

ENUM and Asterisk

VoIP Workshop

APRICOT 2008

Ed Lewis

ed.lewis@neustar.biz

Agenda

- What/why is ENUM
- Role in "call set up"
- Provisioning
- History and future
- An exercise/lab

The What & Why



E-N-U-M vs. "ENUM"

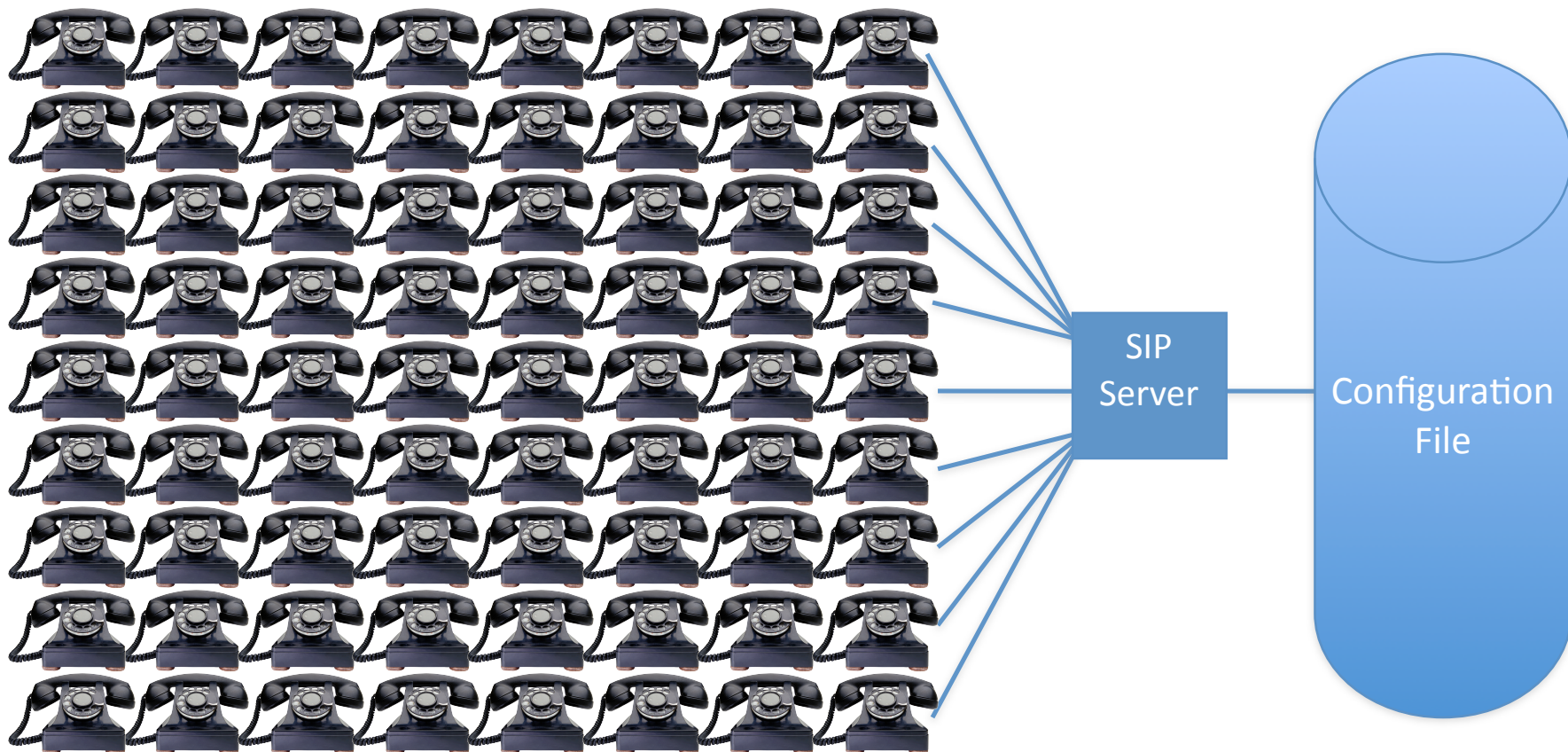
- Like all buzzwords, ENUM has two (or more) meanings
- The one in the original defining documents
 - I call that E-N-U-M here
- The one vendors use
 - I call that "ENUM" here
- So I'll start trying to make the two clear
 - Eventually, it's just ENUM (no hyphens, no quotes)

What is E-N-U-M?

