Networking at the Speed of Light

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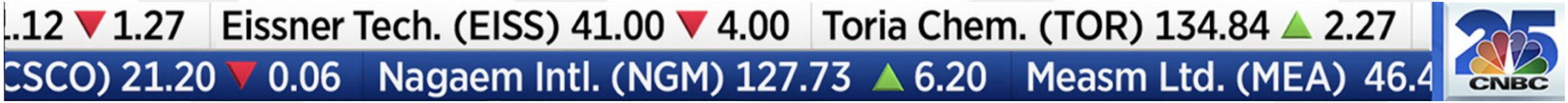
Agenda

- Financial Market Data
  - *multicast*
- The Need for Speed
  - *latency*
- Knowing When
  - *timestamps*
- Q&A

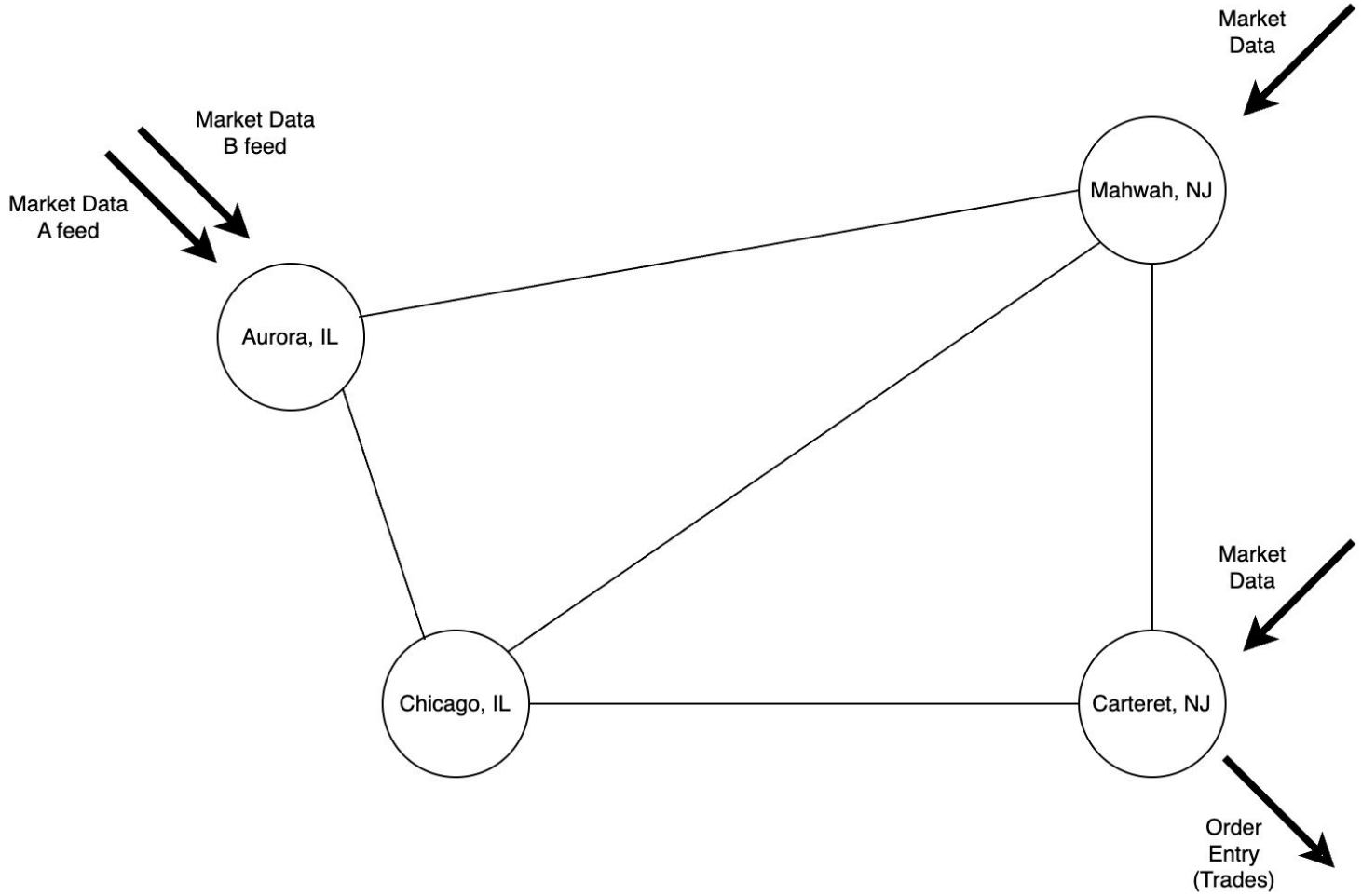
Financial Market Data

- Transmitted via multicast over extranet connection
- Converted to a consumable multicast stream
- Propagated to remote data centers for use in trading algorithms



