

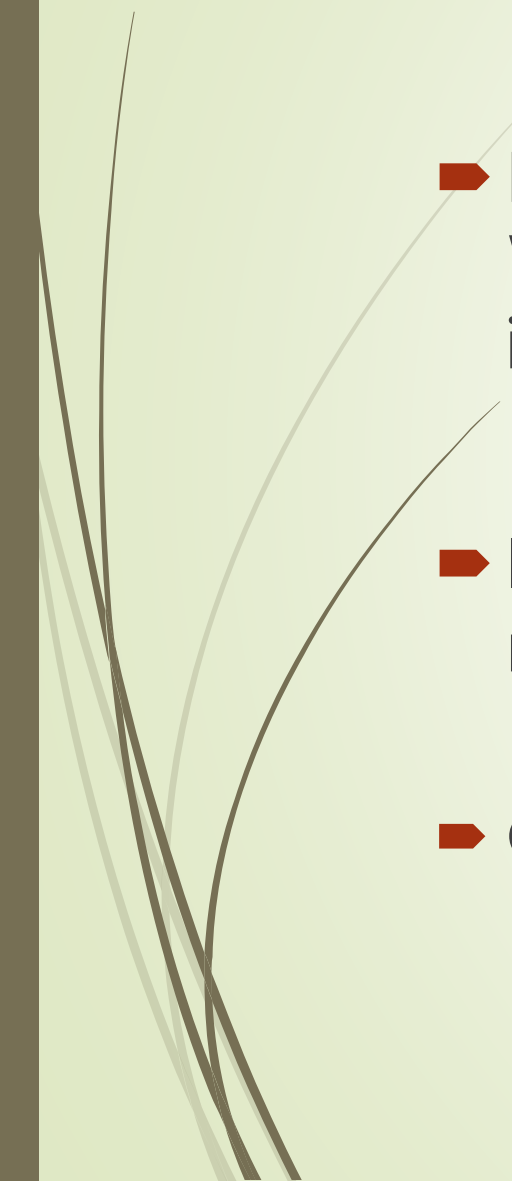


Dynamic Host Configuration Protocol (DHCP)

Lecture



When and Who

- DHCP was created by the Dynamic Host Configuration Working Group of the **IETF** (Internet Engineering Task Force) in the year **1987**.
 - It's definition was recorded in the **RFC 1531** initially and was made obsolete by **RFC's 1541** and **2131** subsequently.
 - Carried by UDP, **Client UDP Port 68, Server UDP Port 67**
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Overview

- DHCP is an **application-layer** protocol in the TCP/IP model. whereby a **DHCP server dynamically assigns** an IP address (& other network configuration parameters) to client devices on a network so they can communicate with other IP networks.

Internet protocol suite

Application layer

BGP • DHCP • DNS • FTP • HTTP • IMAP •
LDAP • MGCP • MQTT • NNTP • NTP • POP •
ONC/RPC • RTP • RTSP • RIP • SIP • SMTP •
SNMP • SSH • Telnet • TLS/SSL • XMPP •
more...

Transport layer

TCP • UDP • DCCP • SCTP • RSVP • *more...*

Internet layer

IP (IPv4 • IPv6) • ICMP • ICMPv6 • ECN • IGMP •
IPsec • *more...*

Link layer

ARP • NDP • OSPF • Tunnels (L2TP) • PPP •
MAC (Ethernet • DSL • ISDN • FDDI) • *more...*



Why is DHCP Important?

- Important when it comes to adding a machine to a network
- When computer requests an address, the administrator would have to manually configure the machine
 - ✓ Mistakes are easily made
 - ✓ Causes difficulty for both administrator as well as neighbors on the network
- DHCP solves all the hassle of manually adding a machine to a network



DHCP must

- Guarantee **unique** network address.
- **Retain** DHCP client **configuration** across a client reboot.
- Allow **automated assignment** of configuration parameters to new clients.
- Support **fixed allocation** of configuration parameters to specific clients.

