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ICN IDENTIFIER / LOCATOR

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A brief review of ID/Locators in IETF

It's long, and we'll skim over it

Then we discuss the CCNx & NDN approaches to ID/Locator (or Map-Encap)

Then open discussion

(PARTIAL) HISTORY OUTSIDE OF ICN

- IEN1 (1977) “Issues in the interconnection of datagram networks”
- Draft-odell-8+8-00 (1996) “8+8 - An Alternate Addressing Architecture for IPv6”
- RFC 1955 (1996) “New Scheme for Internet Routing and Addressing (ENCAPS) for IPNG”
- RFC 4423 (2006) “Host Identity Protocol (HIP) Architecture”
- RFC 4984 (2007) “Report from the IAB Workshop on Routing and Addressing”
- RFC 6740 (2012) “Identifier-Locator Network Protocol (ILNP) Architectural Description”
- RFC 6830 (2013) “The Locator/ID Separation Protocol (LISP)”

IEN1 (1977) “ISSUES IN THE INTERCONNECTION OF DATAGRAM NETWORKS”

- <internet ID> ::= <net ID> <TCP ID> <port ID>
  - <net ID> “universally agreed code for distinguishing individual networks”
  - <TCP ID> “it is decided purely by the local network without reference to others”
  - <port id> distinguishes the process
- Proposal: make <TCP ID> host independent and do a mapping at the “terminal gateway” to the local network.

8+8 - AN ALTERNATE ADDRESSING ARCHITECTURE FOR IPV6

The 16 byte IPv6 address is split into two 8-byte objects stored in the existing 16-byte container.

- The lower 8 bytes (least significant) form the "End System Designator," or ESD.
- The upper 8 bytes (most significant) are called the "Routing Goop", or RG.
- The ESD designates a computer system and the RG encodes information about its attachment to the global Internet topology.

- "Public Topology" is structure which must be understood by a number other organizations, especially and specifically transit networks, for constructing global Internet connectivity.
- "Private Topology" is structure which is of no particular interest outside the containing organization.
- In particular, general transit service is provided by networks exposed in the Public Topology; networks composed of only Private Topology cannot provide general transit service to the Global Internet.

RFC 1955 (1996) "NEW SCHEME FOR INTERNET ROUTING AND ADDRESSING (ENCAPS) FOR IPNG"

The mechanism to do this is for the border routers to encapsulate the original IP datagrams with another IP header. The source and destination addresses in the new header (I will call it the AD-Header from here on) represent the source and destination ADs.

- When the first (entrance) border router receives a datagram from a host or router without an AD-Header
  - It looks at the source and destination address and **does a DNS lookup** to get the addresses for the AD-Header.
  - It then adds an AD-Header and forwards the encapsulated datagram to its proper destination AD.

[emphasis added]

RFC 4423 (2006) "HOST IDENTITY PROTOCOL (HIP) ARCHITECTURE"

- The proposed Host Identity namespace fills an important gap between the IP and DNS namespaces.
- The Host Identity namespace consists of Host Identifiers (HIs). A Host Identifier is … the public key of an asymmetric key-pair.

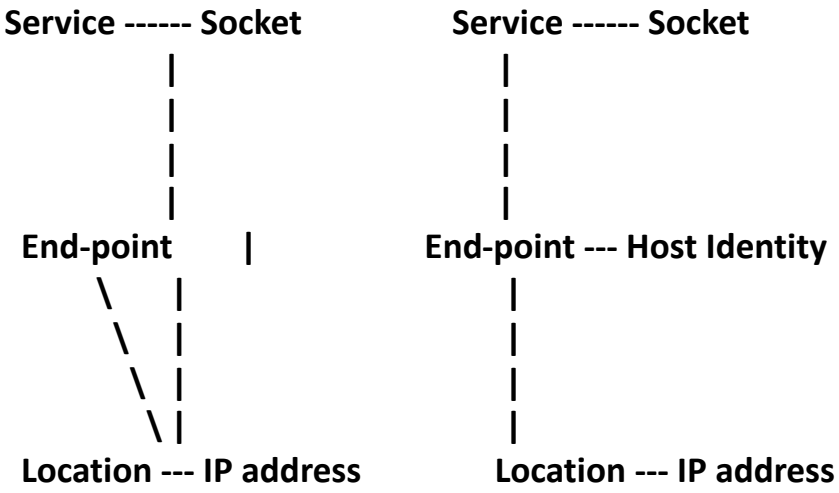
IP numbers are a confounding of two namespaces, the names of a host's networking interfaces and the names of the. **The names of locations should be understood as denoting routing direction vectors**, i.e., information that is used to deliver packets to their destinations.

