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System and Network Engineering

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Analysis of DNS Resolver Performance Measurements

Introduction

- Domain Name System
- Internet Building Block
- Distributed Tree structure
  - Delegations
  - Responsibility
  - Ownership

Introduction

- DNS Authoritatives
- DNS Resolvers

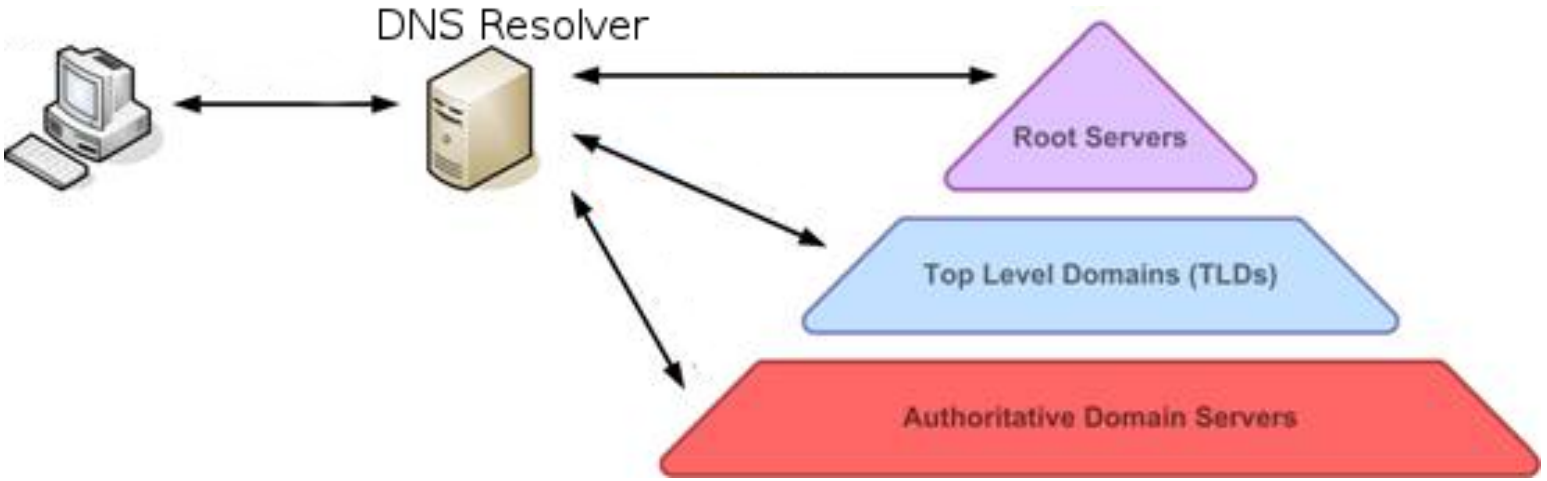


Figure 1: http://www.technicalinfo.net/

Related Work

B. Ager, W. Mhlbauer, *Comparing DNS Resolvers in the Wild*, IMC'10, November 1-3, 2010, Melbourne, Australia.

J. Jung, E. Sit, H. Balakrishnan, R. Morris, *DNS Performance and the Effectiveness of Caching*, IMW'01, November 1-2, 2001, San Francisco, CA, USA.

Y. Sekiya, K. Cho, A. Kato, J. Murai, *Research of Method for DNS Performance Measurement and Evaluation Based on Benchmark DNS Servers*, Wiley Periodicals, Vol. 89, No. 10, 2006.

Wouter C.A. Wijngaards, Benno J. Overeinder, *Securing DNS: Extending DNS Servers with a DNSSEC Validator*, IEEE Security & Privacy, vol.7, no. 5, pp. 36-43, September/October 2009.

Secure64 Software Corporation, *White paper: Lies, Damn Lies and DNS Performance Statistics*, Greenwood Village, CO, USA.

Research Question

What is the performance of different DNS resolver implementations?

Can a method be devised to measure the performance of DNS resolver implementations objectively?

What are corner cases of the DNS resolver implementations measured?

Scope

- Measurement on Open Source Resolvers
- Devise method to perform measurements
- Setup environment with different resolvers
- Write code to extract data from measurements

- Measurements will not be performed on hardware
- Analysis of DNS Resolver code is also not performed

Approach

- Devise method for measurements
- Setup environment (in OS3 lab)
  - Resolvers
  - Tools
  - Code
- Perform measurements
- Analyse results
- Uncover (possible) corner cases

