DNS Database

The DNS Database

- A set of text files such that
  - Maintained and stored on the domain’s master name server
  - Two types of entries
    - Resource Records (RR)
      - Used to store the information of
      - The real part of DNS database
    - Parser commands
      - Used to modify or manage other RR data

The DNS Database – Parser Commands

❑ Commands must start in first column and be on a line by themselves

❑ $ORIGIN domain-name

- Used to append to un-fully-qualified name

❑ $INCLUDE file-name

- Separate logical pieces of a zone file
- Keep cryptographic keys with restricted permissions

❑ $TTL default-ttl

- Default value for time-to-live filed of records

❑ $GENERATE start-stop/[step] lhs type rhs

- Used to generate a series of similar records
- Can be used in only CNAME, PTR, NS record types

The DNS Database
– Resource Record (1)

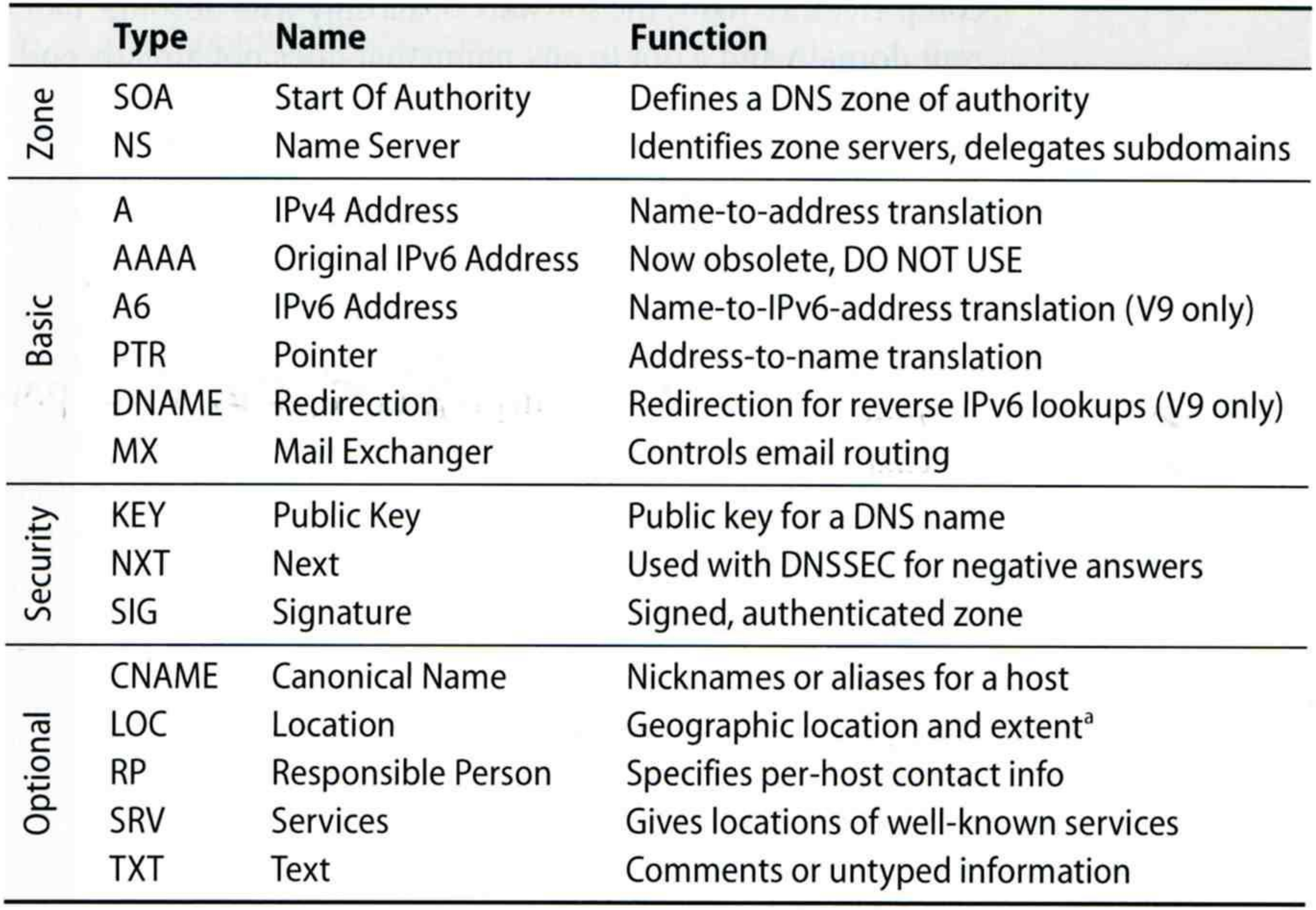
❑ Basic format

- [name] [ttl] [class] type data
    - ➢ name: the entity that the RR describes
        - – Can be relative or absolute
    - ➢ ttl: time in second of this RR’s validity in cache
    - ➢ class: network type
        - – IN for Internet
        - – CH for ChaosNet
        - – HS for Hesiod
- Special characters
    - ➢ ; (comment)
    - ➢ @ (The current domain name)
    - ➢ () (allow data to spam lines
    - ➢ * (wild card character, *name* filed only)

The DNS Database – Resource Record (2)

- ❑ Type of resource record discussed later
  - Zone records: **identify domains and name servers**
    - **SOA**
    - **NS**
  - Basic records: **map names to addresses and route mail**
    - **A**
    - **PTR**
    - **MX**
  - Optional records: **extra information to host or domain**
    - **CNAME**
    - **TXT**
    - **LOC**
    - **SRV**

