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

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OMG Embedded Object-Based Workshop

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Santa Clara, CA

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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

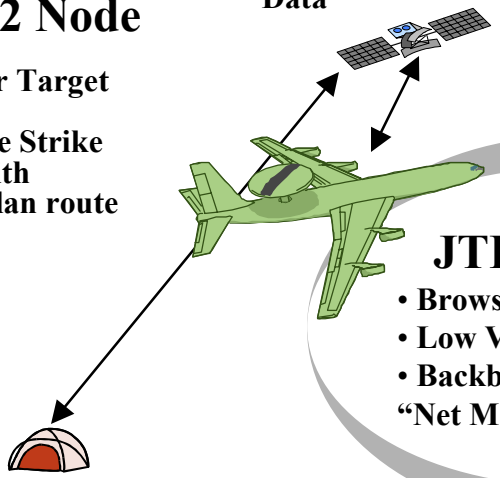
WSOA Project Concept

Commercial Satellite / GBS

- Broadcast of Time Critical Data

Airborne C2 Node

- Collaborates for Target Validation
- Retasks Enroute Strike
- Net Meeting with Warrior to replan route



JTIDS RF Net

- Browser Requests
- Low Volume Imagery
- Backbone for Tactical "Net Meeting"

Virtual Data Archive

- IPL Provides Target Imagery
- Generates Mission Preview
- Injects Time Critical Tactical Data into Broadcast

Warrior

- "Browser" Requests for Target and Imagery data
- Net Meeting with C2 Node for Target Review and Mission Replan
- "Browser" Requests for Mission Rehearsal
- Pulls Imagery and Rehearsal Data
- Previews Updated Mission Enroute

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

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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

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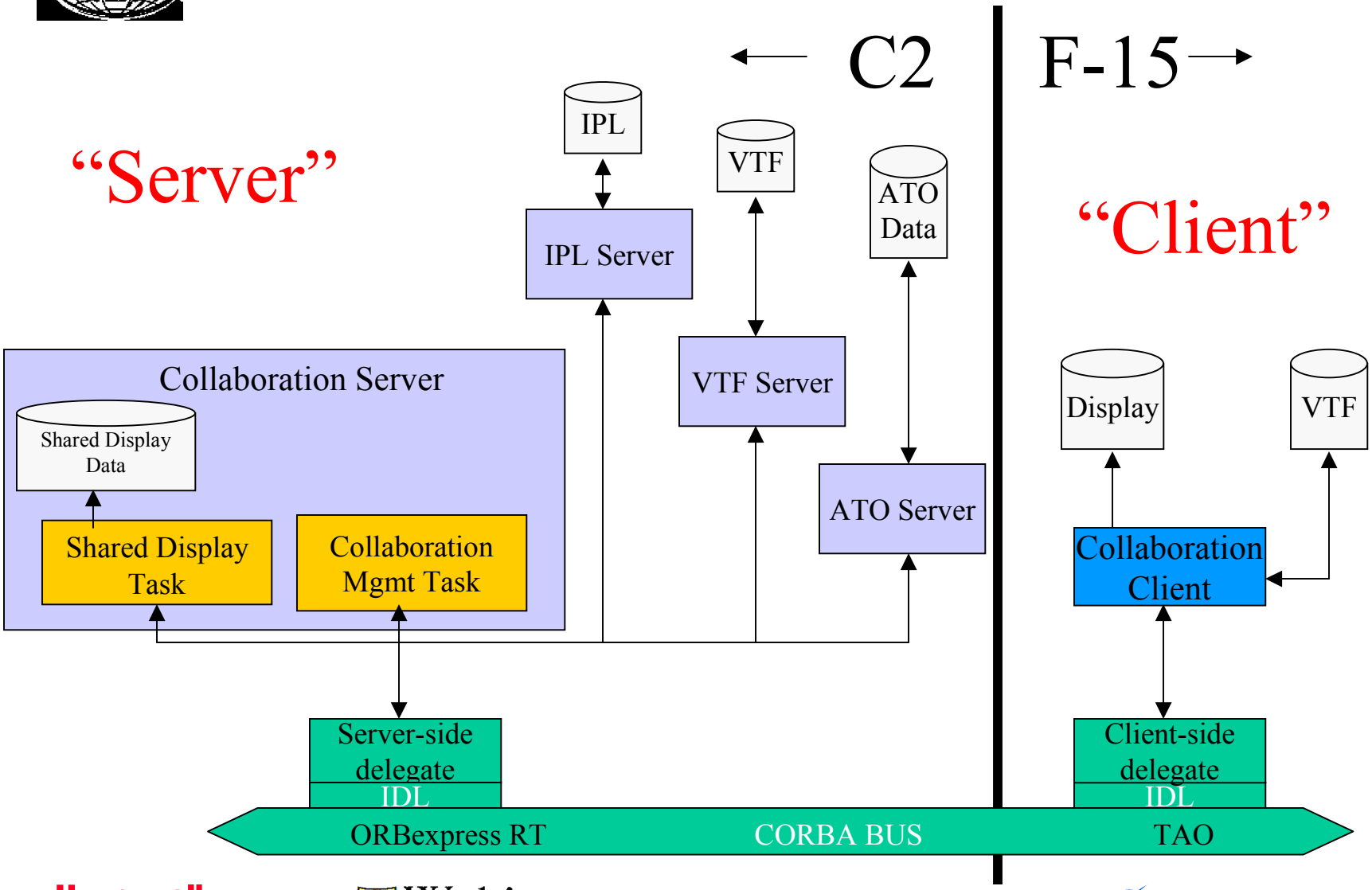
WSOA Software Architecture