[emphasis added]

HIP ARCHITECTURE

Architecturally, HIP provides for a different binding of transport-layer protocols. That is, the transport-layer associations, i.e., TCP connections and UDP associations, are no longer bound to IP addresses but to Host Identities.

Traditional TCP/IP *HIP Architecture*



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RFC 4984 (2007) "REPORT FROM THE IAB WORKSHOP ON ROUTING AND ADDRESSING"

- As its name suggests, locators identify locations in the topology, and a network's or host's locator should be topologically constrained by its present position.
- Identifiers, in principle, should be network-topology independent.
- That is, even though a network or host may need to change its locator when it is moved to a different set of attachment points in the Internet, its identifier should remain constant.

RFC 6740 (2012) "IDENTIFIER-LOCATOR NETWORK PROTOCOL (ILNP) ARCHITECTURAL DESCRIPTION"

- The key idea proposed for ILNP is to directly and specifically change the overloaded semantics of the IP Address.

- The Internet community has indicated explicitly, several times, that this use of overloaded semantics is a significant problem with the use of the Internet protocol today [RFC1498] [RFC2101] [RFC2956] [RFC4984].

ILNP

Layer	IP	ILNP
Application	FQDN or IP Address	FQDN
Transport	IP Address	Identifier
Network	IP Address	Locator
Physical i/f	IP Address	MAC address

FQDN = Fully Qualified Domain Name
i/f = interface
MAC = Media Access Control

In ILNP, transport-layer protocols use only an end-to-end, non-topological node Identifier in any transport-layer session state. Identifiers have the same syntax as IPv6 interface identifiers [RFC4291] (EUI-64).

RFC 6830 (2013) “THE LOCATOR/ID SEPARATION PROTOCOL (LISP)”

- This document describes a network-layer-based protocol that enables separation of IP addresses into two new numbering spaces:
  - Endpoint Identifiers (EIDs) and
  - Routing Locators (RLOCs).
- No changes are required to either host protocol stacks or to the "core" of the Internet infrastructure.
- N.B.: The EID does not need to be an IP address, there’s RFCs on mapping other structures.

LISP OPERATION

- A Tunnel Router prepends LISP headers on host-originated packets and strips them prior to final delivery to their destination.
- The IP addresses in this "outer header" are RLOCs.
- During end-to-end packet exchange between two Internet hosts, an ITR prepends a new LISP header to each packet, and an ETR strips the new header.
- **The ITR performs EID-to-RLOC lookups to determine the routing path to the ETR**, which has the RLOC as one of its IP addresses.

[emphasis added]

USE IN THE ICN COMMUNITY

- NetInf
- Mobility First
- NDN: NDNS & LINKs
- CCNx: Nameless Objects

NETINF [1]

- Global Information Network Architecture
  - The *REX*, a global name resolution system that maps the authority part of NDO names into routable network domain identifiers (locators).
  - A BGP-style routing system for the network domain identifiers. The network identifiers can be compared with today's IP prefixes which are announced in the global BGP routing infrastructure.
  - Label stacks (source and destination) in the packets carrying network and node identifiers (locators). The stacks facilitate explicit aggregation of routing information and late binding of names to locators.

