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Advocacy and Industry Insight

Implementation Issues: A/V Synchronization

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Sorting Out Lip-Sync

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- A/V Synchronization Differences
  - Broadcast Facility
  - Television Receivers
- Recommended Practice for Televisions
  - Scope, direction
  - Coverage
  - Specific Recommendations

Synchronization Differences

- Analog
  - A/V Synchronization was reasonably simple
  - Content arrived with good sync
  - It was easy to compensate for fixed plant a/v differences
  - It was possible to test the plant for sync issues
- Digital
  - A/V Synchronization is a very difficult, complex topic
  - Content often arrives with unknown sync
    - Content providers sometimes don't know
  - Delays through the plant are variable, delays through equipment changes moment to moment
  - It's very difficult to test the plant

Fixes for Broadcast Facilities

- Recently good in-circuit live test tools for synchronization have become available
  - Evertz & Miranda have products
  - Dolby presenting related paper at the SMPTE Conference
- Facility synchronization is becoming easier

- But!

Consumer Receivers

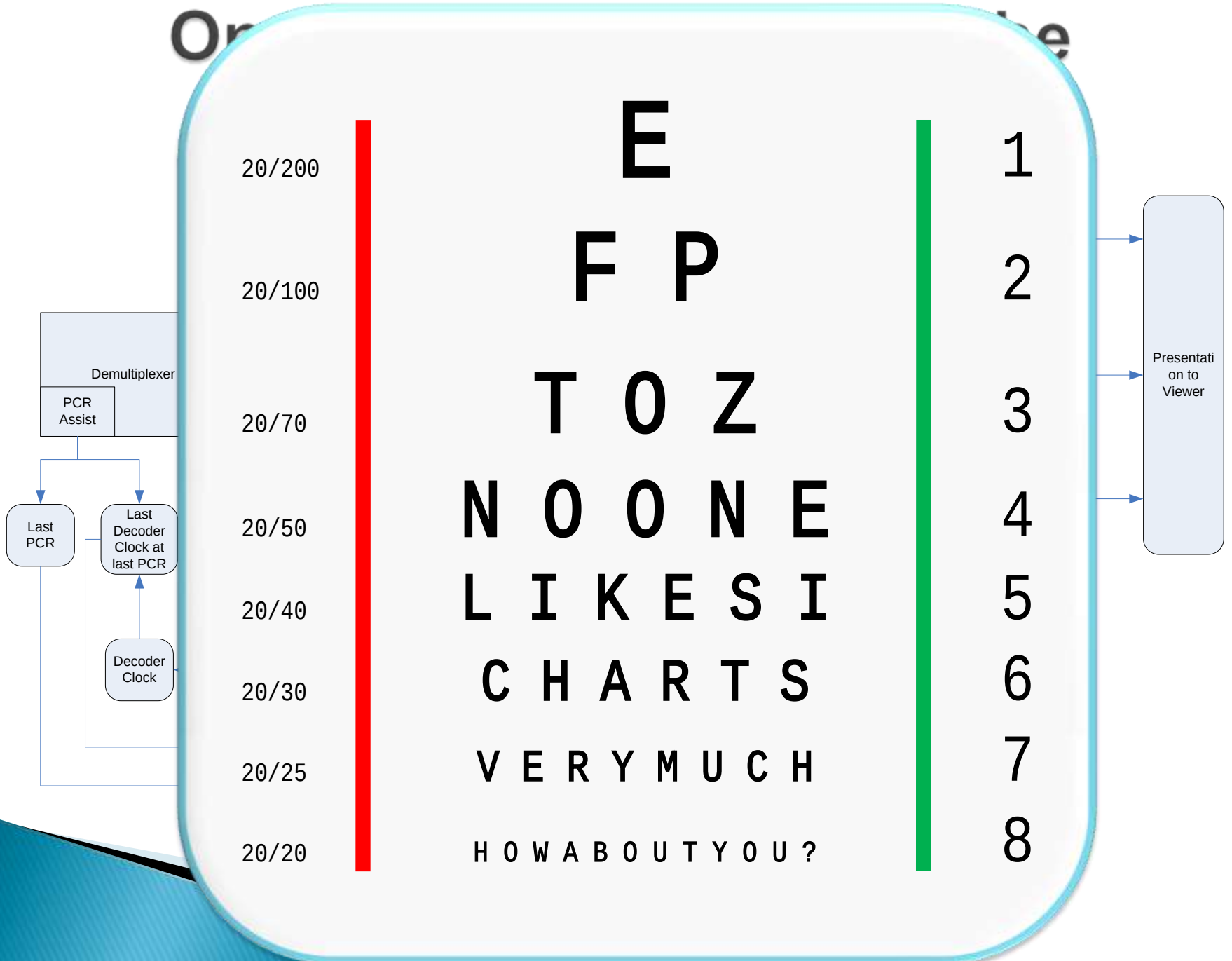
- A/V Sync is a continuing issue
  - Which is, of course, vexing (especially a decade later)
- Receiver/Decoders often have poor A/V synchronization – even with perfect streams
  - Poor or naive design choices
  - (oh, yea, streams aren't always perfect)
- "Stuff" Rolls Downhill
  - If receivers aren't "known good", great temptation to blame receivers for problems which are upstream (studio or other problems)

