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?

Use this number for any service
+44 1698 852881
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?
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
What happens at Tier-1 becomes a “national matter”

- 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
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
• IAB/IETF Tier-0 domain name is not endorsed by ITU
  > 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
• 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

- **Scaling**
  - 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
Questions?