

ns-3 training

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Outline

> TCP

- tcp-variants-comparison.cc example
- Connection of TCP trace sources at runtime
- PCAP tracing
- Flow Monitor tracing and processing

> Flow Monitor

- PyViz demonstration

> Bake and DCE (included in another presentation)



History of ns-3 TCP

- Until ns-3.10
 - it was a port of TCP model from GTNetS (Georgia Tech Network Simulator)
- For ns-3.10
 - it was substantially rewritten by Adriam Tam in 2011
- For ns-3.25
 - the module was refactored as a part of GSoC 2015 project by Natale Patriciello
 - one of the major changes involved how congestion control algorithms are implemented (more details to follow)
 - other notable change was about automating the tests
 - Target is to align the implementation with that of Linux

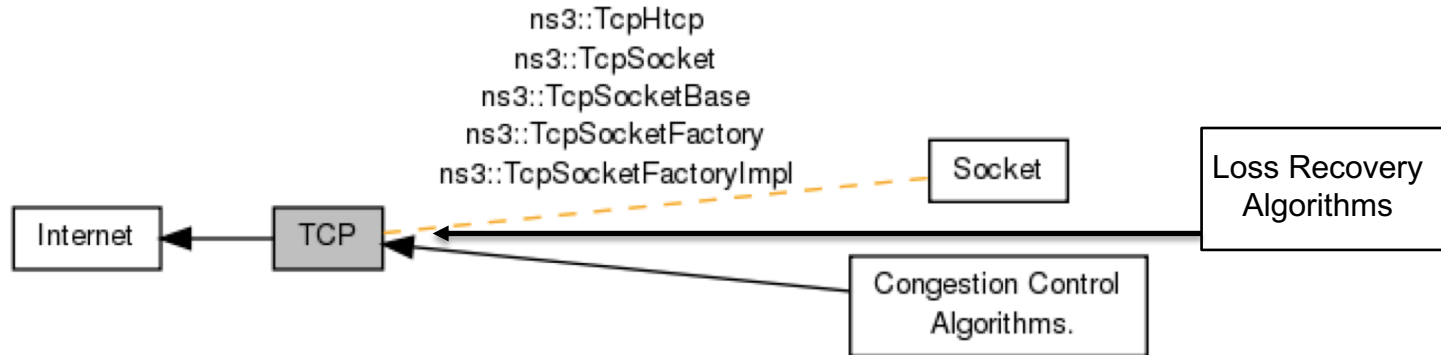
Congestion control algorithms

- NewReno (*default*)
- Westwood, Westwood+
- Hybla
- HighSpeed
- Vegas
- Scalable
- Veno
- Binary Increase Congestion Control (BIC)
- Yet another HighSpeed TCP (YeAH)
- Illinois
- H-TCP
- Low Extra Delay Background Transport (LEDBAT)
- Data Center TCP (DCTCP)-- under review

Loss detection and recovery algorithms

- Loss detection
 - Traditional timeout
 - Traditional 3 DUPACKs
 - SACK
 - RACK (under review)
- Recovery mechanisms
 - Traditional timeout
 - NewReno fast retransmit and recovery
 - Proportional Rate Reduction (PRR)

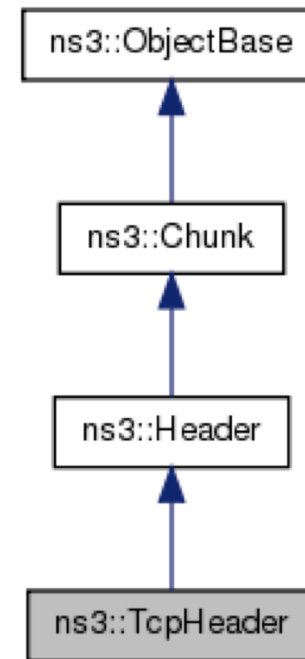
TCP implementation in ns-3



- Source code can be found at: `src/internet/model/`
 - `tcp-header.{h,cc}`
 - `tcp-socket.{h,cc}`
 - `tcp-socket-base.{h,cc}`
 - `tcp-socket-factory-impl.{h,cc}`
 - `tcp-l4-protocol.{h,cc}`
 - `tcp-congestion-ops.{h,cc}`
 - `tcp-recovery-ops.{h,cc}`
 - ...

