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Next Generation Networks
MultiService Network Design

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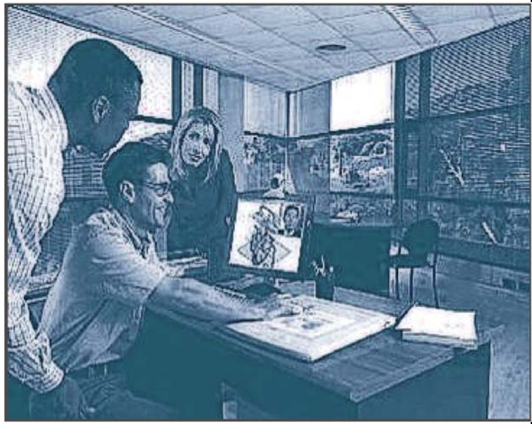
Operators face difficult network planning and design questions

- Can your current planning methods handle the complexity of network design with multiple applications on a single shared infrastructure?
- Can you estimate the impact of your applications on the traffic in an IP environment?
- Does your network architecture and design accommodate varying QoS and reliability for multiple applications?
- Do you have a unified process spanning multiple network layers and multiple vendors' equipment?
- Does your process allow for uncertainty in forecasts?
- Does your business case prove in, and how sensitive is it to various assumptions?



Next Generation Network transformation is a complex undertaking
and requires a unified multi-service, multi-layer and multi-vendor approach

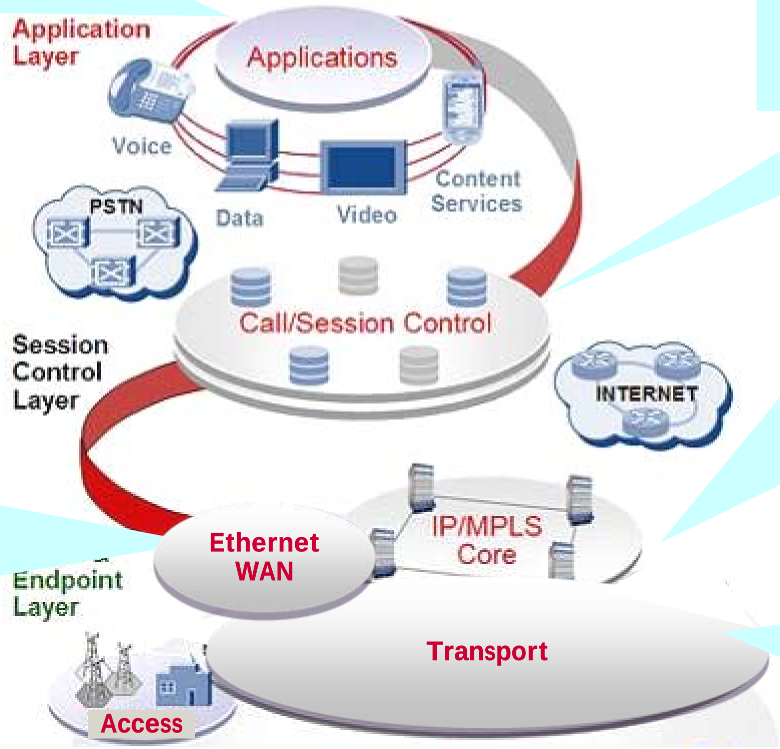
A Unified Multi-Layer Approach to NGN Design

Application Characterization and Traffic Modeling

All of the NGN applications must be characterized and traffic models developed in order to calculate traffic loads on all the network layers

Control Plane

The signaling traffic loads must be used to determine the optimal control network topology and configure nodes



Converged IP/MPLS Core

The signaling and bearer traffic loads, broken down into Classes of Service, must be routed and the nodes and links configured

Carrier Ethernet

The traffic must be assigned to Spanning Trees based on Classes of Service, which must be designed and nodes and links configured

Optical Transport

The required link bandwidths and application protection needs will drive the optical transport design

