ILNP
in a nutshell

http://ilnp.cs.st-andrews.ac.uk/

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ILNP
Identifier-Locator Network Protocol

1. **Why?**
2. What?
3. How?
4. Where?

The changing world of IP

- How to support a ***harmonised solution to many*** **network functions in a scalable manner?**
  - Multi-homing (host and site).
  - Mobility (host and network).
  - Multi-path capable transport protocols.
  - Localised addressing (NAT).
  - Traffic engineering capability.
  - Packet-level, end-to-end security.
  - Virtual machine migration/mobility.
- Current solutions for such functions remain disparate, do not function well together and/or may not scale well.

Naming Architecture: IP vs ILNP

Protocol Layer	IP	ILNP
Application	FQDN or IP address	FQDN (RFC1958)
Transport	IP address (+ port number)	(Node) Identifier (+ port number)
Network	IP address	Locator
(Interface)	IP address	(dynamic mapping)
	Entanglement ☹	**Separation ☺**

FQDN = fully qualified domain name

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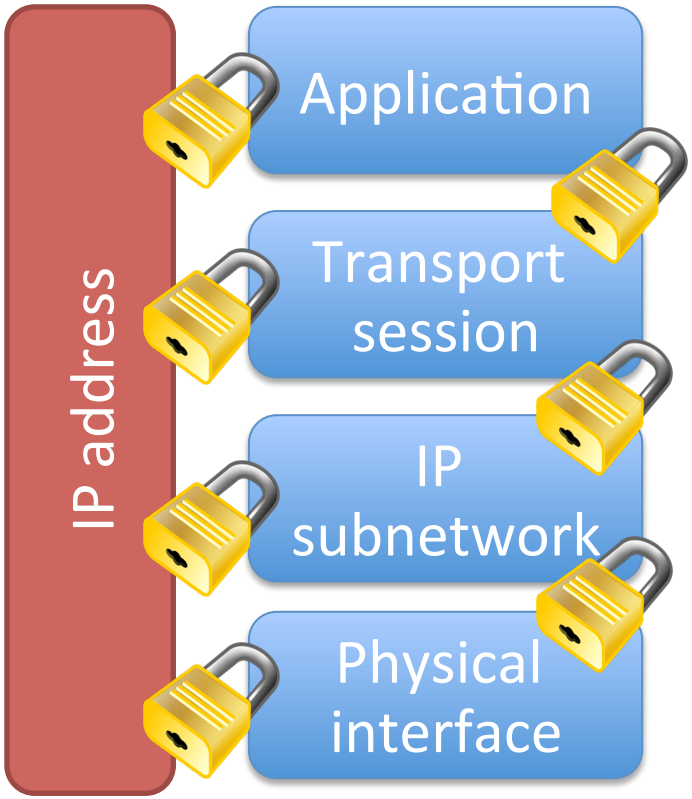
Identifier-Locator namespaces in ILNP

