CERN central DHCP service: Migration from ISC DHCP to Kea

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Outline

Section 1

Introduction

Motivation

- Foreseen end of life of ISC DHCP (dhcpd)
  - Date not announced yet
- No new features, only security fixes (few customers left)

Kea DHCP

- Developed by ISC
  - https://www.isc.org/
- Used for example by Facebook
- Still under development
- New features
- Some features from ISC DHCP dropped on purpose
- Can be customized using "hooks" libraries
  - Free: High Availability, MySQL Configuration Backend, BOOTP, ...
  - Premium: Forensic Logging, Flexible Identifier, additional management API commands, ...

Section 2

Configuration translation

Current setup

- ISC DHCP
- 3 separate network domains
  - 2 DHCP servers in each
- DHCPv4, DHCPv6, DDNS
- ~7000 subnets
- ~400 000 host reservations
- Configuration re-generated every 5 minutes
  - Client information and topology extracted mainly from the CERN central network database

ISC DHCP configuration

- Topology
  - Shared networks
  - Subnets
  - IP address pools
- Client classes
  - E.g., list of MAC addresses blocked by the security team
  - Allow/deny statements in pool configuration
- Client groups
  - DHCP options (next-server, boot-file-name, ...)
  - Host reservations (hostname, IP address, options)
- Other
  - Vendor spaces
  - Lease times
  - BOOTP
  - ...

Client classes in Kea (1)

- Configure 3 different elements from ISC DHCP configuration
  - Client groups
  - Client classes
  - Allow/deny statements in IP address pools

Client classes in Kea (2)

```
"client-classes": [
  {
    "name": "LINUX",
    "test": "substring(option[vendor-class-identifier].text, 0, 9) == 'PXEClient'",
    "option-data": [
      {
        "name": "vendor-class-identifier",
        "csv-format": true,
        "data": "PXEClient"
      }
    ],
    "next-server": "10.0.0.99"
  }
]
```

Client classes in Kea (3)

```
"client-classes": [
  {
    "name": "blocked-list",
    "test": "pkt4.mac == 0xaabbccddeeff or pkt4.mac == 0x112233445566"
  },
  {
    "name": "pool#!blocked-list",
    "test": "not member('blocked-list')"
  }
],
"subnet4": [
  {
    "subnet": "10.0.0.0/24",
    "pools": [
      {
        "pool": "10.0.0.100 - 10.0.0.200",
        "client-class": "pool#!blocked-list"
      }
    ]
  }
]
```

Host reservations in Kea

- Not in client classes
- Client class specified in the reservation
- Host reservations with a fixed IP address
  - Inside subnet configuration
- Host reservations without a fixed IP address
  - Global reservations

Host reservations in ISC DHCP

```
group { # LINUX Clients
    host HOST1-AA-BB-CC-DD-EE-FF {
        hardware ethernet AA:BB:CC:DD:EE:FF;
        option host-name "host1";
        fixed-address 10.0.0.99;
    }
    host HOST2-11-22-33-44-55-66 {
        hardware ethernet 11:22:33:44:55:66;
        option host-name "host2";
    }
}
```

Subnet reservations in Kea

```
"subnet4": [
  {
    "subnet": "10.0.0.0/24",
    "reservations-global": true,
    "reservations-in-subnet": true,
    "reservations": [
      {
        "hw-address": "aa:bb:cc:dd:ee:ff",
        "ip-address": "10.0.0.99",
        "hostname": "host1",
        "client-classes": [
          "LINUX"
        ]
      }
    ]
  }
]
```

Global reservations in Kea

```
"Dhcp4": [
  {
    "reservations": [
      {
        "hw-address": "11:22:33:44:55:66",
        "hostname": "host2",
        "client-classes": [
          "LINUX"
        ]
      }
    ]
  }
]
```

Problems

- Cannot redefine standard DHCP options (e.g., *ntp-servers*)
  - Workaround: set the value in hexadecimal regardless of the type of the option
- String type was not supported in vendor-encapsulated-options
  - Added in 1.3.0
- BOOTP support added in Kea 1.7.2
- Multiple host reservations for the same IP address were not allowed in the same subnet
  - Possibility to disable the uniqueness test since 1.9.1
- Client hardware addresses needed in class configuration
  - It was not enough to specify the class in the host reservations
  - Fixed in 1.9.5
- Multiple IP addresses not allowed in DHCPv4 host reservations
- Authoritative clause not supported in DHCPv6

