# Performance Measurements With DNS/DNSSEC

Daniel Migault

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Goal of the presentation :

- DNS/DNSSEC implementations have different performances
- How DNSSEC affects platforms performances

This presentation :

- Based on *A Performance View on DNSSEC Migration*, CNSM2010
- Extended version with the mathematical expression of measured curves is expected soon
- We have a python library with all curves
- Fell free to contact me to get them : *mglt.ietf@gmail.com*

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# Experimental Measurements

Experimental work measures the cost of DNSSEC migration :

- Cost between different implementations - BIND9 , NSD , UNBOUND
- Cost for Authoritative & Resolving servers
- Cost between different DNSSEC policies - DNS, DNSSEC without validation (DNSSEC), DNSSEC with validation (DNSSEC* )

Costs consider :

- Latency & Processing Time for Unitary Tests
- CPU Load
- Response Time
- Update Operations
- Cache Hit Rate

# Experimental Measurements

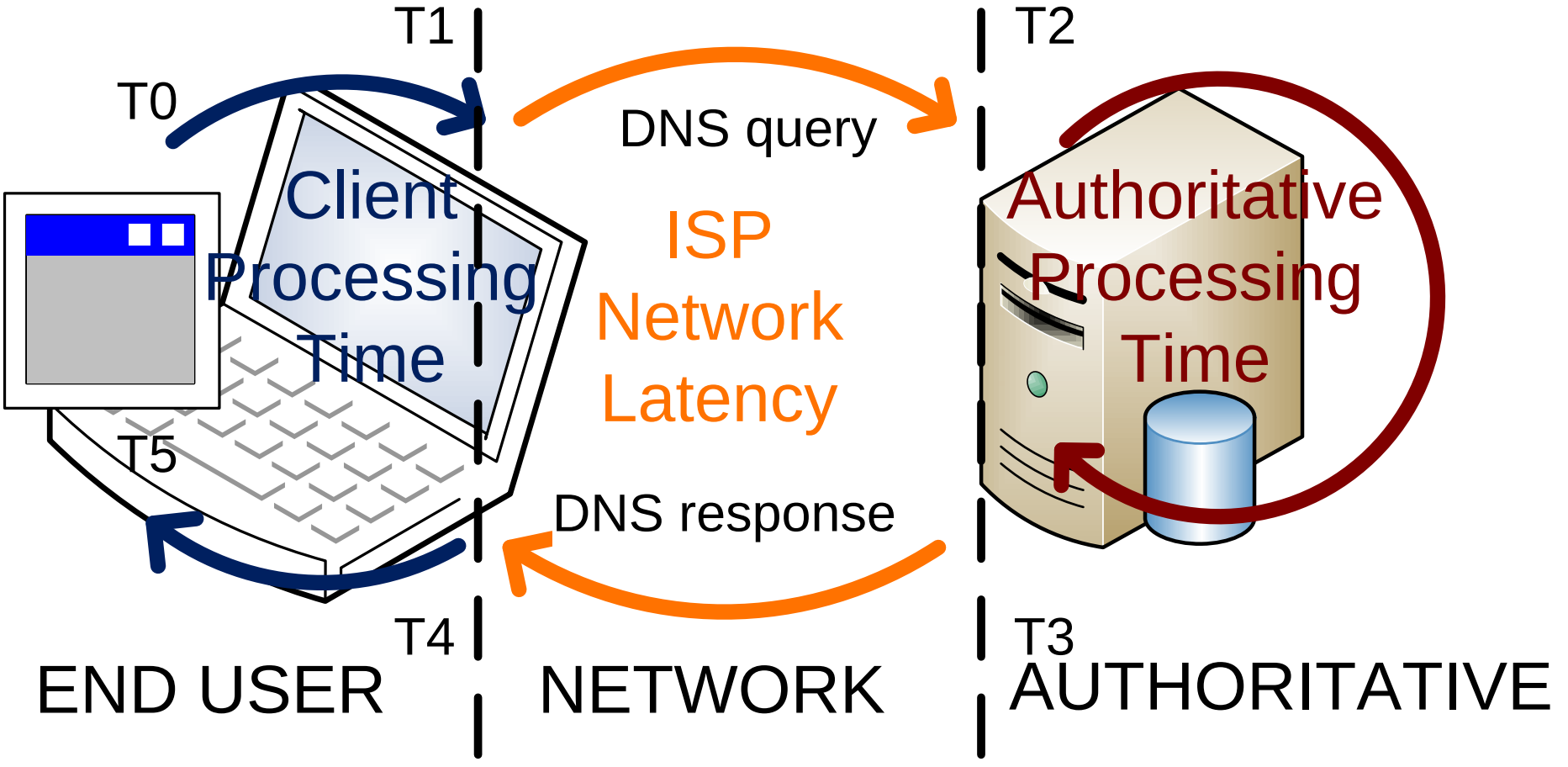
Software :

- DNS servers : BIND 9.6.0-P1, UNBOUND 1.2.1, NSD 3.2.1
- DNS server configuration : we run all servers with a mono thread mode
- Tools : dnsperf, resperf, collectl, Wireshark

