ENUM Technical Aspects

National Information Technology Center

ENUM Task Force

History

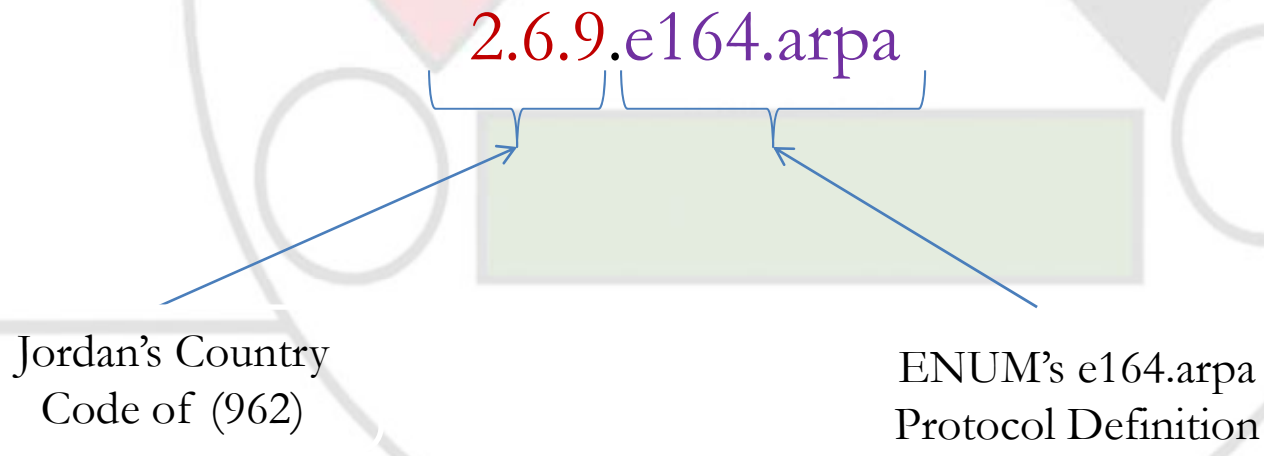
- Voice transmitted over PABX
  - All signals are analog
  - Both ends are physical telephones
- Voice transmitted over Internet
  - All signals digital
  - Both ends are soft phones
  - Requires software at both ends
- Voice Over IP (VoIP)
  - Signals are mixture of analog and digital
  - End points could be physical phones, e-mails, or websites

What is ENUM?

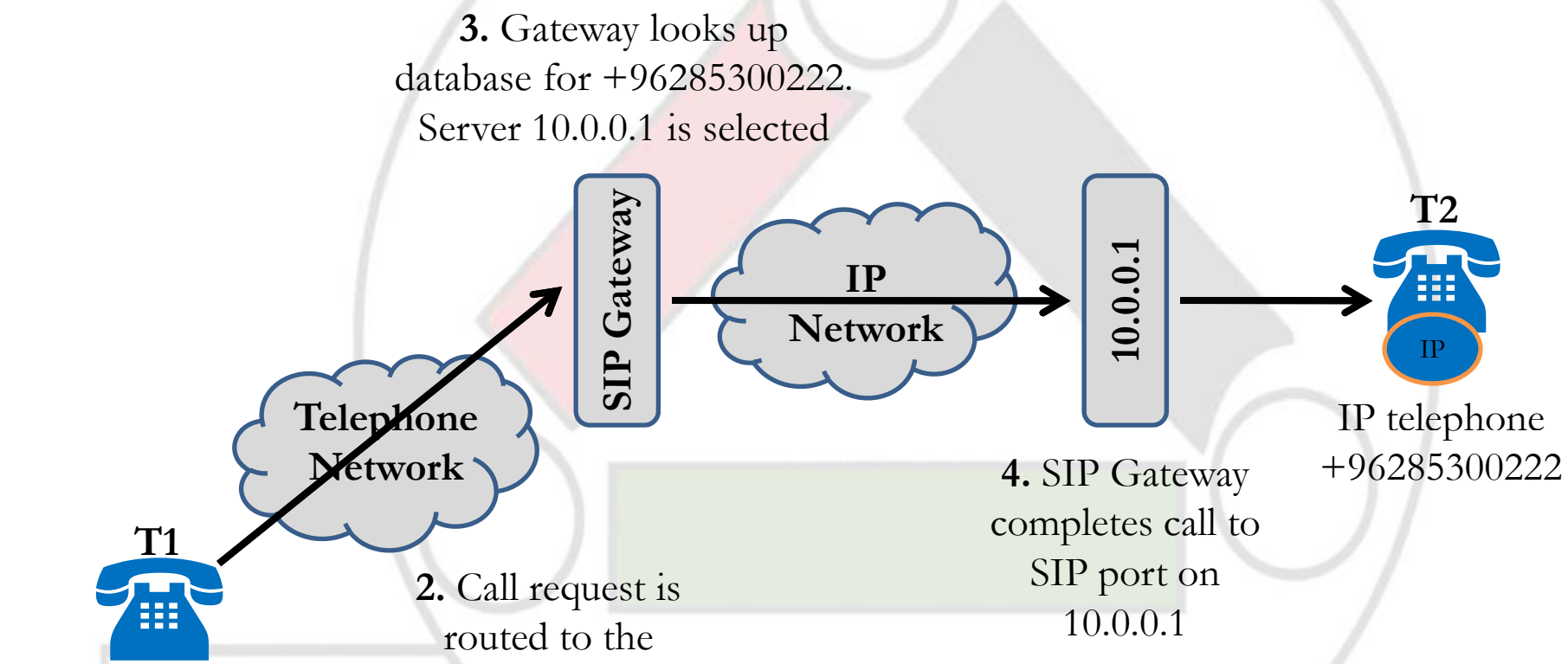
- ENUM is an abbreviation for E.164 NUmber Mapping
- This protocol is best explained in RFC 3761 and RFC 2916 (http://www.ietf.org/)
- It involves 2 main concepts:
  - Creating a domain name from a telephone number, and then resolving it over an Internet Address (Uniform Resource Identifier (URI)) via DNS; i.e. telephone number to IP address mapping
  - ENUM numbers are hosted in the e164.arpa domain space

