Ein Lied geht um die Welt… - Medienübertragung im Internet

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A few „facts“, June 2010[1]

- The sum of all forms of video (TV, video on demand, Internet, and P2P) will continue to exceed 91 percent of global consumer traffic by 2014.
  - Internet video alone will account for 57 percent of all consumer Internet traffic in 2014.
- Advanced Internet video (3D and HD) will increase 23-fold between 2009 and 2014.
  - By 2014, 3D and HD Internet video will comprise 46 percent of consumer Internet video traffic.
- Real-time video is growing in importance.
  - By 2014, Internet TV will be over 8 percent of consumer Internet traffic, and ambient video will be an additional 5 percent of consumer Internet traffic.

[1] http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/VNI_Hyperconnectivity_WP.pdf

But what does video traffic need?

- Media applications are different than data!
  - They don‘t need full, but only predictable reliability
    - Loss tolerance determined by use case and AV-codec
  - They require a predictable, upper bounded delay
    - Determined by usage scenario (interactive, communicative etc.)
- Delay and loss tolerance are application specific
  - Interactive apps need N × 10 ms, broadcast apps n × 100 ms and NVOD etc. N × 100 ms
  - Very efficient codecs need 10^{-6}, very robust ones 10^{-2}
- Media Transport needs to be adaptiv
  - Due to low coherence time very dynamic (n × 100 ms)

Let's get more detailed

- Media Transmission requires (ITU-T Y.1541)
  - Predictable Delay
    - Application dependent
  - Predictable Reliability
    - Application dependent
- Coding delay essential
  - FEC determined by packet arrival
  - ARQ determined by round trip time

Class	IPTD	IPDV	IPLR	IPER	IPRR	Applications (examples)
0	100 ms	50 ms	1×10^{-3}	1×10^{-4}	–	Real-time, jitter sensitive, low delay, highly interactive
1	400 ms	50 ms	1×10^{-3}	1×10^{-4}	–	Real-time, jitter sensitive, medium delay, interactive
2	100 ms	U	1×10^{-3}	1×10^{-4}	–	Transaction data, low delay, highly interactive
3	400 ms	U	1×10^{-3}	1×10^{-4}	–	Transaction data, medium delay, interactive
4	1 s	U	1×10^{-3}	1×10^{-4}	–	Low loss
5	U	U	U	U	–	Best effort
6	100 ms	50 ms	1×10^{-5}	1×10^{-6}	1×10^{-6}	High bit rate, strictly low loss, low delay, highly interactive
7	400 ms	50 ms	1×10^{-5}	1×10^{-6}	1×10^{-6}	High bit rate, strictly low loss, medium delay, interactive

Notes – U: undefined
IPTD: IP Packet Transfer Delay
IPDV: IP Packet Delay Variation
IPLR: IP Packet Loss Rate
IPER: IP Packet Error Ratio
IPRR: IP Packet Reordering Ratio

Everything over IP

- IP makes things worse:
  - Not „*noisy*“ (AWGN) but „*lossy*“ (E[rasure]) channel
  - Complete IP packets get lost due to contention and/or queuing
  - IP packet rate low even for high rate signals:
    - 4 Mbps SD video has ~2.5 ms IP packet rate
      (assumed 7 MPEG-2 TS packet per IP packet; see later)
    - Small blocks already consume time budget
      (40 packets / 100 ms)
- Channel capacity has to be revisited
  - Capacity under delay constraints
    - Time dependent minimum redundancy
  - Residual error rate tolerable

