Resilient Timing for Critical Infrastructure

|	Redundancy and Monitoring	Solutions for Backup Resiliency	Diversity of Sources (Beyond GNSS)	An Example of Resilience and Assurance
Media-Broadcast	Doug Arnold Principal Technologist Meinberg			
Finance and Data Center		David Chandler Product Line Manager Microchip		
Telecom- Mobile			Anand Ram Vice President, Business Development Calnex	
Smart Grid				Nino De Falcis Senior Director of Business Development Oscilloquartz

Finance and Data Center Applications Requiring Synchronization

- REGULATORY DRIVEN — Financial Sector — 1 microsecond
  - SEC rule 613
  - MiFIDII
  - Premium on security

- APPLICATION DRIVEN — Distributed Databases
  - Add replications at edge to increase speed
  - Linearization challenges
  - External synchronization allows
    - Faster databases
    - An improved log file
   - Faster recovery

Precise Time in Data Centers

- Exponential growth in Transactions Per Second (TPS) require more accurate time stamping
  - Thousands of TPS — Network Time Protocol (NTP)
  - Millions of TPS — Precision Time Protocol (PTP)
- Time stamping consistency critical across not only servers in a datacenter, also distributed datacenters in a network


200 km fiber
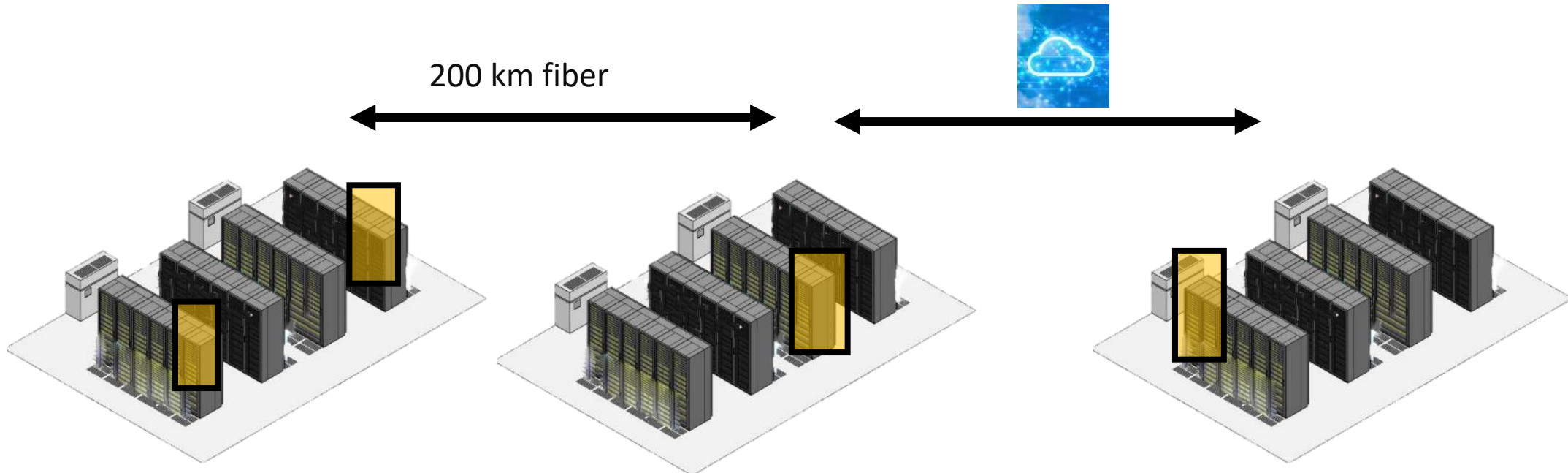
Why Distributed Data Centers?

