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ANSA Phase III

An Open Architecture for Real-Time: Engineering Aspects (Nov 93 TC Presentation Slides

List of author names goes here

Abstract

Need some instructions here.

APM.1090.00.02 **Draft** 10 November 1993

Request for Comments (confidential to ANSA consortium for 2 years)

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The authors acknowledge the help and assistance of their colleagues, in sponsoring companies and the ANSA team in Cambridge in the preparation of this report.

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An Open Architecture for Real-Time: Engineering Aspects

(Work in Progress Report)

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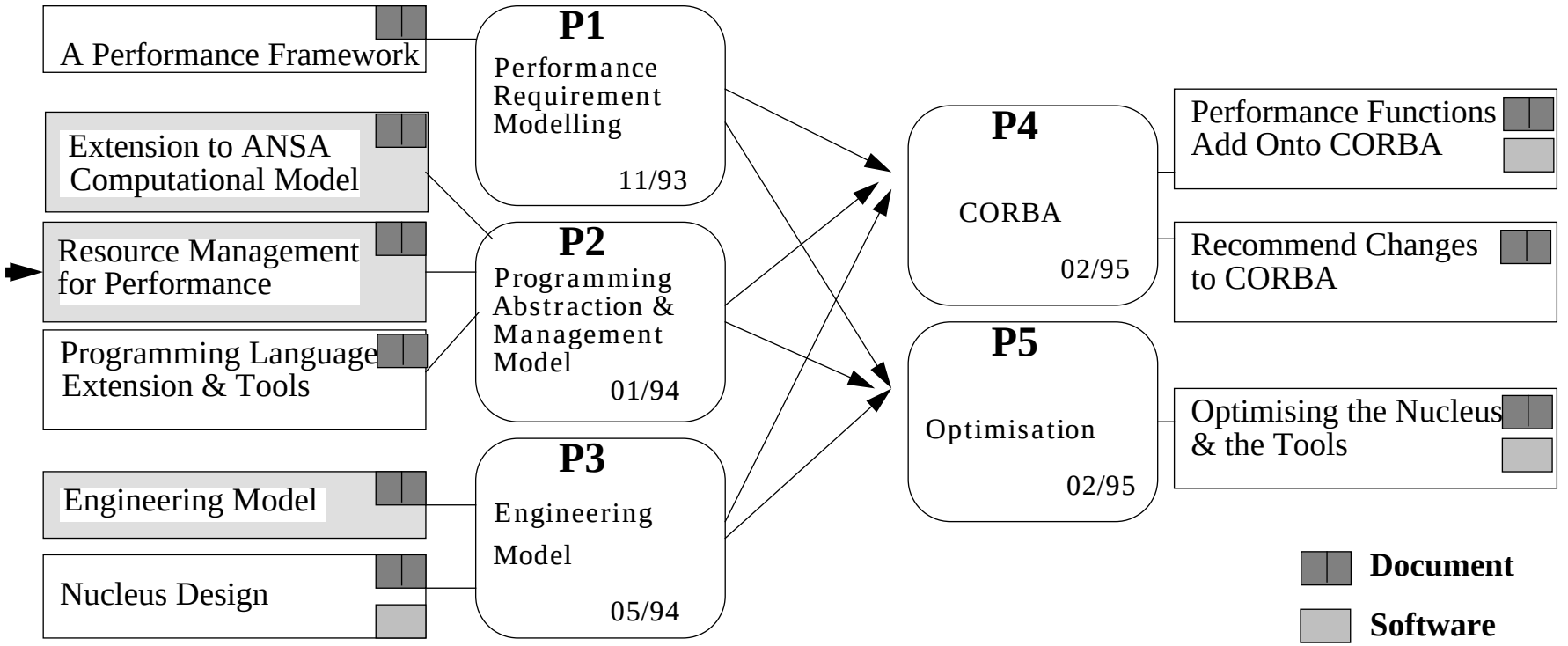
Group Activities



Objectives, Benefits and Outline

- **identifies real-time architectural issues in engineering aspects**
  - **background, rationale and context**
- **benefits**
  - **permits the application of open system architecture to real-time systems**
  - **identifies how and where real-time applications may constrain open systems**
  - **explains how real-time technologies are integrated with open systems**
- **presents the areas of work**
  - **programming model, real-time communication, temporal synchronization**
- **explains initial design**
  - **stress on a design that would stand on both *current* and future technologies**
  - **resource management, real-time scheduling, tasking, communications**
- **documented in *APM.1072***

