Delay Analysis of Unicast Video Streaming over IEEE 802.11 WLAN Networks

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Outline

- Multimedia Streaming
  - MPEG-4
  - Hint Tracks
  - Video Analysis
- Experimental test-bed
  - Test set-up
  - WLAN Probe
- Resource Usage
- Delay Analysis
- Conclusions
- Future Work

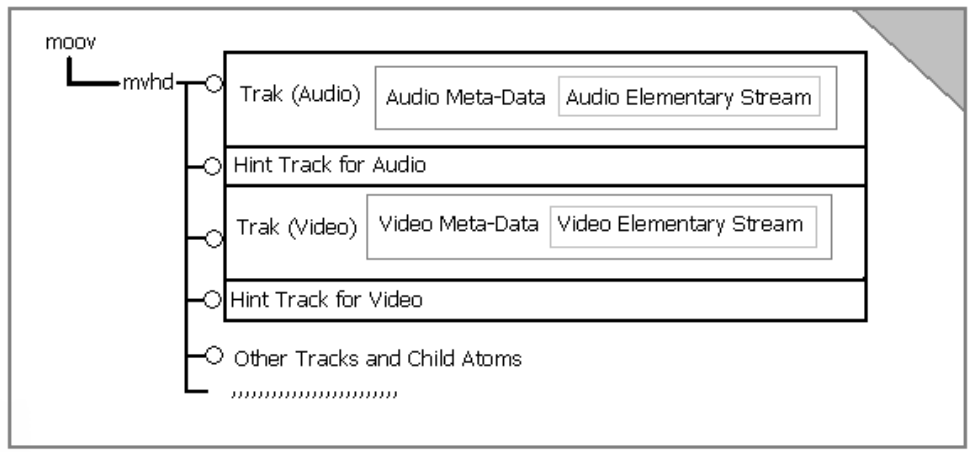
Variables in Multimedia Streaming

- Content and Complexity of the content
  - Affects the efficiency of the encoder to compress the stream, for example animation clips.
- Compression scheme being used
  - Differing levels of efficiency and target applications. i.e. MPEG-2, MPEG-4, H.264
- Encoding configuration
  - Frame rate,
  - I-frame rate,
  - Quantization parameter,
  - Target bit rate (if any) supplied and
  - Target stream type i.e. VBR, CBR or near CBR.
- Packetisation scheme
  - If the file to be streamed is .MP4 or .3gp, then a hint track must be prepared that indicates to the server how the content should be streamed.
- The streaming server being used
  - Rate control adaptation algorithm being used, and the methods of bit rate adaptation used by the server.

MPEG-4

- In the MPEG-4 standard, there are a number of profiles.
- Profiles determine the capabilities of the player to play out encoded content.
  - Codec only needs to implement a subset of the MPEG-4 standard whilst maintaining inter-working with other MPEG-4 devices built to the same profiles.
- Two main profiles: Simple Profile (SP) and Advanced Simple Profile (ASP) and are part of the non-scalable subset of visual profiles.
- MP4 files contain a number of tracks (media tracks and hint tracks).
  - A *trak* represents a single independent data stream and an MP4 file may contain any number of video, audio, hint, Binary Format for Scenes (BIFS) or Object Descriptor (OD) tracks.
- Hint tracks are required to stream MP4 and .3gp files.

