Networking Aspects of a Distributed Resource Management Architecture

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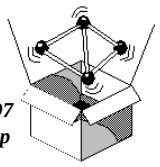
Opensig Spring '97 Workshop



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Overview

- Introduction to the Architecture
- Implementation Completed
- Connection Management and QoS Routing
- Support for Heterogeneous Networks
- Requirements of a Binding Interface Base
- Future Work

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Project Context

The development of a framework for the deployment of multimedia services in a broadband environment

This includes :

- Investigating approaches to open signalling for resource control;
- Providing support for heterogeneous networking;
- Development of QoS assurance mechanisms, through monitoring, management and adaptation;

The work fits into the context of the "Information Services Supermarket", an information network prototype

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Main Concepts

Our work is based on :

- The incorporation of stream interfaces to represent continuous interactions between entities;
- The use of binding object abstractions to encapsulate the communications and processing between two or more stream interfaces;
- Emphasis on a high level of complexity in the end system;
- The concept of "hierarchical binding" to allow scaling to a large number of components in both the network and the end system;

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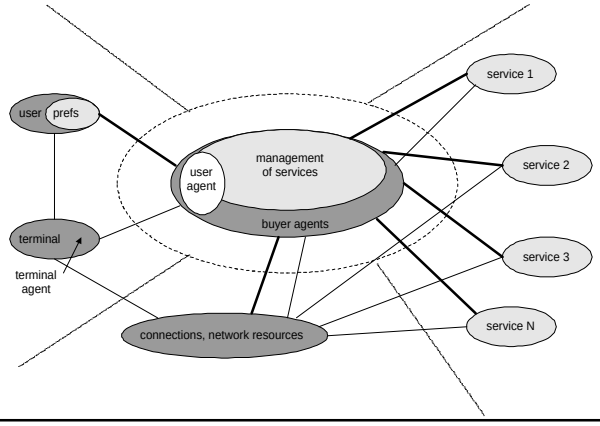
The Information Services Supermarket



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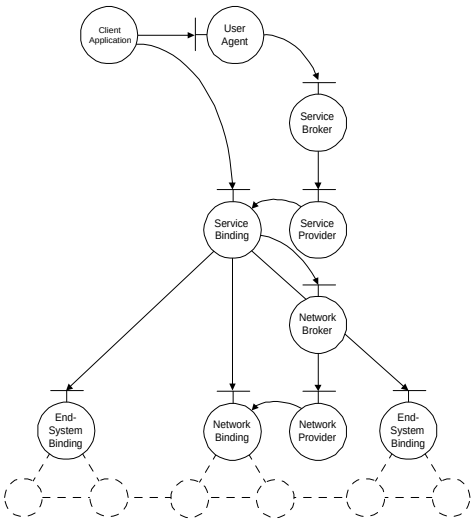
Service Brokering



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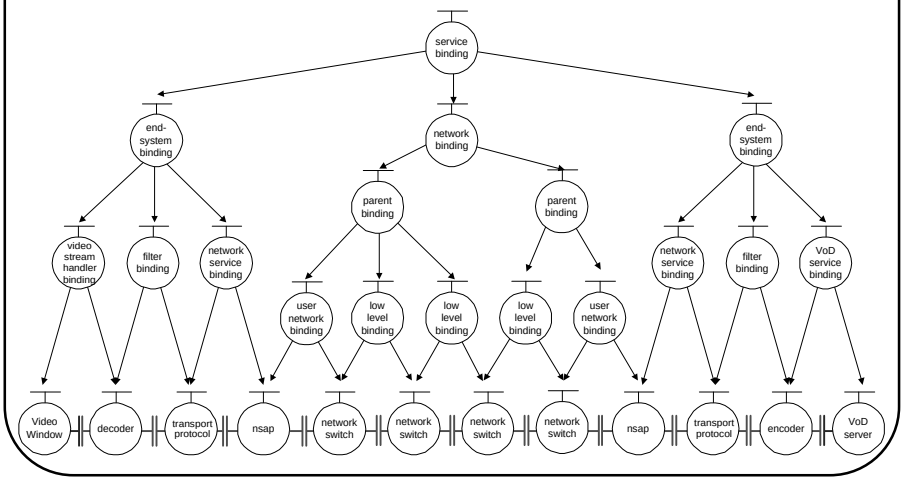
Overall Binding Model



