

# Analysis of Managed and “Over-The-Top” Streaming Services in Mobile Networks

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- Measurement Setup

- Results of Study of Streaming Services

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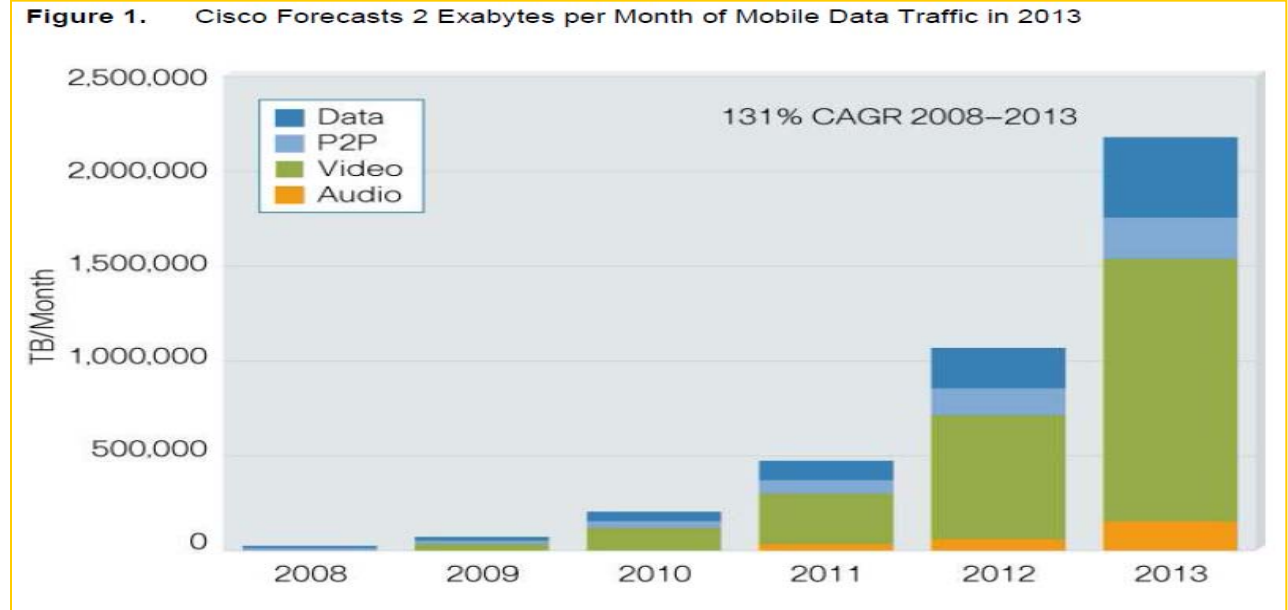
  - OTT Services

  - Data Rates

- Conclusions




# Motivation

- Streaming traffic will considerably increase
- it will be the dominant traffic type in the next years (~ 50%)



- High QoE for streaming services is important for users satisfaction
- Streaming server use variable bit rate transport to stream media
  - ➔ use of GBR bearer with GBR set to peak rate would waste resources
- Transport of streaming media via non-GBR bearers may impact during high load / congestion
- ➔ Suitable mechanisms are required to efficiently support streaming services

# Motivation

- Understand behavior of streaming services
- “Study of streaming services” performed by VTT
  - Study includes analysis of streaming services
    - **Managed services:** provided by mobile network operators
    - **OTT:** provided by service providers via Internet
  - Analysis includes streaming services provided by mobile network operators (Managed Services) in
    - Great Britain 
    - Spain 
    - Germany 

# Measurement Setup

- Several device and connection types have been used
  - Symbian (S60; S^3), Android (2.2; 2.3), iOS4, Windows XP (LifeBook)



E 72



C 7



Galaxy Tab



Nexus



iPhone



LifeBook

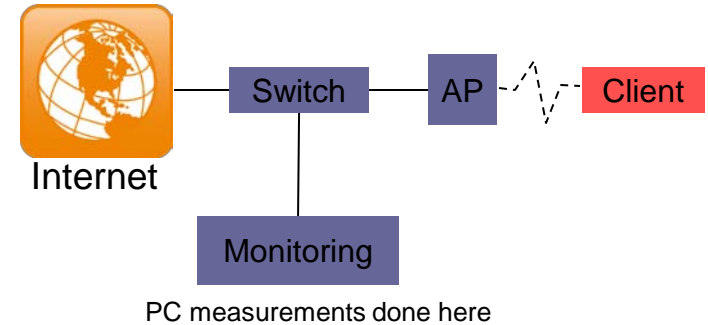
- Measurements were performed over different networks (WLAN, 3G of different operators)
- When direct measurement was not feasible, traffic was captured, re-played and analyzed
- Media Information:
  - **Managed services:** Media information has been extracted from Session Description Protocol (SDP)
  - **OTT services:** The media was carved out of captures and then analyzed
  - Extracting media information for OTT services was not always feasible, e.g. due to encryption of data
- To study availability of adaptation mechanisms: Capacity of the last hop was artificially limited

