



Network-Based



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Timing and Synchronization

“Genlock in the Cloud”

IEEE Meetings, Victoria, BC.

May 14th, 2013

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Sync and Timing in Media

Why do we synchronize things?

Video

- Switching, Mixing
- Use Genlock – Black Burst or TLS

What about digital audio?

- DARS (AES3 / AES11)

What about time?

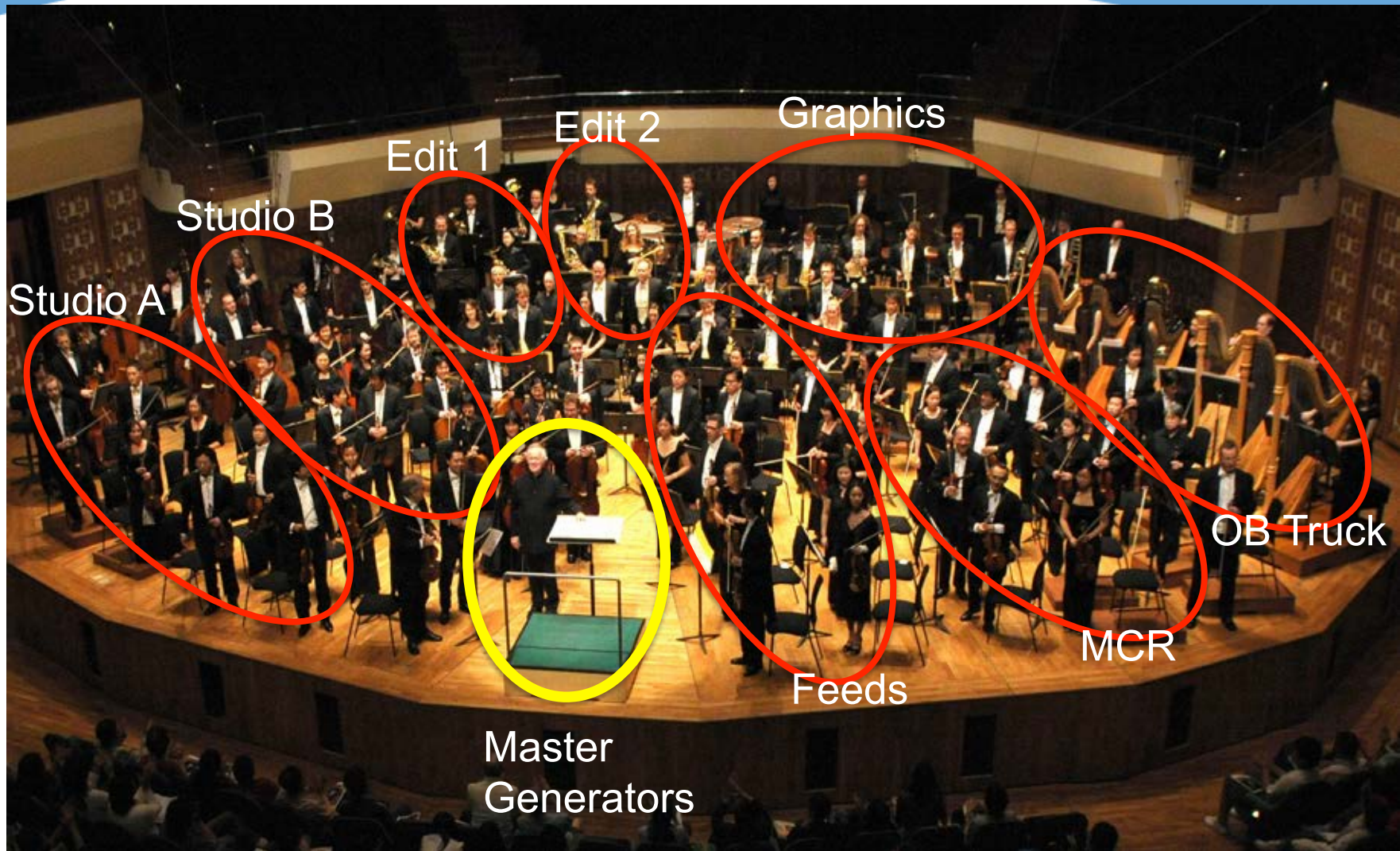
- Timecode SMPTE ST-12



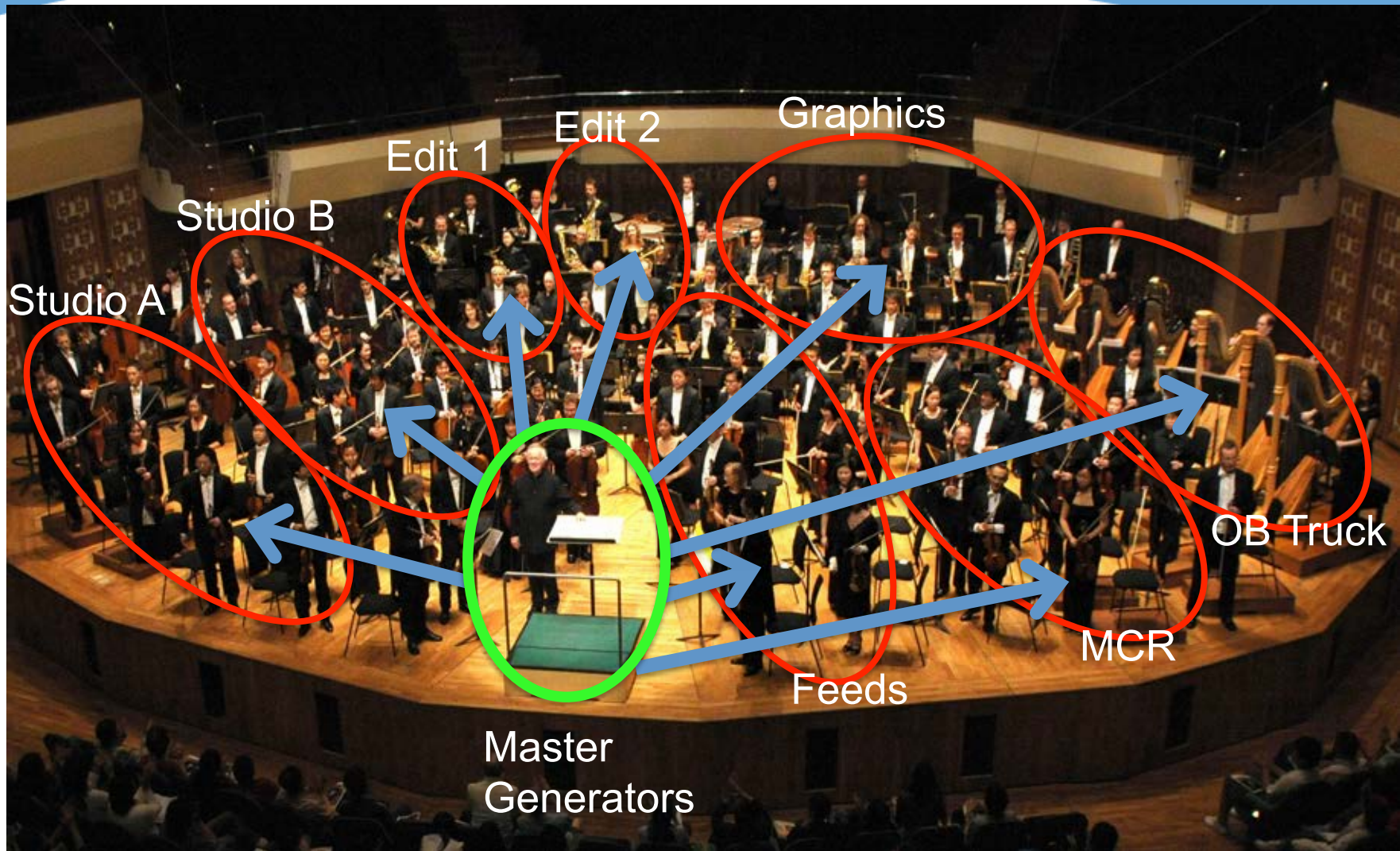
Synchronization in Media



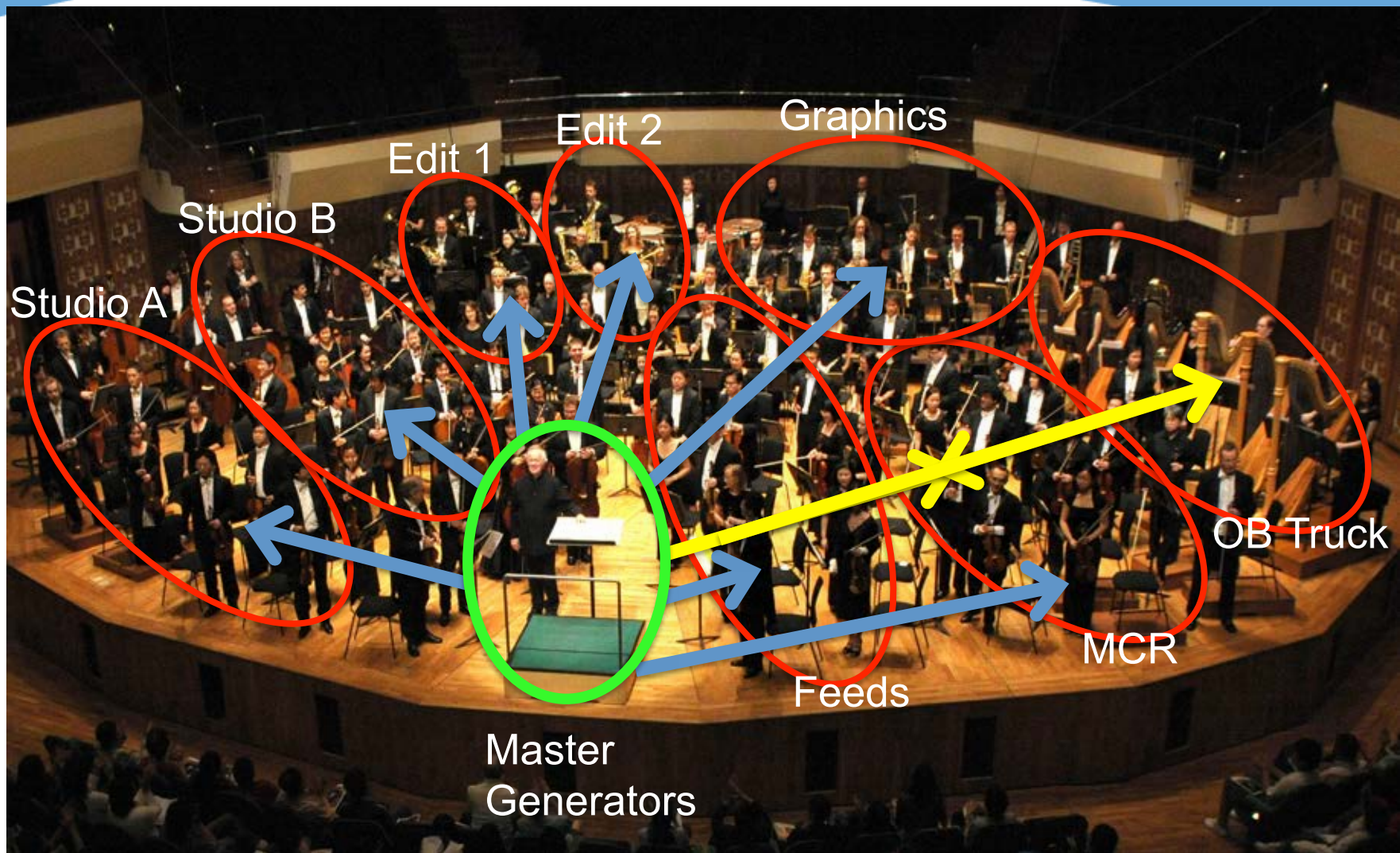
System Synchronization



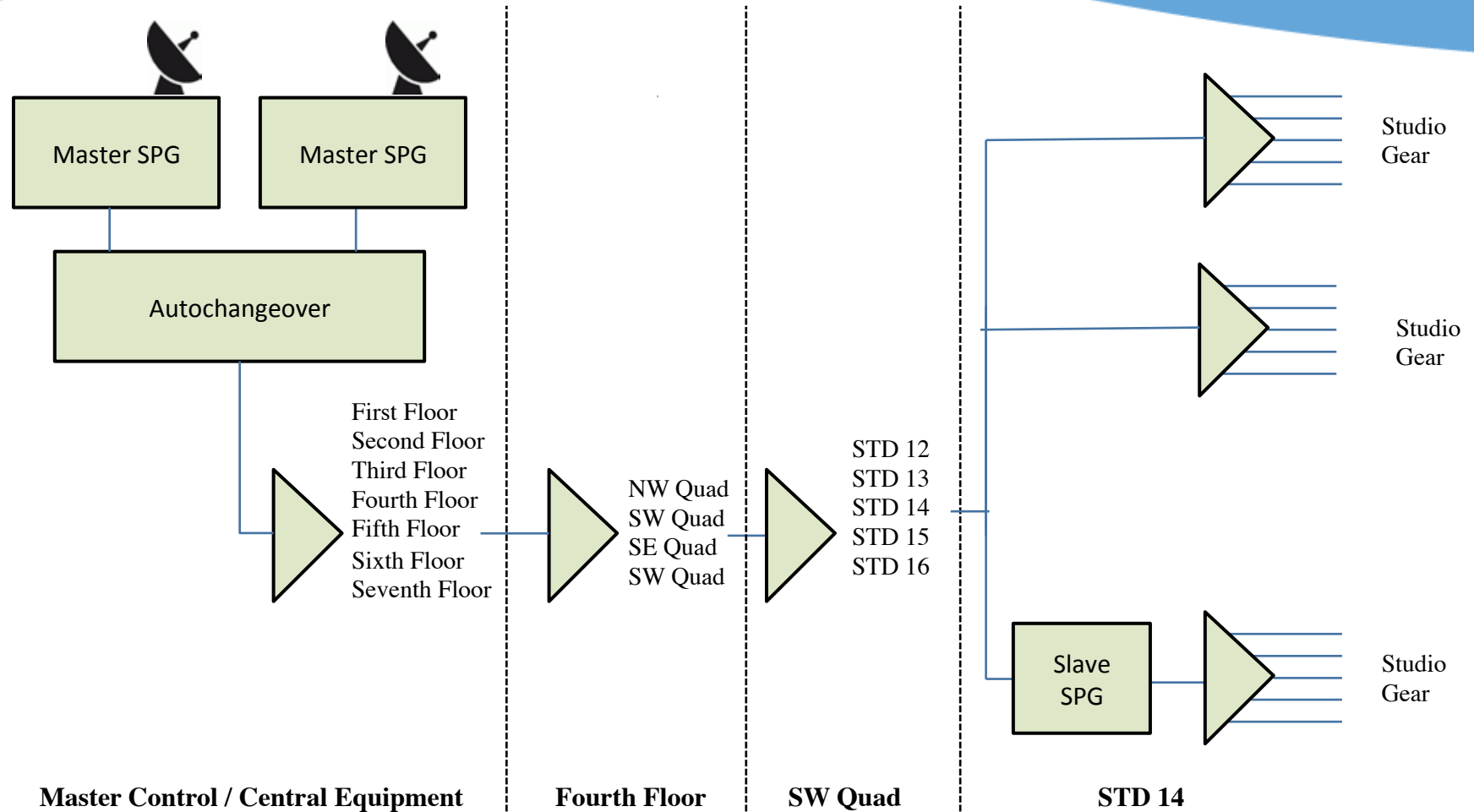
System Synchronization



