Update on experimental BIND features to rate-limit recursive queries

OARC Spring 2015 – Cathy Almond, ISC

What is this talk about?

- Random DNS query attacks against specific domains – a (very) quick recap
- Mitigation approaches
- Results from production environments
- Future thoughts/ideas/plans

The attack

- Attack is directed at DDOSing DNS authoritative provider, but incidentally degrades ISP resolvers in the path
- Higher query loads than usual
- Non-responding authoritative servers (directly filtering the resolvers, or simply overwhelmed)
- Increased network traffic levels

Identifying an attack

high volume of queries for non-existant sub-domains

<randomstring>.www.example.com
<anotherstring>.www.example.com

does not exist

??

exists

◎

The source

- Open resolvers
  - your servers
  - your clients (CPE devices/proxies and forwarders)
- Compromised clients (botnets)
- Compromised devices

Symptoms

- Increased inbound client query traffic
- Increased outbound NXDOMAIN and SERVFAIL responses
- Resolution delays to clients
- Dropped responses
- Increased memory consumption
- Firewall connection table overflows

Evidence

- Backlog of recursive client queries
  - which queries are in the backlog?
  - is there a pattern?
  - originating from few or many clients?
- Open outbound sockets
  - to which servers; is there a pattern?
- Query logging / query-errors logging
- Network packet traces

First steps

- Eliminate open resolvers
  - is yours an open resolver?
  - open client CPE devices?
  - open resolvers forwarding to yours?
- Investigate compromised/infected clients
  - potentially several device types
  - source addresses may be spoofed
  - block spoofed addresses (internal)

What doesn’t help?

- Increasing server resources (e.g. recursive client contexts, sockets, network buffers etc..)
- Blocking clients (without investigating them properly first)
  - *Some exceptions to this*

Not enough…

MITIGATION TECHNIQUES

What can we do?

What has been tried in production?

What do we want to achieve?

Stage 1: Lie!

- Make recursive server temporarily authoritative for the target domain
  - Local zone
  - DNS-RPZ (*qname-wait-recurse no;)

- *Manual configuration change*
- *Need to undo the mitigation afterwards*
- *Responds NXDOMAIN to all queries*

Stage 2: Automate filtering

(Near) Real Time Block Lists

- Detect ‘bad’ domain names or just the problematic queries & filter them at ingress to the resolver
- Local auto-detection scripts
- Nominum Vantio
- BIND DNS-RPZ
- Costs associated with feeds
- Potential false-positives

