NGN Naming, Addressing and Identification

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Outline

- Naming and Numbering Attributes in NGN
- Addressing Structures
- IPv4 to IPv6 Issues
- Uniform Resource Identifiers (URI)
- The ENUM Initiative
- Standards issues in Naming and Addressing
- Conclusions

NGN Attributes For Addressing

- **Convergence of telephony, data and broadcast networking**
  - **But does this mean convergence of naming and addressing ?**
- **IP based core networking – with multiple access technologies**
  - **Ubiquitous use of IPv4 address for routing. What about IPv6 ?**
- **Seamless interworking between host applications and PSTN / PLMN**
  - **How will VoIP applications be handled ?**
- **Separation between Applications, Services and Transport Layers**
  - **The OSI/ISO Model simplified ?**
- **Multimedia services**
  - **And Terminals in "Home Networks" ?**

What's in a Name….

- Traditionally, PSTN/ISDN relies on <Name : Number> associations for communications
  - Works well because names are "human-friendly" (i.e. easier to remember)
    and numbers are "machine-friendly" (i.e. can be machine processed) !

- Connectionless data networks require entities to be uniquely identified
  - for intended packets to be delivered to the right end point and application.

- Typically, such identifiers are termed "Addresses", by analogy to "postal addresses".
  - E.g. MAC address, IP address, PSTN/ISDN number, etc.

- So email "addresses" are NOT addresses. They are names !

- In the NGN context we assume names and numbers will have similar relationship.

NGN will need Name-to-Address Translation Functions – DNS+

Some Attributes of Names and Addresses

Names

- Human readable, generally text based.
- Convenient to remember and use in everyday language.
- Not necessarily unique or definitive.

Addresses

- Machine processable, typically numeric for use in switching /routing of data.
- Not necessarily location significant in the data networking context.
- Can be either hierarchical or flat. (E.g. E.164 numbers or IP Addresses).

NGN functions require a consistent, coherent naming system/terminology
May have to deal with Name-to-Multiple Addresses associations
Also needs to be "backwards compatible" !

Examples of Names and Addresses

Examples of Names

- Access Network
- Name Server
- Billing Record
- etc.

Examples of Addresses

- Media Access Control (MAC) Address,
  - e.g. <Manufacturer ID + Device ID /serial number>
- IPv4 addresses e.g. dotted decimal representation, such as 47.145.54.120
- IPv6 addresses e.g. AAAA (quad A) representations for DNS compatibility
- ITU-T E.164 (ISDN/PSTN) numbers
  - e.g. <country code><area code><exchange/carrier><subscriber number>

Names identify entities to humans - Addresses identify entities to machines

Hierarchical and Flat Address Structures

Addresses are basically data structures (i.e. can be processed by machines),
So can have either Flat or Hierarchical structure.

Hierarchical

- Easier for routing (e.g. E.164 series)
- Can imply useful location information
- Limited portability if user moves

Flat

- More complex routing (e.g. IP addresses)
- May not say much about the user
- Often not user friendly

Distinction between Hierarchical and Flat addresses often blurred
NGNs will use both types – implying need for efficient translation

E.164 Based Addressing

- PSTN/ ISDN oriented E.164 / E.212 series numbering schemes designed for global scalability:
  - Geographic hierarchy provides for fast, convenient routing:
    <Country Code + Area Code + Carrier/Local Exchange + Subscriber Number >
  - Four hops and I am anywhere in the world – hard to beat for routing efficiency !
- Ubiquitous use in most national numbering plans – including mobile networks.
- Number portability requirements pose a challenge to conventional E.164 based systems.
  - Proposed solutions typically based on name servers, directories and title translation schemes. Clumsy, but not insoluble.
- VoIP growth may also pose challenges to traditional numbering plans.
  - Number portability promoted as big “selling feature” of VoIP services.
- In PNNI/ATM based networks the NSAP based “ATM End System Address” (AESA) was intended as generalized extension to E.164 based addressing.
  - AESA format was designed to be flexible and inclusive – what happened ?

I love my phone number – I don’t know my IP address (but I don’t need to) !

