University of Turku
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Communication Systems

Effects of transmission errors on quality of audiovisual services delivered over DVB-H

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Background on DVB-H and mobile broadcasting

- DVB-H is based on the DVB-T standard
  - All data encapsulated into MPEG2 TS packets
- Key differences
  - Time slices: Transmission in bursts to save power at the receiver
  - Link layer error correction (MPE-FEC): Provides additional robustness by encapsulating transmitted data in an MPE-FEC frame which is protected with Reed-Solomon coding

- Huge amount of parameters at physical layer, link layer and application (A/V) layer
  - Optimization is a challenging and complex task

- Error behavior in mobile reception is very different than in stationary reception
  - Completely error-free reception can almost never be guaranteed
  - An acceptable level of error has to be defined in order to optimize and evaluate transmission networks
  - In most cases, transmission errors have a dominant role over the quality loss caused by video compression

Motivation

- Currently the only quality metric defined for streaming audiovisual services in a DVB-H system is the MPE-FEC frame error ratio, or MFER.
  - Reception quality with an MFER value of 5 % or less is defined acceptable
- Due to the complexity of the DVB-H system and the simplicity of the MFER criterion, it does not have a very strong correlation with either the subjective audiovisual experience or the actual amount of lost audiovisual material.
- Previous studies on the subject also show that the subjective quality acceptability level may actually be greater than 5 % in terms of MFER.
- The audiovisual quality experience is highly dependent on:
  - Encoded video and audio quality (bit rate, resolution, frame rate, sample rate)
  - Content type
  - The length, amount and spacing of the audiovisual errors
- A simple quality criterion cannot be used to evaluate these aspects.
- Practical criteria for measuring and representing the impact of transmission errors in a mobile audiovisual service does not exist.

Examples of the MFER criterion

Channel	Settings	C/N	TS PER	IP PER	MFER
PO 3 km/h	Case 1	16 dB	2.8 %	3.1 %	5.7 %
PO 3 km/h	Case 2	16 dB	2.8 %	3.0 %	7.9 %

In this example, the simulation with a higher MFER value has essentially the same IP PER.

Here, there is only a small difference in terms of IP PER, but a huge difference in MFER.

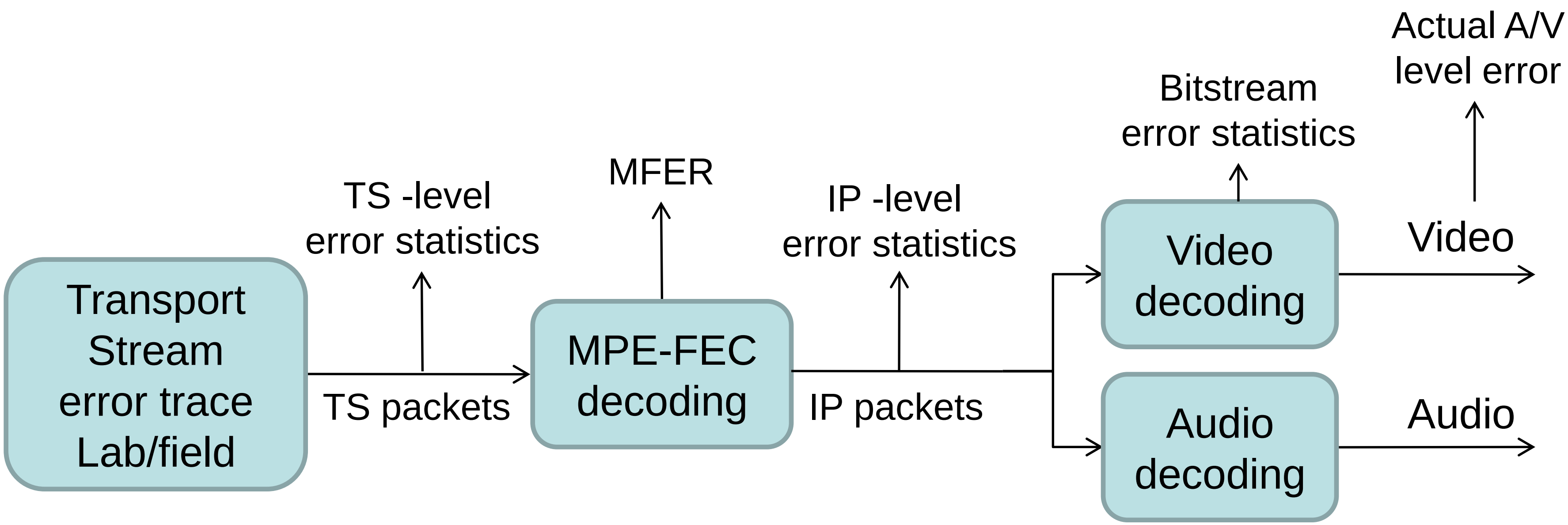
Channel	Settings	C/N	TS PER	IP PER	MFER
PO 3 km/h	Case 1	15 dB	9.2 %	9.9 %	16.8 %
VU 30 km/h	Case 1	15 dB	9.2 %	8.7 %	23.3 %

