Implementation and Evaluation of Concurrent Multipath Transfer for SCTP in the INET Framework

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

Stream Control Transmission Protocol (SCTP, RFC 4960)

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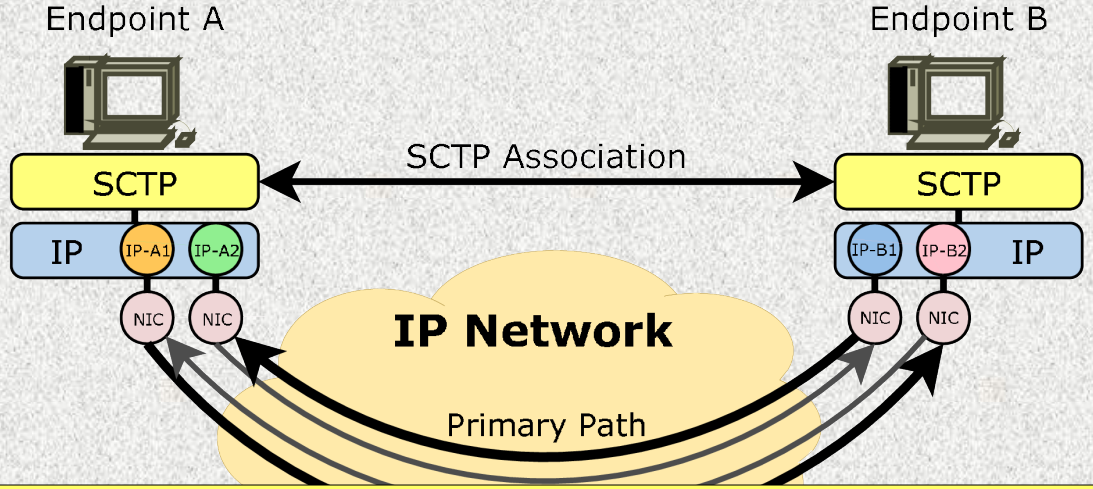
- SCTP Features
  - Transport Layer Protocol (like TCP or UDP – but much more powerful!)
  - Reliable, message-oriented, ordered/unordered, multi-streaming
- Multi-Homing
  - Support for multiple addresses per endpoint; may be changed (“Add-IP”)
  - Multiple unidirectional **paths** in the network (can be disjoint or shared)
  - One path in each direction is chosen for user data (**primary path**)
  - Other paths: backup only (only used for retransmissions)



What about utilizing <u>all</u> paths simultaneously?

Concurrent Multipath Transfer (CMT)