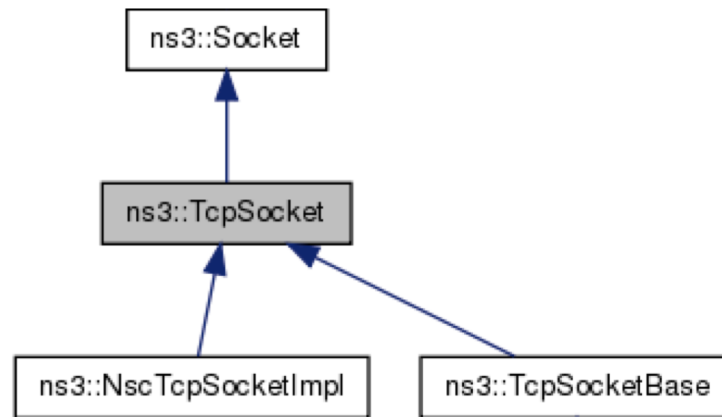
TcpHeader class

- This class implements the TCP header and contains:
 - port numbers
 - sequence numbers
 - acknowledgment numbers
 - flags
 - ...
- It also contains:
 - setters and getters
 - methods for serialization
 - and deserialization



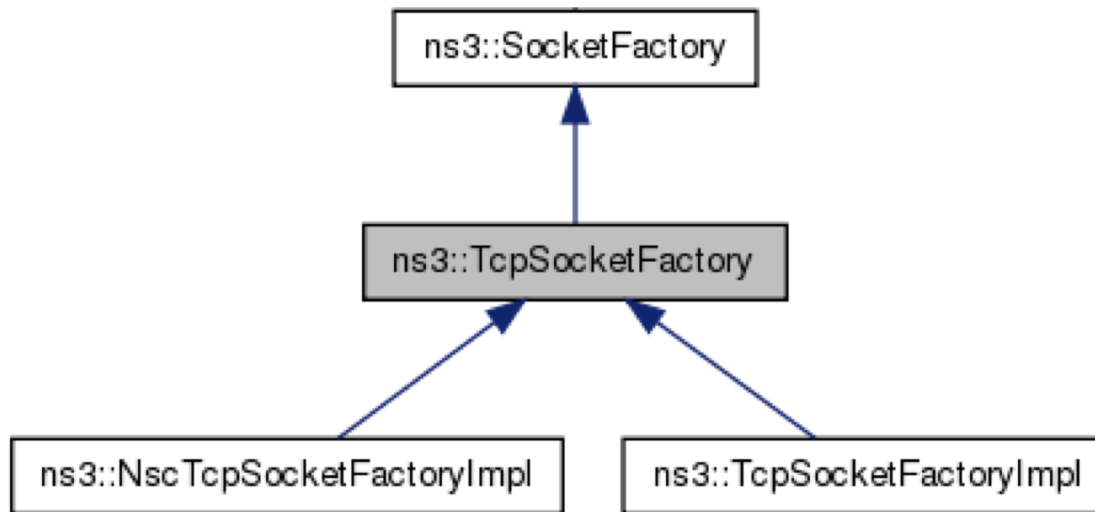
TcpSocket class

- This class:
 - is an abstract base class for all TcpSockets
 - contains TcpSocket attributes that can be reused across different implementations.
- Examples of such attributes include:
 - SndBufSize
 - RcvBufSize
 - SegmentSize
 - InitialCwnd
 - DelAckCount
 - DelAckTimeout
 - ...



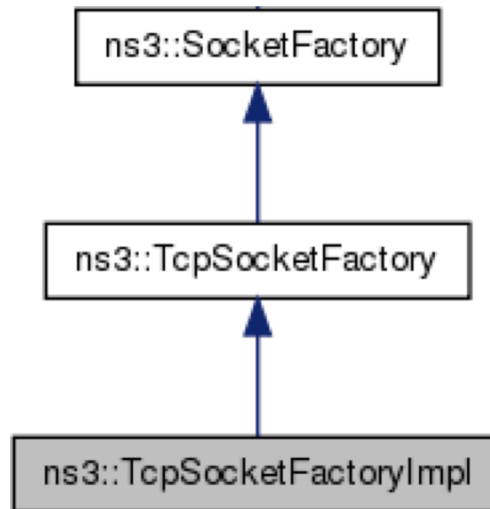
TcpSocketFactory class

- This class:
 - is an abstract base class
 - defines API for TCP sockets
 - contains global default variables to initialize new sockets



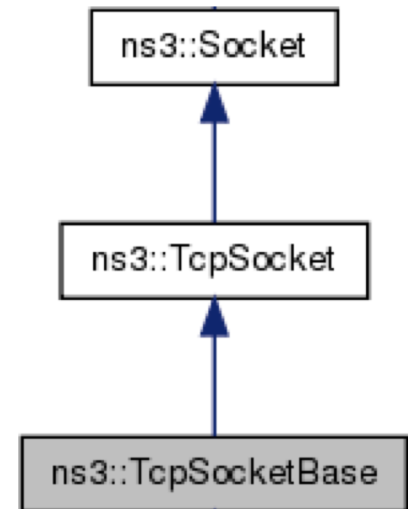
TcpSocketFactoryImpl class

- This class:
 - is an implementation of socket factory for ns-3 TCP
 - creates sockets of type TcpSocketBase



TcpSocketBase class

- This class:
 - is a base class for the implementation of TCP stream socket
 - contains essential components of TCP and provides a socket interface for upper layers to call
- Examples of components include:
 - Connection orientation
 - Sliding window mechanism
 - Fast retransmit
 - Fast recovery
 - Enable/disable window scaling, timestamps
 - Congestion state machine
 - Congestion control interface