- Latency – Los Angeles to New York
  - Speed of light — 13.1ms across US
  - Single read request — two way ~ 26ms
  - Real world fiber ~ 75 to 100ms

- System limited to ~ 10 requests per second

- Lead applications require > 500,000 per second
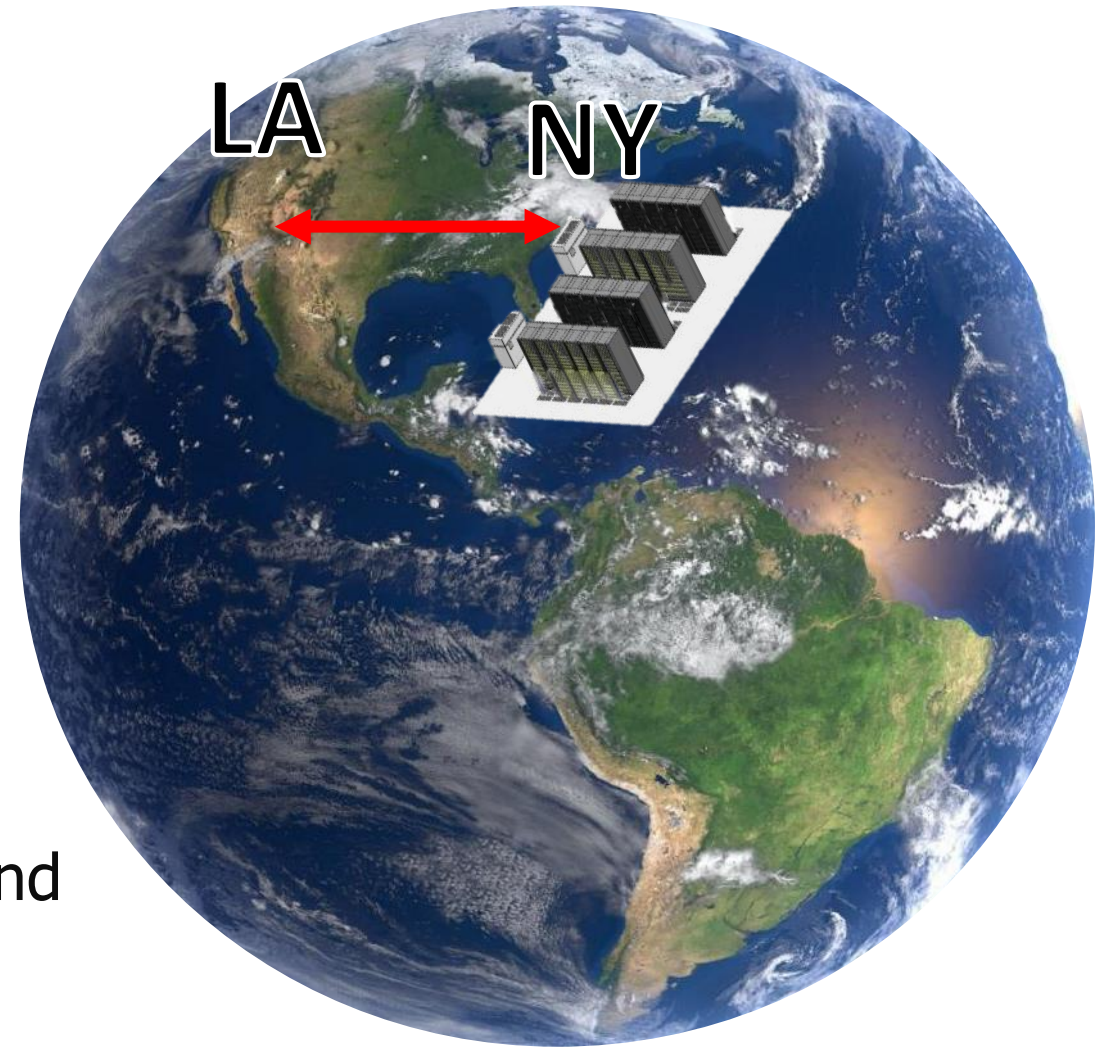
Why Distributed Data Centers?

