



Measurements of Multicast Television over IP



Kashif Imran
Marco Mellia
Michela Meo

*presented by
Michele Petracca*



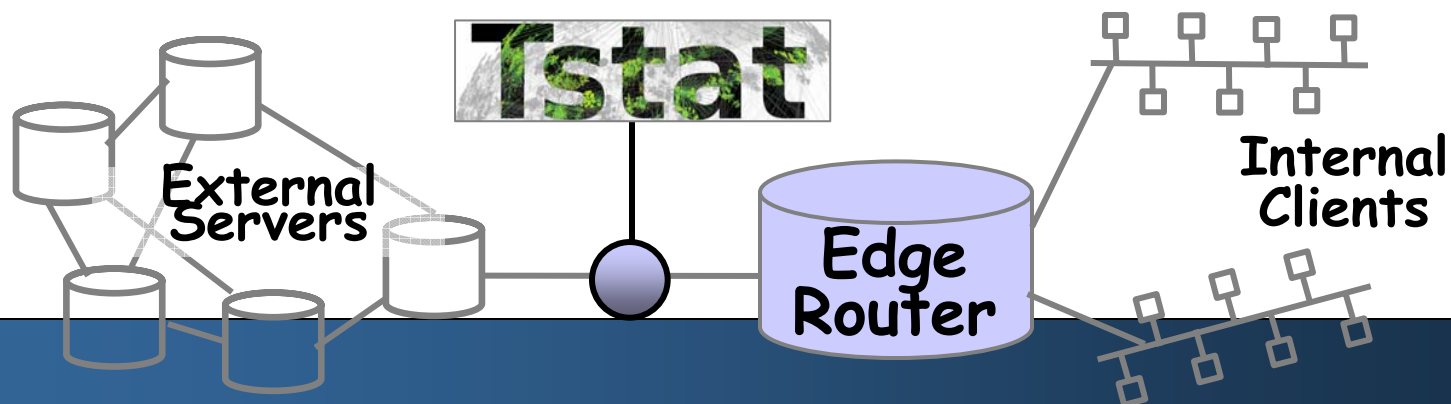
Traffic Measurement



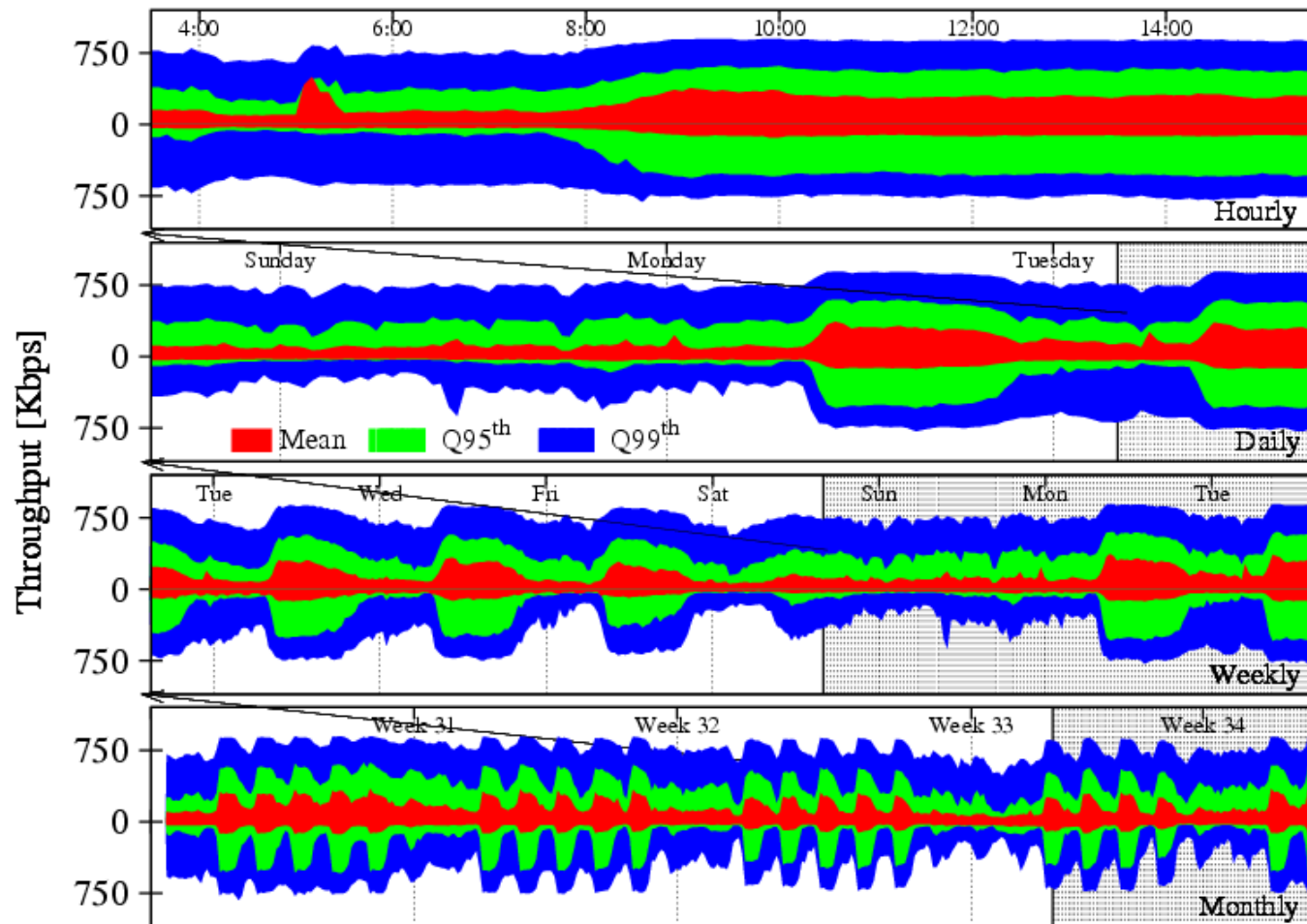
- **Why?**
 - Characterize the **network** and its **users**
 - Identify normal and **anomalous** behaviors
- **How?**
 - By means of **passive** measurements collecting full traces (all packets)
- **What?**
 - Network (IP), Transport (TCP/UDP) and Session (Applications)
 - Both data and multimedia traffic

Tstat: Layer-4 Analysis

- Statistical Analysis at IP/TCP/UDP/RTP levels
 - **Passive** inspection of packet headers
 - Rebuild **bidirectional** TCP/UDP connections
 - Features **real-time** analysis (pcap, DAG)
 - **Offline** processing of several trace formats
 - Offers **persistent** and **scalable** monitoring