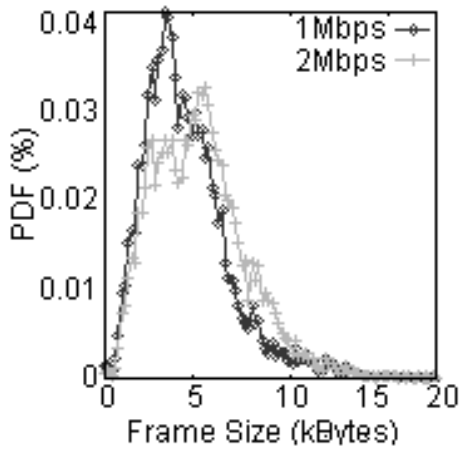
Hint Tracks

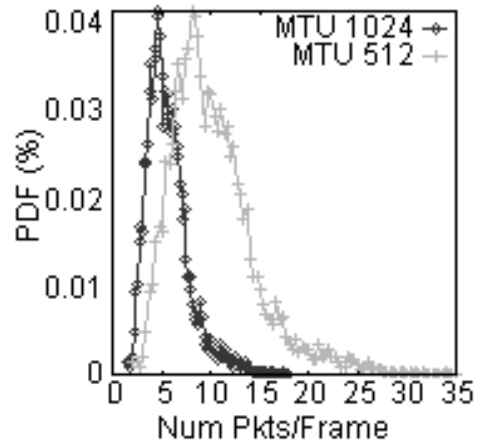


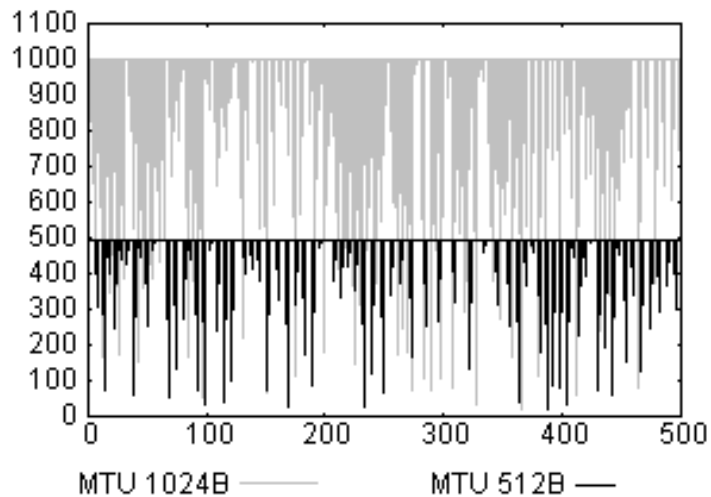
- Each track in a media file is sent as a separate stream.
- Each sample in a hint track tells the server how to optimally packetise a specific amount of media data.
- Reduce processing on server.

Video Details/Analysis

- X4Live MPEG-4 encoder from Dicas.
- CIF display size.
- Duration 5min
- MPEG-4 SP
- 2-pass encoding
- Hinted MP4Creator, M4IF

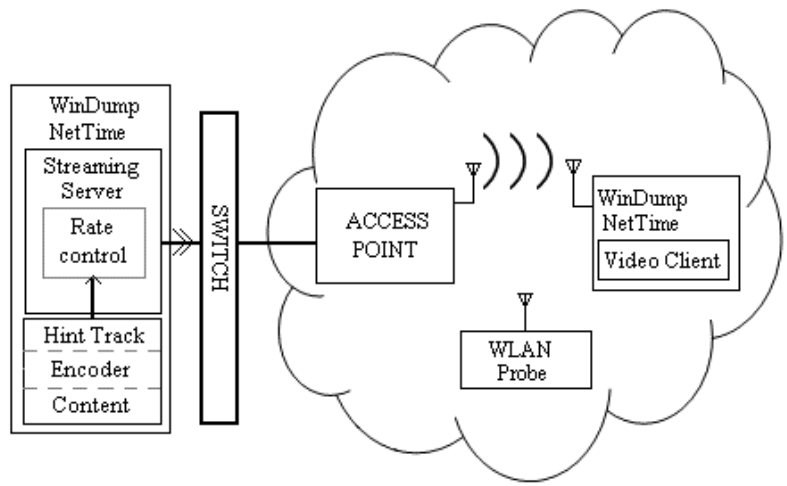






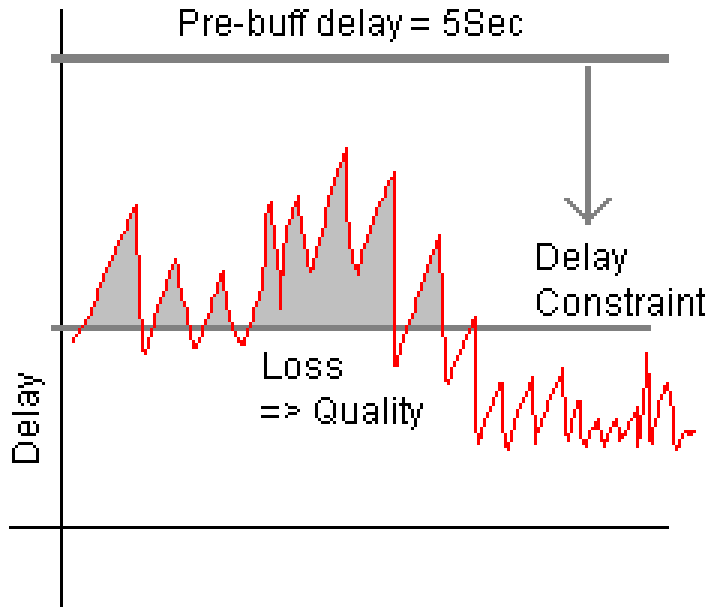
Test-bed

- Darwin Streaming Server (DSS)
  - Compliant to MPEG-4 standard profiles, ISMA streaming standards and all IETF protocols.
  - RTP/UDP/IP stack with RTCP/UDP/IP with RTSP.
- Playout Delay
- WinDump
  - Promiscuous capture of all RTP/UDP/IP packets at both client and server.
- NetTime
  - Clock sync
  - Skew removal using Paxsons alg.
- MGEN