- Replication — Distributed Data Centers
  - Near user to limit latency
  - Need correct time and sequence

- Externally timed to UTC
  - Accurate time stamps for sequencing
  - Clock uncertainty determines TPS
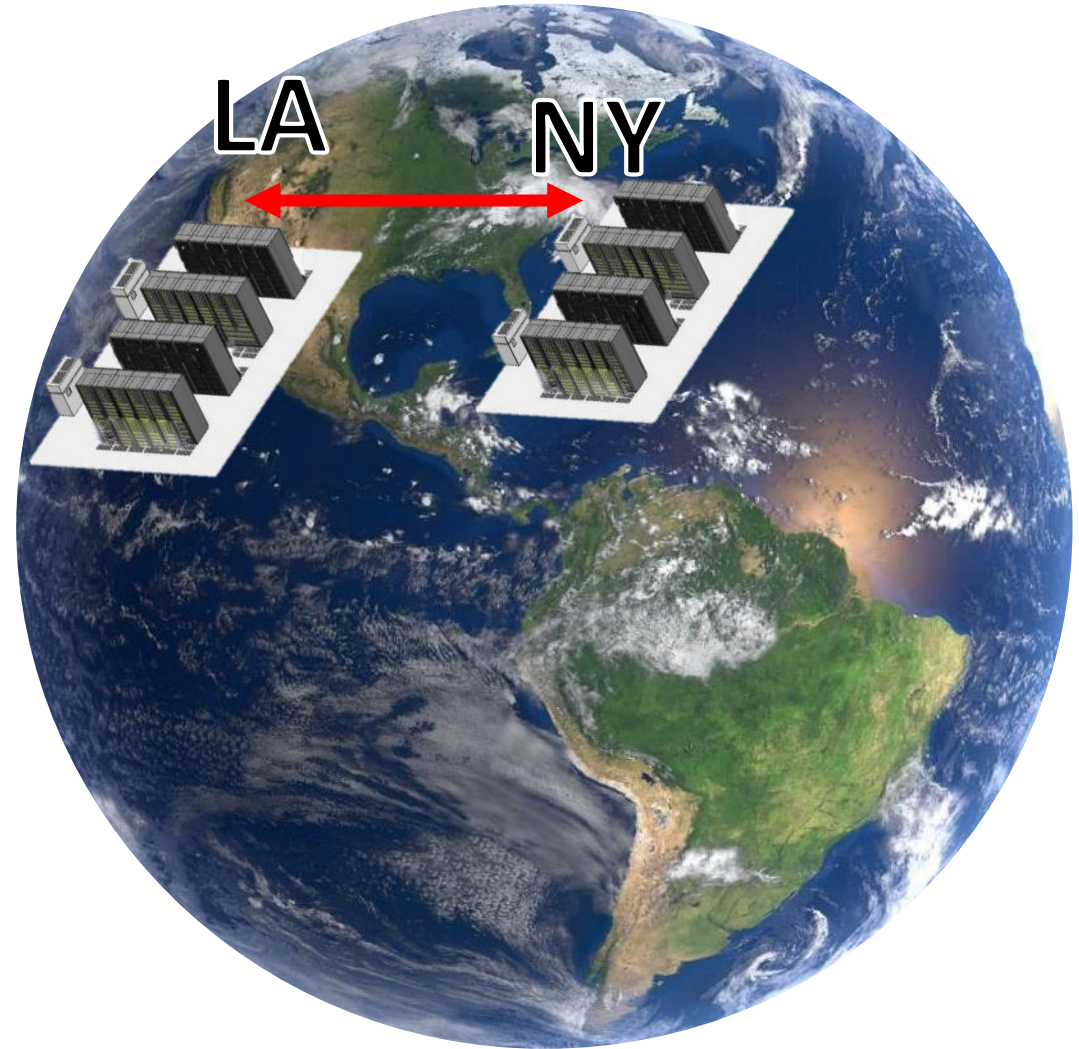
Three Elements of Precise Time for Data Centers

