SYSTEM SUPPORT FOR IMPLEMENTATION AND EVALUATION OF REAL-TIME ORBS

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Spartan Conference

MOTIVATION

- CORBA is an attractive implementation technology for emerging uses of the next generation telecommunication networks
- Applications with real-time constraints are increasing in number and importance
- Real-time applications require the ability to provide performance guarantees
  - Guarantees are based on predictability of behavior
  - Behavior of an application is influenced by *all aspects of the system*
  - A system is only as predictable as its least predictable component
- Detailed performance evaluation of ORB implementations and operational scenarios is necessary to achieve performance and predictability goals
- Explicit system support for real-time applications is required to meet the requirements of real-time applications

RELATED KU PROJECTS

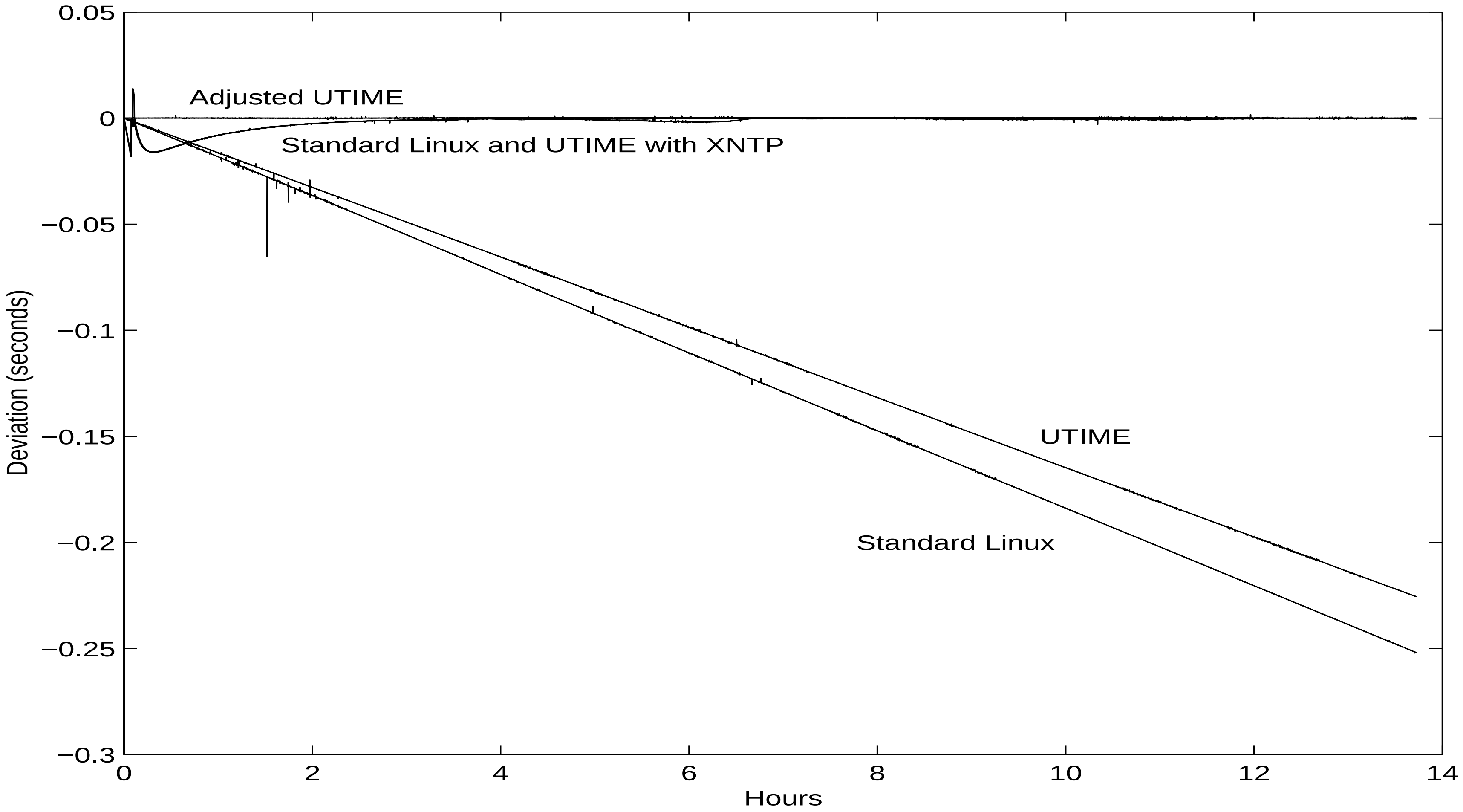
- KU Real-Time (KURT)
  - Modifications to Linux to increase time resolution and support for *firm real-time* applications
- Performance Measurement Object (PMO)
  - NetSpec based test demon explicitly addressing the performance evaluation of ORBs in general and real-time ORBs in particular
- Data Stream Kernel Interface (DSKI)
  - Pseudo-device driver providing an interface for specifying and collecting a time-stamped kernel event stream
- Smart-GDB
  - Extension to GDB to support user programmable custom debugging interfaces → thread aware debugging

