



Chapter 4

DHCP and DNS

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Content

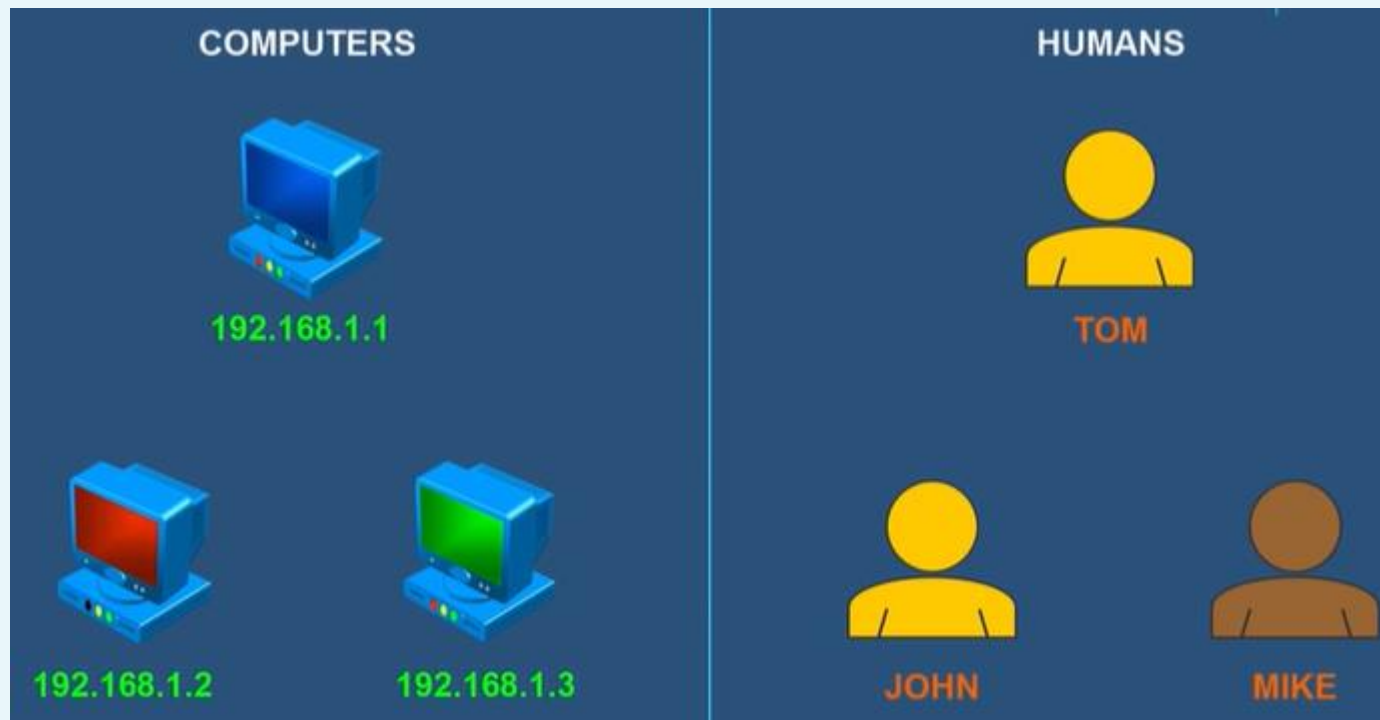
- The purpose of DNS
- Types of DNS zones
- Types of DNS records
- DHCP
- Creating a DHCP scope



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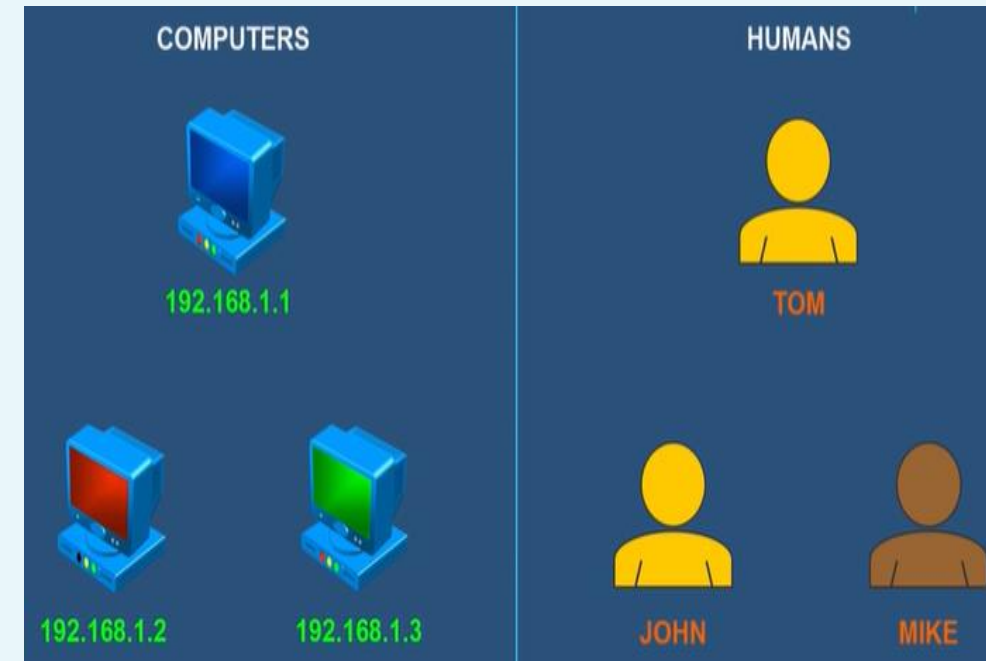
The purpose of DNS

- In the world of networking, computers and devices identify and talk each other over a network using numbers (e.g., IP address)
- On the other hand, Humans are accustomed to using names



The purpose of DNS

- To bridge the gap to make the communication a lot easier, DNS developed
- DNS resolves names to numbers, i.e., domain names to IP addresses
- Basically, DNS works like a phone book:
 - When you find a number, you don't look up the number first.
 - You look up the name first then it will give you the number





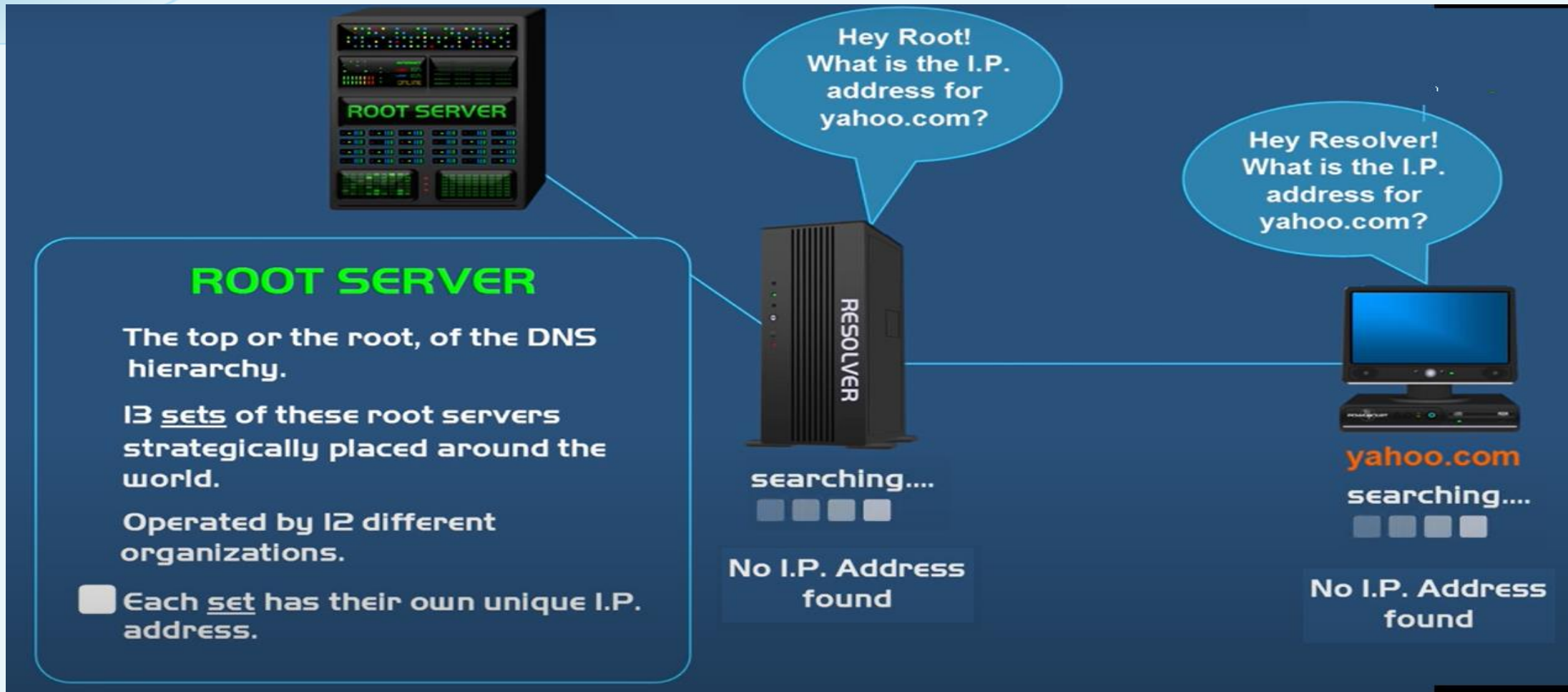
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DNS