System Synchronization

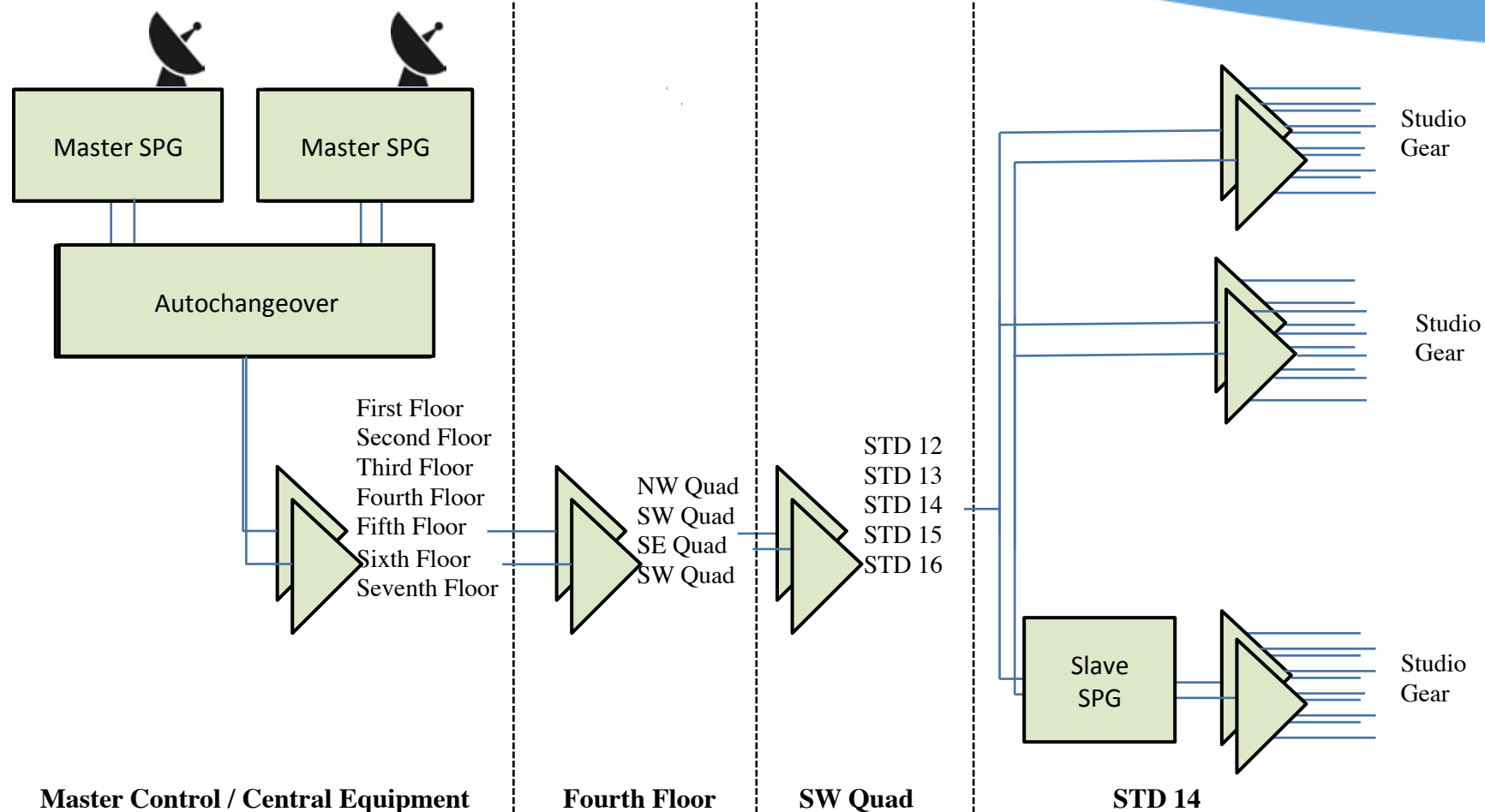


Distribution System





Distribution System Layers



What do References Deliver?

Frequency

- Different for each signal type used
- Varying degrees of tolerance

Phase

- Known phase references
 - VSync, HSync - ST318 BlackBurst
 - Audio block, frame - AES3 / AES11
 - Time of Day - ST12 Timecode

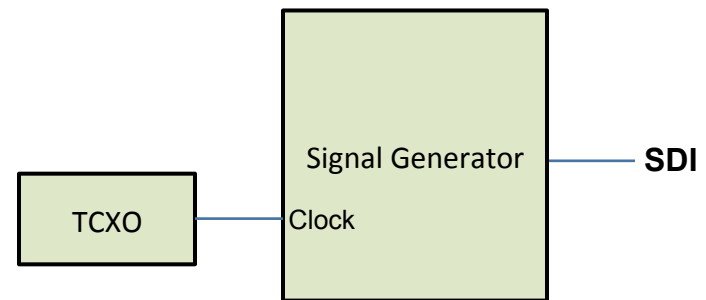
• Date - ST309

Generating Signals

- Logic state machines generate signals from a clock (timebase)
- Operate at framerate modulus
 - Generate the same thing over and over and over
 - Known rate, but arbitrary phase = asynchronous
 - This is every piece of free-running gear