1. Secure Time Traceability
   Address spoofing and jamming
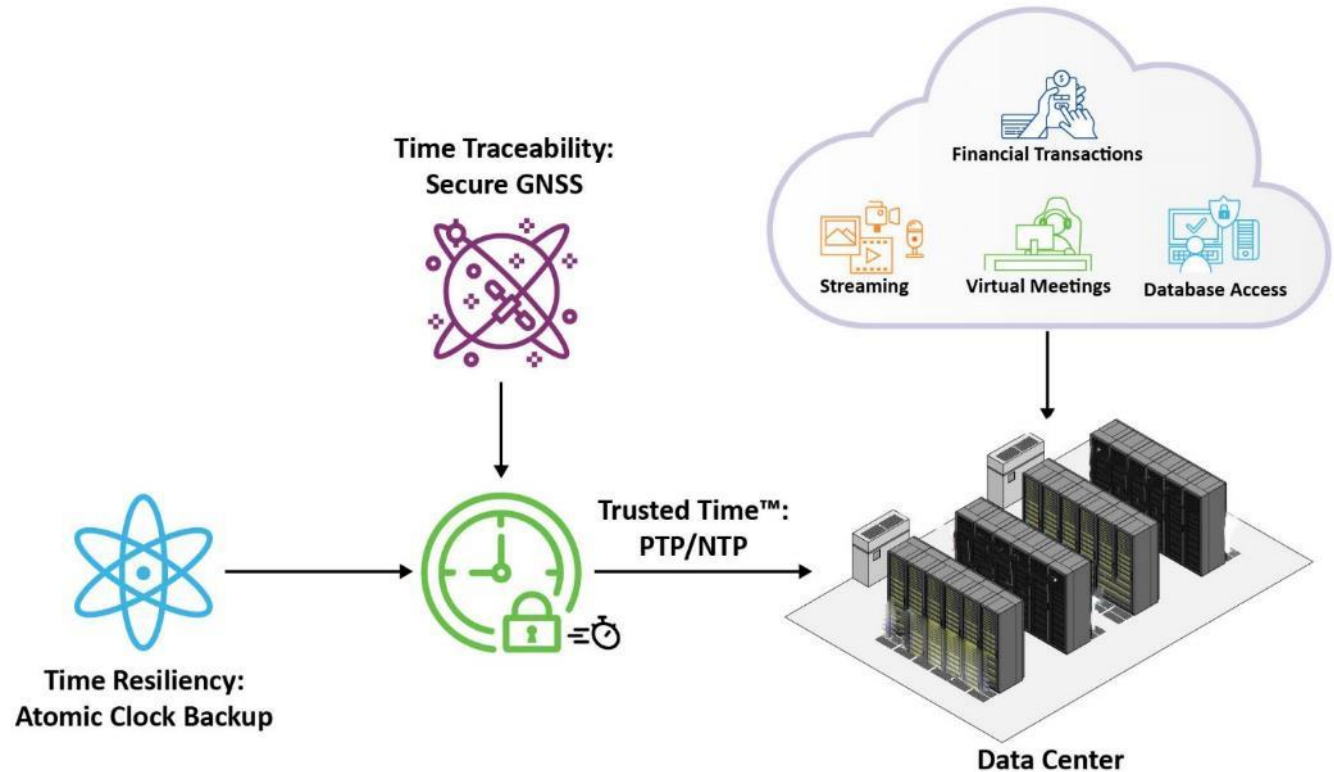
2. Resiliency and Backup
   Address GNSS outages

3. Time Distribution
   Throughout the data center

Synchronization — External Time
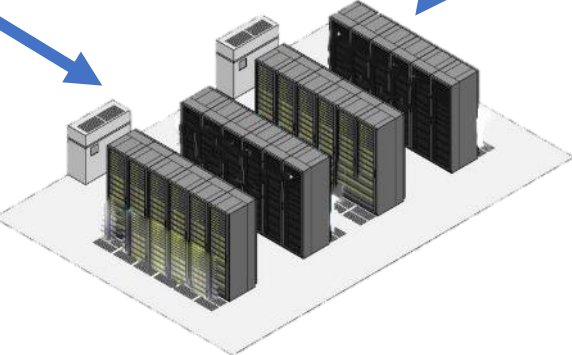
Solutions for Resiliency

24- Hour Holdover Drift

milliseconds   microseconds   nanoseconds   picoseconds

MEMS

Approximate values, assumes $\pm 2\ ^{o}C$

Crystal Oscillator (XO)

Temperature Compensated (TCXO)

Oven Controlled (OCXO)

Chip Scale Atomic Clock (CSAC)

