

Enhancement of the TCP Module in the OMNeT++/INET Framework



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Thomas Dreibholz's SCTP Page
<http://tdrwww.iem.uni-due.de/dreibholz/sctp/>

■ Transmission Control Protocol (TCP)

- The most important Transport Protocol in the Internet
- Many variants and various optimizations
- => INET/OMNeT++ to examine its performance

■ Missing TCP Features in OMNeT++/INET

- Finite receiver buffer
 - Allowing “Zero Window” (i.e. “send no more data yet”)
 - Requires “Window Probing”
- TCP options handling
- Maximum Segment Size (MSS) negotiation
- **Selective Acknowledgement (SACK)**

■ Goal:

- Enhancement of the TCP model in OMNeT++/INET ...
- ... to perform **state-of-the-art TCP** performance evaluations

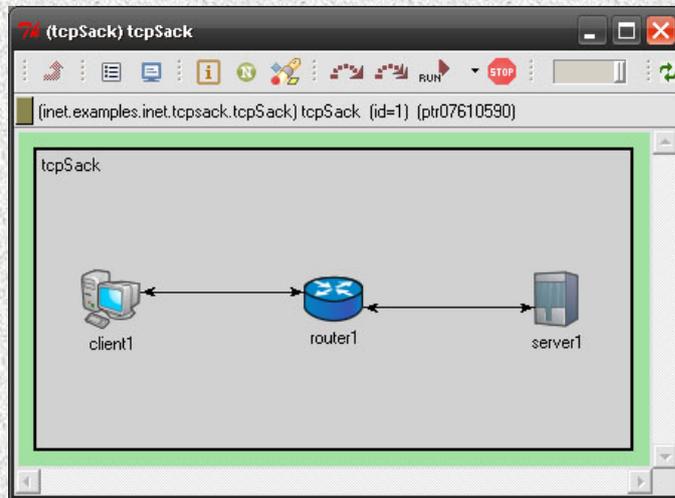
Selective Acknowledgements (RFC 2018)

Idea:

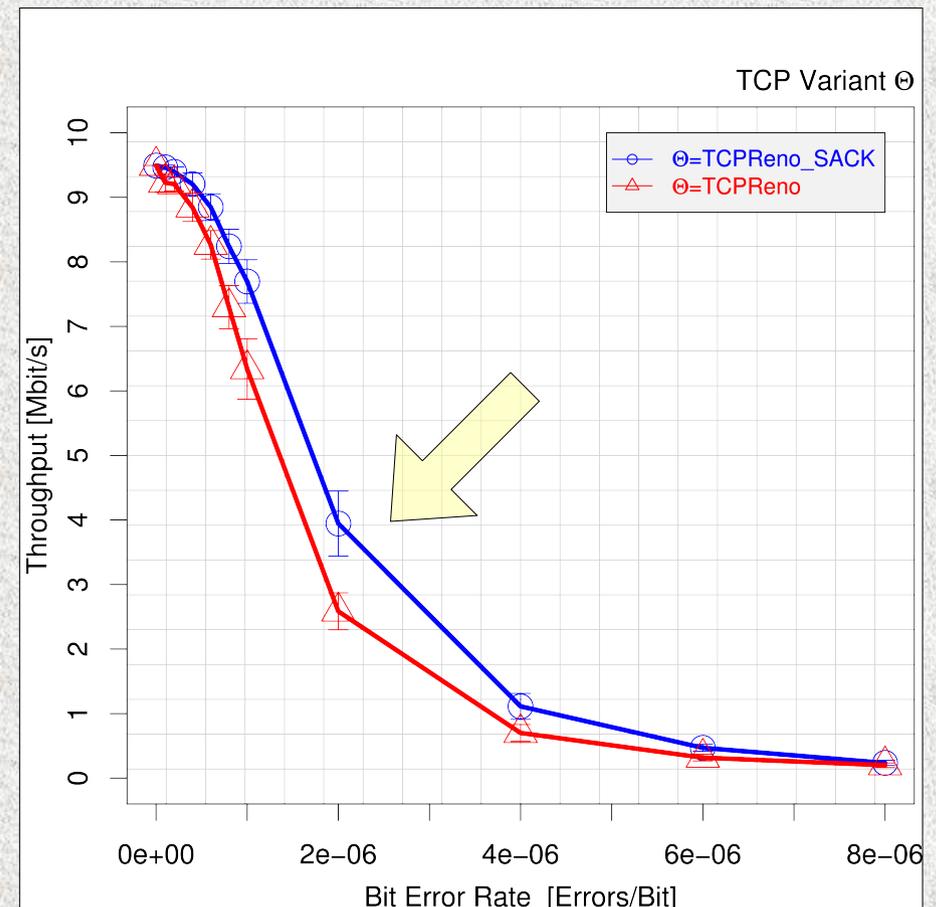
- Lost segments are retransmitted, of course ...
- ... but already received segments are not transmitted again
- => Tell sender what has already been received (by SACK option fields)

Simulation example:

- 10 Mbit/s path
- Variation of the bit error rate

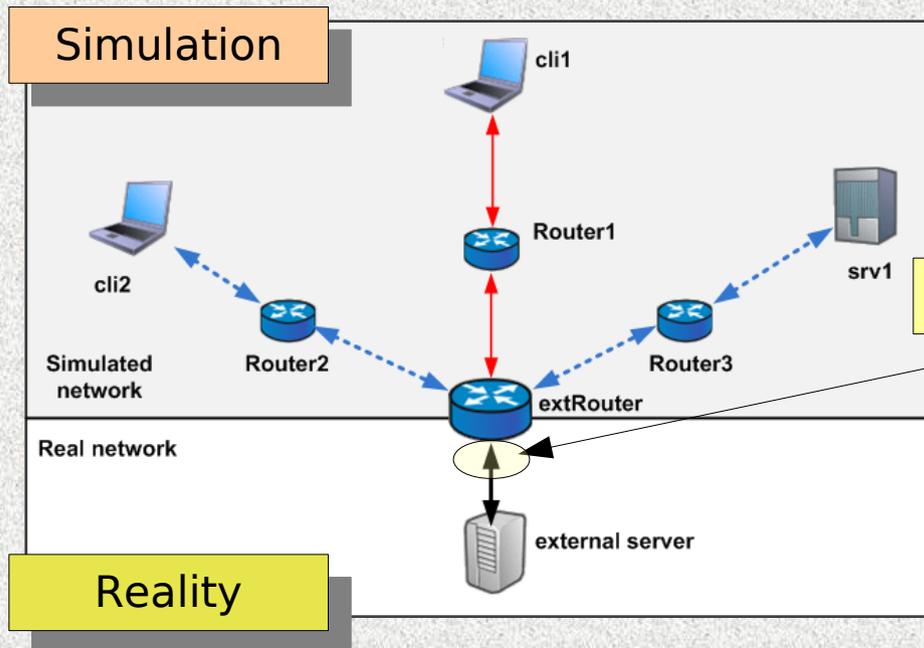


SACK support is important for accurate TCP performance evaluation!



Interoperability with Real Systems using the External Interface

ExtInterface: connecting simulations to real network components



ExtInterface

The screenshot shows the OMNeT++/INET framework interface. The top window is titled '(ExtRouter) ExtWithRouter.extRouter' and displays a network diagram with modules like notificationBoardInterfaceTable, routingTable, and namTrace. The bottom window is titled '(ExtInterface)' and shows a table of 5 objects:

Class	Name	Info	Pointer
cPar	filterString	"ip and (dst host 10.1 or dst host 10.0.1.129)"	ptr0x3f3a658
cPar	device	"eth0"	ptr0x3f3a670
cPar	mtu	1500	ptr0x3f3a688
cGate	netwIn	<-- tcpdump.ifOut[3]	ptr0x3f3a9f0
cGate	netwOut	--> tcpdump.ifIn[3]	ptr0x3f3aa90

Improved TCP module supports connections over ExtInterfaces

- Support for TCP options, including SACKs

Using the TCPCDump Module for Exporting a Packet Trace

■ Improved TCPCDump module to export TCP option fields ...

No. .	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.0.111	172.0.1.111	TCP	45315 > 10021 [SYN] Seq=0 Win=5808 Len=0 MSS=1452 TSV=3226577 TSER=0
2	0.007217	172.0.1.111	192.168.0.111	TCP	10021 > 45315 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=1452
3	0.007263	192.168.0.111	172.0.1.111	TCP	45315 > 10021 [ACK] Seq=1 Ack=1 Win=5808 Len=0

Flags: 0x12 (SYN, ACK)
window size: 65535
Checksum: 0xc838 [correct]
Options: (8 bytes)
Maximum segment size: 1452 bytes
NOP
NOP
SACK permitted

■ ... including SACK handling ...

No. .	Time	Source	Destination	Protocol	Info
99	0.245918	172.0.1.111	192.168.0.111	TCP	10021 > 45315 [ACK] Seq=1 Ack=182977 Win=65535 Len=0
100	0.247596	172.0.1.111	192.168.0.111	TCP	10021 > 45315 [ACK] Seq=1 Ack=185881 Win=65535 Len=0
101	0.248681	172.0.1.111	192.168.0.111	TCP	[TCP Dup ACK 100#1] 10021 > 45315 [ACK] Seq=1 Ack=185881 Win=65535 L

Flags: 0x10 (ACK)
window size: 65535
Checksum: 0x973b [correct]
Options: (12 bytes)
NOP
NOP
SACK: 187333-188785

■ ... for analysis with external tools (e.g. Wireshark)



■ Conclusion

- TCP model in OMNeT++/INET has lacked of some important features
- Features have been added and contributed to GitHub tree of INET ...
- ... allowing for TCP evaluations with state-of-the-art model
- Interoperability with real TCP implementations

■ Future Work

- Adding further options:
 - Window Scaling (already done)
 - Timestamp (in progress)
 - ...
- Performance evaluations

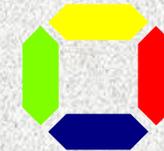
Thank You for Your Attention!

Any Questions?

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To be continued ...



Visit Our Project Homepage:

<http://tdrwww.iem.uni-due.de/dreibholz/sctp>

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