ICT SHOK Future Internet program

WP1: Driving directions for packets (and some parking tips)

Hannu Flinck, Nokia Siemens Networks

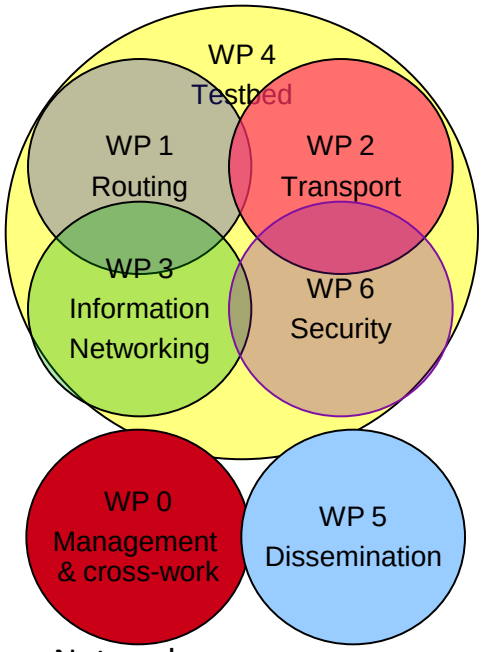
12.04.2011

Tivit Future Internet Program 2008 - 2013

Vision: Future Internet = a mission critical backbone of global information society

Mission: Enhance the Internet technology and ecology as a *platform for innovation* while providing strong governance over the use of the network resources and information

4 yr Strategic Research Agenda: www.futureinternet.fi

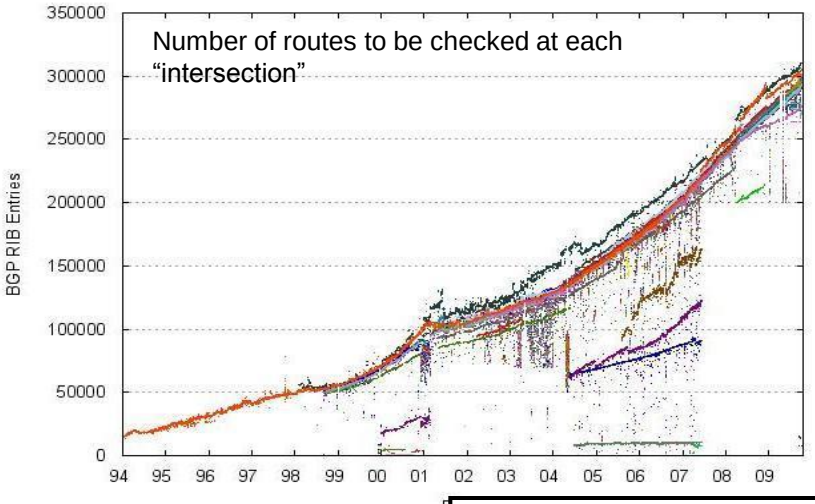


Phase 2 Partners (6/2009 – 3/2011):
CSC – IT Center for Science, Cybercube, F-Secure, Ericsson, Nokia, Nokia Siemens Networks, Stonesoft, TeliaSonera Finland, Aalto University, Universities of Helsinki, Jyväskylä and Turku, Tampere University of Technology, VTT Technical Research Centre of Finland, Tivit

Routing scalability challenge

Developed mechanisms and protocols to enable cost efficient **Next Generation Internet routing systems** that have been contributed to standardization

- Work area spans from Link layer to IP and Transport layer
- Close linkage to the IETF, IRTF and 3GPP
- Name based socket -- a fundamental, yet backwards-compatible re-design of the existing host stack architecture.
- HIP extensions for multipath
- Locator Identifier separation mapping systems
- Compact routing algorithms
- L2 Customer Edge Switching
- IPv6 transition mechanism evaluation
- MIP-based scheme providing reliable yet economical Intranet connectivity