# Measurement Setup

- WLAN: Mirrored traffic was collected and measured on a PC using Wireshark and Qosmet
- 3G/HSPA: Collected the results on the end devices themselves
- Measurement tools to capture and measure:
  - Wireshark (on PC)
  - Shark + tcpdump (on Android)
  - Qosmet - VTT's passive monitoring tool to measure IP- and application-level metrics
    - <http://www.cnl.fi/qosmet.html>

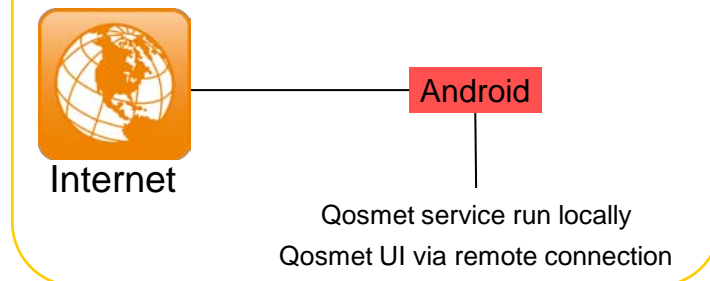
## Setup for measurements over WLAN

### all platforms

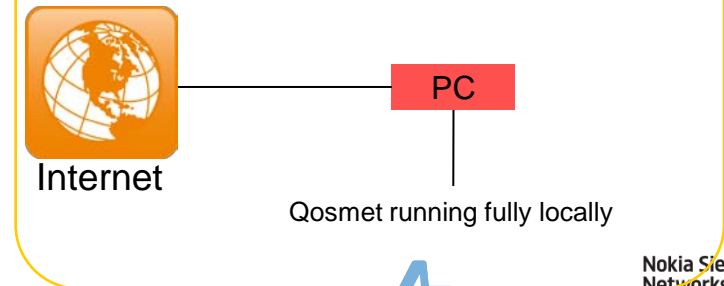


## Setup for measurements over 3G

### with Android devices



### on PC



# Streaming services under study

Streaming services provided by the operator  
- managed streaming services -

Streaming services provided over the Internet  
- over-the-top (OTT) streaming services -

# Managed streaming services

## Studied service providers

<b><i>Service Name</i></b>	<b><i>Country</i></b>	<b><i>Provider</i></b>	<b><i>Protocols</i></b>
Digital+ Mobile TV	Spain	Orange	RTP/UDP + RTSP + RTCP
MobileTV	Germany	T-Mobile	RTP/UDP + RTSP + RTCP
Three Free Video	U.K	Three	RTP/UDP + RTSP + RTCP
Virgin 3G VoD	U.K	Virgin	RTP/UDP + RTSP + RTCP

### Observation:

- Managed streaming services use RTSP as control protocol
- Streaming media are transported via RTP/UDP

# Managed streaming services

## Characteristics

<b><i>Service Name</i></b>	<b><i>Bitrate (kbps)</i></b>	<b><i>Resolution</i></b>	<b><i>Encoding</i></b>	<b><i>RR frequency</i></b>
Digital+ Mobile TV	250--290	640x480	H.264 + MP4-LATM	1 second
MobileTV	60--225	320x240	H.264 + MP4-LATM	5 seconds
Three Free Video	110	144x176	MP4V + AMR	1 second
Virgin 3G VoD	193	320x176	H.264	1 second

### Results:

- RTCP sender and receiver reports are exchanged periodically between client and server
- Frequency of reports is higher than recommended by RTCP spec. (~1s for several services)

# OTT streaming services

OTT streaming services offered via the Internet use different streaming protocols:

- RTMP
  - YLE Areena (streaming to PC) with application specific RTCP reports
- RTSP and RTP/UDP
  - TV services (e.g. Freebe.tv)
  - YouTube for mobiles (used by S60 only)
- HTTP
  - progressive download (e.g. YouTube)
  - adaptive streaming (e.g. MS SmoothHD, Apple HLS)

