Measuring Efficiency of Aggressive Use of DNSSEC-Validated Cache (RFC 8198)

Was it worth the effort?

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CZ DOMAIN
REGISTRY

Talk outline

- RFC 8198 promises

  vs.

- Normal traffic
- Random subdomain attack

RFC 8198: Promises

- Use of NSEC/NSEC3 RRs to
  - increase "performance"
  - **decrease latency**
  - **decrease resource utilization**
  - increase privacy
  - **increase resilience**

RFC 8198: Efficiency

- Query pattern
    - normal traffic
    - random subdomain attack
- Distribution of names in DNS zones
- Wildcards
- TTL

RFC 8198 + NSEC

vs.

Normal traffic

Normal traffic: Experimental setup

- Replay query PCAP to BIND 9.12.0
  - synth-from-dnssec yes / no;
- Record to PCAP
  - traffic to auth
  - answers
- Analyze
  - # packets to auth
  - bandwidth to auth
  - latency for answers

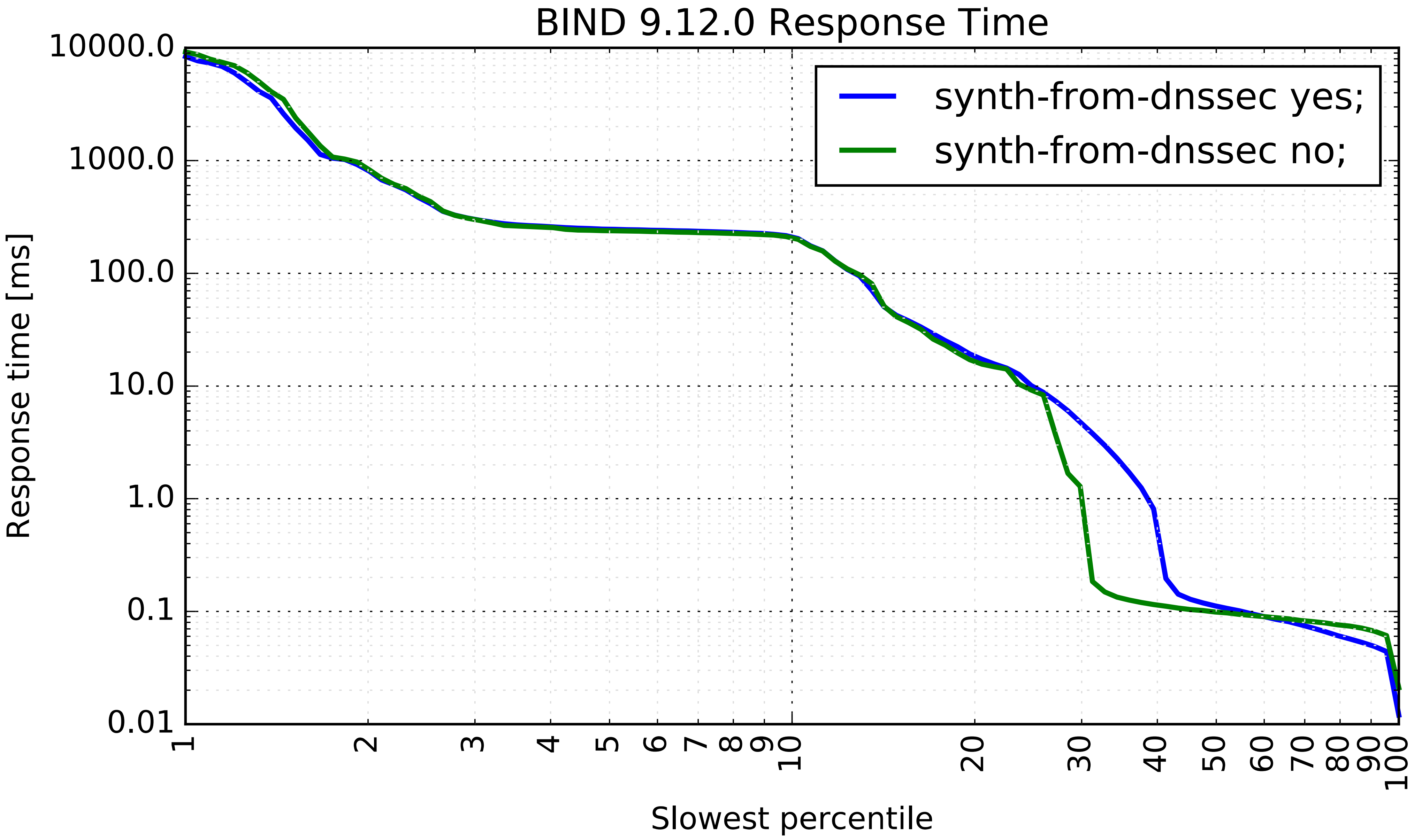
Normal traffic: Data set

- 2 hours of traffic in PCAP
- Public Open Resolver run by CZ.NIC
  - ~ 2500 q/second (excluding QTYPE=ANY)
  - 14 % answers NXDOMAIN
  - 3 % answers SERVFAIL
  - anonymized

Normal traffic: Tools

- BIND 9.12.0
  - "unlimited" cache size (max-cache-size unlimited)
- Drool 1.1.0 to replay traffic with timing
- DNS Collector to analyze latencies
  - (new project by CZ.NIC, to be released)
- Libtrace 3.0.21 to analyze packet #, bandwidth

Normal traffic: Latency … ?



RFC 8198's promises & normal traffic

- ☐ Lower latency
  - Some unexplained increase, a measurement error?
  - Likely not significant for eyeballs (0.1 vs 10 ms)
- ☑ Lower network utilization
  - Small but reproducible decrease
  - 1-2 % decrease of # packets to auth
  - 3-4 % decrease of bandwidth to auth

RFC 8198 + NSEC
vs.
Random subdomain attack

R.S.A. traffic: Experimental setup

- Auth server with a test zone
- Replay random query names to Knot Resolver
- Record **traffic to auth** into PCAP
- Analyze
  - # packets to auth
  - bandwidth to auth

R.S.A. traffic: Tools

- Knot DNS 2.6.4
  - RSASHA256 2048 b, automatic signing
- Knot Resolver 2.1.1
  - "unlimited" cache size (20 GiB)
- dnsperf 2.1.0 to replay queries
- libtrace 3.0.21 to analyze packet #, bandwidth