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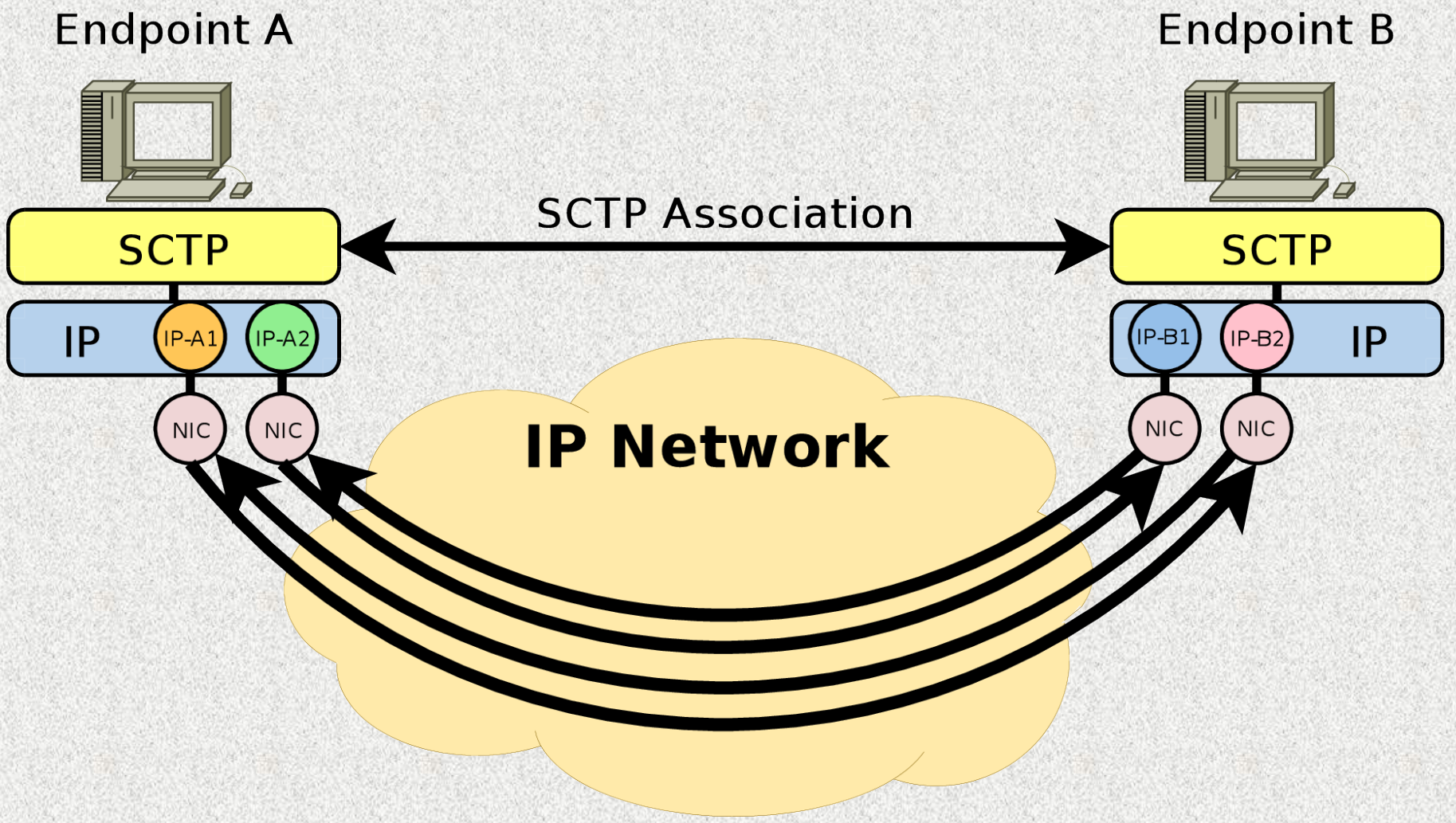

- All paths are used for data transmission
- Assumption of CMT: paths are disjoint → congestion control