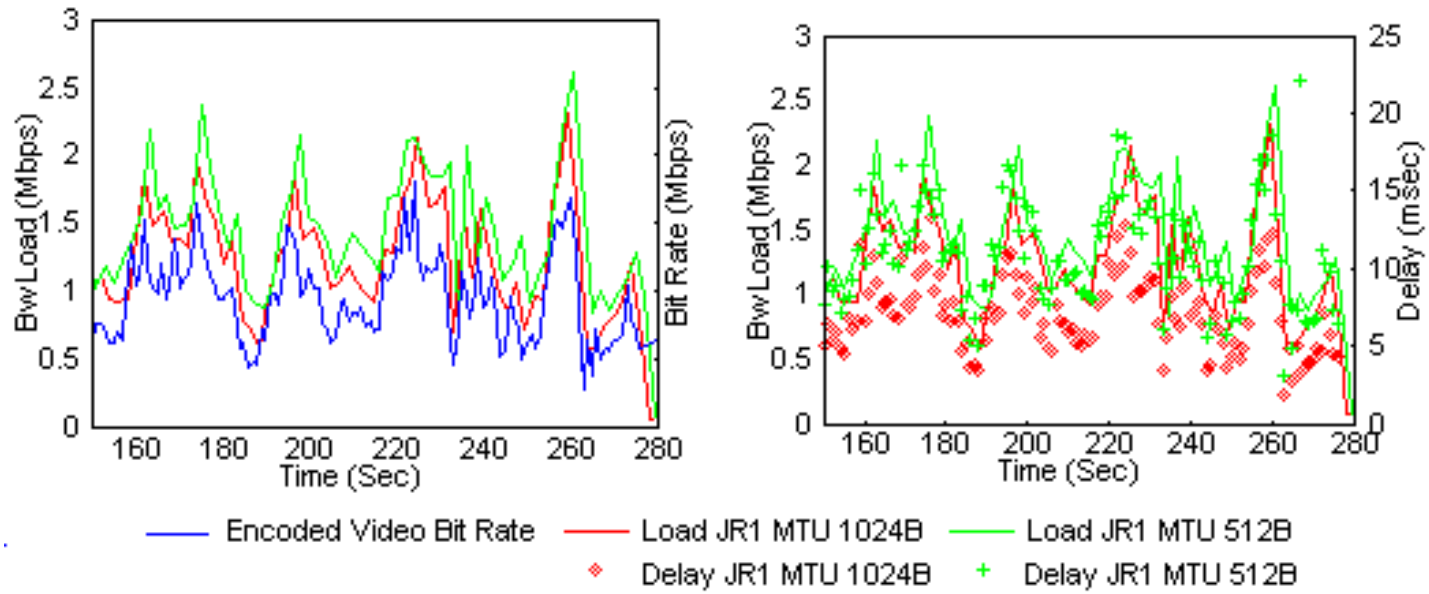


Playout Delay

- Need to isolate the streaming application from adaptation algorithm.
- Use large pre-buffering delay.
  - Ensure no adaptation.
- From delay measurements and setting playout delay constraints, we can find the packet loss rates.
- Statistical analysis
  - Quality of Delivery (QoD)
  - 3gpp



Resource Usage Variations

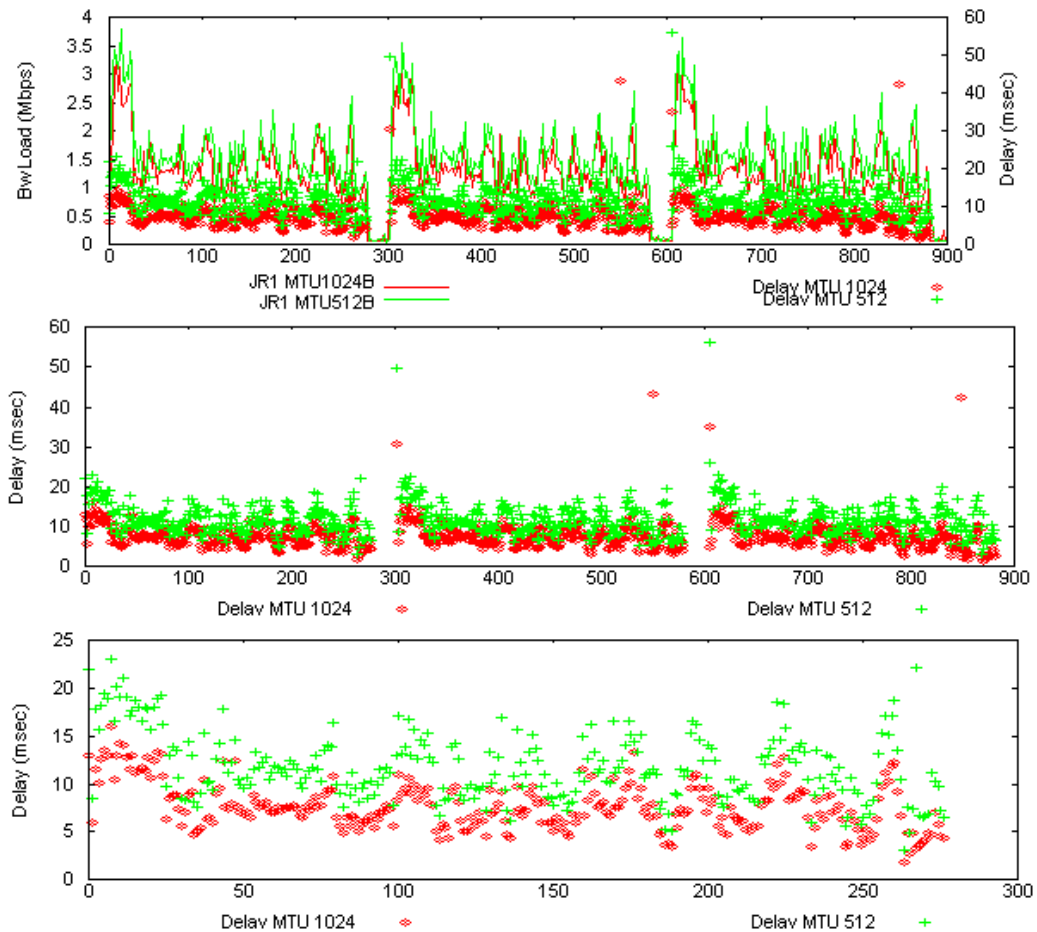


- Relationship of bitrate variations of video and resource usage
- Relationship of bitrate variations and mean end-to-end delay

