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Video quality testing of Video Assistant Refereeing (VAR) Systems

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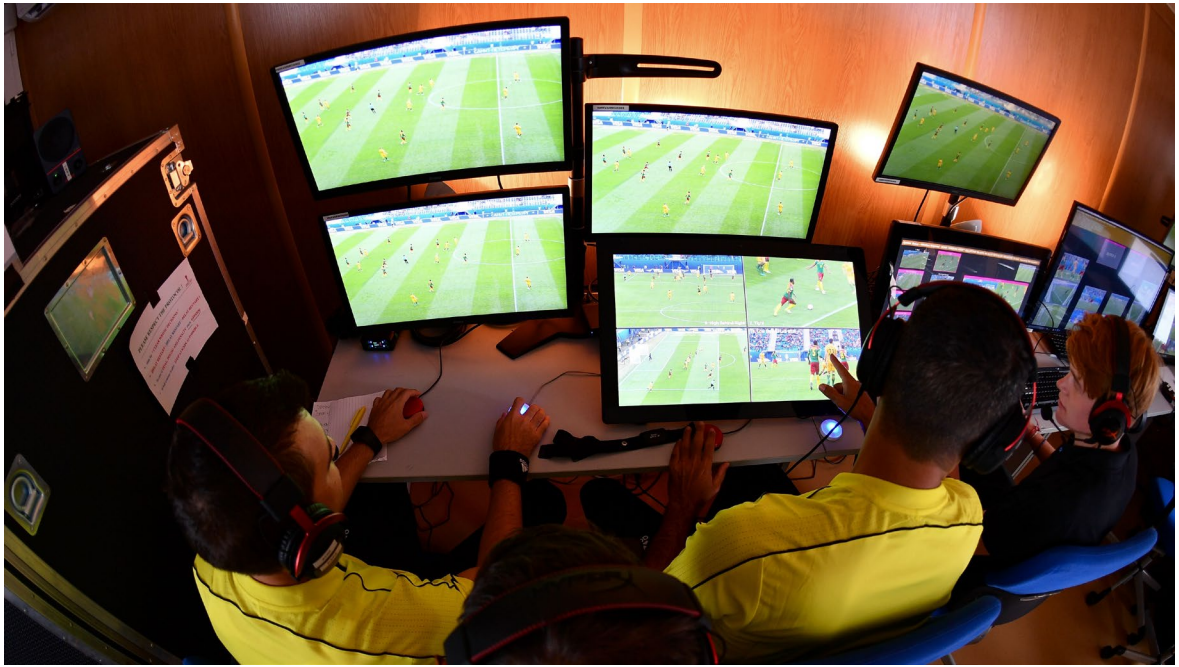
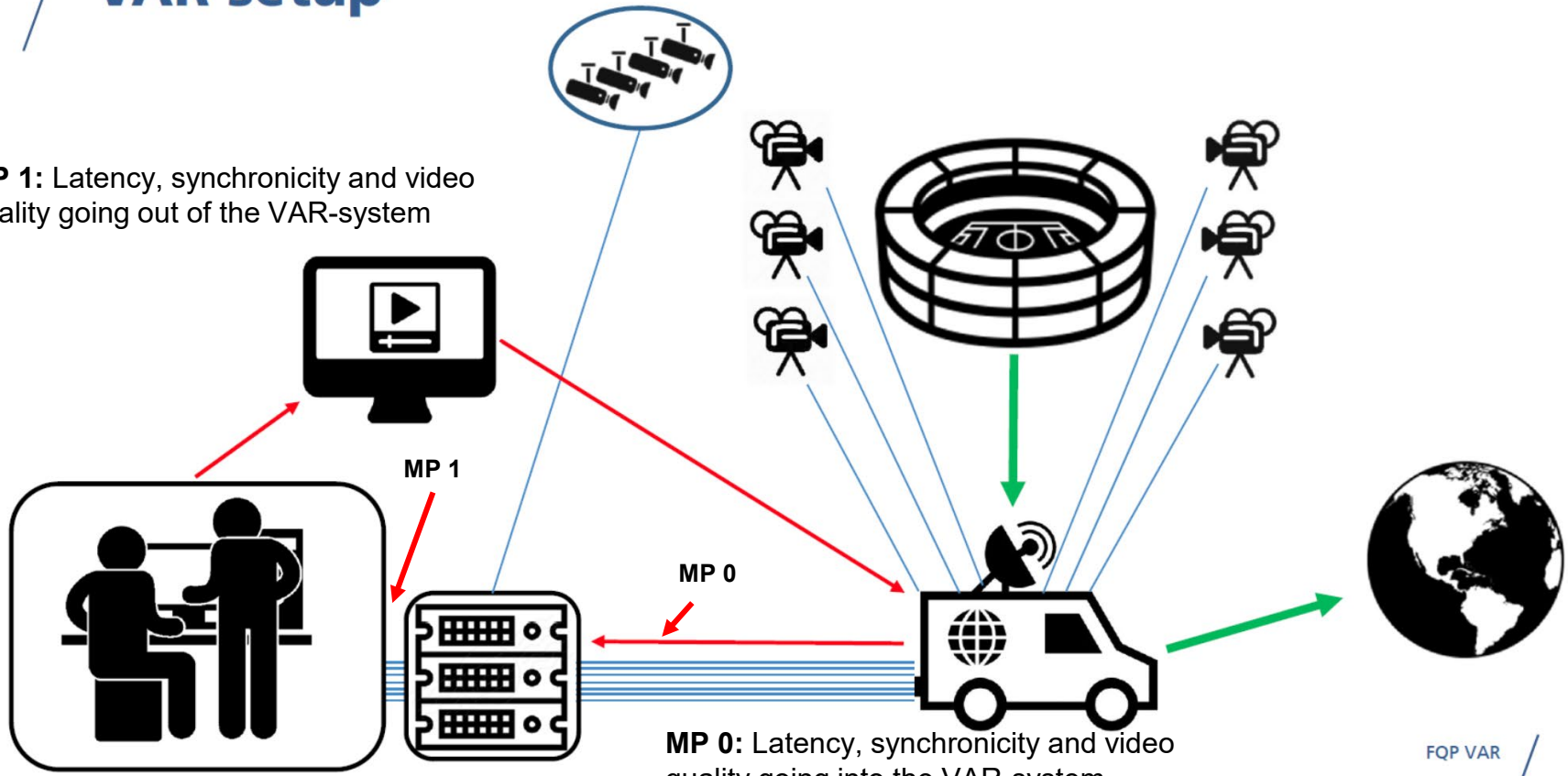
Video assistant referee (VAR)



