The Center for Distributed Object Computing

Research Synopsis

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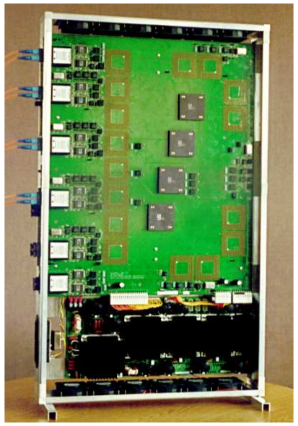
Sponsors

NSF, DARPA, Bellcore/Telcordia, BBN, Boeing, CDI/GDIS, Hughes, Kodak, Lockheed, Lucent, Microsoft, Motorola, Nokia, Nortel, OCI, OTI, SAIC, Siemens SCR, Siemens MED, Siemens ZT, Sprint, USENIX

April 7^{th}, 1999

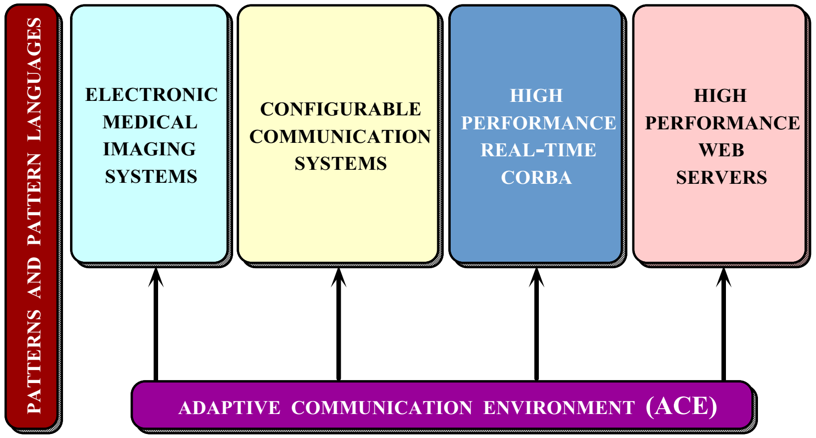
Motivation: the Communication Software Crisis



www.arl.wustl.edu/arl/

- **Symptoms**
  Communication ***hardware*** gets smaller, faster, cheaper
  – Communication ***software*** gets larger, slower, more expensive
- **Culprits**
  – ***Inherent*** and ***accidental*** complexity
- **Solution Approach**
  – ***Standard communication middleware***

DOC Center Research Focus



www.cs.wustl.edu/~schmidt/research.html

Members in the DOC Center

Group Members

- *Director*
  – Douglas C. Schmidt
- *Full-time staff*
  – C. Gill, F. Kuhns, D. Levine, J. Parsons, I. Pyarali, N. Wang
- *PhD students*
  – C. Gill, J. Hu, C O'Ryan, O. Othman, I. Pyarali, N. Wang
- *Masters students*
  – A. Arulanthu, P. Gore, V. Kachroo, Y. Krishnamurthy, B. Natarajan, K. Parameswaran, M. Spivak, N. Surendran
- *Undergrads*
  – M. Braun and D. Brunsch

Sponsors

1. Bellcore/Telcordia
2. BBN
3. Boeing
4. CDI/GDIS
5. DARPA
6. Hughes
7. Kodak
8. Lucent
9. Lockheed
10. Microsoft
11. Motorola
12. Nokia
13. Nortel
14. NSF
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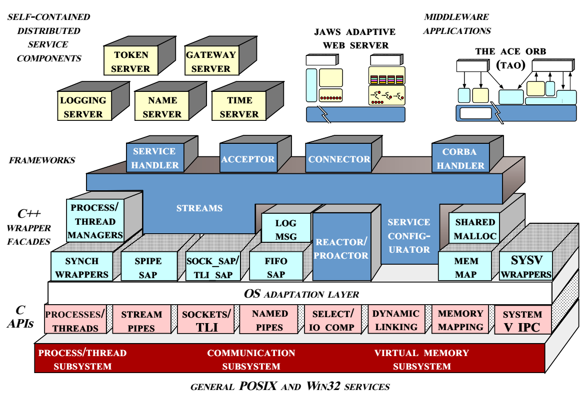
16. OTI
17. SAIC
18. Siemens
19. Sprint
20. USENIX