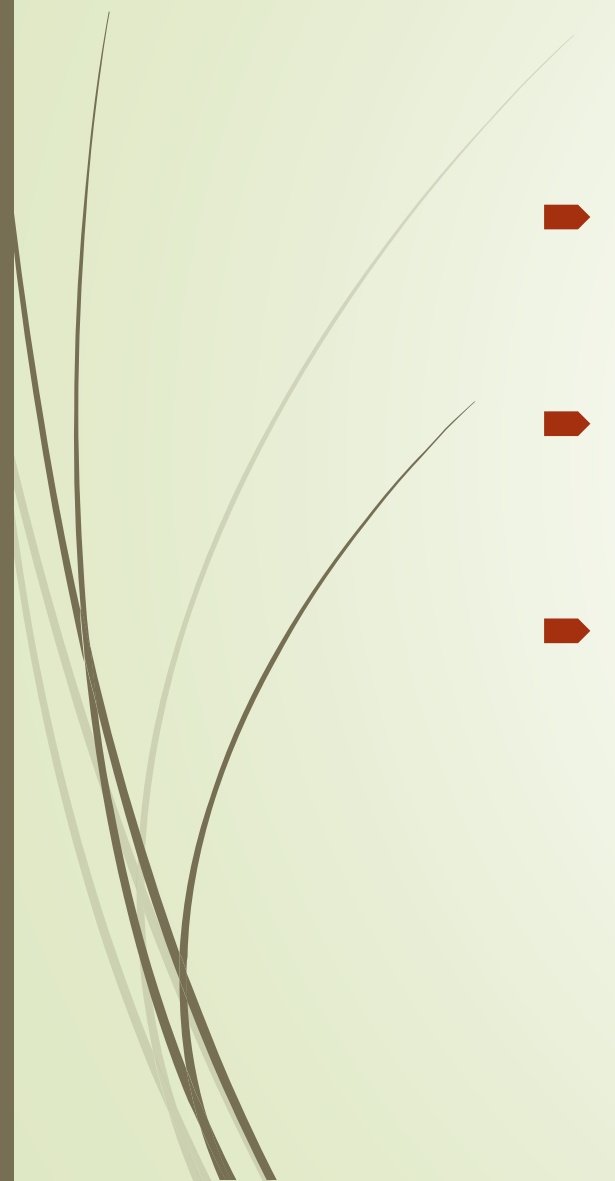


Advantages of DHCP

- DHCP minimizes the **administrative** burden, providing **centralized administration** of IP configuration.
- **Seamless IP** host **configuration**
- By using DHCP there is **no** chance to **conflict IP address**
- By using **DHCP relay agent** you provide IP address to **another network**
- Flexibility
- Scalability



Components of DHCP

- DHCP Server
 - DHCP Client
 - DHCP/BOOTP relay agent
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How does DHCP work?

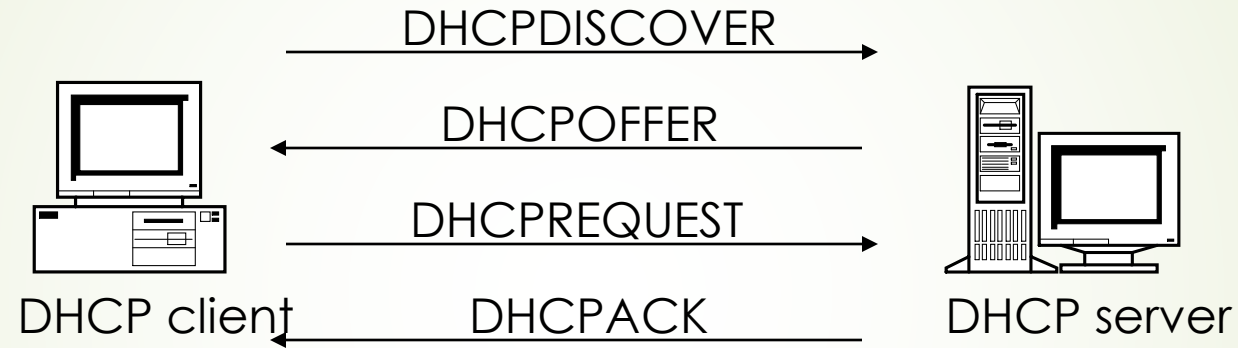
- When a client needs to start up TCP/IP operations, it **broadcasts a request** for address information
- The DHCP server **will not reallocate the address** during the lease period and **will attempt to return the same address** every time the client requests an address
- The client can **extend its lease** or send a message to the server before the lease expires that it no longer needs the address so it can be released and assigned to another client on the network.

