IP SHOWCASE REAL TIME MEDIA

iabm

Synchronization and the IP Revolution

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Legacy reference signals we know and love

BlackBurst, TLS, DARS, Time Code

Generate them in a central place (Master (redundant))

Distribute them to all equipment that needs them (Slaves)

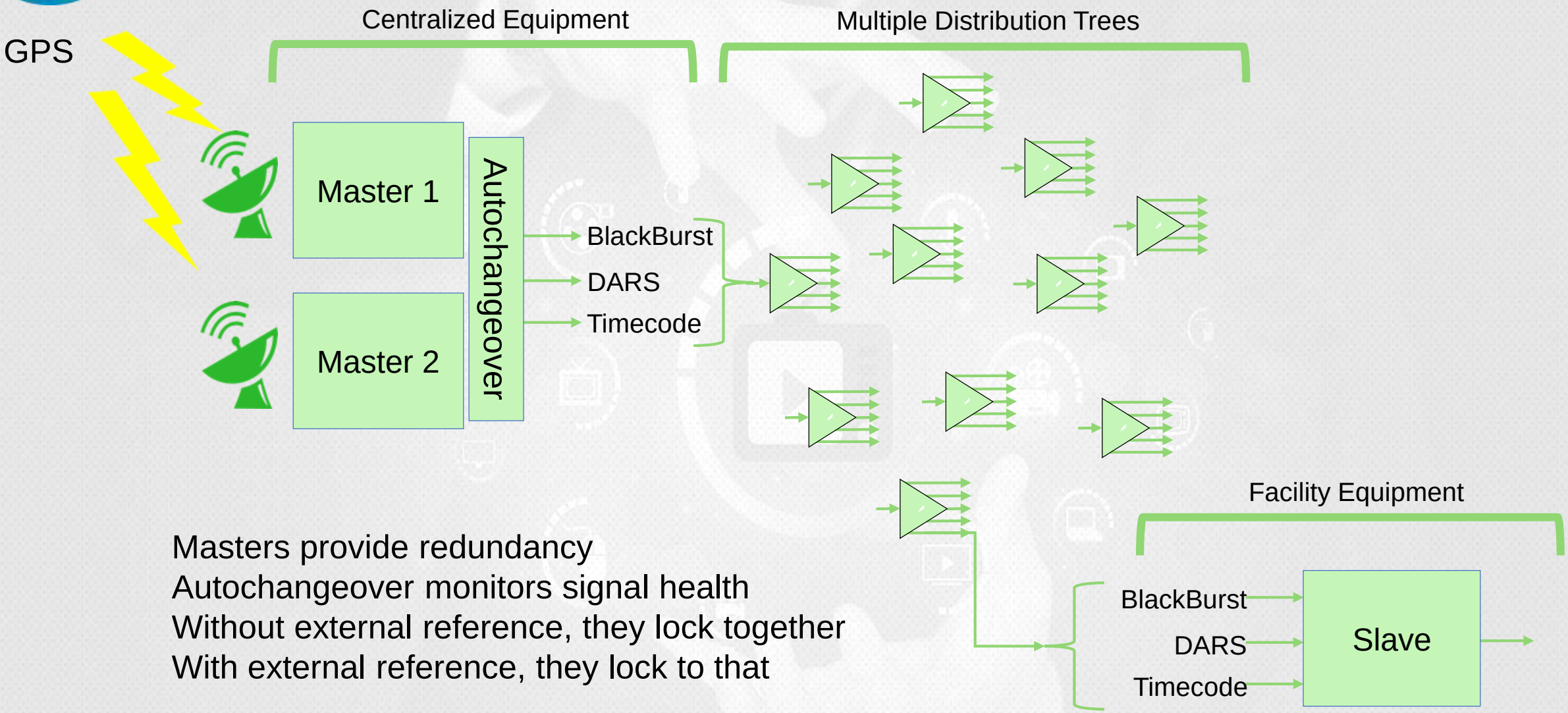
Used to establish output timing, input windows, time of day

Allows building synchronous facilities

Can lock master(s) to GPS (GNSS, etc.)