What Number Did We Get?

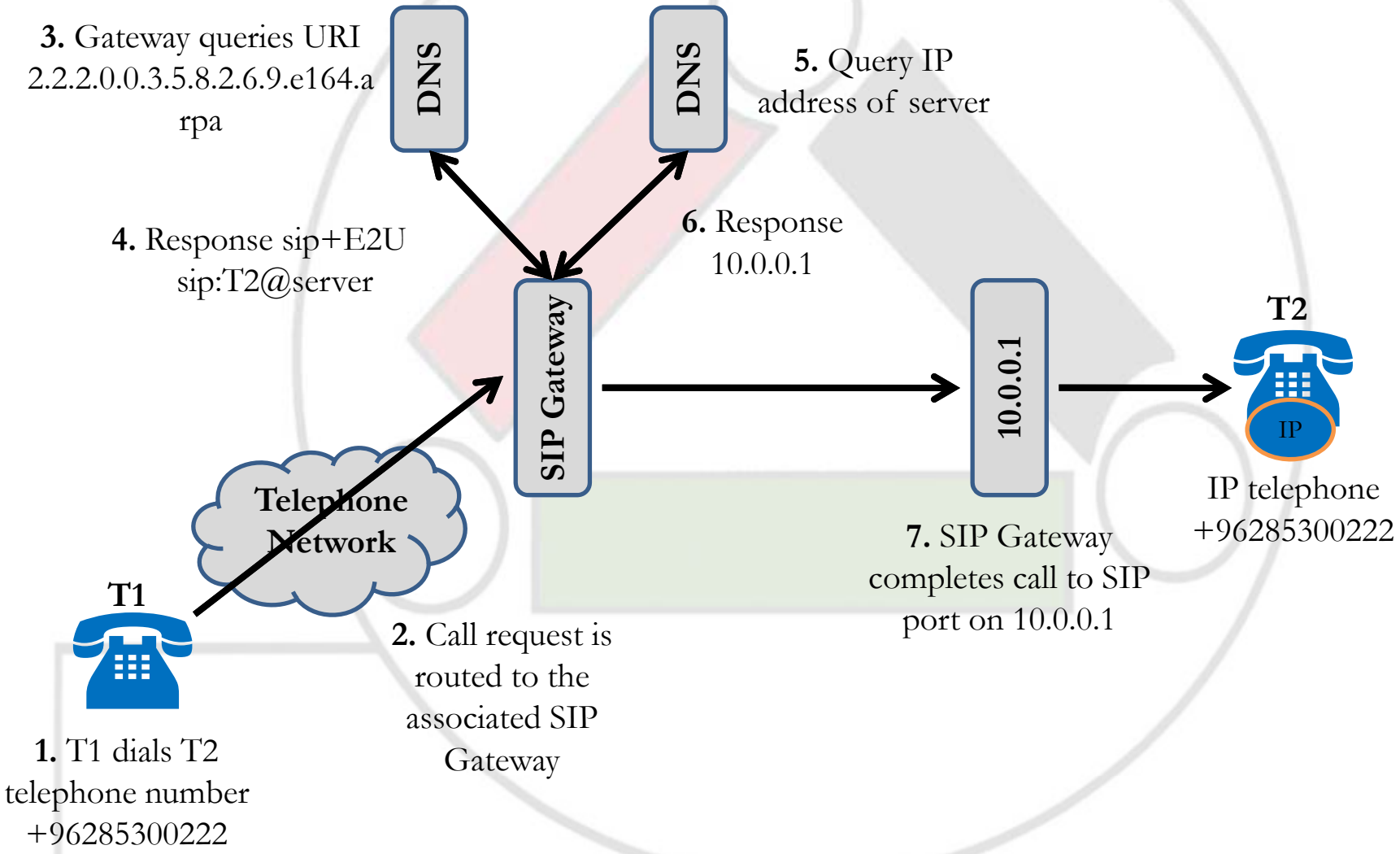
- Jordan will register ENUM numbers under its official country code with ITU; i.e. (962)
- The ENUM DNS resolving will be done by the recognition of the 2.6.9.e164.arpa code



