

# Capacity Measurement for IP Networks

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# 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

# TCP/IP Protocol Issues

## TCP/IP Data Flow Rate Adaptation

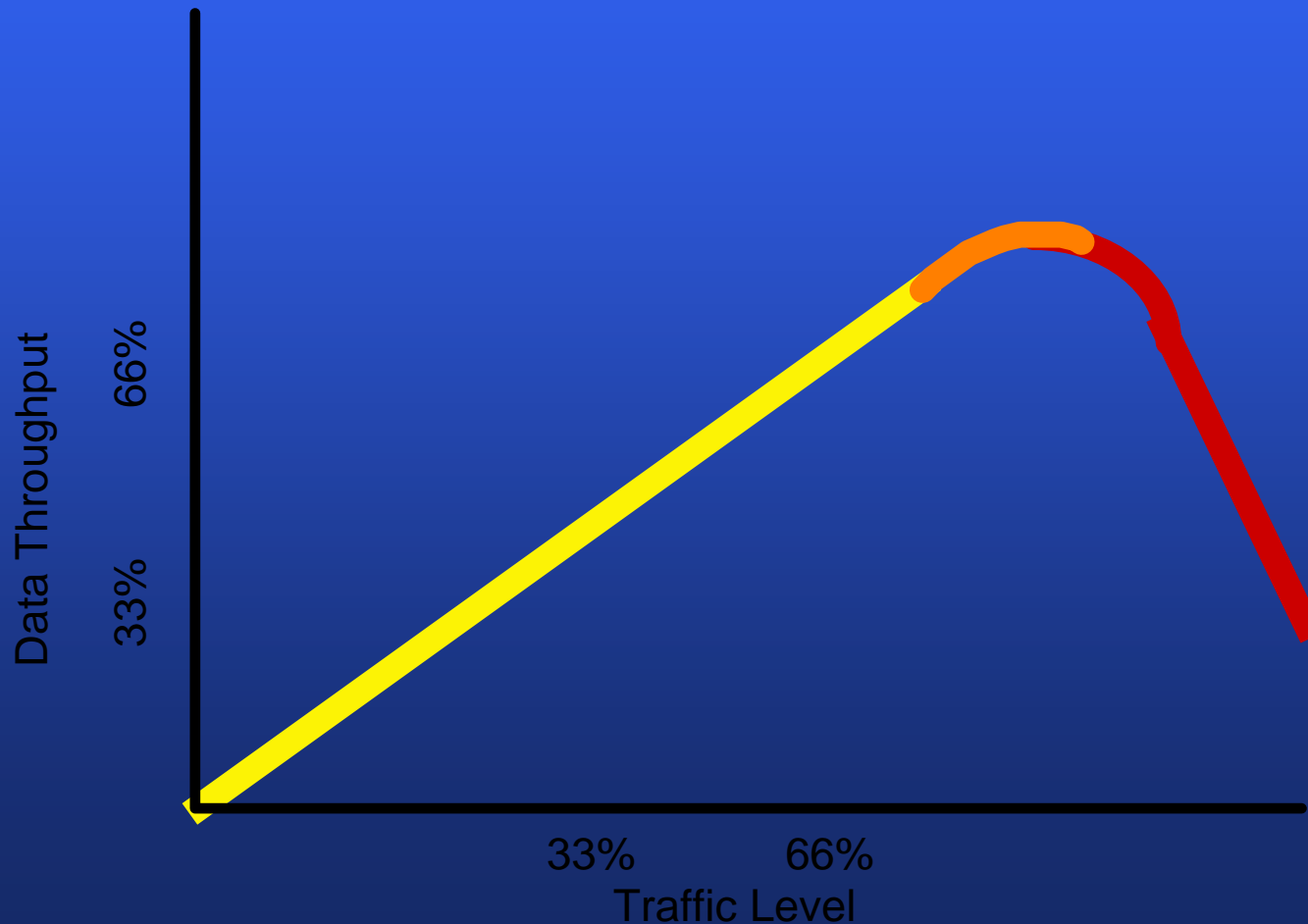


# TCP/IP Protocol Issues

- No network-based flow control mechanism
- Network-based packet loss signals end systems to collapse 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

