Realtime Burstiness Measurement

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PFLDnet2006, Feb. 3 2006, Nara Japan

AIST

R. Takano et al, “Design and Evaluation of Precise Software Pacing Mechanisms for Fast Long-Distance Networks,” PFLDnet2005, Feb. 2005.

⇨ **PSPacer**

Achieves precise pacing only by software

PSPacer can be downloaded from:

http://www.gridmpi.org/gridtcp.jsp

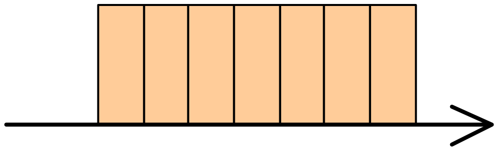
Outline

- Background
- Definition of Burstiness
- Burstiness Measurement Method
- Experiment
- Conclusion

Bursty traffic (1)

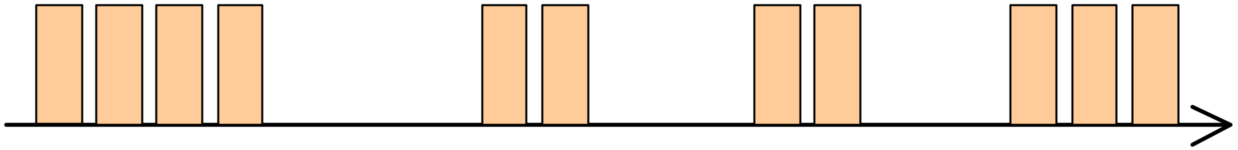
- Burst is a sequence of packets transmitted back-to-back

8 packets are transmitted back-to-back



- Bursty traffic is traffic in which the short-term bandwidth exceeds the average bandwidth

bursy traffic



Bursty traffic (2)

- Causes
  - TCP's slow start, ACK compression, etc
- Problems
  - Bursty traffic may cause excessive queuing delay and packet loss
  - Such packet loss may markedly degrade TCP communication performance over high bandwidth-delay product networks

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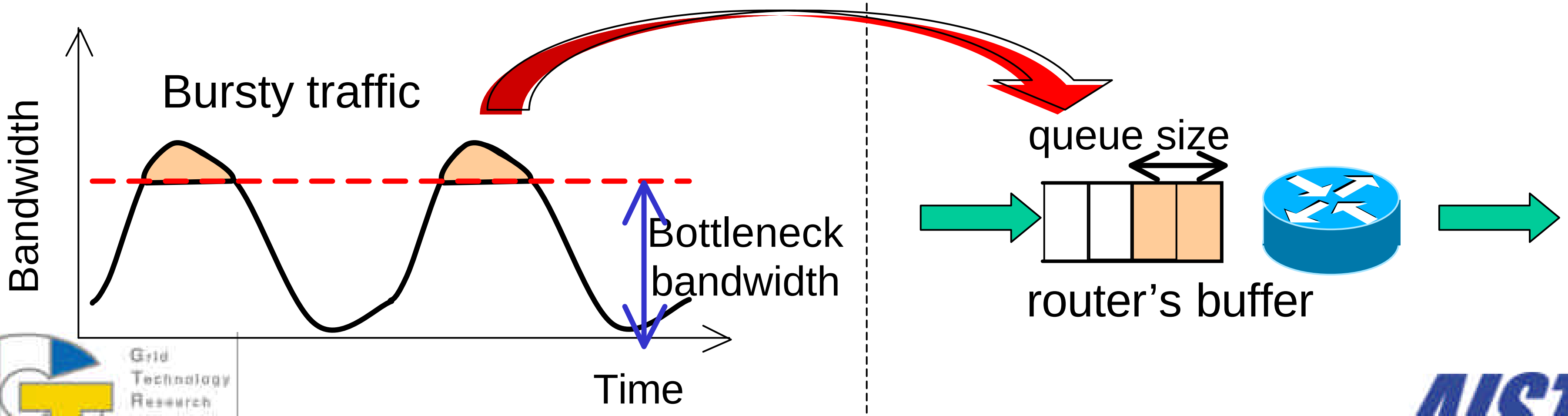
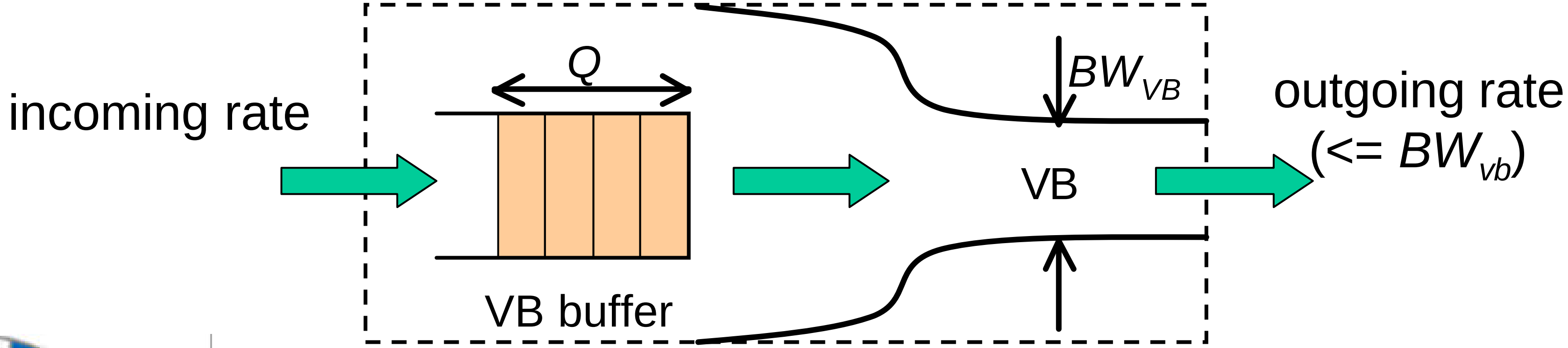
Basic idea

