Migrating away from NetBEUI to TCP/IP

using DHCP, DDNS, and NBNS (Dynamic IP)

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Agenda

- **Migrating to NetBIOS over TCP/IP**
  - What does this really mean?
  - Performance considerations
- **NetBEUI ... What is next?**
  - Fastest LAN Protocol, but ...
- **Introducing OS/2 TCP/IP V4.31**
- **Automated Configuration**
  - DHCP IP Address Management
  - DDNS Host Names Management
  - NBNS / WINS
    NetBIOS Names Management
  - Security
- **PPP Remote Access Services**

The Vision of a Perfect Network

- **Allow people in a company to instantly and effortlessly connect**
  - **any kind of computing device**
  - **to the network and be connected to the information they need**
- **Assure that connection will always be available**
- **Provide superior performance**
- **Protect from unwanted access**
- **Grow and change easily**
- **Ease of administration**

Migrating away from NetBIOS. What does it really mean?

- **Implementing a TCP/IP Infrastructure**
  - Subnetting your Network
    - Routers devide Networks
  - Purchase IP Addresses from an ISP or run your Network using private IP addresses
    - Class A
      - **10.0.0.0** **(1 Class A Group)**
    - Class B
      - **172.16.0.0 - 172.31.0.0** **(16 Class B Groups)**
    - Class C
      - **192.168.0.0 - 192.168.255.0** **(256 Class C Groups)**
  - Assign IP addresses to all Servers and Workstations (dynamically?)
  - Use NAT (Network Address Translation) if you plan to access the public Internet from your private intranet.
  - Implement IP address and host names resolver.
- **Re-configure your Servers and Workstations to communicate using NetBIOS over TCP/IP**
- **Solve and tune NetBIOS Names Resolution**
  - Using NBNS (NetBIOS Names Server), DNS, or other methods.

Dynamic IP Candidates

TCP/IP Network

DHCP Server
Dynamic DNS Server
BINL Server

Network Stations, Thin Clients, DHCP/BootP-printers and other net-work devices

OS/2, WSOD, DOS, Windows 95/98/NT/2000, Linux and other clients

Dynamic IP Considerations

Manual TCP/IP Configuration Disadvantages	Automatic TCP/IP Configuration Advantages
IP Addresses and other TCP/IP configuration information must be entered manually on each computer.	IP addresses and other TCP/IP configuration information are supplied automatically to all computers.
Possibility of entering incorrect or invalid IP addresses.	Can ensure that clients always use correct configuration information.
Incorrect configuration can lead to communications and network problems.	Elimination of a common source of network problems.
Administrative overload on networks where computers are frequently moved.	Client configuration is updated automatically to refelct changes in network structure.

NetBEUI ... What is next?

- **NetBIOS is the interface to NetBEUI, hence, NetBIOS is the network.**
- **NetBEUI is speedy, efficient, and easy to use and configure in small, usually one-segmented networks.**
- **Computers and Network Resources on the local Network are discovered through broadcasts.**
  - Because NetBEUI is broadcast-based, it is **not routable**.
  - Impact choice of routers to bridging routers.
  - Major limitation for growing companies.

NetBIOS over TCP/IP Facts

- NetBIOS **does not** rely on any specific underlying protocol to connect systems together.
- It is adaptable to protocols that allow **packet forwarding**, such as TCP/IP.
- RFCs (Request for Coments) 1001 and 1002 describe the standard way to implement NetBIOS on top of TCP (Transmission Control Protocol) and UDP (User Datagram Protocol).
- RFC 1001/1002 **is translation** and **not** an **encapsulation technique**. Packets are send through UDP/IP and TCP/IP.
- TCPBEUI builds a **4-byte session header** that precedes the actual user data which results in a **very small overhead**.
- NetBIOS over TCP/IP is known as NBT and TCPBEUI.

NetBIOS Names

- **NetBIOS names are made up of 16 bytes**
  - Consists of a 15 characters name with a 1 character suffix.
  - All 16 bytes can be binary.
- **Some NetBIOS Names and Suffixes**

Name	Number	Type	Usage
computername	00	U	Workstation service
computername	03	U	Messenger service
computername	20	U	File server service
domain	00	G	Domain name (IBM)
domain	1B	U	Domain master browser
domain	1C	G	Domain name (Microsoft™)
domain	1D	U	Master browser
domain	1E	G	Browser broadcast
computername	1F	U	NetDDE service
MSBROWSE	01	G	Master browser broadcast

Huge Tuning Topic: Resolving NetBIOS Names to IP Addresses

- **Various methods for NetBIOS Names Resolution**
  - Simplest one is broadcasting and hoping the computer you are trying to reach responds
    - can be very time-consuming apart from the fact that broadcasts increase network traffic
  - Make computername and host name identical so that you can use DNS (Domain Name System)
    - traditionally grown networks come with different NetBIOS and host names
  - Best method would be a server that does NetBIOS name to IP address resolution
    - NBNS (NetBIOS Names Server), such as Shadow IPserver
    - Configure clients
      - M-Node (Mixed Mode) Clients
        - name query through broadcast first, and if that fails, it uses NBNS
      - H-Mode (Hybrid Mode) Clients
        - Uses NBNS first, and if that fails, it uses broadcast
      - P-Mode (Point-to-Point Mode)

NetBIOS Names Resolution Order

- Windows World
  1. NetBIOS name cache (local)
  2. WINS query
  3. local broadcast
  4. LMHOSTS
  5. DNS
  6. HOSTS

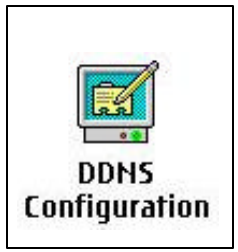
- OS/2 World
  1. NetBIOS name cache (local)
  2. RFCNAMES.LST
  3. DNS Lookup, if DOMAINSCOPE is configured. ENABLEDNS specifies encoded/unencoded order for DNS lookup
  4. If B-node, local broadcast and RFCBCST.LST
  5. If P- or H-node, NBNS query
  6. If H-node and NBNS query fails, local broadcast and RFCBCST.LST