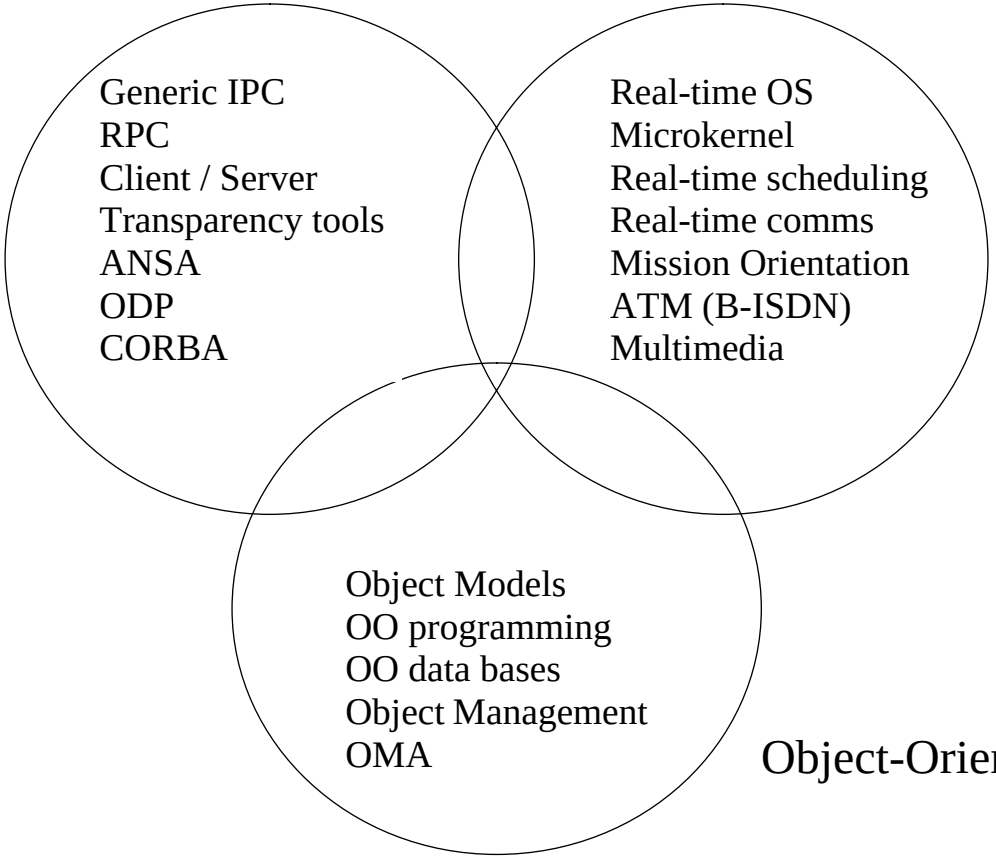
Engineering Initial Design: Context

- practical approach --- check feasibility --- able to demonstrate
- stress on extensions to AW based on available real-time technology
- gain experience of an execution environment for the RT computational model
  - which will be developed in parallel
- input to detailed engineering design
  - alongside an exploration of transparency issues and mechanisms
- explore the relationships between
  - programming environment
  - computational model
  - engineering model
  - execution environment
- guide for prototyping

