

Uniformity and Independence of Hash Functions for Packet Sampling

Nick Duffield, AT&T
Saverio Niccolini, NEC
Maurizio Molina, DANTE
Juergen Quittek, NEC

Hash-based Packet Selection

□ Router calculates hash of each packet

- ✦ Input: $x \in$ hash domain = subset of invariant packet content
- ✦ Output: $h(x) \in$ hash range R

□ Router selects packet if $h(x) \in$ selection range $S \subset R$

□ Required statistical properties

- ✦ Assumption: need representative sample, e.g. estimate traffic rates
- ✦ Want selection to resemble sampling at specified target rate p
 - \Rightarrow hash values $h(x)$ should appear uniformly distributed: $p = \#S/\#R$
- ✦ Want selection to resemble independent sampling between packets
 - \Rightarrow hash values $h(x_i)$ should appear independent over packets i

□ This work

- ✦ Evaluate hash uniformity and independence for PSAMP hash functions
 - Previous work examined uniformity, and execution speed.

Test Setup

□ Hash Functions Evaluated

- ✦ BOB, CRC32, IPSX, MMH

□ Data

- ✦ Packet traces from MAWI (wide area), and NEC (campus)

□ Tests

- ✦ Do packet hashes conform to uniform independent distribution?
- ✦ Diverse Significance Tests
 - Chi-Square: uniformity
 - Box-Ljung: independence
 - Collision Test: uniformity and independence

□ Dimensions

- ✦ Dependence on hash input length
 - 16 bytes from IP/transport header + n bytes payload
- ✦ Granularity of hash values (= minimum sampling rate considered)
- ✦ Variability of results between traces

Summary of Results

- Lowest sampling rates considered is 1 in 1000

- Uniformity

- ✦ BOB closest, CRC32 close to uniform, MMH and IPSX not close
- ✦ BOB more consistent than CRC32 across different traces
- ✦ BOB needs 20 bytes input (header + 4 bytes payload) in worst case

- Independence

- ✦ Only BOB appears close to independent in all tests (20 byte input)
- ✦ CRC32 matches BOB performance in some tests, but needs more input

- Execution speed

- ✦ IPSX nearly order of mag. faster than BOB, which is faster than CRC32
 - IPSX potentially useful if scant resources in router, some applications