- Burstiness is the degree of busty traffic
- Quantitative definition of burstiness is not well established.
- The definition should be directly related to performance factors (i.e. packet loss, queuing delay)
- At bottleneck router, the excessive packets are stored on the buffer. The queue size indicates burstiness



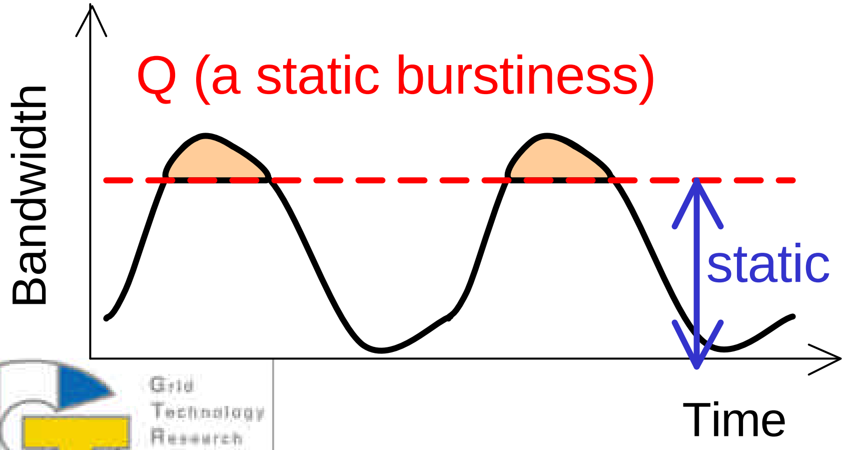
Virtual Bottleneck (VB)

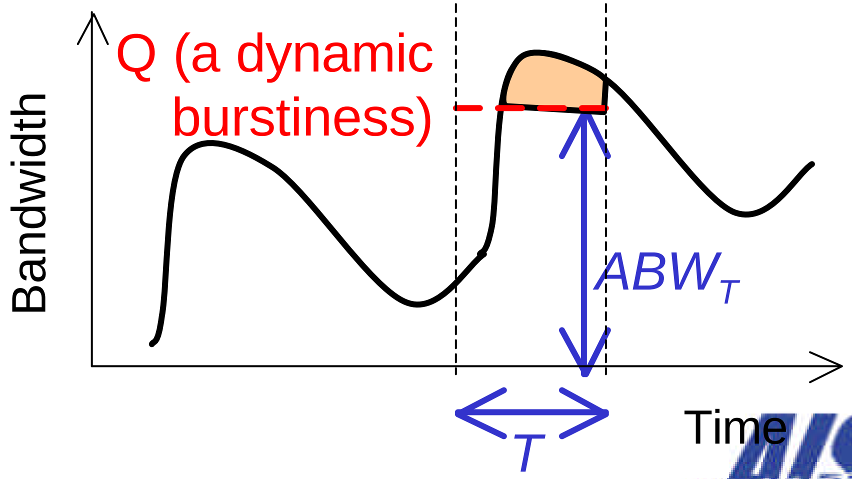
- To measure burstiness of traffic, we introduce a Virtual Bottleneck (VB)
  - The bandwidth of VB is BW_{vb}
  - Excessive packets are stored on the buffer just before VB (VB buffer)
  - The queue size (Q) indicates burstiness