[1] http://www.sail-project.eu/wp-content/uploads/2012/06/SAIL_DB2_v1_0_final-Public.pdf

NETINF SPECIFICS

- Conceptually, NetInf global routing is a name-based routing scheme, but to enable aggregation of routing state, routing is aided by translation to locators. These locators are called *routing hints*.
- Use IP addresses as locators.
- The NetInf routing scheme thus operates using the ni: URI scheme in combination with IP addresses.

NETINF EXAMPLE

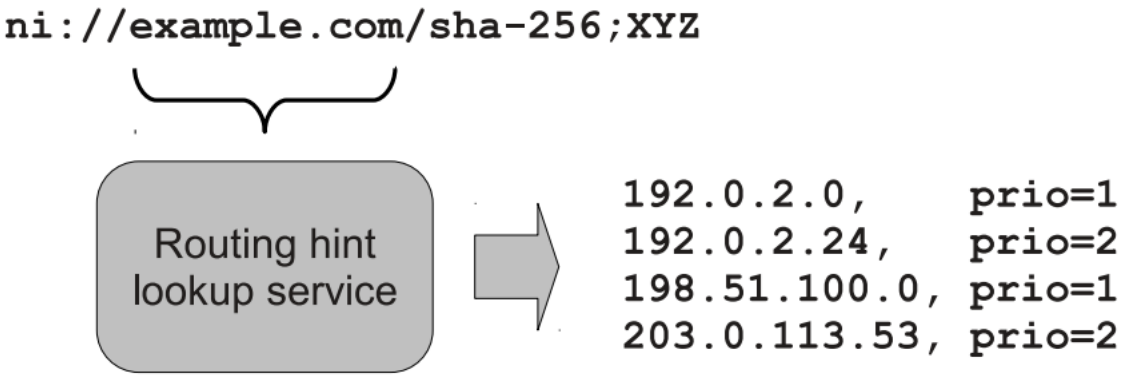

Figure 2.3: The routing hint lookup service.

[1] http://www.sail-project.eu/wp-content/uploads/2012/06/SAIL_DB2_v1_0_final-Public.pdf

