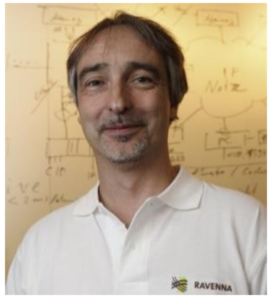
CURATED BY

Synchronization of ST 2110 Audio

- Andreas Hildebrand –

RAVENNA Technology Evangelist

ALC NetworX, Munich



Andreas Hildebrand, RAVENNA Technology Evangelist

- more than 25 years in the professional audio / broadcasting industry
- graduate diploma in computer science
- R&D, project & product management experience
- member of AES67 TG and ST2110 DG

ALC NetworX GmbH, Munich / Germany

- established 2008
- R&D center
- developing & promoting RAVENNA
- Partnerships with > 40 manufacturers

RAVENNA

- IP media networking technology
- designed to meet requirements of professional audio / broadcasting applications
- open technology approach, license-free
- fully AES67-compliant (*built-in*)

Timing & Synchronization – General Requirements

- Media bit-transparency
  → no sample rate conversion
  → streams need to run on same media clock
- Concurrent operation of different sample rates on same network
- Determinable (low) end-to-end latency
- Time alignment between media streams
- Replacement for "house clock" distribution (word clock, black burst etc.)

⇨ Clock reassembly from stream data not appropriate
⇨ Distribution of master clock beats not sufficient
⇨ Common understanding of absolute time required ("wall clock")

Timing & Synchronization – Accuracy Requirements

- Audio applications have highest time accuracy & precision demands:
  - ⇨ Sample accurate alignment of streams (± ½ sample)
    - @ 48 kHz: ± 10 µs
    - @ 96 kHz: ± 5 µs
    - @ 192 kHz: ± 2.5 µs
  - ⇨ "Distribution" of word clock reference
    (AES11 calls for ± 5% max jitter / wander):
    - @ 48 kHz: ± 1 µs
    - @ 96 kHz: ± 500 ns
    - @ 192 kHz: ± 250 ns

Synchronization & Media Clocks

- All nodes are running local clocks
- Local clocks are precisely synchronized to a common wall clock via IEEE 1588-2008 (PTPv2)
- *PTPv1 standardized by IEEE in 2002 (IEEE 1588-2002)*
  PTPv2 followed in 2008 (IEEE1588-2008)
  PTPv1 and PTPv2 are not compatible!