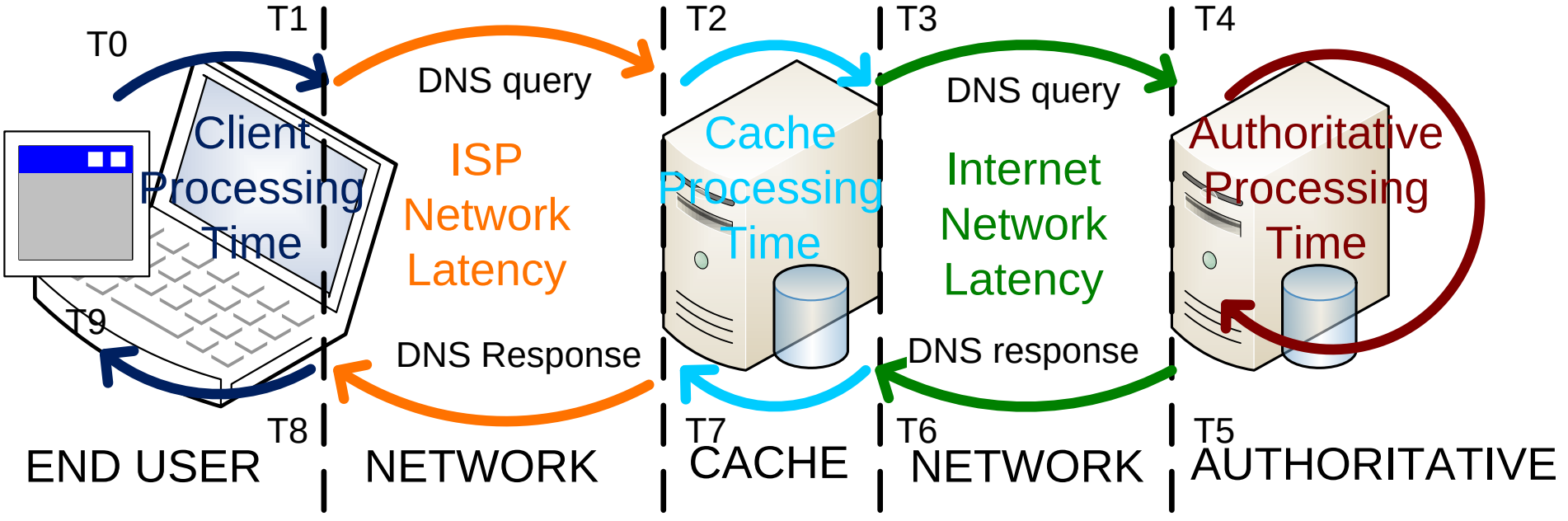
Hardware :

- Servers : Intel Pentium III ( @ 1GHz 32 bits) CPU, 384MB of RAM with Debian 5.0 (lenny), Linux kernel 2.6.24.
- End user : Intel Xeon E5420 (Quad-Core @ 2.5GHz 32bits) CPU, 3GB RAM with Ubuntu 8.10 (hardy) 32 bits version with Linux kernel 2.6.27.

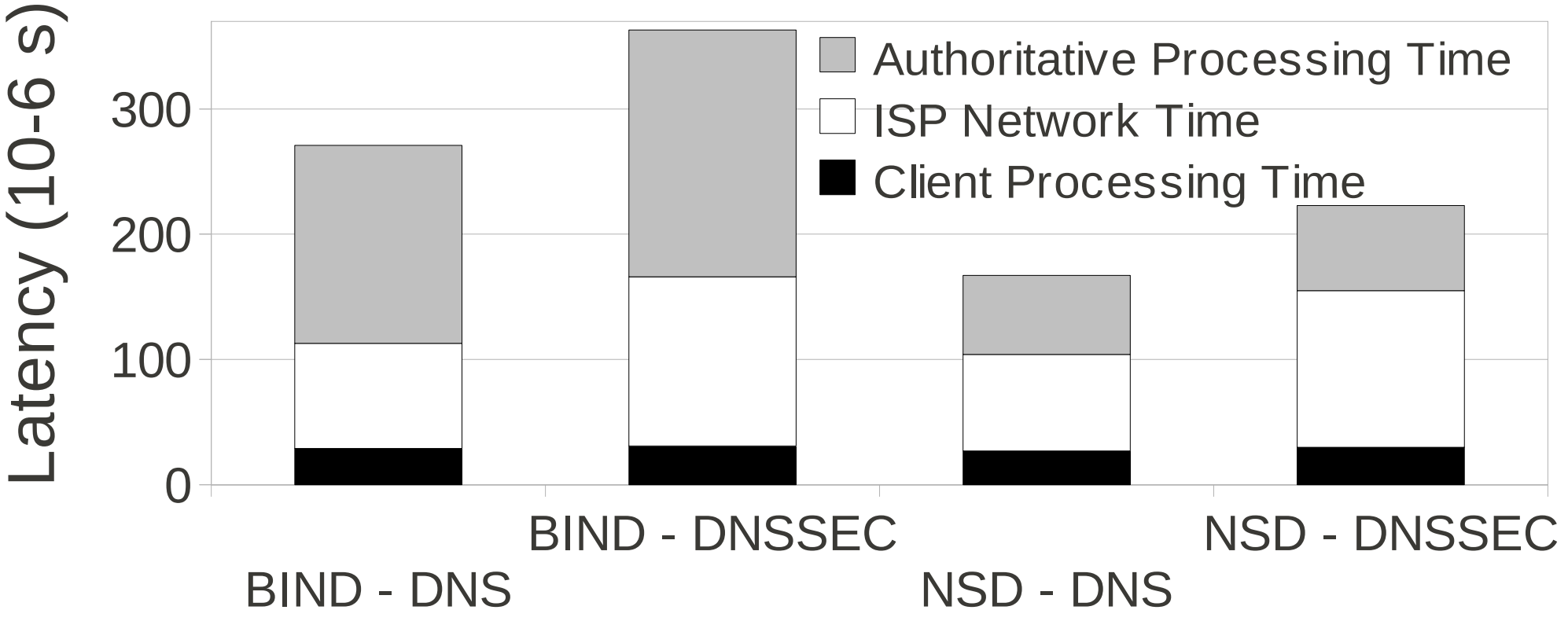
# Testing Environment - Authoritative Servers



