Kea DHCP

High-Availability options

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    - Split/Shared Pool
    - Pure static DHCP
    - Shared Database
    - Kea High-Availability Cluster

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@@html:%3C/div%3E@@
  - It supports a HA implementation that aligns with the Kea software design and covers most use-cases

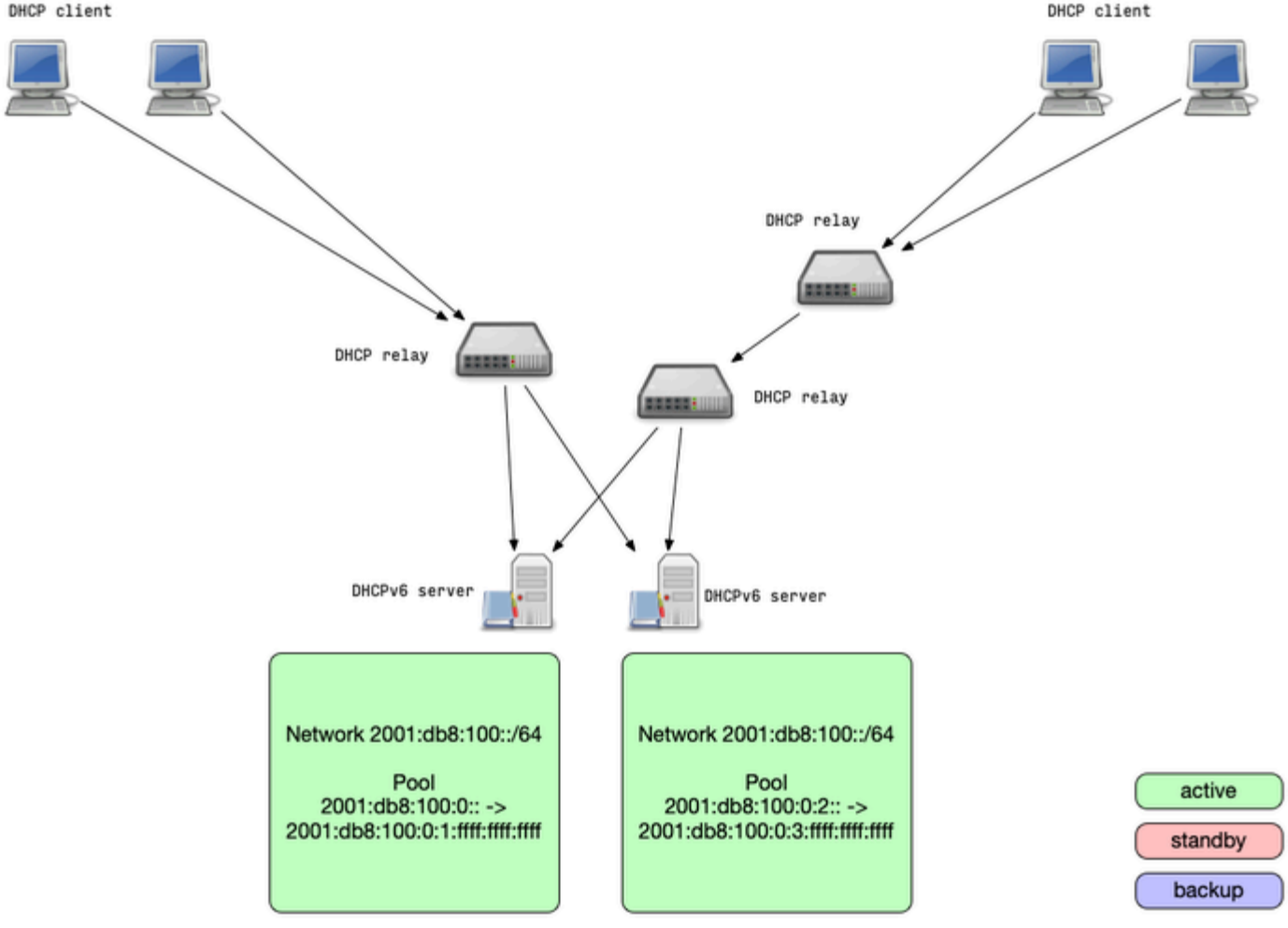
DHCPv6 Split Pool / Shared Pool

- 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)