Methods of allocating IP addresses

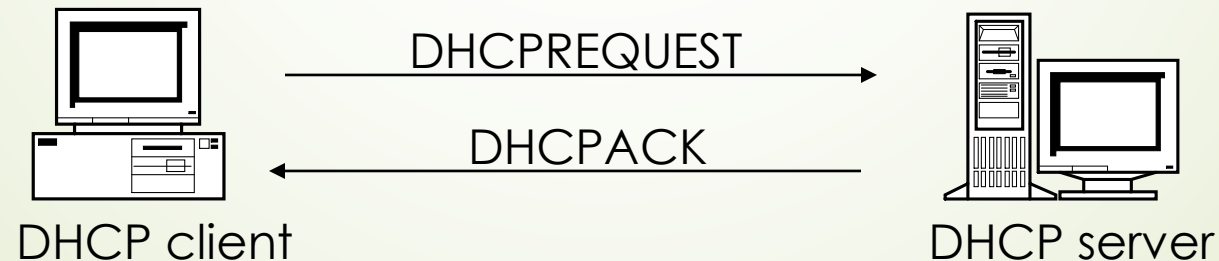
- **Dynamic** allocation: A network administrator reserves a range of IP addresses for DHCP, and each DHCP client on the LAN is configured to request an IP address from the DHCP server during network initialization
- **Automatic** allocation: this is like dynamic allocation, but the DHCP server keeps a table of past IP address assignments, so that it can preferentially assign to a client the same IP address that the client previously had.
- **Manual** allocation: The DHCP server issues a private IP address dependent upon each client's MAC address, based on a predefined mapping by the administrator. (**DHCP Reservations**)

How DHCP Works

➤ Obtaining an initial lease



➤ Renewing a lease





DHCP Messages

- **DHCPDISCOVER** - Client broadcast to locate available servers.
- **DHCPOFFER** - Server to client in response to DHCPDISCOVER with offer of configuration parameters.
- **DHCPREQUEST** - Client message to servers either (a) requesting offered parameters from one server and implicitly declining offers from all others, (b) confirming correctness of previously allocated address after, e.g., system reboot, or (c) extending the lease on a particular network address.
- **DHCPACK** - Server to client with configuration parameters, including committed network address.



DHCP Messages (..Contd)

- **DHCPNAK** - Server to client indicating client's notion of network address is incorrect (e.g., client has moved to new subnet) or client's lease as expired
- **DHCPDECLINE** - Client to server indicating network address is already in use.
- **DHCPRELEASE** - Client to server relinquishing network address and canceling remaining lease.
- **DHCPINFORM** - Client to server, asking only for local configuration parameters; client already has externally configured network address.

BOOTP/DHCP Message Format

OpCode	Hardware Type	Hardware Address Length	Hop Count
Number of Seconds		Unused (in BOOTP) Flags (in DHCP)	
Transaction ID			
Client IP address			
Your IP address			
Server IP address			
Gateway IP address			
Client hardware address (16 bytes)			
Server host name (64 bytes)			
Boot file name (128 bytes)			
Options			

(There are >100 different options)

BOOTP/DHCP

- **OpCode:** 1 (*Request*), 2(*Reply*)

Note: DHCP message type is sent in an option

- **Hardware Type:** 1 (*for Ethernet*)
- **Hardware address length:** 6 (*for Ethernet*)
- **Hop count:** *set to 0 by client*
- **Transaction ID:** *Integer (used to match reply to response)*
- **Seconds:** *number of seconds since the client started to boot*
- **Client IP address, Your IP address, server IP address, Gateway IP address, client hardware address, server host name, boot file name:**
client fills in the information that it has, leaves rest blank

DHCP Message Type

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- ➡ Message type is sent as an option.

