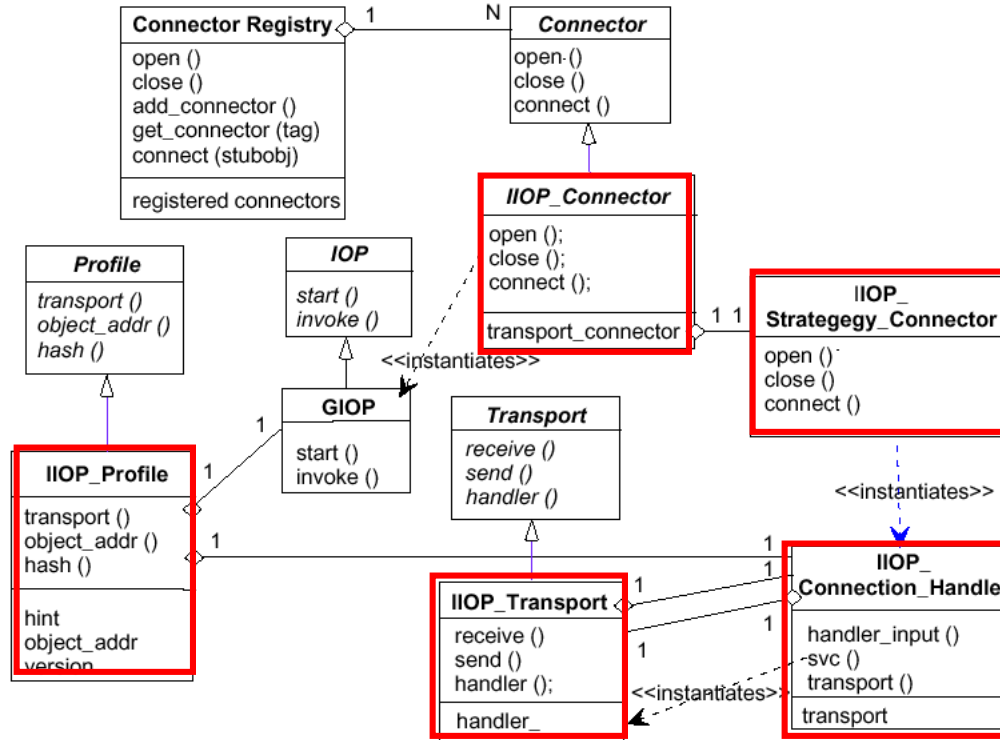
- Connection-initiation model

- Dummy connect() call implemented. IOR strings used.