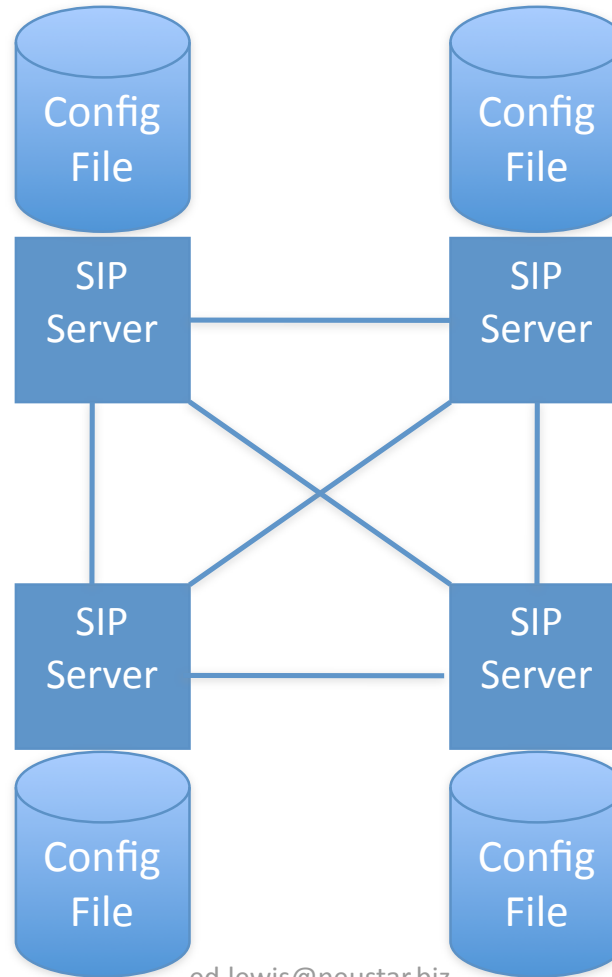
- E(lectronic)NUM(bering)
- Converts tel-numbers into Domain Names
 - +866227002323 becomes
 - 3.2.3.2.0.0.7.2.2.6.6.8.<\$e164>.<\$tld>
 - E.g., 3.2.3.2.0.0.7.2.2.6.6.8.e164.arpa
- Name is used to store NAPTR records which lead to SRV records which lead to addresses
 - But, Ed, "why?" That's for later...

Why "ENUM"?