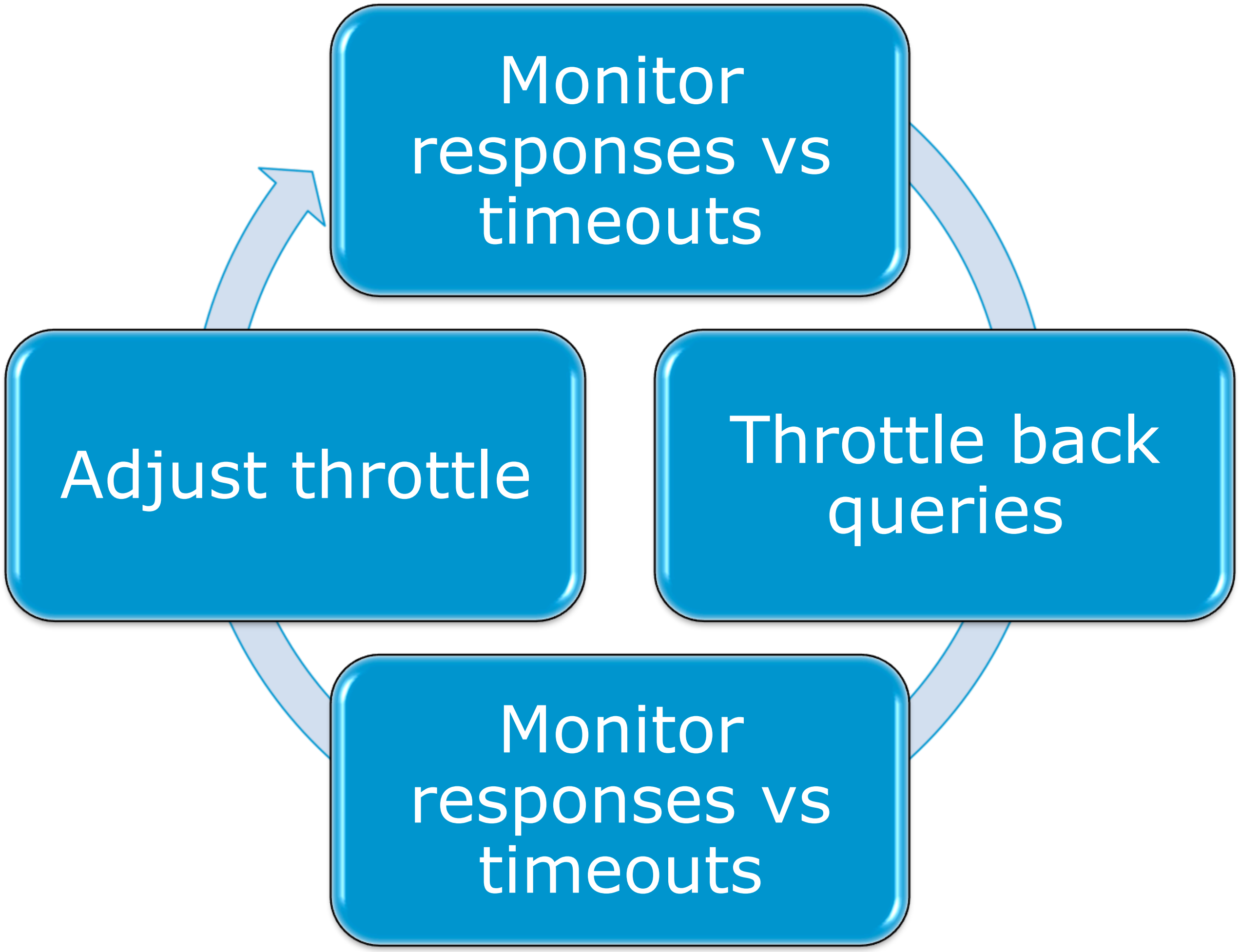
Stage 3: Tune your resolver

PER ZONE

PER SERVER

Respond SERVFAIL without waiting to timeout

Fetches-per-server



fetches-per-server

- Per-server quota dynamically re-sizes itself based on the **ratio of timeouts to successful responses**
- Completely non-responsive server eventually scales down to fetches quota of 2% of configured limit.
- Similar (loosely) in principle to what NLnet Labs is doing in Unbound

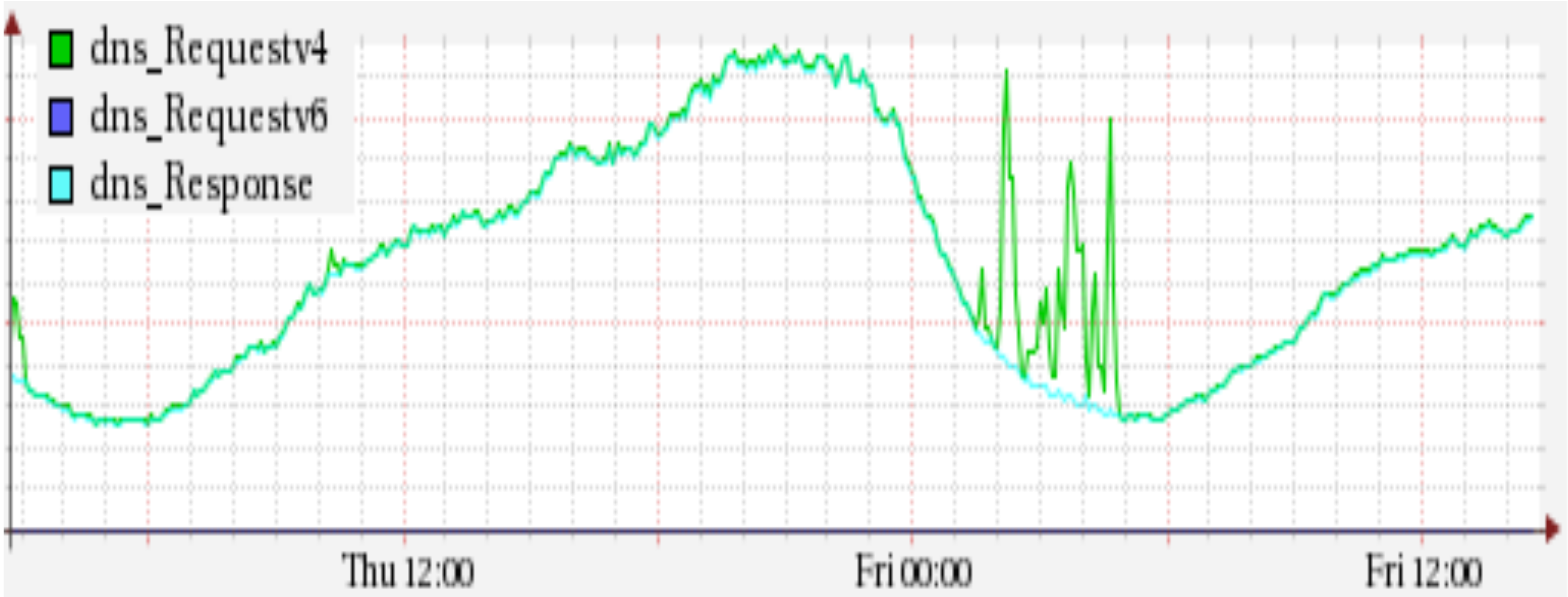
fetches-per-server

- default tuning :
  fetch-quota-params 100 0.1 0.3 0.7;
  - Recalculate fetch quota every 100 queries
  - 10% or below timeout – raise threshold
  - 30% of above timeouts – reduce threshold
  - 70% weighting given to recent counting period when computing timeout ratio