Tstat at a Glance



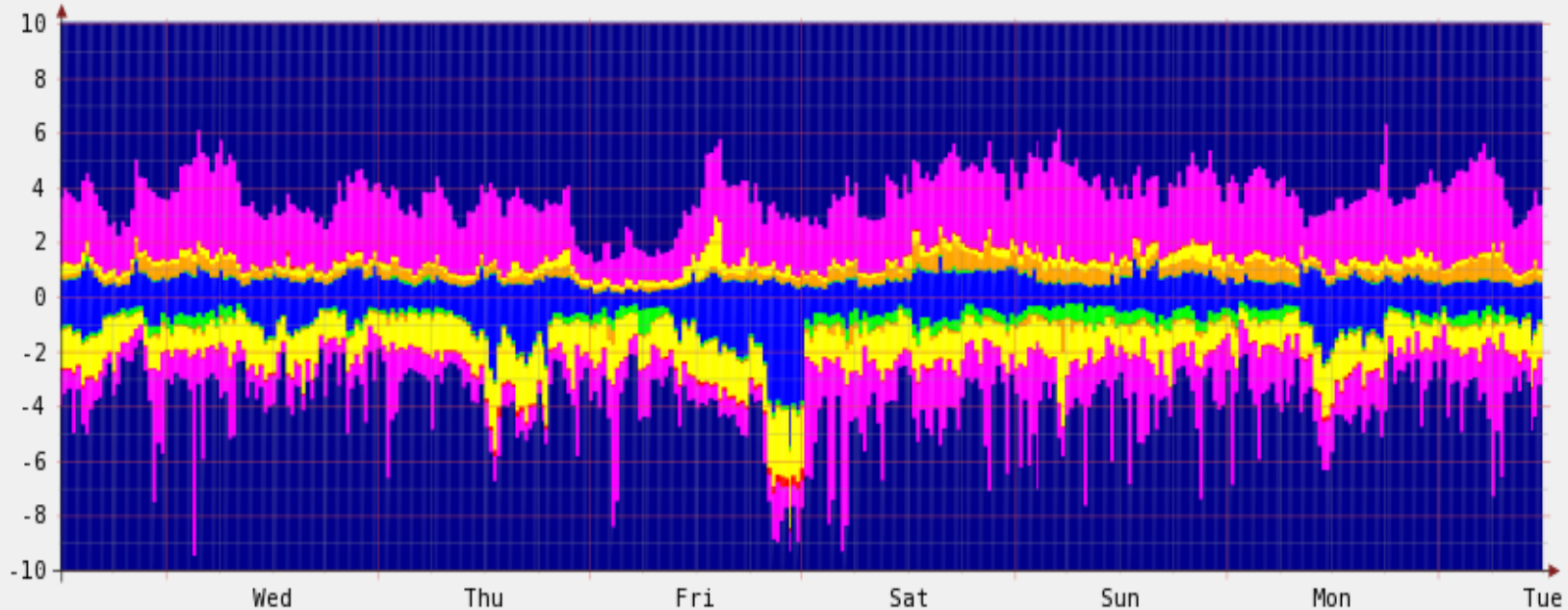
Scalable and persistent measurements ...

Tstat at a Glance

to.it

RRTOOL / TOBI OETIKER

TCP total number of anomalies - outgoing (+) and incoming (-) flows [Normalized Values]



- Unknown
- Unnecessary Retr. by RTO
- Network Duplicate
- Retr. by Fast Retransmit
- In Sequence
- Unnecessary Retr. by Fast Retransmit
- Flow Control (Window Probing)
- Network Reordering
- Retr. by RTO

...and **advanced** performance indexes

Current activities



- Data traffic characterization
 - TCP anomalies
 - Traffic burstiness
 - Impact of access link (WiFi/UMTS/ADSL)
- Multimedia traffic characterization
 - VOTP QoS
 - IPTV (streaming and multicast)
- Detection of
 - Encrypted traffic (Skype)
 - Traffic Anomalies

Measurement setup



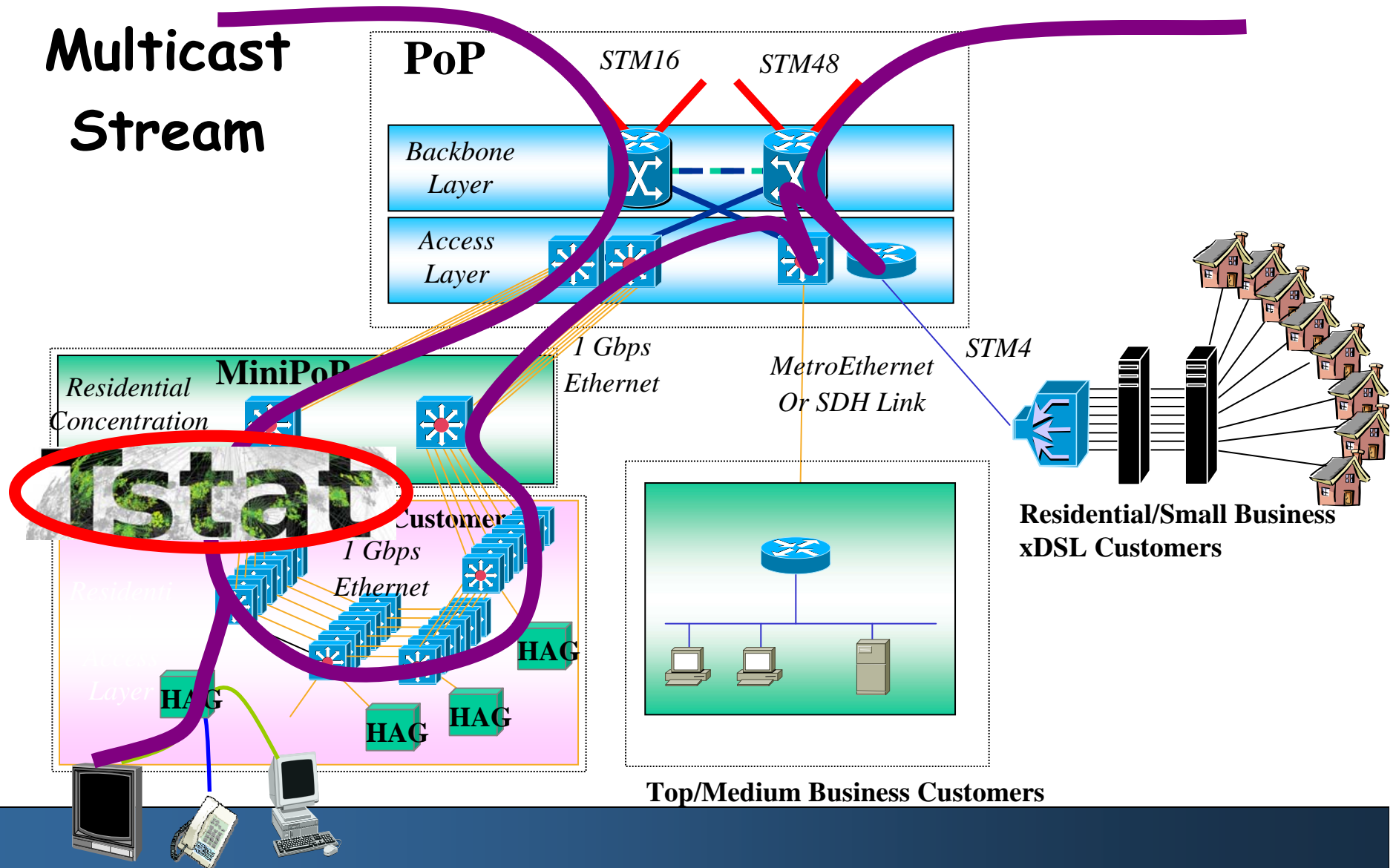
FASTWEB

- Fiber-To-The-Home.....
 - A single high-speed access (either FTTH or ADSL) to offer data, VoIP, IPTV
 - "future proof" technology
 - Started in 1999
- And service integration over IP
 - VoIP
 - IPTV: Video on Demand, Streaming