From OIS, CORBA Programming with ORBexpress in Ada 95



Plug-in Transport Framework



TAO Client Class Diagram

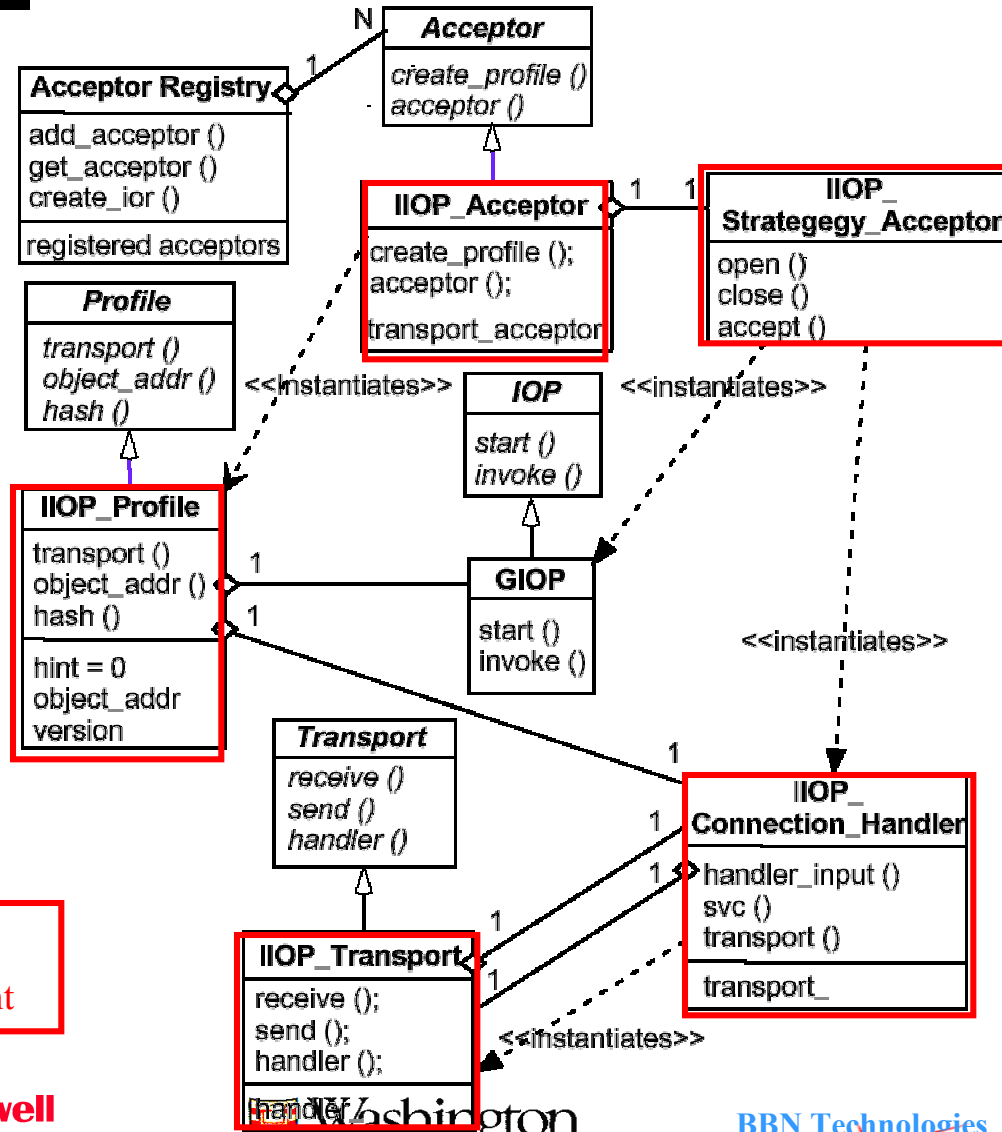
classes to implement

from Kuhns et al., *The Design and Performance of a Pluggable Protocols Framework for Real-time Distributed Object Computing Middleware*





