

## A Qualitative Measurement Survey of Popular Internet-based IPTV Systems

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## Overlay Applications in the Internet

- Overlay networks emerged in the last years ...
  - File sharing: eDonkey, BitTorrent, Gnutella, ...
  - P2P-based VoIP: Skype
  - and others: gaming, VPNs, CDN Akamai, ...
  - Video-on-Demand and live TV streaming: Joost, PPLive, Zattoo, ...
- ... to overcome limitations of the Internet,
  - emulate multicast on application layer, not supported by underlay
  - efficient, scalable content distribution
  - easy deployment in complex environments
- ... and generate a large portion of Internet traffic !
  - P2P file sharing around 80% according to different ISPs
  - YouTube is about 10% - 20% of entire traffic volume

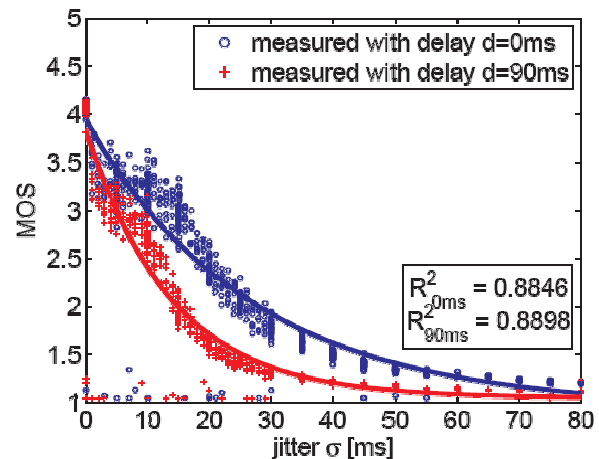
# QoE and Application Requirements

- ❑ Internet traffic transported according to a “best effort” approach
- ❑ However, some overlay applications such as IP-TV, VoD, VoIP, videoconference or gaming present strict requirements in terms of delay and/packet loss

## ❑ Quality of Experience

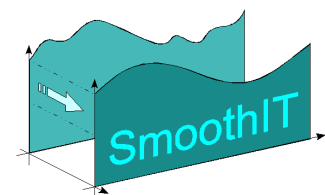
## ❑ Example: iLBC codec

T. Hossfeld, D. Hock, P. Tran-Gia, K. Tutschku,  
M. Fiedler  
*Testing the IQX Hypothesis for Exponential  
Dependency between QoS and QoE.*  
ITC Specialist Seminar, Karlskrona, 2008



## The SmoothIT Project

- Overlay applications and requirements: QoE++
- Operator's Point of View: Costs--
- New Approach for Overlay Traffic Management:  
combine QoE, Costs, Security through Incentives



Identify traffic characteristics and requirements

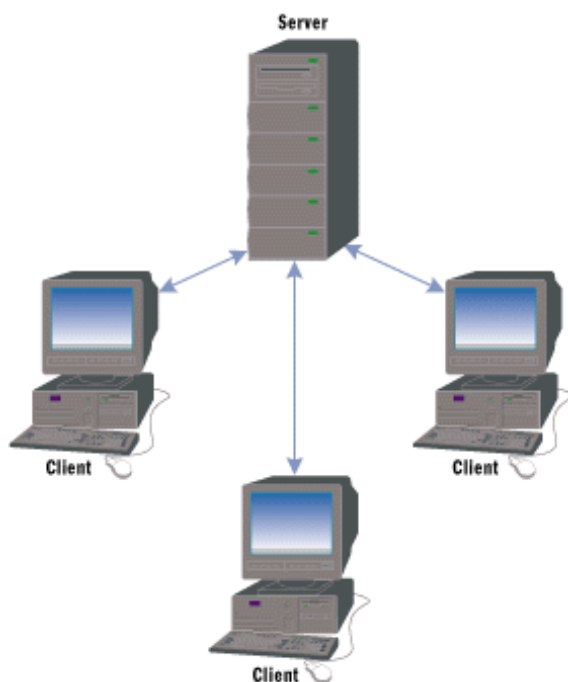
- for popular IPTV systems in order
- to assess parameters for good QoE
- to model IPTV for performance evaluation



