Dense Anycast Deployment of DNS Authority Servers

RIPE 64

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Background

In the beginning

- Authority service provided with a discrete server per entry in the NS RRSet
- Practical limit to the number of entries in the NS RRSet
- Small number of servers means high RTT for many users

In the beginning (2)

- An unreachable server means resolvers must retry
- Scaling and performance characteristics are not great

Anycast

- Anycast allows copies of a single server to exist at multiple points in the topology
- Some root servers have been anycast for well over a decade
- Typical model involves a stack of servers and network equipment hosted at IXP locations

Anycast enables...

- Avoid the limitation on number of servers
- Take the service closer to the user, lower RTT
- More query handling capacity
- Flexibility, it's easy to add more servers, and easy to disable a broken server
- Keep attack traffic closer to the source

L root

- Anycast since 2007
- Old model had 3 big nodes at IXP locations in Los Angeles, Miami, Prague
- Big nodes have one router and many servers

Expansion of L root

Why?

- Present in North America and Europe, wanted to take the service closer to underserved regions
- Wanted to significantly increase our query handling capacity

How?

- Change from a small number of big nodes to many small nodes
- Lots of nodes would mean lots of work, a redesign was required to significantly reduce opex

Where?

- No one good heuristic for locating nodes
  - Typical model says IXPs are good places to be, interested parties will peer
  - L is just one of 13 root servers, can add diversity by doing something different
  - We decided to go directly into eyeball networks, interested parties will provide a server

When?

- Field trial in 2011
  - Deployed 30 small nodes
- Working concurrently on new, fully automated platform
- Began rollout of the new platform in 2012
- Deployed at 60 locations in March

What?

- 21 physical servers at 20 locations.
- Quick win by deploying into virtual machines operated by PCH. Rolled out 146 VMs at 40 locations during March.

Before March 2012

68 servers at 37 locations

Deployed in March 2012

21 servers at 20 locations, 146 VMs at 40 locations

Now

89 physical servers and 146 VMs at 97 locations

Redesign

Old platform

- Servers run CentOS
- Some in-house scripts to automate things but installation and administration largely done by manual effort

New platform

- Servers run Ubuntu
  - More flexible
  - Prefer Debian package management
- Fully automated install
- Fully automated administration with Puppet
- Can treat the whole cloud as one system with one set of controls

Puppet

- Open Source IT Automation Software
  - Ensures that all systems have correct packages and configuration
  - Ensures easy system-wide application of configuration policy
  - Clients check in periodically and have policy enforced

Configuration

- Single YAML configuration file per server
  - Used by Puppet and in-house Perl scripts
- Describes
  - Location, Network info, Zone transfer auth

Example configuration

yxu01.l.root-servers.org.yaml

```
location:
     town: London
     state: Ontario
     country: Canada
drac:
     addr4: 192.0.2.1/24
     gw4: 192.0.2.254
interfaces:
     eth0:
        addr4: 192.0.2.2/24
        gw4: 192.0.2.254
bgp:
     as: 64496
     desc: Example Limited
     addr4:
        - 192.0.2.254
     enable_advertisements: true
tsig:
     name: yxu01-20120101.
     algo: hmac-sha256
     data: tsigsecret=
```

Install

- Host acquires and racks the server, does basic configuration of the DRAC
- ICANN DNS Ops run the installer
  - Generates custom install ISO, attaches it to the DRAC as a virtual CD, tells the DRAC to boot
- Custom install CD
  - Fully automated install, bootstraps Puppet, which starts working on first boot

Post install

- Some pre-flight checks to verify that the nameserver is working correctly, then we update the configuration and the node goes live

```
bgp:
   as: 64496
   desc: Example Limited
   addr4:
      - 192.0.2.254
   enable_advertisements: false
   enable_advertisements: true
```

