Network Services

Domain Names & DNS

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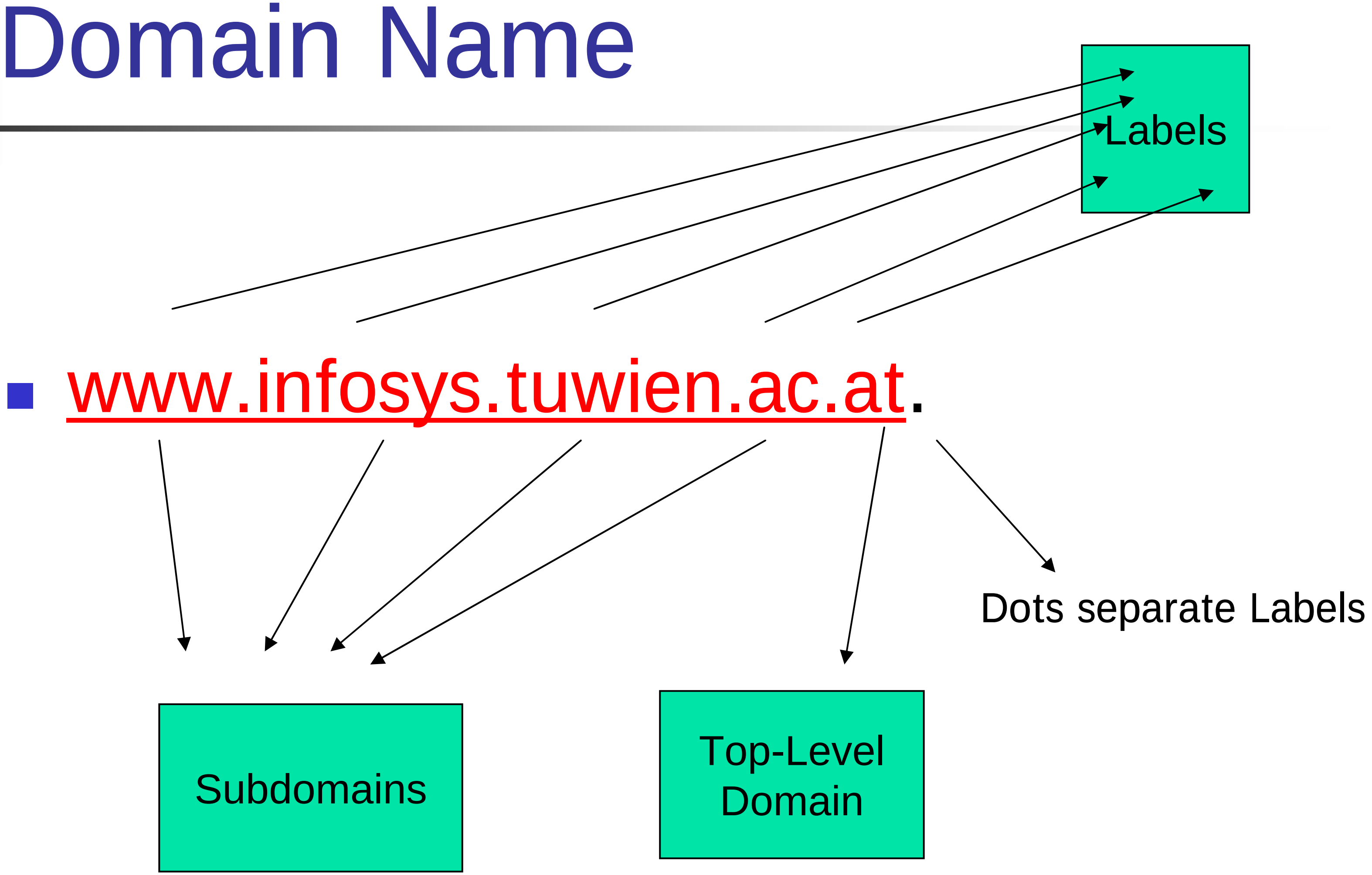
Agenda

- Domain Names
- Domain Name System
- Internationalized Domain Names

Domain Names

- Naming of Resources
- Problems of Internet's IP focus
    - IP addresses (123.25.33.44) difficult to remember
    - Event worse for IPv6
    - IPs may change
  - Name resolution
    - Host name (www.myserver.com) -> IP
  - Back resolution / reverse lookup
    - IP -> Host name
  - Additional information about hosts

Domain Name



- www.infosys.tuwien.ac.at.