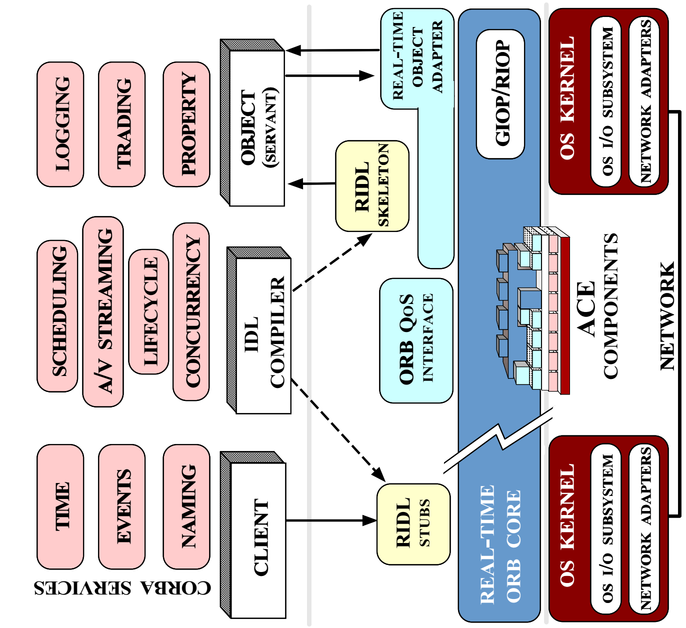
The ADAPTIVE Communication Environment (ACE)



www.cs.wustl.edu/∼schmidt/ACE.html

- **ACE Overview**
  - Concurrent OO networking framework
  - Ported to C++ and Java
  - Runs on VxWorks, POSIX, and Win32
- **Related work**
  - x-Kernel
  - SysV STREAMS

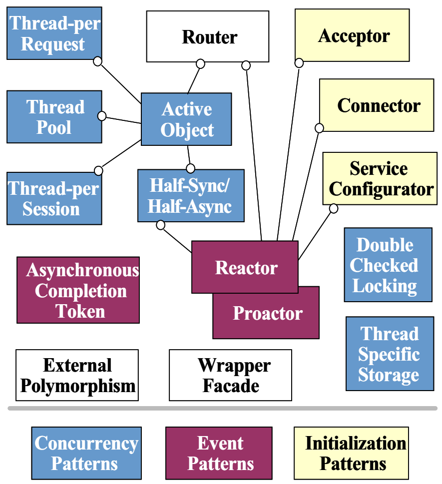
The ACE ORB (TAO) and Its CORBA Object Services



ACE and TAO Statistics

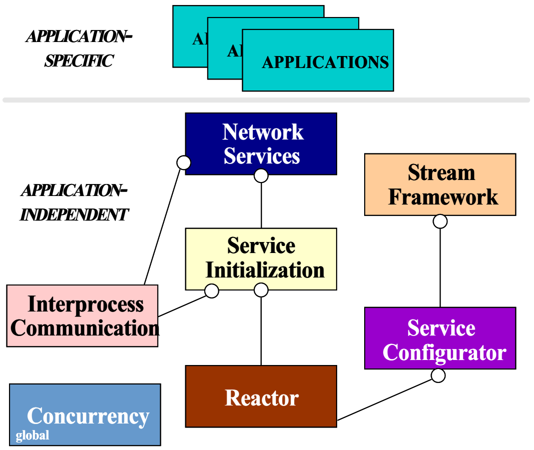
- Over 30 person-years of effort
  - ACE > 185,000 LOC
  - TAO > 100,000 LOC
  - TAO IDL compiler > 100,000 LOC
  - TAO CORBA Object Services > 150,000 LOC
- Ported to UNIX, Win32, MVS, and RTOS platforms
- Large user community
  - www.cs.wustl.edu/∼schmidt/ACE-users.html
- Currently used by dozens of companies
  - Bellcore, Boeing, Ericsson, Kodak, Lockheed, Lucent, Motorola, Nokia, Nortel, Raytheon, SAIC, Siemens, etc.
- Supported commercially
  - ACE → www.riverace.com
  - TAO → www.ociweb.com