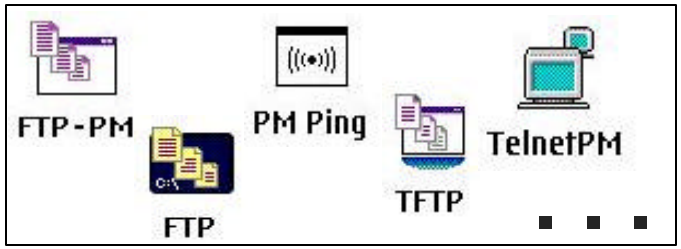
Source:
Windows NT™ 4.0 Manual

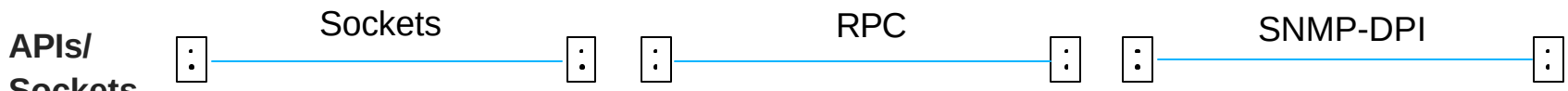
Dynamic IP Server Offerings on Intel

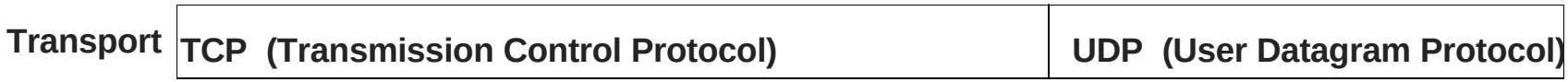
- **IBM's OS/2 Warp Server for e-business (WSeb) comes with a DHCP and DDNS server. Updates through ConveniencePaks or with optionally available TCP/IP V 4.3 from Software Choice.**
- **Network TeleSystems (NTS), acquired by Efficient Networks, offers Shadow IPserver (on DOS, Windows NT and as a "black box") which provides DHCP, (D)DNS, and NBNS.**
- **Microsoft Windows NT 4.0 Server provides a DHCP server, a static DNS server, and a WINS (NBNS for Microsoft-only clients) server.**
- **Microsoft Windows 2000 Server comes with a DHCP server, a (D)DNS server, and a WINS (NBNS for Microsoft-only clients) server.**
- **Other vendors, such as Novell.**

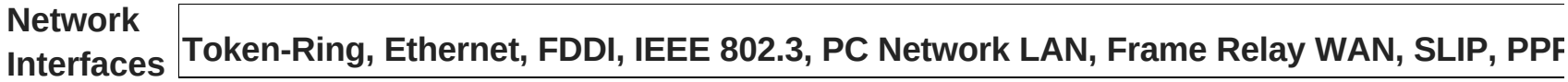
OS/2 TCP/IP V4.31 Services











Note: Web Explorer, Gopher, Ultimail, and NewsReader/2 have been replaced by Netscape Communicator V4.61.

OS/2 TCP/IP V4.31 New Functions

- **Dynamic IP Enhancements**
  - DDNS Server can now be queried for non-RFC encoded NetBIOS computer names
    - done through **`GetHostByName`** to TCP/IP
  - Run a REXX or PM Application when a certain DHCP Option was received by the DHCP Client
    - Server sends predefined data as a parameter
    - Application as defined in \MPTN\ETC\DHCPCD.CFG will execute.
- **Java-based Configuration and Management**
  - Allows remote Web-based Administration
  - Works OK with Java VM 1.3
- **DHCP Relay Agent (`\TCPIP\BIN\DHCPRD.EXE`)**
  - NetBIOS names broadcast catcher

OS/2 TCP/IP V4.31 New Functions *(continued)*

- **Redundancy for a failed LAN Adapter Enhancement**
  - A previously configured LAN Adapter can dynamically replace a failed LAN Adapter to become the primary one.
  - TCPBEUI clients would need to re-establish the sessions. Depending upon what is happening at the time, this could be automatically taken care of by retries, or it could possibly mean manual intervention, such as restarting a 'net use', new logon, etc.
  - Only works with TCP/IP (**not** ODI2NDI or NetBEUI) on Token-Ring Adapters.
- **Implement Fault Recovery and Isolation For Host**
  - Whenever TCP layer communicates that the service is defective, the IP layer can pick the next gateway from the list of available gateways, and switch to it.

OS/2 TCP/IP V4.31
New Functions *(continued)*

- **PreBoot eXecution Environment (PXE) 2.1 Support**
  - The DHCP/PXE server can control the IPL of the client by allowing the client to boot from any available server or from a specific list of servers.
- **FTPD**
  - The FTPD sever now supports the Passive mode of data transfer. This facilitates the transfer of files through packet filter-based firewalls.
- **RXFTP**
  - The User can now set the data transfer mode to Active or Passive. The Passive mode is preferred when data needs to be transferred between two terminals separated by a firewall which may not allow calls to random port numbers.

OS/2 TCP/IP V4.31 -- TCP/IP and TCPBEUI Enhancements

- **SENDMAIL**
  - Handles unsolicited commercial e-mail or spamming.
  - New rule sets were added to the SENDMAIL configuration file (**`\MPTN\ETC\SENDMAIL.CF`**)
- **Support for up to 4 physical LAN adapters**
  - with up to 254 sessions each on different subnets from the same system
  - Still true, a physical LAN adapter can have up to 4 logical TCPBEUI adapters
- **Use of DNS for NetBIOS name resolution**
  - **`PROTOCOL.INI`**
    - **`ENABLEDNS=2`**
      DNS Lookup of an RFC-unencoded name first, then, if that fails, DNS Lookup of RFC-encoded name.
    - NetBIOS name and TCP/IP host name must be identical.

OS/2 TCP/IP V4.31
TCPBEUI Enhancements *(cont.)*

- **Dynamic update of the Names List and Broadcast List for NetBIOS name resolution**
  - This feature provides an API to update the Names and Broadcast lists without rebooting.
    - **RFCNAMES.LST**
      Up to 2000 NetBIOS name / IP address pairs to resolve a NetBIOS name without broadcasting to the network
    - **RFCBCST.LST**
      List of up to 128 host names, host addresses, or directed broadcast addresses that are to be a logical part of the local NetBIOS broadcast domain.
      Note: The GUI only supports 32 entries, however, the TCPBEUI code underneath supports 128 entries.

Note: RFCADDR.EXE could already manually update NetBIOS cache.

IP Lease Contents

- **IP Addressing Information sent to the DHCP Clients typically contain several elements, such as:**
  - IP Address with "Expiration time"
  - 001 Subnet Mask
  - 003 Gateway (Router) IP Address
  - 006 IP Address of DNS Server
  - 012 Host Name (Computername is used by Microsoft)
  - 044 IP Address of NBNS (WINS) Server
  - 045 IP Address od NBDD (NetBIOS Datagram Distributor)
  - 046 NBNS Node Type
  - 047 NetBIOS Scope ID
  - 060 Vendor Class ID
  - 061 Client ID
  - 077 User Class ID (if subnet selection is necessary)

  OS/2 Extensions:
  - 081 DHCP Interaction with DDNS
  - 129 User Information (DNS TXT Record)
  - 205 Default Socks Server

DHCP Client/Server Interaction

LAN Clients

DHCP/DDNS Clients

DHCP Server

IP Lease Request (Broadcast)

(DHCPDISCOVER)

IP Lease Offer (with server identifier)

(DHCPOFFER)

Receive Offers

OK? No? → **Use previous Configuration**

IP Lease Selection

(DHCPREQUEST)

Verify

IP Lease Acknowledgement

(DHCPACK)

Verify (ARP)

OK? No?