Labels

Dots separate Labels

Subdomains

Top-Level Domain

HOSTS.TXT

- Original naming facility
  - RFC 810, later 952
  - Maintained by SRI NIC (Network Information Center)
- Stores address mappings
  - IP to Domains
- Disadvantage:
  - Load on central server
  - Bandwidth for distribution proportional to N^2
    - N=Number of hosts
  - Name clashes
    - Simultaneous updates

HOSTS.TXT - Example

NETWORK: 10.0.0.0 : ARPANET :

HOST: 10.2.0.11: SU-TIP,FELT-TIP :::

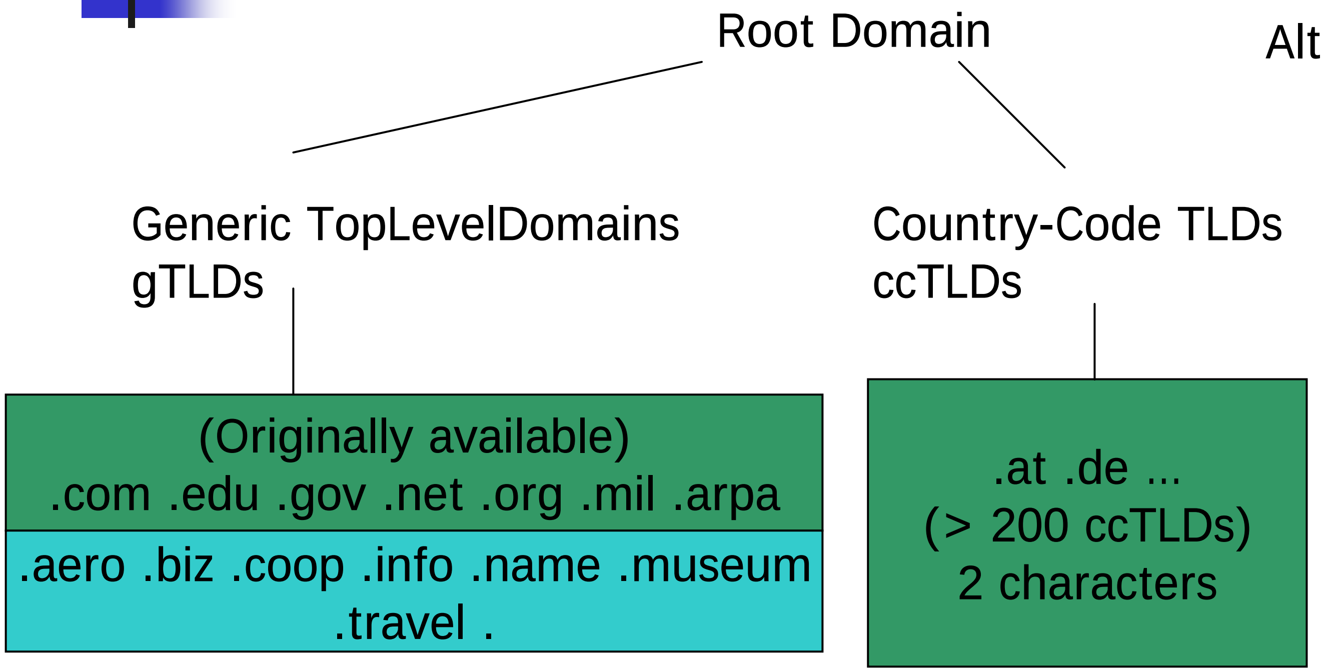
- Today different format:

ipAddress	*localhost*	*aliases*
127.0.0.1	localhost	
192.168.0.1	bar.mydomain.org	bar

Domain Name System (DNS) - Design Goals

- Consistent name space
- Distributed by design
  - Multiple servers
  - Hierarchically
    - Tree structure
    - organizations may maintain their own servers
- Names used to get
  - Host addresses
  - Mailbox Data
  - Other, yet undefined information
- Access to data critical
- Instantaneous updates less importan

Domain Name System - Structure



Root Domain

Generic TopLevelDomains gTLDs

(Originally available)
.com .edu .gov .net .org .mil .arpa

.aero .biz .coop .info .name .museum .travel .