IP Addressing Issues

- NGN assumed to to based on IP networking.
- IPv4 used generally for routing of IP packets everywhere on web now.
- But original 4-octet IPv4 addressing structure was not designed for such scalability !
- Limited address space – originally grouped into 5 address "classes" resulted in inefficient use of address space.
- Address classes not generally used now.
    - Replaced by "Classless Inter Domain Routing" (CIDR) scheme, which essentially relies on variable length subnet masking (VLSM) technique to make more efficient use of the limited IPv4 address space.
    - CIDR introduces more hierarchy into IP addressing for more efficient routing.
- Proliferation of Network Address Translation (NAT) devices for corporate networking (IP PBXs) also effectively extends IPv4 address space.
- IPv6 is intended to be the "real" solution to IPv4 limitations:
    - 16 octet IPv6 address provides huge address space – maybe address overkill !
    - IPv6 address coded in "dotted hexadecimal" format. Not user friendly.
    - "Backwards compatible" with IPv4 address structure.

IPv4 address structure was a "mistake" we are still trying to fix !

The IPv4 to IPv6 Evolution Dilemma

- You have been warned: The IPv4 address will run out of ‘space’ soon (5-10 yrs)
- For now IPv4 life has been extended by schemes such as:
  - Classless Inter Domain Routing (CIDR) with Variable Length Subnet Masking.
  - Network Address Translation (NAT) for corporate networking.
- Address starvation was main motivation for IPv6, with 128 bit address space.
- Generally accepted by Internet community that IPv6 will happen eventually.
  - The question really is “when” and “How”…. ??
- Evolution scenarios from IPv4 to IPv6 not well understood.
  - Costly upgrades to network elements / name servers.
  - Interworking between “islands” of IPv4 and IPv6 can be messy.
- Who will pay for the upgrade to IPv6 ? No added value to end user, e.g. me.
  - What is the business case ?
- Common myth that IPv6 inherently provides enhanced security and QoS. Not so !
  - IPv6 needs IPsec for security
  - IPv6 needs DiffServ and/or RSVP for QoS

Evolution picture to IPv6 is unclear – who pays ?

MAC Addresses

- Ubiquitous “hardware” addresses for many types of devices, hosts, terminals, etc.
- Data networking requires every host /terminal to have unique MAC address.
- Network maintains the <IP address: MAC address> pair (tuple) for packet delivery.
    - e.g. using protocol such as Dynamic Host Config. Protocol (DHCP) and ARP.
- Different for Ethernet or Token-Ring based LANs, including transmission order!
- Administered by the IEEE, but option for “local” administration exists.
- MAC addresses are a 6 octet hexadecimal number :
    - First 3 octets identify manufacturer, e.g. Organizationally Unique ID (OUI)
    - Next 3 octets signifies a unique device number, e.g. serial number, etc.
- Since MAC addresses are typically “hardwired” tends to be permanent – can be “spoofed”. Security is an issue as MAC addresses can be easily read.
- Authentication based on MAC addresses not advisable.
- MAC addresses will remain part of identification suite in NGN architecture
    - Unlikely to evolve beyond a “physical” address as used now.

MAC Addressing is here to stay – will be part of NGN

Uniform Resource Identifiers (URI)

- Initiative by the IETF to develop generic identifiers for resources on the Internet
- resources in this context means anything that has identity
  - e.g. web sites, documents, services etc.
- Most widespread manifestation of URI is the Uniform Resource Locator (URL)
  - commonly used for retrieving files etc. from web sites.
- URI initiative has generated related work to develop generic naming /addressing schemes:
  - Uniform Resource Names (URN)
  - Uniform Resource Characteristics (URC)
  - Persistent Uniform Resource Locator (PURL)
  - Digital Object Identifier (DOI)
- Some of these schemes have limited usage in publishing, libraries, etc.
  but not much used in general.
- URI scheme important for NGN usage – SIP requires URI syntax for addressing

NGN naming and addressing standards will need to deal with URI/URL based schemes in consistent manner

URI /URL Issues

- URLs can change for various reasons resulting in broken links
  - This was the primary motivation for developing URNs and PURL, etc. but these are not widely used so far.
- URI/URL syntax is clumsy and not human friendly – long, difficult to type.
  - e.g. http://www.xxxx/yyyyy/zzzzz/forgetit…. !/etc.html
- Adoption of URI format by SIP architecture for addressing will require additional translation capabilities to E.164 for PSTN interworking.
- URL format may be O.K. for documents/files resources identification and retrieval but not very useful for general network capabilities.
  URN is better but not widely used. Structures are too machine dependent.

Is it possible to develop a "simple" (i.e. user-friendly/ text based) Identification scheme for universal naming / addressing in NGN context ?
Maybe yes, but who will do it – ITU-T ?