fetches-per-zone

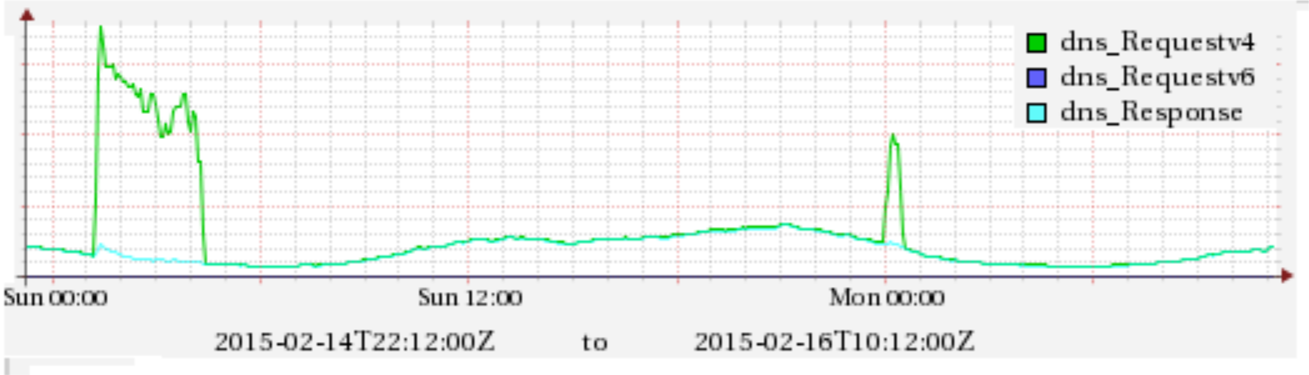
- Works with unique clients
- Default 0 (no limit enforced)
- Tune larger/smaller depending on normal QPS to avoid impact on popular domains

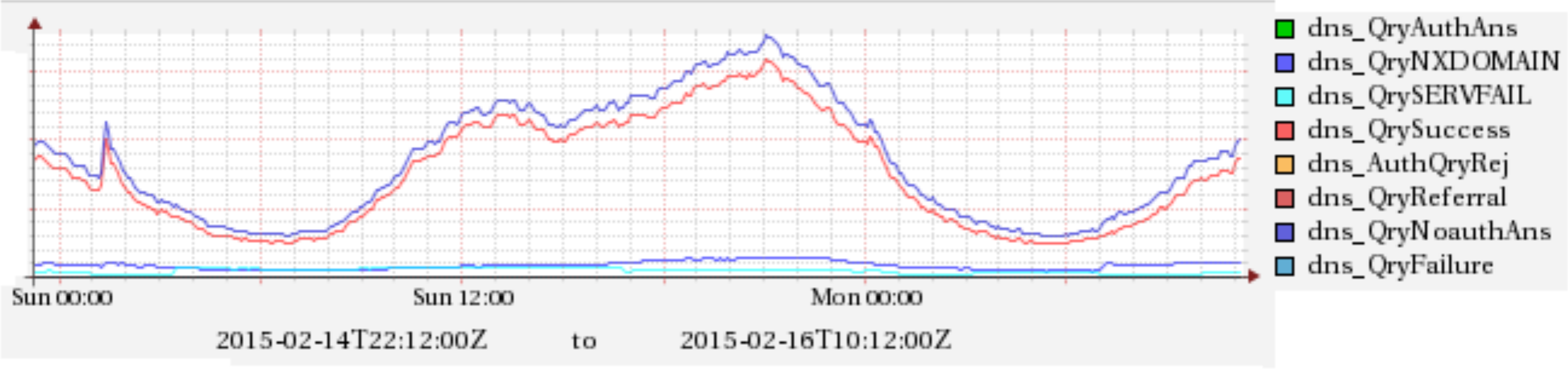
fetches-per-zone at Jazztel



Spanish triple-play ADSL carrier & ISP
Roberto Rodriguez Navio, Jazztel Networking Engineering
used with permission