Measurement setup



Multicast Stream



Measurement Setup



- Two weeks of traffic characterization
- 83 video streams; high quality, MPEG-2 standard codecs (2.5-4 Mb/s per flow)
- Constant packet size (1336 B)
- No loss at the probe (reliable measurements)
- Metrics
 - **Throughput**: instantaneous and average
 - **Delay Jitter** and Inter Packet Gap (**IPG**)

Classes



We identified three coarse classes

TABLE I

DISTRIBUTION OF THE FLOWS OVER THE CLASSES

Class	No. of flows	% (over 83)
CBR	33	39.7
2-VBR	13	15.7
VBR	37	44.6

Class characteristics

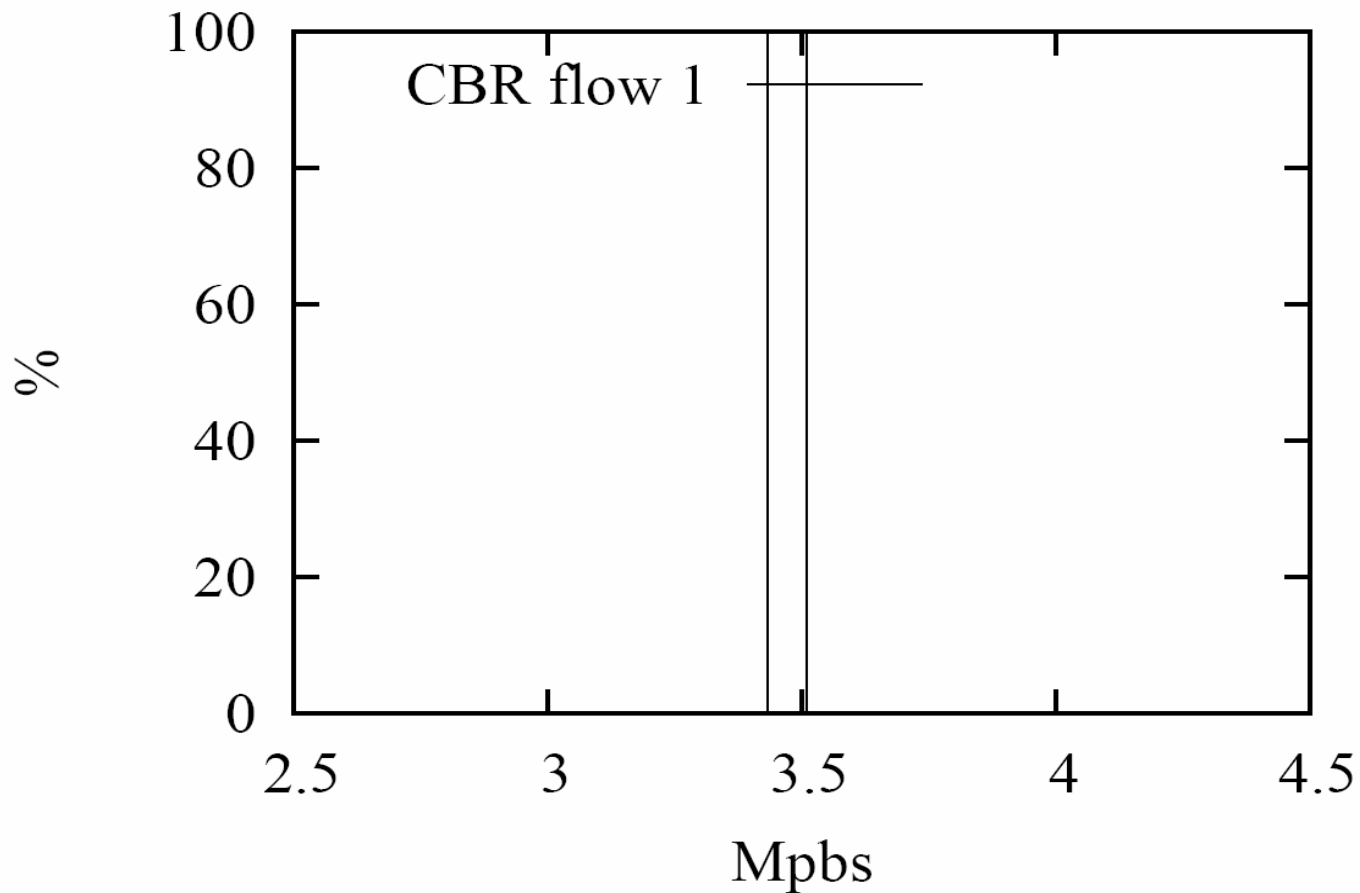


TABLE II