- Quality needs to be assured
- Important aspects
  - Latency
  - Synchronicity
  - Video Quality

VAR setup

MP 1: Latency, synchronicity and video quality going out of the VAR-system



MP 0: Latency, synchronicity and video quality going into the VAR-system

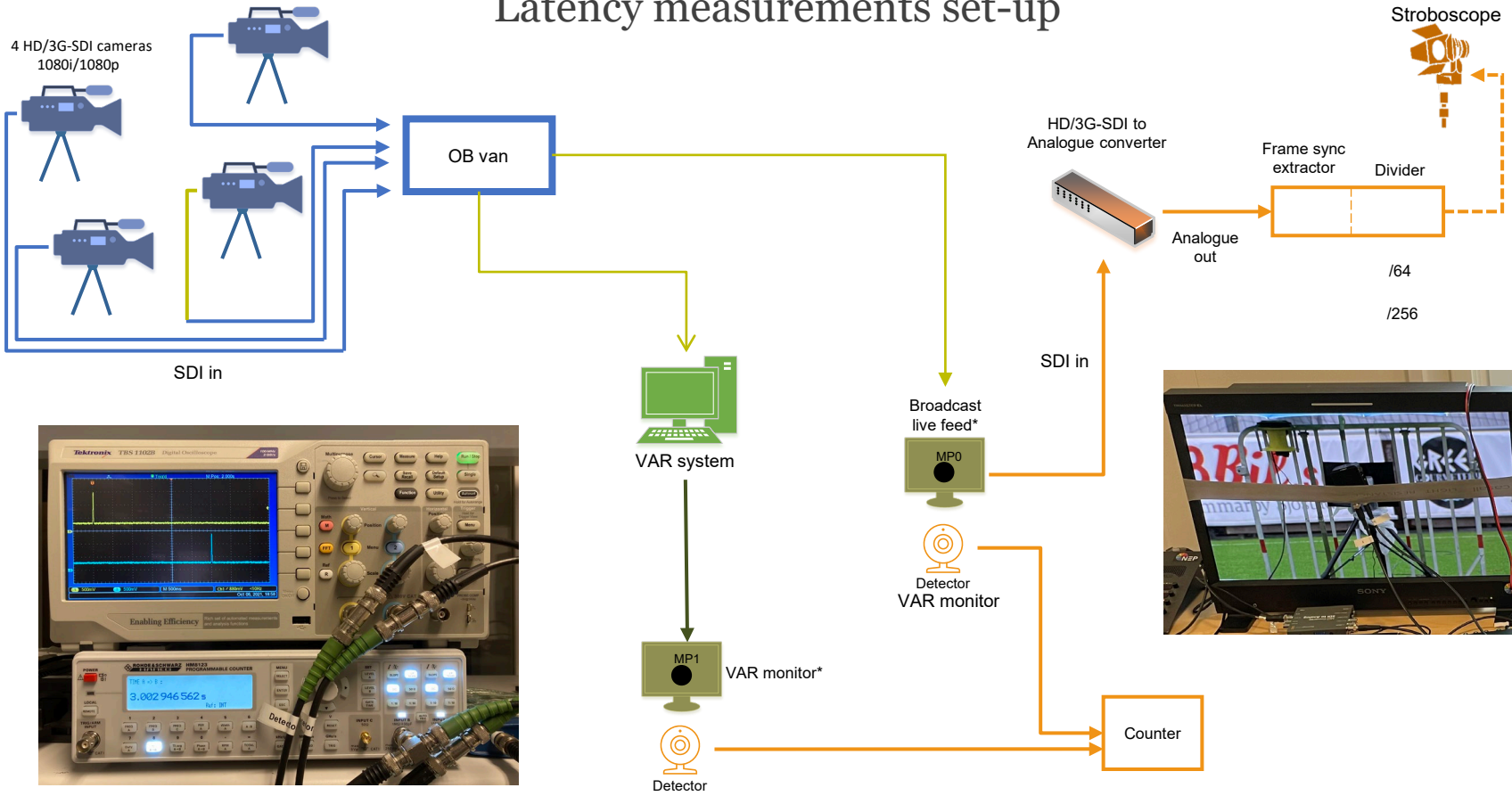
Timeline

- Research project from end of 2018 to beginning of 2020
- Field tests
  - Düsseldorf (Germany) in Jan 2020
  - Zeist (The Netherlands) in March 2020
- Improvement development 2020 - 2022
- Certification events
  - Stockholm (Sweden) in August 2021
  - Stockholm (Sweden) in May 2022