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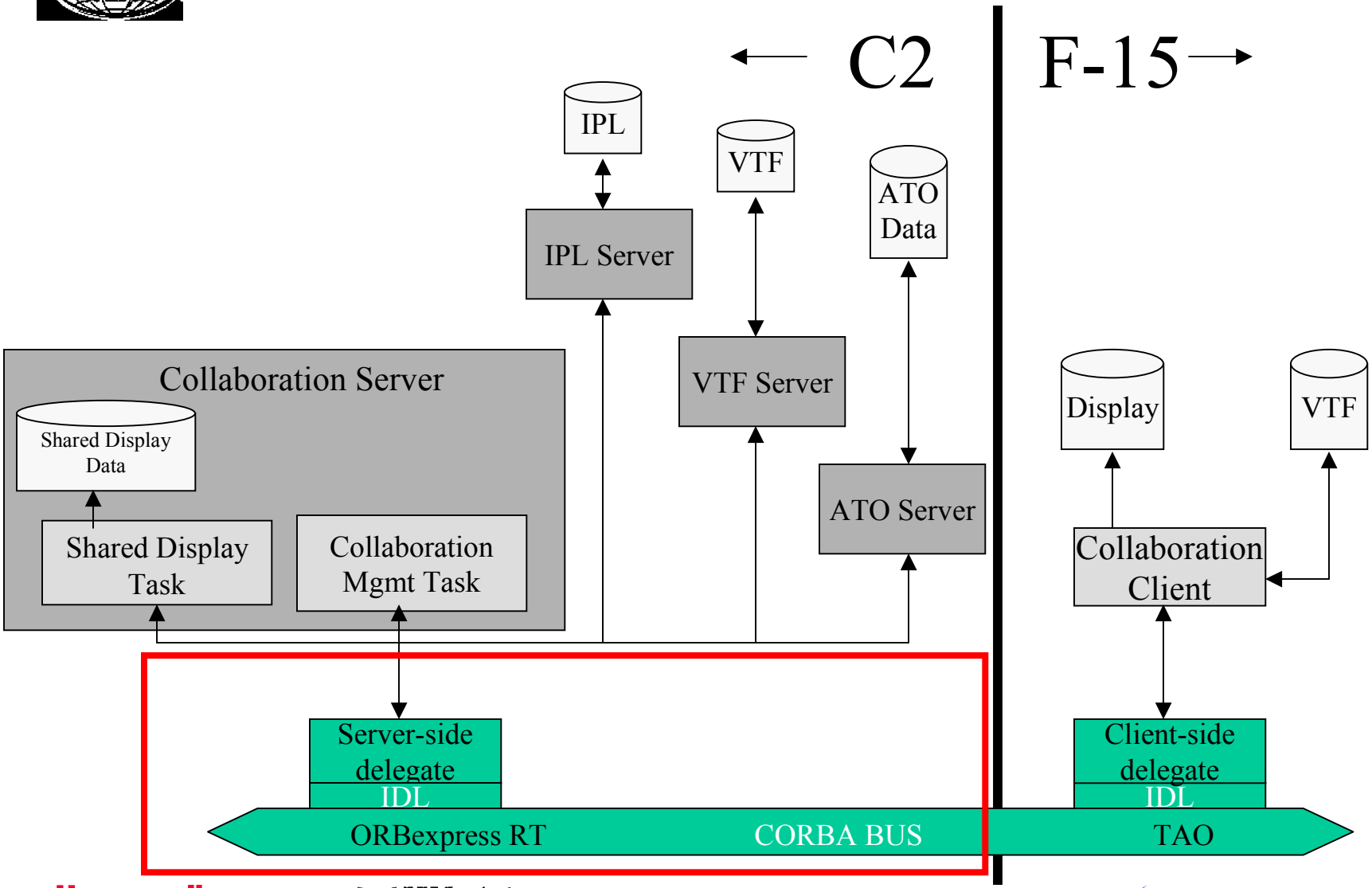
WSOA Software Architecture



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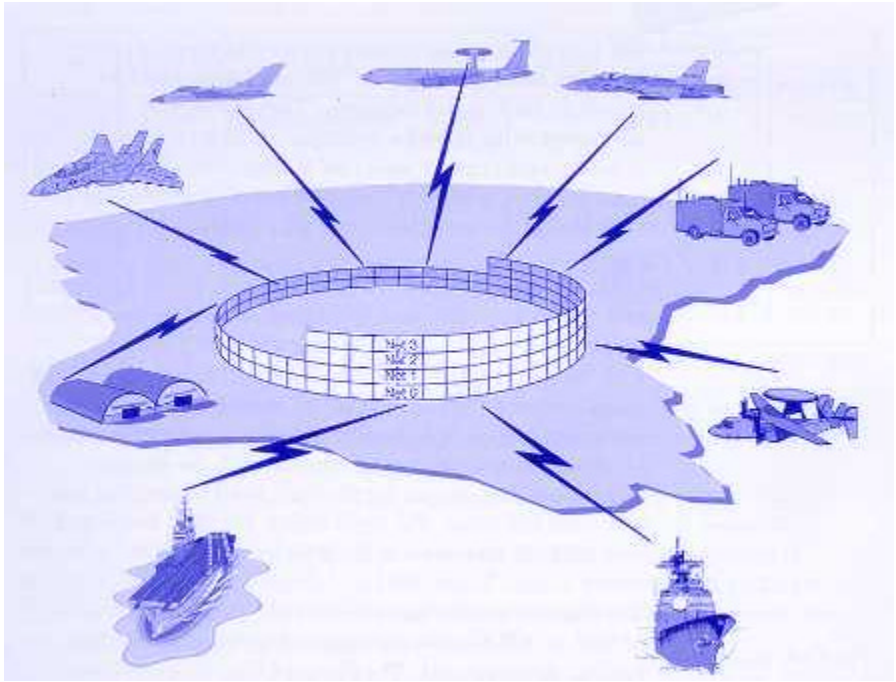
Link 16 Transport

