Kea Webinar

Database and High-Availability options

Carsten Strotmann

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https://www.isc.org

Welcome

- Welcome to part four of our webinar series "the KEA DHCP Server"

About this Webinar

- Database backend support for Kea
- Database setup
- Maintaining the Kea-Database with kea-admin
- Kea Database Configuration
- Host/Reservation in a SQL Database
- Kea Configuration Database Backend
- Recovering from Database failures
- High Availability
- Kea HA Maintenance
- "so many options, which should I implement?"

Database backend support for Kea

Why a database backend?

- The Kea DHCP server can store in a database:
  - Lease information
  - Host addresses and prefixes
  - Host options
  - Host names
  - Host classification
  - Configuration (MySQL only)

Benefits of using a database backend

- Faster turn-around for configuration changes in large deployments (many DHCP servers)
- Easy access to DHCP information from scripts
- Option to build a custom management interface for the DHCP service
- High-Availability through database redundancy
- Easier to integrate into existing backup systems

Drawbacks of using a database backend

- when issuing a lease, Kea DHCP must wait for the storage backend to acknowledge the successful storage of lease information
  - depending on the database setup and implementation, this is often slower then the Kea in-memory (lease-file) storage
- Some databases cannot store lease information that reaches beyond the year 2038

PostgreSQL

- powerful, open source object-relational database system
  - flexible and extensible
  - performance is in par with commercial database offerings on Linux/Unix
  - PostgreSQL License (permissive open source license)
- PostgreSQL: https://www.postgresql.org

MySQL/MariaDB

- MySQL is the most popular (network based) open source SQL database system
  - MariaDB is a compatible fork of MySQL by the original MySQL development team
  - MySQL/MariaDB is available in most Linux/Unix systems
  - MySQL and MariaDB are GPLv2 licensed
- MariaDB:
  https://mariadb.com
- MySQL:
  https://www.mysql.com

Cassandra

- Apache Cassandra is a NoSQL database for large amounts of data
  - it provides linear scalability and fault-tolerance on commodity hardware
  - Support for the Cassandra Database in Kea is experimental
  - Cassandra is available under the Apache License 2.0
- Cassandra Database: https://cassandra.apache.org

Database setup

Preparing the database

- steps required before Kea can connect to a database system:
  - create the database
  - create a user for Kea in the database system
  - set the access permissions on the Kea database

PostgreSQL (1/2)

- Most PostgreSQL installations come with a dedicated operating system user account for the PostgreSQL database (in our examples, the user postgres).
    - all database configuration steps should be done as this database user

PostgreSQL (2/2)

- Creating the database for storing Kea lease information and giving the user kea access permissions on this database

```
(kea-server)# su - postgres
(kea-server)$ psql -U postgres
Password for user postgres:
psql (12.4)
Type "help" for help.
postgres=# CREATE USER kea WITH PASSWORD 'secure-password';
CREATE ROLE
postgres=# CREATE DATABASE kea_lease_db;
CREATE DATABASE
# GRANT ALL PRIVILEGES ON DATABASE kea_lease_db TO kea;
postgres=# \q
```

Preparing a MariaDB/MySQL database (1/2)

- To prepare the MySQL/MariaDB database for Kea, first the database are created (in this example, one database for leases)

```
mysql -u root -p
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 8
Server version: 10.4.14-MariaDB MariaDB Server

Copyright (c) 2000, 2018, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MariaDB [(none)]> CREATE DATABASE kea_lease_db;
Query OK, 1 row affected (0.000 sec)
```

Preparing a MariaDB/MySQL database (2/2)

- In the next step, the database user kea is created and given access to the lease-database:

```
MariaDB [(none)]> CREATE USER 'kea'@'localhost' IDENTIFIED BY 'secure-password';
Query OK, 0 rows affected (0.006 sec)

MariaDB [(none)]> GRANT ALL ON kea_lease_db.* TO 'kea'@'localhost';
Query OK, 0 rows affected (0.005 sec)

MariaDB [(none)]> quit
Bye
```

MySQL performance tuning

- If MySQL is used with the InnoDB database backend (the default), changing the MySQL internal value `innodb_flush_log_at_trx_commit` from default value 1 to 2 can result with huge gain in Kea performance
  - It can be set per session for testing:

```
mysql> SET GLOBAL innodb_flush_log_at_trx_commit=2;
mysql> SHOW SESSION VARIABLES LIKE 'innodb_flush_log%';
```

  - or permanently in `/etc/mysql/my.cnf`

```
[mysqld]
innodb_flush_log_at_trx_commit=2
```

- Changing this value can create problems during data recovery after a database crash - please check the MySQL documentation

`https://dev.mysql.com/doc/refman/8.0/en/innodb-parameters.html`

Maintaining the Kea-Database with kea-admin

Initializing the Kea database (1/3)

- The command `db–init` of the `kea–admin` tool is used to initialize the database
  - while it is possible to initialize the SQL databases with the SQL-scripts provided with Kea, it is recommended to use the kea-admin tool, as it provides extra security checks in the process

Initializing the Kea database (2/3)

- Example: initializing a PostgreSQL database for lease database

```
# kea-admin db-init pgsql -u kea -h 127.0.0.1 -p secure-password -n kea_lease_db
Checking if there is a database initialized already. Please ignore errors.
Initializing database using script /opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:142: NOTICE:  function lease4dumpheader() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:150: NOTICE:  function lease4dumpdata() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:180: NOTICE:  function lease6dumpheader() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:188: NOTICE:  function lease6dumpdata() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:892: WARNING:  there is already a transaction in progress
Database version reported after initialization: 6.1
```

Initializing the Kea database (3/3)

- Example: initializing a MySQL database for leases

```
# kea-admin db-init mysql -u kea -p secure-password -n kea_lease_db
Checking if there is a database initialized already. Please ignore errors.
Verifying create permissions for kea
MySQL Version is: 10.4.14-MariaDB
Initializing database using script /opt/kea/share/kea/scripts/mysql/dhcpdb_create.mysql
mysql returned status code 0
Database version reported after initialization: 9.3
```

Upgrade of database schema (1/3)

- Sometimes a new Kea version may require a new database schema
  - The existing database will need to be upgraded
  - After upgrade, it may be impossible to subsequently downgrade to an earlier version
  - Before upgrading, please make sure that the database is backed up
  - The `kea-admin db-upgrade` command can be used to upgrade an existing database

Upgrade of database schema (2/3)

- To check the current version of the database, use the following command (<db-product> can be mysql or pgsql):

```
$ kea-admin db-version <db-product> -u <db-user> -p <db-password> -n <db-name>
```

- If the version does not match the minimum required for the new version of Kea (as described in the release notes), the database needs to be upgraded.
- see also Databases and Database Version Numbers https://kea.readthedocs.io/en/latest/arm/admin.html#kea-database-version

Upgrade of database schema (3/3)

- The `kea-admin` command is used to upgrade the database schema of the database (<db-product> can be mysql or pgsql):

```
$kea-admin db-upgrade <db-product> -u database-user -p database-password -n database-name
```

Kea Database Configuration

Configuration Example: Lease Database in PostgreSQL

- Example of a lease database configuration in Kea (file kea-dhcp4.conf or kea-dhcp6.conf)
  - for MySQL/MariaDB, just change the type to mysql

```
 "lease-database": {
     "type": "postgresql",
     "name": "kea_lease_db",
     "user": "kea",
     "password": "secure-password",
     "host": "localhost"
},
```

Test the configuration

```
# kea-dhcp4 -t /opt/kea/etc/kea/kea-dhcp4.conf

2020-10-22 11:43:23.772 INFO  [kea-dhcp4.hosts/61595.139911418369920]
           HOSTS_BACKENDS_REGISTERED the following host backend types are available: mysql
2020-10-22 11:43:23.773 INFO  [kea-dhcp4.dhcpsrv/61595.139911418369920]
           DHCPSRV_CFGMGR_SOCKET_TYPE_DEFAULT "dhcp-socket-type" not specified , using default socket type raw
2020-10-22 11:43:23.774 INFO  [kea-dhcp4.dhcpsrv/61595.139911418369920]
           DHCPSRV_CFGMGR_NEW_SUBNET4 a new subnet has been added to configuration: 192.0.2.0/24 with params: t1=900, t2=1800, valid-lifetime=3600
```

Host/Reservation in a SQL Database

Host/Reservation in a SQL Database - Why?

- Larger deployments might want to change the DHCP reservations dynamically and programatically via the API
  - The Host Commands hook (part of the Premium hooks package) adds a number of new commands to Kea used to query and manipulate host reservations
  - see Webinar 3 of this series for a discussion of the Host-Commands API
- the Host Commands hook requires a database for storing the host reservations
- If reservations are specified in both file and database, file reservations take precedence over the ones in the database

Creating a PostgreSQL database to store host reservations

- Creating the database for storing Kea host information (reservations) and giving the user kea access permissions on this database

```
(kea-server)# su - postgres
(kea-server)$ psql -U postgres
Password for user postgres:
psql (12.4)
Type "help" for help.

postgres=#  CREATE DATABASE kea_host_db;
CREATE DATABASE
postgres=# GRANT ALL PRIVILEGES ON DATABASE kea_host_db TO kea;
GRANT
postgres=# \q
```

Initializing the Host reservation database

- The command db-init of the kea-admin tool is used to initialized the database
  - while it is possible to initialize the SQL databases with the SQL-scripts provided with Kea, it is recommended to use the kea-admin tool, as it provides extra security checks in the process
- Example: initializing a PostgreSQL database for use as a host reservation database

```
# kea-admin db-init pgsql -u kea -h 127.0.0.1 -p secure-password -n kea_host_db
Checking if there is a database initialized already. Please ignore errors.
Initializing database using script /opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:142: NOTICE:  function lease4dumpheader() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:150: NOTICE:  function lease4dumpdata() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:180: NOTICE:  function lease6dumpheader() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:188: NOTICE:  function lease6dumpdata() does not exist, skipping
psql:/opt/kea/share/kea/scripts/pgsql/dhcpdb_create.pgsql:892: WARNING:  there is already a transaction in progress
Database version reported after initialization: 6.1
```

Configuration Example: Host Database in PostgreSQL

- Host database for PostgreSQL configuration in Kea (file `kea-dhcp4.conf` or `kea-dhcp6.conf`)
  - for MySQL/MariaDB, just change the type to mysql

```
 "hosts-database": {
     "type": "postgresql",
     "name": "kea_host_db",
     "user": "kea",
     "password": "secure-password",
     "host": "localhost"
},
```