- If there were one SIP Server in the world



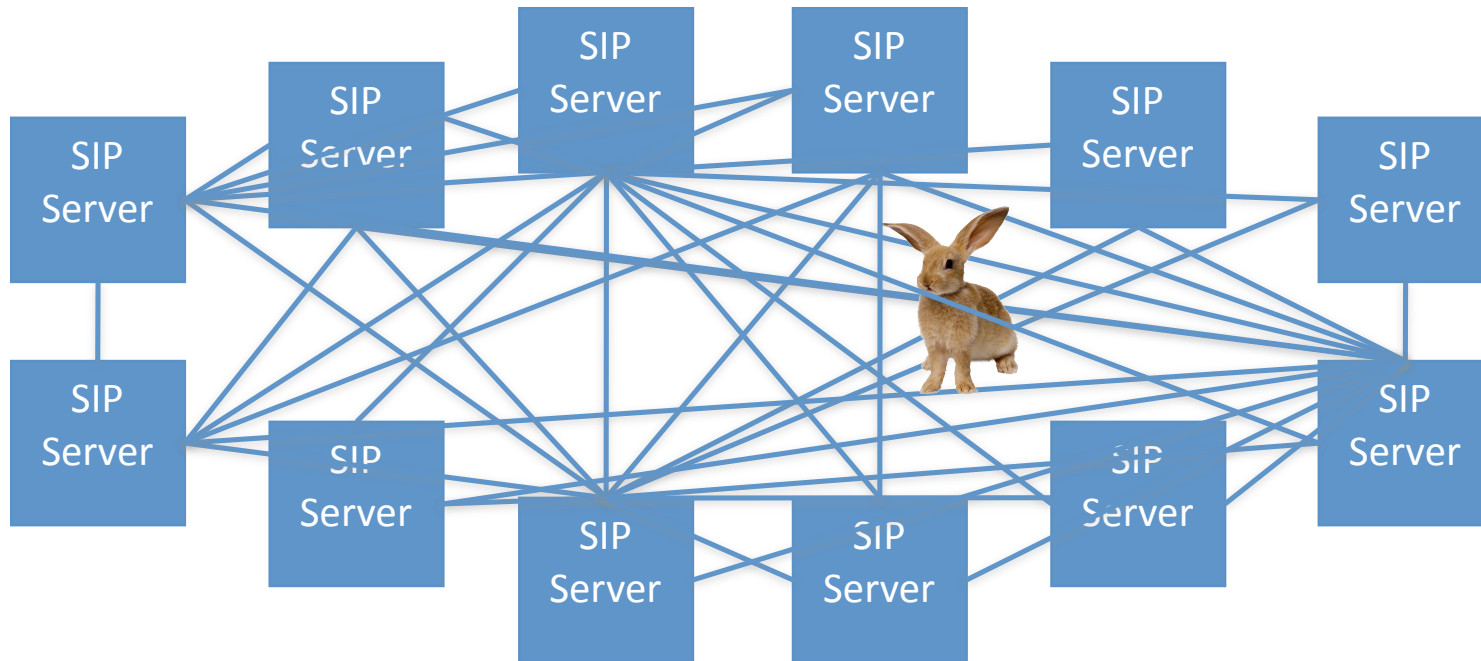
Four Servers?



ed.lewis@neustar.biz



More Servers?