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



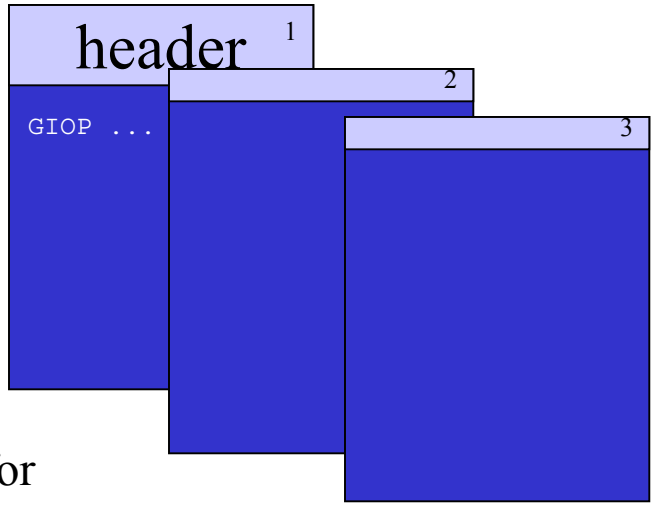
Link 16 Transport

- 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

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?

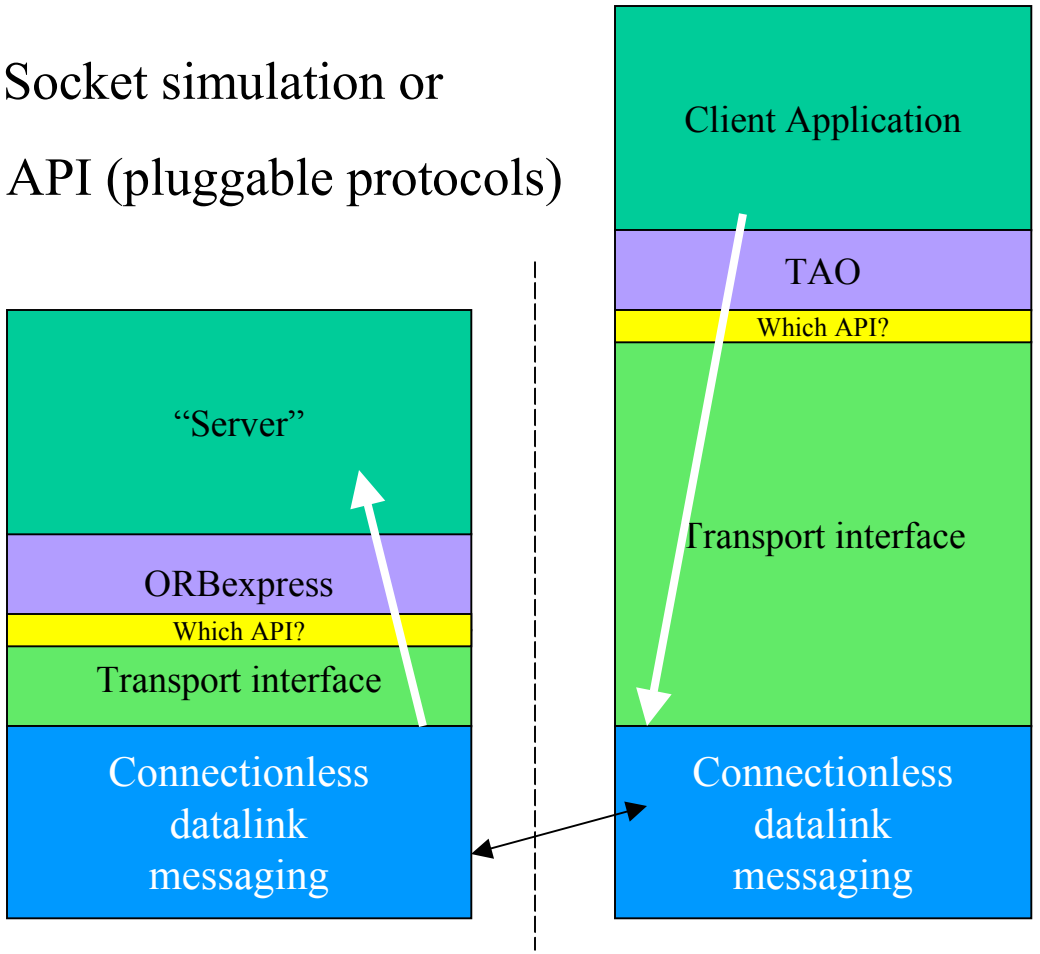
TCP/IP Feature	Protocol or Mechanism	Drawbacks and Limitations
Connection-Oriented		Unsuitable, or at least inefficient, for use in multi-point communication.
Reliable, Ordered	Acknowledgements	Unsuitable or inefficient for simplex, half duplex, or multipoint communication media. Inefficient for high-latency 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