Using Read-Only Databases with Host Reservations

- the host reservation information might be stored in a database that contains other (sensible) inventory information for the network
- in some cases, for policy and security reasons, the Kea DHCP server should not be able to write into this database
  - read-only access for retrieving reservations for clients and/or assigning specific addresses and options, can be configured explicitly in Kea with the read-only mode

```
"Dhcp4": {
  "hosts-database": {
      "readonly": true,
      ...
  },
  ...
}
```

Kea Configuration Database Backend

Storing Kea configuration in a database

- The Kea DHCPv4 and DHCPv6 servers support loading their configuration from an MySQL database
- The configuration back end supports
  - subnet and shared-network configurations
  - global DHCPv4/DHCPv6 parameter
  - option definitions
  - global, network and pool options

Benefits of the Kea database configuration backend

- The local Kea configuration on each server can be simple and static
  - Each DHCP server can share an almost identical preconfigured configuration
  - Enables offline configuration
  - Sharing configuration between HA cluster members -> keeping the config in sync
  - Helps with automatic configuration management

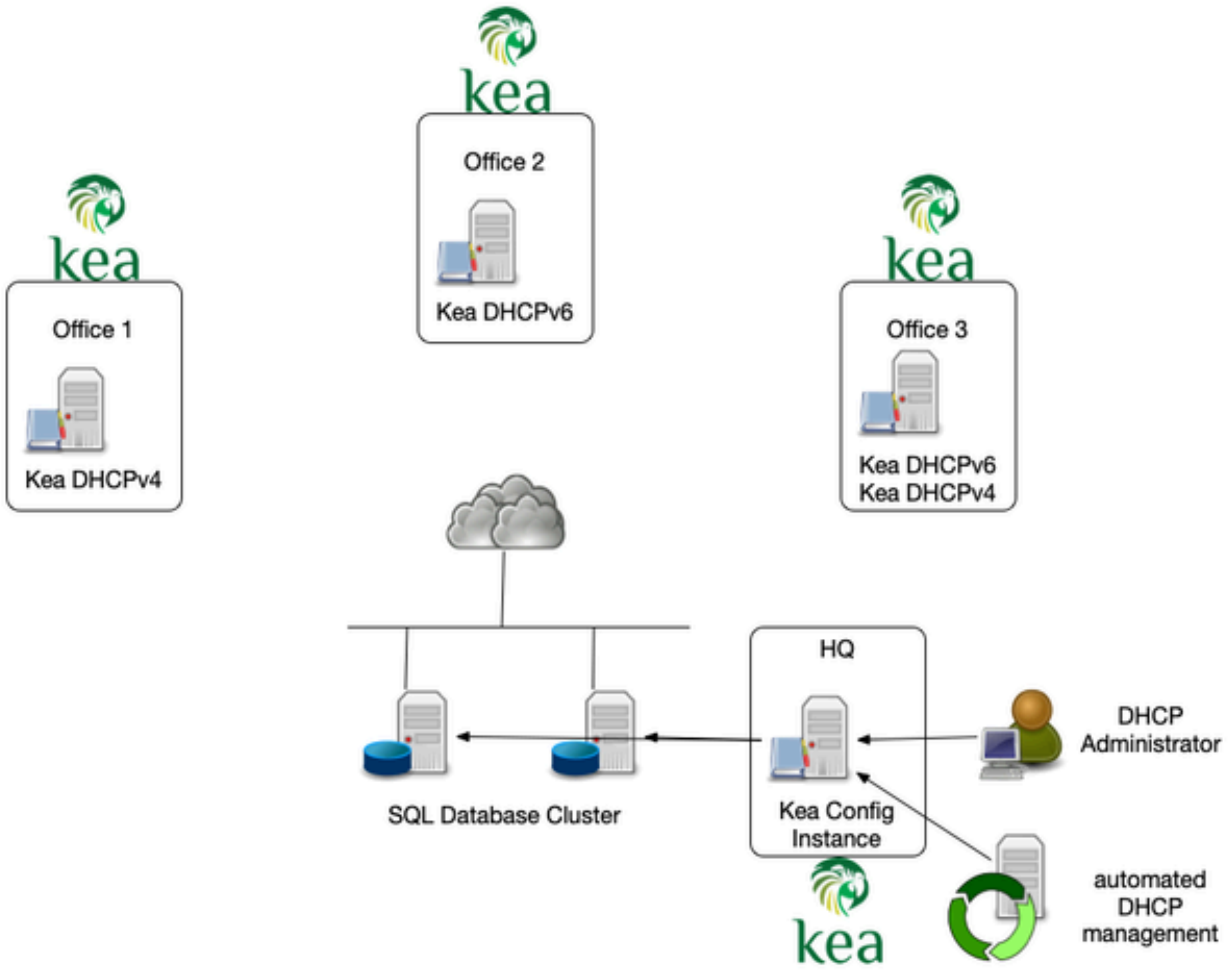
Kea configuration backend design (1/4)

- Administrators apply changes to the configuration into the database via the Kea Configuration Backend Commands hook
  - it is also possible to directly access the configuration on the SQL database level
  - changing the configuration on the database level requires a good understanding of the configuration database schema
  - the Kea configuration command hook provides essential business logic that ensures logical integrity of the data

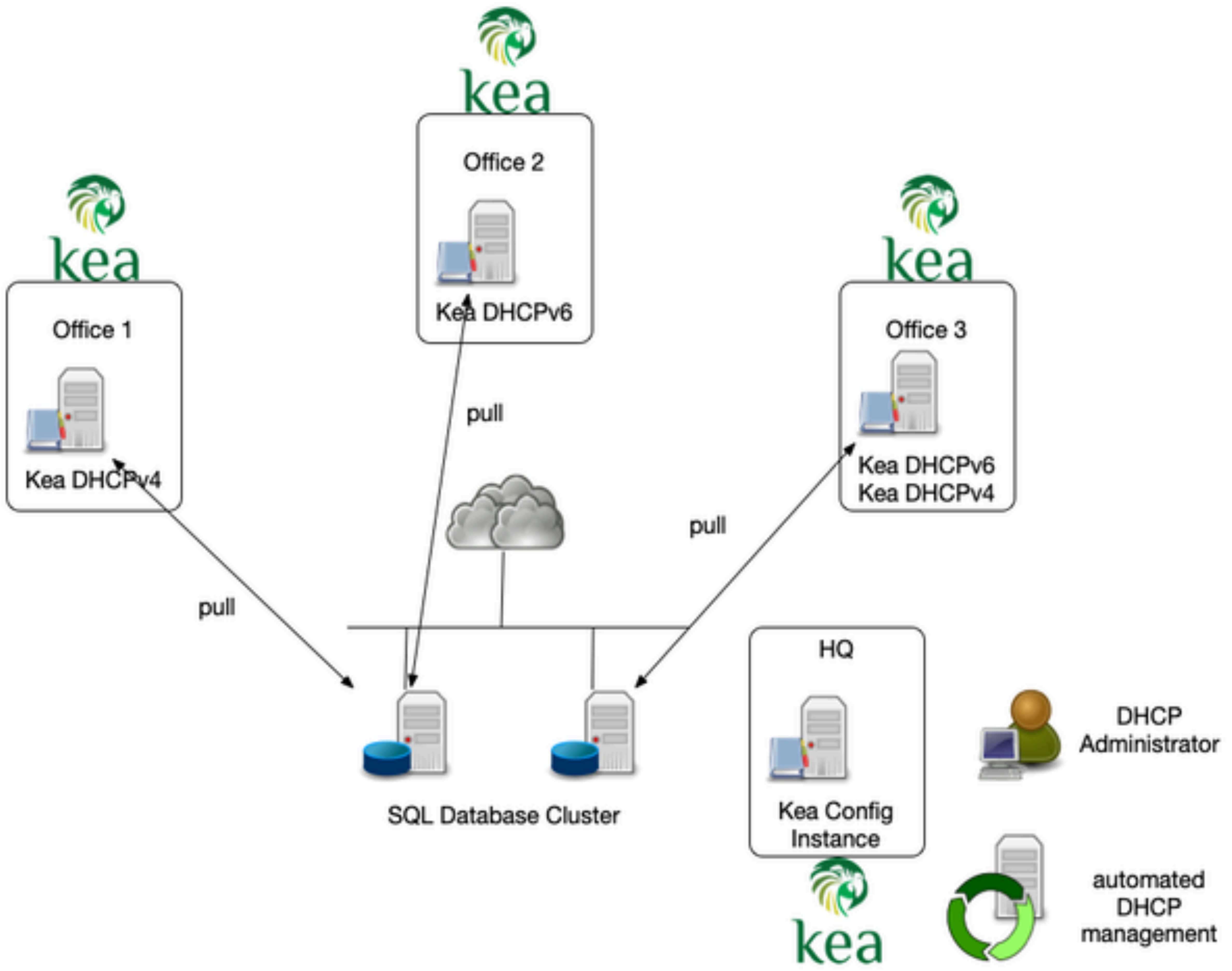
Kea configuration backend design (2/4)

- Kea DHCP server will pull/poll the configuration from the database
  - the poll intervall is configured with the config-fetch-wait-time parameter
  - if a change is detected, the Kea DHCP server will fetch the delta to its current configuration and will reconfigure the service

Kea configuration backend design (3/4)



Kea configuration backend design (4/4)



Basic configuration for a Kea DHCP using the Config Backend

- each DHCP server that uses the Kea configuration backend can run on a simple and static configuration
  - the `server-tag` is selecting the individual configuration for this DHCP server
  - `config-fetch-wait-time` parameter defines the poll intervall for new configuration (default 30) in seconds

```
"Dhcp6": {
   "server-tag": "office-1",
   "config-control": {
     "config-databases": [{
        "type": "mysql",
        "name": "kea_config_db",
        "user": "kea",
        "password": "secure-password",
        "host": "2001:db8:568::568"
    }],
    "config-fetch-wait-time": 120
  },
  [...]
}
```

Hooks required for the config backend

- The hook `libdhcp_mysql_cb.so` is the implementation of the Configuration Backend for MySQL.
- It must be always present when the server uses MySQL as the configuration repository.
  - this hook is part of the base open source Kea distribution

```
"hooks-libraries": [{
    "library": "/usr/lib/kea/hooks/libdhcp_mysql_cb.so"
}, {
    "library": "/usr/lib/kea/hooks/libdhcp_cb_cmds.so"
}],
```