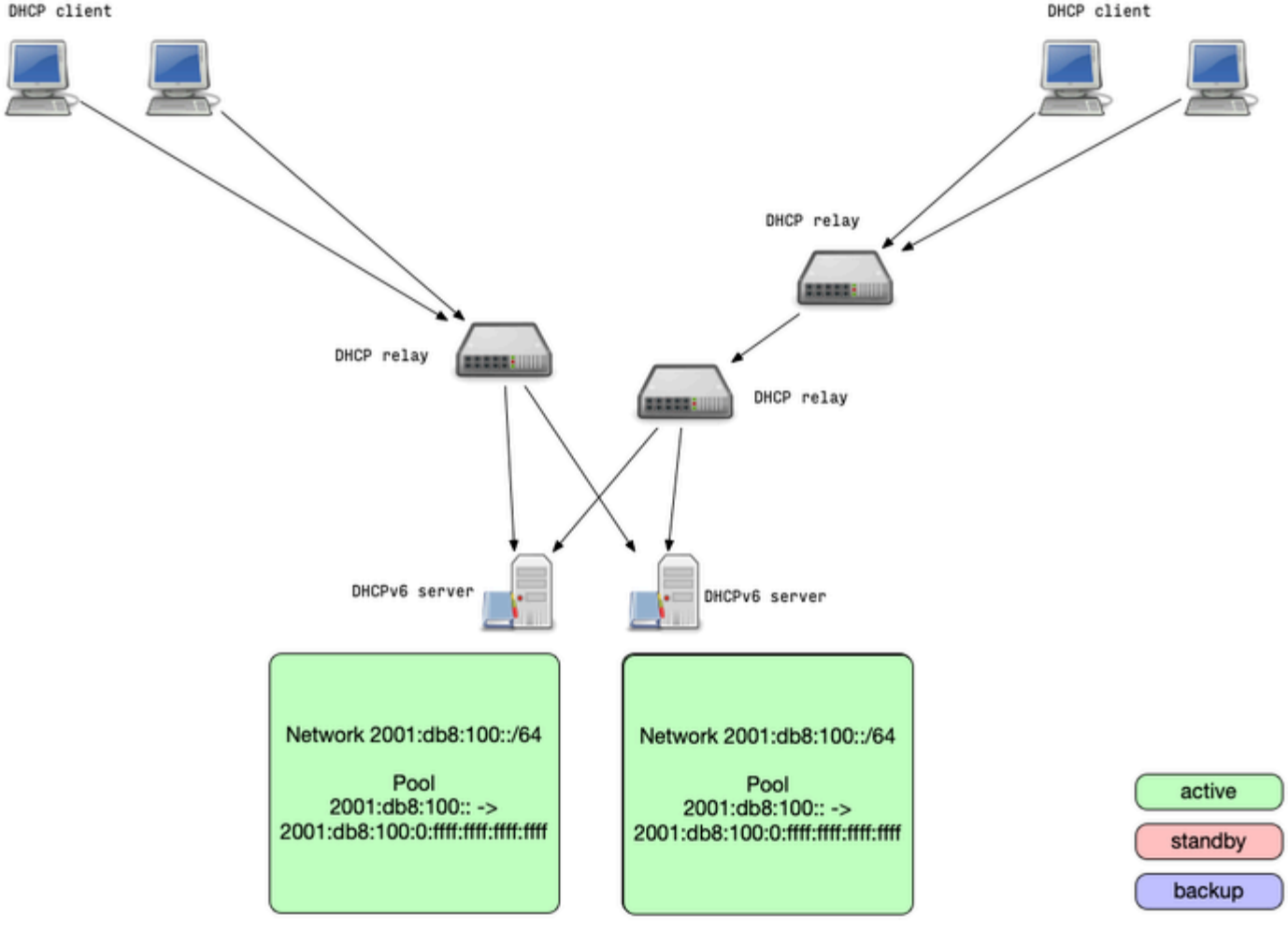
DHCPv6 Split Pool



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

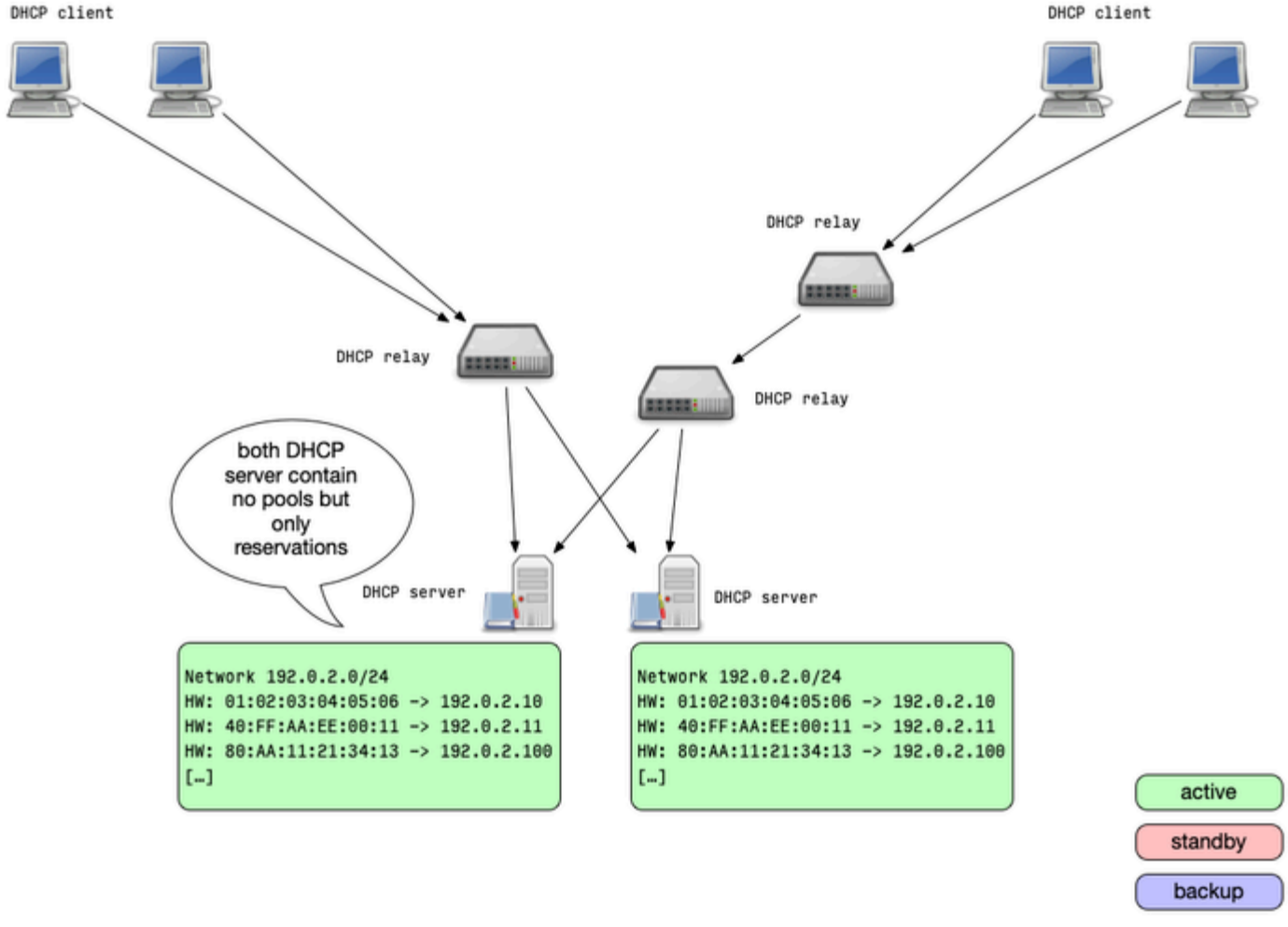