The DNS Database – Resource Record (3)



	Type	Name	Function
Zone	SOA	Start Of Authority	Defines a DNS zone of authority
	NS	Name Server	Identifies zone servers, delegates subdomains
Basic	A	IPv4 Address	Name-to-address translation
	AAAA	Original IPv6 Address	Now obsolete, DO NOT USE
	A6	IPv6 Address	Name-to-IPv6-address translation (V9 only)
	PTR	Pointer	Address-to-name translation
	DNAME	Redirection	Redirection for reverse IPv6 lookups (V9 only)
	MX	Mail Exchanger	Controls email routing
Security	KEY	Public Key	Public key for a DNS name
	NXT	Next	Used with DNSSEC for negative answers
	SIG	Signature	Signed, authenticated zone
Optional	CNAME	Canonical Name	Nicknames or aliases for a host
	LOC	Location	Geographic location and extent[a]
	RP	Responsible Person	Specifies per-host contact info
	SRV	Services	Gives locations of well-known services
	TXT	Text	Comments or untyped information

The DNS Database – Resource Record (4)

- SOA: Start Of Authority
  - Defines a DNS zone of authority, each zone has exactly one SOA record.
  - Specify the name of the zone, the technical contact and various timeout information
  - Format:
    - **[zone] IN SOA [server-name] [administrator's mail] (serial, refresh, retry, expire, ttl)**
  - Ex:

;	means comments
@	means current domain name
( )	allow data to span lines
*	Wild card character

```
$TTL 3600;
$ORIGIN cs.nctu.edu.tw.
@       IN      SOA     csns.cs.nctu.edu.tw.    root.cs.nctu.edu.tw.    (
                        2007052102              ; serial number
                        1D                      ; refresh time for slave server
                        30M                     ; retry
                        1W                      ; expire
                        2H      )               ; minimum
```

The DNS Database – Resource Record (5)

❑ NS: Name Server

- Identify the authoritative server for a zone
- Usually follow the SOA record
- Every authoritative name servers should be listed both in current domain and parent domain zone files
  - ➢ Delegation purpose
  - ➢ Ex: cs.nctu.edu.tw and nctu.edu.tw

```
$TTL 3600;
$ORIGIN cs.nctu.edu.tw.
@       IN      SOA     csns.cs.nctu.edu.tw.    root.cs.nctu.edu.tw.    (
                        2007052102              ; serial number
                        1D                      ; refresh time for slave server
                        30M                     ; retry
                        1W                      ; expire
                        2H      )               ; minimum
        IN      NS      dns.cs.nctu.edu.tw.
        IN      NS      dns2.cs.nctu.edu.tw.
```

The DNS Database – Resource Record (6)

❑ A record: Address

- Provide mapping from hostname to IP address
- Ex:

```
$ORIGIN cs.nctu.edu.tw.
@         IN      NS       dns.cs.nctu.edu.tw.
          IN      NS       dns2.cs.nctu.edu.tw.
dns       IN      A        140.113.235.107
dns2      IN      A        140.113.235.103

www       IN      A        140.113.235.111
```

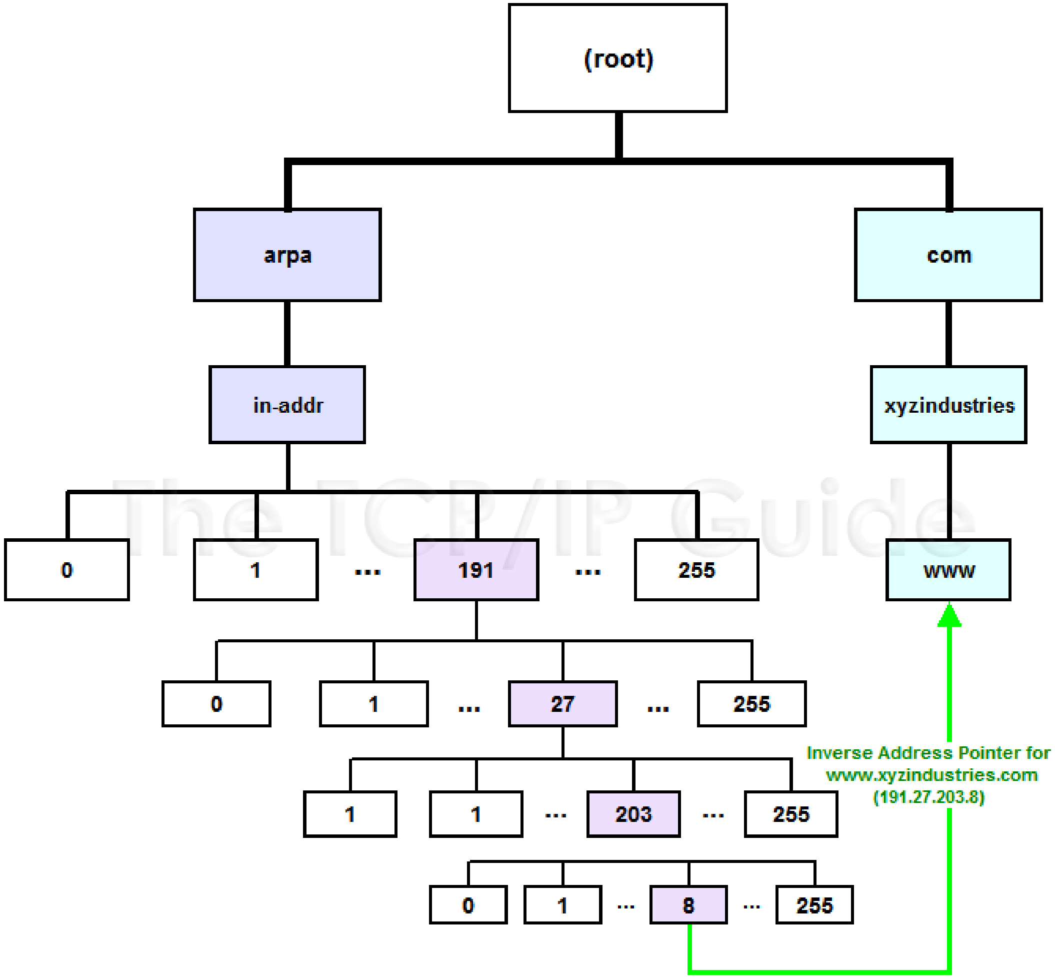
The DNS Database – Resource Record (7)