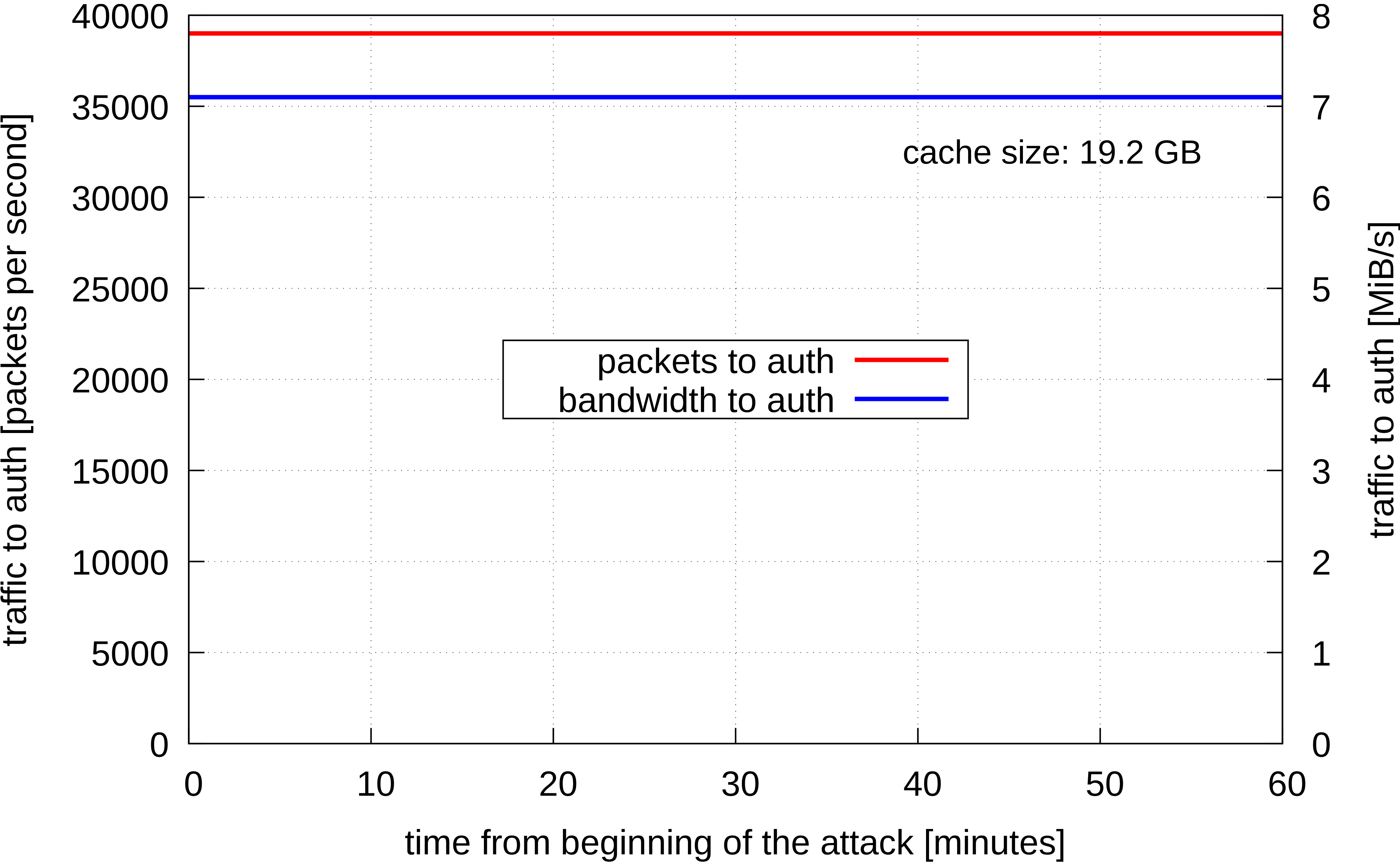
R.S.A. traffic: Query pattern

- 1000 simulated clients
- Next query right after answer to previous query
- Pseudorandom unique query names (256 bits)
  - GCZDKQIS7F7TTHXBIBC4HHZDYTFCPH5XLR6PGEI3WIESK7BS45WQ.test.knot-resolver.cz. A
  - GCZDKQIS7F7TTHXBIBC4HHZDYTFCPH5XLR6PGEI3WIESK7BS45WQ.test.knot-resolver.cz. AAAA
  - OF6OVT2SNIV54B7HI77V5TJ3TFVULN5AMQ2Z6IWQX6GBHQ254LNQ.test.knot-resolver.cz. A

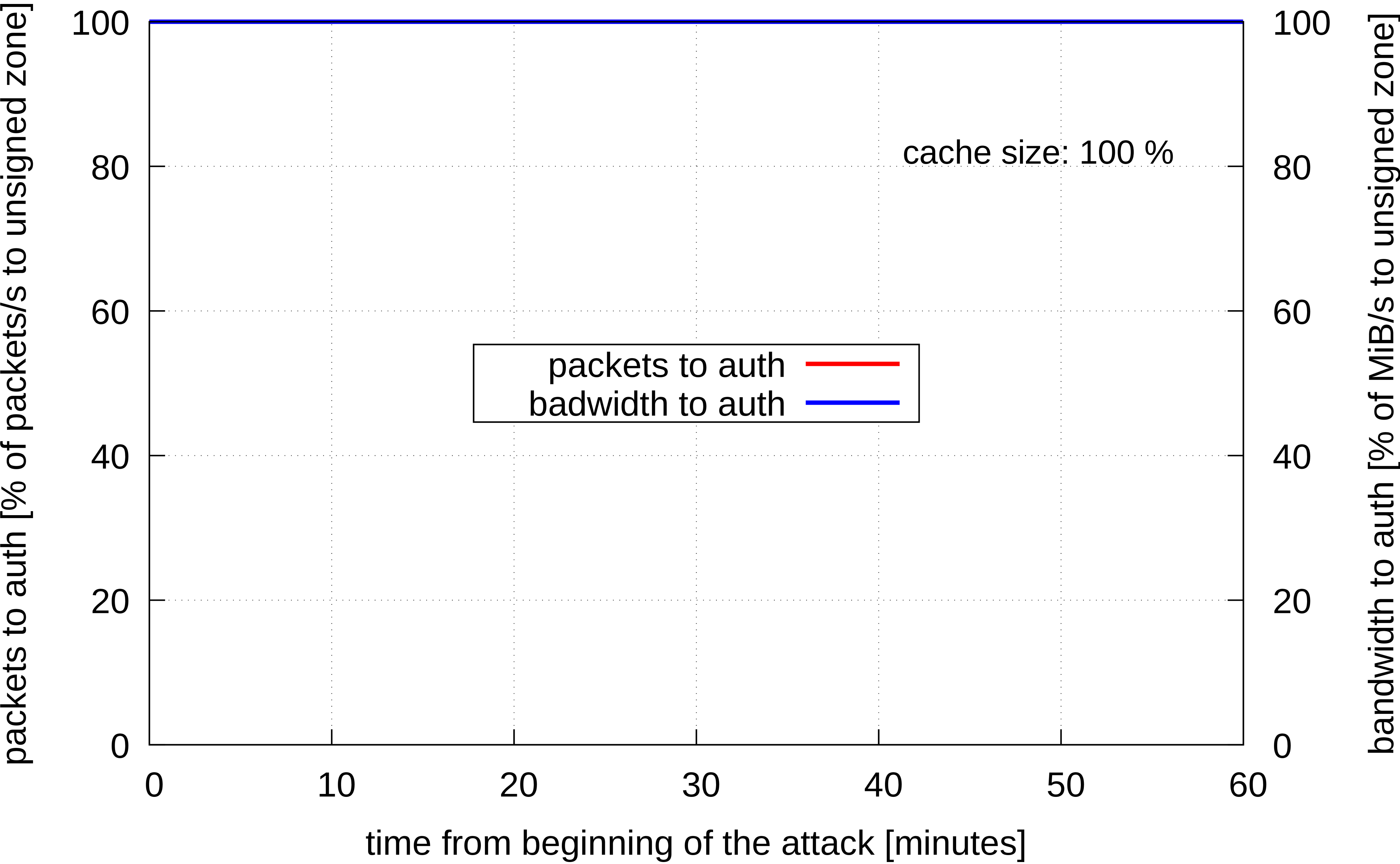
R.S.A. scenarios

- Unsigned zone (baseline)
- Signed zone
  - SOA minimum, NSEC TTL
    - 3600 s / 60 s
  - name distribution (real zones)
    - small zone with wildcard (50 names + 1 wildcard)
    - medium size zone (14k names)
    - big zone (110k names)
    - huge zone (1M names)