IPv4/IPv6 pure static DHCP

- 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

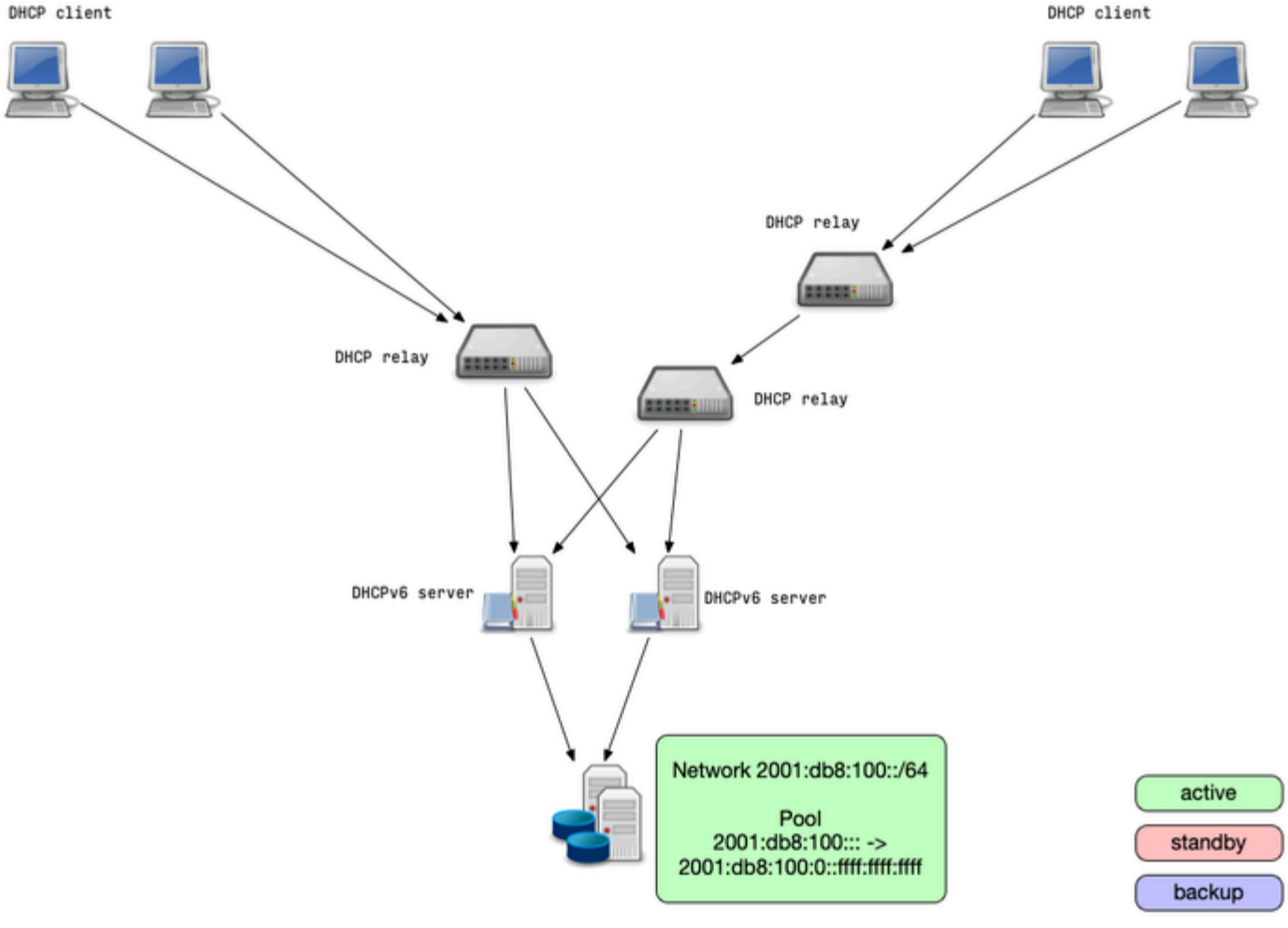


IPv4/IPv6 shared database

- 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