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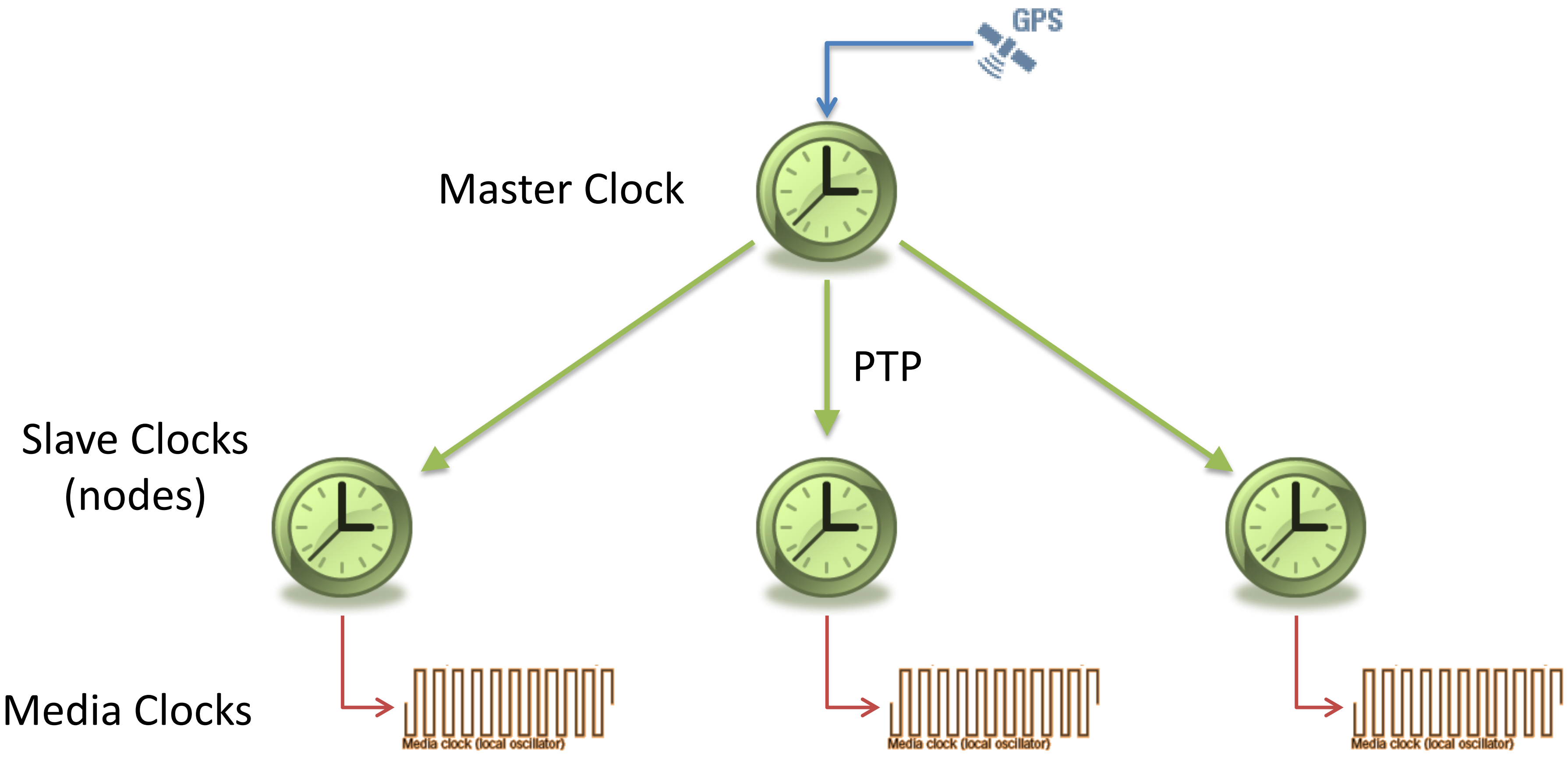
Synchronization & Media Clocks



