NETWORK MANAGEMENT

- functions
- quality of service
- out-sourcing

Network Mgmt Functions

- performance management
- configuration control
- applications management
- security
- fault & crisis management
- accounting & reporting

Performance Management

- availability
  - MTBF
  - MTTR
- error rate
- effective capacity – throughput
- peak / off-peak
### IP Backbones, Aug-Oct 2003

<table>
<thead>
<tr>
<th></th>
<th>Latency (ms)</th>
<th>Packet loss (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
<td>35.0</td>
<td>0.01</td>
</tr>
<tr>
<td>Sprint</td>
<td>48.88</td>
<td>0.08</td>
</tr>
<tr>
<td>Cable &amp; Wireless</td>
<td>42.0</td>
<td>0.01</td>
</tr>
</tbody>
</table>

### Network Surveillance

- performance measures
  - internal network
  - external providers
- monitoring intensity
  - importance of communications
  - alternative options

### External Surveillance

- weather, fire
- power failure
- political/economic emergency
TQM

• focus on process, not results
• approach
  – identify customers (internal & external)
  – analyze needs & priorities
  – link to processes
• continuous improvement
  – Deming cycle
  – benchmarking

Google

• Data cached at distributed locations
• How to replicate the database (many Terabytes)?

Out-Sourcing

• historical practice – telecommunications
• more recent outsourcing
  – data communications
  – content delivery
When to out-source

• for out-sourcing
  • cost – scale economies, competition
  • transparency
  • flexibility
• against out-sourcing
  - control & security
  - customization

Scale Economies

Q content providers serving N users
• if each provides for peak demand, must have capacity N: total capacity = QN
• if each sends content to specialist host, need only capacity N

Out-sourcing: Checklist

• integration
• quality assurance
• customer service
• documentation
• training
• research and development
Service Level Agreement

- service provider commits to specific QoS standards and compensation in case of failure to meet standards

Sprint SLA

- port availability: 99.9% (100% if enhanced Metropolitan Area Network access)
  - 3-day port charge credit for outages of an hour or less, one day credit for each additional hour of outage
- delay:
  - 3-day port charge credit for violation of average backbone delay

Sprint SLA, cont'd

- packet loss: 0.3% for Dedicated Internet Access and 0.1% for IP VPN
  - 3-day port charge credit for violation of average backbone delay
- installation: credit for up to 150% of installation charge
Internet: Network Mapping

- peering points
- router hops
- traffic load

Sprint: Network Map

Akamai: Edge Solution

Deploy servers at network edge
- closer to end-user
- avoid peering points and reduce router hops to end-user
- modified URLs to improve caching accuracy
Benefit from hosting service

• static content – need speed
• stream content – need speed and continuity

Summary

network design
  ◇ network management
  ◇ network operations