Decline an Offer (very rare)

(DHCPDECLINE)

Initiate the entire Process again

Bind and register with DDNS

Classing and Multiple Subnets

- **Flexibility in grouping clients**
  - through Classing and/or defining multiple Subnets
  - For example, creating a subnet for the Financial and Account Group on the same wire
    - Extra Router would be needed though
- **DHCP client must send DHCP Option 077 User Class ID**
  - Specific IP Address Ranges and other DHCP Options, such as LPR Printers can be specified

Case 1

Subnet A
- IP Pool for no class
- IP Pool for "Sales"
- IP Pool for "Admins"

Case 2

Subnet A
- IP Pool for "Managers"
- IP Pool for "Supervisors"

Subnet B
- IP Pool for no class
- IP Pool for "Accounting"

Beyond DHCP: Dynamic DNS Basics

- **DNS is a distributed database system that can serve as the foundation for name resolution in an IP network.**
- **DNS server translates host names to IP addresses**
- **A forward lookup query is a request to resolve a name to an IP address.**
- **A reverse lookup query is a request to resolve an IP address to a host name.**
  - DNS uses a special domain called **`in-addr.arpa`**.
  - Format: reverse octet order of an IP address concatenated with "**`in-addr.arpa`**"; for example, **`1.1.168.192.in-addr.arpa`**.
- **The fully qualified domain name (FQDN) describes the exact relation of a host to its domain.**
- **DDNS servers are a superset to static DNS servers, and therefore, fully compatible.**

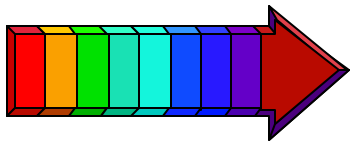
Beyond DHCP: Dynamic DNS Basics *(continued)*

- **DDNS clients can dynamically register their name and address mappings in the DNS tables directly.**
  - Uses two major components to determine how and where to send DDNS update requests:
    - Resolver, which uses the **`\MPTN\ETC\RESOLV2` file**
    - NSUPDATE agent, which uses the **`\MPTN\ETC\DDNS.DAT`** file

RSA Digital Signature Technology at DHCP Server

I am the owner of IP addresses.
No one can change PTR records.

DHCP Server



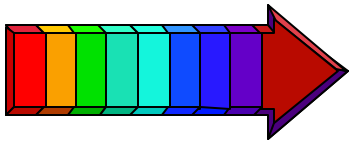
encrypted plus RSA digitally signature

DNS Reverse Mapping File

99 KEY j8xazY...
PTR myhost
SIG PTR aR7Gy..
SIG KEY i7yr..

public key

I am the owner of "myhost".
No one can change my A record.



encrypted plus RSA digitally signature

DNS Forward Mapping File

myhost KEY aYbkid...
A 9.3.1.99
SIG A kjoj...
SIG KEY 0Aor..

RSA Digital Signature Technology at DDNS Client

- **Based on the use of private - public key pairs**
  - The private key is used to generate a unique digital signature
  - Can only be validated by using the corresponding public key
  - Cannot be derived from either digital signature or the public key or the combination of the two
- **DDNS Client registers its hostname**
  - It generates a RSA key pair when registering the first time. The public key is sent to the DDNS server.
  - Client retains the RSA key pair (with the private key encrypted) in DDNS.DAT
- **DDNS Server uses client's public key (KEY resource record) for update requests.**

DHCP / DDNS Files & Commands Examples

- **DHCP Server**
  - Configuration File: **`\MPTN\ETC\DHCPSD.CFG`**
  - Administration Command: **`\TCPIP\BIN\DADMIN.EXE`**
    for example, to display available IP leases: **`dadmin -s`**
    or, to re-initialize the DHCP Server: **`dadmin -i`**
- **DDNS Server**
  - Boot File: **`\MPTN\ETC\NAMEDB\NAMED.BT`**
  - Cache File: **`\MPTN\ETC\NAMEDB\NAMED.CA`**
  - Extended Conf.: **`\MPTN\ETC\NAMEDB\DNSEXT.CFG`**
    for configuration options beyond BIND DNS, such as IBM's DDNS.
  - Domain data files, **`DNSF000x.DOM`** and **`DNSF000x.STA`**
  - Server Key File: **`\MPTN\ETC\DDNS.DAT`**
    RSA key pair created and used by **`NSUPDATE`**
- **DDNS Client (pre-secured Mode)**
  - At DDNS Server: **`\MPTN\ETC\NAMEDB\<`*`domain`*`>\<`*`hostname`*`>.KEY`**
- **DHCP Relay Agent**
  - Command: **`\TCPIP\BIN\DHCPRD.EXE`**
  - Configuration File: **`\MPTN\ETC\DHCPRD.CFG`**

DDNS Client/Server Interaction Scenario 1

DHCP Server

DDNS Clients
- **OS/2 Warp 4**
- **OS/2 Warp 4 ConveniencePak**
- **Windows 95/98/NT/2000™ with IBM DDNS Client**

DHCP Configuration
Information received OK

Register PTR RR
IP Address to Host Name

Register A RR
Host Name to IP Address

DDNS Server

DDNS Client/Server Interaction Scenario 2

DHCP Server
ProxyArec

sends Option 12 Hostname

Register PTR RR and A RR through ProxyArec

DDNS Server

DHCP Clients
- OS/2 Warp 4
- OS/2 Warp 4 ConveniencePak
- Windows 95/98/ME/NT/2000™
- DOS DLS
- other DHCP Clients

DHCP Configuration
Information received OK

DDNS Client/Server Interaction Scenario 3

DDNS Clients
- OS/2 Warp 4
- OS/2 Warp 4 ConveniencePak
DHCP Configuration
Information received OK

DHCP Server
ProxyArec

Option 12 Hostname
Option 81 No-ProxyArec

Register PTR RR only

Register A RR
(Hostname to IP Address)