The system


Internet Transport and
Coding
for 3D-HDTV
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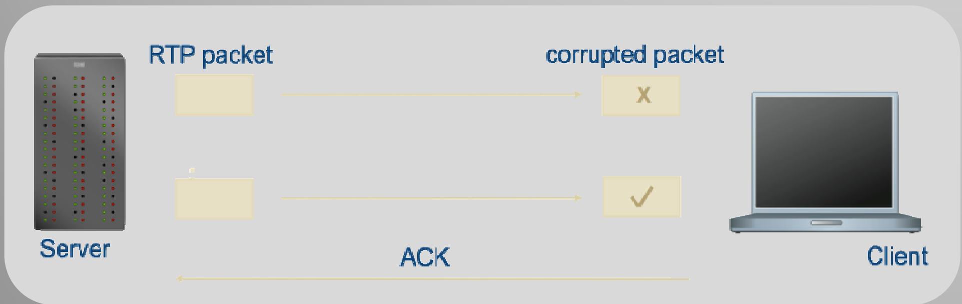
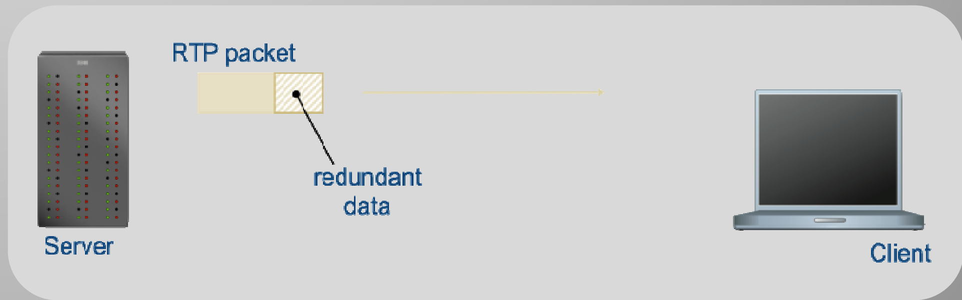
Error Correction: „State of the Art“

- HTTP/TCP
  - Pure ARQ
  - Exhaustive, adaptive error correction
  - Unlimited retransmissions, unlimited delay
- UDP/RTP(/MPEG-2 TS)
  - No error correction
  - Optional profile with FEC or retransmission
  - Multicast support

ARQ (Automatic Repeat Request)