Channel	Settings	C/N	TS PER	IP PER	MFER
VU 30 km/h	Case 2	16 dB	4.8 %	0.9 %	4.5 %

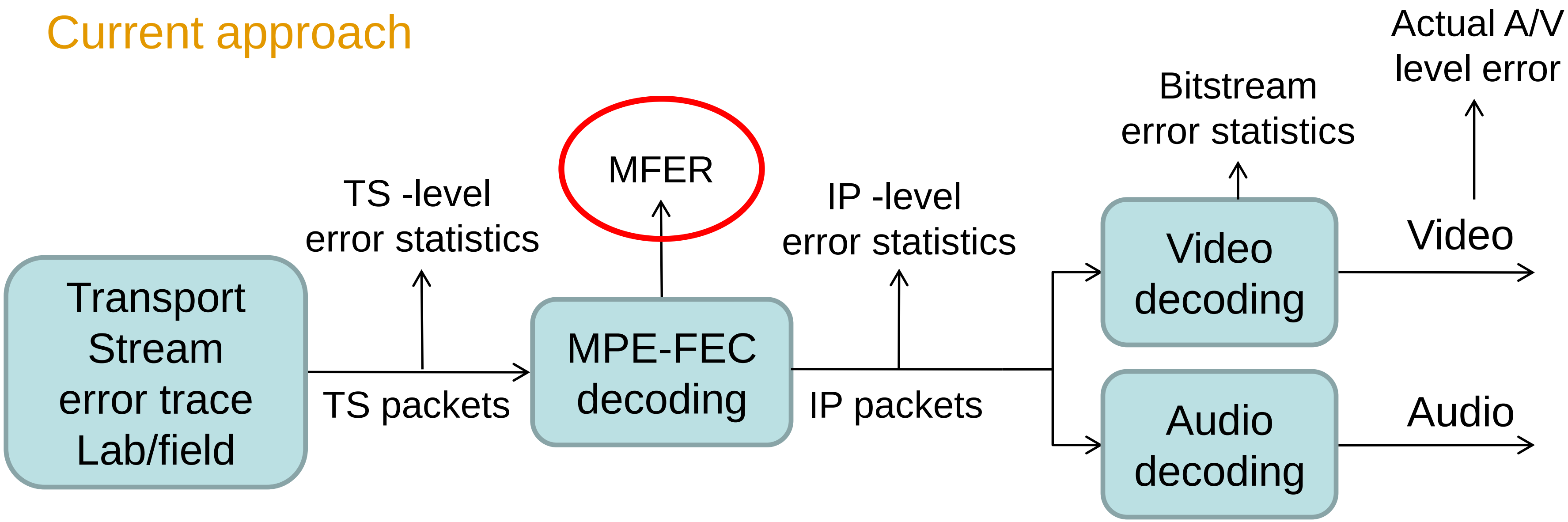
A relatively high MFER (close to the 5% threshold) can also result in very low IP PER.