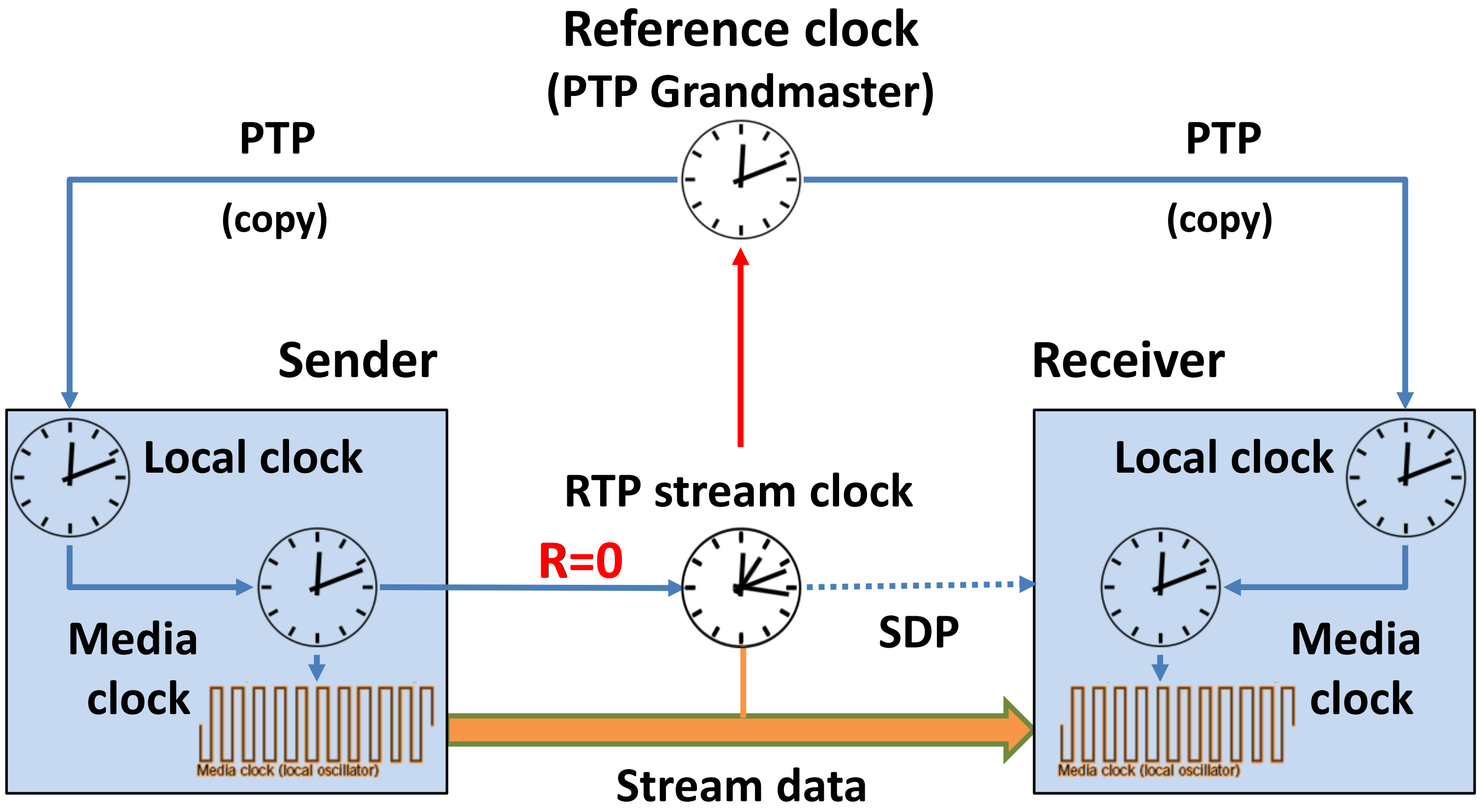
Synchronization & Media Clocks

- All nodes are running local clocks
- Local clocks are precisely synchronized to a common wall clock via PTP
- Media clocks are generated locally from synchronized local clock
- Generation of any desired media clock (sample rate) possible
- Concurrent operation of different media clocks possible
- Phase accuracy of AES 11 (± 5% of sample period) achievable
  by deployment of PTP-aware switches (BC or TC)
- Synchronization across facilities possible by reference to absolute time (TAI / GPS)
- Essence data (audio samples or video frames) is related to the media clock upon intake
  - essentially receiving a generation "time stamp" with respect to the media clock

Synchronization & media clocks

- 3 type of clocks in the system:
    - Wall clock - provided by Grandmaster
        - local copy of the wall clock in each node
    - Media clock – derived from the local clock (i.e. 48 kHz for audio, 90 kHz for video)
    - RTP clock (stream clock) – derived from the media clock