Hooks required for the config backend

- The hook `libdhcp_cb_cmds.so` is optional.
- It should be loaded when the Kea server instance is to be used for managing the configuration in the database
  - This hooks library is only available to ISC customers with a support contract

```
"hooks-libraries": [{
    "library": "/usr/lib/kea/hooks/libdhcp_mysql_cb.so"
}, {
    "library": "/usr/lib/kea/hooks/libdhcp_cb_cmds.so"
}],
```

Objects in the configuration database

- Kea can read the configuration of different DHCP objects from the database
  - global parameter
  - option definitions
  - options
  - shared subnet
  - subnet
  - pools

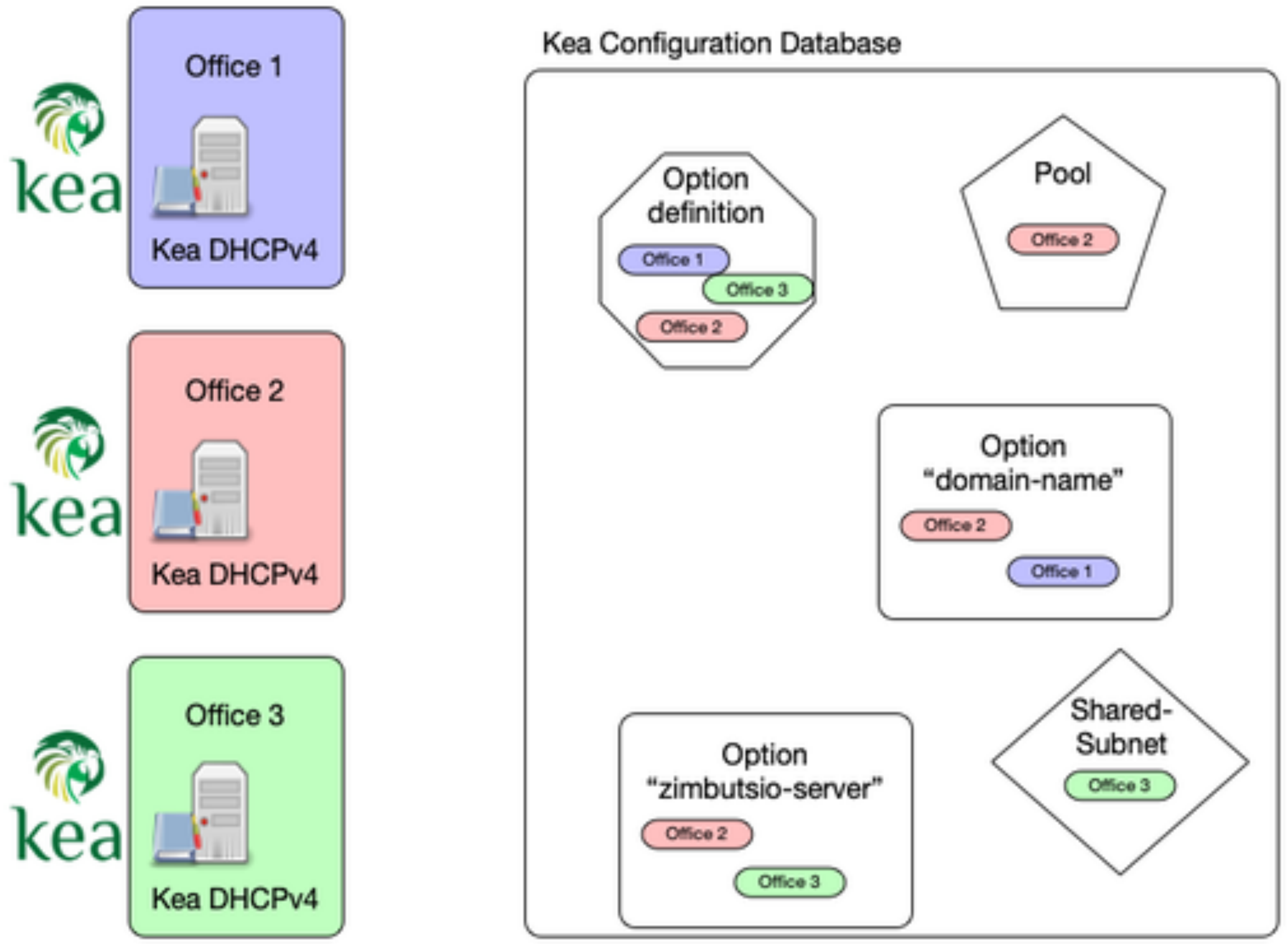
The role of server tags (1/2)

- DHCP server select their configuration objects by the use of server-tags
  - each DHCP server has one tag
  - multiple servers can share a tag
  - a server without an explicit server-tag configuration uses the special `all` tag

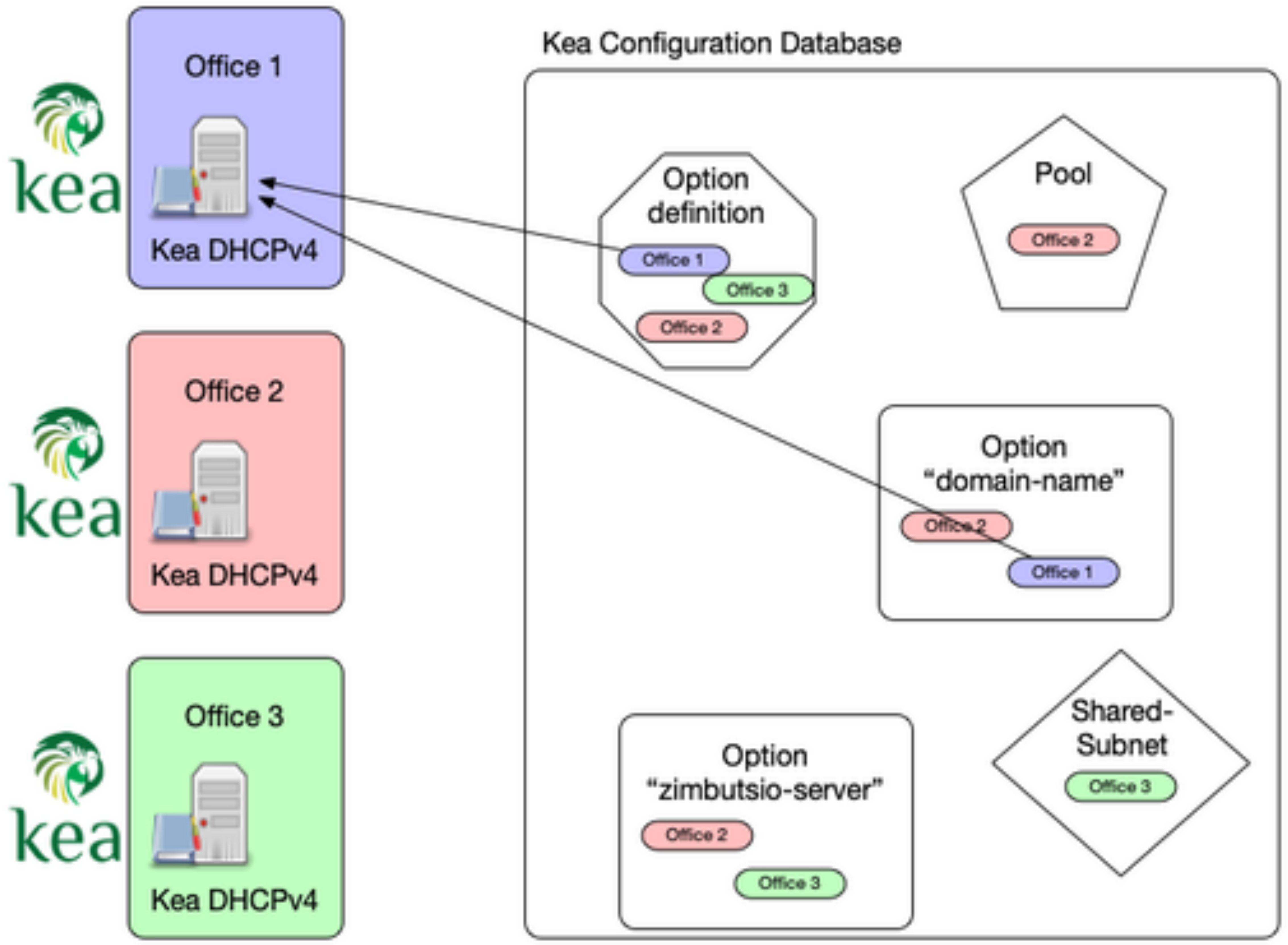
The role of server tags (2/2)

- Configuration objects in the database have tags assigned
  - objects can reference multiple server tags
  - objects can reference no server (empty tag "")
  - objects can reference the special tag "all" to reference all DHCP servers

