

CWTe 2013 Research Retreat Symposium 29 October 2013, Eindhoven, The Netherlands



Three questions about video streams



<u>Video</u> is the predominant media, yet we still don't know how to transfer it effectively

- How do we 'perceive' videos?
- How do networks 'repel' videos?
- How should networks 'handle' videos in 2020?



<u>**Bandwidth</u>** is a necessary but not sufficient condition for good video</u>



The video delivery chain

- Open-loop system
- Best-effort network
- Massive overprovisioning



Can we afford to overprovision 1 trillion 'things' in 2020?



Bandwidth alone can't ensure a smooth video

1% packet loss; no edge buffering



A. Liotta, L. Druda, G. Exarchakos, V. Menkovski, **Quality of Experience management for** video streams: the case of Skype. In proc. of the 10th International Conference on Advances in Mobile Computing and Multimedia, Bali, Indonesia, 3-5 December 2012 (ACM). Does our brain process different videos differently?



We looked at 10 video categories ...







(d)



(g)













... to cover a broad range of dynamics



It turns out that not every video was born the same



Do networks treat different videos differently?

TU/e test facility for multimedia networking



Network latency has little effect but only if we can afford to buffer

Frame resolution = 768 x 432



Different videos are affected rather differently

Network latency = 50 msec.



Stockholm video is severely affected





Packet Loss = 0%

Packet Loss = 2%



Do networks treat better videos better?



Sometimes 'better' is 'worse'!





Packet loss plays a 'reversing' effect



All types of videos suffer this reversing effect



Current networks fail 25% of the standard video stress-tests



The network according to ITU G.1050

Network model for evaluating multimedia transmission performance over Internet Protocol



ITU G.1050 stress tests on river video



ITU G.1050 stress test on river video



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What I'd like to see in 2020 networks

Smart networks at TU/e



networks

Self-wiring meshes alongside conventional networks

Strictly non-deterministic, spectrum-efficient

Coordinated response to extreme stresses (autonomic networks)



Ability to makes sense of context and patterns, make inference, learn and evolve continuously (learning-based networks)



2020 is much more than just providing more bandwidth

Selected publications

- G. Exarchakos, V. Menkovski, L. Druda, A. Liotta, **Network analysis on Skype end-to-end video quality**. International Journal of Pervasive Computing and Communications. Emerald. (in press)
- A. Liotta, **The Cognitive Net is Coming**, IEEE Spectrum, Vol.50(8), pp.26-31, August 2013, IEEE http://dx.doi.org/10.1109/MSPEC.2013.6565557
- G. Exarchakos, L. Druda, V. Menkovski, P. Bellavista, A. Liotta, **Skype resilience to high motion videos**. International Journal of Wavelets, Multiresolution and Information Processing, Vol.11(3), 2013, World Scientific Publishing <u>http://dx.doi.org/10.1142/S021969131350029X</u>
- V. Menkovski, A. Liotta, Intelligent control for adaptive video streaming, in proc. of the International Conference on Consumer Electronics, Las Vegas, US, January 11-14, 2013.
- A. Liotta, **Farewell to deterministic networks**, in proc. of the 19th IEEE Symposium on Communications and Vehicular Technology in the Benelux, Eindhoven, the Netherlands, 16 November 2012 (IEEE).
- V. Menkovski, A. Liotta, Adaptive Psychometric Scaling for Video Quality Assessment. Journal of Signal Processing: Image Communication. Vol.26(8), pp.788-799. Elsevier. 2012 (*invited paper*) <u>http://dx.doi.org/10.1016/j.image.2012.01.004</u>
- F. Agboma, A. Liotta, **Quality of Experience Management in Mobile Content Delivery Systems**, Journal of Telecommunication Systems, special issue on the Quality of Experience issues in Multimedia Provision. Vol. 49(1), pp. 85-98, Springer 2012 (DOI: <u>10.1007/s11235-010-9355-6</u>)
- V. Menkovski, G. Exarchakos, A. Liotta, The Value of Relative Quality in Video Delivery, Journal of Mobile Multimedia. Vol.7(3), pp. 151-162. Rinton Press, September 2011 <u>http://www.rintonpress.com/xjmm7/jmm-7-3/151-162.pdf</u>
- V. Menkovski, G. Exarchakos, A. Liotta, A. Cuadra Sánchez, Quality of Experience models for Multimedia Streaming, International Journal of Mobile Computing and Multimedia Communications. Vol.2(4), pp. 1-20, IGI Global, October-December 2010 (DOI: <u>10.4018/jmcmc.2010100101</u>)

More about my work

TU/e More @TU/e

In the press



My slidecasts

"All of YouTube through a 40-year-old funnel"



http://bit.ly/Volkskrant-EN

http://bit.ly/autonomic_networks

http://bit.ly/press_articles

http://www.slideshare.net/ucaclio

"The cognitive Net is coming"



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http://bit.ly/spectrum_LIOTTA

"Networks for pervasive services"

Lecture Notes in Electrical Engineering 92

Antonio Liotta George Exarchakos

Networks for Pervasive Services

Six ways to upgrade the internet

http://bit.ly/pervasive-networks

Prof. A. Liotta