- ▶ Classification by Architecture: Client/Server vs. Peer-to-Peer
- ▶ Overview of IPTV Types
- ▶ Measurement Results
  - Centralized Systems: OnlineTVRecorder, YouTube
  - P2PTV Systems: Joost, Zattoo, PPLive
  - Comparison
- ▶ Conclusions

## Problems in Centralized Systems

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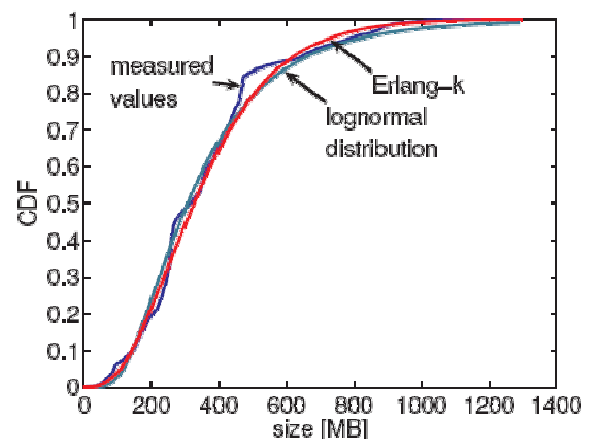
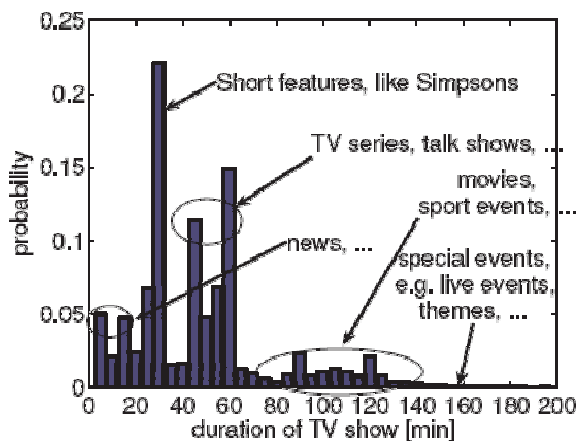


- ▶ Scalability
  - more services: multimedia, video, ...
  - millions of users
  - more required resources: bandwidth, memory storage, CPU
- ▶ QoS and QoE
  - jitter for video streaming
  - congestion due to flash crowd effects
- ▶ Flexible, adaptive, cheap network and service elements
- ▶ **Peer-to-Peer**