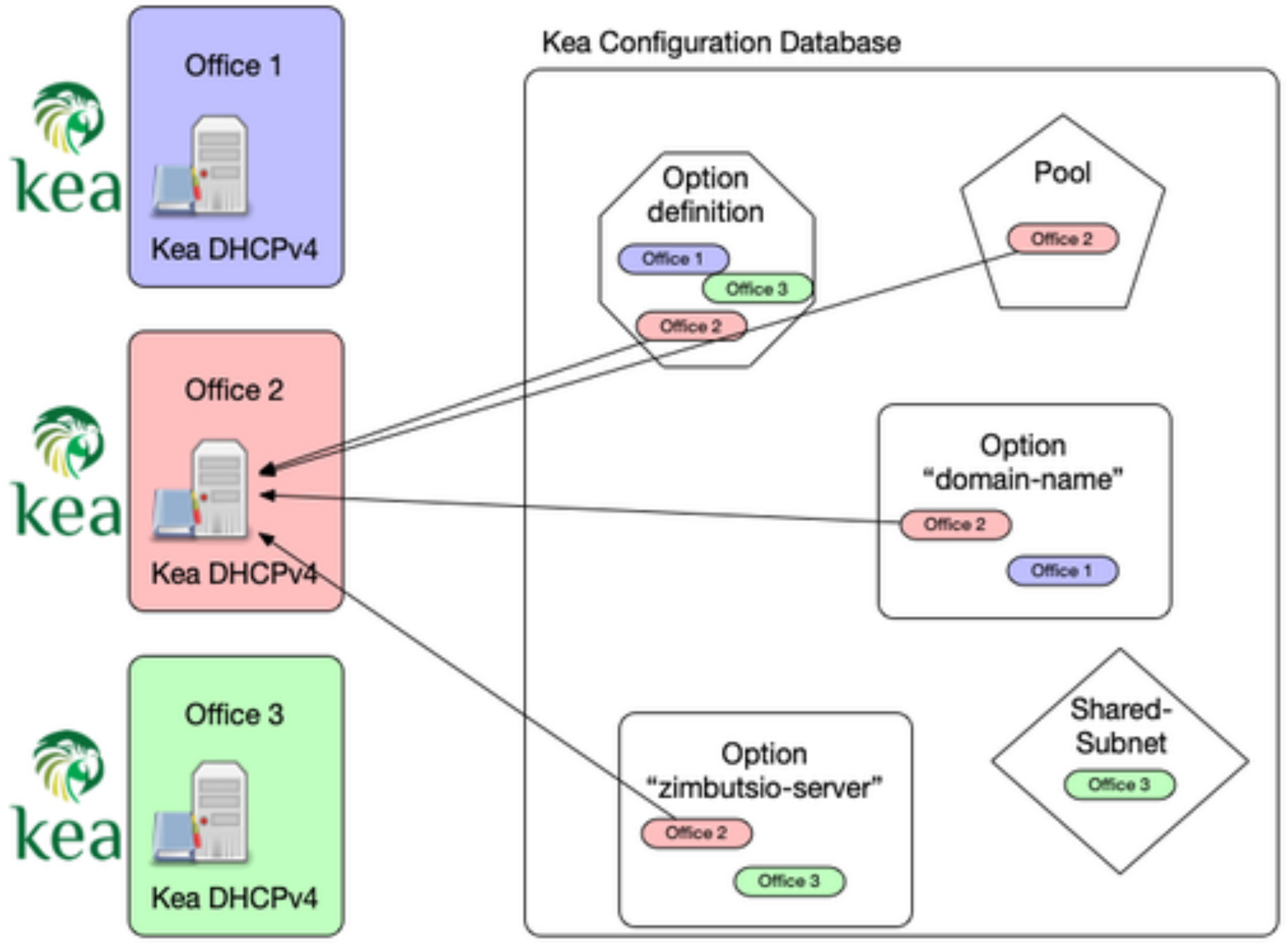
Use of Server-Tags in the configuration backend (1/4)



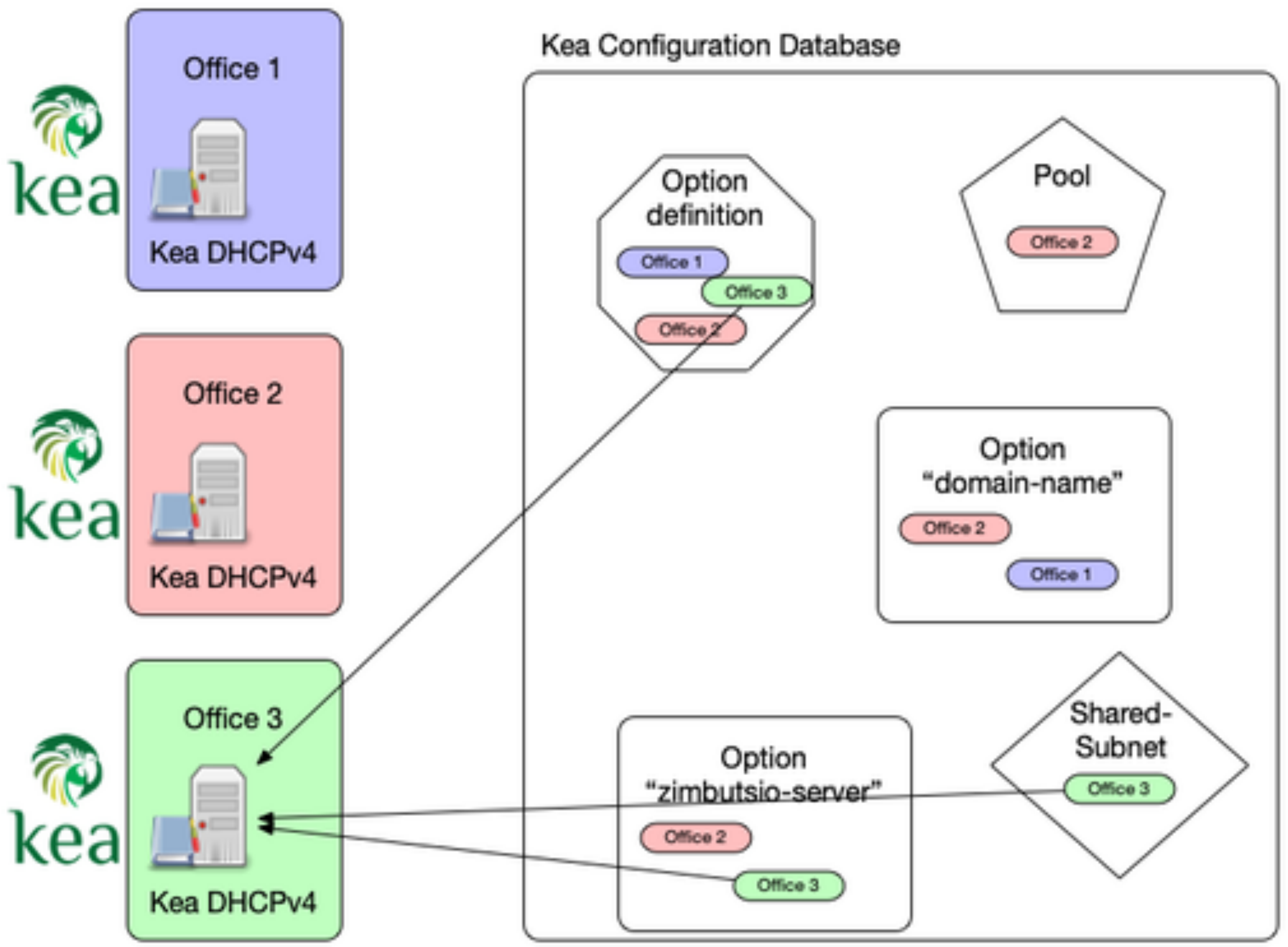
Use of Server-Tags in the configuration backend (2/4)



Use of Server-Tags in the configuration backend (3/4)



Use of Server-Tags in the configuration backend (4/4)



Configuration Backend Resources

- Kea Reference Manual: Kea Configuration Backend https://kea.readthedocs.io/en/kea-1.8.0/arm/config.html#kea-configuration-backend

- Kea Configuration Backend Design https://gitlab.isc.org/isc-projects/kea/-/wikis/designs/configuration-in-db-design

- Video: Alan Clegg: Using the Kea Configuration Backend https://www.youtube.com/watch?v=gnVEO4ThE10

Recovering from Database failures

Recovering from Database failures (1/3)

- When operating Kea with a database backend, the database or the connection to the database might fail
  - During server start-up, the inability to connect to the database is considered fatal and the server will exit
- During dynamic reconfiguration, the databases are disconnected and then reconnected using the new configuration
  - If connectivity to the database(s) cannot be established, the server will log a fatal error but remain up.
  - It will be able to process commands but will not serve clients
    - This allows the configuration to be fixed via a remote command, if required

Recovering from Database failures (2/3)

- During normal operations, if connectivity to database is lost and automatic recovery is enabled …
  - … the server will disconnect from all databases
  - … and then attempt to reconnect them
- During the recovery process, the server will cease serving clients, but continue to respond to commands
  - Once connectivity to all databases is restored, the server will return to normal operations
  - If connectivity cannot be restored after `max-reconnect-tries`, the server will issue a fatal error and exit

Recovering from Database failures (3/3)

- The parameter `reconnect-wait-time` configures number of milliseconds the server will wait between attempts to reconnect to the database after connectivity has been lost
  - The default value for MySQL and PostgreSQL is 0, which disables automatic recovery and causes the server to exit immediately upon detecting the loss of connectivity to a database

High Availability

DHCP High-Availability

- DHCP is a critical resource in most networks
  - If the DHCP service is down, machines and computers cannot join the network
- DHCP administrators like to make the DHCP service redundant and high-available

Kea High-Availability options

- Kea DHCP supports different high availability (HA) options
  - some require only configuration changes
  - other require the (free) HA hook
- Kea does not support the standardized DHCPv6 fail-over protocol (RFC 8156 "DHCPv6 Failover Protocol") https://tools.ietf.org/html/rfc8156
  - it supports a HA implementation that aligns with the Kea software design and covers most use-cases