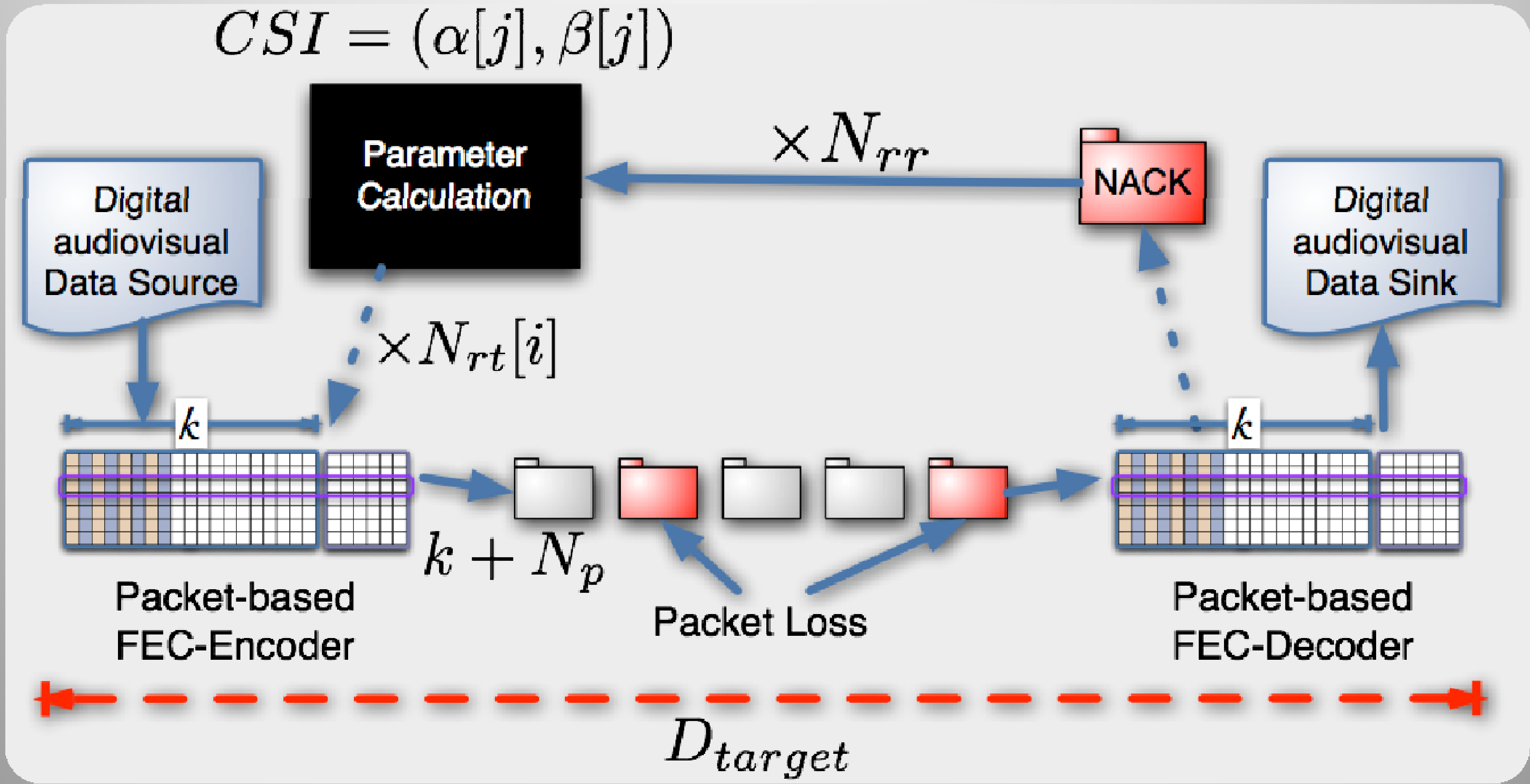


FEC (Forward Error Correction)



Up to now: Either ARQ or FEC. Require loss-tolerant, scalable real-time transmission which combines the advantages of ARQ and FEC.

