Technische Universität Berlin · Fakultät für Elektrotechnik und Informatik

Time Machine

Gregor Maier · Stefan Kornexl (TUM) · Anja Feldmann · Vern Paxson (ICSI) · Robin Sommer (ICSI)
Fabian Schneider · Bernhard Ager · Holger Dreger (TUM)

Motivation

- Trouble shooting
  - What happened before a fault?
- Security Monitoring (“Forensics”)
  - Break in 3 days ago!
    How? What else have they done?
- Network packet traces are invaluable for forensics
- High traffic volume prevents naive bulk-recording

Approach

- Buffer packets, using a connection cutoff
- Leverages heavy-tailed nature of network traffic
- Buffer several **days** of high-volume traffic
- Provide flexible, automated query interface
- Interface to other security devices (e. g. NIDS)
- Time Machine allows us to
  ”travel back in time”

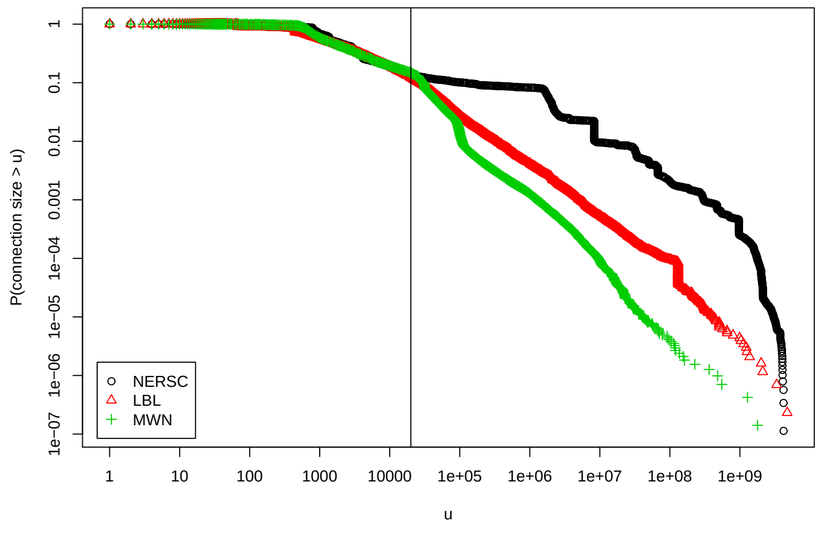
Summary

- Connection Cutoff (15 kB) reduces the capturing volume by 90 %
- Can store a week worth of data with reasonable disk size
- Can handle Gigabit links; Runs on commodity hardware
- Enables allocation of resources to different classes of traffic
- Offers highly flexible and fast queries
- In use at TUM and LBL
- Interface with Bro operational

www.net.t-labs.tu-berlin.de/research/tm/

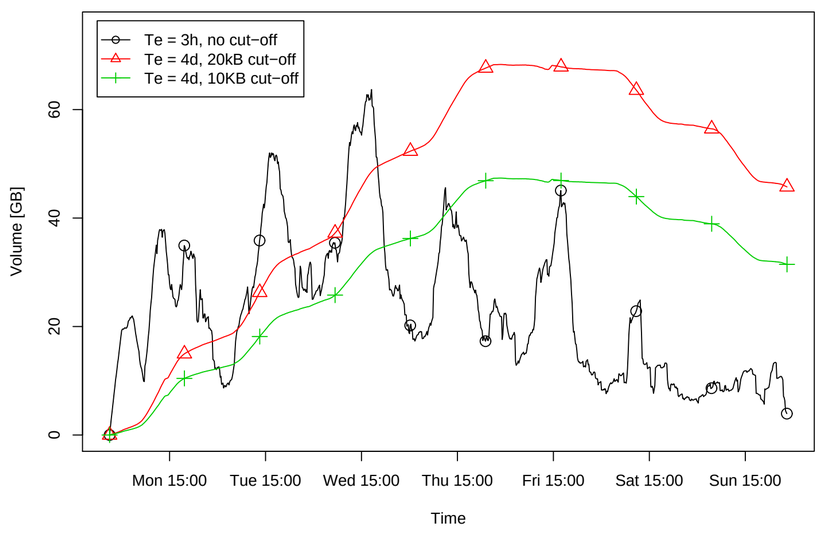
Impact of Connection Cutoff

Connection Cutoff



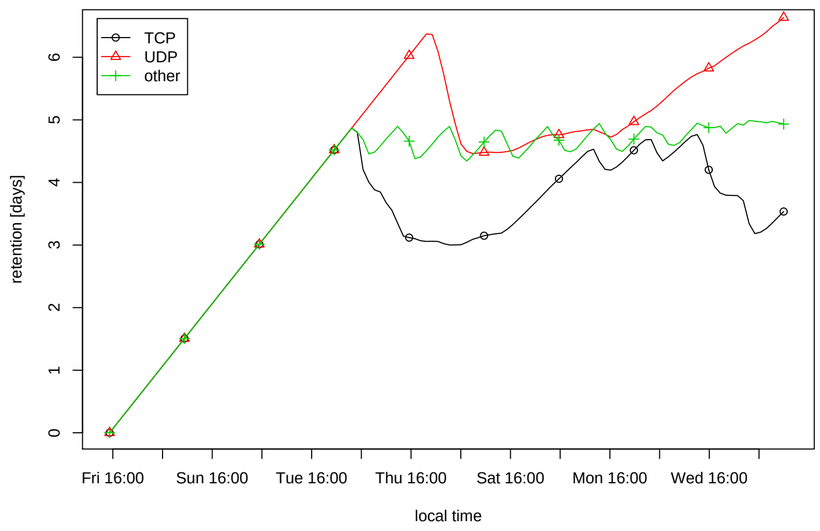
Probability that a connection is of a certain size (vertical line at 20 kB).
⇒ **only 12–15 % of the connections are larger than 20 kB.**