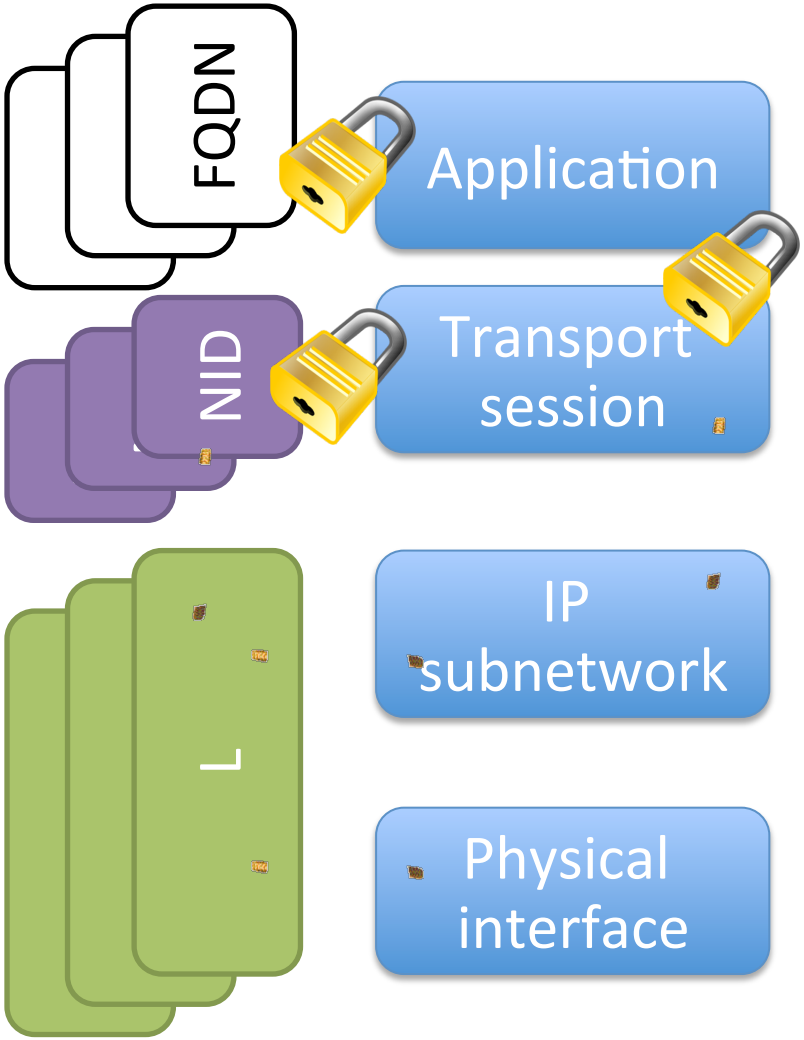
- **Locator, L:**
  - **Topologically significant.**
  - Names a (sub)network (as today's **network prefix**).
  - Used only for routing and forwarding in the core.
- **(Node) Identifier, NID:**
  - **Is not topologically significant.**
  - Names a logical/virtual/physical node, does **not** name an interface.
- **Upper layer protocols bind only to NID.**

Namespaces & namebindings

IP – static



ILNP – dynamic



animated knot from http://meritbadge.org/wiki/index.php/Knot#Granny_knot

ILNP: Locator Properties

- Locator names an IP (sub)network.
- Locator is equivalent to an IP Routing Prefix:
  - Multiple Locators can be used simultaneously.
  - **Nodes can change their Locator values during the lifetime of an ILNP session.**
  - Enables "NAT", mobility, multi-homing, end-to-end IPsec, site-controlled traffic engineering, etc.
- Locators NEVER used for transport layer state, e.g. by TCP, UDP, SCTP, etc.
  - **end-to-end state now independent of topology**

ILNP: Identifier (NID) Properties

- NID names a **node**, not an **interface**
- **Remains constant** during the lifetime of a transport session
- Nodes may use multiple NIDs concurrently:
  - only one NID for a given transport session
  - NIDs can be stable over time
- Other IPv6 ID formats supported by ILNP:
  - e.g. Private (RFC4941), CGA (RFC3972)
- Only NID is used by IPsec, TCP, UDP, SCTP, etc.

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ILNP: Engineering

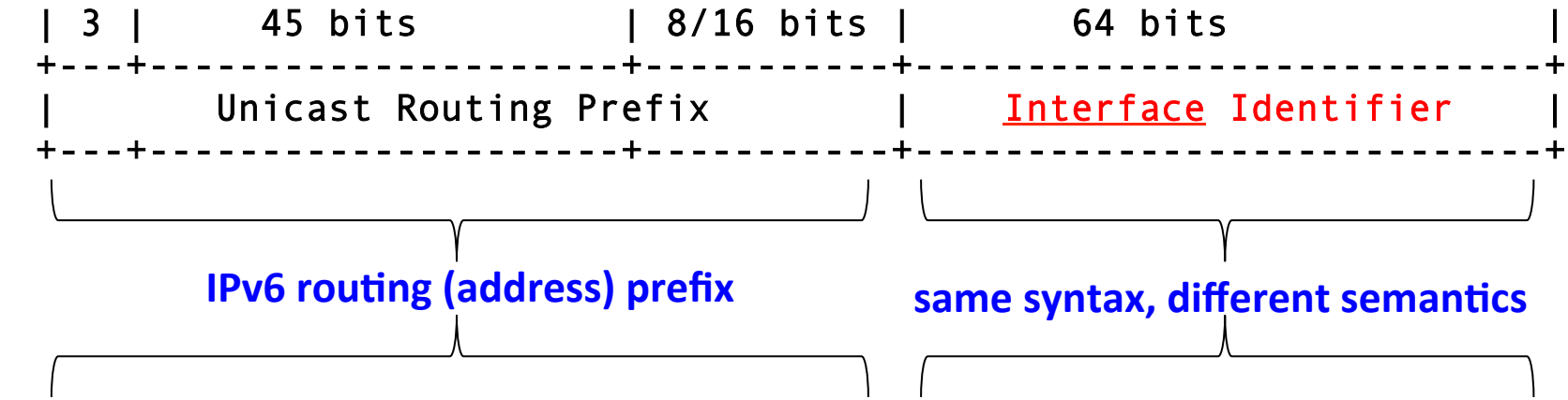
- Could have gone "clean slate" ... not practical.
- Main architectural ideas can be applied as extensions to both IPv4 and IPv6:
  - current RFCs cover both
- Focus here is on IPv6, as the engineering is cleaner, but IPv4 is also possible.
- ILNP extensions to IPv6 – **ILNPv6**:
  - Routers see an ordinary IPv6 packet.
  - ILNPv6 hosts see an ILNPv6 packet.