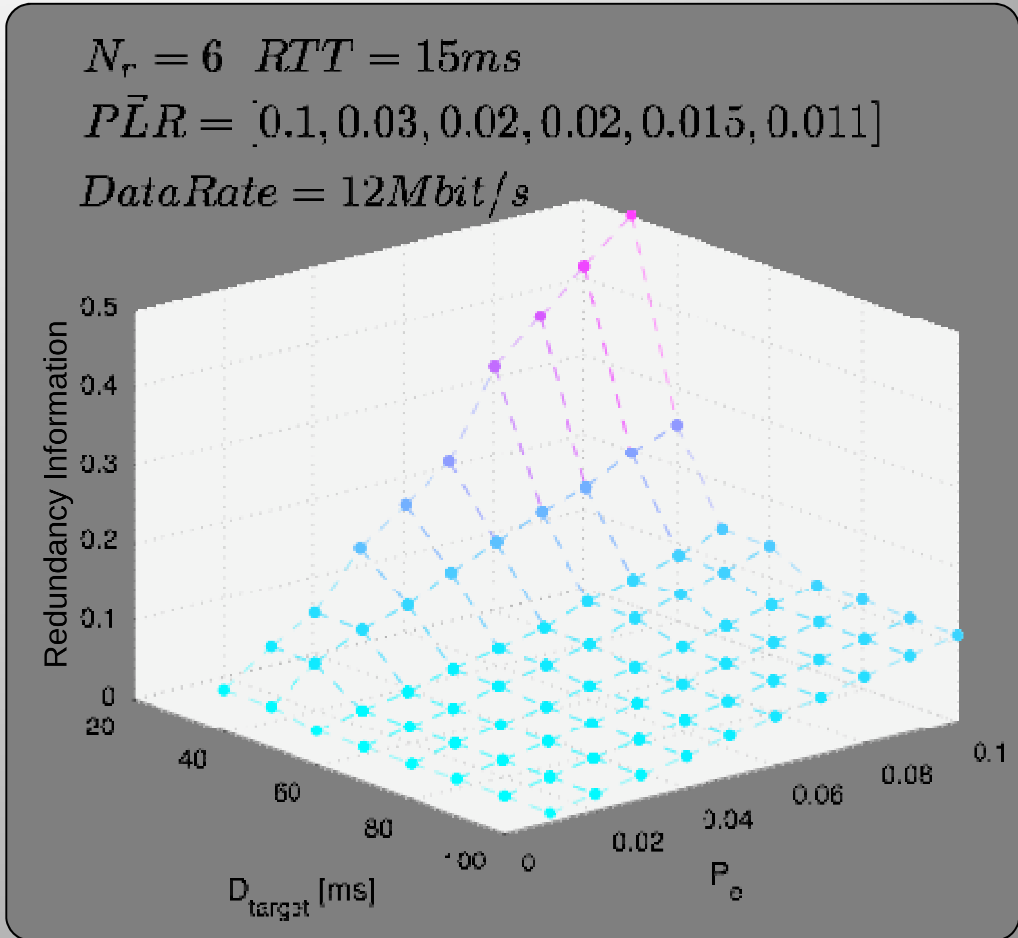
Hybrid Error Correction



Adaptive Hybrid Error Correction

Time vs. Redundancy

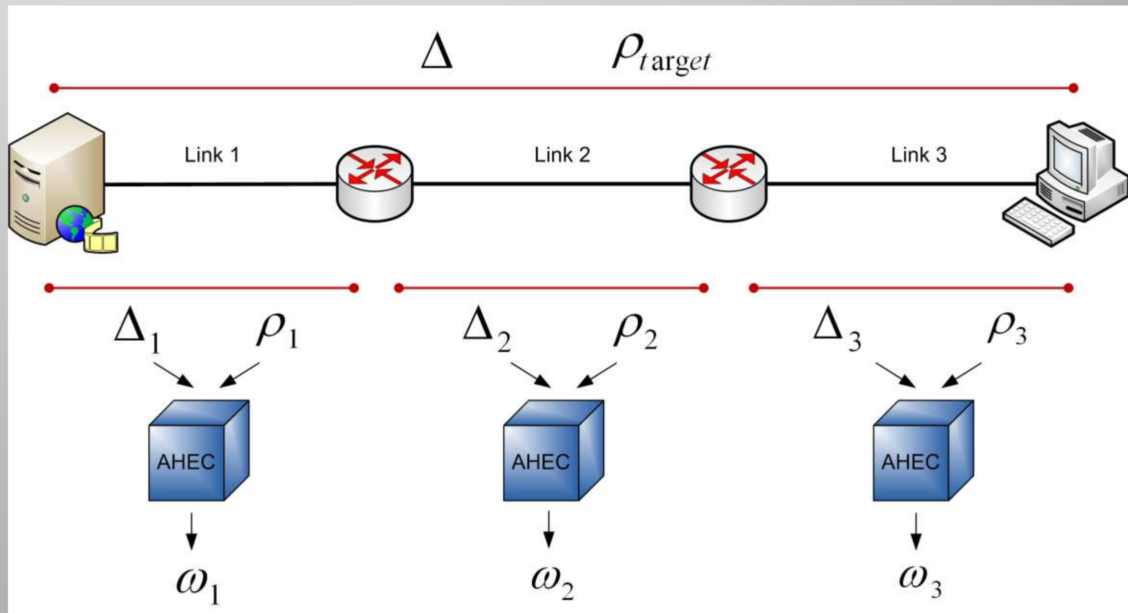
- Common Principle for capacity approaching codes:
  - „Make codes as long as possible“ (if decoding complexity allows it)
  - Contradicts the delay constraint
- Short delays require optimal erasure codes
  - Better scalability for short code sequences
  - Trade-off between time and redundancy