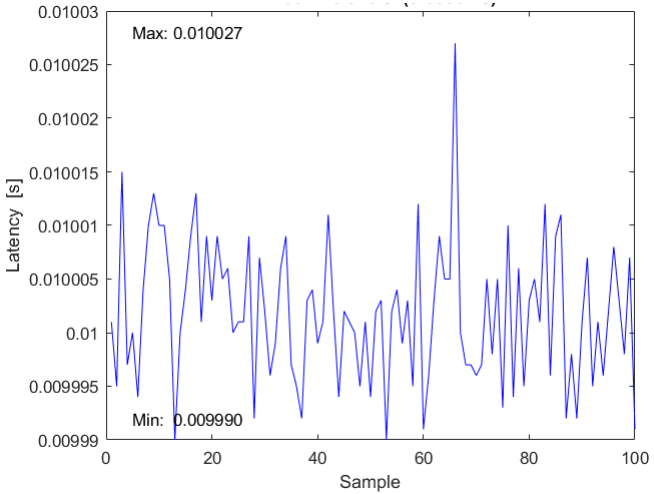
Synchronicity and latency measurements

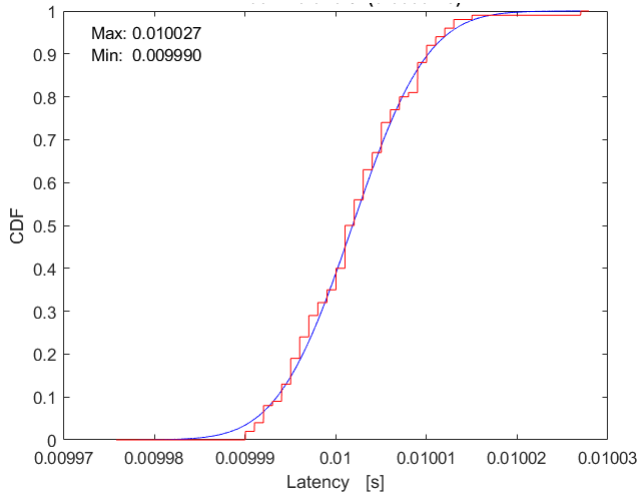
- Based around a stroboscope placed on the pitch