DDNS Server

DHCP ProxyArec

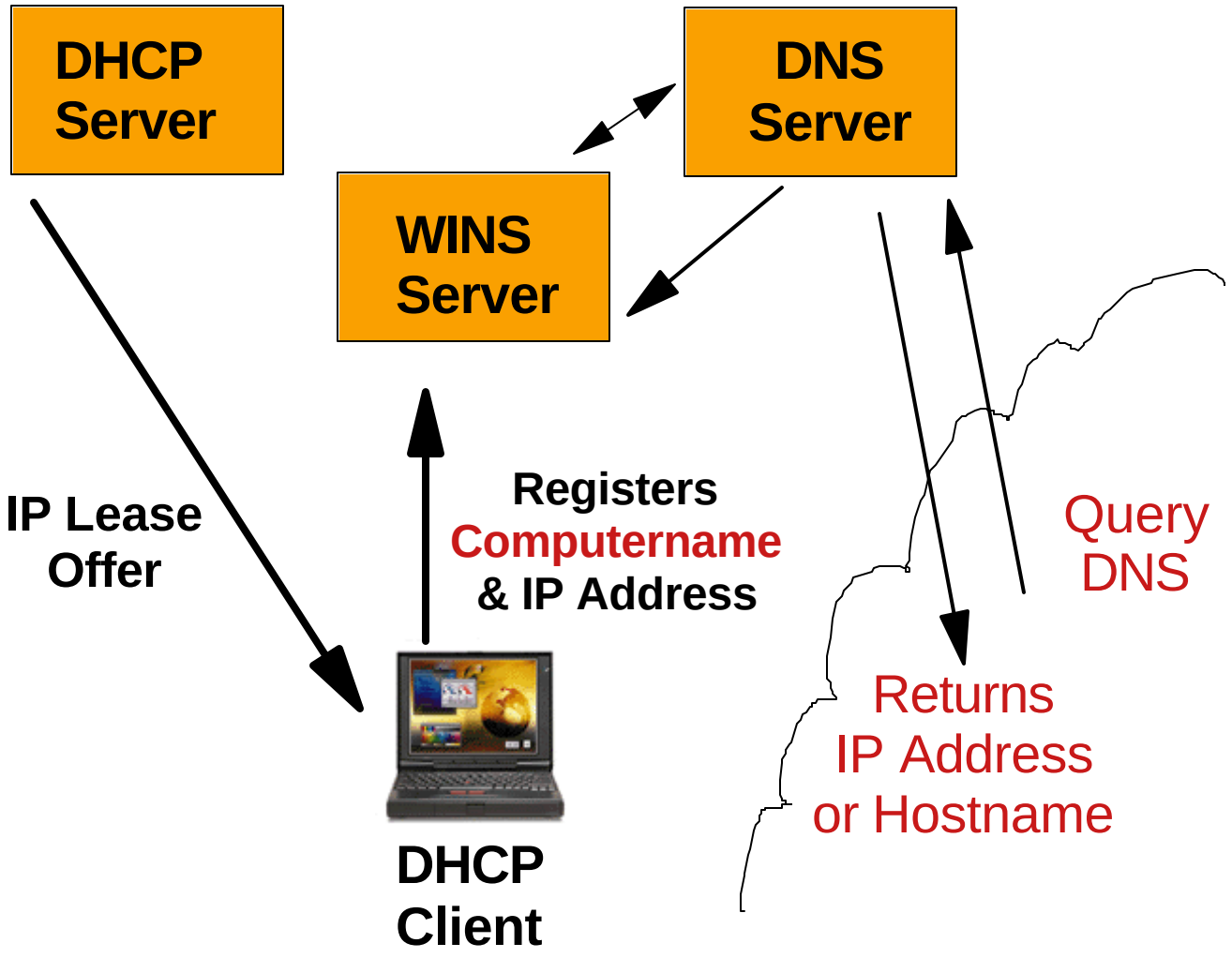
- **ProxyArec is based on IETF Internet draft called *Intercation between DHCP and DNS*.**
- **IBM's DHCP Server uses its own MD5 RSA Digital Signature for all interactions.**
- **DHCP Server registers and updates a client's Address Record, A RR, (Hostname to IP Address) on behalf of the client.**
- **Security Feature stores the client's MAC Address to the DDNS database as HINFO and compares if an Update Request comes from a different MAC.**

DHCP ProxyArec *(continued)*

- Standard Option
  - No MAC Address comparisons are made for update requests Possibility of Unwanted Override
- Protected Option
  - Hostname updates are based on MAC Address comparisons
- Duplicate names?
  - DHCP Server reponds to Option 12 Hostname.
  - Windows clients use Computername against Option 12. Possiblity of conflicts when Computername is not equal Hostname.

- **IBM's implementation of Dynamic DNS is exceptional, however, additional client code is necessary (standard in OS/2 Warp 4 and higher)**
  - The A RR update is verified through Digital Signature (MD5 RSA) to prevent unwanted updates.
  - Windows 95/98/NT/2000™ need the *Dynamic IP Client 1.0 for Windows 95 and Windows NT* from SWChoice.