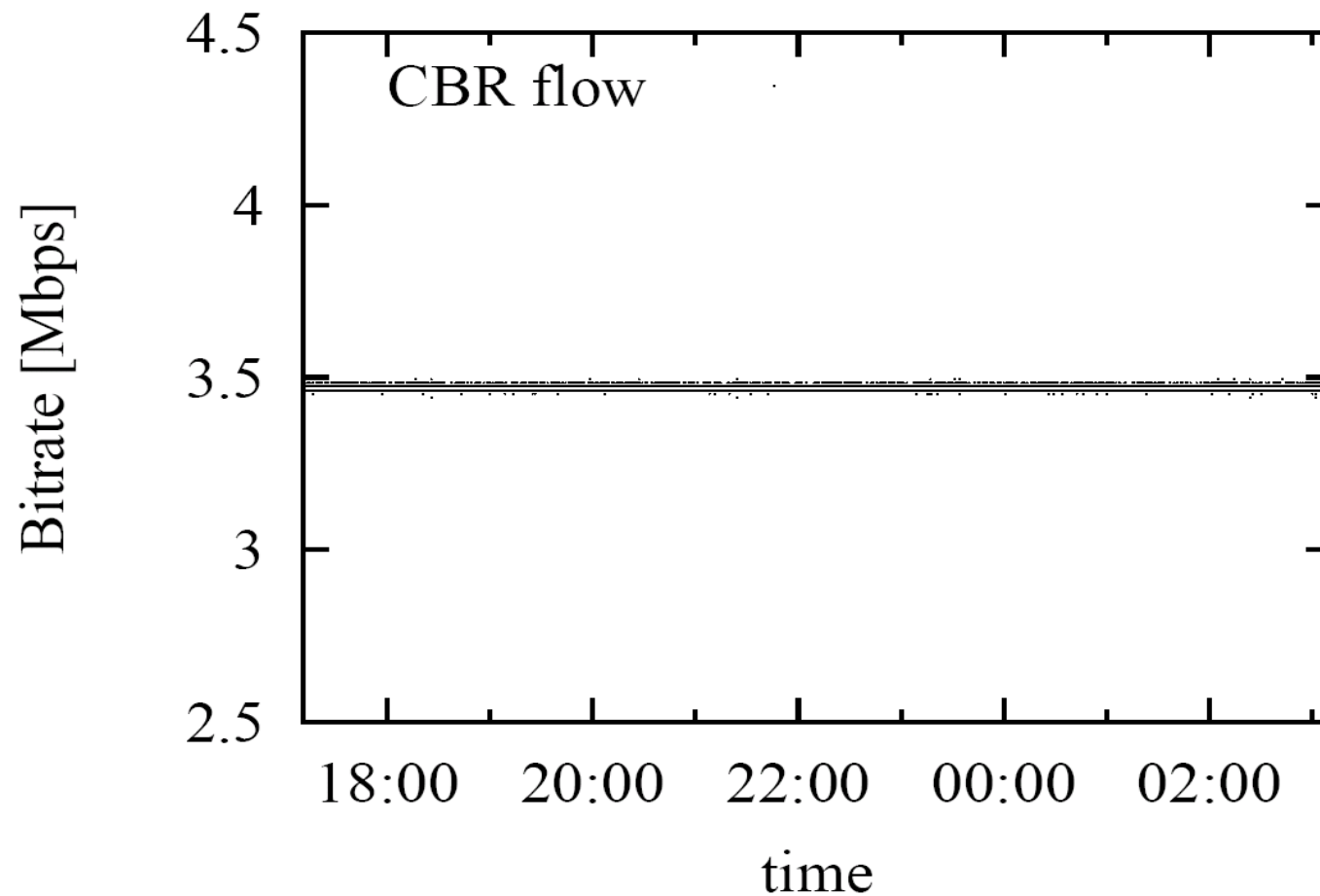
AVERAGE BIT RATE PER TIME INTERVAL: MEAN, STANDARD DEVIATION AND VALUES OF THE PEAKS (WHEN APPLICABLE, DEPENDING ON THE CLASS OF FLOW)

Class	FID	Mean [kbps]	Std [kbps]	1st peak [kbps]	%	2nd peak [kbps]	%
CBR	1	3471	16	3471	100	-	-
	2	3571	16	3571	100	-	-
	3	3486	18	3485	95	-	-
	4	2040	91	2042	97	-	-
2-VBR	1	3587	399	3863	49	2836	15
	2	3162	100	3241	55	3043	44
	3	3701	400	4017	45	2990	15
	4	3626	374	3863	53	2836	11
VBR	1	4064	291	-	-	-	-
	2	3706	149	-	-	-	-
	3	3188	420	-	-	-	-
	4	3365	97	-	-	-	-

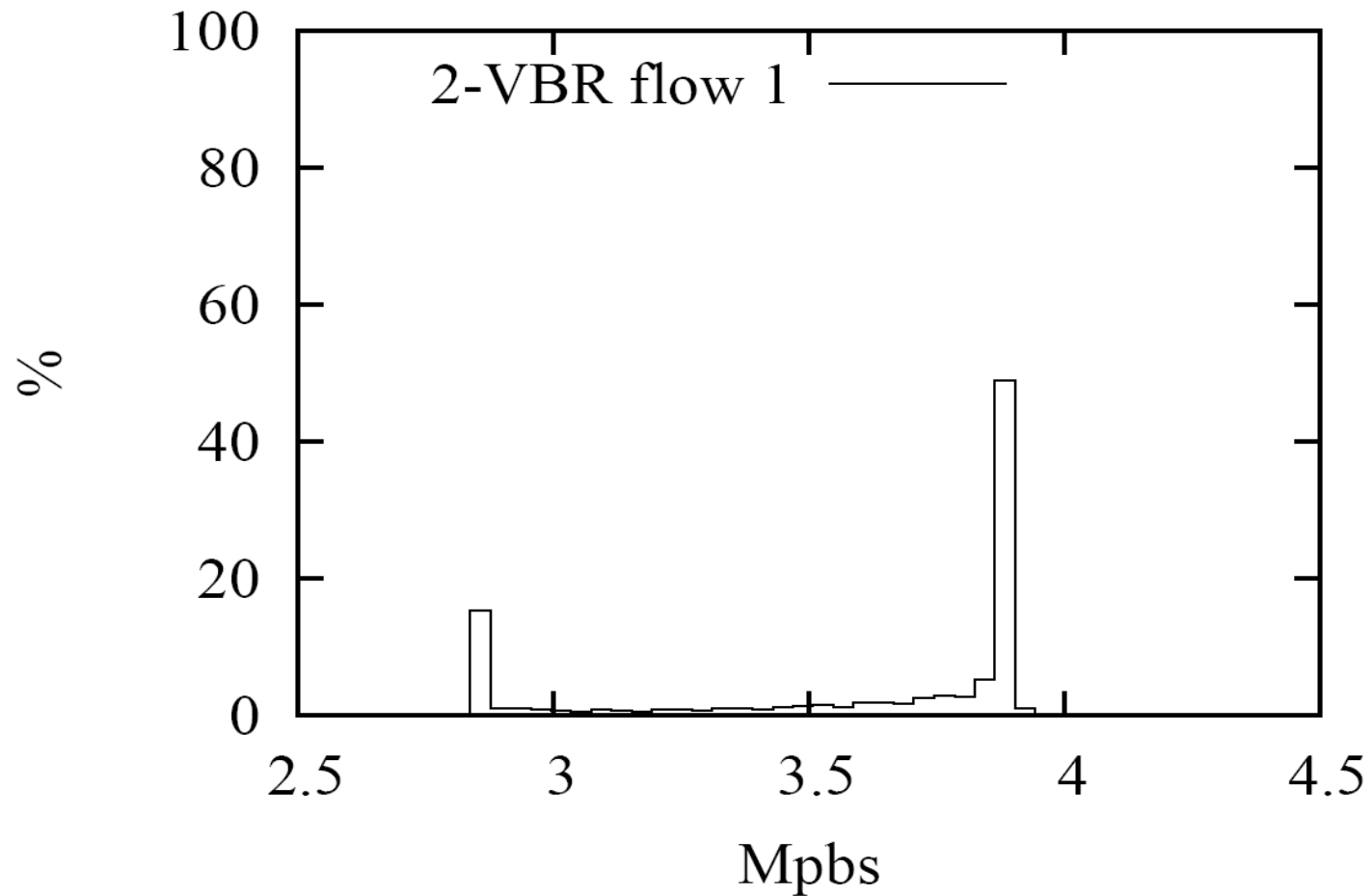
Throughput PDF [CBR class]