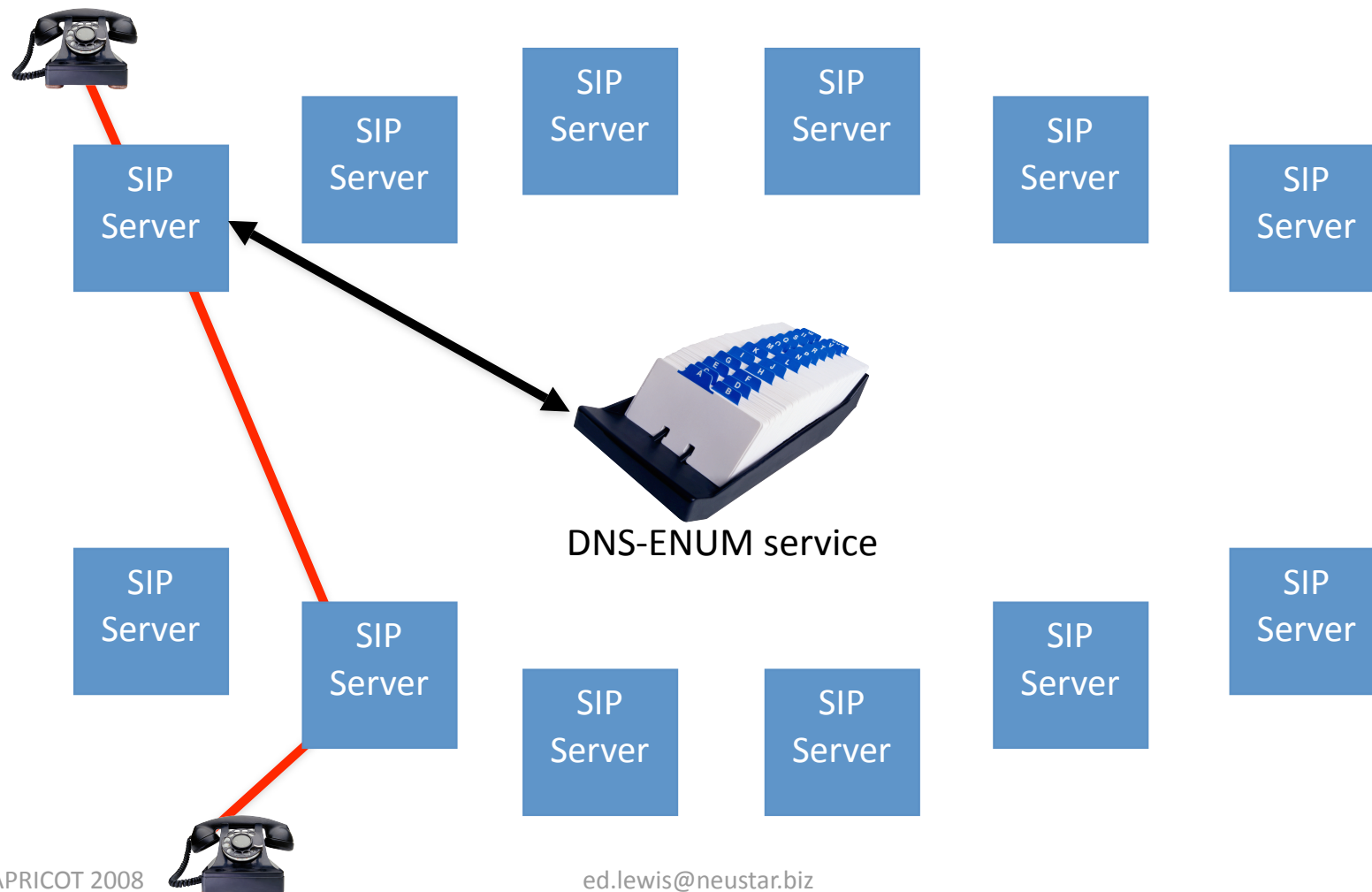


Aaaaaaaaaagggggghhhhhhhh!!!

Scalable way to find numbers

- Need to be able to know where to route a call
 - Traditional Telephony: Signaling System 7
 - Internet Candidate: Domain Name System
- Desirable features of DNS
 - Quick response
 - Very scalable
 - Can be operated for high availability, reliability
 - (OTOH, also easy to "not" do it right!)

With "ENUM"



E-N-U-M vs. "ENUM"

- Both are known as ENUM, but...
- E-N-U-M is the mapping of E.164 to DNS
- "ENUM" refers that plus the entire process of discovering where to send a call
 - Convert telephone number to a URL
 - Discover the service location of the URL
 - Discover the network address of the server
- ENUM is usually used to describe the process

ENUM in standards

- IETF RFC documents
 - 3403 "DDDS Part Three: The DNS Database."
 - Part of the series 3401-3405
 - 3761 "The E.164 to URI DDDS App. (ENUM)"
 - 3824 "Using E.164 numbers with the SIP"
 - 4706 Year of the Rat/Mouse (current lunar year)
 - 5067 "Infrastructure ENUM Requirements"
 - <http://www.iana.org/assignments/enum-services>

Call Set-Up



Mechanics of ENUM

- User dials a number, assumption is made that this is for a voice call
- Server tries to set up a SIP session
 - First get a "sip:" URL for the dialed number
 - Next find where the host part or URL is serviced
 - Then find the network address
- Failing that, use the PSTN

Telephone Number to URL

- Accomplished via a DNS NAPTR Resource Record
 - NAPTR is "Naming Authority Pointer"
 - Beat's me
- ENUM(TN) owns it
 - ENUM(TN) means "E.164 converted into a domain name"
- When used in ENUM, it holds a URL

ENUM(TN)

- Start with an E.164 number
 - +866227002323 (福華大飯店的電話)
- Reverse it, dots between digits, drop "+"
 - 3.2.3.2.0.0.7.2.2.6.6.8
- Append the "ENUM root" to the name
 - strictly as an example, "e164.tld."
 - 3.2.3.2.0.0.7.2.2.6.6.8.e164.tld.
- Reversed because that's the DNS way
 - All TW numbers are under 6.6.8.e164.tld.