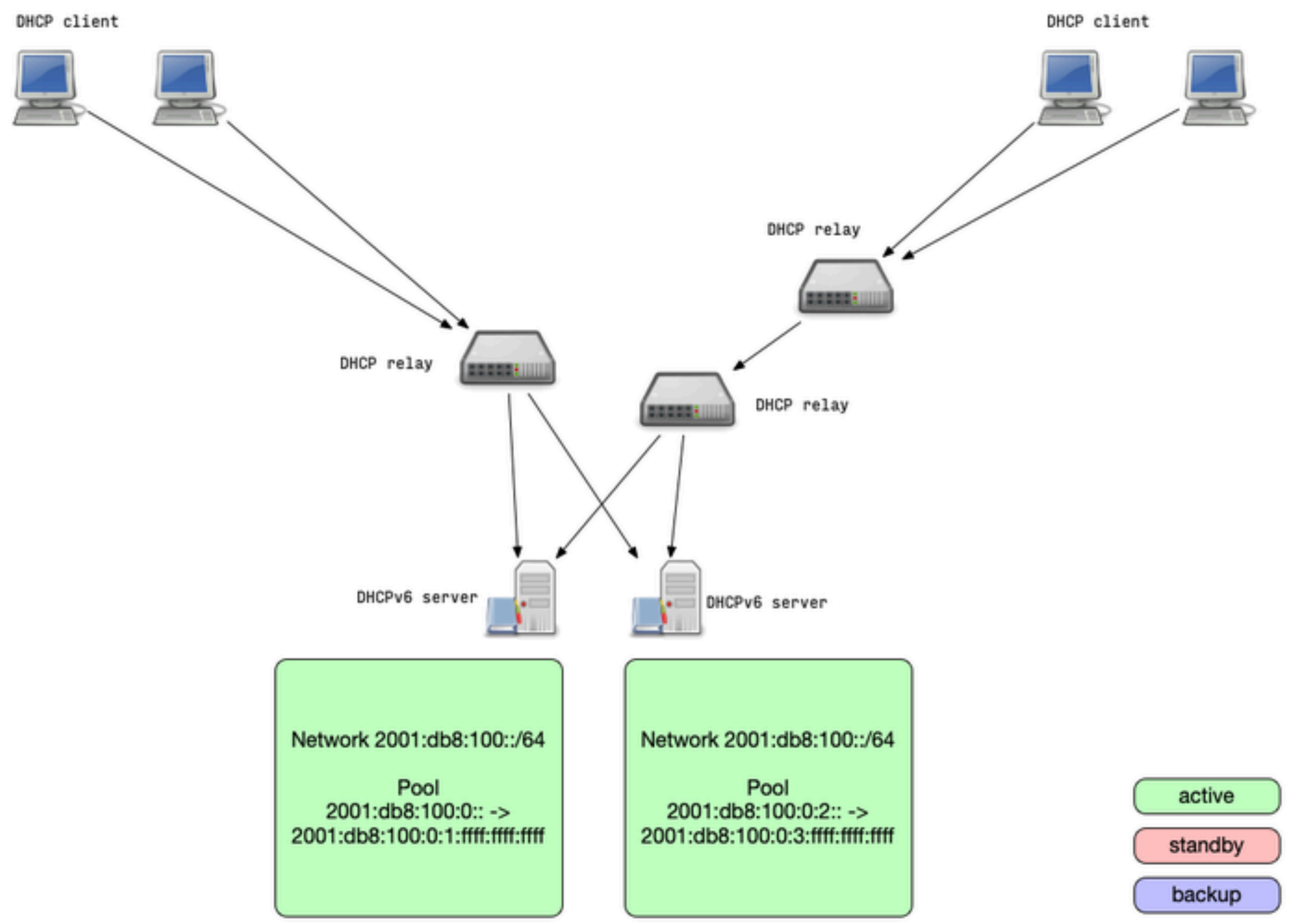
DHCPv6 Split Pool / Shared Pool

- The DHCPv6 split pool or shared pool HA solution are independent from the DHCPv6 server implementation
- these HA solutions do not require any synchronization between the DHCP server
- these solutions make use of the vast address space available in one IPv6 /64 subnet
- these solutions are not good solutions for DHCPv4, because the address space in IPv4 is too small

DHCPv6 Split Pool

- Split-Pool: because one IPv6 /64 is so large, it usually can be split in two parts that are served by two independent DHCPv6 servers
  - the pools are not overlapping, it is impossible that the two DHCPv6 servers will return the same lease address to different clients
  - if one DHCPv6 server stops responding, the clients will receive a new lease from the remaining DHCPv6 server (after lease expiry)

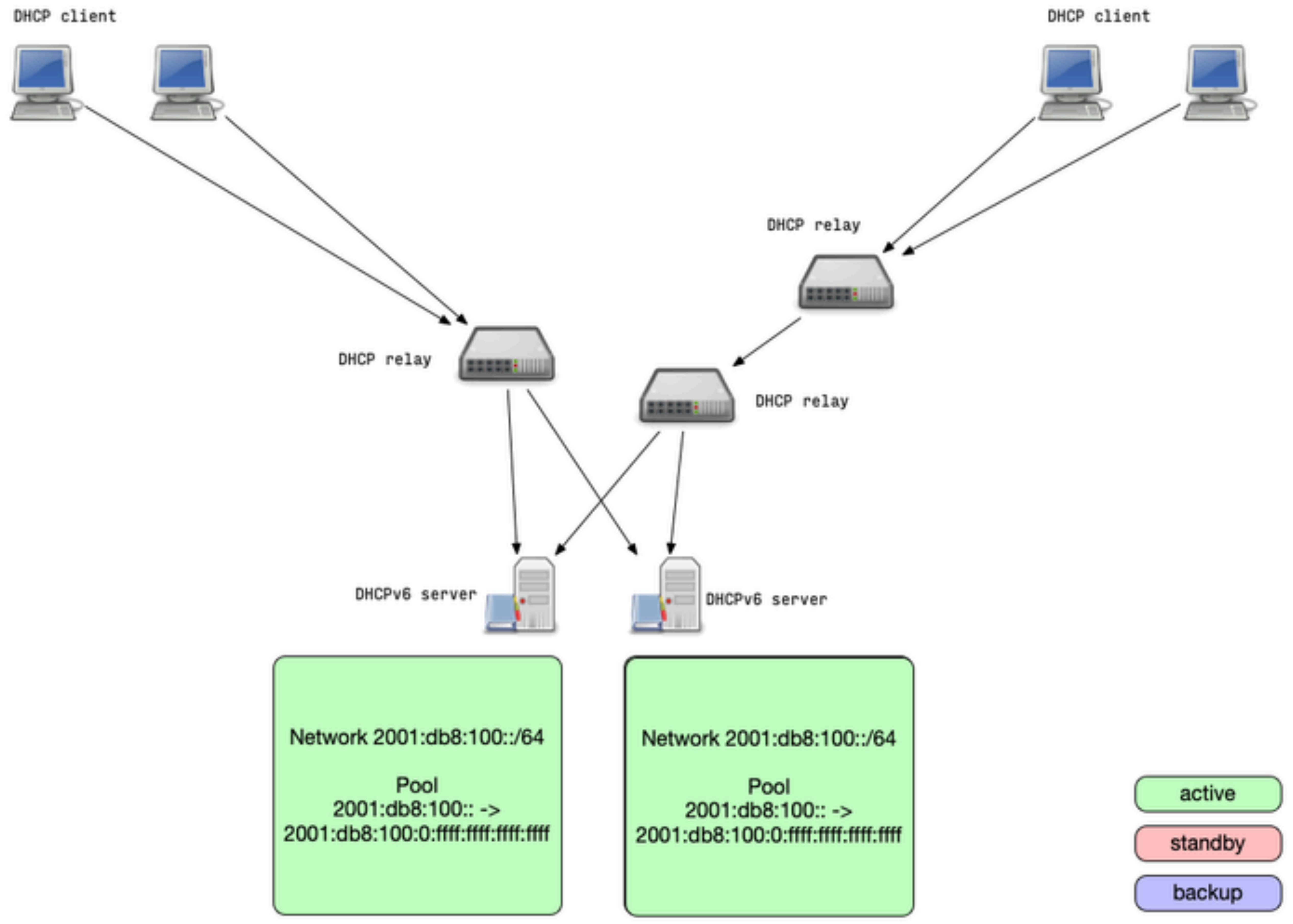
DHCP Split Pool



DHCPv6 Shared Pool

- Shared-Pool: two DHCPv6 server are authoritative for the same addresses from a pool
  - because of the size of one IPv6 /64 subnet, the chance that both servers give out the same address to different clients is statistically very low
  - and if they did, IPv6 duplicate address detection (DAD) will cover this rare edge case
  - if one DHCPv6 server stops responding, the clients will receive a new lease from the remaining DHCPv6 server (after lease expiry)

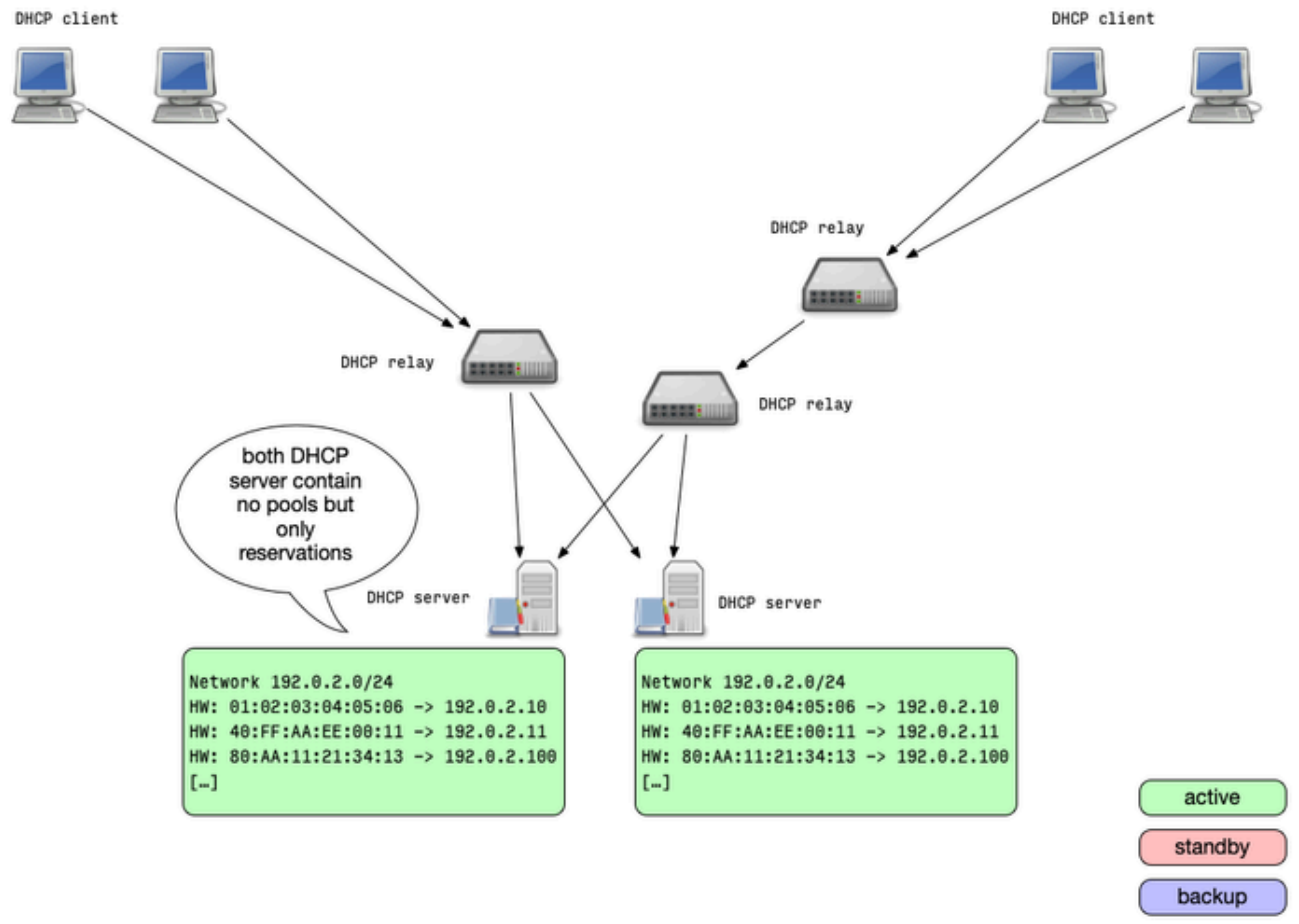
DHCPv6 Shared Pool



IPv4/IPv6 pure static DHCP

- The pure static solution also works with any DHCP server, in IPv4 and IPv6 networks
  - The idea is to not use dynamic allocation of addresses, but only static reservations
  - Two or more DHCP server are equipped with the same reserveration configuration
  - Each server will always return the same IP address lease to the same client
- This solution requires an out-of-band synchronization of the reservation
  - This could be done on the database level with a shared host reservation database