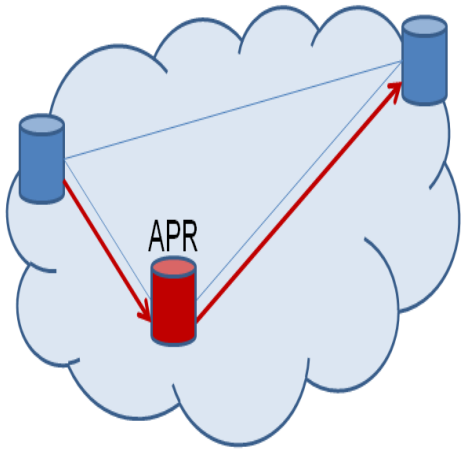


Geoff Huston: CIDR Report
www.cidr-report.org

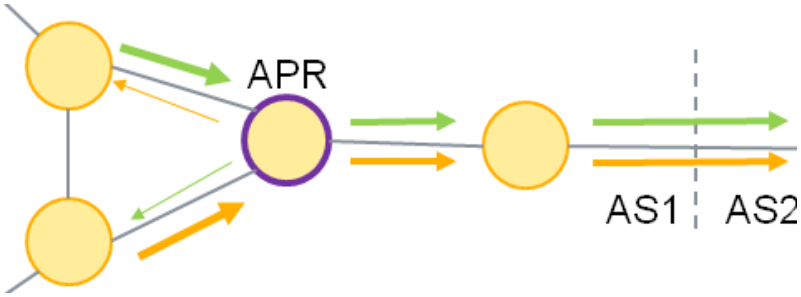
Approaches Next Generation Internet routing systems

- **Evolutionary approaches to reduce routing table**
  - Use of compression techniques
  - Virtual aggregation
- **Host based approaches for multihoming**
  - Name based stack
  - Host Identity Protocol (HIP) with multipath extensions
  - Redundant array of inexpensive Internet connections
  - Identifier Locator Network Protocol (ILNP, was not covered in the project)
- **Locator Identifier separation based solutions**
  - Locator Identifier Separation Protocol (LISP)
  - Customer Edge Switching (CES)
- **New routing approaches based on compact routing**
  - Powernet: compact routing on Internet-like random networks
  - Compact routing based mapping of locators with identifiers

Evolution through Virtual Aggregation



- Reduces router memory need
- Based on defining roles to routers
  - Only APRs install full FIBs
  - Virtual Prefixes (VP) advertized from aggregation point routers (APR)
  - Tunnels to and from APRs needed for routing correctness
- Main drawbacks: path stretch and network complexity
- Studied VP and APR allocation schemes:
- Uniform VP allocation & directly routed popular prefixes (PP)
  - Achieves on avg. 95 – 99% FIB reduction
  - Low stretch (< 20 % in latency)
- Popularity based VP allocation
  - Average FIB reduction (avg. ~90%)
  - Low stretch (< 15 %)