Generating Signals - Freerunning

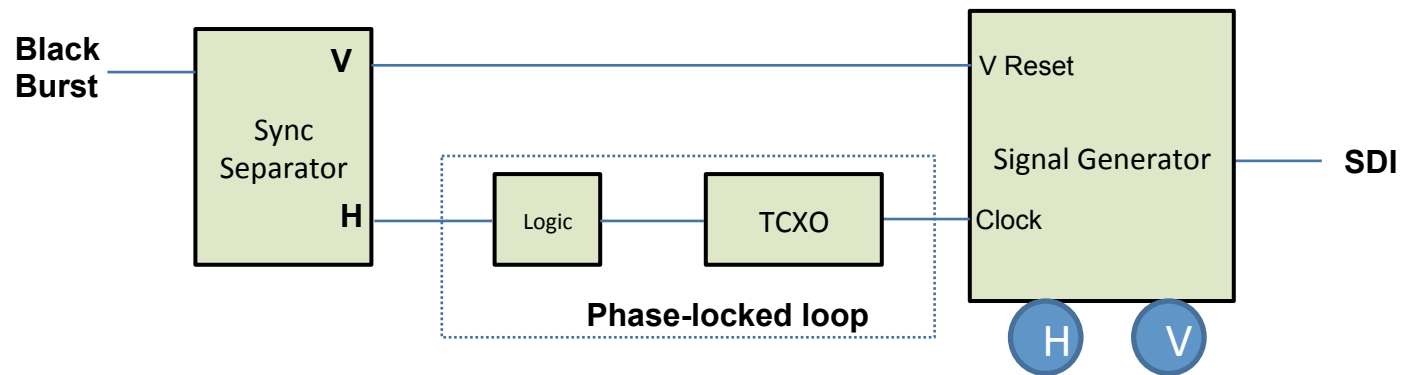
- Local high-precision oscillator generates clock
 - SMPTE Frequencies
- Logic state machines generate signals
- Free-running



Generating Locked Signals

- Frequency Lock – clock for signal generator
- Phase Lock – vertical (and horizontal) alignment
 - Achieved by resetting the generator to an anchor
 - Vertical Sync is a natural anchor for video

Generating Locked Signals



- Sync Separator extracts H and V
- H drives PLL to generate locked timebase
- V resets signal generator to known phase
- H and V knobs adjust timing relative to reference

Sync and Timing Systems Today

So what's the problem with that?