# Testing Environmment - Resolving Servers

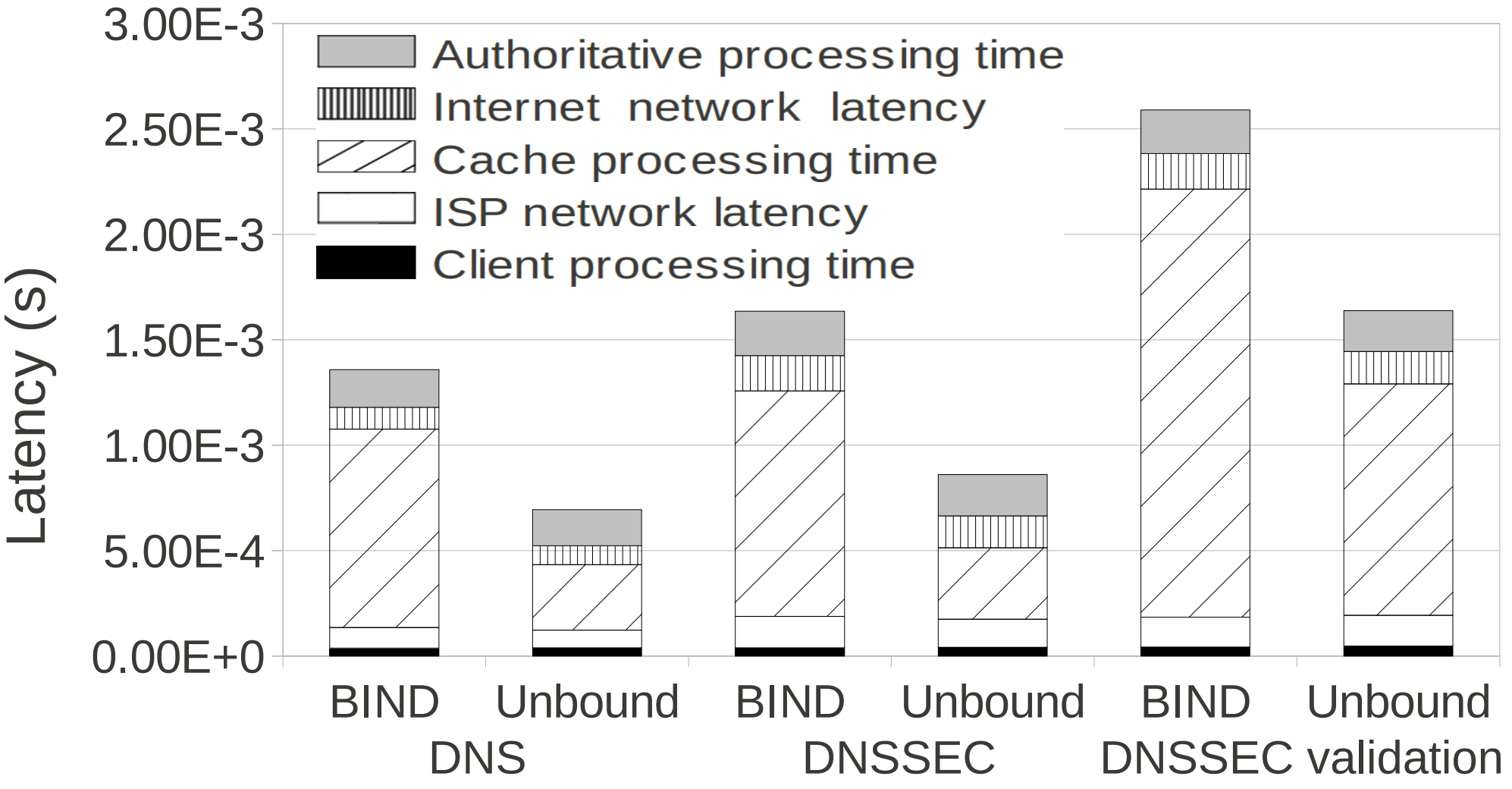


# Unitary Tests - Authoritative Servers




- NSD 's Processing Time (PT) is 40 % of BIND9 's
- NSD Network Latency (NL) is 92 % of BIND9 's Latency
- DNSSEC migration increases PT by 25 % for BIND9 and 8 % for NSD
- DNSSEC migration BIND9 / NSD increases NL by 60 %