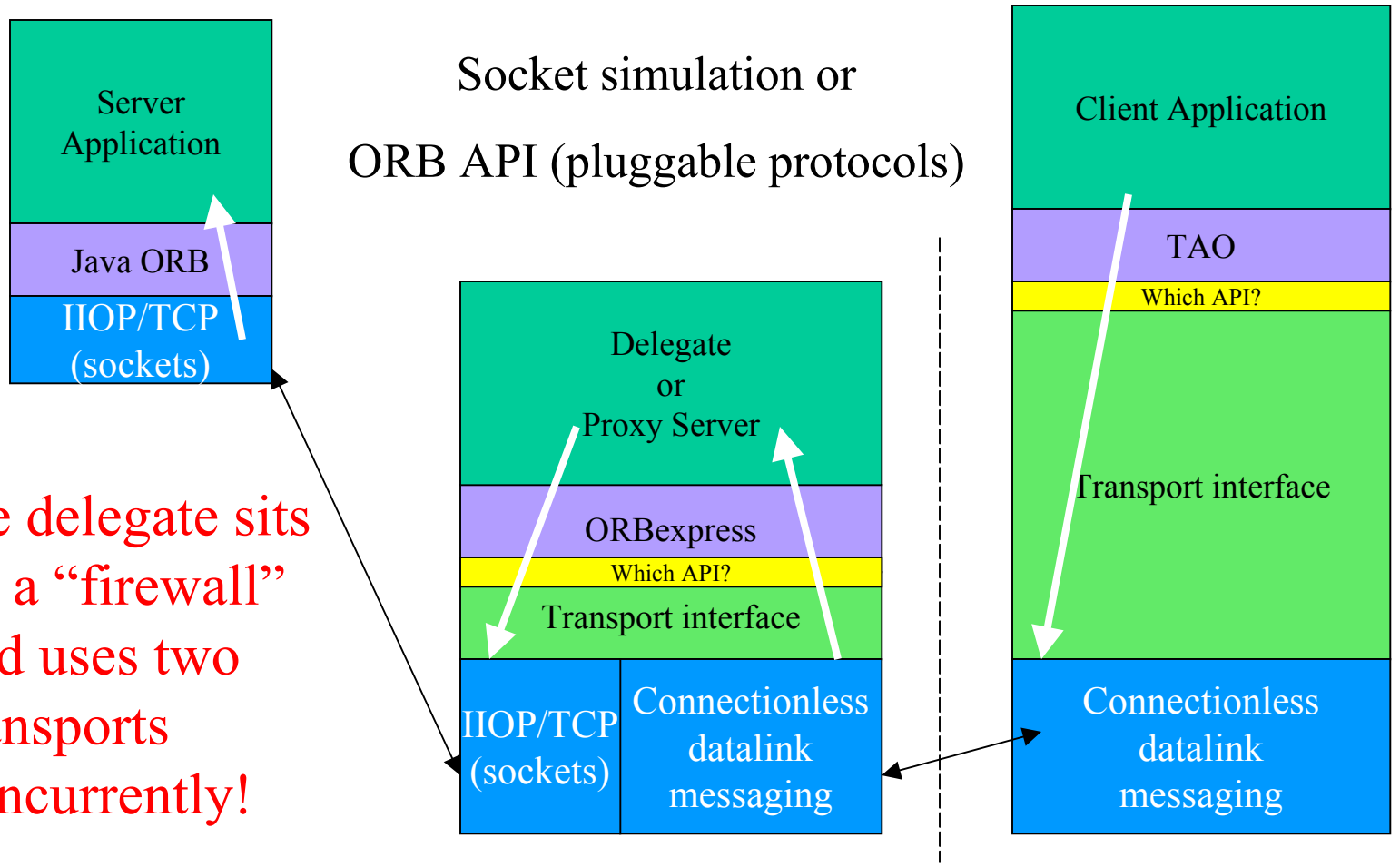
CORBA Implementation - Inline Bridge

Socket simulation or

ORB API (pluggable protocols)