- Ancient technologies (from a simpler time)
- Mix of analog and digital-ish signals
- Serious modern functional limitations
 - Don't support > 60 fps, VFR
 - BlackBurst \neq HDTV
 - Require multiple distributions
 - CAPEX, OPEX
 - nailed down architectures

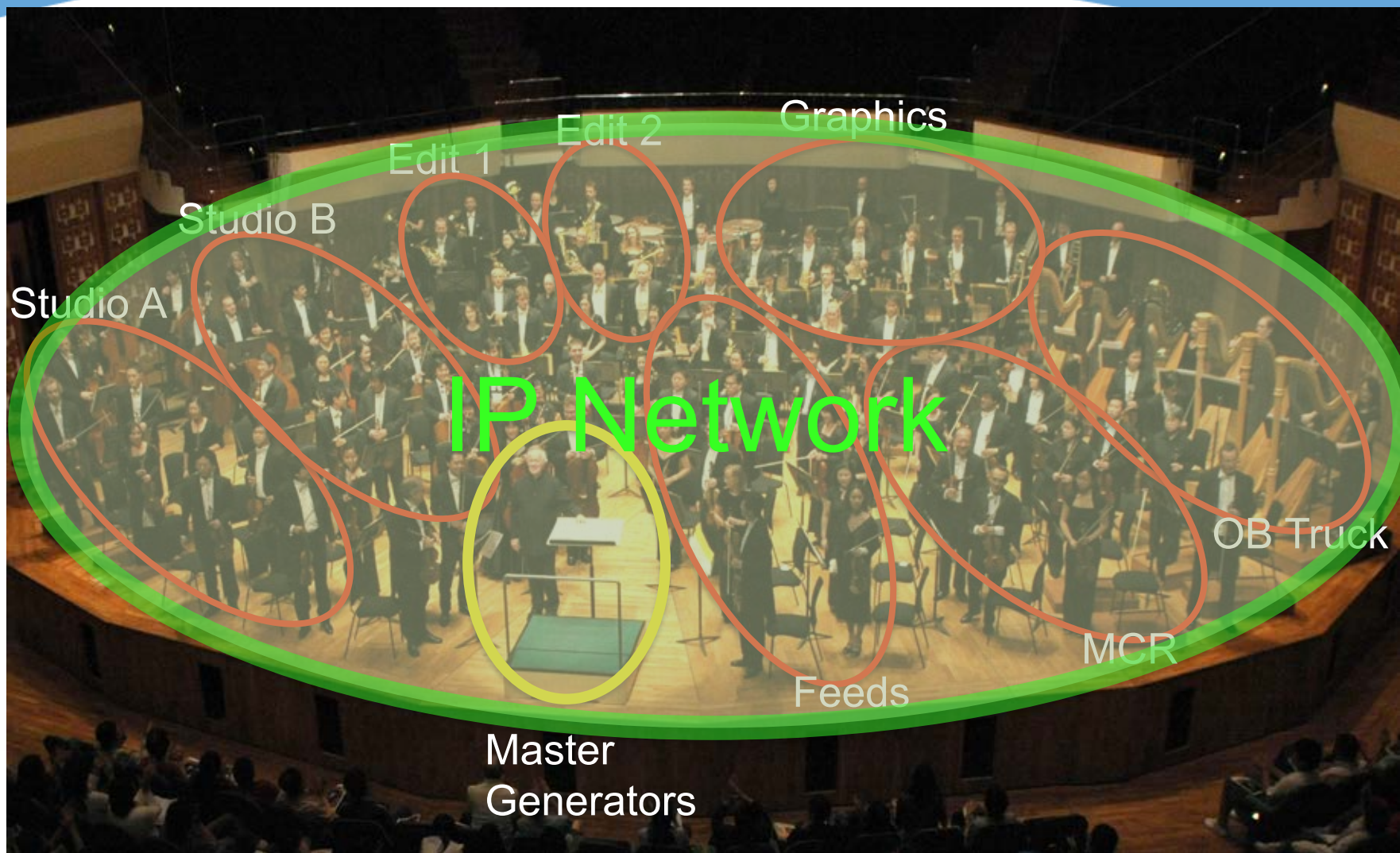
IP Networks

Touch most equipment today
Easy to deploy, modify
Remotely / centrally managed
Security provisions

The new core infrastructure for media

Might be a good way to distribute
references

New Opportunity



Network-Delivered Reference Requirements

- Deliver references over IP network
- Provide capability of legacy systems
- Deterministic behaviour
- Provide open platform for future
 - Signals (transports)
 - Formats (essence)
- Use COTS technology wherever possible

Network Performance

Non-deterministic

- Can't predict when things happen
- Traffic all shares the road
- Message delays are variable

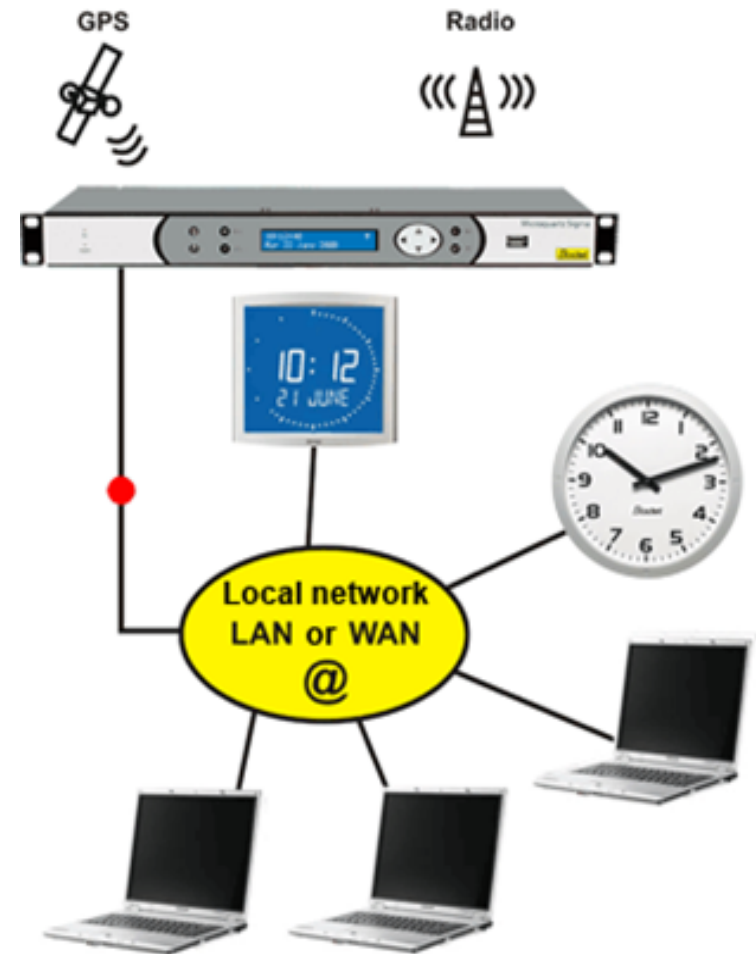
Jitter!