More on fetches per zone





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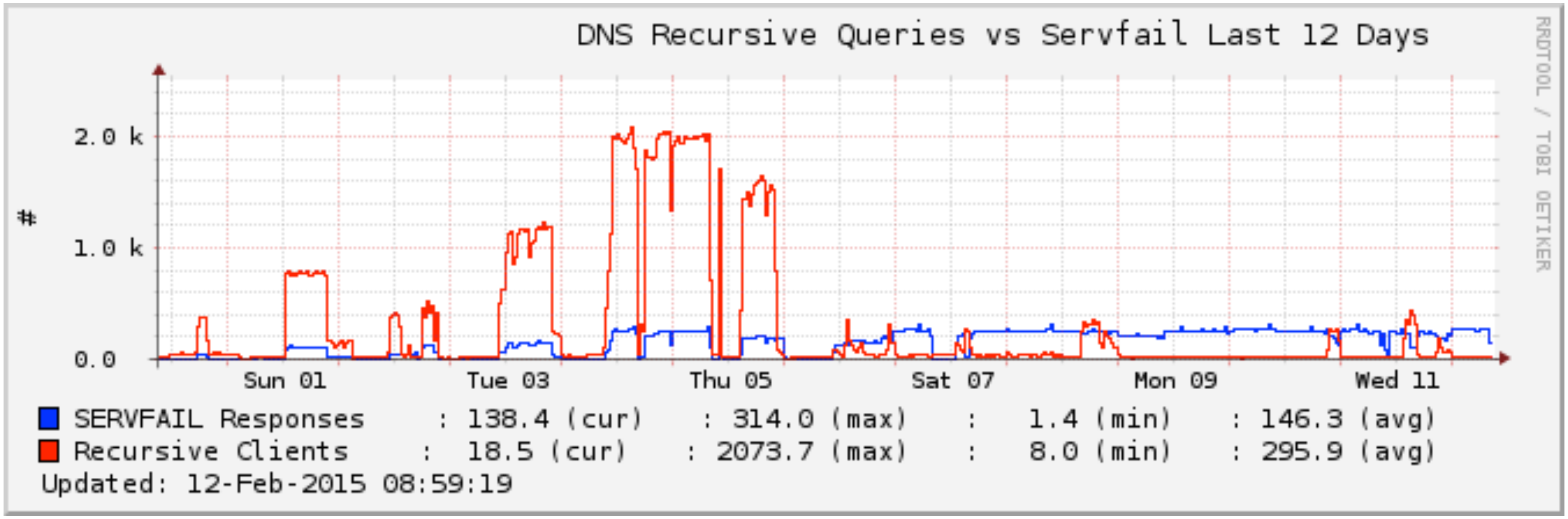
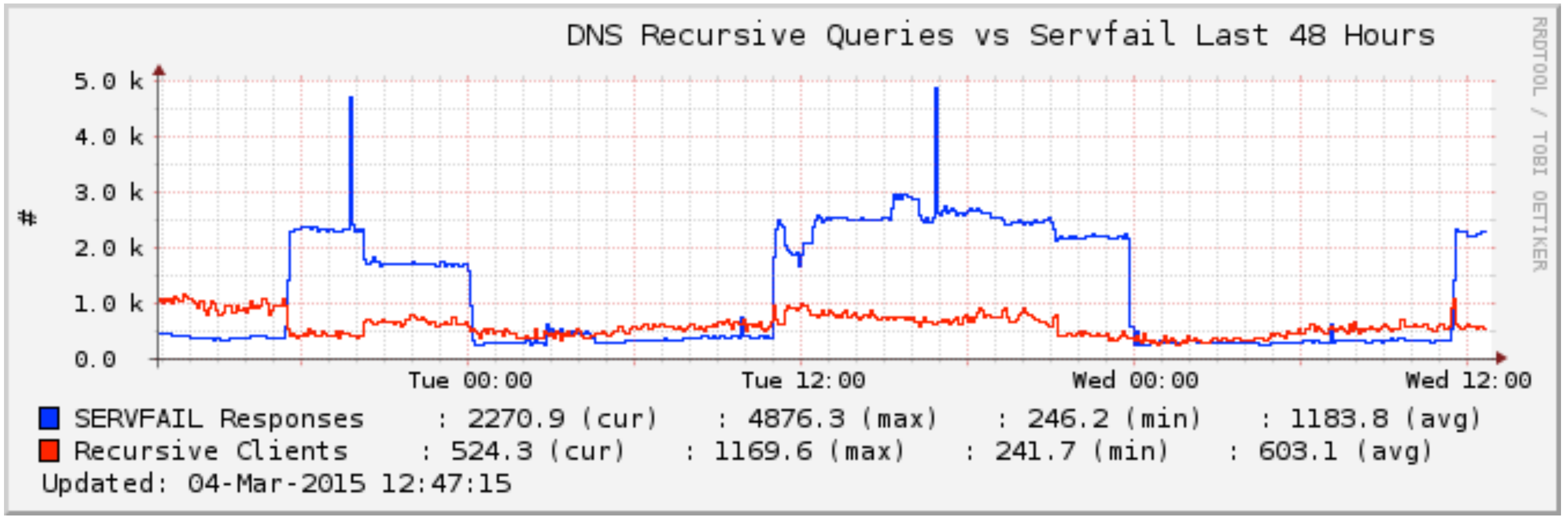
fetches-per-server