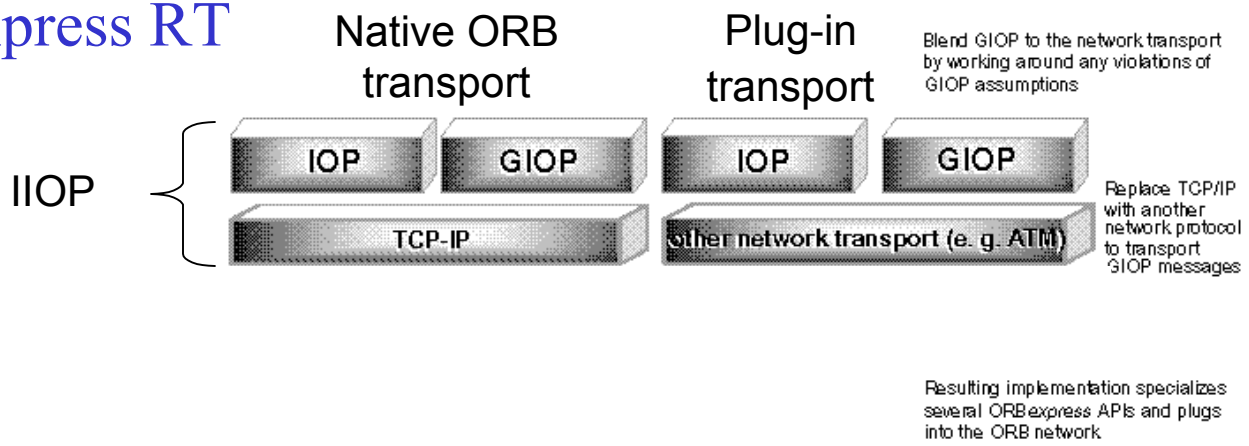
CORBA Implementation - Inline Bridge



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

CORBA Implementation - Transport

- Pluggable transport protocol between TAO and ORBexpress RT



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

From OIS, CORBA Programming with ORBexpress in Ada 95

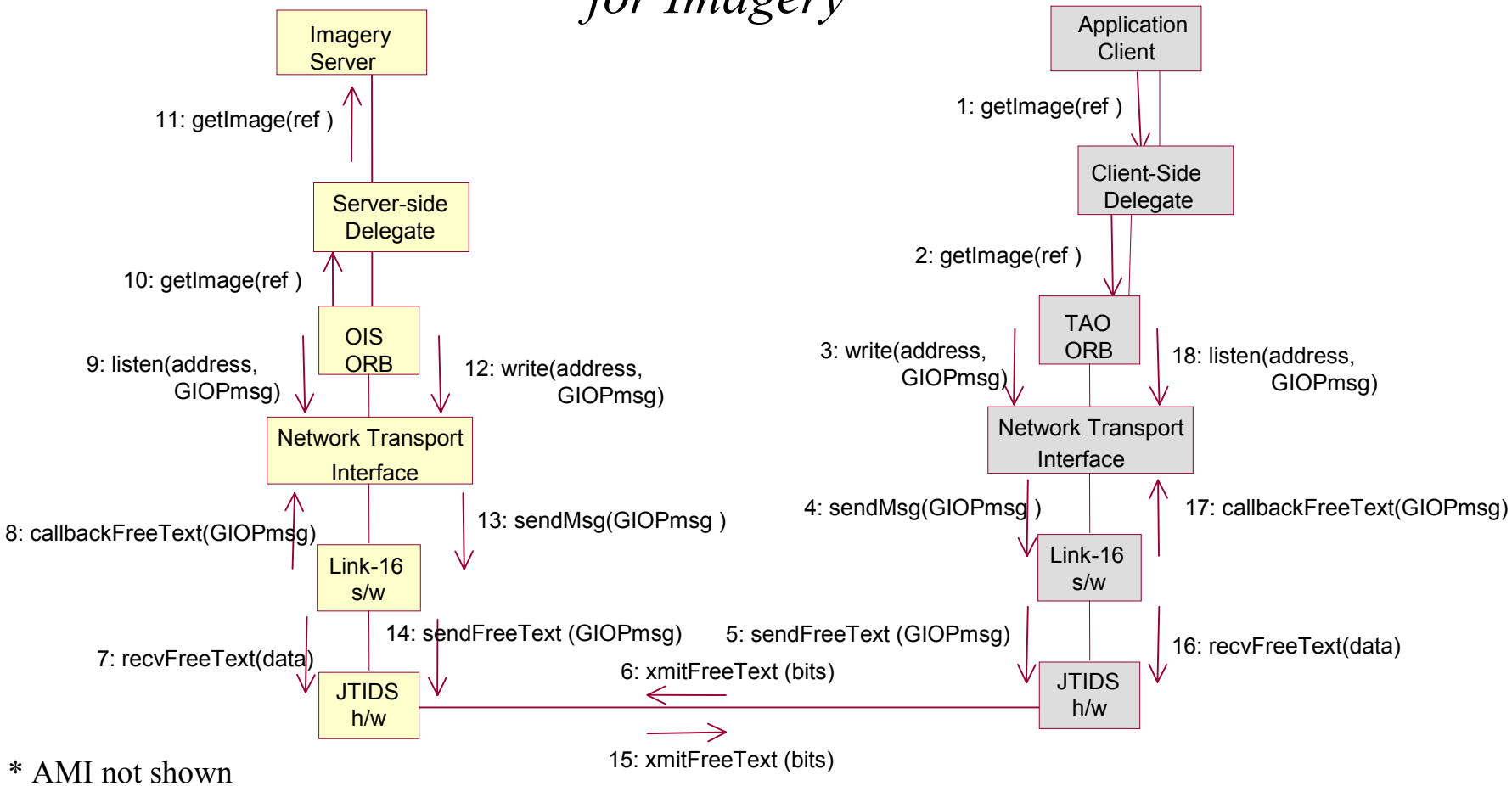
CORBA Implementation - Inline Bridge

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

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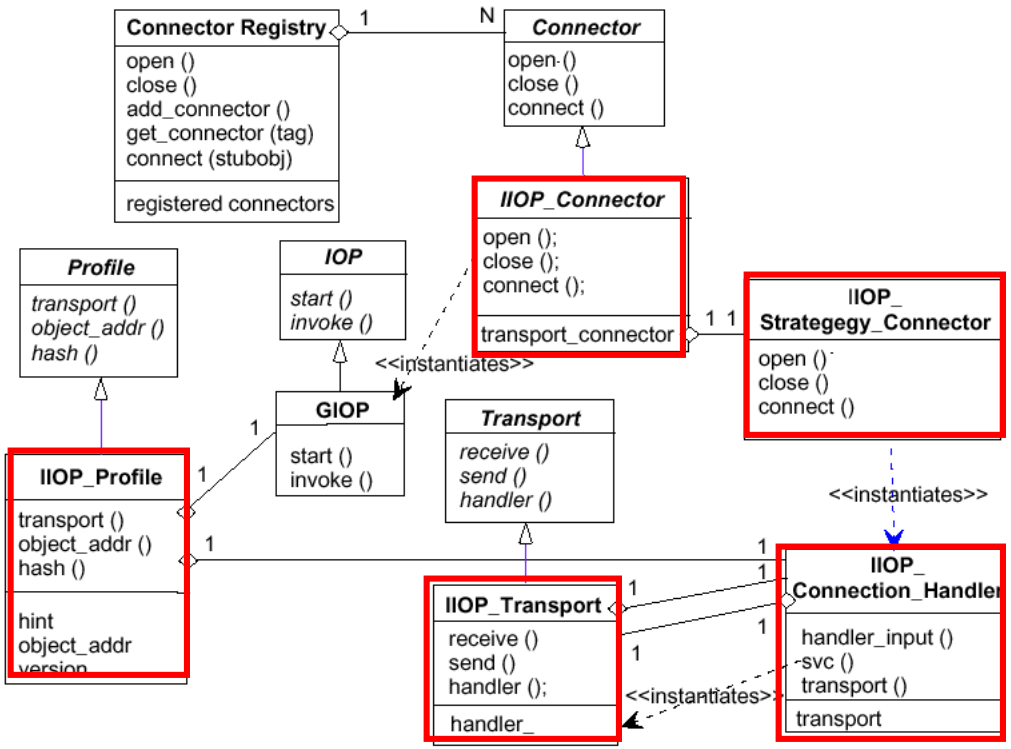
GIOP Transport Requirements