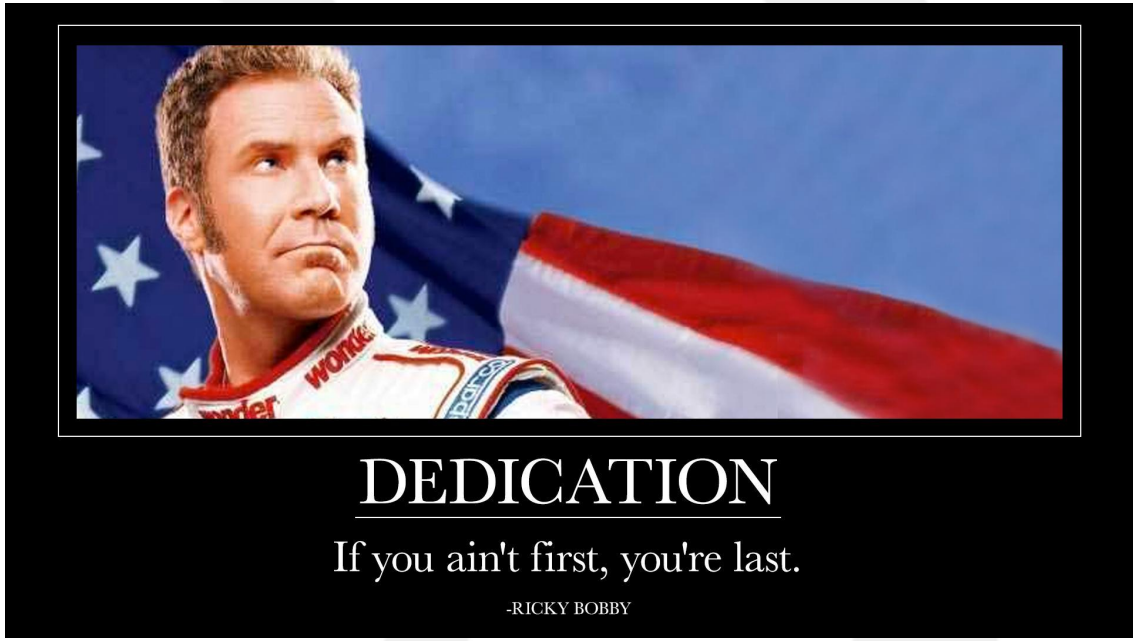
Multicast

- Protocols
  - BGP, OSPF
  - PIM ASM, SSM
- Exchange Connection
  - IGMP, PIM
- PIM Sparse Mode (ASM)
  - Rendezvous Placement
- Dealing with Drops
  - Replay Request
  - Arbitration



The Need for Speed

- Opportunities in markets are fleeting
- Competition is fierce
- Reducing latency is critical to success

