Capacity Planning for Internet Service Networks

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Issues

TCP/IP Protocol Behavior

Issues

Usage Profile

Capacity Guidelines

Growth Levels
Planning Issues

- Understand the domain of operation
  - technical issues
  - market issues
  - competitive issues
  - regulatory issues
TCP/IP Protocol Issues

TCP/IP is NOT a flow damped protocol
- end to end flow management
- sliding window protocol
- adaptive flow rate designed to probe and use max available end to end bandwidth
- only limited by end system buffering size
  - bandwidth x delay
- system buffers are getting larger as OS vendors come to understand the problem
TCP/IP Protocol Issues

TCP/IP Data Flow Rate Adaptation

Data Flow Rate vs. Time

Steady State Available Bandwidth

Rate overflow loading into network queues
TCP/IP Protocol Issues

- No network-based flow control mechanism
- Network-based packet loss signals end systems to collapse transmission window size
- Varying window size allows adaptive flow metrics to adapt to changing maximum available capacity
- Sustained insufficient capacity leads to congestion induced collapse of data throughput
TCP/IP Protocol Issues

- Many simultaneous TCP sessions interact with non-predictive non-uniform load
- Peaks start to synchronize with each other
- Buffering evens out individual flows, but buffers themselves behave with fluctuating load
- Buffering adds latency
TCP/IP Protocol Issues

TCP/IP efficiency under congestion load

Traffic Level | Data Throughput
--- | ---
33% | 33%
66% | 66%

Congestive Collapse - The slide to misery and packet loss
TCP/IP Protocol Issues

- TCP vs UDP
- UDP-based applications
  - Internet Phone, Video, Workgroup
- UDP Issues
  - no flow control mechanism
  - sustained use forces precedence over TCP flows
  - increasing use of flow bandwidth negotiated protocols for these applications (RSVP)
TCP/IP Protocol Issues

- Damping network capacity is not a demand management tool
- Network capacity must be available to meet peak demand levels without congestion loss
Two major Internet use profiles:

- Business use profile
  - Peak at 1500 - 1600
  - Plateau 1000 - 1730

- Residential dial profile
  - Peak at 2030 - 2330
  - Plateau 1900 - 2400
Usage Profile

Distance profiles
- 12% Local
- 18% Domestic Trunk
- 70% International

Traffic mix due to:
- Distance invisible applications without user control
- Distance independent user tariff
Capacity Guidelines

● Link Utilisation
  ▶ Average weekly traffic level set to 50% of available bandwidth.

● Core network capacity should be dimensioned according to aggregate access bandwidth
Link Usage Profile - optimal

- peak loading less than 10% time
- greater than 50% loading for 50% time
- traffic bursting visible
Link Usage Profile - overloaded

- 90% peak loading for 45% time
- 60% peak loading for 60% time
- no burst profile at peak loads
- imbalanced traffic (import based)
Link Usage Profile - saturated

- visible plateau traffic load signature
- small load increases cause widening plateau
Overall Growth Levels

Two growth pressures:

- serviced population
- the changing Internet service model
  - more network-capable applications
  - using more bandwidth
Overall Growth Levels

- For a constant service model the growth curve will exhibit demand saturation
Overall Growth Levels

- For a changing service model the saturation point will move
- More intense network use by increasingly sophisticated applications
How to plan

- Generate a market demand model
  - forecast the number of services in operation
    - existing services
    - growth rate
    - market capture level (competitive position)
  - forecast the average demand per service
    - dial access, leased line
    - web, ftp, usenet
    - caching trends
    - new Internet services
How to plan

- Demand models are typically very uncertain indicators
  - high level of uncertainty of externalities
  - highly dynamic competitive position
  - poorly understood (and changing) service demand model
How to plan

- Forward extrapolation
  - Assume existing traffic follows a general growth model
  - Forward extrapolate the growth model
- Good for short term planning (12 months)
- Cannot factor
  - Latent demand
  - Market price sensitivity
Trend forecasting

- historical usage vs capacity data
Growth Trends
Planning

- undertake demand and trend forecast models
- constantly review the model against generated usage data
- recognise that the larger the capacity you need the longer the lead time to purchase it
- recognise that the bigger the purchase the greater the requirement for capital