Design and Simulation of a H.264 AVC Video Streaming Model

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Outline:

- MPEG2 traffic Model
- H.264 VBR traffic model
- H.264 OPNET model
  – Process model design
  – Node model design
  – Simulation scenarios
- Ongoing / future work

Hogeschool Antwerpen

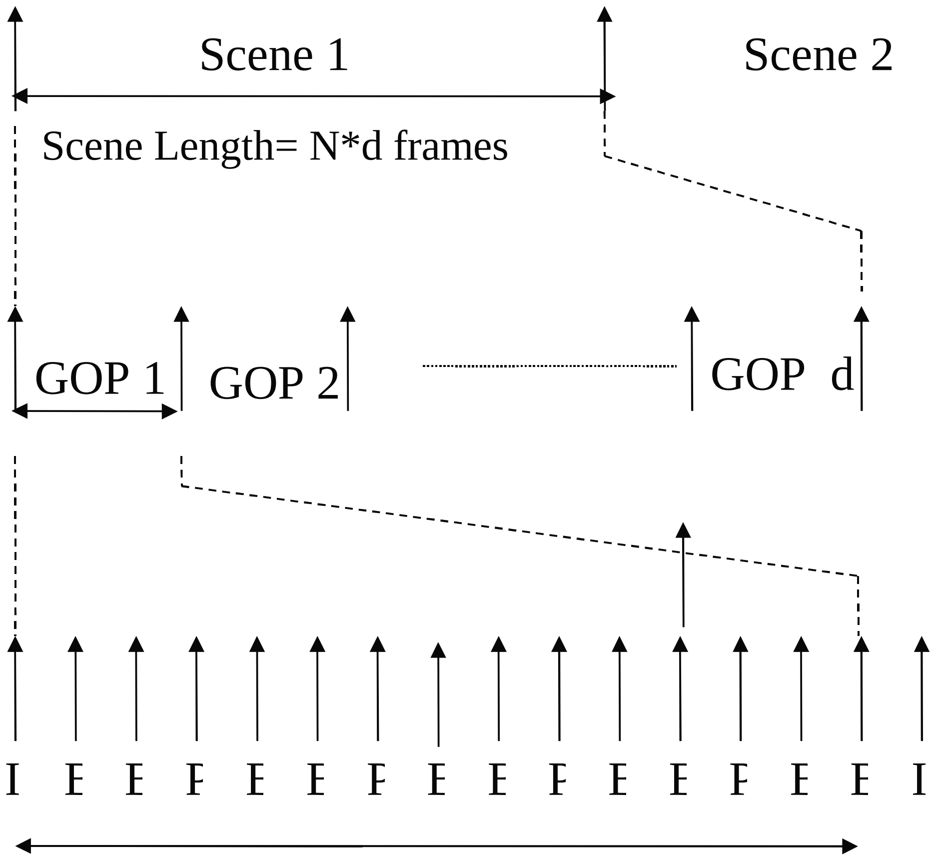
elab

Introduction

- MPEG2
  - Audio & video coding standard
- H.264 / AVC / MPEG4 Part10
  - Next generation coding standard
  - Higher compression rates
- Many possible applications
- Frame types
  - I-frame: intermediate
  - P-frame: predicted
  - B-frame: bi-predictive
- Group of pictures (GOP)
  - Repeating frame sequence (i.e. IBBPBBPBBP)

Introduction

Stream Structure:



Introduction

CBR vs VBR

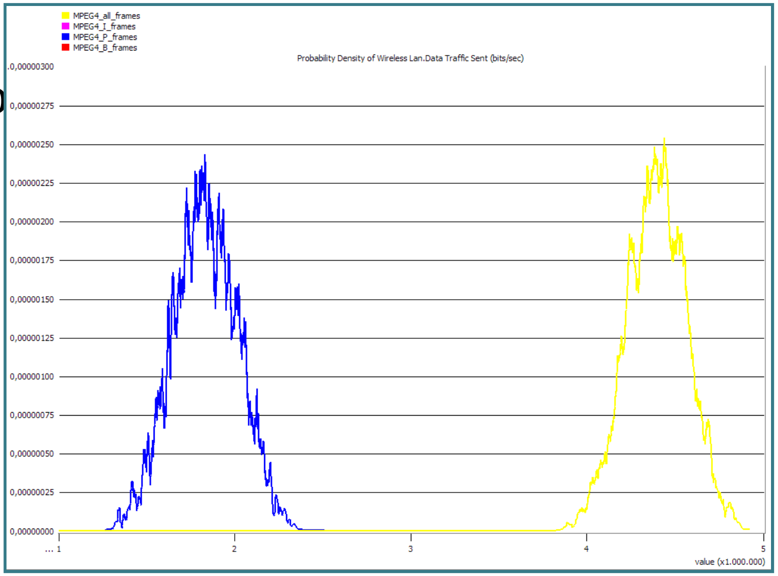
- Stream structure
- Scene length distribution
  - Sudden change in I-frame size
  - iid-random, geometric distribution