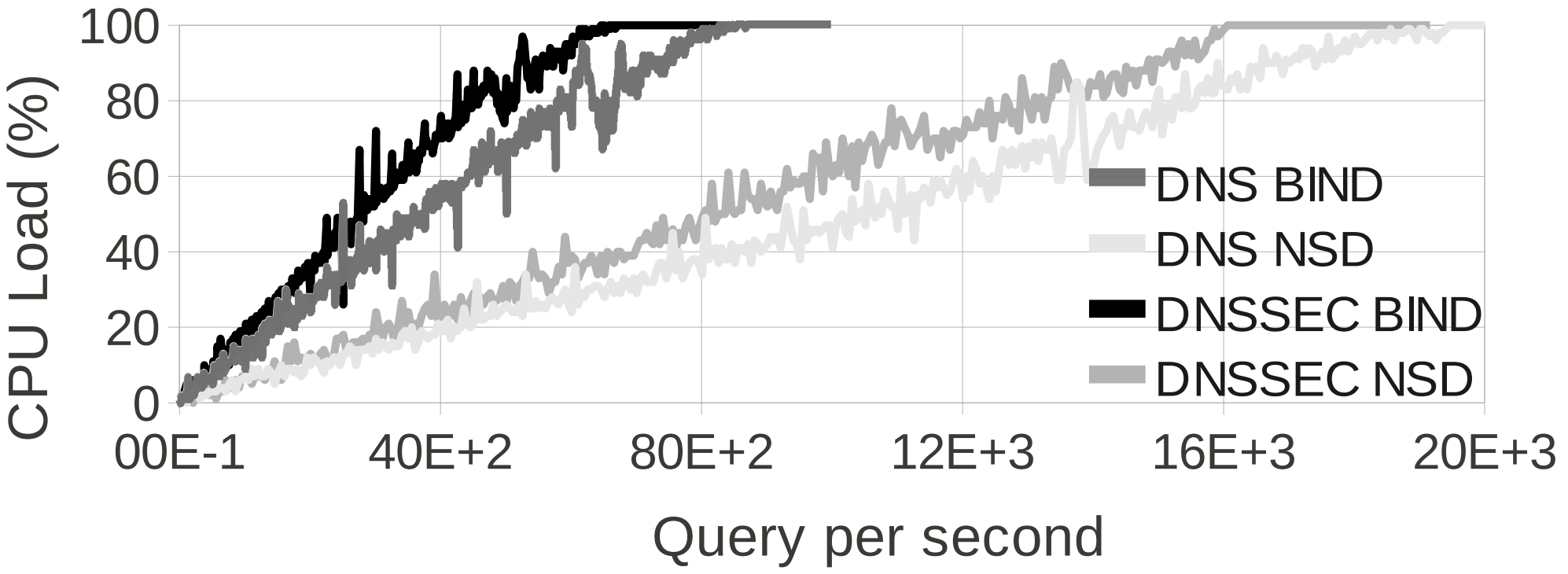
# Unitary Tests - Resolving Servers



# Unitary Tests - Resolving Servers

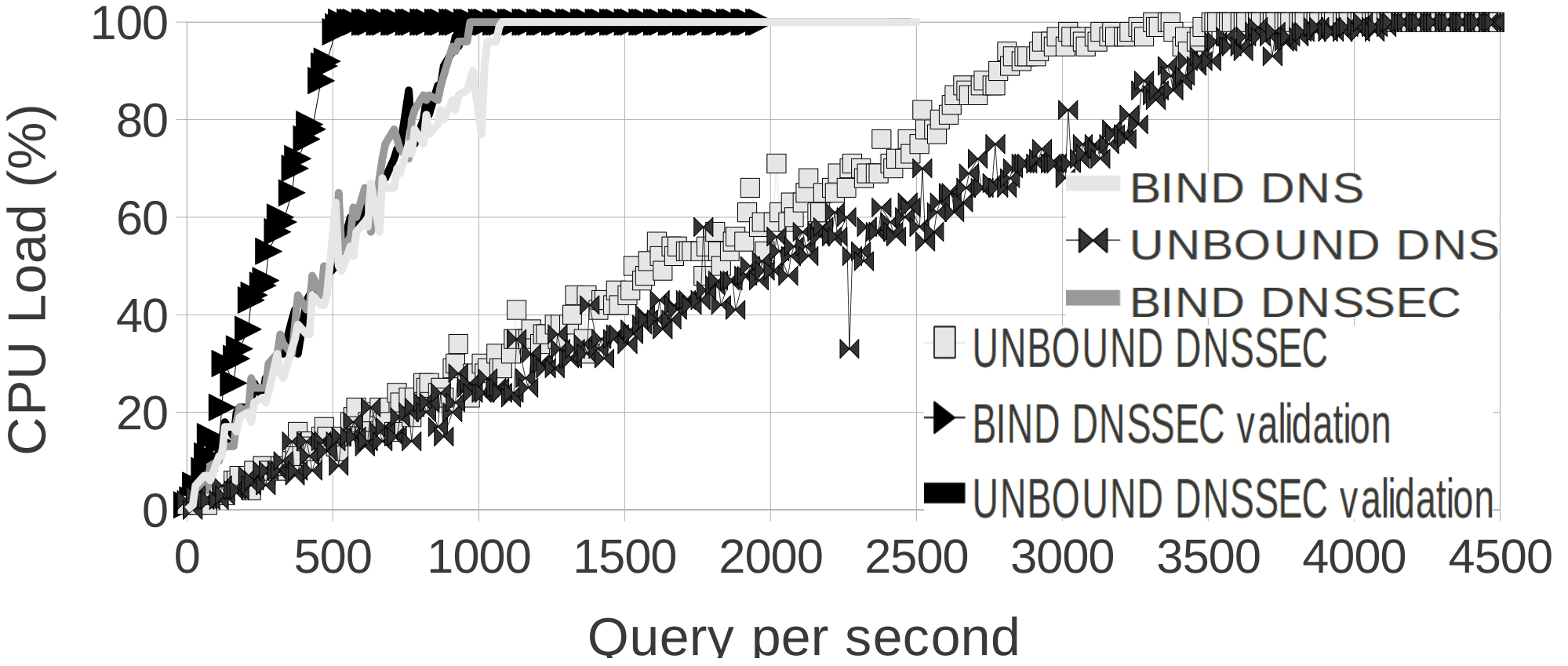
- UNBOUND Processing Time is respectively 33 %, 22 % and 54 % of BIND9 's for DNS, DNSSEC and DNSSEC with validation
- Migration from DNS to DNSSEC without validation increases Processing Time of 9 % for UNBOUND and 14 % for BIND9
- Migration from DNS to DNSSEC with validation increases Processing Time of 353 % for UNBOUND and 216 % for BIND9