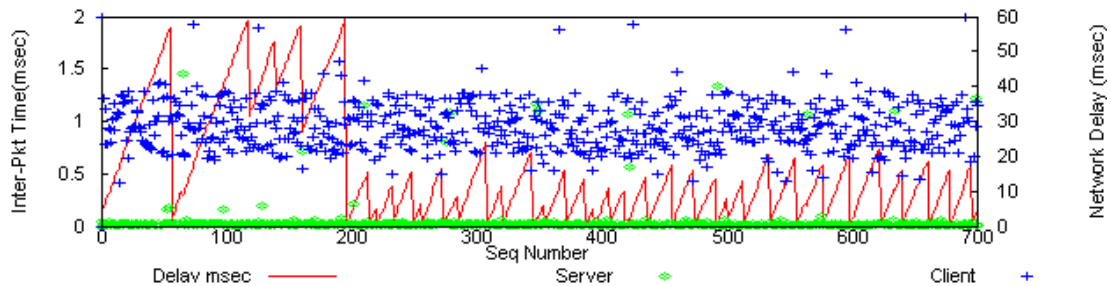
Summary Resource Usage Data

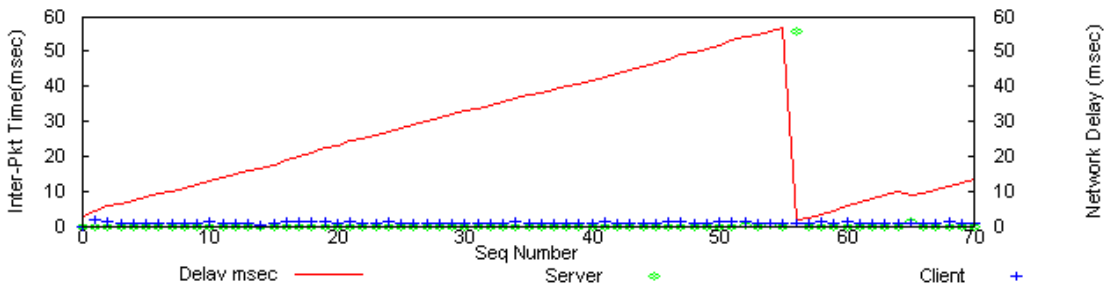
Mean Resource Usage								
Clip	**MTU 1024B**				**MTU 512B**			
	Access Efficiency	**BW_{ACCESS} (Mbps)**	**BW_{LOAD} (Mbps)**	**Ratio BW_{LOAD} BitRate**	**Access Efficiency**	**BW_{ACCESS} (Mbps)**	**BW_{LOAD} (Mbps)**	**Ratio BW_{LOAD} BitRate**
JR1	2.145	0.585	1.289	0.816	1.367	1.097	1.489	0.706
JR4	2.155	0.583	1.286	0.827	1.369	1.131	1.531	0.695
JR5	2.136	0.574	1.260	0.841	1.368	1.091	1.471	0.720
JR6	2.133	0.572	1.251	0.810	1.363	1.076	1.456	0.696
JR7	2.112	0.542	1.190	0.848	1.370	1.076	1.457	0.692

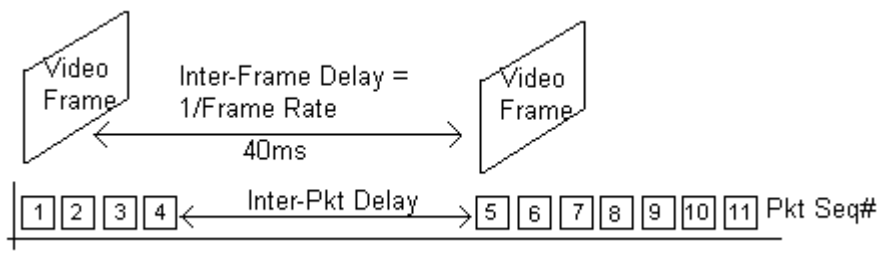
Delay Analysis (1)



