# An Architecture for Performance and Configuration Management on Xunet

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## *Some History*

Summer 1992:

- First implementation of an OSI management agent for Xunet.
- Investigated the technology behind OSI Management and its applicability for emerging ATM networks
- functionality: Managed Objects for hardware modules and the first version of the call processing software

Summer 1993:

- Extension of the OSI agent to include objects for performance management
- Extensions to the Xunet signalling software to allow external monitoring of call level activity.
- First implementation of a network browser tool, retrieving information from agents installed in Xunet switches.

November 1993:

- First release of the Xunet Management System package, containing the OSI agent, and several management applications.

January 1994:

- Second version of the browser tool. Can produce time-series graphs of the traffic on Xunet, by retrieving information directly from the agents.
- Advanced MIB browser tool with integrated event reporting subsystem.

February 1994:

- Improved OSI agent with MOs for all Xunet hardware modules
- Combined Virtual Circuit / Virtual Path signalling software in operation.

## *Objectives of the Network Management Project*

Configuration and Fault Management:

- Hardware configuration of every switch (Queue/Line modules etc.)
- Periodic checking of the maintenance bus for errors -> event reports.
- Expert fault diagnosis system (in progress)

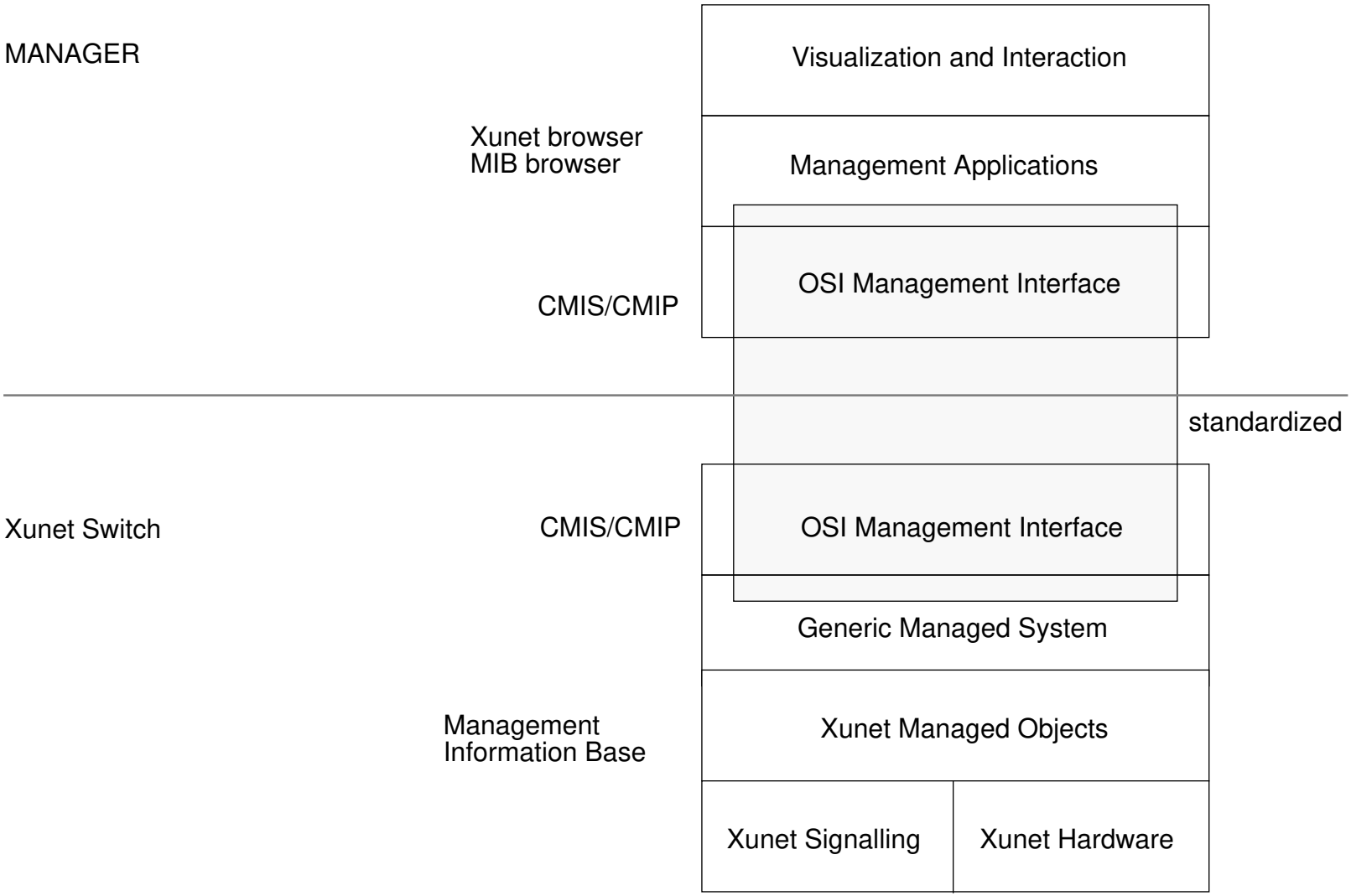
Performance Management:

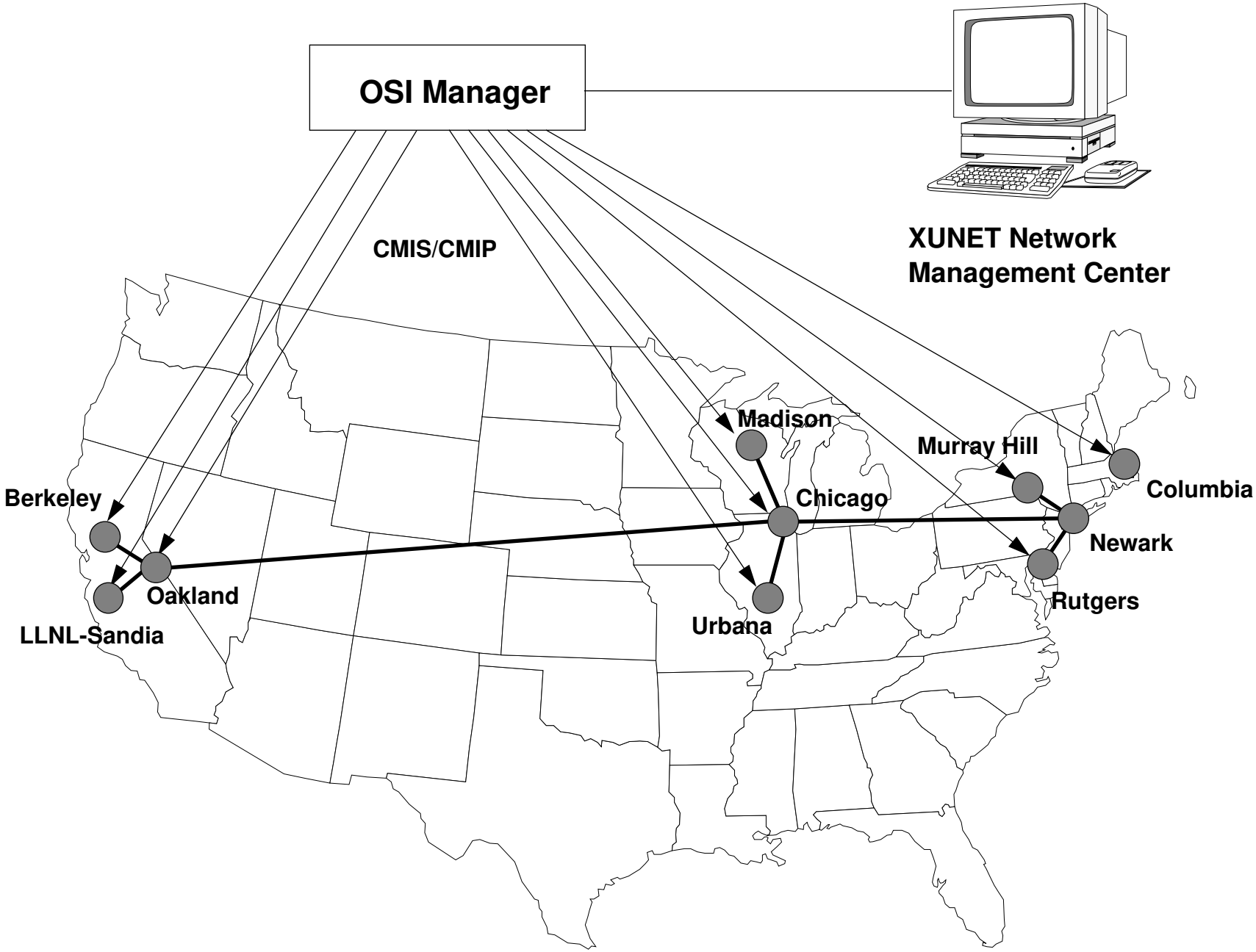
- Observation of call and cell level information
  call level: call arrival rate, call blocking rate, call setup time etc.
  cell level: cell loss, queueing delay, link utilization etc.
- Determination and installation of the Virtual Path distribution policy
  trade-off: Minimize call processing load
  Maximize utilization of network resources
- Subsequent monitoring and control of VPs, to adjust to traffic fluctuations.