- ❑ Quality of Service and Reliability built into each layer of the design
- ❑ The entire results can be analyzed in a single business case

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Application Characterization and Traffic Modeling

NGN requires new techniques for modeling network traffic in order to facilitate introduction of new services

- **Quickly assess the impact of introducing a new set of applications**
- **Avoid traffic congestion and consequent degradation of service**
- **Control both Capex and OpEx by avoiding extensive over-engineering**

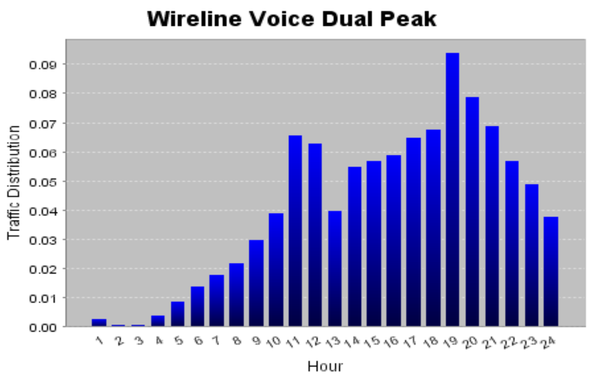
Application Type	Market	Session	Inter-Networking	Quality of Service	Bandwidth
IP Multimedia	Total Addressable Market	Call Flows	On-net	Delay	Mean Bit Rate
Data	Subscriber Locations	Daily Sessions	Peer NGN	Jitter	Peak Bit Rate
PSTN-Like	Take Rates	Traffic Profile	PSTN	Packet Loss	Burstiness
Public Interest	Growth Forecast	Duration	Internet	Blocking	Codec
Transport	Device Types	Number Transactions		Set-up Delays	Payload
Blended		Push vs. Pull		Availability	Packet Size
		Number Endpoints			Overhead
		Group List			
		Status Changes			

Application-Driven Traffic Models are needed to:

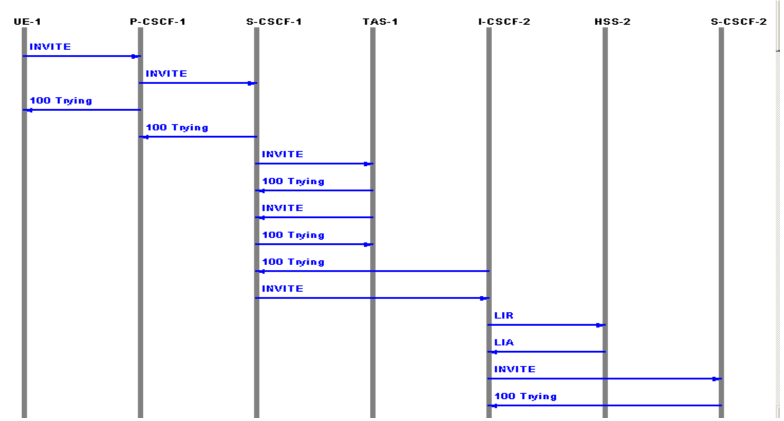
- Systematically determine the impact of a specific service mix
- Calculate aggregate signaling and bearer traffic loads, according to a number of dimensions
- Provide a consistent and re-usable traffic model used for all layers of the design
- Allow “what if” studies where application assumptions are varied and fed through the design