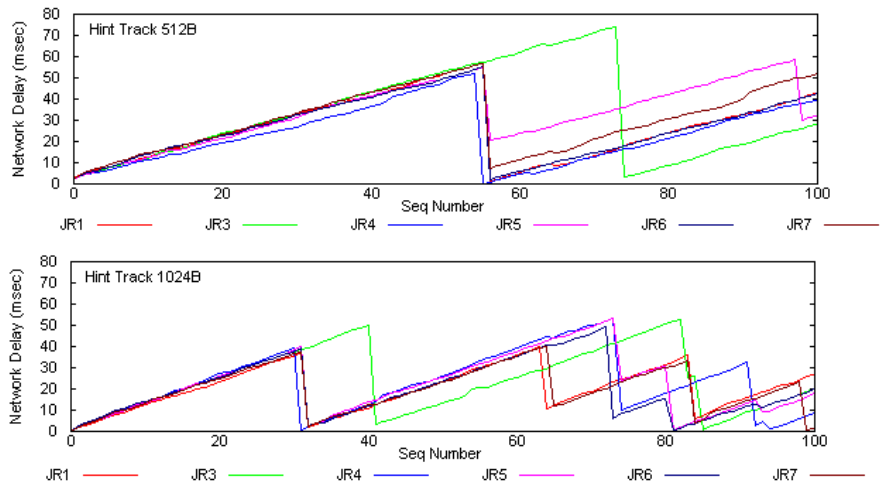
Delay Analysis (2)







Different Video Files



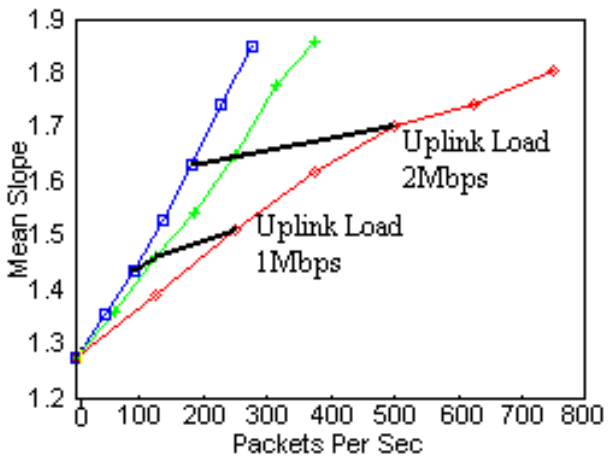
- Same characteristics regardless of encoding configuration.

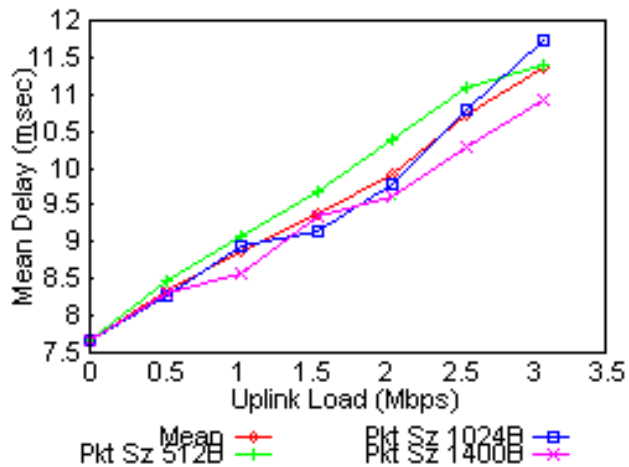
Summary Delay Data

Mean Delay Burst Details								
Clip	MTU 1024				MTU 512			
	Delay Slope	Mean Delay (msec)	Mean Max Burst Delay (msec)	Pkts/Burst	Delay Slope	Mean Delay (msec)	Mean Max Burst Delay (msec)	Pkts/Burst
JR1	1.27	7.69	13.42	10.0	0.96	11.82	19.77	17.7
JR4	1.27	8.08	13.68	10.0	0.96	12.33	20.06	17.9
JR5	1.27	7.66	13.45	9.8	0.96	11.44	19.44	17.3
JR6	1.27	7.38	13.15	9.6	0.96	11.26	19.75	18.4
JR7	1.26	6.79	9.69	6.8	0.96	11.24	19.92	18.6

Delay Variations with Background Uplink Load

- Preliminary results of mean delay variations with increasing uplink load and pkts/sec.