How DNS works

- Example



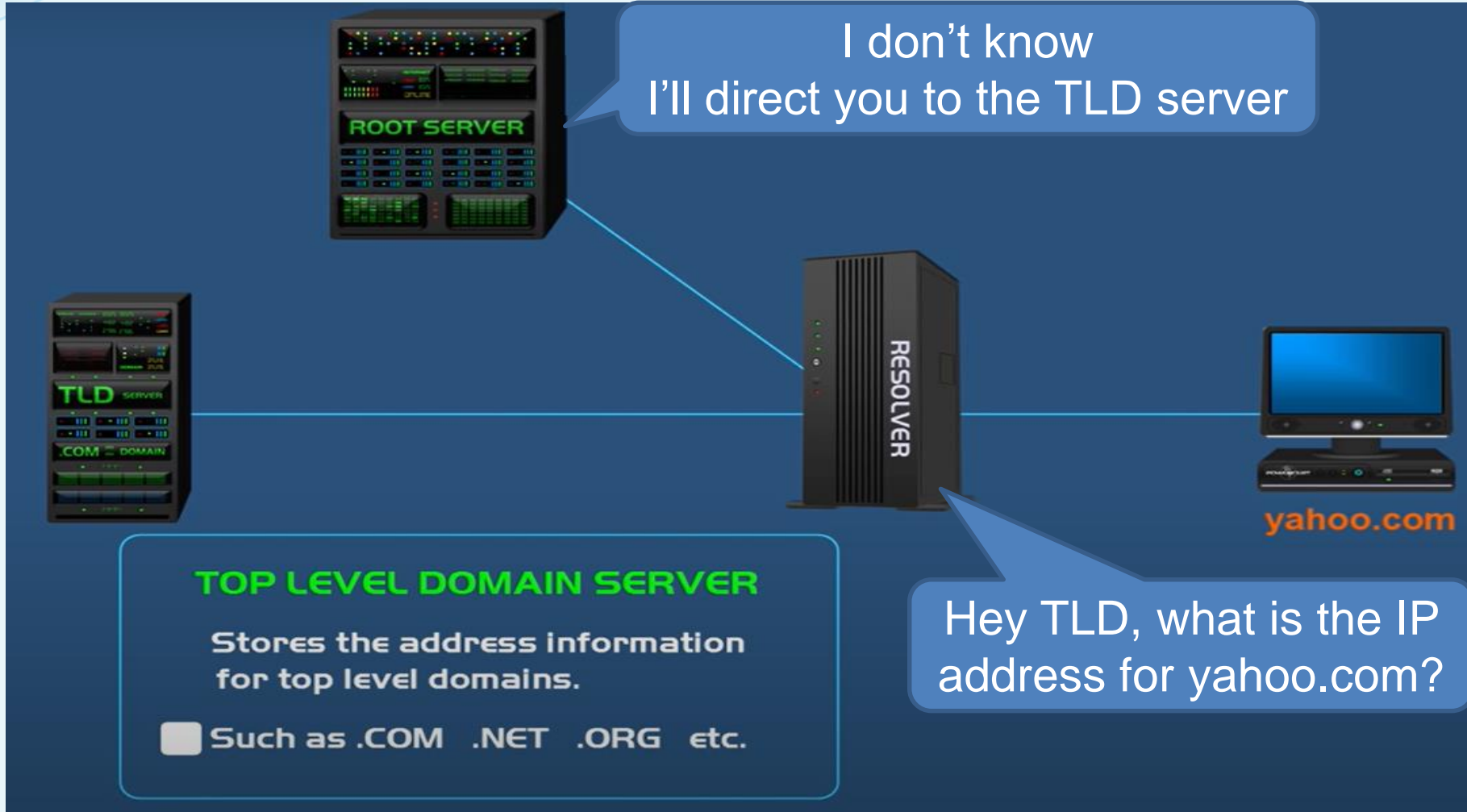




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DNS

How DNS works

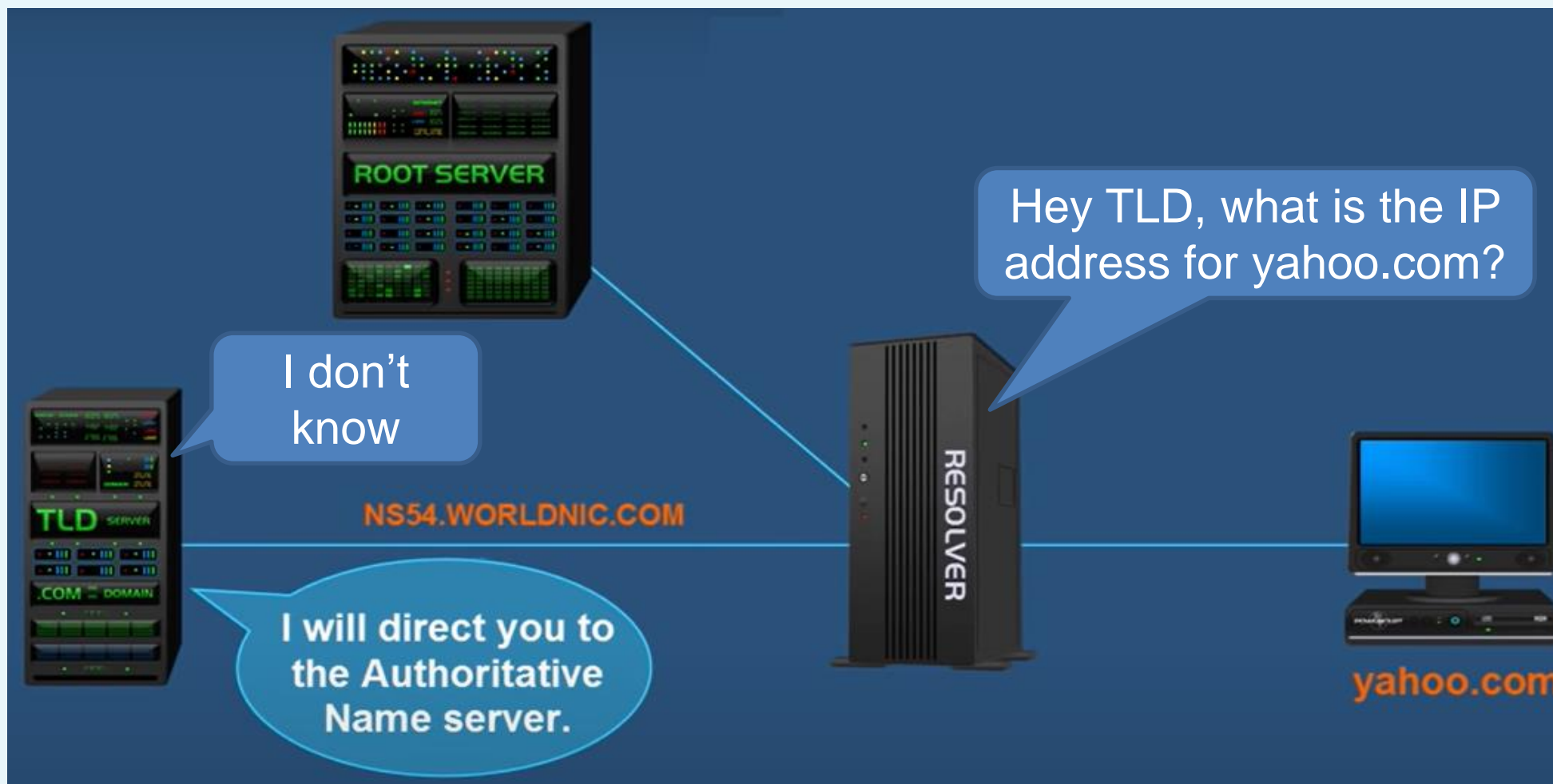




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How DNS works

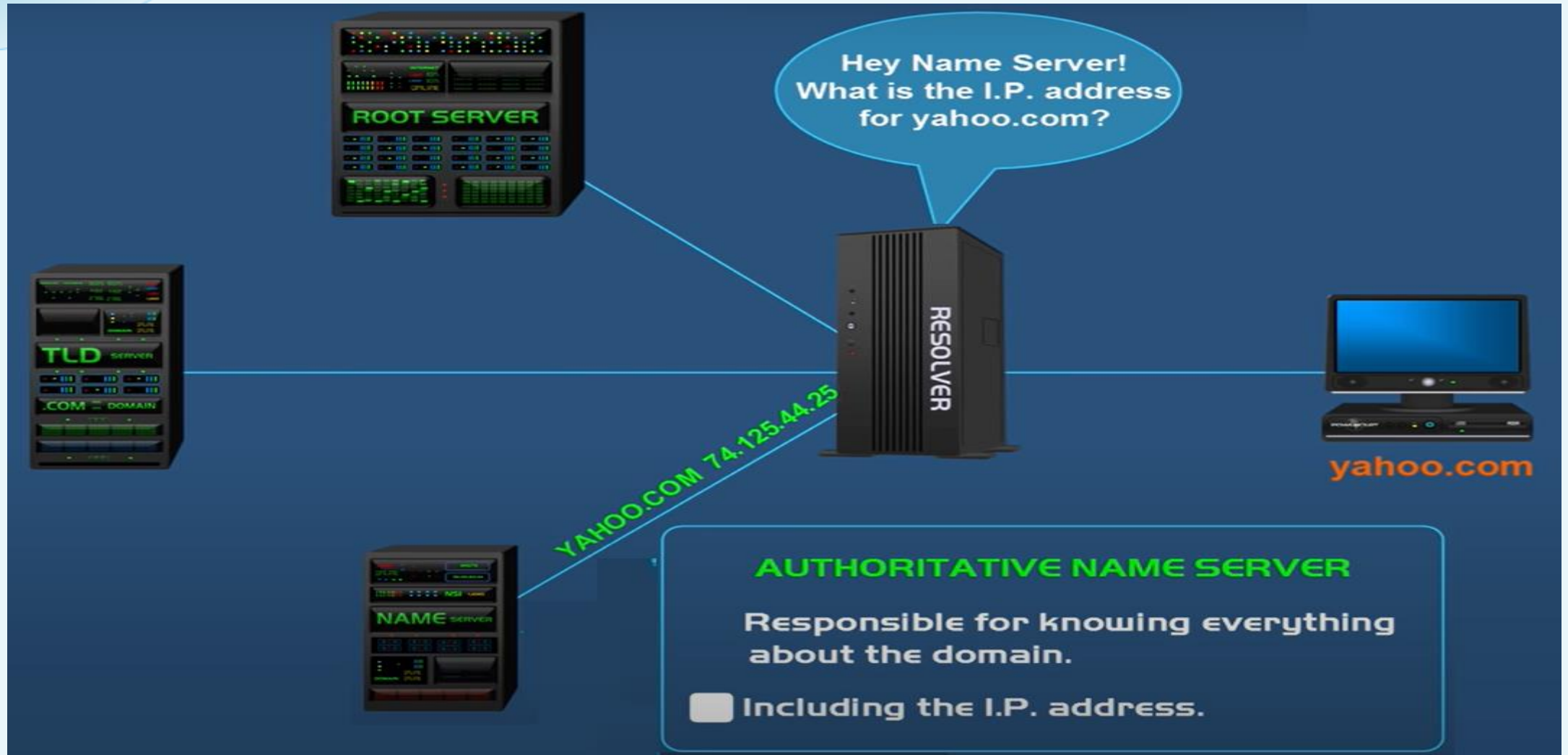




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DNS

How DNS works



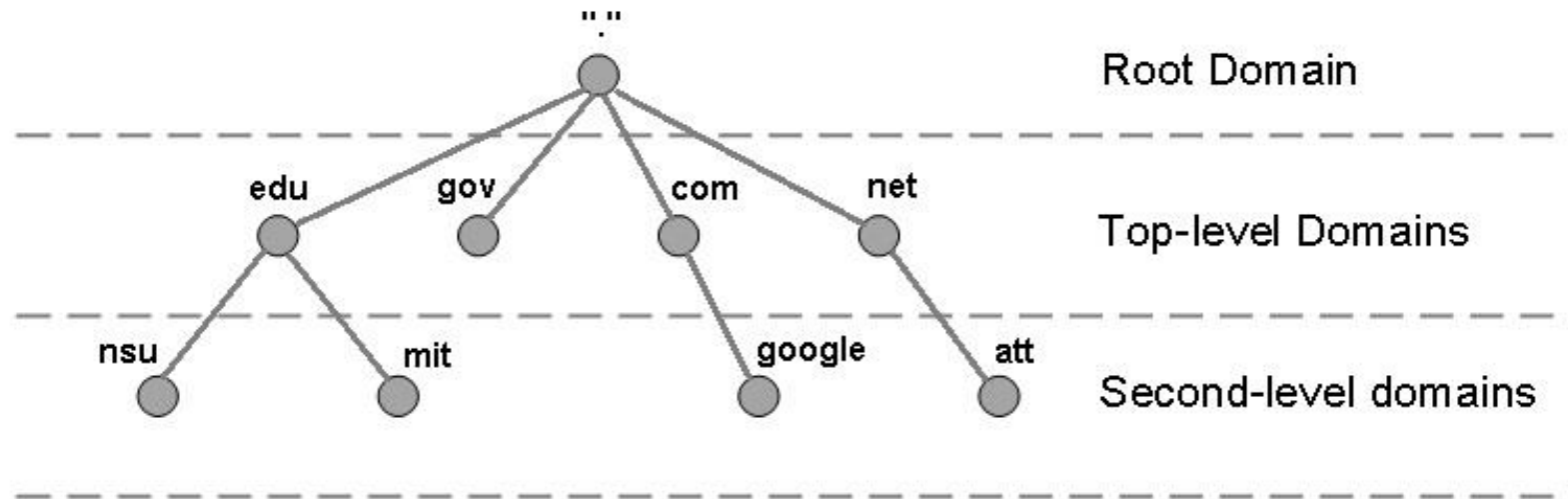


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DNS

A hierarchically distributed database

- DNS – a hierarchically distributed database:
 - Its layers are arranged in a definite order
 - And its data is distributed across a wide range of machines
- Establishes an inverted logical tree structure called the domain namespace



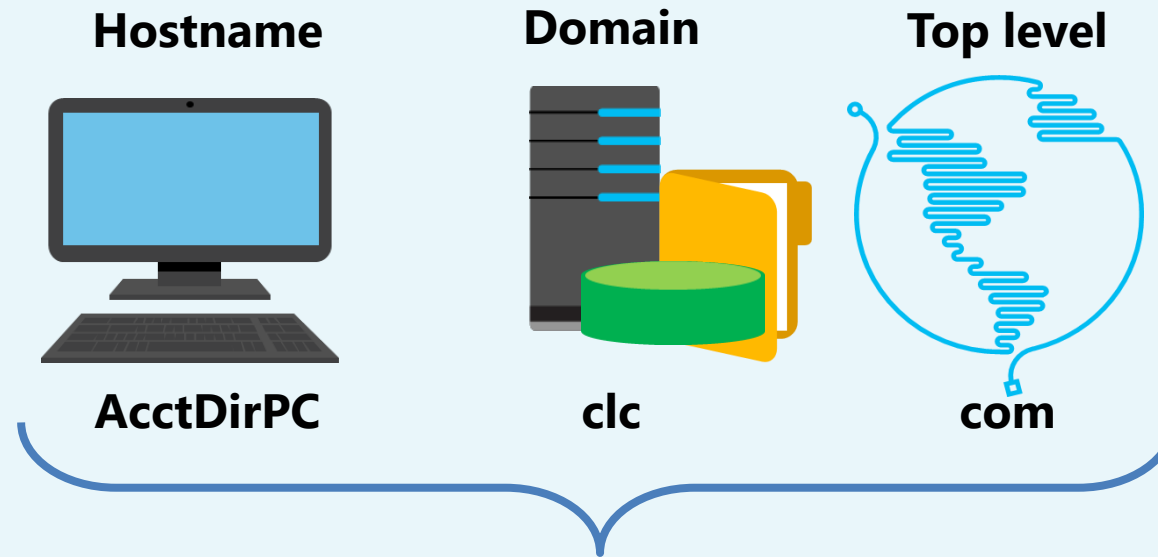
Each node, or domain, in that space has a unique name.



DNS

Fully qualified domain name

- If someone wanted to contact that host, they would use the Fully Qualified Domain Name (FQDN)
- A computer name added to a domain name and top level domain to make a FQDN



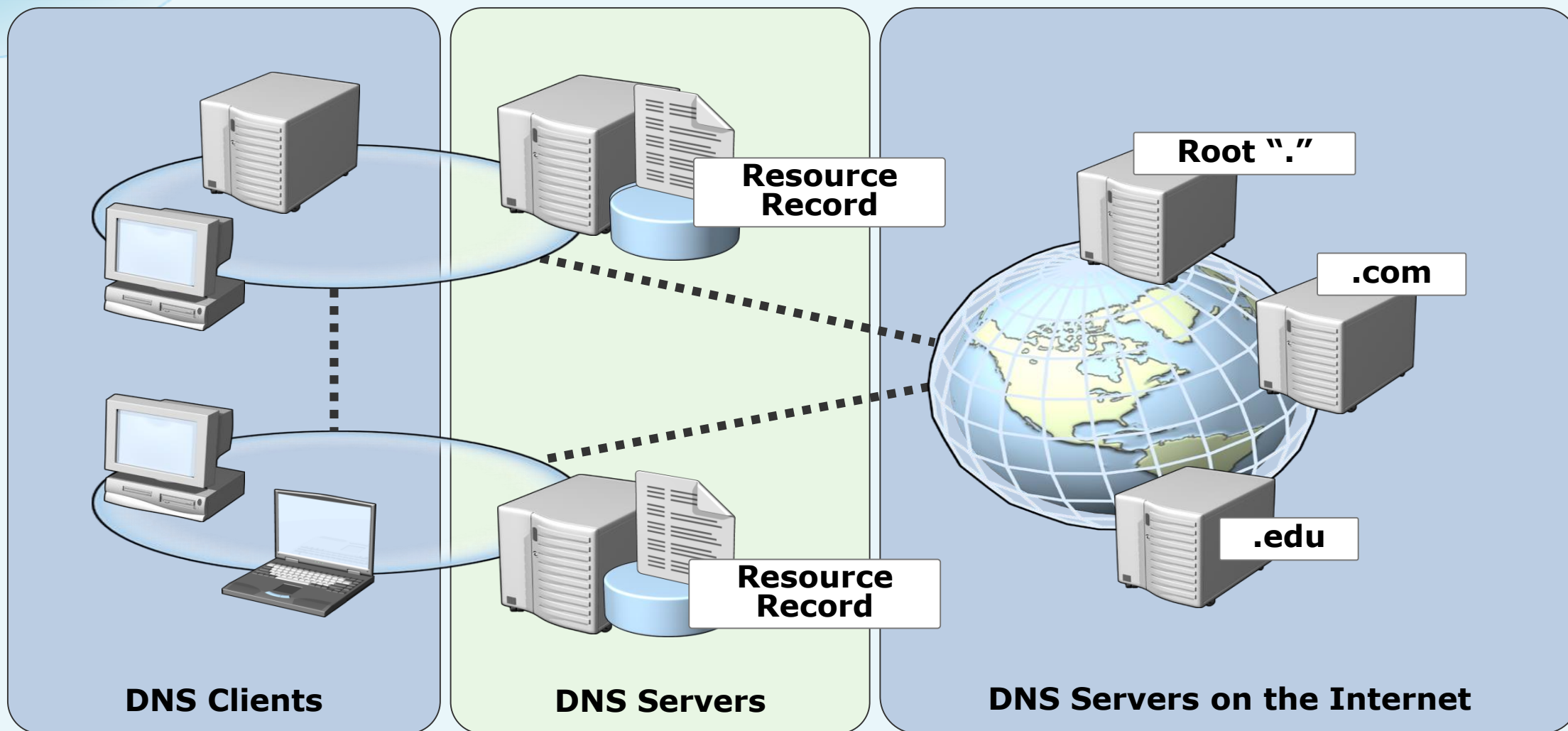
Fully qualified domain name = AcctDirPC.clc.com



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DNS

DNS Architecture

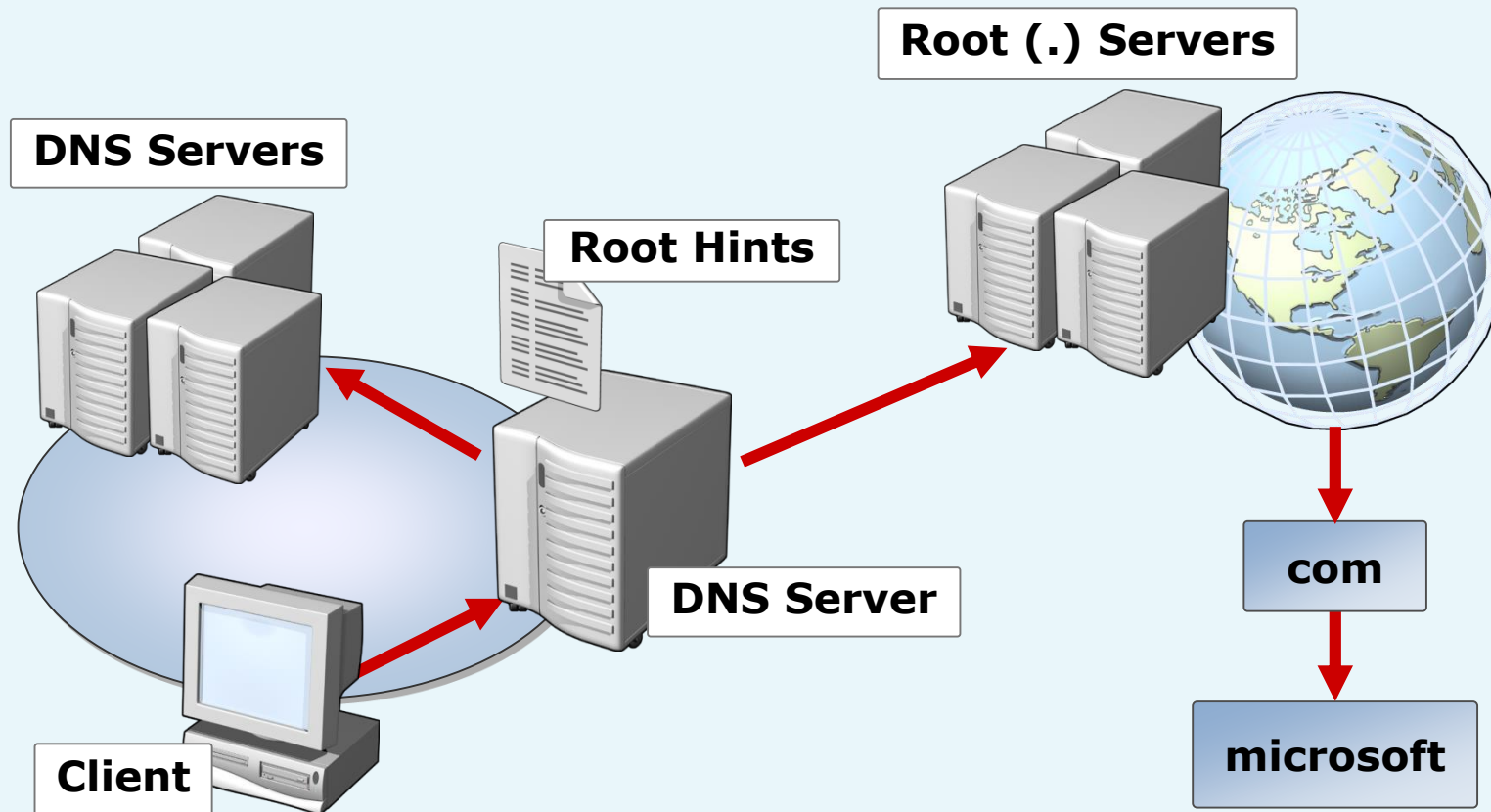




DNS

DNS: Root Hints

Root hints contains IP of root servers





DNS

The root name servers

The root name servers know other TLD servers





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DNS

The TLD servers

The rightmost part of every domain name



DNS servers for .com



DNS servers for .org



DNS servers for .ca

Number of DNS servers varies by TLD



DNS

Authority Name servers

- Name server giving answers in response to questions asked about names in a zone



Google.com



yahoo.com



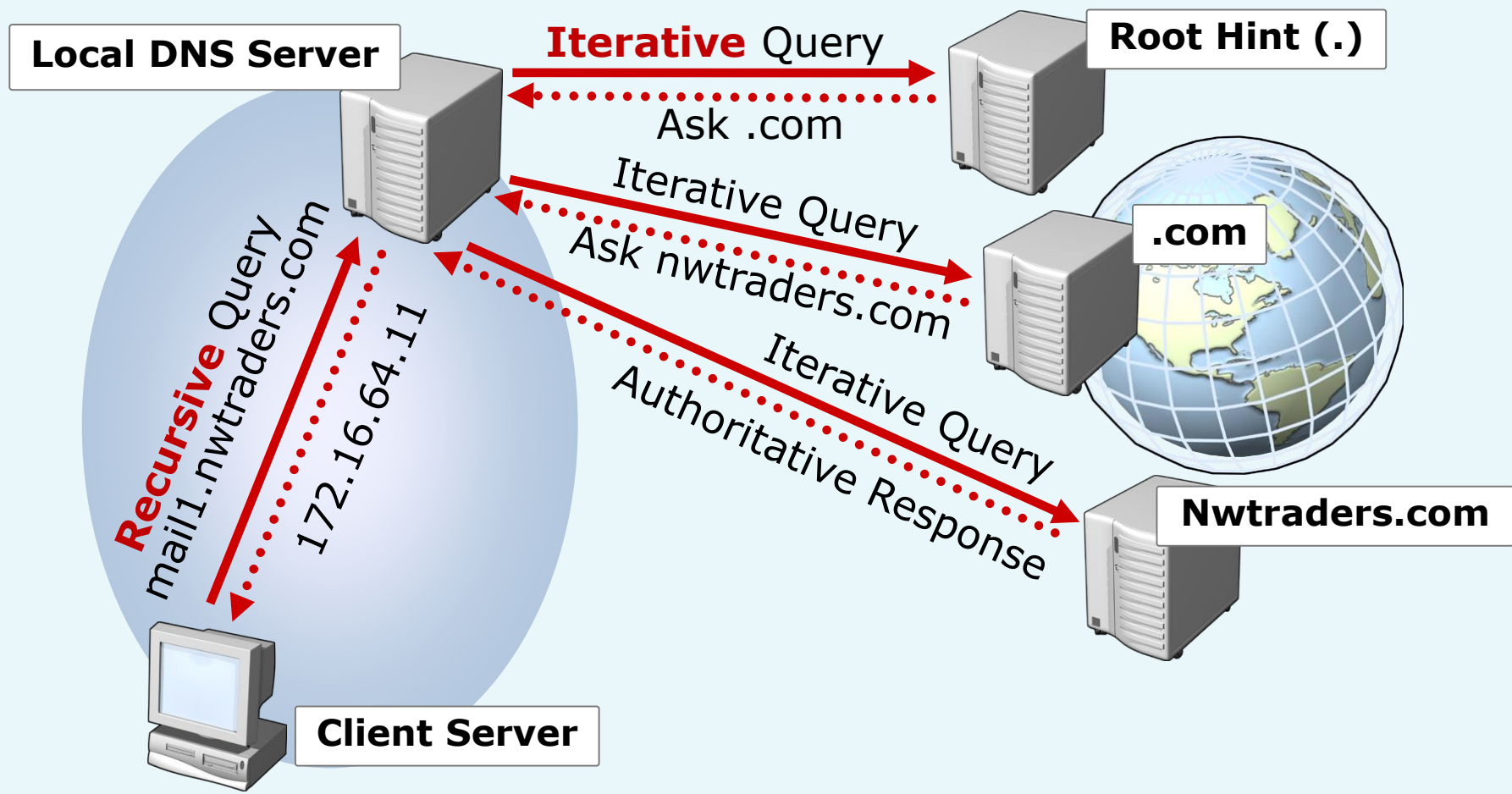
ctu.edu.vn



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DNS

DNS queries



- DNS is a standard set of protocols that defines the following:
 - A mechanism for querying and updating address information in the database
 - A mechanism for replicating the information in the database among servers
 - A schema of the database
- DNS infrastructure components include: **DNS server; DNS zone; DNS resolvers; Resource records**

- DNS server is responsible for:
 - storing and resolving all of the names on the network
 - turning FQDN into something else in order to get the traffic to the correct destination
- DNS servers work together to resolve hierarchical names
 - If a server already has information about a name, it simply fulfills the query for the client.
 - Otherwise, it queries other DNS servers for the appropriate information.

- A DNS zone is a specific portion of DNS namespace over which a specific DNS server has authority
- DNS zone contains *resource records* defining the hosts and other types of information that make up the database for the zone.
- **Zone types:**
 - Primary zones
 - Secondary zones
 - Stub Zones



Primary zones

- Responsible for maintaining all of the records for the DNS zone
- It contains the primary copy of the DNS database
- All record updates occur on the primary zone
- Two types of primary zones:
 - Primary zone: Local database (stored locally in a file on the server)
 - Primary zone with Active Directory Integration (Active Directory DNS)
 - The DNS database is stored in Active Directory.
 - All Active Directory DNS servers can have access to the same data
 - It has to reside on a domain controller

Secondary zones

- Noneditable copies of the DNS database
- Used for load balancing
- Gets its database from a primary zone
- It can be used to resolve DNS requests

Stub zones

- The database is a noneditable copy of a primary zone
- Contains only the information necessary to identify the authoritative DNS servers for a zone
- Contain only three record types:
 - name server (NS)
 - start of authority (SOA)
 - glue host (A).