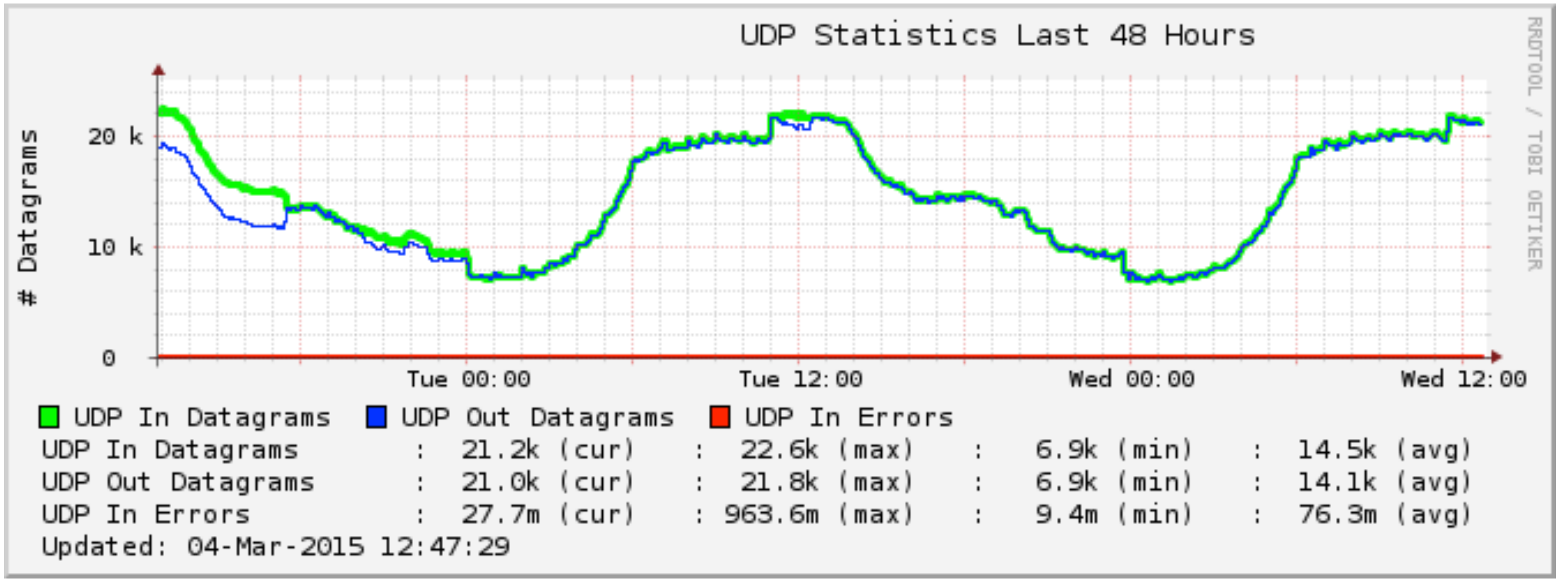


```
🟦 SERVFAIL Responses     :  138.4 (cur)    :  314.0 (max)    :    1.4 (min)    :  146.3 (avg)
🟥 Recursive Clients     :   18.5 (cur)    : 2073.7 (max)    :    8.0 (min)    :  295.9 (avg)
Updated: 12-Feb-2015 08:59:19
```

per-zone v. per-server



```
🟦 SERVFAIL Responses    : 2270.9 (cur)   : 4876.3 (max)   : 246.2 (min)   : 1183.8 (avg)
🟥 Recursive Clients    : 524.3 (cur)   : 1169.6 (max)   : 241.7 (min)   : 603.1 (avg)
Updated: 04-Mar-2015 12:47:15
```

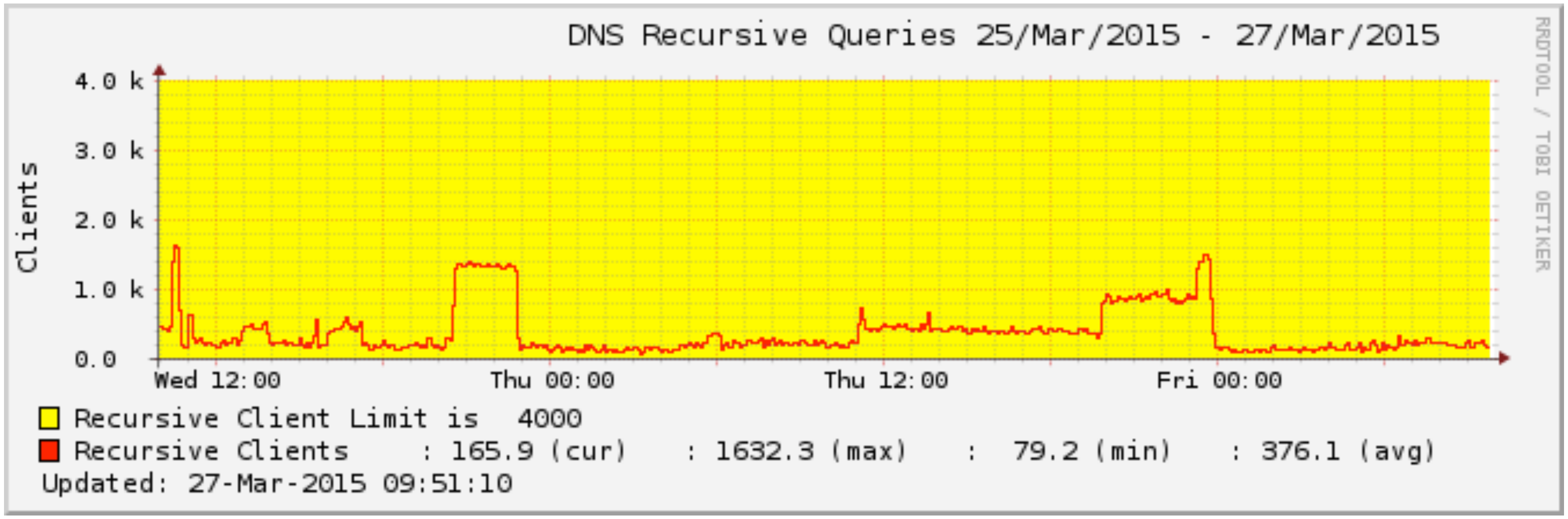


```
🟩 UDP In Datagrams  🟦 UDP Out Datagrams  🟥 UDP In Errors
UDP In Datagrams       :  21.2k (cur)  :  22.6k (max)  :   6.9k (min)  :  14.5k (avg)
UDP Out Datagrams      :  21.0k (cur)  :  21.8k (max)  :   6.9k (min)  :  14.1k (avg)
UDP In Errors          :  27.7m (cur)  : 963.6m (max)  :   9.4m (min)  :  76.3m (avg)
Updated: 04-Mar-2015 12:47:29
```