Puppet Modules

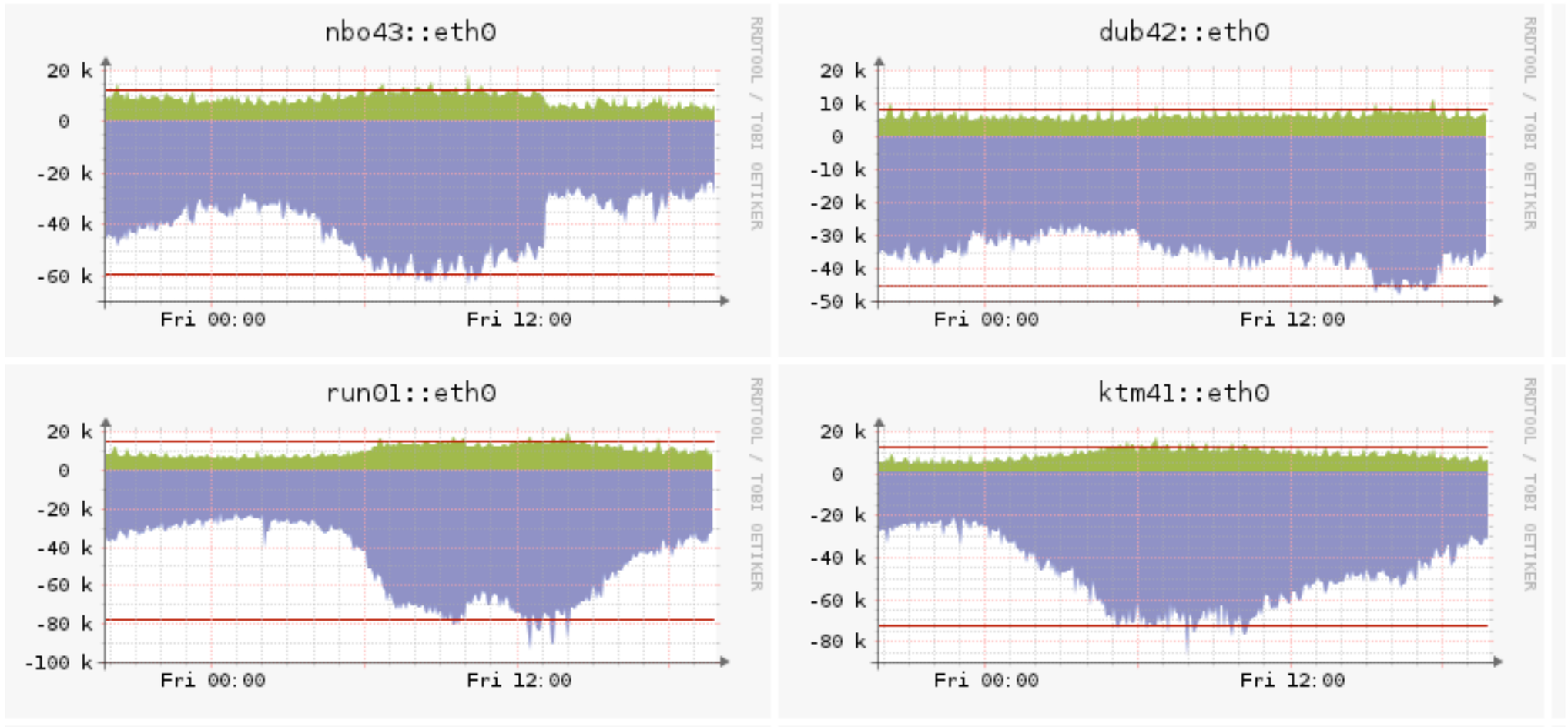
- Our Puppet code is organized into modules, one per service, for example, every server runs the NSD nameserver software, so we have a module for that which contains
  - A Puppet manifest which describes the policy regarding required packages, files, permissions, controls, dependencies, etc
  - A ruby template for the NSD config file

Monitoring

- Currently use Intermapper for alerts
- Puppet is well integrated with Nagios, we will migrate to use Nagios for alerts
  - In the manifest for a service we can simply state that the service should be monitored by Nagios and it is
  - A new node is therefore being monitored with Nagios as soon as the install completes

Monitoring (2)

- We use Observium to track resource usage, essentially everything we can graph with SNMP: Disk, Network, etc