# CPU Load - Authoritative Servers




- For DNS/DNSSEC, NSD deals with around *2.3* times more traffic than BIND9
- DNSSEC Maximum Load is *79* % and *83* % of DNS Maximum Load for BIND9 and NSD
- DNSSEC costs roughly corresponds to *30* % of the DNS traffic

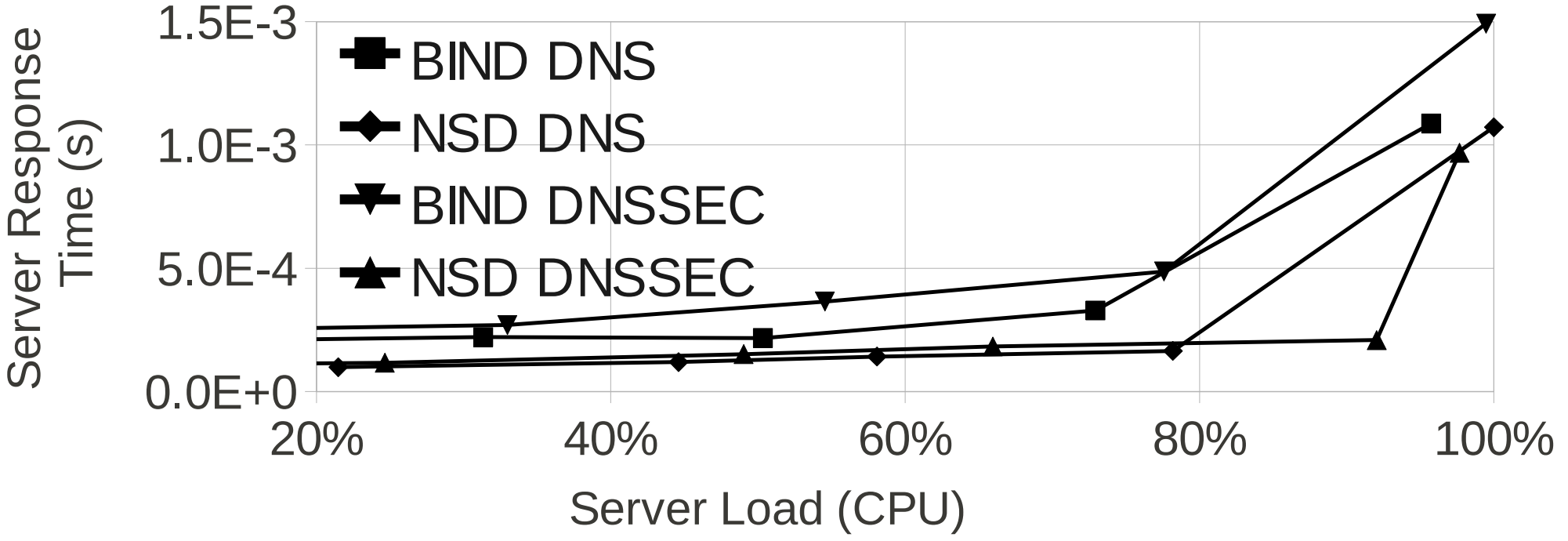
# CPU load - Resolving Servers



# CPU load - Resolving Servers

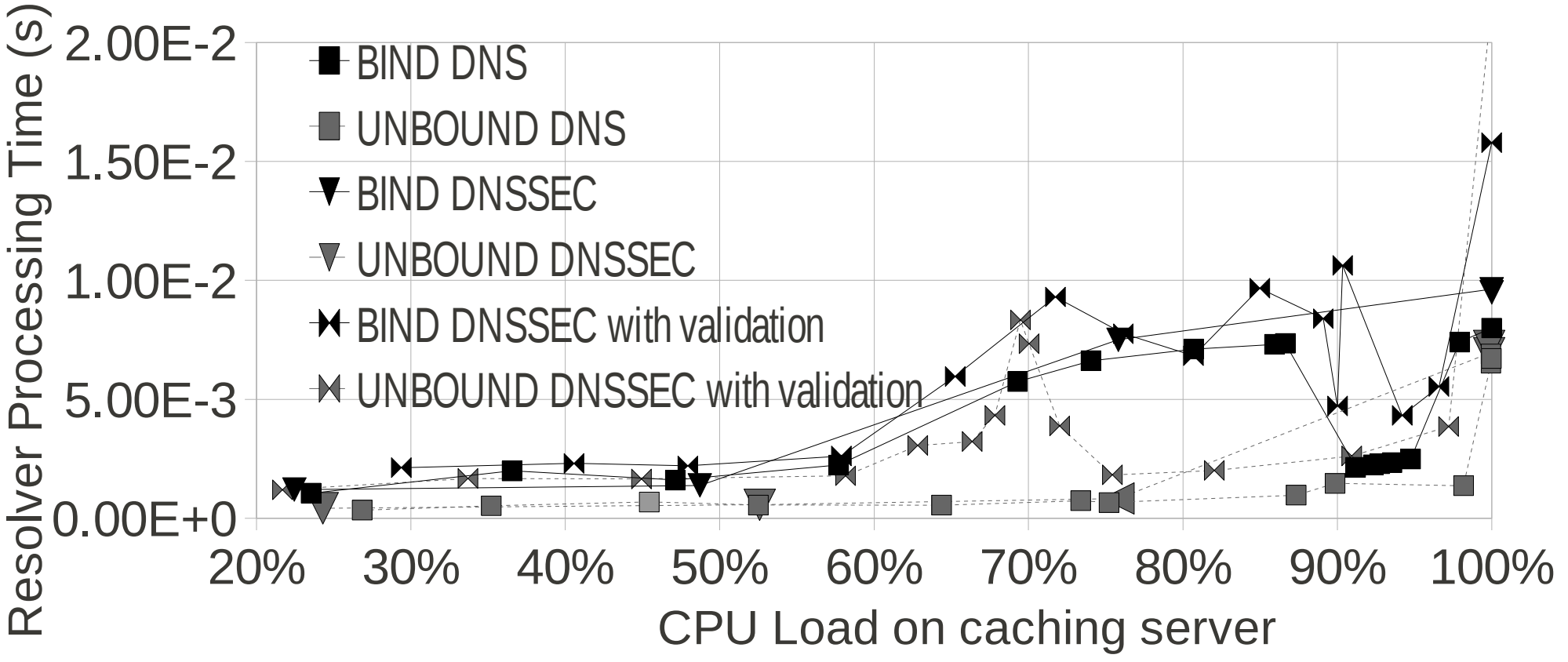
- UNBOUND deals with 3.4 (resp. 1.8) times more traffic than BIND9 with DNS/DNSSEC (resp. DNSSEC with validation)