Fast Retransmissions

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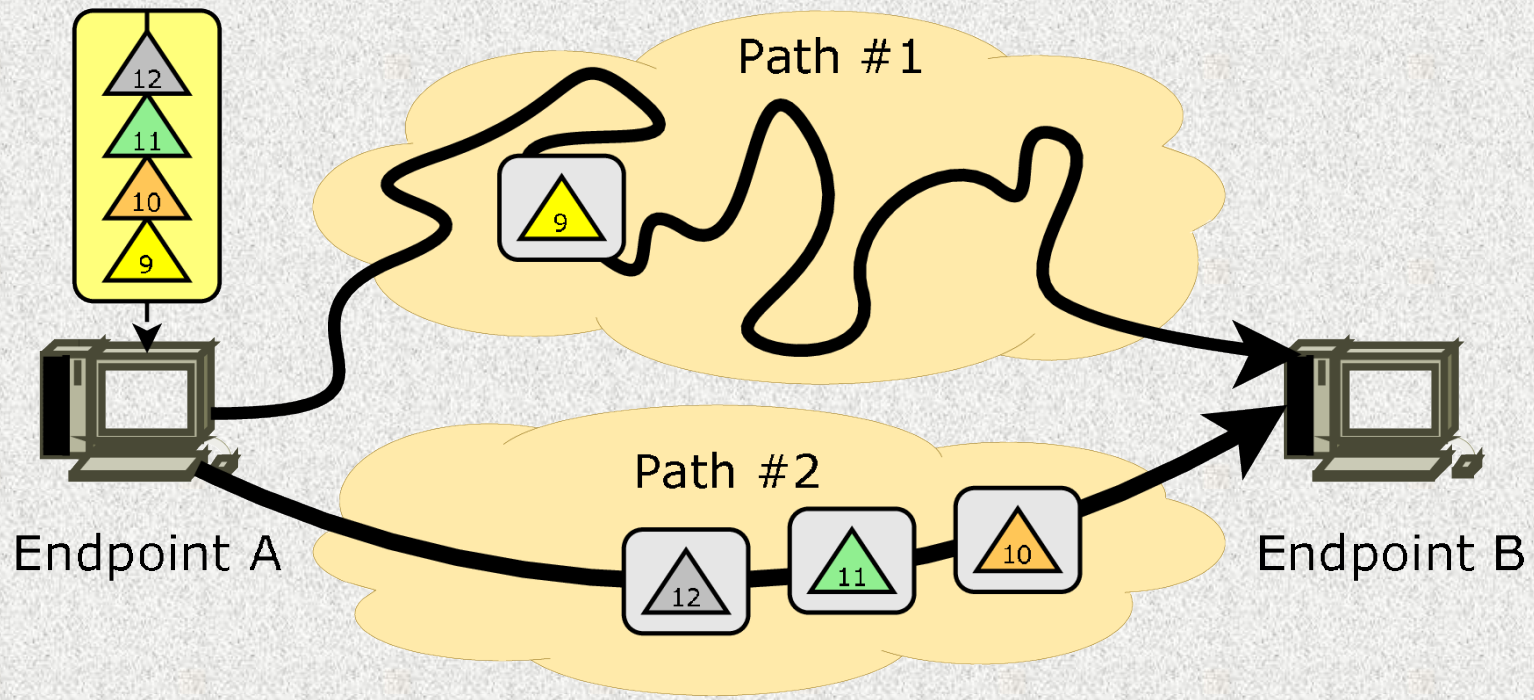
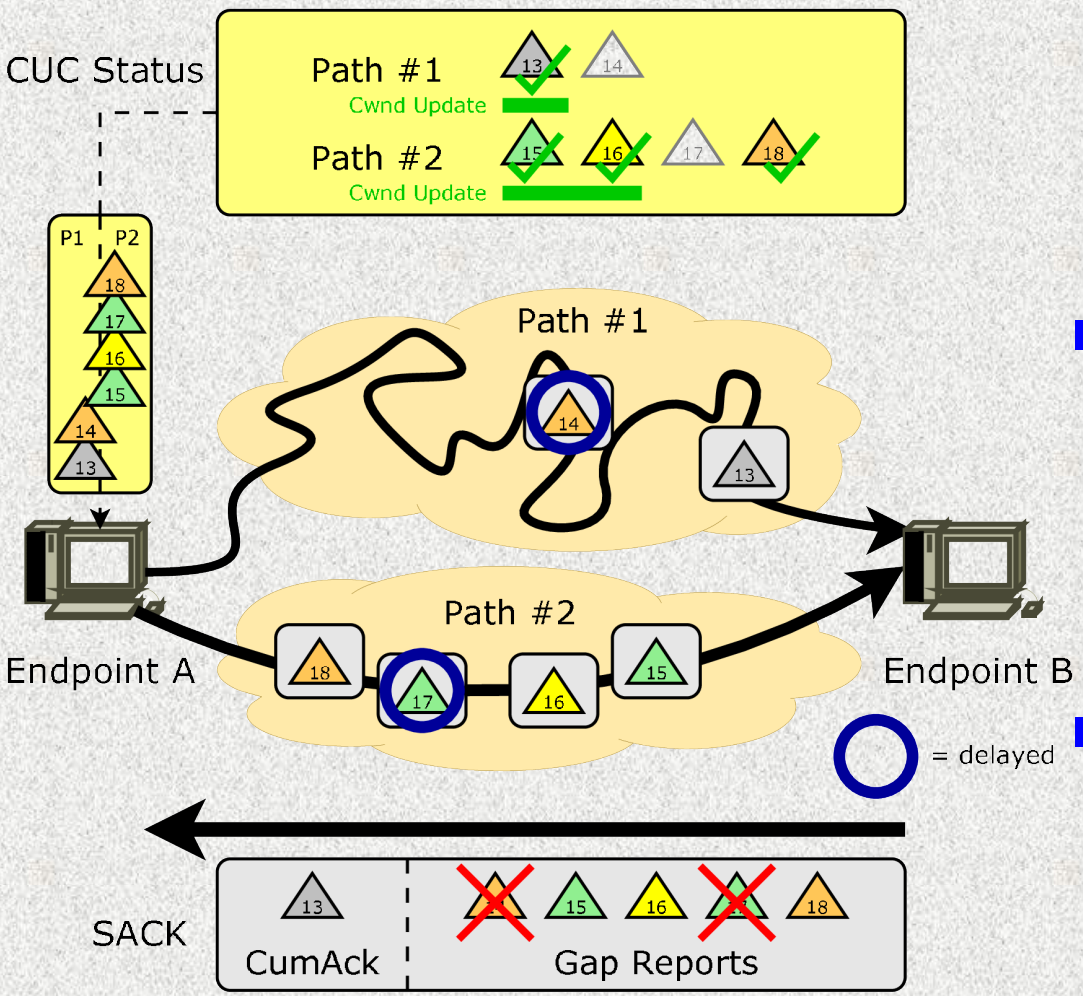