Problem Identified – Fix Described

- ATSC TSG/S6-4 identified issue(s) where receivers were (reportedly) not implementing A/V Sync as expected; identified a need for a recommended practice
- CEA R4 (Video Systems) began developing a recommended practice ("Consumer Electronics Bulletin", in CEA parlance)
  - CEA CEB-20 has been completed and published (July 2009)

Scope & Direction of CEB-20

- Recommending the proper tools, and how to use them, necessary to achieve AV sync correctly
  - Internal receiver/decoder processing
- Intended audience
  - Receiver implementers
  - Developers who are not expert in MPEG AV Sync mechanisms, but have some knowledge
  - Written for “AV Sync 401”, i.e., for a 4th year college course
    - Not a Ph.D. course, not a simplistic introduction


20/200
20/100
20/70
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E
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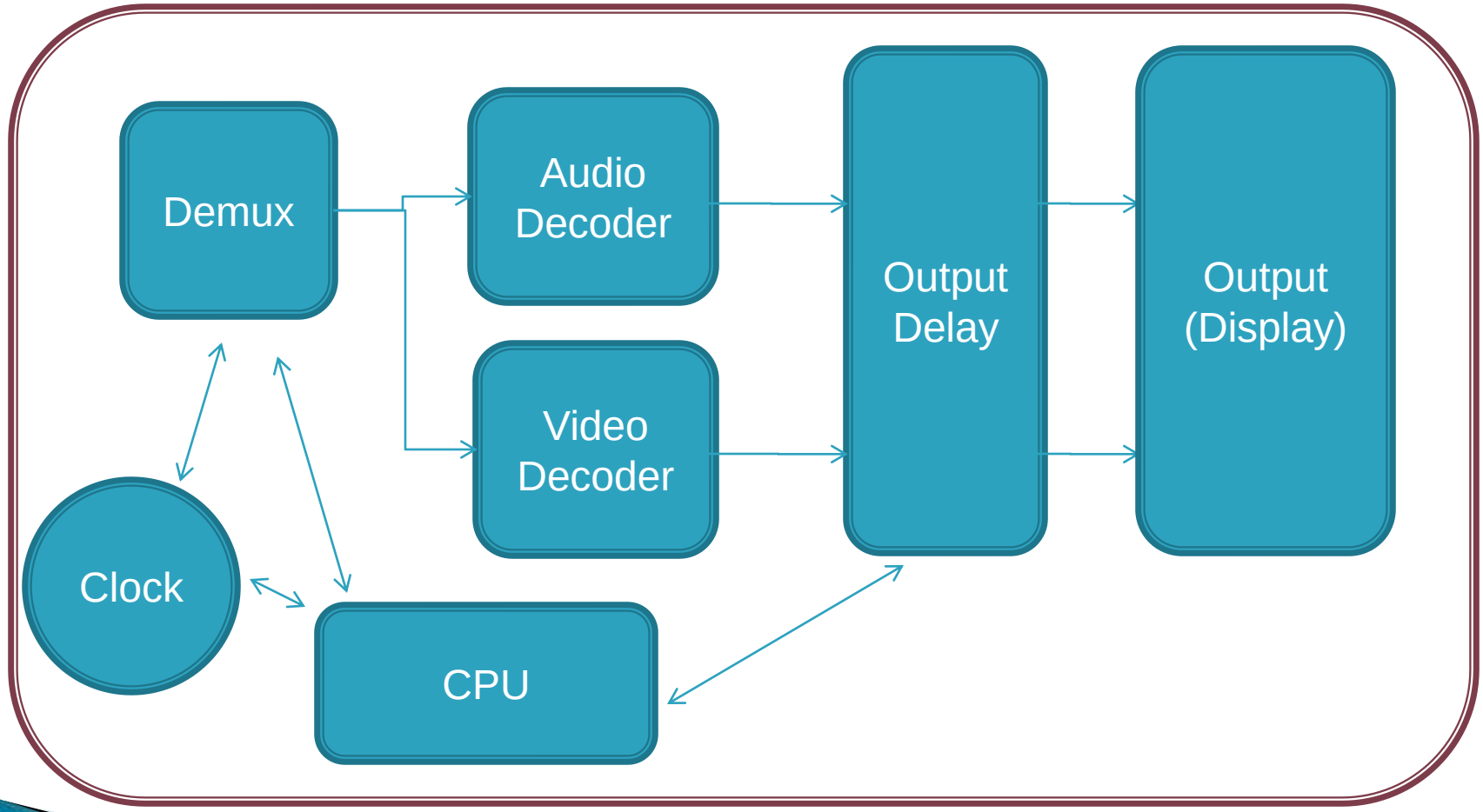
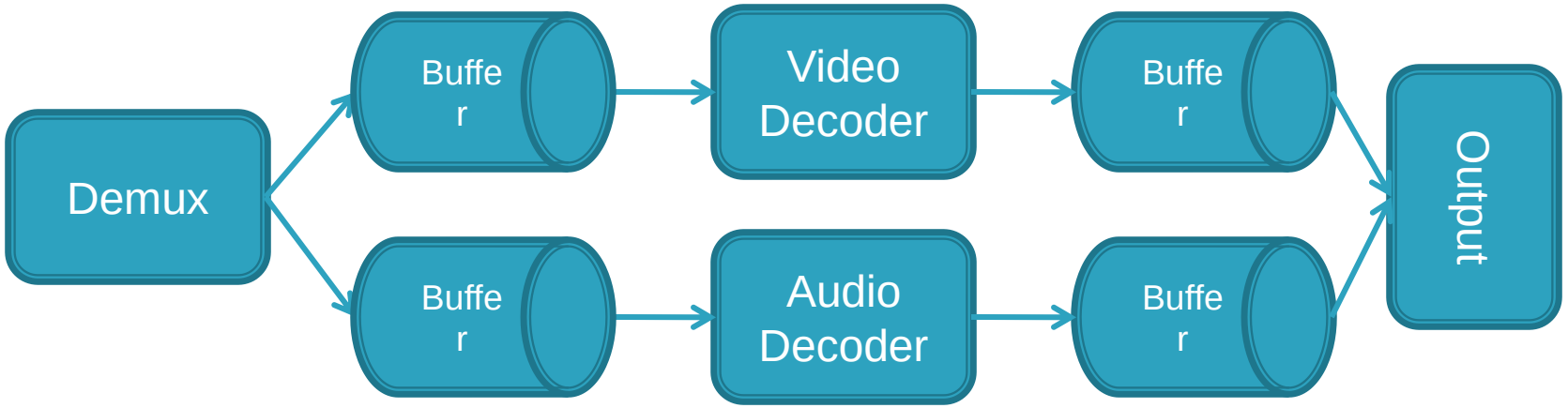
C H A R T S
V E R Y M U C H
H O W A B O U T Y O U ?
1
2
3
4
5
6
7
8
Demultiplexer
PCR Assist
Last PCR
Last Decoder Clock at last PCR
Decoder Clock
Presentation to Viewer

On what components is the recommendation?



