# An Introduction to ENUM

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### Introduction

- What is ENUM?
- Explaining the jargon & roles
- The Politics of ENUM
- Getting a delegation
- DNS Considerations for ENUM
- Deployment Status
- Threats & opportunities
- Web sites & mailing lists for more information



### What is ENUM?



- A protocol to map E.164 telephone numbers into domain names
  - > Defined in RFC3671 (was RFC2916)
- Very simple:
  - > Phone number +44 1698 852881 becomes
    1.8.8.2.5.8.8.9.6.1.4.4.e164.arpa
- Resulting name looked up in the DNS
  - > Returns a set of NAPTR records

### NAPTR Records

- Defined in RFCs 3401, 3402, 3403 & 3404
- Horribly complex
  - > Define preferences and order to reach services
  - > Can include regular-expressions and substitutions
  - > Ultimately identify URIs
  - > Example:

NAPTR 100 10 "u" "E2U+voice:sip" "!^.\*\$!sip:jim@rfc1035.com!"

- > How to reach a SIP gateway for some phone number
- > Order and Preference fields allow intelligent selections of services & protocols to be made:
  - "Send email if the SIP gateway is unable to process fax now"
  - "Don't call my mobile phone when I'm overseas"
  - "Get my PGP key or X.509 certificates from...."

### What ENUM Is And Is Not

#### • ENUM IS NOT:

- > A directory
- > A search service
- > A transport service
- > A telephony service or voice encoding method
- > A rendezvous protocol

### • ENUM IS:

 A partial mapping of E.164 numbers to domain names that define a set of services identified by a URI labels

### **ENUM Misconceptions**



- It's not just about SIP (Session Initiation Protocol)
  - > SIP gateways are often the targets of NAPTR records
- Or just Voice over IP (VoIP)
  - > Not just voice traffic
  - > Not just about IP-based services
- ENUM can be used for other telephony (like) services
  - > Fax
  - > SMS, MMS
  - > Paging
  - > Instant Messaging

### E.164 as a common address substrate ?



### **ENUM Potential**



- Convergence between telephony and Internet worlds
  - > i.e. one network for everything
- Smarter devices
  - > Routing & diverting telephone calls
- Integrated Messaging Services & multi-media
- E.164 number becomes the only thing to remember
  - > An ENUM DNS lookup could return the user's email address(es), web site, IRC identifier, SIP gateway, etc.
- ENUM also being considered by telephone companies to simplify call routing and number portability
  - > One phone number for life?

### ENUM Jargon - 1

Most of this originates from the work by ETSI

> European Telephone Standardisation Institute

• Tier-0

> The registry operator for **e164**.**arpa** and its name servers

#### • Tier-1

- > Registry for a "country": e.g. 4.4.e164.arpa
- > Codes are not just for countries: satellite operators, multinational telcos, international free phone numbers

#### • Tier-2

- > Registrars who process registration requests
- > Not area code level delegations as the terminology might suggest

### ENUM Jargon - 2



- > It's up to each country to decide:
  - How its registry is chosen and operated
  - How any sub-delegations (if necessary) are done
  - What rules and policies apply nationally
  - Whether it participates in ENUM or not

### The Golden Tree

- Simply follows the Tier-0, Tier-1 & national numbering hierarchy under e164.arpa
  - > Widely accepted by the industry & regulators
  - Regulators need to control their national telephone numbering plans and how they are used
  - > Telephone companies won't stray from E.164 and ITU recommendations
- Golden tree is sparsely populated today
- Various efforts to set up rival trees
  - > Currently not credible, but could be significant
  - Typically attempts to gain commercial advantage by pre-empting the market
  - Unlikely to succeed unless a major vendor forces a universal, de-facto solution

### Alternate ENUM Trees

#### Other ENUM-like trees exist

- > Far worse than "Alternate Roots" in the DNS
- > Don't just fragment the name space
  - Jeopardises the integrity of E.164 numbering
  - Causes user confusion
    - > Which tree is someone's number registered?
  - Creates ugly impersonation and domain name disputes
    - > What if your number is registered in another tree by someone else?
    - > What if that tree is owned by a company that doesn't operate in your country?
    - > Or that company ignores your national telco regulator?
    - > What about national privacy, data protection or consumer protection considerations?
- If it's not anchored under e164.arpa it can't be ENUM

### Legal Considerations

#### • Data privacy & protection

- > ENUM names (phone numbers) usually identify people
- > Restrictions on how that data is stored and processed
- > Generally implies ENUM has to be opt-in
- What about unlisted phone numbers?
- What about a household with 1 phone number?
- Competition legislation
  - > Is there fair and free competition?
  - > By definition, domain names are a monopoly
- Potential for telephone by-pass
  - > Use SIP gateways and VoIP: where's the phone call?