Plug-in Transport Framework



TAO Server Class Diagram

classes to implement

Honeywell

Washington University in St. Louis

BBN Technologies
a part of verizon

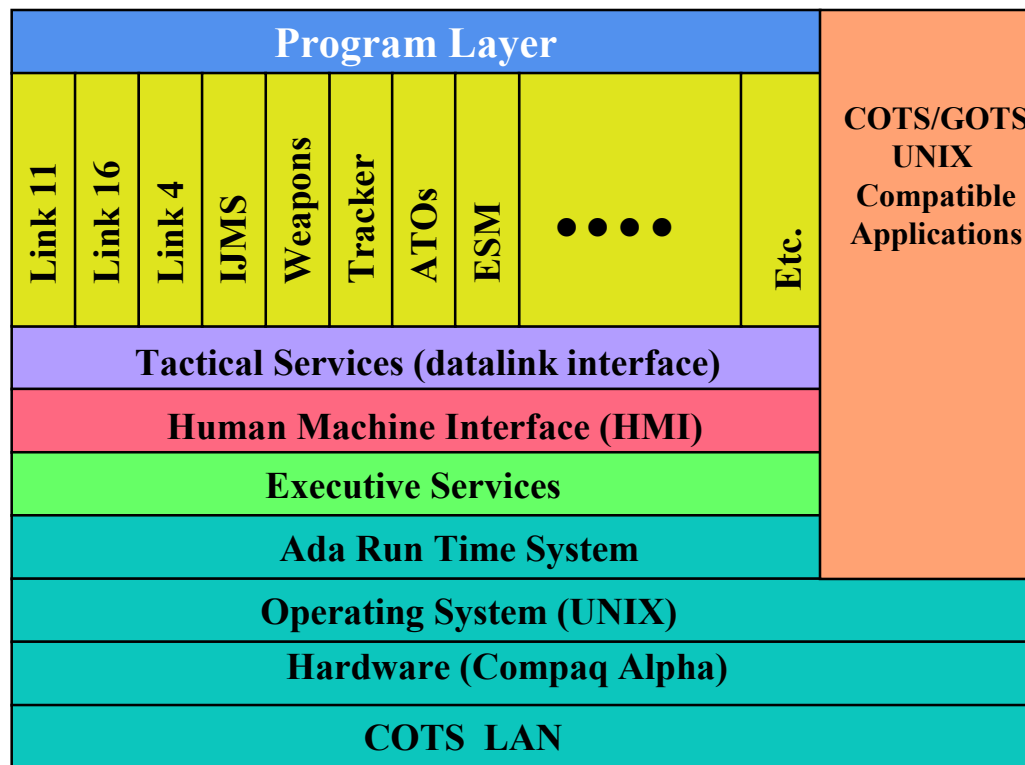
from Kuhns et al., *The Design and Performance of a Pluggable Protocols Framework for Real-time Distributed Object Computing Middleware*