- How to keep primary and secondary DNS service in synchronized?
- Secondary DNS servers receive their zone databases through zone transfers
- Configure a secondary server: specify the primary server that is authoritative for the zone and will send the zone transfer.
- The primary server must also permit the secondary server to request the zone transfer.
- Zone transfers occur in one of two ways:
 - full zone transfers (AXFR)
 - and incremental zone transfers (IXFR)

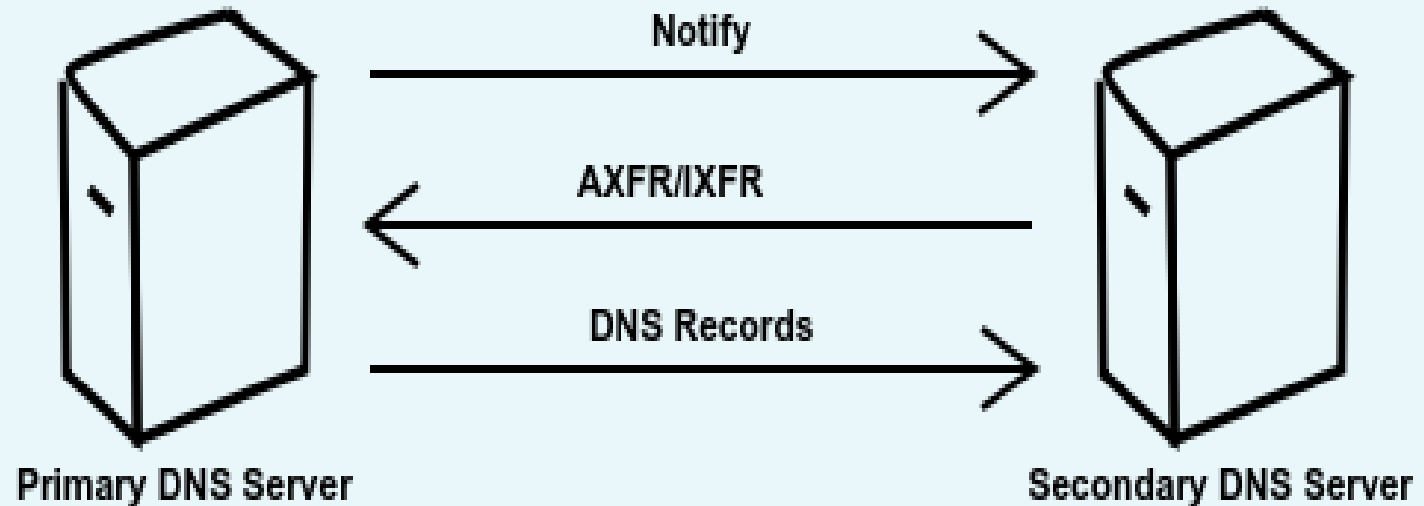


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DNS

Infrastructure components: zone transfers and replication

- The DNS system provides the Notify feature.
 - A primary DNS provider can notify the secondary providers that the records have changed.
 - After receiving the Notify message, secondary servers can use AXFR or IXFR query type to fetch the zone records.



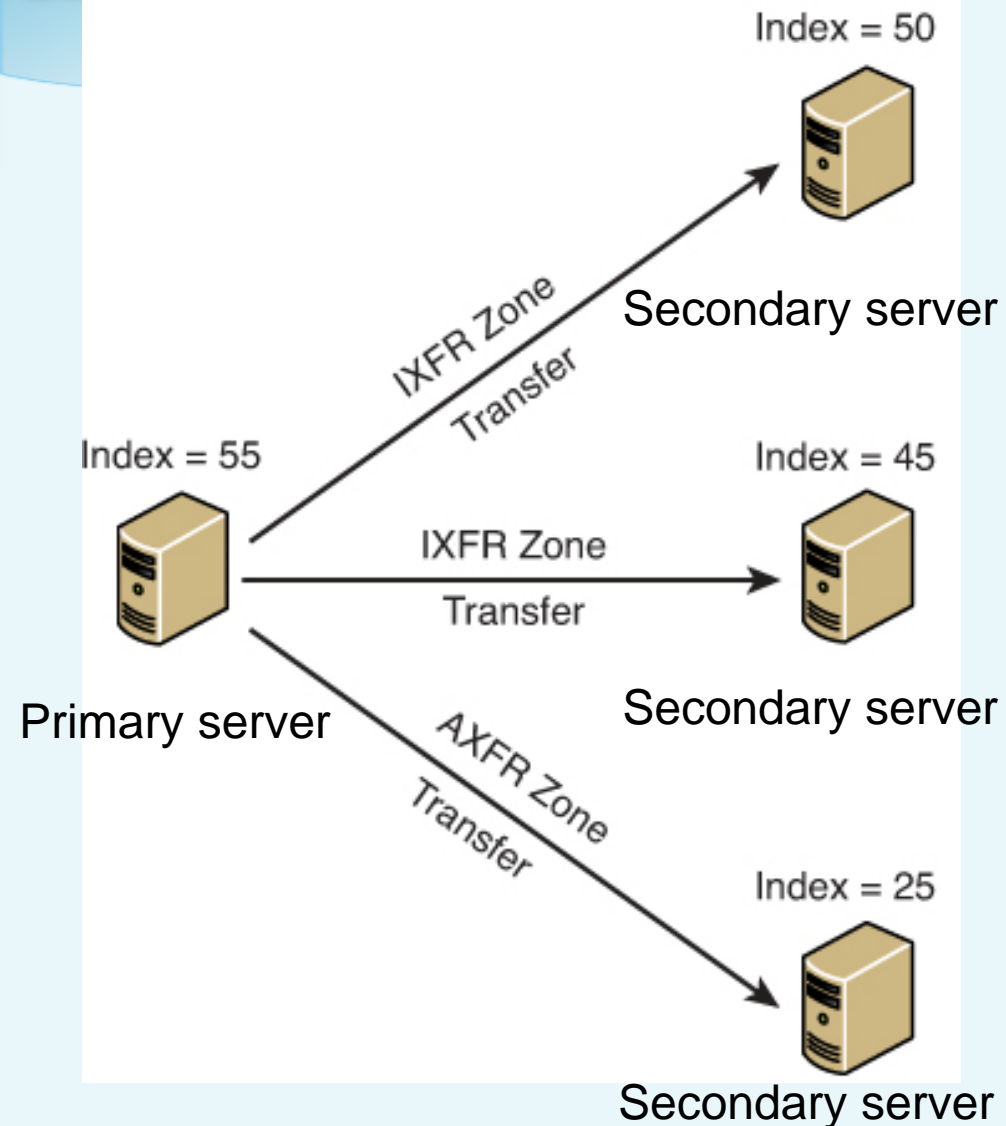
Message flow between DNS Servers

Infrastructure components: zone transfers and replication

- When configured for the first time, a new secondary server receives a full zone transfer from the primary DNS server
- After the secondary receives its first full zone transfer, subsequent zone transfers are incremental.
 - Based on the difference of the zone version number between two servers, and the primary sends only the changes that have been made in the interim
- The secondary server typically initiates zone transfers when:
 - The refresh interval time for the zone expires
 - The secondary or stub server boots.
 - The primary notifies the secondary whenever any changes to the zone database occur



Infrastructure components: zone transfers and replication



A zone transfer for all changes from index 50 to 55 is initiated from the Primary to Secondary

A zone transfer for all changes from index 45 to 55 is initiated from the Primary to Secondary

Because the difference between index number is great, a full AXFR zone transfer is initiated from the Primary to Secondary

- Not a zone type, but an option can be selected when create some types of DNS zone
- A checkbox that states **Store the zone in Active Directory**
- The new zone stored inside Active Directory
- Capable of being replicated automatically to all DC servers in your domain



- Forward Lookup Zones:
 - Traditional DNS zones
 - Take an incoming DNS request and turn that DNS name request into an IP address
- Reverse Lookup Zones
 - opposite of forward
 - Mapping IP addresses backward into names



- DNS database zone files consist of a number of resource records.
- DNS records used to resolve names to their corresponding IP addresses
- Resource records in forward lookup zones include: A, MX, SRV, NS, SOA, and CNAME
- Resource records in reverse lookup zones include: PTR



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DNS

Types of DNS records

DNS Manager console

The screenshot shows the DNS Manager console with the following structure:

- DNS
 - DC1
 - Forward Lookup Zones
 - _msdcs.contoso.local
 - contoso.local
 - Reverse Lookup Zones
 - Trust Points
 - Conditional Forwarders

The main pane displays a list of DNS records for the selected zone:

Name	Type	Data
_msdcs		
_sites		
_tcp		
_udp		
DomainDnsZones		
ForestDnsZones		
(same as parent folder)	Start of Authority (SOA)	[97], dc1.contoso.local., h...
(same as parent folder)	Name Server (NS)	dc1.contoso.local.
(same as parent folder)	Name Server (NS)	dc2.contoso.local.
(same as parent folder)	Host (A)	10.10.10.10
(same as parent folder)	Host (A)	10.10.10.11
CA1	Host (A)	10.10.10.18
dc1	Host (A)	10.10.10.10
DC2	Host (A)	10.10.10.11
WEB1	Host (A)	10.10.10.15
WEB3	Host (A)	10.10.10.17
WIN10	Host (A)	10.10.10.100

Types of DNS records: Host record (A or AAAA)

- Used to associate a host's name to its IP addresses
- A records are for IPv4 addresses; AAAA (pronounced Quad A) records serve for IPv6 addresses
- The most common kind of DNS records
- Format

host_name optional_TTL IN A IP_Address

- Example:

www IN A 192.168.0.204

Types of DNS records: Host record (A or AAAA)

1. Open DNS Manager console
2. Right-click on the name of your domain listed under the Forward Lookup Zones folder, and then choose New Host (A or AAAA)

New Host

Name (uses parent domain name if blank):

RA1

Fully qualified domain name (FQDN):

RA1.contoso.local.

IP address:

10.10.10.13

☐ Create associated pointer (PTR) record

☐ Allow any authenticated user to update DNS records with the same owner name

Add Host

Cancel



Types of DNS records: Host record (A or AAAA)

```
Administrator: Windows PowerShell

PS C:\Users\Administrator> ping ra1

Pinging ra1.contoso.local [10.10.10.13] with 32 bytes of data:
Reply from 10.10.10.13: bytes=32 time=3ms TTL=128
Reply from 10.10.10.13: bytes=32 time<1ms TTL=128
Reply from 10.10.10.13: bytes=32 time=1ms TTL=128
Reply from 10.10.10.13: bytes=32 time<1ms TTL=128

Ping statistics for 10.10.10.13:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 3ms, Average = 1ms
PS C:\Users\Administrator>
```

Types of DNS records: Alias record – CNAME

- Take a name and points it at another name.
- Format: *alias optional_TTL IN CNAME hostname*
- It still needs to resolve the final name to an IP address to get the traffic where it needs to go
- CNAME is useful in many scenarios, including:
 - create some additional administrative flexibility;
 - Need to replace a web server;
 - Need to add another web server;
 - creates a very simple form of load balancing



Types of DNS records: Mail Exchanger (MX) record

- Used to specify which servers accept mail for this domain
- When resolving Domain name follows the "@" in your e-mail address, the DNS servers look up an MX record
- Format:

domain *IN* *MX* *preference* *mailserver_host*

Example:

example.com.	IN	MX	0	mail.example.com.
example.com.	IN	MX	10	backupmail.example.com.

- The preference value specifies which server should be used if more than one MX record is present (The lower the number, the more preferred the server)

Types of DNS records: Name Server (NS)

- List the name servers for a domain
- Identify which DNS servers are authoritative for the domain your are calling for
- Format: Name Class Type Name server

Field	Meaning
Name	The domain that will be serviced by this name server
Class	Internet (IN)
Record Type	Name server (NS)
Name Server	The FQDN of the server responsible for the domain

- Windows client query DNS servers for the location of a domain controller
- Service (SRV) records tie together the location of a service (like a domain controller)
- Format: *domain TTL Class Record-Type Priority weight port-number target*

Example:

ldap.tcp.example.com. 86400 IN SRV 10 100 389 hsv.example.com

ldap.tcp.example.com. 86400 IN SRV 20 100 389 msy.example.com

- Priority: Specifies a preference, SRV record with the lowest priority is used first (10).
- Weight: Service records with equal priority are chosen according to their weight (100)
- Port number: The port where the server is listening for this service (389).
- Target: The FQDN of the host computer

- Mapping an IP address to a hostname through the use of the in-addr.arpa zone

- Format:

reversed_address.in-addr.arpa. optional_TTL IN PTR targeted_domain_name

- *Example:*

10.1.168.192.in-addr.arpa. IN PTR www.example.com.



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Configuring DNS

Installing DNS

Server Manager ▸ Dashboard

WELCOME TO SERVER MANAGER

QUICK START

WHAT'S NEW

LEARN MORE

1 Configure this local server

2 [Add roles and features](#)

3 Add other servers to manage

4 Create a server group

5 Connect this server to cloud services

Add Roles and Features Wizard

Select installation type

Before You Begin

Installation Type

Server Selection

Server Roles

Features

Confirmation

Results

Select the installation type. You can install roles and features on a running machine, or on an offline virtual hard disk (VHD).

☒ **Role-based or feature-based installation**

Configure a single server by adding roles, role services, and features.

☐ **Remote Desktop Services installation**

Install required role services for Virtual Desktop Infrastructure (VDI) or session-based desktop deployment.

< Previous

Next >

Configuration: Load Balancing with Round Robin

- Implementation of DNS supports load balancing
- Distribute the network load among multiple network hosts if they are available
- Round-robin load balancing: creating multiple resource records with the same hostname but different IP addresses for multiple computers
- If round robin is enabled:
 - When a client requests name resolution, the first address entered in the database is returned to the resolver and is then sent to the end of the list.
 - The next time a client attempts to resolve the name, the DNS server returns the second name in the database (which is now the first name) and then sends it to the end of the list, and so on.
- Round robin is enabled by default.



Configuration: Load Balancing with Round Robin

The screenshot shows the DNS Manager application window. On the left, the 'DNS' tree view is expanded, showing a server named 'WIN-61I53MQ8V4R'. A right-click context menu is open over this server, with the 'Properties' option highlighted. The main pane of the DNS Manager is empty. To the right, the 'WIN-61I53MQ8V4R Properties' dialog box is open. It has several tabs: 'Debug Logging', 'Event Logging', 'Monitoring', 'Security', 'Interfaces', 'Forwarders', 'Advanced', and 'Root Hints'. The 'Advanced' tab is selected. In the 'Advanced' tab, the 'Server version number' is '10.0 14393 (0x3839)'. Under 'Server options', the following options are checked: 'Enable round robin', 'Enable netmask ordering', and 'Secure cache against pollution'. Other options like 'Disable recursion (also disables forwarders)', 'Enable BIND secondaries', and 'Fail on load if bad zone data' are unchecked. Below these, 'Name checking' is set to 'Multibyte (UTF8)', 'Load zone data on startup' is set to 'From Active Directory and registry', and 'Enable automatic scavenging of stale records' is unchecked. The 'Scavenging period' is set to '0 days'. At the bottom of the dialog are 'OK', 'Cancel', 'Apply', and 'Help' buttons. A 'Reset to Default' button is also present.

Opens the properties dialog box for the current selection.

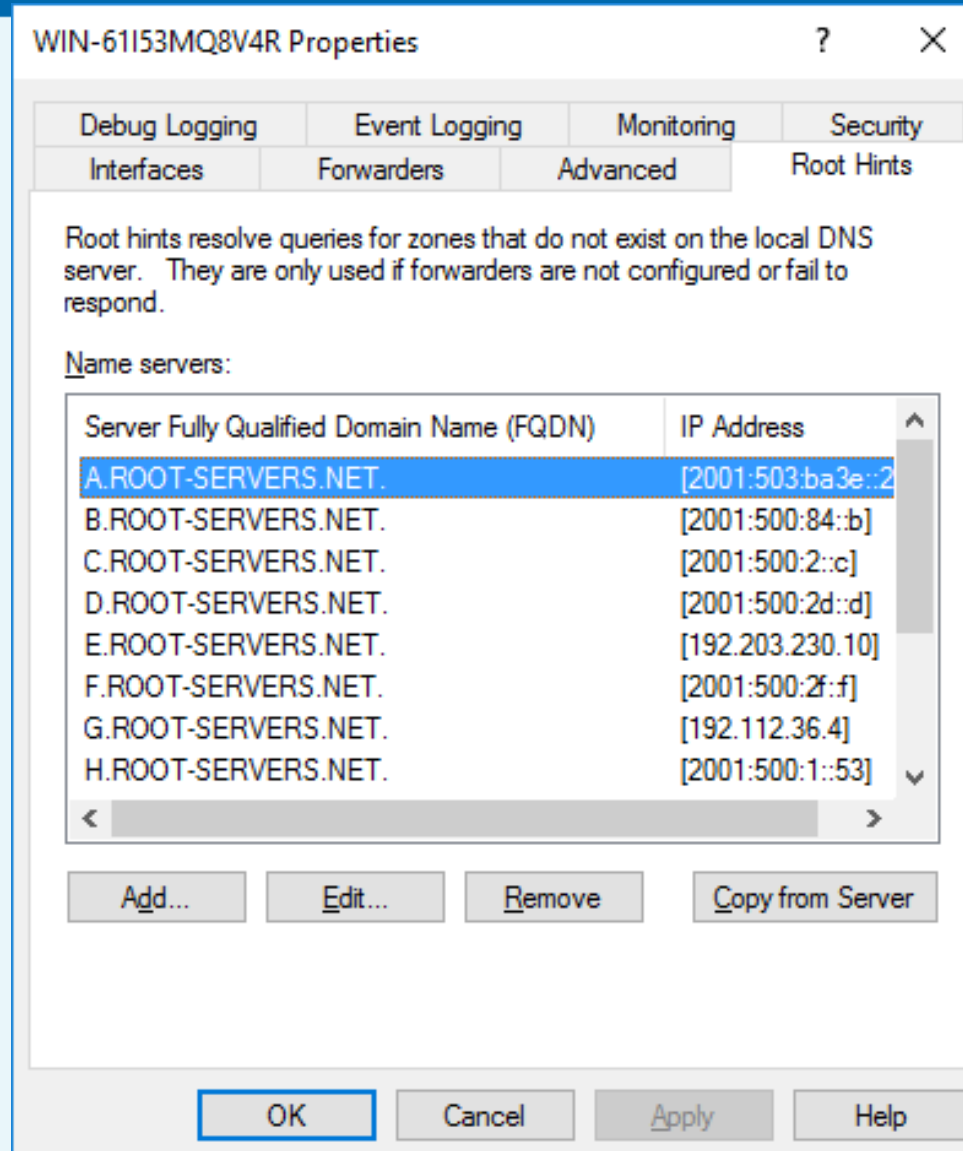


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Configuration: Caching-Only Server

- Only perform queries, cache the answers, and return the results
- Not authoritative for any domains
- Do not have any zone files, and don't participate in zone transfers
- Easy to configure: After installing the DNS service, simply make sure the root hints are configured properly





Configuration: Setting Zone Properties

clc.com Properties

WINS Zone Transfers Security

General Start of Authority (SOA) Name Servers

Status: Running Pause

Type: Active Directory-Integrated Change...

Replication: All DNS servers in this domain Change...

Data is stored in Active Directory.

Dynamic updates: Secure only

⚠ Allowing nonsecure dynamic updates is a significant security vulnerability because updates can be accepted from untrusted sources.

To set aging/scavenging properties, click Aging. Aging...

OK Cancel Apply Help

See and control whether this zone can be used to answer queries

Allow to select the zone type.

Allow to change the replication scope if the zone is stored in Active Directory.

Specify whether to support Dynamic DNS updates from compatible DHCP servers.



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Start Of Authority (SOA) record

DNS

Configuration: Setting Zone Properties

clc.com Properties

WINS Zone Transfers Security
General Start of Authority (SOA) Name Servers

Serial number:

Primary server:

Responsible person:

Refresh interval:

Retry interval:

Expires after:

Minimum (default) TTL:

TTL for this record: : : : (DDDDD:HH.MM.SS)



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Configuration: Setting Zone Properties

Indicate which name servers are authoritative for the zone.

clc.com Properties

WINS Zone Transfers Security
General Start of Authority (SOA) Name Servers

To add name servers to the list, click Add.