ILNPv6

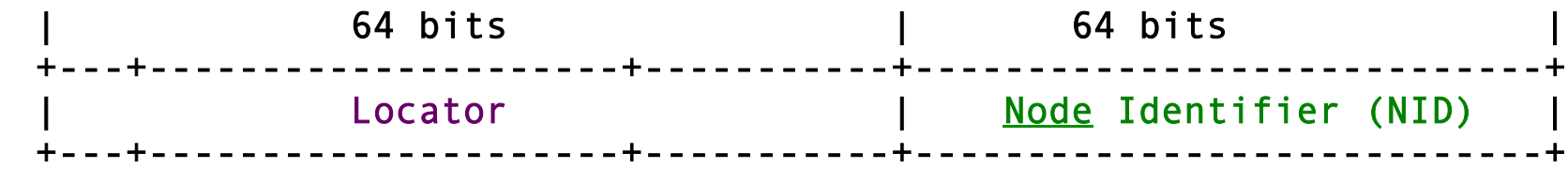
- A set of extensions to IPv6:
  - Same packet format as IPv6, with extensions
  - No changes required in the IPv6 routers
  - Incrementally deployable on IPv6 networks
  - Backwards compatible with IPv6 devices
- Split 128-bit IPv6 address:
  - **64-bit Locator (L64)** **(sub)network name.**
  - **64-bit Identifier (NID)** **node name.**
  - **encode NID and L64 into existing IPv6 packet**

IPv6 addresses and ILNPv6 I-L vectors

IPv6 address (as in RFC3587 + RFC4291):