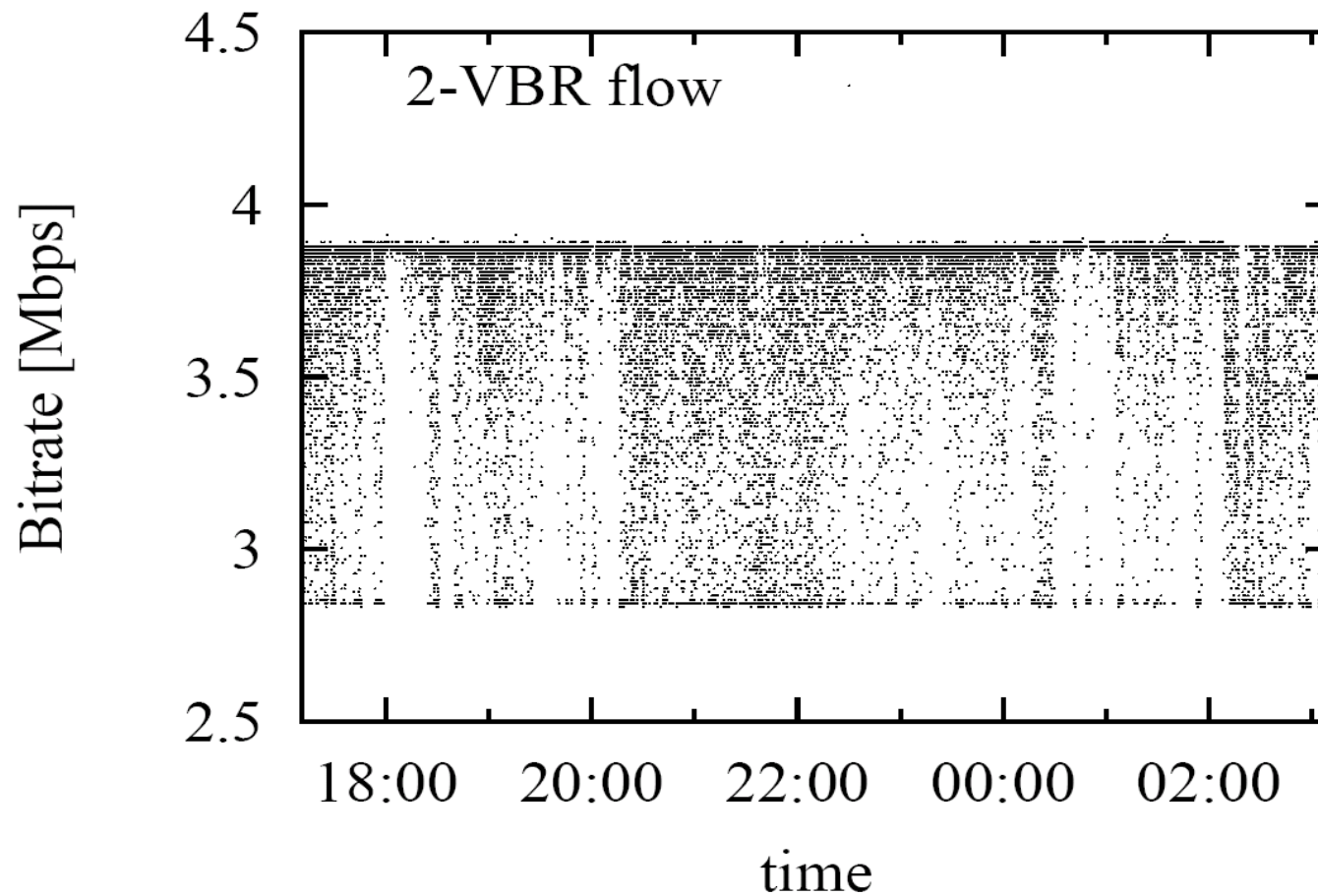
Throughput(t) [CBR class]



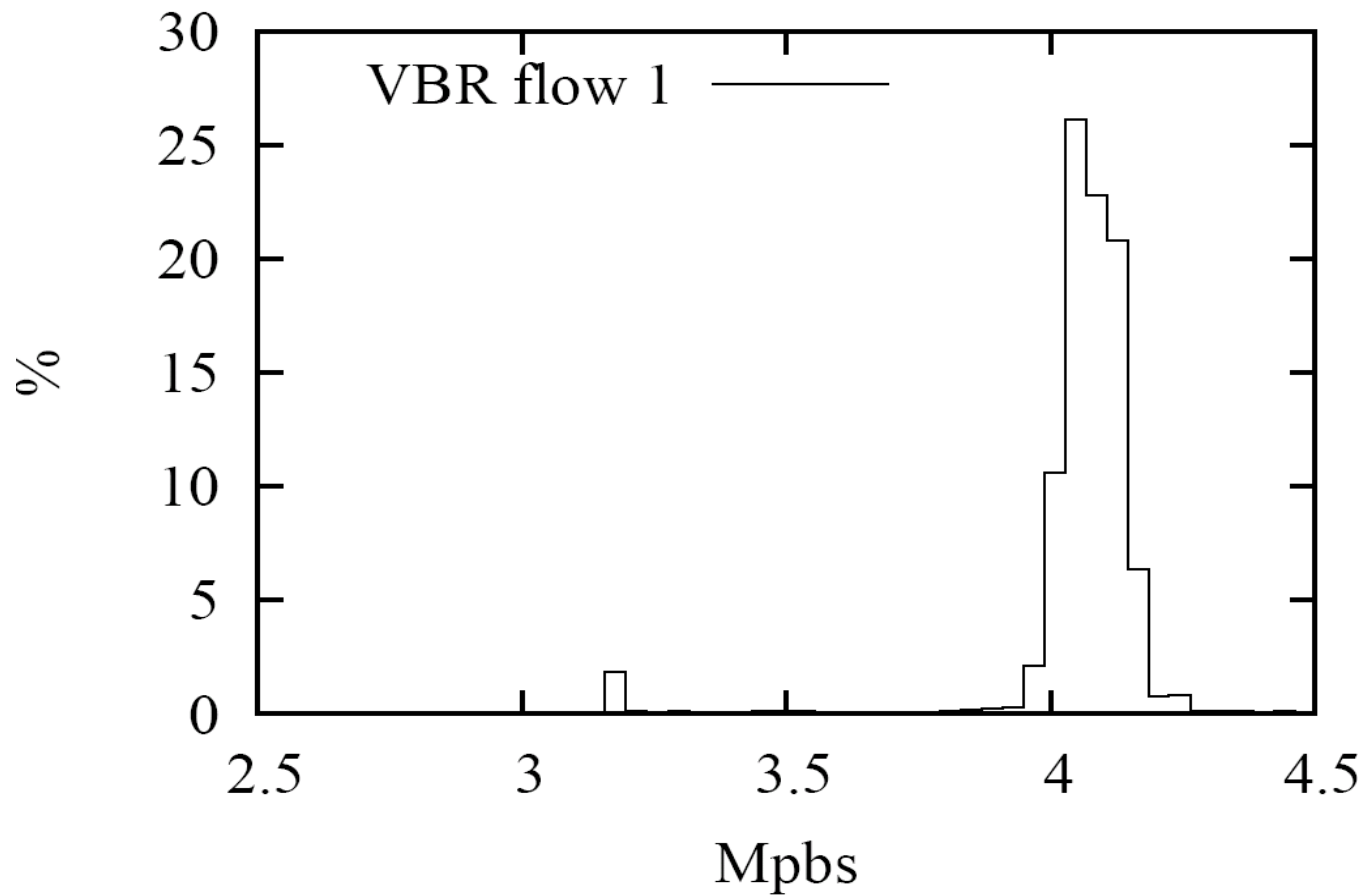
Throughput PDF [2-VBR class]