Characterizing Applications and Calculating Traffic

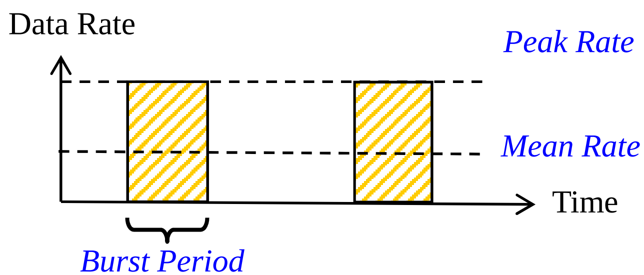
Daily Traffic Profile



Call Flow

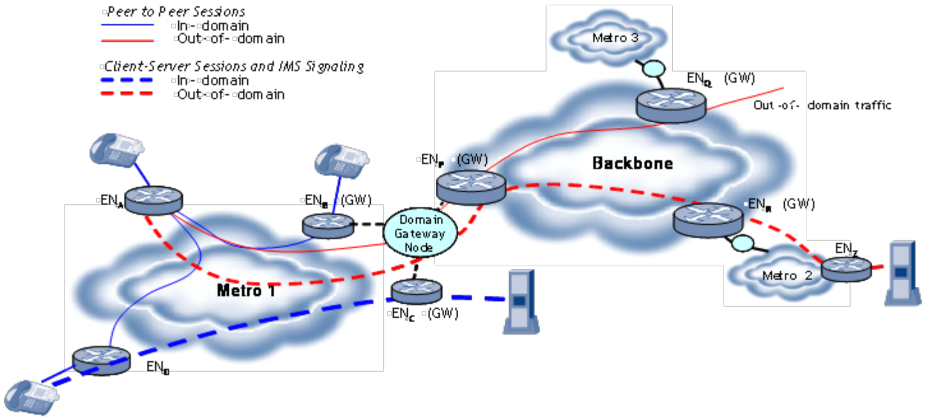


Traffic Descriptors



Effective bandwidth calculated based on multiplexing and traffic descriptors specified for dynamic applications

Internetworking



- For each application, calculate the point-point demands and loads on control functions
- Aggregate traffic with common Quality of Service requirements for routing

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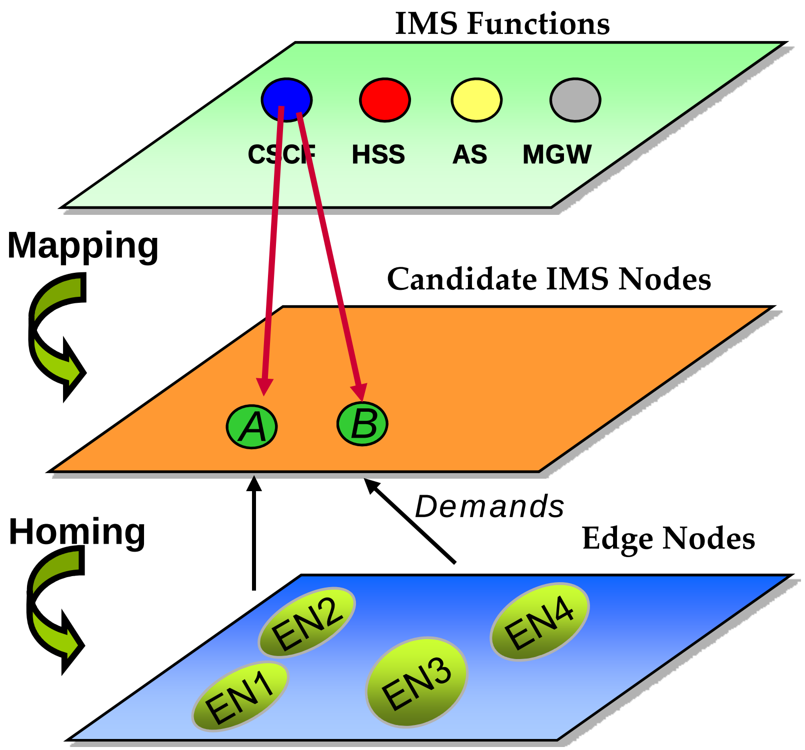
Designing an IMS Control Layer Network



The load on the IMS control functional elements is input to the design which determines the:

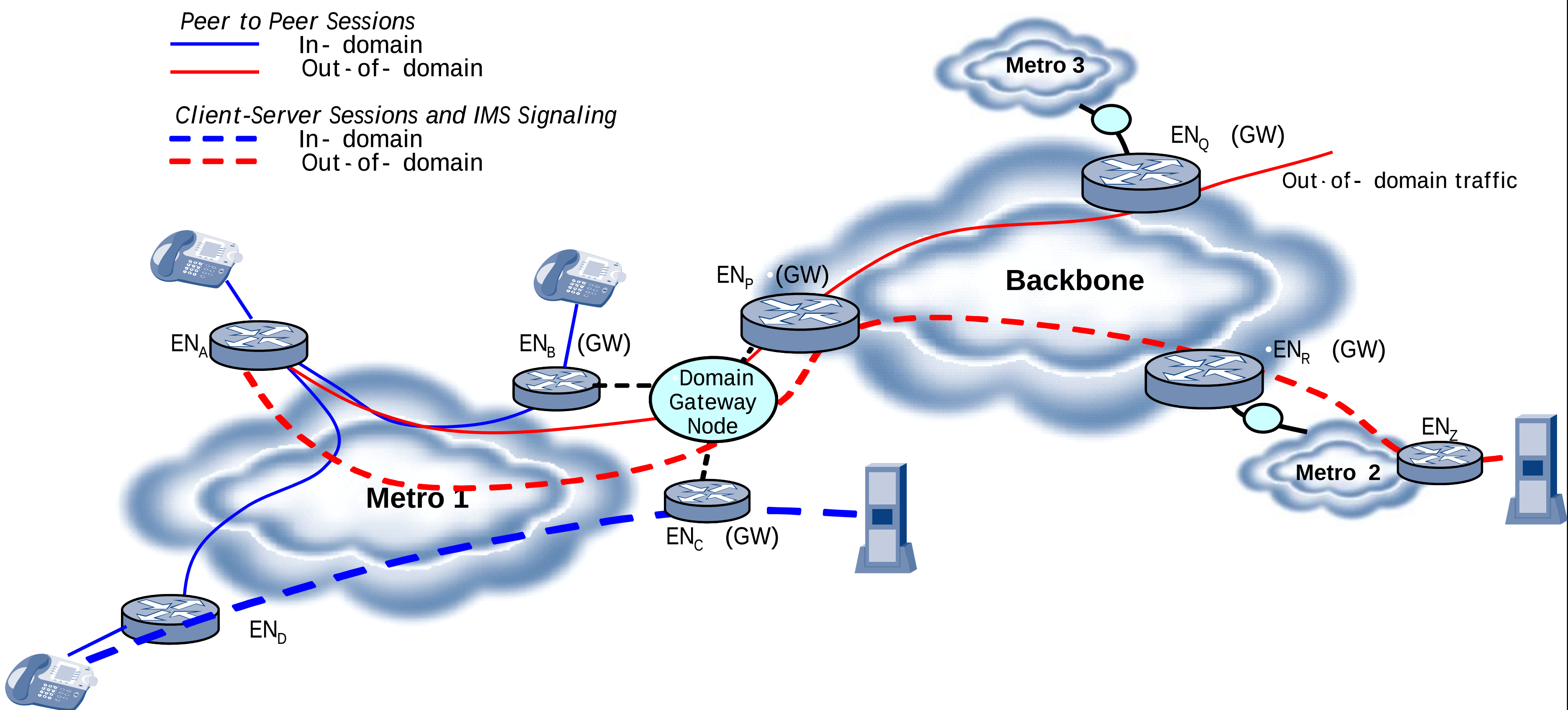
- *Optimal topology,*
- *Number and location, and*
- *Homings on end-users*

for each of the IMS functional network elements.

Once the location of the IMS elements and homing are known, accurate point to point traffic matrices for the signaling traffic can be constructed.