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*

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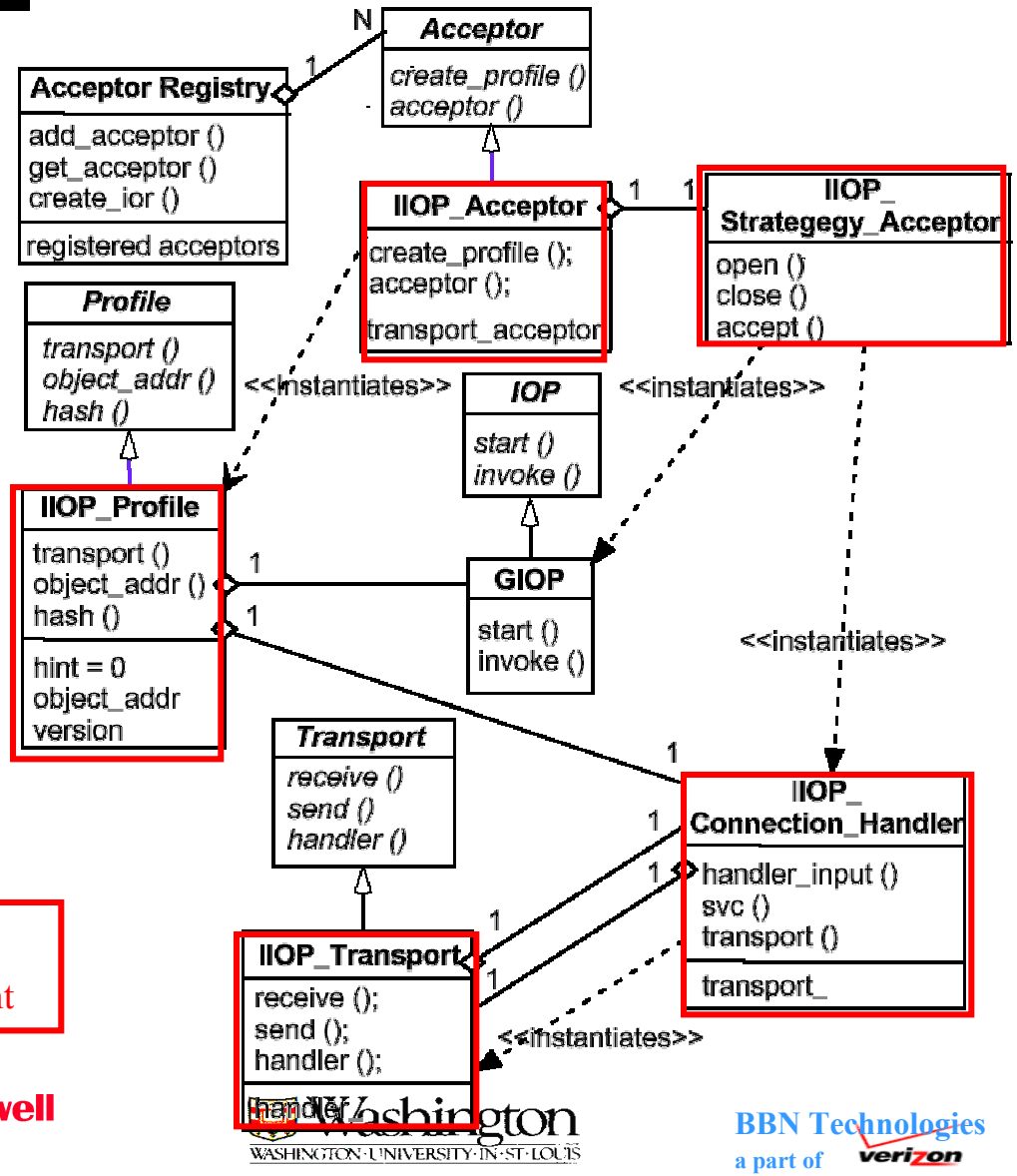
Plug-in Transport Framework



TAO Server Class Diagram

classes to implement

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

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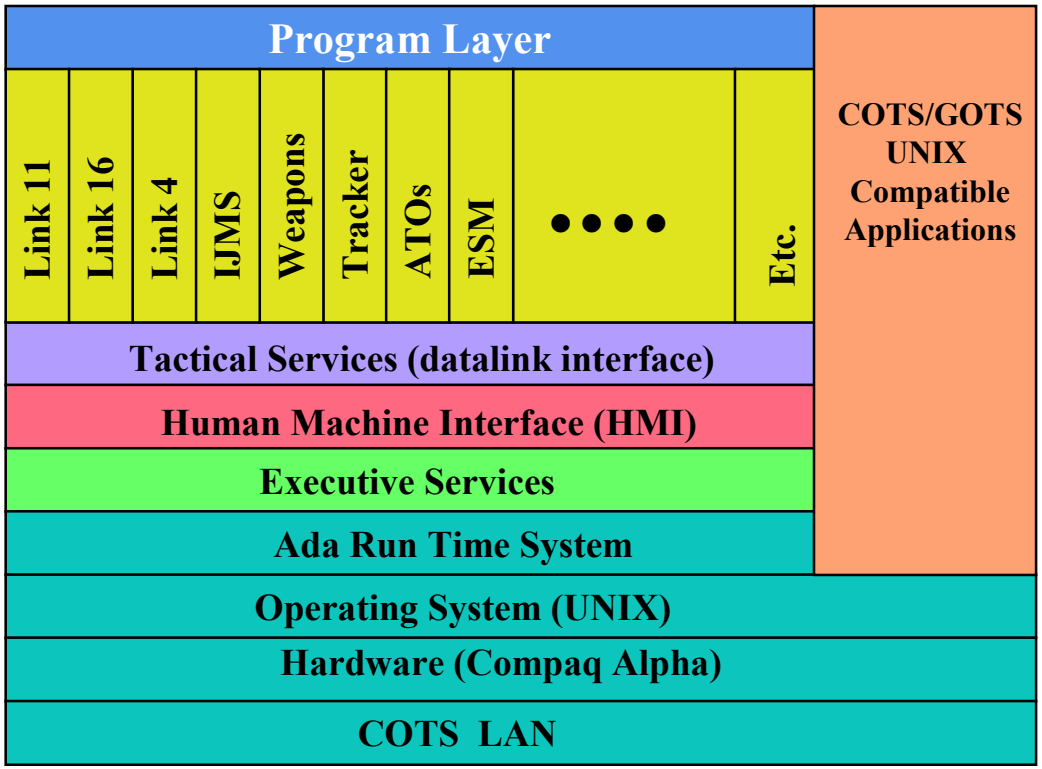
WSOA Server Side Architecture

