

Future Internet Architecture

A Survey on Proposals for Future Internet Architecture and Technologies

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Some Internet Facts

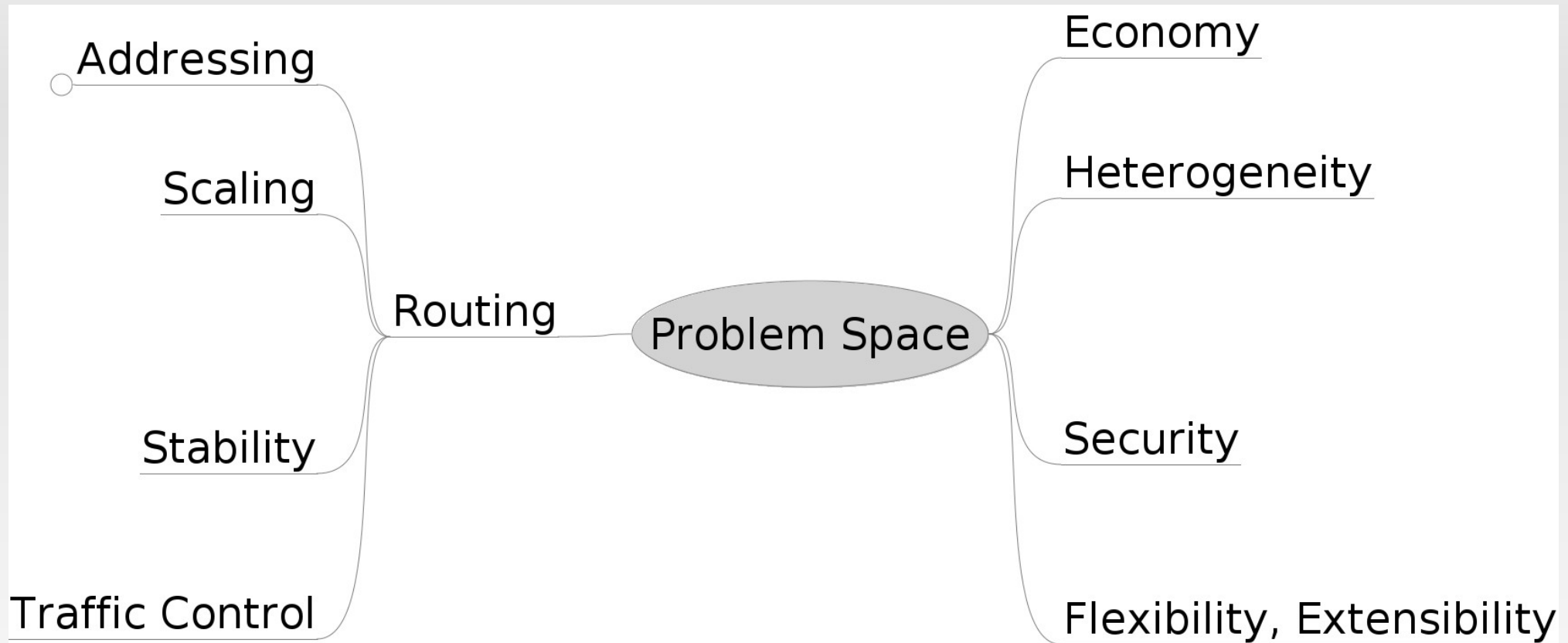
- Developed and deployed 40 years ago
- Designed as a wired, hierarchical network
- From Military Project, via Scientific Network to global source of information and entertainment
- Over 500 Million connected hosts (2008)
- Over 1.7 Billion Internet users
- Routing table size in core network over 300.000 entries (bgp.potaroo.net)

Outline

- Problem Space
- Solution Space
 - Concepts
 - Proposals
- Summary

Problem Space

Overview on Problem Space

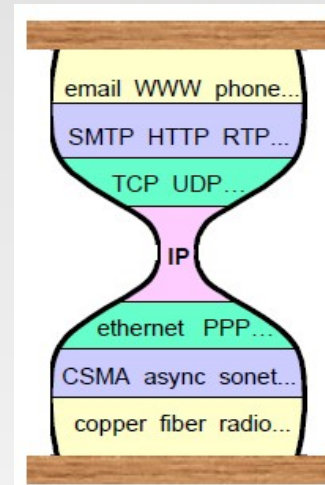


Problem Space – Details (1)