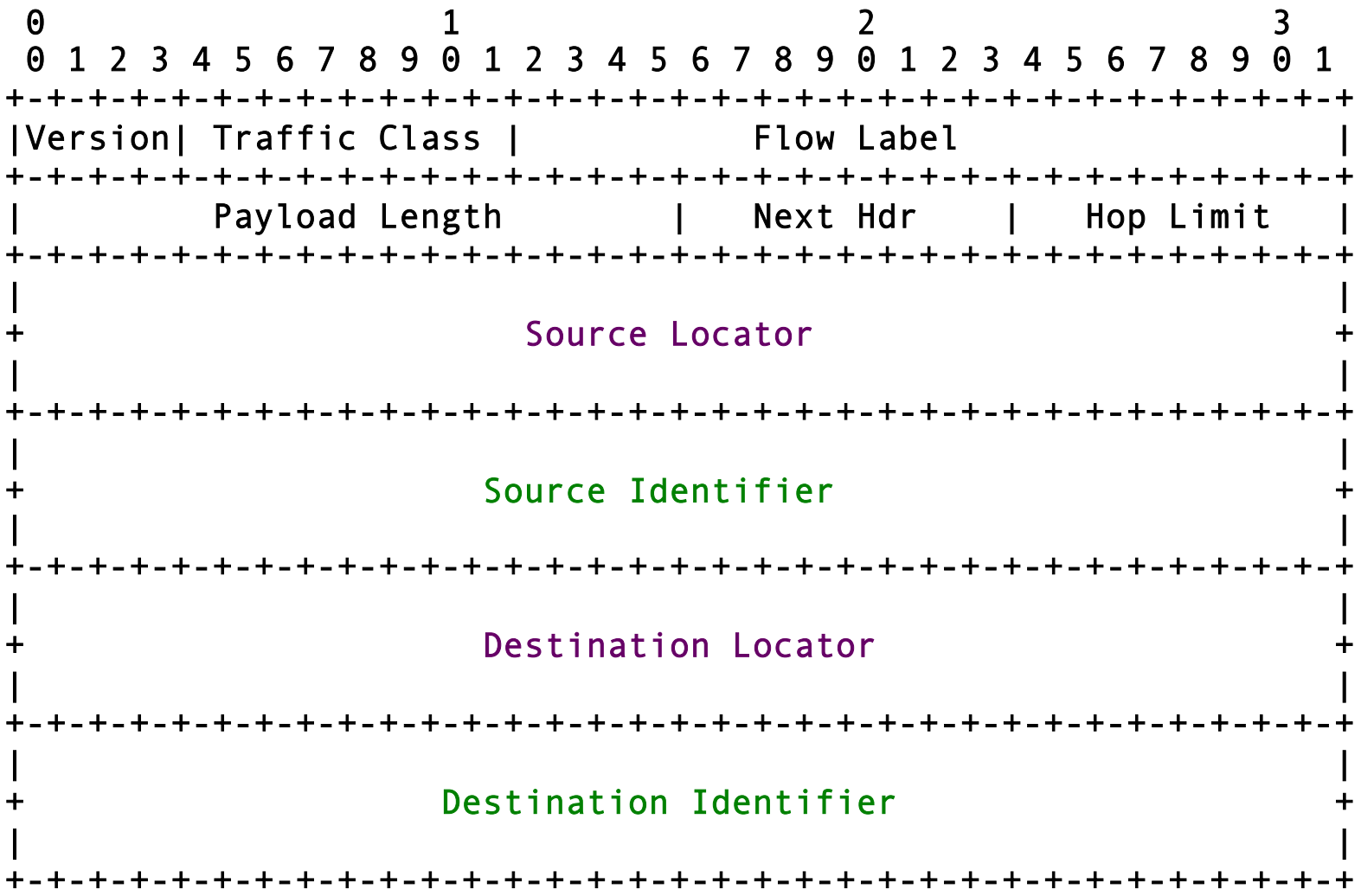
ILNPv6 I-L vector (as in RFC6741):



same syntax and semantics as IPv6 routing (address) prefix so IPv6 core routers work as today

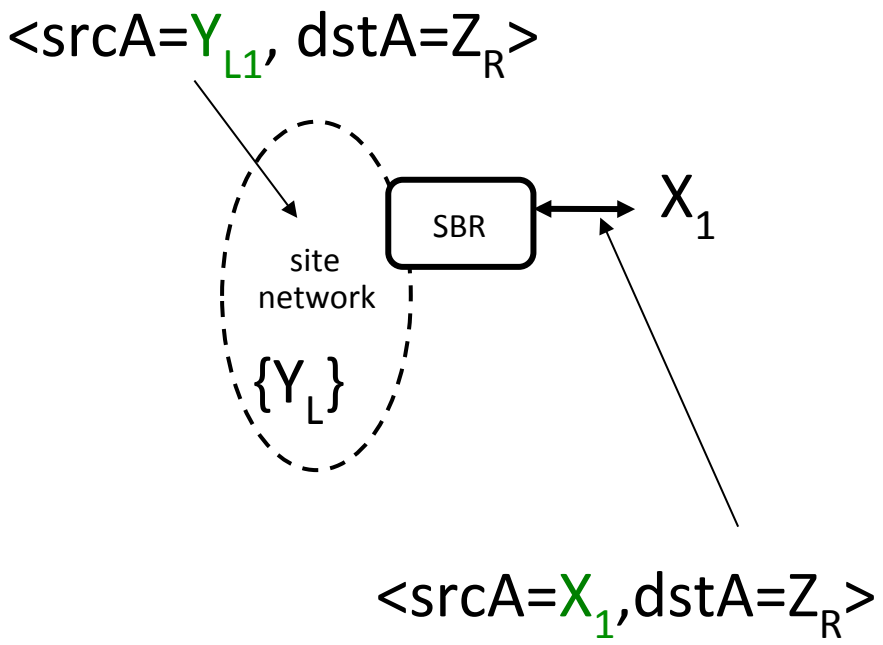
these bits only examined and acted upon by end systems