❑ PTR: Pointer

- Perform the reverse mapping from IP address to hostname
- Special top-level domain: in-addr.arpa
  - ➢ Used to create a naming tree from IP address to hostnames

```
$TTL 259200;
$ORIGIN 235.113.140.in-addr.arpa.
@       IN      SOA     csns.cs.nctu.edu.tw. root.cs.nctu.edu.tw.    (
                        2007052102                  ; serial
                        1D                          ; refresh time for secondary server
                        30M                         ; retry
                        1W                          ; expire
                        2H)                         ; minimum
        IN      NS      dns.cs.nctu.edu.tw.
        IN      NS      dns2.cs.nctu.edu.tw.
$ORIGIN in-addr.arpa.
103.235.113.140         IN PTR csmailgate.cs.nctu.edu.tw.
107.235.113.140         IN PTR csns.cs.nctu.edu.tw.
```

The DNS Database – Resource Record (8)



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The DNS Database – Resource Record (9)

- ❑ MX: Mail exchanger
  - Direct mail to a mail hub rather than the recipient’s own workstation
  - Ex:

```
$TTL 3600;
$ORIGIN cs.nctu.edu.tw.
@       IN      SOA     csns.cs.nctu.edu.tw.   root.cs.nctu.edu.tw.   (
                    2007052102      ; serial number
                    1D              ; refresh time for slave server
                    30M              ; retry
                    1W              ; expire
                    2H      )       ; minimum
      IN      NS      dns.cs.nctu.edu.tw.
      IN      NS      dns2.cs.nctu.edu.tw.
      7200   IN   MX  1 csmx1.cs.nctu.edu.tw.
      7200   IN   MX  5 csmx2.cs.nctu.edu.tw.

csmx1   IN      A       140.113.235.104
csmx2   IN      A       140.113.235.105
```

The DNS Database – Resource Record (10)

❑ CNAME: Canonical name

- nikename [ttl] IN CNAME hostname
- Add additional names to a host
  - ➢ To associate a function or to shorten a hostname
- CNAME record can nest eight deep in BIND
- Other records must refer to its real hostname
- Not for load balance
- Ex:

```
www             IN      A       140.113.209.63
                IN      A       140.113.209.77
penghu-club     IN      CNAME   www
King            IN      CNAME   www

R21601          IN      A       140.113.214.31
superman        IN      CNAME   r21601
```

The DNS Database – Resource Record (11)

❑ TXT: Text

- Add arbitrary text to a host’s DNS records

```
$TTL 3600;
$ORIGIN cs.nctu.edu.tw.
@       IN      SOA     csns.cs.nctu.edu.tw.    root.cs.nctu.edu.tw.    (
                        2007052102      ; serial number
                        1D                      ; refresh time for slave server
                        30M                     ; retry
                        1W                      ; expire
                        2H      )               ; minimum
        IN      NS      dns.cs.nctu.edu.tw.
        IN      NS      dns2.cs.nctu.edu.tw.

        IN      TXT     “Department of Computer Science”
```

The DNS Database
– Resource Record (12)

- LOC: Location
  - Describe the geographic location and physical size of a DNS object
  - Format:
    - name [ttl] IN LOC latitude longitude [altitude [size [hp [vp]]]]
      - latitude 緯度
      - longitude 經度
      - altitude 海拔
      - size: diameter of the bounding sphere
      - hp: horizontal precision
      - vp: vertical precision

```
caida.org.          IN        LOC       32 53 01 N 117 14 25 W 107m 30m 18m 15m
```

The DNS Database – Resource Record (13)

❑ SRV: Service

- Specify the location of services within a domain
- Format:
  - ➢ service.proto.name [ttl] IN SRV pri weight port target
- Ex:

```
; don’t allow finger
finger.tcp          SRV     0       0       79      .
; 1/4 of the connections to old, 3/4 to the new
ssh.tcp             SRV     0       1       22      old.cs.colorado.edu.
ssh.tcp             SRV     0       3       22      new.cs.colorado.edu.
; www server
http.tcp            SRV     0       0       80      www.cs.colorado.edu.
                    SRV     10      0       8000    new.cs.colorado.edu
; block all other services
*.tcp               SRV     0       0       0       .
*.udp               SRV     0       0       0       .
```

The DNS Database – Resource Record (14)