MPEG2 Traffic Model

Developed by M. Krunz, and H. Hughes [Ref:1]

Frame size distribution for each frame type

- B & P-frames
  - iid lognormal distribution pro
- I-frames
  - Constant within a scene
  - iid lognormal distribution



[1] *M. Krunz, and H. Hughes, "A Traffic model for MPEG- coded VBR streams", Proc. ACM Sigmetrics, 1995*

H.264 VBR Traffic Model

Developed by H. Koumaras, C. Skianis, G. Gardikis and A. Kourtis [Ref: 2]

- The same stream structure
- The same scene length distribution
- Frame size distribution:
- One distribution for each frame type
- I-frames
  - Constant within a scene
  - iid gamma distribution
- B & P-frames
  - iid gamma distribution provides best fit

[2] H. Koumaras, C. Skianis, G. Gardikis, and A. Kourtis, "Analysis of h.264 video encoded traffic", Proceedings of the 5th International Network Conference, (INC2005), pp. 441–448, 2005

H.264 VBR Traffic Model

– Gamma distribution

$$F(x;k,\theta) = \begin{cases} x^{k-1}\frac{e^{-x/\theta}}{\theta^k\,\Gamma(k)} & x > 0 \\ 0 & otherwise \end{cases}$$

With:

- $k\theta \;= M$: Expected Value (Mean)
- $k\theta^2 \;= V$: Variance
- $V/M = \theta$: Scale Factor
- $M^2/V = k$: Shape Factor

– Example of calculated distribution values

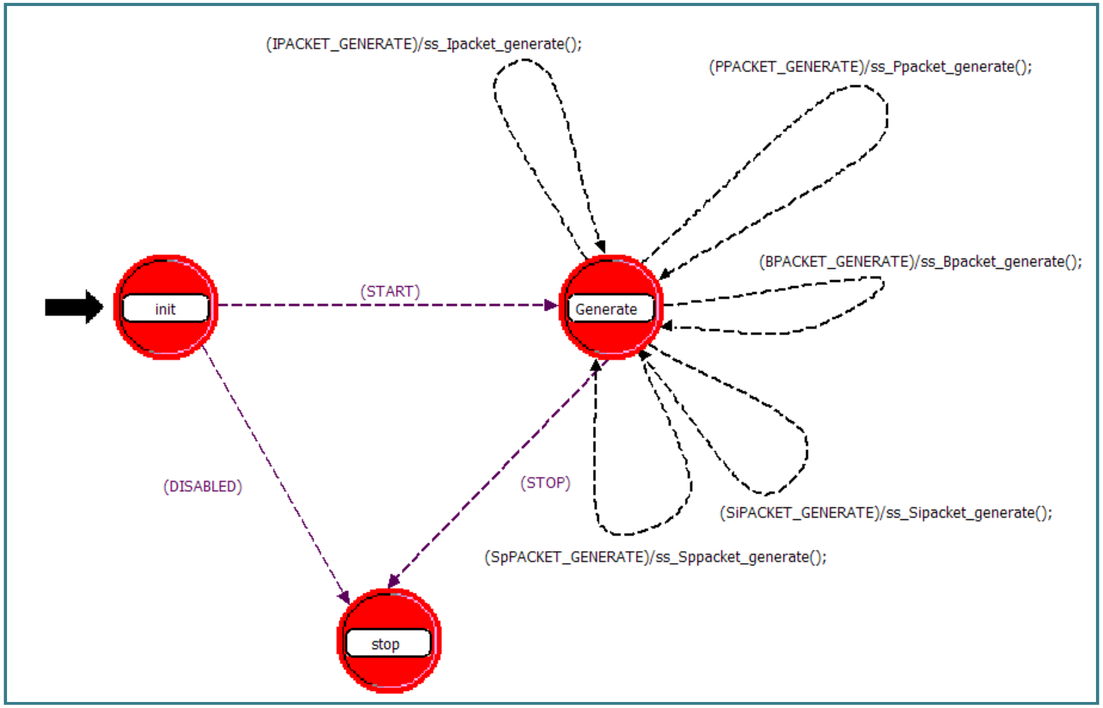
		M (10^3)	V (10^9)	θ	k (10^3)
525*384	I	53,91	659,6	4,406	12,24
	B	7,86	75,90	0,814	9,660
	P	16,33	194,0	1,374	11,88
Mean Bitrate:	438 Kbps				
720*576	I	110,27	1,350	9,013	12,24
	B	16,08	0,155	1,665	9,660
	P	33,40	3,968	2,812	11,88
Mean Bitrate:	896 Kbps				