- Addressing
 - IPv4-Address as Identifier and Locator
- Scalability
 - Routing must scale with number of nodes
- Stability
 - Responsivnes to fluctuations
- Traffic Control
 - Optimize resource utilization and network performance

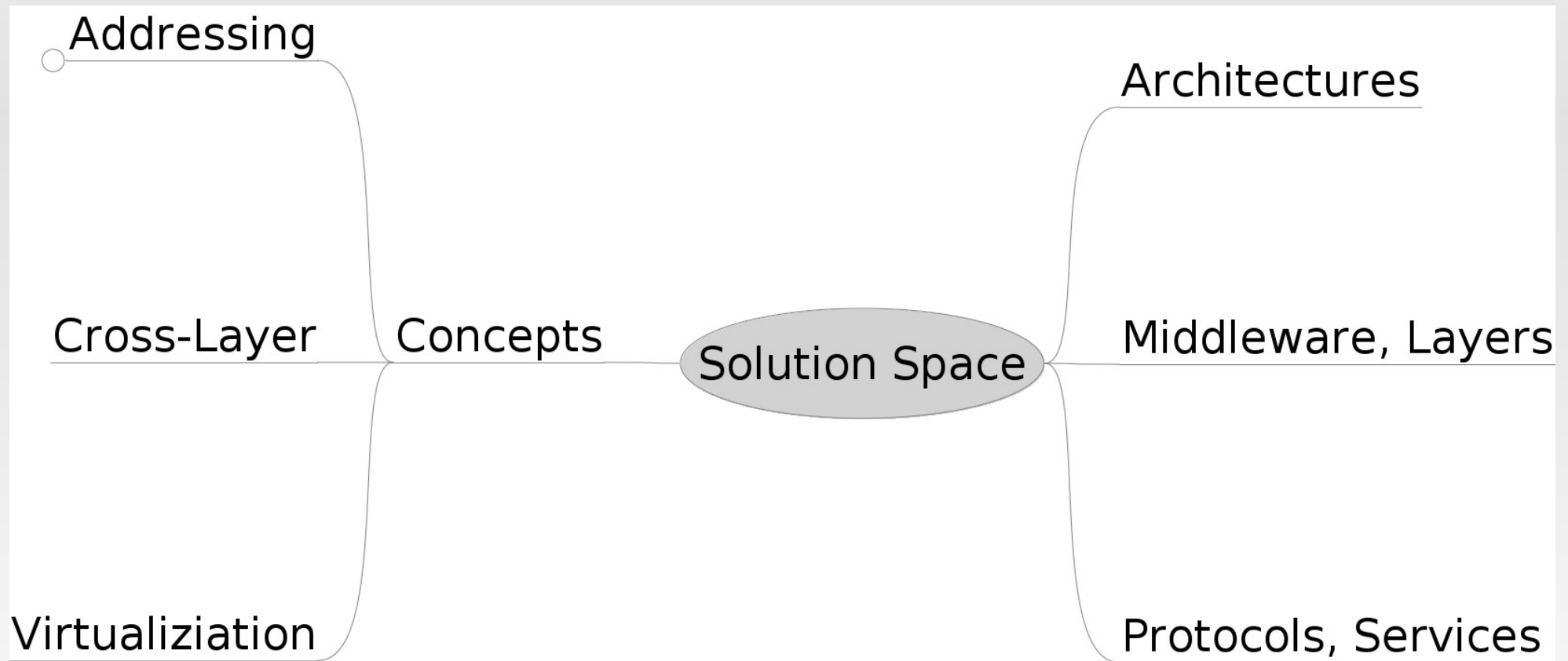
Problem Space – Details (2)

- Economy
 - Network and Service Provider costs
- Heterogeneity
 - IP-Hourglass
- Security
 - authentication
- Flexibility, Extensibility
 - Introduction of Innovations and new services



Solution Space

Overview on Solution Space



Alternative Classification

- Type of Proposal
 - Abstract, vision
 - Concrete concept (Prototype)
- Design, implementation
 - Fundamentally new, Clean Slate
 - Update, Upgrade, evolutionary
- Migration
 - Not possible, Flag day needed
 - Possible, incremental, co-existence