- ❑ Glue record – Link between zones
  - Parent zone needs to contain the NS records for each delegated zone
  - Ex: In zone files of nctu, it might contain:

```
cs          IN    NS    dns.cs.nctu.edu.tw.
            IN    NS    dns2.cs.nctu.edu.tw.
dns.cs      IN    A     140.113.235.107
dns2.cs     IN    A     140.113.235.103

ee          IN    NS    ns.ee.nctu.edu.tw.
            IN    NS    dns.ee.nctu.edu.tw.
            IN    NS    reds.ee.nctu.edu.tw.
ns.ee       IN    A     140.113.212.150
dns.ee      IN    A     140.113.11.4
reds.ee     IN    A     140.113.202.1
```

- ❑ Lame delegation
  - DNS subdomain administration has delegate to you and you never use the domain or parent domain’s glue record is not updated

BIND configuration

BIND

- ❑ BIND
  - the Berkeley Internet Name Domain system
- ❑ Main versions
  - BIND4
    - ➢ Announced in 1980s
    - ➢ Based on RFC 1034, 1035
  - BIND8
    - ➢ Released in 1997
    - ➢ Improvements including:
      - – efficiency, robustness and security
  - BIND9
    - ➢ Released in 2000
    - ➢ Enhancements including:
      - – multiprocessor support, DNSSEC, IPv6 support, etc

BIND – components

❑ Three major components

- named
  - ➢ Daemon that answers the DNS query
  - ➢ Perform Zone transfer
- Library routines
  - ➢ Routines that used to resolve host by contacting the servers of DNS distributed database
    - – Ex: res_query, res_search, ...etc.
- Command-line interfaces to DNS
  - ➢ Ex: nslookup, dig, hosts

named in FreeBSD

- ❑ startup
  - Edit /etc/rc.conf
    - ➢ named_enable="YES"
  - Manual utility command
    - ➢ % rndc {stop | reload | flush …}
      - – In old version of BIND, use ndc command
- ❑ Configuration files
  - /etc/namedb/named.conf (Configuration file)
  - /etc/namedb/named.root (DNS root server cache hint file)
  - Zone data files
- ❑ See your BIND version
  - % dig @127.0.0.1 version.bin txt chaos
    - ➢ version.bind. 0 CH TXT "9.3.3"

BIND Configuration – named.conf

- ❑ /etc/namedb/named.conf
  - Roles of this name server
    - Master, slave, or stub
  - Global options
  - Zone specific options

- ❑ named.conf is composed of following statements:
  - include, options, server, key, acl, zone, view, controls, logging, trusted-keys

BIND Configuration – named.conf address match list

- Address Match List
  - A generalization of an IP address that can include:
    - An IP address
      - Ex. 140.113.17.1
    - An IP network with CIDR netmask
      - Ex. 140.113/16
    - The ! character to do negate
    - The name of a previously defined ACL
    - A cryptographic authentication key
  - First match
  - Example:
    - {!1.2.3.4; 1.2.3/24;};
    - {128.138/16; 198.11.16/24; 204.228.69/24; 127.0.0.1;};

BIND Configuration – named.conf acl

❑ The “acl” statement

- Define a class of access control
- Define before they are used
- Syntax

```
acl acl_name {
    address_match_list
};
```

- Predefined acl classes
  - any, localnets, localhost, none
- Example

```
acl CSnets {
   140.113.235/24; 140.113.17/24; 140.113.209/24; 140.113.24/24;
};
acl NCTUnets {
  140.113/16; 10.113/16; 140.126.237/24;
};

allow-transfer {localhost; CSnets; NCTUnets};
```

BIND Configuration – named.conf key

❑ The “key” statement

- Define a encryption key used for authentication with a particular server
- Syntax

```
key key-id {
    algorithm string;
    secret string;
}
```

- Example:

```
key serv1-serv2 {
        algorithm hmac-md5;
        secret “ibkAlUA0XXAXDxWRTGeY+d4CGbOgOIr7n63eizJFHQo=”
}
```

- This key is used to
  - ➢ Sign DNS request before sending to target
  - ➢ Validate DNS response after receiving from target

BIND Configuration – named.conf include

❑ The “include” statement

- Used to separate large configuration file
- Another usage is used to separate cryptographic keys into a restricted permission file
- Ex:

```
include "/etc/namedb/rndc.key";

-rw-r--r--  1 root  wheel  4947 Mar  3  2006 named.conf
-rw-r-----  1 bind  wheel    92 Aug 15  2005 rndc.key
```

- If the path is relative
  - ➢ Relative to the directory option

BIND Configuration – named.conf option (1)

- The “option” statement
  - Specify global options
  - Some options may be overridden later for specific zone or server
  - Syntax:

```
options {
    option;
    option;
};
```

- There are about 50 options in BIND9
  - version “There is no version.”; [real version num]
    - version.bind. 0 CH TXT “9.3.3”
    - version.bind. 0 CH TXT “There is no version.”
  - directory “/etc/namedb/db”;
    - Base directory for relative path and path to put zone data files

BIND Configuration – named.conf option (2)

- notify yes | no [yes]
  - Whether notify slave sever when relative zone data is changed
- also-notify 140.113.235.101; [empty]
  - Also notify this non-advertised NS server
- recursion yes | no [yes]
  - Recursive name server
- allow-recursion {address_match_list }; [all]
  - Finer granularity recursion setting
- check-names {master|slave|response action};
  - check hostname syntax validity
    - Letter, number and dash only
    - 64 characters for each component, and 256 totally
  - Action:

ignore:	do no checking
warn:	log bad names but continue
fail:	log bad names and reject

  - default action

master	fail
slave	warn
response	ignore

BIND Configuration
– named.conf option (3)