Static IP Telephony



Dynamic IP Telephony (ENUM)



End Point Options

- Normal telephone - +962-6-5300222
- Soft phone - Skype
- Cell phone - +962-7xy-123456
- Fax - +962-6-5300277
- E-Mail – info@nitc.gov.jo
- Website – http://www.nitc.gov.jo/
- LDAP server – ldap://ldap.nitc.gov.jo/
- Instant Messaging

End Point Possibilities

Sender ► / Recipient ▼	Land Phone	Cell Phone	IP Phone	E-Mail
Land Phone	No need for ENUM	No need for ENUM	Dial the land line number, no need for ENUM	Could arrive as SMS
Cell Phone	No need for ENUM	No need for ENUM	Dial the cell phone number, no need for ENUM	Could arrive as SMS
IP Phone	Dial the ENUM Number	Dial the ENUM Number	Dial the ENUM number, or free chat on messenger	Could arrive as SMS
E-Mail	No need for ENUM	No need for ENUM	Sender sends an SMS, recipient receives as E-Mail	Normal E-Mails, no need for ENUM
Website	N/A	Point browser to ENUM number, a website opens	N/A	N/A

Converting e.164 Numbers to URIs

1. Write the number in full expression

   +962-8-5300222

2. Remove all non-digit characters

   96285300222

3. Add dots between each number

   9.6.2.8.5.3.0.0.2.2.2

4. Reverse the order of the digits

   2.2.2.0.0.3.5.8.2.6.9

5. Append e164.arpa after reversing the digit order

   2.2.2.0.0.3.5.8.2.6.9.e164.arpa

Which Zone Files are in Question?

- Zone file at RIPE NCC under e164.arpa
- Zone file at NITC under 2.6.9.e164.arpa
- Zone file at each telecom operator under y.x.2.6.9.e164.arpa
- Zone file for each e164 number under f.e.d.c.b.a.y.x.2.6.9.e164.arpa

Zone File at IANA

- At IANA – via RIPE NCC, our entry in their ENUM DNS server under the zone file e164.arpa looks as

```
$ORIGIN e164.arpa.
.
.
.
   2.6.9  IN  NS  jo-enum01.enum.jo.
          IN  NS  jo-enum02.enum.jo.
           jo-enum01.enum.jo  IN  A  193.188.66.1.
           jo-enum02.enum.jo  IN  A  193.188.66.107.
.
.
.
```

Zone File at NITC

- Assuming we follow a registry / registrar module, on our ENUM servers, we will have an entry as follows:

```
$ ORIGIN 2.6.9.e164.arpa.
    2 IN NS ns.land.orange.jo.
    3 IN NS ns.land.orange.jo.
    5 IN NS ns.land.orange.jo.
    6 IN NS ns.land.orange.jo.
      ns.land.orange.jo IN A a.b.c.d.
   74 IN NS ns.cell.express.jo.
       ns.cell.express.jo IN A e.f.g.h.
   77 IN NS ns.cell.orange.jo.
      ns.cell.orange.jo IN A i.j.k.l.
   78 IN NS ns.cell.umniah.jo.
      ns.cell.umniah.jo IN A m.n.o.p.
   79 IN NS ns.cell.zain.jo.
      ns.cell.zain.jo IN A q.r.s.t.
```