Concepts

Addressing

- Communication needs names and addresses
- Applications use identifiers to communicate
- Routing uses locators to deliver data
- Types of namespaces
 - hierarchical
 - Flat identifier

Loc/ID Split: Address Rewriting

- Same namespace for locator and Identifier
- Separate locator from identifier within this namespace
- Applications use Identifier-Part, Routing uses Locator-Part
- Example:
 - Identifier-Locator Network Protocol (ILNP)
 - 128 Bit IPv6-Address =
64 Bit Locator + 64 Bit Identifier

Loc/ID Split: Map-n-encap

- Different namespaces for Identifier and Locator
- Border-Router provides mapping mechanism
- Encapsulation during inter-domain routing
- Inner/Outer header
- Example:
 - Host Identity Protocol (HIP)
 - Locator/ID Separation Protocol (LISP)

Publish/Subscribe

- decoupling of publisher and subscriber
- Sender offers data/information
- Receiver shows/announces interest in data/information
- Examples:
 - Internet Indirection Infrastructure (i3)
 - Content Centric Networks

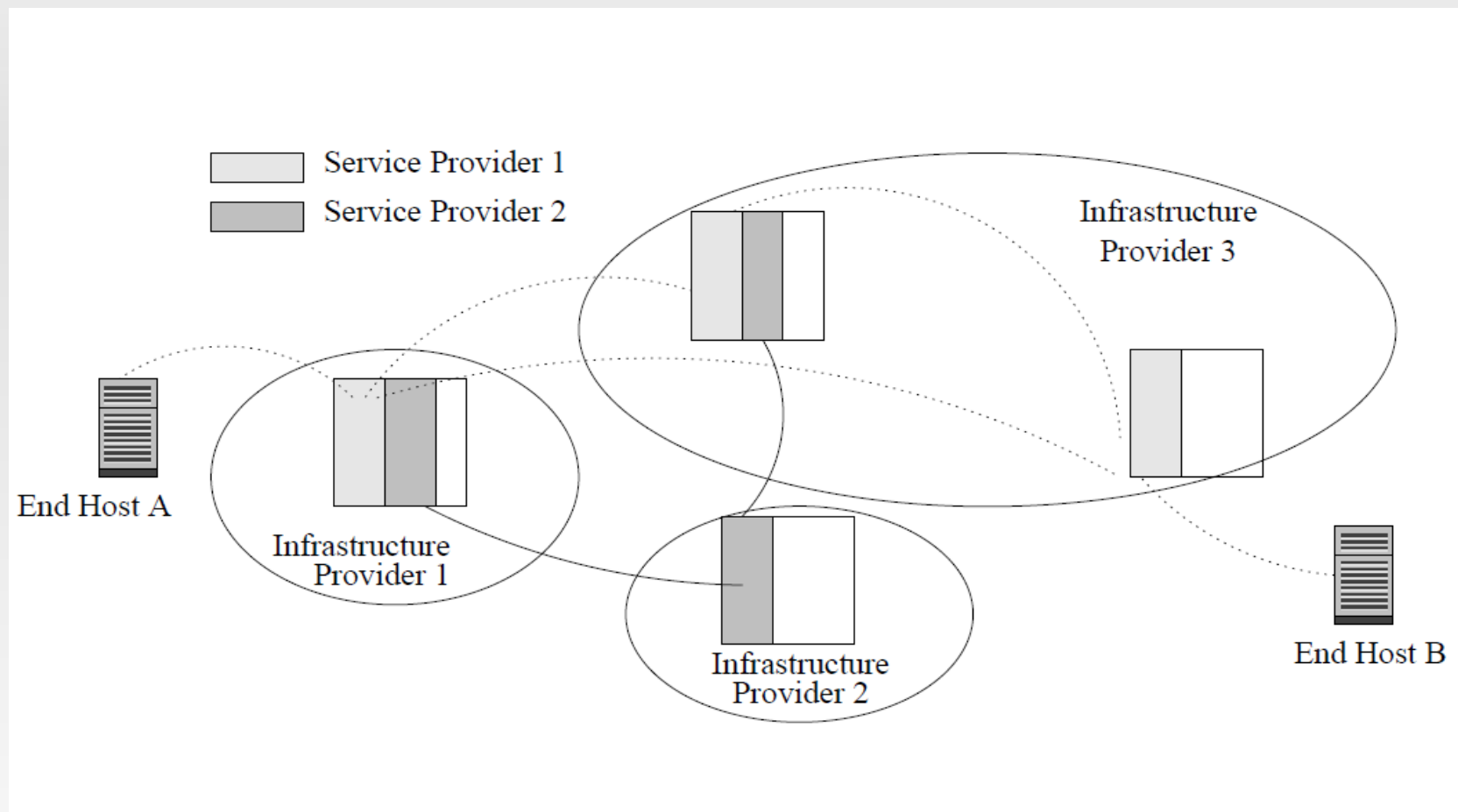
Cross-Layer

- Break up layered protocol structure
- Enable network optimization
- Resource awareness
- Internetworking on:
 - Wired Networks
 - Wireless Networks
 - Sensor Networks
 - Disruption Tolerant Networks

Virtualization

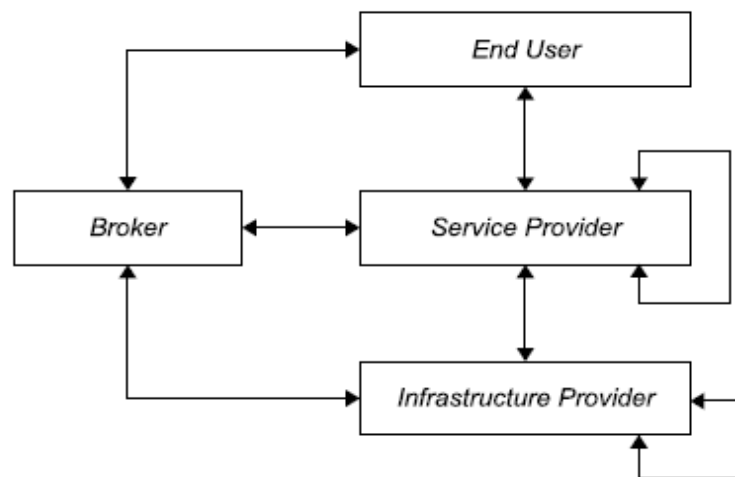
- Key concept in Future Internet?
- Enable Heterogeneity
- Precondition: devide ISPs into:
 - Infrastructure Provider
 - Service Provider
- Todays Internet just a network under networks?