- listen-on port ip_port address_match_list; [53, all]
  - NIC and ports that named listens for query
  - Ex: listen-on port 5353 {192.168.1/24;};
- query-source address ip_addr port ip_port; [random]
  - NIC and port to send DNS query
- forwarders {in_addr; …}; [empty]
  - Often used in cache name server
  - Forward DNS query if there is no answer in cache
- forward only | first; [first]
  - If forwarder does not response, queries for forward only server will fail
- allow-query address_match_list; [all]
  - Specify who can send DNS query to you
- allow-transfer address_match_list; [all]
  - Specify who can request zone transfer of your zone data
- blackhole address_match_list; [empty]
  - Reject queries and would never ask them for answers

BIND Configuration – named.conf option (4)

- transfer-format one-answer | many-answers; [many-answers]
  - Ways to transfer data records from master to slave
  - How many data records in single packet
  - Added in BIND 8.1
- transfers-in num; [10]
- transfers-out num; [10]
  - Limit of the number of inbound and outbound zone transfers concurrently
- transfers-per-ns num; [2]
  - Limit of the inbound zone transfers concurrently from the same remote server
- transfer-source IP-address;
  - IP of NIC used for inbound transfers

BIND Configuration – named.conf server

- The “server” statement
  - Tell named about the characteristics of its remote peers
  - Syntax

```
server ip_addr {
    bogus no|yes;
    provide-ixfr yes|no;    (for master)
    request-ixfr yes|no;    (for slave)
    transfers num;
    transfer-format many-answers|one-answer;
    keys { key-id; key-id};
};
```

  - ixfr
    - Incremental zone transfer
  - transfers
    - Limit of number of concurrent inbound zone transfers from that server
    - Server-specific transfers-in
  - keys
    - Any request sent to the remote server is signed with this key

BIND Configuration – named.conf zone (1)

❑ The “zone” statement

- Heart of the named.conf that tells named about the zones that it is authoritative
- zone statement format varies depending on roles of named
  - ➢ Master or slave
- The zone file is just a collection of DNS resource records
- Basically

```
Syntax:
zone "domain_name" {
        type master | slave| stub;
        file "path”;
        masters {ip_addr; ip_addr;};
        allow-query {address_match_list};                [all]
        allow-transfer { address_match_list};            [all]
        allow-update {address_match_list};               [empty]
};
```

allow-update cannot be used for a slave zone

BIND Configuration – named.conf zone (2)

- Master server zone configuration

```
zone "ce.nctu.edu.tw" IN {
    type master;
    file "named.hosts";
    allow-query { any; };
    allow-transfer { localhost; CS-DNS-Servers; };
    allow-update { none; };
};
```

- Slave server zone configuration

```
zone "cs.nctu.edu.tw" IN {
    type slave;
    file "cs.hosts";
    masters { 140.113.235.107; };
    allow-query { any; };
    allow-transfer { localhost; CS-DNS-Servers; };
};
```

BIND Configuration – named.conf zone (3)

- ❑ Forward zone and reverse zone

```
zone "cs.nctu.edu.tw" IN {
    type master;
    file "named.hosts";
    allow-query { any; };
    allow-transfer { localhost; CS-DNS-Servers; };
    allow-update { none; };
};
```

```
zone "235.113.140.in-addr.arpa" IN {
    type master;
    file "named.235.rev";
    allow-query { any; };
    allow-transfer { localhost; CS-DNS-Servers; };
    allow-update { none; };
};
```

BIND Configuration – named.conf zone (4)

❑ Example

- In named.hosts, there are plenty of A or CNAME records

```
…
bsd1            IN      A       140.113.235.131
csbsd1          IN      CNAME   bsd1
bsd2            IN      A       140.113.235.132
bsd3            IN      A       140.113.235.133
bsd4            IN      A       140.113.235.134
bsd5            IN      A       140.113.235.135
…
```

- In named.235.rev, there are plenty of PTR records

```
…
131.235.113.140    IN    PTR    bsd1.cs.nctu.edu.tw.
132.235.113.140    IN    PTR    bsd2.cs.nctu.edu.tw.
133.235.113.140    IN    PTR    bsd3.cs.nctu.edu.tw.
134.235.113.140    IN    PTR    bsd4.cs.nctu.edu.tw.
135.235.113.140    IN    PTR    bsd5.cs.nctu.edu.tw.
…
```

BIND Configuration – named.conf zone (5)

- Setting up root hint
  - A cache of where are the DNS root servers

```
zone “." IN {
    type hint;
    file "named.root";
};
```

- Setting up forwarding zone
  - Forward DNS query to specific name server, bypassing the standard query path

```
zone "nctu.edu.tw" IN {
    type forward;
    forward first;
    forwarders { 140.113.250.135; 140.113.1.1; };
};

zone "113.140.in-addr.arpa" IN {
    type forward;
    forward first;
    forwarders { 140.113.250.135; 140.113.1.1; };
};
```

BIND Configuration – named.conf view (1)

- The "view" statement
  - Create a different view of DNS naming hierarchy for internal machines
    - Restrict the external view to few well-known servers
    - Supply additional records to internal users
  - Also called "split DNS"
  - In-order processing
    - Put the most restrictive view first
  - All-or-nothing
    - All zone statements in your named.conf file must appear in the content of view

BIND Configuration – named.conf view (2)

- Syntax

```
view view-name {
        match_clients {address_match_list};
        view_options;
        zone_statement;
};
```

- Example

```
view “internal” {
        match-clients {our_nets;};
        recursion yes;
        zone “cs.nctu.edu.tw” {
                type master;
                file “named-internal-cs”;
        };
};
view “external” {
 match-clients {any;};
        recursion no;
        zone “cs.nctu.edu.tw” {
                type master;
                file “named-external-cs”;
        };
};
```