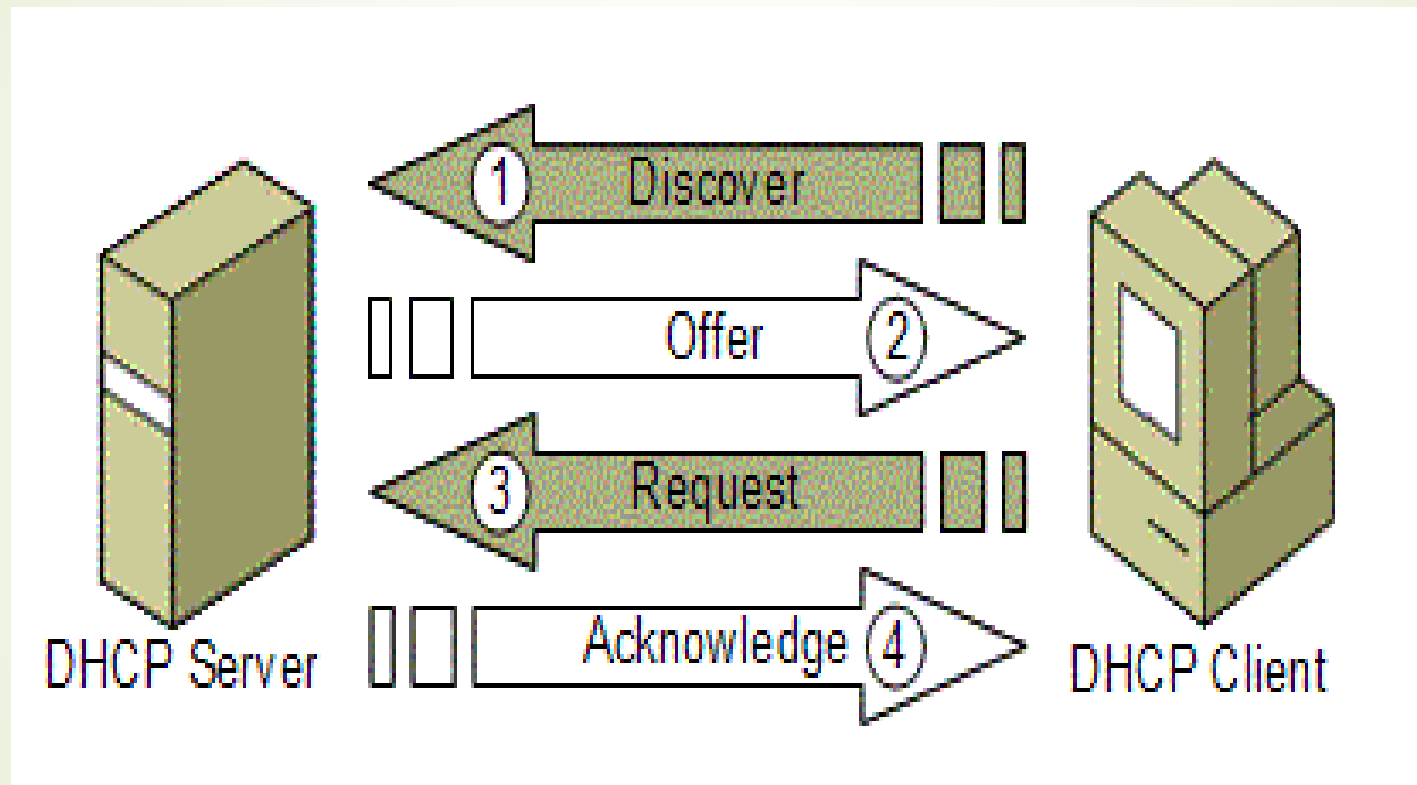
Value	Message Type
1	DHCPDISCOVER
2	DHCPOFFER
3	DHCPREQUEST
4	DHCPDECLINE
5	DHCPACK
6	DHCPNAK
7	DHCPRELEASE
8	DHCPINFORM

Other options (selection)

- Other DHCP information that is sent as an option:

Subnet Mask, Name Server, Hostname, Domain Name, Forward On/Off, Default IP TTL, Broadcast Address, Static Route, Ethernet Encapsulation, X Window Manager, X Window Font, DHCP Msg Type, DHCP Renewal Time, DHCP Rebinding, Time SMTP-Server, SMTP-Server, Client FQDN, Printer Name, ...