Country-Code TLDs ccTLDs

.at .de ...
(> 200 ccTLDs)
2 characters

Alternative Root Domains

Organizations Introduce additional Inofficial TLDs

Disadvantage:
- Not useable for normal Internet users
- conflicts

.family, .med, .ngo, .men,.chem

Root domain has always an empty label!

DNS - Elements

- Resolvers
  - Programs/Routines that extract information from Name Servers
- Name Servers
  - Hold information about the domain tree‘s structure
  - May cache any information of the whole domain tree
  - In general holds information about a subset
    - Name server is an AUTHORIY for this subset
  - Authoritative information organized as
    - ZONES

Resolver

- Client part of DNS
  - triggers DNS queries
  - Parts of the OS (or libraries)
    - Convert names to IP addresses
    - IP addresses to names

Resolv.conf

- Unix OS
  - In Lab environment in /etc/resolv.conf
- Configuration how to build a name
- Configuration options
  - **nameserver** *ip-address*
    - Which nameservers (max 3) shall be used
  - **domain** *localdomainname*
  - **search** *domainname1* ...
    - extends names without . with names in searchlist
    - Mutual exclusive to domain keyword

Resolv.conf - Example

```
domain mydomain.org
nameserver 128.131.171.77
nameserver 128.131.171.212
```