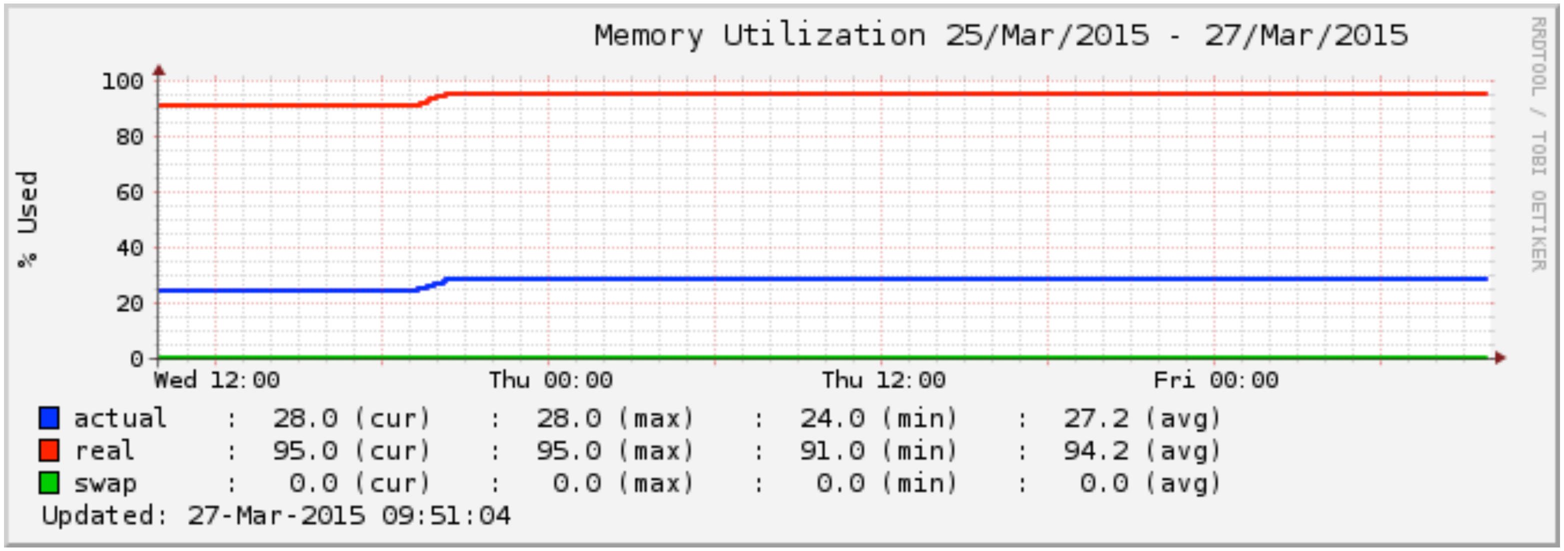
What will the user see?

- Situation normal – no change to their usual experience (for most)
- (Some) SERVFAIL responses to names in zones that are also served by under-attack authoritative servers (collateral damage)
- NXDOMAIN responses for names in legitimate zones for which we ‘lie’