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Implementation Details

- "Hybrid" Model
  - Microsoft COM for engineering stream interfaces
  - CORBA for engineering distributed control interfaces
- Chorus COOL-ORB CORBA Implementation
- End-system Components
  - Windows NT 4.0 workstations
  - ActiveMovie architecture
- Network Implementation
  - FORE ASX200 ATM switch
  - Winsock2 beta implementation of AAL5 service provider (incorporating UNI 3.1 signalling)

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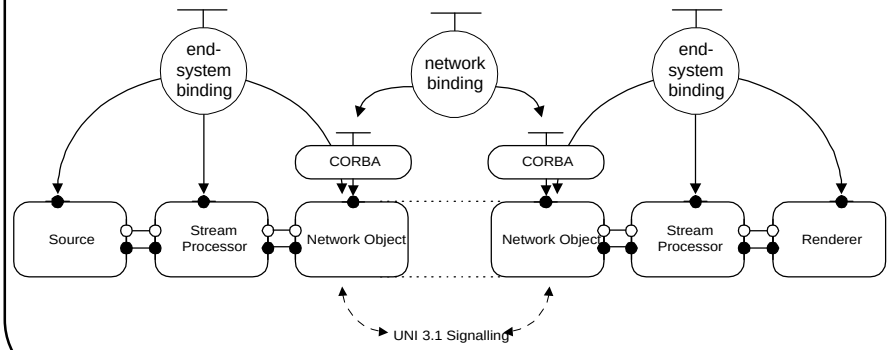
Current Implementation



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Connection Management Objectives

- Connection Management present within the entire network binding hierarchy
- Support for interoperability between different network types in a multivendor environment
- Provision for third party connectivity
- Provision of a scalable network topology
- Support for multiple types of media flow
- “QoS based” routing and resource reservation

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QoS Based Routing

- The question of routing :
  - The two main approaches to routing are hop-by-hop, and source routing;
  - Many algorithms for routing exist, often with different aims; shortest path, lowest cost, most reliable… etc…
  - Real-time services require consistency within the network;
  - QoS based routing involves finding a path subject to multiple constraints (such as bandwidth, delay, loss probability);
- Within our model :
  - Routing decisions are based on the QoS requirements of a given stream, in order to provide end-to-end QoS guarantees;
  - Connections requiring the same level of QoS may use a different path because of variations in the availability and cost of resources;

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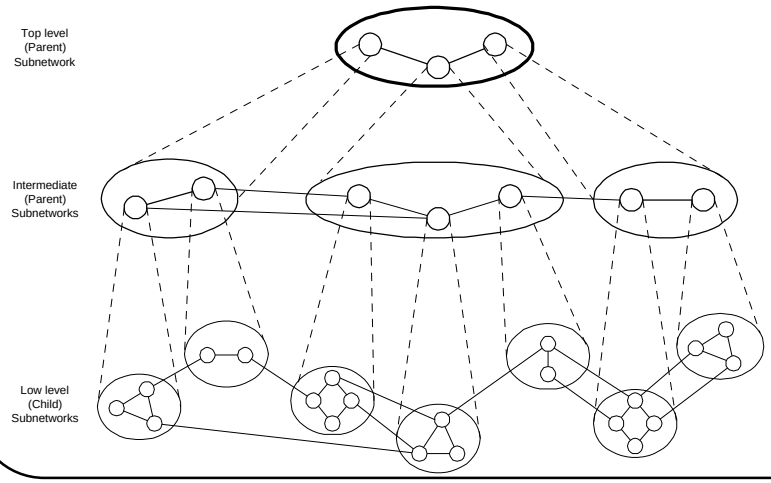
Scalable Network Hierarchy



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Routing Information Requirements

Within the network hierarchy, a certain amount of routing information must be present

- For each *logical* subnetwork :
  - knowledge of the connection topology of the subnetwork nodes;
  - details of the QoS characteristics of links between nodes;
  - an interface repository specifying binding interfaces for the different services available on the subnetwork links;
- At the *physical* subnetwork level :
  - topology knowledge and QoS characteristics in terms of physical "network specific" requirements;
  - stream interfaces defining available physical network services;