**Majority of video traffic in the Internet is streamed via HTTP**

# OTT streaming services using RTSP

## Characteristics

<b>Service Name</b>	<b>Protocols</b>	<b>Bit rate (kbps)</b>	<b>Encoding</b>	<b>Resolution</b>	<b>RR frequency</b>
BooxTV (s60)	RTSP + RTP/UDP				
Freebe.tv	RTSP + RTP/UDP + RTCP	~100	H.264	144x176	1 ps
YLE Areena	RTSP + RTP/UDP + RTCP	~100	H.264 + MP4-LATM	640x360	1 ps
YouTube (s60)	RTSP + RTP/UDP	80-310	MPEG-4 Visual	144x176	

### Results:

- No adaptation observed for OTT streaming services (though RTCP messages were sent)

# OTT streaming services using HTTP

## Characteristics

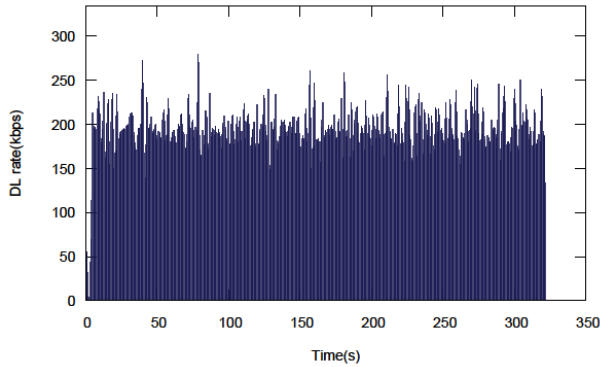
<b>Service Name</b>	<b>Protocol</b>	<b>Bit rate* (kbit/s)</b>	<b>Resolution</b>
Akamai iPhone Video Showcase	Apple HTTP Live Streaming		
BooxTV	HTTP	~150–500	320x176
CDOOn.com	MMS/HTTP		
Dailymotion	HTTP	~300–3000	512x288–1280x720
Facebook Video	HTTP	~500–2200	530x316–720x300
Livestream	HTTP	~250–1300	420x27–768x432
Vimeo	HTTP	~500–3100	640x360–1280x720
Vodder	HTTP	~520–1000	640x360
SmoothHD (Akamai/MS test)	MS Smooth Streaming		
YouTube	HTTP	~185–2120	320x240–1280x720

\*bit rates refer to mean values; different values are listed in case of different resolutions or adaptations mechanisms in place

# Data rates for RTSP-based Streaming services

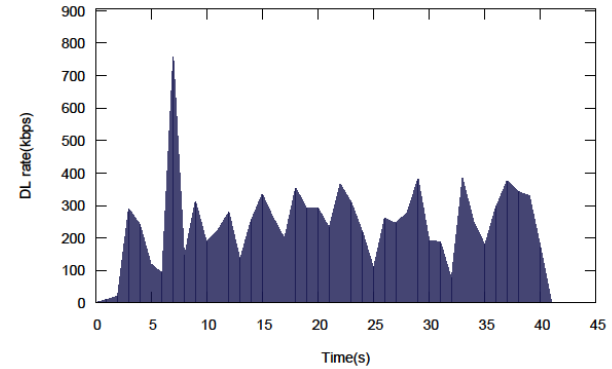
## Managed Services

Virgin Player Pass over 3G Heroes S1E1 Android SE XperiaArc 2011-07-05  
(avg = 190.07, stddev = 33.97)



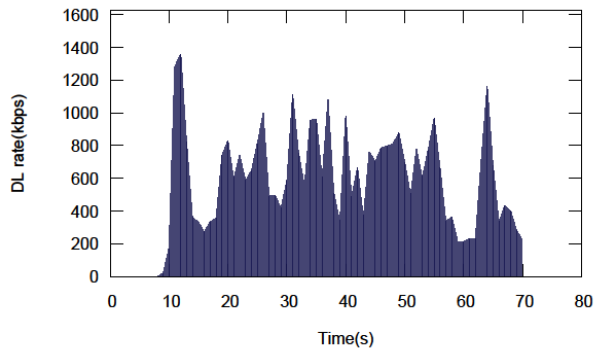
DL Rate  Virgin Player Pass (U.K.)