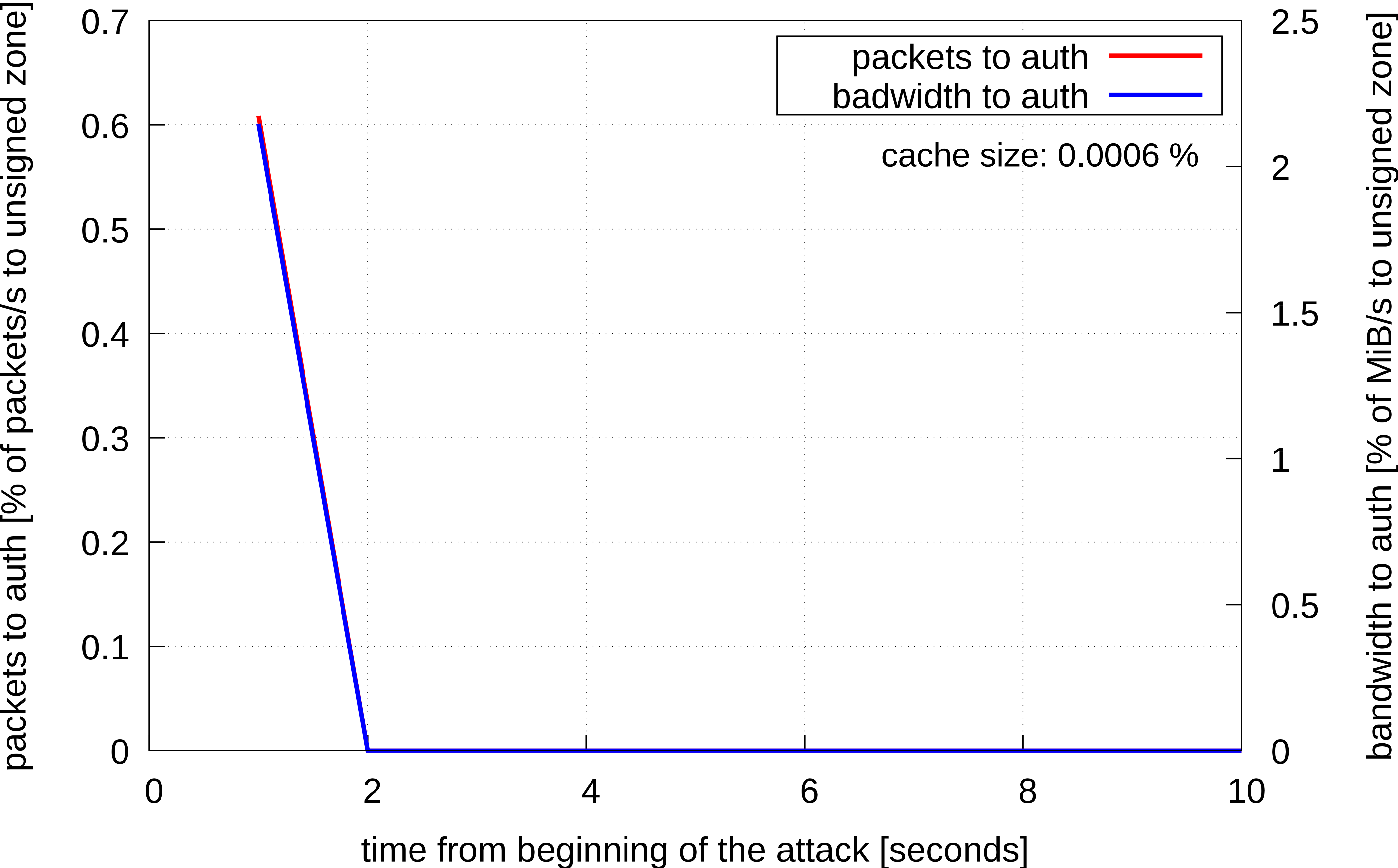
R.S.A.: unsigned zone (abs baseline)



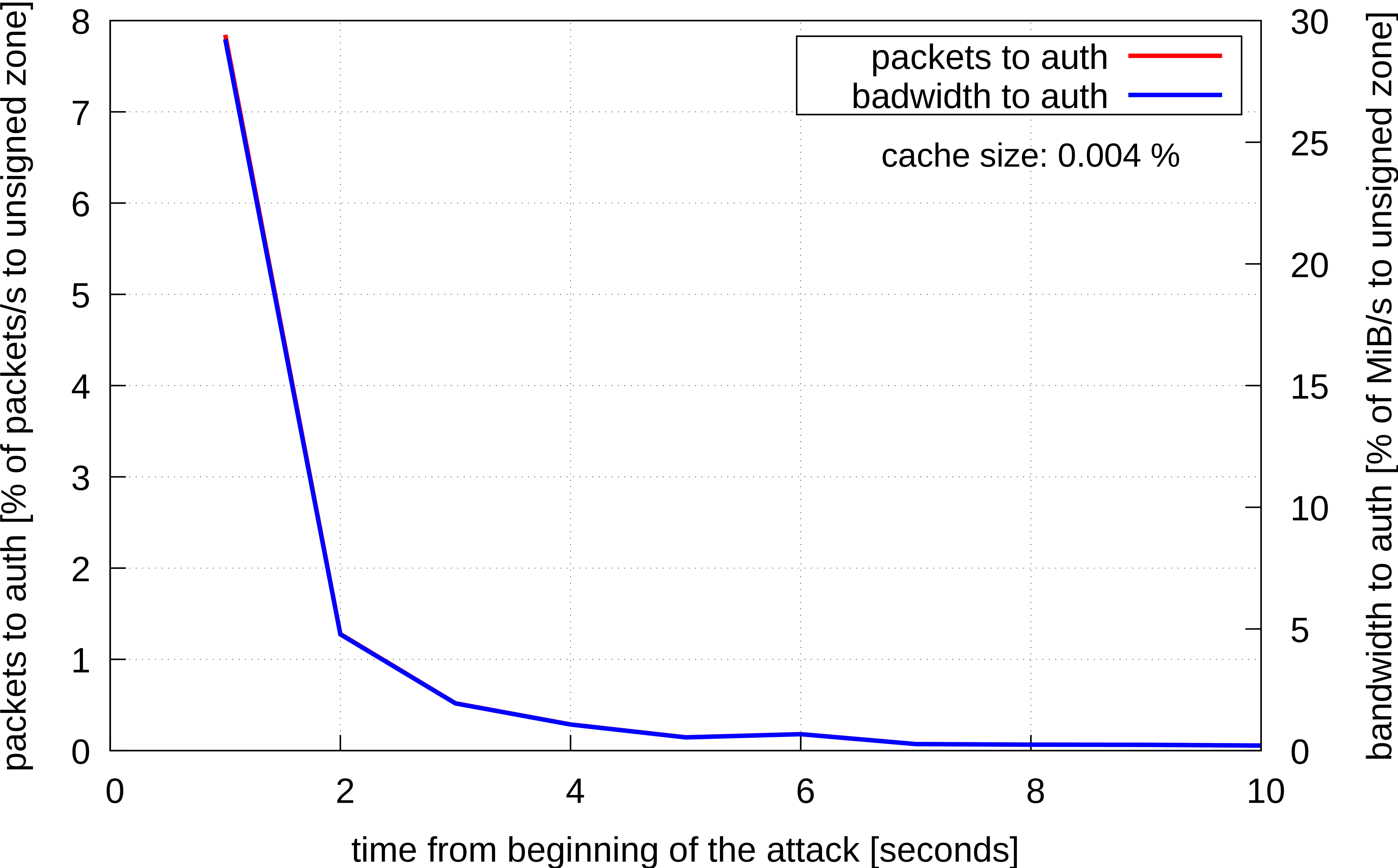
R.S.A.: unsigned zone (baseline %)