Synchronization & media clocks

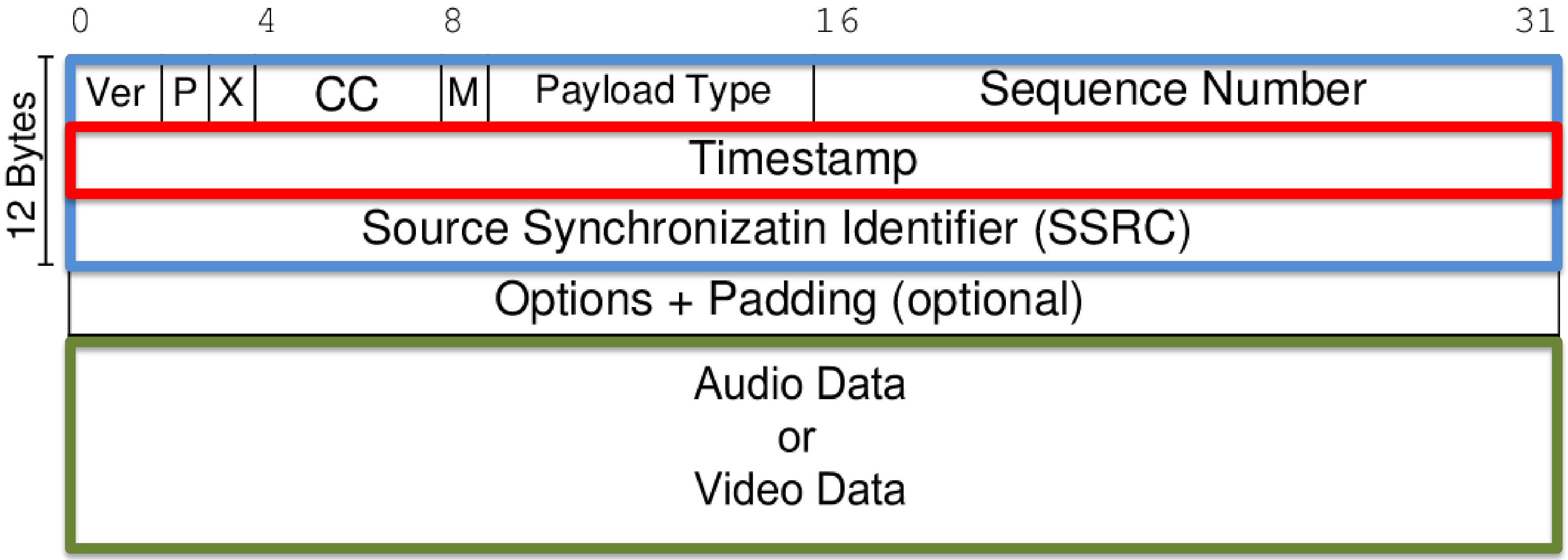


- Offset **R** is established on stream start-up
- **R** may be random to defeat crypto-text attacks
- This offset will be constant throughout the stream's lifetime

- The offset (**R**) will be conveyed via SDP (a=mediaclk:direct=<offset>) **– must be "0" in ST2110**

RTP Packets (Layer 5)

- Consist of RTP header, optional payload headers and the payload itself
- RTP header (overhead) = 12 bytes, payload (linear audio data) = up to 1440 bytes
- RTP Timestamp = media clock counter (for linear PCM audio) = 32 bits (4 bytes)



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- Essence data (audio samples or video frames) is related to the media clock upon intake
  - essentially receiving a generation “time stamp” with respect to the media clock
- Fixed / determinable latency by configuring a suitable link offset (“playout delay”)
- Inter-stream alignment by comparing and relating the time stamps of individual essence data