Name servers:

Server Fully Qualified Domain Name (FQDN)	IP Address
win-61i53mq8v4r.clc.com.	[172.18.160.100]

Add... Edit... Remove

*represents an IP address retrieved as the result of a DNS query and may not represent actual records stored on this server.

OK Cancel Apply Help



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DNS

Configuration: Setting Zone Properties

Specify whether the servers allow zone transfers and, if so, to whom.

clc.com Properties

General Start of Authority (SOA) Name Servers
WINS Zone Transfers Security

A zone transfer sends a copy of the zone to the servers that request a copy.

☐ Allow zone transfers

☒ To any server

☐ Only to servers listed on the Name Servers tab

☐ Only to the following servers

IP Address	Server FQDN
------------	-------------

Edit

To specify secondary servers to be notified of zone updates, click Notify...

Notify...

OK Cancel Apply Help



Configuration: Delegating Zones for DNS

- DNS provides the ability to divide the namespace into one or more Zones
- A need to delegate management of part of the DNS namespace to another location or department within the organization
- Each newly delegated zone requires a primary DNS server just as a regular DNS zone does



Configuration: Delegating Zones for DNS

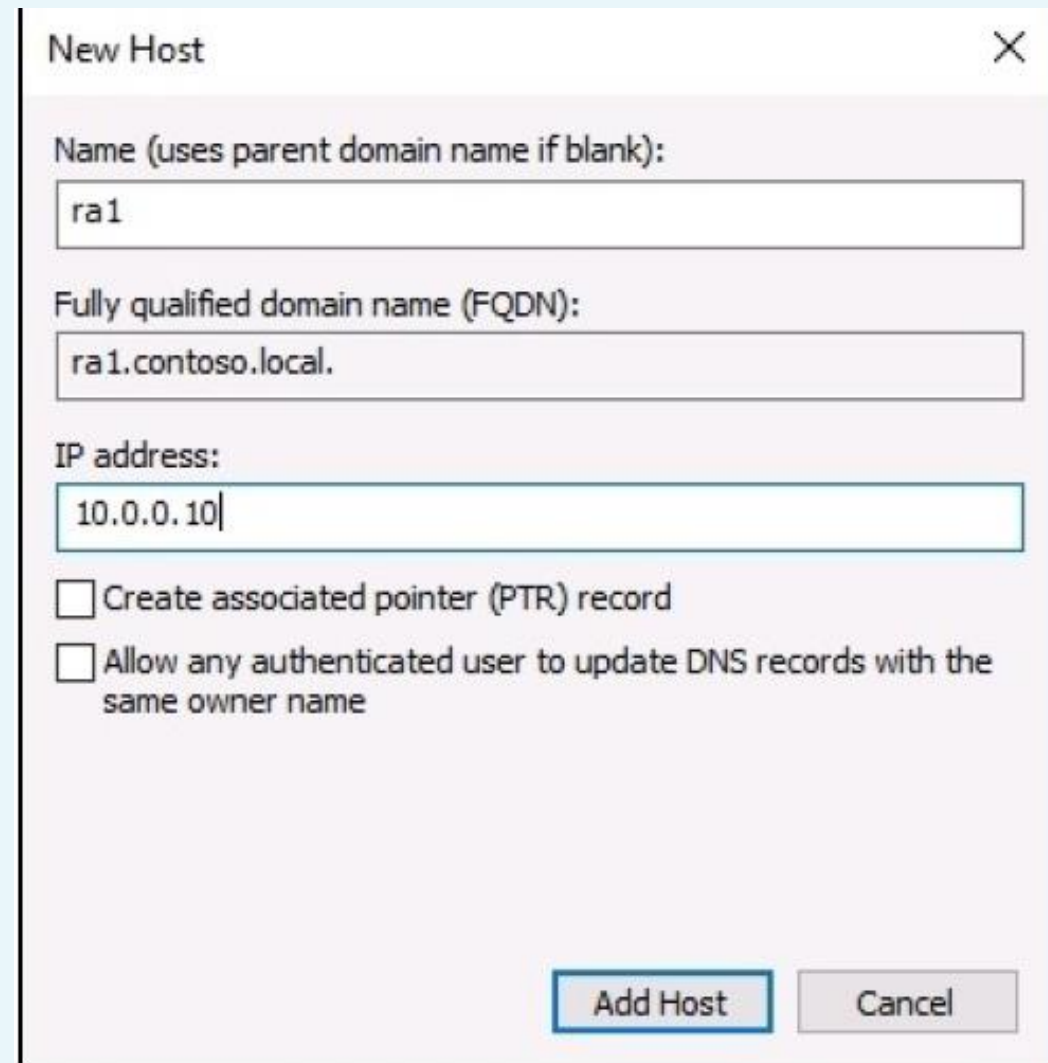
Create a new delegated



Configuration: Delegating Zones for DNS

Creating Records: Host record

1. Open DNS Manager
2. Right-click on the name of domain listed under the Forward Lookup Zones folder, and then choose New Host (A or AAAA)
3. Enter the name of the server, and the IP address configured on its network interface.



New Host

Name (uses parent domain name if blank):
ra1

Fully qualified domain name (FQDN):
ra1.contoso.local.

IP address:
10.0.0.10

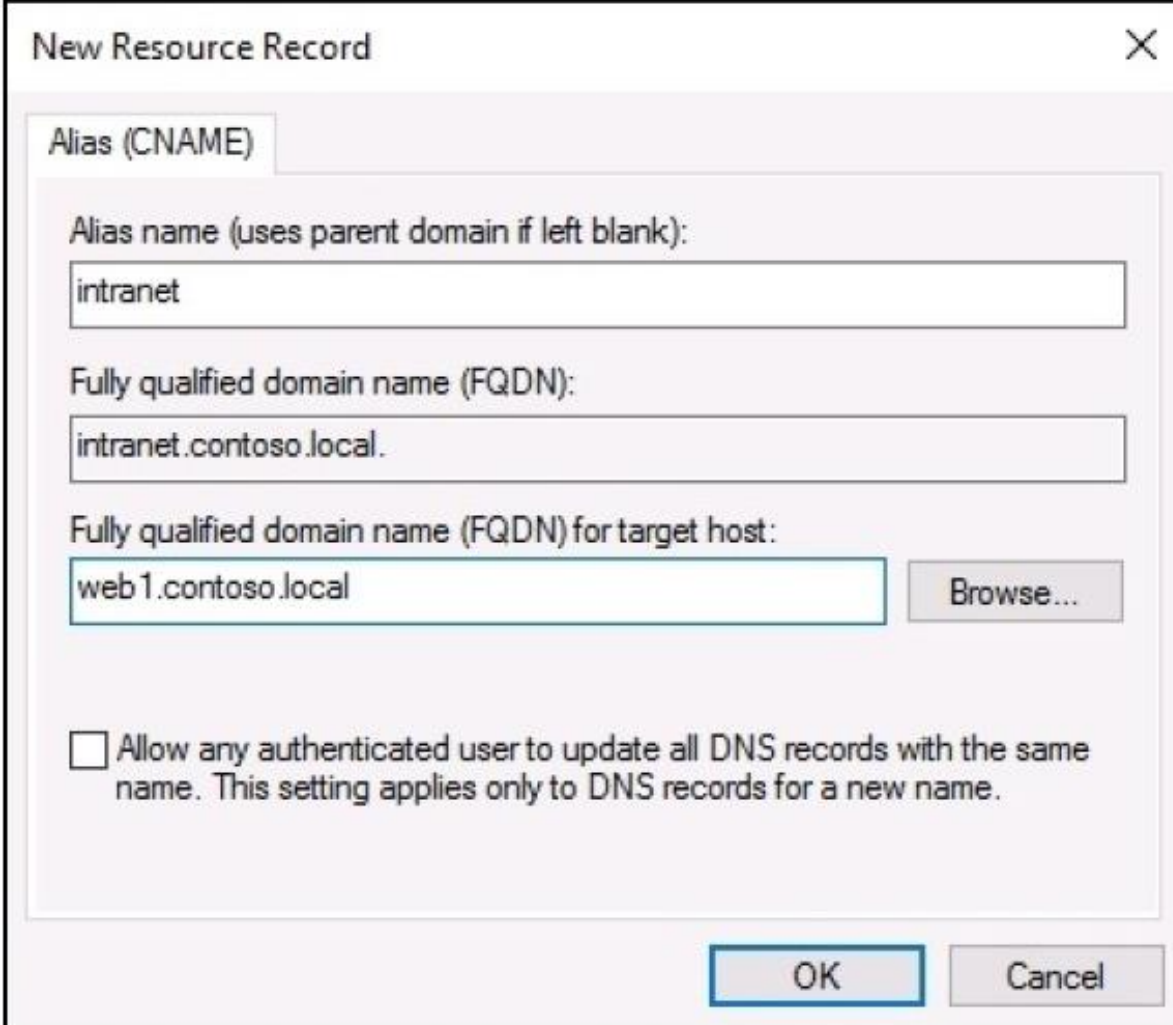
☐ Create associated pointer (PTR) record

☐ Allow any authenticated user to update DNS records with the same owner name

Add Host Cancel

Creating Records: Alias record – CNAME

1. Open DNS Manager
2. Right-click on the name of domain listed under the **Forward Lookup Zones** folder, and then choose **New Alias (CNAME)**
3. Enter Alias for host name



New Resource Record

Alias (CNAME)

Alias name (uses parent domain if left blank):
intranet

Fully qualified domain name (FQDN):
intranet.contoso.local.

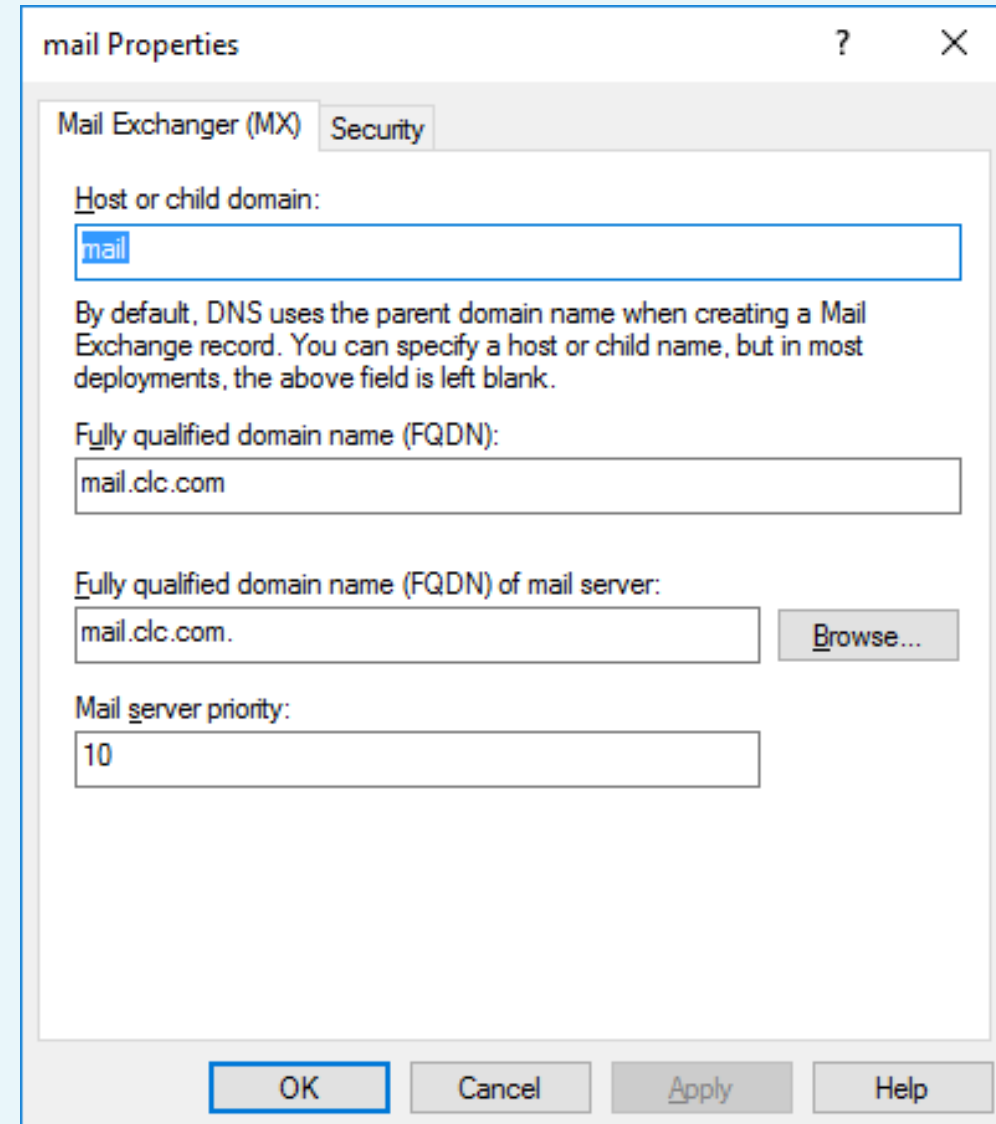
Fully qualified domain name (FQDN) for target host:
web1.contoso.local Browse...

☐ Allow any authenticated user to update all DNS records with the same name. This setting applies only to DNS records for a new name.

OK Cancel

Creating Records: Mail Exchange (MX) record

1. Open DNS Manager
2. Right-click on the name of domain listed under the **Forward Lookup Zones** folder, and then choose **New Mail Exchange (MX)**...
3. Enter Host or child domain and FQDN of mail server



The screenshot shows the 'mail Properties' dialog box with the 'Mail Exchanger (MX)' tab selected. The 'Host or child domain' field contains 'mail'. Below it, a text box explains: 'By default, DNS uses the parent domain name when creating a Mail Exchange record. You can specify a host or child name, but in most deployments, the above field is left blank.' The 'Fully qualified domain name (FQDN):' field contains 'mail.clc.com'. Below that, the 'Fully qualified domain name (FQDN) of mail server:' field also contains 'mail.clc.com', with a 'Browse...' button to its right. The 'Mail server priority:' field contains '10'. At the bottom are 'OK', 'Cancel', 'Apply', and 'Help' buttons.

mail Properties

Mail Exchanger (MX) Security

Host or child domain:
mail

By default, DNS uses the parent domain name when creating a Mail Exchange record. You can specify a host or child name, but in most deployments, the above field is left blank.

Fully qualified domain name (FQDN):
mail.clc.com

Fully qualified domain name (FQDN) of mail server:
mail.clc.com. Browse...

Mail server priority:
10

OK Cancel Apply Help



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DNS

Configuring clients

Internet Protocol Version 4 (TCP/IPv4) Properties

General

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

☐ Obtain an IP address automatically

☒ Use the following IP address:

IP address: 172 . 16 . 0 . 50

Subnet mask: 255 . 255 . 255 . 0

Default gateway: 172 . 16 . 0 . 1

☐ Obtain DNS server address automatically

☒ Use the following DNS server addresses:

Preferred DNS server: 172 . 16 . 0 . 10

Alternate DNS server: 172 . 16 . 0 . 21

☐ Validate settings upon exit

Advanced...

Advanced TCP/IP Settings

DNS

DNS server addresses, in order of use:

172.16.0.10
172.16.0.21

Add... **Edit...** **Remove**

The following three settings are applied to all connections with TCP/IP enabled. For resolution of unqualified names:

☒ Append primary and connection specific DNS suffixes

☒ Append parent suffixes of the primary DNS suffix

☐ Append these DNS suffixes (in order):

Add... **Edit...** **Remove**

DNS suffix for this connection:

☒ Register this connection's addresses in DNS

☐ Use this connection's DNS suffix in DNS registration

OK **Cancel**

Set-DnsClientServerAddress -InterfaceIndex 12 -ServerAddresses ("172.16.0.10","172.16.0.21")



■ To monitor and set logging options

WIN-61I53MQ8V4R Properties

Interfaces Forwarders Advanced Root Hints
Debug Logging Event Logging Monitoring Security

To assist with debugging, you can record the packets sent and received by the DNS server to a log file. Debug logging is disabled by default.

☒ Log packets for debugging

Packet direction: Transport protocol:

☒ Outgoing } select at least one ☒ UDP } select at least one
☒ Incoming } ☒ TCP }

Packet contents: Packet type:

☒ Queries/Transfers } select at least one ☒ Request } select at least one
☒ Updates } ☒ Response }

Other options:

☒ Log unmatched incoming response packets
☒ Details
☐ Filter packets by IP address Filter...

Log file

File path and name: c:\logfile\debug.txt

Maximum size (bytes): 500000000

OK Cancel Apply Help

WIN-61I53MQ8V4R Properties

Interfaces Forwarders Advanced Root Hints
Debug Logging Event Logging Monitoring Security

The DNS event log maintains a record of errors, warnings, and other events encountered by the DNS server. You can use this information to analyze server performance.

Log the following events:

☐ No events
☐ Errors only
☐ Errors and warnings
☒ All events

OK Cancel Apply Help

WIN-61I53MQ8V4R Properties

Interfaces Forwarders Advanced Root Hints
Debug Logging Event Logging Monitoring Security

To verify the configuration of the server, you can perform manual or automatic testing.

Select a test type:

☒ A simple query against this DNS server
☒ A recursive query to other DNS servers

To perform the test immediately, click Test Now. Test Now

☒ Perform automatic testing at the following interval:

Test interval: 10 minutes

Test results:

Date	Time	Simple Query	Recursive Q...
8/21/2020	1:18:36 AM	Pass	Fail
8/21/2020	12:27:31 AM	Pass	Fail
8/21/2020	12:17:18 AM	Pass	Fail
8/20/2020	11:26:14 PM	Pass	Fail

OK Cancel Apply Help



```
debug - Notepad
File Edit Format View Help
DNS Server log file creation at 8/20/2020 11:14:21 PM
Log file wrap at 8/20/2020 11:14:21 PM

Message logging key (for packets - other items use a subset of these fields):
Field # Information Values
-----
1 Date
2 Time
3 Thread ID
4 Context
5 Internal packet identifier
6 UDP/TCP indicator
7 Send/Receive indicator
8 Remote IP
9 Xid (hex)
10 Query/Response R = Response
blank = Query
11 Opcode Q = Standard Query
N = Notify
U = Update
? = Unknown
12 [ Flags (hex)
13 Flags (char codes) A = Authoritative Answer
T = Truncated Response
D = Recursion Desired
R = Recursion Available
14 ResponseCode ]
```



- To confirm that DNS server is resolving and replying to client DNS requests.
- When troubleshooting DNS problems, ask yourself the following basic questions:
 - What application is failing? What works? What doesn't work?
 - Is the problem basic IP connectivity, or is it name resolution?
 - Have the things that don't work ever worked on this computer or network? If so, what has changed since they last worked?



