Timing in Broadcast, Finance, Datacenters

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Agenda

- The need for packet timing in industry
- Broadcast (media)
- Finance
- Data centers

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Every technical industry

- Timing is always needed in distributed control systems and/or communication systems
- Moving to datacom/telecom networks for cost reasons

Past	Present	Future
• Industry specific network technology • Industry specific timing signals, usually in dedicated timing networks	• Mixture of past and future • Datacom networks with legacy timing signals	• Ethernet, WIFI, IP, 5G • NTP and PTP for timing • Driven by cost

time

Why time is essential in Broadcast and Media

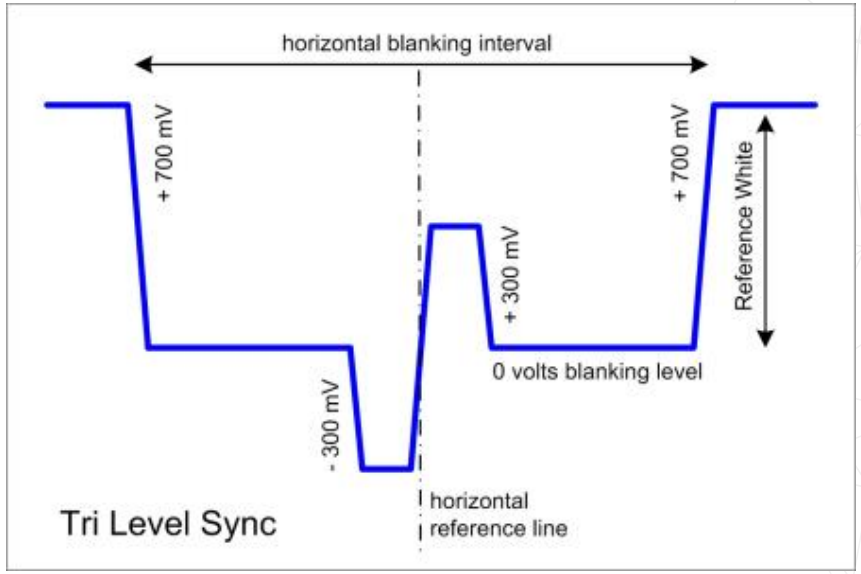
- Multiple audio and video files captured on separate equipment
  - Must be recombined for broadcast or steaming based on audio/visual file timestamps
  - Need smooth transitions among cameras, playback devices and other audio-visual sources
  - Color accuracy
  - Prevent jitter and artifacts
- Timing requirements
  - For video and mono audio: ~10 ms
  - For stereo audio: ~10 μs
  - Error budgeted to network time distribution is typically 1 μs.

NBC Nightly News. Photo by Jeff Maurone

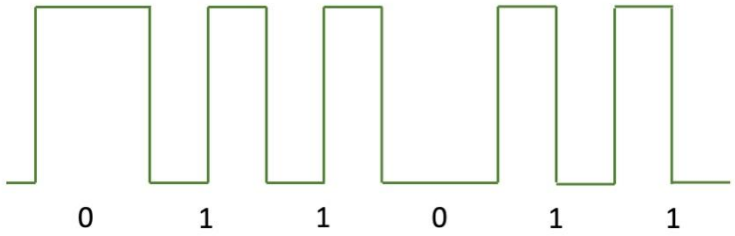
Legacy Broadcast timing signals

- Video signals
  - Black burst
  - Tri-level sync (supports HDTV)
- Audio signals
  - Word clock (square wave)
  - Digital Audio Reference Signal (DARS)