Rubidium

Cesium

Hydrogen Maser
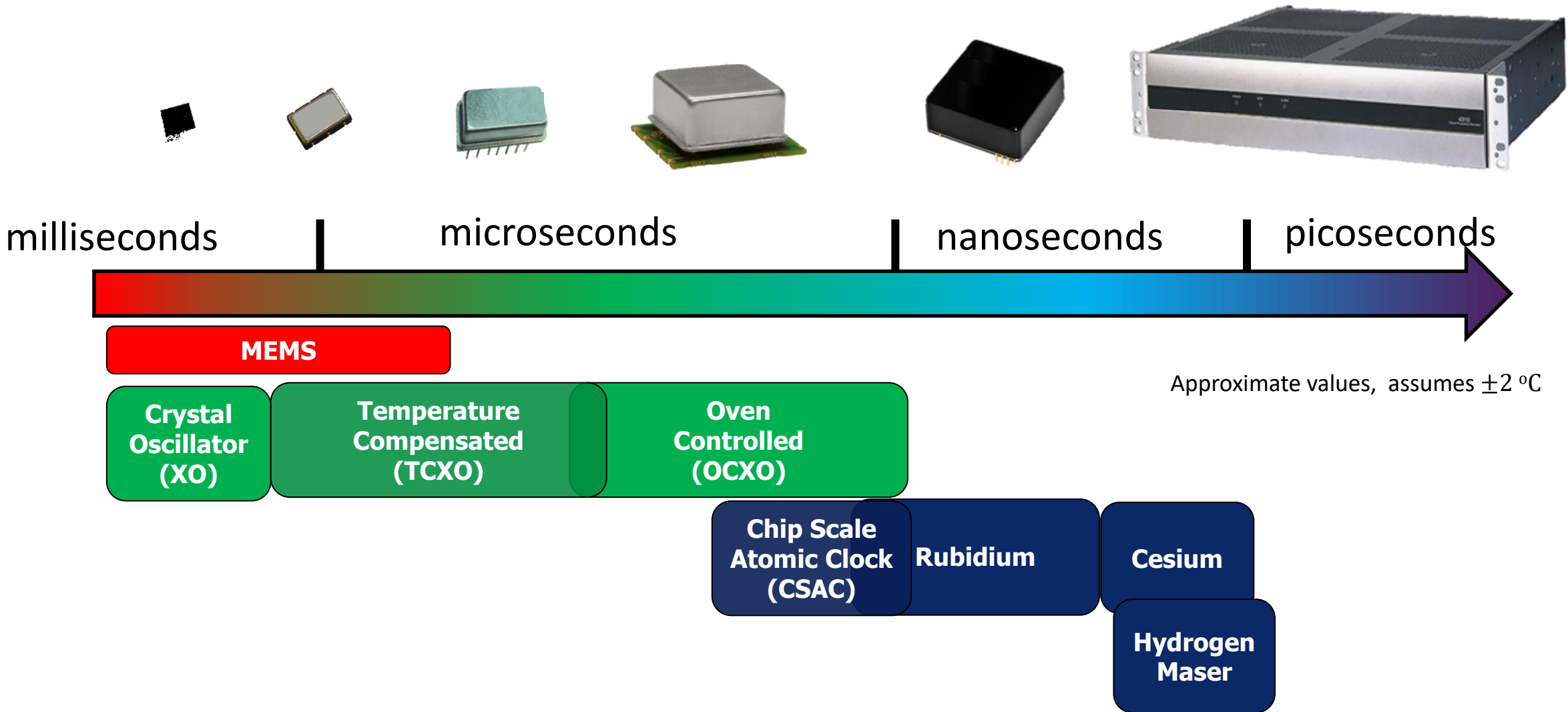
Data Center Timing Options – One Solution Does Not Fit All

Hyperscale Data Center

- Thousands of servers owned by one entity
- Hosted Cloud services
- Clients lease capacity and services

Colocation Data Center Provider

- One entity owns structure, utilities and services
- Clients place hardware in cages
- Clients lease infrastructure, utilities and services

Colocation Data Center Client

- Clients place hardware in cages
- Clients lease infrastructure and services