TCN
Trace Control for Netem
Porting the Trace Based Network Emulator RplTrc to the Linux Kernel 2.6 Network Emulator Netem

Semester Thesis

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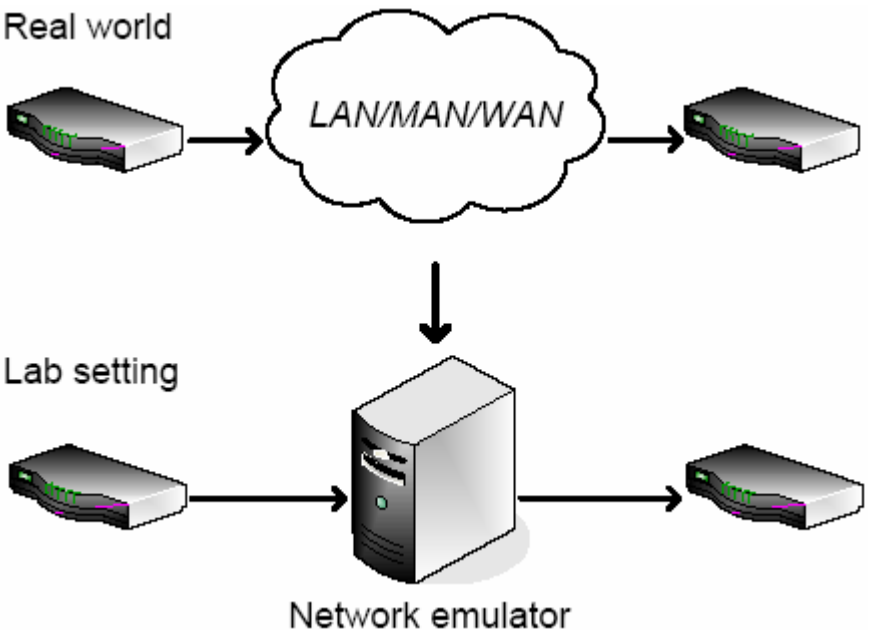
Network Emulation

Goal: Facilitate network protocol testing by emulating network properties such as packet delay, duplication and loss



Problems:

- Real time task
- Statistical properties such as long-range dependency

Solutions:

- Kernel programming
- Trace based emulation

NIST Net and RplTrc

Original NIST Net

- Network emulation with commodity PC
- Emulation of packet delay, duplication and loss based on statistical tables
- Implemented as a Linux kernel module for kernel 2.4

RplTrc

- Enhancement of NIST Net to emulate long-range dependency and self-similarity of cross traffic
- New source of packet action values: trace file
- Implemented by Thomas Hug in his master thesis at TIK

Problem Statement

Motivation

- Linux kernel version 2.6. includes a network emulator called netem.
- Easy installation by configuring Linux kernel.
- Wide spread of Linux Kernel

My task

- Porte the trace reader from RplTrc
  to the Linux 2.6 network emulation tool netem.
- Extend it and eliminate weaknesses.
- Write a comprehensive manual for TCN
  and the Linux traffic control tool tc.

Netem

Structure

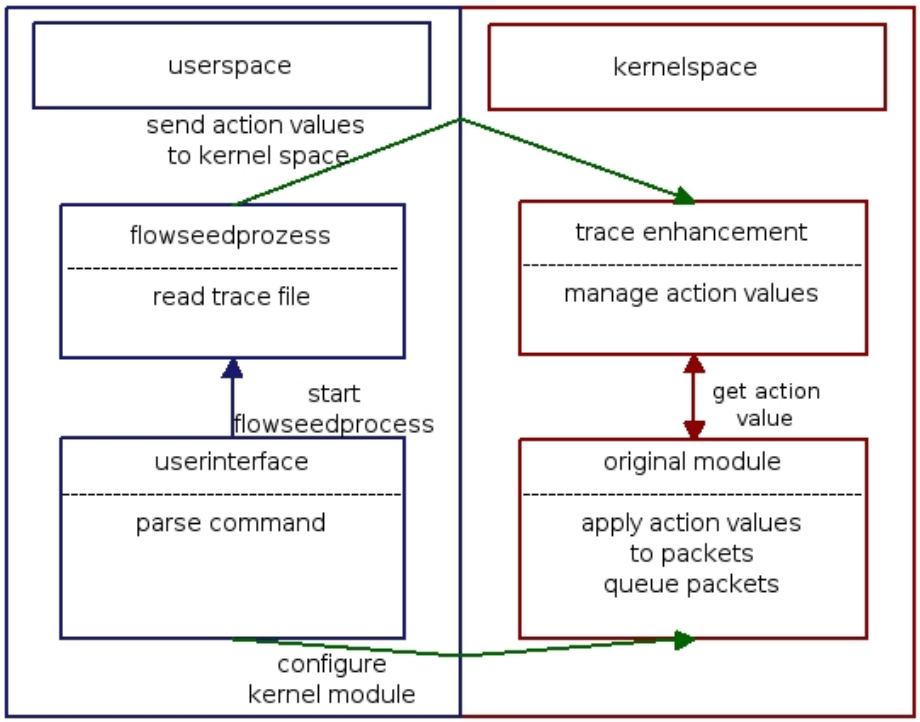
- Linux Kernel Module based on NIST Net
- User interface as an extension to the Linux traffic control tool tc