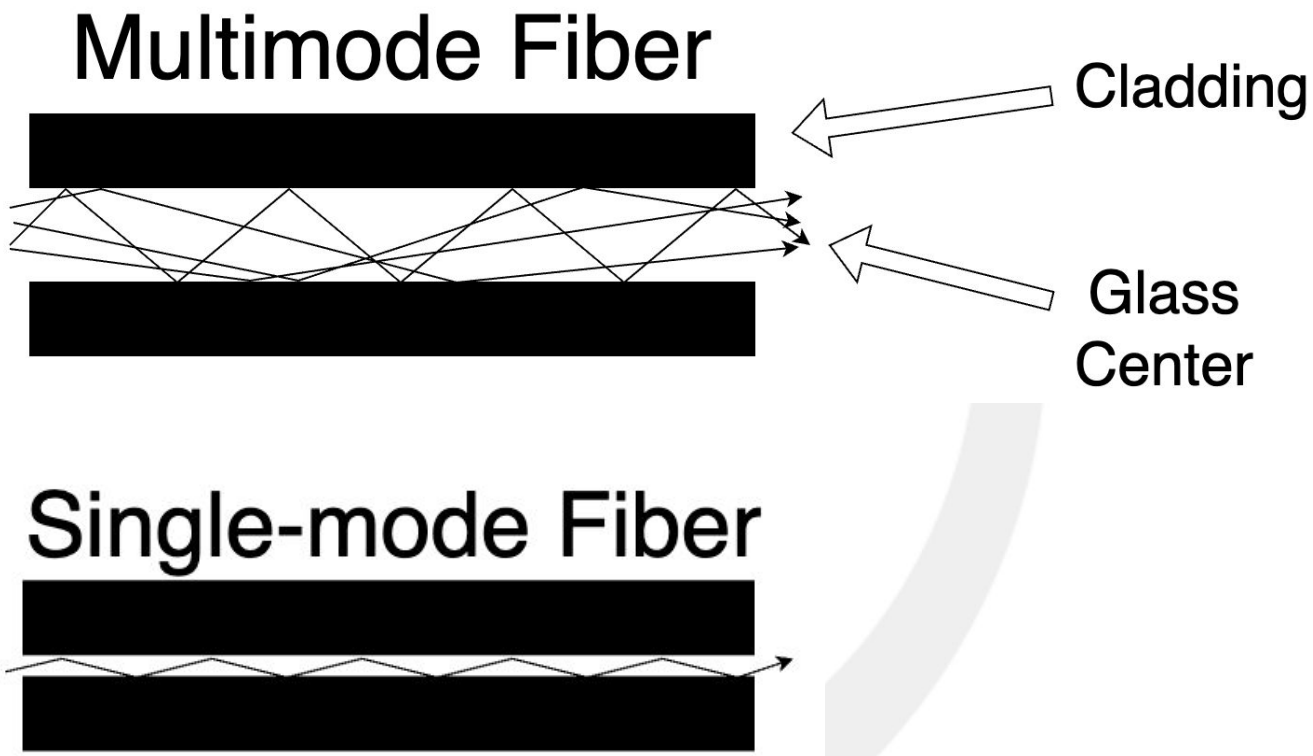


Causes of Latency

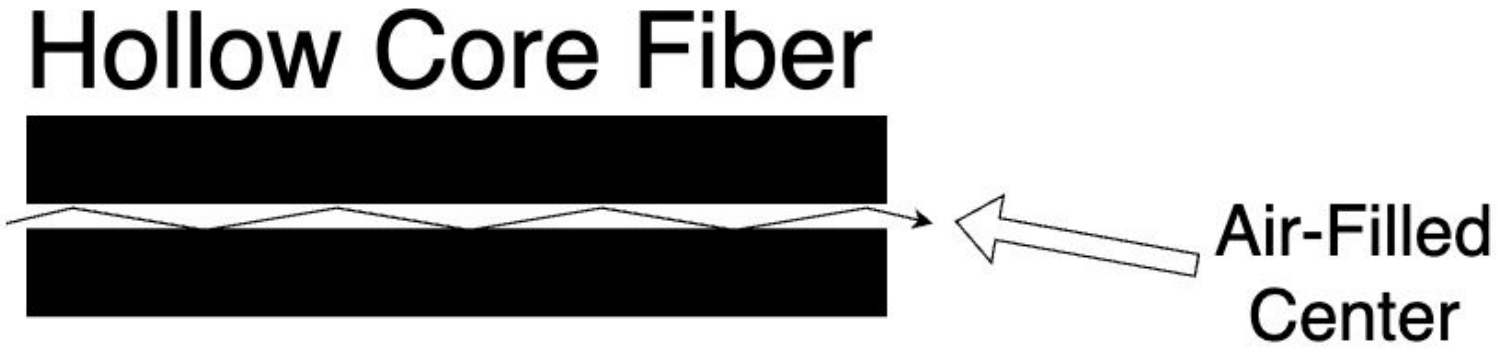
- Queuing Delay
  - Network Congestion
- Transmission Delay
  - Bitrate of Link, Encoding Method
- Processing Delay
  - Cut-Through vs Store-and-Forward
  - Forward Error Correction
- Propagation Delay
  - Speed of Light?