	FEC rows	ADT cols	RS cols	Burst length	Video bit rate	Audio bit rate
Case 1:	256	190	38	48 ms	768 kbps	48 kbps
Case 2:	768	190	38	145 ms	768 kbps	48 kbps

Sources of error statistics in a DVB-H system

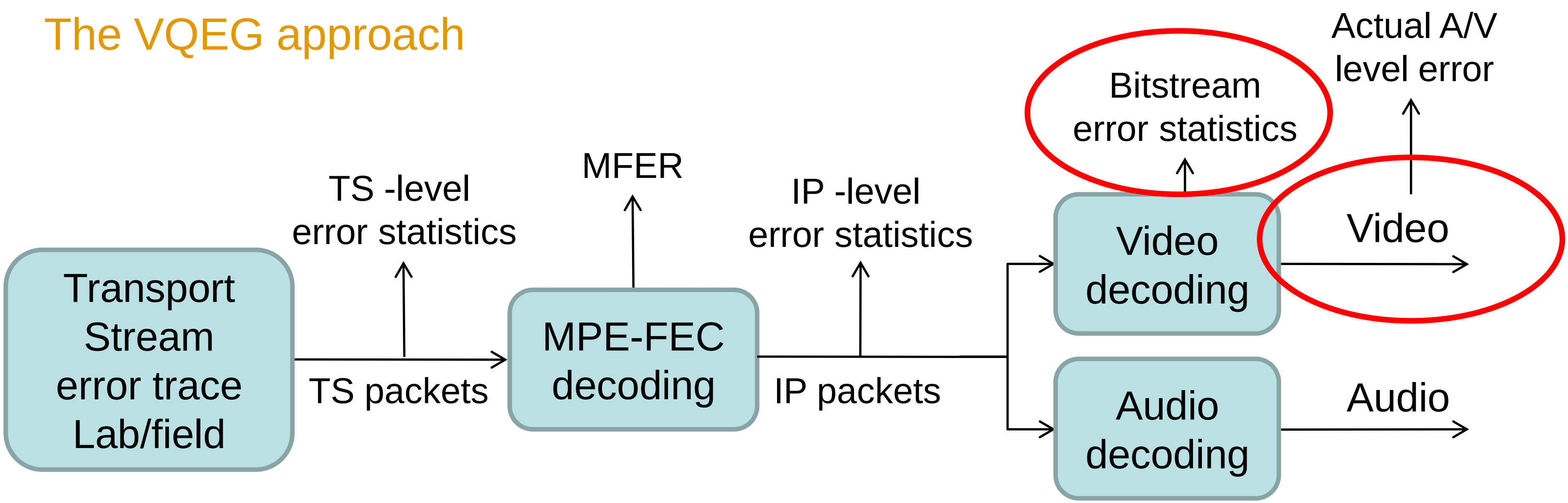


Current approach



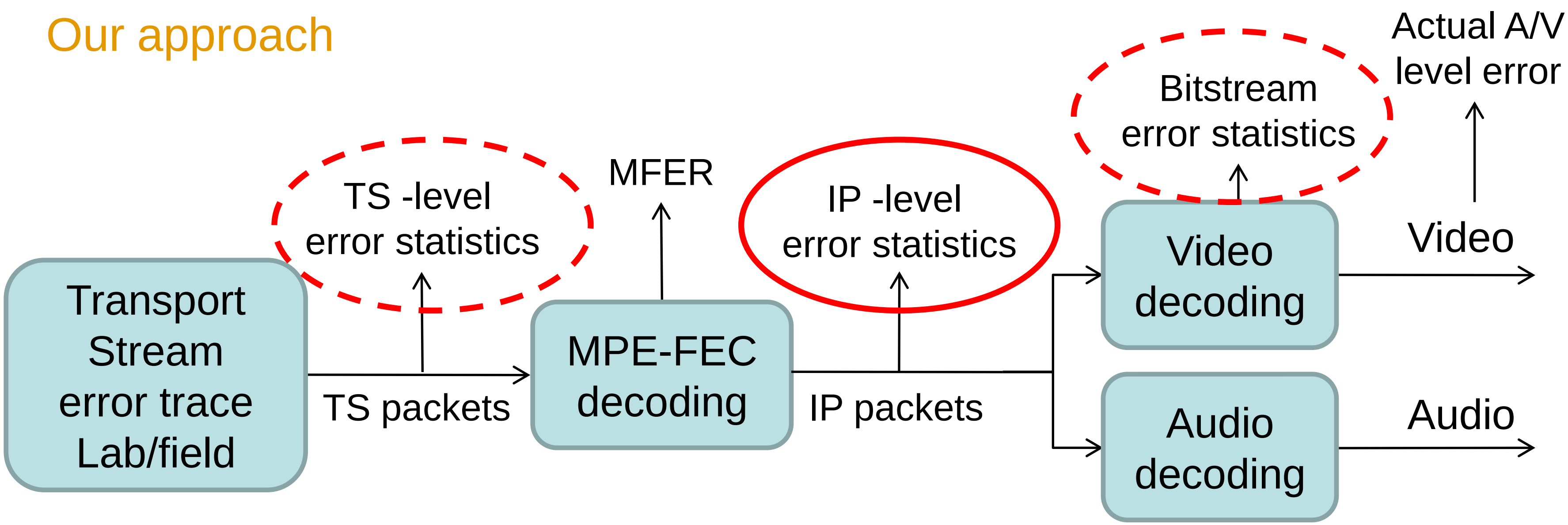
- Only one source for error statistics is used
- Simple and fast to compute
- Provides only little information on the error conditions

The VQEG approach



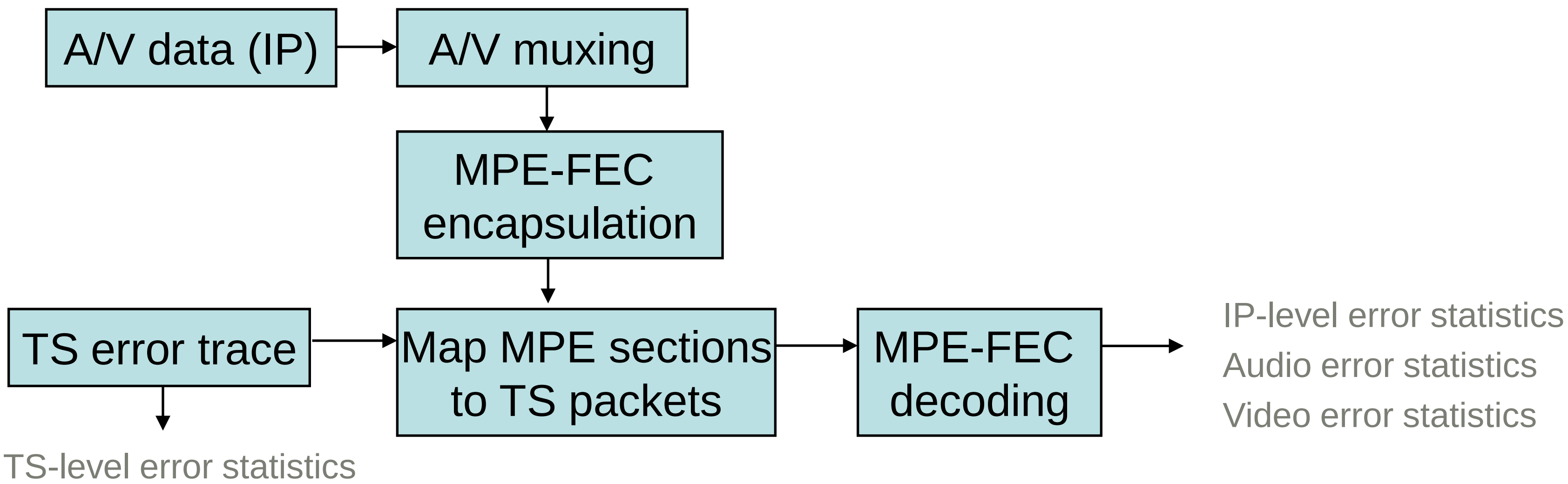
- The Video Quality Experts Group is developing a non-reference quality metric that will take input from both the encoded video bitstream and the decoded video
- Will probably provide the most accurate quality estimation of video content
- Audio not considered
- Advanced quality metrics that implement processing of the decoded video are typically demand a nontrivial amount of processing power
  - Implementation on a handheld receiver may be difficult or impossible
  - Large-scale simulation for network planning may be impossible