(more) accurate frequency reference

Time of day for timecode



Masters provide redundancy
Autochangeover monitors signal health
Without external reference, they lock together
With external reference, they lock to that

Problem? What problem?

Multiple signals = multiple distributions

- CAPEX
  - Different distribution hardware and (maybe) cabling
- OPEX
  - Physical equipment maintenance / single points of failure

Inflexible – have to pull cables to evolve

Break in a path in the tree causes downstream disruption(s)

Analog signals (*old* analog signals!)

Technology horizon - EOL

What are we distributing?

What we distribute are media signals posing as reference signals

- BlackBurst (or TLS) – video with no picture
- DARS – audio with no sound
- Timecode –Good ol' ST12 (12M to some) longitudinal timecode

Why? History.

Easy to use in slave equipment – natural frequencies (for media)

Same interfaces and systemization technologies as media signals

Made sense when life was simple.

What are we *actually* distributing?

Two fundamental things:

Frequency (timebase), which ensures:

Signals are locked (stationary in time) wrt one another

Frequency of signal is correct (per SMPTE, etc. STDs)

Phase (“timing” or “alignment”), which ensures:

Signals are in a deterministic time relationship “timed”

- made coincident (-ish) at points of use

This can be virtualized through use of PTP

Frequency (timebase)

- Derived from interface signal edges
  - H (and SC) in video
  - Edges in DARS and Timecode

Phase (“timing” or “alignment”)

- Largest periodic element of signal (“alignment event”)
  - Vertical in video
  - X or Z preamble in DARS
  - Bit 0 in timecode

Meanwhile….

Things are changing quickly underfoot

- Analog going away fast – no more critical timing performance
- Technologies are changing – *really fast*
  - Product implementation technologies – HW > SW
  - Broadcaster systemization technologies – digital > network
  - Distribution technologies – many > network
  - Consumption technologies - network
- Workflows are changing – network

DO YOU SEE A TREND HERE?

Is there a better way?

Nice to have:

- meets legacy performance requirements
- one distribution infrastructure, not many
- one method method to carry all references, not many
- a means of providing redundancy in the distribution
- something that would directly support new / future standards
- something that can be externally / globally referenced
- as close to plug and play as today
- ***something that can run on a network***

IEEE1588 PTP

IEEE1588 Precision Time Protocol (PTP)

Delivers precision time to slave devices over network

- Runs on IP (and Layer 2) networks
- Provides for a master (“Grandmaster”) and slave devices
- Offers master and distribution redundancy
- Offers external (GPS, etc.) lock to frequency and time
- Can coexist happily with other network traffic
- Network switches can participate to improve performance

So what? Where’s the frequency and phase?

What does PTP do?

Transfers precision time to many slave devices over a network

PTP transfers frequency via running time:

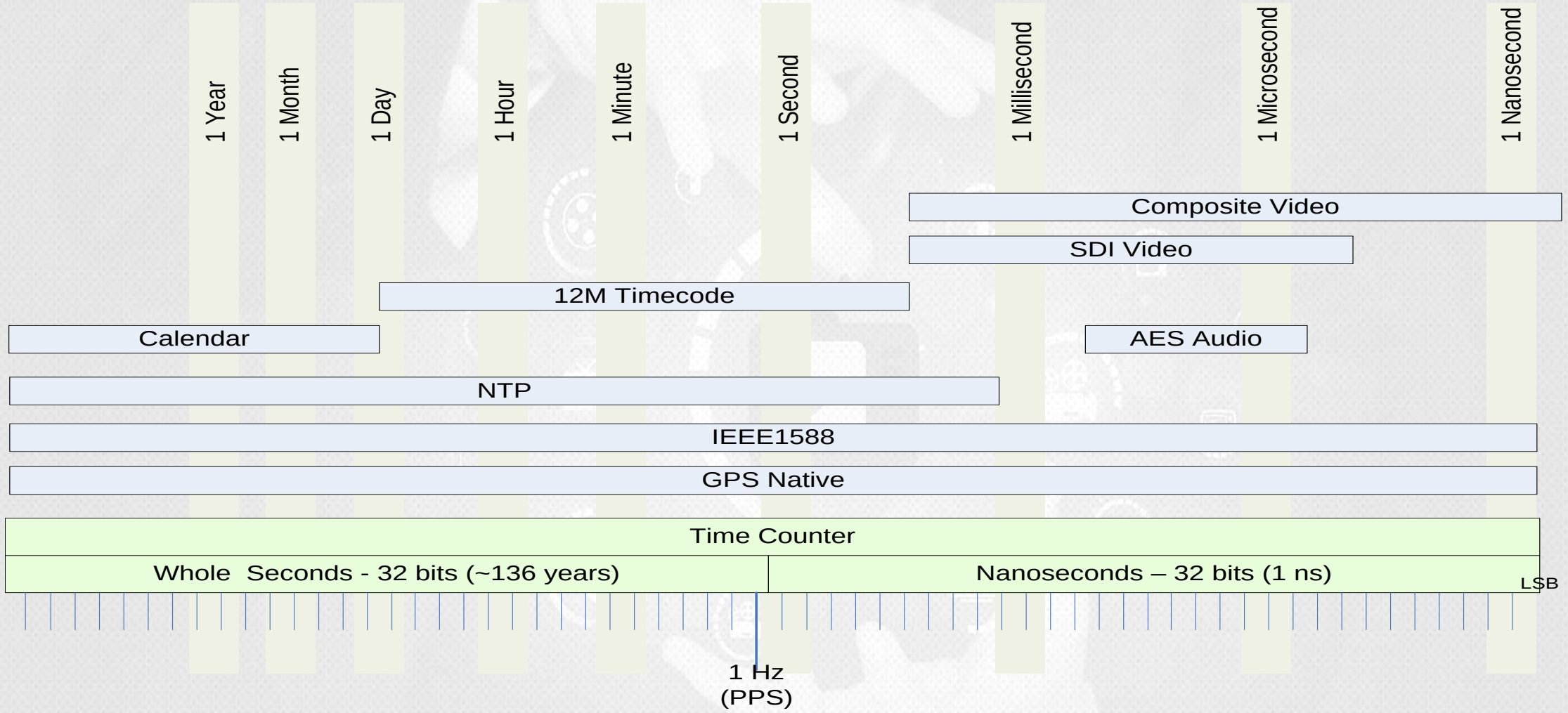
- 1 GHz virtual clock (timebase) (typically a submultiple)