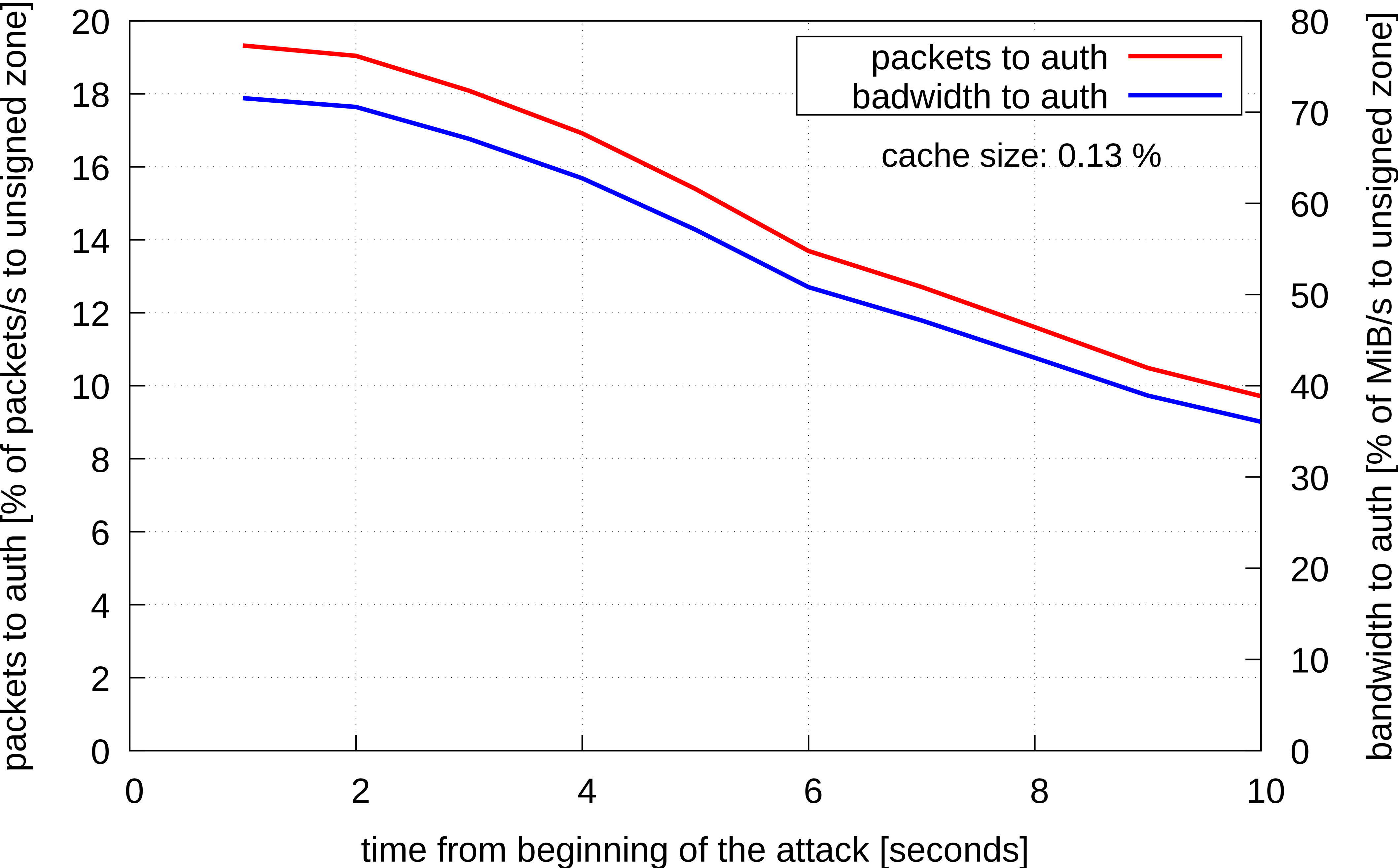
R.S.A.: 50 names + wildcard, TTL 60



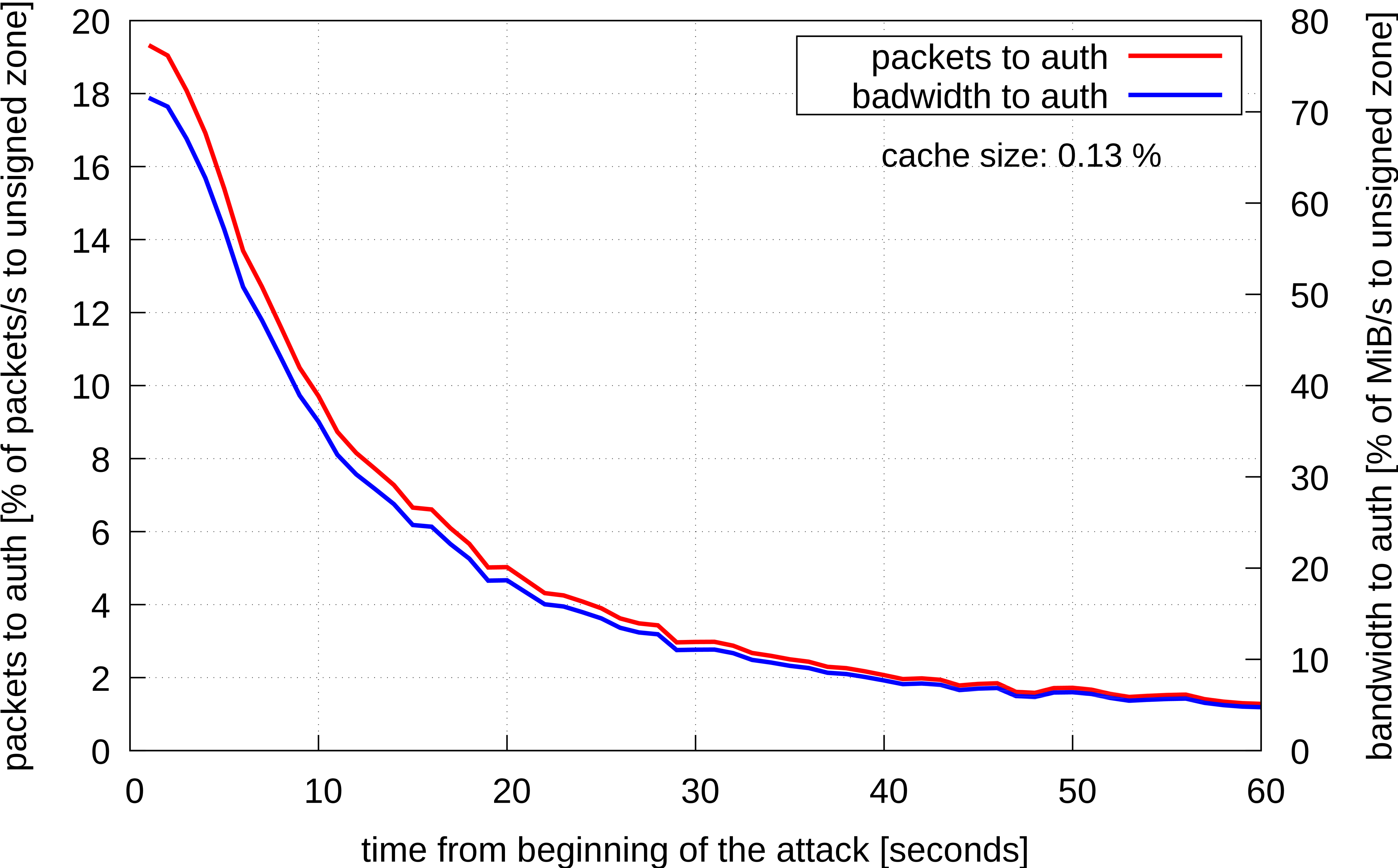
R.S.A.: 14k names, TTL 3600



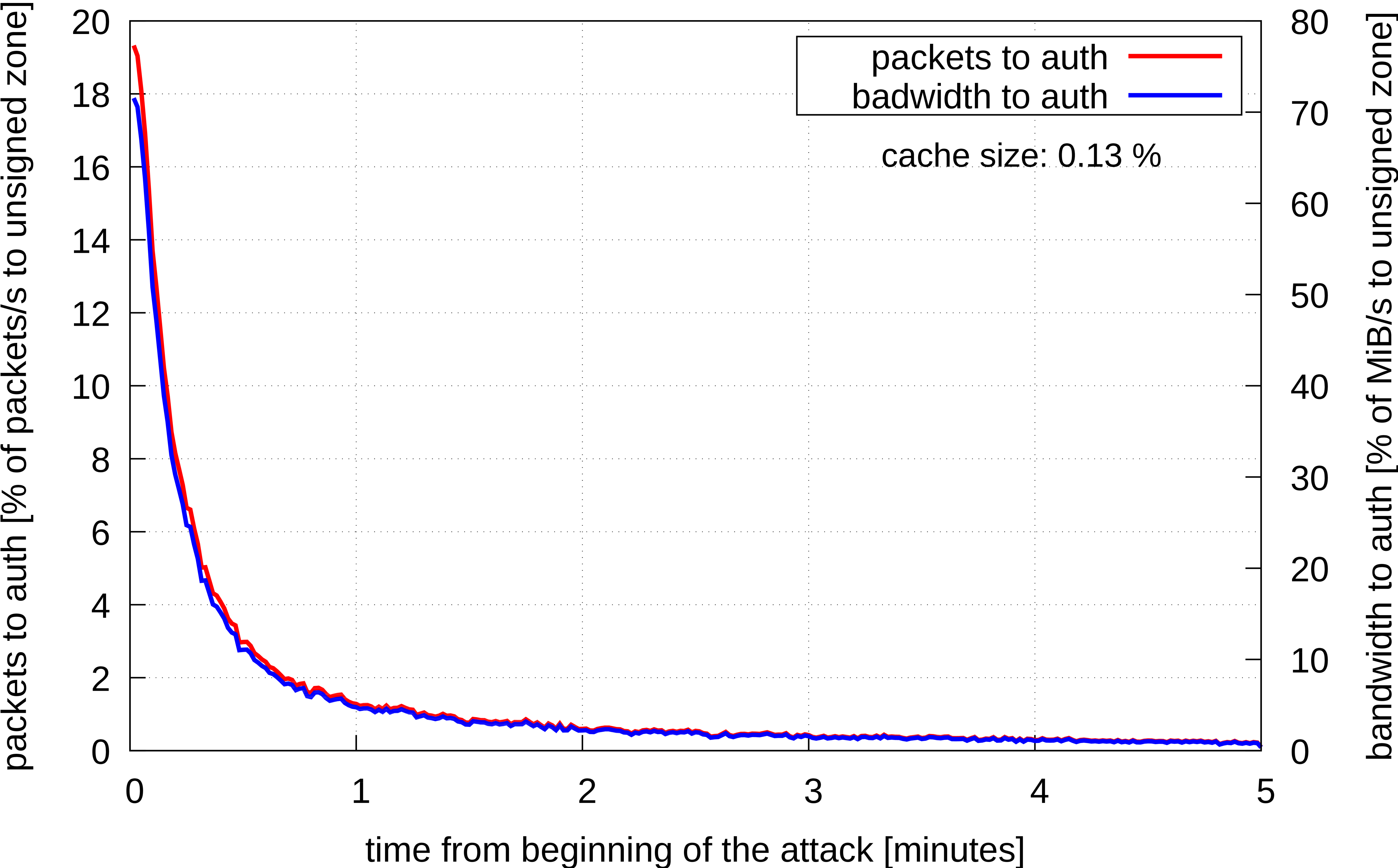
R.S.A.: 110k names, TTL 3600



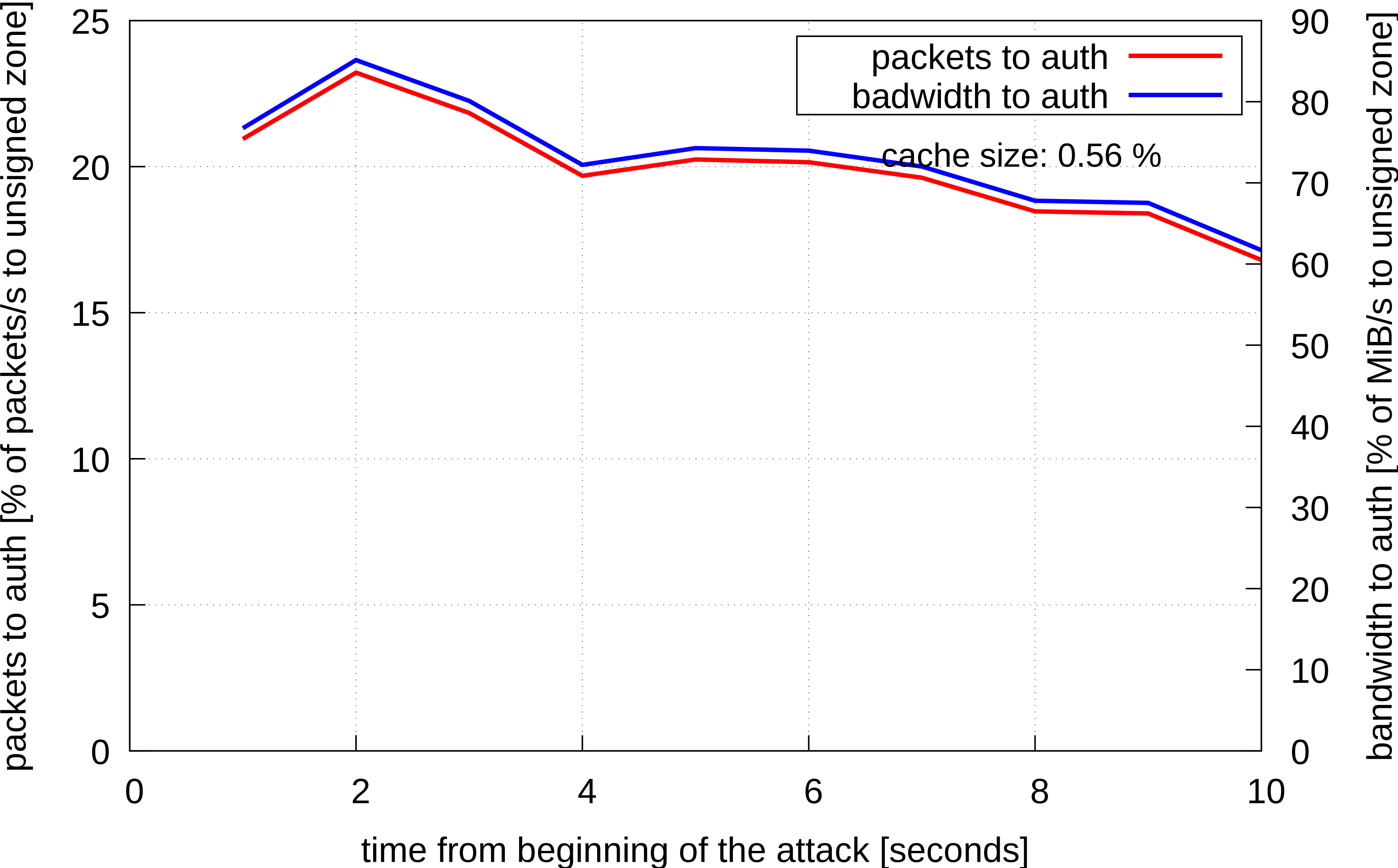
R.S.A.: 110k names, TTL 3600



