

GENERAL DYNAMICS

Decision Systems

SUCCESSFULLY INTRODUCING CORBA INTO THE SIGNAL PROCESSING CHAIN OF A SOFTWARE-DEFINED RADIO

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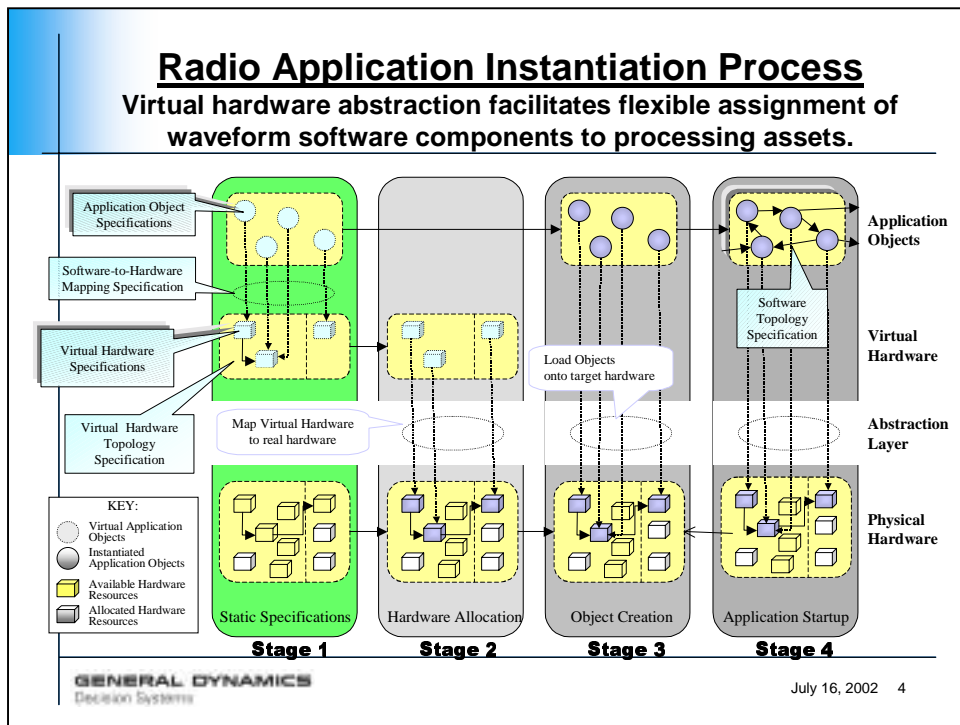
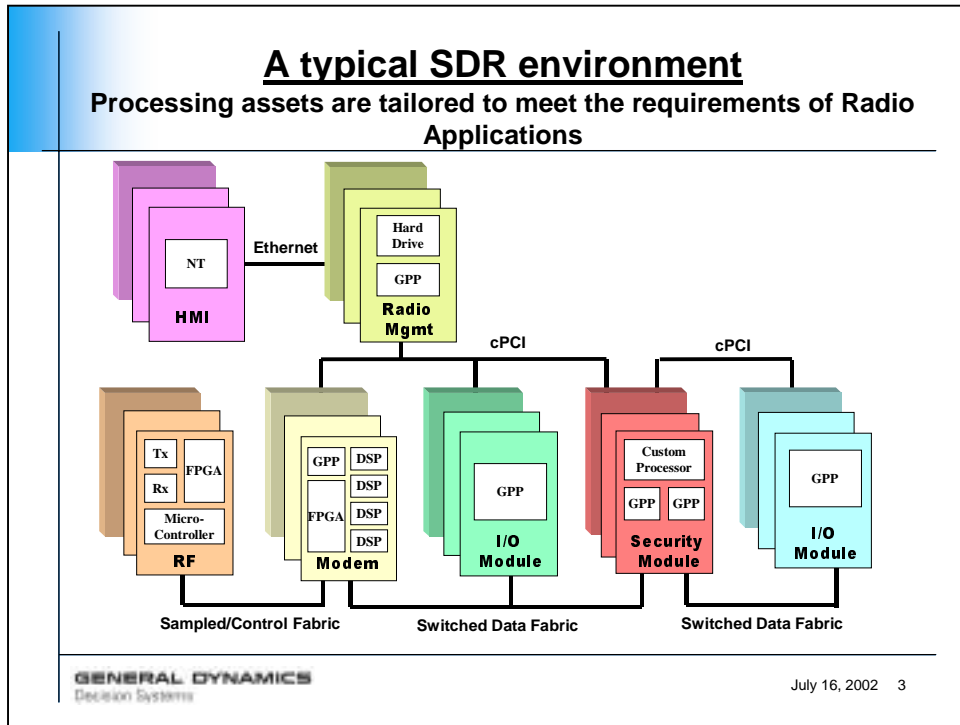
Application of CORBA within an SDR