# Why using P2P for Live TV or Video-on-Demand?

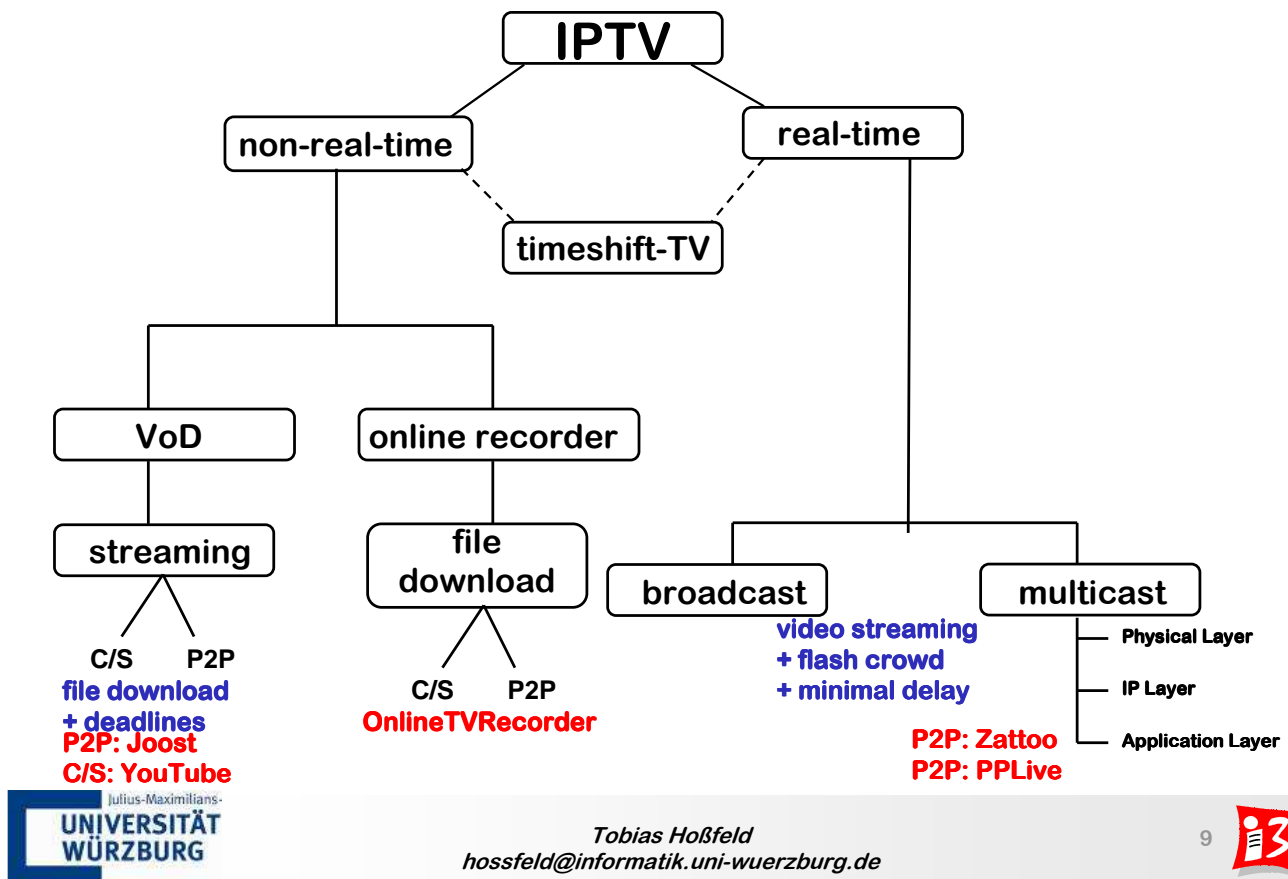
- ▶ P2P technology successfully applied in the Internet
  - BitTorrent, eDonkey: efficient exchange of large contents, even in flash crowd scenarios, **scalability**
  - Skype VoIP: smart, adaptive mechanisms (codec, bandwidth, application layer re-routing), **edge-based intelligence**
  - Distributed Hash Tables, e.g. Chord: efficient, robust lookup system, **self-organization** of nodes in structured overlays
- ▶ Reason for the success of P2P systems?
  - Popularity due to free applications → many users
  - Resources of users are utilized in system (bandwidth, memory usage, CPU power) → reliability & availability
  - High-speed Internet access (DSL), tariff models (flat rate)
- ▶ **How to use P2P technology for IPTV? Performance of P2PTV?**

## Example: OnlineTVRecorder



- ▶ on average 8.8 Mbyte/minute required
- ▶ storing contents for 20 TV channels of 1 week: 1.7748 TByte
- ▶ study of Goldmedia:
  - ▶ in 2010, world-wide number of subscribers is 60 millions
  - ▶ → 2.8160 TByte/s required to serve all users
- ▶ **P2P solution** requires per peer a capacity of 0.7395 MB

# Classification by Type of Content Distribution



## Outline

- ▶ Classification by Architecture: Client/Server vs. Peer-to-Peer
- ▶ Overview of IPTV Types
- ▶ Measurement Results
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  - P2PTV Systems: Joost, Zattoo, PPLive
  - Comparison
- ▶ Conclusions

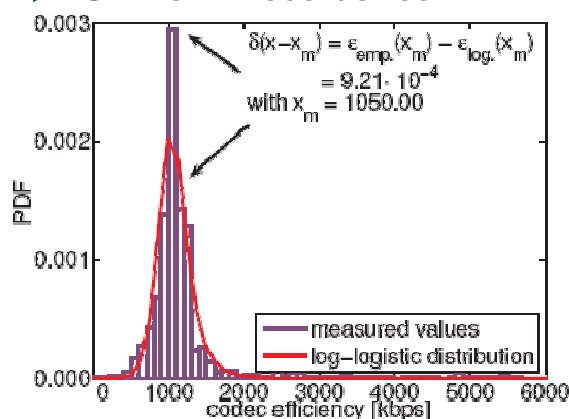
# Comparison of Centralized Systems

- ▶ **OnlineTVRecorder.com**
- ▶ web-based personal video recorder, storing contents online → download of files
- ▶ resolution: 512 x 384
- ▶ download: up to 1 Mbps via TCP from mirror servers
- ▶ business model: commercials during shows, tons of advertisements on servers, but service is for free!
- ▶ registration of users required
- ▶ **YouTube**
- ▶ video sharing web site with user-created contents → video-on-demand streaming
- ▶ resolution: 320 x 240
- ▶ download: 320 kbps via TCP