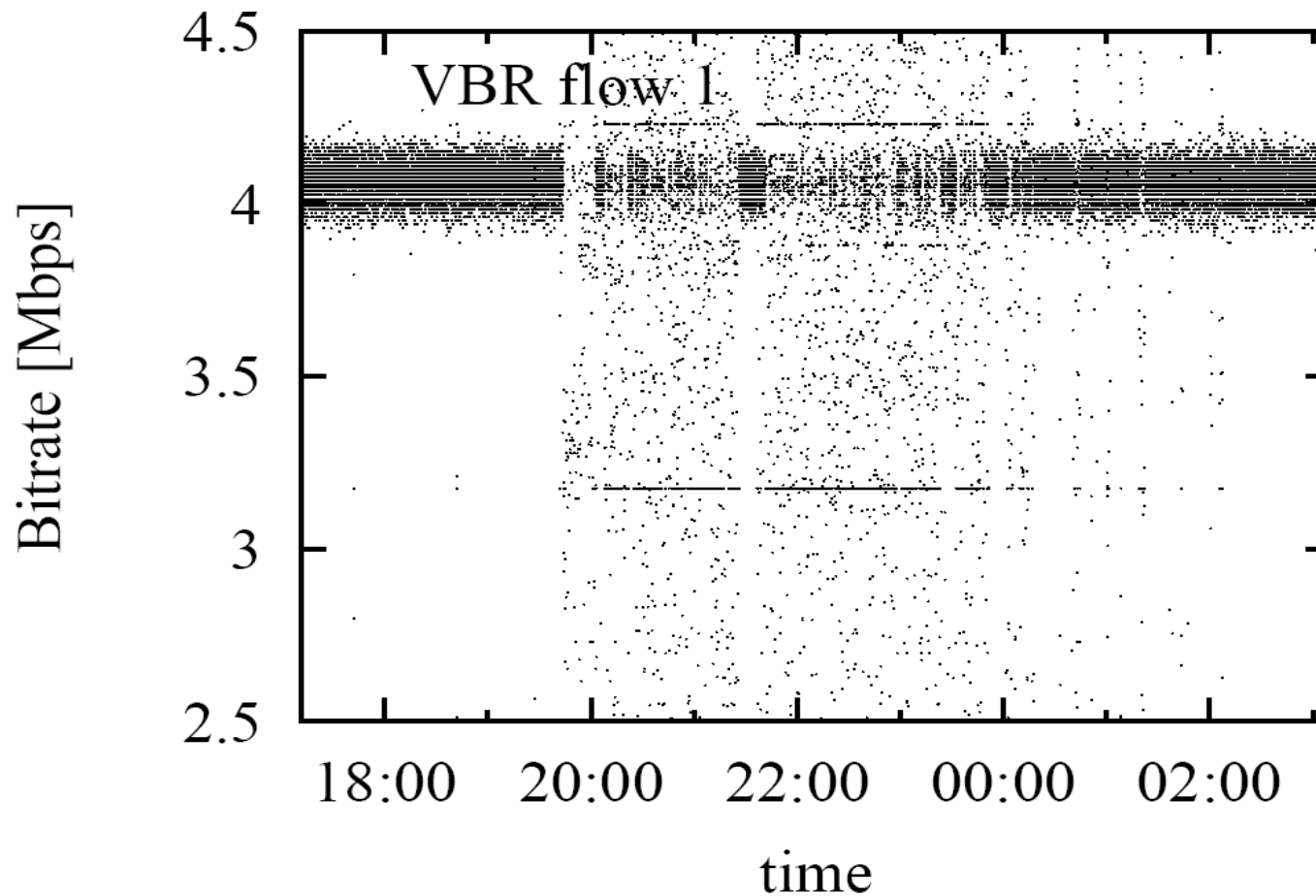
Throughput(t) [2-VBR class]



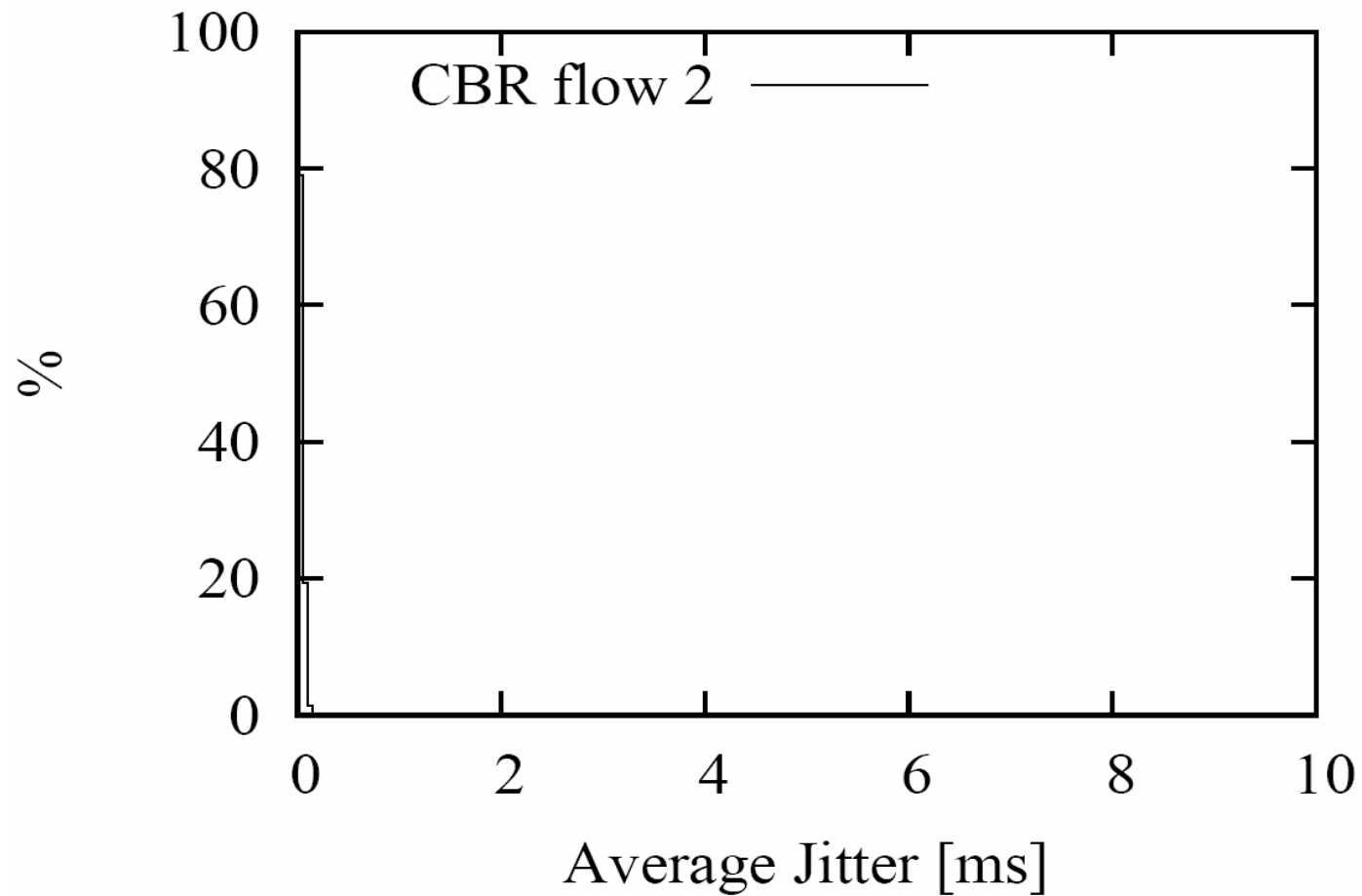
Throughput PDF [VBR class]