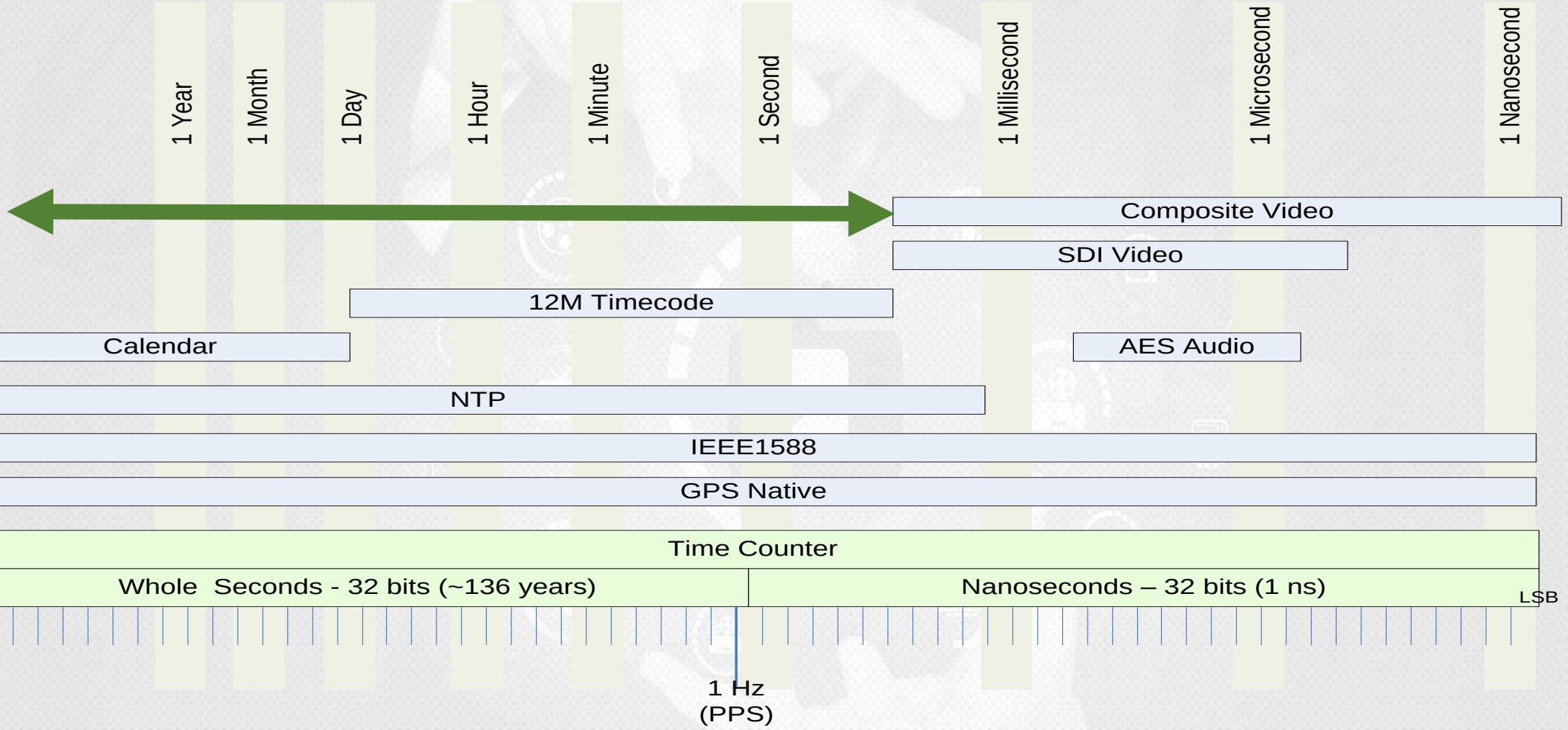
PTP transfers phase via running time:

- A count value since the time the counter was zero *(“Epoch”)*
  - High span (~136 years) / high granularity (1 ns)

When locked to an external authoritative source, multiple independent masters will have same time and frequency.

- Global locking possible via GNSS (e.g. GPS)


1 Year
1 Month
1 Day
1 Hour
1 Minute
1 Second
1 Millisecond
1 Microsecond
1 Nanosecond
Composite Video
SDI Video
12M Timecode
Calendar
AES Audio
NTP
IEEE1588
GPS Native
Time Counter
Whole Seconds - 32 bits (~136 years)
Nanoseconds – 32 bits (1 ns)
LSB
1 Hz
(PPS)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LSB
1 Hz
(PPS)

PTP on the network

- Transmits very small packets
- Can be all of either or a mix of unicast and multicast messaging
  - Reserved addresses
  - Specific network domains
- Very robust in the presence of traffic
- IP switches can provide PTP-specific services to improve performance
  - Boundary Clock switches provide unique master on each port
  - Transparent Clock switches process timestamps
  - QoS can provide deterministic latency

So what?

We need:

Special SMPTE frequencies, not 1 GHz submultiples

Specific phase information related to our signals (events)

A way to establish deterministic phase relationships

And of course SMPTE Timecode!