Two definitions of burstiness

- A static burstiness
  - BW_{vb} is set to a given value
    - Q: a static burstiness
  - Useful for traffic with fixed and known bandwidth
    - e.g. CBR transmission
- A dynamic burstiness
  - BW_{vb} is set to the average bandwidth (ABW_T)
    - Q: a dynamic burstiness
  - Useful for long-term variable traffic





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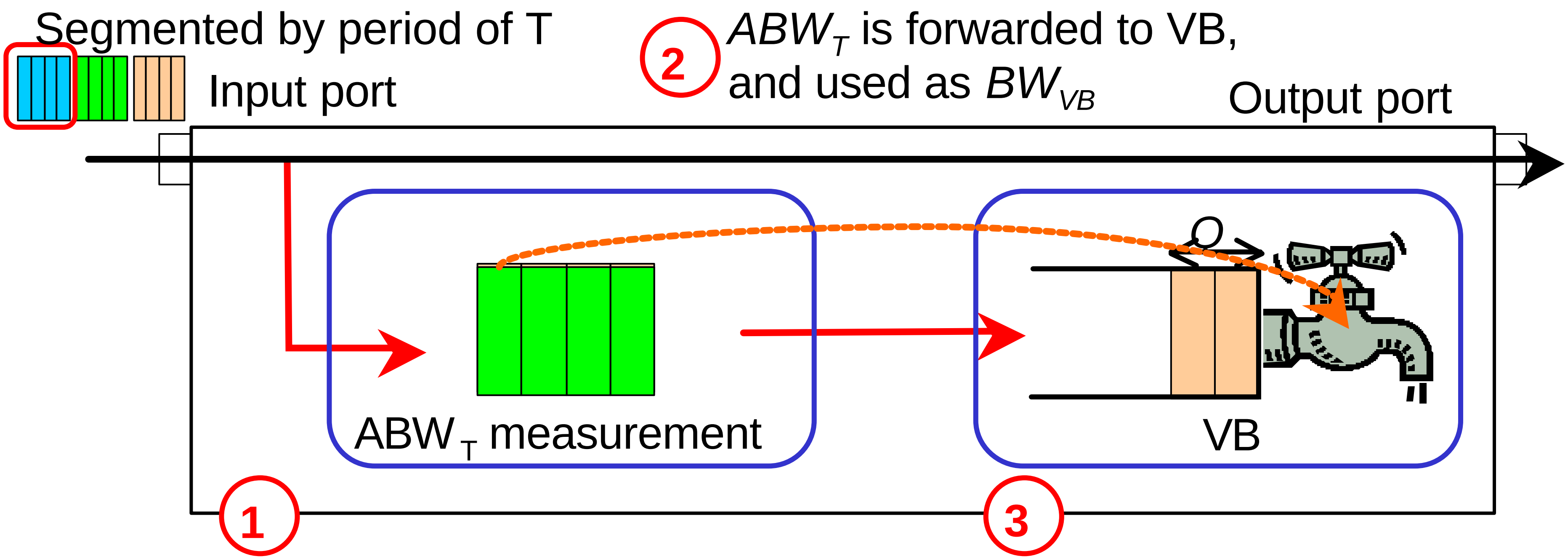
Dynamic burstiness measurement logic