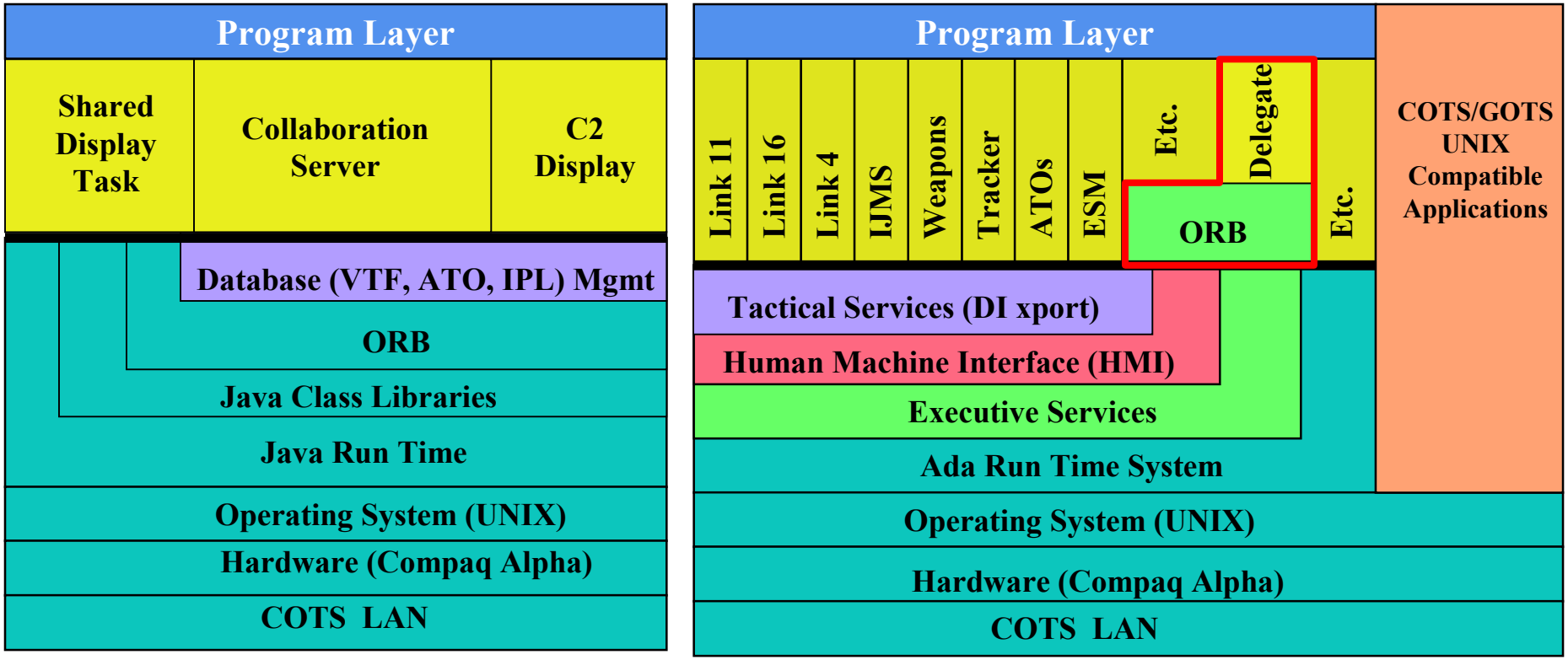
Existing Command and Control Architecture



Mission Computer Program

WSOA Server Delegate Architecture

Detailed WSOA CORBA Architecture



WSOA Server Application

Mission Computer Program

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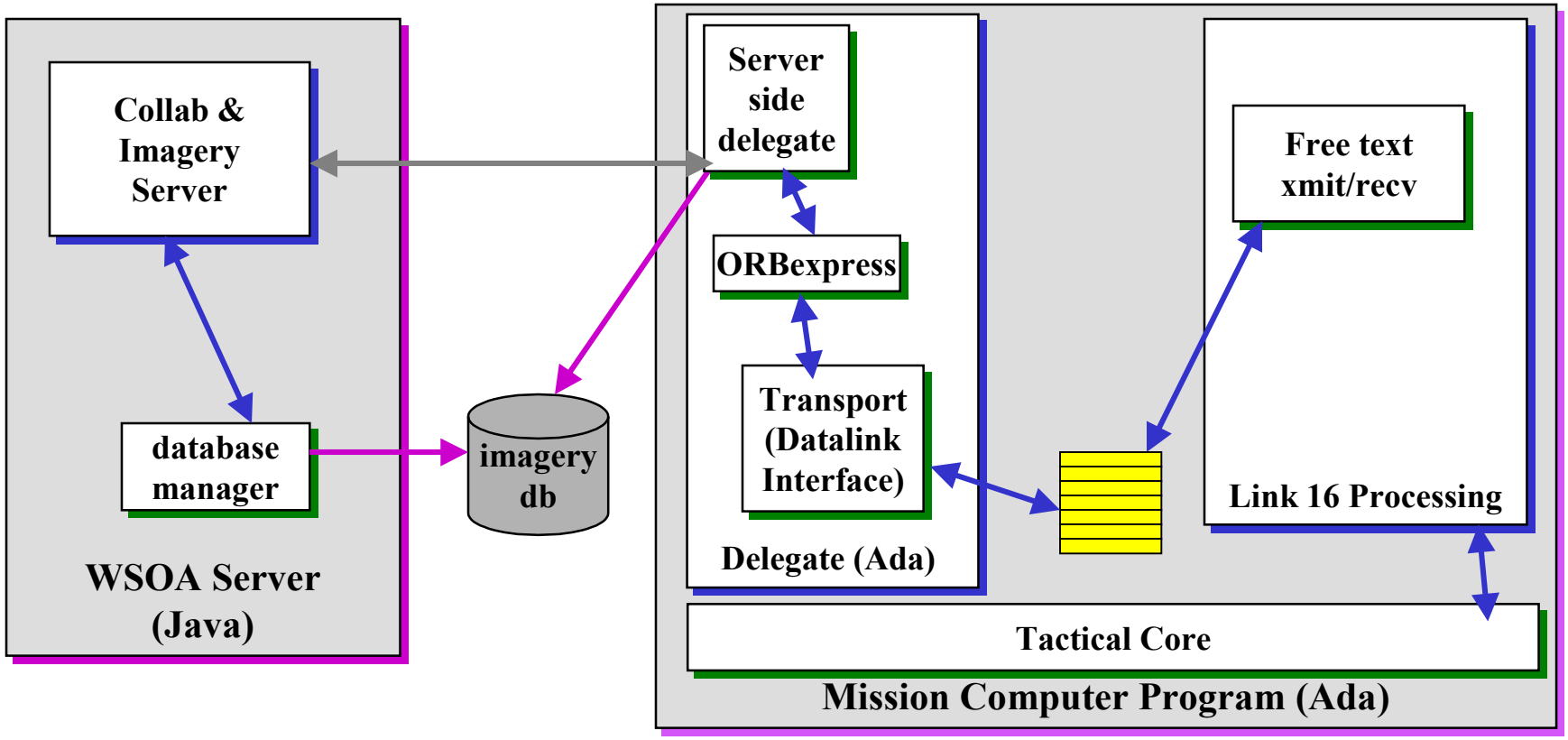
Concurrency Model - C2 (Server)