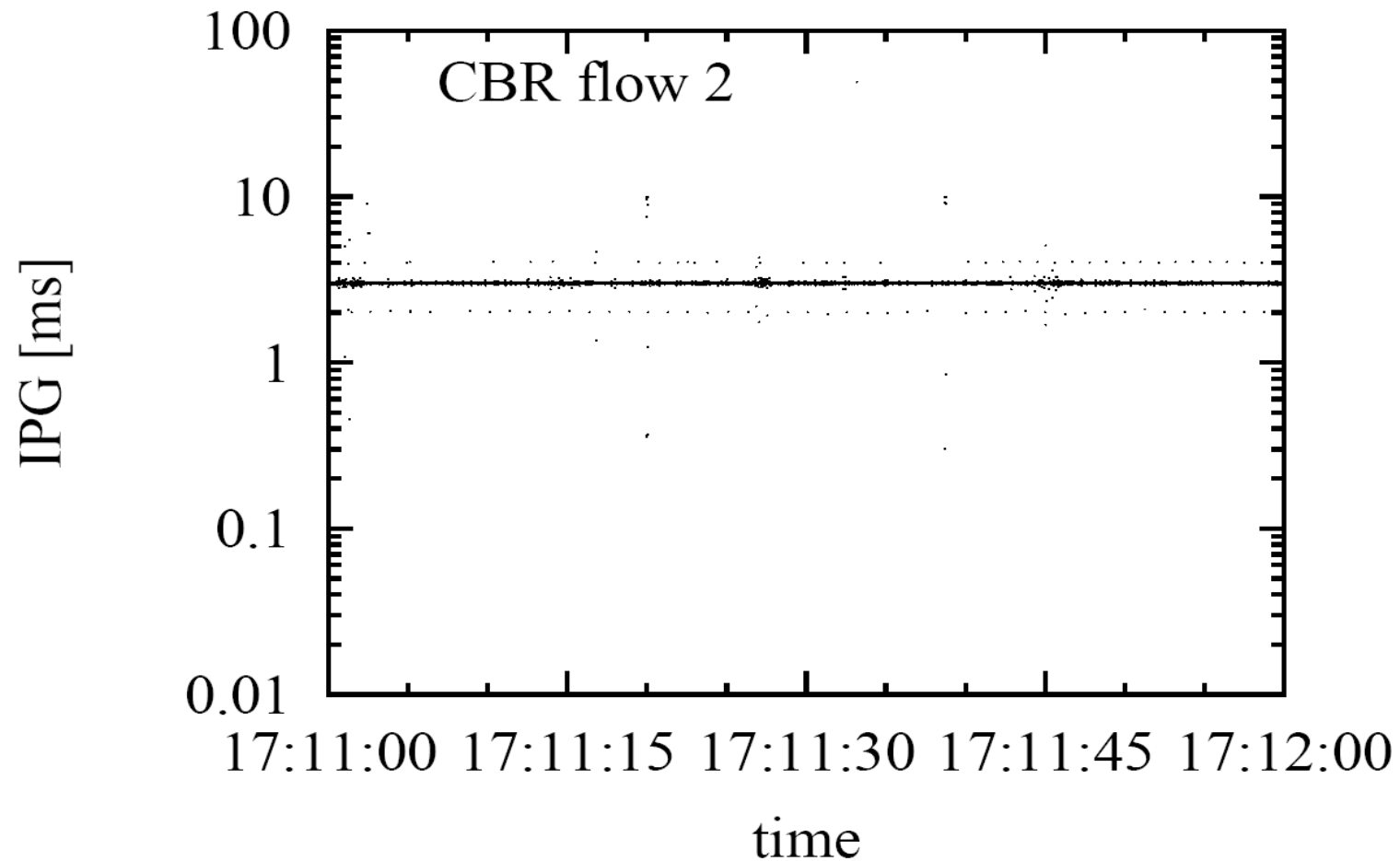
Throughput(t) [VBR class]