Human-Machine Interaction:

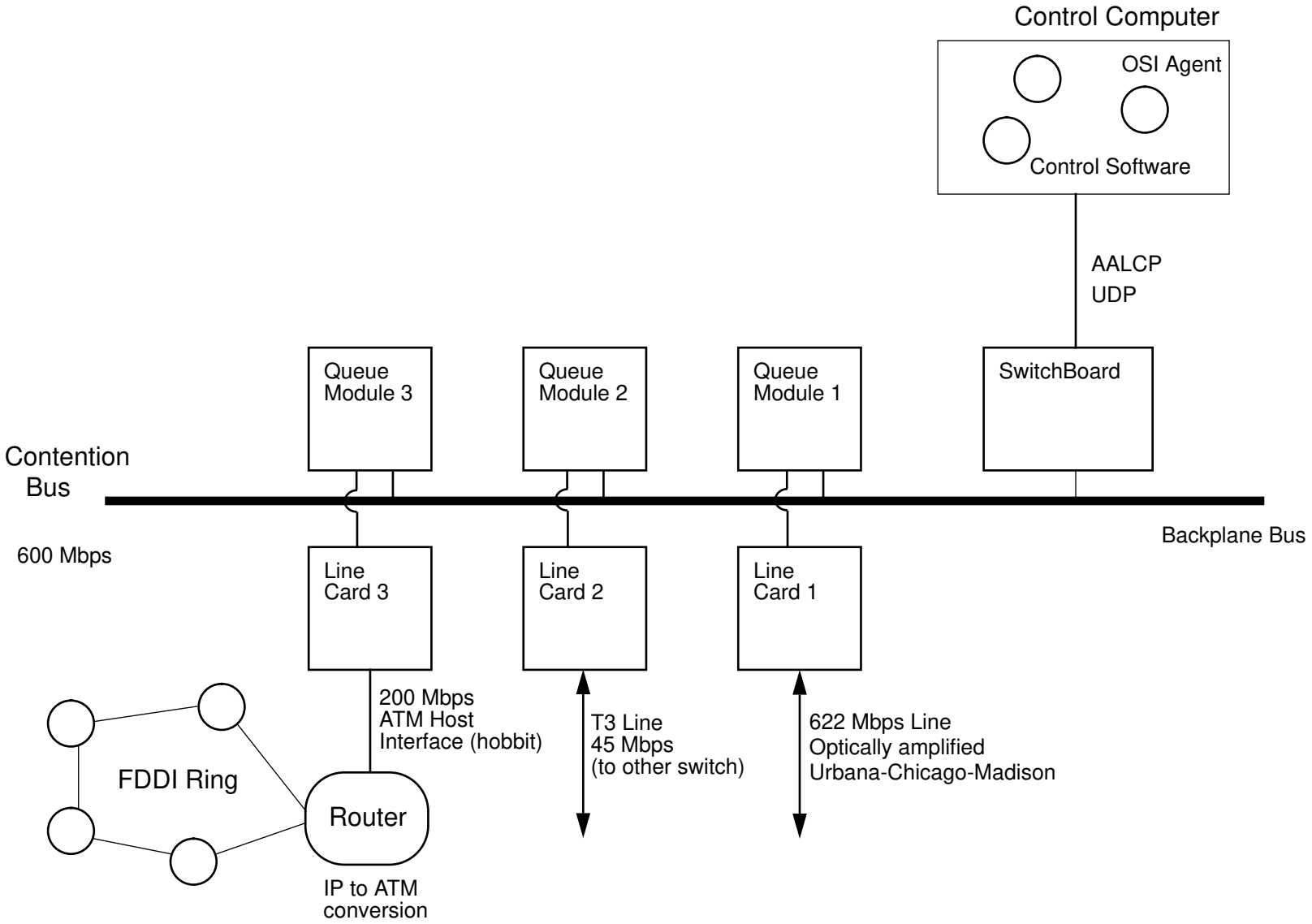
- Minimize navigation time for *distributed* information
- Increase the observing and controlling ability of the manager by presenting integrated network *views*, rather than raw data.
- Minimize response time in emergencies, through a comprehensive control interface.