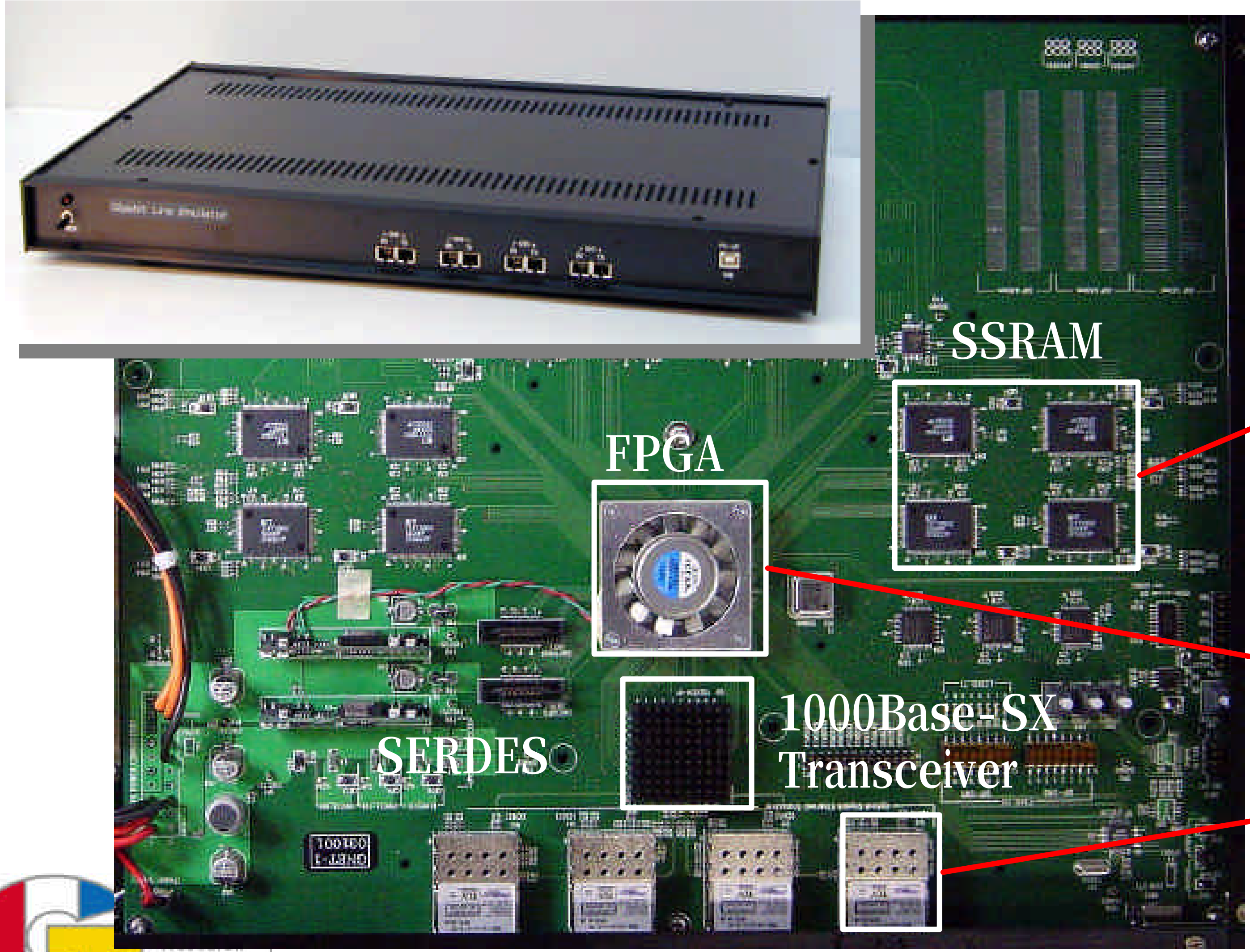
- 2 stages: ABW_T measurement, VB
- Incoming traffic is processed by pipeline manner



ABW_T is measured by the amount of incoming packet during a period of T

Packets are dequeued at the rate of BW_{vb}, and burstiness is measured.