IPv4/IPv6 pure static DHCP



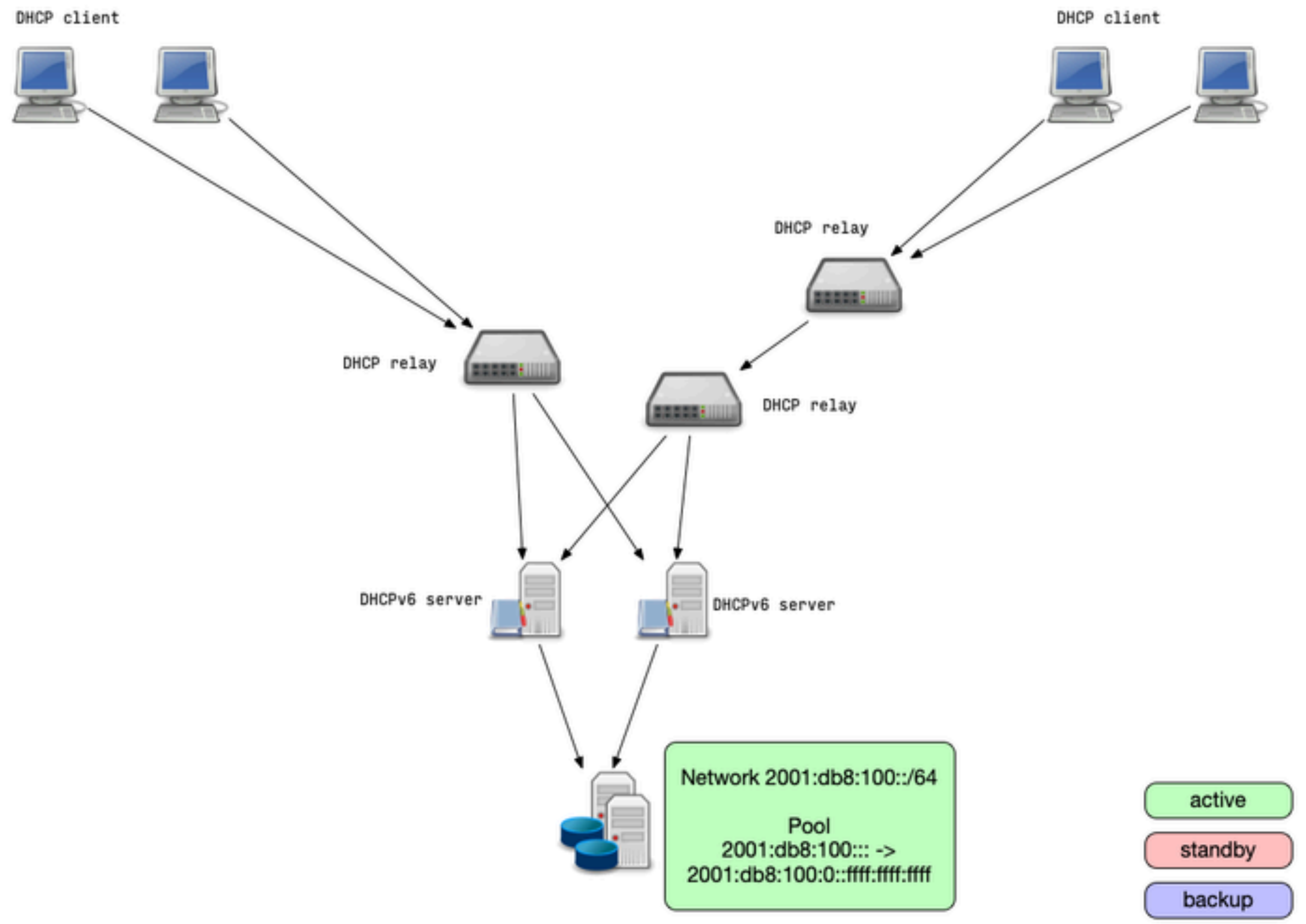
```
Network 192.0.2.0/24
HW: 01:02:03:04:05:06 -> 192.0.2.10
HW: 40:FF:AA:EE:00:11 -> 192.0.2.11
HW: 80:AA:11:21:34:13 -> 192.0.2.100
[…]
```

```
Network 192.0.2.0/24
HW: 01:02:03:04:05:06 -> 192.0.2.10
HW: 40:FF:AA:EE:00:11 -> 192.0.2.11
HW: 80:AA:11:21:34:13 -> 192.0.2.100
[…]
```

IPv4/IPv6 shared database

- The shared database solution moves the redundancy to the database level
  - this solutions allows high availability with more than two DHCP server nodes
  - two or more DHCP server are connected to the same (logical) database containing the lease information
  - the database itself should be made high available
  - all DHCP servers read and write lease information from/to the same database
- database locking can lead to performance degradation(!) on high rate of leases/renewals

IPv4/IPv6 shared database



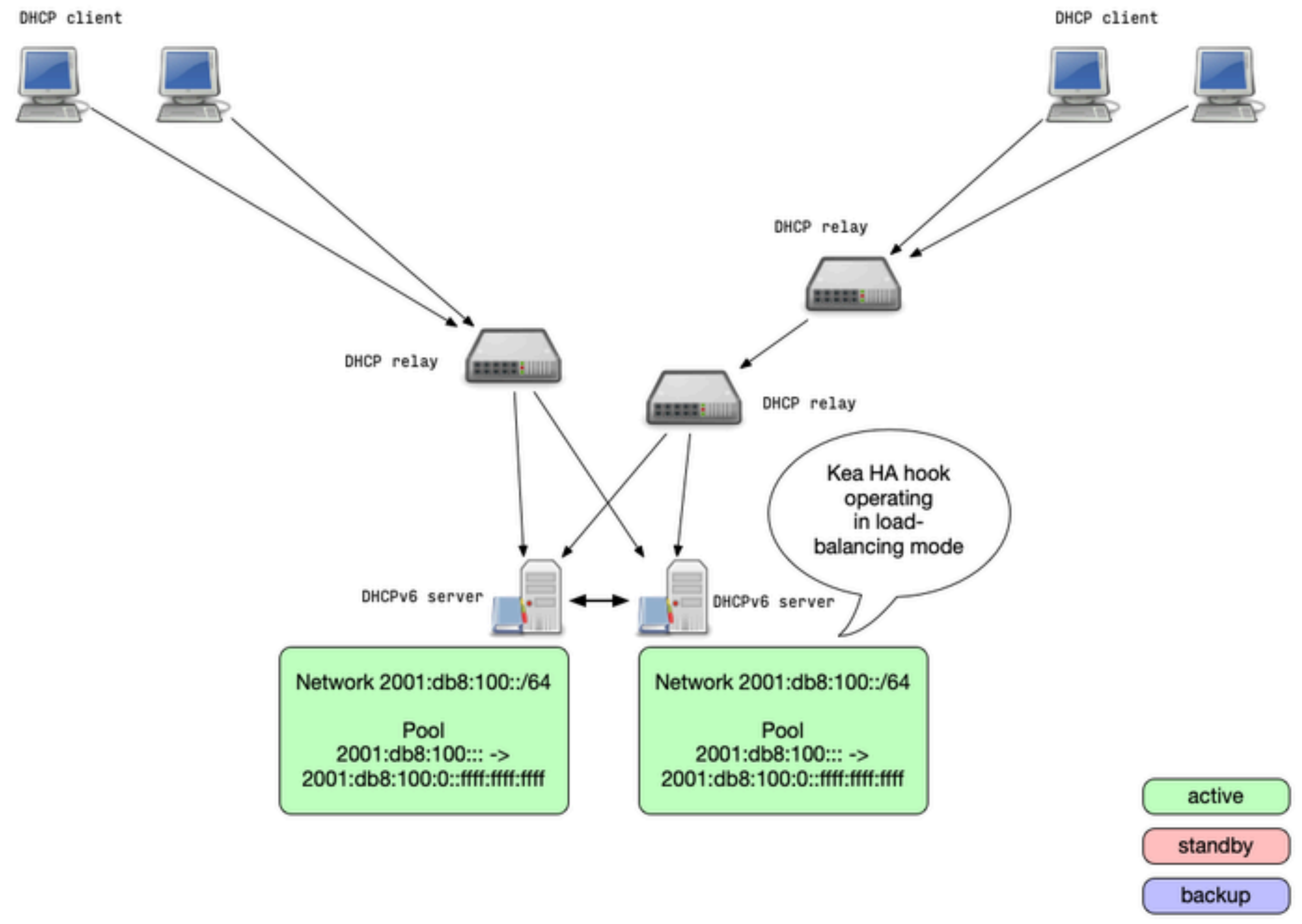
High Availability Hook

- Using the Kea DHCP High-Availability extension (HA hook) is the most feature rich high availability solution
- The HA hook offers different operation modes
  - load-balancing: all DHCP server are active and return leases
  - hot-standby: all DHCP server are in sync but only one is active and returns leases
  - passive-backup: one DHCP server is active and send lease database updates to a number of backup servers.