Latency measurements set-up

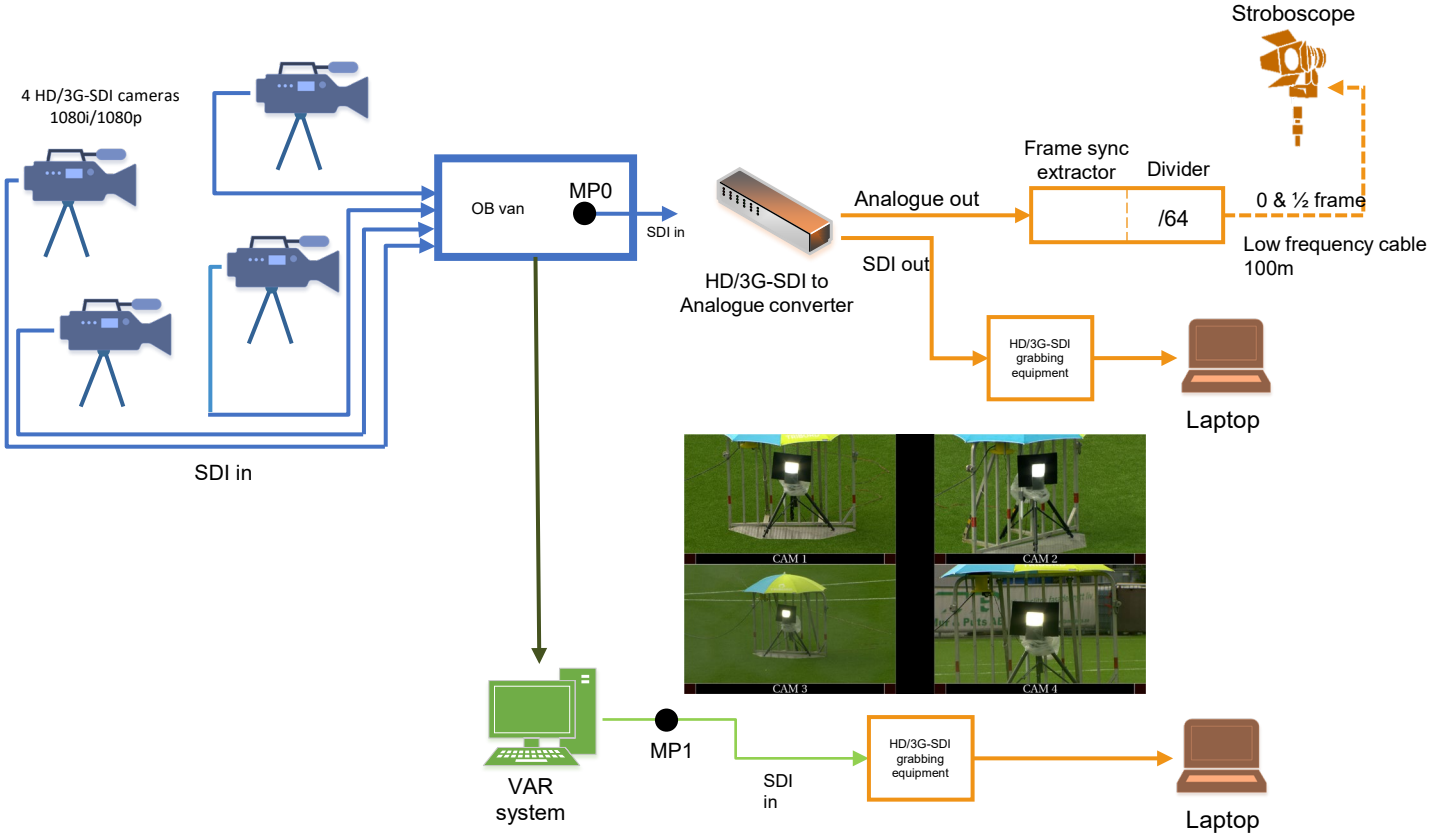


Latency measurements data

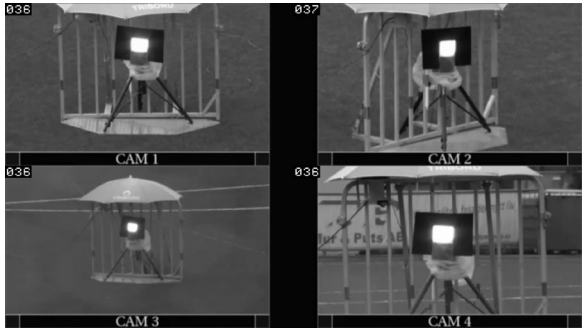




Synchronicity measurements set-up