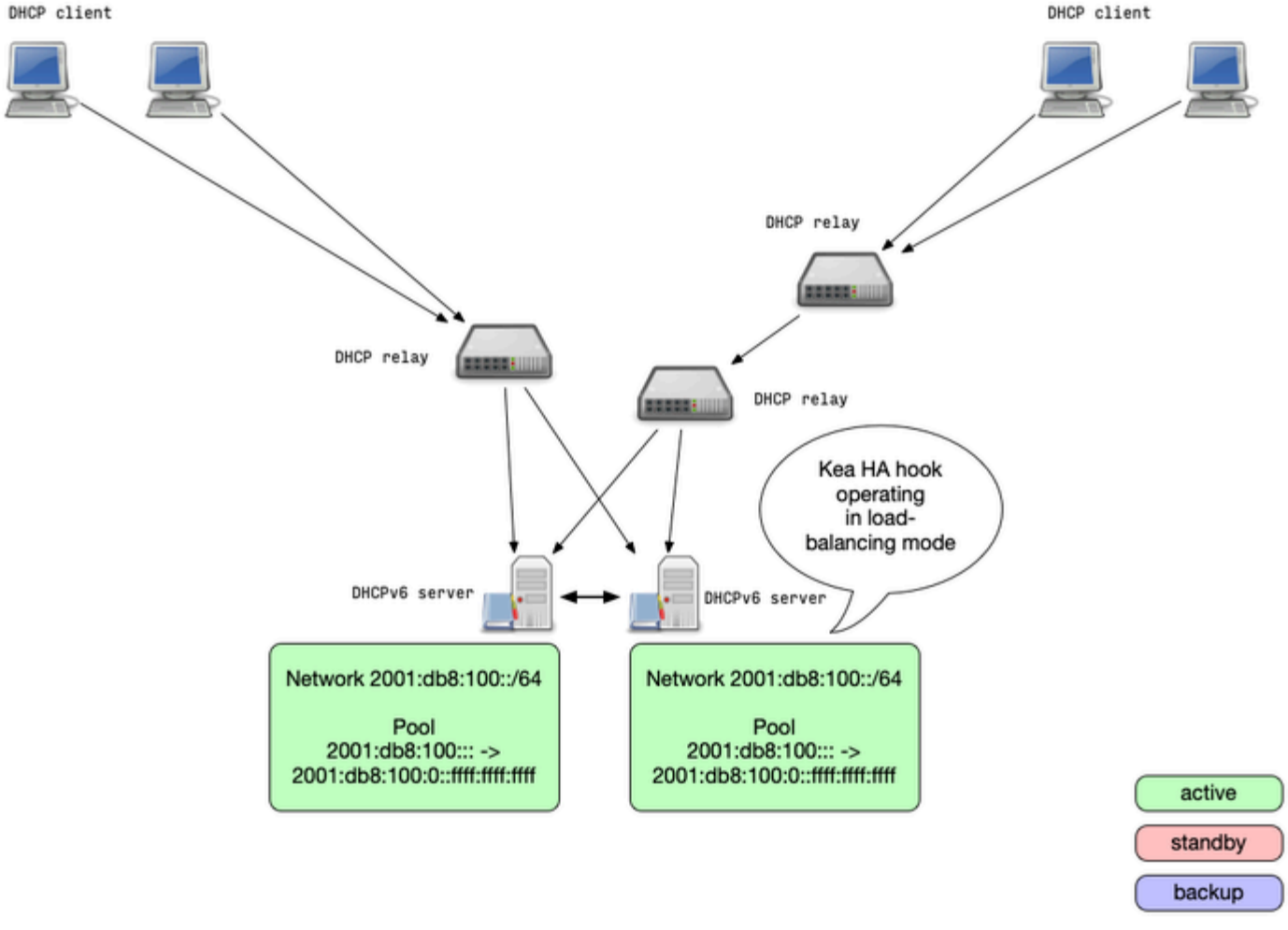
High Availability Hook

- 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

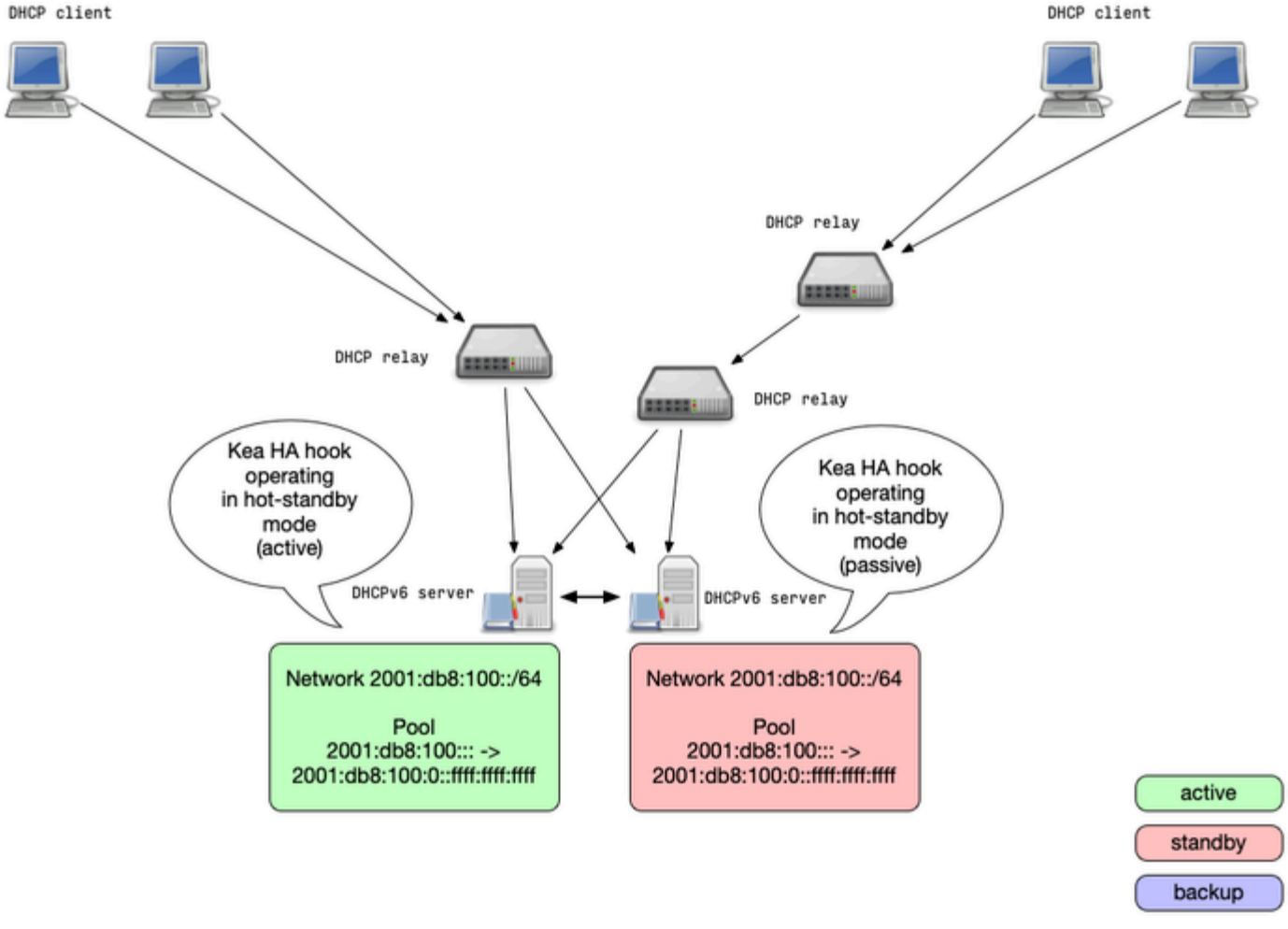