- IMS Control Layer traffic becomes an input to the lower layer transport design

Creating Aggregate Traffic Loads



- Each session is characterized as peer-peer, client-server or server-server.
- P-P traffic is distributed within the domain using a gravity model
- C-S and S-S traffic is calculated based on location of the edge node and server(s)
- The out of domain traffic is routed through domain gateways

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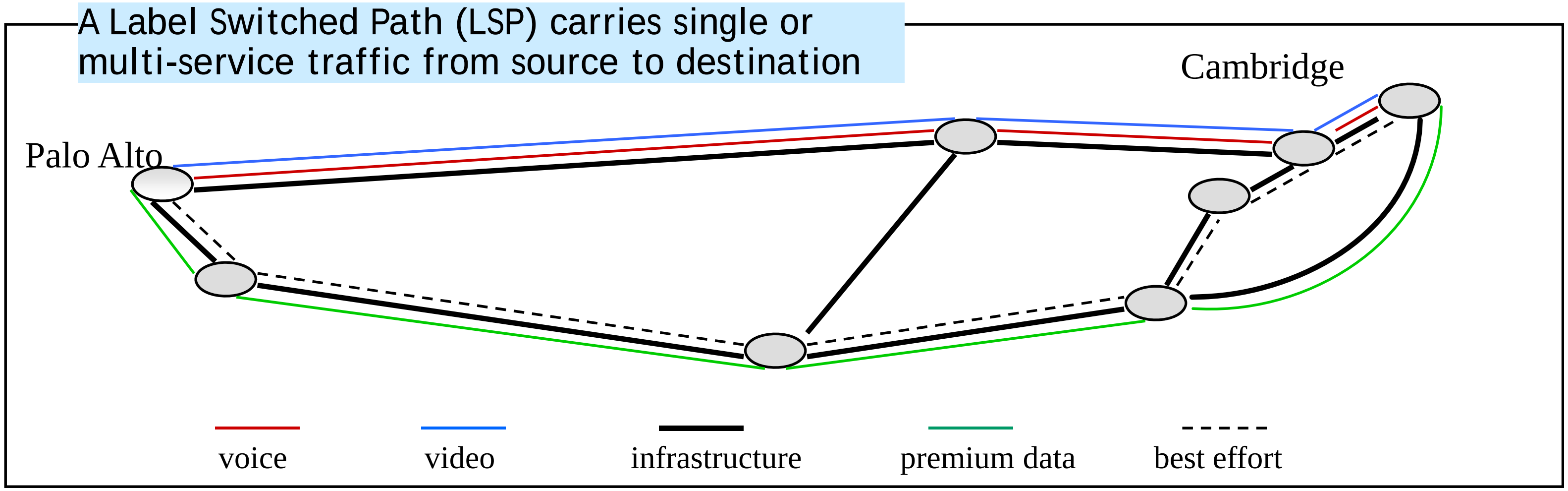
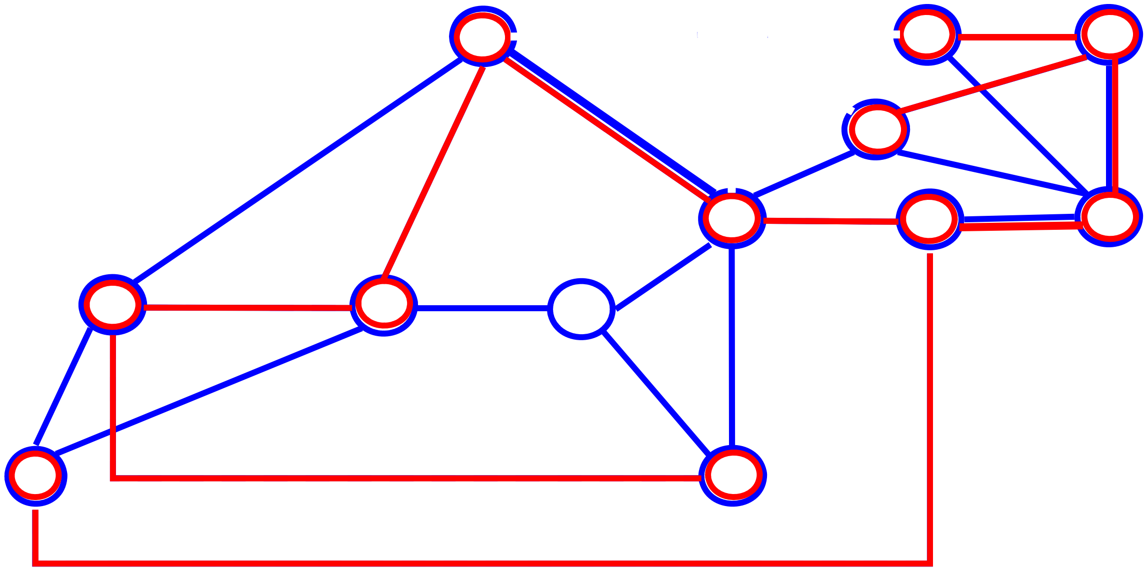
MPLS Network Design – Key Issues