H.264 VBR Traffic Model

- Real-world tests
  - Encode a high definition test sequence
    - x264 open source encoder
    - Different resolutions @calculated bitrates
      - 525*384
      - 720*576
      - 1280*720
    - Output sequences found adequate after visual inspection
    - PSNR test are not necessary (at this stage)

H.264 OPNET Model

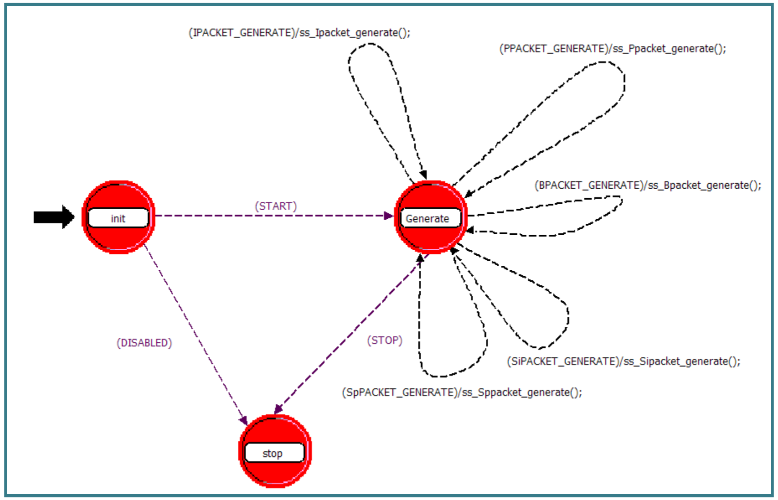
- Process model design
  - ‘Init’ state
  - ‘Generate’ state
  - ‘Stop’ state



H.264 OPNET Model

‘generate’ state

- Schedule next packet arrival based on GOP
- Six interrupts
  - ⇒ One for each packet type
  - ⇒ One to go to stop
- Calculate scene lengths



H.264 OPNET Model

GOP generator

- C commandline application
  - Possible GOPs
    - IBBPBBP..PBBI (MPEG2)
    - ..PBBPBBIBB (MPEG2 transmission order)
    - IPI (real-time H.264)
    - IPP…PI (offline H.264)
    - IPBPB..PBI (offline H.264)
    - More GOPs are possible by configuring parameters
- OPNET Modeler
  - Replace "*printf*" with "*appropriate command to schedule a packet* "