*Overview of the Management System*

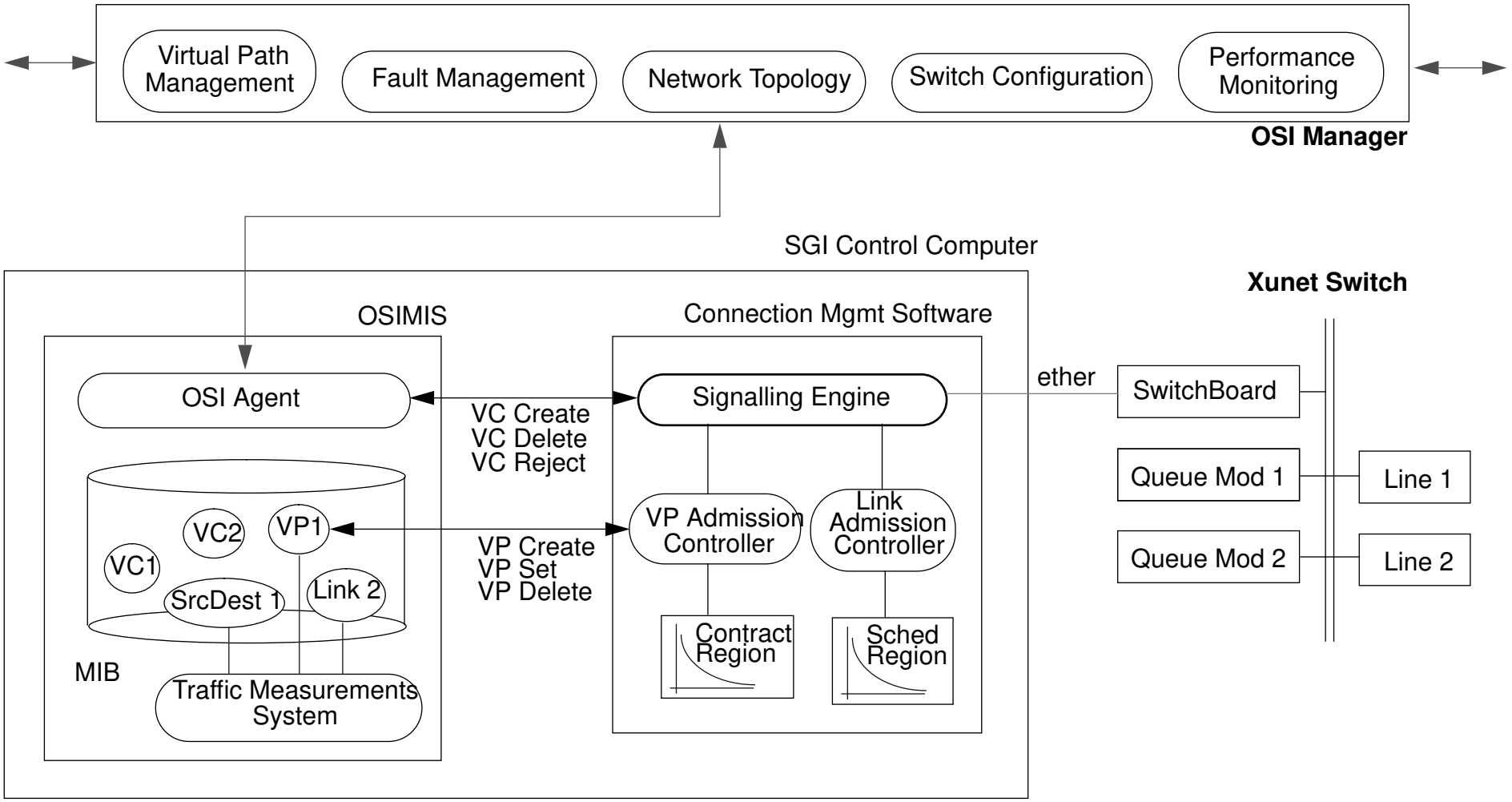



OSI Manager
CMIS/CMIP
XUNET Network
Management Center
Madison
Murray Hill
Columbia
Berkeley
Chicago
Newark
Oakland
Rutgers
LLNL-Sandia
Urbana

*The OSI agent on Xunet*



*System Structure*



## *Performance Management Capabilities*

Monitoring of traffic on links or source-destination pairs.