Getting the funny frequencies

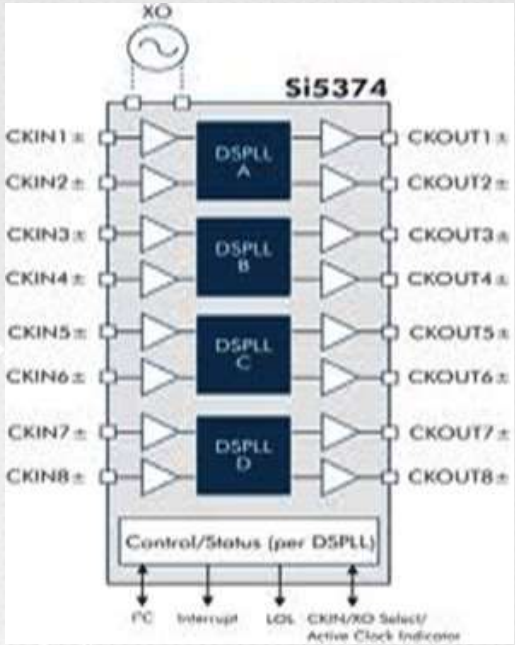
Media frequencies are unusual

PTP is based on integer frequency

Today, cross-synthesis is trivial

- FPGA-based logic
- COTS components

Source oscillator performance is transferred



We do this all the time today inside equipment.

Not a big deal.

Phase anchoring in PTP

We need to have an anchor so all slaves are event-synchronous

PTP defines 1970.01.01 00:00:00 as the “Epoch”

Count value was
00000000000000000000000000000000000000000000000000

We (SMPTE) define that all signals had their events at the epoch

Knowing this, slaves can calculate future events

Because events occurred at a known time (epoch), all slaves calculate the same event times.

This concept is central to the ST-2059 standard.

So what about the network?

IP networks profuse media systems today

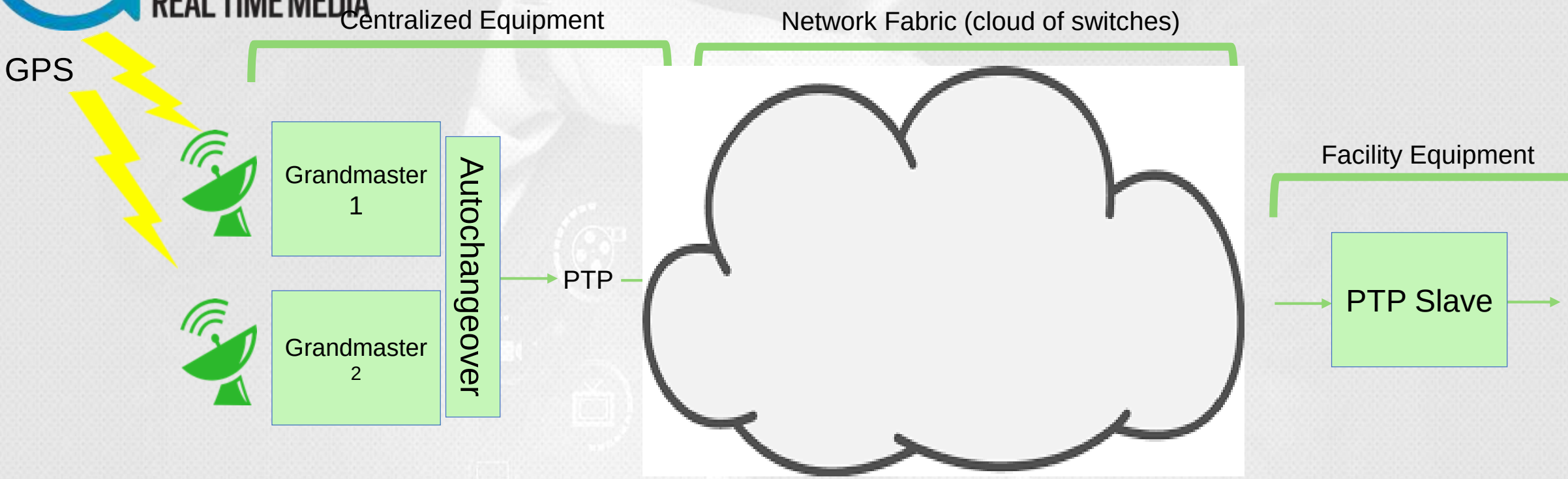
Touch most equipment already

Non-time-sensitive networks:

- Configuration and software upgrade
- Monitoring and Control

Time-sensitive networks:

- ***Live media transport like SMPTE 2110 and AES67***



Masters provide native redundancy (2+)
Autochangeover is virtual between masters (PTP BMCA)
With external reference, they lock to that, one ‘drives’ the network
Without external reference, one becomes master, other(s) lock to it.
With failure of master, another picks up the role

The ‘greenfield’ problem

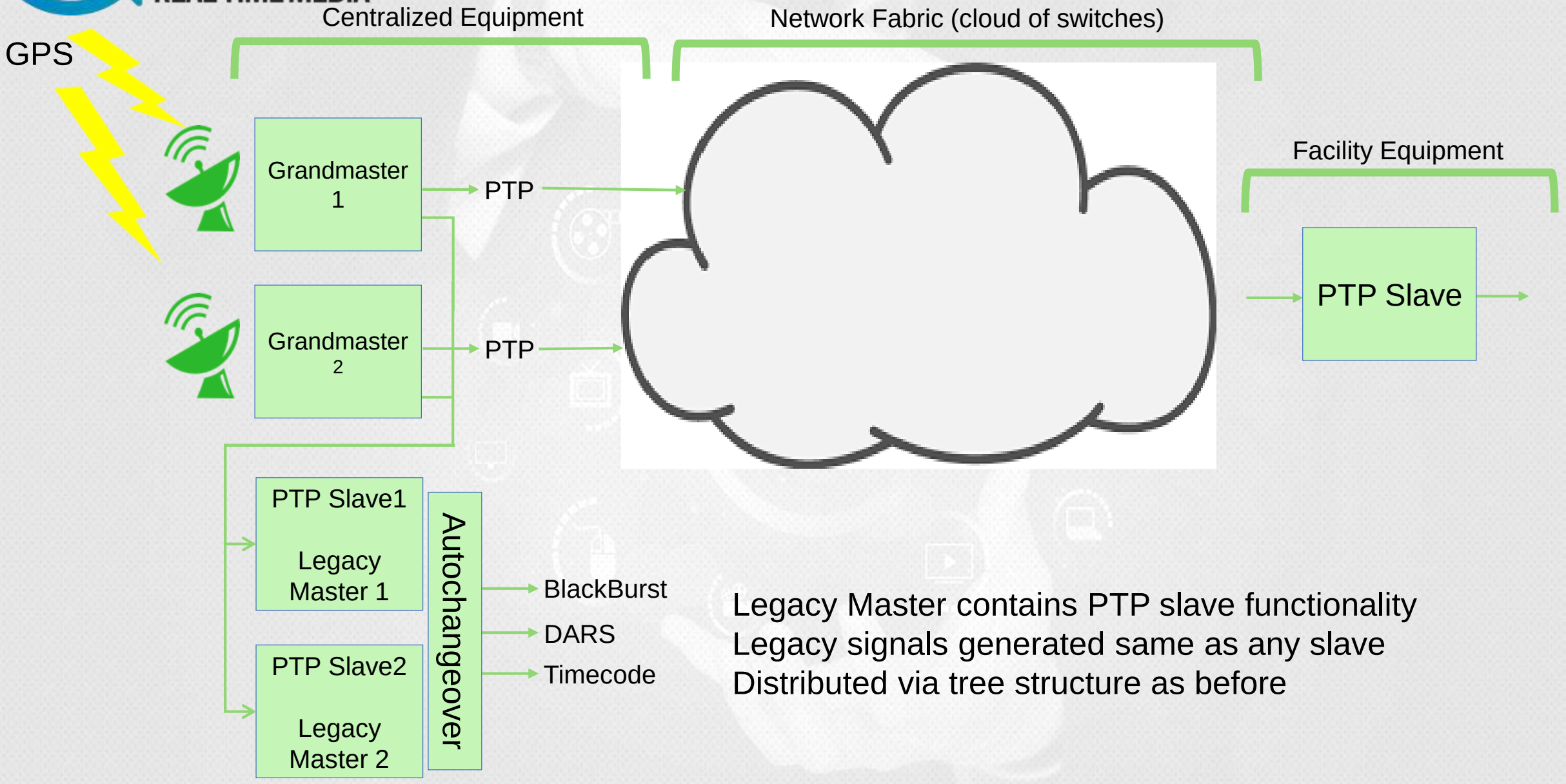
Most people will evolve to network equipment and infrastructure