- **Traffic Uncertainty** – Avoid network over-engineering or potential traffic congestion
- **Effective Bandwidth** - What are the BW requirements for each LSP, considering dynamic traffic generated by applications?
- **Minimal Cost Topology Design** - Assure sufficient network capacity at minimal cost
- **Optimized Routing of LSPs** to maximize BW efficiency while meeting QoS constraints
- **Protection** of high priority traffic at a minimal cost

❑Solving MPLS Design Issues Requires Intelligent and Complex Optimization Algorithms

Topology & Spanning Tree Design



- Ethernet design challenge: you get less capacity than what you can see in design – Spanning Tree Protocol (STP) always forms trees to carry traffic
- Multiple spanning trees must be designed based on traffic load to support differentiated QoS, balance load, and increase network utilization
- In case of a single link or node failure, new backup trees are chosen by STP to redirect traffic

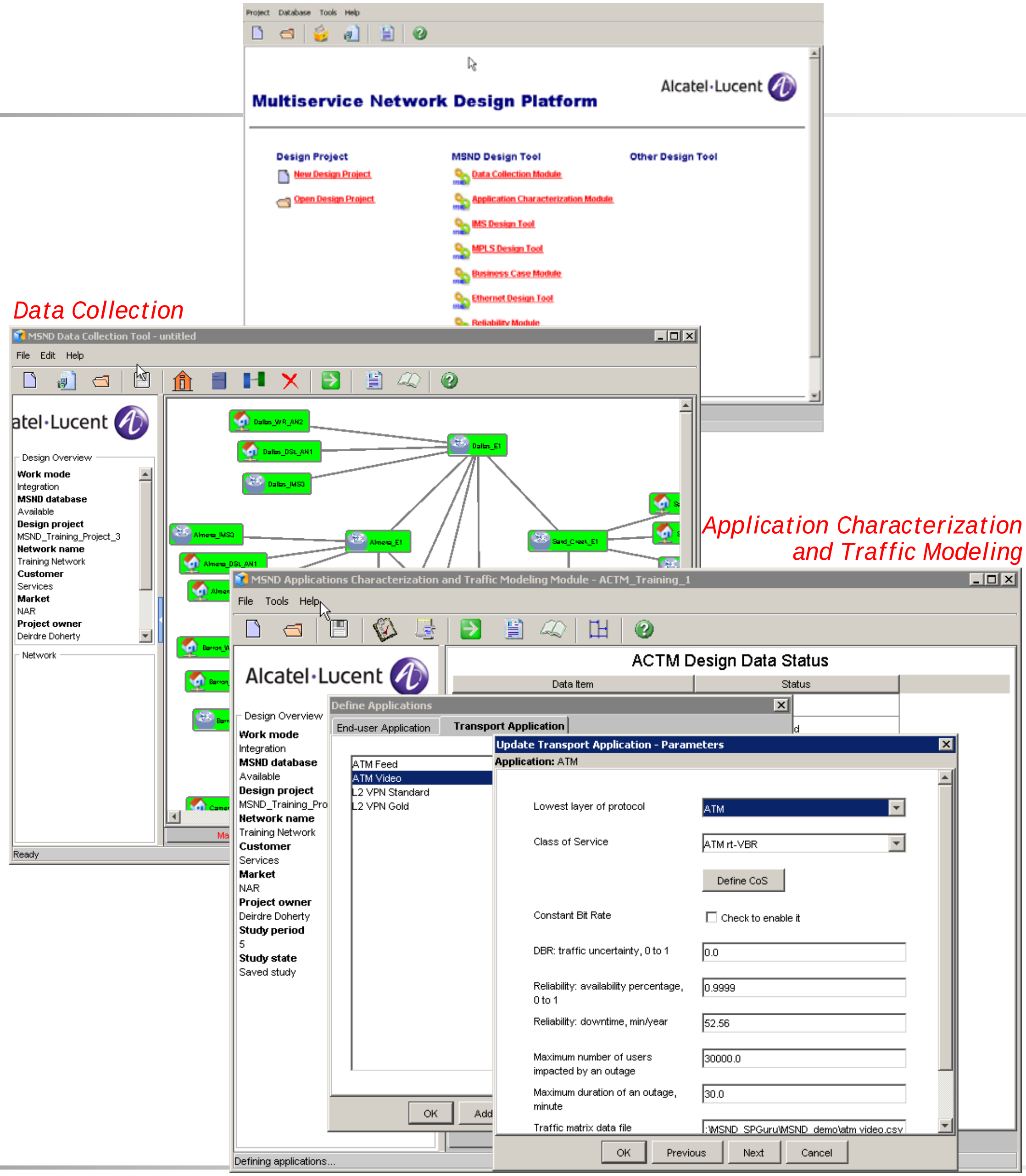
❑Multiple Spanning Trees must be designed for different classes of service.

