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

	Latency (ms)	Packet loss (%)
AT&T	35.0	0.01
Sprint	48.88	0.08
Cable & Wireless	42.0	0.01

Network Surveillance

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

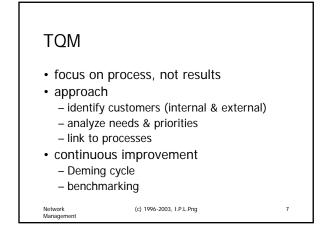## External Surveillance

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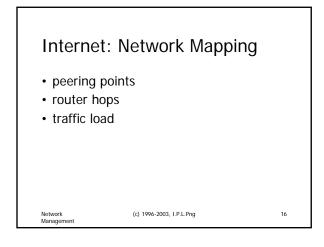
- service provider commits to specific QoS standards and compensation in case of failure to meet standards

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

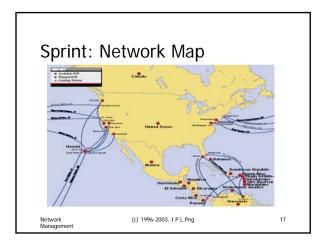## Akamai: Edge Solution

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