averages spain disney 1  
(avg = 203.17, stddev = 149.75)



DL Rate  Digital+ Mobile TV (Spain)

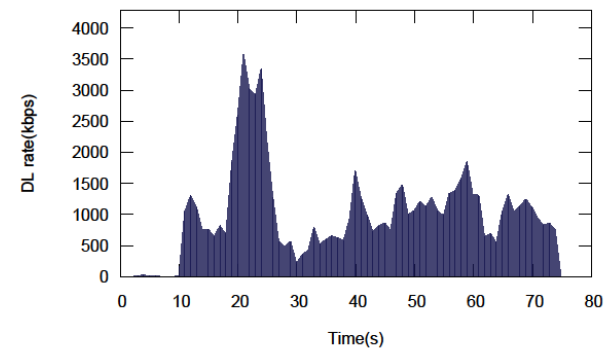
averages DNA 3G (CNL) YLE Areena, HQ, uutiset minuutissa, Android  
(avg = 498.78, stddev = 350.53)

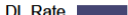


DL Rate  YLE Areena - Android (RTSP)

## OTT Services

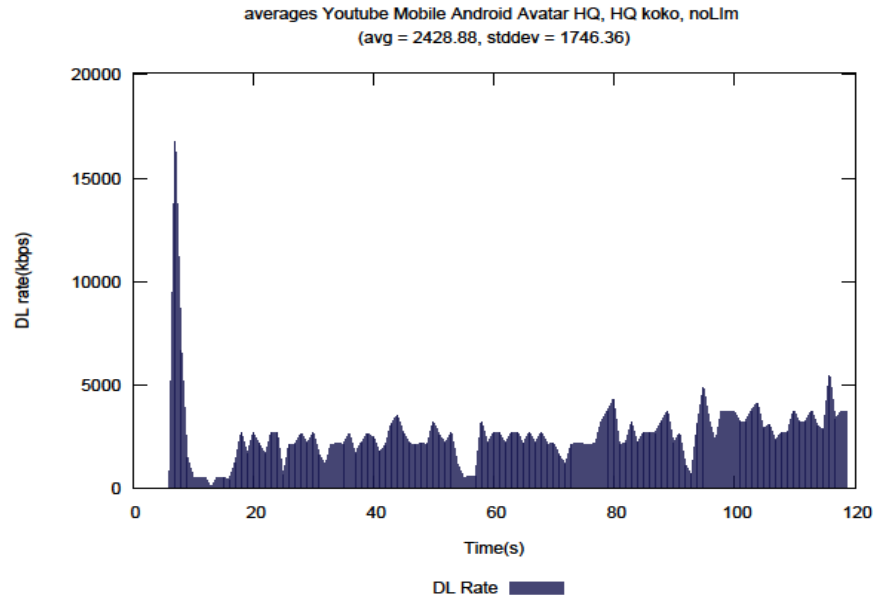
averages YleAreena mobiili HQ s60 uutisetminuutissa  
(avg = 887.47, stddev = 774.16)



DL Rate  YLE Areena - s60 (RTSP)

# Data rates for OTT streaming services via HTTP

- Media transmission via HTTP has variable transmission rates
- Transmission starts with very high-speed initial burst to fill buffer (aggressive initial buffering behavior)
  - YouTube buffers at least 8–12s of play-out time before starting playing
  - These bursts could cover between 20–100% of the video file, depending on video resolution and stream duration
- Transmission behavior is platform dependent



YouTube  
transmission



# Streaming services via RTSP/RTP

## Transmission characteristics

- Media transmission via RTP/UDP uses variable transmission rate (likely due to VBR encoding)
- Average throughputs correspond to the bit-rates announced in the SDP data on session initiation
- Rate adaptation could be provided due to exchange of receiver reports
  - adaptation by the server was not observed (cannot be ruled out, but hard to verify without being able to control the available bandwidth)
  - T-Mobile increases transmission rate (starts with low rate and then increases)