MODIFICATIONS TO LINUX FOR REAL-TIME

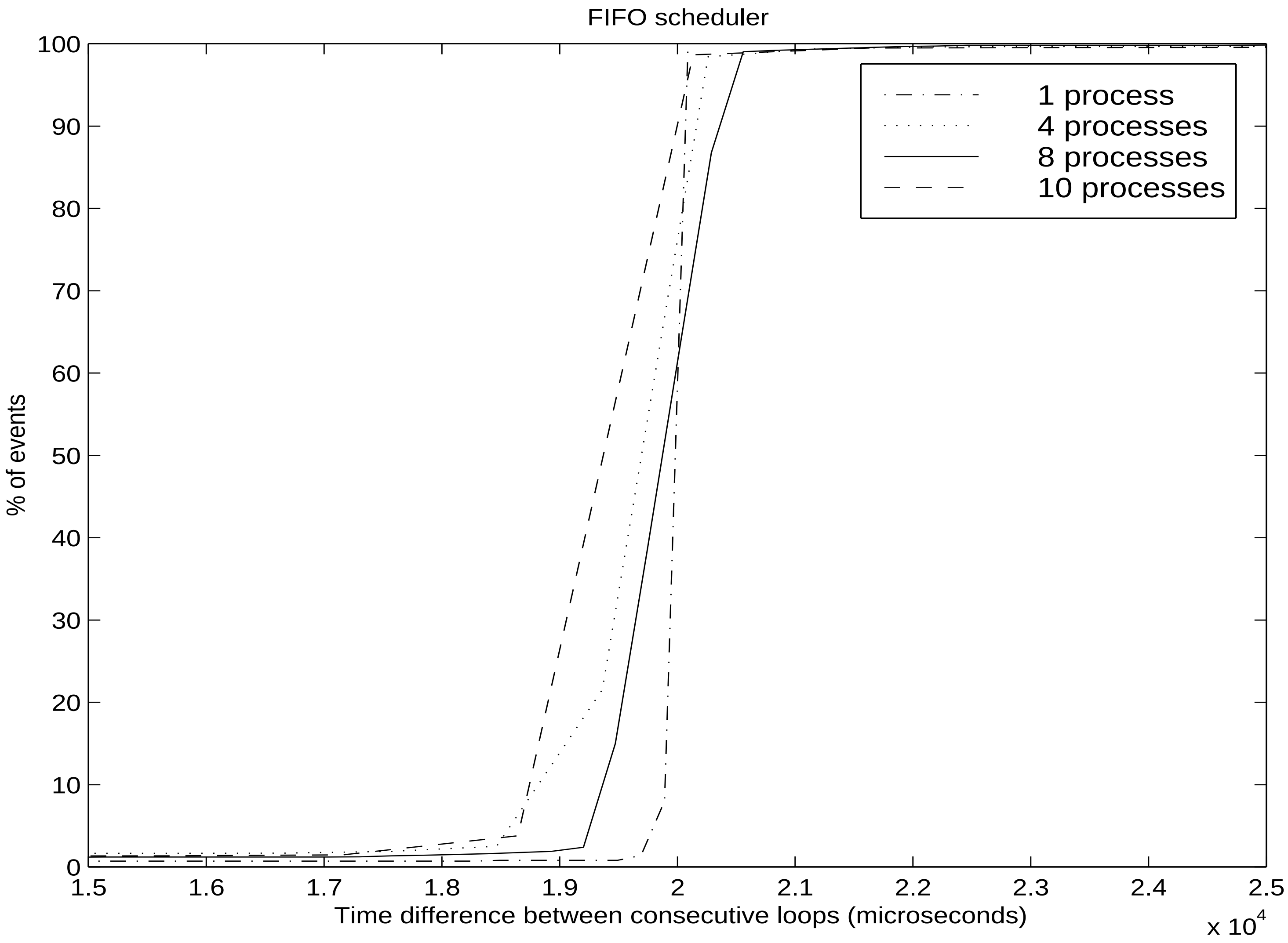
- Provides support for *firm real-time* applications
  - Those with stringent but not individually critical timing constraints
  - Multi-media, telecommunications, interactive virtual environments
- Students: Balaji Srinivasan, Robert Hill, Shyam Pather, Furquan Ansari, Raghavan Menon, Jason Keimig, Apurva Sheth
- Increased temporal resolution (UTIME)
  - Generic Linux has a timing resolution of 10ms, similar to most commercial systems
  - Modified Linux's time keeping method to provide microsecond temporal resolution with minimal increase in overhead
  - Added the ability to schedule events with a resolution of 10 to 20 microseconds
  - Good for general use as well as real-time support

