Week 3: Connectivity, losses, latency, and geolocation

1. Introduction - Ping
2. Connectivity
3. **Losses**
4. Latency
5. Geolocation
6. Conclusion

Losses

- A best effort network
- Causes of loss
  - Congestion
  - Medium errors
  - Routing loops
- Loss rates
- Conclusion

Losses

- **A best effort network**
- Causes of loss
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Losses

- A best effort network
- Causes of loss
  - **Congestion**
    - ✓ Full buffers
    - ✓ Queue management (tail drop, RED or other)
  - Medium errors
  - Routing loops
- Loss rates
- Conclusion

Losses

- A best effort network
- Causes of loss
  - Congestion
  - **Medium errors**
    - ✓ Wireless: interference, multipath induced fading, etc.
    - ✓ Fiber optics, copper: lower rates
    - ✓ Individual bits ➔ corrupted packet
    - ✓ Burst of bits ➔ lost packet
    - ✓ Data link layer retransmission ➔ additional delays
  - Routing loops
- Loss rates
- Conclusion

Losses

- A best effort network
- Causes of loss
  - Congestion
  - Medium errors
  - **Routing loops**
    - ✓ TTL ➔ 0
- Loss rates
- Conclusion

Loss rates

loss rate	quality
below 0.1%	excellent
0.1% to 1%	good
1% to 2.5%	acceptable
2.5% to 5%	poor
5% to 12%	very poor
above 12%	bad

Source: PingER initiative at Stanford University, ICFA annual report 2015

- Loss rates to wealthier countries 0.01% to 0.1%
- Loss rates to poorer countries 0.1% to 1%
- Trend worldwide to lower loss rates
  - Very roughly an order of magnitude decrease over a decade

Losses

- A best effort network
- Causes of loss
  - Congestion
  - Medium errors
  - Routing loops
- Loss rates
- **Conclusion**
  - ✓ Bursty losses ➔ 2-state Markov model
    i.e., "Gilbert Elliott" model, alternating between:
  - – Burst state: high loss probability
  - – Gap state: low loss probability