Ordinary Clock (OC) Application Service Interface

802.1AS Precision Timing & Synchronization

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Chuck Harrison, Far Field Associates
cfharr@erols.com

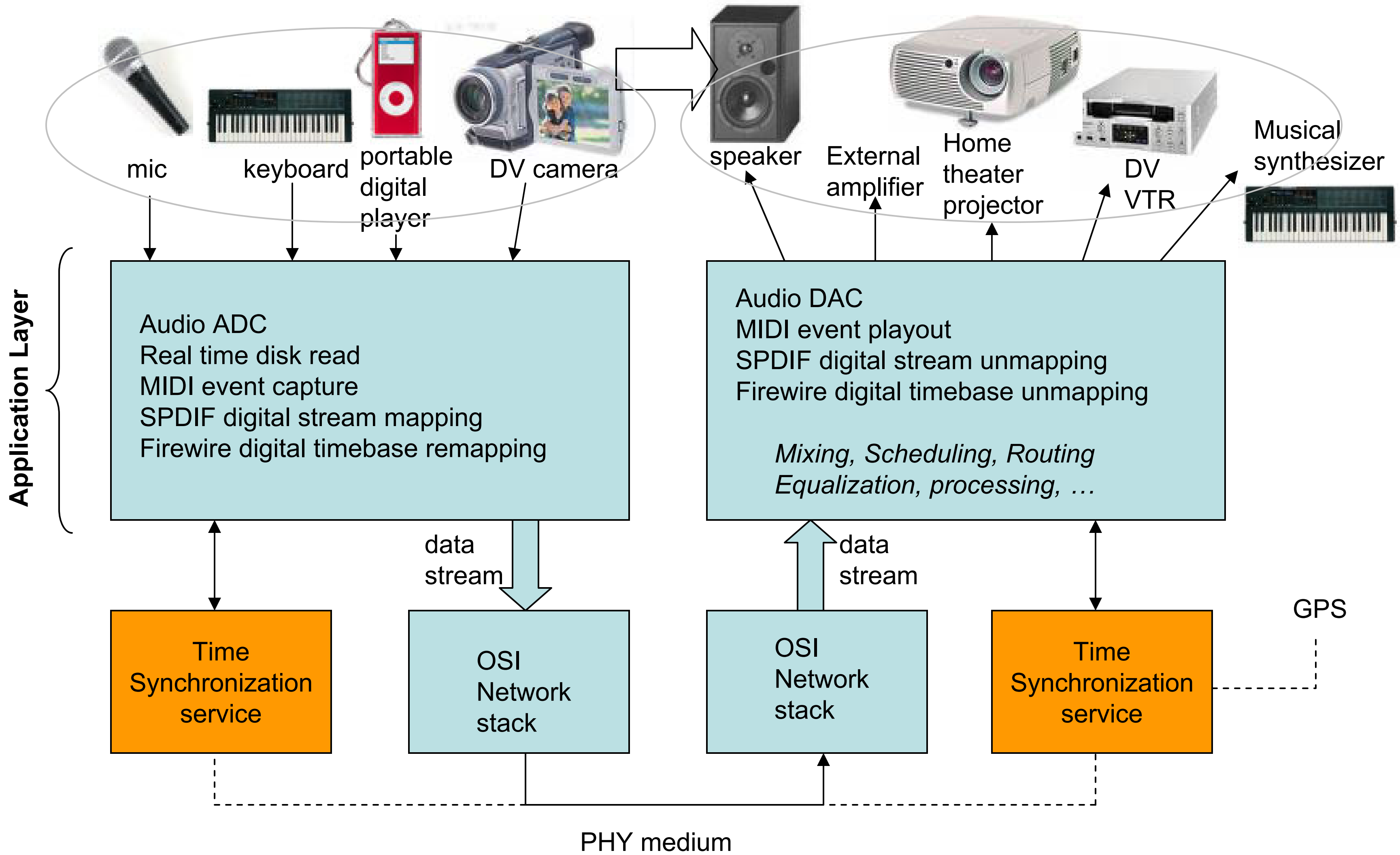
Media Timing & Synchronization – more subtle than you think!

- Sync in traditional media production & distribution has relied on monolithic, per-application standards, e.g.
  - NTSC television
  - AES/SPDIF digital audio
  - MIDI
- Different features/behaviors for different media, markets, and tasks
- AVB is creating a *layered* synchronization environment which ideally supports all media, markets, and tasks with a single abstraction

Overview

- Application layer *vs* time synchronization layer
- Time at the media application layer
- What is a clock? (2 answers)
- Media clock implementations
- Application service interface (inter-layer)
- Performance specification at the ASI