Measurement Method

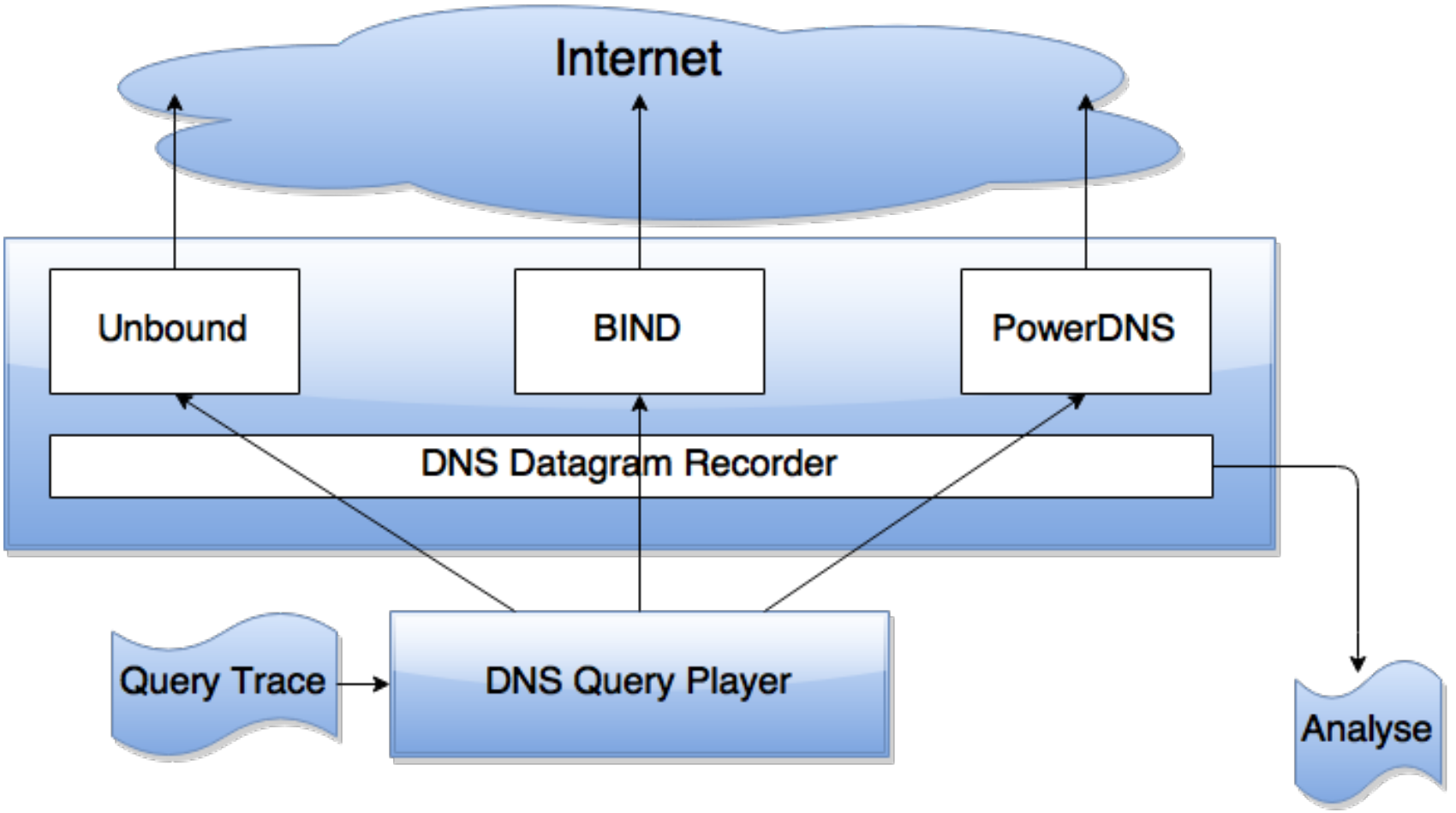
- Challenges devising a method for measuring DNS Resolvers
  - Recursiveness
  - Extraction of information
  - Benchmarking

Measurement Method

- Measure in terms of time (time per query)
- Real World, in other words, the Internet
  - Not biased
  - Diversity of queries
- Changing nature of the Internet

- Unbound
  - NLnet Labs
- BIND
  - Internet Systems Consortium
- PowerDNS
  - PowerDNS.COM

Measurement Method



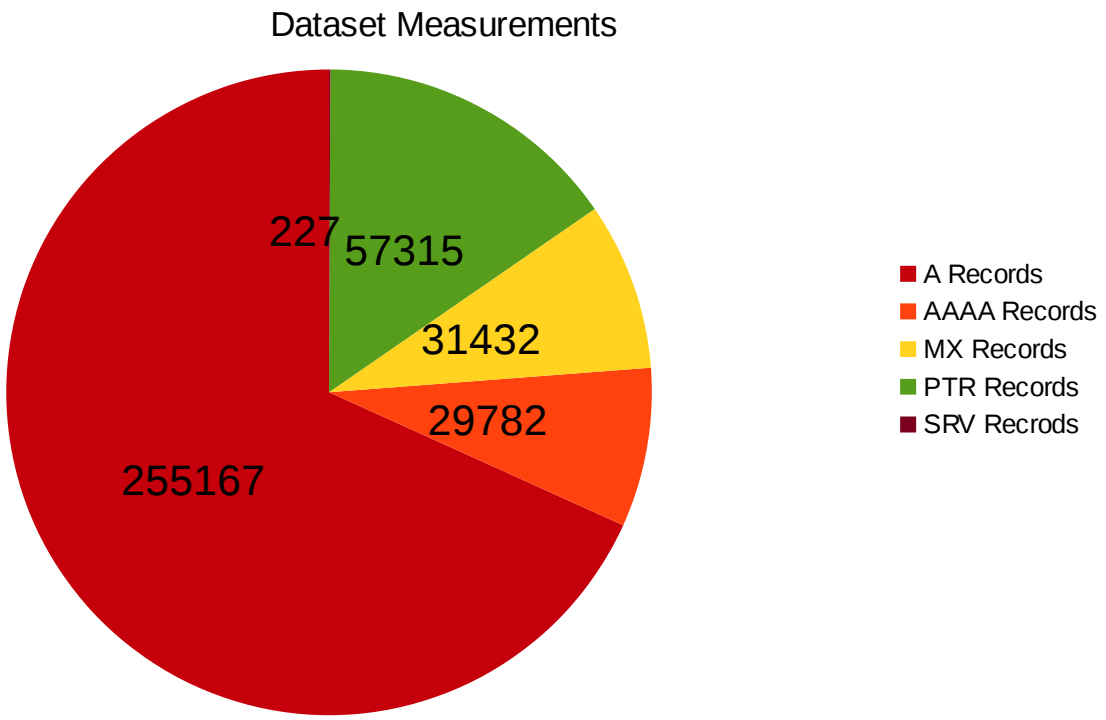
Measurement Method

- PCAP for storing DNS traffic
  - All data you need
  - Easy to parse
- Nominum Query Trace
- Python to Analyse
  - DPKT library
  - Matplotlib library