Our approach



- The work is currently concentrated on producing a model that maps the IP error statistics to the observable video and audio errors
- The following statistics are extracted from the IP packet trace:
  - Probability of packet error
  - Mean length of sequences of correctly received packets
  - Mean length of sequences of erroneously received packets
  - Corresponding variances
- Video and audio encoding parameters and content should be known, or they can be determined from the bitstream (to an extent)
- Future work will include a mapping of the TS –level errors to the IP –level errors (DVB-H –specific)

Simulation model



- A simplified block diagram of the simulation model
- Provides data on A/V, IP and TS level error behavior with different:
  - Channel models, modulations, code rates
  - Link layer parameters
  - A/V encoding parameters

Assumptions

- Quality experience of a corrupted audviovisual stream is dependent on the length, amount and spacing of audiovisual errors
- These properties are evaluated over one minute of audiovisual service
- DVB-H system with H.264 video coding and AAC audio coding
  - Adaptable to other environments
- Typical IP encapsulation (statistics obtained from a real DVB-H network)
- One IDR video frame in the beginning of each transmission burst
- Simplest possible bitstream and receiver/decoder
  - Minimum defined by the standards
  - No error robustness features
  - No error concealment features

The QosCRIBS project (1)

- "Quality of Service Criteria for Broadcasting Services"

- The goal of this project is to develop objective quality metrics reflecting the subjective experience in selected broadcast services.
- The developed quality metrics and criteria can be used for the following purposes:
  - They could enable accurate system design, parameter optimization and performance evaluation.
  - They can be used in field measurements and simulations when networks are planned, tuned and dimensioned.
  - They can be included in broadcasting standards as a performance threshold.
  - They could also be used for monitoring of commercial systems, when at least some receivers have a return channel available and send feedback on received quality. Feedback could be used to check that network operates as expected.