- Split Fast Retransmission (SFR)
  - Handle paths independently ...
  - ... i.e. take paths into account when looking for gaps in acknowledgements

Congestion Window Updates



- SCTP Congestion Handling
  - AIMD behaviour (like TCP) with
    - Slow Start
    - Congestion Avoidance
  - For each path separately
- Congestion Window Update for CMT (CUC)
  - "Pseudo CumAck" for each path
  - When Pseudo CumAck is advanced, the congestion window can be increased
- CUC Variants:
  - Version 1 (CUCv1)
  - Version 2 (CUCv2)
    - Distinction between
      - First-time transmissions
      - Retransmissions

Delayed Acknowledgements

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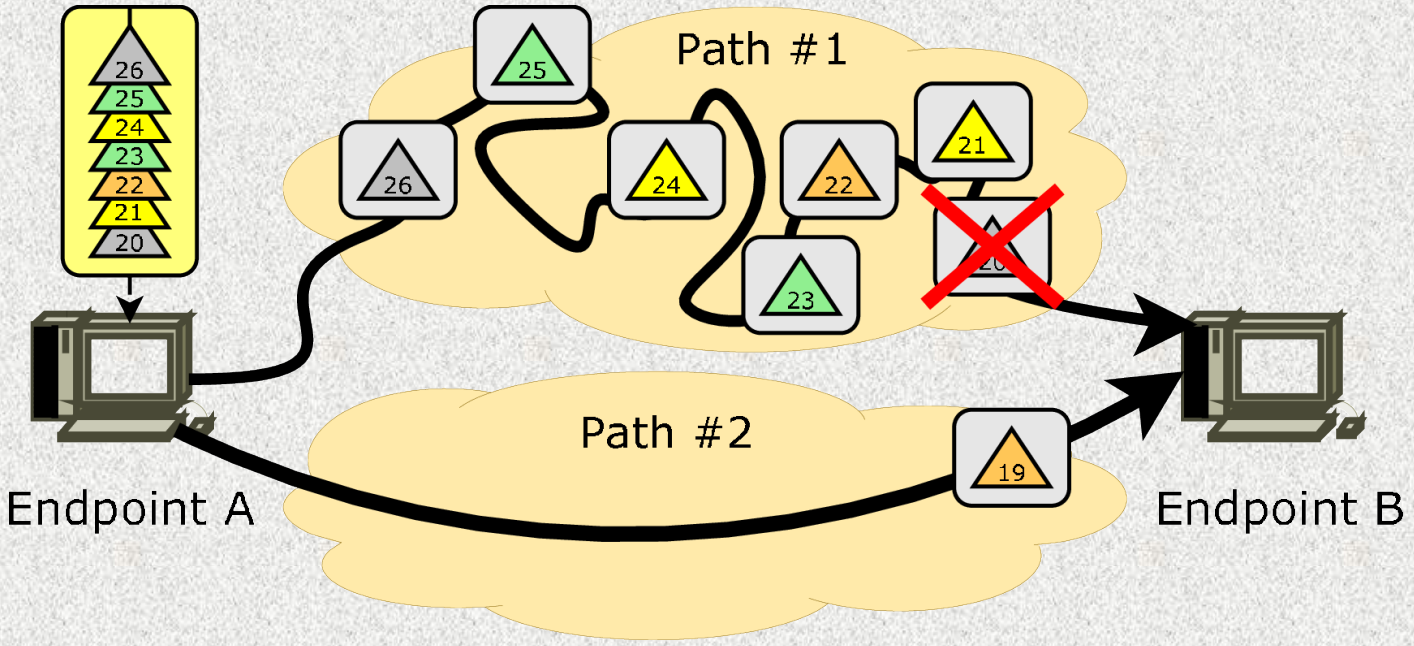