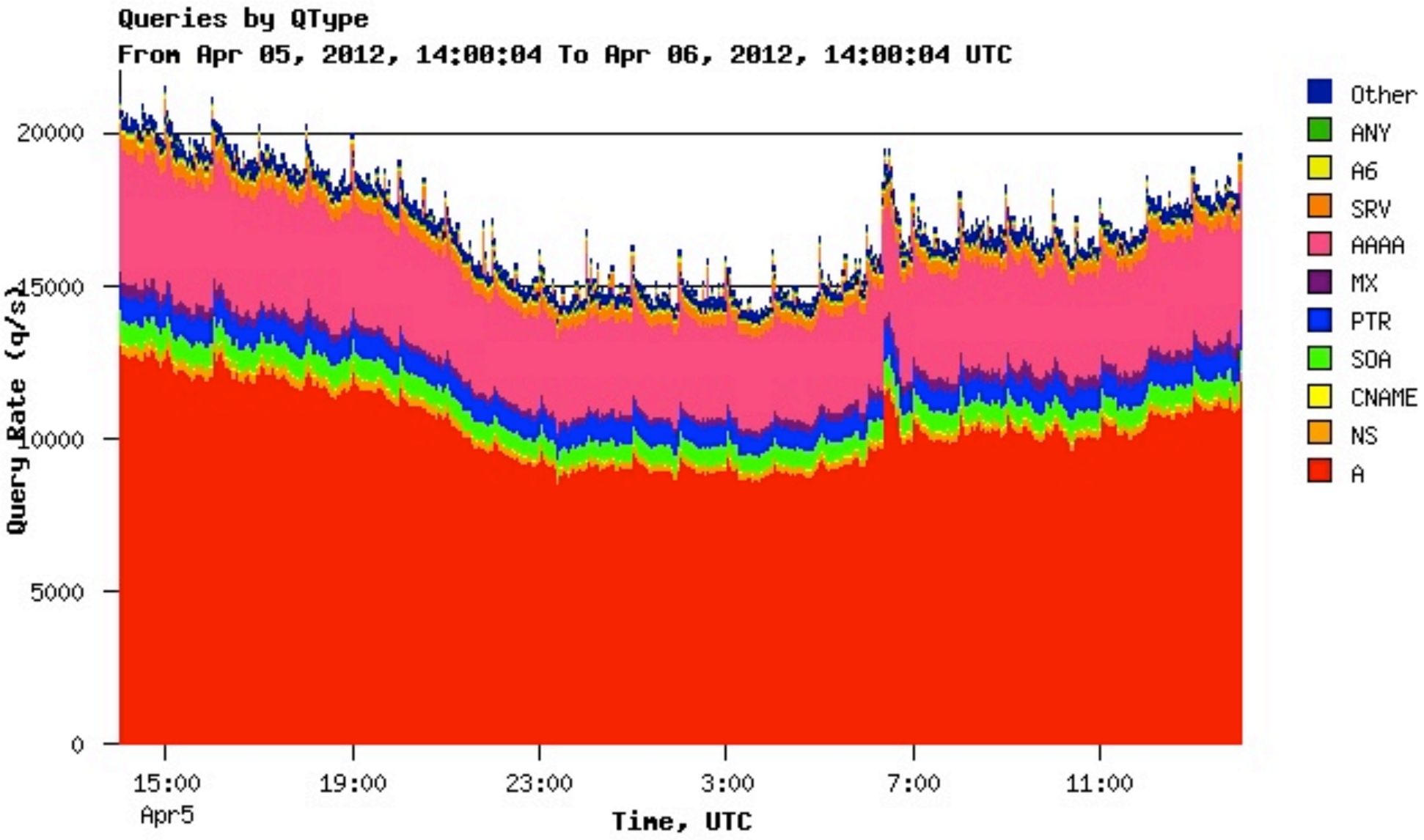
Monitoring (3)

- We have custom scripts generating reports on the state of all nameservers we have any involvement with, the configuration of the L root portion of that is automatically generated from Puppet data.
- And of course we rely on RIPE NCC's DNSMON

Measurement

- We monitor DNS traffic with DSC
  - Every server collects DSC stats locally and uploads them to a central server
  - We publish our DSC stats
  - http://dns.icann.org/lroot/stats/

Measurement (2)



Aggregate traffic at all nodes, by Query Type

Measurement (3)

- Will do ongoing capture of query packets
- Periodically upload those as part of a DITL

Further Work

Continue the migration

- Around 70 L root servers still running CentOS, they will be reinstalled with Ubuntu over the next few weeks
- Much of the back office services still run on CentOS: DSC, Observium, etc. They will be migrated to Ubuntu+Puppet
- Goal is to have a process where the initial deployment is the only manual step required in adding a server

Further Expansion

- We continue to deploy more nodes
- Interested parties can find more information at

http://dns.icann.org/

Questions?

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