### **ENUM Flavours**

#### • User ENUM

- > Public e164.arpa golden tree
- > Generally means validated opt-in by end-user

#### Carrier ENUM

- > Private trees operated by telcos
- > Number portability, MMS interworking, call routing
- > Work just starting at ETSI & IETF

#### • Enterprise ENUM

- > Private name spaces used by companies
  - Routing calls over internal network instead of PSTN
- > Could apply to ENUM-like trees used by VoIP providers

### The Politics of ENUM

- Many players
- Internet Engineering Task Force (IETF)
  - > Define the ENUM protocol & NAPTR record format
  - > Also define related protocols: SIP, VoIP, etc
- Internet Architecture Board (IAB)
  - > Steering body for IETF
  - > Tasked with making the Internet work
- International Telecommunications Union (ITU)
  - > International institution (part of United Nations)
  - > Define telephony & radio standards
    - G. series codecs
  - > Owns the E.164 telephone numbering standard

### Potential ENUM Political Problems

#### • Integrity of E.164 numbering plan

- > Critical for world's telephone system
- > Phone companies need this for billing, routing, etc.

#### National Identity

- > What is and isn't a country?
- > Who is authorised to represent that country?

#### National Sovereignty

- > Who controls what happens to a country's national resources? i.e. its E.164 numbers?
- E.164 "national" codes
  - > What codes are valid and who owns them?

### **Pragmatic Solution**

- IAB selected RIPE NCC to operate Tier-0 registry
- Delegation requests checked by ITU
  - > ITU determines what is and isn't a country
  - > ... and what is and isn't a valid E.164 country code
  - > ITU has diplomatic immunity
  - > Also used to dealing with sovereign states, national telco regulators, governments, etc
  - > ITU also knows the official government contacts and representatives on telephony matters
- Delegations only proceed if ITU says so
  - > ITU has effective administrative control over the contents of e164.arpa

### **ITU Interim Procedure**

- Anyone can submit a delegation request
  > To ITU or RIPE NCC or both
- ITU sends request to official government contact for the country concerned
- Government says yes or no
- Response is relayed to RIPE NCC
  - > Delegation made or rejected as appropriate
- Result is no delegations get made without government approval
  - > National interests safeguarded
  - > E.164 integrity protected

### ENUM at ITU - 1



- > Other TLDs under consideration
- > Some countries perceive .arpa to be controlled by the US Government
- > Can't have an international resource under the control of one state as a matter of principle

#### • On-going discussion within ITU

- > ITU documents on ENUM deliberately do not mention the name of the ENUM root domain
  - Will do so once consensus is reached inside ITU
  - Hopefully that will be e164.arpa, but this can't be assumed
- Some member states want Tier-0 to be totally under the control of ITU

### ENUM at ITU - 2

- General acceptance of a golden tree
  - > Some ITU member states just don't want that golden tree to be under e164.arpa

#### • Current ITU process is an interim procedure

- > Allow ITU more time to reach consensus
- > Enabled some countries to carry out trials
- > Pragmatic approach:
  - Trials can proceed for those who want them
  - Final decision from ITU can be deferred until consensus is reached

### **DNS Considerations - 1**



- > If ENUM is successful, every phone number will be in the DNS, each with 5-10 NAPTR records
- > Orders of magnitude increase in DNS data
  - More zones, more resource records, more name servers, bigger registry & registrar systems
- > Example: UK
  - Currently 3-4M delegations under .co.uk
  - Approx. 100M UK phone numbers in use today
- > Editing BIND zone files and named.conf won't work
  - RDBMS for zone & customer data
  - Integrate with telco provisioning & billing systems?

### **DNS Considerations - 2**

#### • Performance

- > Need to guarantee service levels & response times by name servers
  - How long after "dialling" before a phone rings?
- > Existing DNS infrastructure in many countries is not yet good enough
  - Many broken ccTLDs
- > Software like BIND may not be up to the job
  - Zone loading, zone management, query throughput
  - Fine-grained access controls
- Robustness
  - > Usual stuff about server placement, SPoFs, code diversity, Carrier Class QoS

## **DNS Considerations - 3**

#### • Security & Integrity

- > DNSSEC is almost guaranteed to be mandatory for production ENUM services
- > Only way to validate answers from the DNS
  - Essential for verifying E.164 numbers in the DNS
  - Potential billing & integrity issues
- > Introduces obvious key management problems
  - Choosing and changing keys
  - Emergency key revocation
  - Simplicity for end-users
- Tooling
  - > NAPTR record manipulation
  - > Handling crypto material: DNSSEC keys, certificates