Kea HA Mode: load-balancing



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



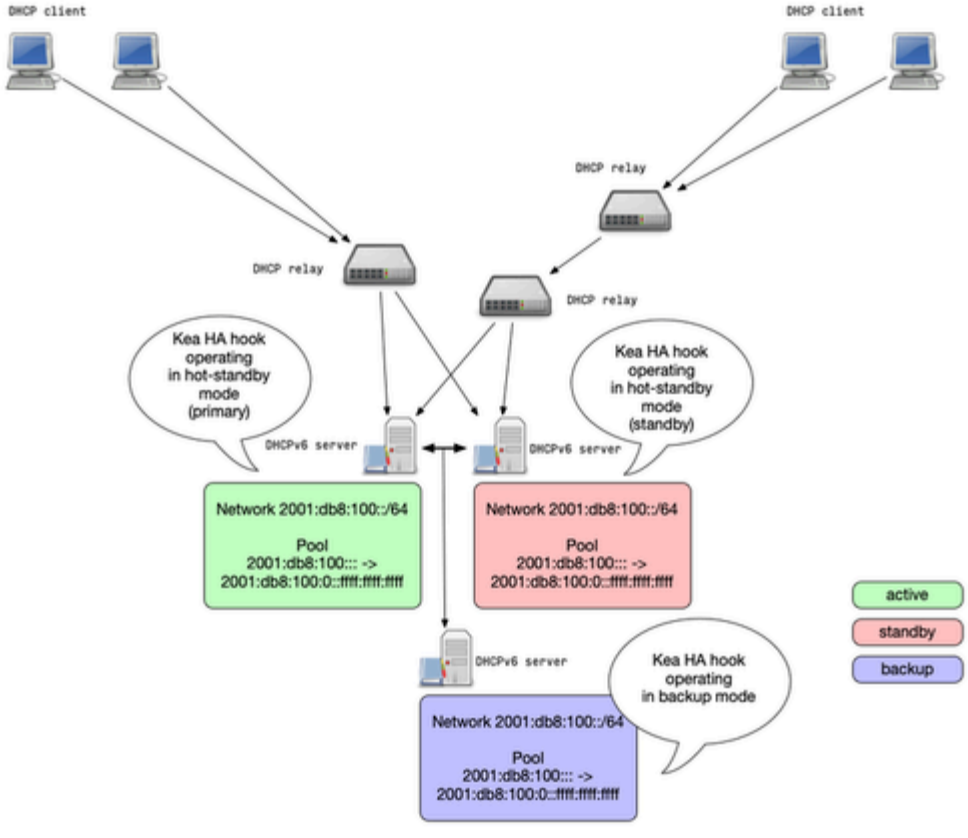
Kea HA Mode: hub-and-spoke

- In an *hub-and-spoke* configuration one (central) Kea-DHCP server provides backup for a number of active (satellite) Kea-DHCP server
- The satellite Kea-DHCP server are often located in branch-offices
- The backup central Kea-DHCP is often located at the organizations head-quarter (HQ)
- Hub-and-spoke mode is available since Kea-DHCP 3.0