Propagation Delay

Optical Cable Types



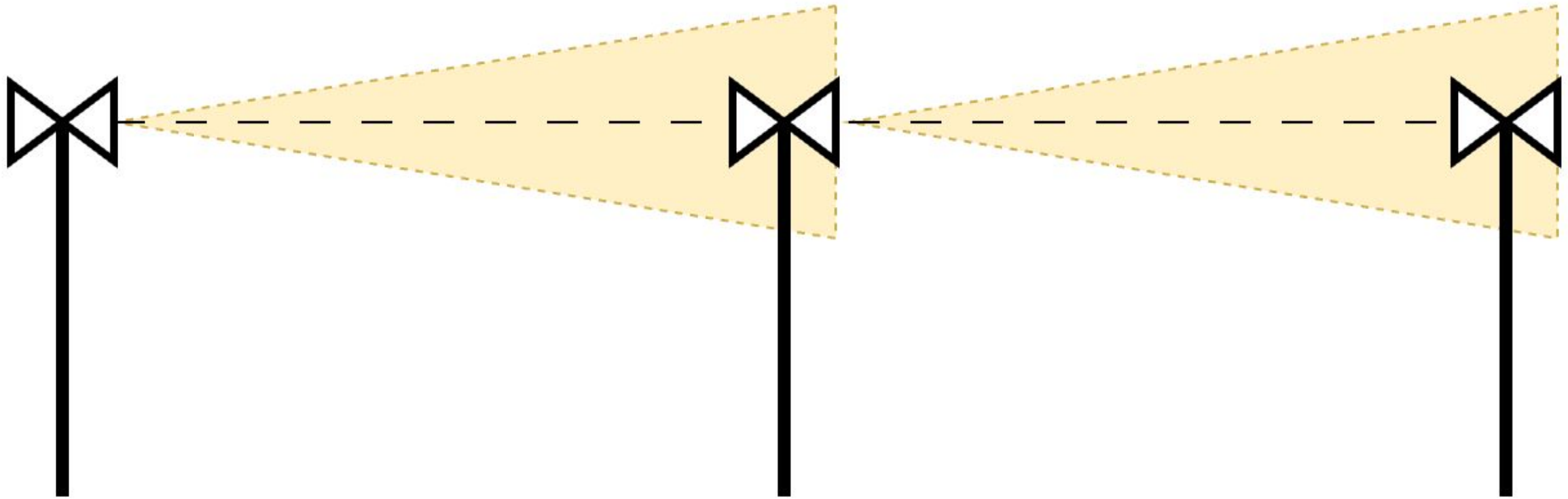
Propagation Delay
Optical Cable Types



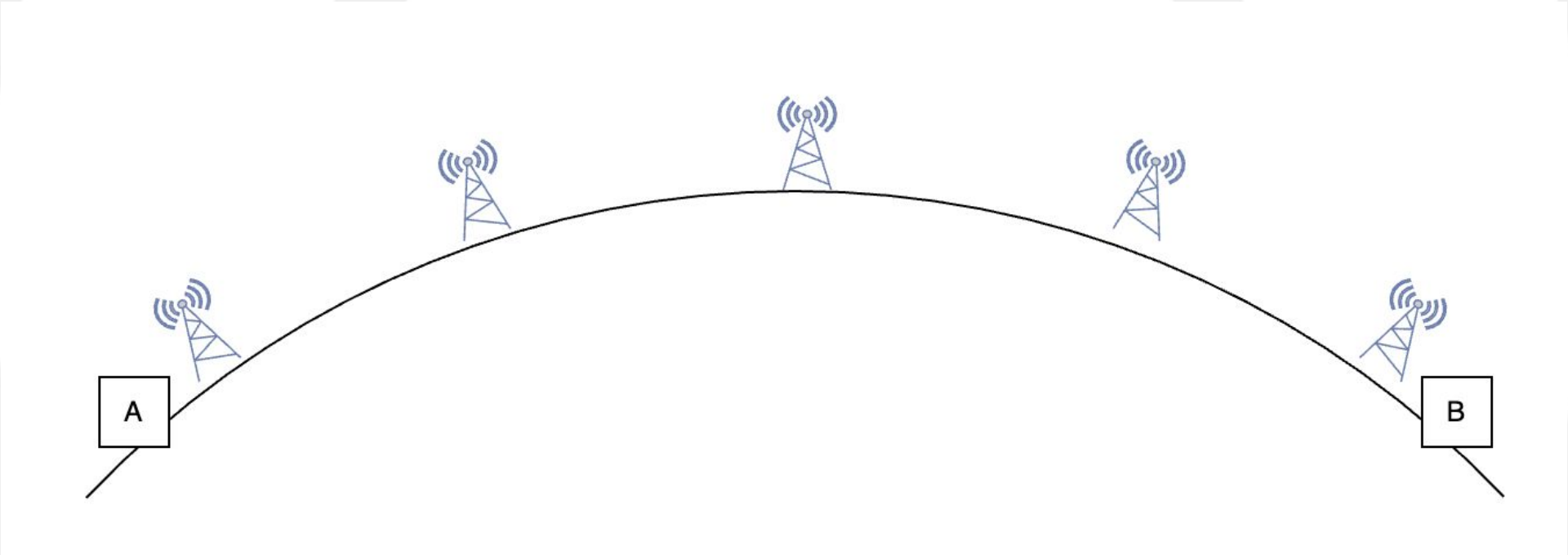
- Light travels through air
- ~45% reduction in latency