- With BIND9 DNSSEC without validation (resp. with validation) maximum traffic corresponds to 90 % (resp. 49 %) DNS maximum traffic
- With UNBOUND with DNSSEC without validation (resp. with validation) maximum traffic corresponds to 86 % (resp. 25 %) DNS maximum traffic

# Response Time - Authoritative Servers



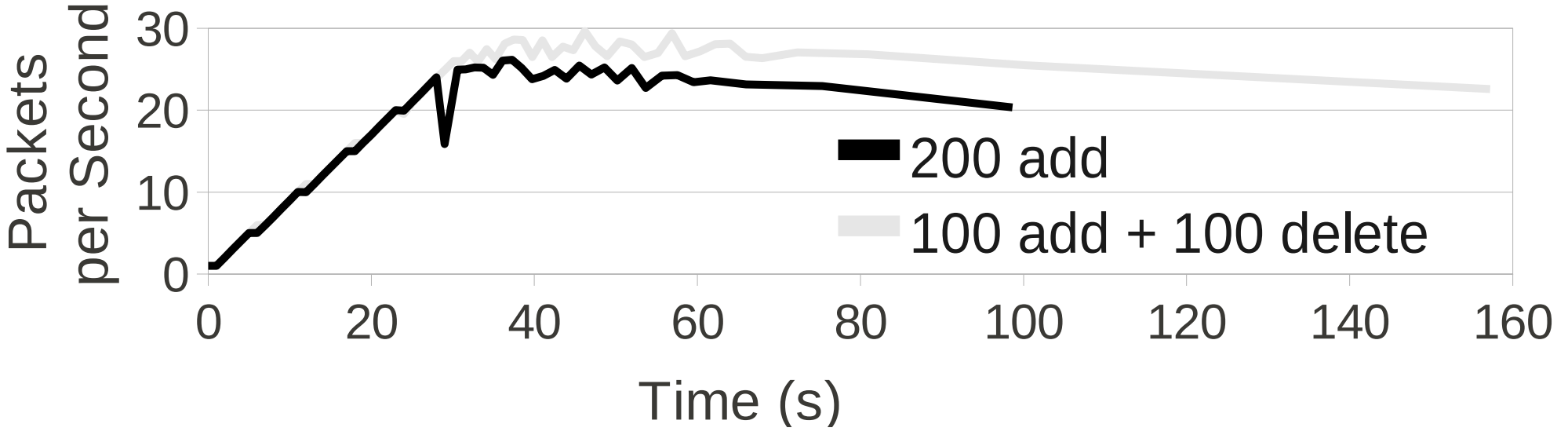

- For CPU time below 40 %, NSD is about two time faster than BIND9
- Migration to DNSSEC increases response time of 20 % for NSD and 10 % for BIND9