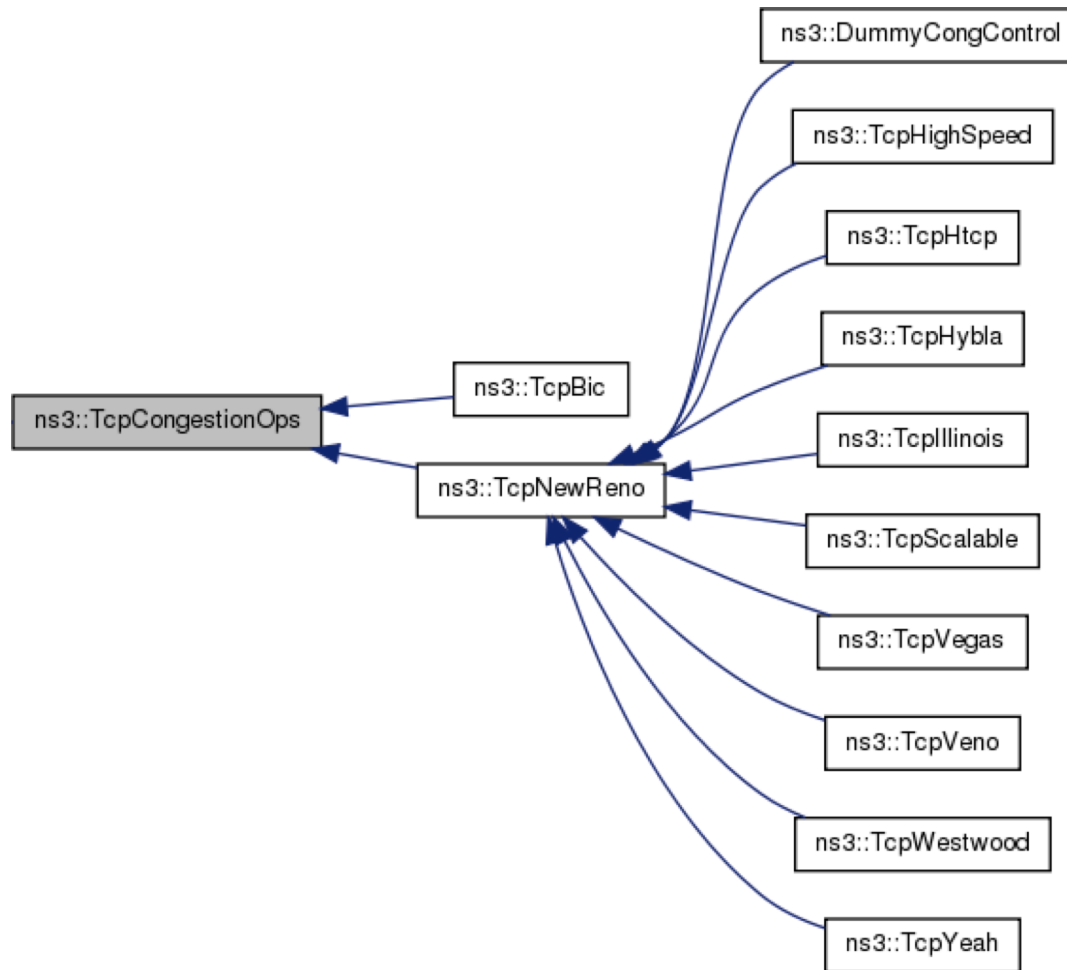
TcpSocketState class

- This class:
 - records the congestion state of a connection
 - saves the information that is passed between the socket and the congestion control algorithms
- Examples of such information include:
 - the current value of congestion window
 - the current congestion state (CA_OPEN, CA_RECOVERY, etc)
 - the current value of slow start threshold
 - Last sequence number acknowledged
 - Next sequence number to be transmitted
 - ...

TcpCongestionOps class

- This class:
 - is an abstract class for congestion control
 - provides an interface between the main socket code and congestion control; variables are stored in TcpSocketState
 - inspired by the design in Linux
- Some methods implemented in this class include:
 - `GetSsThresh (Ptr<TcpSocketState>, uint32_t)`
 - `IncreaseWindow (Ptr<TcpSocketState>, uint32_t)`
 - `CongestionStateSet (Ptr<TcpSocketState>, TcpSocketState::TcpCongState_t)`
 - `PktsAcked (Ptr<TcpSocketState>, uint32_t, Time)`

TcpCongestionOps class



Example review

- found in `examples/tcp/tcp-variants-comparison.cc`
 - based on past WNS3 paper:
 - <http://www.ittc.ku.edu/resilinet/papers/Gangadhar-Nguyen-Umapathi-Sterbenz-2013.pdf>
 - PCAP output
 - flow monitor output
 - the need to defer connection of trace sinks until after time 0