Dynamic IP Basic Interactions Windows NT™ DHCP/WINS/DNS

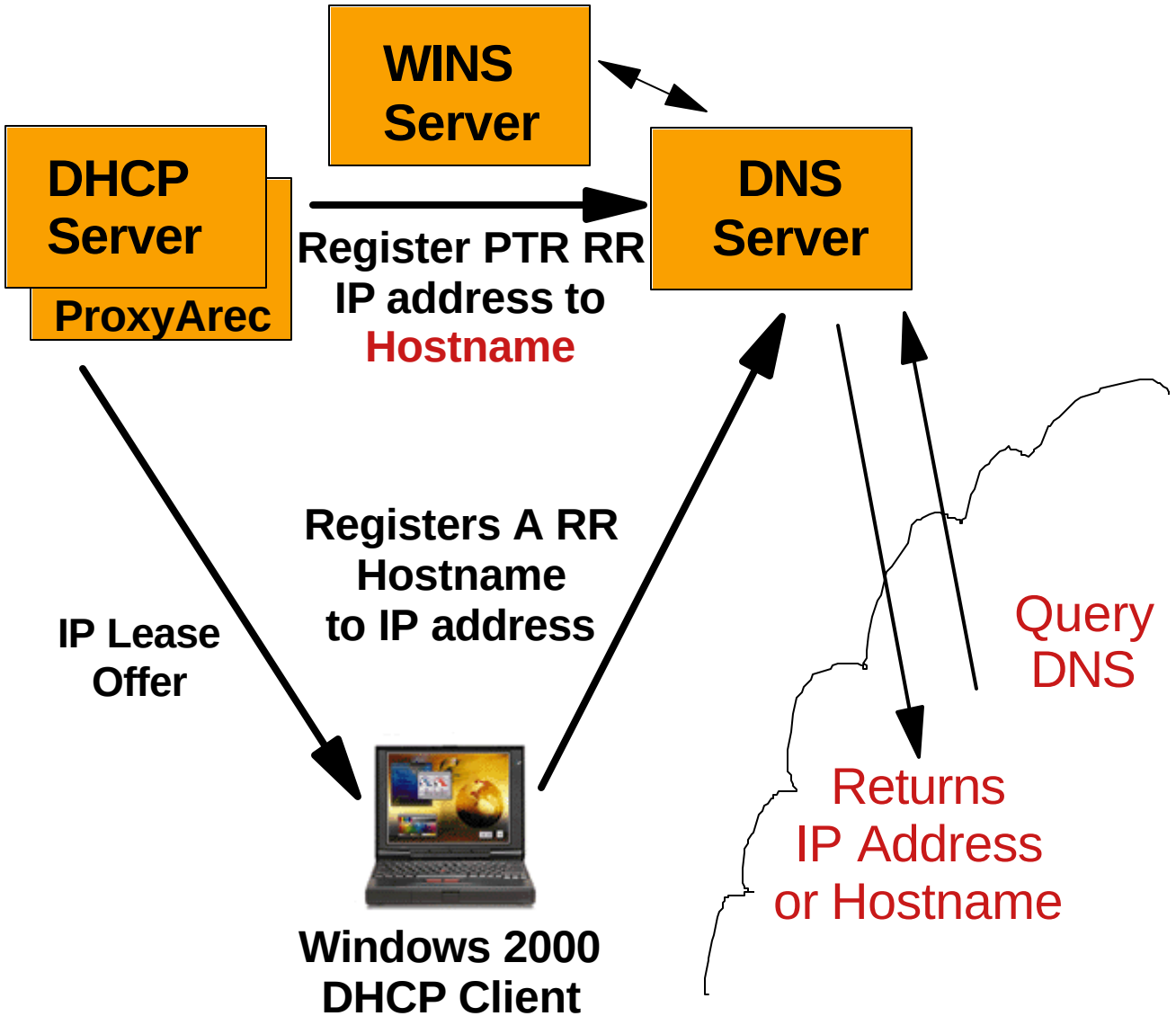


Source:
Windows NT™ 4.0 Manual

Windows NT™ DHCP/WINS/DNS Technical Issues

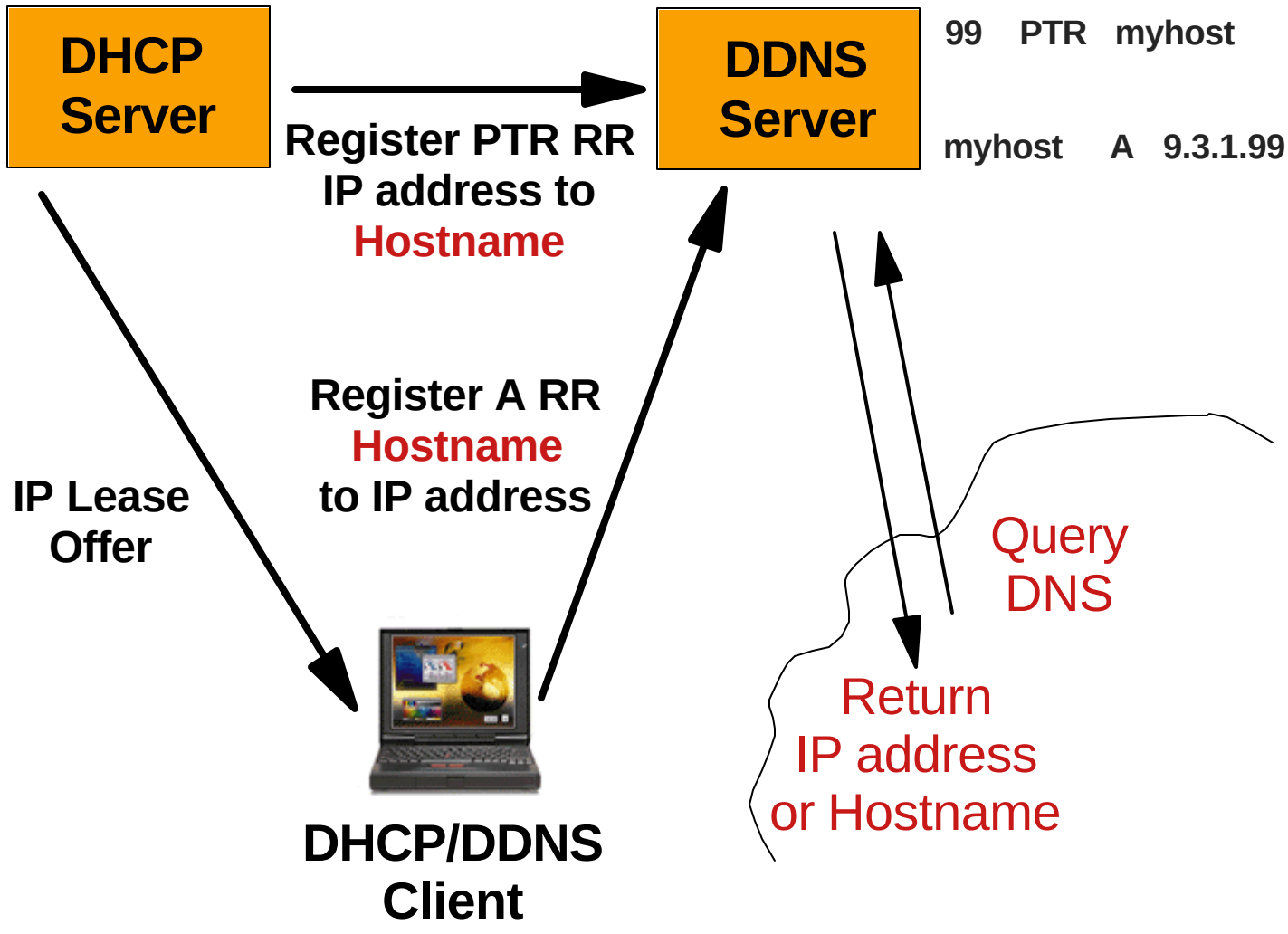
- **There is no interaction between the DHCP and DNS server**
- **Windows client encounters a problem sending DHCP Option 12 (Hostname)**
  - Host Name, as defined in Registry (DNS -TCP/IP Setting) is never used.
  - Instead, Computername (NetBIOS name) is used as DHCP Option 12.
  - Microsoft recommends to set Computername and Hostname identical.
    - Remember, DNS-WINS returns a Computername.
- **Windows NT 4.0 DNS cannot be upgraded to other platforms**
  - WINS Record is Microsoft-unique.
- **Duplicate name problem**
  - Hostname can be registered by any PCs.
  - This can cause a problem when, for example, "abc" points to 1234, and 5678 points to "abc".
- **Windows 2000 DNS is fully BIND-compatible.**