CORBA is the engine for Software-Defined Radio (SDR) Flexibility

- **As demonstrated in development of the Navy's Digital Modular Radio (DMR), CORBA facilitates:**
 - Redeployment of objects to a variety of processing resources including simulation environments
 - Routing of communications from an object to other known objects on any other processing resource
 - Quick creation of applications via modification of high-level application topology scripts to specify a new connectivity for objects
 - this capability enabled creation of a radio simulcast capability within a matter of hours for an Open System Architecture (OSA) evaluation of DMR
 - Real-Time mechanisms for the deterministic operation necessary within an SDR
 - Datapath reconfigurability for loopback, repeating, bridging

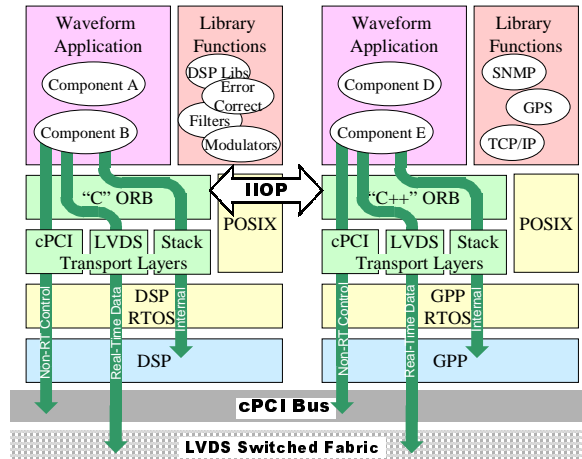
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Pluggable Transport Alternatives to TCP/IP

Addressing schemes and aliasing provide a means for dictating client/server transport mechanisms and segregating control/data.



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CORBA Real-Time Policy Extensions

Deterministic operation is made possible through time-out and priority mechanisms not available in standard CORBA.

- **Priority Mappings [CORBA 24.12]**
 - Normalizes priority of clients across RTOS's to insure against priority inversion
- **Mutex Interface [CORBA 24.16]**
 - Extends RTOS Mutex protections to CORBA as a means of locking access to CORBA implementations (e.g., memory)
- **Threadpools [CORBA 24.17]**
 - Processing "lanes" (collections of execution threads) providing protection from encroachment by other threadpools
- **PrivateConnectionPolicy [CORBA 24.20]**
 - Allows the establishment of dedicated transport connections
- **Invocation Timeout [CORBA 24.21]**
 - Provides a uniform method of specifying timeouts relative to connection failures and delays prior to attempting renewal of connections

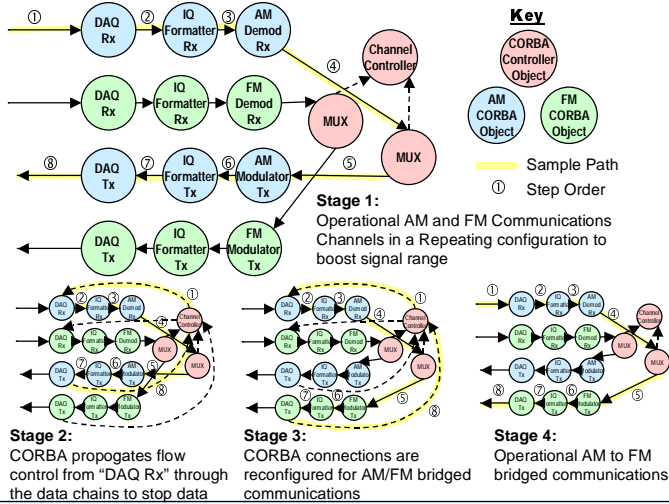


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SDR Bridging via CORBA

CORBA enables the dynamic reconfiguration of SDR datapaths necessary for "true" bridging of Radio Applications.

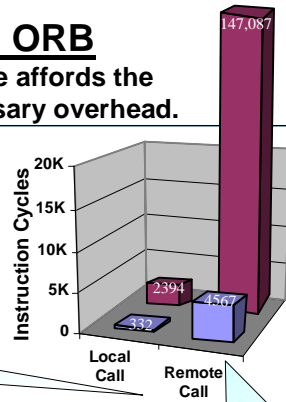


High-performance "C" ORB

Demonstrated superior performance affords the flexibility of CORBA without unnecessary overhead.