„Time as new dimension in Shannon´s Theorem“

Multi-Hop Error Correction

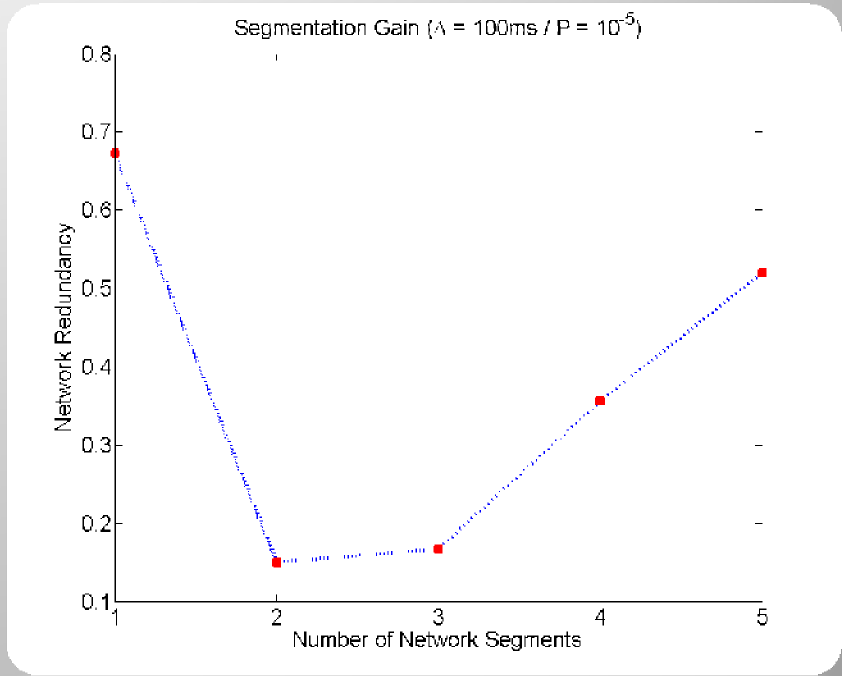
- Multi-Link / Multi-Hop
  - uses individual segment properties
  - intermediate nodes act as error correction relay
  - apply AHEC as atomic unit
  - expect significant coding gain



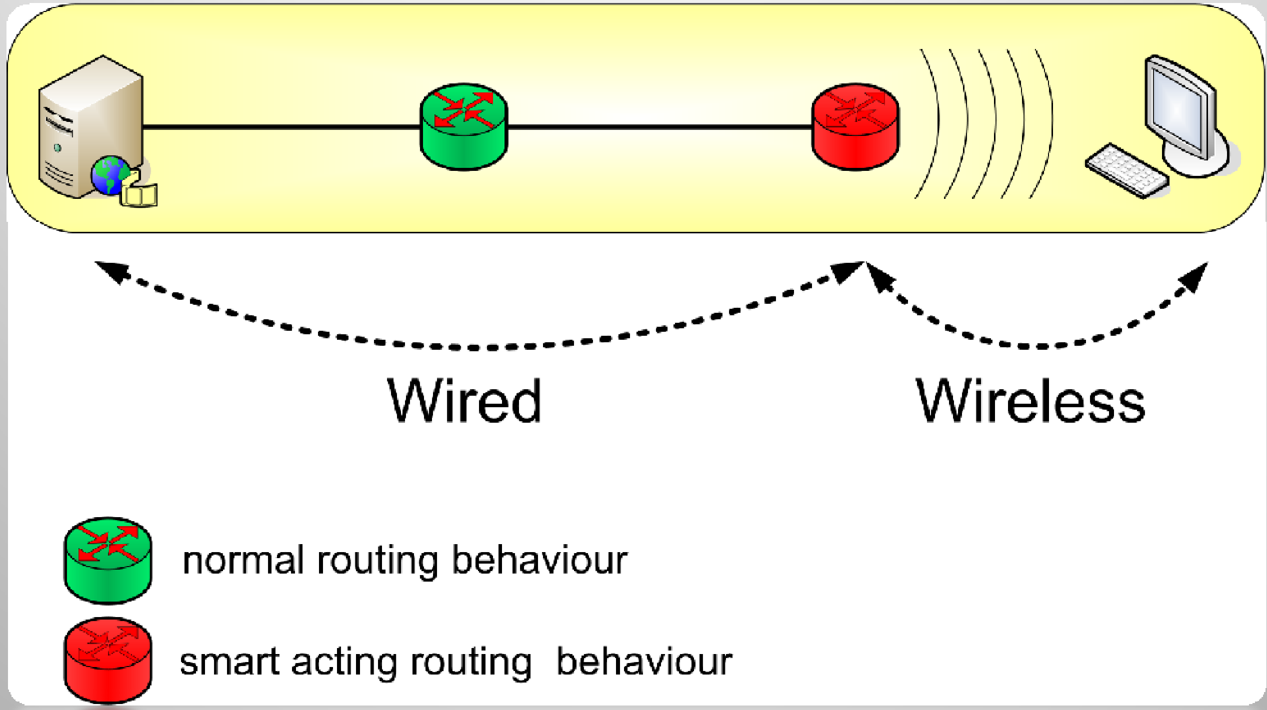
Error Correction in „Overlay Mode“

Saturation

- Remember:
  - Time per link decreases
  - Efficiency per link decreases
- Consequence:
  - Optimal *number* of links
  - Optimal *grouping* of links
- Good news:
  - E2E gain always possible
  - Efficiency can be increased in an avolutionary way

