Implementation of Stateless Transport Protocols in ns-3

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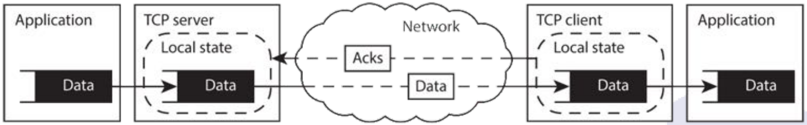
TCP Architecture



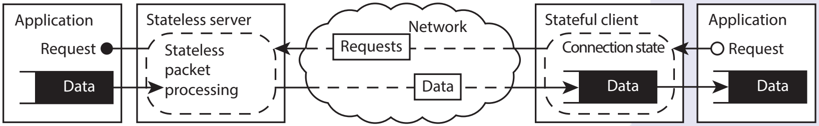
- Originally from 1980s: in-order delivery, loss recovery, congestion control;
- Many major improvements: new congestion control algorithms etc.;
- Tons of minor improvements: bug fixes, specific corrections etc.

Stateless architecture

- **Store no application state on your servers**

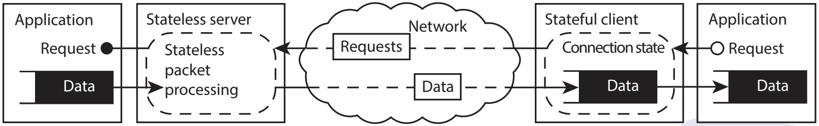
AWS Tips I Wish I'd Known Before I Started

(https://wblinks.com/notes/aws-tips-i-wish-id-known-before-i-started/)



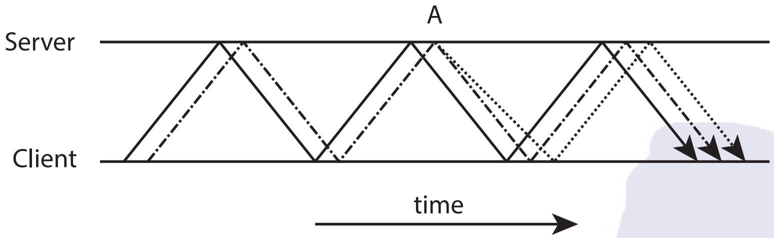
Must retain in-order delivery, loss recovery, congestion control.

Trickles protocol



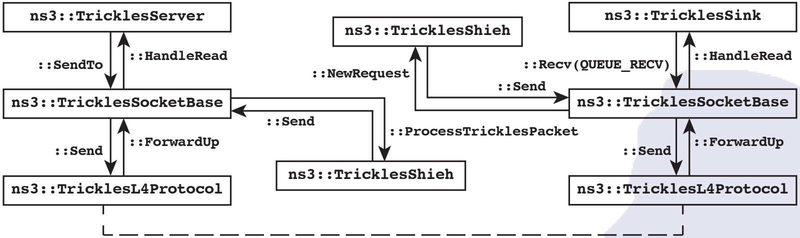
- Developed in Cornell in 2000s:
  A. Shieh, A.C. Myers, E.G. Sirer, "A Stateless Approach to Connection-Oriented Protocols", ACM Trans. Comput. Syst., Vol. 26, No 3, Sept., 2008, 50 p.
- Sample implementation exists for Linux kernel (last commit in 2006)

Trickles congestion control



- Trickle management: split, continue, terminate;
- Follows Reno congestion control algorithm: slow start, congestion avoidance, fast retransmit.

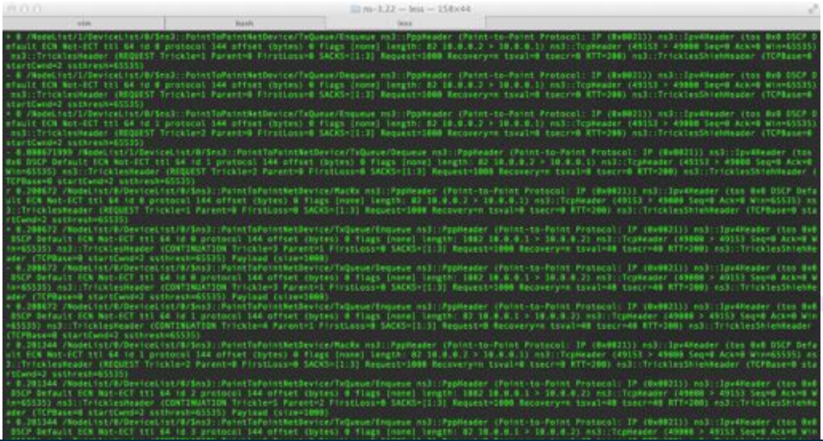
Overview of Trickles model in ns-3



Source code is available at *https://github.com/dchaly/stateless*

Stages of modeling in ns-3

- Build a model of your own protocol or use existing ones.
- Describe an experiment using ns-3 classes.
- Compile, run and get a trace file:



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+ 0 /NodeList/1/DeviceList/0/$ns3::PointToPointNetDevice/TxQueue/Enqueue ns3::PppHeader (Point-to-Point Protocol: IP (0x0021)) ns3::Ipv4Header (tos 0x0 DSCP D
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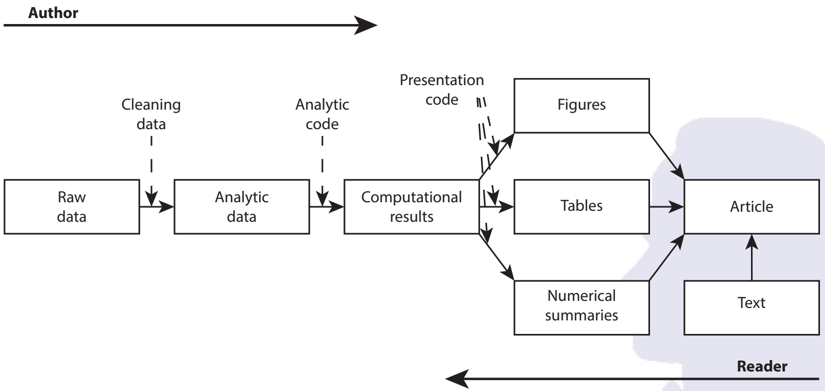
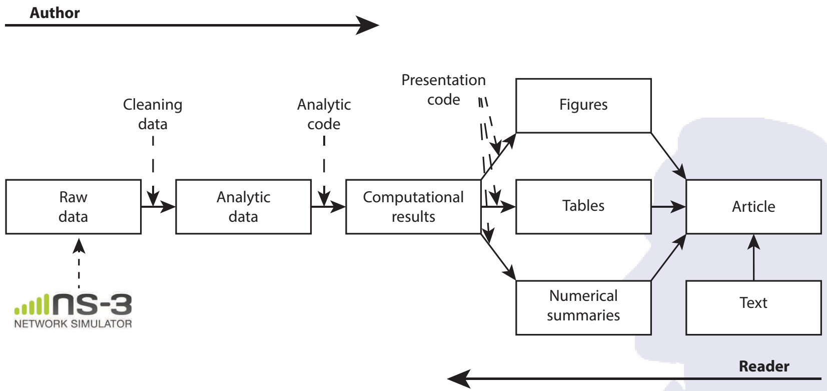
Research pipeline



Research pipeline with ns-3

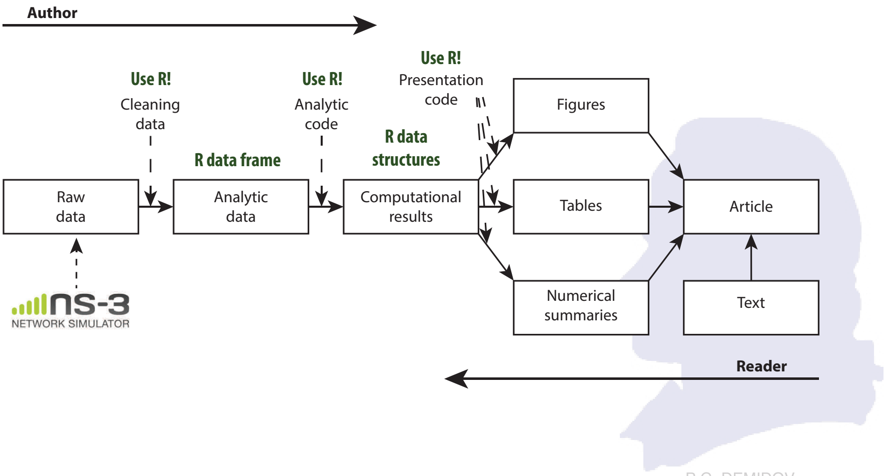


A tool for filling the pipeline

Key insight: use data science methods. Use R!

- Free software for statistical computing
- Tons of packages for different needs (CRAN)
- R-studio is a free IDE for developing
- `http://www.r-project.org`

Research pipeline



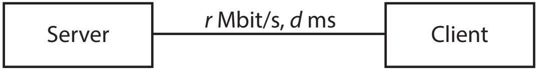
Literate programming

- Introduced by D. Knuth in 1984
- Essentially a programming language and a documentation system
- ns-3 uses C++ and Doxygen, thus it follows the literate programming ideas
- How to introduce the concept of literate programming to experiments?

R+Markdown+knitr+ns-3

- R is a programming language
- Markdown is a documenation language
- knitr is an R package that ties R and Markdown and produces a report
- R executes ns-3 using shell commands and parses stdout and stderr

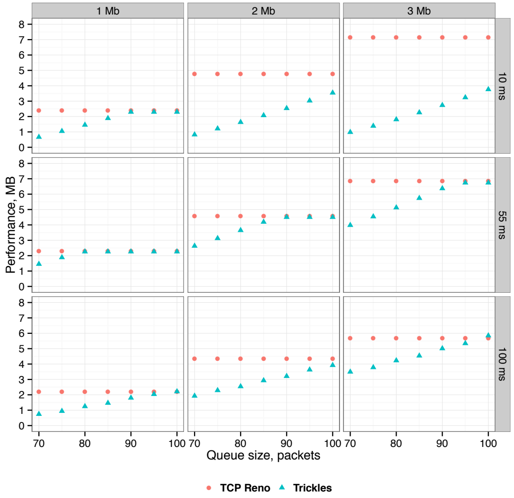
Simple experiment



- $r = \{1.0Mb/s, 2.0Mb/s, 3.0Mb/s\}$;
- $b = \{10ms, 55ms, 100ms\}$;
- queue length varies from 70 to 100 with the step of 5 packets.

R Markdown source code is available at
https://github.com/dchaly/stateless/ns-3.20/ns3-stateless-report.Rmd

Experimental evaluation



Future work

- More model evaluations, testing and debugging
- Develop new stateless protocols
- Performance analysis of stateless protocols in different settings: wired, wireless, SDN etc.