Dynamic IP Basic Interactions Windows 2000™ DHCP/DNS

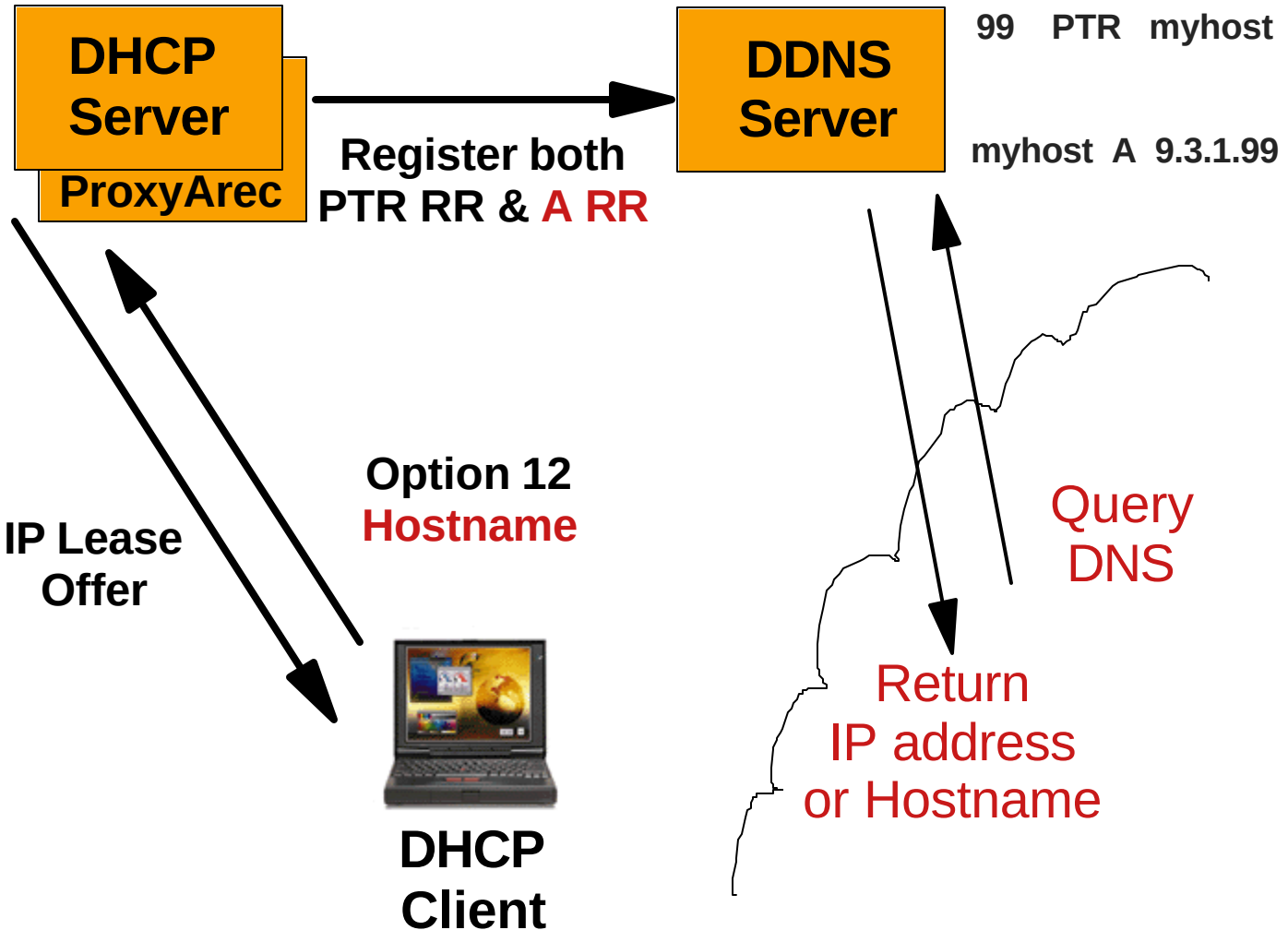


Source:
Windows 2000™ Manual

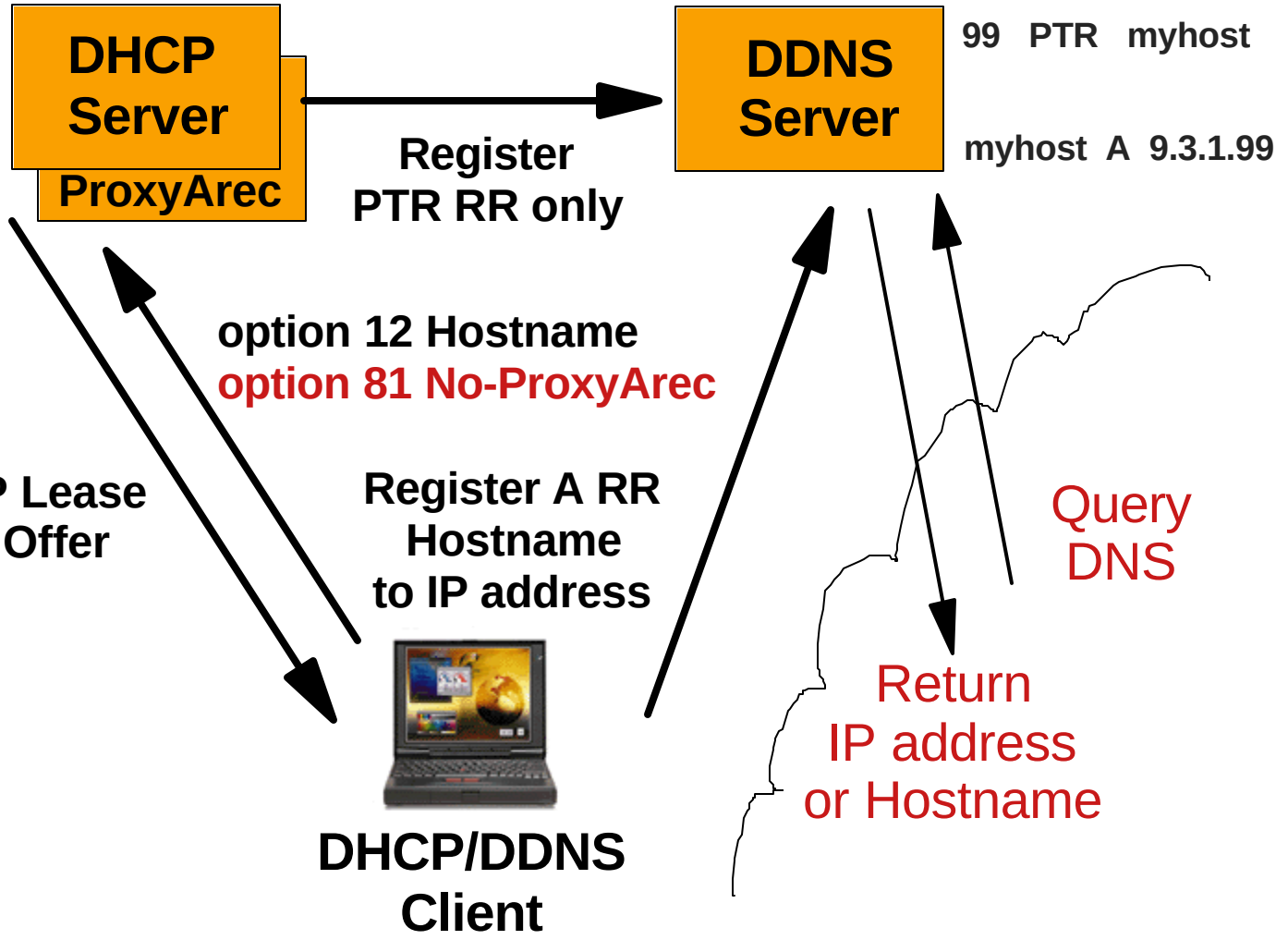
Dynamic IP Interactions
IBM DHCP - Dynamic DNS