Memory consumption



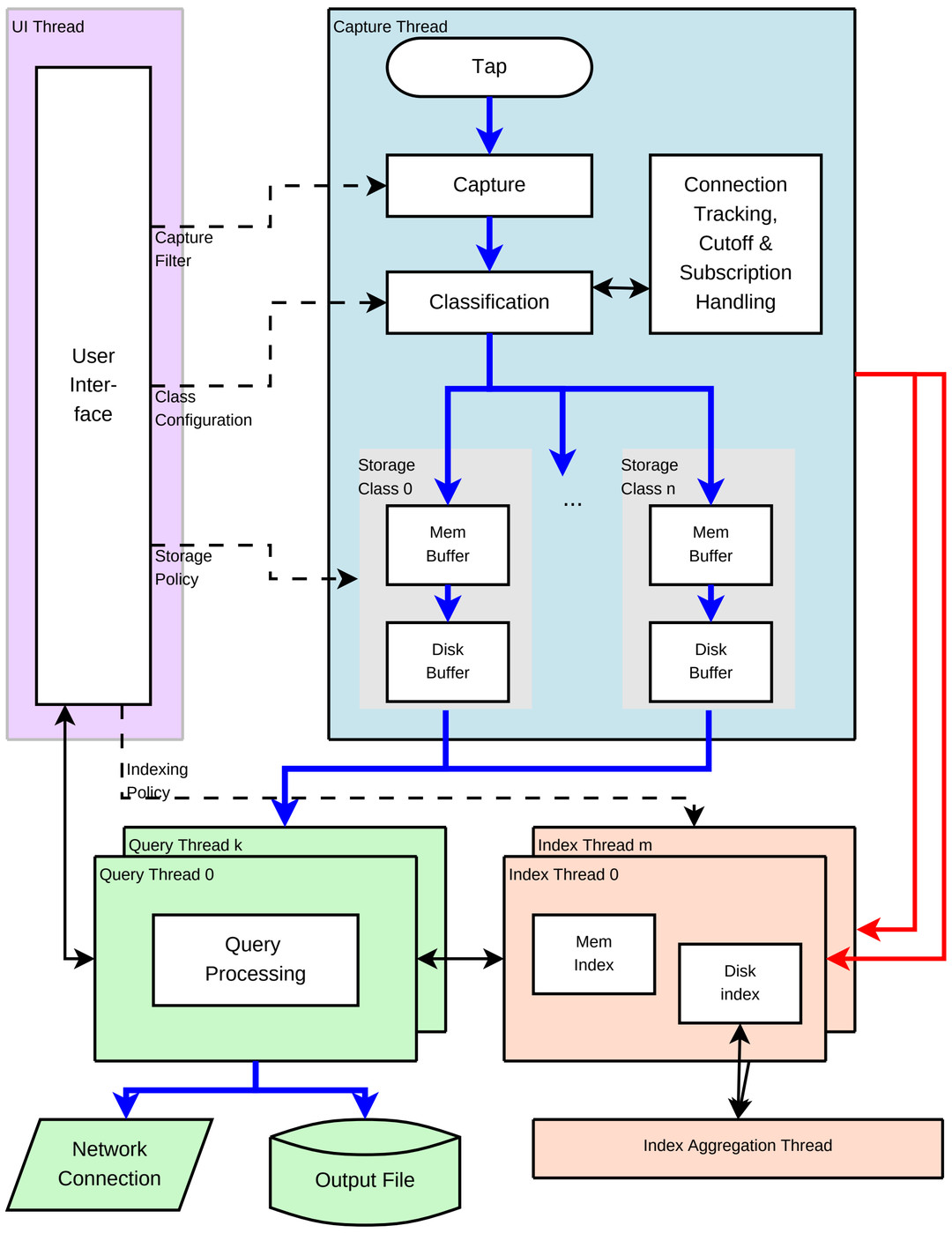
Memory consumption for different eviction times T_e and cutoff.
⇒ **The cutoff reduce the memory needs dramatically, allowing up to four days retention within less than 120 GB.**

Retention time



Retention time (in days) for different classes (cutoff 20 kB, TCP 90 GB, UDP 30 GB, Other 10 GB) of traffic.
⇒ **Even those small memory buffers allow up to three days of retention**

Design



Indexing

- Used to allow easy access to the stored packets (via time-intervals).
- Connection 5-tuple, IP address pairs and single IP addresses are the most common index keys (additional indexes are possible).
- The indexes to packets in memory are kept in memory and the indexes for packets on disk are kept on disk.
- Index files are sorted for fast access.
- Index files on disk are aggregated by a separate thread.

Integration with NIDS’es

A Network Intrusion Detection System (NIDS) can

- control TM to, e.g.:
  - permanently store malicious traffic for forensics
  - dynamically tune operation parameters
- query TM to retrospectively analyze traffic to e. g.:
  - perform in-depth analysis of past traffic originating from detected attackers
  - examine traffic it did not see (due to resource trade-offs, gaps)