GtrcNET-1: Programmable Gigabit Network Testbed



1 Gbps read and write simultaneously 144Mbits/port

Xilinx XC2V6000 (76K logic cells)

4 GbE ports

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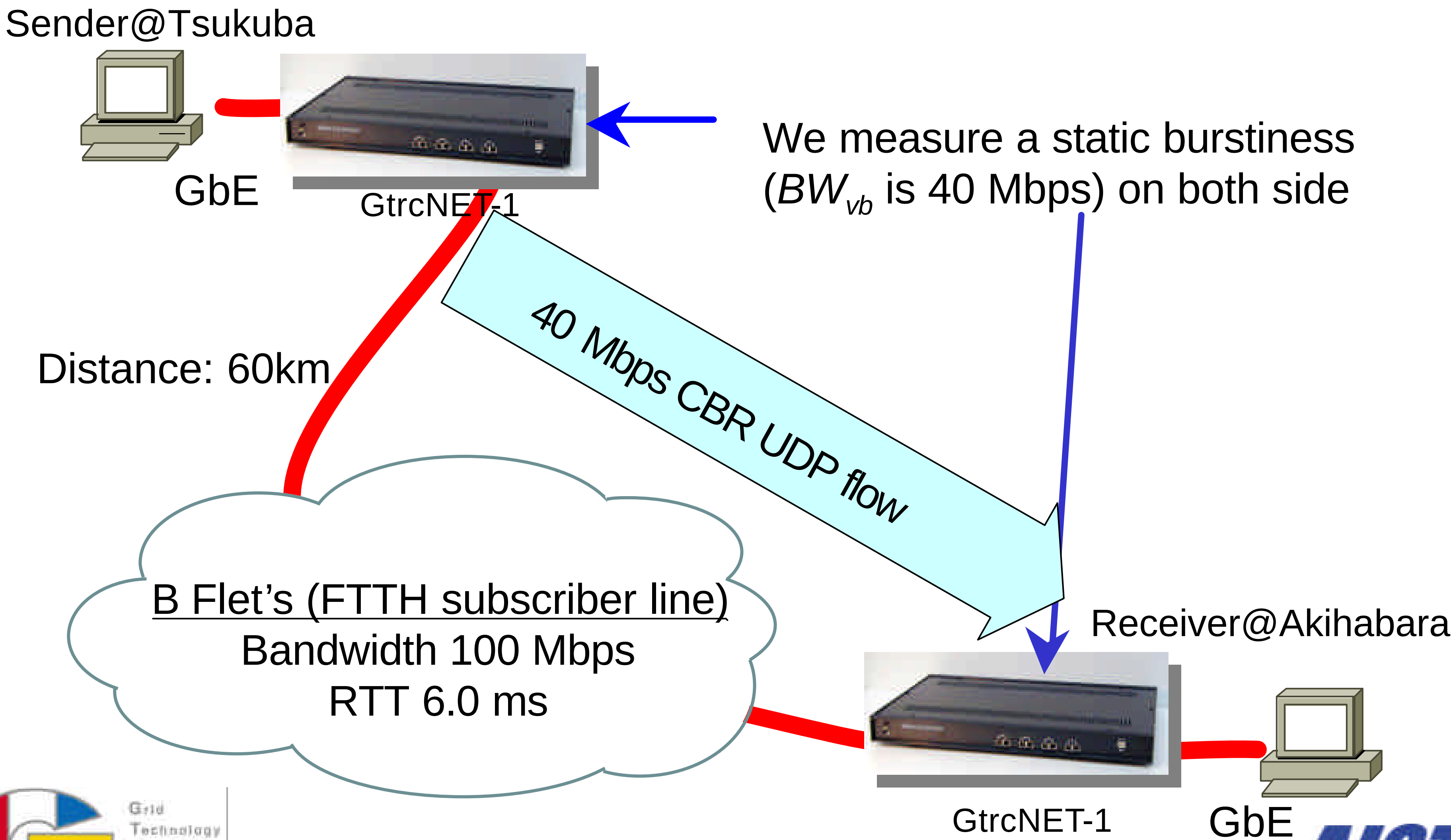
  - Relationship between burstiness and packet loss
  - Behavior of Flow aggregation (on proceeding)
- Conclusion