Point-to-Point Wireless Transmission

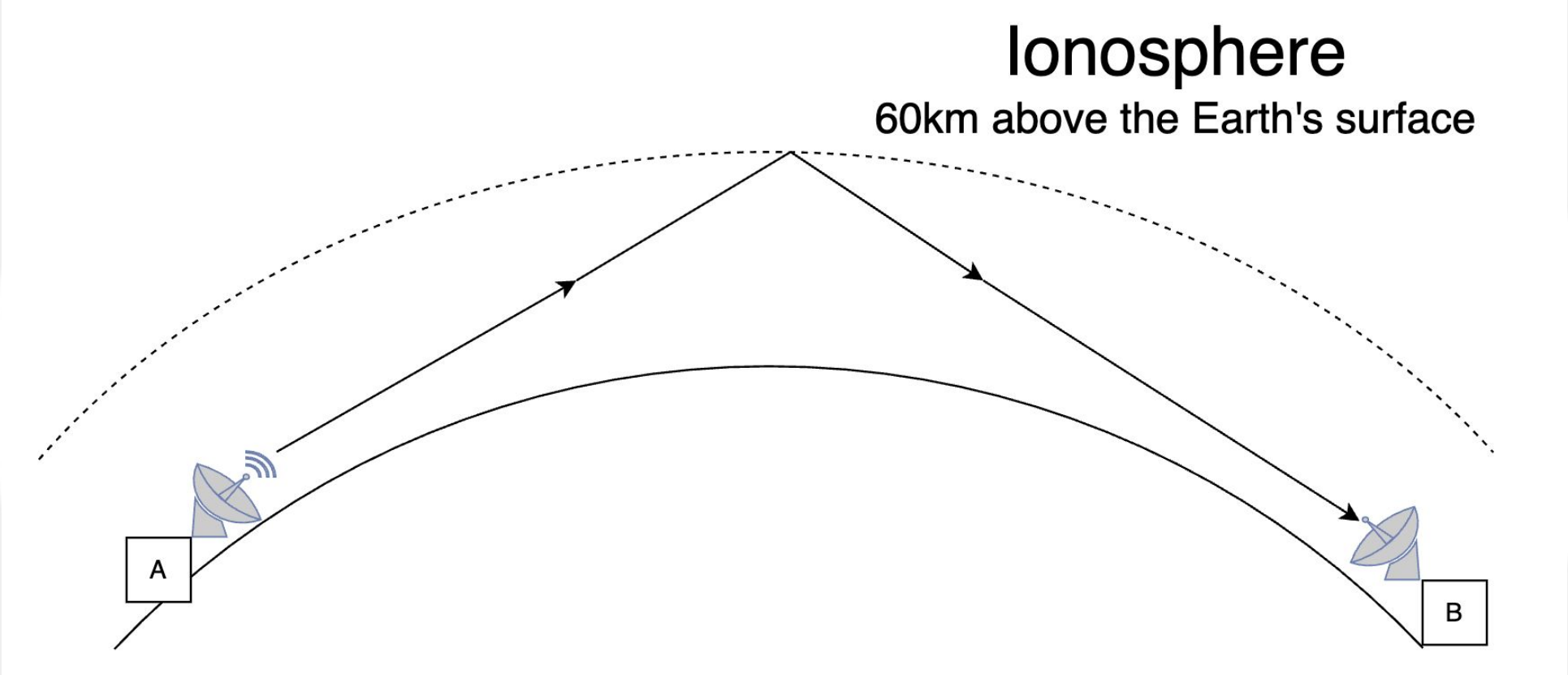
- Free Space Optics
- Communication at the Speed of Light



Point-to-Point Wireless Transmission



Shortwave



Knowing When

- Need to know when messages are received
- Packet Captures
  - Troubleshooting
  - Regulatory
  - Building Trading Strategies