BIND Configuration
– named.conf controls

❑ The “controls” statement

- Specify how the named server listens for control message
- Syntax

  controls {

  inet ip_addr **allow** {address_match_list} **keys** {key-id;};

  };

- Example:

```
key "rndc_key" {
    algorithm       hmac-md5;
    secret "GKnELuie/G99NpOC2/AXwA==";
};
```

```
include "/etc/named/rndc.key";
controls {
    inet 127.0.0.1  allow {127.0.0.1;}   keys {rndc_key;};
}
```

```
SYNOPSIS
        rndc [-c config-file] [-k key-file] [-s server] [-p port] [-V]
              [-y key_id] {command}
```

BIND Configuration – rndc

- RNDC – remote name daemon control
  - reload, restart, status, dumpdb, …..
  - rndc-confgen

```
# Start of rndc.conf
key "rndc-key" {
        algorithm hmac-md5;
        secret "ayVEG7gJJdx+AMhA8+9jbg==";
};

options {
        default-key "rndc-key";
        default-server 127.0.0.1;
        default-port 953;
};
# End of rndc.conf
```

```
SYNOPSIS
       rndc [-c config-file] [-k key-file] [-s server] [-p port] [-V]
            [-y key_id] {command}
```

Updating zone files

- ❑ Master
  - Edit zone files
    - ➢ Serial number
    - ➢ Forward and reverse zone files for single IP
  - Do “rndc reload”
    - ➢ 〝notify〞 is on, slave will be notify about the change
    - ➢ 〝notify〞 is off, refresh timeout, or do 〝rndc reload〞 in slave
- ❑ Zone transfer
  - DNS zone data synchronization between master and slave servers
  - AXFR (all zone data are transferred at once, before BIND8.2)
  - IXFR (incremental updates zone transfer)
  - TCP port 53

Dynamic Updates

- ❑ The mappings of name-to-address are relatively stable
- ❑ DHCP will dynamically assign IP addresses to the hosts
  - Hostname-based logging or security measures become very difficulty

```
dhcp-host1.domain          IN       A         192.168.0.1
dhcp-host2.domain          IN       A         192.168.0.2
```

- ❑ Dynamic updates
  - BIND allows the DHCP daemon to notify the updating RR contents
  - Using allow-update
  - nsupdate
  - DDNS – dynamic DNS

Non-byte boundary (1)

❑ In normal reverse configuration:

- named.conf will define a zone statement for each reverse subnet zone and
- Your reverse db will contains lots of PTR records
- Example:

```
zone "1.168.192.in-addr.arpa." {
    type master;
    file "named.rev.1";
    allow-query {any;};
    allow-update {none;};
    allow-transfer {localhost;};
};
```

```
$TTL     3600
$ORIGIN 1.168.192.in-addr.arpa.
@        IN       SOA      chwong.csie.net chwong.chwong.csie.net.   (
                           2007050401       ; Serial
                           3600             ; Refresh
                           900              ; Retry
                           7D               ; Expire
                           2H )             ; Minimum
         IN       NS       ns.chwong.csie.net.
254      IN       PTR      ns.chwong.csie.net.
1        IN       PTR      www.chwong.csie.net.
2        IN       PTR      ftp.chwong.csie.net.
…
```

Non-byte boundary (2)

- ❑ What if you want to delegate 192.168.2.0 to another sub-domain
  - Parent
    - ➢ **Remove** forward db about 192.168.2.0/24 network
      - – Ex:

```
pc1.chwong.csie.net.    IN   A    192.168.2.35
pc2.chwong.csie.net.    IN   A    192.168.2.222
…
```

    - ➢ **Remove** reverse db about 2.168.192.in-addr.arpa
      - – Ex:

```
35.2.168.192.in-addr.arpa.       IN   PTR   pc1.chwong.csie.net.
222.2.168.192.in-addr.arpa.      IN   PTR   pc2.chwong.csie.net.
…
```

    - ➢ Add glue records about the name servers of sub-domain
      - – Ex: in zone db of “chwong.csie.net”

```
sub1          IN          NS     ns.sub1.chwong.csie.net.
ns.sub1       IN          A      192.168.2.1
```

      - – Ex: in zone db of “168.192.in-addr.arpa.”

```
2             IN          NS     ns.sub1.chwong.csie.net.
1.2           IN          PTR    ns.sub1.chwong.csie.net
```

Non-byte boundary (3)

- ❑ What if you want to delegate 192.168.3.0 to four sub-domains (a /26 network)
  - 192.168.3.0 ~ 192.168.3.63
    - ns.sub1.chwong.csie.net.
  - 192.168.3.64 ~ 192.168.3.127
    - ns.sub2.chwong.csie.net.
  - 192.168.3.128 ~ 192.168.3.191
    - ns.sub3.chwong.csie.net.
  - 192.168.3.192 ~ 192.168.3.255
    - ns.sub4.chwong.csie.net.