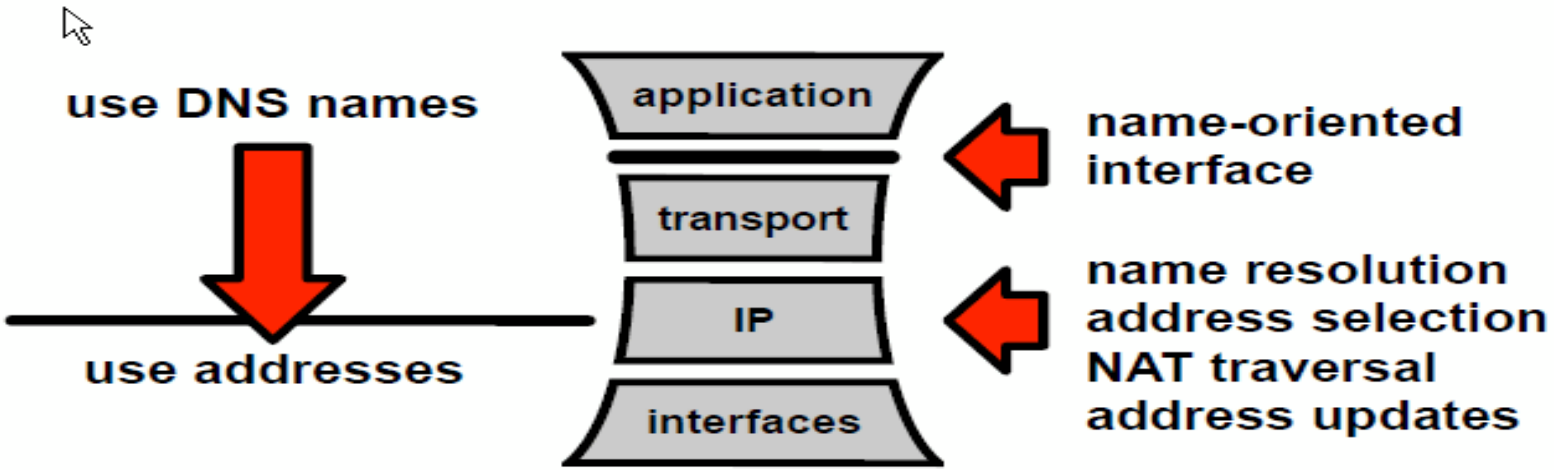
- Compared to router local FIB Aggregation, Virtual Aggregation gives smaller FIBs but with higher planning overhead

Routing scalability

Host based approaches for multi-homing

Name based socket

- Shield developers from IP networking details:
  - Provides only name based abstraction, no IP – addresses to

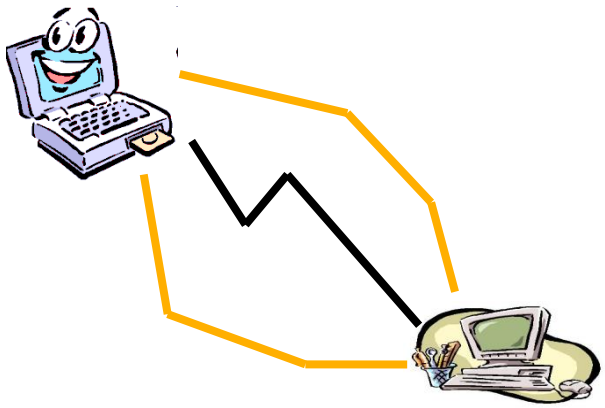


no new namespace — no new infrastructure — opt-in

- BOF session in the IETF 79

Work continues in Swedish institute of Computer Science and Tsinghua University

Multipath Internet Transport

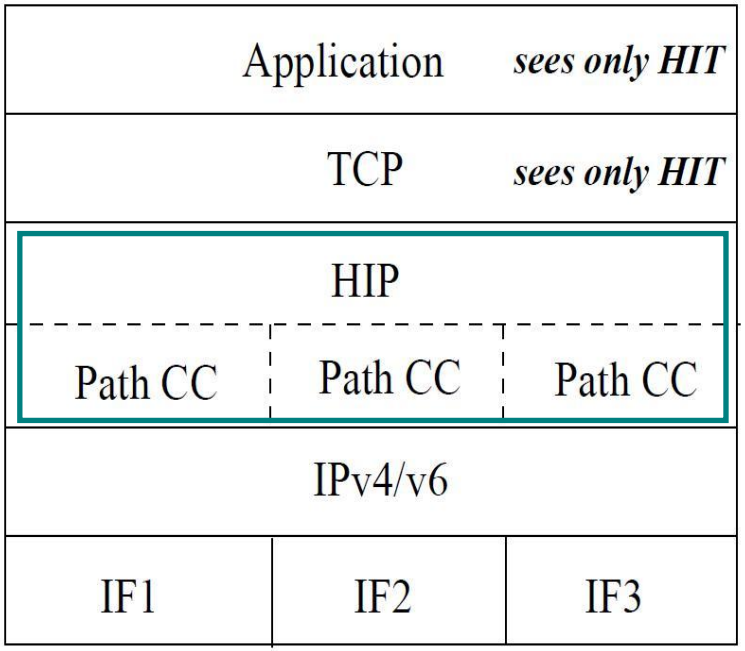


Motivation

- Bandwidth aggregation
- Throughput increase
- Better paths utilization
- Load balancing
- Fault tolerance
- Improved security