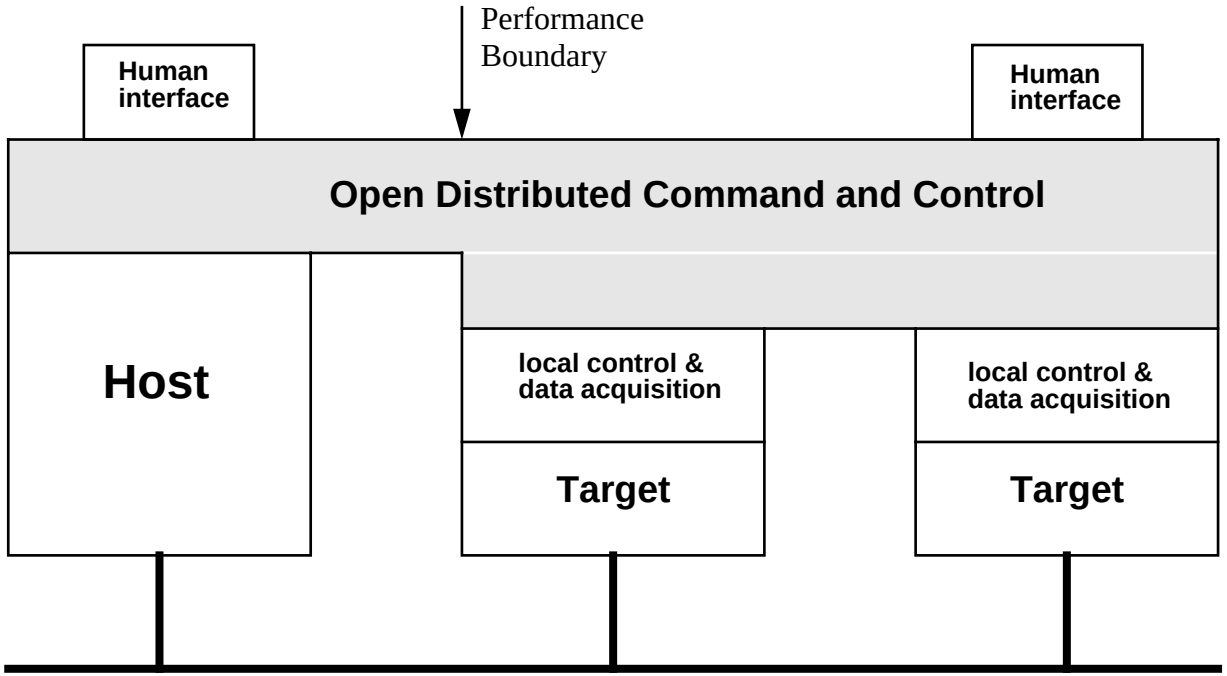
System Integration

- **real-time objects are *first class citizens***
- **a common platform for both real-time and non-real-time objects**
- **a *TOTAL* system design architecture**
- **importance of system integration**
  - **general purpose distributed computing environments are evolving towards real-time systems**
  - **real-time applications are evolving towards large distributed systems**
- **real-time applications increasingly need to cross organisational boundaries**
  - **all distributed systems will become federated**

Contributory Technologies



Target: Supervisory Control



Areas of Work

- **real-time programming model --- predictability, programmer control and mission orientation.**
  - **what differentiates real-time objects from non real-time objects**
  - **mapping real-time programming concepts into ANSA programming concepts**
- **resource management engineering**
  - **tasking, communications, synchronisation**
- **new object execution model**
  - **mapping tasks to interfaces and activities**
- **RPC based real-time communication system**
  - **predictability, timeliness and performance**
- **temporal synchronization --- predictability and timeliness**
  - **adding synchronous concepts**

Real-Time Programming Model

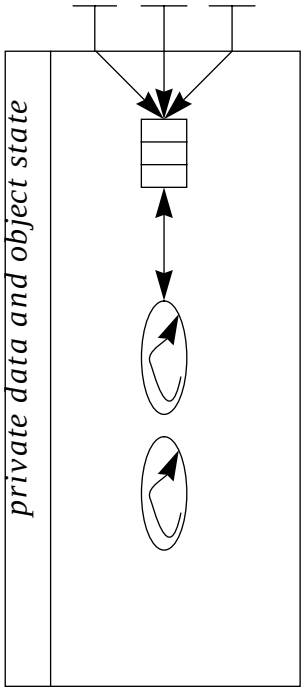
- **object oriented programming model can be divided into two parts**
  - **static part --- typing, interfacing, etc.**
  - **dynamic part --- object execution model**
- **real-time object oriented programming model (or what differs real-time objects from non-real-time objects)**
  - **needs a predictable (taking resource sharing into account) object execution model**
  - **programming resource requirement and management**
- **specifying resource requirement**
  - **QoS --- simple as priority or complex as multimedia QoS (jitter, volume etc.)**
  - **associated with activities, invocations, interfaces and bindings**
- **explicit resource management**
  - **explicit binding**
  - **resource allocation and scheduling (e.g., tasks and communication channels)**