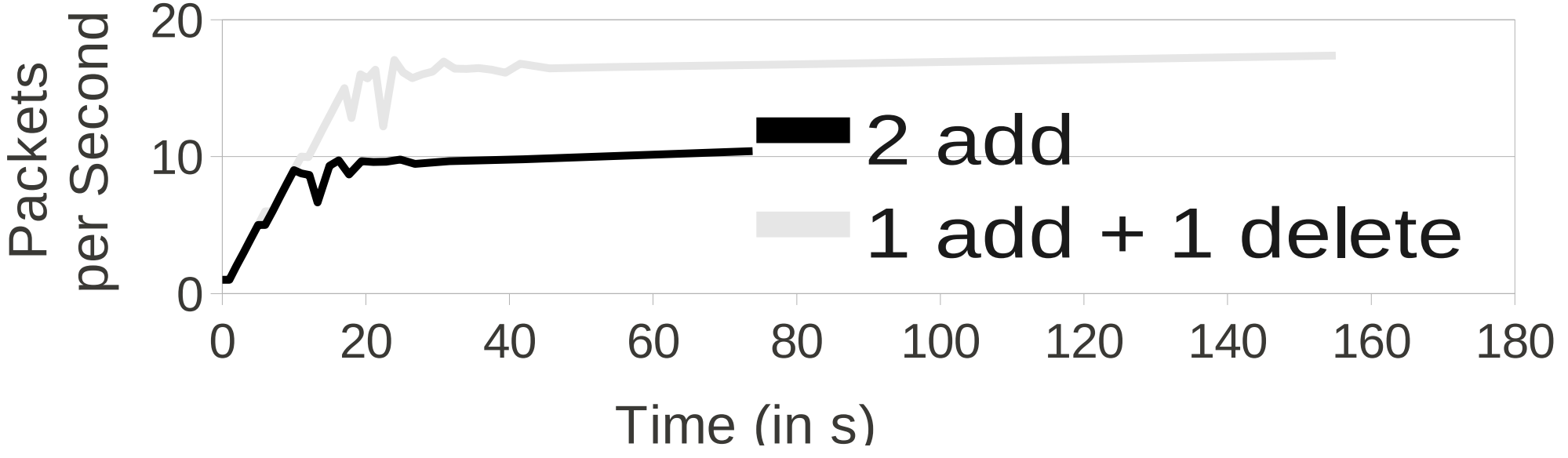
# Response Time - Resolving Servers




- For CPU time below 50 %, UNBOUND response time is 35 % (resp. 30 % and 75 %) of BIND9 's for DNS (resp. DNSSEC, DNSSEC* )
- With DNSSEC and validation, migration increases DNS response time by 35 % for BIND9 and 215 % for UNBOUND