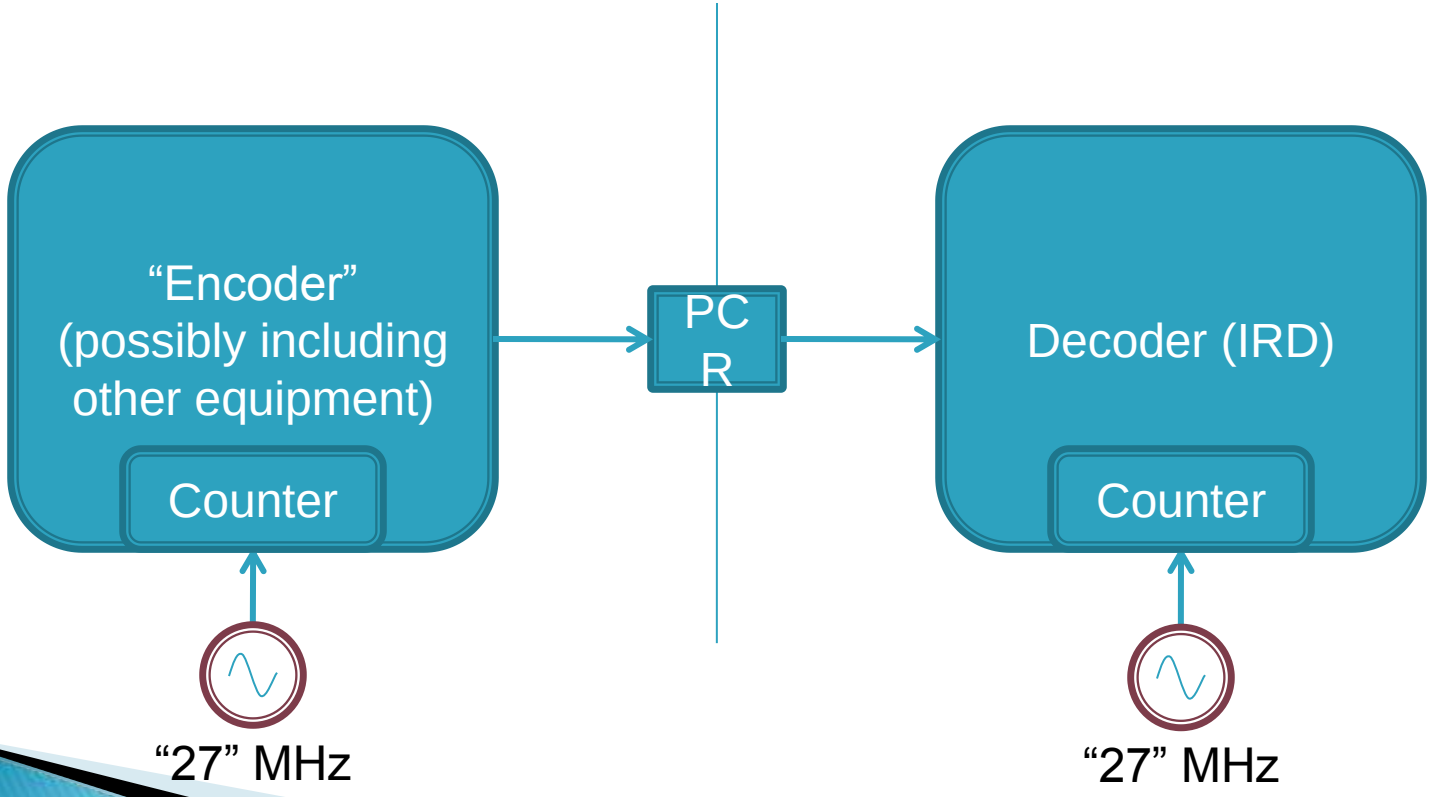
A (Brief) How-To in 3 parts

- Part 1: Buffers
  - Properly-sized buffers are guaranteed to not over or underflow