Application layer *vs* Time Synchronization layer

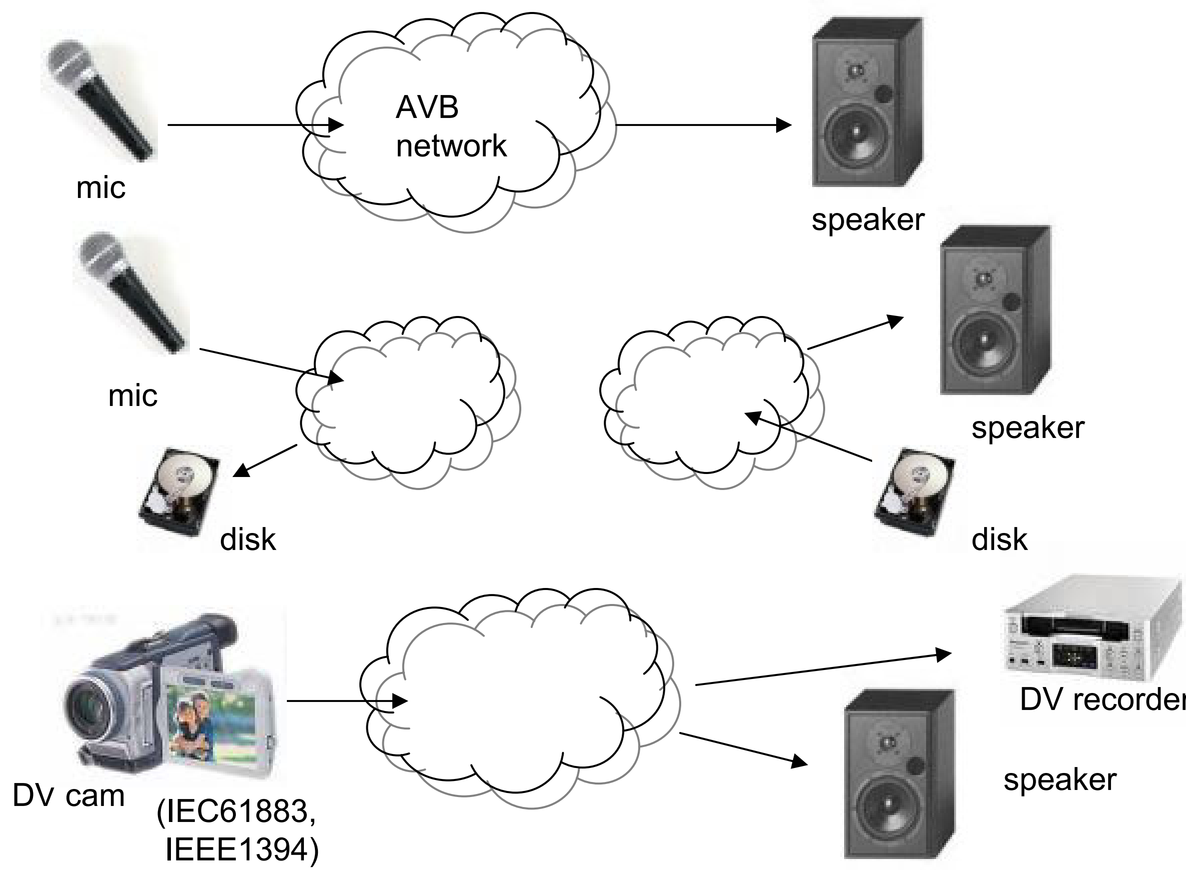


Time Requirements at the Media Application Layer

Fixed Latency

Uniform Sampling

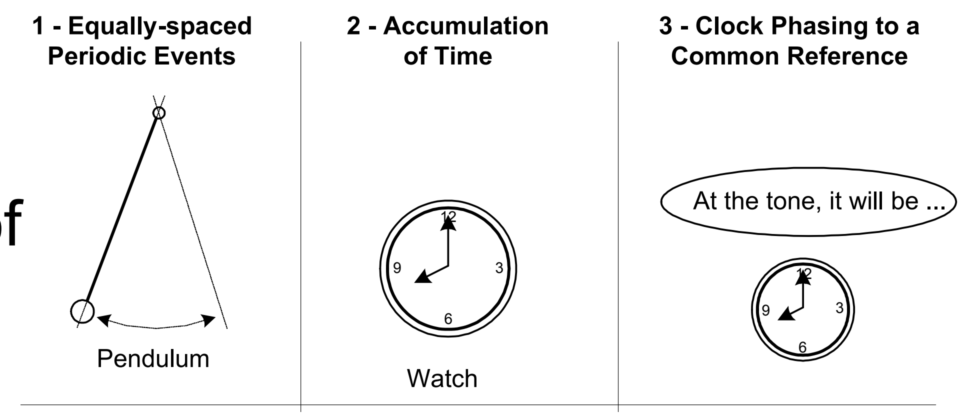
Mapping/wrapping



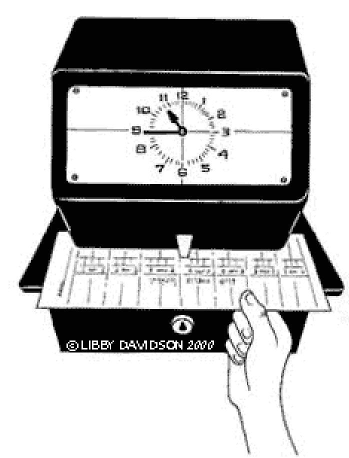
Media sample clock *may* come from an external asynchronous source

What is a clock?