- ❑ It is easy for forward setting
  - In zone db of chwong.csie.net

```
➢ sub1              IN          NS   ns.sub1.chwong.csie.net.
➢ ns.sub1           IN          A    1921.68.3.1
➢ sub2              IN          NS   ns.sub2.chwong.csie.net.
➢ ns.sub2           IN          A    192.168.3.65
➢ …
```

Non-byte boundary (4)

- ❑ Non-byte boundary reverse setting
  - Method1

```
$GENERATE 0-63      $.3.168.192.in-addr.arpa.     IN   NS     ns.sub1.chwong.csie.net.
$GENERATE 64-127    $.3.168.192.in-addr.arpa.     IN   NS     ns.sub2.chwong.csie.net.
$GENERATE 128-191   $.3.168.192.in-addr.arpa.     IN   NS     ns.sub3.chwong.csie.net.
$GENERATE 192-255   $.3.168.192.in-addr.arpa.     IN   NS     ns.sub4.chwong.csie.net.

And

zone “1.3.168.192.in-addr.arpa.” {
    type master;
    file “named.rev.192.168.3.1”;
};

; named.rev.192.168.3.1
@    IN   SOA     sub1.chwong.csie.net. root.sub1.chwong.csie.net. (1;3h;1h;1w;1h)
     IN   NS      ns.sub1.chwong.csie.net.
```

Non-byte boundary (5)

- Method2

```
$ORIGIN  3.168.192.in-addr.arpa.
$GENERATE  1-63             $          IN   CNAME     $.0-63.3.168.192.in-addr.arpa.
0-63.3.168.192.in-addr.arpa.           IN   NS        ns.sub1.chwong.csie.net.
$GENERATE  65-127           $          IN   CNAME     $.64-127.3.168.192.in-addr.arpa.
64-127.3.168.192.in-addr.arpa.         IN   NS        ns.sub2.chwong.csie.net.
$GENERATE  129-191          $          IN   CNAME     $.128-191.3.168.192.in-addr.arpa.
128-191.3.168.192.in-addr.arpa.        IN   NS        ns.sub3.chwong.csie.net.
$GENERATE  193-255          $          IN   CNAME     $.192-255.3.168.192.in-addr.arpa.
192-255.3.168.192.in-addr.arpa.        IN   NS        ns.sub4.chwong.csie.net.

zone “0-63.3.168.192.in-addr.arpa.” {
    type master;
    file “named.rev.192.168.3.0-63”;
};
```

```
        ; named.rev.192.168.3.0-63
        @    IN    SOA   sub1.chwong.csie.net. root.sub1.chwong.csie.net. (1;3h;1h;1w;1h)
             IN    NS    ns.sub1.chwong.csie.net.
1    IN    PTR  www.sub1.chwong.csie.net.
2    IN    PTR  abc.sub1.chwong.csie.net.
…
```

BIND Security

Security
– named.conf security configuration

- ❑ Security configuration

Feature	Config. Statement	comment
allow-query	options, zone	Who can query
allow-transfer	options, zone	Who can request zone transfer
allow-update	zone	Who can make dynamic updates
blackhole	options	Which server to completely ignore
bogus	server	Which servers should never be queried

Security – With TSIG (1)

- TSIG (Transaction SIGnature)
  - Developed by IETF (RFC2845)
  - Symmetric encryption scheme to sign and validate DNS requests and responses between servers
  - Algorithm in BIND9
    - HMAC-MD5, DH (Diffie Hellman)
  - Usage
    - Prepare the shared key with dnssec-keygen
    - Edit "key" statement
    - Edit "server" statement to use that key
    - Edit "zone" statement to use that key with:
      - allow-query
      - allow-transfer
      - allow-update

Security
– With TSIG (2)

- TSIG example (dns1 with dns2)

1. % dnssec-keygen –a HMAC-MD5 –b 128 –n HOST cs

```
% dnssec-keygen -a HMAC-MD5 -b 128 -n HOST cs
Kcs.+157+35993
% cat Kcs.+157+35993.key
cs.  IN KEY 512 3 157 oQRab/QqXHVhkyXi9uu8hg==
```

```
% cat Kcs.+157+35993.private
Private-key-format: v1.2
Algorithm: 157 (HMAC_MD5)
Key: oQRab/QqXHVhkyXi9uu8hg==
```

2. Edit /etc/named/dns1-dns2.key

```
key dns1-dns2 {
    algorithm hmac-md5;
    secret “oQRab/QqXHVhkyXi9uu8hg==”
};
```

3. Edit both named.conf of dns1 and dns2
   - Suppose dns1 = 140.113.235.107 dns2 = 140.113.235.103

```
include  “dns1-dns2.key”
server 140.113.235.103 {
    keys {dns1-dns2;};
};
```

```
include  “dns1-dns2.key”
server 140.113.235.107 {
    keys {dns1-dns2;};
};
```

BIND Debugging and Logging

Logging (1)

- ❑ Terms
  - Channel
    - ➢ A place where messages can go
    - ➢ Ex: syslog, file or /dev/null
  - Category
    - ➢ A class of messages that named can generate
    - ➢ Ex: answering queries or dynamic updates
  - Module
    - ➢ The name of the source module that generates the message
  - Facility
    - ➢ syslog facility name
  - Severity
    - ➢ Priority in syslog
- ❑ Logging configuration
  - Define what are the channels
  - Specify where each message category should go
- ❑ When a message is generated
  - It is assigned a “category”, a “module”, a “severity”
  - It is distributed to all channels associated with its category

Logging (2)

- The "logging" statement
  - Either "file" or "syslog" in channel sub-statement
    - size:
      - ex: 2048, 100k, 20m, 15g, unlimited, default
    - facility:
      - ex: daemon, local0 ~ local7
    - severity:
      - critical, error, warning, notice, info, debug (with an optional numeric level), dynamic
      - Dynamic is recognized and matches the server's current debug level

```
logging {
    channel_def;
    channel_def;
    …
    category category_name {
        channel_name;
            channel_name;
        …
    };
};
```

```
channel channel_name {
    file path [versions num|unlimited] [size siznum];
    syslog facility;

    severity severity;
    print-category yes|no;
    print-severity yes|no;
    print-time yes|no;
};
```