Production Workflow Timing

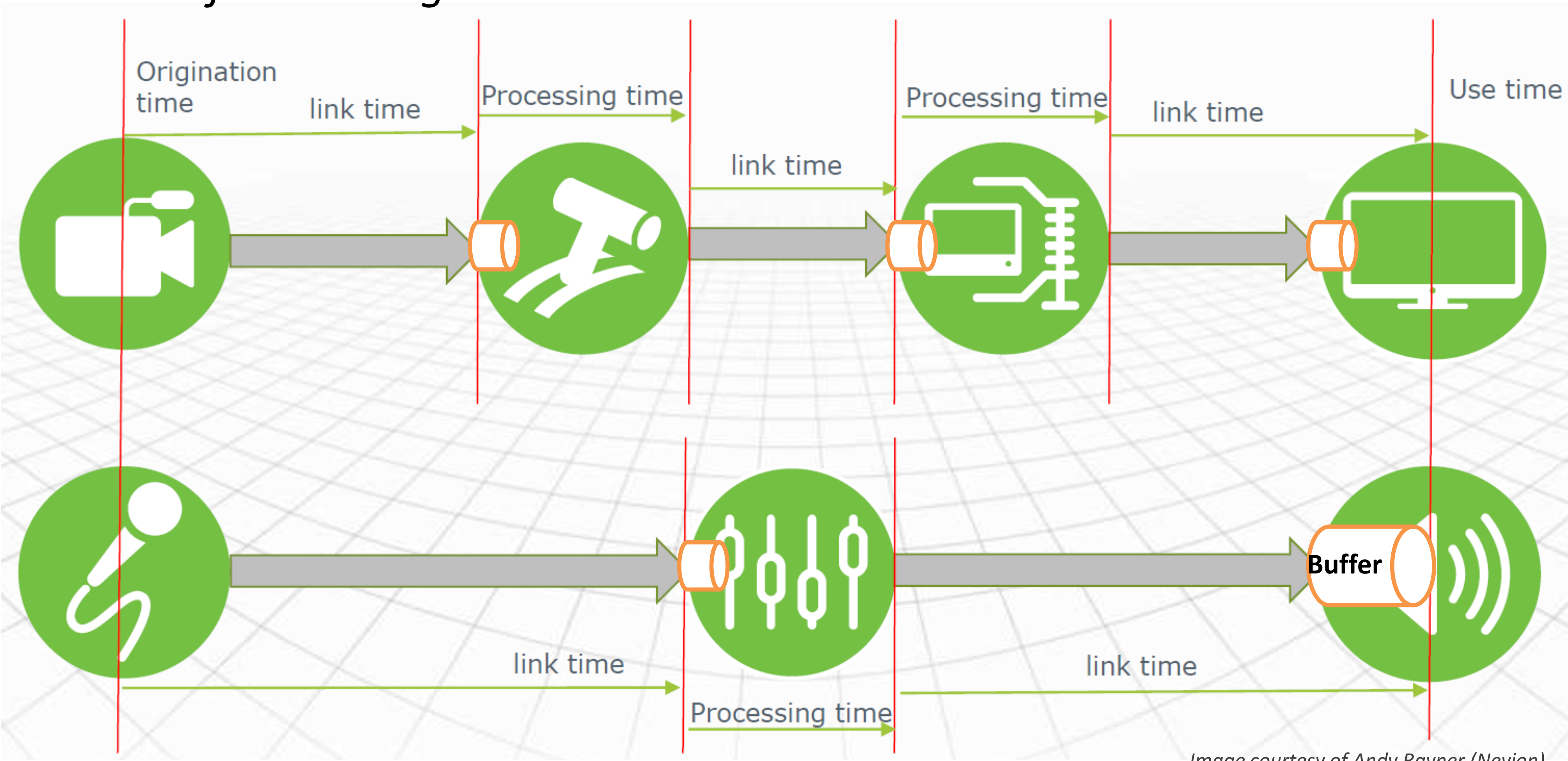

Image courtesy of Andy Rayner (Nevion)

How to synchronize streams across various processing stages

- Problem:
  - Any stream leaving a (processing) device is a new stream
  - New alignment of (processed) essence to wall clock time
  - Alignment of original essence is lost
- Possible solutions:
  - Use of original time alignment for new stream (RTP timestamps adjusted to those of original essence)
    - Offest increases, might be too large for downstream Rx buffer
    - Which timestamps serve as reference when mixing essence?
    - How does the (processing) host now the exact relationship between ingress / and egress essence?
  - Carry origin timestamps as in-band meta data
    - Requires new payload format (audio essence data + audio meta data), or
    - Needs to make use of (experimental) RTP header extensions mechanism (which in turn may result in variable / decreased audio payload segments)
  - Carry origin timestamps as out-of-band meta data
    - Requires new standard (in the works → **AES X242**!)