WSOA Server Side Architecture

Existing Command and Control Architecture



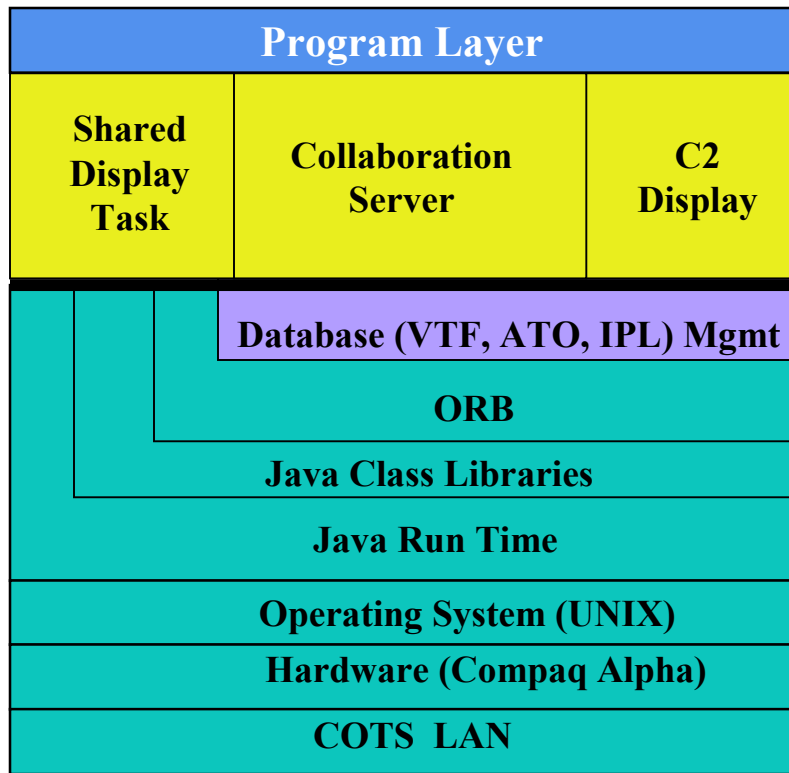
Mission Computer Program



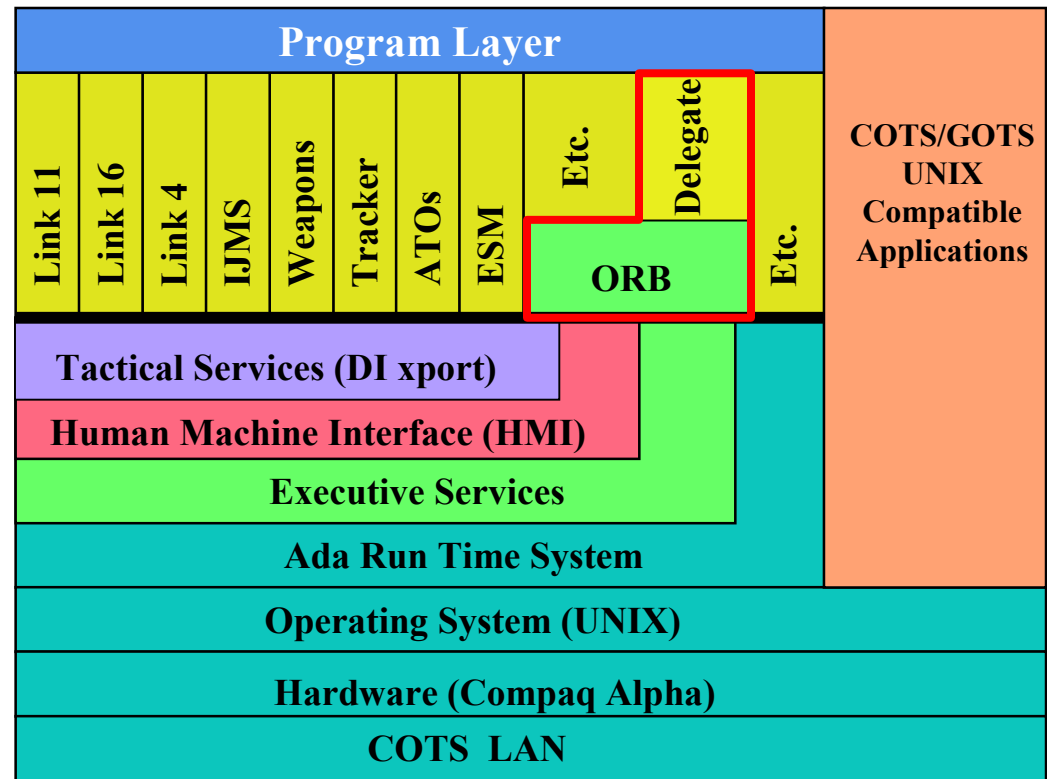


WSOA Server Delegate Architecture