Dynamic allocation of a network address



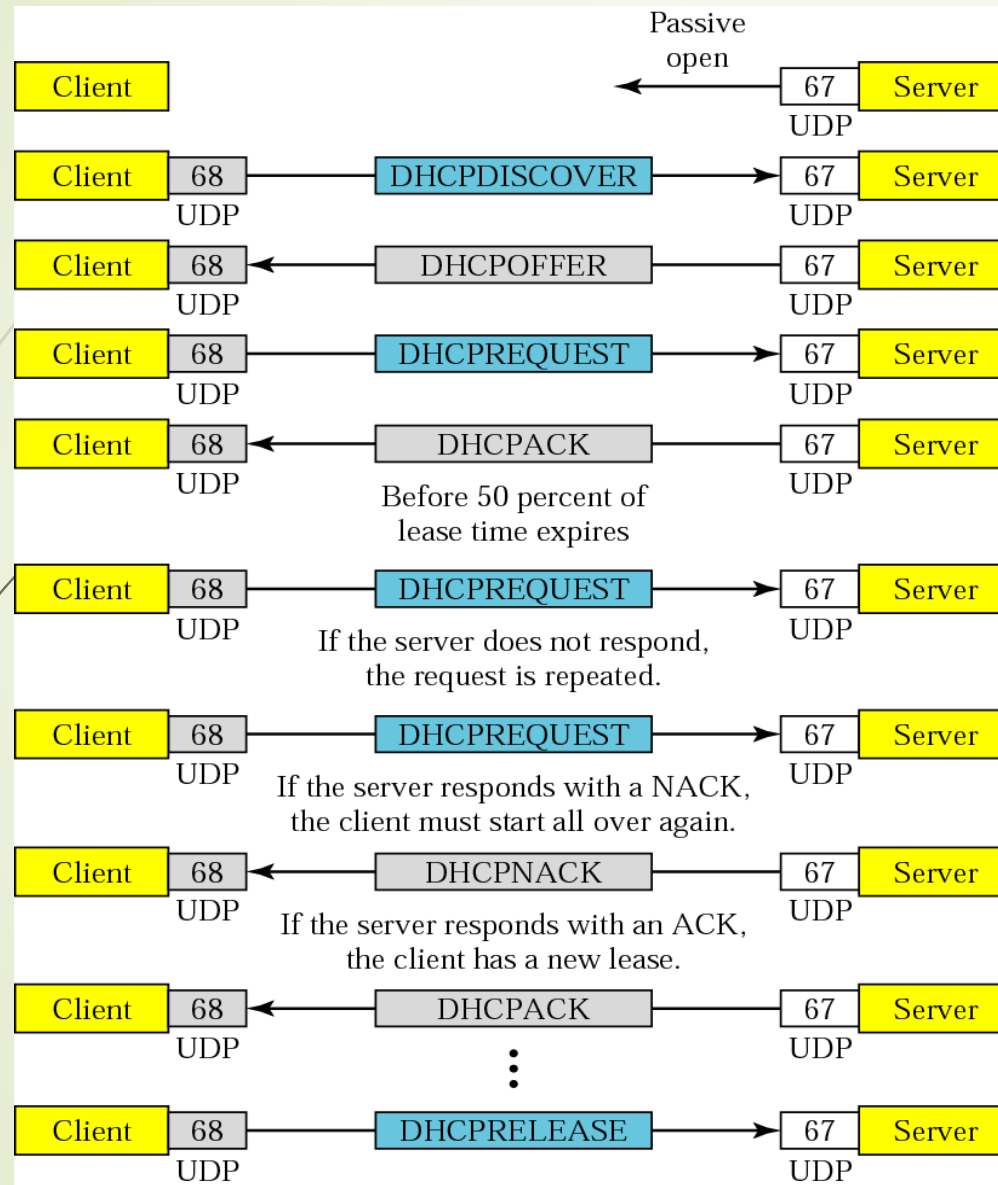


Event Flow Diagram

- Two cases:
 - Client-server interaction while allocating a new network address
 - Client-server interaction while reusing previously allocated network address

Exchanging messages

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Discover: client tries to find out what servers are out there.

Offer: those servers that can provide this service respond

Request: client selects one offer and makes a request

ACK: server acks the request

When 50% of the lease period is expired, client asks for a renewal.

If ACK received, reset timer.
If NAK, go back to initializing state.