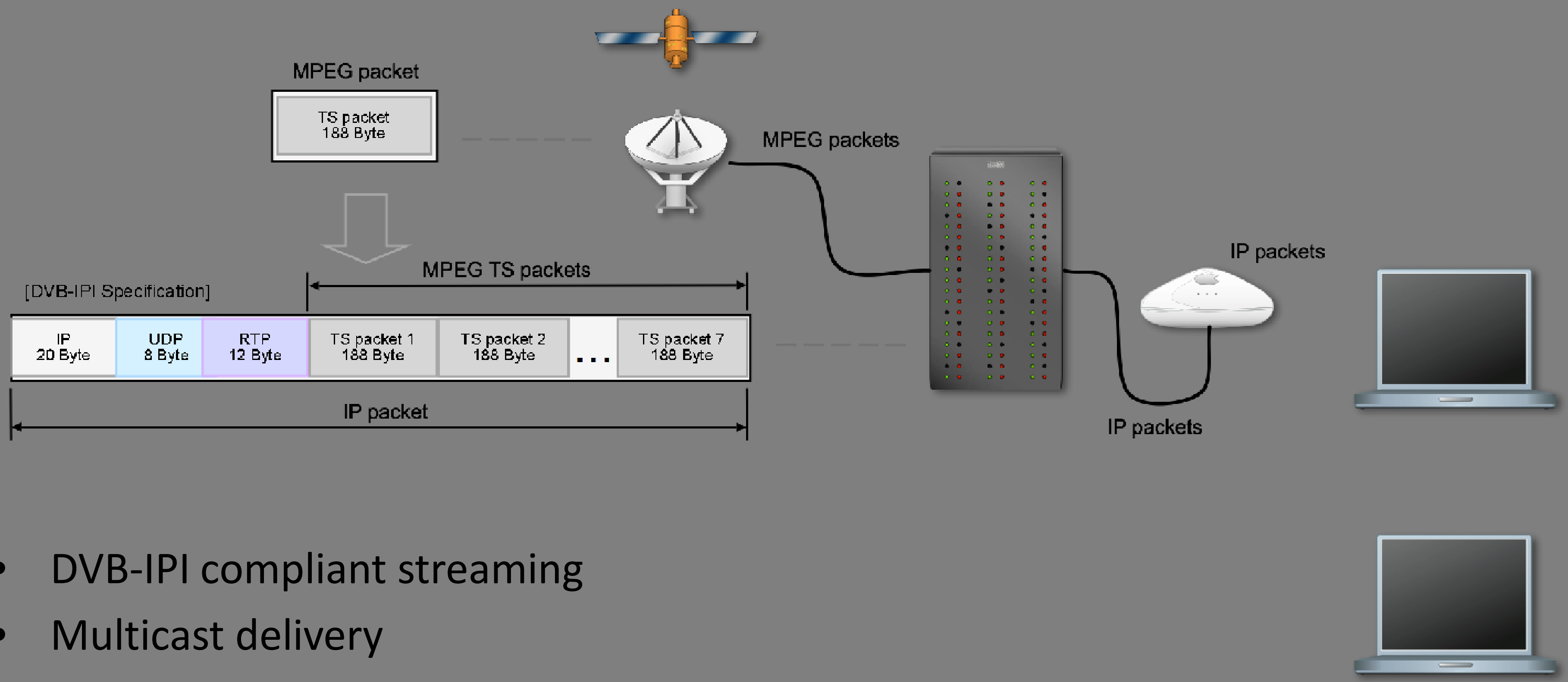


Example



- Use wired and wireless segments with independent transport schemes to obtain optimum efficiency.