ILNPv6 packet header – host view



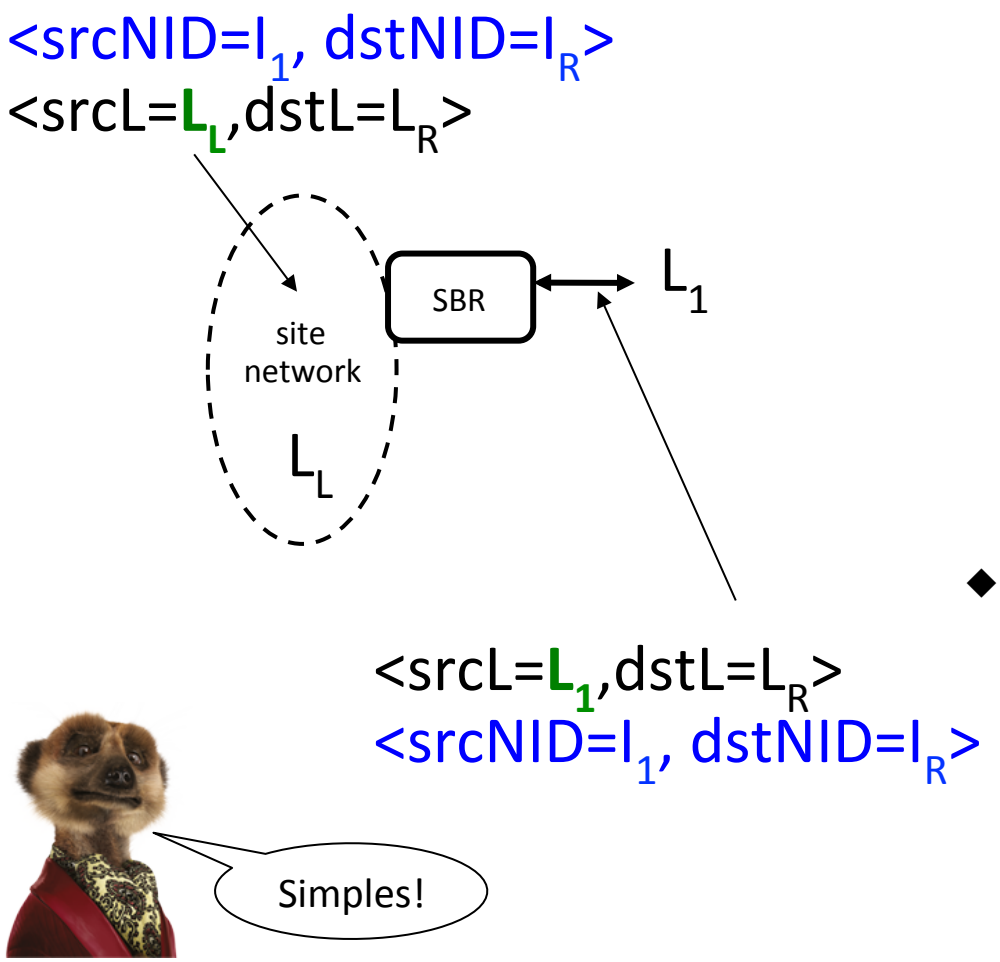
Example 1:
Localised Addressing
(aka NAT)

NAT in IPv4 and IPv6



- **NAT**:
  - single address shared amongst many hosts (use of port numbers for multiplexing)
- **End-to-end integrity lost**, as identity namespace has a discontinuity at the site border router (SBR), impacting other end-to-end functions (e.g. IPsec)
- SBR may have to perform other functions also