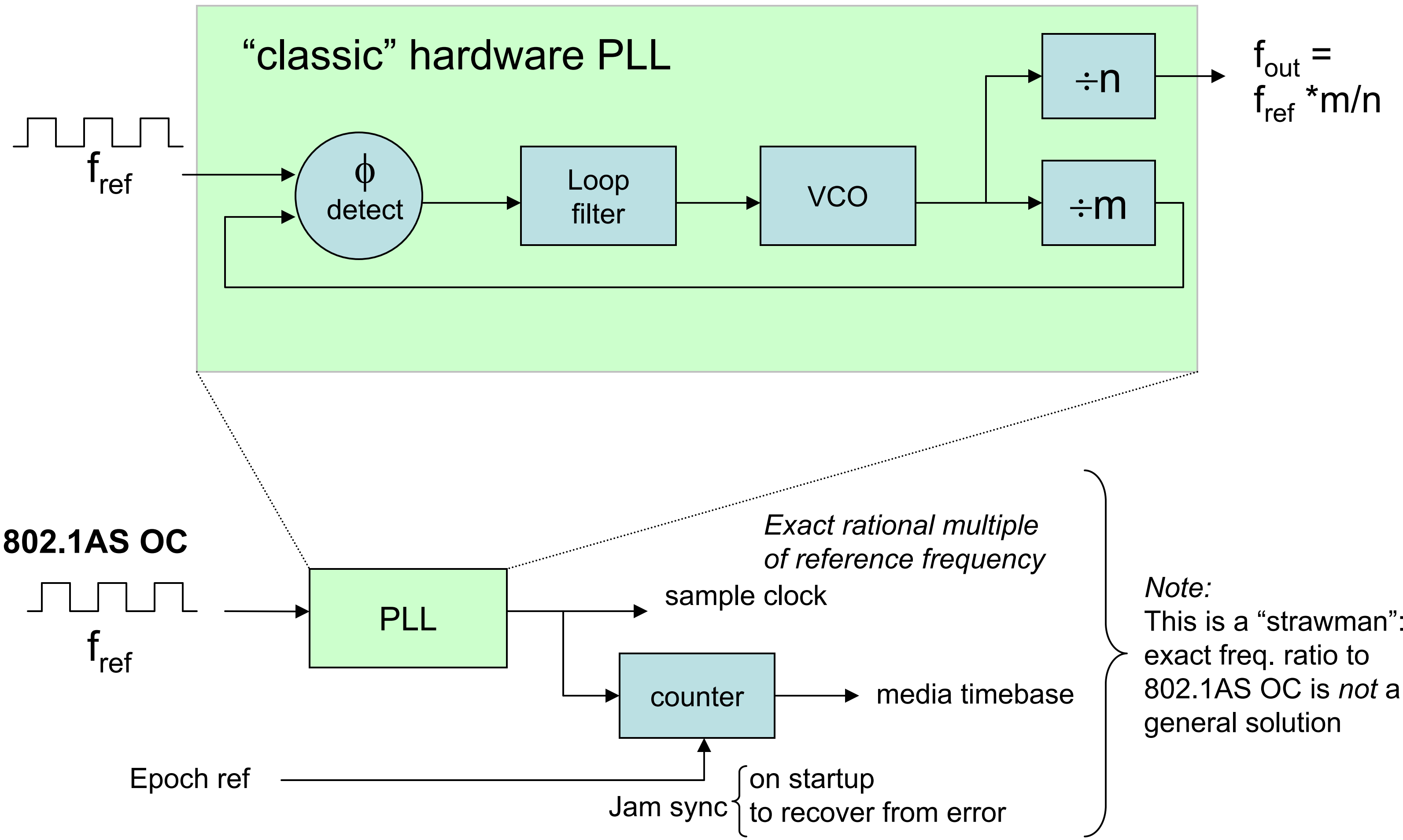
- *Constructive* definition: (SMPTE S22) “periodic events + accumulation of time + phasing to common reference”