❑Single failure modes should be taken into account to ensure adequate backup capacity on secondary spanning trees

A Design Example (1)

Scenario – An end-to-end network design across IMS and MPLS backbone, with a financial assessment

- Network Data Collection
  - 18 access nodes and 9 edge nodes (with coordinates)
  - 2 IMS locations
  - OC12 POS or 10GE as BB links
- Application Characterization and Traffic Modeling (ACTM)
  - 9 end-user applications – VoIP, IM, phonebook, conferencing for consumer & enterprise wireless and wireline users
  - 4 transport applications – ATM and L2 VPN
  - Generate traffic data
    - Busiest-hour session demands, traffic descriptors and CoS for end-user applications
    - Demand matrices and Cos for transport applications



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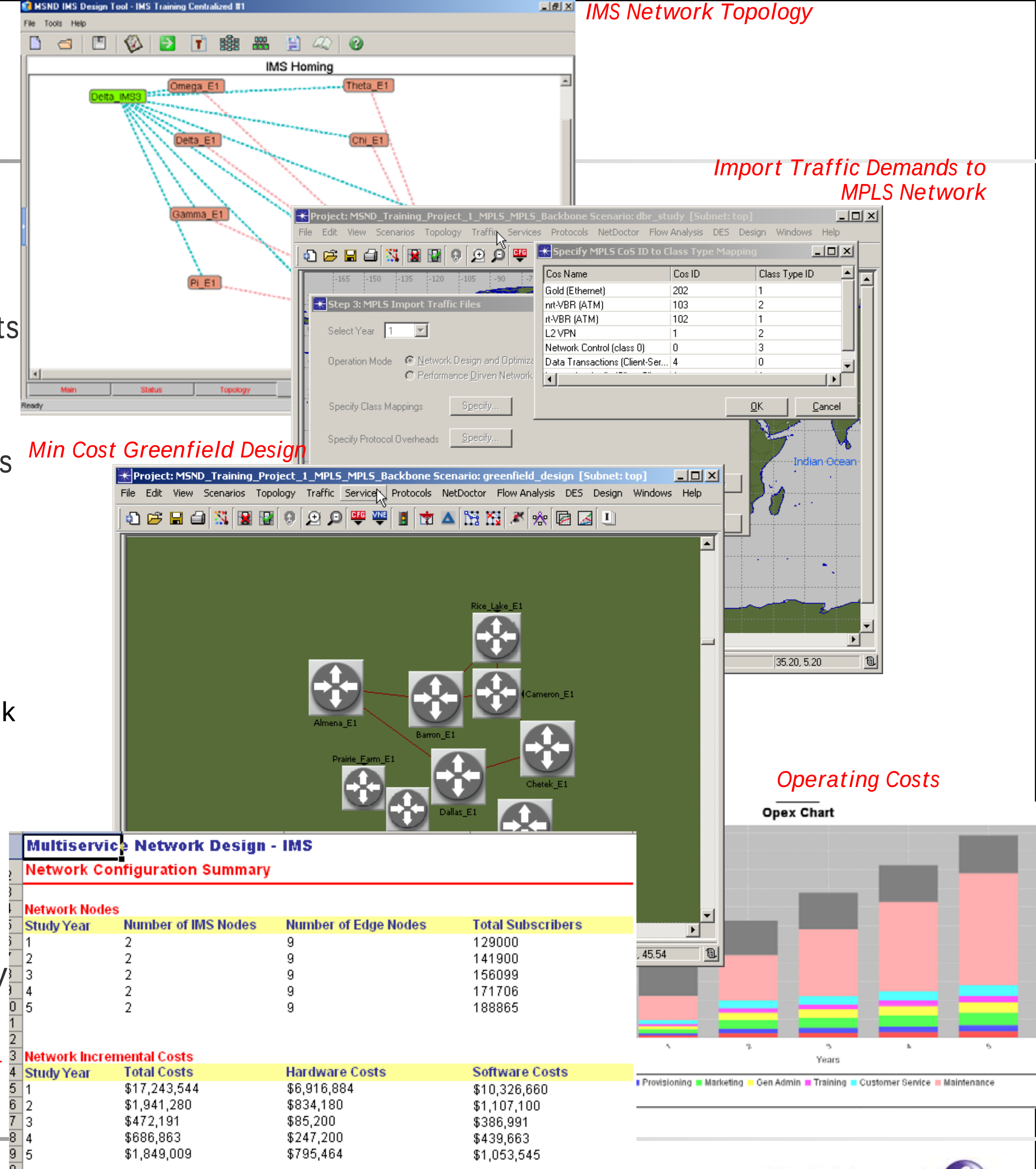
A Design Example (2)

- IMS Network Design
  - Determine optimal location for IMS equipment
  - Determine homing arrangements
- MPLS Backbone Design
  - Import network topology – nodes, candidate links and costs
  - Import traffic demands (based on data generated by ACTM)
    - CoS to MPLS CT mapping
    - LSP configuration
  - Min cost greenfield net design
    - TE constraints (BCM, max link utilization, etc)
    - Design output includes network topology and LSP demand routing
- Configuration Design
  - Mid-level equipment configuration and cost summary

Equip Config and Cost



Multiservice Network Design - IMS

Network Configuration Summary

Network Nodes

Study Year	Number of IMS Nodes	Number of Edge Nodes	Total Subscribers
1	2	9	129000
2	2	9	141900
3	2	9	156099
4	2	9	171706
5	2	9	188865

Network Incremental Costs

Study Year	Total Costs	Hardware Costs	Software Costs
1	$17,243,544	$6,916,884	$10,326,660
2	$1,941,280	$834,180	$1,107,100
3	$472,191	$85,200	$386,991
4	$686,863	$247,200	$439,663
5	$1,849,009	$795,464	$1,053,545

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Summary of Key Take-Aways

- Network usage is application driven, and there is a great deal of uncertainty in applications demand and user behavior
- Operators face critical choices in network architecture and technology that can have great impact on their business goals
- A unified multi-service, multi-layer and multi-vendor approach is needed
  - Common application traffic modeling
  - Flow through of results
  - Sophisticated optimization algorithms
  - Automation for “what-if” studies
  - Models that link technical and financial analysis
- The problems are too complex for traditional planning methods

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