Virtualization

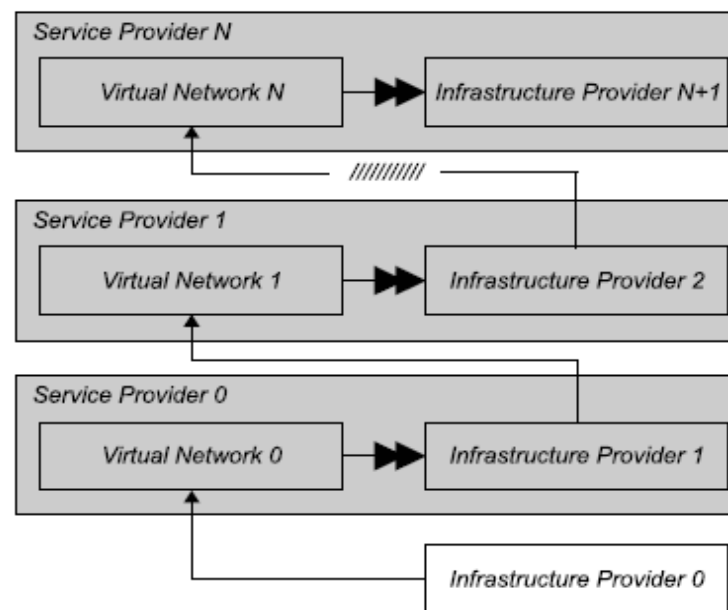


CABO by Feamster, Gao and Rexford

Virtualization - NVE



(a) Relationship between Players



(b) Hierarchy of Roles

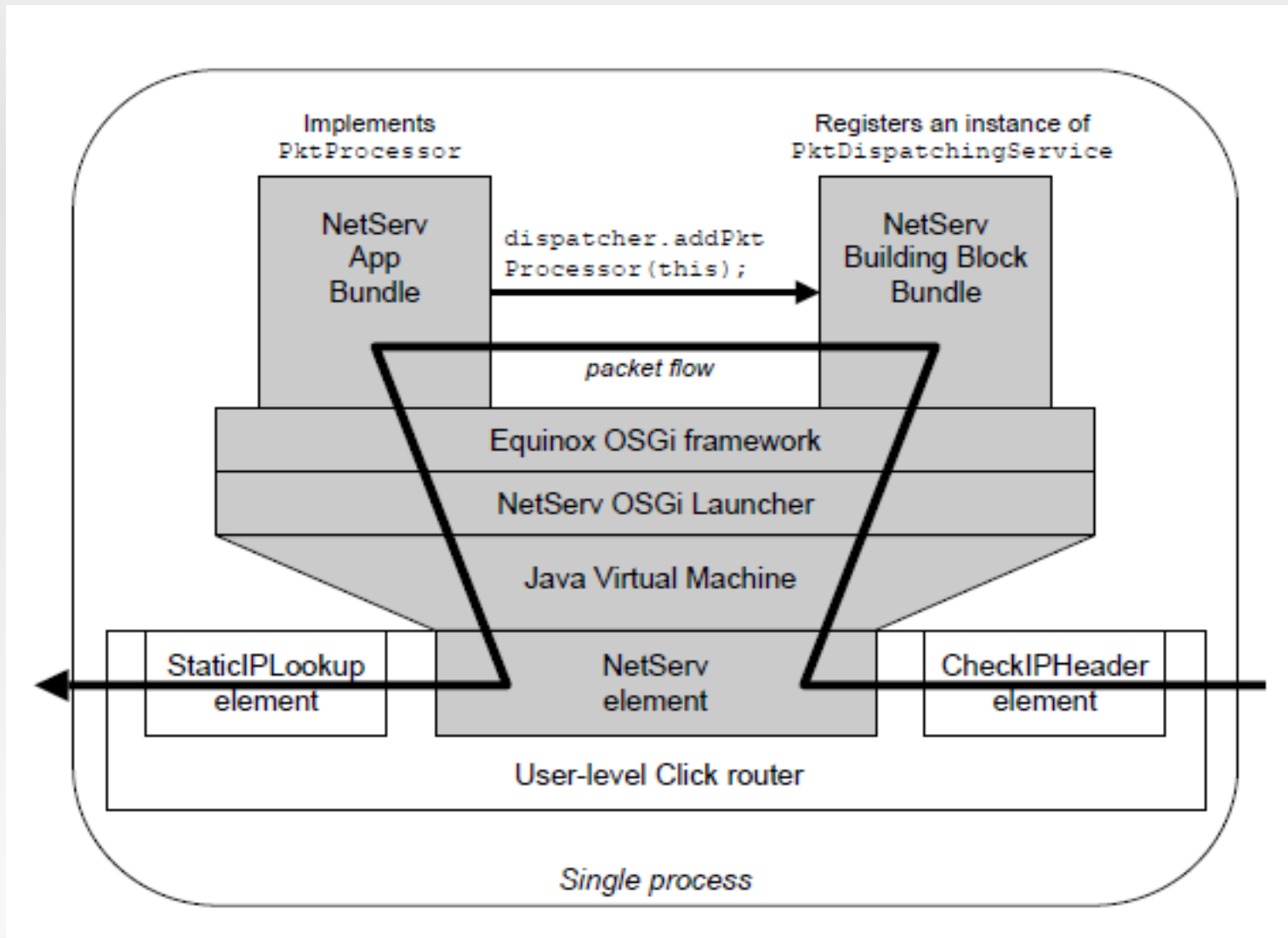
NVE by Chowdhury and Boutaba

Proposals

NetServ (1)

- Extensible architecture for core network services
- Reusable *building blocks* form services
- *Virtual Services Framework* acts as a secure, portable execution environment
- Prototype implementation on Click-Router with Java VM