Logging (3)

- ❑ Predefined channels

default_syslog	Sends severity info and higher to syslog with facility daemon
default_debug	Logs to file "named.run", severity set to dynamic
default_stderr	Sends messages to stderr or named, severity info
null	Discards all messages

- ❑ Available categories

default	Categories with no explicit channel assignment
general	Unclassified messages
config	Configuration file parsing and processing
queries/client	A short log message for every query the server receives
dnssec	DNSSEC messages
update	Messages about dynamic updates
xfer-in/xfer-out	zone transfers that the server is receiving/sending
db/database	Messages about database operations
notify	Messages about the "zone changed" notification protocol
security	Approved/unapproved requests
resolver	Recursive lookups for clients

Logging (4)

- Example of logging statement

```
logging {
    channel security-log {
        file ″/var/named/security.log″ versions 5 size 10m;
        severity info;
        print-severity yes;
        print-time yes;
    };
    channel query-log {
        file ″/var/named/query.log″ versions 20 size 50m;
        severity info;
        print-severity yes;
        print-time yes;
    };
    category default        { default_syslog; default_debug; };
    category general        { default_syslog; };
    category security       { security-log; };
    category client         { query-log; };
    category queries        { query-log; };
    category dnssec         { security-log; };
};
```

Debug

❑ Named debug level

- From 0 (debugging off) ~ 11 (most verbose output)
- % named –d2 (start named at level 2)
- % rndc trace (increase debugging level by 1)
- % rndc trace 3 (change debugging level to 3)
- % rndc notrace (turn off debugging)

❑ Debug with "logging" statement

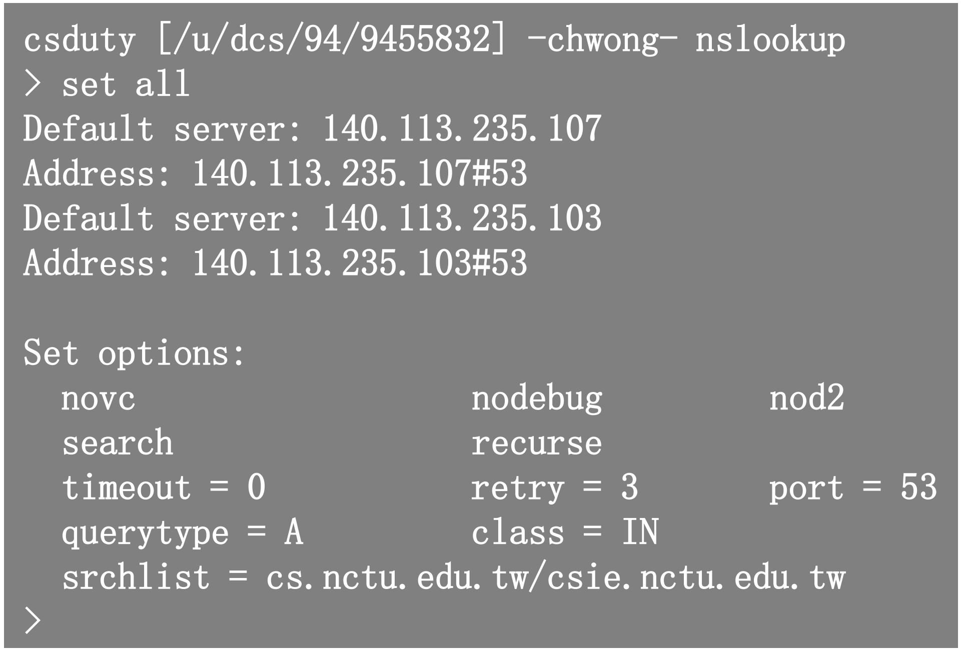
- Define a channel that include a severity with "debug" keyword
  - ➢ Ex: severity debug 3
  - ➢ All debugging messages up to level 3 will be sent to that particular channel

Tools

Tools
– nslookup

❑ Interactive and Non-interactive

- Non-Interactive
  - ➢ % nslookup cs.nctu.edu.tw.
  - ➢ % nslookup –type=mx cs.nctu.edu.tw.
  - ➢ % nslookup –type=ns cs.nctu.edu.tw. 140.113.1.1
- Interactive
  - ➢ % nslookup
  - ➢ > set all
  - ➢ > set type=any
  - ➢ > server host
  - ➢ > lserver host
  - ➢ > set debug
  - ➢ > set d2



```
csduty [/u/dcs/94/9455832] -chwong- nslookup
> set all
Default server: 140.113.235.107
Address: 140.113.235.107#53
Default server: 140.113.235.103
Address: 140.113.235.103#53

Set options:
  novc                  nodebug         nod2
  search                recurse
  timeout = 0           retry = 3       port = 53
  querytype = A         class = IN
  srchlist = cs.nctu.edu.tw/csie.nctu.edu.tw
>
```

Tools – dig

- ❑ Usage
  - % dig cs.nctu.edu.tw
  - % dig cs.nctu.edu.tw mx
  - % dig @ns.nctu.edu.tw cs.nctu.edu.tw mx
  - % dig -x 140.113.209.3
    - ➢ Reverse query

- ❑ Find out the root servers
  - % dig @a.root-servers.net . ns

Tools – host

❑ host command

- % host cs.nctu.edu.tw.
- % host –t mx cs.nctu.edu.tw.
- % host 140.113.1.1
- % host –v 140.113.1.1