H.264 OPNET Model

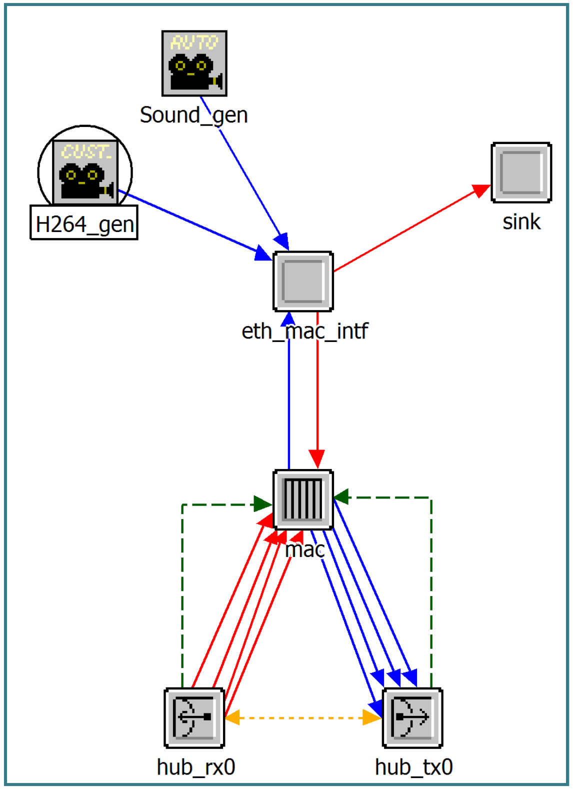
Node model design

- Adapted "*ethernet_station_adv*"
  - "*H264_gen*"

    H.264 video source

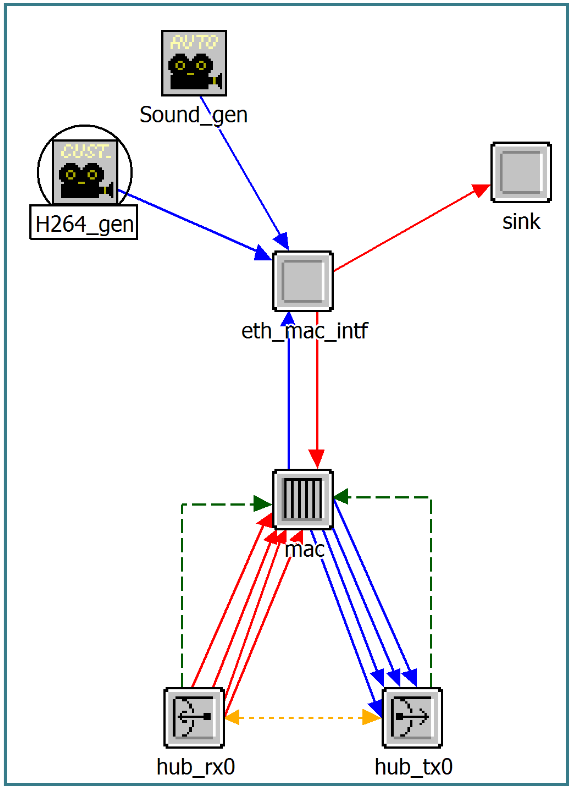
  - "*Sound_gen*"

    e.g. 'MP3 @128Kbps'
    - Packet size: 500 Bytes
    - Interarrival time: 32^{-1}s
    - Uses "*simple_source*" model



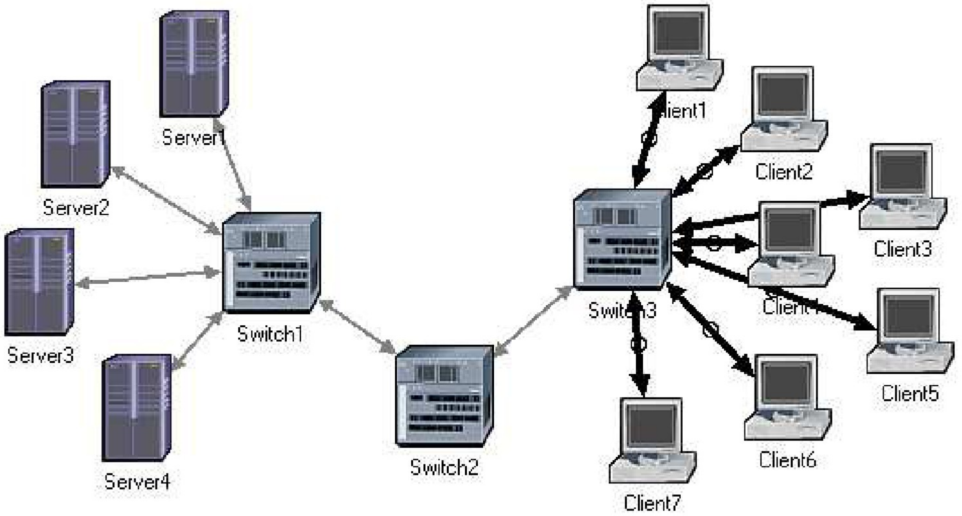
H.264 OPNET Model

- Node model design
  - Changes to process model
    - Packet segmentation
    - Standard 1500 byte (ethernet MTU)
    - Configurable
  - Limitations
    - No higher OSI layers supported
    - Packet-header overhead