or

```
search infosys.org dslab.org
nameserver 128.131.171.77
```

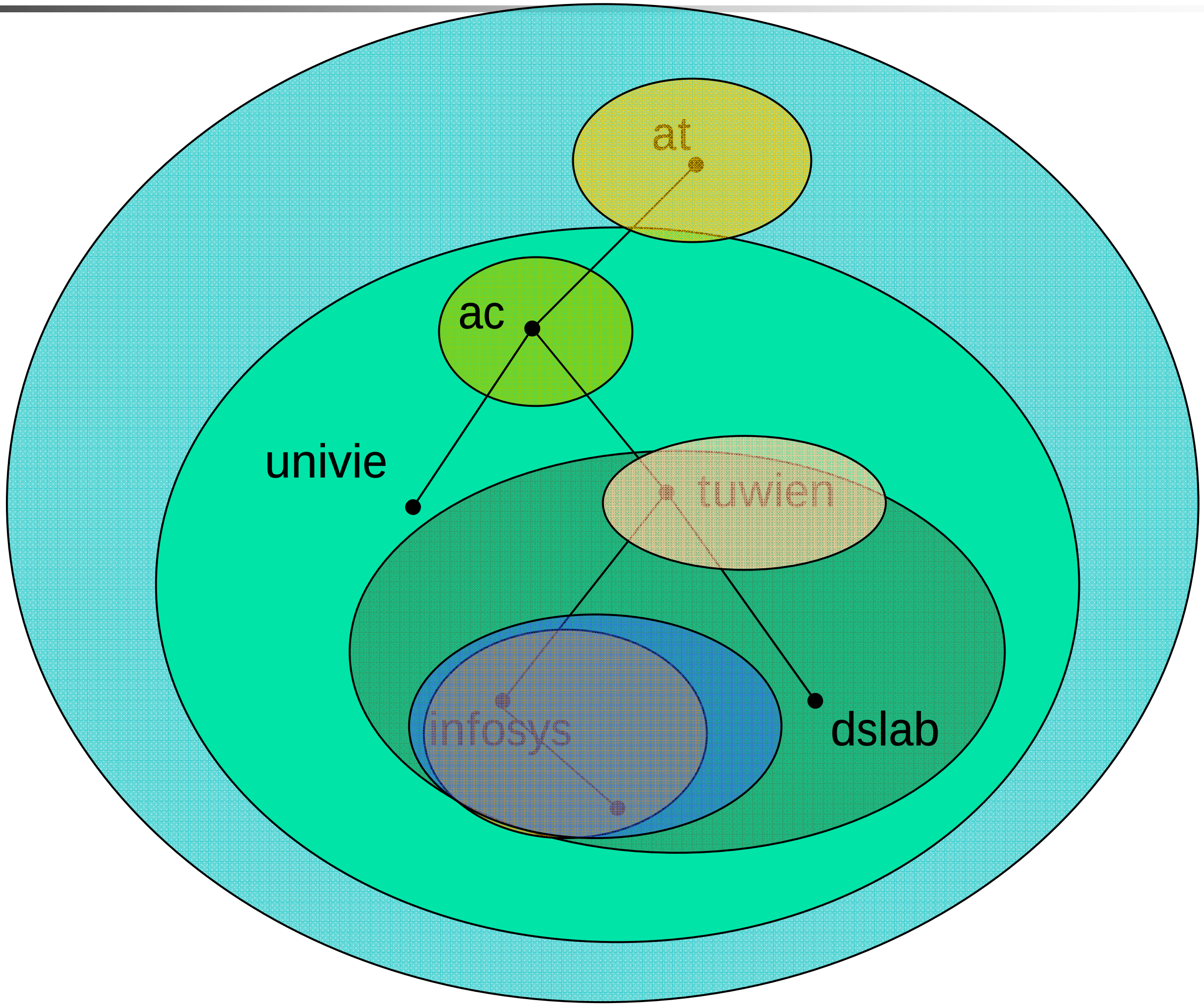
Resolver

- Iterativ
  - Queries the first (top-level) nameserver
  - Based on the result the next nameserver is queried
- Rekursiv
  - Asks the nameserver to do the whole query for the resolver
- Resolvers located at both client and server
- (Verteilte Systeme, VO)

Name Server Configuration

- Domain
  - Contains whole DNS subspace under a treenode
- Zone
  - Subdomains may be in their own zones
  - Primary/Master DNS servers have authority
  - Secondary/Slaves servers have copies of information
  - Zone files contain info about zone in resource records