Results of Measurements

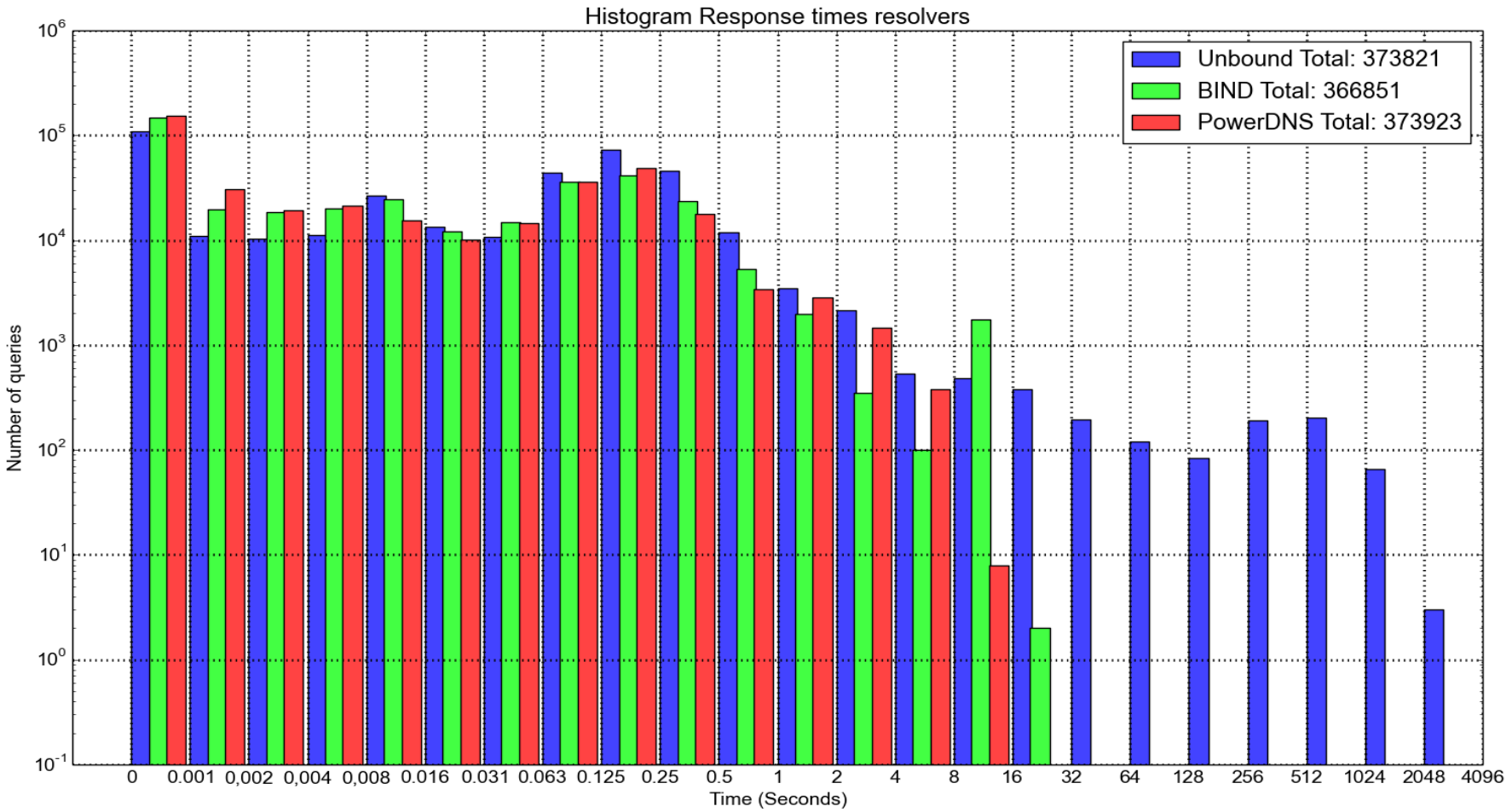
- Analysis by comparison
- Analysis by division

- Dataset:

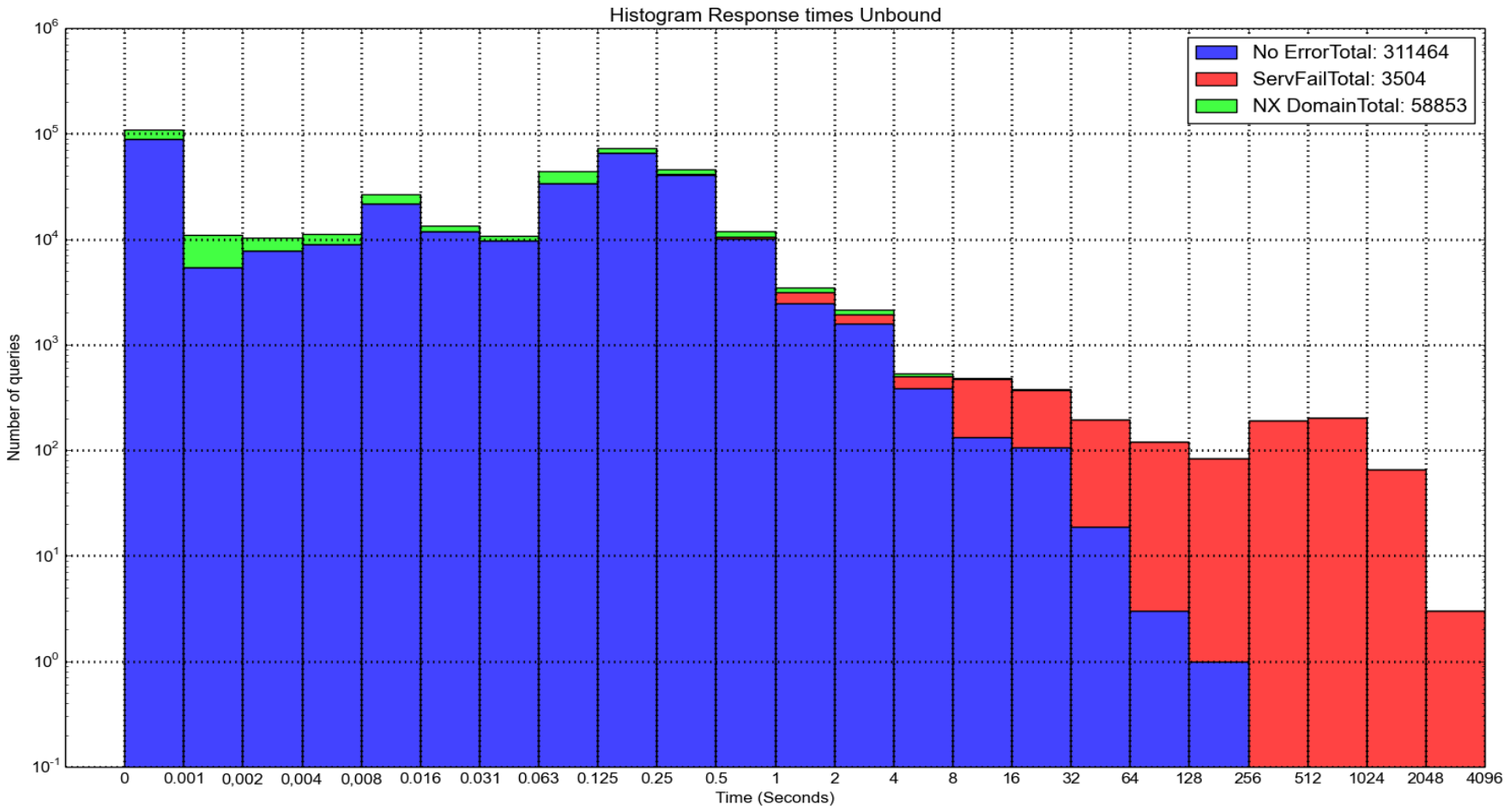


Total: 373,923

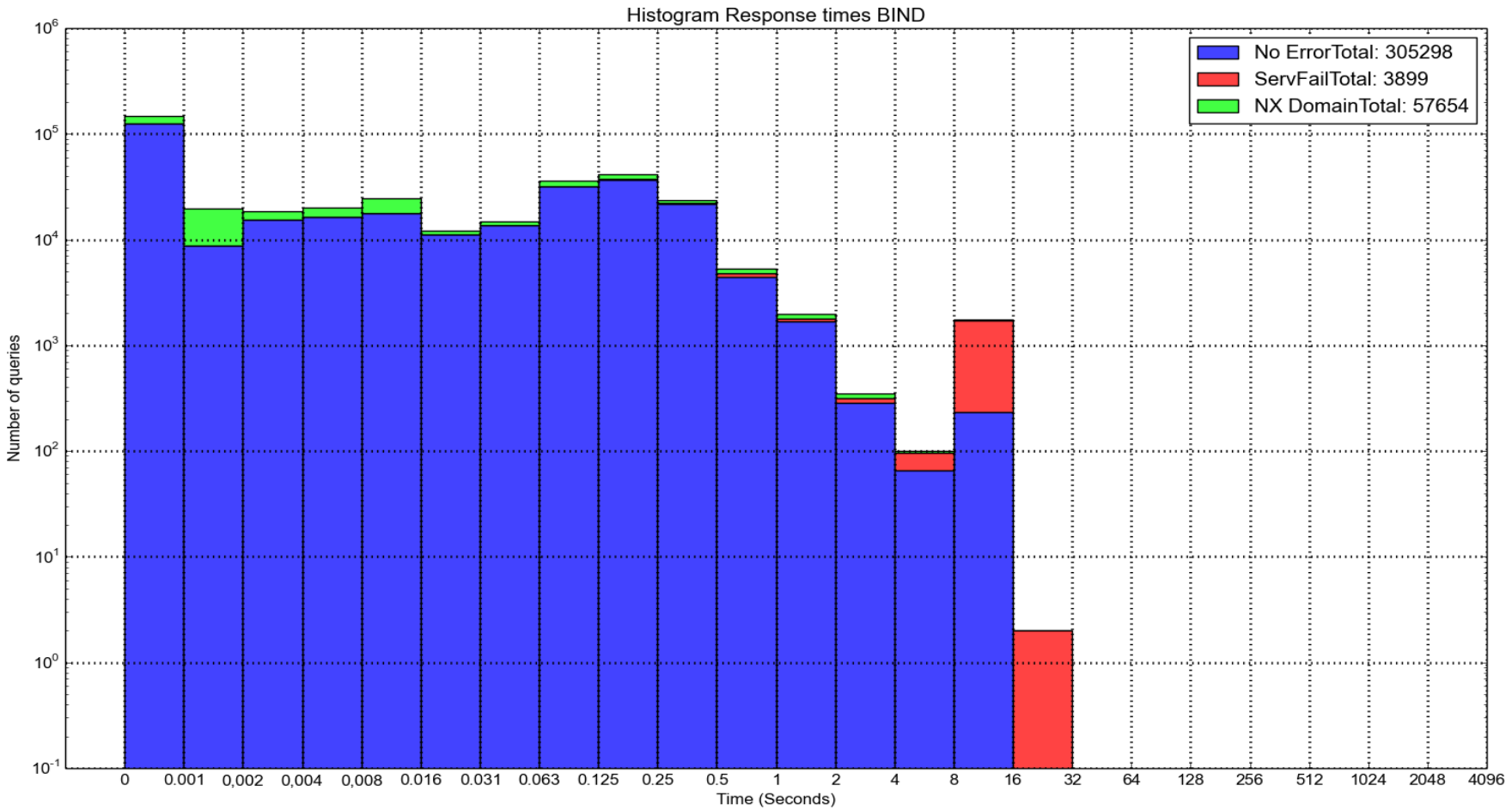
Results of Measurements DNS



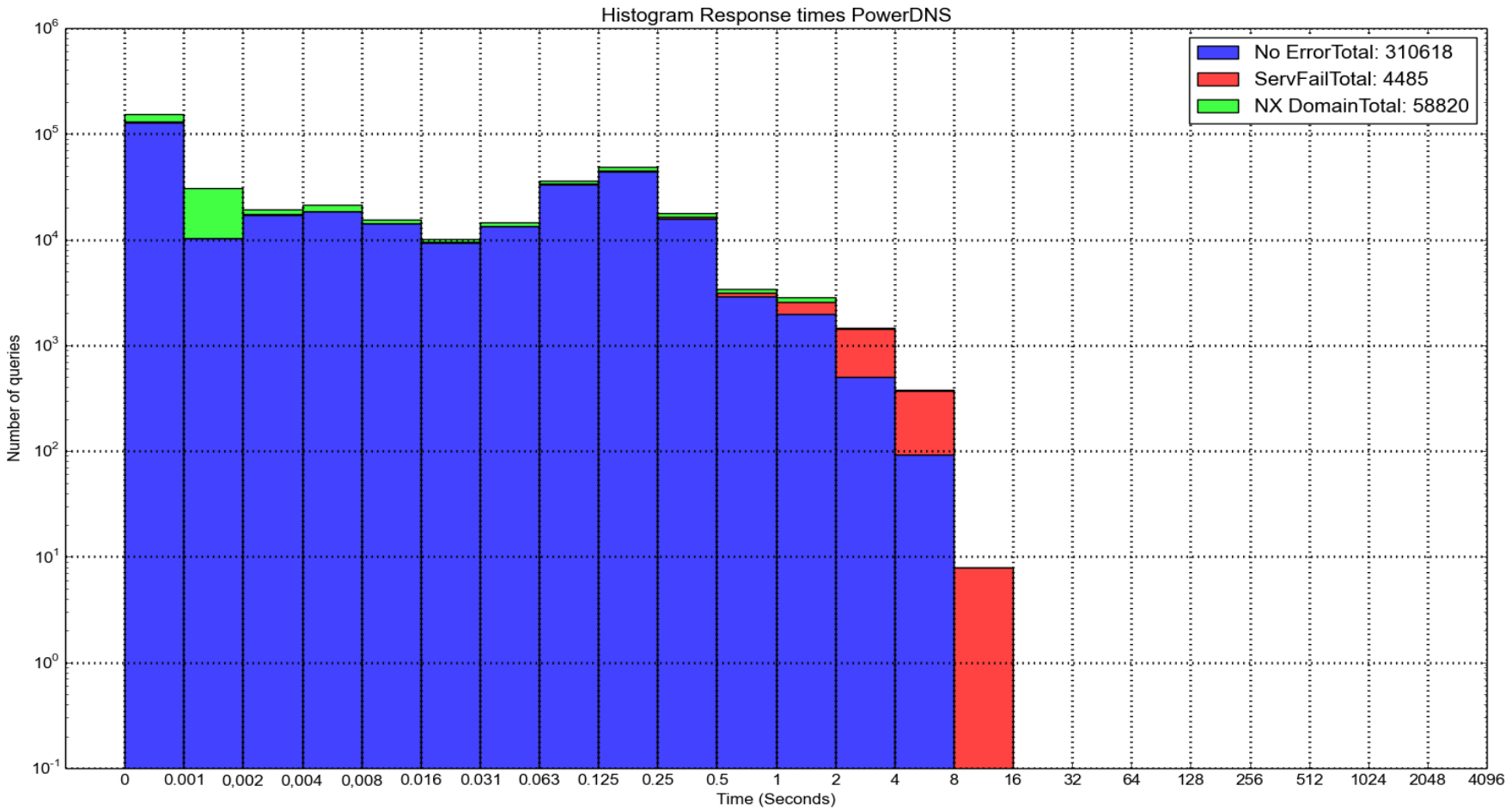
Unbound


Histogram Response times Unbound
No ErrorTotal: 311464
ServFailTotal: 3504
NX DomainTotal: 58853
Number of queries
Time (Seconds)
0
0.001
0,002
0,004
0,008
0.016
0.031
0.063
0.125
0.25
0.5
1
2
4
8
16
32
64
128
256
512
1024
2048
4096