Kea HA Mode: load-balancing

- When operating in **load-balancing** mode, two Kea DHCP server are active and respond to lease requests
  - The lease information is synced between the Kea DHCP HA servers
  - the pools are split 50/50 between the two DHCP servers
  - Every DHCP server can take over the full service if needed
  - Via the HA protocol a DHCP HA node will detect if one partner node is down and takes over the service
    - once the partner is online again, the lease database is synced

Kea HA Mode: load-balancing

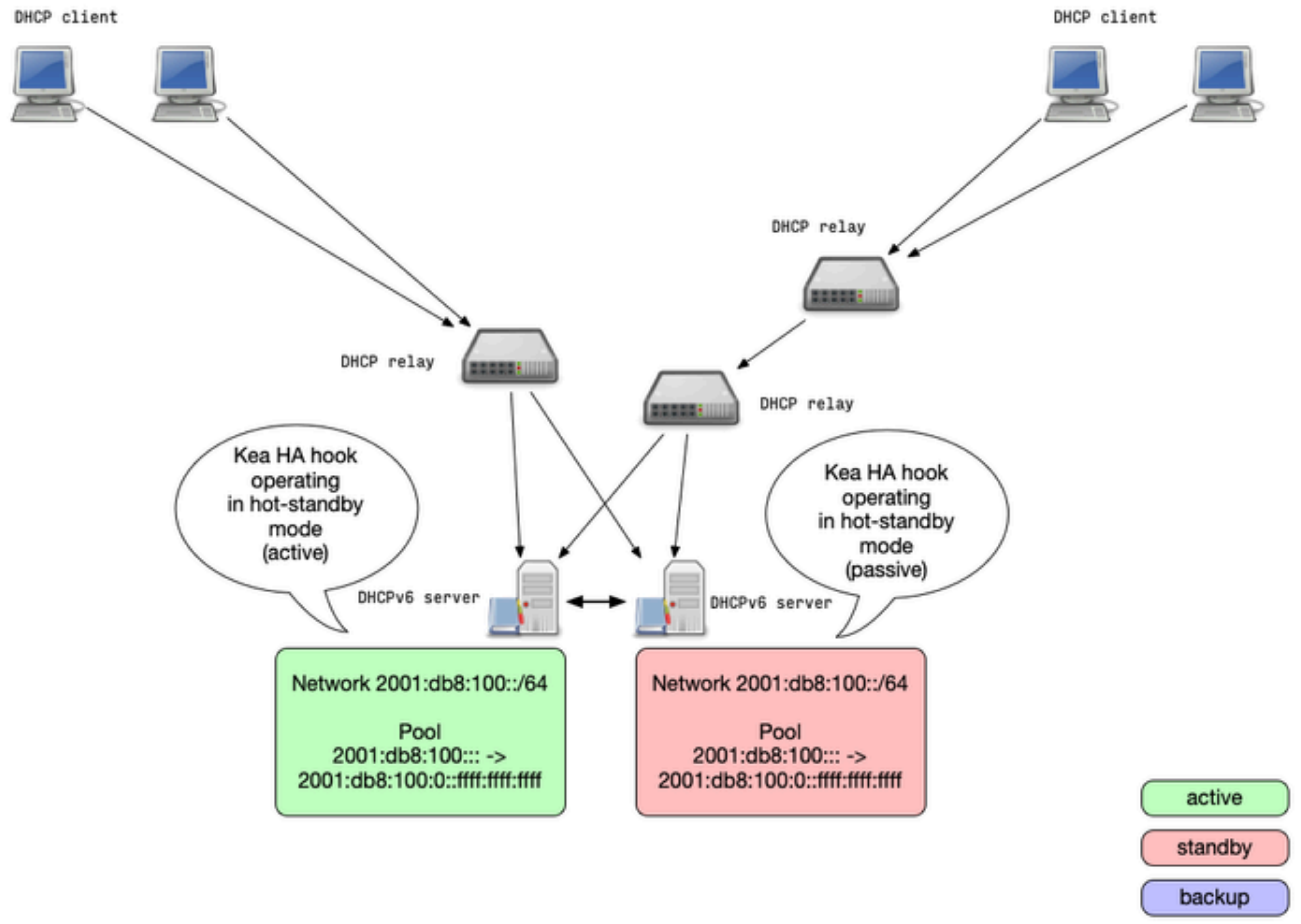


DHCP client
DHCP client
DHCP relay
DHCP relay
DHCP relay
Kea HA hook operating in load-balancing mode
DHCPv6 server
DHCPv6 server
Network 2001:db8:100::/64
Pool
2001:db8:100::: ->
2001:db8:100:0::ffff:ffff:ffff
Network 2001:db8:100::/64
Pool
2001:db8:100::: ->
2001:db8:100:0::ffff:ffff:ffff
active
standby
backup

Kea HA Mode: hot-standby

- A Kea DHCP cluster configured for the hot-standby mode will have the primary node serving DHCP clients and another node (secondary) only receiving the lease-database updates, but not serving clients
  - If the secondary server detects the failure of the primary, it starts responding to all DHCP queries

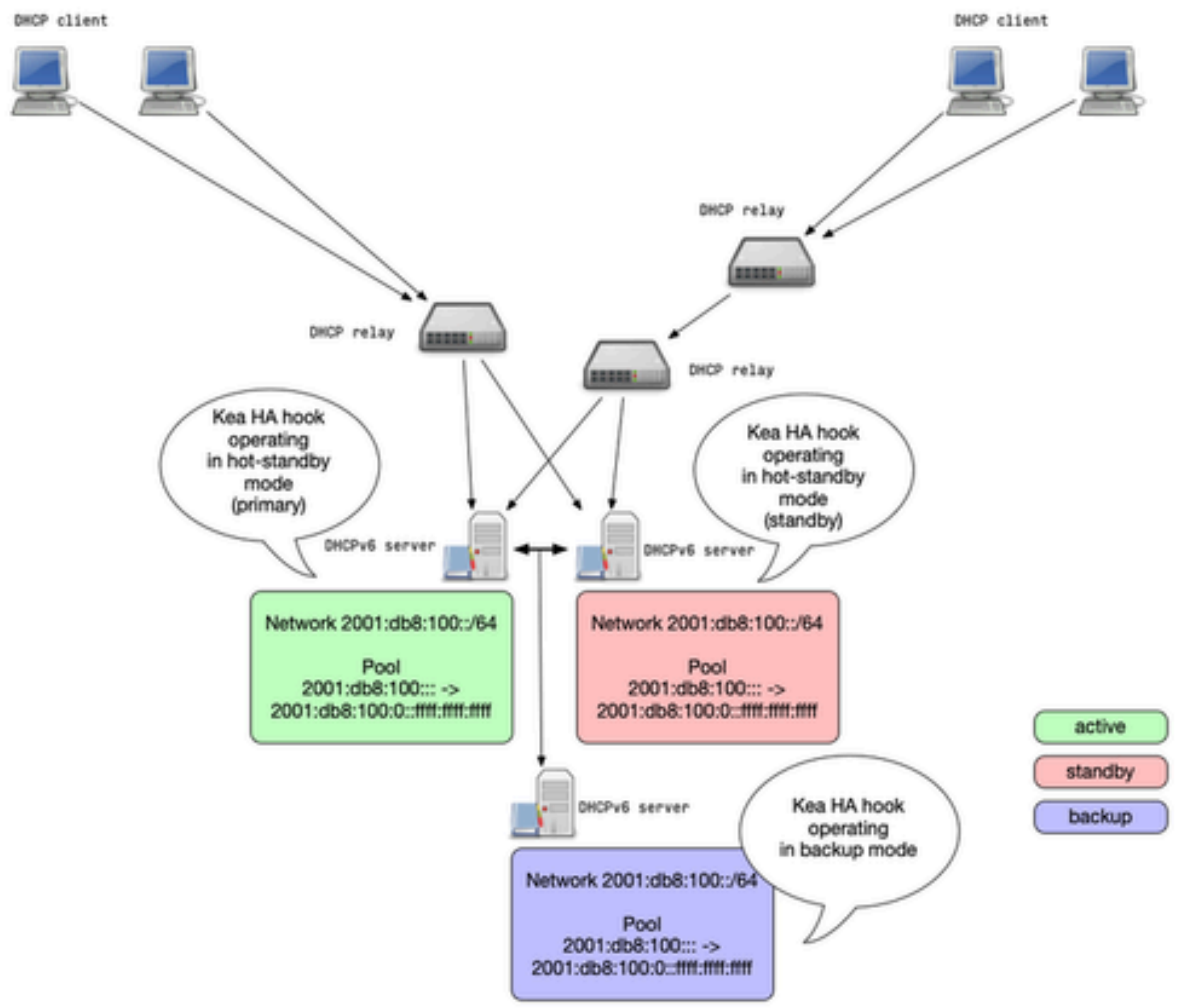
Kea HA Mode: hot-standby


DHCP client
DHCP client
DHCP relay
DHCP relay
DHCP relay
Kea HA hook operating in hot-standby mode (active)
Kea HA hook operating in hot-standby mode (passive)
DHCPv6 server
DHCPv6 server
Network 2001:db8:100::/64 Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
Network 2001:db8:100::/64 Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
active
standby
backup

Kea HA Mode: Backup Servers

- Kea DHCP supports any number of backup servers
  - Backup server receive lease database updates but are not an active part of an HA setup
  - Backup server can be deployed in addition to the other Kea HA modes