- Solutions on different layers
  - MPTCP ietf working group,
  - SCTP with CMT,
  - multipath RTP,
  - several network layer solutions
- Not widely deployed yet
- Developed mHIP between IP and transport

Multipath Host Identity Protocol (mHIP)



- HIP provides natural multiaddressing support and guarantees security
- Multipath functionality is transparent to the upper layer protocols
- Multipath scheduler is located on the sender side below HIP, it splits traffic optimally between available paths according to their capacity
- Two-level congestion control provides TCP-fairness and friendliness
- Prototype was implemented, tested within HIIT and presented to hiprg for ietf standartization

Refs: http://www.hiit.fi/~tpolishc/

Developers: Tatiana Polishchuk, Andrei Gurtov, Dmitriy Kuptsov

Redundant array of inexpensive Internet connections (RAIIC)

Technology approach to provide economical, guaranteed Intranet connectivity:

- Leverage cheap consumer-grade Internet connections and multi-homing
- Standard consumer Internet connection usually works ”most of the time”

- Idea: Bundle several consumer connections to improve availablity
  - On the assumption that they have e.g. 2 % average downtime each:
  - 3 connections = 0,0008% downtime ➔ 99,9992% uptime, ”five-nines” reliability

- Based on Mobile IP with additional extensions (draft-mip4-nemo-haaro)
- Requires NO changes to existing end-user terminals
- Uses existing infrastructure, immediately deployable

Prototype of RAIIC

- Based on Dynamics Mobile IP stack, originally developed at TKK circa 2002

Heavily amended to support

- UDP encapsulation
- Network Mobility
- Route Optimization

…

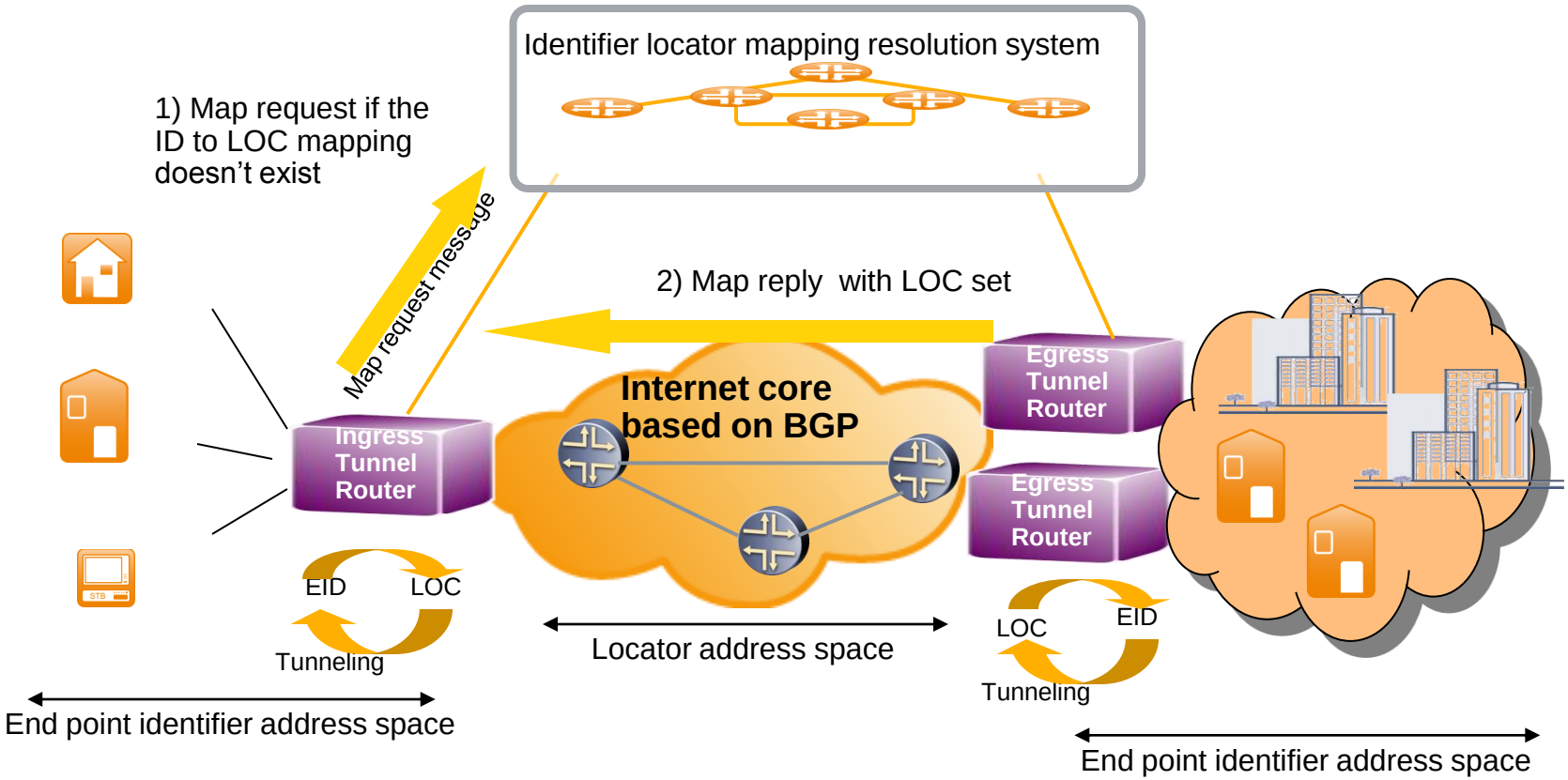
and experiments show that approach is feasible