How to synchronize streams across various processing stages

- Problem:
  - Any stream leaving a (processing) device is a new stream
  - New alignment of (processed) essence to wall clock time
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- Intermediate (?) / current solution:
  - Leave alignment task to management layer (i.e. Broadcast Controller)
    - Devices report processing delays to BC (or have fixed / configurable delays)
    - BC configures required Rx delay for subsequent stages (playout delay)

Production Workflow Timing

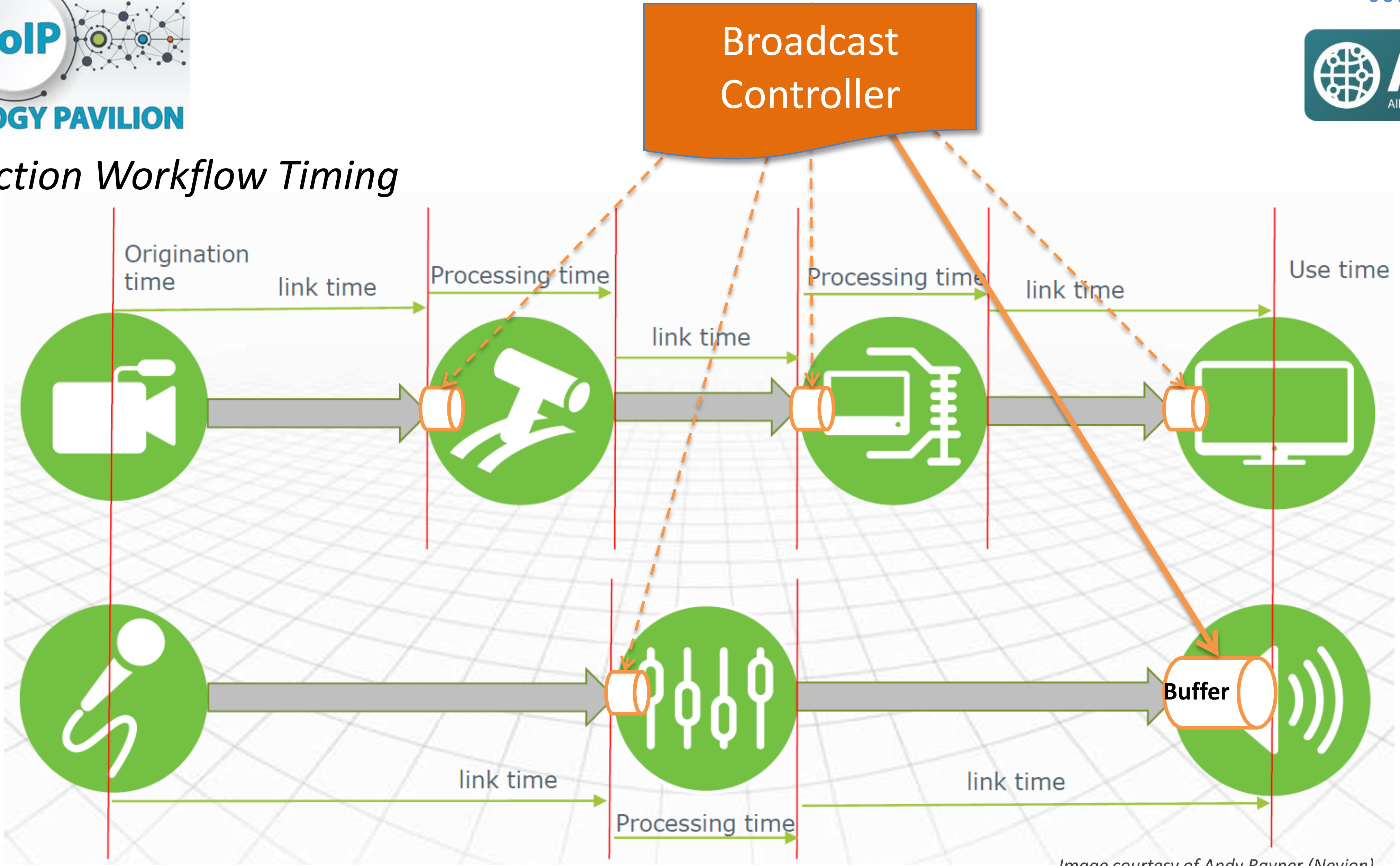

Image courtesy of Andy Rayner (Nevion)

AoIP TECHNOLOGY PAVILION

CURATED BY AIMS Alliance for IP Media Solutions

Thank you for your attention!

RAVENNA pod
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RAVENNA AES67 built-in

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