- GD Custom "C" ORB**
 - 40 MHz Sharc DSP, Liberty OS over a cPCI bus
 - ORB is characterized by use of **Custom Transport and Pre-connects** which minimize overhead.
- Commercial C++ ORB**
 - 266 MHz Pentium GPP over a PC-104 Bus
 - C++ language** (vs. "C") and Full CORBA spec compliance support for **Dynamic Invocation** introduce greater overhead vs. a Minimum CORBA "C" ORB

Local Call - occurs on the processor stack
Remote Call - involves marshalling & data transmission across bus using transport layer



ORB	Message Type	Bytes	CORBA Latency (µs)	Transport Latency (µs)	Speed (MHz)	Instruction Cycles
GD custom "C" ORB	Local	40	8.3	0	40	332
	Remote	20	60	54	40	4,567
Commercial C++ ORB [†]	Local	256	9	0	266	2,394
	Remote	32	553	471	266	147,087

Key "C" ORB Advantages:

- Custom Transport over cPCI bus using Shared Memory vs. IP
- Pre-connects used to establish persistent transport connections when objects are created.

[†] Source: "CORBA Delays in a Software-Defined Radio" IEEE Communications Magazine, February 2002. Distributed Commercial C++ ORB Remote latency as 46% Transport, 54% ORB per "Real-Time CORBA Trade Study", 1/10/2000 Boeing Corporation Phantom Works, doc. nos. D204-31159-1-5; http://ois.com/technical/rt_dicoe/release.html.

CORBA Myths



- **Myth #1: CORBA footprint starves DSPs of critical memory resources**

- Fact: A Minimum CORBA Compliant "C" ORB can be optimized to use only 75KB of external DSP memory
- Fact: Internal DSP memory and remaining external memory is available for user applications – e.g., on a TI C5510 DSP, that leaves all 320KB of internal memory and most of the 8MB of addressable external memory

- **Myth #2: CORBA runtime overhead heavily taxes real-time processing budgets**

- Fact: Taking advantage of alternative transports to TCP/IP and setting up persistent connections for datapath operations removes the bulk of overhead typically attributed to "CORBA"
- Fact: CORBA communications occurring on a 40 MIP DSP processor stack were measured at 8.3 microseconds and over cPCI bus (1.6K Bytes) required 80 microseconds

CORBA Myths (cont'd)



- **Myth #3: CORBA is not appropriate for a non-Object Oriented languages like "C"**

- Fact: It is possible to introduce inheritance mechanisms for "C" via CORBA and provide the user with a level of control over realization of inherited operations (e.g., copies or shared implementations)

- **Myth #4: Flexibility offered by CORBA is unnecessary for an embedded SDR environment**

- Fact: CORBA provides fault tolerant mechanisms which facilitate failover to secondary objects
- Fact: CORBA provides a means of dynamically switching an SDR datapath to bridge communications

Conclusion



- **CORBA provides SDRs with the means for adapting to a wide range of processing assets**
- **Key to the effective use of CORBA in an SDR is the blending of minimum CORBA with optimized Transport layers, Pre-connects and Real-Time processing mechanisms**
- **The Digital Modular Radio (DMR) demonstrates that CORBA can be effectively applied to an SDR**
 - The DMR is currently in limited production,
 - The DMR is successfully executing during independent Navy shipboard Technical Evaluation
 - The DMR SATCOM waveform is nearing successful completion of US Government Joint Interoperability Test Command (JTIC) certification

References

- [1] Irfan Pyarali, Carlos O’Ryan, Douglas Schmidt, Aniruddha Gokhale, Nanbor Wang, and Vishal Kachroo, “Applying Optimization Principle Patterns to Real-time ORBs”, 5th USENIX Conference on OO Technologies and Systems (COOTS ’99), San Diego, CA, May 1999.
- [2] Object Management Group, *The Common Object Request Broker: Architecture and Specification*, Revision 2.4.2, February 2001
- [3] John Bertrand, John W. Cruz, Bryan Majkrzak, Thomas Rossano - ITT Aerospace/Communications, "CORBA Delays in a Software-Defined Radio" IEEE Communications Magazine, February 2002.
- [4] Jeffrey H. Reed, *Software Radio: A Modern Approach to Radio Engineering*, Prentice Hall PTR, 2002.