Evaluation conducted using Spirent's industry-standard testing platform

Routing scalability

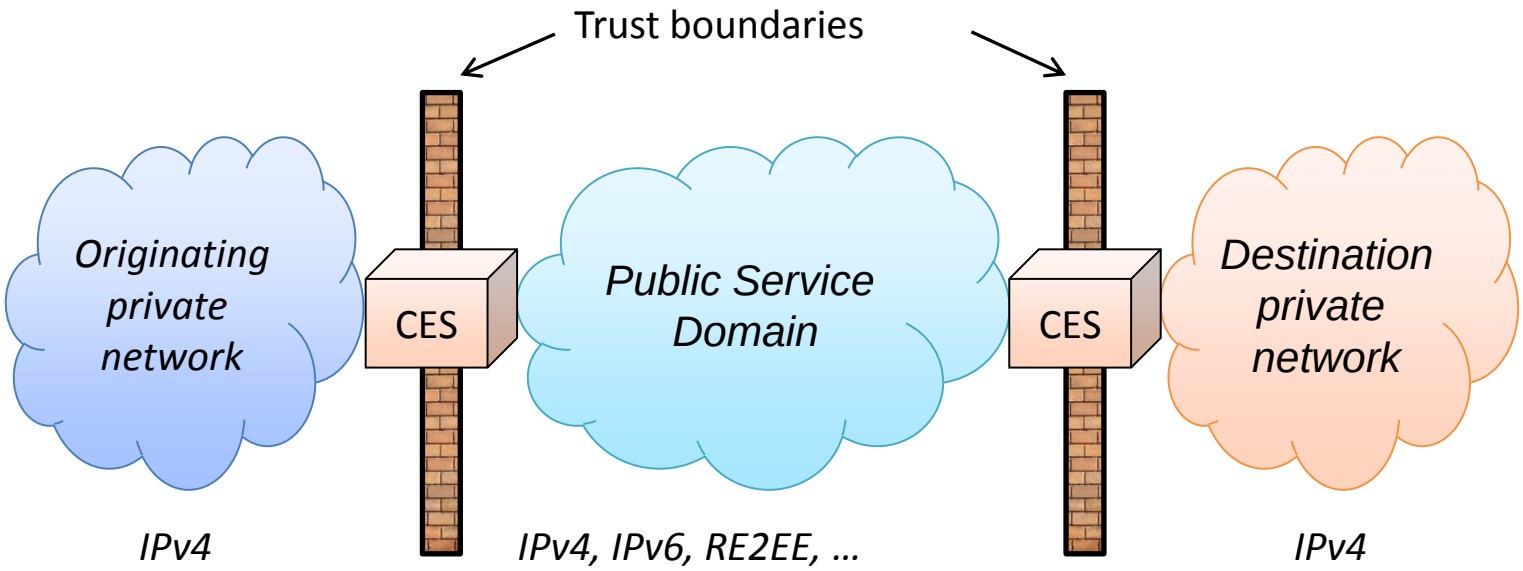
Locator Identifier separation based solutions