Object Execution Model: Tasking

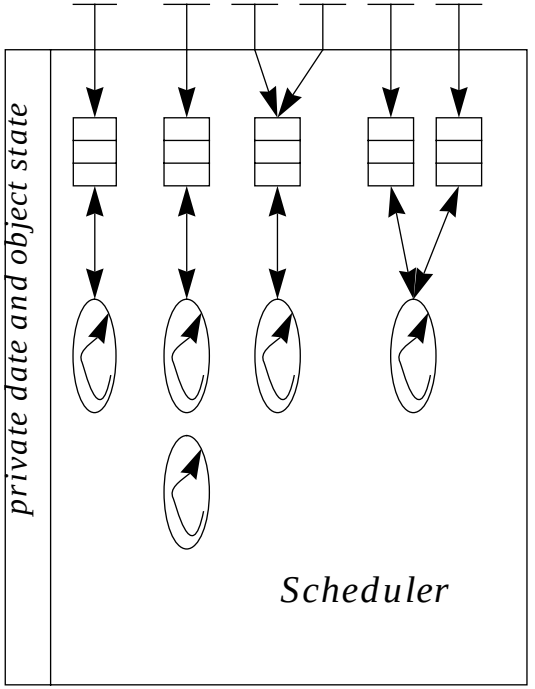
- goals
  - separation of concerns from scheduling point of view
    - the separation of real-time services from non-real-time services
    - the separation of different real-time services
  - permitting the pre-allocation of tasks with possibly pre-allocated special (application dependent) resources to services, e.g. a task with a specific QoS
  - supporting multiple (service based) scheduling schemes
  - enabling application direct control over scheduling
  - engineering --- policy/mechanism separation
- a design
  - a new abstraction called *entry,* which is a thread queue
  - an explicit task/thread *rendezvous* facility