Kea features

- High Availability
  - Multiple cooperating server instances
  - Load balancing (each server responds to 1/2 of the requests)
  - If any of these instances becomes unavailable a surviving server instance can continue providing the reliable service to the clients
- Management API
  - Online reconfiguration without requiring server shutdown
  - Modify configuration, enable/disable DHCP service, get service status, ...
- Monitoring with Stork
  - See up-to-date details regarding pool utilization, monitor the state of the server instances, ...
  - Can be integrated with Prometheus and Grafana

Section 3

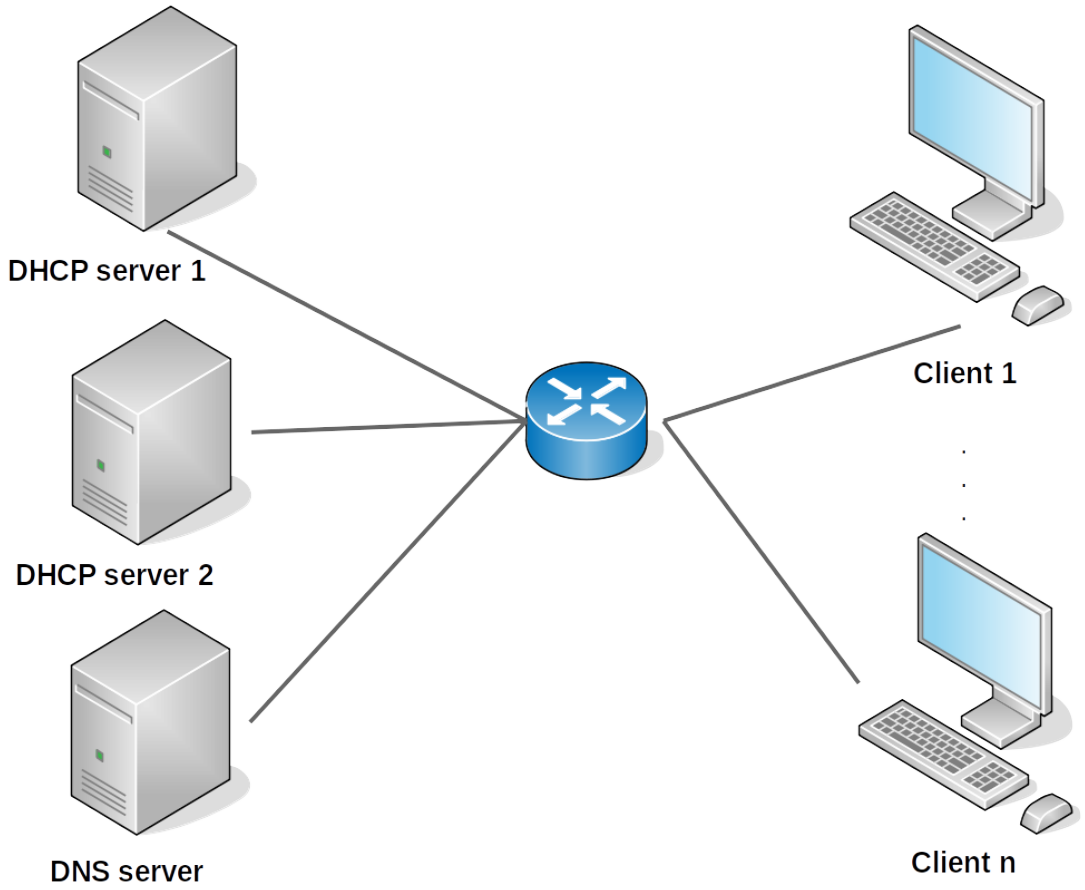
Testing

Validation of Kea configuration

- Goal: make sure that the new Kea configuration behaves the same way as the previous ISC DHCP configuration
- Generate a sample ISC DHCP configuration that covers all needed use cases
- Generate a matching Kea configuration
- Send identical queries to both servers and compare the replies
  - ~17000 DHCPv4 requests

Test environment

- Virtual network in Podman



Section 4

Configuration generation

DHCP Updater

- Golang
  - Used Perl for updating ISC DHCP configuration
- Generate Kea configuration using data from the CERN central network database
- Update the DHCP configuration on the servers every 5 minutes

Section 5

Migration status and plans

Migration status and plans

- Translated and tested DHCPv4 configuration
  - Except for dhcp-server-identifier and BOOTP
- Translated DHCPv6 and DDNS configuration, testing in progress
- TODO
  - Implement regular configuration updates
  - Setup monitoring and alarms
  - Solve last problems
  - Pilot in Q2

Questions?