Locator Indentifier Separation (LISP) reference model



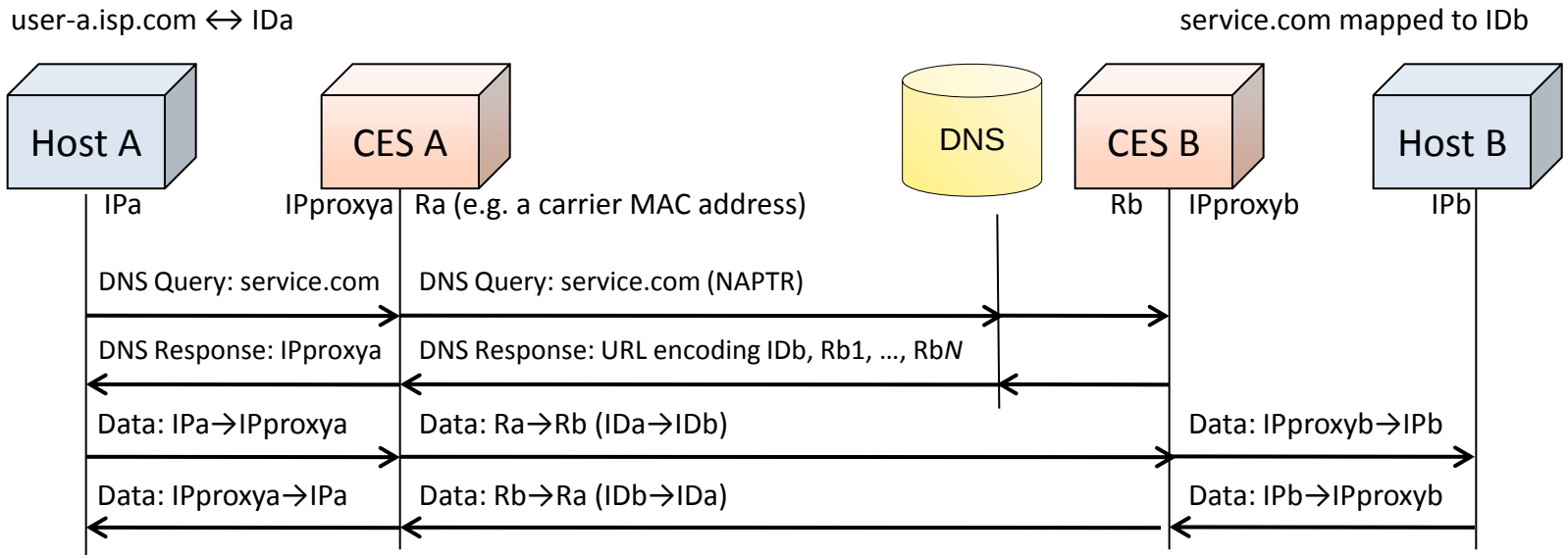
- our focus was in the implications of LISP to 3GPP systems
- the functionality of the mapping system

Customer Edge Switching (CES)