Things get lost

*We need a core technology that
overcomes this!*

One Possible Solution

- NTP
 - Works on IP networks
 - Deterministic
 - Delivers time
 - Not enough performance
 - millisecond-class time accuracy

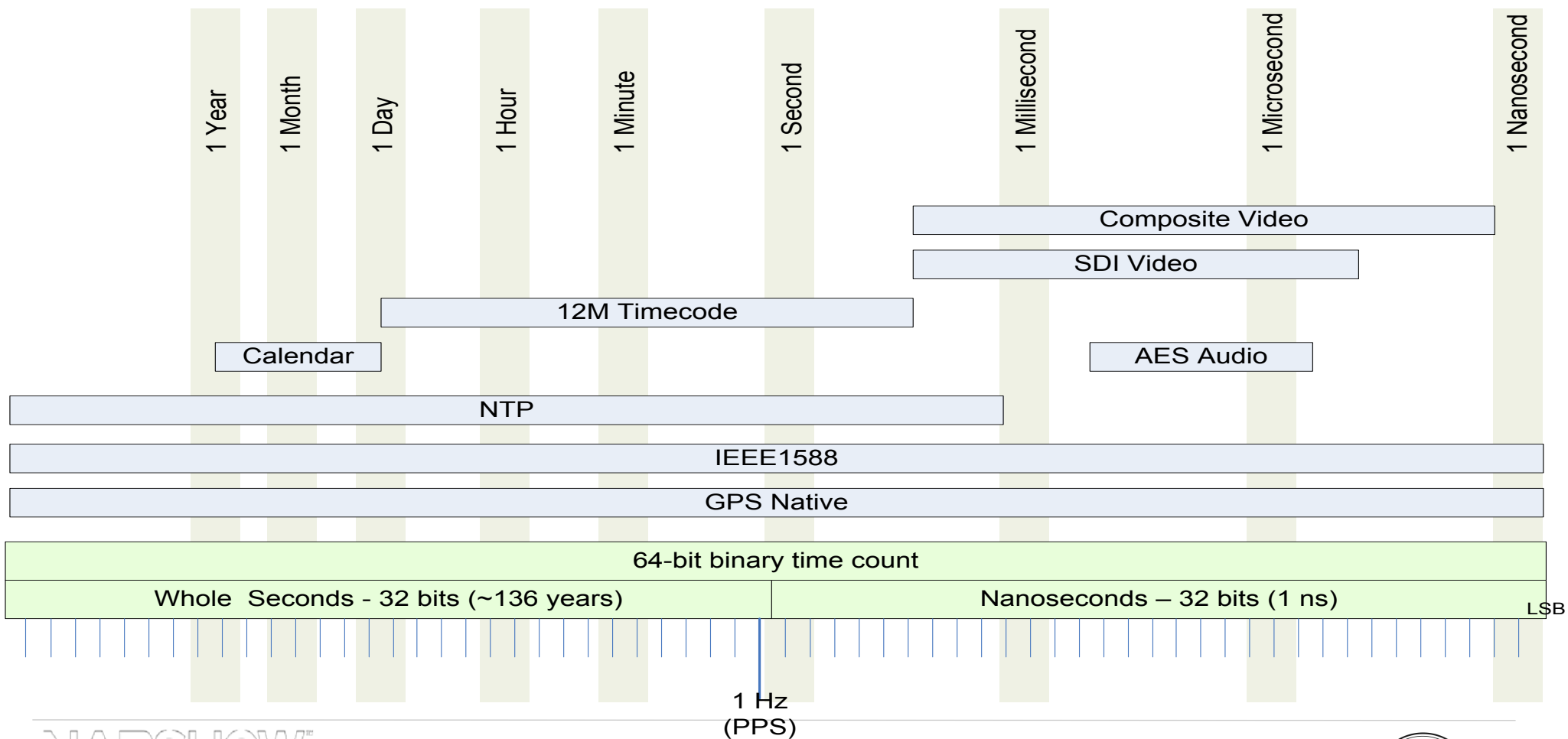


Enter IEEE 1588 PTP

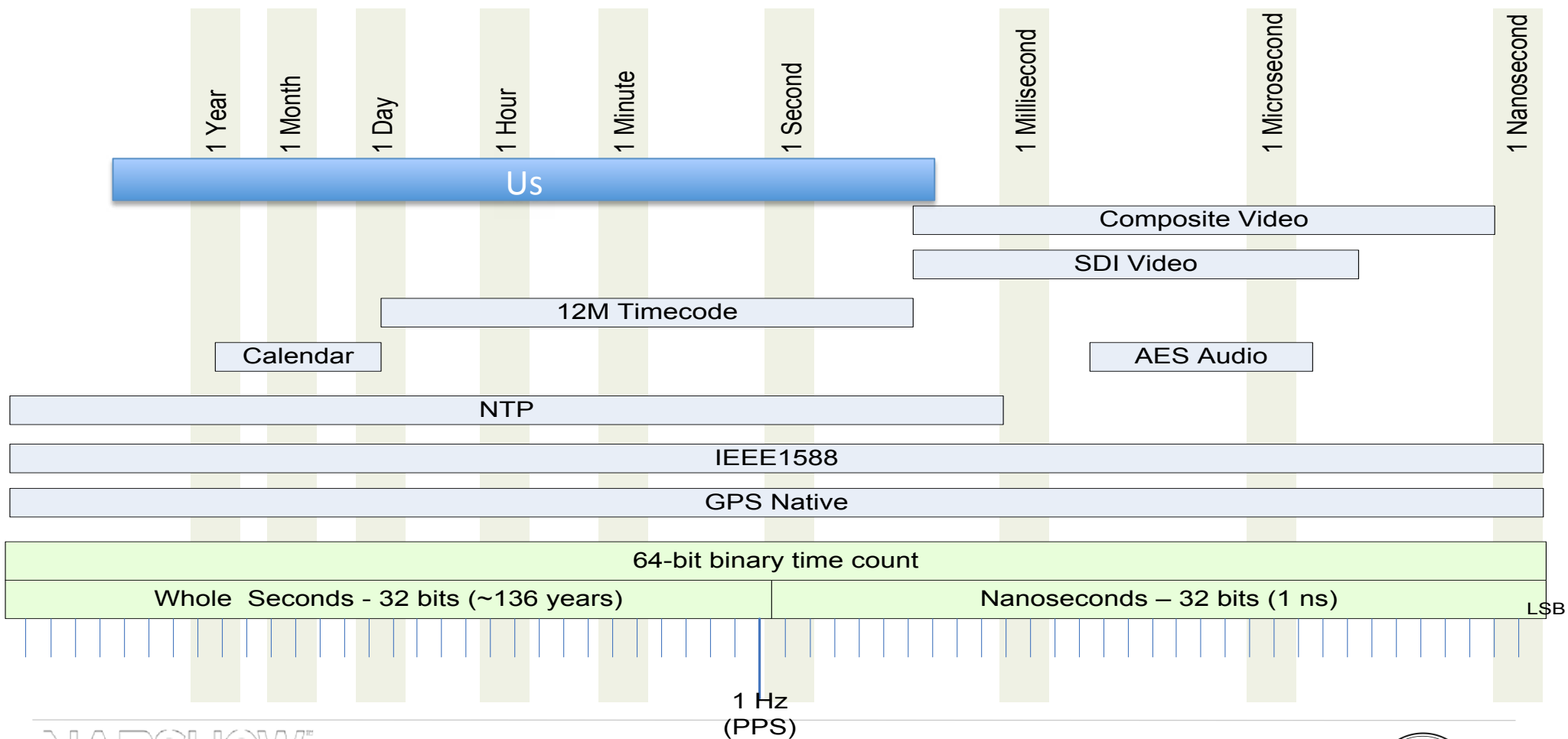
Network-based Precision Time Protocol *Delivers precision time to many slaves*

- Spans hundreds of years
- Sub-nanosecond granularity
- Delivered over IP network
- Can be globally locked
- Can co-exist with other traffic