Domain vs Zone

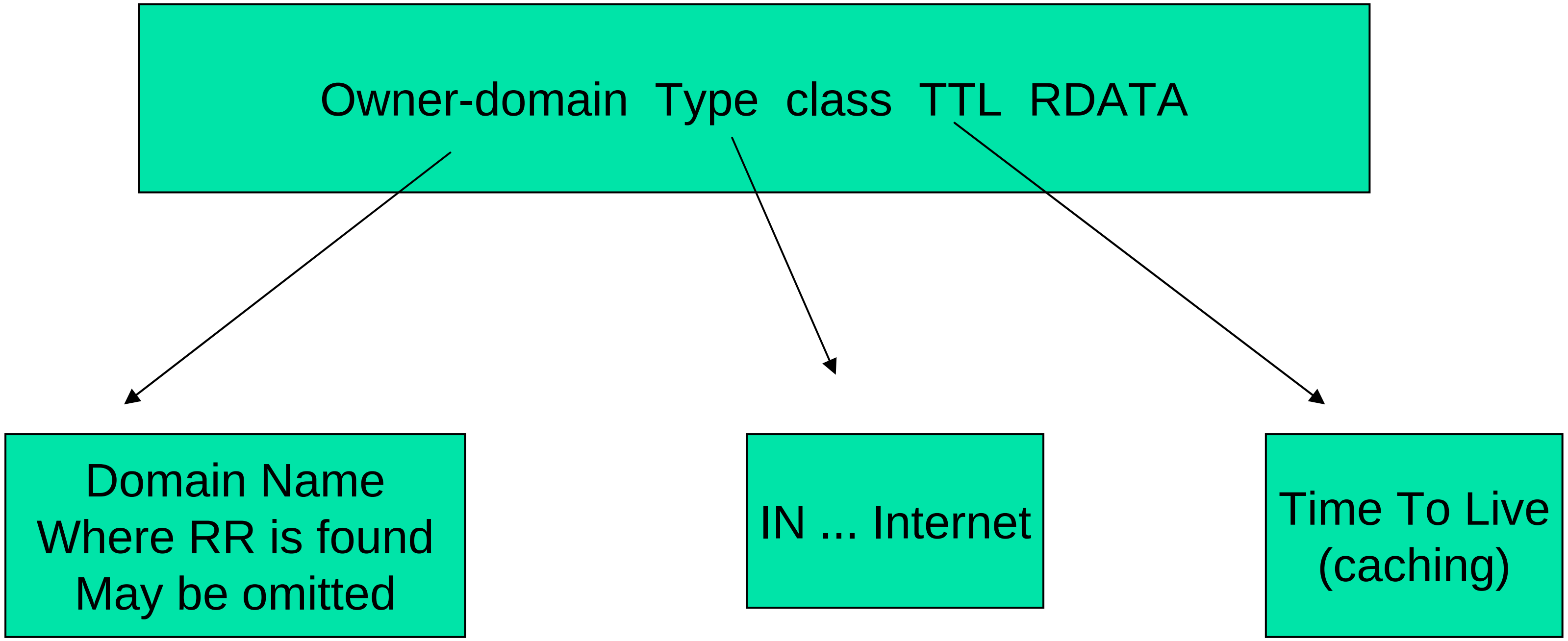


Name Servers

- Repositories that make up the domain database
- Primary task of name servers
  - Answer queries using data in its zones
    - Answer created using only local data
    - Or Referral to other name servers
  - Answers are resource records
- Name server typically supports one/more zones
- Allows partioning at points where an organization wants control
- Root.hint already installed
  - Points to root nameservers

DNS Resource Records

- Resource Record (RR)
  - Different types
- Syntax



Owner-domain Type class TTL RDATA

Domain Name
Where RR is found
May be omitted

IN ... Internet

Time To Live
(caching)

SOA Resource Record

- Defines Start Of an Authority for a zone

```
Domain IN SOA primmastersrv contactemail (
  serialnumber; Serial number
  refreshtime; how often try to refresh
  retrytime; when to retry
  expiretime; when to abandon zone info
  negativecaching; how long cache negative answers
)
```

Zone Transfers

- Multiple nameservers
  - More robust
  - Additional servers usually slave nameservers
- Where is zone information?
  - Master server zone files
  - Slave server gets from another server
- When is data updated?
  - Controlled with numbers in SOA record
  - After Refreshtime: slave checks if serial number has changed
  - If no connection was possible after refreshtime
    - wait retrytime and try refresh again
  - If no connection was possible after expiretime
    - Declare zone as invalid
  - negativecaching; how long cache negative answers
- DNS Notify
  - RFC 1996
  - Master server triggers update to slaves when serial number has changed

SOA Example

```
mydom.org. IN SOA mastersrv.mydom.org.
   dnsadmin.mail.mydom.org. (
   2006033001; serial number
   3h; refresh
   1h; retry
   1w; expire
   1h; negative Caching TTL
)
```

NS RR – Nameserver

- Defines a nameserver for this zone
- Example:

Zone IN A *Nameserver*

subdom1.org. IN NS namesrv.myorg.org.

A RR - Adress

- Maps a name to an IPv4 address
- Example:

Hostname	IN	A	ipAddress
MyHost	IN	A	1.2.3.4

CNAME RR – Assign alias

- Each host has a canonical name defined with an A record
- CNAME allows definition of alias without introducing additional host with same IP
- Example:

```
Aliasname  IN    CNAME     canonicalName
www        IN    CNAME     myHost
```

- Some applications/resolvers do not work correctly with Aliases!