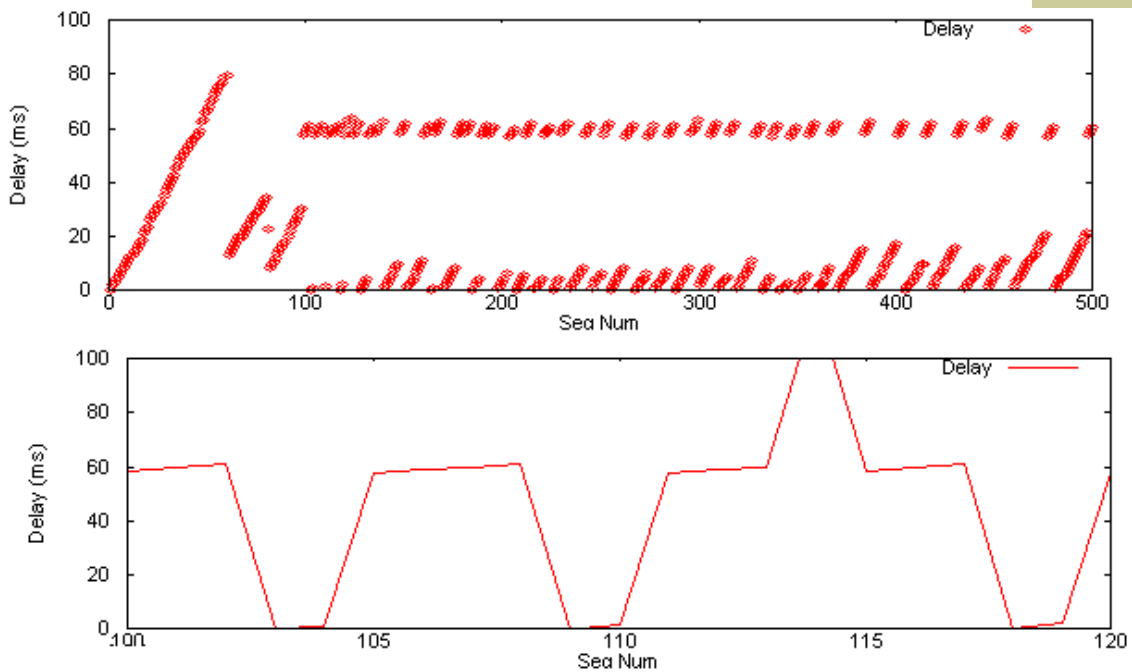




Conclusions

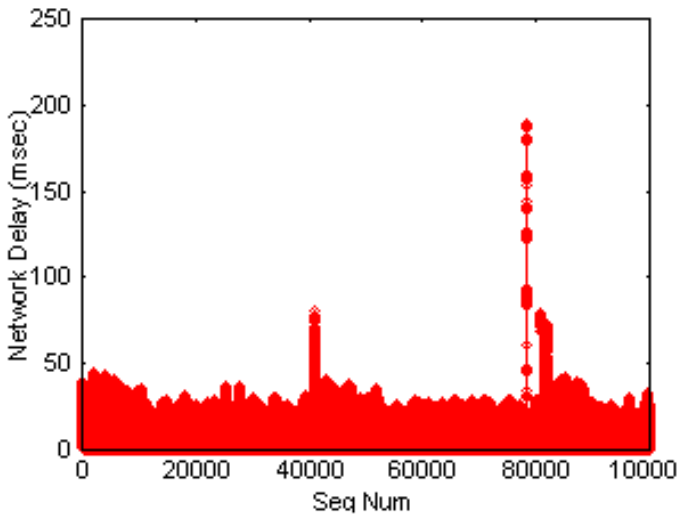
- Relationship between video bit rate, packetisation scheme, bandwidth load and mean delay.
- Frame based nature of video results in packet bursts.
- These bursts cause the per-packet delay to increase in see-saw manner.

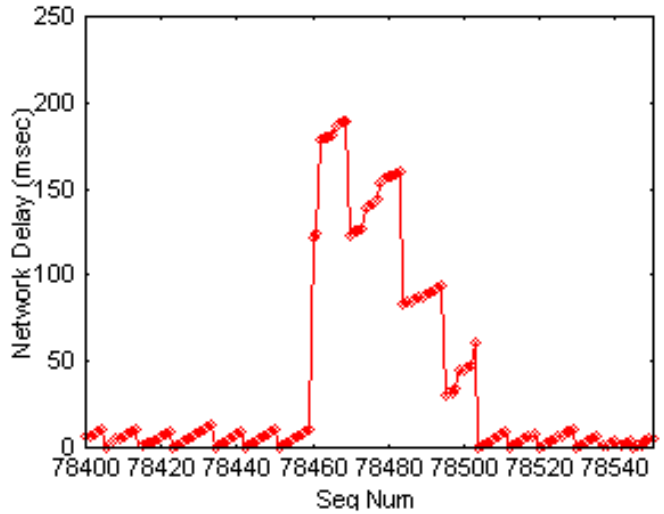
Future Work (1)



- Analysis of the effects of contention and load on delay.
- Finish analysis of delay variations with increasing uplink load with varying packet rates and number of STA creating the load.
- Interleaving traffic on downlink.

Future Work (2)