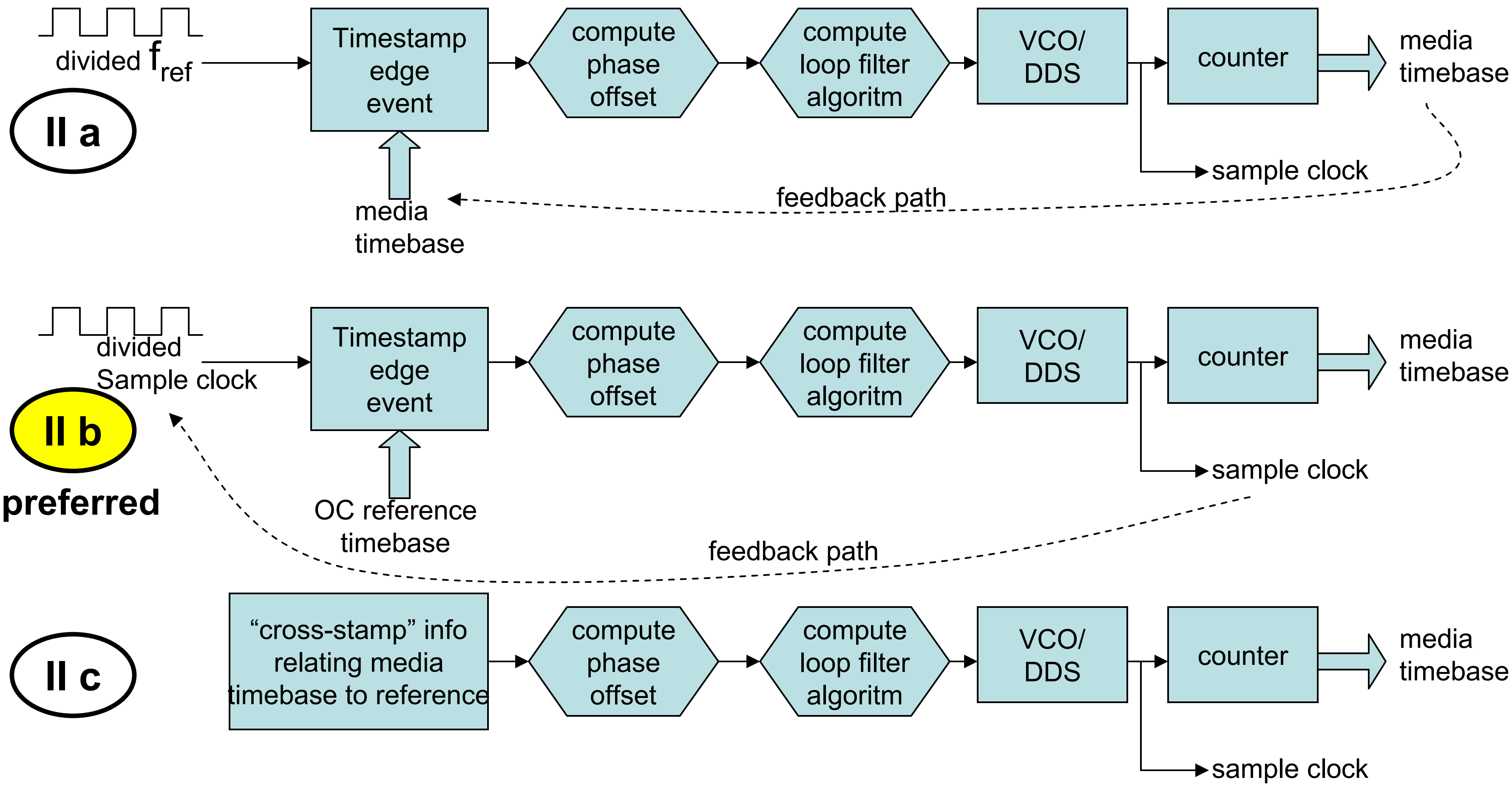
- *Functional* definition: (IEEE1588) “a node that is capable of providing a measurement of the passage of time since a defined epoch.”
  - Event ***E*** happened at time ***T***
  - Matches modern physics definition