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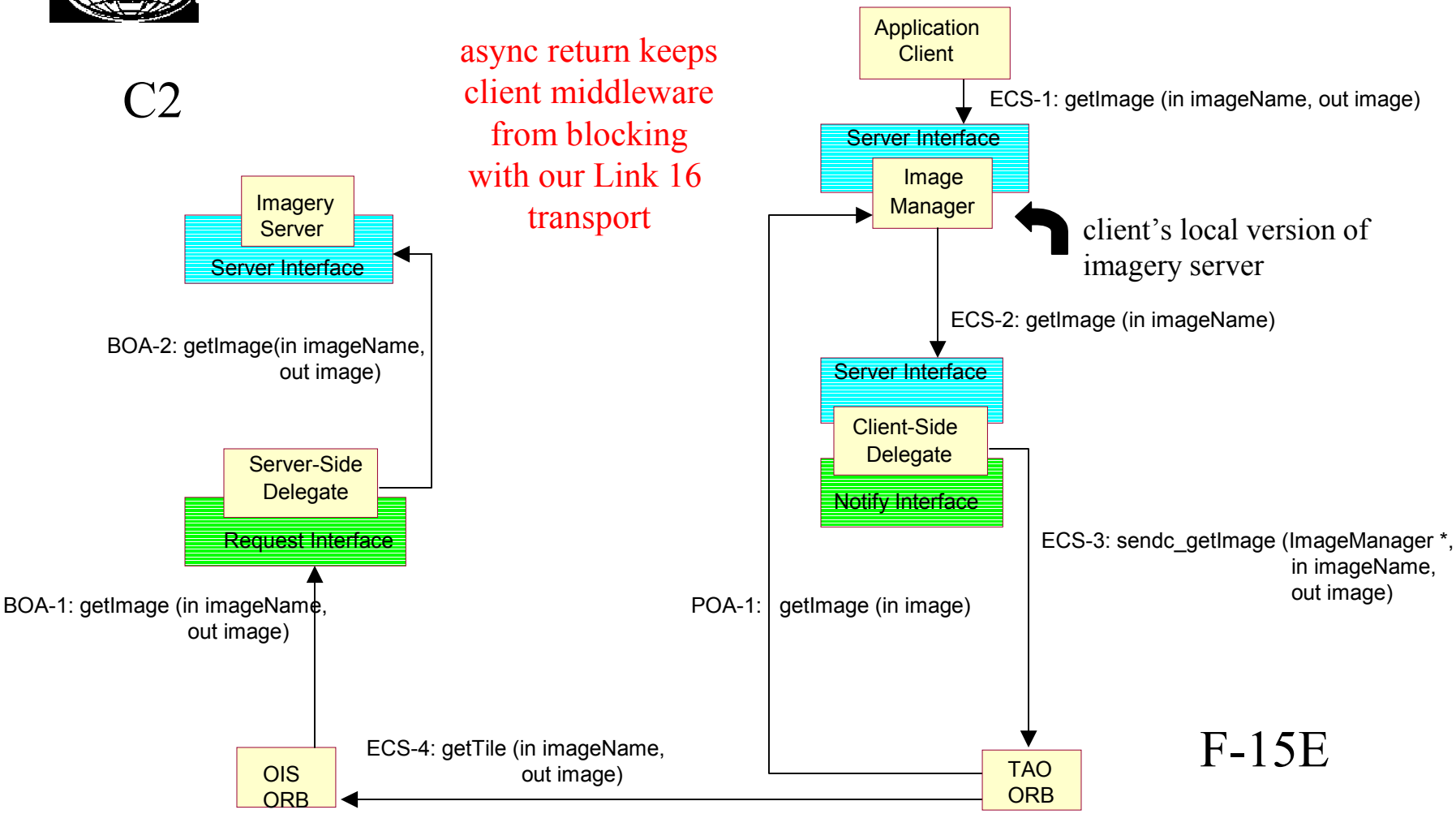
Concurrency Model - Client/Server

C2

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



F-15E

Asynchronous Callback AMI Programming Model

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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 IIOP

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

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Integration Issues and Lessons Learned

- Simple IDL interfaces work well
  - don't push on all sides of the envelope at once!

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

  exception INVALID_TOKEN
  {
    string explanation;
  };

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

- A RT CORBA standard for plug-in transports would be extremely valuable
- Pluggable Protocol Services, too?
  - we built our own COS Name Service wrapper