NAPTR RR

- NAPTR RR
 - ENUM(TN) "owns" it
 - Record contains 6 elements
 - order = uninteresting
 - preference = uninteresting
 - flags = always "u" for ENUM
 - service = "E2U+<something>" (see IANA page)
 - regular expression = interesting – THE URL we want
 - replacement = uninteresting

An example

- +866227002323 to
 - "sip:866227002323@hotel.tw.tld."

```
$ORIGIN 3.2.3.2.0.0.7.2.2.6.6.8.e164.tld.
```

```
@ NAPTR 10 ( ; order
          10 ; preference
          "u" ; flags
          "E2U+sip" ; (enum)service
          "!(^.*)$!sip:\1@hotel.tw.tld." ;
rpl
      .) ; replacement (unused)
```


Zonefile-ism

- Note that in the previous slide this
 - `"!(^.*)$!sip:\1@hotel.tw.tld."`
- is written
 - `"!(^.*)$!sip:\\1@hotel.tw.tld."`
- in the zone files to "escape" the back-slash

So, NAPTR does what?

- After finding the DNS version of the E.164
- NAPTR gives us the "rewrite rule to determine the URL we want"
- Reg Exp
 - +866227002323 and "(^.*\$)" makes "\1" = the TN
 - sip:\1@hotel.tw.tld. becomes
 - sip:+866227002323@hotel.tw.tld.
- This isn't an HTTP, "hotel.tw.tld" isn't a host

Now we have an URL, so what?

- We want to start a SIP session with hotel.tw.tld.
- Using another DNS convention, we ask for the service location
- The DNS name for this is
 - <service>.<transport>.hotel.tw.tld.
 - <service> for SIP is _sip.
 - <transport> for SIP is _udp.
- Ask for the SRV RR

SRV RR

- Service (location) resource record
- <owner> SRV <priority><weight><host><port>
 - priority= uninteresting
 - weight = uninteresting
 - host = DNS of host where process runs
 - port = port number

Example

- hotel.tw.tld has a SIP server on "sip.hotel.tw.tld." and port 5060

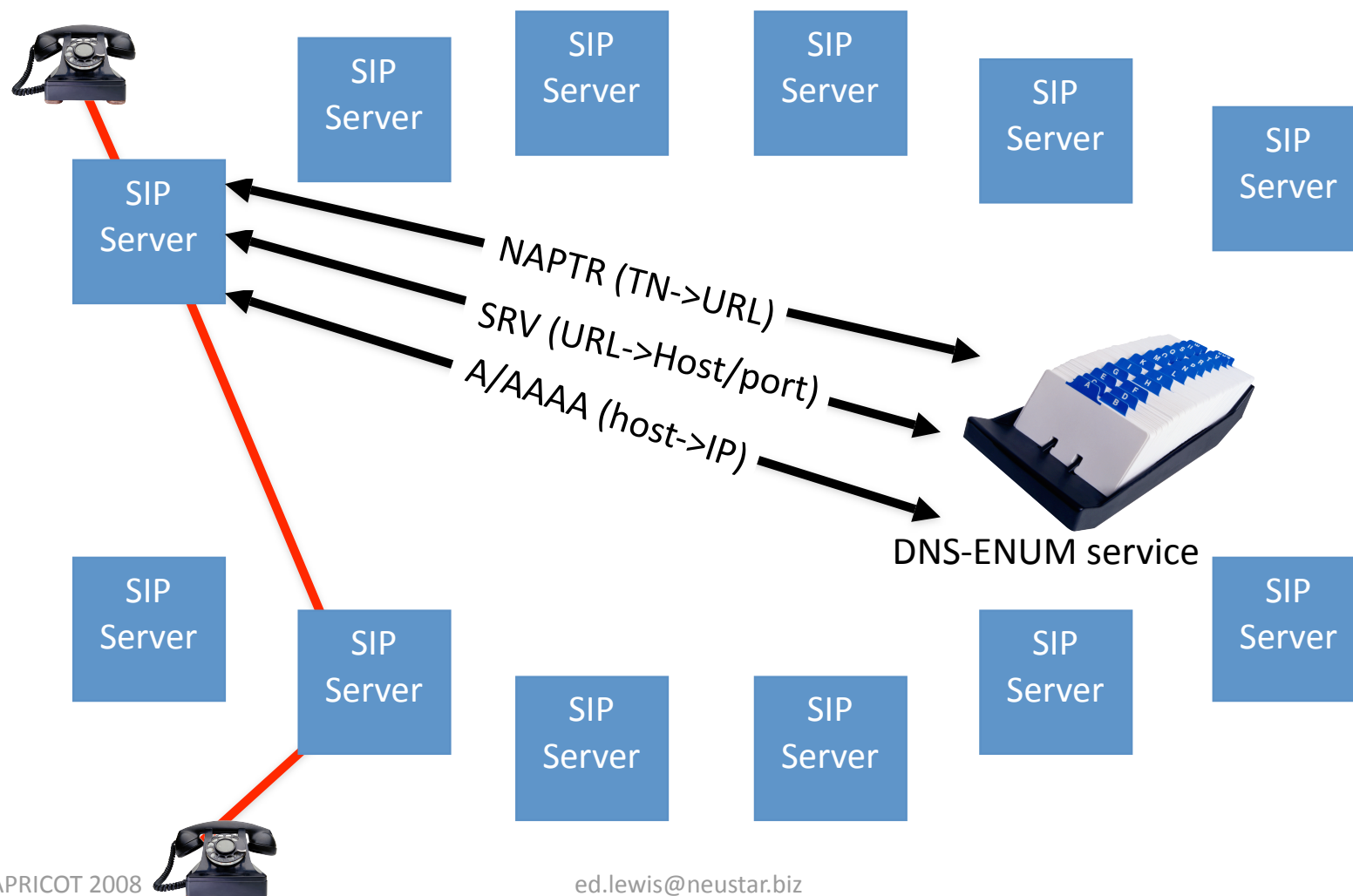
```
$ORIGIN hotel.tw.tld.
```

```
_sip._udp SRV 10 10 sip.hotel.tw.tld. 5060
```