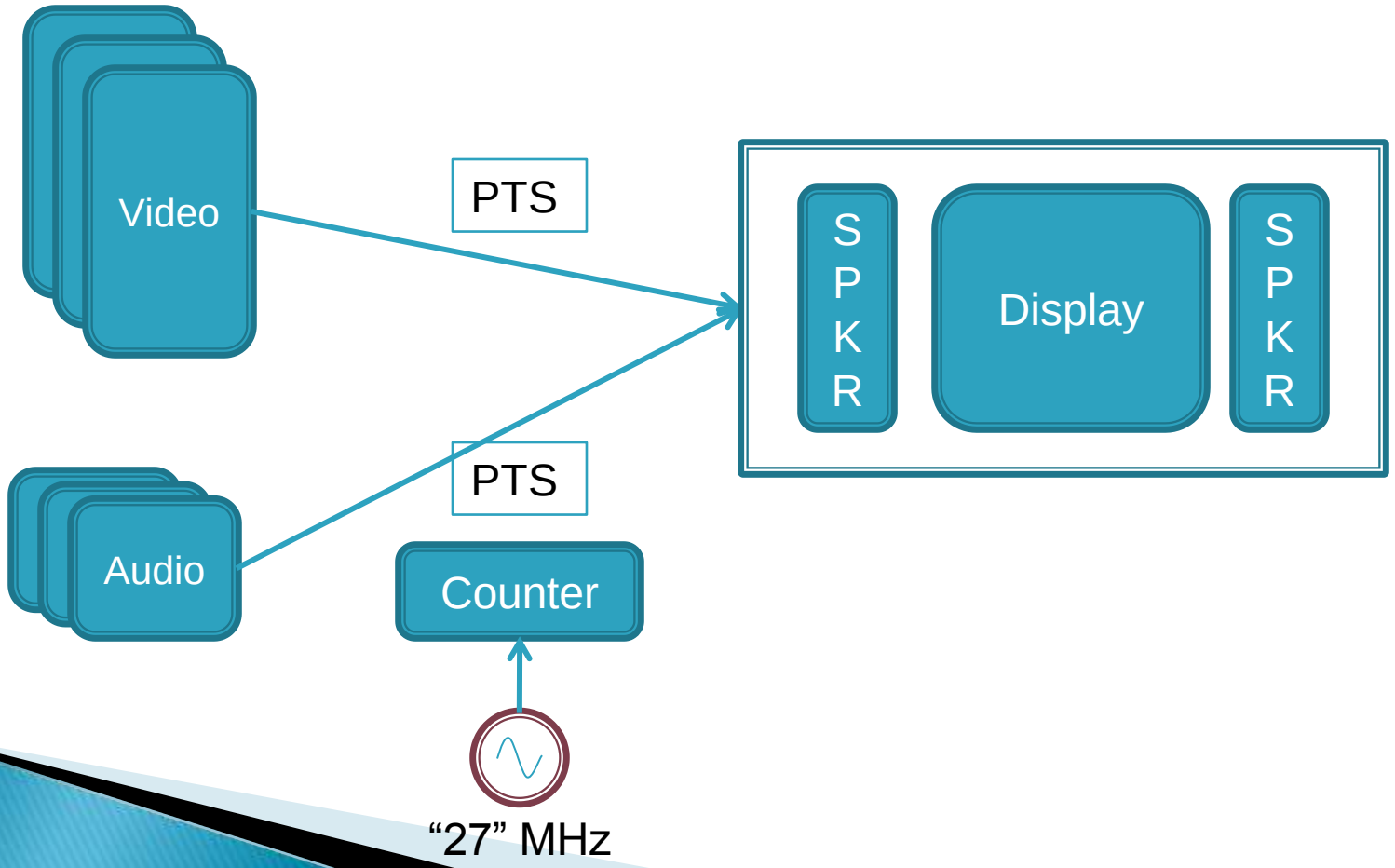
A (Brief) How-To in 3 parts

- Part 2: Clocks
  - Recover 27MHz clock (STC) by constantly using PCRs



A (Brief) How-To in 3 parts

- Part 3: Display



Recommendations

- Hardware Recommendations
  - Demux
  - Clock
  - Delay Hardware
- Functional Recommendations
  - STC Acquisition and Tracking
  - PTS
- Overzealous Reading of the Standard

Hardware Recommendations

- PCR Latching/Loading Hardware
  - Hardware to capture an incoming PCR and the decoder's STC counter simultaneously
  - Hardware to update STC counter immediately from PCR reception
- Clock
  - Software-controllable variable rate oscillator
    - Pull-in range ***larger*** than MPEG-2 specification of 27MHz ± 810Hz
  - Oscillator drives a 33-bit counter

Hardware Recommendations

- Delay Hardware
  - Ability to skip and repeat pictures, and adjust the audio output rate

Functional Recommendations

- STC Acquisition
  - Load STC from (stream) PCR immediately
  - Verify subsequent STC/PCR differences are low
  - Only then enable synchronization adjustments
- STC Tracking
  - Low-pass filter on STC/PCR comparison; feedback loop to controllable oscillator
- In general
  - Should constantly monitor PCRs and adjust clock

Functional Recommendations

- Presentation Time Stamps (PTS)
  - Should process ***each*** PTS, for each audio, video (and other) presentation unit
  - Should adjust presentation of ***each*** stream (audio, video, other) so that presentation is ***as close as possible*** to ideal (PTS value)
  - Should ***not*** synchronize “video-to-audio”; should synchronize to STC

Overzealous Reading of the Standard

- Theoretical/Ideal vs. Practical Implementations
- MPEG-2 (systems) can be confusing
  - MPEG makes simplistic assumptions (instantaneous decode time, etc.)
  - MPEG makes requirements on streams in an idealized world
- Receivers shouldn't try to be a MPEG Cop
  - Buffer models are ***models*** of the system operation, receivers should not attempt to implement them or enforce them
    - It's hard to automate Matthew

Questions?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