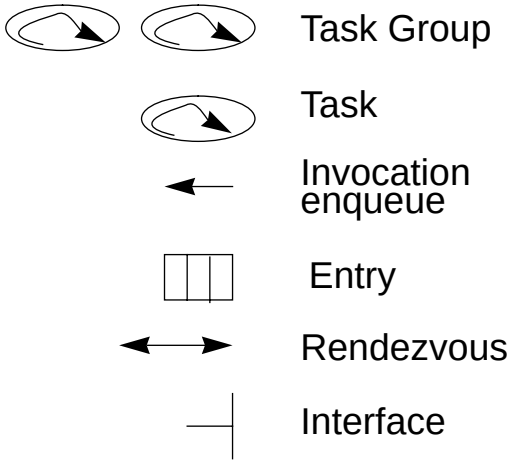
Tasking: Current Engineering Model

- **time-sharing based design --- efficient in resource sharing**

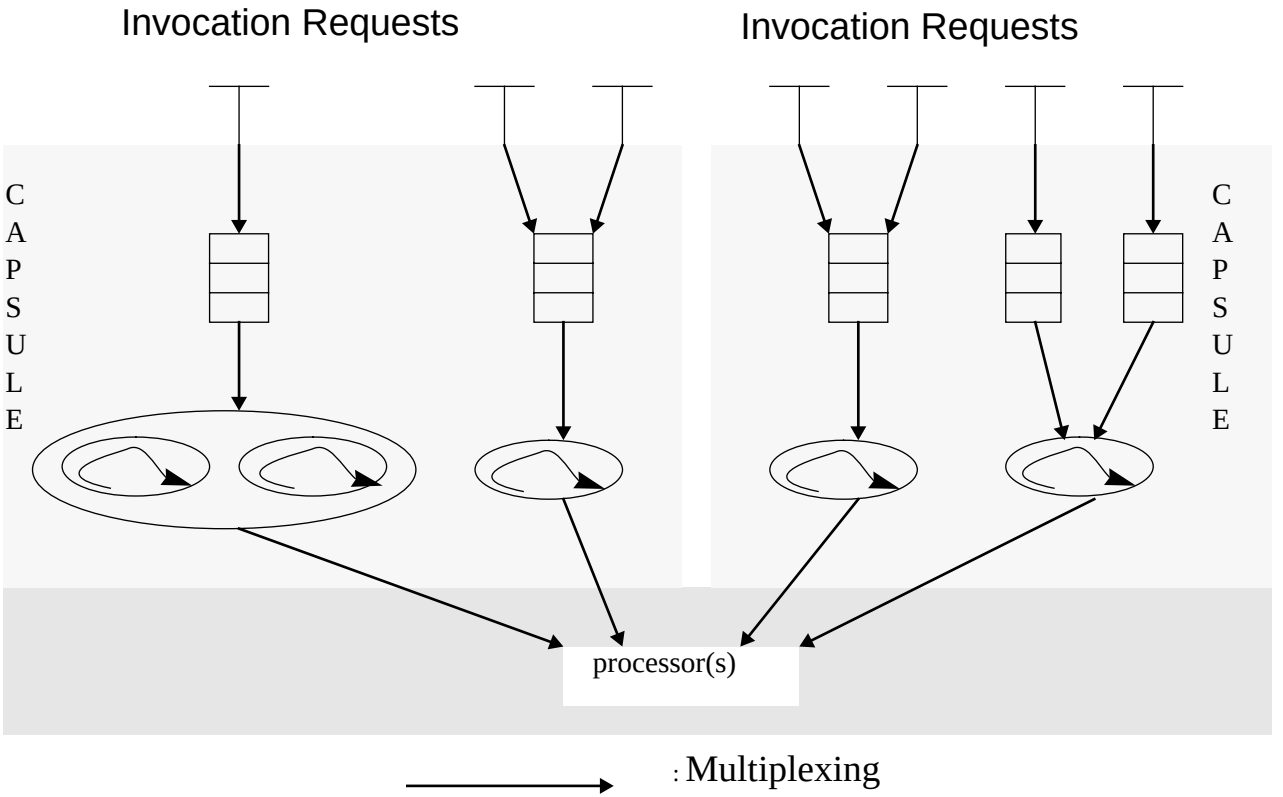


Tasking: New Design





Scheduling: Two Levels



Programming with Priority

- **why programming with priority?**
  - **well understood --- researched for about 20 years**
  - **well supported --- most commercial real-time platforms, e.g. OSF/1, HP/RT, Chorus.**
  - **well accepted --- POSIX 1003.4a, Ada 9X**
  - **widely used**
- **issues**
  - **static and dynamic priorities --- the design of the (task/thread) rendezvous model**
  - **task allocation and task preemption --- vital in a mixed environment to give real-time activities the required response time.**
  - **curb priority inversions --- to bound the computation time of high-priority activities**

Programming with Deadline

- **why deadline?**
  - **intuitive (easy to use) and global**
  - **associated with activities**
- **issues**
  - **deadline as priority in scheduling (doesn't mean guarantee) --- e.g., earliest deadline scheduling**
  - **task preemption is not possible if OS has no support**
  - **deadline and RPC protocol (the meaning of deadline) --- requires the cooperation of processor scheduler and the communication scheduler**
  - **deadline guarantee --- requires many of almost impossible assumptions (activity computing time known, message transportation time bounded, a scheduler (one application, or one address space) controls the whole system cpu resource etc.).**
- **other scheduling schemes --- priority and deadline combination**

Real-Time Communication

- **real-time applications require complicated communication support --- both in functionality and performance**

- **three RPC based designs for:**

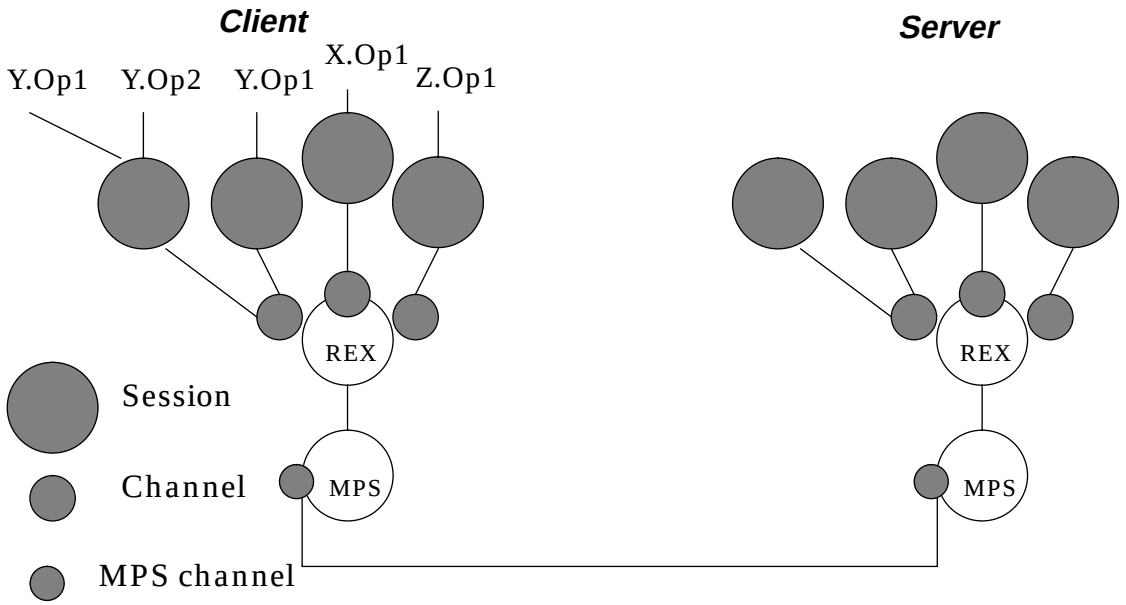
  - **minimize layered multiplexing --- parallel protocol stack to allow the association of communication QoS in the future**