Patterns for Communication Middleware



- **Observation**
  - *Failures rarely result from unknown scientific principles, but from failing to apply proven engineering practices and patterns*
- **Benefits of Patterns**
  - Facilitate design reuse
  - Preserve crucial design information
  - Guide design choices

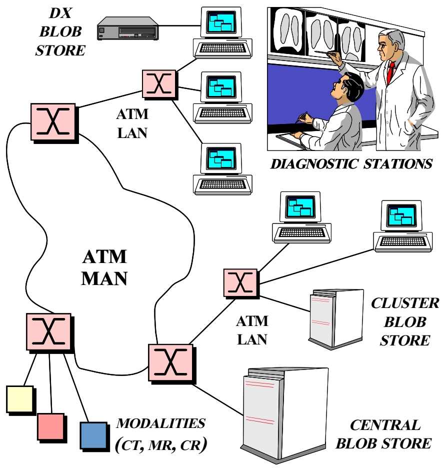
Use-cases for ACE and TAO



Domains

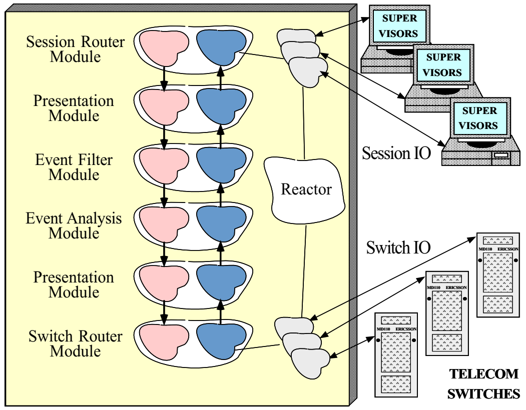
- Medical imaging
- Network management
- Wireless PCS
- Real-time avionics
- Multimedia services
- Distributed interactive simulation

Applying ACE and TAO to Medical Imaging



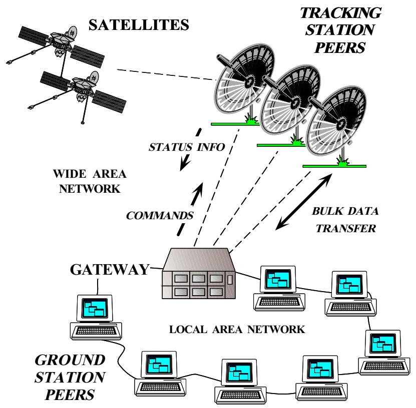
- **Domain Challenges**
  - Large volume of "Blob" data
    - *e.g.*, 10 to 40 Mbps
  - "Lossy compression" isn't viable
  - Prioritization of requests
- **URLs**
  - ~schmidt/COOTS-96.ps.gz
  - ~schmidt/av.ps.gz
  - ~schmidt/NMVC.html

Applying ACE to Network Management



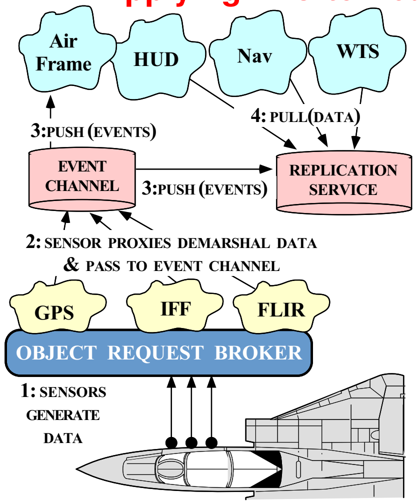
- **Domain Challenges**
  - Low latency
  - Multi-platform
  - Family of related services
- **URLs**
  - ~schmidt/DSEJ-94.ps.gz
  - ~schmidt/ECOOP-95.ps.gz

Applying ACE to Global PCS



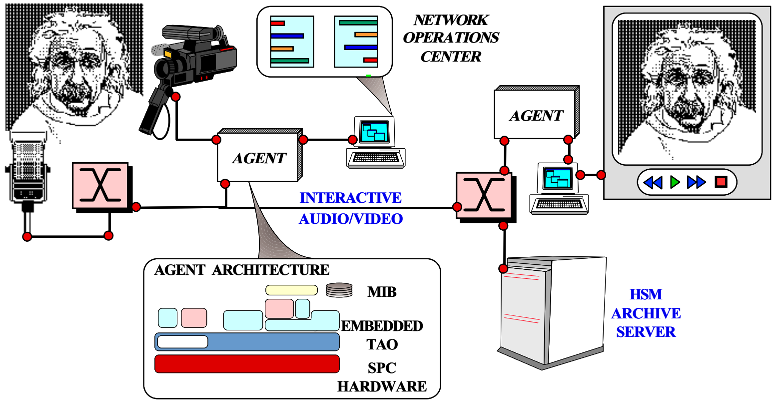
- **Domain Challenges**
  - Long latency satellite links
  - High reliability
  - Prioritization
- **URL**
  - ~schmidt/TAPOS-95.ps.gz