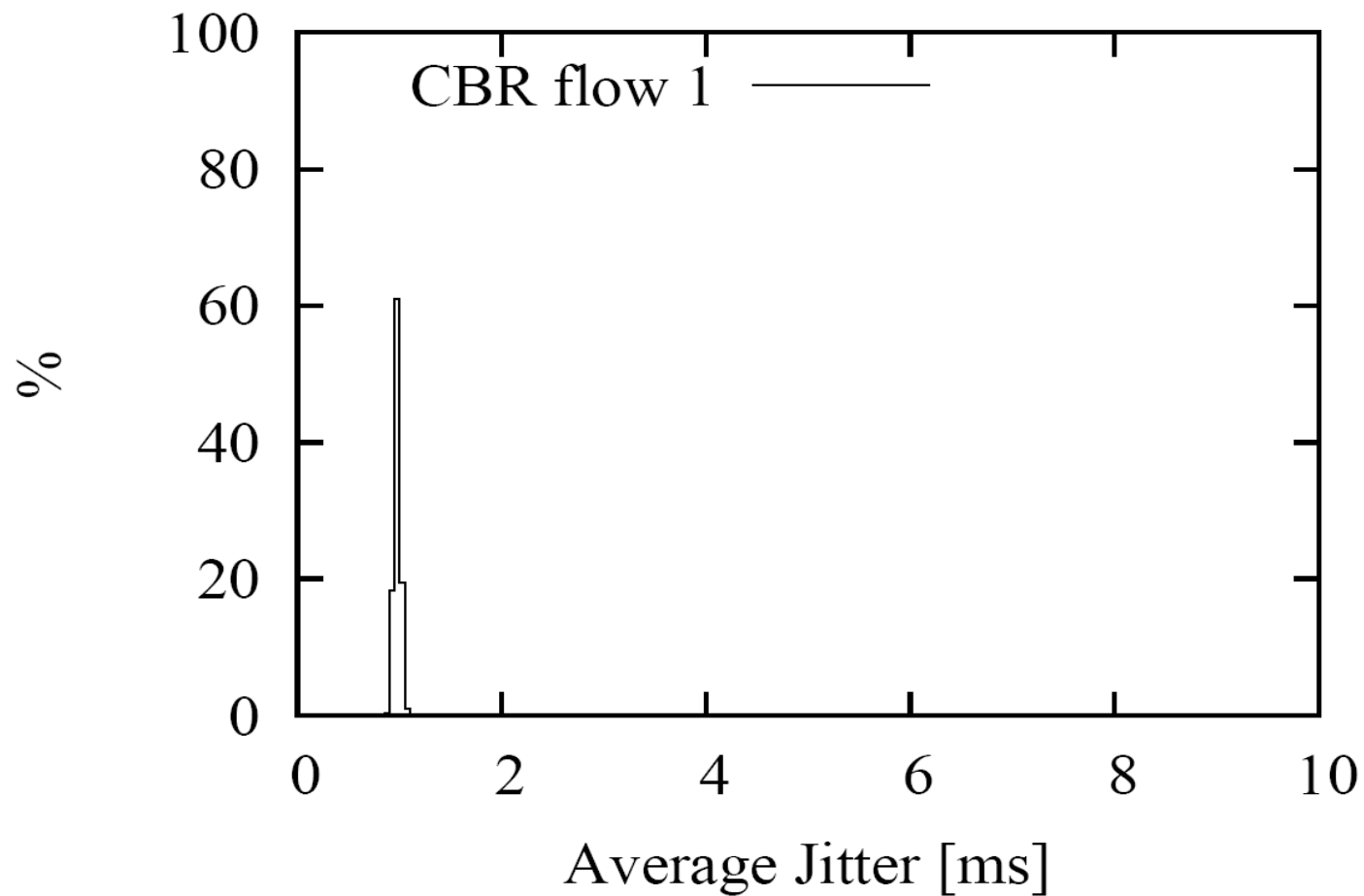
Jitter PDF [CBR flow]



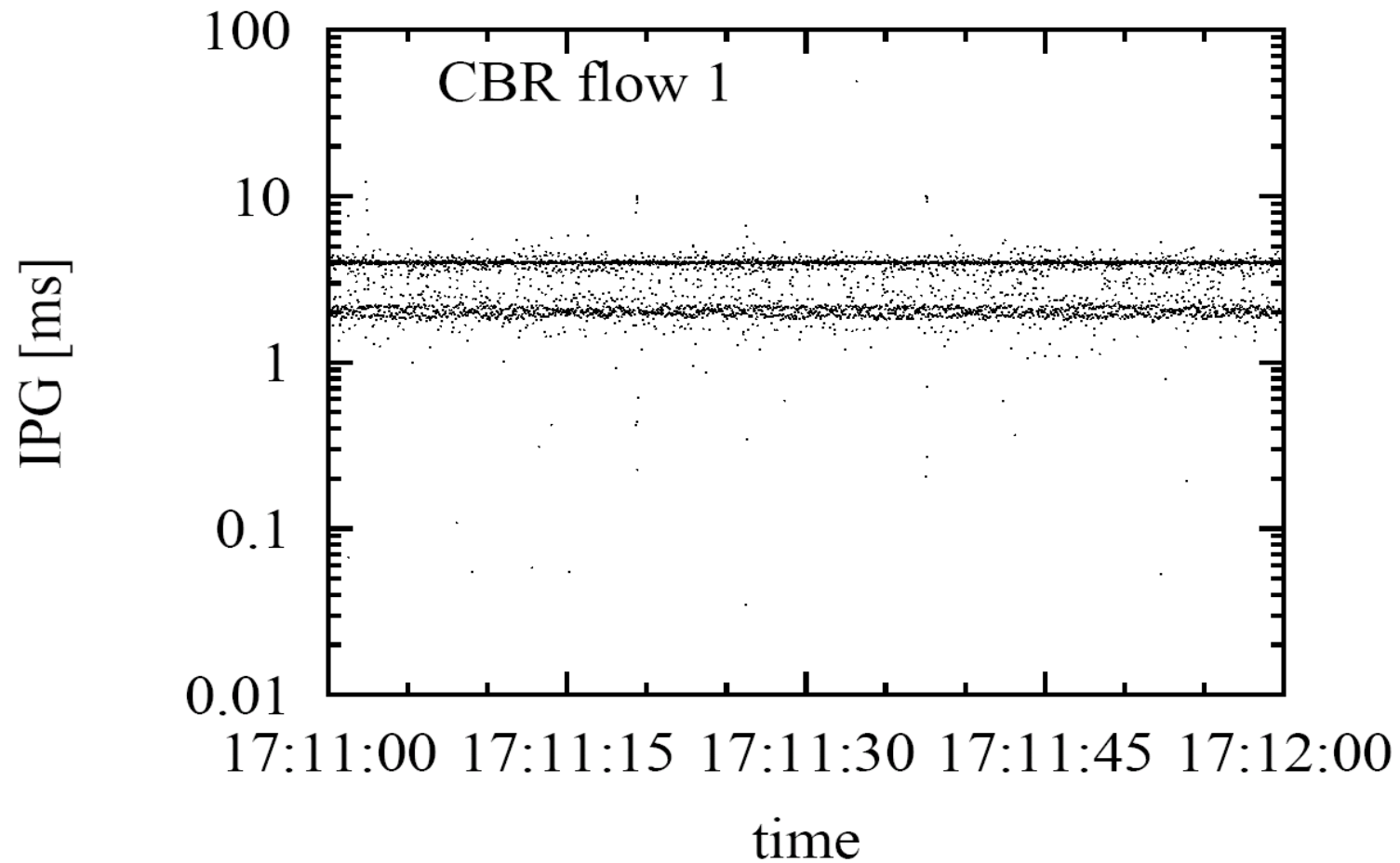
Jitter(t) [CBR flow]



Jitter PDF [CBR flow]



Jitter (t) [CBR flow]



Loss



- What about packet drops?

NEVER SEEN A SINGLE DROPPED PACKET

- In more than 2 weeks of measurements

- Thanks to QoS policies (Video streams have higher priority than data packets)

Conclusions



Video sources may exhibit different characteristics

- CBR, 2-VBR, VBR throughputs
- (low jitter, constant IPG) vs. (high jitter, bursty IPG)
- No loss
- Almost perfect service
- Not easy to model them
 - Simple models may fit
 - But multiplexing gain is difficult to predict and model