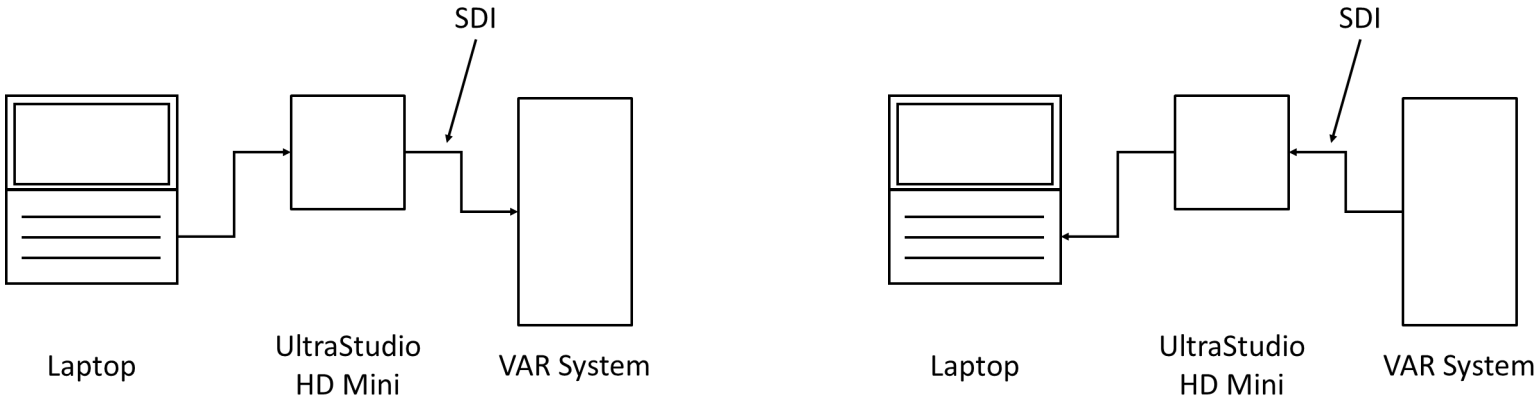
Synchronicity measurements data



- Reference camera: flash in lowest frame number
- Difference to reference camera
- Max 3 to pass