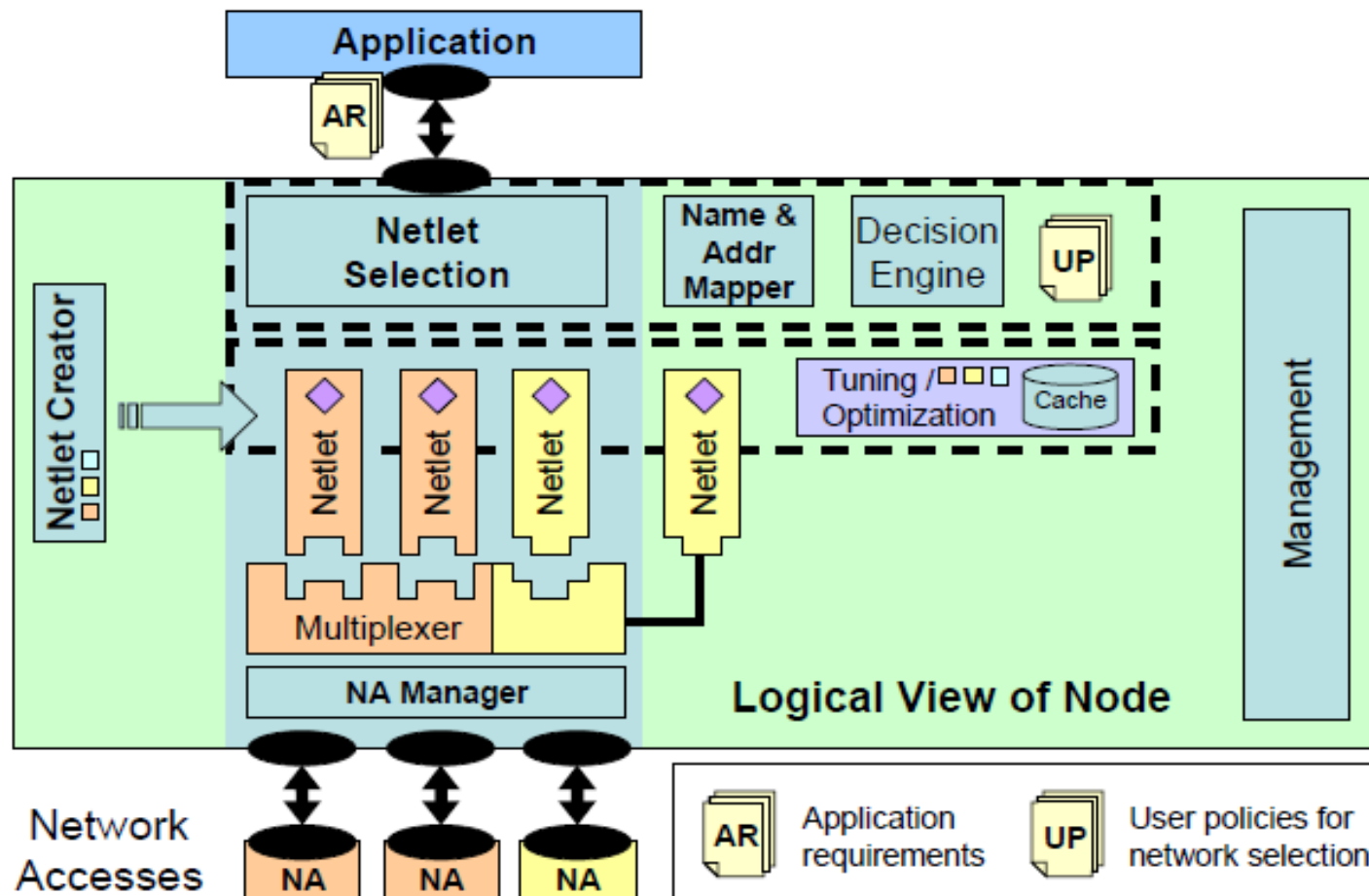
NetServ (2)



NetLets (1)

- Virtualization for multiple concurrent networks
- *NetLets* = vertical protocol stack container
- Today's Internet can be seen as one *NetLet*
- They offer a simple abstract API
- *NetLet Selection* component chooses a *NetLet*, which meet application requirements
- *NetLets* can be replaced during communication, if conditions change