# Update - add / delete Costs

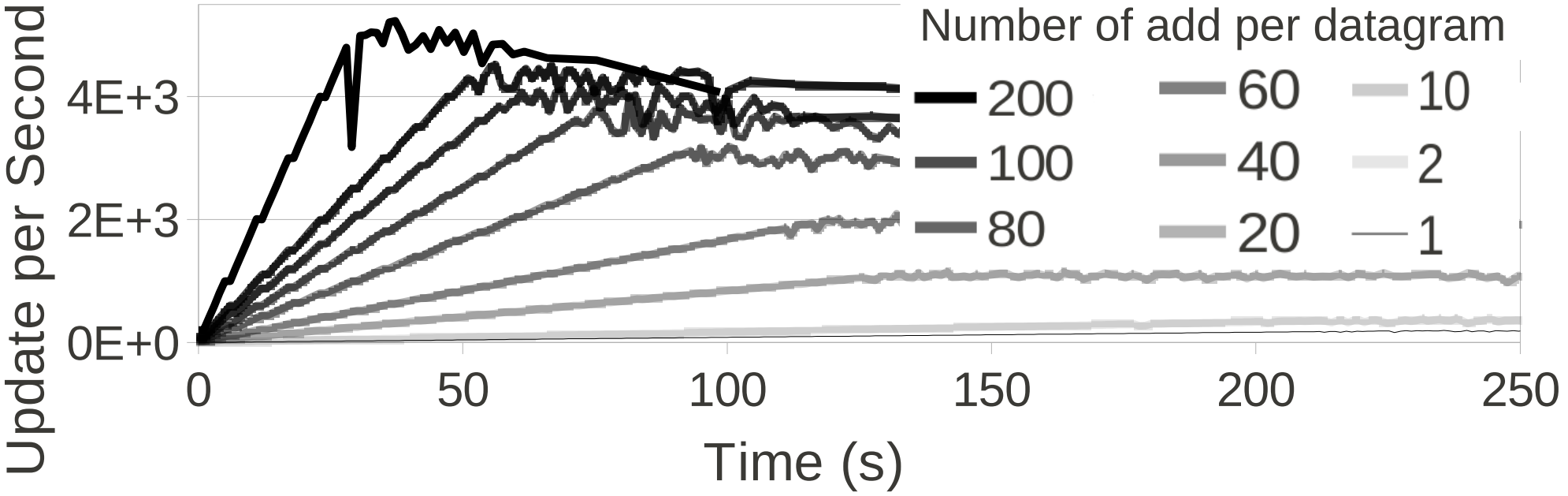


# Update - add / delete Costs

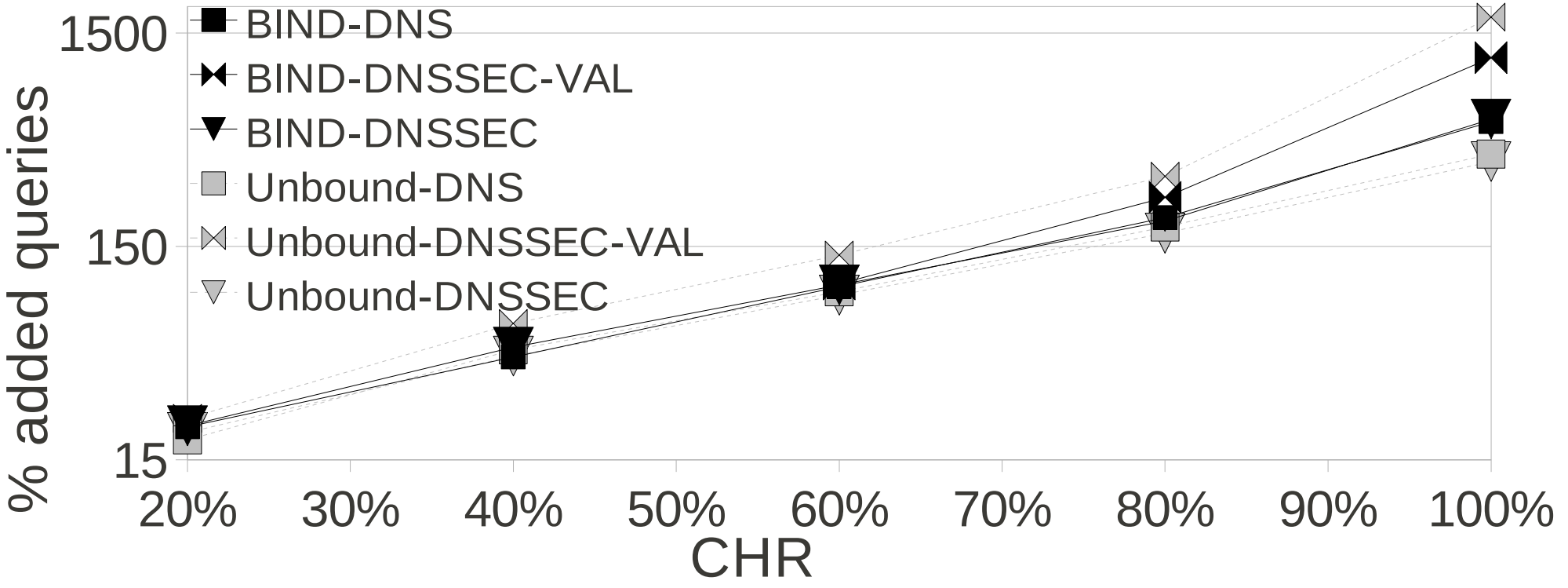
- Updates are performed on BIND9
- With DNS (resp. DNSSEC) add requires 1.42 (resp. 4.16) more time than delete
- Migration from DNS to DNSSEC makes add (resp. delete) operation 221 (resp. 75) times longer

# Update - Operations per Datagram




- Sending multiple updates is more efficient, both with DNS and DNSSEC

# Traffic Cache Hit Rate




- $AQR(CHR) = \frac{q^{CPU}_{CHR} - q^{CPU}_{CHR=0}}{q^{CPU}_{CHR=0}}$
- DNSSEC* has an AQR that varies from 1149 % to 1779 %
- DNSSEC and DNS has an AQR varying from 374 % to 592 %

# Conclusion

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DNSSEC performances are impacted by :

- The DNS/DNSSEC/DNSSEC* policies
- The servers implementations
  - NSD / BIND9 & UNBOUND / BIND9
- The platform's node hardware
  - Intel Pentium III (@ 1GHz 32 bits) CPU, 384MB of RAM
- Operating System
  - Debian 5.0 (lenny), Linux kernel 2.6.24
- The server's configuration
  - Default configuration - 1 thread

# Conclusion

- The DNS/DNSSEC traffic
  - CHR, 1 signature per response
- DNSSEC deployment over the Internet
  - We did not consider mixed DNS/DNSSEC/DNSSEC* traffic
- ...

So, the conclusion of this presentation might be :

- DNSSEC is a hard nut to crack
- Platform design should be carefully handled
- Move to DNSSEC ASAP and carefully!

# Application

# Application

Example of DNS Traffic :

- Daily query rate is $40.000\ \mathrm{q}.s^{-1}$ , with pics up to $120.000\ \mathrm{q}.s^{-1}$
- Cache Hit Rate : $\mathrm{CHR} = 0.7$

Thus, we design the platform for :

- $40.000\ \mathrm{q}.s^{-1}$
- $\mathrm{cpu}_{max} = 20\ \%$
- With nodes Intel Pentium III (@ 1GHz 32 bits) CPU, 384MB of RAM

In our design we consider for the different Protocols/Implementations :

- Number of nodes
- Response time

# Application - Authoritative Servers

| Nodes | DNS | DNSSEC |
|---|---|---|
| BIND9 | 29 (1.00*) | 38 (1.31*) |
| NSD | 9 (1.00*) | 12 (1.33*) |
| $\frac{\text{UNBOUND}}{\text{BIND9}}$ (IR**) | 0.31 | 0.32 |

| Response Time µs | DNS | DNSSEC |
|---|---|---|
| BIND9 | 239.38 (1.00*) | 1161.80 (4.85*) |
| NSD | 92.27 (1.00*) | 130.42 (1.41*) |
| $\frac{\text{UNBOUND}}{\text{BIND9}}$ (IR**) | 0.39 | 4.50 |

*: Protocol Ratio, ** Implementation Ratio

# Application Resolving Servers

| Nodes | DNS | DNSSEC | DNSSEC* |
|---|---|---|---|
| BIND9 | 80 (1*) | 87 (1.09*) | 160 (2.00*) |
| UNBOUND | 20 (1*) | 24 (1.20*) | 85 (4.25*) |
| $\frac{\text{UNBOUND}}{\text{BIND9}}$ (IR**) | 0.25 | 0.28 | 0.53 |

| Response Time ($\mu s$) | DNS | DNSSEC | DNSSEC* |
|---|---|---|---|
| BIND9 | 1402 (1*) | 1161 (0.80*) | 2300 (1.63*) |
| UNBOUND | 401 (1*) | 366 (0.92*) | 2000 (4.99*) |
| $\frac{\text{UNBOUND}}{\text{BIND9}}$ (IR**) | 0.20 | 0.20 | 0.87 |

* : Protocol Ratio, ** Implementation Ration

# Q & A