BIND

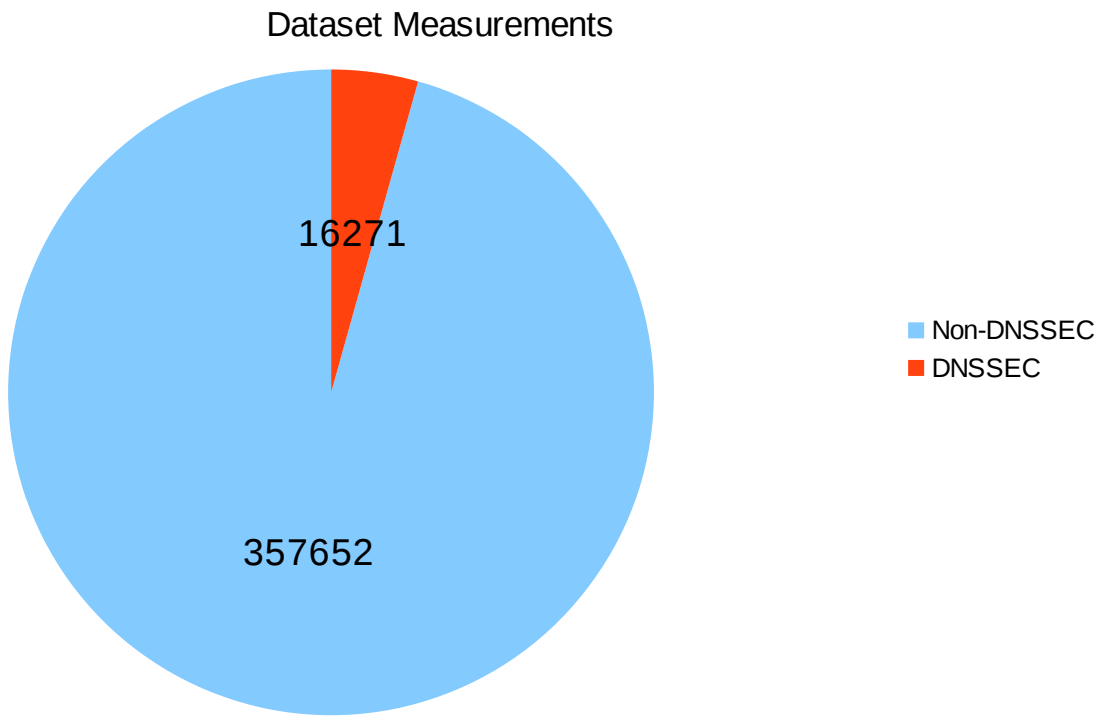

Histogram Response times BIND
No ErrorTotal: 305298
ServFailTotal: 3899
NX DomainTotal: 57654
Number of queries
Time (Seconds)
0
0.001
0,002
0,004
0,008
0.016
0.031
0.063
0.125
0.25
0.5
1
2
4
8
16
32
64
128
256
512
1024
2048
4096

PowerDNS


Histogram Response times PowerDNS
No ErrorTotal: 310618
ServFailTotal: 4485
NX DomainTotal: 58820
Number of queries
Time (Seconds)
0
0.001
0,002
0,004
0,008
0.016
0.031
0.063
0.125
0.25
0.5
1
2
4
8
16
32
64
128
256
512
1024
2048
4096

