the Race to Zero Latency

Every Microsecond Counts & Must be Measured™

Defining Latency:

o Zero latency is the speed of light = 300,000 kilometers per second

o Milliseconds = 1 thousandth of a second
o Microseconds = 1 millionth of a second
o Nanoseconds = 1 billionth of a second

o One meter of fiber optic cable = 4.8 - 5 nanoseconds latency

o Transmission Latency - Convert data to bits
o Propagation Latency - Movement of bits across a network [distance]
o Processing Latency - The application of data through middleware (feed handlers)
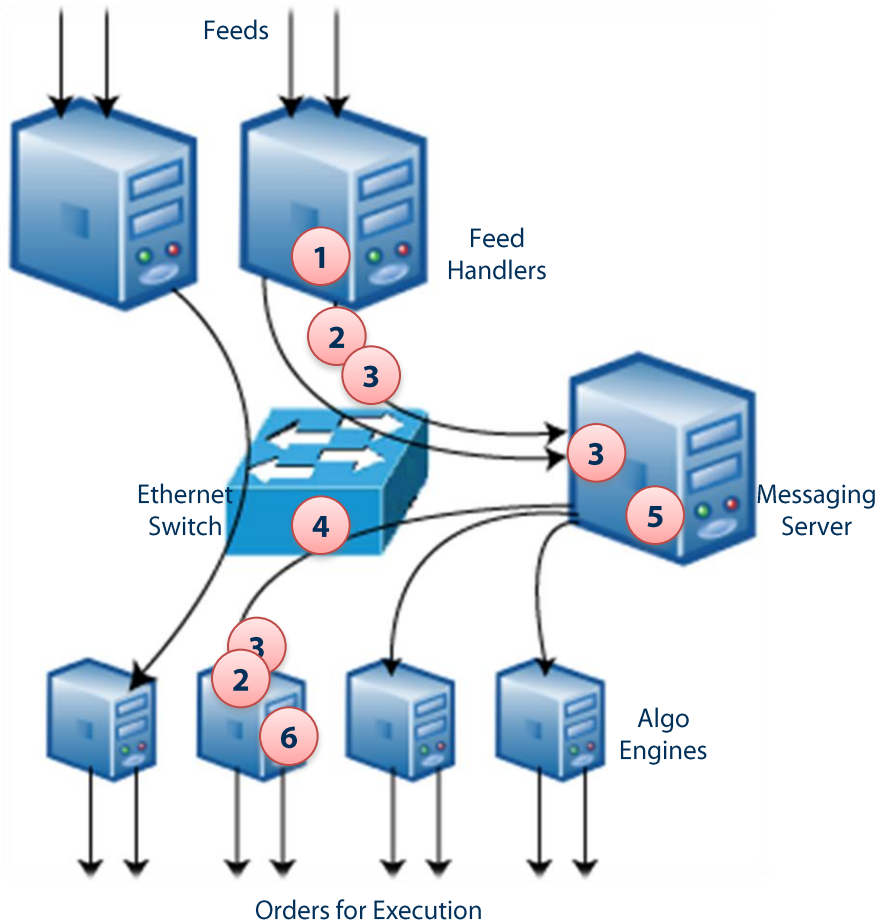   to trading systems (algorithmic engines)

Lightning Strike: 1ms

Blink of an eye: 300 - 400ms

HFT Latency Sources:

Sources of Latency

1. Feed handler/ticker plant
2. Messaging API
3. Network stack
4. Ethernet switch
5. Messaging middleware (server)
6. Algorithm performance
7. Transition to order execution

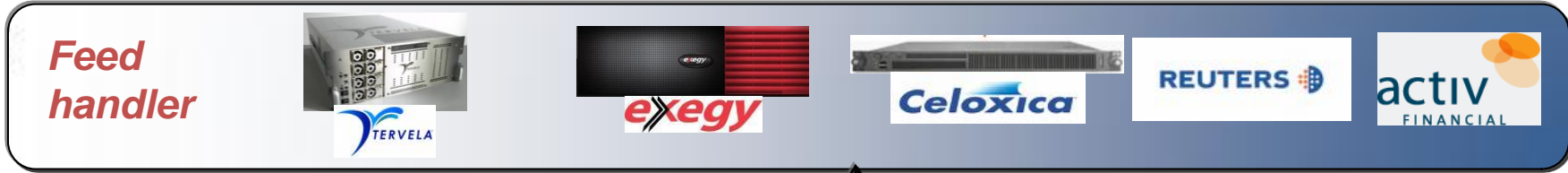## Other Latency Issues

High volumes:
- Jitter
- Context switching
- Network I/O

Physical distance:
- Speed of light

Feeds

Feed Handlers

Ethernet Switch

Messaging Server

Algo Engines

Orders for Execution

Leigh Wilson, Director Arista Networks **www.aristanetworks.com**

Achieving lowest latency:

- Fastest servers
- Fastest switches
- Fastest host adaptors
- Co-locate with exchange
- Low latency WAN links
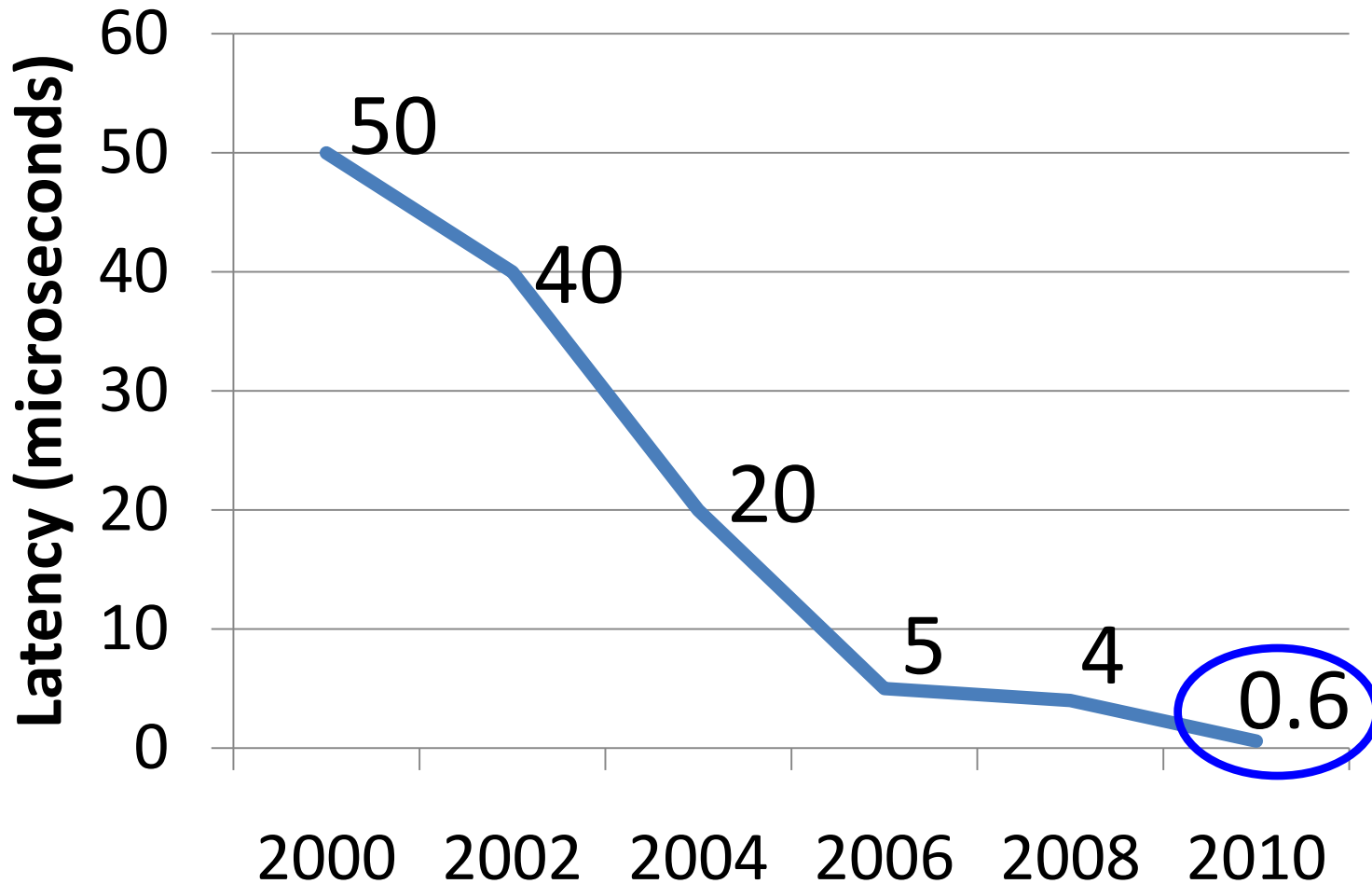- Second and Third order derivatives

Performance Tuned Infrastructure

Competitive Advantage - Nanoseconds

Ethernet has come a long way

Leigh Wilson, Director Arista Networks **www.aristanetworks.com**

Current Latency examples

Latency Example at NYSE

2000	10 sec	1
2007	350 ms	0.035
2008	100 ms	0.010
2009	5 ms	0.0005
2010	900 μs	0.00009

Some 2010 Latency Examples

Nasdaq Inet	250 μs
BATS Europe	270 μs
Chi-X Europe	400 μs
NYSE Arca	900 μs
LSE TradElect	2700 μs

Trends in Latency Technology

Networking
- Lower latency
- Tighter integration: L2, L3, Mcast with no penalty
- Advanced monitoring
- Latency Analysis

Messaging
- Unified platform
- Hardware acceleration
- Standardized APIs

Synchronization
- 1588 time stamping
- Atomic clock accuracy
- Servers, switches, feed handlers to see the same "time"

ARISTA

enabling financial capital markets

Competitive advantage
Ask IT

"Is our latency and performance competitive?" (must be <1usec)

"Can we sustain infrastructure competitive advantage"

"How predictable will our performance be during major market events"