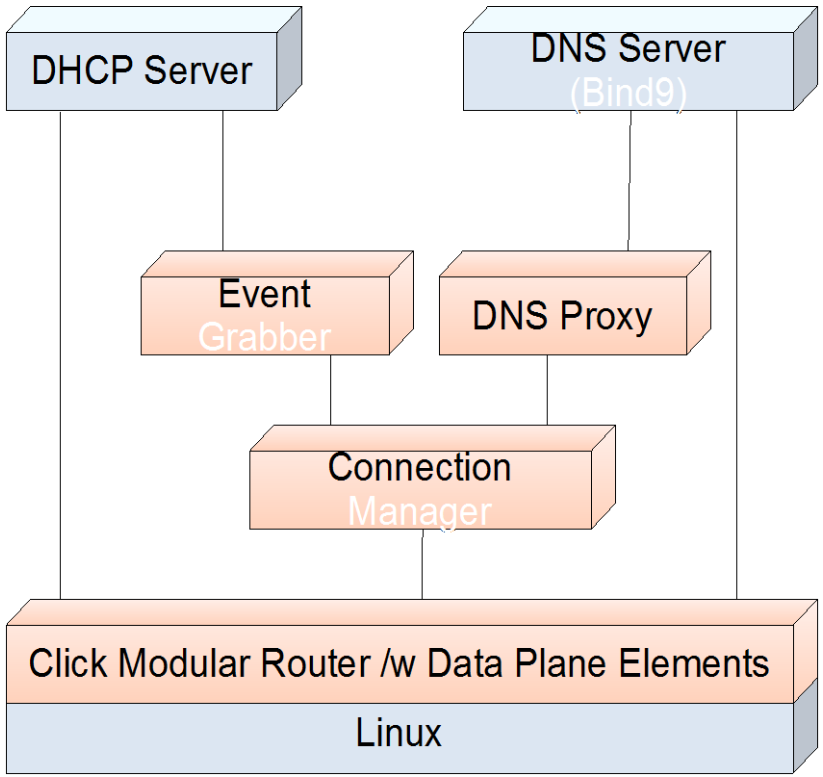
- Separates customer and provider networks with *trust* boundaries
- Independent addressing and transport in public and private networks
- Allows current terminals to communicate without modifications while enhancing both security and scalability.
- Makes hosts with private IP addresses globally reachable according to policy
- Concept developed by Aalto Univ., prototyped by VTT

Basic scenario of CES



- CES extends the NAT/firewall with network technology translation, multihoming, and trust and identity management
- Provides an IP-like interface to ordinary hosts
- DNS name is the global name, IP addresses are used only locally
- Translation triggered by DNS query – no packet buffering needed
- ID represents the DNS name in data packets (can be generated by hashing)

CES device prototype architecture



Prototype is based on existing software packages

- DNS, DHCP, Avahi, PythonDNS
- Data plane is implemented for Click Modular Router
- Mapping of local and remote addresses

Control Plane communicates with gateway functions and data plane

- Access control
- Service registrations
- Service discovery

CES with dynamically formed trust can be utilised in different usage areas

- Smart energy grid control
- Safe urban environment services
- Distributed online gaming