Now we know where to go, but...

- +866227002323 is dialed
- NAPTR says sip:+866227002323@hotel.tw.tld
- SIP says sip.hotel.tw.tld, port 5060
- Still need an IP address (IPv4 or IPv6)
- So we ask for the A or AAAA record of the hostname
- Now, we can send() the packet

So, With ENUM



That seems like a lot of work

- Details of DNS include
 - Caching of answers to speed things up
 - Redundant servers to scale
 - The SRV RR also works for sip URLs that aren't tied to E.164 numbers. (More flexible)
- Why do this?
 - It's supposed to be cheaper than the alternative (SS7 or configuring all peer servers)
 - It allows for more than just voice (IM, for example)

ENUM's job

- Once the call set up is over, ENUM plays no role in the call
 - It only tells Asterisk where to direct SIP traffic
 - After that, the SIP session is independent of ENUM
- But we aren't done just yet

Provisioning



Call set up is just a part of the work

- How does the ENUM data get into DNS?
 - An activity called "provisioning."
 - Voice service providers have to register the NAPTRs, SRVs, and address records for the telephone numbers

Setting up a VoIP service offering

- Install an Asterisk server (or commercial alternative)
- Get phone numbers for customers
- Plan to accept incoming calls on the server
- The SRV and A/AAAA record(s) are then set
- For each of my phone numbers add an NAPTR record where others will look - a registry

ENUM operation

- Likely scenario is that ISPs will use a separate organization to operate the ENUM root
- Currently there are a number of "trade-associations" for this
 - Telephone operators seem to associate with others on the same media, VoIP, wireless, wireline, cable (TV), etc.
- A central ENUM registry is usually planned for the "top"

Tiers

- Infrastructure (trade association) ENUM is usually divided into three tiers
 - Tier 0, the top of the ENUM hierarchy
 - Tier 1, country codes
 - Tier 2, individual numbers

Tier 0

- Tier 0 is closely tied with the international standards of telephone number allocation
- As you can imagine, this gets political
- The ITU has instructed RIPE NCC (the European version of APNIC) to operate a registry with the ENUM root of e164.arpa.