- Command-line tools to troubleshoot configuration issues:
 - Nslookup
 - DNSCmd
 - DNSlint
 - Ipconfig
- The troubleshooting process:
 - Identify client DNS server with nslookup or Resolve-DnsName
 - Communicate via ping
 - Use nslookup to verify records



- Used to perform DNS queries and to examine the contents of zone files on local and remote servers
- Offer the ability to perform query testing of DNS servers and to obtain detailed responses at the command prompt.
- Useful for:
 - diagnosing and solving name resolution Problems
 - verifying that resource records are added or updated correctly in a zone,
 - debugging other server-related problems



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DNS

Troubleshooting DNS: Nslookup

```
Command Prompt - nslookup

C:\Users\hc-kh>nslookup
Default Server:  cachingdns2.vnpt.vn
Address:  123.26.26.26

> server 172.18.27.2
Default Server:  [172.18.27.2]
Address:  172.18.27.2

> ctu.edu.vn.
Server:  [172.18.27.2]
Address:  172.18.27.2

Name:  ctu.edu.vn
Addresses:  172.18.27.2
            172.18.45.2
            10.18.36.54
            172.18.27.6
            172.18.45.6

>
```

Change the
DNS server

Look up a
name



Command Prompt - nslookup

```
> microsoft.com.  
Server: [172.18.27.2]  
Address: 172.18.27.2
```

```
Non-authoritative answer:  
Name: microsoft.com  
Addresses: 40.113.200.201  
13.77.161.179  
104.215.148.63  
40.76.4.15  
40.112.72.205
```

```
> microsoft.com.  
Server: [172.18.27.2]  
Address: 172.18.27.2
```

```
Non-authoritative answer:  
Name: microsoft.com  
Addresses: 13.77.161.179  
104.215.148.63  
40.76.4.15  
40.112.72.205  
40.113.200.201
```

Non-authoritative???

Round-robin



Command Prompt - nslookup

```
> set type=MX
> ctu.edu.vn.
Server: [172.18.27.2]
Address: 172.18.27.2

ctu.edu.vn      MX preference = 5, mail exchanger = alt2.aspmx.l.google.com
ctu.edu.vn      MX preference = 10, mail exchanger = alt3.aspmx.l.google.com
ctu.edu.vn      MX preference = 10, mail exchanger = alt4.aspmx.l.google.com
ctu.edu.vn      MX preference = 30, mail exchanger = aspmx4.googlemail.com
ctu.edu.vn      MX preference = 5, mail exchanger = alt1.aspmx.l.google.com
ctu.edu.vn      MX preference = 1, mail exchanger = aspmx.l.google.com
ctu.edu.vn      MX preference = 30, mail exchanger = aspmx5.googlemail.com
alt2.aspmx.l.google.com internet address = 74.125.127.26
alt2.aspmx.l.google.com AAAA IPv6 address = 2607:f8b0:4003:c11::1a
alt3.aspmx.l.google.com internet address = 209.85.234.26
alt3.aspmx.l.google.com AAAA IPv6 address = 2607:f8b0:4001:c17::1b
alt4.aspmx.l.google.com internet address = 173.194.209.26
alt4.aspmx.l.google.com AAAA IPv6 address = 2607:f8b0:4024:c02::1a
aspmx4.googlemail.com  internet address = 209.85.234.26
aspmx4.googlemail.com  AAAA IPv6 address = 2607:f8b0:4001:c17::1b
alt1.aspmx.l.google.com internet address = 74.125.28.26
alt1.aspmx.l.google.com AAAA IPv6 address = 2607:f8b0:400e:c04::1a
aspmx.l.google.com     internet address = 172.217.194.26
aspmx.l.google.com     AAAA IPv6 address = 2404:6800:4003:c03::1b
aspmx5.googlemail.com  internet address = 173.194.209.26
aspmx5.googlemail.com  AAAA IPv6 address = 2607:f8b0:4024:c02::1a
>
```

Lookup mail
servers for a
domain



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DNS

Troubleshooting DNS: Nslookup

Listing the
Contents of a
Domain



Command Prompt - nslookup

```
> set type=a
> ls -t ctu.edu.vn.
[[172.18.27.2]]
*** Can't list domain ctu.edu.vn.: Query refused
> _
```

- utility to help diagnose:
 - some common DNS name-resolution issues
 - potential problems of incorrect delegation

```
C:\> Command Prompt

C:\dnslint>dnslint /d ctu.edu.vn /v /s 172.18.27.2

DNSLint will attempt to verify the DNS entries for:

    ctu.edu.vn

This process may take several minutes to complete...

by-passing www.internic.net lookup...
using 172.18.27.2

Attempting to find host name for 172.18.27.2...name found

Verifying the DNS records for the specified
domain name on each name server...

Checking SOA record on:
ctuad2.ctu.edu.vn (172.18.27.2)...
Authoritative name server: ctuad2.ctu.edu.vn
```




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DNS

Troubleshooting DNS: DNSLint

DNSLint Report

System Date: Mon Aug 24 08:41:01 2020

Command run:

```
dnslint /d ctu.edu.vn /v /s 172.18.27.2
```

Domain name tested:

[ctu.edu.vn](#)

The following 4 DNS servers were identified as authoritative for the domain:

DNS server: ctuad2.ctu.edu.vn
IP Address: 172.18.27.2
UDP port 53 responding to queries: YES
TCP port 53 responding to queries: Not tested
Answering authoritatively for domain: YES

SOA record data from server:
Authoritative name server: ctuad2.ctu.edu.vn
Hostmaster: hostmaster.ctu.edu.vn
Zone serial number: 375045
Zone expires in: 0.13 day(s)
Refresh period: 900 seconds
Retry delay: 600 seconds
Default (minimum) TTL: 60 seconds

Additional authoritative (NS) records from server:
ctuad2.ctu.edu.vn 172.18.27.2
ctuad3.ctu.edu.vn 172.18.45.2
ctuad7.ctu.edu.vn 172.18.27.6
ctuad8.ctu.edu.vn 172.18.45.6

Host (A) records for domain from server:

172.18.27.2
172.18.45.2
10.18.36.54
172.18.27.6
172.18.45.6

Mail Exchange (MX) records from server (preference/name/IP address):

5 alt1.aspmx.l.google.com 74.125.28.27
1 aspmx.l.google.com 172.217.194.27
30 aspmx5.googlemail.com 173.194.209.27
5 alt2.aspmx.l.google.com 74.125.127.27
10 alt3.aspmx.l.google.com 209.85.234.27
10 alt4.aspmx.l.google.com 173.194.209.26
30 aspmx4.googlemail.com 209.85.234.26

DNS server: ctuad7.ctu.edu.vn

IP Address: 172.18.27.6
UDP port 53 responding to queries: YES
TCP port 53 responding to queries: Not tested
Answering authoritatively for domain: YES

SOA record data from server:

Authoritative name server: ctuad7.ctu.edu.vn
Hostmaster: hostmaster.ctu.edu.vn
Zone serial number: 375045
Zone expires in: 0.13 day(s)
Refresh period: 900 seconds
Retry delay: 600 seconds
Default (minimum) TTL: 60 seconds



- To view your DNS client settings
- To view and reset cached information used locally for resolving DNS name queries
- To register the resource records for a dynamic update client.

```
Command Prompt

C:\dns\nt>ipconfig /all

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : ctu.edu.vn
    Description . . . . . : Intel(R) Ethernet Connection (7) I219-LM
    Physical Address. . . . . : F4-39-09-2C-99-FB
    DHCP Enabled. . . . . : Yes
    Autoconfiguration Enabled . . . . : Yes
    Link-local IPv6 Address . . . . . : fe80::cce6:ed8b:4ae6:885a%2(Preferred)
    IPv4 Address. . . . . : 172.18.160.136(Preferred)
    Subnet Mask . . . . . : 255.255.255.0
    Lease Obtained. . . . . : Sunday, August 23, 2020 1:24:21 AM
    Lease Expires . . . . . : Tuesday, September 1, 2020 4:01:10 AM
    Default Gateway . . . . . : 172.18.160.1
    DHCP Server . . . . . : 172.18.45.6
    DHCPv6 IAID . . . . . : 351549705
    DHCPv6 Client DUID. . . . . : 00-01-00-01-24-0A-0C-9D-F4-39-09-2C-99-FB
    DNS Servers . . . . . : 172.18.45.6
                           172.18.27.6
                           172.18.27.2
                           172.18.45.2
    NetBIOS over Tcpip. . . . . : Enabled

    DNS Servers . . . . . : fec0:0:0:ffff::1%1
                           fec0:0:0:ffff::2%1
                           fec0:0:0:ffff::3%1
    NetBIOS over Tcpip. . . . . : Enabled
```

- After created, a new DNS record needs to replicate itself around to all of the other DCs in your network
- Once the new record exists on all of DC servers, your clients may still take a little bit of time to utilize the new record
- If you immediately test out a new DNS record just created and it's not working, try to run the command *ipconfig /flushdns* on your client computer



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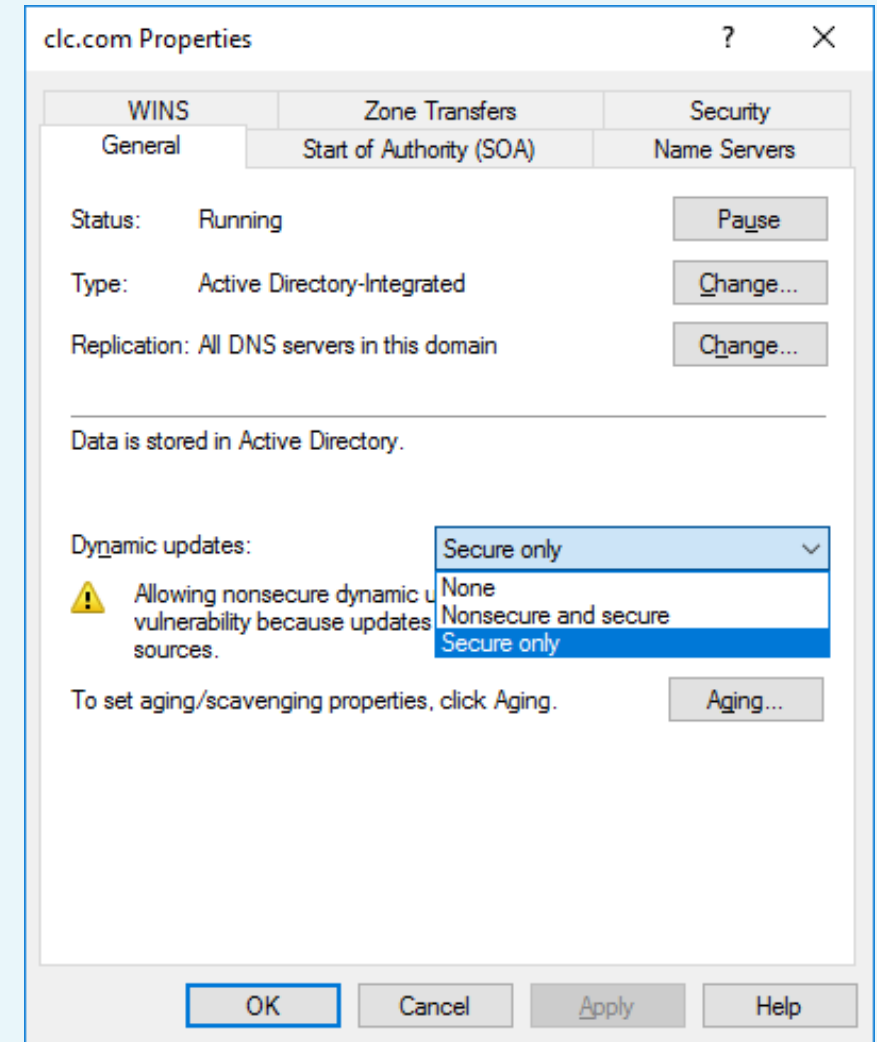
Integrating Dynamic DNS and IPv4 DHCP

Integrating Dynamic DNS and IPv4 DHCP

- Dynamic DNS server can be updated in two ways:
 - DHCP client to tell the DNS server its address.
 - DHCP server tells the DNS server when it registers a new client
- Configuring DNS server to use Dynamic DNS at two level:
 - The scope level, it will apply only to the scope.
 - The server level, it will apply to all scopes and superscopes served by the server.

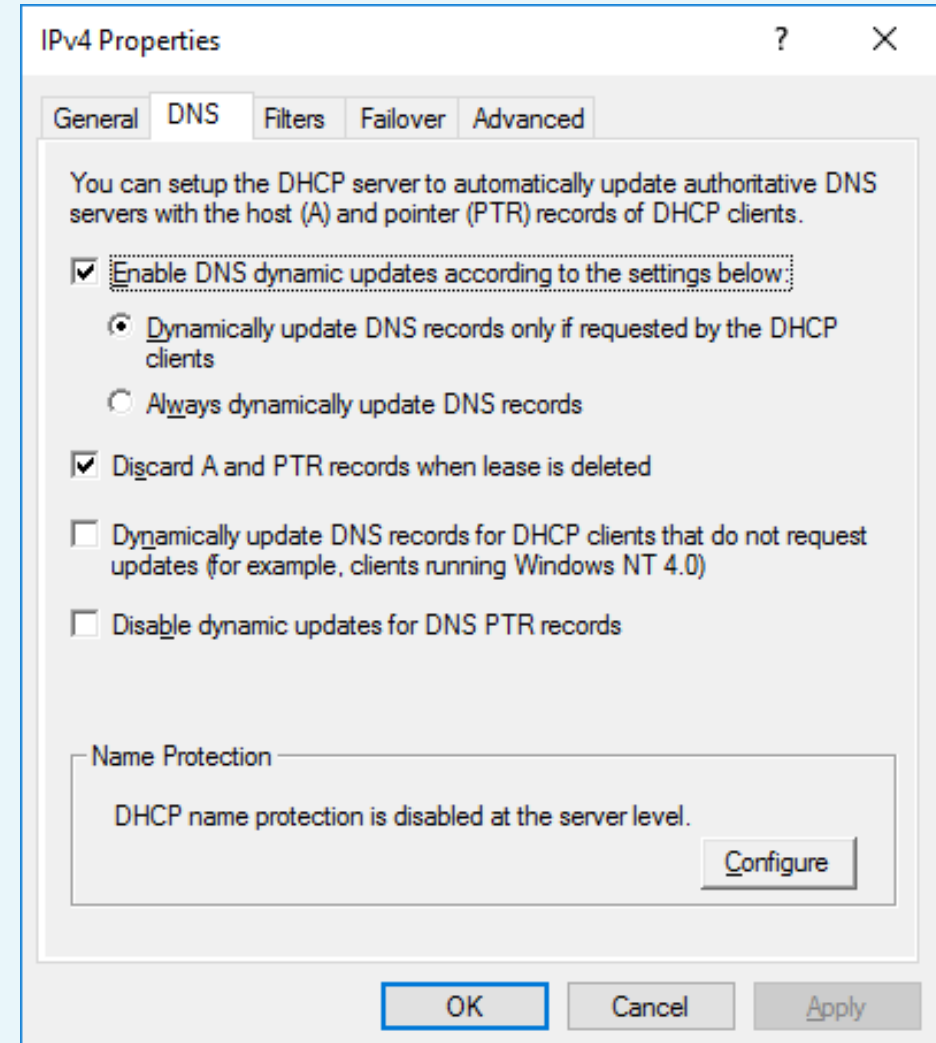
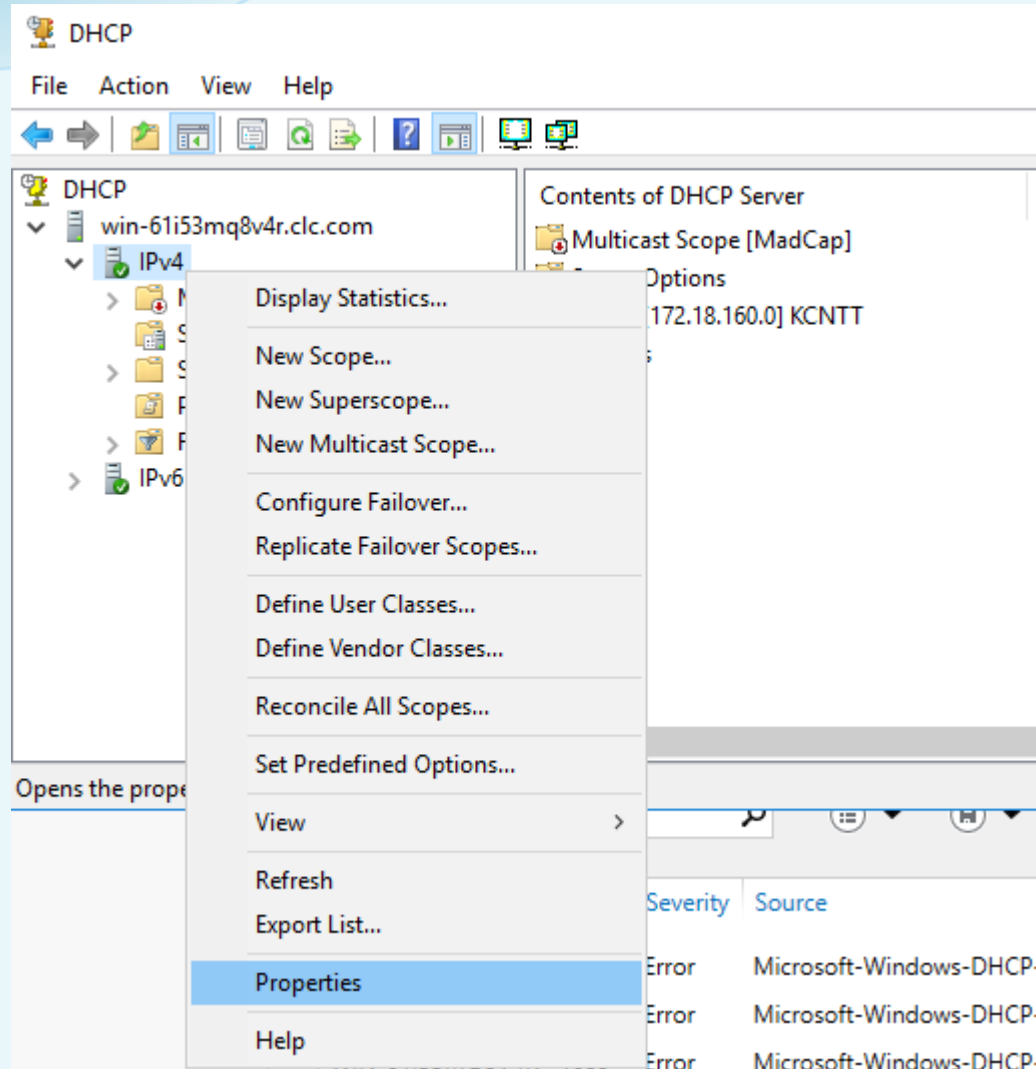
Integrating Dynamic DNS and IPv4 DHCP

- Allow DNS clients to update information in the DNS database files
- Used with Dynamic IP address
- Allow to access devices in your home even if IP address changes





Integrating Dynamic DNS and IPv4 DHCP





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DHCP

Dynamic Host Configuration Protocol



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DHCP

Static IP Address

- Manually assigned by administrator
- IP address not automatically change
- Must know the basic TCP/IP settings
 - Available IP address
 - Subnet mask
 - Default gateway
 - DNS servers
- Will not work if settings are invalid



- Appropriate for servers, but what about on the client and device side?
- Are you willing to do static addressing if the company has 1000 devices?
- What happens if the company changes to new IP address (sub)net



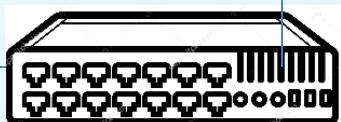


- Dynamic Host Configuration Protocol (DHCP)
- Solve static addressing problem by allowing DHCP server to automatically set IP configuration network for client computers
- Users uses DHCP every day without even realizing it
- DHCP can run on the router or on OS such as Windows.