Simulation Scenarios

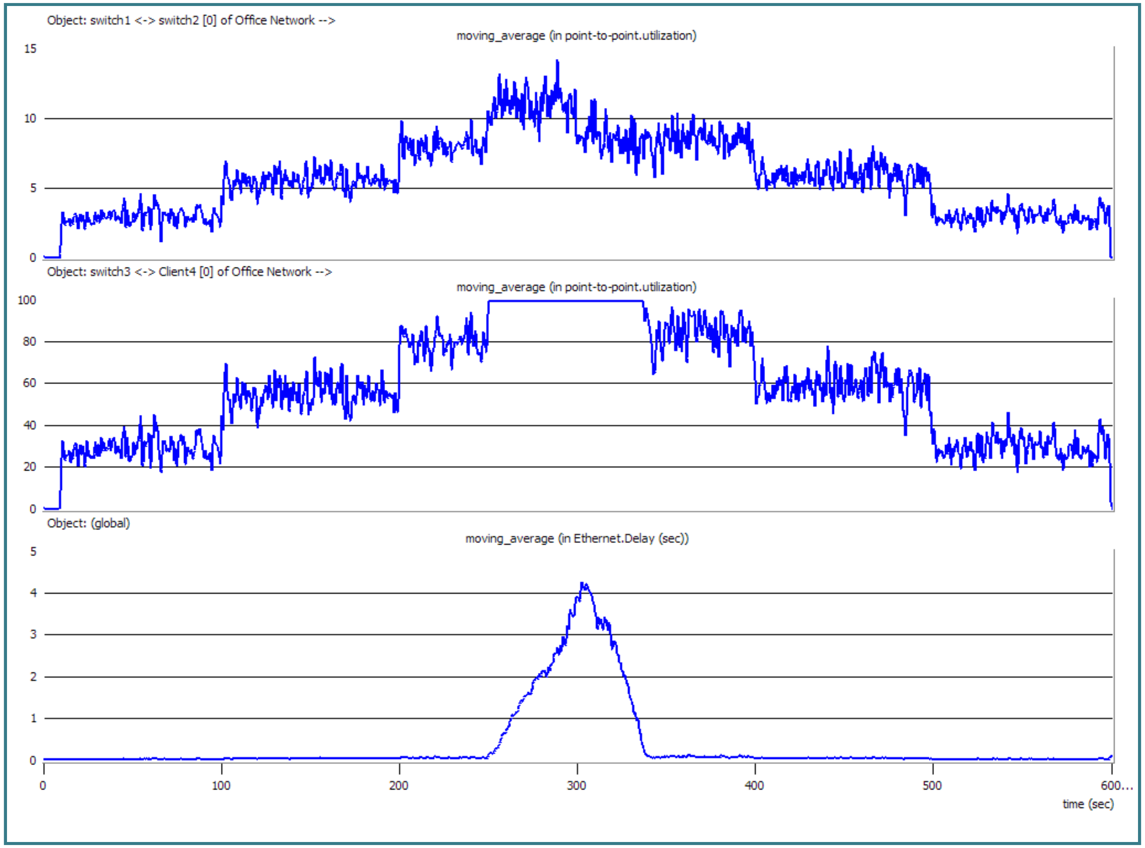
Switched Ethernet



- 4 servers
- 7 clients
- 10 Mbps links (Thick arrows)
- 100 Mbps links (Thin arrows)
- Variable start/stop times for the servers

Simulation Scenarios

- Switched Ethernet



H.264 OPNET Model

Conclusion

- Process model works as expected
- Node model can be applied in many environments
- Any Audio/Video stream can be configured
- Better node model possible
- Simulation results are as expected

• Ongoing / Future Work

– Model Validation @ VRT (Flemish TV Broadcaster)
  - Extend model for further analysis
  - Compare model to real world test results
  - Simulate networks using real traffic traces vs traffic model simulations

– Scalable Video Coding over Wireless LAN
  - Influence of packet-loss on PSNR

Thank you for your attention!

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