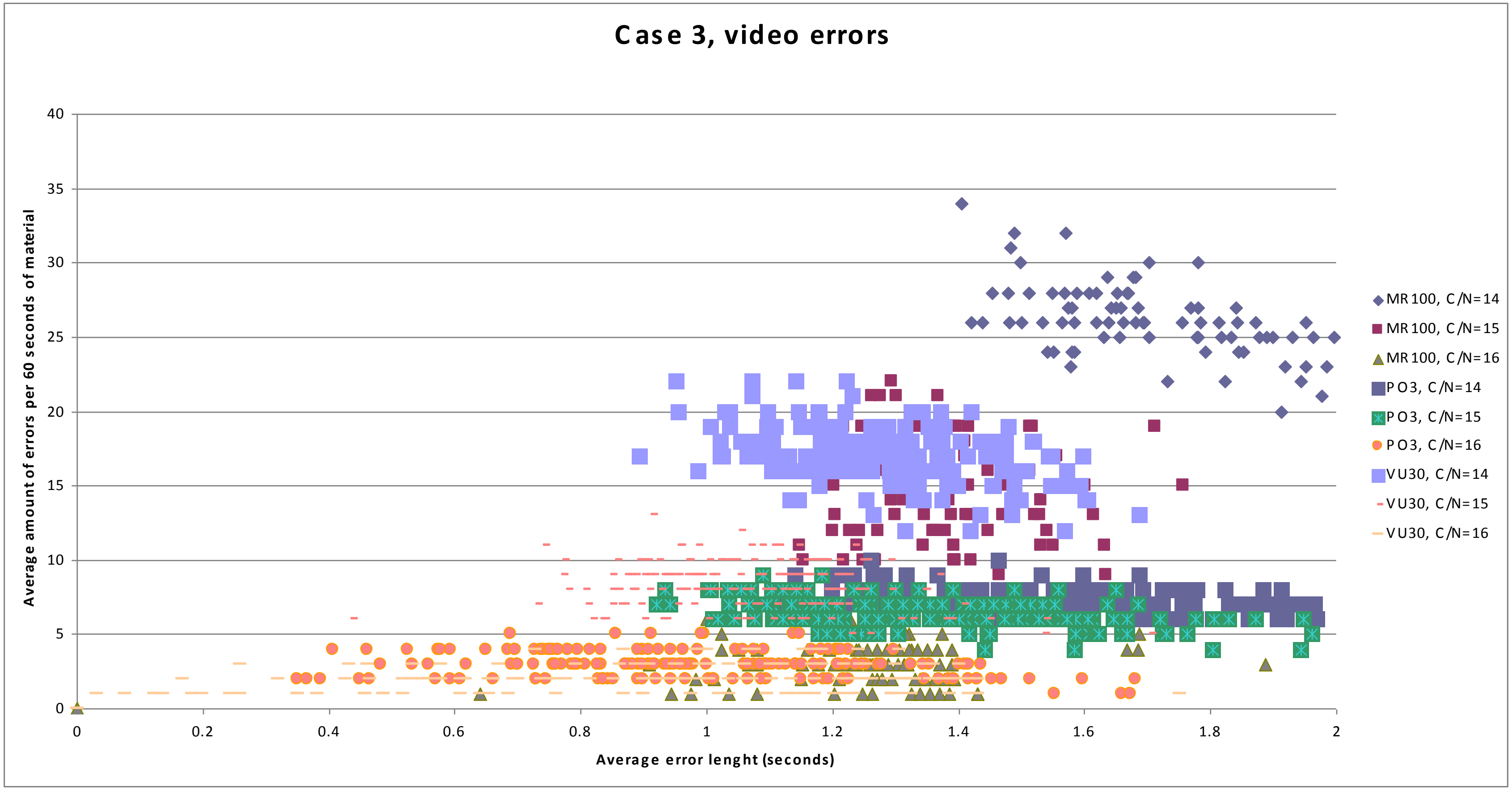
The QosCRIBS project (2)

- UTU tasks:
  - Effect of transmission errors on audiovisual quality
    - Mapping the TS- and IP-level errors to audiovisual errors
  - Producing a model or a metric that could estimate the audiovisual quality of a broadcast service using error data only from the IP- and TS-levels

- Other project tasks:
  - Subjective experiments on audiovisual quality
  - Subjective verification of the model
  - Evaluation of objective audio and video quality metrics that could be used in our context
  - If necessary, developing an objective audiovisual quality model or metric

Preliminary results (1)

- Example: Amount and average length of video errors
  - 3 channel models, 3 C/N conditions, same link layer and A/V encoding settings



Preliminary results (2)

- Effect of burst length
  - Longer transmission bursts (up to 300 ms) result in more lost video material, but less lost audio material
- Effect of channel switching time
  - Effect to video material is dominant
    - The amount of lost material remains essentially the same
    - Shorter channel switching times result in a larger amount of shorter errors
    - Longer channel switching times result in a smaller amount of longer errors
  - Effect to audio error distribution is relatively small
- Effect of video bit rate
  - Changing the video bit rate has nearly no effect on the amount of lost material
  - Small differences in error distribution exist

Thank you!

Questions?

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