Detailed WSOA CORBA Architecture

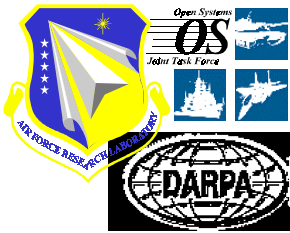


WSOA Server Application

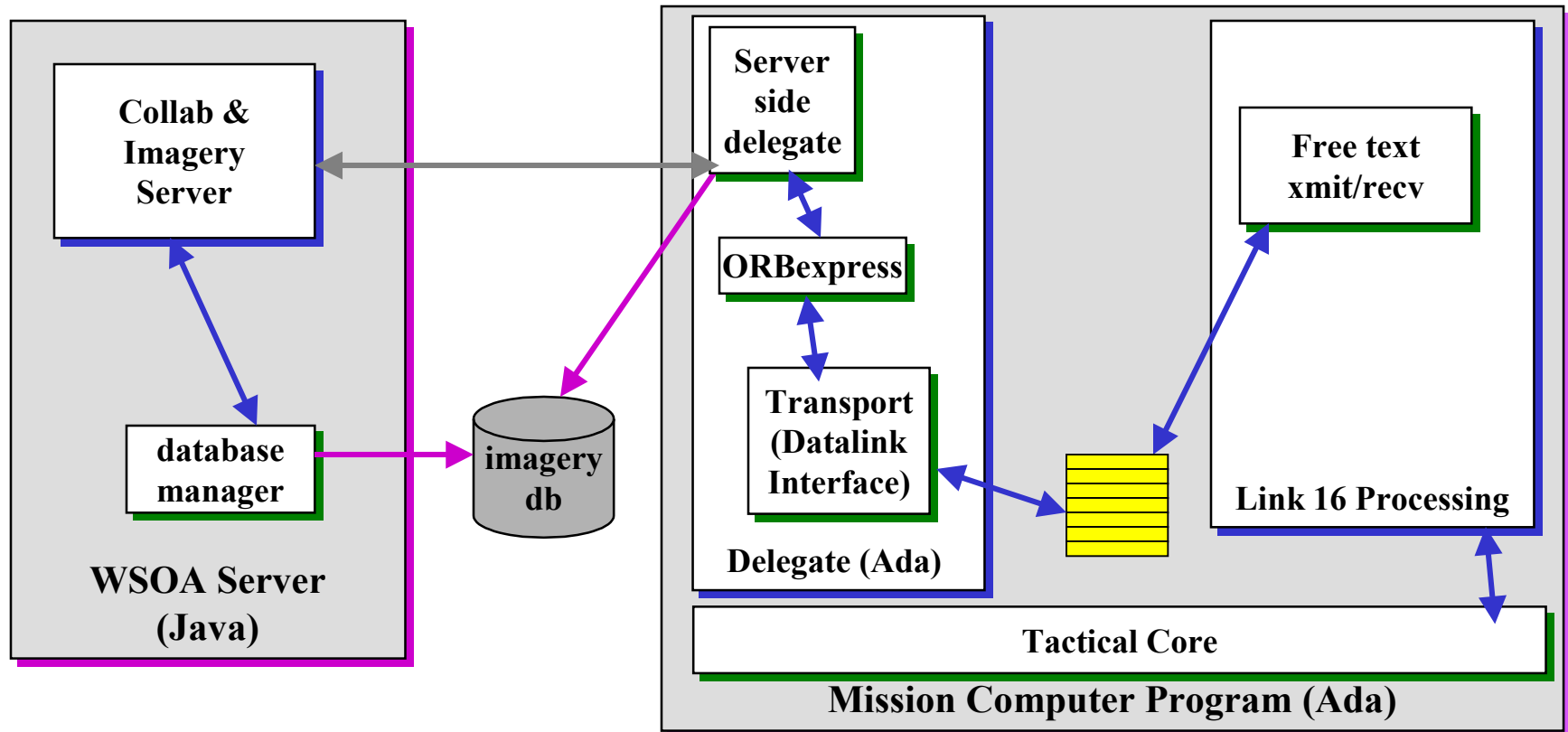


Mission Computer Program





Concurrency Model - C2 (Server)