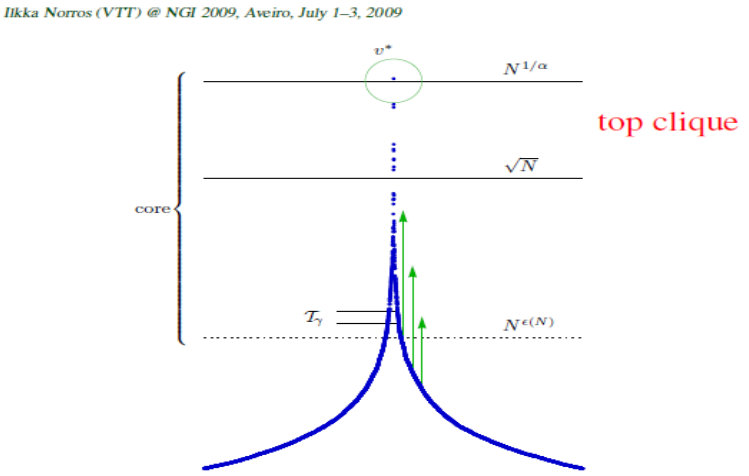
Routing scalability

New routing approaches based on compact routing

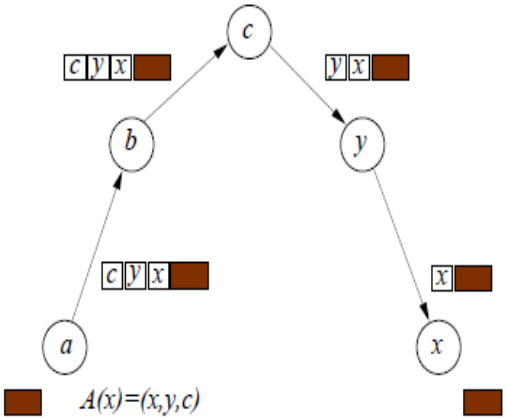
Powernet: compact routing on Internet-like random networks

A routing scheme is said to be compact if

- Node names/labels and header sizes scales (poly) logarithmically
- Routing table size (local memory space in terms of number of bits) scales sublinearly
- Stretch bounded by a constant (remains constant independently of the network size growth)

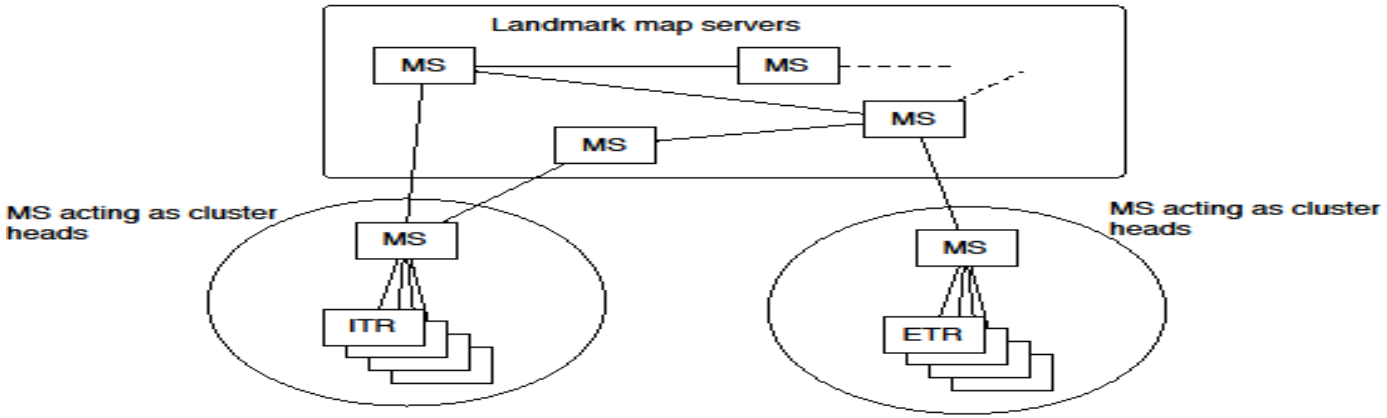


Let us call the locators as name-paths. The elements of the name-path can be implemented as small headers to a packet:



Compact routing based mapping system

Offers: bounded routing table sizes and delays



- Map Servers willing to aggregate more will become candidate “Landmarks”.
- All Landmarks announce their aggregate EIDs to other Landmarks
- Map Servers will select their own Landmarks and register to the Landmark.
- Landmark selection criteria is critical:
  - pertain the system compactness
- Through simulations demonstrated that with a simple Landmark selection role compactness is achievable (to be published)

Conclusion

- A large variety of approaches were studied with a close linkage to the IETF and 3GPP

- Multi-homing and Multi-path support remains to be an area of rising interest in the communication industry
- IPv6 transition leads naturally to identifier locator separation type of approach
- New use modes such as M2M together with IPv6 transition will place pressure to the global routing system

Thank you!

www.futureinternet.fi

TIVIT