How to deploy PTP references with legacy systems?

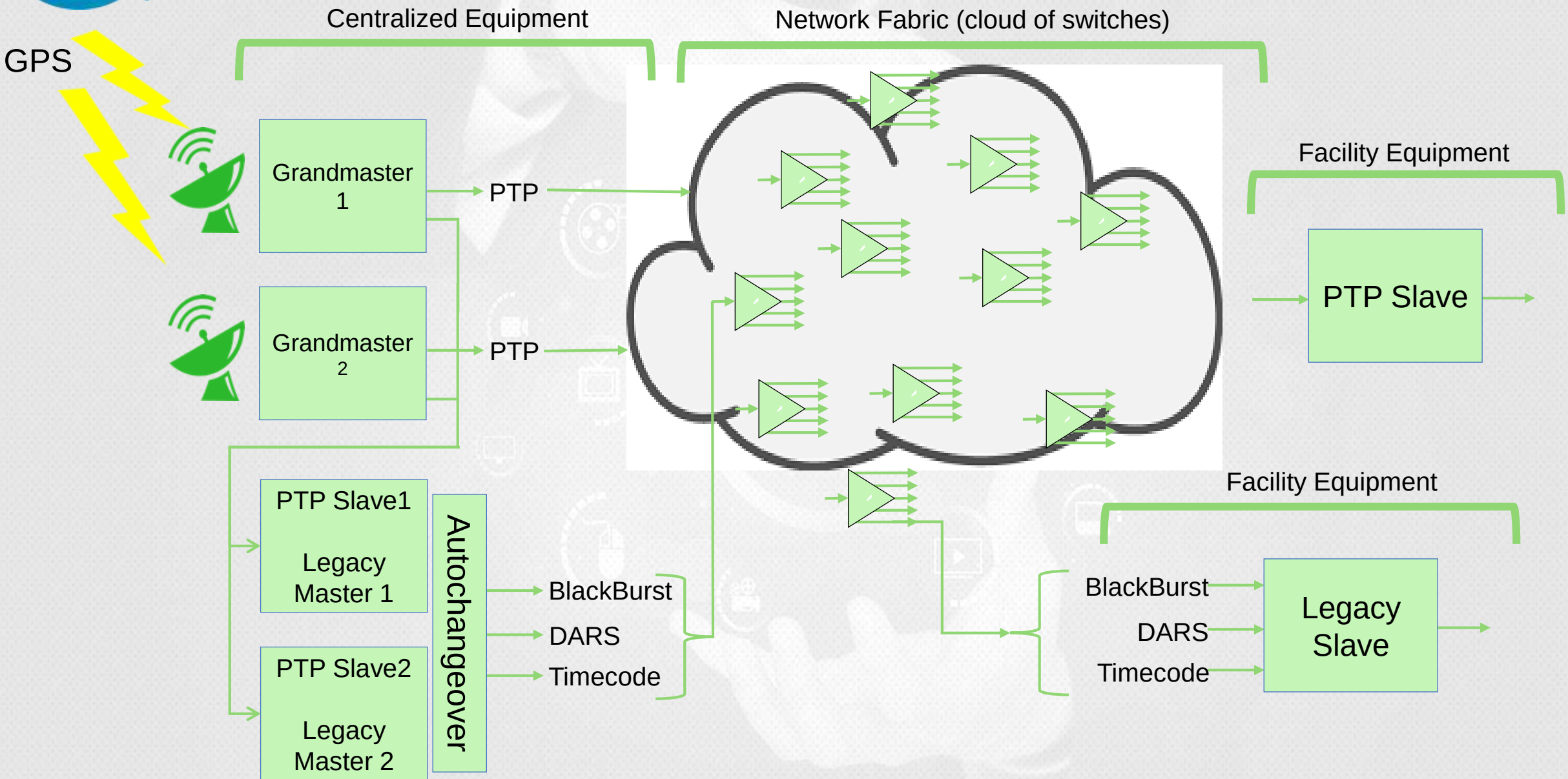
- Both systems need to have same timebase
- Both systems need to provide the same signal alignment
- Facilities / equipment can pick and choose which to use
- User can evolve from old to new at their will