But not yet perfect…

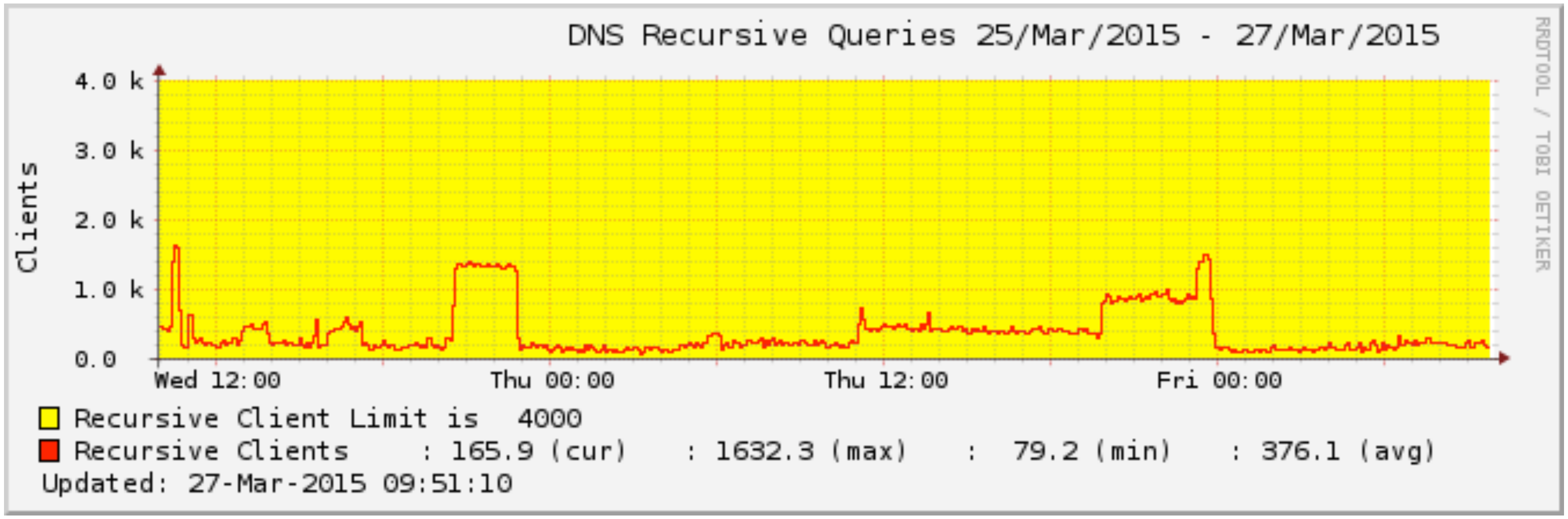


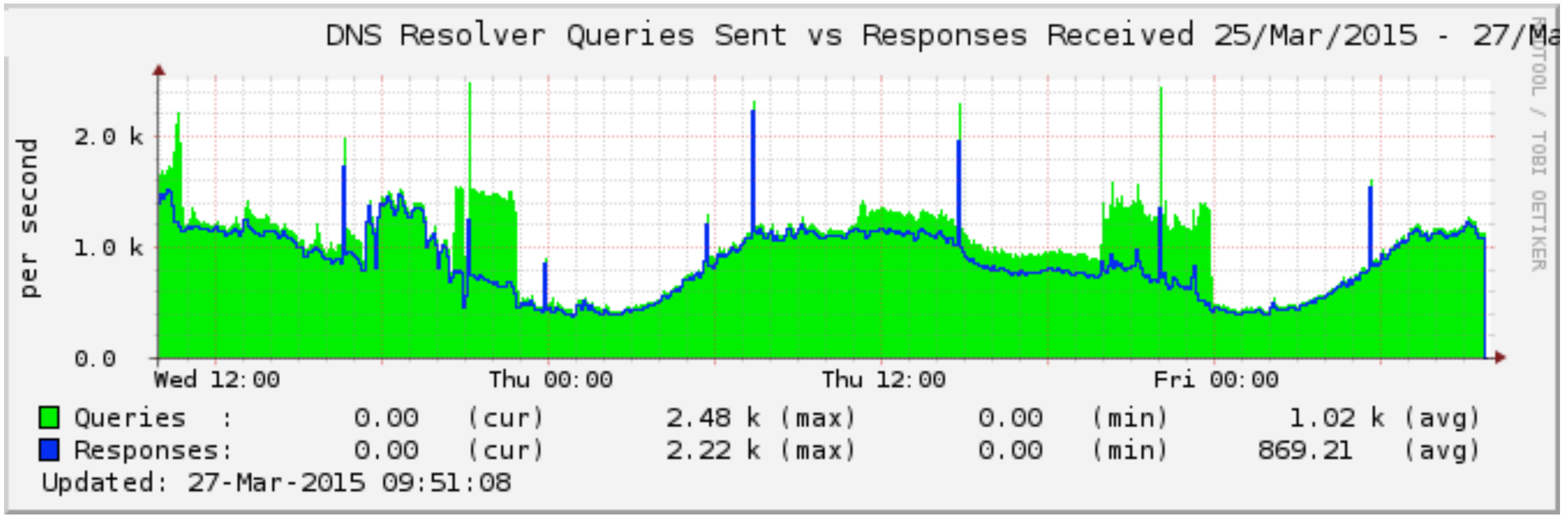
```
🟨 Recursive Client Limit is   4000
🟥 Recursive Clients     : 165.9 (cur)    : 1632.3 (max)    :   79.2 (min)    : 376.1 (avg)
Updated: 27-Mar-2015 09:51:10
```