- KU Real-Time (KURT)
  - Added system calls and modified scheduling to support *explicit time line* scheduling
    - ∗ Schedule explicitly states when each real-time process will run
    - ∗ Periodic processes supported by executing a time line cyclicly
  - Real-time Modes
    - ∗ Focussed: executes *only* the designated real-time processes
    - ∗ Integrated: executes non-real-time processes as resources are available
- KURT's predictability and temporal resolution significantly exceeds that of many applications using specialized and expensive commercial real-time OSs
- More Information:
  - http://hegel.ittc.ukans.edu/projects/utime
  - http://hegel.ittc.ukans.edu/projects/kurt

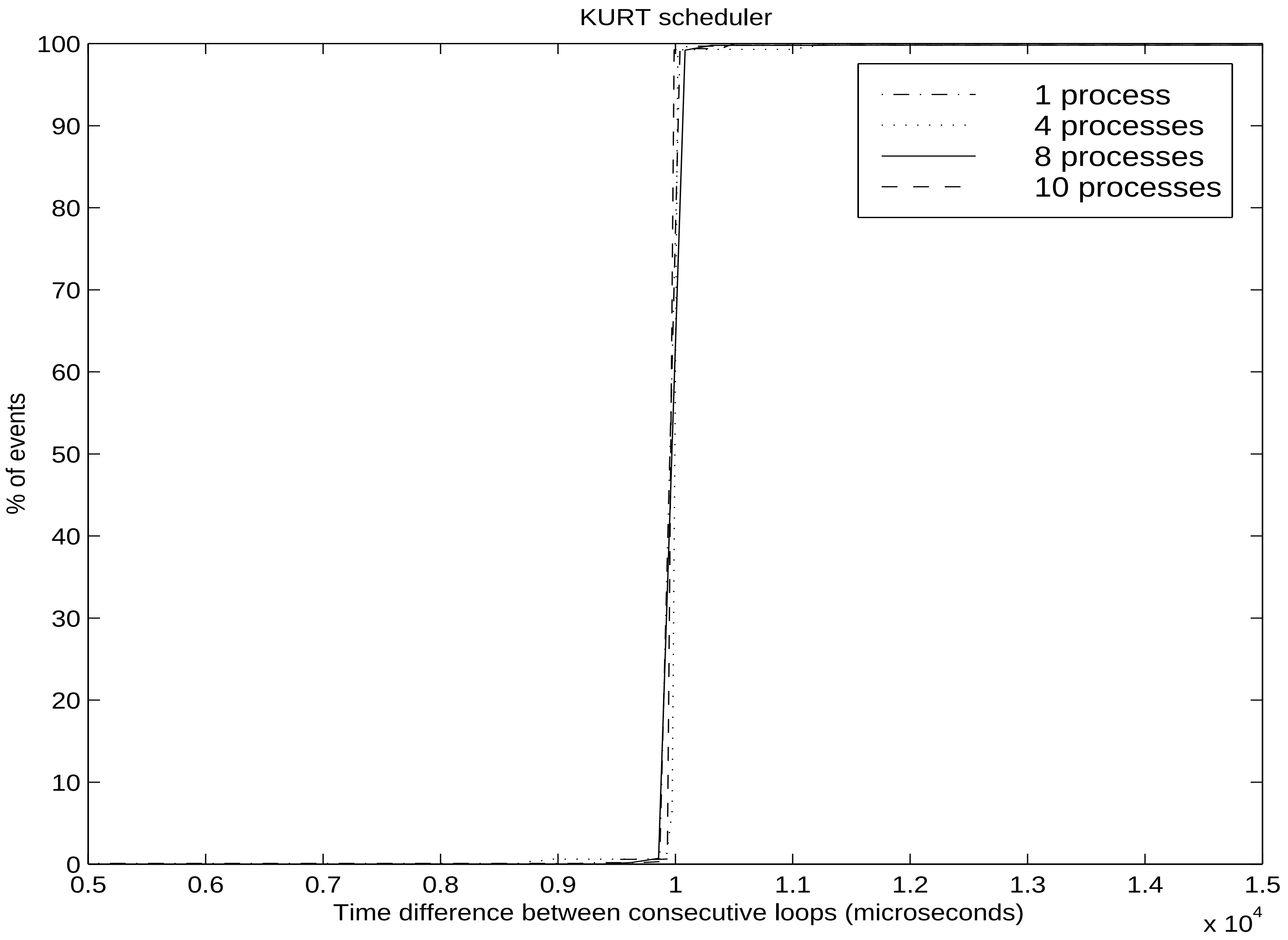
UTIME CLOCK DRIFT



LINUX FIFO SCHEDULING PERFORMANCE



LINUX FIFO SCHEDULING PERFORMANCE

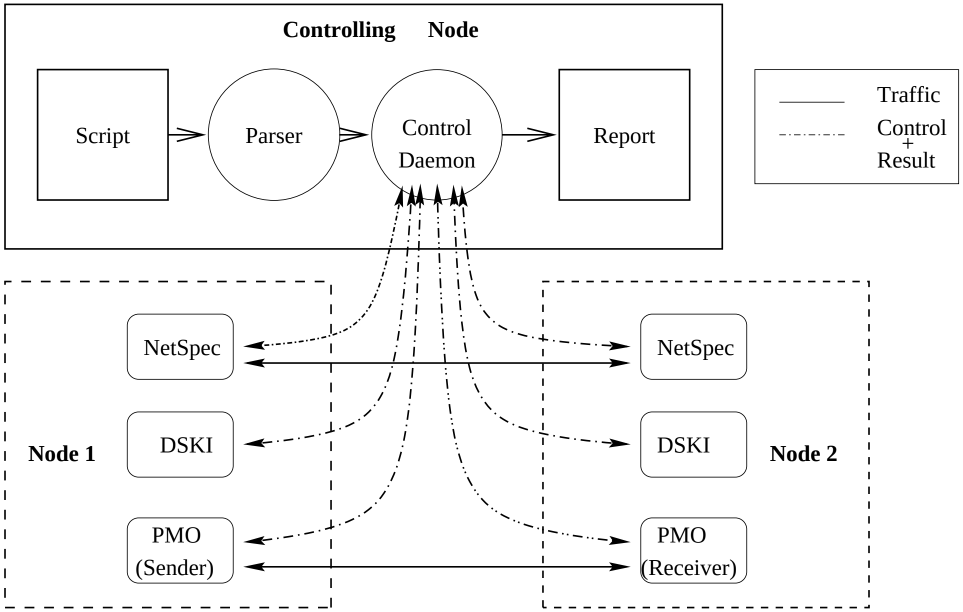


PERFORMANCE MEASUREMENT OBJECT

- NetSpec test demon which is also an ORB object and thus provides the ability to implement ORB based performance evaluation benchmarks as sets of NetSpec scripts
- Initial development and testing of the framework is complete
- Extension of the framework and implementation of comprehensive benchmarks is the next step
- Students: Anil Gopinath, Sridhar Nimmagadda, Chanaka Liyanaarachchi
- More Information:
  - http://hegel.ittc.ukans.edu/projects/pmo