Abilities

- Packet delay, duplication and loss based on statistical tables
- Insert Bit error at random position
- Various possibilities for packet classification using tc

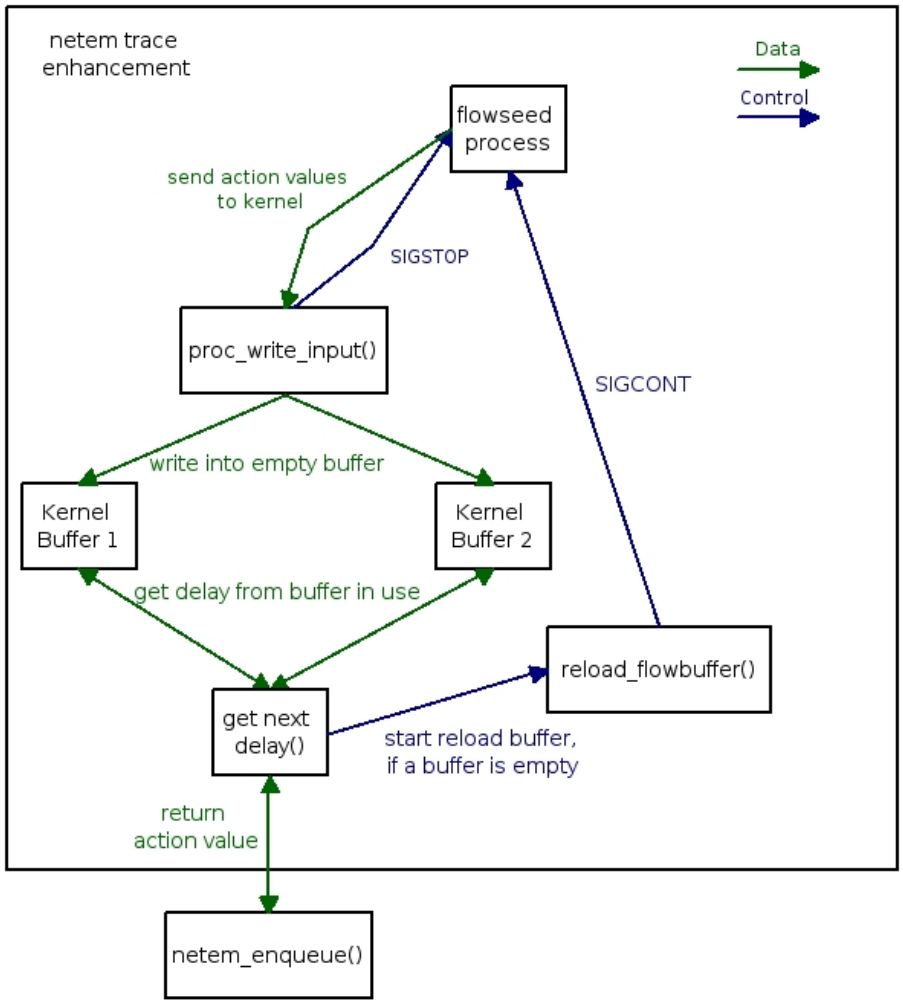
Netem Trace Enhancement: Architecture I

Architecture based on RplTrc and netem



- Time consuming tasks are done in user space.
- Time critical tasks are done in kernel space.
- Synchronization between start of flowseed process and command registration in kernel.

Netem Trace Enhancement: Architecture II



- Two buffers provide continuous availability of action values.
- SIGCONT and SIGKILL signals control flowseed process.

Evaluation

Functional Verification

- Correct application of packet delay, duplication, loss and corruption
- Add, change and delete multiple instances of the emulator on-the-fly

Performance Evaluation

- Maximal packet rate: 80’000 packets/second
- Delay precision: approximately 1ms due to Linux timer resolution
- Similar results for the original netem emulator and the trace enhancement
  → TCN has no negative impact on netem.

TCN ↔ RplTrc

+ Part of kernel 2.6	- Addition to kernel 2.4
+ Packet filtering according arbitrarily fields	- Packet filtering only per flow (IP src and dst address, ports)
- Timer resolution 1ms	+ Timer resolution 122µs
+ Delay, duplication, loss, corruption	- Delay, duplication, loss
+ Manual with examples	- Only README file
+ Configurable options	- No options

Conclusion

Result: Network Emulator for Linux Kernel 2.6 that supports long-range dependency and self similarity of cross-traffic

Limitations:
- timer resolution of 1ms
- not a real-time implementation

Further work:
- Implementation on a hard real-time System
- Extension of the bit error possibilities

Questions