Applying TAO to Real-time Avionics

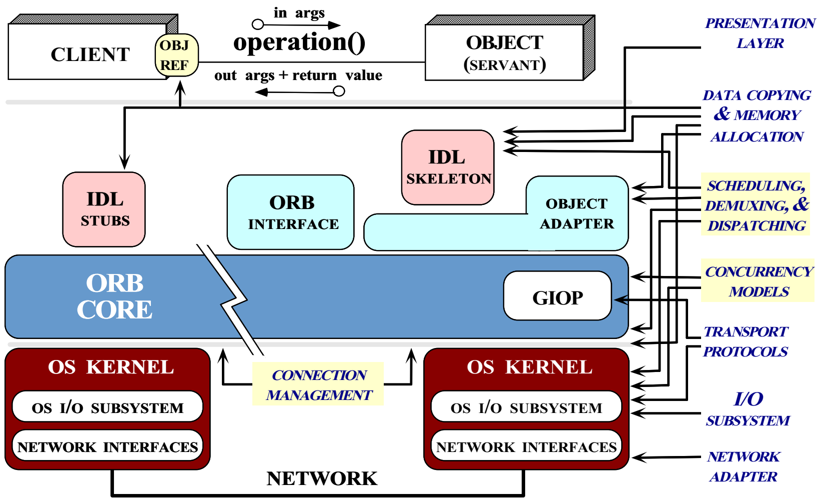


- **Domain Challenges**
  - Real-time periodic processing
  - Complex dependencies
  - Very low latency
- **URL**
  - ~schmidt/JSAC-98.ps.gz

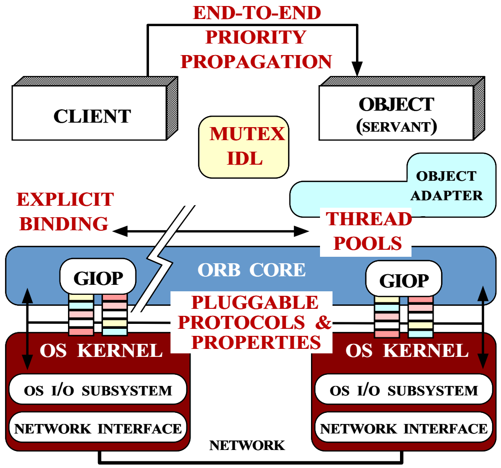
Applying TAO to Distributed Interactive Simulations



Real-time Optimizations in TAO

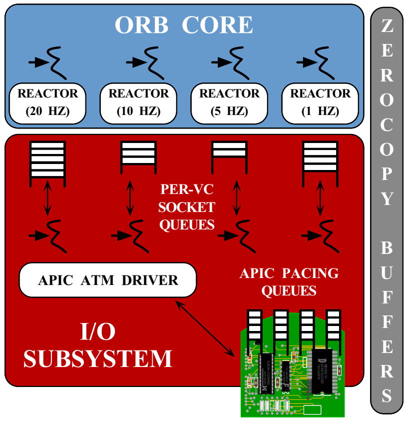


New TAO Features and Optimizations



- **New Features**
  - CORBA "branding" from Open Group and OMG
  - Real-time CORBA
  - Minimum CORBA
  - CORBA Messaging
  - Fault Tolerance
- **URL**
  - ~schmidt/TAO-status.html