- Regular Delayed Acknowledgement
  - Send acknowledgement for every second packet ...
  - ... but for each out-of-order packet
- Delayed Acknowledgement for CMT (DAC)
  - Always delay acknowledgements (leading to late Fast RTX)
    - Each new SACK contains the number of received sequence numbers since the previous SACK
    - => Sender may perform Fast Retransmissions as fast as before

CMT-SCTP in OMNeT++/INET

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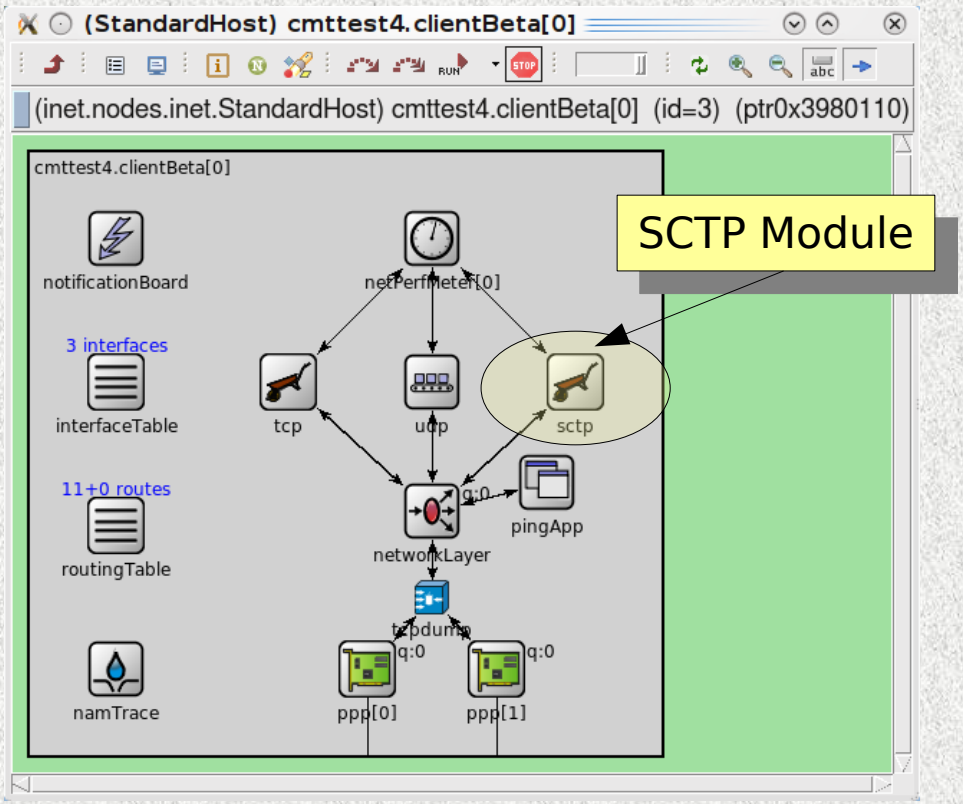
- Model Overview
  - Part of the SCTP module ...
  - ... which is integrated into StandardHost
  - CMT-SCTP can be turned on by parameter setting
  - Existing SCTP applications can use it without changes!