Will require a new kind of master generator scheme

- PTP GrandMaster + legacy SPG master



Legacy Master contains PTP slave functionality
Legacy signals generated same as any slave
Distributed via tree structure as before


Centralized Equipment
Network Fabric (cloud of switches)
GPS
Grandmaster 1
Grandmaster 2
PTP
PTP
Facility Equipment
PTP Slave
PTP Slave1
Legacy Master 1
PTP Slave2
Legacy Master 2
Autochangeover
BlackBurst
DARS
Timecode
Facility Equipment
BlackBurst
DARS
Timecode
Legacy Slave

What about 2110?

Live IP uses PTP as its native timing infrastructure

Live media and PTP live on same network

Live media transport is by RTP protocol

RTP uses timestamps for payload synchronization

Network senders use PTP to create media timestamps

Network receivers use timestamps to align media streams

-also use PTP for internal and legacy output timing

PTP used for timecode generation

PTP can be used for locking non-IP media equipment

2110 Timing Performance

Timestamps in 2110 are derived from PTP

- Video - 90 KHz precision
- Audio – 48 KHz precision

Lipsync is easy to establish and maintain tightly

Video alignment between 2110 and legacy baseband is straightforward

Multi-channel audio alignment – sample accurate

- AES-67 compatible
- Soundfield preservation

Signal Generation

ST 2059-1 specifies the alignment of all common media signals and formats to the Epoch including AES-3 and timecode.

Tables convey specific alignment point definitions

Formulae convert PTP time value into specific media elements

lines, pixels, bits, edges, blocks, samples

ST 2110 timestamps correspond to time anchors in media

Because everything is aligned to a common epoch, 2110 and legacy systems can interoperate transparently.

Back to the big picture

Which will come first, chicken or egg?

Multiple island evolution scenarios available

Which kind of island? Which kind of reference?

Dual-reference equipment – when and for how long?

Will it really play nicely on media networks?

Will users trust everything on one interface?

How long is the ramp?

So many questions.

SMPTE Activity

2059 WG is developing EG documents

2059 Interop group has conducting interoperability tests with AES to harmonize PTP Profiles – AES r16 document

Documents are at the one-year review point

Small clarifications resulting from interop testing will be made

SMPTE ST 2110 standards suite uses 2059 for IP Standard

ST 2110 suite approved and in the publication workflow

In summary

Will work happily alongside legacy SDI / AES systems

Will enable new workflows using SMPTE 2110

Higher confidence system building

Reduced CAPEX and OPEX

Can be evolutionary or revolutionary as appropriate

Can support any foreseeable future standard / format

SMPTE 2110 and SMPTE 2059 PTP – it's here, it's now.

Thank-you!

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