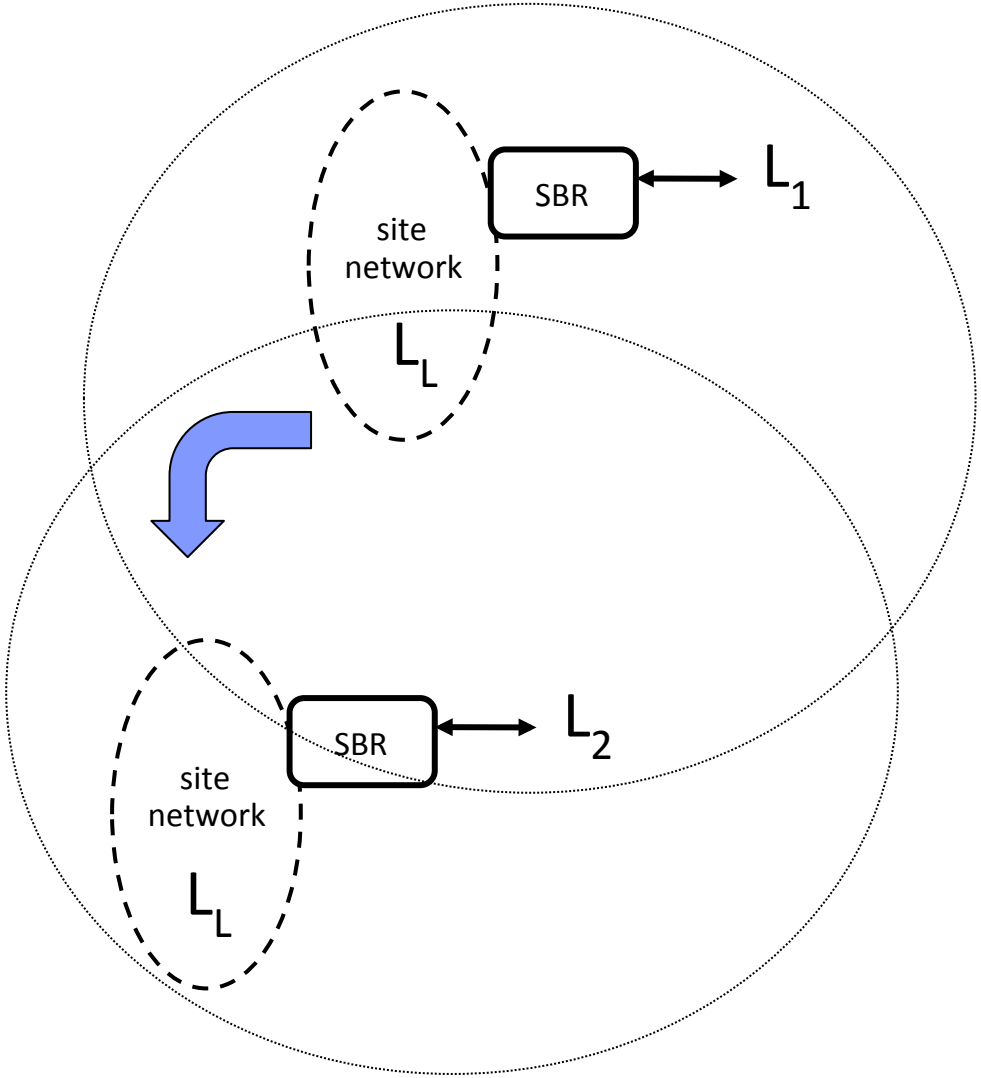
NAT equivalent in ILNPv6



- **Localised 'addressing' is a feature not a hack**:
  - Locator is **not** part of the end system transport session state.
  - L_L as in RFC4193 (ULA)
  - **end-to-end view**
- SBRs perform **Locator rewriting** without affecting end-to-end state.