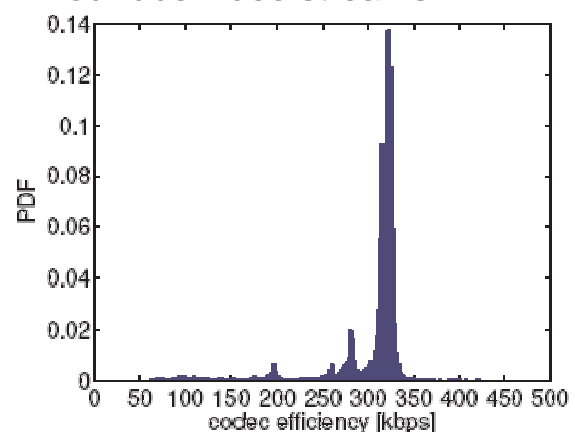


## Measurement Results for Centralized Systems

### ▶ OnlineTVRecorder.com



### ▶ YouTube video streams



		mean	std	CoV	skewness	kurtosis	median	min	max
<b>OTR</b> 11563 samples	duration [min]	47.21	29.27	0.62	1.14	4.42	45	1	195
	size [MB]	343.19	186.71	0.54	1.12	4.31	303.87	0.06	1236.87
	efficiency [kbps]	1155.01	662.93	0.57	7.33	86.05	1038.42	0.71	16310
<b>YouTube</b> 21014 samples	duration [s]	339.11	419.16	1.24	7.91	90.64	252	5	10233
	size [MB]	12.38	14.88	1.20	7.09	69.25	9.41	0.07	274.59
	efficiency [kbps]	302.11	52.43	0.17	-1.61	16.81	318.54	1.12	1040.52

- ▶ Analytical evaluations with **models based on measurement data**

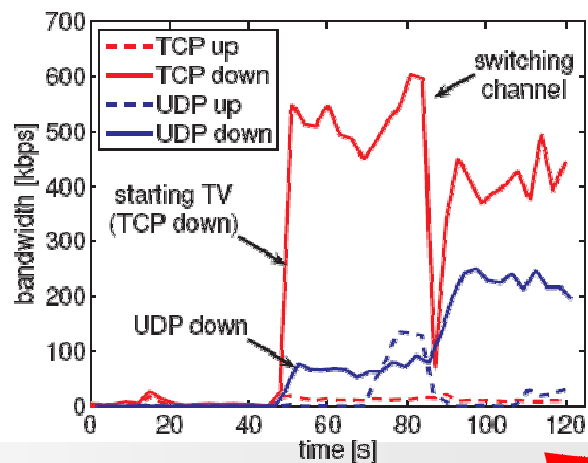
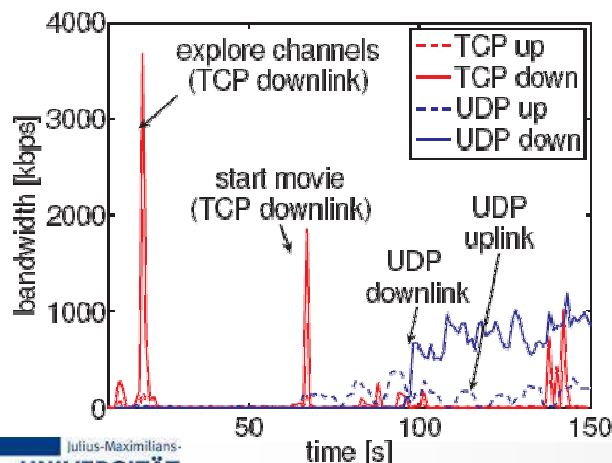




# P2P-based VoD and Live TV System

- ▶ **Joost Video-on-Demand**
- ▶ resolution: 720 x 576 (PAL)
- ▶ Down: 500kbps, Up: 70kbps
- ▶ TCP: 10kbps, UDP: 550kbps
- ▶ Server-assisted P2P: 50% uploaded by server here