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 Server

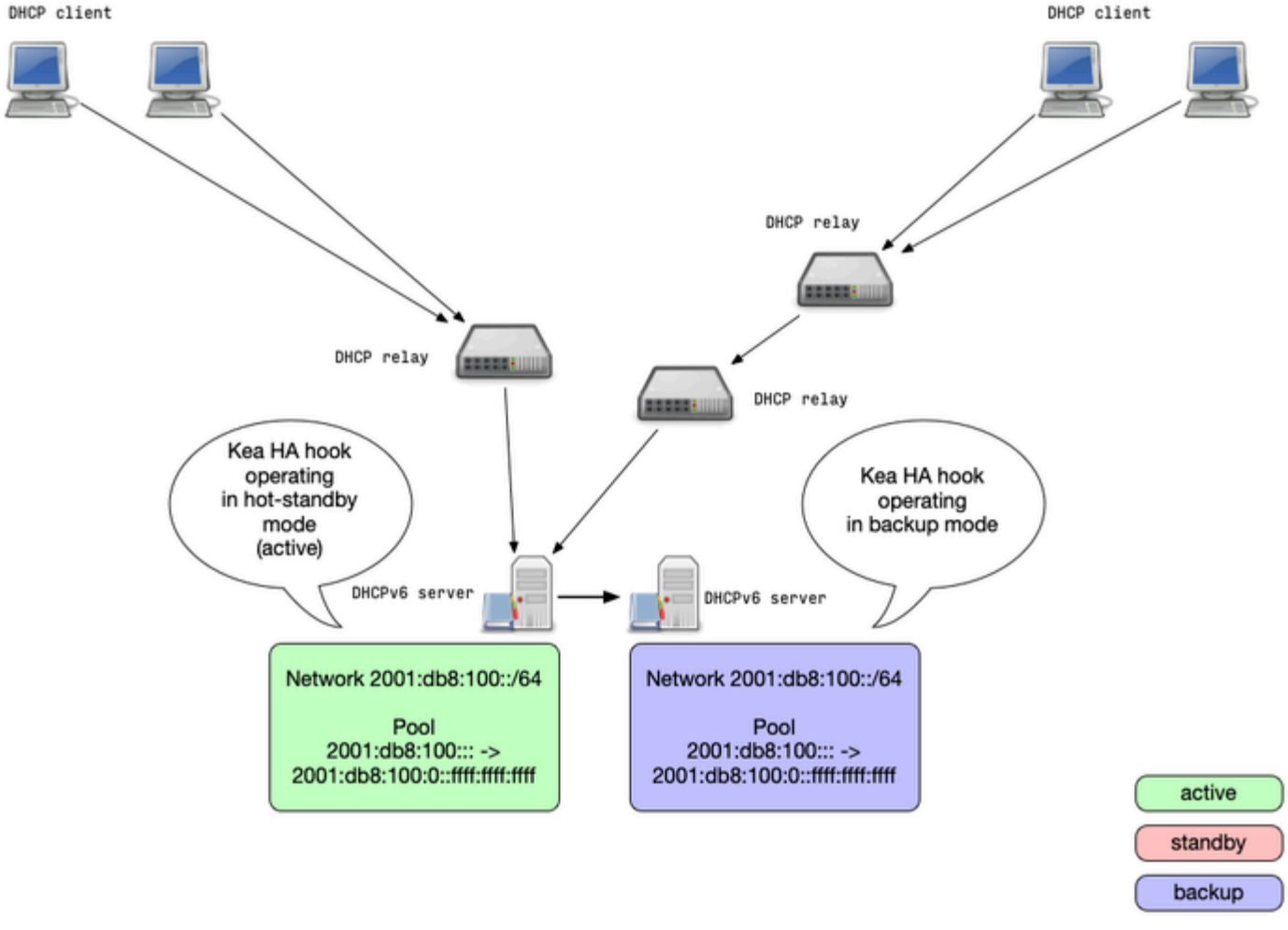


Kea HA Mode: passive-backup

- 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



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@@html:%3C/div%3E@@

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*** and SQL-Database)