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172.18.160.100



①

③

②

④



DHCP Server

172.18.160.5

Subnet: 172.18.160.x

DHCP

Overview

1. Address please!
2. Want 172.18.160.101
3. I'll take 172.18.160.101
4. Alright

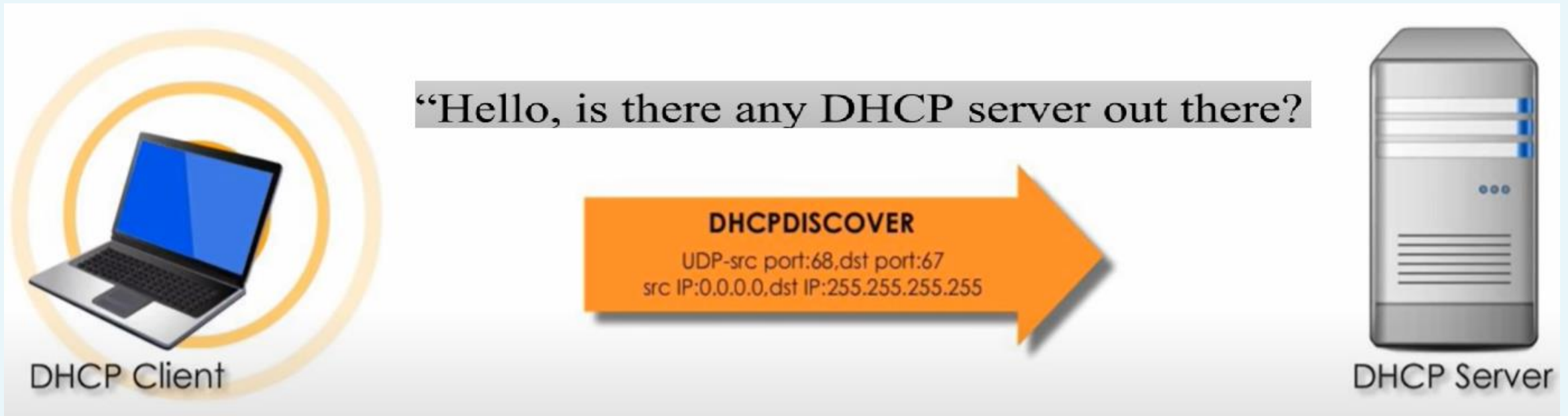


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DHCP

How DHCP works

Step 1: DHCP client searches for DHCP server





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DHCP

How DHCP works

Step 2: DHCP servers make an offer



Subnet mask, Default gateway, DNS servers and lease duration

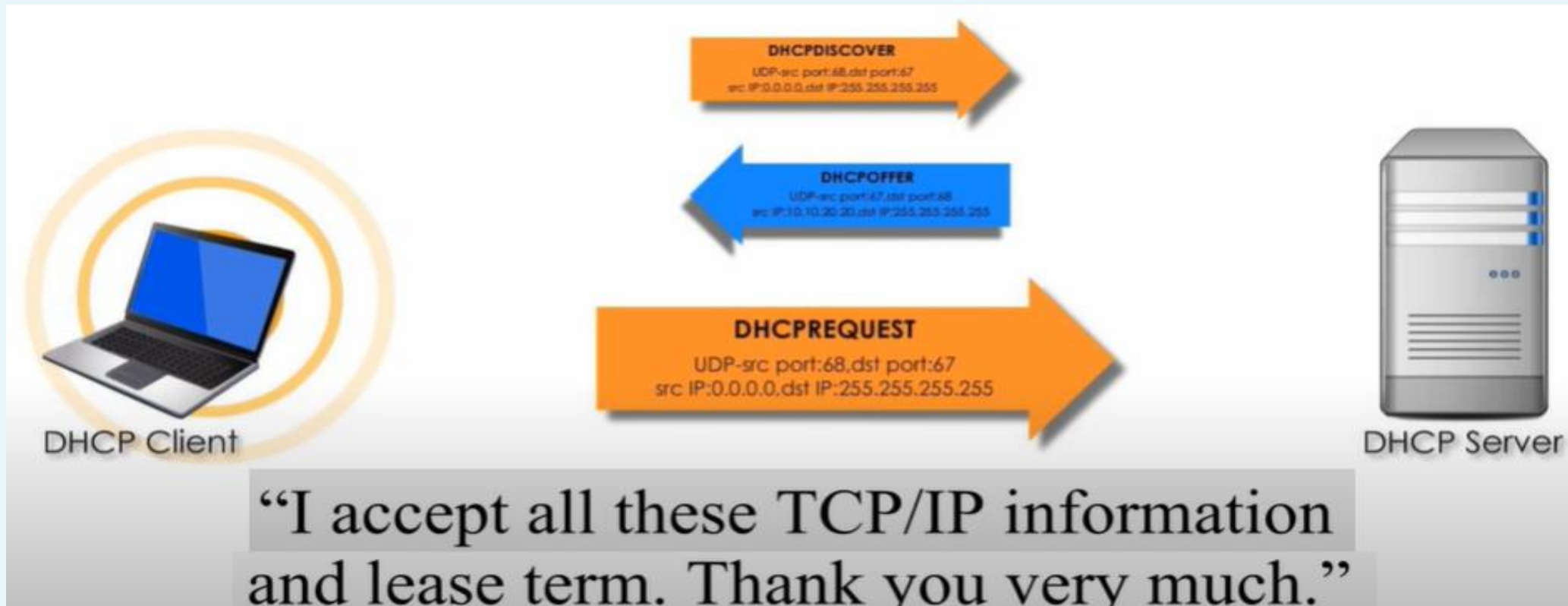


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DHCP

How DHCP works

Step 3: Host chooses offer and requests address





DHCP

How DHCP works

Step 4: DHCP server confirms the address



OK, Let's do these. You go ahead use the network, and I register your MAC address and other IP information in my DHCP database!



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DHCP

Benefits of using DHCP

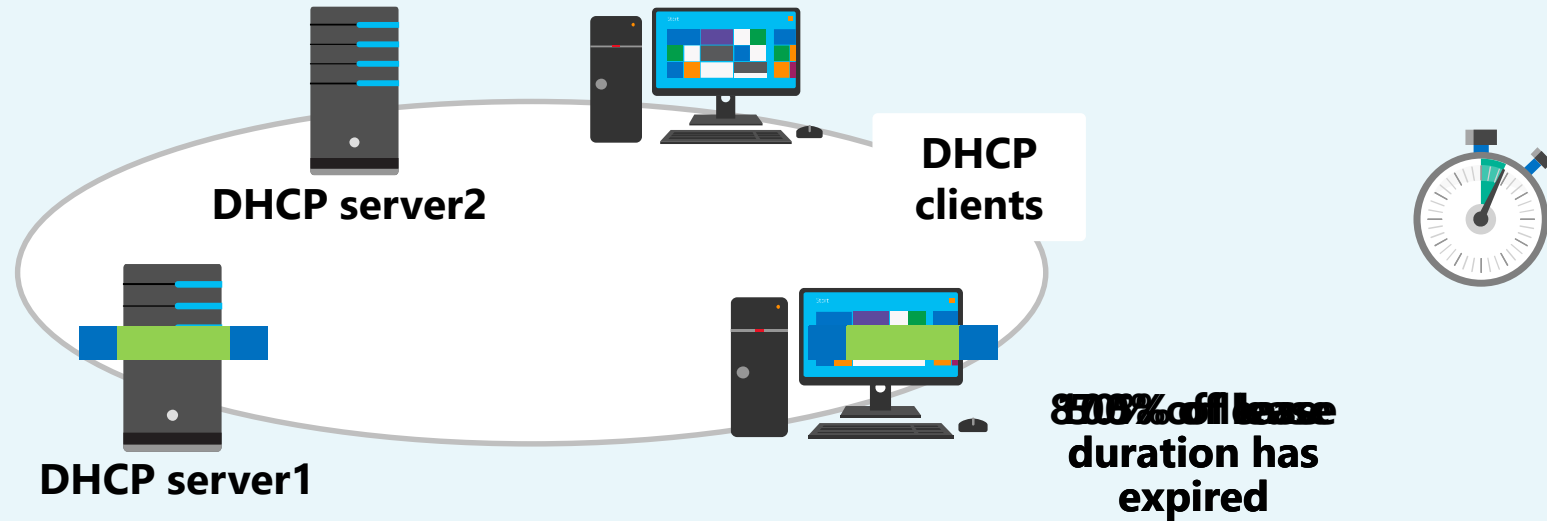
- DHCP reduces the complexity and amount of administrative work by using automatic IP configuration

Automatic IP configuration	Manual IP configuration
Supplies IP addresses automatically	Type IP addresses manually
Ensures correct configuration information	Typing incorrect IP address is a possibility
Updates client configuration automatically	Can result in possible communication and network issues
Eliminates a common source of network problems	Frequent computer moves increase administrative effort



DHCP

DHCP lease renewal



1. DHCP client sends a DHCPREQUEST packet
2. DHCP Server1 sends a DHCPACK packet
3. If the client fails to renew its lease after 50% of the lease duration has expired, the DHCP lease renewal process begins again after 87.5% of the lease duration has expired
4. If the client fails to renew its lease after 87.5% of the lease has expired, the DHCP lease generation process starts over again with a DHCP client broadcasting a DHCPDISCOVER



- DHCP uses scopes as the basis for managing and assigning IP addressing information.
- Contiguous range of addresses
- There's usually one scope per physical subnet
- Each scope has a set of parameters, scope options, that can be configured
- Scope options control what data is delivered to DHCP clients



- The range of IP addresses that the DHCP server can assign
- **For example:** let's say you set up a new DHCP scope covering the 192.168.1 subnet.
 - 255 IP addresses in the pool.
 - After adding an exclusion from 192.168.1.240 to 192.168.1.254
 - Having 241 (255 – 14) IP addresses left in the pool.
 - That means (in theory, at least) that you can service 241 unique clients at a time before you run out of IP addresses



- Enable the DHCP server to provide addresses from more than one scope to clients on the same physical subnet
- Helpful when clients within the same subnet have more than one IP network and thus need IPs from more than one address pool
- Must still configure other scope options individually for each child scope

- **Exclusions**

- IP addresses within the range that you never want automatically assigned
- Used to set aside addresses that you want to assign permanently to servers

- **Reservations**

- IP addresses within the range for which you want a permanent DHCP lease
- Essentially reserve a particular IP address for a particular device.
- The device still goes through the DHCP process but it always obtains the same addressing information from the DHCP server.

- Installation process installs just the service and its associated snap-in
- At that point, it's not delivering any DHCP service

Installing the DHCP Service

1. Choose Server Manager by clicking the Server Manager icon on the Taskbar.
2. Click **Add Roles And Features**.
3. Choose **role-based or feature-based installation** and click Next.
4. Choose your server and click Next.
5. Choose **DHCP Server**, then click **Add Features** and click Next.

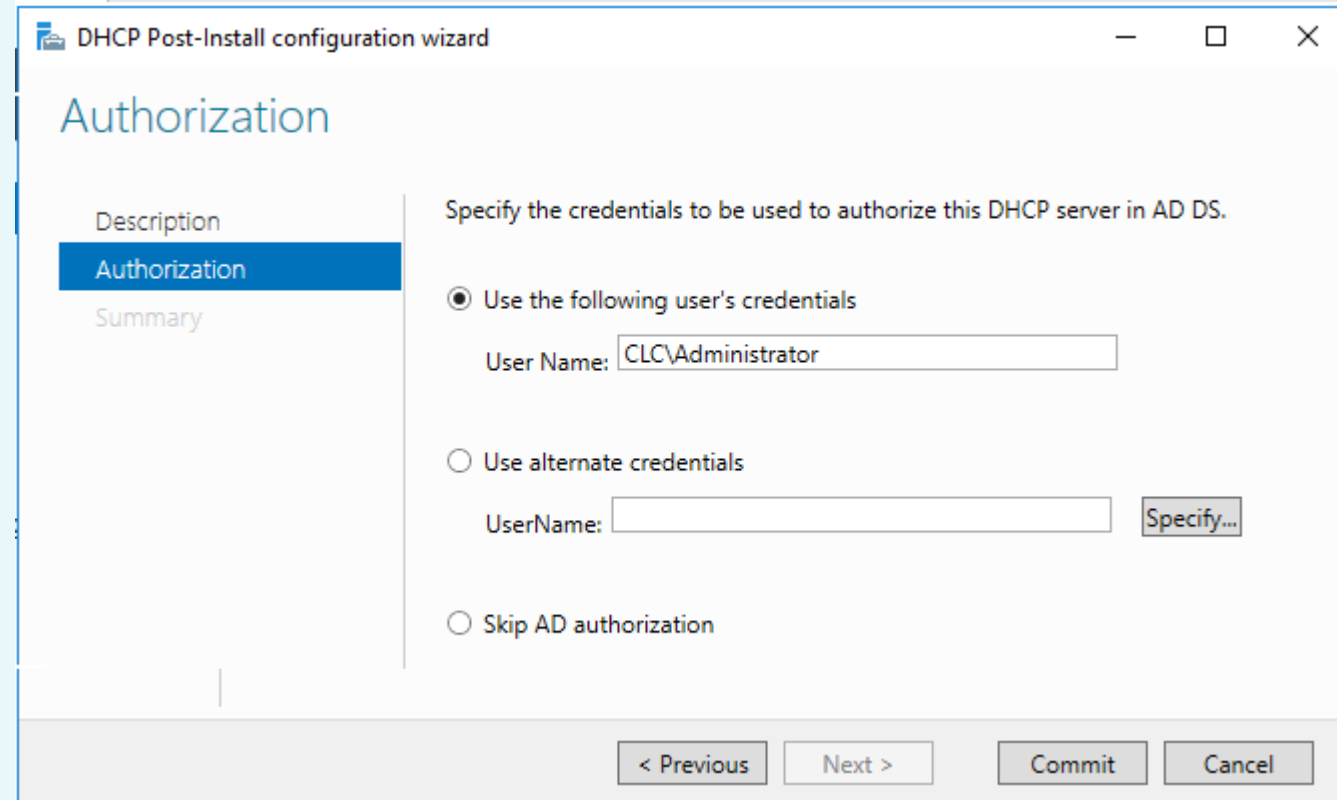
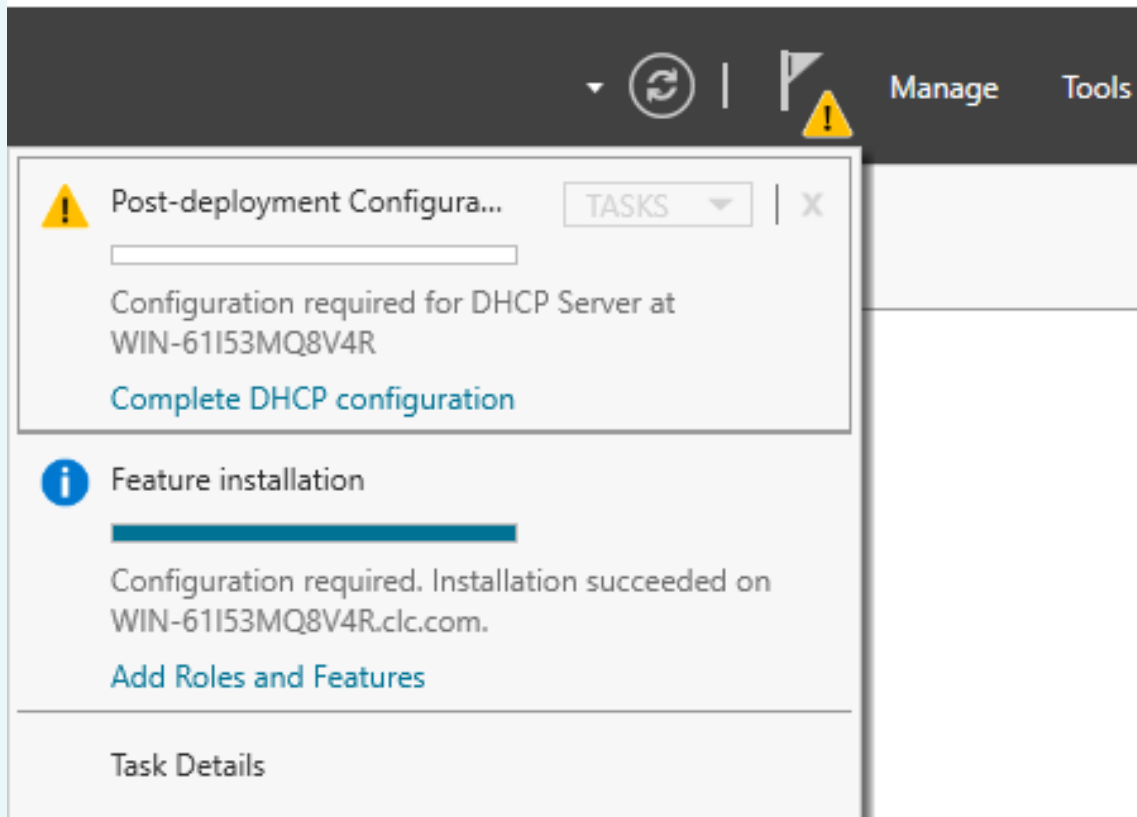


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DHCP

DHCP configuration

- After installing, we need to configure the DHCP server



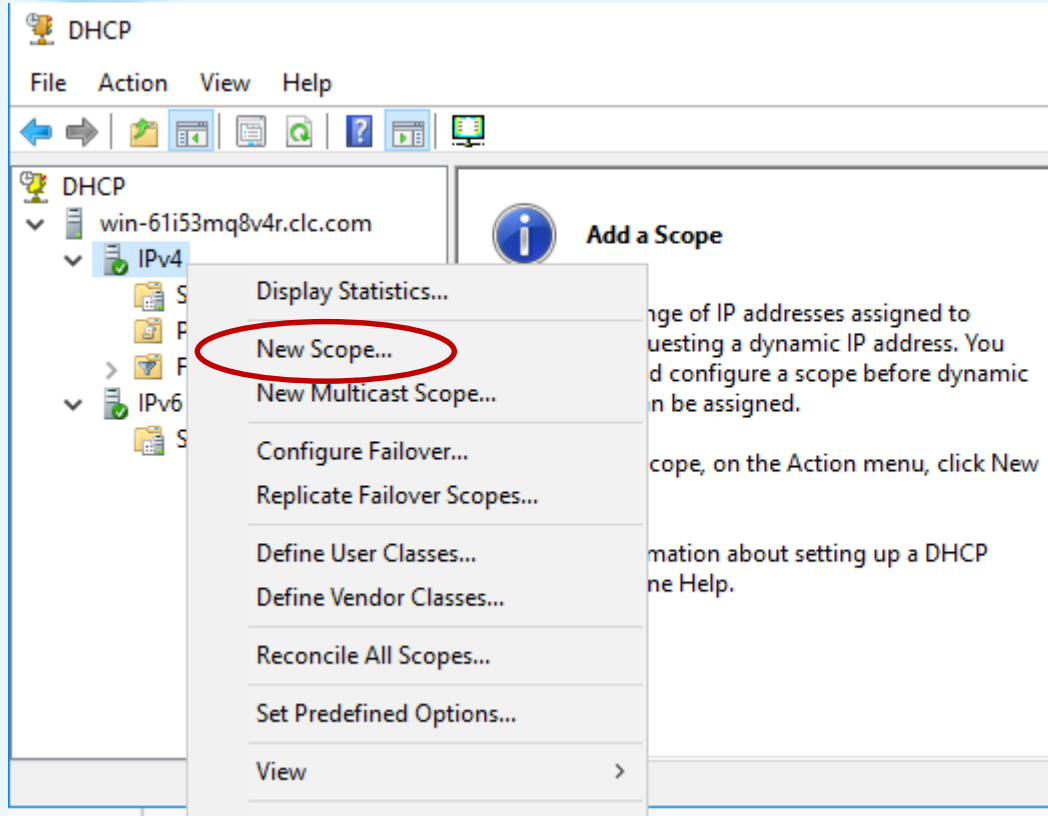
- Create scopes to define the network information distributed to clients
- Need the following information to define a scope:
 - A range of IP addresses and subnet mask;
 - A lease duration
 - IP addresses to exclude from the pool
 - IP Addresses to be reserved
- Values for DHCP options: Default gateway address; DNS server, suffix,...