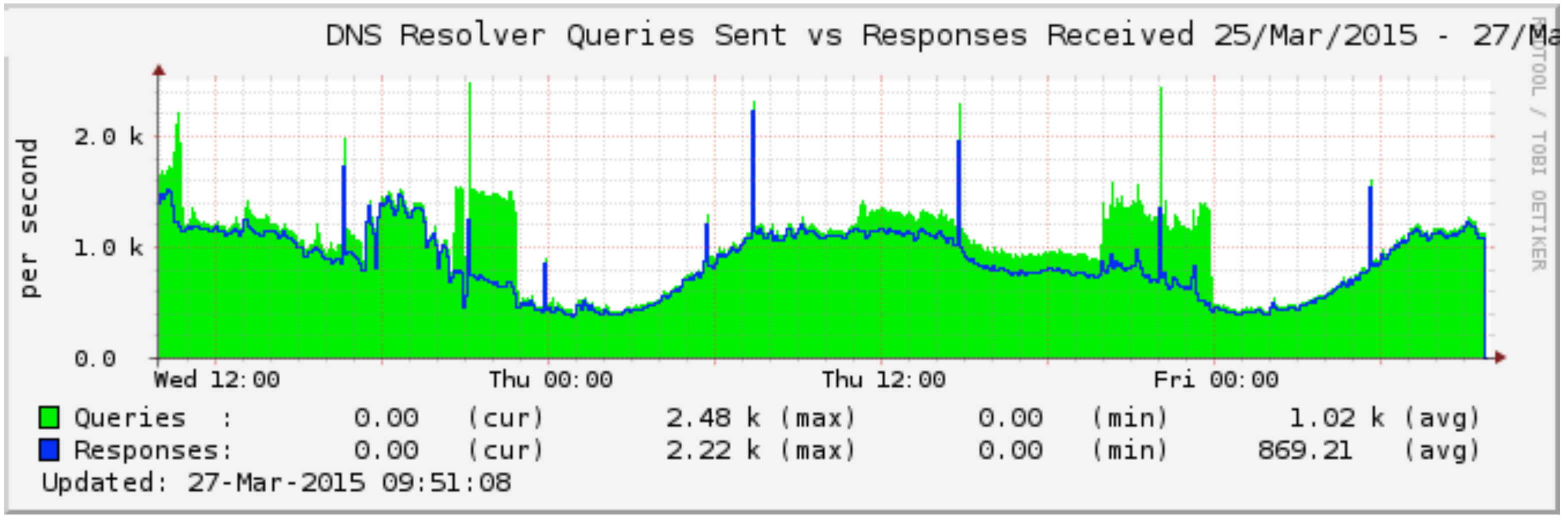
```
🟦 actual    :  28.0 (cur)   :  28.0 (max)   :  24.0 (min)   :  27.2 (avg)
🟥 real      :  95.0 (cur)   :  95.0 (max)   :  91.0 (min)   :  94.2 (avg)
🟩 swap      :   0.0 (cur)   :   0.0 (max)   :   0.0 (min)   :   0.0 (avg)
Updated: 27-Mar-2015 09:51:04
```

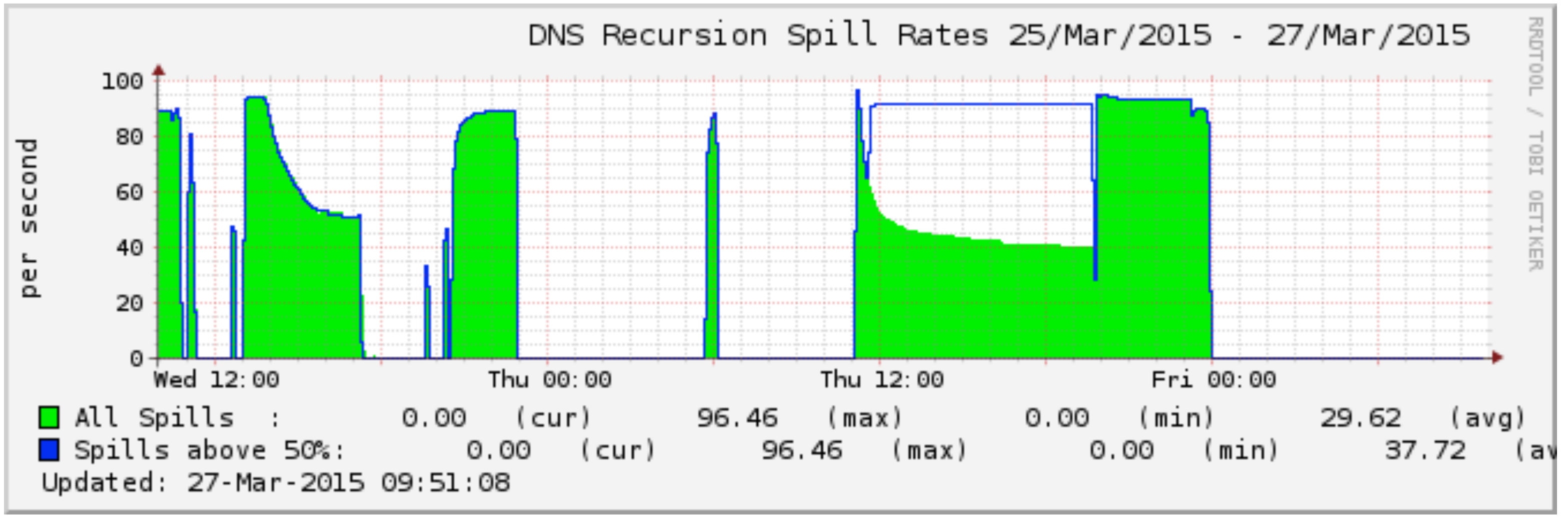
But not yet perfect...





But not yet perfect…





More ideas…

- SERVFAIL or drop (or NXDOMAIN)?
- Whitelists may be needed
- Per-server/zone override settings
- SERVFAIL cache (for client retries)
- Improved reporting & statistics
- Built-in ‘auto-DNS-RPZ’
- Persistent (non-expiring) RRsets (for ‘good’ answers)

Summary of techniques

1) Clean up your network

   eliminate open resolvers & compromised clients; look at BCP 38

2) Configure your resolver to lie

   answer authoritatively yourself; potentially automate your blacklist or subscribe to a feed for this.

3) Consider adaptive quotas

   per server; per zone

(Good feedback on these from many sources)

QUESTIONS?

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