Experimental setting

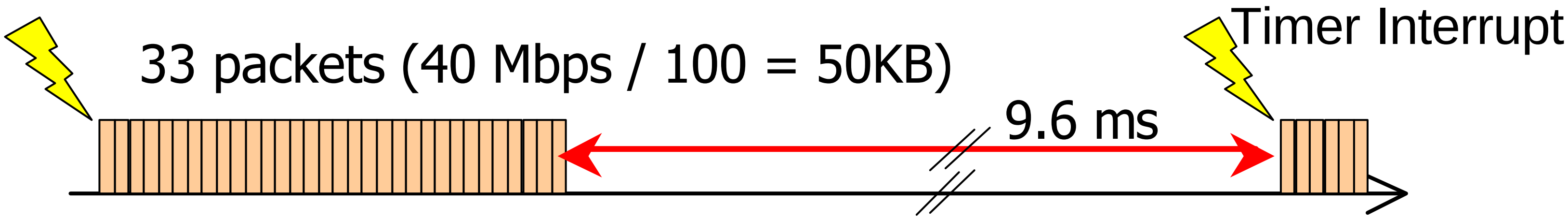


Specifications of hosts

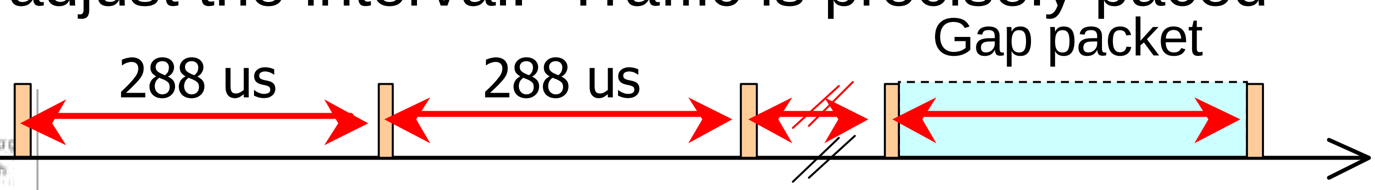
	Sender@Tsukuba	Receiver@Akihabara
CPU	AMD Opteron/2.8GHz dual	Intel Xeon/2.4GHz dual
M/B	IBM eServer 325	SuperMicro X5DAE
Memory	6GB (PC2700)	2GB (PC2100)
NIC	Broadcom BCM5704 (GbE)	Intel 82545EM (GbE)
I/O bus	PCI-X 133MHz/64bit	PCI-X 133MHz/64bit
OS	SUSE SLES 8.1 Kernel 2.4.21-251	FedoraCore 3 Kernel 2.6.13.3

CBR transmission methods

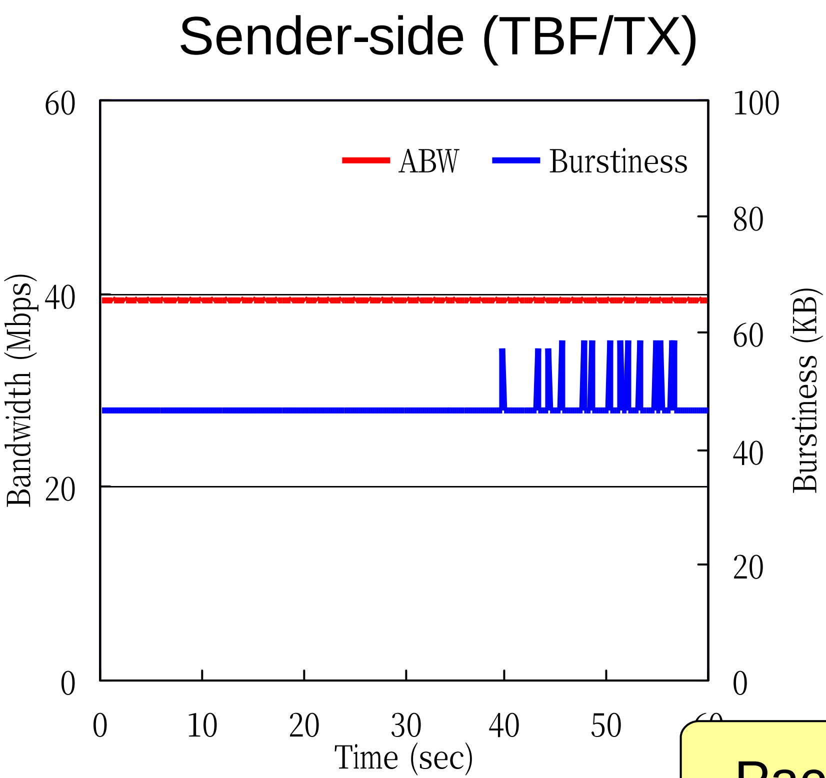
- Target rate: 40Mbps on GbE
- <u>Token Bucket Filter (TBF)</u>
  - TBF is a timer-interrupt driven method, and its burst size is as large as “*rate / a timer frequency*”