- Call Arrival rate
- Call Blocking rare
- Number of Calls in progress
- Call holding time
- Call setup time
- Available networking capacity (Schedulable region)
- Allocated networking capacity (obtained from the traffic descriptor)
- Used networking capacity (measured from the switch cell counts)

Control capabilities:

- Virtual Path distribution
- Virtual Path performance monitoring and control

*The Virtual Path Distribution problem*

**Given**:

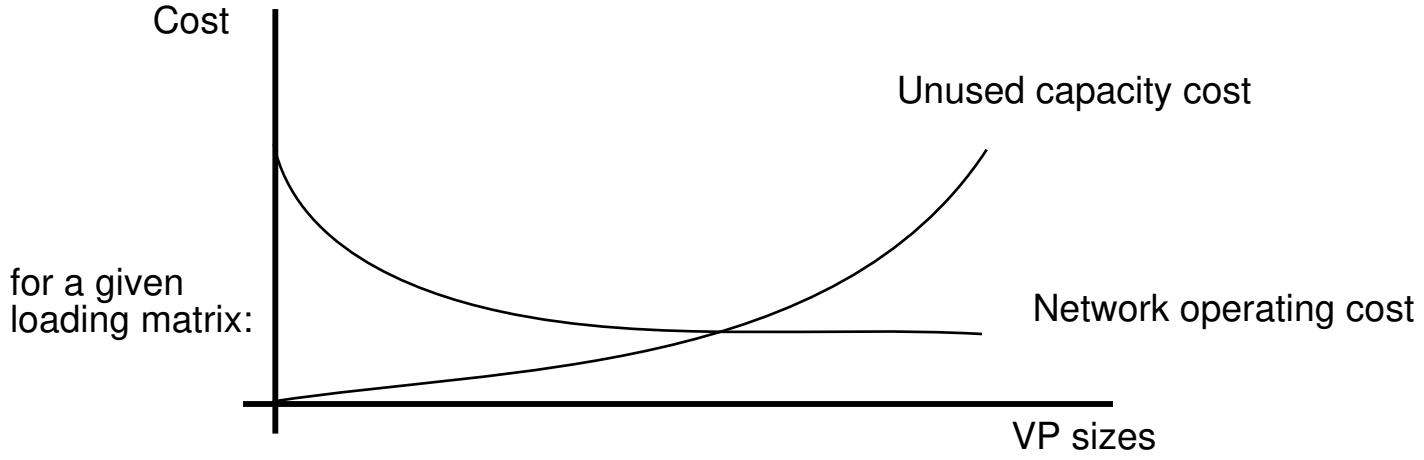
Network Traffic Loading matrix (call arrival rates, call holding times)
Network Topology
VP Call blocking objectives