Flash	Main cam = 1	16m right	16m left	Centre line pitch level	Max diff	Decision
1	34	36	35	37	3	pass
2	35	35	36	37	2	pass
3	35	35	36	37	2	pass
4	35	35	35	35	0	pass
5	35	35	35	35	0	pass

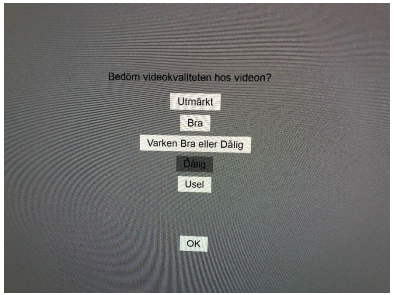
Video Quality measurements



- Ingesting known video
- Grabbing the played ingested video
- Measure video quality degradation (VMAF)

Video Quality measurements

- Based on subjective experiment with 25 video experts
- Three sessions were performed by each subject, but the order was randomized.
    1) Full size 1920x1080 video based on progressive source (1080p).
    2) Full size 1920x1080 video based on interlaced source (1080i).
    3) Quarter size 960x540 video based on interlaced source (540i).
- A high-end consumer-grade 65” 4K TV (Ultra HD, LG OLED65E7V)
- ACR-HR with the VQEGPlayer
- ITU-R Rec. BT-500-14



Video processing

- 1080p
  - H.264 (80 Mbit/s – 10 Mbit/s) and Motion JPEG (80 Mbit/s – 20 Mbit/s)
- 1080i:
  - H.264 (50 Mbit/s – 10 Mbit/s), Motion JPEG (80 Mbit/s – 20 Mbit/s) and bad deinterlacing
- 540i:
  - H.264 (50 Mbit/s – 10 Mbit/s) and different scaling algorithms

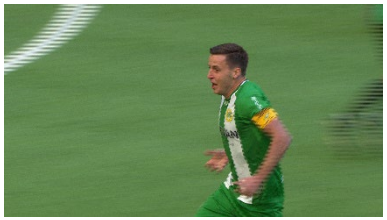
- Interlaced video were deinterlaced before playing using FFMPEG yadif (1:0:0,mcdeint=3:0:1)

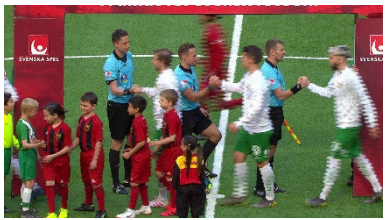
Source videos (1080p)






Source videos (1080i)







Objective models evaluation (1080p)

Model	VMAF	VQM_VFD	VQM General	SSIM	PSNR
VMAF					
VQM_VFD	0.00014 *				
VQM_General	0.22	< 0.0001 *			
SSIM	0.0067 *	< 0.0001 *	0.042		
PSNR	0.0034 *	< 0.0001 *	0.024	0.40	
VIF	0.0040 *	< 0.0001 *	0.028	0.43	0.48

Objective models evaluation (1080i)

Model	VMAF	VQM_VFD	VQM General	SSIM	PSNR
VMAF					
VQM_VFD	0.17				
VQM_General	0.29	0.066			
SSIM	0.00046 *	< 0.0001 *	0.0027 *		
PSNR	0.044	0.0042 *	0.12	0.049	
VIF	0.0343	0.0030 *	0.10	0.062	0.45

Video Quality measurements

- VQM_VFD best model
- Video Multimethod Assessment Fusion (VMAF) was decided to be used
  - Second best
  - Easier to use and don’t require Matlab to be used
  - Open and well spread

Summary and challenges

- Measurement methods for Quality evaluation of VAR systems have been developed
- Latency and synchronicity methods are based on controlled flashes from stroboscope
  - Get clean pulses (e.g. noise and backlight modulations)
  - Complexity on-site mixing of equipment from different sources
- Video quality is based on sending known videos and measure quality degradations with VMAF
  - Interlace and deinterlacing
  - New broadcast formats

THANK YOU

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