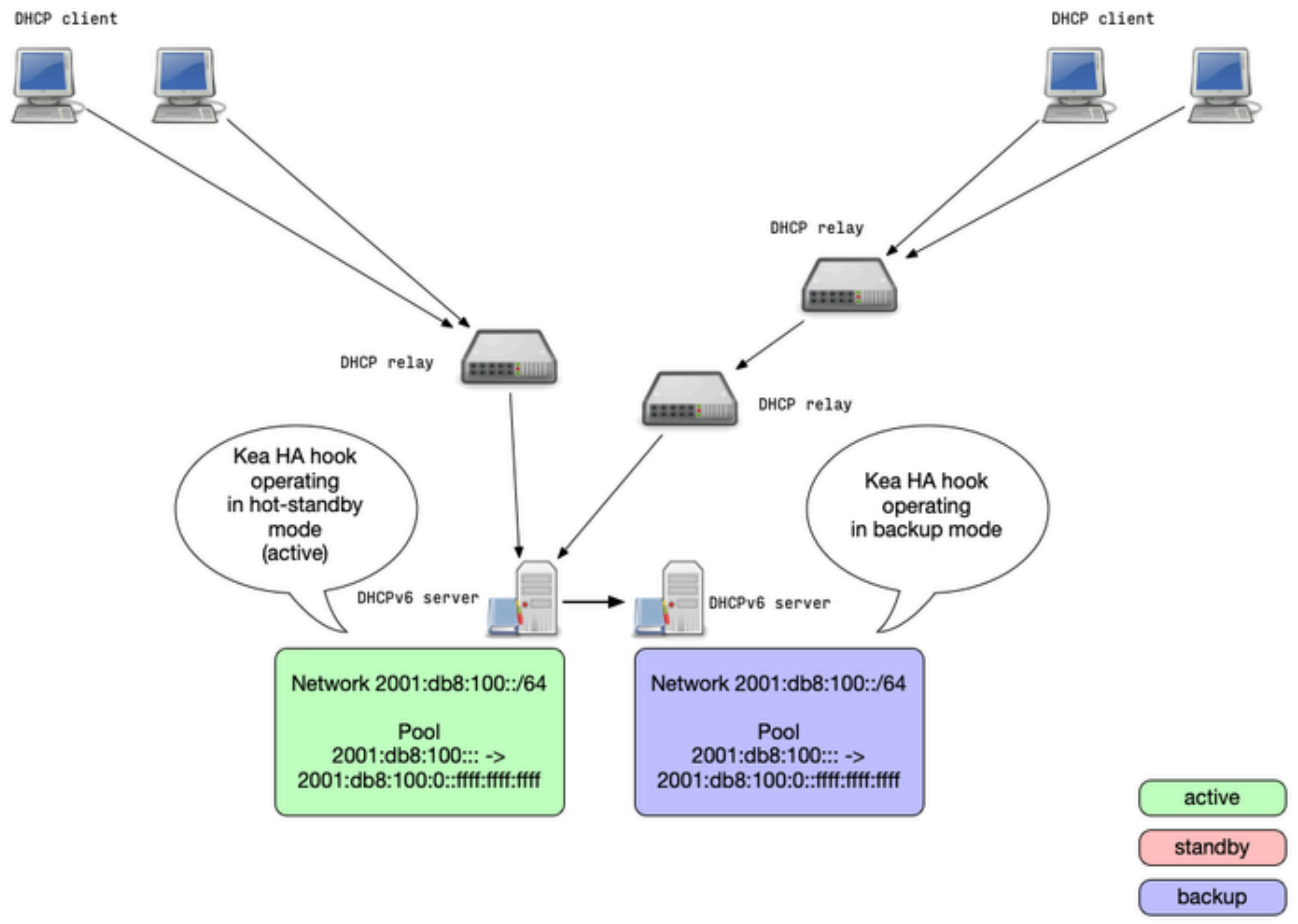
Kea HA Mode: Backup Servers


DHCP client
DHCP client
DHCP relay
DHCP relay
DHCP relay
Kea HA hook operating in hot-standby mode (primary)
Kea HA hook operating in hot-standby mode (standby)
DHCPv6 server
DHCPv6 server
Network 2001:db8:100::/64 Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
Network 2001:db8:100::/64 Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
DHCPv6 server
Kea HA hook operating in backup mode
Network 2001:db8:100::/64 Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
active
standby
backup

Kea HA Mode: passive-backup

- In the passive-backup configuration, only one Kea server is active and is serving leases to the clients
  - Any number of passive (not answering to clients) backup servers receive lease database backups
  - Since Kea 1.7.8, the active server does not need to wait for a lease update confirmation from the backup servers before giving the lease to a client
    - this reduces the latency compared to the other HA modes
- In case of an failure of the active server, a backup server needs to be manually promoted to be active
  - this could be automated outside of Kea with API calls from a monitoring system

Kea HA Mode: passive-backup


DHCP client
DHCP client
DHCP relay
DHCP relay
DHCP relay
Kea HA hook operating in hot-standby mode (active)
Kea HA hook operating in backup mode
DHCPv6 server
DHCPv6 server
Network 2001:db8:100::/64
Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
Network 2001:db8:100::/64
Pool 2001:db8:100::: -> 2001:db8:100:0::ffff:ffff:ffff
active
standby
backup

Example Configuration: Kea DHCP Failover Cluster

Kea HA Configurations

- The Kea HA configuration parts are symmetric, all HA peers can share an almost identical configuration file
  - the only difference in the HA configuration is the `this-server-name` parameter
- The HA mode is selected with the mode parameter

Example Load-Balancing Configuration

```
"Dhcp4": {
    "hooks-libraries": [{
        "library": "/usr/lib/kea/hooks/libdhcp_lease_cmds.so", "parameters": { }
    }, {
        "library": "/usr/lib/kea/hooks/libdhcp_ha.so", "parameters": {
            "high-availability": [{
                "this-server-name": "server1",
                "mode": "load-balancing",
                "heartbeat-delay": 10000, "max-response-delay": 40000, "max-ack-delay": 5000,
                "max-unacked-clients": 5,
                "peers": [{
                    "name": "server1",
                    "url": "http://192.0.2.33:8000/",
                    "role": "primary", "auto-failover": true
                }, {
                    "name": "server2",
                    "url": "http://192.0.2.66:8000/",
                    "role": "secondary", "auto-failover": true
                }, {
                    "name": "server3",
                    "url": "http://192.0.2.99:8000/",
                    "role": "backup",
                    "basic-auth-user": "foo", "basic-auth-password": "bar",
                    "auto-failover": false
                }]
            }]
        }
    }],
[...]
```

Example Hot-Standby Configuration

```
"Dhcp4": {
    "hooks-libraries": [{
        "library": "/usr/lib/kea/hooks/libdhcp_lease_cmds.so",  "parameters": { }
    }, {
        "library": "/usr/lib/kea/hooks/libdhcp_ha.so", "parameters": {
            "high-availability": [{
                "this-server-name": "server1",
                "mode": "hot-standby",
                "heartbeat-delay": 10000, "max-response-delay": 40000,
                "max-ack-delay": 5000,    "max-unacked-clients": 5,
                "peers": [{
                    "name": "server1",
                    "url": "http://192.0.2.33:8000/",
                    "role": "primary", "auto-failover": true
                }, {
                    "name": "server2",
                    "url": "http://192.0.2.66:8000/",
                    "role": "standby", "auto-failover": true
                }, {
                    "name": "server3",
                    "url": "http://192.0.2.99:8000/",
                    "basic-auth-user": "foo",  "basic-auth-password": "bar",
                    "role": "backup",  "auto-failover": false
                }]
            }]
        }
    }],
    [...]
```

Kea HA Maintenance

Sending control commands to the Kea HA Module

- As many other parts of the Kea system, the HA module can be controlled over the network with the REST-API
  - it receives commands in JSON format via the Kea Control Agent (CA)
  - The following slides give examples of useful API commands
  - More commands and details can be found in the Kea Reference Manual
    https://kea.readthedocs.io/en/latest/arm/hooks.html#control-commands-for-high-availability

Database synchronization

- the ha-sync command triggers the server to sync the lease database with the selected peer

```
{    "command": "ha-sync",
     "service": [ "dhcp4 "],
     "arguments": {
          "server-name": "server2",
          "max-period": 60
     }
}
```

Retrieving the HA status

- The command ha-heartbeat can be used to check the current state of a Kea DHCP server HA node

```
{ "service": [ "dhcp4" ], "command": "ha-heartbeat" }
```

- The returned JSON structure describes the current DHCP server state

```
{
  "result": 0,
  "text": "HA peer status returned.",
  "arguments":
    {
        "state": "partner-down",
        "date-time": "Thu, 07 Nov 2019 08:49:37 GMT"
    }
}
```

Fetching the HA configuration

- With the status-get command, the administrator can request the current HA configuration from a Kea DHCP server node

```
{
    "result": 0,
    "text": "",
    "arguments": { "pid": 1234,
                   "uptime": 3024,
                   "reload": 1111,
                   "high-availability": [{
                     "ha-mode": "load-balancing",
                     "ha-servers": {
                        "local": {
                          "role": "primary",
                          "scopes": [ "server1" ],
                          "state": "load-balancing" },
                      "remote": {
                          "age": 10,
                          "in-touch": true,
                          "role": "secondary",
                          "last-scopes": [ "server2" ],
   [...]
                          "analyzed-packets": 8 }
                  }}],
            "multi-threading-enabled": true,
            "thread-pool-size": 4,
            "packet-queue-size": 64
    }
}
```

Controlling Maintenance Mode

- Before removing a Kea DHCP server from a HA setup, the server should be set into maintenance mode
  - the commands `ha-maintenance-start` and `ha-maintenance-cancel` commands can be use to bring a server in or out of maintenance mode

Decision tree for production systems

"so many options, which should I implement?"

- Kea offers many different high-availability options
  - for an user new to Kea or DHCP administration, this can be a hard choice
- the next slides give some general recommendations and guidance on how to select an high-availability option for a Kea deployment

Load-balancing vs. hot-standby

- As the name implies, in the load-balancing mode the load is distributed across both active DHCP servers
  - with complex client classing rules, this can be faster than a single active server
  - the load-balancing mode requires a 50/50 split of the pools across both HA server nodes
- The hot-standby mode is simpler
  - only one active server, one active log file for trouble shooting
  - no split pools required

HA Module vs. shared database

- A shared database setup offers redundancy for more than two active DHCP servers
- In a shared database setup, two clients might be offered the same IP address
  - one will succeed, the other will get a DHCPNAK from the server and has to start the DHCP process again.
- The HA module works with the memfile lease database, which offers better performance most of the time compared to an SQL database

HA Module vs. split/shared Pool

- Split- or shared pools only work well with DHCPv6
  - these are good options for IPv6-only networks
  - Split- or shared pools are simple and easy to maintain
- The HA module is more universal
  - it works for DHCPv4 and DHCPv6 and across all supported lease file storage back ends (memfile, SQL-Database, Cassandra)

Next Webinars

- 18th November - Kea DHCP - Monitoring, Logging, and Stork
- 2nd December - Kea DHCP - Migrating to Kea from ISC DHCP

Resources

- Kea Performance Optimization

  `https://kb.isc.org/docs/en/kea-performance-optimization`

- MariaDB 10.x and Kea

  `https://kb.isc.org/docs/en/maria-10x-and-kea`

- Using the Kea Configuration Backend

  `https://kb.isc.org/docs/en/using-the-kea-configuration-backend`

Questions and Answers