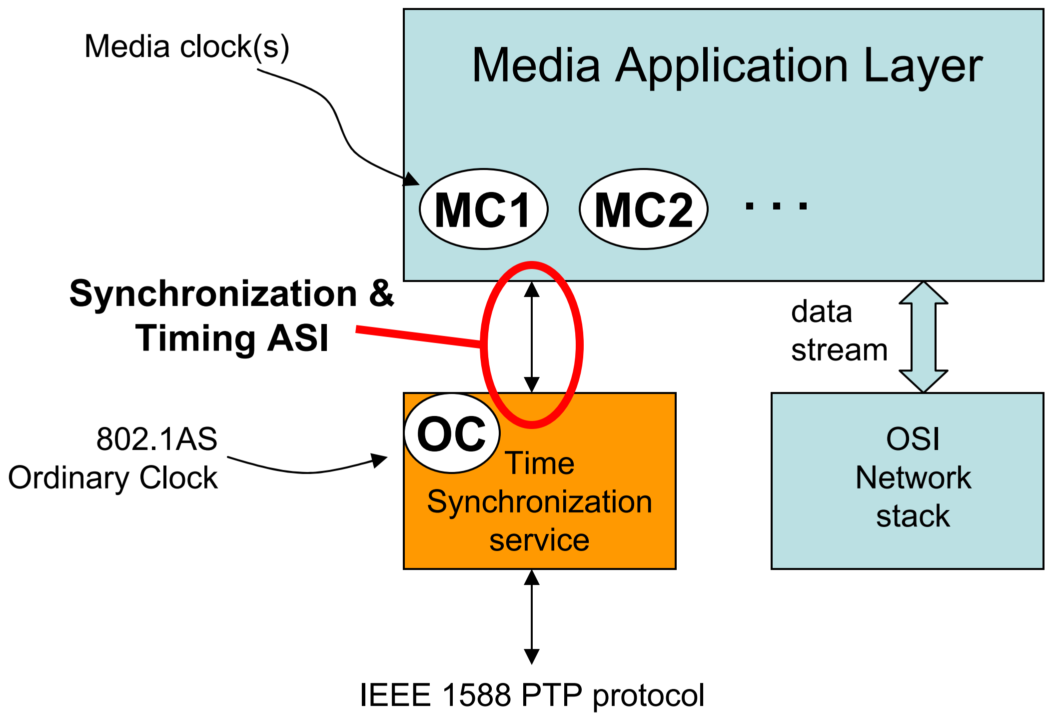
Media clock implementations I



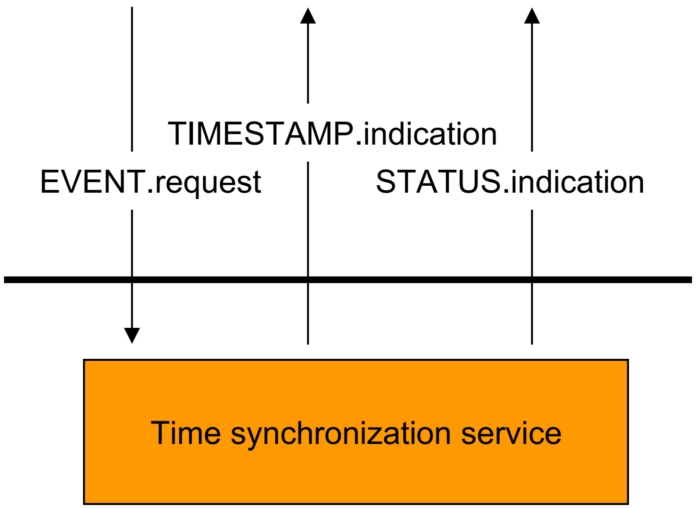
Media clock implementations II

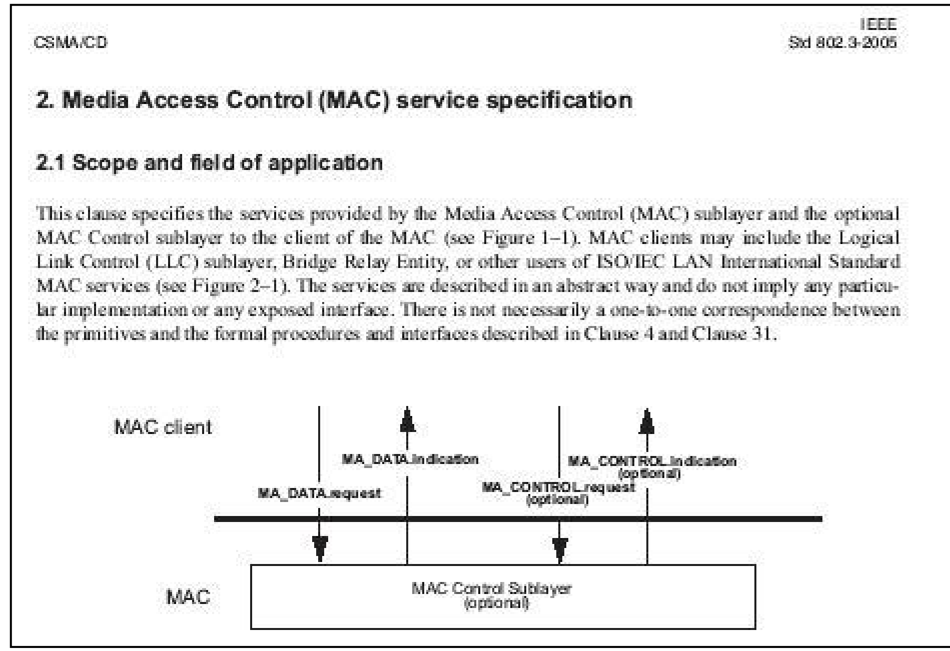


Application service interface I



Application service interface II



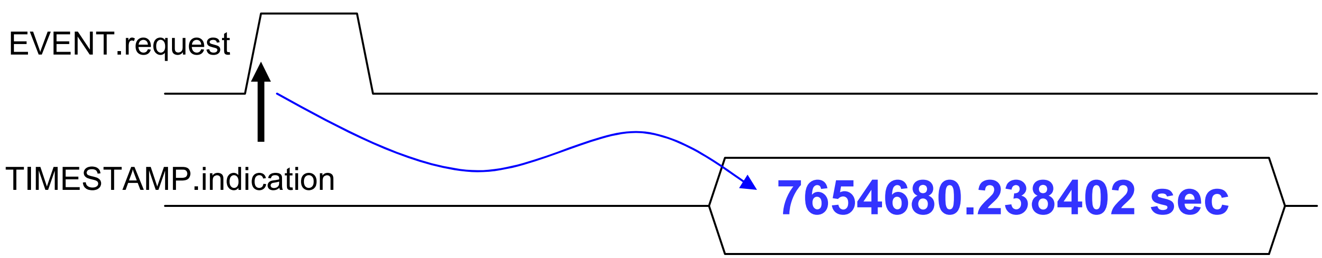

CSMA/CD

IEEE
Std 802.3-2005

2. Media Access Control (MAC) service specification

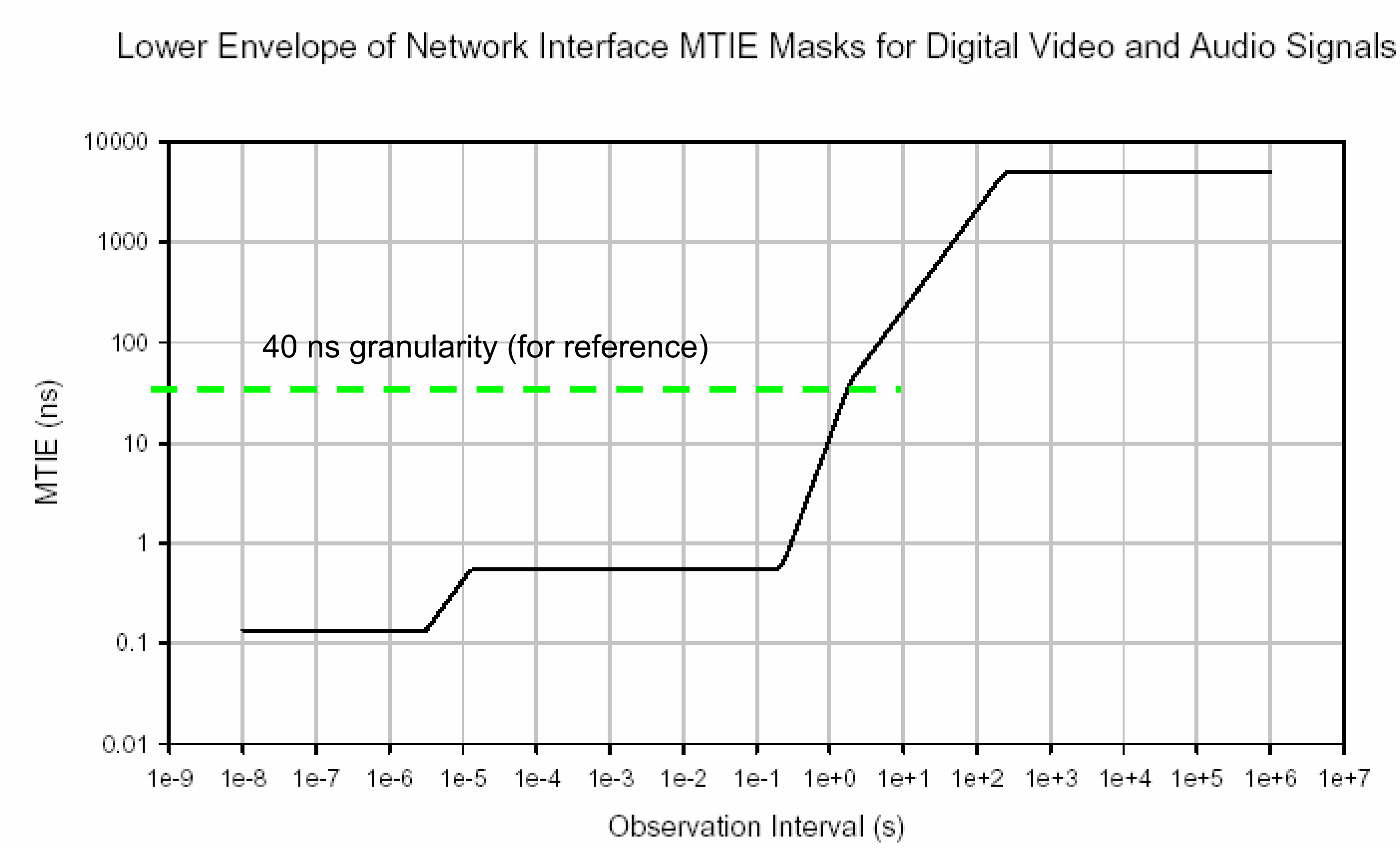
2.1 Scope and field of application

This clause specifies the services provided by the Media Access Control (MAC) sublayer and the optional MAC Control sublayer to the client of the MAC (see Figure 1–1). MAC clients may include the Logical Link Control (LLC) sublayer, Bridge Relay Entity, or other users of ISO/IEC LAN International Standard MAC services (see Figure 2–1). The services are described in an abstract way and do not imply any particular implementation or any exposed interface. There is not necessarily a one-to-one correspondence between the primitives and the formal procedures and interfaces described in Clause 4 and Clause 31.



STATUS.indication: <timebase stabilized>, <timestamp valid>, <overrun>, …

Jitter requirements for Media clocks



avb-garner-requirements-summary-r4-060217.pdf

Performance specification at the Application Service Interface (ASI)