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DHCP

Create a DHCP scope

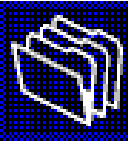


New Scope Wizard

Set the scope name

Scope Name

You have to provide an identifying scope name. You also have the option of providing a description.



Type a name and description for this scope. This information helps you quickly identify how the scope is to be used on your network.

Name:

Description:

< Back

Next >

Cancel



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DHCP

Create a DHCP scope

Defining IP Address Range

New Scope Wizard

IP Address Range

You define the scope address range by identifying a set of consecutive IP addresses.

Configuration settings for DHCP Server

Enter the range of addresses that the scope distributes.

Start IP address: 172 . 18 . 160 . 10

End IP address: 172 . 18 . 160 . 254

Configuration settings that propagate to DHCP Client

Length: 24

Subnet mask: 255 . 255 . 255 . 0

< Back Next > Cancel

Adding Exclusions and Delay

New Scope Wizard

Add Exclusions and Delay

Exclusions are addresses or a range of addresses that are not distributed by the server. A delay is the time duration by which the server will delay the transmission of a DHCP OFFER message.

Type the IP address range that you want to exclude. If you want to exclude a single address, type an address in Start IP address only.

Start IP address: . . . End IP address: . . . Add

Excluded address range:

172.18.160.100 to 172.18.160.105 Remove

Subnet delay in milli second:

0

< Back Next > Cancel



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DHCP

Create a DHCP scope

Setting a Lease Duration

New Scope Wizard

Lease Duration

The lease duration specifies how long a client can use an IP address from this scope.

Lease durations should typically be equal to the average time the computer is connected to the same physical network. For mobile networks that consist mainly of portable computers or dial-up clients, shorter lease durations can be useful. Likewise, for a stable network that consists mainly of desktop computers at fixed locations, longer lease durations are more appropriate.

Set the duration for scope leases when distributed by this server.

Limited to:

Days: Hours: Minutes:

< Back Next > Cancel

Configuring Basic DHCP Options

New Scope Wizard

Configure DHCP Options

You have to configure the most common DHCP options before clients can use the scope.

When clients obtain an address, they are given DHCP options such as the IP addresses of routers (default gateways), DNS servers, and WINS settings for that scope.

The settings you select here are for this scope and override settings configured in the Server Options folder for this server.

Do you want to configure the DHCP options for this scope now?

☒ Yes, I want to configure these options now

☐ No, I will configure these options later

< Back Next > Cancel



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DHCP

Create a DHCP scope

Configuring Default Gateway

New Scope Wizard

Router (Default Gateway)
You can specify the routers, or default gateways, to be distributed by this scope.

To add an IP address for a router used by clients, enter the address below.

IP address:

.	.	.
172.18.160.1		

Add
Remove
Up
Down

< Back Next > Cancel

Providing DNS Settings

New Scope Wizard

Domain Name and DNS Servers
The Domain Name System (DNS) maps and translates domain names used by clients on your network.

You can specify the parent domain you want the client computers on your network to use for DNS name resolution.

Parent domain: clc.com

To configure scope clients to use DNS servers on your network, enter the IP addresses for those servers.

Server name:	IP address:
dns.clc.com	.
	100.100.100.100

Resolve Add
Remove
Up
Down

< Back Next > Cancel

Activating the Scope

- After finishing creating the scope, it is immediately active and any computer can obtain address from a DHCP server

New Scope Wizard

Activate Scope
Clients can obtain address leases only if a scope is activated.

Do you want to activate this scope now?

☒ Yes, I want to activate this scope now

☐ No, I will activate this scope later

< Back Next > Cancel

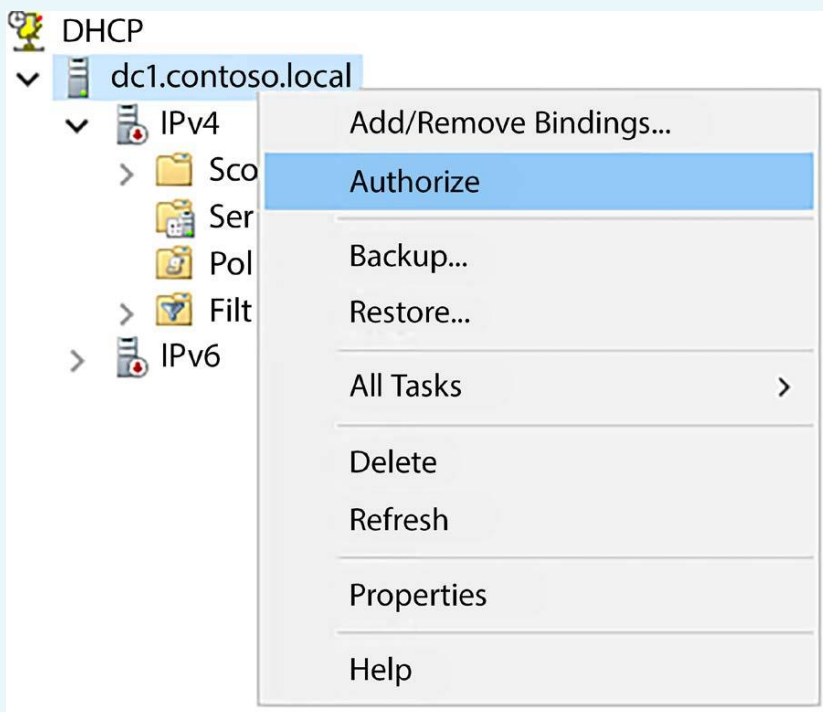


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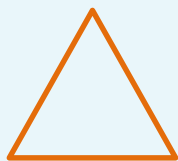
DHCP

Authorize the DHCP server

- Register the DHCP Server in the AD to support DHCP clients



Domain
controller



AD DS

DHCP client



DHCP server1



Authorized



Serves DHCP
requests

DHCP server2



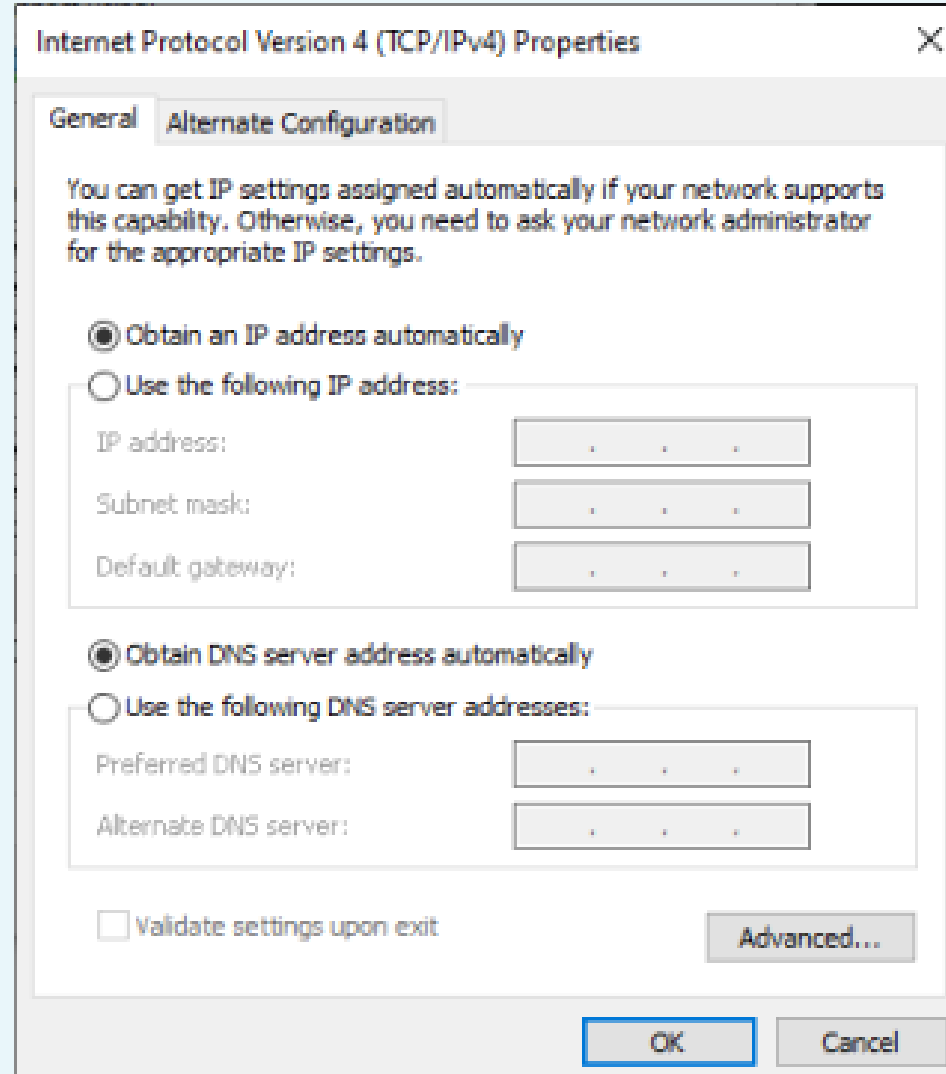
Unauthorized



Does not service
DHCP requests

- If DHCP Server1 finds its IP address on the list, the service starts and supports DHCP clients

- To test the operation of DHCP server, start a windows 10 client and configuring it to obtain IP from DHCP



Internet Protocol Version 4 (TCP/IPv4) Properties

General Alternate Configuration

You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

☒ Obtain an IP address automatically

☐ Use the following IP address:

IP address:

Subnet mask:

Default gateway:

☒ Obtain DNS server address automatically

☐ Use the following DNS server addresses:

Preferred DNS server:

Alternate DNS server:

☐ Validate settings upon exit

Advanced...

OK Cancel



Network Connection Details

Network Connection Details:

Property	Value
Connection-specific DN...	clc.com
Description	Intel(R) 82574L Gigabit Network Connect
Physical Address	00-0C-29-AA-41-CA
DHCP Enabled	Yes
IPv4 Address	172.18.160.10
IPv4 Subnet Mask	255.255.255.0
Lease Obtained	Tuesday, August 18, 2020 1:39:22 AM
Lease Expires	Wednesday, August 26, 2020 1:39:22 AM
IPv4 Default Gateway	172.18.160.1
IPv4 DHCP Server	172.18.160.100
IPv4 DNS Server	100.100.100.100
IPv4 WINS Server	
NetBIOS over Tcpip En...	Yes
Link-local IPv6 Address	fe80::c575:9233:5309:b842%8
IPv6 Default Gateway	
IPv6 DNS Server	

Close

Command Prompt

Ethernet adapter Ethernet0:

```
Connection-specific DNS Suffix . : clc.com
Description . . . . . : Intel(R) 82574L Gigabit Network Connection
Physical Address. . . . . : 00-0C-29-AA-41-CA
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
Link-local IPv6 Address . . . . . : fe80::c575:9233:5309:b842%8(Preferred)
IPv4 Address. . . . . : 172.18.160.10(Preferred)
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained. . . . . : Tuesday, August 18, 2020 1:39:22 AM
Lease Expires . . . . . : Wednesday, August 26, 2020 1:39:22 AM
Default Gateway . . . . . : 172.18.160.1
DHCP Server . . . . . : 172.18.160.100
DHCPv6 IAID . . . . . : 100666409
DHCPv6 Client DUID. . . . . : 00-01-00-01-26-91-75-E4-00-0C-29-AA-41-CA
DNS Servers . . . . . : 100.100.100.100
NetBIOS over Tcpip . . . . . : Enabled
```



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DHCP

Managing DHCP scope

- From **Server Manager**, click on **Tools** menu and then choose **DHCP**

The screenshot shows the DHCP console window. The left pane displays a tree view with the following structure:

- DHCP
 - win-61i53mq8v4r.clc.com
 - IPv4
 - Server Options
 - Scope [172.18.160.0] KCNTT
 - Address Pool (selected)
 - Address Leases
 - Reservations
 - Scope Options
 - Policies
 - Policies
 - Filters
 - IPv6

The right pane displays a table with the following data:

Start IP Address	End IP Address	Description
172.18.160.10	172.18.160.254	Address range for distribution
172.18.160.100	172.18.160.105	IP Addresses excluded from distribution

The 'Actions' pane on the far right shows 'Address Pool' and 'More Actions'.

View the IP address range and exclusion



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DHCP

Managing DHCP scope

IP addresses assigned to clients

The screenshot shows the DHCP console window. The left pane displays the hierarchy: DHCP > win-61i53mq8v4r.clc.com > IPv4 > Scope [172.18.160.0] KCNTT > Address Leases. The main pane shows a table of assigned IP addresses.

Client IP Address	Name	Lease Expiration	Type
172.18.160.10	DESKTOP-JV0G7S3....	8/26/2020 1:39:22 AM	DHCP

The right pane shows the 'Actions' menu with 'Address Leases' and 'More Actions' options.

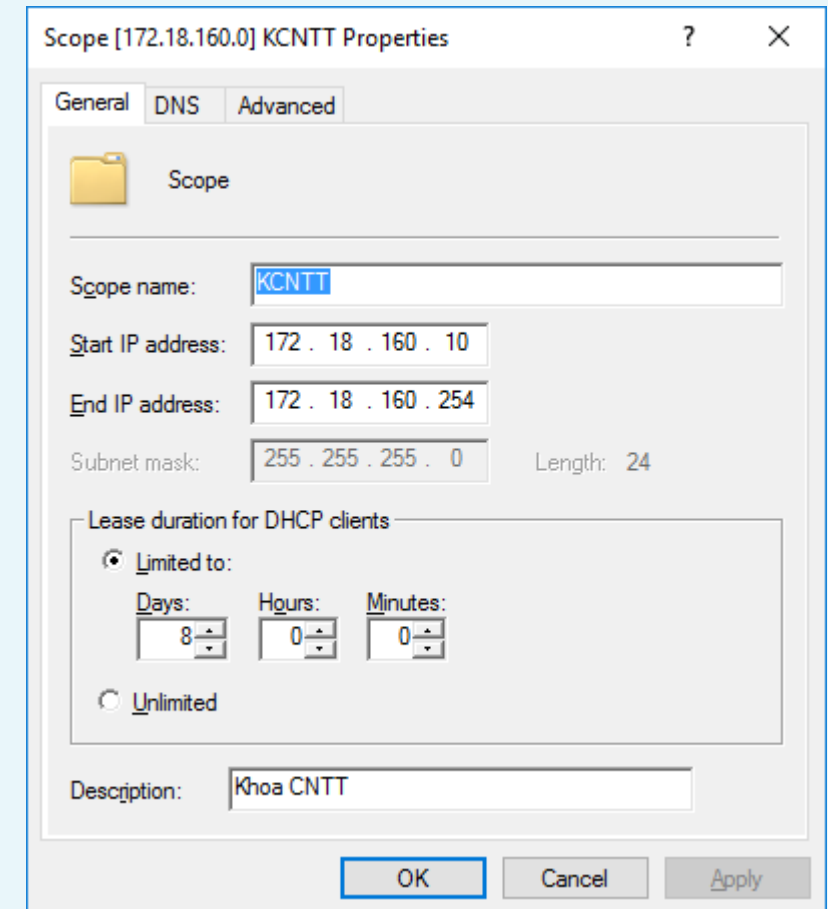
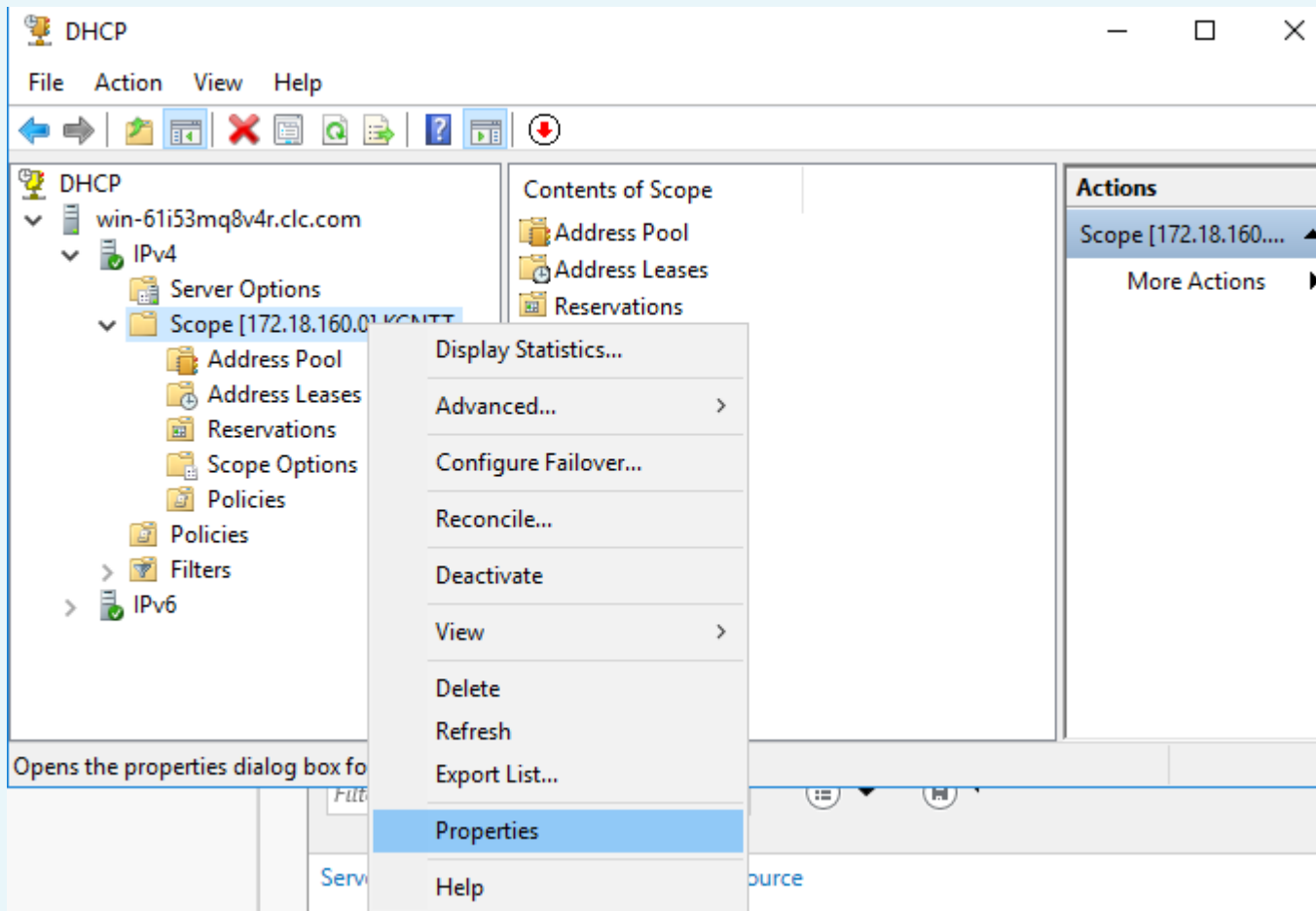


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DHCP

Managing DHCP scope

Changing the IP address range





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DHCP

Managing DHCP scope

Adding exclusion address range

The screenshot shows the DHCP console window with the following structure:

- Tree view:
 - win-61i53mq8v4r.clc.com
 - IPv4
 - Server Options
 - Scope [172.18.160.0] KCNTT
 - Address Pool (selected)

The 'Address Pool' context menu is open, showing the following options:

- New Exclusion Range... (highlighted)
- View >
- Refresh
- Export List...
- Help

The main pane displays a table of IP addresses:

Start IP Address	End IP Address	Description
172.18.160.10	172.18.160.254	Address range for distribution
172.18.160.100	172.18.160.105	IP Addresses excluded from distribution

The 'Add Exclusion' dialog box is open, prompting the user to enter an IP address range to exclude. It includes the following text and fields:

Type the IP address range that you want to exclude. If you want to exclude a single address, type an address in Start IP address only.