**Calculate**:

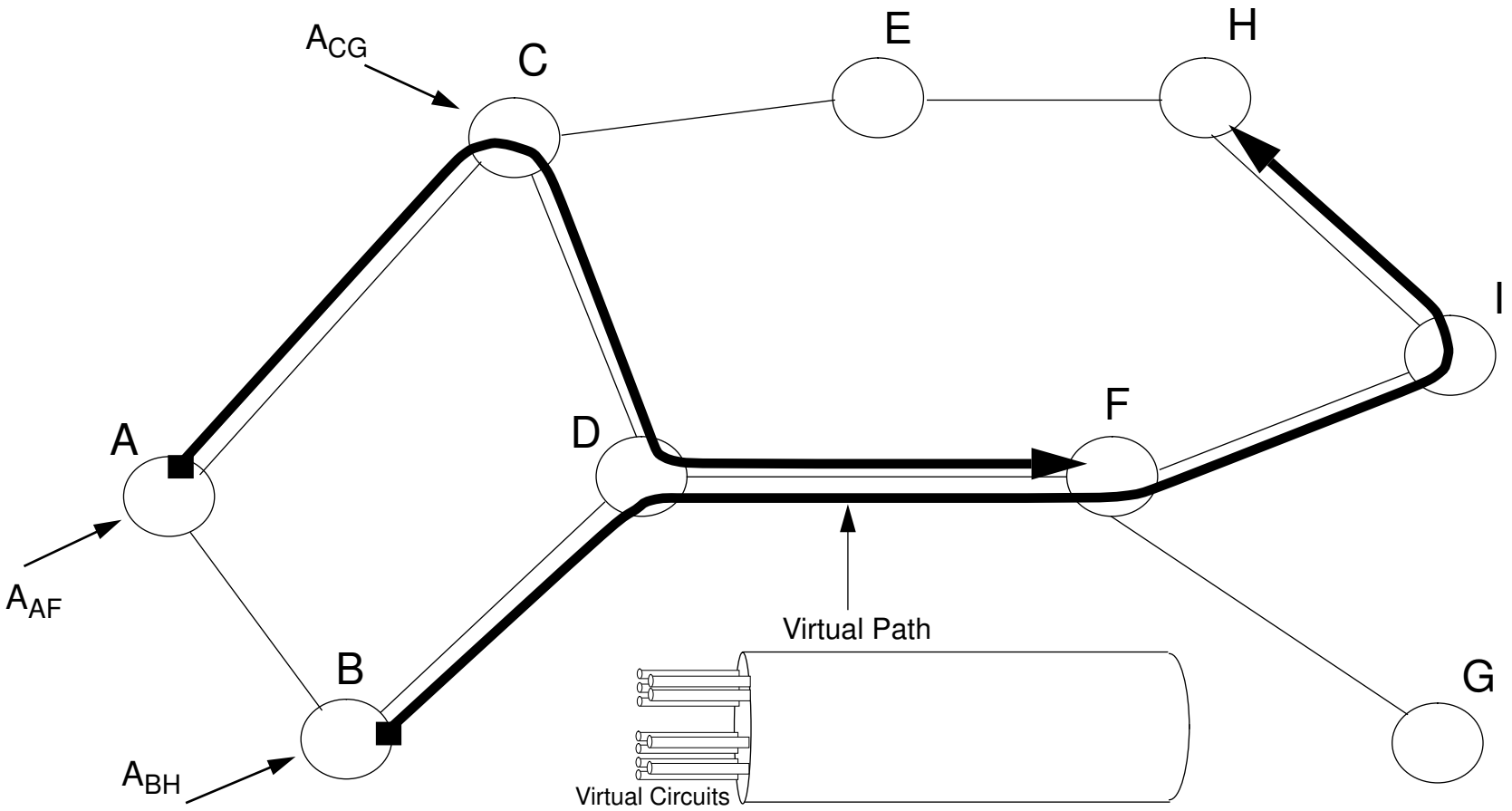
Virtual Path Sizes
Virtual Path Routes

**Such that**:

The cost from reserving networking capacity is balanced by the gain from reduced network operating costs (reduced call setup time, reduced call processing load in tandem switches).