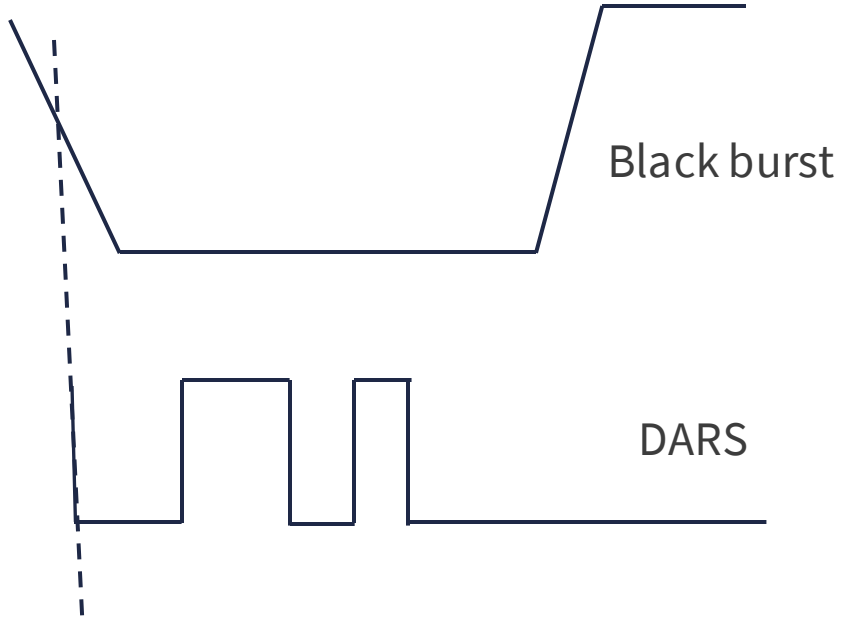
Genlock



- Linear time code
  - Used to insert timestamps in captured media



Linear timecode



Alignment point

Broadcast standards

Audio Engineering Society

- AES67: includes PTP Profile
  - Layer 3, E2E
  - Can be compatible with SMPTE ST2059-2

Image by RTFMASAP

SMPTE

- Society of Motion Picture and Television Engineers
- ST2059-2: PTP Profile
  - Layer 3, E2E
  - Special signaling message sent by GMs with timing metadata
  - Master/slave replaced by Leader/Follower, Grandmaster still Grandmaster

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Image by ZUMAPRESS.com/Newscom

IT in Finance Industry

- Enterprise IT technical viewpoint
  - IETF is where standards come from
  - Comfortable with non-standard approaches (Especially HFT firms)
  - Sometimes use non-standard NTP rather than PTP
- Regulatory compliance is mission critical
- Need time at software layer in standard hardware
  - PCIe cards
  - Software timeReceivers/clients
- HFT algorithms often implemented in FPGAs on PCIe cards

Timing Requirements in Finance

- To trade in the United States (Consolidated Audit Trail)
  - Financial transactions need to be timestamped to 50 ms by traders
  - 100 µs by exchanges
  - To UTC:NIST
- To trade in the Europe (MiFID II)
  - Financial transactions need to be timestamped to 100 µs
  - To UTC
  - Most trading firms do business all over the world, so they will need to meet the strictest time accuracy for
- HFT
  - To measure network performance, not for regulation
  - 1-50 ns

Image from QuoteInspector.com

Timing Protocols in Finance

- Default PTP Profile
- Enterprise PTP Profile
  - Draft RFC in IETF
  - Mixed multicast/unicast operation (hybrid mode)
- Specialized NTP
  - High message rates, Lucky packet filters, Hardware timestamping
- High Accuracy PTP for HFT
  - For example, White Rabbit

Image by FMT

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Timing Requirements in Data Centers

- To make data synchronization in distributed databases more efficient
  - Fewer messages needed required to harmonize DB copies if time sync < latencies between copies
  - Commit =wait time reduced, increasing storage bandwidth
  - Typically want ~ 10 µs
    - Future requirements will be tighter
- Other distributed applications will need timing
  - For example, distributed AI training
- Cloud vendors starting to host infrastructure for finance
  - Must meet CAT and MiFID II requirements

Image by cloudwatt

Timing technology in Data Centers

- PTP or NTP
  - PTP without on path support common
  - Often engage in leap smeared NTP
    - Add inserted second gradually by slowing down clocks for a period of time
    - Easier to mess up time then change DB software to handle leap seconds

Image by Bob Mical

- Open Compute Project (OCP)
  - Industry consortium for sharing open software, hardware and best practices
  - OCP-TAP: time appliance project (open timecard design)
  - OCP PTP Profile: unicast, layer 3, similar to ITU-T G.8275.2
- Stateless client-server PTP
  - Works similar to NTP
  - Standards project: IEEE 1588.1

Thank You!

If you have questions:

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The Synchronization Experts.