- CMT-SCTP Parameter Overview

Parameter	Functionality	Default
allowCMT	Enable/Disable CMT-SCTP	false
cmtUseSFR	Enable/Disable Split Fast Retransmission for CMT (SFR)	true
cmtUseDAC	Enable/Disable Delayed Ack for CMT (DAC)	true
cmtCUCVariant	Pseudo CumAck Variant	CUCv2

MultihomedFlatNetworkConfigurator - An Auto Configurator for Multi-Homed Networks

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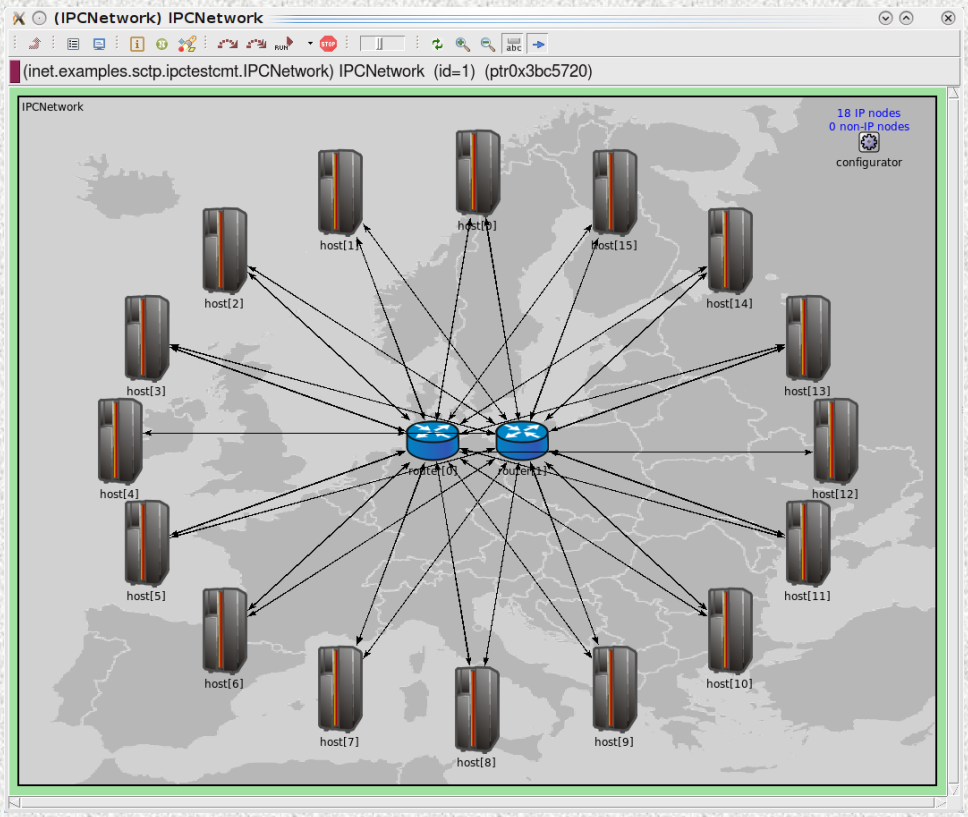
How to set up multi-homed networks easily?



- MultihomedFlatNetworkConfigurator
  - Automatic configuration of IP addresses and routing tables
  - Links belong to a network
    - NetID: the network identifier
    - Special NetID “0”: all networks
  - Dijkstra algorithm is applied on each network separately

NetPerfMeter – A Multi-Protocol Network Test Application

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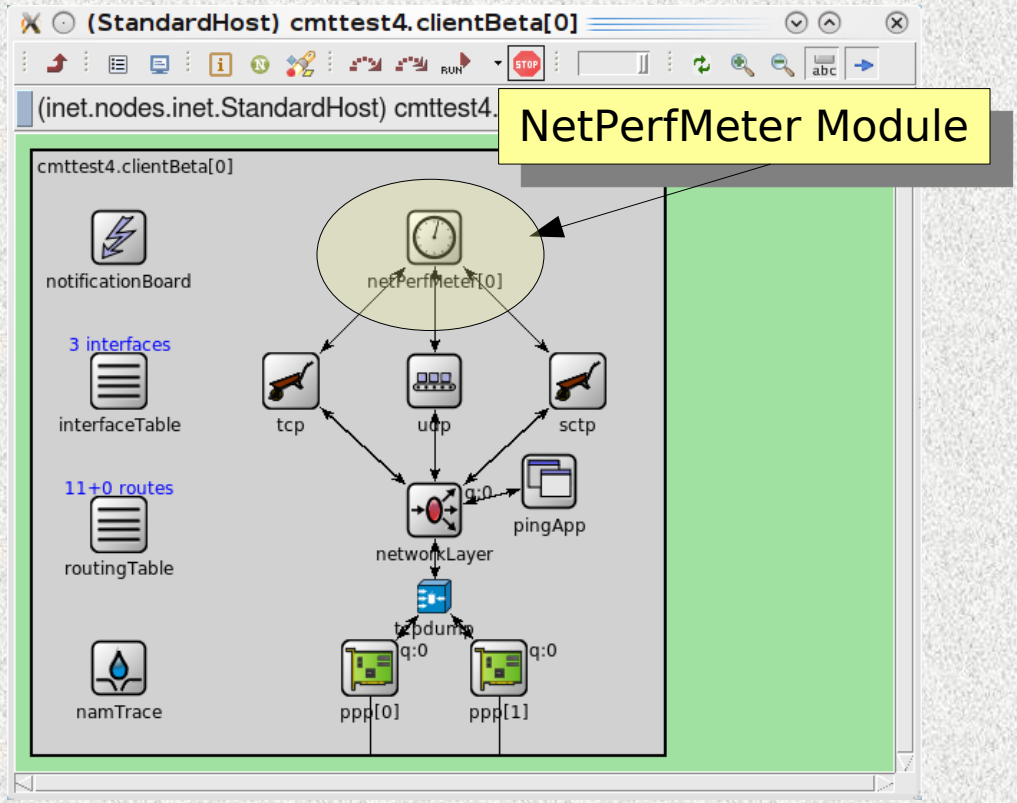