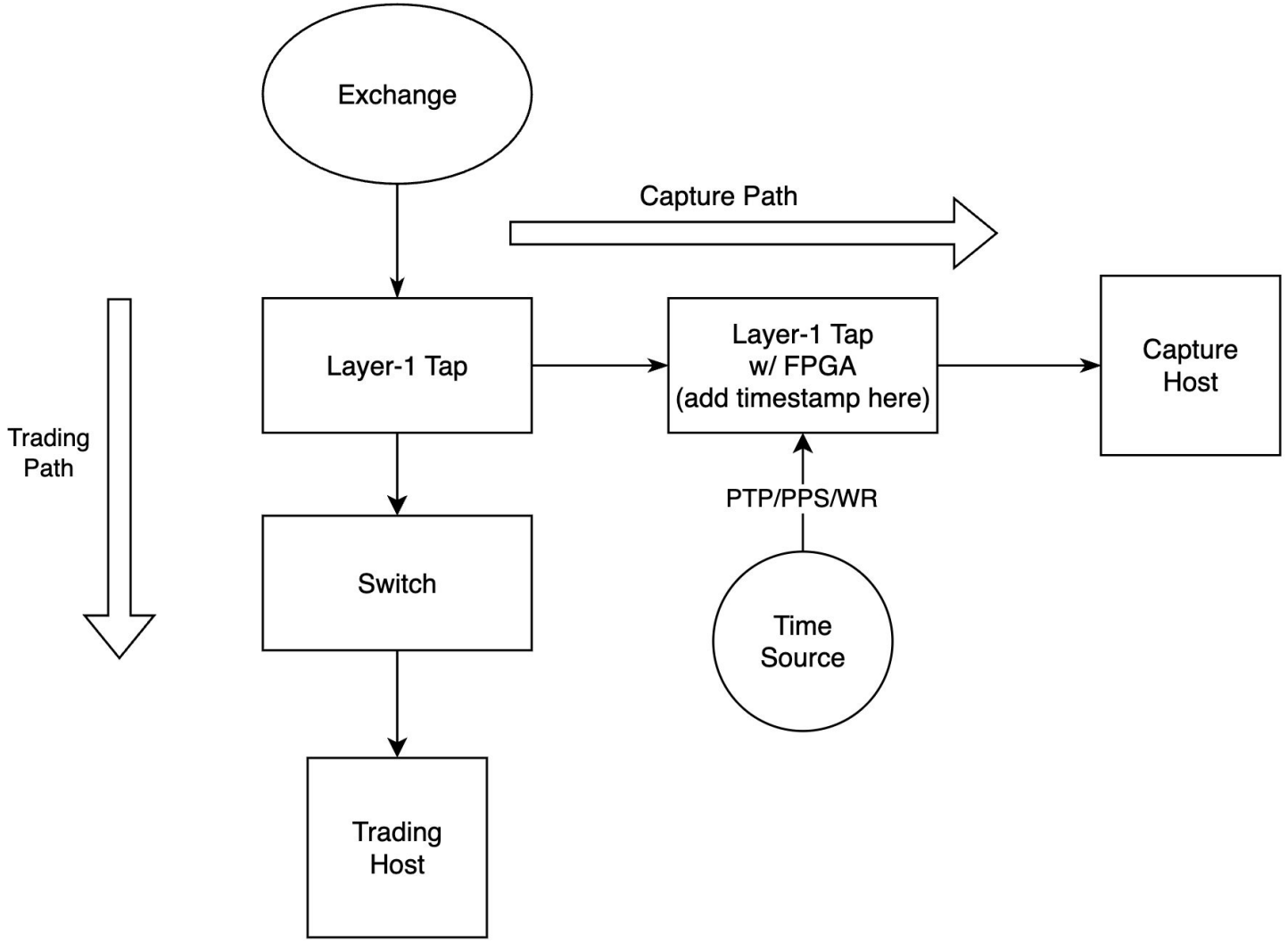
We Are Here

Milliseconds (ms)	1/1,000	Thousandths of a Second
Microseconds (µs)	1/1,000,000	Millionths of a Second
Nanoseconds (ns)	1/1,000,000,000	Billionths of a Second
Picoseconds (ps)	1/1,000,000,000,000	Trillionths of a Second

Time Distribution Protocols

- Network Time Protocol (NTP)
  - 1-10 millisecond accuracy
- Precision Time Protocol (PTP; IEEE 1588)
  - 100ns – 10µs accuracy
- Pulse Per Second (PPS)
  - 10-100ns accuracy
- White Rabbit
  - Sub-nanosecond accuracy

Typical Packet Capture Design



For more information watch

Questions?