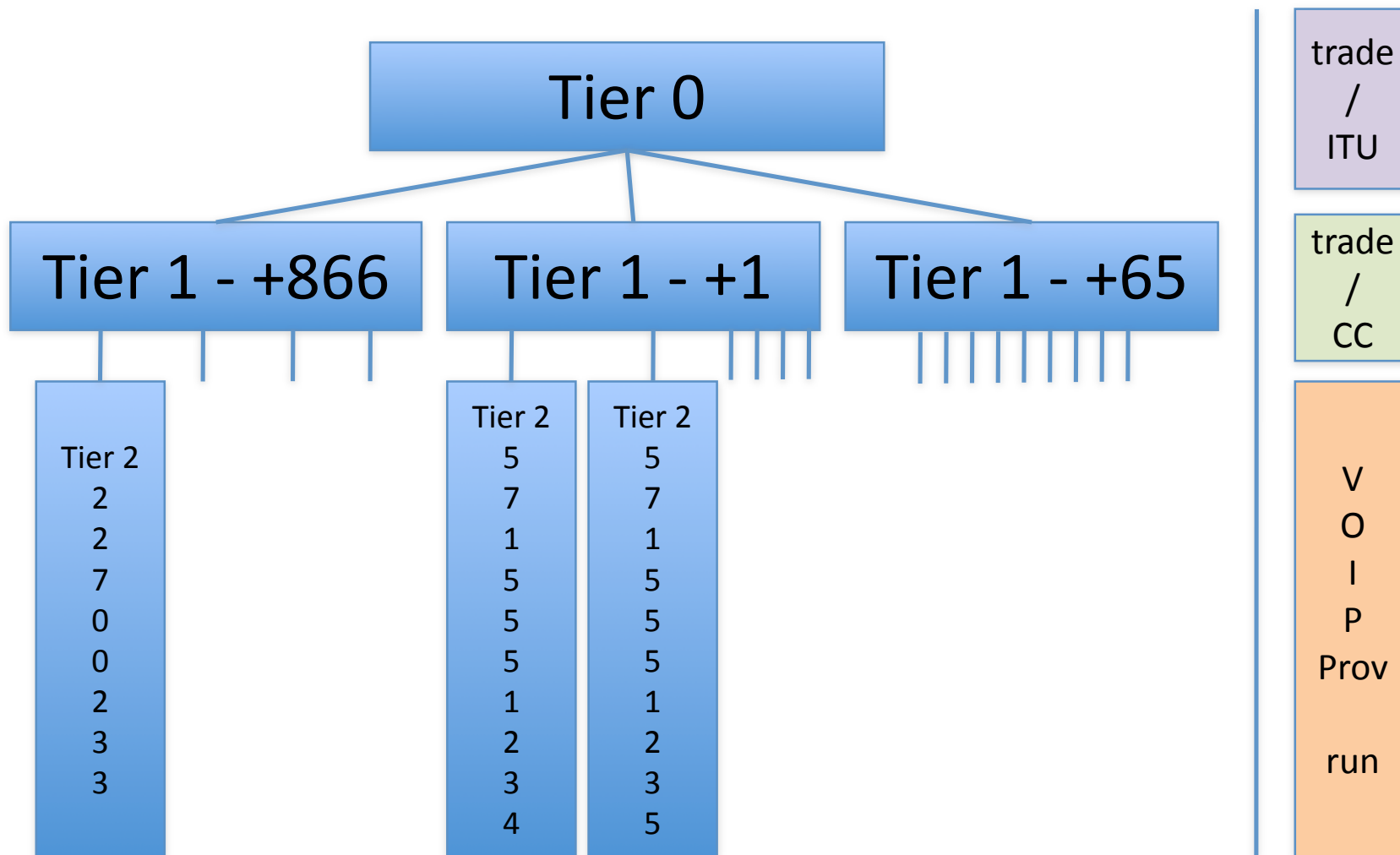
Tier 1

- There are about 200-300 Tier 1's (possible)
- 1 per country code, with a few exceptions
 - +1 is shared by a few countries in North America
- Tier 1's vary greatly
 - Depends on the numbering plan
 - Pooling, blocks of numbers
 - Number portability

Tier 2

- Usually just a block of consecutive numbers managed by a voice service provider
- With number portability, Tier 2 might be one number per zone
- Tier 2 ENUM DNS provider is up to the service provider

Tree of Tiers



Tier 0's

- The ITU has designated e164.arpa as the "public enum root"
 - Few, if anyone use it
- Many voice trade associations are planning their own tier 0's
 - Not all on the global public Internet
- What's the problem with multiple roots?
 - It's best if there's one, really, for SIP servers

Tier 0 registry

- The operator builds the Tier 0 DNS
- Really rather boring, only adjusted when country codes change or when Tier 1 registries change