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Routing Updates

Network capacity information will require updating after the establishment of a connection. This can take two forms :

- Updating of low level network resources
  - a new connection has a direct effect on one or more links;
  - advertised network binding objects, within the interface repository, are adjusted to reflect the overall changes in resource availability;
- Updating of parent subnetwork(s)
  - updates take place when a new connection has repercussions that will affect the services being advertised in the layer above;
  - updates often only traverse a small number of subnetwork levels; this ultimately depends on the importance of the link involved, its load prior to the new connection, and the characteristics of the new connection;

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Connection Set-up Overview

- The Service Binding Object instantiates a Network Binding Object, with a point-to-point requirement
- The Network Binding Object then initiates routing in a top down manner
- At each level in the logical network, connection acceptance will be in terms of whether the requirements for the connection can be met by an available binding object
- If an individual set-up transaction is not successful, a “crankback” mechanism can be used to find an alternative path
- When routing reaches the lowest level of the hierarchy, a mapping takes place to map onto network specific parameters
- Once a connection is accepted, routing updates are made

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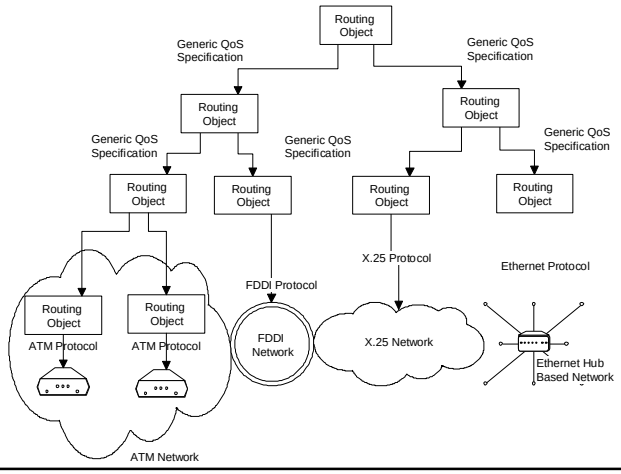
ReTINA QoS Routing



ReTINA

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ReTINA Subnetwork Components

Functional components:

Broker: stores and maintains the parameters that estimate the network capacity

Router: determines a route based on these parameters

Admission Tester: aggregates the individual link and subnetwork parameters into end-to-end figures and decomposes requests hierarchically

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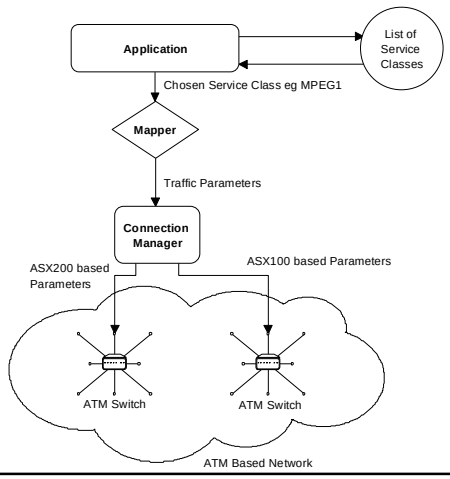
ReTINA Three Levels of QoS



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ReTINA Generic QoS Specification

For QoS Routing ReTINA requires a means of heterogeneously modeling QoS to make considered choices for routing across each subnetwork. ReTINA propose the following parameters:

a) Average Transmission Rate (ATR)
b) Maximum Transmission Rate (MxTR)
c) Minimum Transmission Rate (MnTR)
d) Maximum Burst Size (MBS) - maximum time application will transmit above ATR
e) Maximum Delay (MD) - end to end
f) Maximum Delay Variation (MDV) - jitter
g) Maximum Error Rate (MER) - a bit error rate
h) Consecutive Error Rate (CER) - number of consecutively errored bits
i) Guarantee Type (GT)
j) Security Required (SR)
k) Maximum Cost (MC)