- ▶ **Zattoo for live TV**
- ▶ resolution: 350 x 288
- ▶ Down: 560kbps, Up: 100kbps
- ▶ TCP: 580kbps, UDP: 100kbps
- ▶ supports 20 German TV channels



## Example: Measurement of Joost VoD

- ▶ Test PC in Würzburg: mainly connections to peers in Europe
- ▶ P2P downloads video from peer world-wide and resembles this



## Example: Zattoo Live TV

- ▶ license agreements, user groups according to content (channel, country regulation, also e.g. for eDonkey)
- ▶ group users in cluster, based on network topology



## Traffic Characteristics

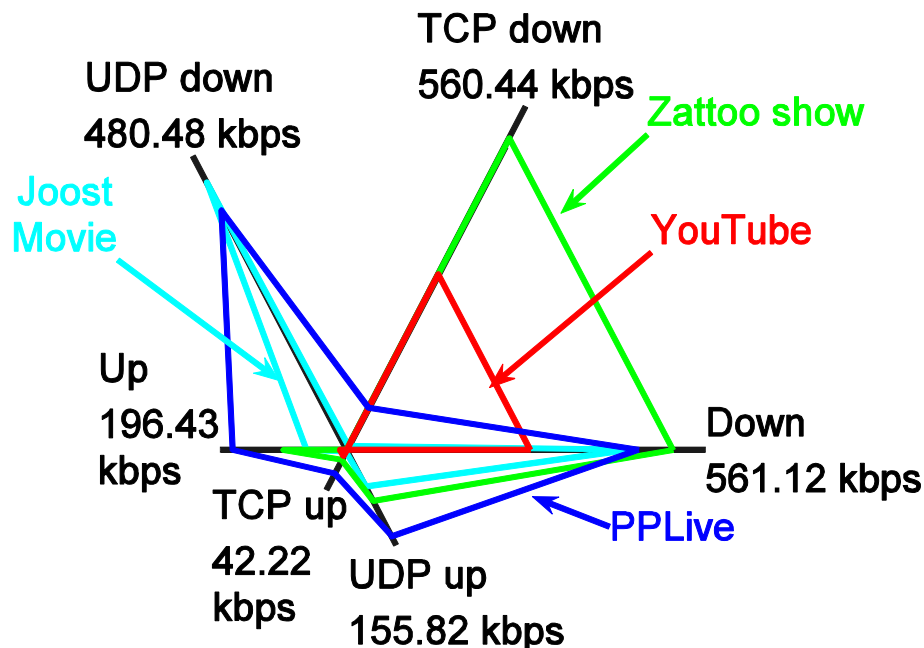
	TCP	UDP	up	down	TCP(up)	TCP(down)	UDP(up)	UDP(down)
Joost (short)	86.12	391.01	91.46	356.14	9.08	77.04	88.99	302.15
Joost Movie	9.85	546.75	69.24	487.08	3.02	6.82	66.32	480.48
Joost (Japan)	9.07	522.78	12.88	516.33	1.06	8.01	11.84	508.77
Zattoo (short)	285.15	104.27	28.68	359.51	11.44	273.71	19.06	86.83
Zattoo show	578.11	92.18	108.85	561.12	17.67	560.44	91.47	0.68
PPLive (short)	209.29	479.17	94.26	582.08	44.68	164.63	50.90	428.44
PPLive	117.95	586.80	196.43	502.29	42.22	75.75	155.82	430.95
PPLive (Japan)	159.73	547.79	196.69	509.95	42.15	117.59	154.58	392.73
YouTube	326.63	0.21	11.19	315.49	11.17	315.47	0.02	0.02

- ▶ Lot of numbers ...
- ▶ ... different kind of visualization !



# Comparison of Traffic Characteristics

- Application classification via observed shapes in spider plots



## Conclusions and Future Work

- Measurement from edge of popular, proprietary IPTV platforms
  - insight in topologies, protocols, bandwidths, ...
  - models for server-based systems for analytical evaluation
  - understanding P2PTV systems
  - traffic characteristics and requirements observed for QoE
- Future work
  - semi-analytical fluid models considering time-dynamics, user behavior, ...
  - quantification of QoE for IPTV applications
  - design of ISP-friendly, peer-assisted IPTV systems

# Thank You