Tier 1 Registry

- Produces country dialing code's DNS
- Only "excitement" comes when numbering allocations or transfers happen
- Tier 0 and Tier 1 usually only host delegations (NS records) and no NAPTR, SRV, nor address records

Tier 2 "registry"

- Contains the NAPTR records for fully (and over) dialed numbers
- Millions of these zones, they may not be traditional DNS zones
- This is where a lot of activity happens in provisioning

Other zones

- SRV and address records are usually in organization domains
 - Data is tied to the service provider
 - Not tied to the customer numbers

In the coming lab

- Tier 0, 1, and 2 are collapsed into one zone
 - e164.tld. is the enum zone
 - We only have extensions, not E.164 numbers
- SRV and addresses are in "groupXY" zones
- Provisioning is already done

History and Future



ENUM started as

- A way for people to attach services to their phone number
- A flop
 - People don't own their number, authority to make a change is not easy
 - User ENUM too complicated for common man
- Some public ENUM service offerings have already been suspended

ENUM is emerging as

- An upgrade to the existing inter-operator call routing database
 - More flexible than voice-only traffic
- Infrastructure ENUM
 - Still fragmented among trade associations

Lab, or Exercise

- Ingredients
 - DNS server on conference.apricot.net
 - 169.223.11.204
 - Your Asterisk servers with new configuration lines
 - SIP phones to dial each other

First, a look at the DNS

- For the lab, the DNS is pre-populated to work for us
 - I hope
- Let's see what this looks like from the DNS perspective

To see the ENUM zone up close

```
$ dig @conference.apricot.net e164.tld.  
axfr
```

- This will show you the whole zone
- The next slide will show the "relevant bits" but you may want to see it closer to you eyes

First the pre-provisioned DNS

- e164.tld. zone has this:

```
*.1.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group01.tld.!" .
*.2.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group02.tld.!" .
*.3.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group03.tld.!" .
*.4.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group04.tld.!" .
*.5.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group05.tld.!" .
*.6.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group06.tld.!" .
*.7.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group07.tld.!" .
*.8.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group08.tld.!" .
*.9.0 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group09.tld.!" .
*.0.1 NAPTR 10 10 "u" "E2U+sip" "!(^.*$)!sip:\\1@group10.tld.!" .
```

Group 14's zone

```
$TTL 900
$ORIGIN group14.tld.
@                IN SOA      ns1.tld. (
                                hostmaster.ns1.tld.
                                1 ; serial number
                                900 ; refresh
                                900 ; retry
                                604800 ; expire
                                900 ; negative cache
@                IN NS       ns1.tld.
_sip._udp         IN SRV      10 10 5060 sip.group14.tld.
sip.group14.tld.  IN A        169.223.146.114
```

Exercise the DNS

- Do these three dig's to see what Asterisk should see

```
dig @169.223.146.100 0.0.4.1.e164.tld. naptr
```

```
dig @169.223.146.100 _sip._udp.group14.tld. srv
```

```
dig @169.223.146.100 sip.group14.tld. a
```

Configure Your Machine

- Has to be done at system level to tell Asterisk where to go to ask DNS questions
 - We are using a "improper" ENUM domain
- As root, edit /etc/resolv.conf
- Place this line in before the other "nameserver" lines

```
nameserver 169.223.146.100
```
- This will send queries to our "ENUM server"

Tell Asterisk to "do" ENUM

- Add to extensions.conf under [phones]

```
exten => _6XXXX,1,  
Dial(SIP/${ENUMLOOKUP(${EXTEN:1},sip,,1,e164.tld.)})
```

- Add 'exten' in [default] to ring phones (lab notes)
- Set 'allowguest=yes' in sip.conf
- Reload and Increase "verbosity"
- Dial "6-<4digits>"

Check to see

- Dialing 60200 should result in
 - URL sip:0200@group2.tld.
- In the live demo, I'll use 'asterisk -r' with verbose > 10.
 - Looking to see a line including 'Called 0200@group2.tld.'
 - in response to dialing 60200

Questions?

- This is a quick introduction to ENUM
- Like many things, it's components are simple
 - More complex macros can be used to handle error conditions
- But the volume of work and business factors are huge

That's all folks

- Time for the 'live demo' and then the hands on portion