### International & National Trials

- Trials carried out in several countries:
  - > Austria, UK, Ireland, France, Germany, Sweden
- Outcomes broadly successful
  - > The technology and protocol works!
    - ... no surprises there
  - > Roles, responsibilities & interfaces much clearer
- Commercial operations beginning despite only interim arrangements in place at ITU

### The UK ENUM Trial

- Under the auspices of an ad-hoc industry body, UK ENUM Group (UKEG), with input from government (DTI) and telco regulator (Ofcom)
- Wide participation from telecom and internet companies:
  - > Atlas Internet, Bango, BT, Firsthand, ICB, MCI, Neustar, Nominet, Nominum, Roke Manor Research, Telcordia, Univ. of Southampton, Vodafone
- Ran until end 2003
  - > Published a report that was input to DTI consultation exercise
- DTI Consultation result recommended commercial operation

## Trial Results/Recommendations

- Single Tier-1 for production ENUM service
  - > Tier-1 is a monopoly
    - Can't do anything else
      - > Conflicts of interest
      - > UK/EU Competition Law
    - Does minimum role: operates the registry
- Authentication handled by other entities:
  - > Effectively UK-Licensed Telephone Operators
    - Compliance with National Telephony regulations
- Non-registry roles can be combined arbitrarily
  - > DNS hosting or registrar service with applications
  - > Authentication with registrar, etc.

### Authentication Agency



- Proposed solution for the authentication problem
  - > How can we be sure someone "owns" the telephone number they are registering?
  - > Complicated by UK Telephone Numbering Scheme
    - Privacy & commercial confidentiality issues
    - No centrally-maintained database
- Trial used manual lookups of BT DQ database
  - > Other on-line solutions planned for commercial operations

### **Unresolved Trial Issues**

- Secure DNS
- Accreditation & Codes of Conduct
  - > Tier-2? Authentication Agencies?
- Tier-1/Tier-2 Interface
  - > EPP or XML/SOAP or both or...?
- Selection process & criteria for production Tier-1
  - > Auction? License? Franchise?
- Regulatory/legislative framework
  - > Stakeholder input
  - > Self-regulation with government oversight
  - > Moving UKEG into a legal entity
    - Governance models, funding

### **Commercial Deployment**

#### Started in mid-2005 in Austria

- > Even have an ENUM-only number range
- > +878 10 predated ENUM in +43

#### Just begun in Germany

> Tier-1 "just given" to DeNIC

#### RFP issued for Tier-1 registry in Ireland

- > Responses due by end Jan 2006
- UK has been delayed
  - > Now light at the end of the tunnel
  - > Should go live some time in 2006... (maybe)

### Threats to ENUM/VoIP

- ITU uncertainty could force a dominant player to deploy a *de facto* solution:
  - > Cisco, Microsoft, etc. "can't wait"
- Onerous authentication requirements
- Regulatory issues
  - > Lawful intercept, emergency numbers, presence info
- Telco obstructiveness & FUD
- VoIP offerings from google, Yahoo!, Skype
  > Get sufficient critical mass to make ENUM irrelevant
- New vector for spam & virus attacks
  - > SPIT
  - > Telemarketers

## **ENUM Service Offerings**

#### Not yet packaged cleanly

- > Turnkey solutions, seamless sign-up & integration
- > Components generally at the screwdriver stage

#### Hardware

- > SNOM phones
- > X-ten, InOne, Grandstream, Cisco

#### Software

- > Asterisk & SER SIP servers
- > Java applets for mobile phones
- > Proof of concept plug-ins for web browsers

### **ENUM Business Models**



- Still to figure out how to make money
  - > Probably not the usual DNS registry-registrar business
- Get ENUM bundled (buried?) with another service
  - > VoIP over broadband
  - > Niche markets for international calling
  - > Integrated messaging
- Intranets and extranets
  - > SIP servers in every retail chain or bank branch
- Telco opportunities
  - > Long-distance call routing by cable companies
  - > MMS messaging between mobile operators

### Useful Web Sites on ENUM

#### • ITU

http://www.itu.int/osg/spu/enum/index.html

#### • RIPE NCC

http://www.ripe.net/enum/index.html

#### UK ENUM Trial

http://www.ukenumgroup.org

#### • US ENUM Forum

http://www.enum-forum.org

### **ENUM Mailing lists**

#### RIPE lists

- > enum-announce@ripe.net
  - Announcements
- > enum-request@ripe.net
  - Requests for delegations
- > enum-trials@ripe.net
  - Information sharing between trials
- > enum-wg@ripe.net
  - ENUM Working Group
- IETF ENUM Working Group list
  - > enum@ietf.org
    - Protocol issues, privacy, provisioning, etc.
    - Carrier ENUM requirements, SIP peering