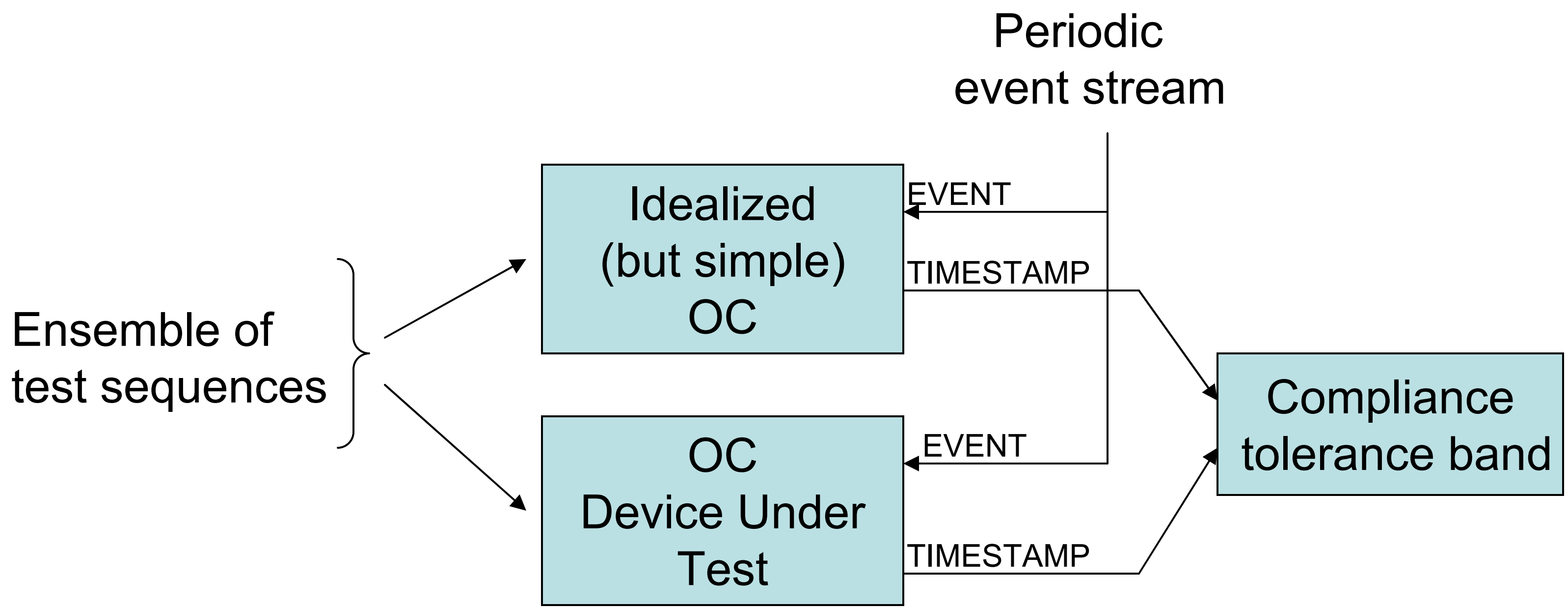
- Critical jitter requirements (previous slide) apply at *media* clocks, not necessarily at OC
- Time delivered at ASI can meet looser specs, as application layer will implement filtering (dependent on application requirements)
- Time delivered at “timestamp” ASI has granularity, e.g. 40ns for 25MHz crystal (in simple implementations)
- IEEE1588 “Sync” message timing has granularity from ingress/egress timestamps anyway
- Best to leave ASI jitter spec loose but well defined: this places the bulk of the filtering responsibility on the application layer

Summary

- Media clocks are distinct from – and often asynchronous to – the OC timescale
- The AVB media application layer will use a lower layer “time synchronization service”, i.e. an 802.1AS OC, to support precise media timing
- The “event/timestamp” style Application Service Interface provides
  - A clear and appropriate abstraction
  - A viable implementation option for media clock generation
- Should define timing performance specs:
  - “contract” for network timing accuracy in AVB *system*
  - Testable compliance spec for 802.1AS *devices*

extras

Timing performance compliance concept



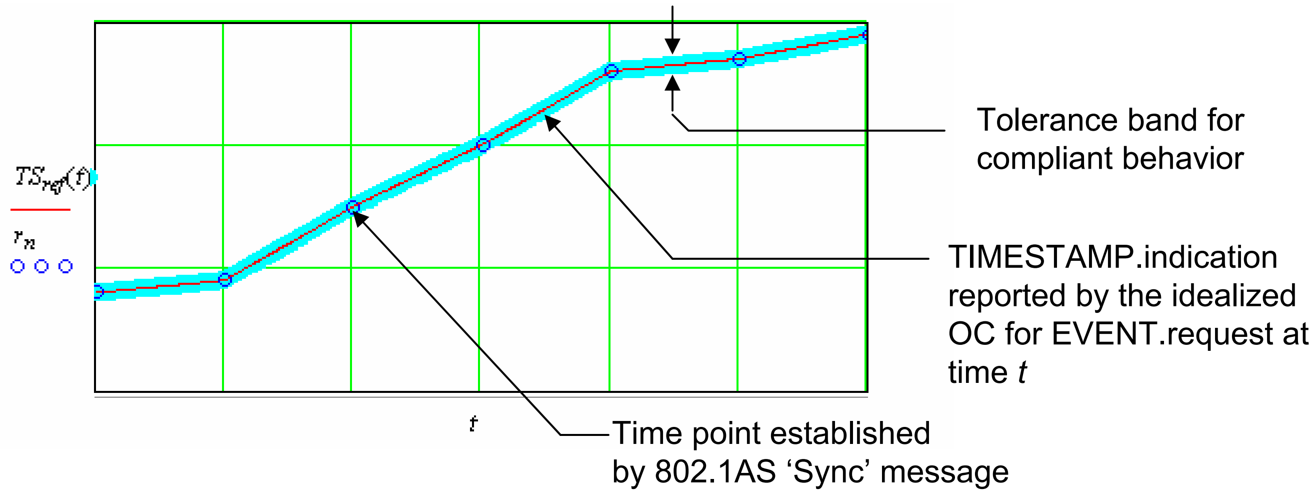
"test sequence":

A sequence of 802.1AS-protocol messages at defined times emulating a certain PTP system environment and behavior

Compliance…

For convenience in modeling, the idealized reference clock is defined in a mathematically simple way which simply interpolates between the adjacent two Sync Event messages. This idealized clock is a model and is not physically realizable. (It is non-causal.)