1588 Span and Granularity



1588 Span and Granularity

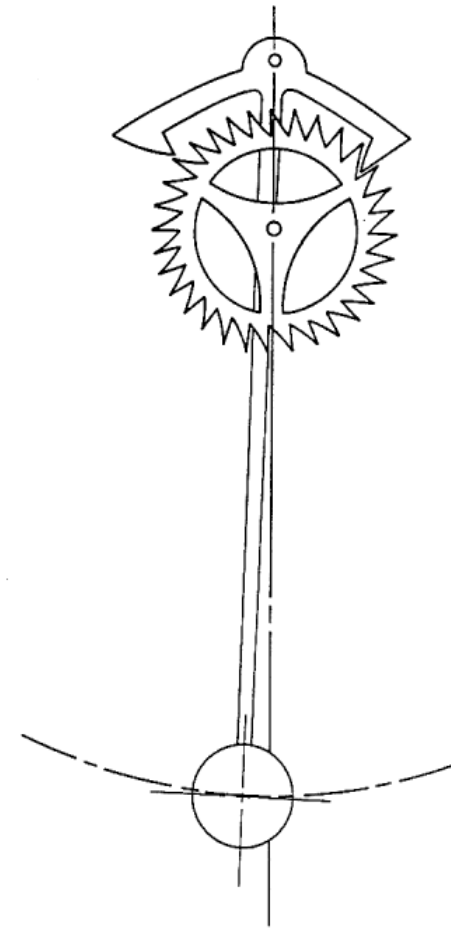


Frequency from Time

PTP delivers time, not frequency

Frequency is transferred by comparing local timekeeping to incoming

“At the tone, the time....”



Pendulum Clock Escapement Mechanism

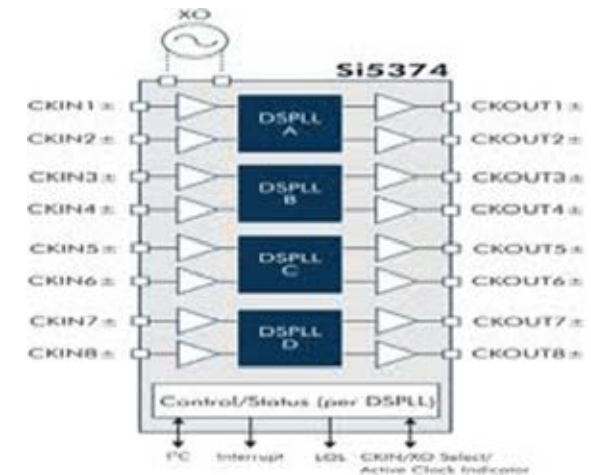
Signals From Time

- Time = signal phase
- Pick an Epoch (instant in time)
 - Some past date and time (PTP Epoch)
- Define alignment of signals to that instant

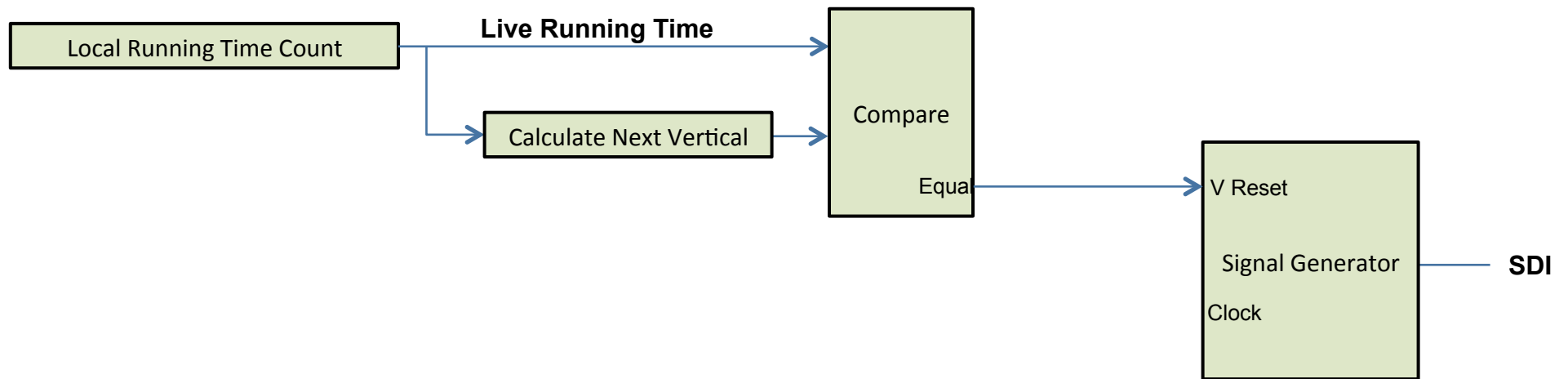
- Can predict future phase of any signal

Timebase Generation from PTP

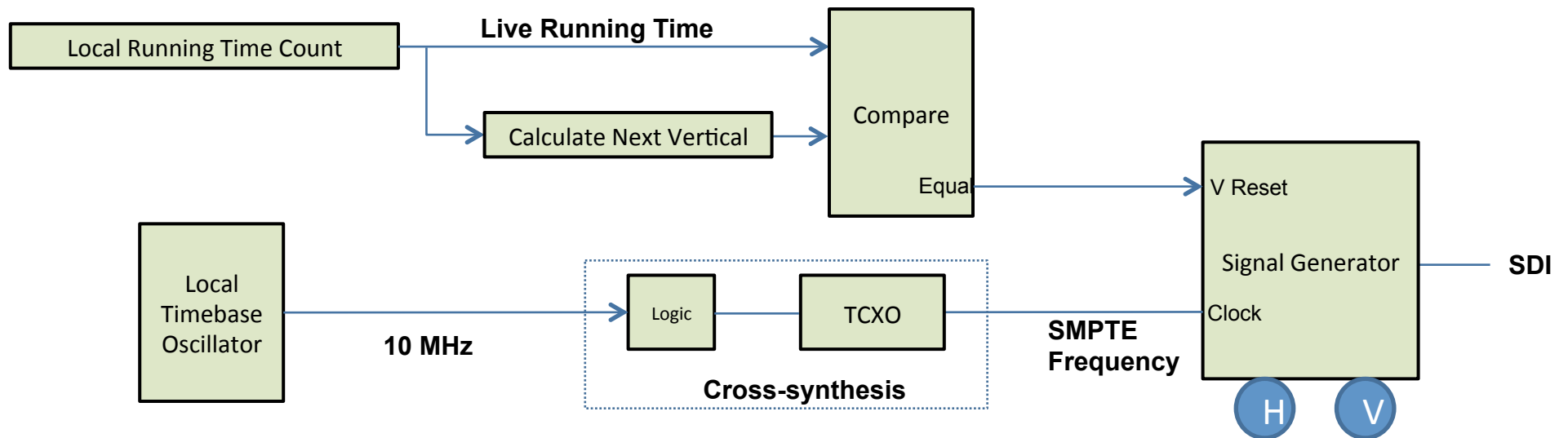
- PTP Slave has locked timebase
- SMPTE Frequencies are cross-synthesized to required frequency
 - Many methods
 - Low cost
 - High accuracy