Telephone Number Mapping (ENUM)

- Popular initiative by IETF to “translate” E.164 numbers as DNS Resource Records (RR).
- Creates “new” ENUM domain “e164.arpa” for telephone number-to-URI conversion.
- E.164 numbers used to populate DNS Naming Authority Pointer (NAPTR) RRs using simple conversion procedure.
- Translation procedure based on:
  - invert E.164 number and remove non-digit characters
  - add dotted decimals
  - append ENUM domain e164.arpa.
  - e.g. +1 613 829 7277 translates to <7.7.2.7.9.2.8.3.1.6.1.e164.arpa>
- ENUM utility has been very successful due to focused, consultative approach:
  - IETF ENUM WG collaborating with ITU-T SG 2 on numbering.
  - ETSI, ATIS and other SDOs also involved for regional numbering plan issues.
- ENUM activities extended to SIP URI usage for VoIP interworking.

ENUM will likely become integral part of NGN NameServer / DNS architecture for address interworking

ENUM, IANA and ICANN

ICANN – Internet Corporation for Assigned Names and Numbers

- Formed in 1998 to "manage" Internet (commercial) naming and numbering
- Now mainly involved in managing Top Level Domains (TLD) and accreditations to companies who assign internet names
- Relies on the IETF (IANA) for technical work related to numbering, etc.

IANA – Internet Assigned Numbers Authority

- Responsible for assigning and maintaining port numbers, codepoints, protocol Ids etc. in IETF. Operates WHOIS service to find domain names.
- Activities are primarily technical and database management oriented now, but some overlap with ICANN activities.
- Not primarily involved in developing overall naming/numbering schema.

ENUM – Telephone Number Mapping (Enhanced Numbering)

- Recognized by ICANN and IANA as means of populating domain e164.arpa
- Useful for PSTN /VoIP interworking via SIP extensions

A complicated dance of Naming Authorities – but who is leading ?

Naming and Addressing Standards Activities

ITU-T SG 2

- Lead Study Group on Numbering and Routing standards.
- Authority for E.164 based numbering and its evolution.
- Working closely with ICANN, IANA, ENUM, ETSI, etc.
- Starting to look at NGN addressing aspects
  (Project 5 and 7 on Global Evolution of Numbering Naming and Addressing)
- Wants to work with NGN FG in this area, including number portability aspects.

ETSI

- Current focus is on ENUM. Collaborating with RIPE NCC.
- Developing ENUM Administrative Guideline for EU.
- Planning ENUM trials in several EU countries.

IETF

- Continuing working on URI/URL drafts and enhancements
- Also ENUM and IANA as registrars

Lots of interlinked activities - but no convergence in sight !

Addressing in SIP

- Session Initiation Protocol (SIP) being promoted as basis for IMS/VoIP services
- SIP is essentially call control signaling using “email-like” text-based messaging instead of ISUP (SS7) like messaging.
- SIP based on HTTP like request/response transaction messaging
- SIP adopts URI like addressing called a “SIP URI”
    - E.g. My SIP address could look like <sip:khalidahmad@namati.com> i.e. similar to my email address !
- SIP Proxies and Location servers are responsible for “translating” SIP URIs to routable addresses, such as an IP address.
    - I.e. analogous to DNS function in email
- SIP messages (called methods) carry session related information as “attachments” encoded using Session Description Protocol (SDP)
    - Analogous to email attachments
- Compatible with ENUM derived Resource Records

SIP implies extensions of DNS-Like capabilities in the NGN
- but no fundamental change in addressing architecture

Addressing Issues for NGN Standards

- NGN concept implies many different types of “Convergence”:
  - PSTN/ISDN convergence with IP based networks.
  - Fixed – Mobile convergence (FMC).
  - Broadcast (Cable) – Telecommunications convergence.
  - Web based services convergence.

- Each has different addressing structures – not to mention terminology !
  - Challenge is to find a consistent, comprehensive scheme and not repeat mistakes of the past – remember AESA - great idea, but did not catch on.

- Constraints to work with are:
  - E.164 number (and its derivatives)
  - MAC Address of each device
  - IP addresses (IPv4 or IPv6)
  - URI ?

Will concept of convergence extend to addressing – and how ?

Conclusions

- NGN is being built on addressing schemes of 20 years ago.

- Networking is divided between phone numbers and IP addresses
  - The great divide. We are nowhere near bridging it yet !

- Address interworking is the name of the game. ENUM, anyone ?

- NGN FG can make a start by developing consistent naming/terminology.
  - Unified numbering scheme for NGN is more difficult.

- E.164 et al hard to beat for (routing) convenience and ubiquity.

- IP address hard to beat for convenience (I don't even need to know it).
  - But evolution to IPv6 is still an open question.

Thank You for Your Attention !

Questions ?

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