PMO ARCHITECTURE

- NetSpec controls the experiment as directed by the script
- Conventional NetSpec test and measurement (DSKI) demons can also be used



SAMPLE SCRIPT

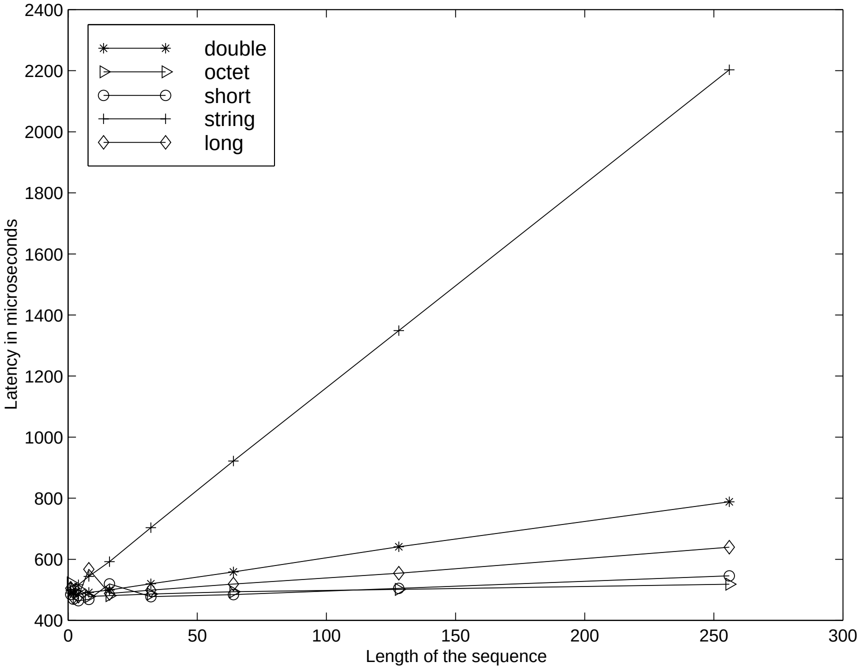
```
#include "corba-requestresp.h"

cluster
{
  corba RECEIVING_HOST
   {
    type = TYPE_OF_TEST (orb        = ORB_NAME,
                         mode       = receiver,
                         numsamples = NUMSAMPLES,
                         minsize    = MINSIZE,
                         maxsize    = MAXSIZE,
                         multiples  = MULTIPLES,
                         predelay   = PREDELAY,
                         postdelay  = POSTDELAY,
                         duration   = DURATION
                        );
    protocol = PROTOCOL_NAME;
    criteria = CRITERIA;
    qos      = QOS;
    objname  = obj1;
    own      = SENDING_HOST (interface = INTERFACE);
   }

  corba SENDING_HOST
   {
    type = TYPE_OF_TEST (orb        = ORB_NAME,
                         mode       = sender,
                         numsamples = NUMSAMPLES,
                         minsize    = MINSIZE,
                         maxsize    = MAXSIZE,
                         multiples  = MULTIPLES,
                         predelay   = PREDELAY,
                         postdelay  = POSTDELAY,
                         duration   = DURATION
                         );
    protocol = PROTOCOL_NAME;
    criteria = CRITERIA;
    qos      = QOS;
    objname  = obj2;
    own      = RECEIVING_HOST (interface = INTERFACE,
                               port = PORT);
   }
}
```