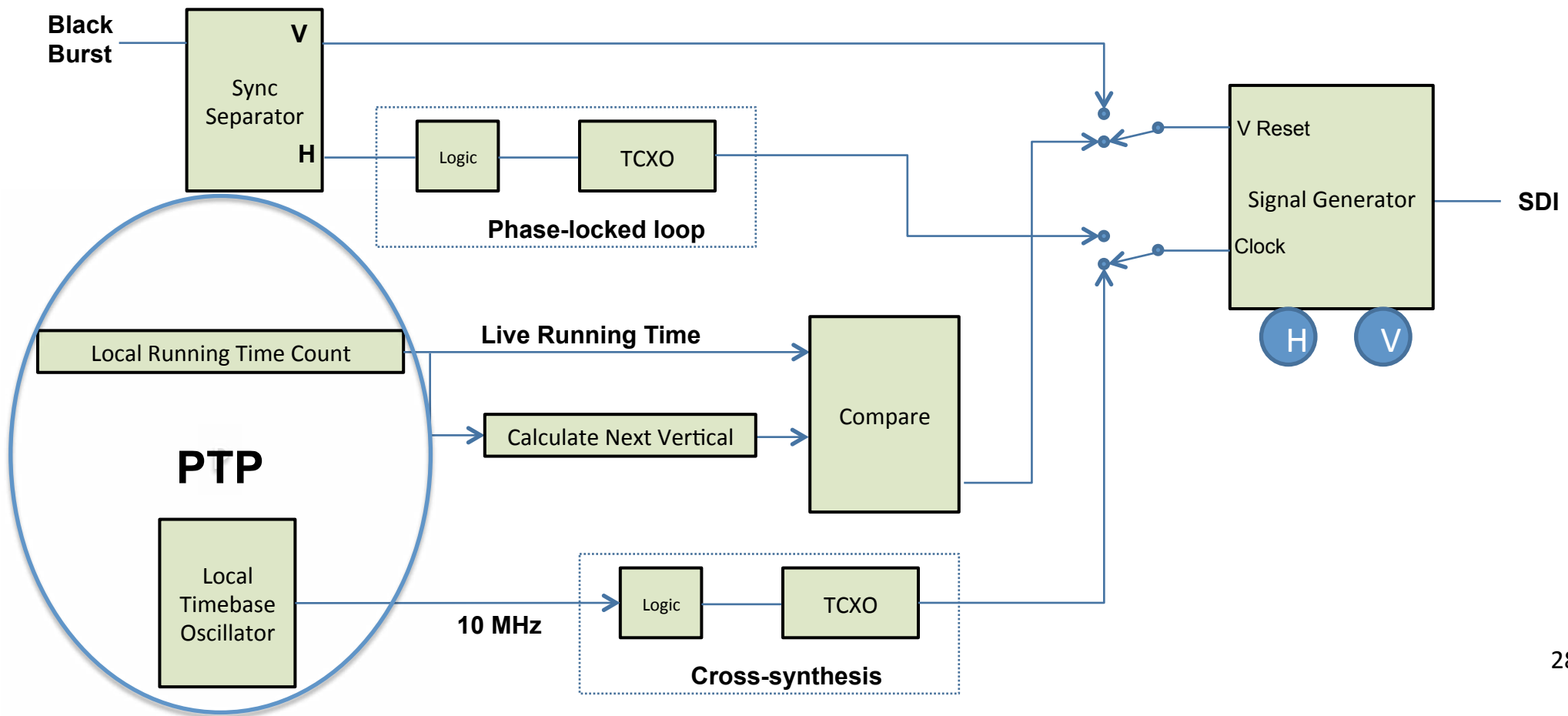
Anchor Generation from PTP



Full Genlock from PTP



Dual-Mode Genlock Equipment

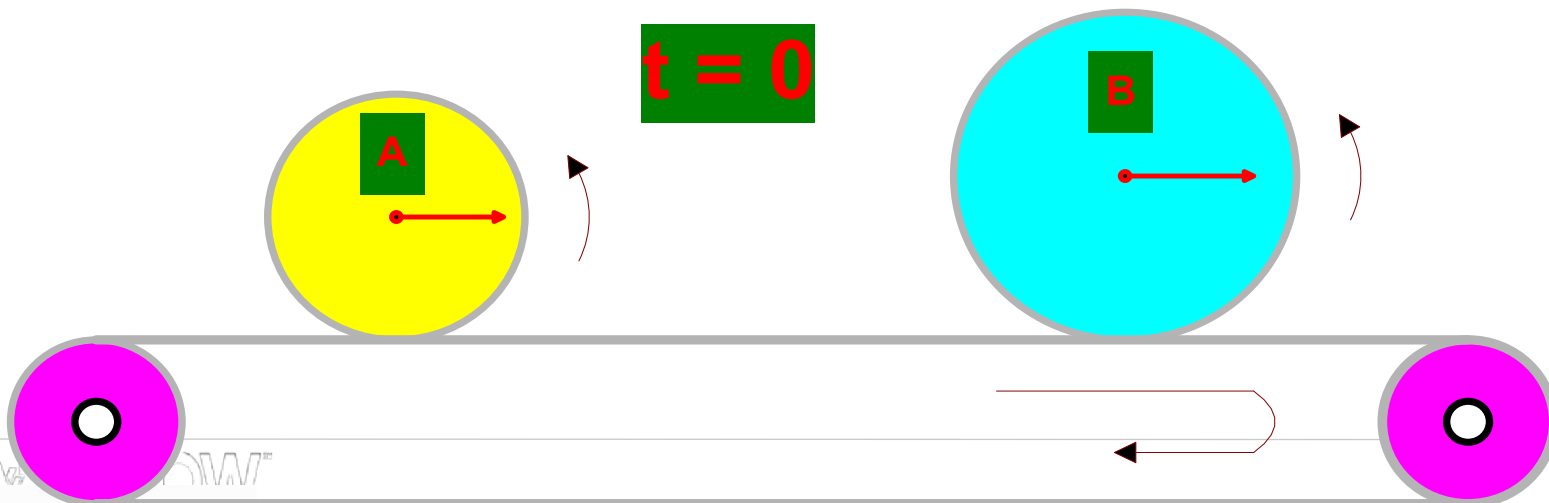


Some Limitations

- Within a system, timing is deterministic
 - All running from same master
- Between systems, timing is non-deterministic
 - Can achieve frequency lock
 - Phase between systems is manual
 - That's why we have frame synchronizers

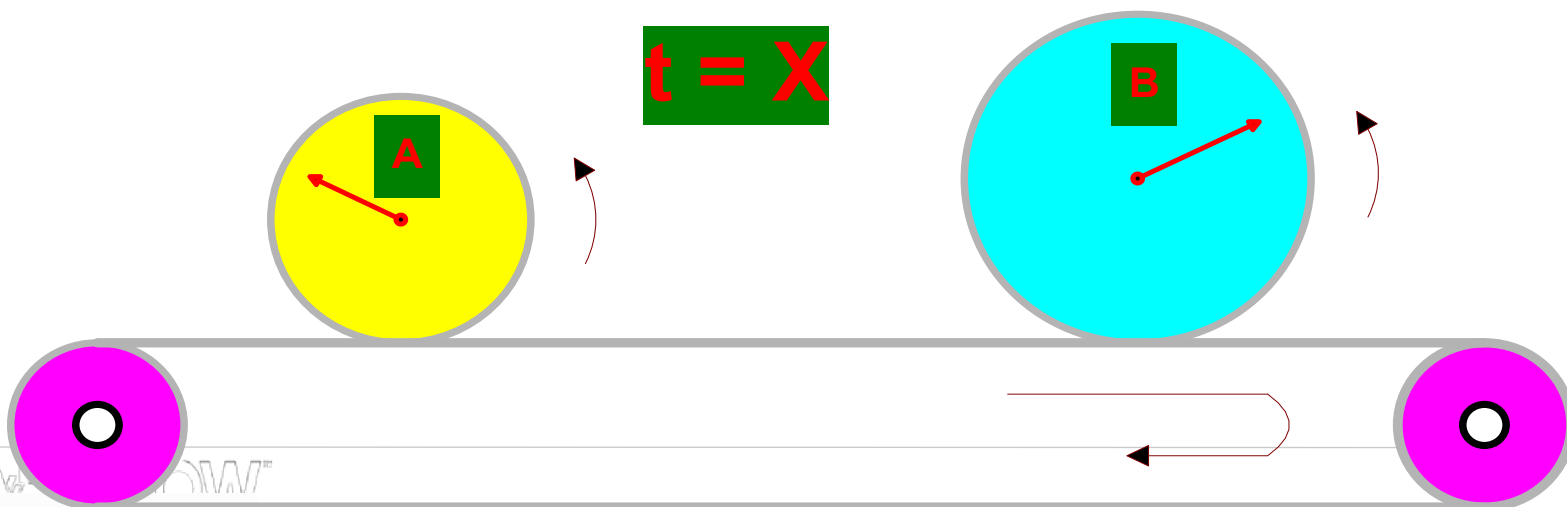
Deterministic Behaviour

- Establish alignment of all signals at Epoch
 - Yellow and blue represent two different SMPTE signal types
 - Conveyor belt is PTP timebase
 - Signals phase (anchor) aligned at Epoch