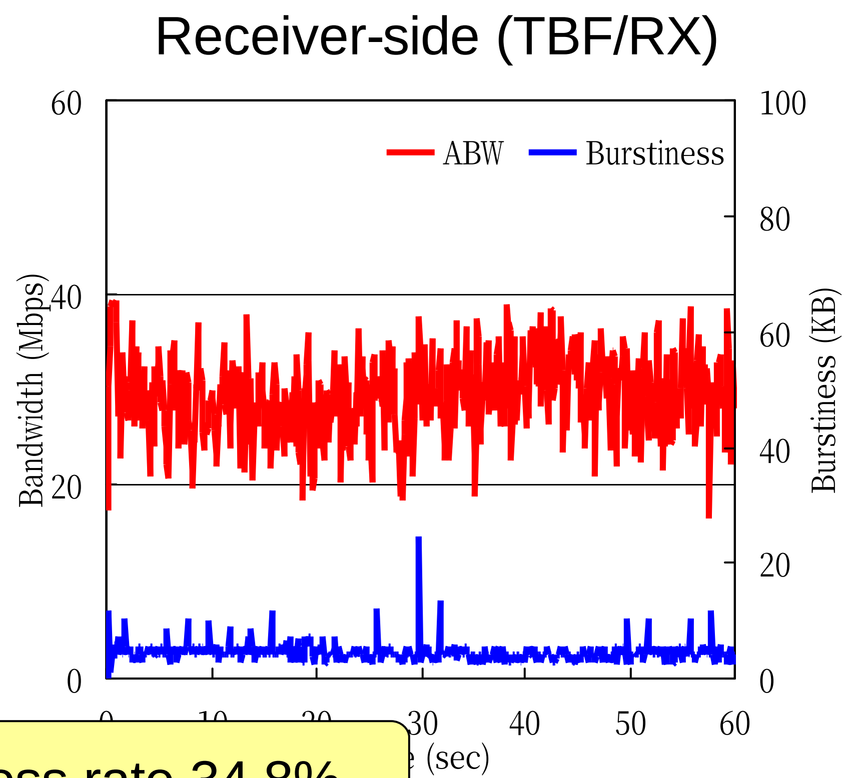


- <u>PSPacer</u>
  - PSPacer inserts a gap packet between packets to adjust the interval. Traffic is precisely paced



TBF





Packet loss rate 34.8%

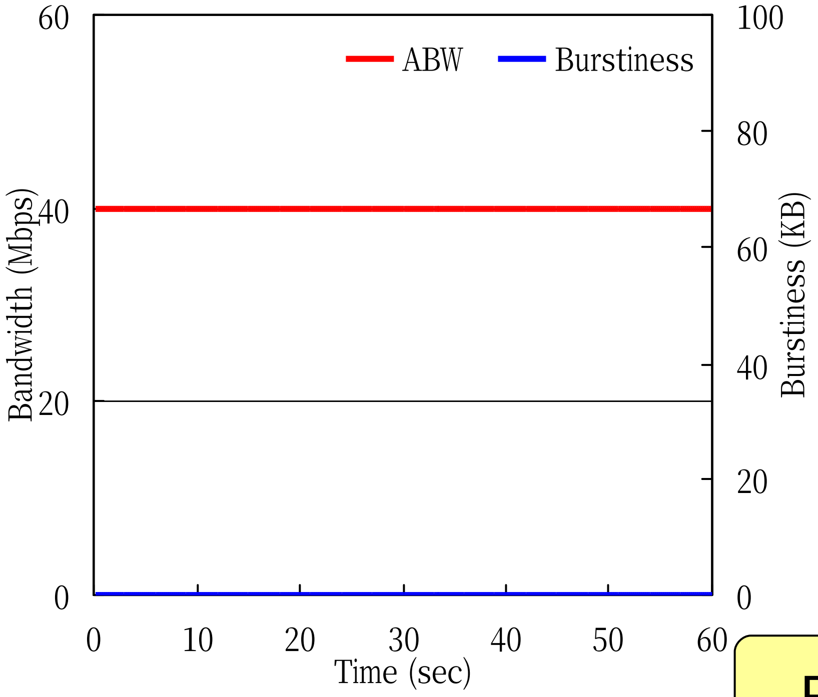
Ave. of ABW_{100ms} 39.4 Mbps → 25.7 Mbps