MOBILITY FIRST NAMING & NRS

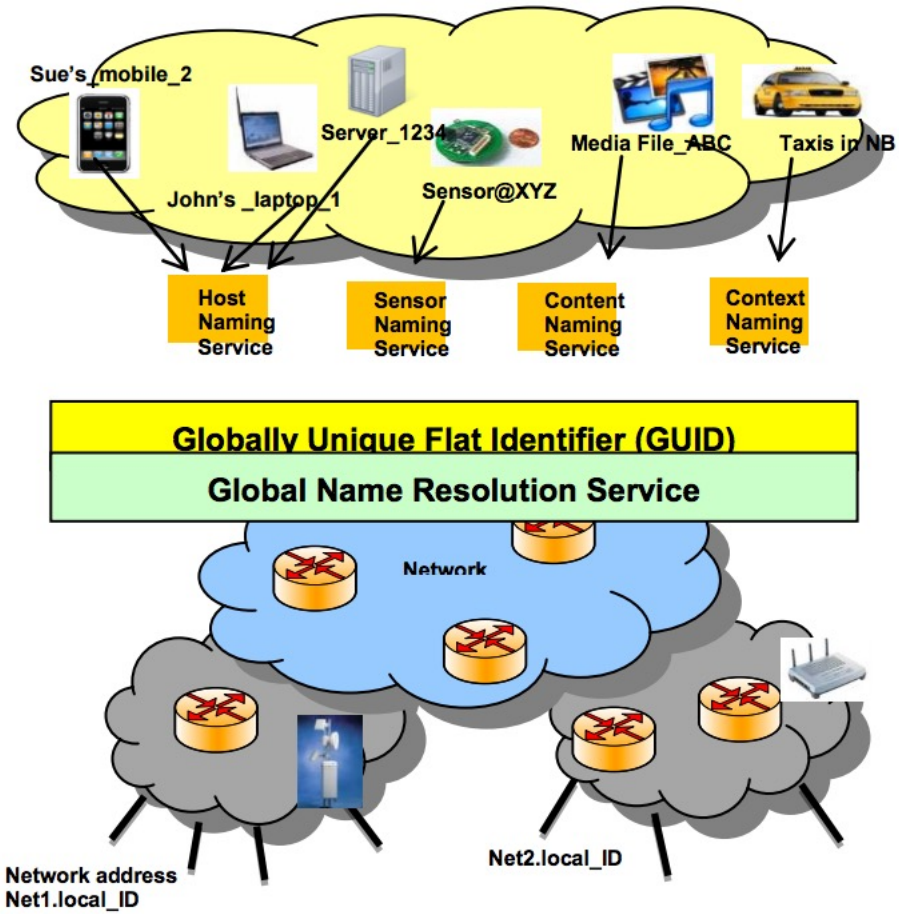

Fig. 1 Separation of Names from Addresses in the MobilityFirst Architecture

http://mobilityfirst.winlab.rutgers.edu/documents/ACM_AINTEC2011_Seskar_paper.pdf

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MOBILITY FIRST

- The name certification service (NCS) securely binds a human-readable name to a globally unique identifier (GUID).
- A global name resolution service (GNRS) securely maps the GUID to a network address (NA).
  - By allowing the GUID to be a cryptographically verifiable identifier (e.g., a public key or hash thereof), MobilityFirst improves trustworthiness;
  - conversely, by cleanly separating network location information (NA) from the identity (GUID), MobilityFirst allows seamless mobility at scale.

NDN: NDNS & LINKS [1]

- Enables the network to forward all interest packets toward the closest data even when not all the data name prefixes are present in the global routing table.
- The mapping information from a name to its globally routed prefixes can be maintained in, and looked up from, a distributed mapping system (NDNS [17]).
- Since data can be retrieved directly using the original names in many or most cases … MAEN performs the name lookup step only when necessary and only by end consumers.
- Because Interest can carry multiple Links, it leaves the choice of best link to the network routing, not the client.

[1] NDN, Technical Report NDN-0004, 2015. http://named-data.net/techreports.html

INTEREST PROCESSING

- Interest
  - Try to satisfy from Cache using Name
  - Try to aggregate Name in PIT
  - Try to forward in FIB using Name and create PIT entry
  - For each Link in the Interest, find the best one in FIB, and if it exists, forward to best
  - Drop the Interest
- Data
  - Not encapsulated, matches against Interest Name & selectors as normal

CCNX NAMELESS OBJECTS

- Interest to Content Object matching:
  - A ContentObject may have a name, if not it can only be matched by hash restriction
  - If a ContentObject does not have a name, the name in the Interest is not used in matching.
  - The KeyIdRestriction and ContentObjectHash restrictions in an Interest are always used if present.
- The Interest Name may be an identifier (if the ContentObject has a name) or may be a routing locator (if it does not) or both (if they align).
- An outside system is needed to determine names / hashes. May be an NRS, may be a Manifest system.

SUMMARY

Layer	IP	ILNP	LISP	Mobility 1st	NDN	CCNx
Resolver	Client (DNS)	Client & Router	Router	Client & Router	Client	Client
Application	FQDN/IP [6]	FQDN [6]	EID	Name	Name [1] & Links [2]	Name [1][3]
Transport	IP	Identifer	EID	GUID	Name	Name
Network	IP	Locator [5]	RLOC [4]	NA	Name & Links	Name
Interface	IP	MAC	MAC	MAC	MAC	MAC

[1] {Name, Selectors} or {Name, KeyIdRestr, HashRestr}
[2] Consumer responsible for resolving Links
[3] Consumer responsible for resolving proper name & hashes
[4] Done by ITR
[5] Border router does lookup
[6] Client responsible for FQDN lookup

TOPICS AND DIRECTIONS

1. Compact routing (no need for indirection)
2. NDN-style multiple locators per Interest
3. CCNx-style
4. Forwarding labels in CCNx
5. ICNRG “hybrid naming”

Research in (1)

Incorporate (2) as a CCNx draft?

Consolidate (4) and (2)?