  - **defining the meaning of deadline --- a dependable timed RPC protocol --- for better predictability (important for event synchronization and control)**

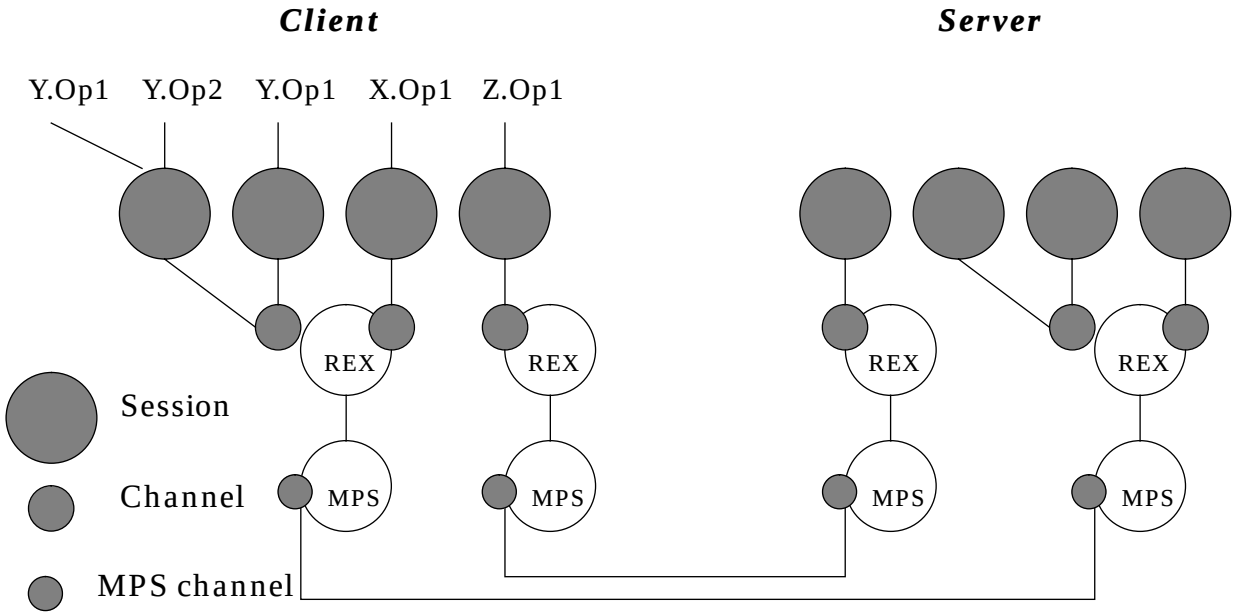
  - **providing an integrated and decomposable RPC protocol stack --- for supporting transportation QoS --- may lead to parametrised transportation protocols for multimedia streams in the future**

Current AW Communication System

- **multiplexing whenever possible --- efficient in resource usage**



New Design: Parallel Protocol Stack



A Timed RPC Protocol

- **associate a deadline with an invocation means:**
  - **the provision of a common sense of time**
  - **the definition of the meaning of the deadline**
  - **the interpretation of the deadline by a communication protocol**
- **the difficulty for a definition --- a deadline has two conflict goals**
  - **goal1: to establish a bound on the time at which the delay in awaiting a reply of an invocation expires**
  - **goal2: to establish a bound on the time at which an invocation is either scheduled to start and/or finish or is *unschedulable* and cancelled, i.e. a *consistent* decision in both a client and its server sites**
- **a design**
  - **using two values, a timeout and a deadline, for separation of concerns**
  - **using different relaxations to allow the programmer to choose different *realistic* combination of goals, i.e. a *typed* deadline**

Remaining Issues

- description of temporal relations
  - the synchronous model
  - the signal extensions
  - a state machine interpreter
- a QoS architecture
- a binding architecture
- a performance transparency architecture
- a stream (or non-operational) interface

Summary

- **architectural**
  - **real-time issues can be addressed in an *OPEN* architecture**
  - **boundaries pose the biggest problem**
- **computational**
  - **the computational model can be extended to cater for real-time programming (no need to redesign from scratch)**
- **engineering**
  - **a real-time open system engineering model is viable**
  - **real-time technologies can be integrated with open architecture**