Main Zone File at Registrar

- At the registrars, each client will have an entry that looks as follows:

```
$ ORIGIN  8.2.6.9.e164.arpa.
.
.
.
    2.2.2.0.0.3.5  IN  NS  zones.ns1.land.orange.jo.
                   IN  NS  zones.ns2.land.orange.jo.
.
.
.
```

Main Zone File for Each Number

```
$ORIGIN 2.2.2.0.0.3.5.8.2.6.9.e164.arpa.
.
.
.
   IN NAPTR 100 10 "u" "E2U+sip"        "!^.*$!sip:dg@sip.nitc.gov.jo".
   # When call initiated, forward to SIP number
   IN NAPTR 100 10 "u" "E2U+mailto"   "!^.*$!mailto:dg@nitc.gov.jo".
   # If SMS sent from cell phone, send to an e-mail ID
   IN NAPTR 100 10 "u" "E2U+http"      "!^.*$!http://www.nitc.gov.jo".
   # If number entered in a web browser, open a default web page
   IN NAPTR 103 10 "u" "E2U+tel"        "!^.*$!tel:+962-6-5300225".
   # If SIP server in the first entry does not reply, forward call to land line
```

- As can be seen in the previous example, the input is a e164 format telephone number while the output is a Uniform Resource Identifier (URI), hence E2U

Meaning of ENUM Entries

- IN ➔ Internet
- NAPTR ➔ Naming Authority Pointers
- 1st Number ➔ Order of processing entries
- 2nd Number ➔ Preference number when a record has the same order number
- "u" ➔ URI Service Field
- "??+E2U" ➔ Various flags such as sip, http, mailto, tel, ldap, … etc
  - E2U ➔ e.164 to URI
- Regular Expressions (regexp) ➔ "!^.*$!<…>"

ENUM Services

Service/Protocol	Service Field	URI Scheme Example
SIP	E2U+sip	sip:info@sip.nitc.gov.jo
H.323	E2U+h323	h323:info@h323.nitc.gov.jo
Internet Fax	E2U+ifax	mailto:fax@fax.nitc.gov.jo
Telephone	E2U+tel	tel:+96265300222;svc=voice
Fax	E2U+fax:tel	tel:+96265300277;svc=fax
E-Mail	E2U+mailto	mailto:info@nitc.gov.jo
Web	E2U+http	http://www.nitc.gov.jo/

ENUM Activation Requirements

1. An E.164 personal telephone number to be used on the PSTN network (06-5300222)
2. A personal URI to be used on the IP network (2.2.2.0.0.3.5.6.2.6.9.e164.arpa)
3. Authority from a TRC for call initiation, forwarding, and termination in the NAPTR record (ENUM DNS record). This record shall be accessible via the personal URI

Security Issues

- Since this technology uses DNS resolvers, security issues found in DNS applies here as well. Some of these issues include:
  1. Malicious Redirection – Resolving an e164 number request to an unintended URI
  2. Denial of Service (DoS) – Removing an URI entry could down the service for some e164 numbers
- DNSSec is an excellent recommendation for securing ENUM servers
- Most of the security concerns are not around ENUM, but rather around VoIP itself!

Miscellaneous Issues

- We can use any domain name other than e164.arpa (such as nitc.gov.jo) upon approval by the ITU and the various RIRs. However, if this is commenced, call initiation will take longer than anticipated since it will involve more normal DNS queering
- At an international level, some entities have requested to replace e164.arpa with e164.int since ARPA is too American!

How Did Jordan Register?

- NITC filled out an electronic application form with RIPE NCC; our RIR
- Once RIPE NCC approved the application, it forwarded it to ITU (International Telecommunication Union)
- Since MoICT are the registered members of ICT with ITU, ITU requested a letter of approval from MoICT
- Once sent, ITU approved the application and forwarded the request back to RIPE NCC

… continue (Registration?)

- RIPE NCC requested technical readiness from NITC; i.e. two ENUM name servers at minimum
- NITC prepared two ENUM name servers:

  jo-enum01.enum.jo IP = 193.188.66.1

  jo-enum02.enum.jo IP = 193.188.66.107

  Once ready, NITC reported them back to RIPE NCC
- RIPE NCC technically checked the servers, and once successful - reported back to NITC on the technical readiness of the registration service

References

- http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_5-2/enum.html
- http://www.ietf.org/rfc/rfc3761.txt
- http://www.ietf.org/rfc/rfc2916.txt
- http://www.enum.org/
- http://en.wikipedia.org/wiki/Telephone_number_mapping

Questions?

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