Integrating TAO with ATM I/O Subsystem

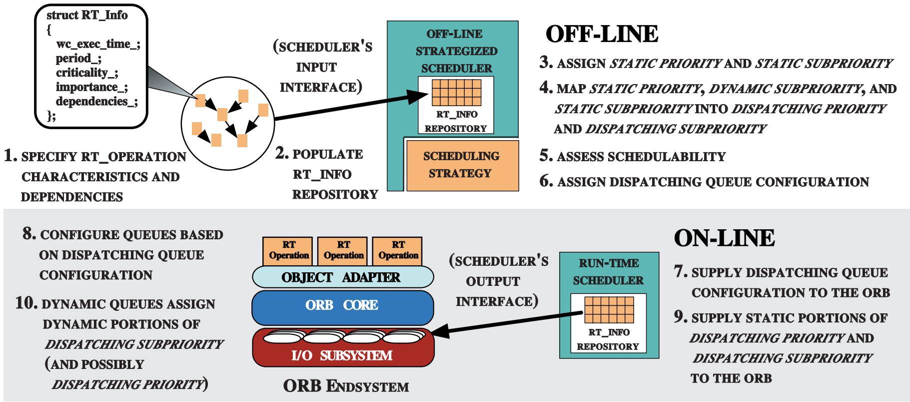


~schmidt/RIO.ps.gz

Features

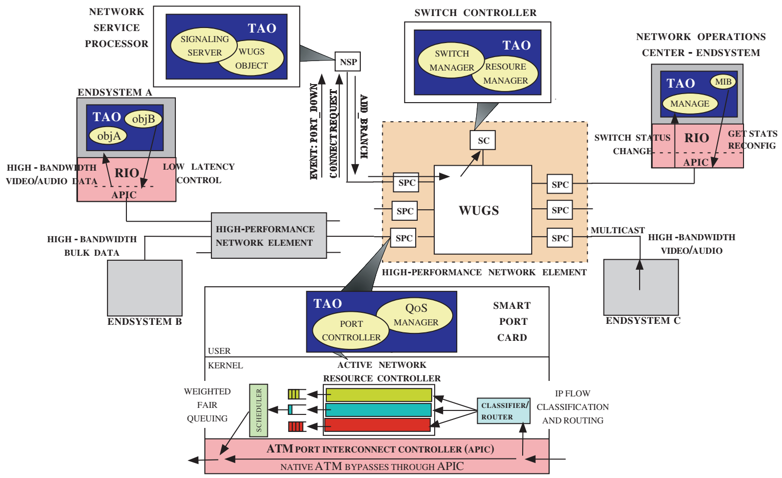
- Vertical integration of QoS through ORB, OS, and ATM network
- Real-time I/O enhancements to Solaris kernel
- Provides rate-based QoS end-to-end
- Leverages APIC features for cell pacing and zero-copy buffering

Strategized Scheduling Framework

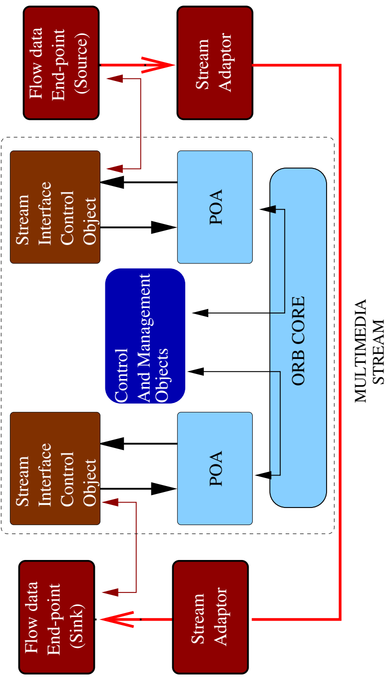


www.cs.wustl.edu/~schmidt/dynamic.ps.gz

Open ATM Signaling & Control



Audio/Video Streaming



www.cs.wustl.edu/~schmidt/av.ps.gz

Flexibility

- Uses CORBA for control messages and properties

Efficiency

- Sockets for data transfer to get high performance

Concluding Remarks

- Researchers and developers of distributed, real-time applications confront many common challenges
  - *e.g.*, service initialization and distribution, error handling, flow control, scheduling, event demultiplexing, concurrency control, persistence, fault tolerance
- Successful researchers and developers apply *patterns*, *frameworks*, and *components* to resolve these challenges
- Careful application of patterns can yield efficient, predictable, scalable, *and* flexible middleware
  - *i.e.*, middleware performance is largely an "implementation detail"
- Next-generation ORBs will be highly QoS-enabled, though many research challenges remain