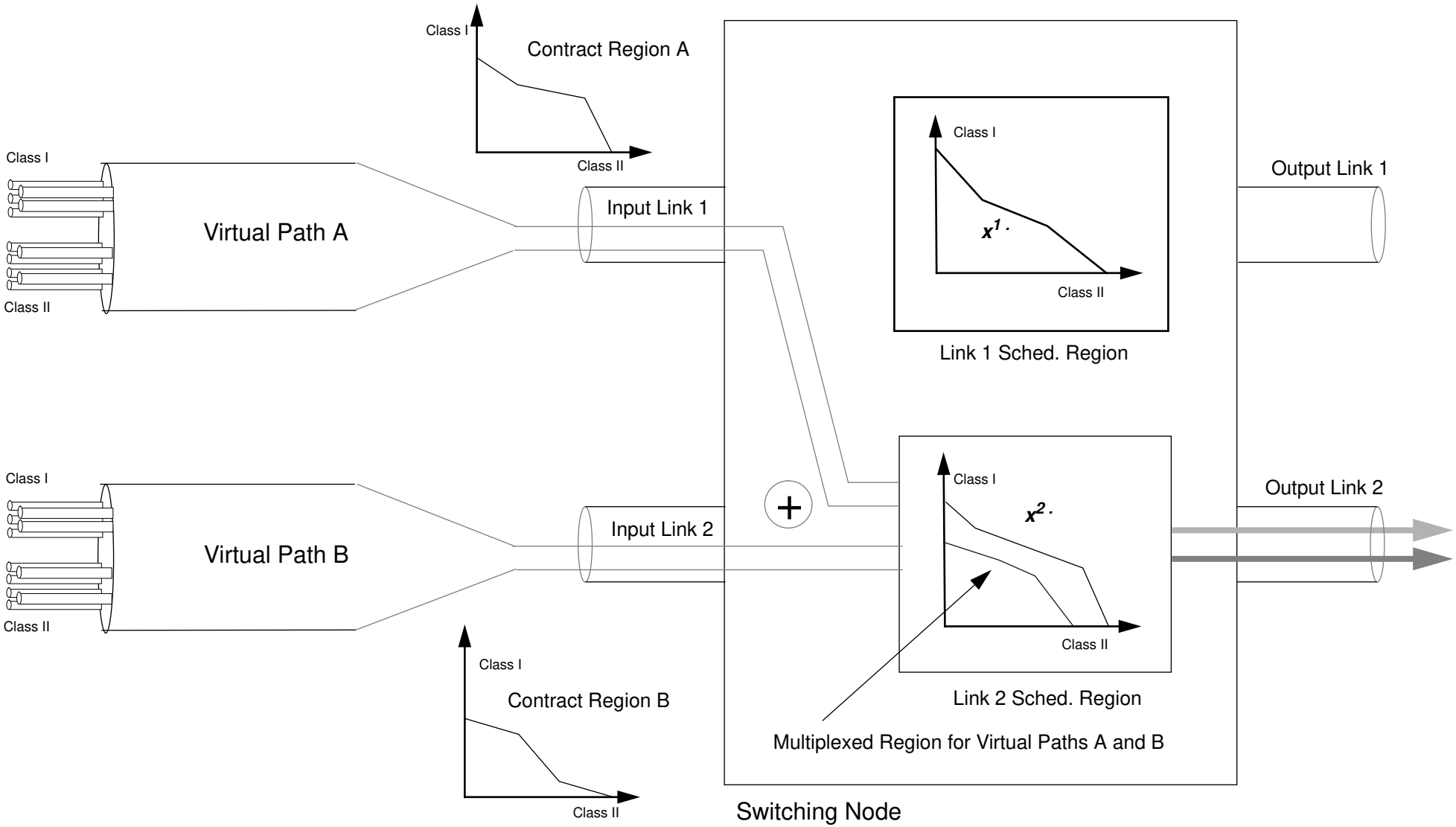


*Example*



*The Network QOS Mechanisms*

## Guaranteeing QOS for Virtual Paths: The Schedulable Region and the Contract Region



## *The Solution*

Heuristic Approach (centralized):

- Monitor network parameters: (traffic load, VP utilization, blocking rate)
- Manually install and control the size of virtual paths to achieve acceptable performance.

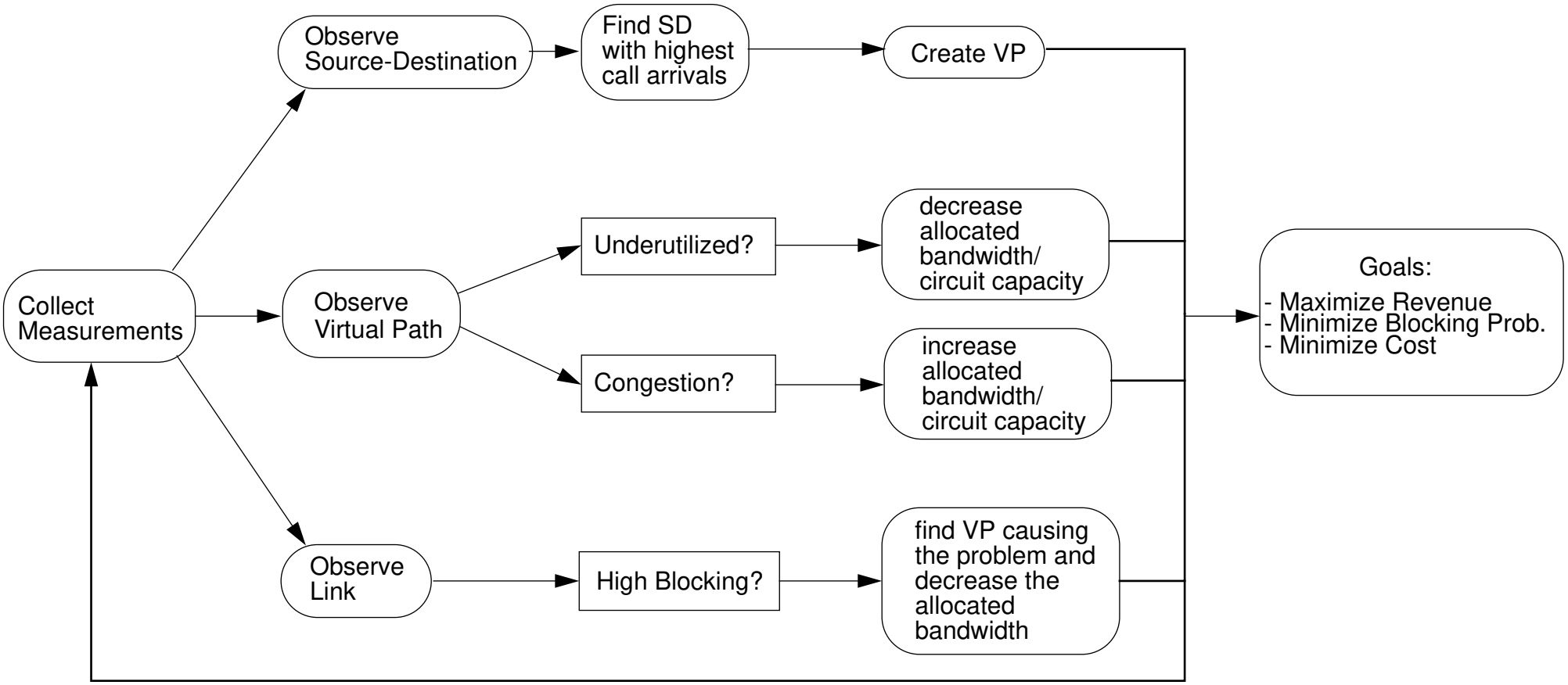
Analytical Approach (centralized):

- Obtain measurements from all the sites
- Solve a linear program that provides the VP sizes with the minimum network cost.
- Configure the Virtual Paths.