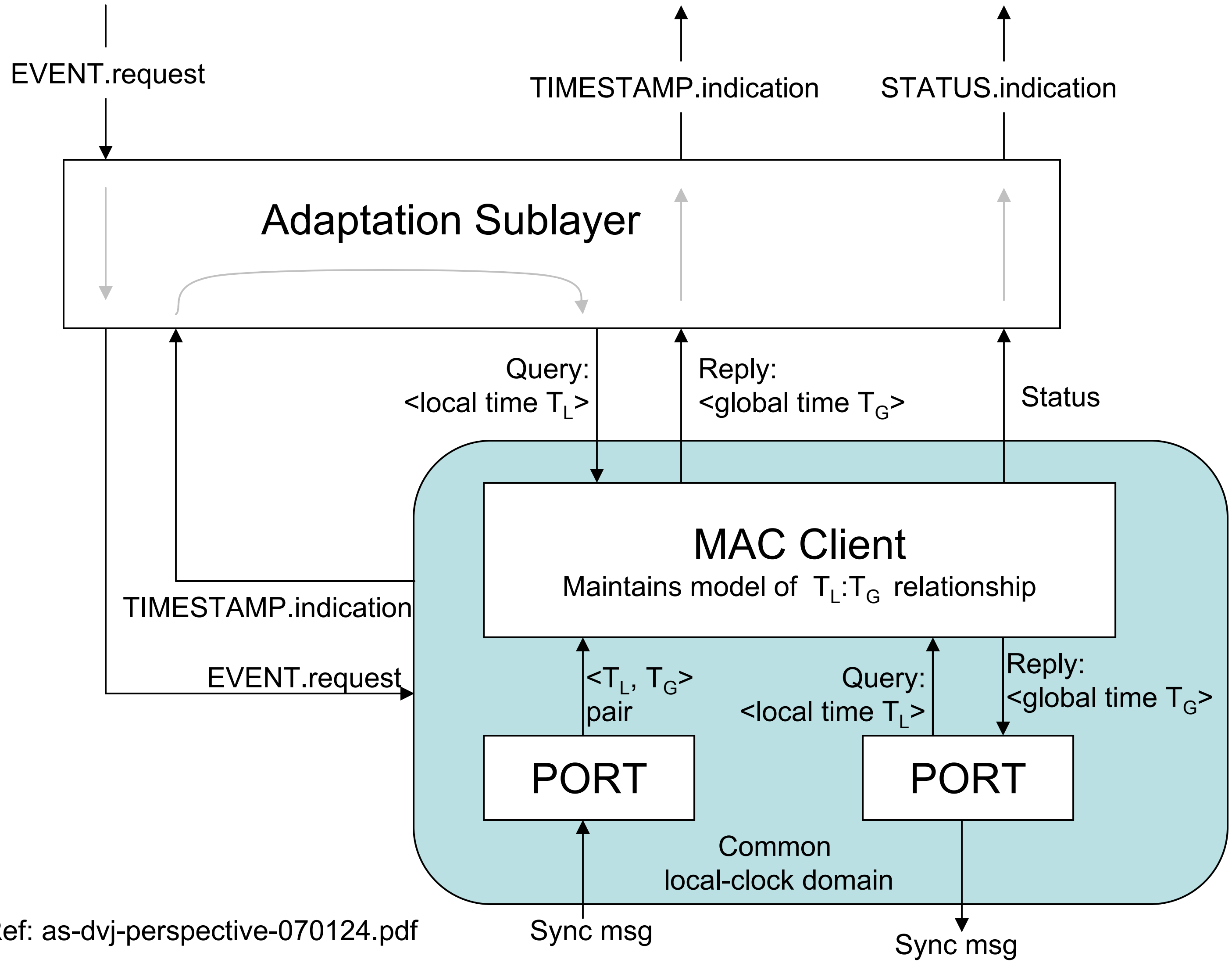
IDEALIZED OC BEHAVIOR



Hidden agenda advantages to EVENT/TIMESTAMP ASI

- OC doesn't inherently need a VCO (instead, use a fixed cheap crystal; all software) – "as digital as possible"
- Maps easily into microcontroller implementation (much like capture/compare registers)
- Service extends painlessly to coexisting multiple domain environment or non-1588 timing functions (e.g. cross-stamp a media clock & μproc cycle counter)
- Works compatibly at arbitrarily high resolution (subnanosecond)
- Same multimedia applications could run over an alternative protocol to 1588 in other environments

“dvj” reference model



Ref: as-dvj-perspective-070124.pdf