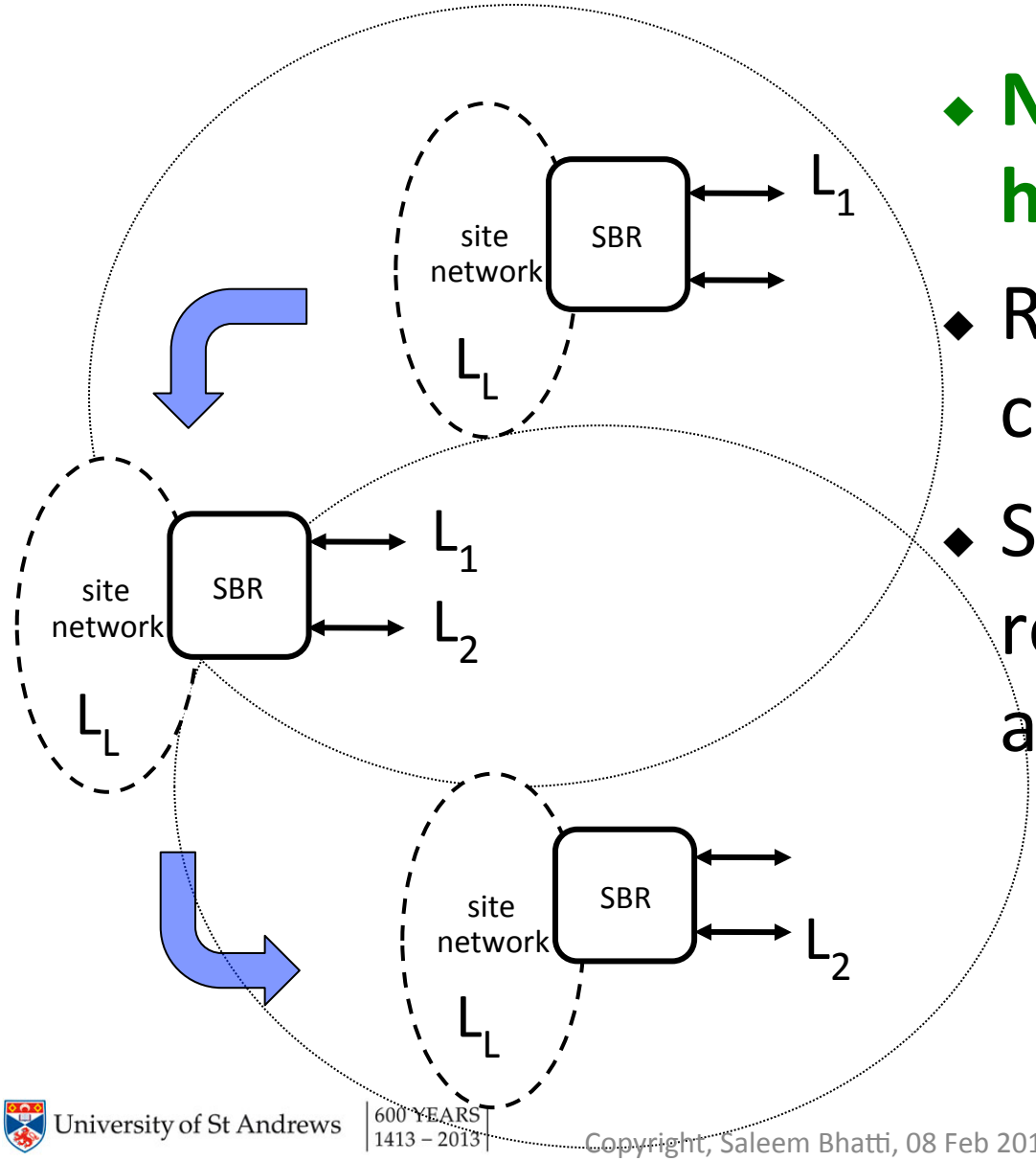
Example 2:
Mobile Networks

Mobile **networks** in ILNPv6 [1]



- Locator re-writing can 'hide' site movement from internal nodes.
- SBR changes Locator value as the mobile network moves:
  - Sends **Locator Update (LU)** messages to correspondents.
  - Updates DNS with new Locator value

Mobile **networks** in ILNPv6 [2]



- **Network layer soft-hand-off possible.**
- Requires 2+ radio channels / interfaces.
- SBRs handle Locator rewriting + forwarding as required.

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ILNP: Status (Jan 2013)

- 8+ years of peer-reviewed architectural research:
  - Papers and talks available at ILNP web site http://ilnp.cs.st-andrews.ac.uk/ (also advert for PhD student)
- 9 Experimental status RFCs (IRTF RRG):
  - RFCs 6740-6748 (Nov 2012)
- PhD students:
  - Bruce Simpson (funding: Cisco, USA)
  - Ditchaphong Phoomikiattisak (funding: Thai Govt)
  - TBA 1 (funding: Time Warner Cable, USA – see advert)
  - TBA 2 (funding: major company, USA)
- Open source prototypes from University of St Andrews:
  - FreeBSD "ping demo" available soon.
  - Linux "ping demo" in ~12 months.

Thank you! Questions?

- ILNP further information:
  - see http://ilnp.cs.st-andrews.ac.uk/ for links to RFCs, papers and talks
  - ... or accost me in the time honoured manner 
- Reading – start off with:
  - "Evolving the Internet Architecture Through Naming", IEEE JSAC, Oct 2010, (7 pages) http://dx.doi.org/10.1109/JSAC.2010.101009
  - RFC6740, Nov 2012 http://tools.ietf.org/html/rfc6740
    RFC6741, Nov 2012 http://tools.ietf.org/html/rfc6741