Combination of the above strategies:

- Calculate the VP distribution analytically every hour (to take into account slow changes in traffic load)
- If trouble spots appear, adjust the VP distribution dynamically, using the heuristic approach

*Heuristic approach:*



## *The OSI Manager*

Main Control Panel:

- θ Topological view of Xunet switches/routers with the AT&T netwidget
- θ Association establishment with OSI agents
- θ Selection of a source and a destination mode, and of any observation mode
- θ Slot configuration information for switches
- θ On-screen Virtual Path display per source node
- θ Reverse mapping of VPs travelling on physical links

Connection Editor:

- θ Displays measurements for Links, SD pairs and Virtual Paths.
- θ Editing of Virtual Path Parameters
- θ List of VCs.

Moving Time Series Window (for VCs and Observation Frames)

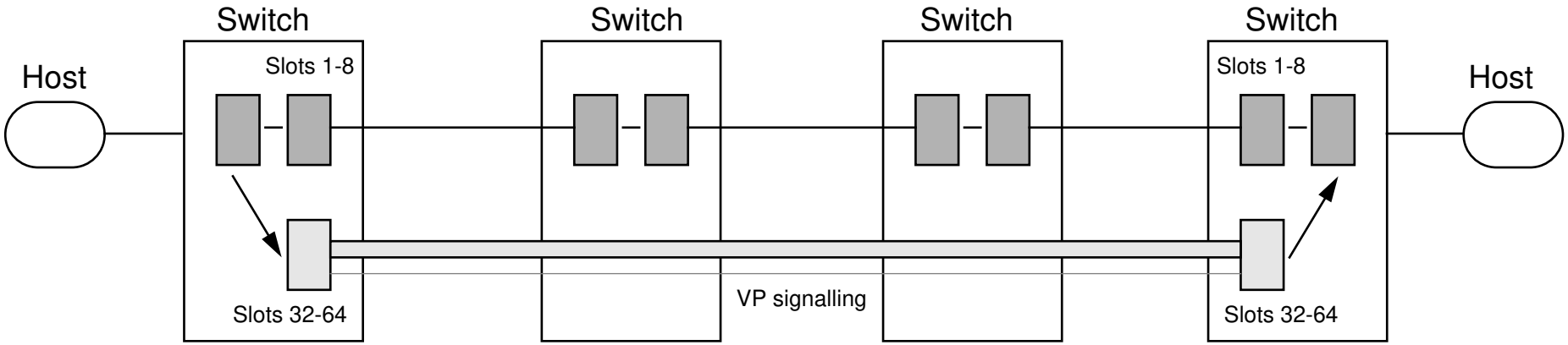
- θ Provide moving time series plots for attributes of interest (e.g. the average used networking capacity)
- θ Can play a “movie” of the attribute over a 24hr period (in progress).

Object Browser

- θ Configuration Information
- θ Management Information Tree
- θ Discriminator editor and Event Report presentation system

## *Virtual Path Signalling*

- θ Up to 32 Virtual Path terminations per node
- θ Virtual Paths exist on “virtual switch slots”, which ensures compatibility with the existing SVC software.
- θ Separate signalling channel between the termination points
- θ Best effort resource allocation of Contract Regions
- θ New channel space manager
- θ VPs are persistent objects. They can survive “epochs” of the signalling software, without explicit re-initialization.
- θ VPs are installed only between Xunet switches. Termination at Xunet routers will be supported in the future,
- θ Admission control based on the Contract Region and a number of “served” destinations.
- θ Easy to use API for VP creation, deletion and rearrangement



## *Conclusions*

- One of the very first implementations of the OSI management framework on an ATM testbed.
- We now have a strong foundation on which we can build fast new management applications.
- The workload has shifted from investigating network management technology to designing integrated management solutions.

## *Future Work*

- Extension of the management capabilities on Host computers
- Powerful visualization techniques on the manager side
- Extensions for software and log file management