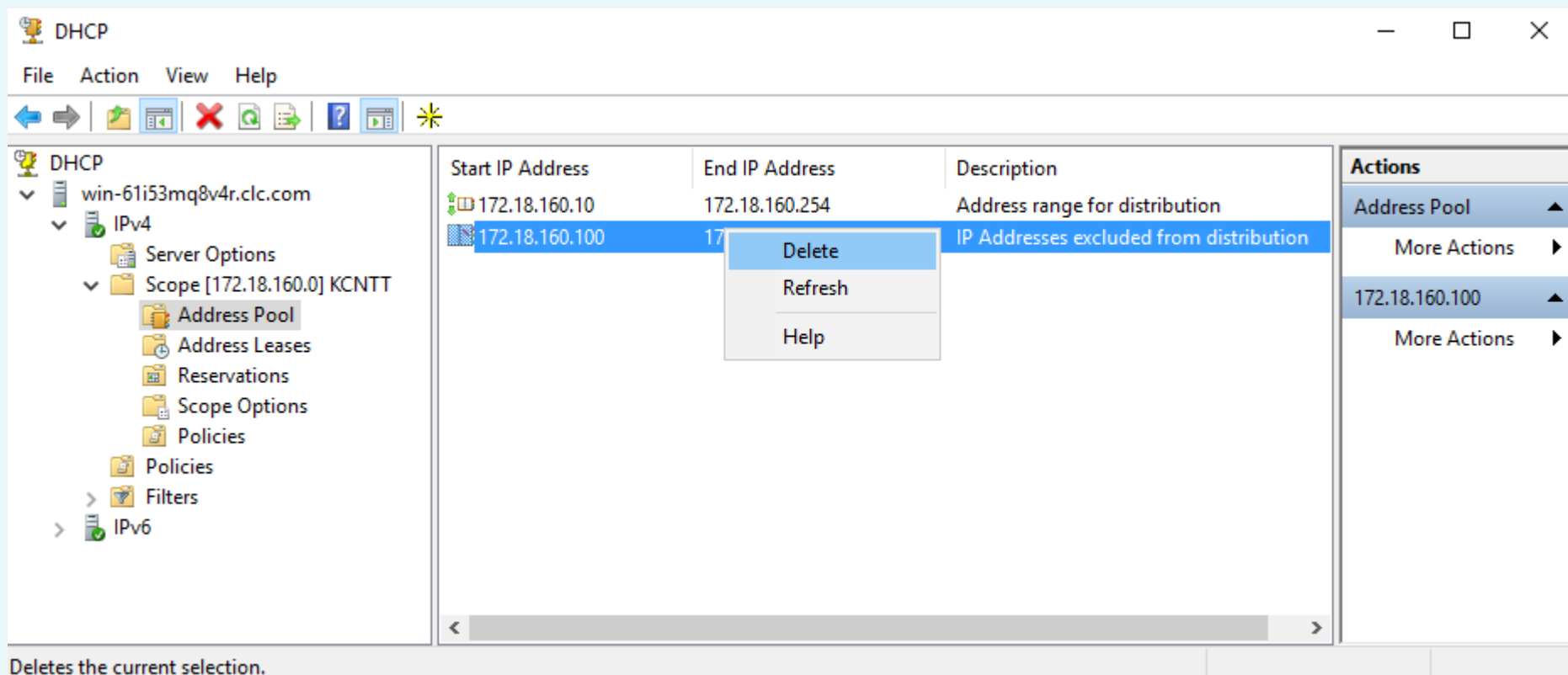
Start IP address:

End IP address:

Buttons: Add, Close

Footer text: Create a new exclusion range

Remove exclusion address range



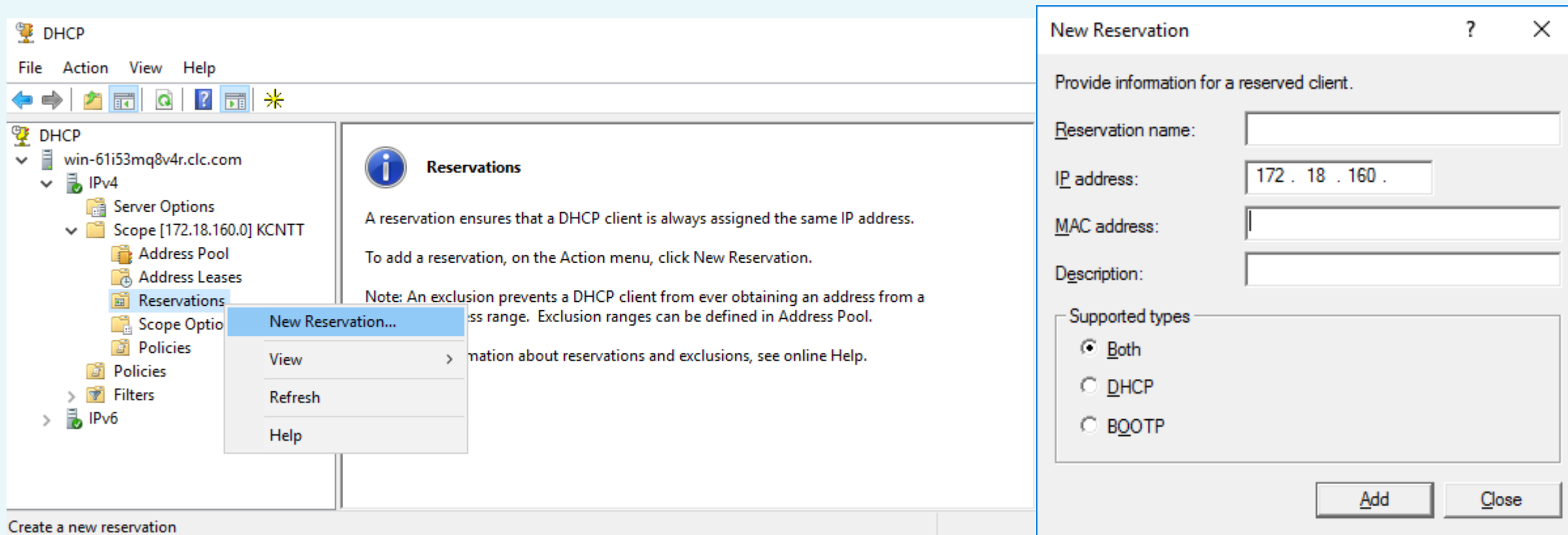
The screenshot shows the DHCP console window with the following structure:

- Left Pane:** A tree view showing the hierarchy: DHCP > win-61i53mq8v4r.clc.com > IPv4 > Scope [172.18.160.0] KCNTT > Address Pool.
- Center Pane:** A table with three columns: Start IP Address, End IP Address, and Description. It lists two entries:

Start IP Address	End IP Address	Description
172.18.160.10	172.18.160.254	Address range for distribution
172.18.160.100	172.18.160.100	IP Addresses excluded from distribution

The second row is selected, and a context menu is open with options: Delete, Refresh, and Help.
- Right Pane:** An 'Actions' pane showing a tree view: Address Pool > More Actions > 172.18.160.100 > More Actions.
- Status Bar:** A message at the bottom left states: "Deletes the current selection."

Add a reservation



The screenshot shows the DHCP console on the left and the 'New Reservation' dialog box on the right.

DHCP Console:

- Tree view: DHCP > win-61i53mq8v4r.clc.com > IPv4 > Scope [172.18.160.0] KCNTT > Reservations.
- Right pane: 'Reservations' tab with an information icon. Text: 'A reservation ensures that a DHCP client is always assigned the same IP address. To add a reservation, on the Action menu, click New Reservation. Note: An exclusion prevents a DHCP client from ever obtaining an address from a specific IP address range. Exclusion ranges can be defined in Address Pool. For more information about reservations and exclusions, see online Help.'
- Context menu: Right-clicked on 'Reservations', showing options: 'New Reservation...', 'View', 'Refresh', and 'Help'.

New Reservation Dialog:

- Title: 'New Reservation'.
- Instruction: 'Provide information for a reserved client.'
- Fields:
 - Reservation name: (empty text box)
 - IP address: 172 . 18 . 160 . (text box with dots)
 - MAC address: (empty text box)
 - Description: (empty text box)
- Supported types section:
 - ☒ Both
 - ☐ DHCP
 - ☐ BOOTP
- Buttons: 'Add' and 'Close'.

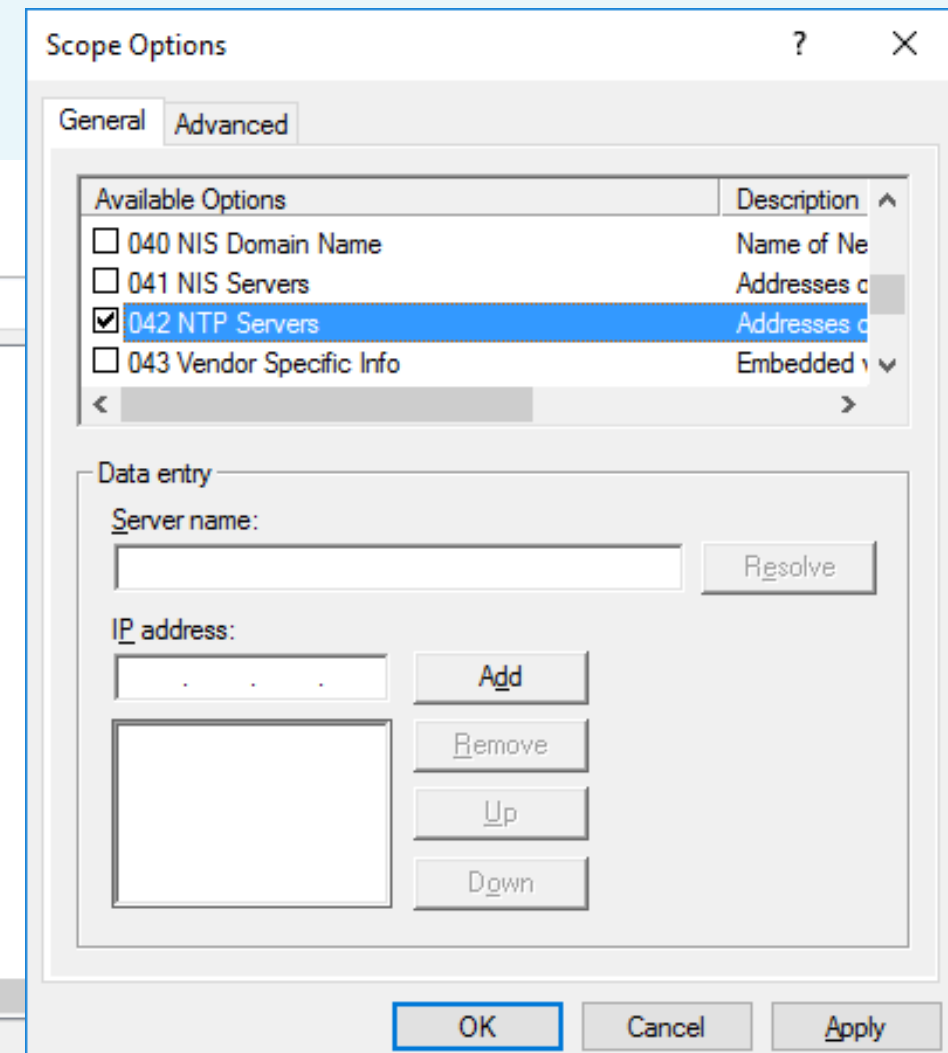
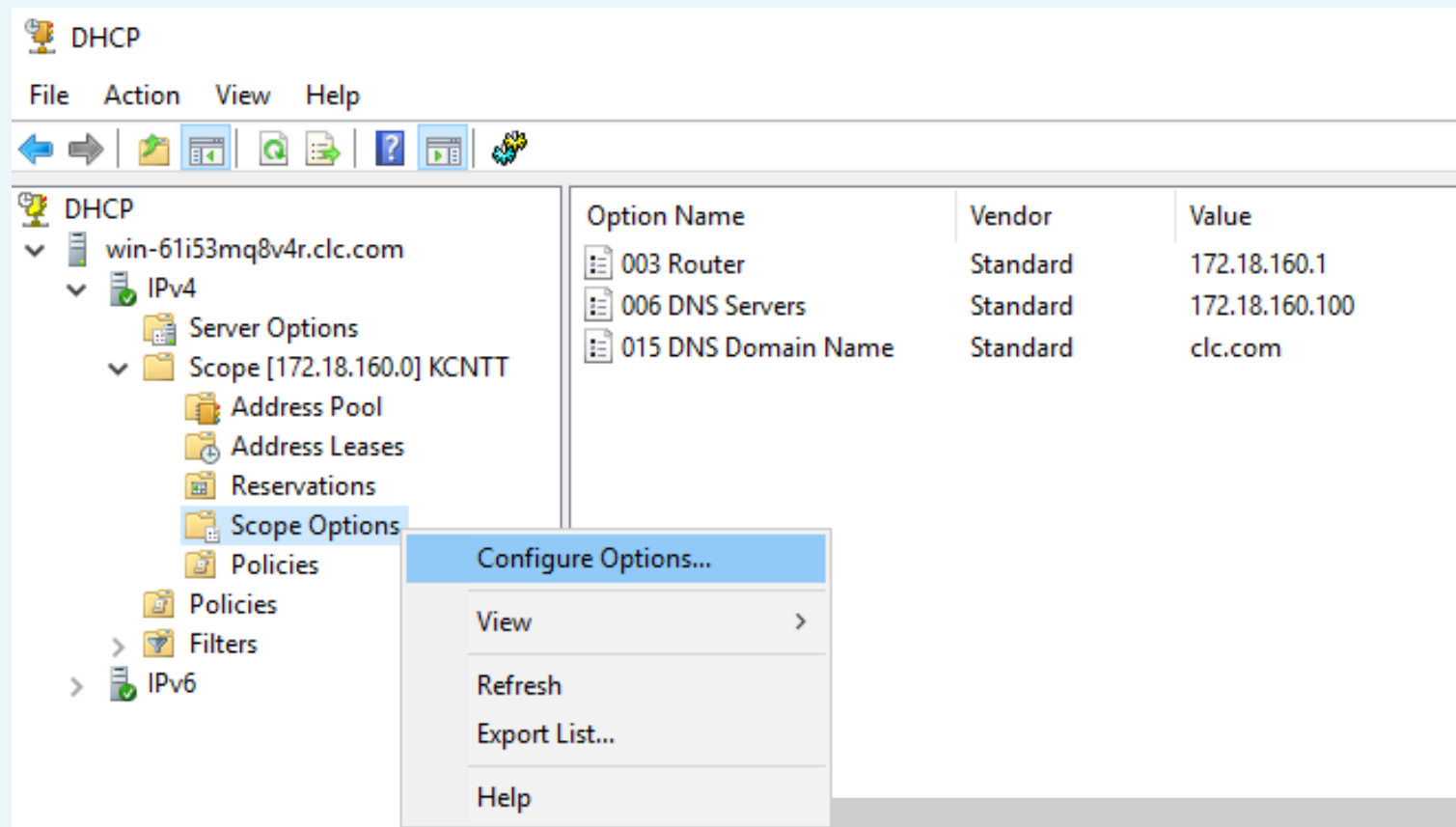


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DHCP

Managing DHCP scope

Setting Scope options





- By design, DHCP is intended to work with clients and servers on a single IP network
- When the client and server are on different IP networks:
 - If no DHCP server is available on the client's network: use a DHCP relay agent to forward DHCP broadcasts from the client's network to the DHCP server.
 - The relay agent acts like a repeater: listening for DHCP client requests and retransmitting them through the router to the server.

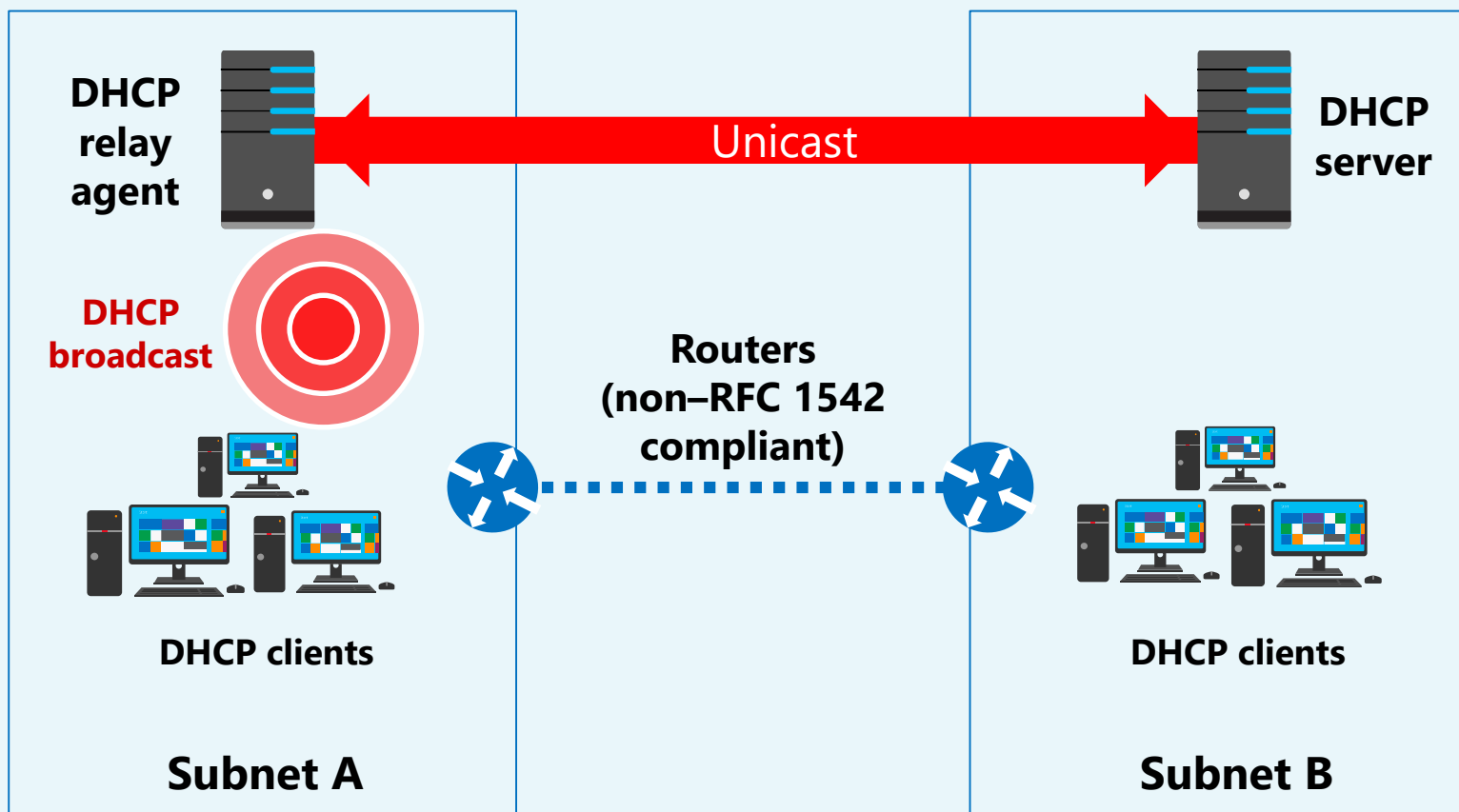


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DHCP

DHCP relay agent

DHCP relay agent listens for DHCP broadcasts from DHCP clients, and then relays them to DHCP servers in different subnets





Summary

- DNS, and DHCP are the core services that underlie and support your entire infrastructure
- DHCP can help your company by issuing all of the TCP/IP settings to your corporate clients
- DNS was designed to be a robust, scalable, and high-performance system for resolving friendly names to TCP/IP host addresses.
- Learned how to install, configure, and manage these necessary services