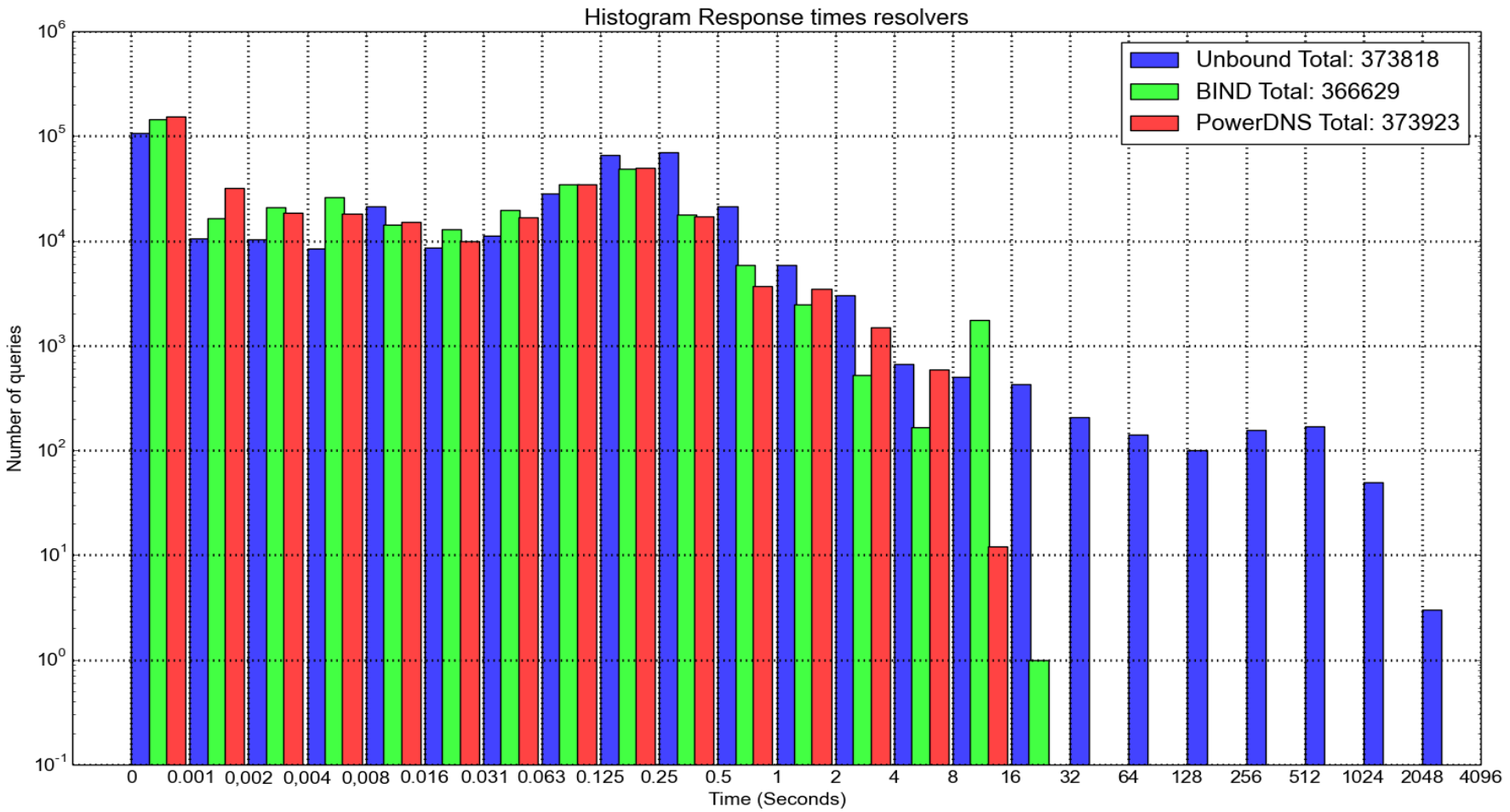
Results of Measurements DNSSEC

- Changed packets to perform DNSSEC
- Dataset:
- 4.5% is DNSSEC

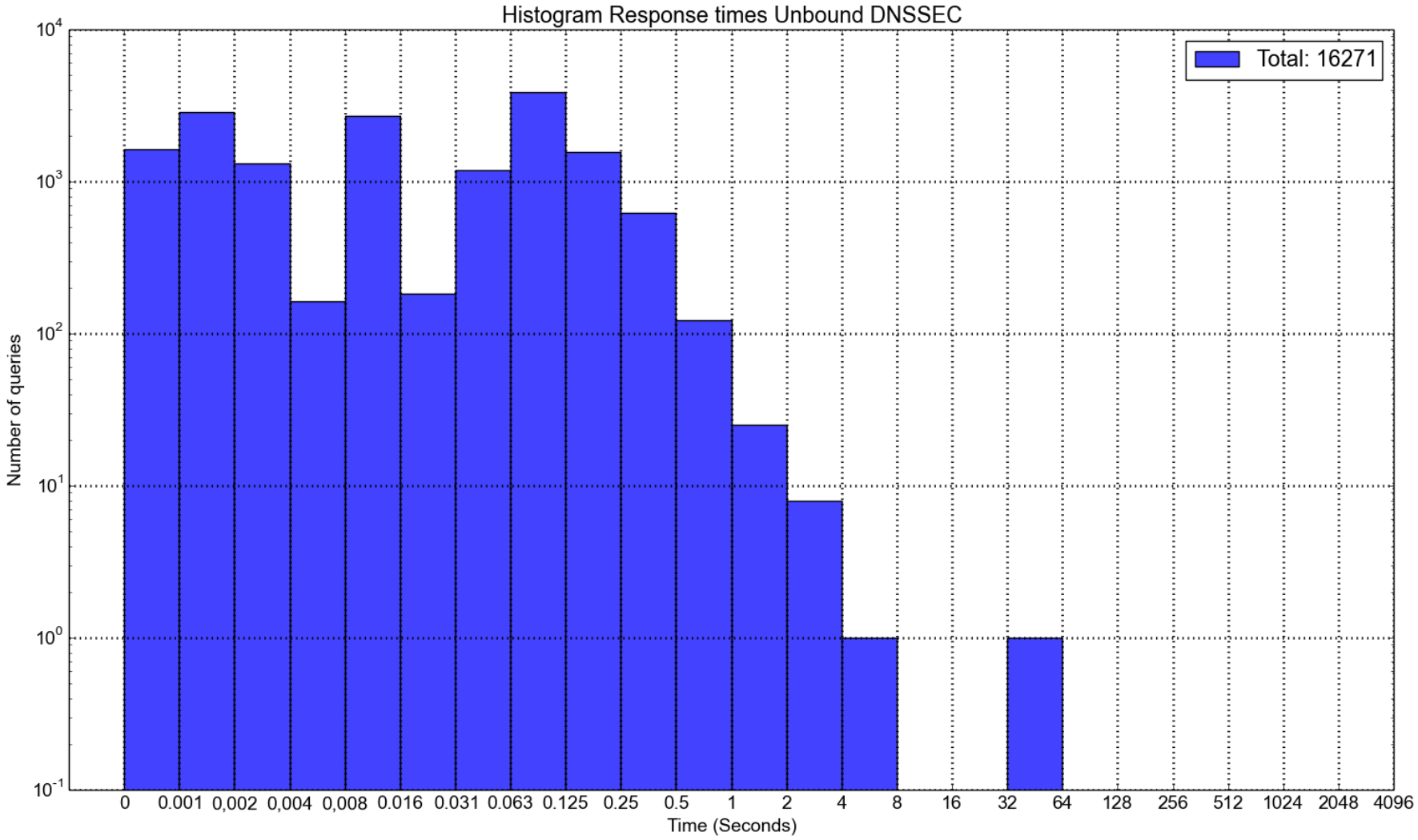


Total: 373,923

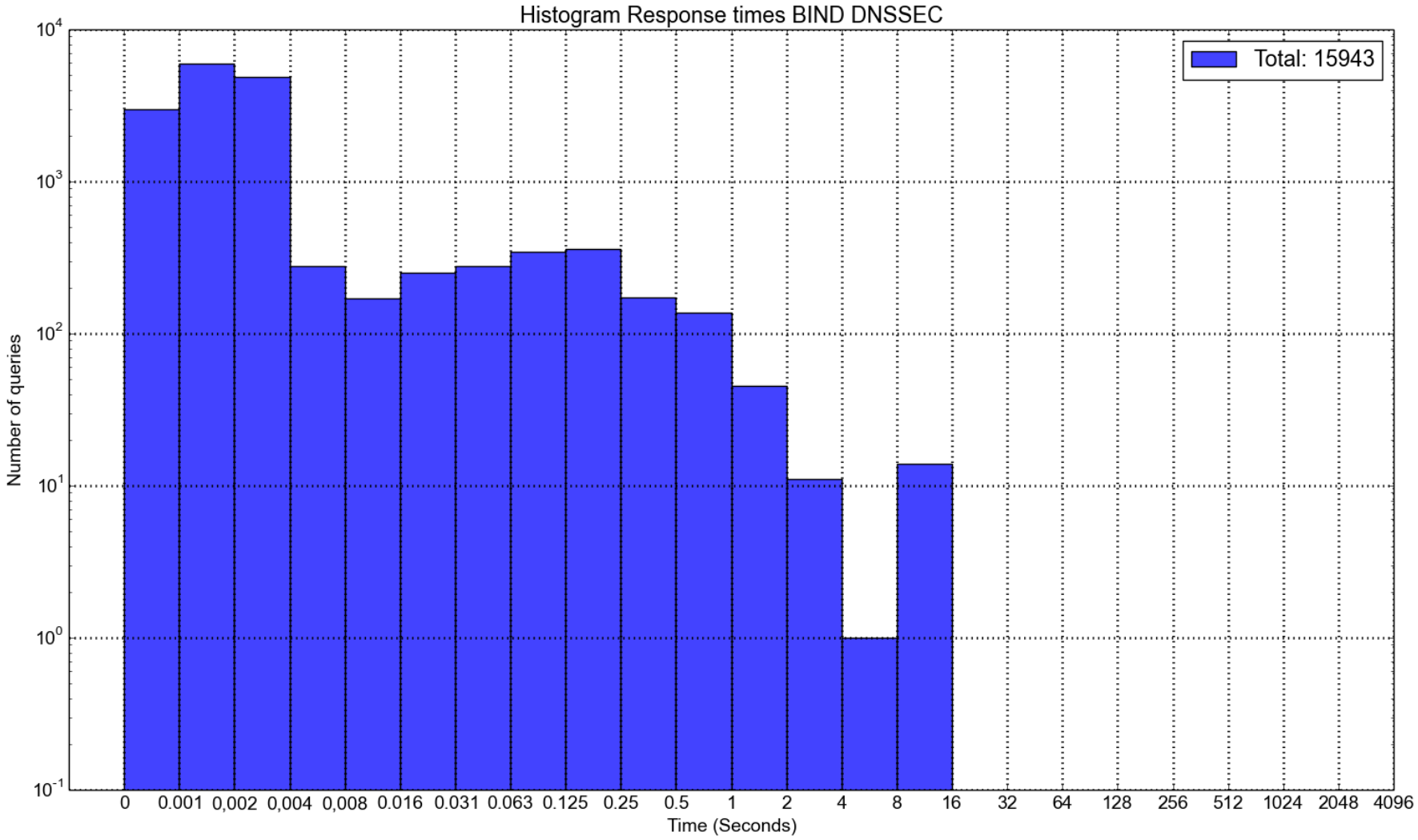
Results of Measurements DNSSEC



Results of Measurements Unbound



Results of Measurements BIND



Corner Cases

- Cases where resolvers act differently
  - Same Query
  - Different response
- Most corner cases
  - No Error No data
  - ServFail

Corner Case Examples

- PowerDNS result in ServFail
- Unbound and BIND result in NoError NoData

  dig italiancookingandliving.com MX

- Not entirely clear who is right
  - If the same domain name exists with different type
  - If no other records exists

Corner Case Examples

- BIND results in ServFail
- Unbound and PowerDNS result in NoError

  dig 102.163.171.69.in-addr.arpa PTR

- It is a mistery why Unbound and PowerDNS are able to resolve.

Corner Case Examples

- Unbound results in ServFail
- BIND and PowerDNS result in NoError

  dig s38.ck.koramgame.com A

- There are 10 CNAMEs

Conclusion

- PowerDNS
  - Performance
  - Short timers
  - Sometimes too lenient
- BIND
  - Performance
  - A bit longer timers
  - Strict
- Unbound
  - Performance
  - Variable timers (can be very long)
  - Lenient
- DNS Resolvers are not always about performance
  - Other variables

Future Work

- Devise other methods for measuring DNS resolvers
- Measure using different dataset
- Investigate corner cases

Questions