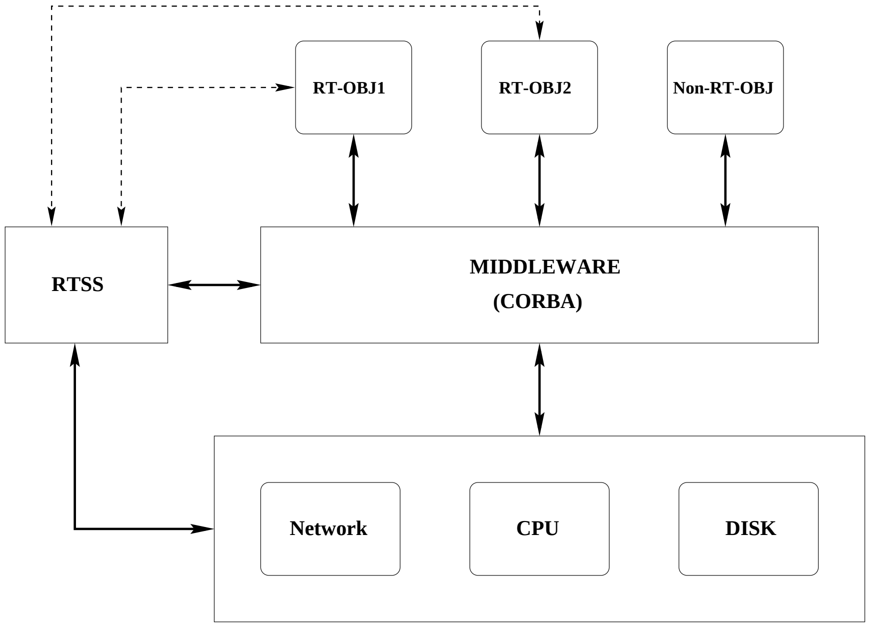
LATENCY BENCHMARK TEST

- Latency observed by a sender object while transferring a sequence of CORBA data types to a receiver object when they are located on different machines



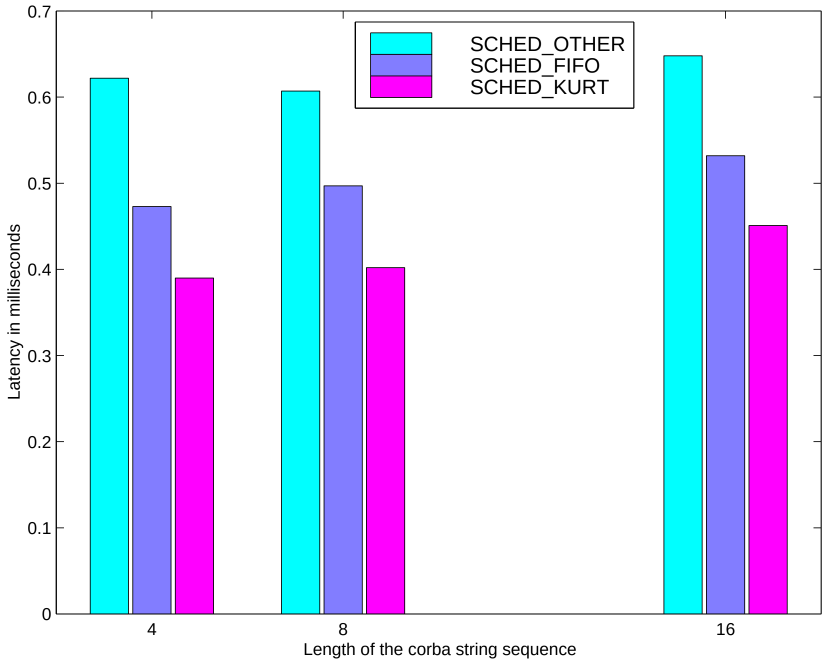
REAL-TIME SCHEDULING SERVICE

- ORB service providing an interface to the underlying real-time services
- KURT provides scheduling and execution support, being extended to include ATM QoS



RTSS SENDER LATENCY EXPERIMENT

Scheduling Policy	Startup latency (millisecs)
SCHED_NORMAL	19.29
SCHED_FIFO	16.00
SCHED_KURT	15.87



CONCLUSIONS

- Real-time applications under CORBA will continue to increase in number and importance
- Performance of real-time systems is influence by all aspects of the system requiring detailed benchmarking and specific support for real-time
- KURT support for real-time and PMO support for ORB performance evaluation provide important elements of the total support which will be required to successfully deploy real-time ORB based applications

FUTURE WORK

- Improve KURT predictability and performance by adapting disk and other I/O subsystems to real-time support
- Adapt KURT to provide specific support to Real-Time Scheduling Service (RTSS) in general and merge with The Ace ORB (TAO) RTSS in particular
- Create ORB specific support in by adding integration between the I/O and scheduling subsystems to KURT
- Extend PMO based benchmarks to first cover traditional point-to-point throughput and latency tests, and then a wide range of application scenarios
- Extend PMO benchmarks specific to real-time
- Fully automate PMO and Netspec based ORB benchmarks and analysis