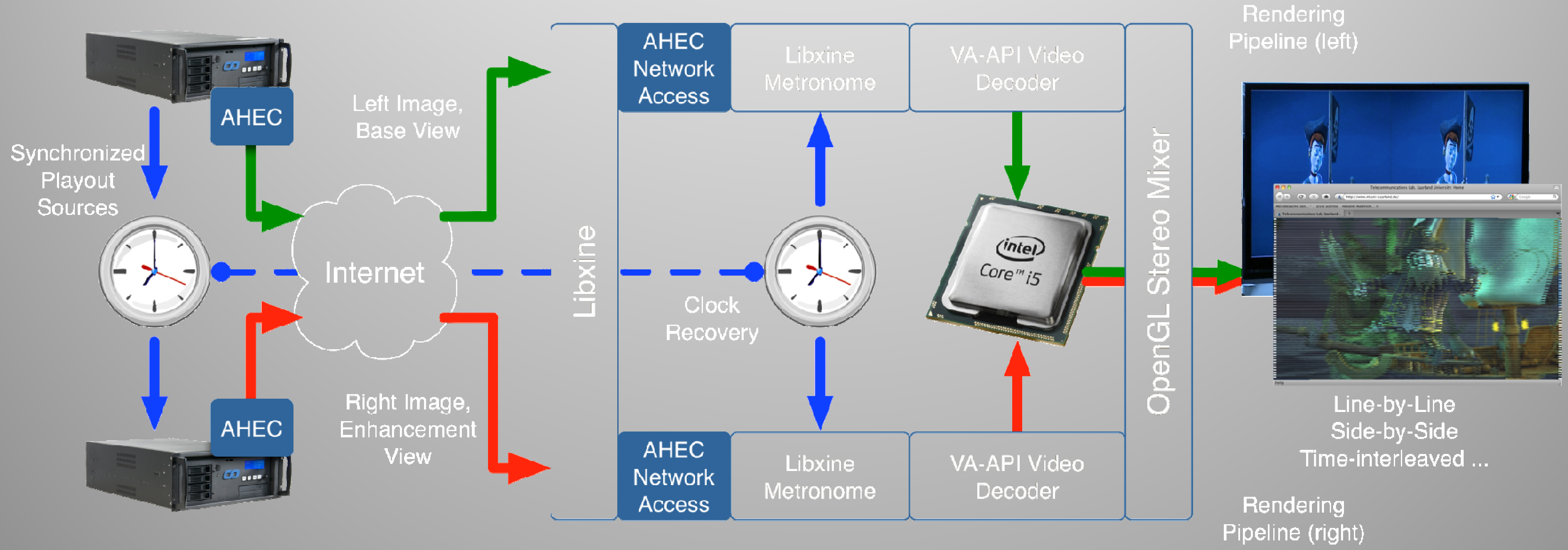
IP-based wireless TV delivery



- DVB-IPI compliant streaming
- Multicast delivery
- PCR-based synchronization of end devices
- A/V multiplexing on Elementary Stream level

And now we‘re going 3D

- Provisioning of two separate streams
  - 2D-HD-IPTV for large multicast group
  - 3D add-on for client-side choice



  - Genlocking (DPLL‘s), VA-API-Decode, OpenGL Rendering

3D-IPTV Browser Integration

- HTML 5 provides integrated elements for 2D video content

```
<video src="movie.ogg“ controls="controls"></video>
```

- Intended to become new standard for video playback
- Enables integration of different codecs within the browser source
  - No need for (buggy) 3rd party plugins
  - But: no standard available yet, vendors choose supported codecs individually:
    - Firefox: Theora codec
    - Safari: MPEG-4
    - Chrome: Theora + MPEG-4
    - Internet Explorer: tbd
- Currently, no build-in support for 3D video material

3D-IPTV Browser Integration

3D Fullscreen
e.g. Side-by-Side

Basic Stream

Enhancement Stream

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Summary

- 3D & HD will make up 46% of Internet traffic in 2014
  - Transport must be as efficient as possible!!!
- Introduced new transport based on PRPD
  - Adaptive to channel variations, optimized efficiency
  - Applicable end-2-end or multihop
- 3D will be a 2D „enhancement“
  - Optimize 2D and 3D multicast, so sum will also be optimal