Performance Issues

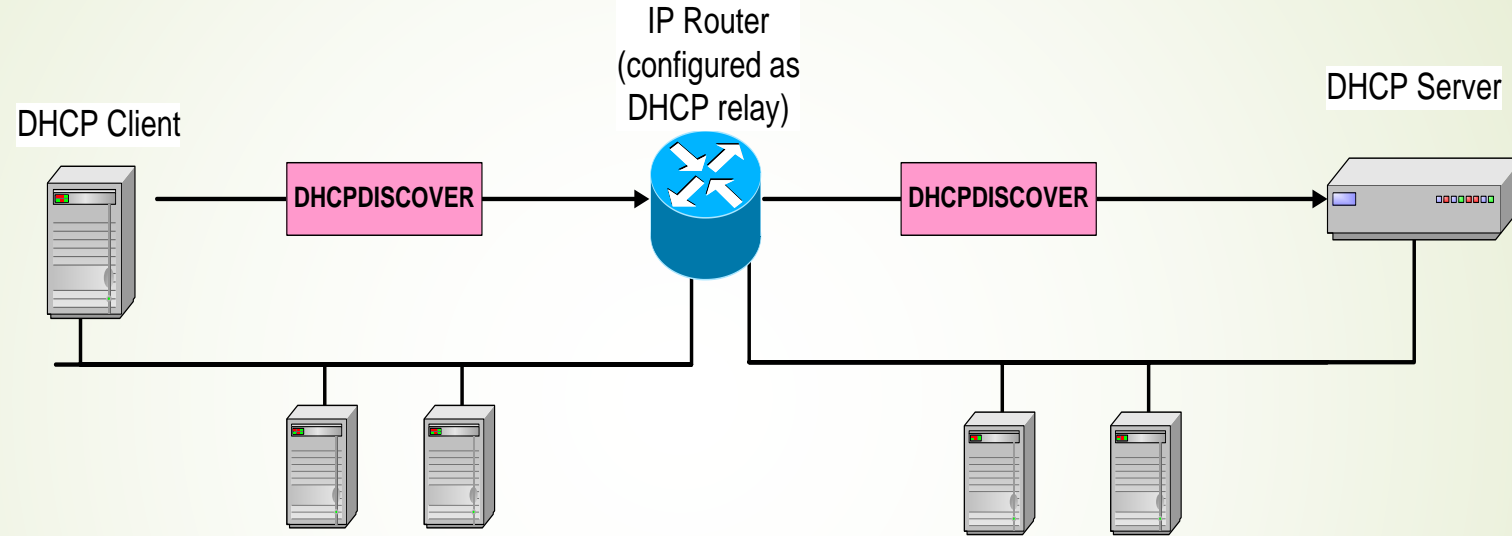
- Appropriate **lease durations**
- **Lengthening** lease duration for **large, fixed networks**
- **Shortening** lease duration for **variable networks with fewer IP addresses**
- Reserve addresses with **reservations**
- **Integrate** DHCP with **other services**



A problem....

- **DHCP** uses some **broadcast** messages in its communications.
- Broadcast messages are **not propagated** through **routers**.
- What to do in networks having **multiple subnets** ????

DHCP Relay Agent



- Problem: DHCP server and DHCP client are not on the same IP subnet
- Destination address 255.255.255.255 is not forwarded by IP router
- DHCP relay agent is a proxy that forwards DHCP requests to a DHCP server
- DHCP relay agent is configured with IP addresses of DHCP server(s)



Disadvantages of DHCP

- When DHCP server is unavailable, client is unable to access enterprises network
- Your machine name does not change when you get a new IP address.



Security problem

- DHCP is an **unauthenticated protocol**
 - When connecting to a network, the **user is not required to provide credentials** in order to obtain a lease
 - Malicious users with **physical access** to the DHCP-enabled **network** can instigate a **denial-of-service attack** on DHCP servers **by requesting many leases** from the server, thereby depleting the number of leases that are available to other DHCP clients.



Vulnerabilities – Impact and solution

➤ Impact

- Remote attacker with ability to send crafted packet to the DHCPD listening port able to crash a DHCP daemon causing a denial of service.

➤ Solution

- ISC* has released DHCP 3.0.1rc14 which resolves this issue.

** Internet Systems Consortium (ISC) is dedicated to developing software and offering services in support of the Internet infrastructure.*



Limitations

- Some **machines** on your network need to be at **fixed addresses**, for example servers and routers
- You need to be able to **assign a machine** to run the **DHCP server** continually as it **must be available** at all times when clients need IP access



Conclusion

- Assigning client addresses automatically is by far the easiest option of the two:
 - ✓ Set-up automatically by DHCP server
 - ✓ Set-up manually
- To set-up clients automatically all you need to do is set your TCP/IP control panels to receive automatically
- If you intend to set up your client computers manually, make sure that the assigned IP address is in the same range of your default router address and that it is unique to your private network



References



- RFCs 1531,1533,1541, 2131,2132, <http://ietf.org/rfc.html>
- DHCP FAQ
http://www.dhcp-handbook.com/dhcp_faq.html
- Microsoft Windows Server 2003 whitepaper
<http://www.microsoft.com/technet/prodtechnol/windowsserver2003/>



Quiz Questions

1. Which protocol and port does DHCP run on?

➤ UDP, Ports 67 and 68.

2. What is the purpose of DHCP?

➤ DHCP server hosts allocate network addresses to the clients and deliver configuration parameters to the dynamically configured hosts.

3. What are the three mechanisms supported by DHCP for IP address allocation?

➤ Automatic allocation, dynamic allocation and manual allocation.