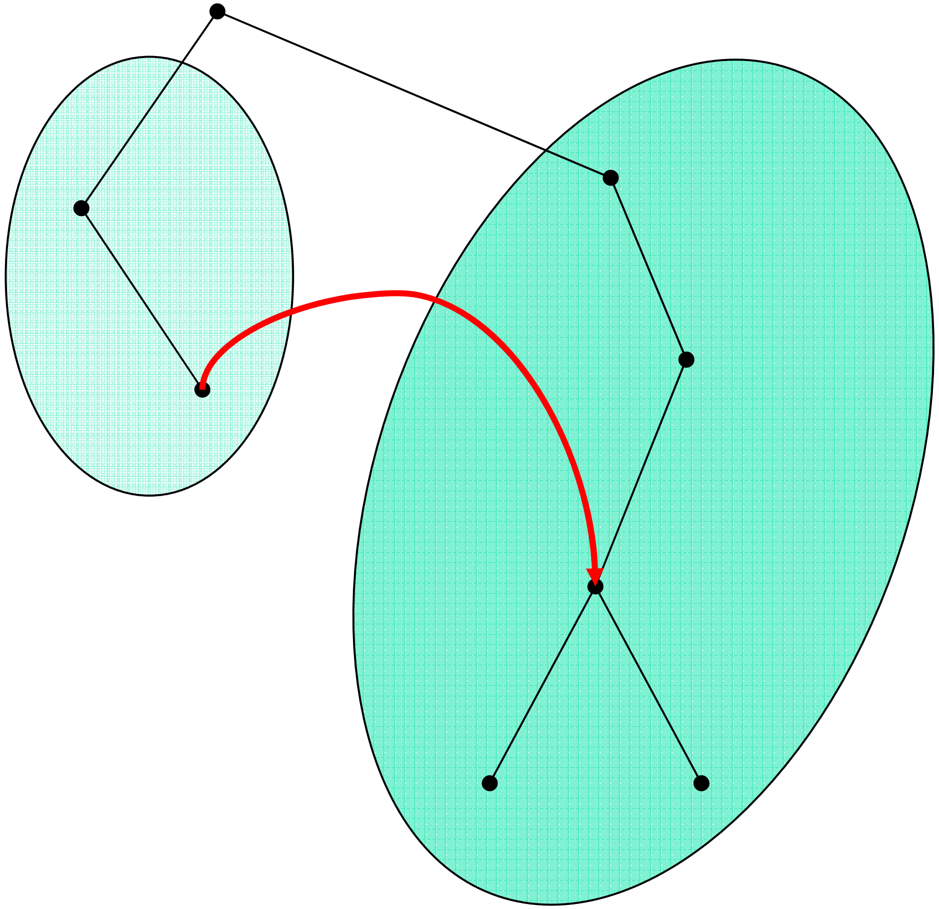
PTR RR – Point to

- Points to another part of the domain space
- Example:

```
Hostname          IN    PTR  Hostname

anotherHost.org. IN     PTR myHost.org.
```

PTR RR



PTR – Reverse Lookup

- How to get a name based on IP
  - How to do a Reverse lookup
- Parallel name space
  - .arpa tld
  - 4.3.2.1.in-addr.arpa.
  - For 1.2.3.4
- Example

```
4.3.2.1.in-addr.arpa.    IN     PTR myHost
```

- Why is order of ip Address reversed?
  - Hierarchical structure of IP addresses

AAAA – ipv6 Address

- Maps a name to an IPv6 address
  - RFC 1886
- Example:

Hostname IN AAAA ipv6 Address

ip6Host.x.y. IN AAAA 0123::ab:1234

IPv6 Reverse Mapping

- New domain ip6.int
- Like .in-addr.arpa.
- Each subdomain represents 4bits of ipV6 address, ie 1 hex character
  - No shortcut for 0s
- Example

4.3.2.1.b.a.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
0.0.0.3.2.1.0.ip6.int. IN PTR ip6host

A6 – ipV6

- RFC 2874
- Another form of specifying IPv6 addresses
  - Chain of A6 records
- Only those parts need to be specified that are controlled by the nameserver
- For the remaining bits another A6 entry is consulted, probably at another nameserver
  - Supports chaining of IPv6 addresses
- Example

ip6Host IN A6 64 ::ab:1234 parentnet.org.