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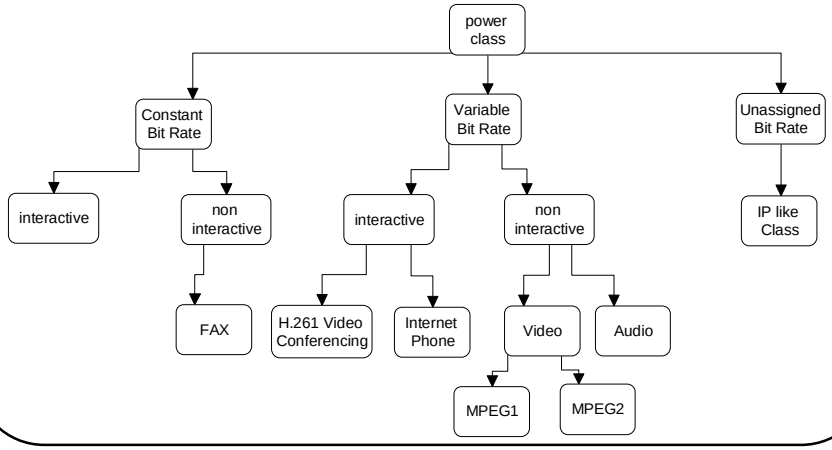
ReTINA Hierarchical QoS Classes



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Useful Features

- The use of Generic QoS (GQS) parameters within ReTINA
  - GQS parameters are relatively simple and therefore mapping is straight forward and not computationally complex;
  - The classes and parameters may possibly find a role in the stream interfaces of the binding hierarchy work;
- The use of binding objects and stream interfaces within the binding hierarchy work
  - Routing is based on stream specific requirements (and therefore the availability of suitable binding objects);
  - Binding objects go beyond connection set-up, allowing for the provision of QoS monitoring;

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Requirements for a Binding Interface Base

- Interfaces within the *xbind* Binding Interface Base are specified solely in terms of control interfaces ;
- Our requirements extend this to include :
  - the ability to model both *control* and *stream* interaction types;
  - within the network, the provision of layered interface repositories to represent the service components / bindings available at the different sub-network levels;
  - the ability to handle both static and dynamic stream interface characteristics;

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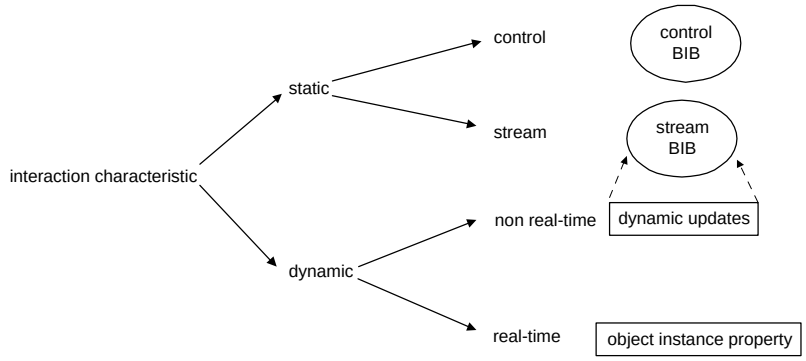
BIB Requirements (cont…)



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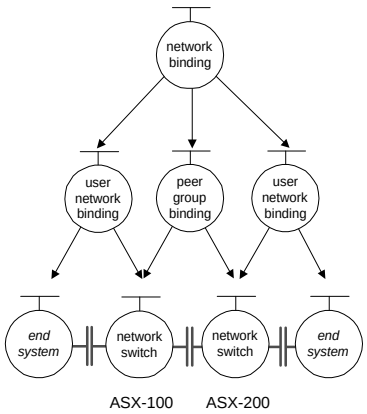
Network Binding Implementation



Initial network implementation to provide :

- proof of concept;
- basic resource reservation and connection set-up;

Open issues :

- suitability of ASX-100;
- access to network QoS parameters
  - Open API ? Simulation ?

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Future Work

- Continuing development of end-system components
- Development of prototype network implementation
  Target system: Fore Systems ASX100 + ASX200 ATM switches, WinNT workstations with Fore Systems ATM PC200 adapter cards
- In-binding QoS monitoring and management mechanisms
- Further analysis of group communication requirements
- Further analysis of hierarchical QoS based routing requirements

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