NetLets (2)

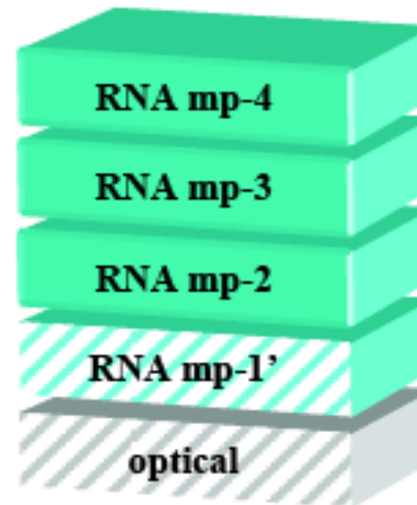
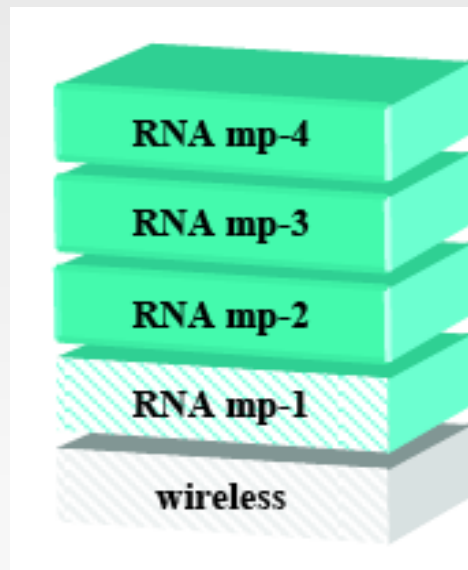
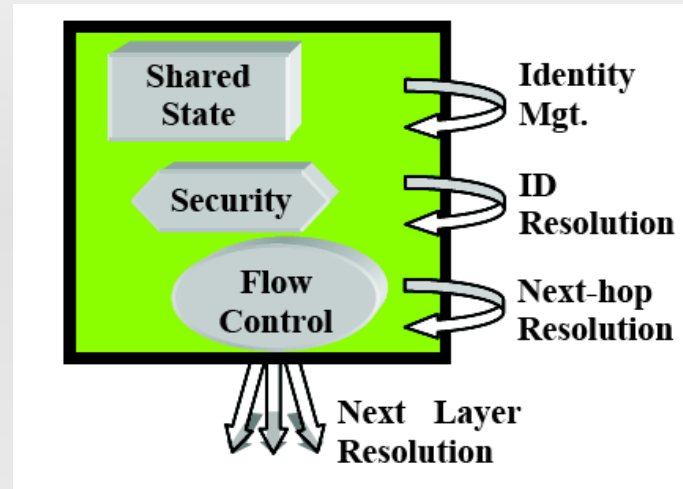
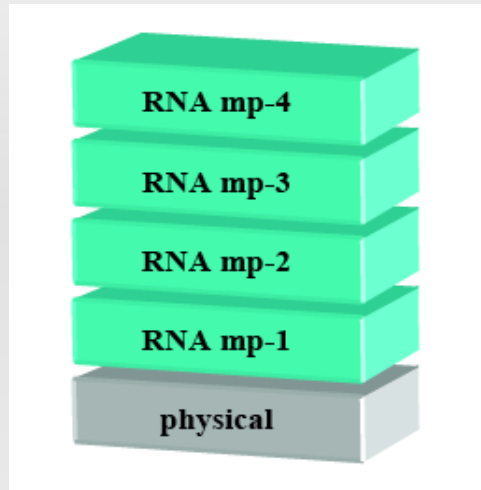


By Völker et al.

RNA (1)

- Recursive Network Architecture
- generic Metaprotocol on every layer
- unified interface and methods
- Functionality reuse to avoid redundancy
- Protocol instance is a context-dependent metaprotocol configuration

RNA (2)



Summary

- Routing is a mayor problem and research field
- IETF RRG is reviewing new approaches
- (Possible) key concepts for Future Internet:
 - Locator/ID Split
 - Cross-Layer optimization
 - Virtualization
- Proposals range from abstract concept to prototypes for Next Generation Internet
- But: no concrete direction up to now!

Last Slide

Thanks for your attention