DNAME – ipv6 Reverse Mapping

- Bitstring-Label
  - Parts of IPv6 Addresses
  - \[x01230000000000000000000000ab1234]
  - \[x0123/16] means bitstring with 16 significant bit
- DNAME
  - \[0x1234/16] IN DNAME ip6.m.net.
- At each step part of the bitstring will be replaced

DNAME – Nameserver entries

Root nameserver:

```
\[0x123/16]        IN      DNAME          ip6.m.net.
```

ip6.m.net:

```
\[0x00000000/32] IN    DNAME          x.y.
```

x.y:

```
\[0x00000000000000ab1234/80] IN   PTR       ip6Host.x.y.
```

DNAME – Resolving Example

Resolving \[x01230000000000000000000000ab1234]

Query at root nameserver:
\[x01230000000000000000000000ab1234]

Returns:

\[x01230000000000000000000000ab1234].ip6.arpa. IN CNAME
\[x0000000000000000000000ab1234].ip6.m.net.

Query to ip6.m.net:

\[x0000000000000000000000ab1234]

Returns:

\[x0000000000000000000000ab1234].ip6.m.net. IN CNAME

\[00000000000000ab1234].x.y.

Query to x.y.:

Finds \[00000000000000ab1234] and returns searched name.

Applications for Reverse Lookup

- Spam Prevention
  - Almost all spam emails contain forged sender addresses
  - Email sender address may easily be forged
    - It's just text!
  - Reverse Lookup off sender mail address and server mail address

DNS Security / TSIG

- Transaction Signatures (TSIG)
  - Secret Key Transaction Authentication for DNS (TSIG)
  - RFC 2845
- Authentication of DNS partners
- Data Integrity
- Secret Key
  - Known by involved DNS Servers
- Used in zone transfers, dynamic updates
- Principle
  - MD5 hash of each DNS packet
  - Stored in a TSIG Resource Record
    - NO corresponding RR in any zone file!
  - Hash verified by receiver

DNS Security / DNSSEC

- Authentication of DNS partners
- Data integrity
- Public key cryptosystem
  - KEY resource record for public key
- Private key used to digitally sign RRs
  - Creates SIG RR
- SIG-RR is delivered in each DNS transaction

Dynamic DNS

- DNS based on static database
- Dynamic Update
  - Rfc 2136
  - Allows updates of DNS from outside
    - Without intervention of administrator
- Allows Dynamic DNS (DDNS)
  - Clients have not a static IP
    - But require static name
  - After startup Dynamic Update is done on DNS server
- Updates incrementally stored in journal files
- Requires either Access Control Lists or TSIG

Server & Clients

- DNS Server
  - Bind 8 & 9
    - Berkely Internet Name Demon
  - Djbdns
    - Daniel J. Bernstein DNS
    - More secure than Bind
  - MS DNS included in Windows Server OS
- Client tools
  - nslookup
  - dig

DNS Protocol

- UDP & TCP port 53
- Header identical for query and answer
- Flags: query/response, authoritative answer recursion desired, recursion available

Identification – 16 bit	flags – 16 bit
Number of questions – 16 bit	Number answers – 16 bit
Number of authority RRs – 16 bit	Number of additional RRs – 16 bit
questions	
Answers (RRs)	
authority (RRs)	
Additional information (RRs)	

Internationalized Domain Names

- Internationalized Domain Name
  - Contains potentially non-ASCII characters
    - Eg. Österreich.at
  - Allows country-specific domain names
    - Umlaute: ä,ö,ü
    - Greek, Cyrilic, Japanese, Chinese Symbols
- Internationalizing Domain Names in Applications
  - RFC 3490
  - Based on Unicode
  - Conversion done by the application
    - DNS not involved

Internationalized Domain Names Example

- Example
  - **www.Österreich.at**
  1. Split into individual labels
     - **Österreich** (has non-US ASCII characters)
  2. Perform Nameprep algorithm
     - RFC 3491 based on StringPrep 3454
     - Normalizes string
     - **österreich**
  3. Perform Punycode algorithm (RFC 3492)
     - Removes Special Characters
     - Encodes symbol and position
     - **sterreich-z7a**
     - Prepend ACE label (ASCII Compatible Encoding): xn--

  - Result: **www.xn- -sterreich-z7a.at**

Internationalized Domain Names

- Browser support
  - Mozilla > 1,4
  - Netscape 7.1
  - Opera 7
  - IE < 7 only with plugin
  - IE 7
- Conversion Tools
  - Search for Punycode or IDN Converter