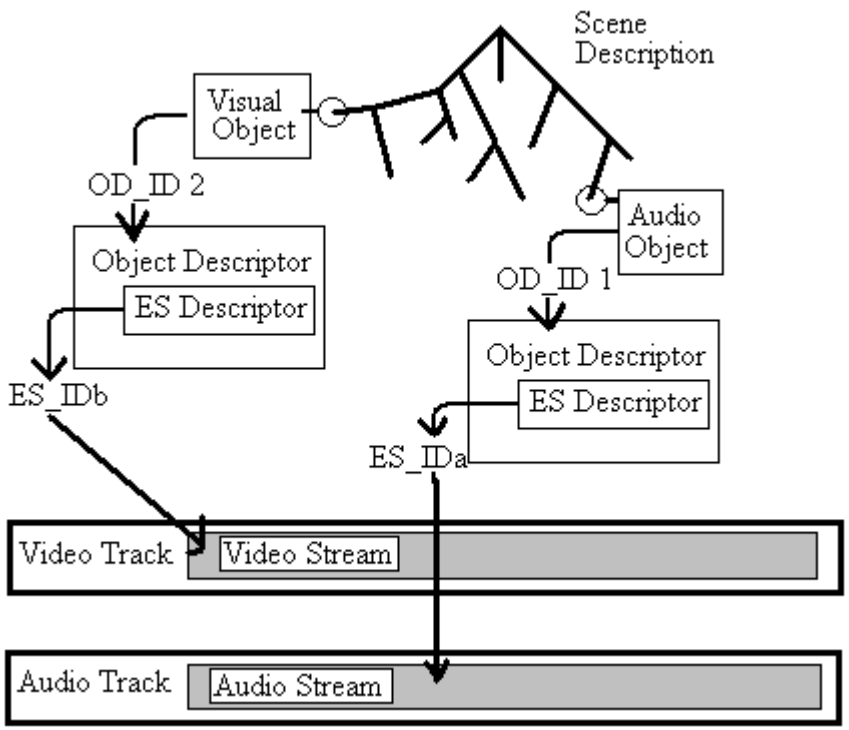


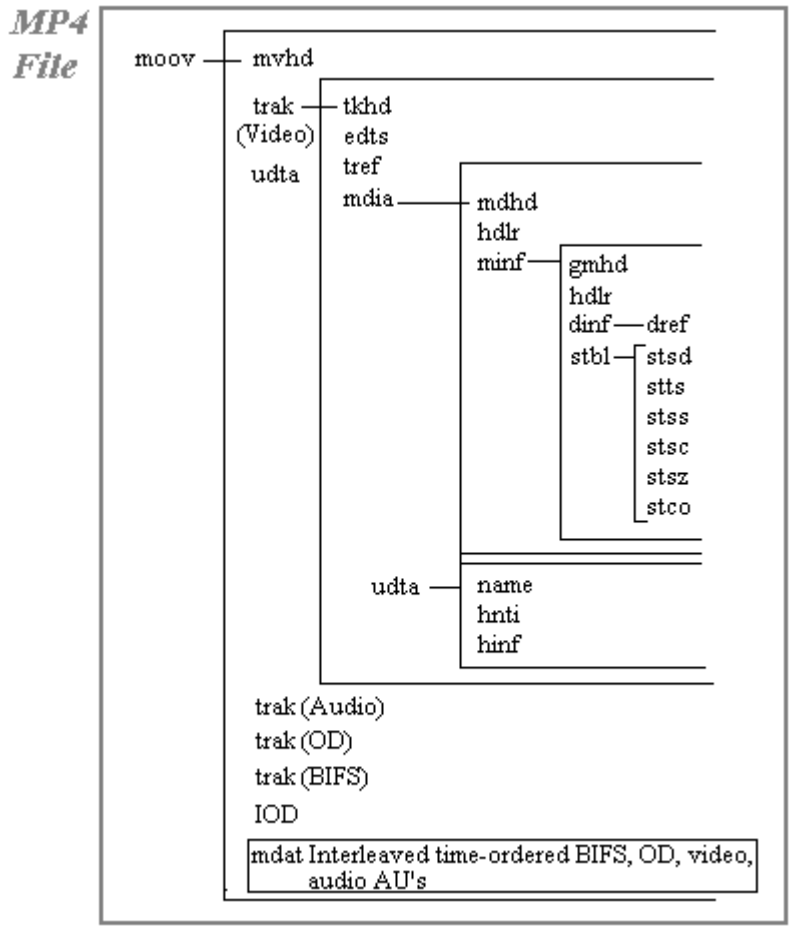


- Analyse rare events

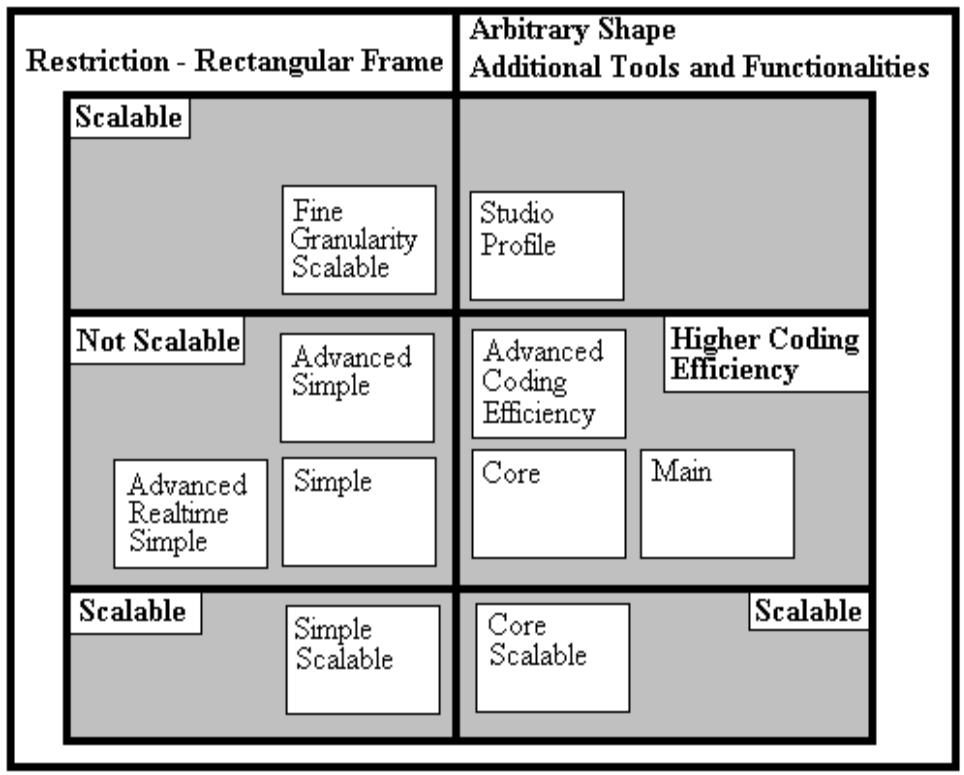
Extra Stuff

MPEG-4 Structure



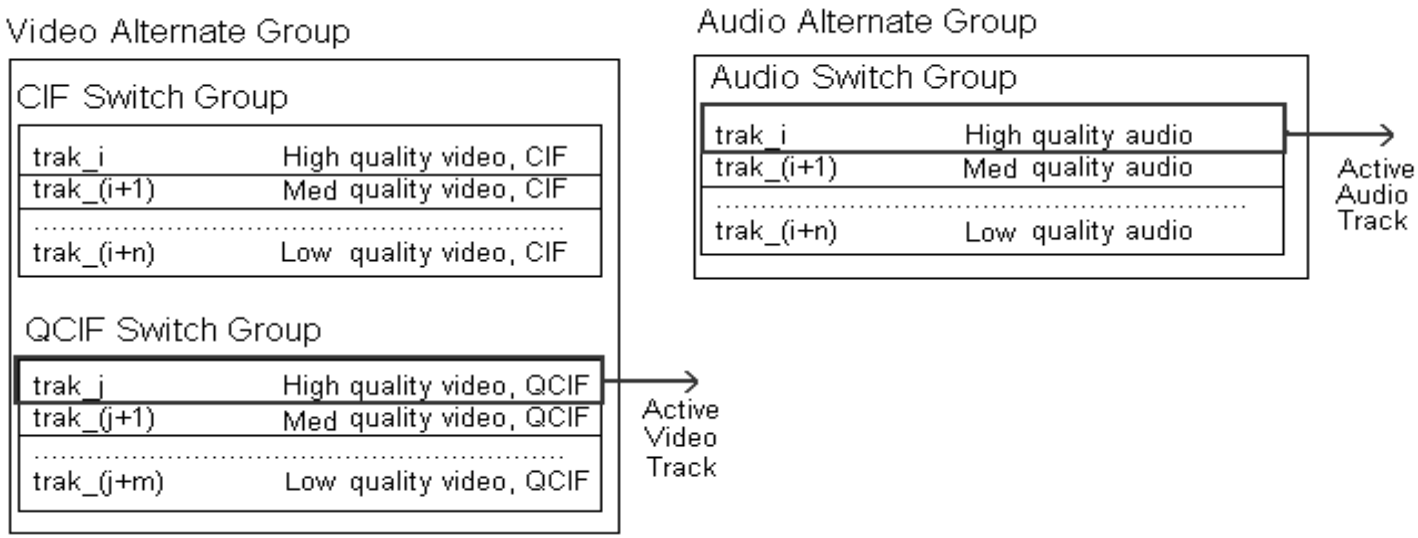


MPEG-4 Profiles



Multi-tracked/3gp Content

- Hint tracks



3gp Content

- Developed for the ***creation, delivery and playback*** of multimedia over ***wireless networks on a variety of devices***.
- 3gp is based on ISO base file format upon which MPEG-4 is based.
- ***Wrapper or container file*** supporting:
  - MPEG-4, H.263, H.263+
  - Advanced Audio Coding (AAC) and Adaptive Multi-Rate (AMR)
  - Timed text tracks.
- Media consists of a ***hierarchy of atoms*** containing ***meta-data and media data.***
  - (3gp has new user data atoms defined by DoCoMo – Copyright, Author, Title and Description)
- Tracks consist of a single independent media data stream.
- Each media stream must have its own ***Hint Track.*** Hint tracks support streaming by the server and indicate how the server should packetize the data e.g. MTU, sample durations

3gp Profiles

- 3GP files may conform to one ore more profiles but it is not mandatory.
- ***Basic profile*:** The 3GP Basic profile is used in MMS and PSS. This profile guarantees the server to inter-work with MMS, as well as the 3GPP file format to be used internally within the MMS service.
- ***Streaming server profile*:** This profile allows interoperability between content creation tools and streaming servers, in particular for the selection of alternative encodings of content and adaptation during streaming.

3gp Structure

- ***Groupings of alternative tracks***: Tracks that are alternatives to each other can be grouped into an alternate group. Tracks in an alternate group that can be used for switching can be further grouped into a switch group.
- ***Alternate group***: Only one track within an alternate group should be streamed or played at any time and must be distinguishable from other tracks in the group via attributes such as bit rate, codec, language, packet size etc.
- ***Switch group***: Tracks that belong to the same switch group, belong to the same alternate group.
- ***Hint tracks***: All media tracks must have their own associated RTP hint track.