- NetPerfMeter
  - Throughput measurements
  - Multi-protocol support
    - SCTP (of course)
      - Ordered/unordered
      - Reliable/unreliable
    - TCP
    - UDP
  - Sender options
    - Saturated ("as much as possible")
    - Non-saturated ("frame rate / frame size")
  - Output of results as scalars
    - Can be processed easily with SimProcTC tool-chain!

Model Validation: Simulation vs. FreeBSD Lab Setup

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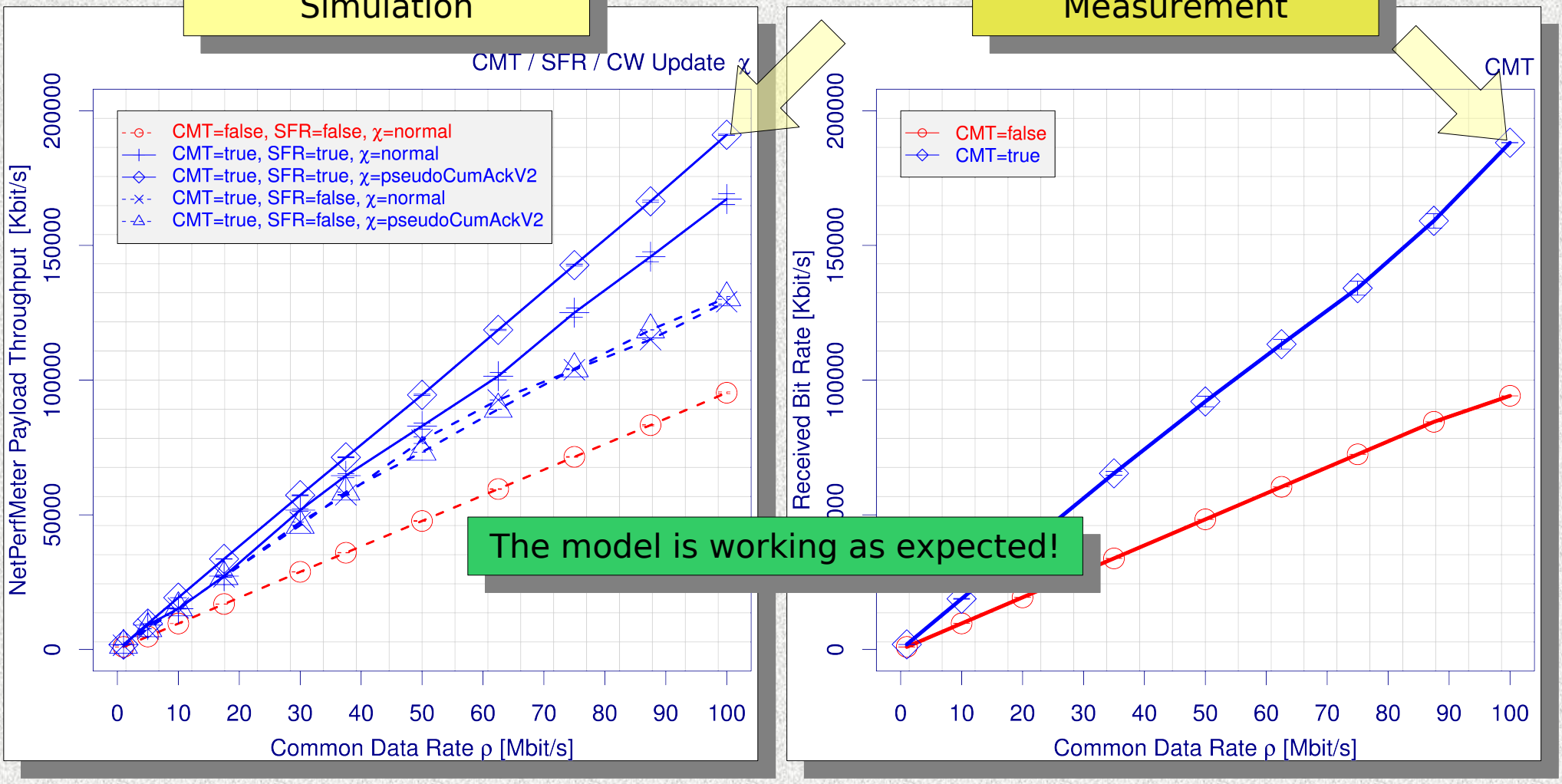