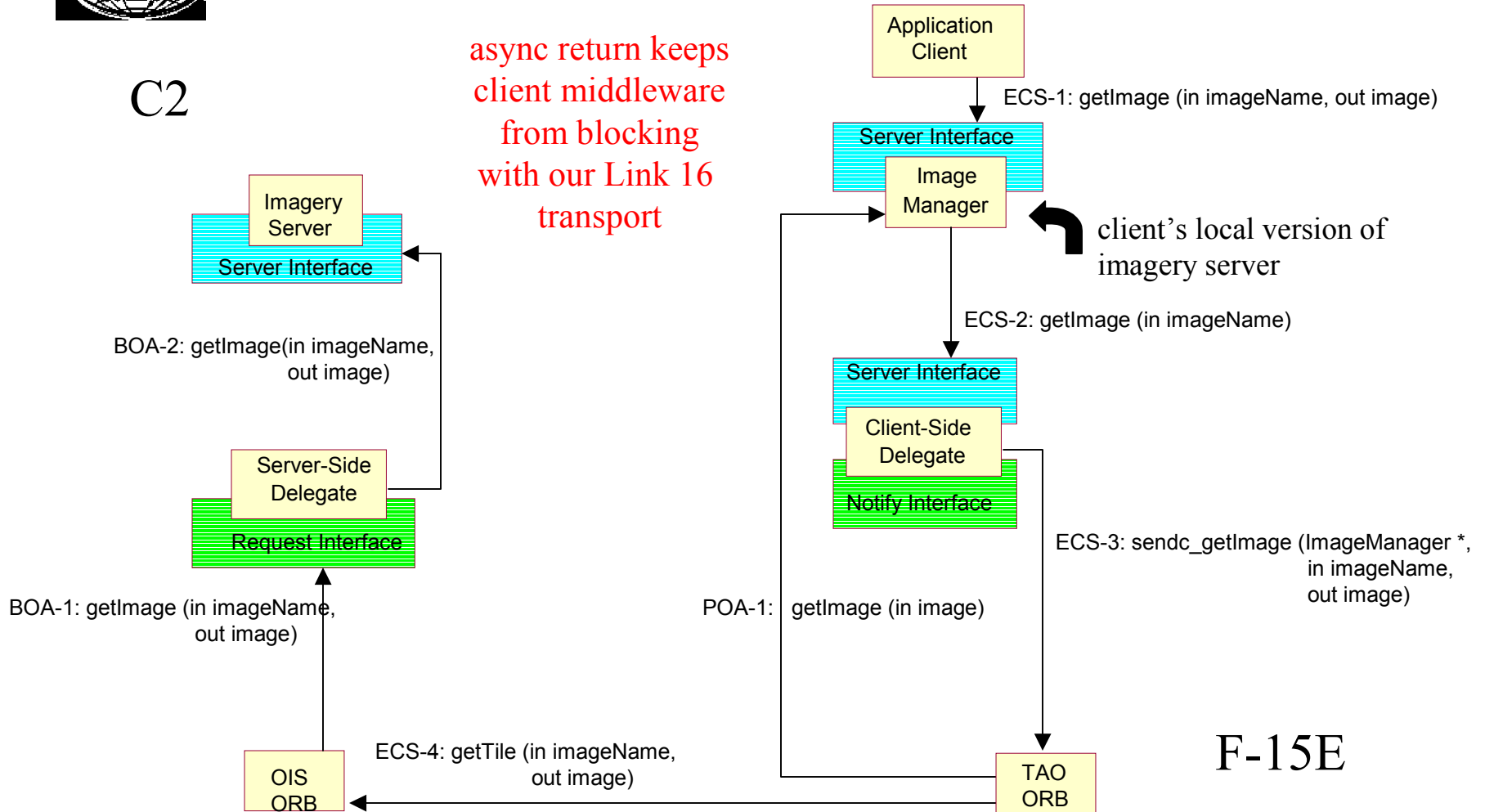




Concurrency Model - Client/Server

C2

async return keeps client middleware from blocking with our Link 16 transport



F-15E

Asynchronous Callback AMI Programming Model





Integration Issues and Lessons Learned

- Full performance data and results available late 2001
 - two way interoperability verified
- Separate transport mapping for each ORB
 - my OE mapping layer:
 - ~ 500 SLOC so far
- IOP Profiles not standard
 - TAO flexible enough to match
 - recommend standardizing on OE's UIOP profile

standard
profile for
IOP



```
module IOP{ // IDL
  struct Version{
    char    major;
    char    minor;
  };
  struct ProfileBody{
    Version  iiop_version;
    string   host;
    unsigned short  port;
    sequence object_key;
  };
};
```



Integration Issues and Lessons Learned

- Simple IDL interfaces work well
 - don't push on all sides of the envelope at once!
- A RT CORBA standard for plug-in transports would be extremely valuable
- Pluggable Protocol Services, too?
 - we built our own COS Name Service wrapper

```
module WSOA
{
  typedef string token;
  typedef sequence <octet> rawImageData;

  exception INVALID_TOKEN
  {
    string explanation;
  };

  interface ClientImage
  {
    rawImageData getImage (in token imageID)
      raises (INVALID_TOKEN);
  };
};
```