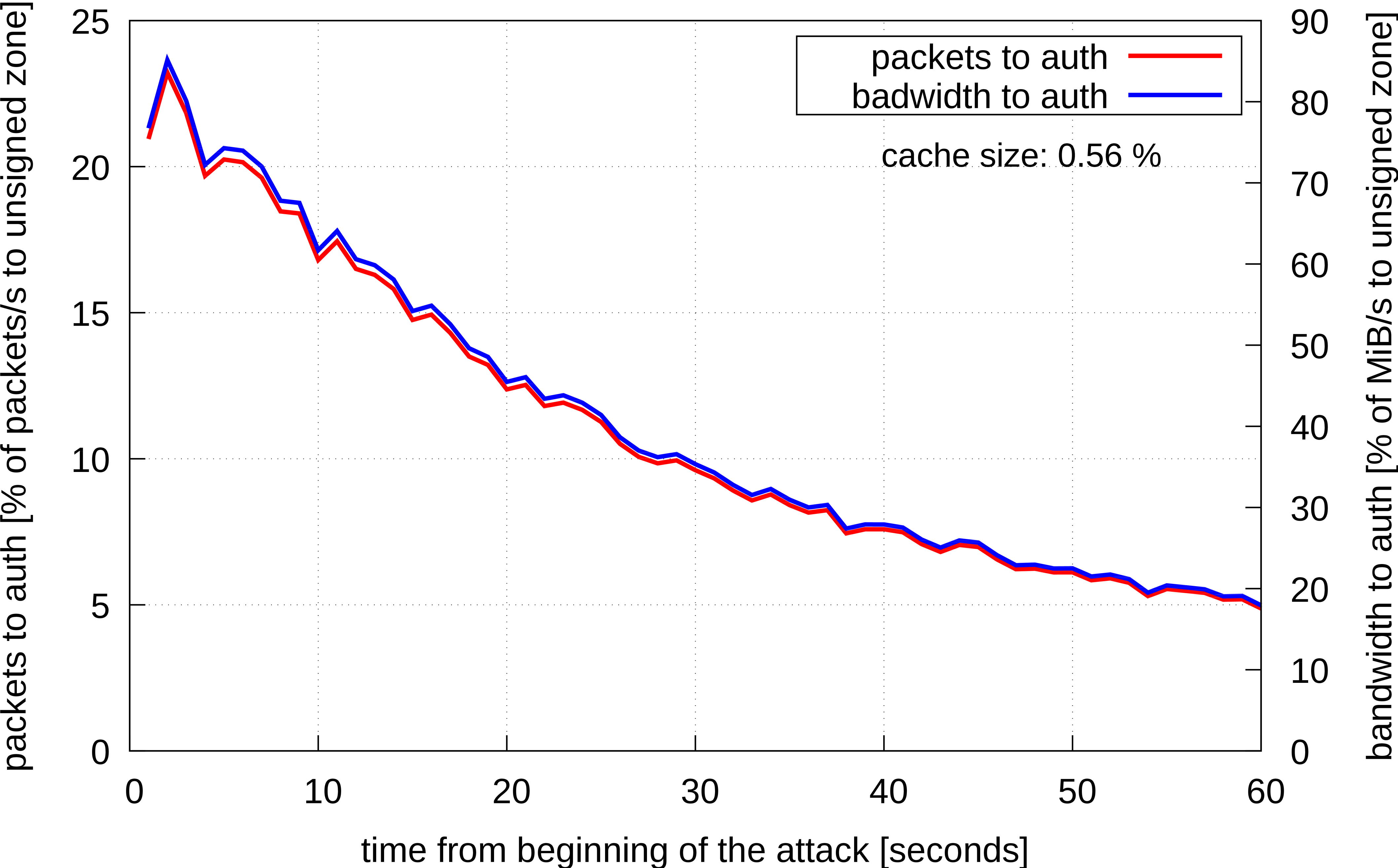
R.S.A.: 110k names, TTL 3600



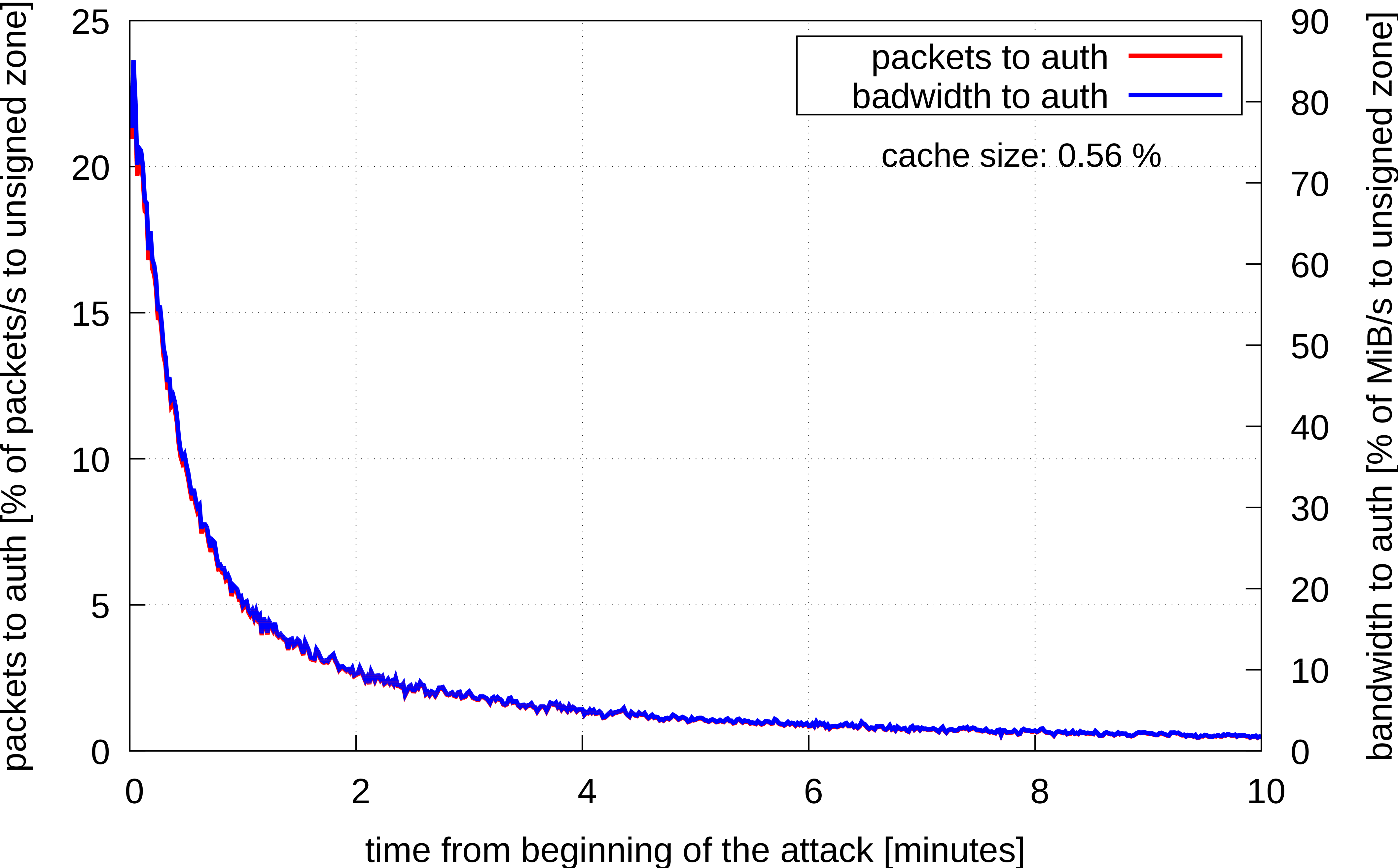
R.S.A.: 1M names, TTL 3600



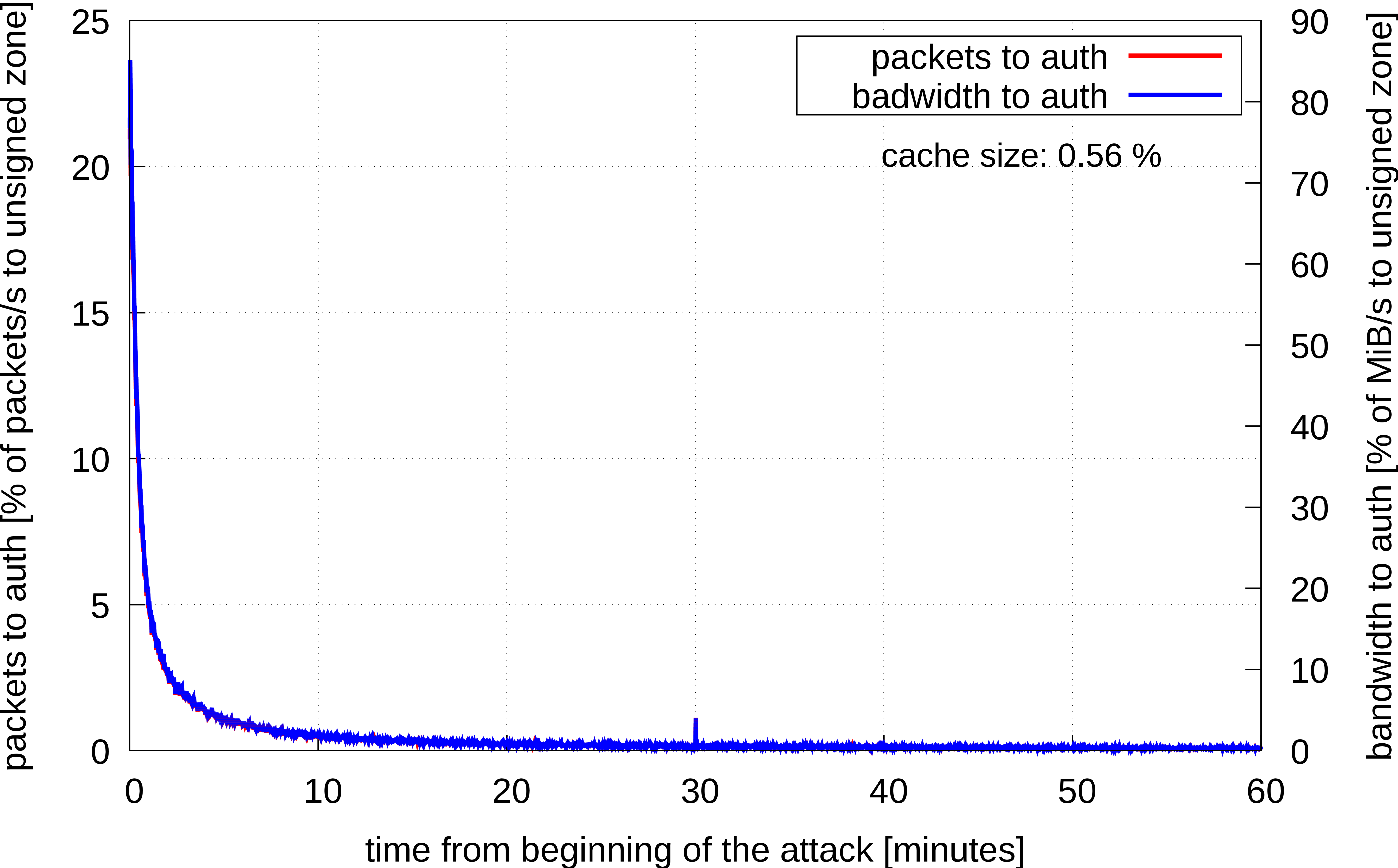
R.S.A.: 1M names, TTL 3600



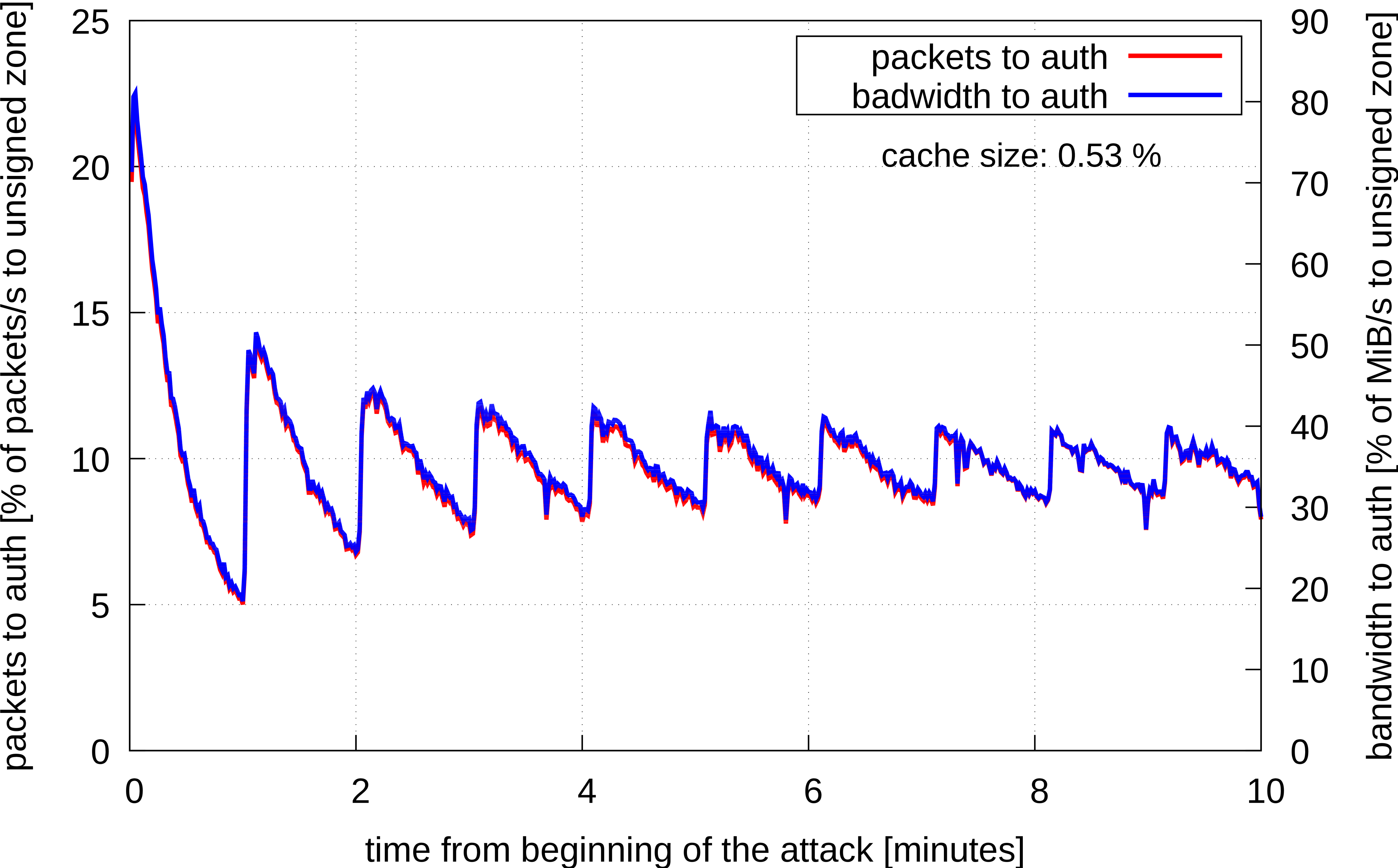
R.S.A.: 1M names, TTL 3600