- 2-path setup, varying path bandwidth ρ
- Simulation results correspond to measurement results in lab setup

Conclusion and Outlook

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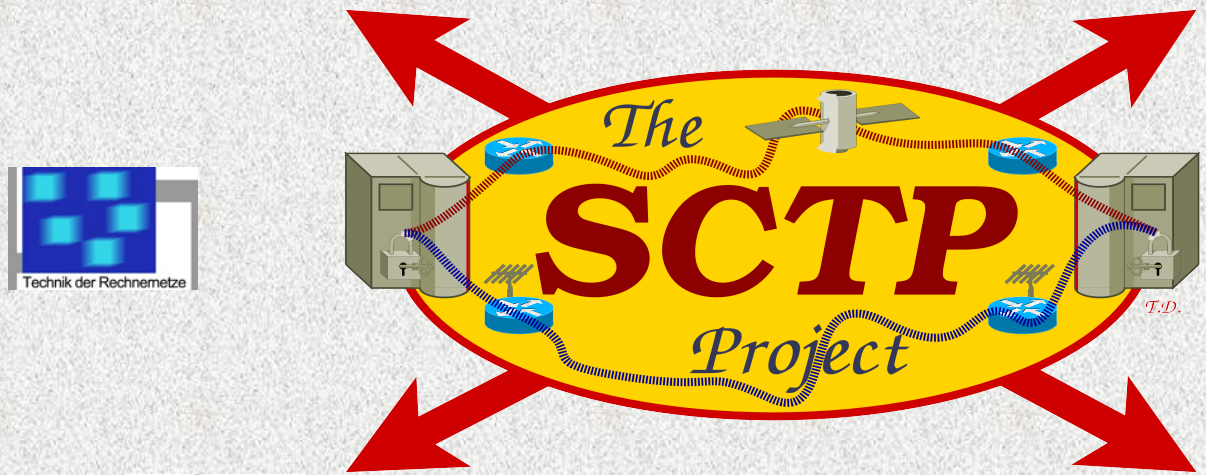
Conclusion

- CMT-SCTP – Concurrent Multipath Transfer with SCTP
- Support for CMT-SCTP added into the INET SCTP module
- Configurator for multi-homed networks
- NetPerfMeter test application
- Model validated against FreeBSD-based lab setup

Future Work

- SimProcTC tool-chain improvements for performance analyses
- Research on CMT-SCTP performance
  - Resource Pooling (RP) for fair bandwidth share in the Internet
    - CMT/RP-SCTP – the combination of CMT-SCTP and RP
  - Performance for asymmetric paths
- Contributions to IETF standardization process

Thank You for Your Attention!
Any Questions?



To be continued ...

Visit Our Project Homepage:

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

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