Ave. of *burstiness* 46.9 KB → 4.43 KB (1/10)

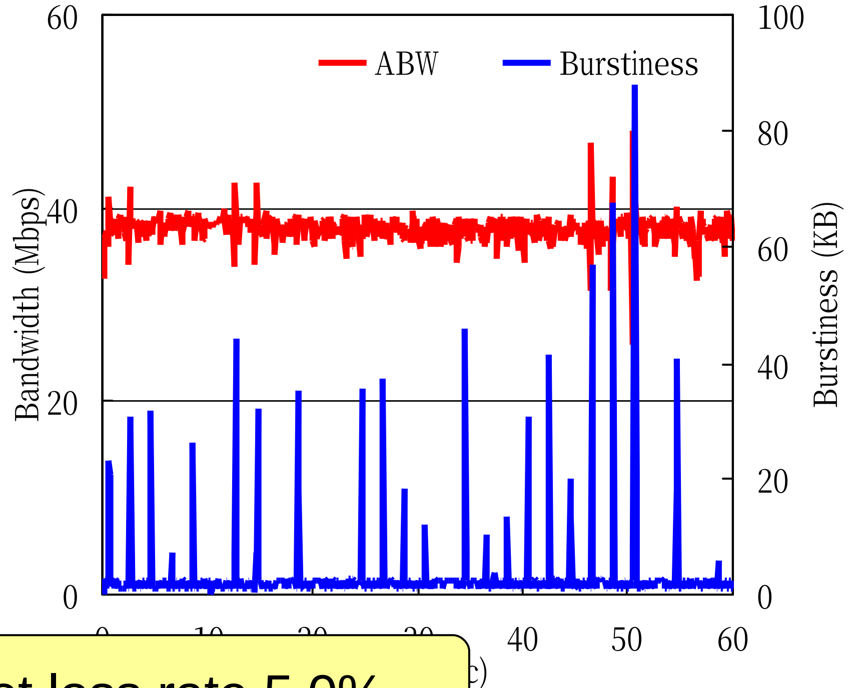
moderated by intermediate bottleneck (FastEther)

PSPacer

Sender-side (PSP/TX)



Receiver-side (PSP/RX)



Packet loss rate 5.0%

Ave. of. *ABW_{100ms}*	39.9 Mbps	→	37.9 Mbps
Ave. of. *Burstiness*	0 KB	→	3.27 KB

effect of packet clustering

Relationship between burstiness and packet loss rate

	ABW_{100ms} (Mbps)		$max(Q)_{100ms}$ (KB)		Packet loss rate (%)
	ave	max	ave	max	
TBF/TX	39.4	39.5	46.9	58.8	34.8
TBF/RX	25.7	39.4	4.43	24.6	
PSP/TX	39.9	39.9	0	0	5.0
PSP/RX	37.9	48.0	3.27	88.1	

(measured over a period of 1 minute)

- Larger burstiness increases the probability of packet loss
  - Pacing can improve the bandwidth utilization
- Burstiness is affected for moderation by intermediate bottleneck and packet clustering

Conclusion

- We proposed a quantitative definition of burstiness
- We implemented a realtime burstiness measurement method on GtrcNET-1
- The preliminary experimental results show relationship between burstiness and packet loss
- There are many works to do…
  - Effectiveness and usage of the quantitative definition of burstiness is not clear

For More Information

- GtrcNET-1: http://gtrc.aist.go.jp/gnet/
- PSPacer: http://www.gridmpi.org/gridtcp.jsp
  - PSPacer has released under the GNU GPL.

- NAREGI: http://www.naregi.org/

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