Dynamic IP Basic Interactions
IBM DHCP-DDNS with ProxyArec



Dynamic IP Basic Interactions
DDNS Client and ProxyArec



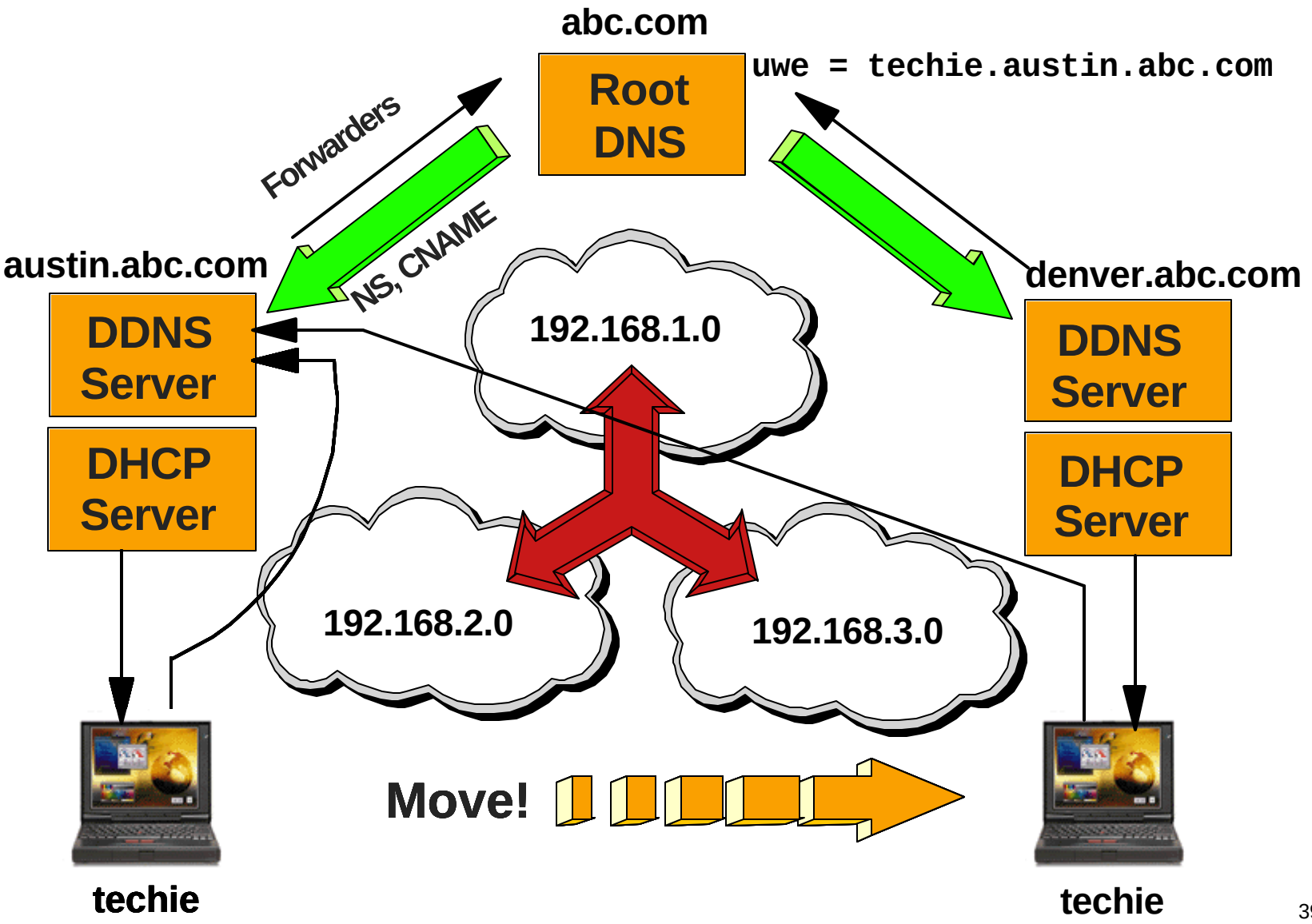
IBM's DHCP & DDNS Notes

- **IBM's DHCP/DDNS implementation is the most flexible and most secure implementation of host updates**
  - Address Resource Record (A RR) updates are verified through a digital signature to prevent "illegal" (impersonated) updates.
  - However, it's not standard for Windows 95/98/ME/2000 clients
    - Additional DDNS client software must be obtained from IBM's Software Choice:

      Dynamic IP Client 1.0 for Windows 95 and Windows NT
      IBM's Dynamic IP Client 1.0 works with the dynamic host configuration protocol (DHCP) to allow hostnames to be updated dynamically.
      Updated 03/31/98

    - Hostname will always be hostname, not Computername
  - All in all, various clients are supported:
    - OS/2 Warp 4 and OS/2 Warp 4 ConveniencePak
    - WorkSpace on-Demand
    - Windows 95, 98, ME
    - Windows NT 4.0, 2000
- **Your hostname travels with you, always!**