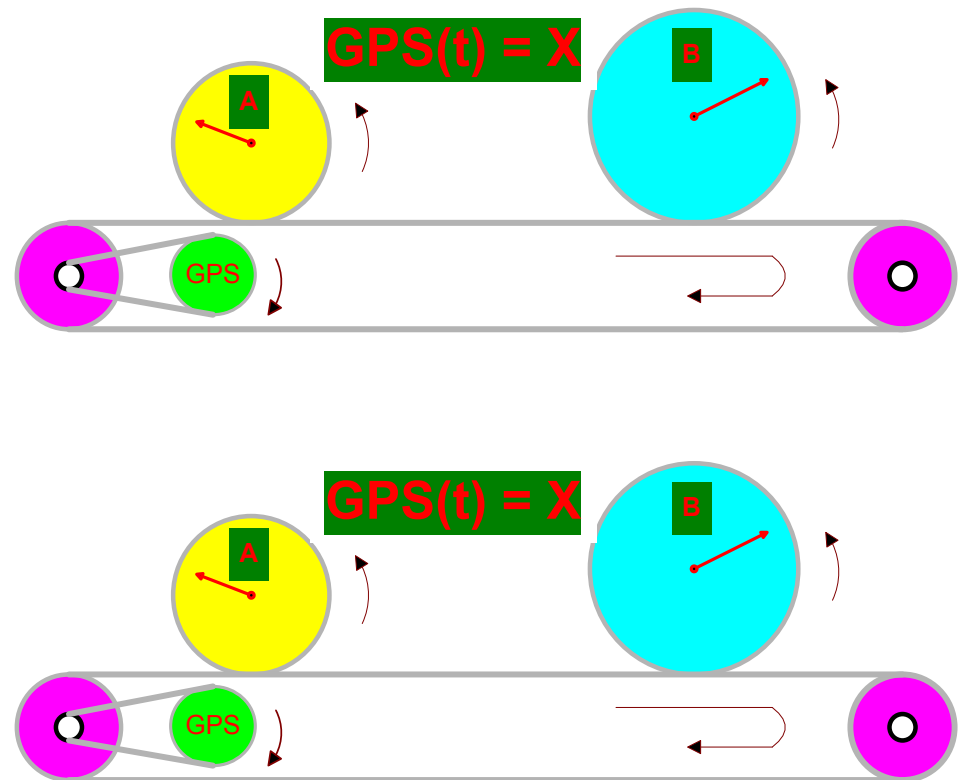
Deterministic Behaviour

- At some future time ($t=X$)
 - Signals will have different phases
 - Each can be calculated from Epoch

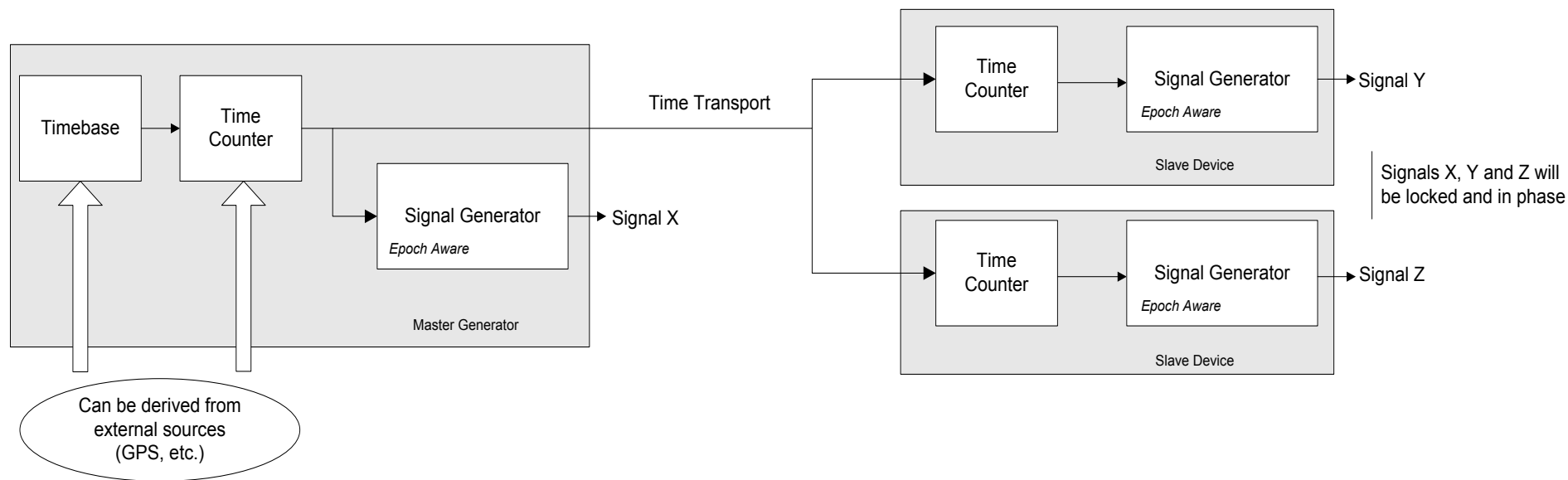


Deterministic Behaviour

- External reference turns belt (GPS)
 - Wheel phase is predictable between systems
- Reference can be GPS, other GNSS, big PTP network



Determinism



Net Result

Can deliver all references over IP network

Can have independent systems in phase

Can share other traffic on same network

- Control, monitoring
- File-based transfers
- Compressed streaming
- Soon live baseband over IP

History of Time-Based References

- 1998 – Leitch (Kupnicki) develops method
Time transport over BlackBurst
- 1999 – SMPTE not ready to embrace
 - That's OK, we use it inside products
- 2007 – SMPTE / EBU establish taskforce
Leitch method modernized to use
PTP
- 2010– Basis for SMPTE Standard work

SMPTE Activities

33TS Synchronization and Time Labeling Standardization Committee

Drafting the ST 2059 Standard Suite

Includes EG and RP

- ST 2059-0 Overview of Standard
- ST-2059-1 Generation of Signals
- ST-2059-2 SMPTE PTP Profile

Signal Generation Document

Specification of SMPTE Epoch
Alignment for each signal of interest
References to root standards
Formulae for each signal of interest
Direct derivation from time
Generation of Time of Day
Generation of Timecode

SMPTE PTP Profile Document

SMPTE-specific performance criteria

- Message Rates
- Node Types
- Master Selection
- Alternate Time Offset

SMPTE-specific metadata

- Timecode Helper Data
- System Framerate
- Miscellaneous System Stuff

SMPTE activities

Working Groups

- 33TS-20 developing sync system
 - Signal Generation and Profile
 - Work nearing completion
- 33TS-10 developing new Time Label
 - Work actively underway

Includes EGs and RPs



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Thank-you!
Questions?

More information? *Shoot me a note*
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