TCP/IP efficiency under congestion load



# 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 (RTP)

# 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

# Usage Profile

- 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



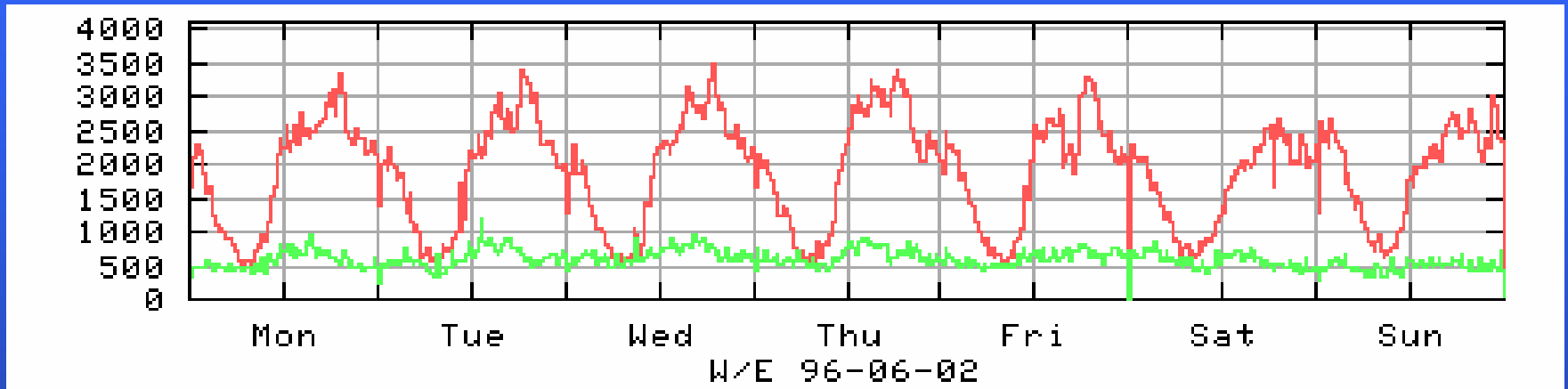
# Usage Profile

- Distance profiles
  - 30% Local
  - 40% Domestic Trunk
  - 30% International
- Traffic mix due to:
  - Distance invisible applications without user control
  - Distance independent tariff

# Capacity Guidelines

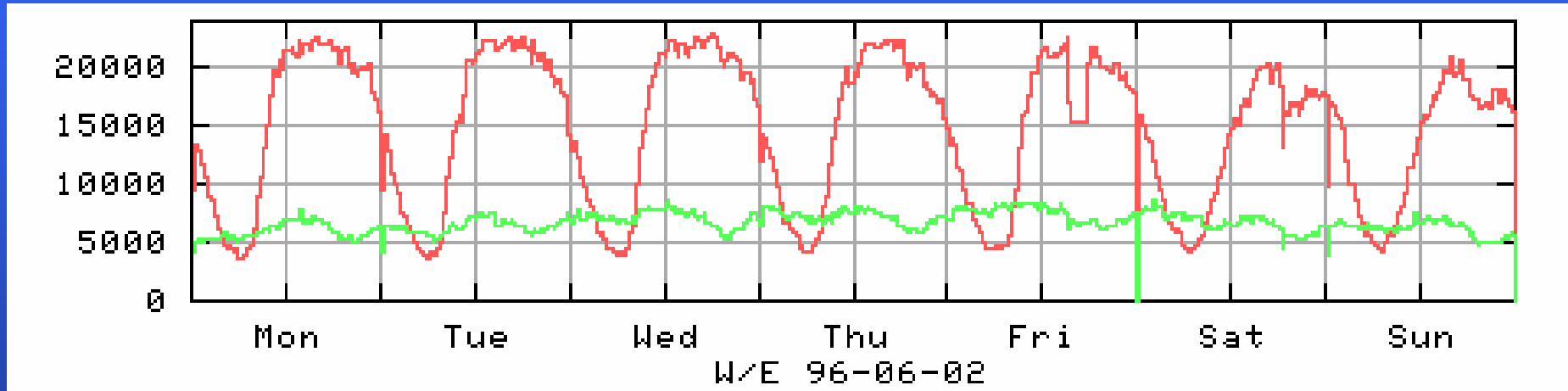
- Link Utilisation
  - Average weekly traffic level set to 40% of available bandwidth.
- Core network capacity should be in excess of access bandwidth

# Link Usage Profile - optimal



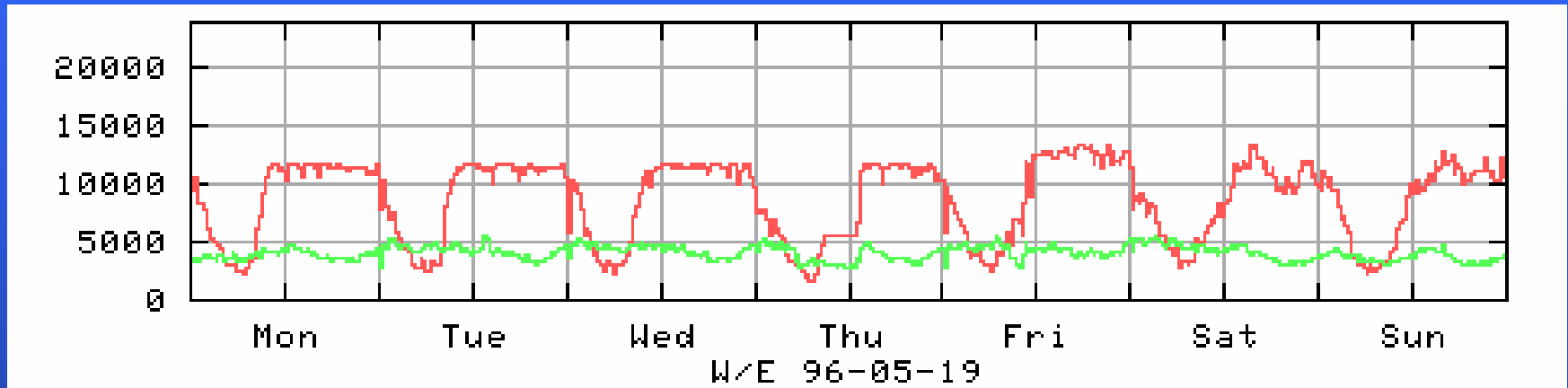
- peak loading less than 10% time
- greater than 50% loading for 50% time
- traffic bursting visible

# 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

- More users
- More intense network use by increasingly sophisticated applications
- No visible saturation of demand to date