# OTT Streaming services

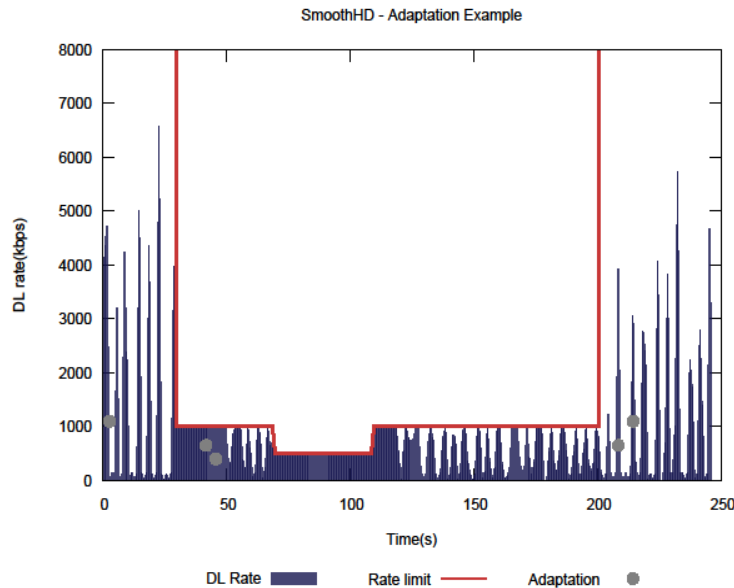
## Transmission characteristics

- Most streaming services do not have adaptation mechanisms built in (only 7 out of 18 tested)
  - Advanced mechanisms such as SVC are not yet implemented
- Some reactions to decreased bandwidth: pause, corrupted stream or stopped
- No device-specific adaptations recognized
- Exceptions: New HTTP-based streaming services adapt
  - MS SmoothHD (application is quite reactive - different bit rates requested)
  - Apple Lifestream (a bit slower reaction times)
  - see also next slide
- OTT streaming services based on RTSP showed variable data rates
  - but no adaptation could be recognized (though control packages were exchanged); Exception: YLE Areena
  - one service was streamed with a constant server rate even though the video bitrate is variable (Boox TV)

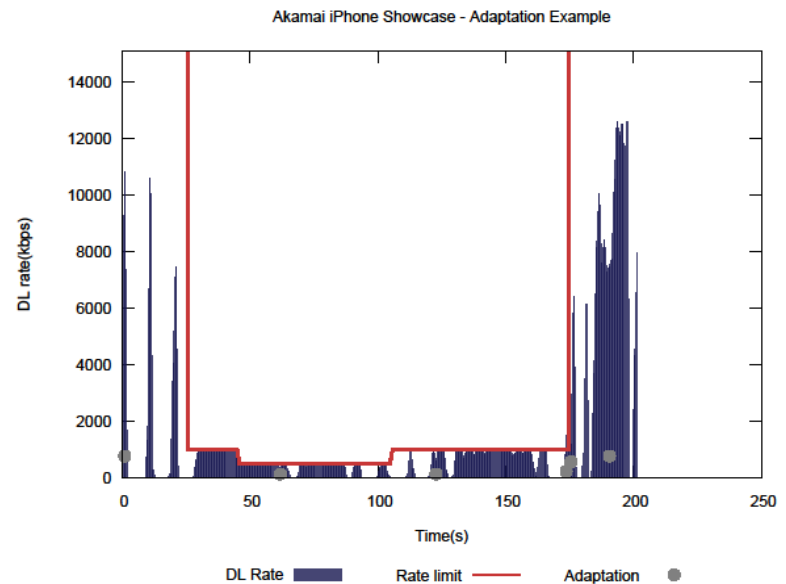
# OTT streaming services via HTTP

## Rate adaptation

- Rate adaptation requires adaptive HTTP streaming protocols like Microsoft Smooth Streaming or Apple's HTTP Live Streaming



Microsoft's SmoothHD streaming adaptation



Apple's HLS's adaptation mechanism

# Conclusions

## Managed streaming services:

- based on RTSP for control, RTP/UDP for media transmission and RTCP for the exchange of sender/receiver reports
- Media transmission uses variable transmission rate

## OTT streaming services:

- Most of them are based on HTTP; only few perform adaptation
- RTSP with RTP/UDP is also used by few OTT streaming services, e.g. for IPTV
- QoE is variable
- same content is available at several different resolutions from the same content provider (in most cases, this choice needs to be made by clients explicitly)

- Rate adaptation is not widely used up to date
- Rate adaptation might not be supported by all servers
  - → a network based adaptation solution could enhance resource usage
- Rate adaptation for streaming via HTTP (i.e. OTT) requires enhanced adaptive HTTP protocols, which are currently not widely deployed (only for test purposes),
  - → a network based solution could enhance resource usage also for those services
- Managed services do not show significant better performance compared with OTT services

# THANKS



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