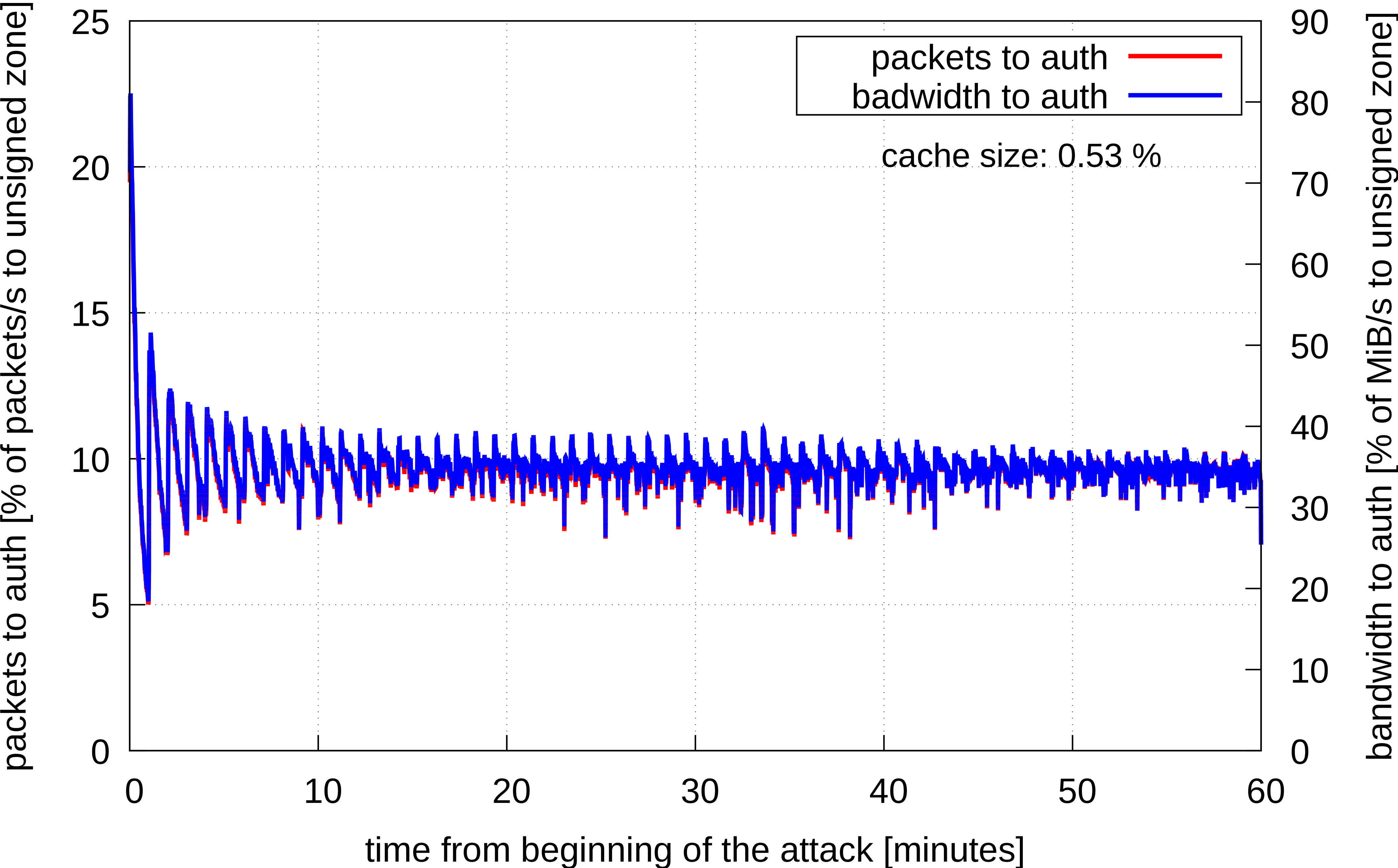
R.S.A.: 1M names, TTL 3600



R.S.A.: 1M names, TTL 60



R.S.A.: 1M names, TTL 60



RFC 8198's promises & R.S.A. traffic

- ☑ **Much** better cache usage
- ☑ **Significantly** lower network utilization
  - Eliminates R.S.A. traffic (over time)

Was RFC 8198 worth the trouble?

- **YES!** (if you use NSEC)
- Normal traffic
  - NSEC only → not a significant difference ??
- Random subdomain attack
  - small & medium zones → eliminates traffic
  - big & huge zones w/ long TTL → eliminates traffic
  - big & huge zones w/ short TTL → cuts traffic to 10-40 %
- NSEC 3 & algorithm impact to be investigated

Knot news for spring 2018

KNOT DNS

- **Knot DNS 2.7**
- Performance optimizations
- Security audit
- DNS cookies

KNOT RESOLVER

- **Knot Resolver 3.0**
- NSEC 3 support for aggressive cache
- Cache pre-fill mechanism