TCP Extensions

Sliding Window – Keeping the Pipe Full

Wrap Around – 32-bit `SequenceNum`

Bandwidth	Time Until Wrap Around
T1 (1.5Mbps)	6.4 hours
Ethernet (10Mbps)	57 minutes
T3 (45Mbps)	13 minutes
FDDI (100Mbps)	6 minutes
STS-3 (155Mbps)	4 minutes
STS-12 (622Mbps)	55 seconds
STS-24 (1.2Gbps)	28 seconds

Bytes in Transit: 16-bit `AdvertisedWindow` $\approx$ 64KB
$\Longrightarrow$ should be big enough to allow S to keep the pipe full

Bandwidth	Delay (100ms RTT) × Bandwidth Product
T1 (1.5Mbps)	18KB
Ethernet (10Mbps)	122KB
T3 (45Mbps)	549KB
FDDI (100Mbps)	1.2MB
STS-3 (155Mbps)	1.8MB
STS-12 (622Mbps)	7.4MB
STS-24 (1.2Gbps)	14.8MB

♠ TCP extensions for `SequenceNum` and `AdvertisedWindow`

TCP Extensions

- Implemented as TCP header *options*

  - TCP header length field – *variable length* header
  - backward compatible (core of TCP header is not changed)

- Sequence # wrap-around too soon on high-speed networks

  - 64-bit sequence # – extend `SequenceNum` with 32-bit *timestamp*
  - timestamp is always *increasing* $\Rightarrow$ to distinguish between 2 different incarnations of the same sequence #
    $\Rightarrow$ **not** for ordering or acknowledging data

- Advertise *larger* window size

  - accommodate delay $\times$ bandwidth pipe of *high-speed* networks
  - option defining a *scaling factor* – *chunk* of bytes