Hybrid Domain Design



Primary DC & Backup DC KEEPALIVE Timer

- **INETCFG -G ALL** creates **\MPTN\ETC\INETCFG.INI**

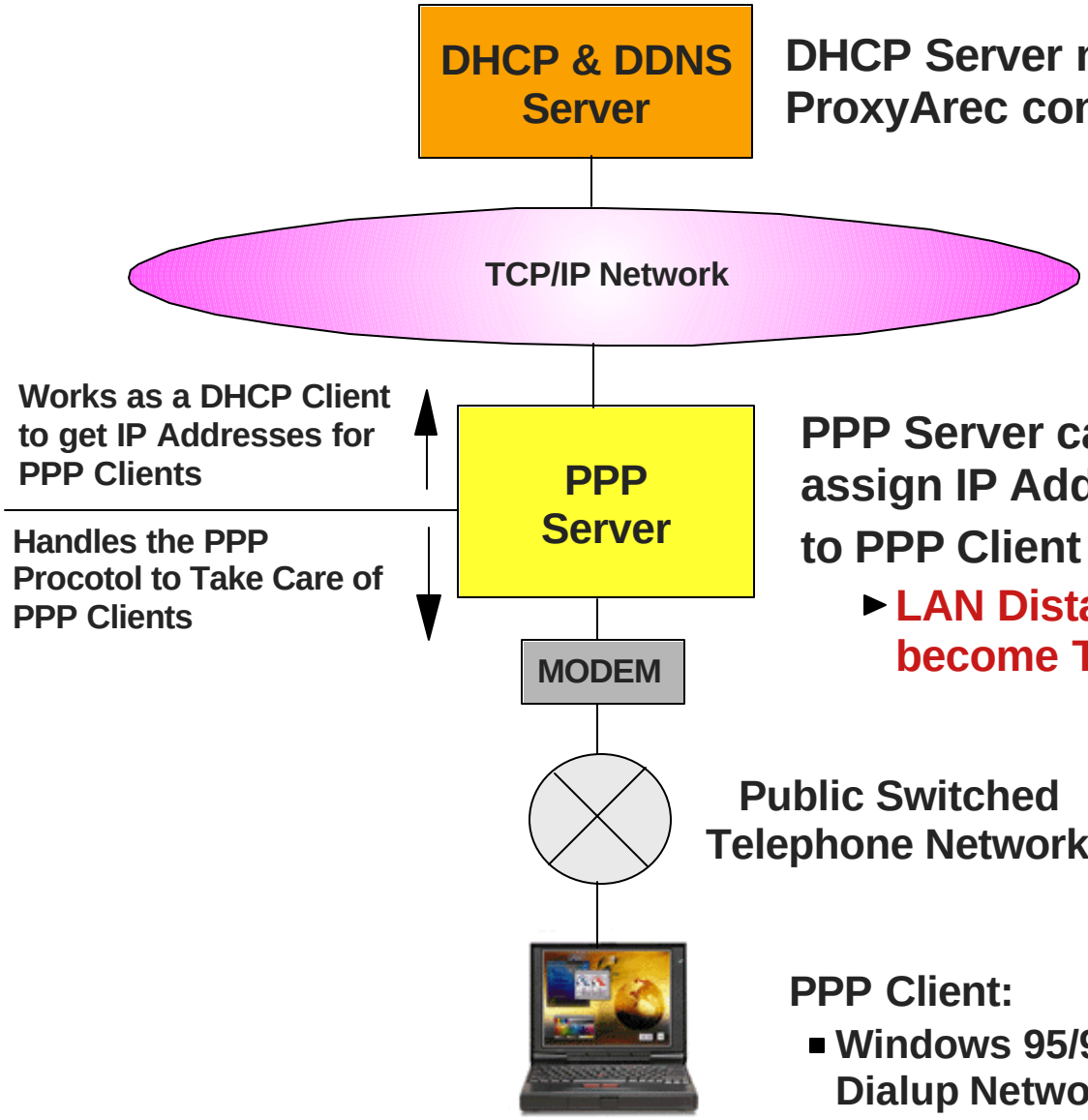
```
keepalive = keepidle + Maxidle
                7200   + 75sec * 8


|---------------------------------|--|--|--|--|--|--|--|
| <----KeepIdle ------------------><------- Maxidle ------>
                            | |
                             ^----- Keepintvl
| <- Timer Starts off -----------1  2  3  4  5  6  7  8 DROP_OFF
```

- **After the Keepidle time the stack starts sending Keepalive probes of one Byte which are outside the window to see if the other side is alive, and if the stack gets a response then the keepalive TCP timer is reset to Zero.**
- **If the successive 8 probes do not respond then at the ninth probe, TCP drops the connection.**

Primary DC & Backup DC KEEPALIVE Timer

- **In TCP/IP V4.1 and up there are two programmable values**
  - **Keepalive time and number of probes to send (between 1 and 8)**
  - **Default is 7200 secs and 8 probes spaced at 75 sec each. (which is 120+10 minutes)**
  - **If the given `keepalive` time is greater than (75*9) then `keepintvl` = 75 sec and the `Keepidle` is the remainder of the [`keepalive` - (75*8)]. Thus the `Keepidle` is guranteed to be 75 sec or up.**
  - **If the `keepalive` value is less than (75*9) then given time is devided into three parts. 2/3rd of `Keepalive` goes as `Keepidle` and the rest 1/3 goes as `Maxidle`. In this case if the probecount is such that the `keepintvl` falls below 1 sec, then the `keepintvl` is rounded off to 1 sec. Also, in this calcualtion if `keepidle` falls to Zero then `Keepidle` is set at 10 seconds.**

LAN Distance PPP Server and DHCP



DHCP Server must have ProxyArec configured

PPP Server can use DHCP to assign IP Address and hostname to PPP Client

- **LAN Distance User ID will become TCP/IP hostname**

PPP Client:

- **Windows 95/98/ME/NT/2000™ Dialup Network**
- **OS/2 Warp 4 TCP/IP Dialer**

PPP Server DHCP Example

DHCPDISCOVER (option 12 = USR01)

DHCPOFFER 192.168.7.13

DHCPACK

PPP logon with UserID "USR01"

Assign 192.168.7.13

ProxyArec

192.168.6.10

DHCP & DDNS Server

Address Pool for 192.168.7 Network

USR01 IN A 192.168.7.13

192.168.6.0 Network

192.168.6.1

192.168.7.1

Router

with DHCP Relay Agent

192.168.7.0 Network

192.168.7.10

LAN 0 Interface

PPP Server

- IP Forwarding must be enabled
- LAN Distance Bridge OFF

192.168.7.7

LAN 1 Interface

LAN Distance Logical Adapter

MODEM

PPP Client:

- Windows 95/98/ME/NT/2000™ Dialup Network
- OS/2 Warp 4 TCP/IP Dialer

List of Web Links discussed in this Presentation

- **IBM** OS/2 Warp home page
  `http://www.ibm.com/software/os/warp/`
- **IBM** Software Choice
  `http://www.ibm.com/software/os/warp/swchoice/`
  `http://service.software.ibm.com/asd-bin/doc/index.htm`
- **Efficient Networks** (formerly known **Network TeleSystems** -- NTS)
  `http://www.nts.com`
- **Microsoft** home page
  `http://www.microsoft.com`
- **Internic**
  `http://www.internic.net`
- **The Internet Engineering Task Force**
  `http://www.ietf.org`

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