A Vision of the Next Generation Internet: A Policy Oriented Perspective

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These slides and Audio/Video recordings of this talk are at:

http://www.cse.wustl.edu/~jain/talks/bcs08.htm

Overview

1. A New Architectural Perspective

2. Locators, Identifiers, Realms, and Zones

3. Policy Oriented Naming Architecture (PONA)

4. Benefits of PONA

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Key Problems with Current Internet

1. Designed for research
   $\Rightarrow$ Trusted systems
   Used for Commerce
   $\Rightarrow$ Untrusted systems

2. Difficult to represent organizational, administrative hierarchies and relationships. Perimeter based.
   $\Rightarrow$ Difficult to enforce organizational policies

Trusted

Un-trusted

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Problems (cont)

3. Identity and location in one
    (IP Address)
    Makes mobility complex.

4. No representation for real end system:
    the human.

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Our Proposed Solution: Internet 3.0

❑ Take the best of what is already known
  ➢ Wireless Networks, Optical networks, …
  ➢ Transport systems: Airplane, automobile, …
  ➢ Communication: Wired Phone, Cellular nets,…

❑ Develop a consistent general purpose, evolvable architecture that can be customized by implementers, service providers, and users

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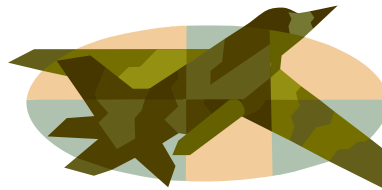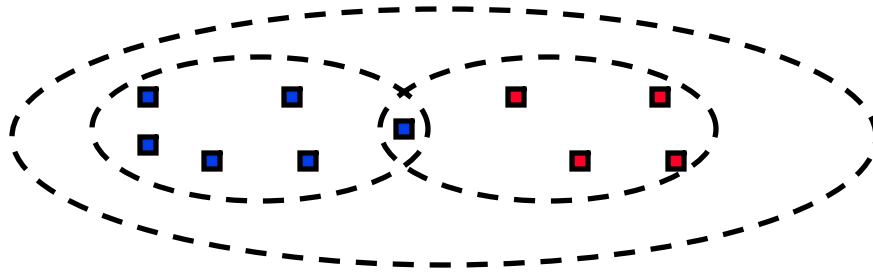
Realms

- Object names and Ids are defined within a realm
- A realm is a **logical** grouping of objects under an administrative domain
- The Administrative domain may be based on Trust Relationships
- A realm represents an organization
  - Realm managers set policies for communications
  - Realm members can share services.
  - Objects are generally members of multiple realms
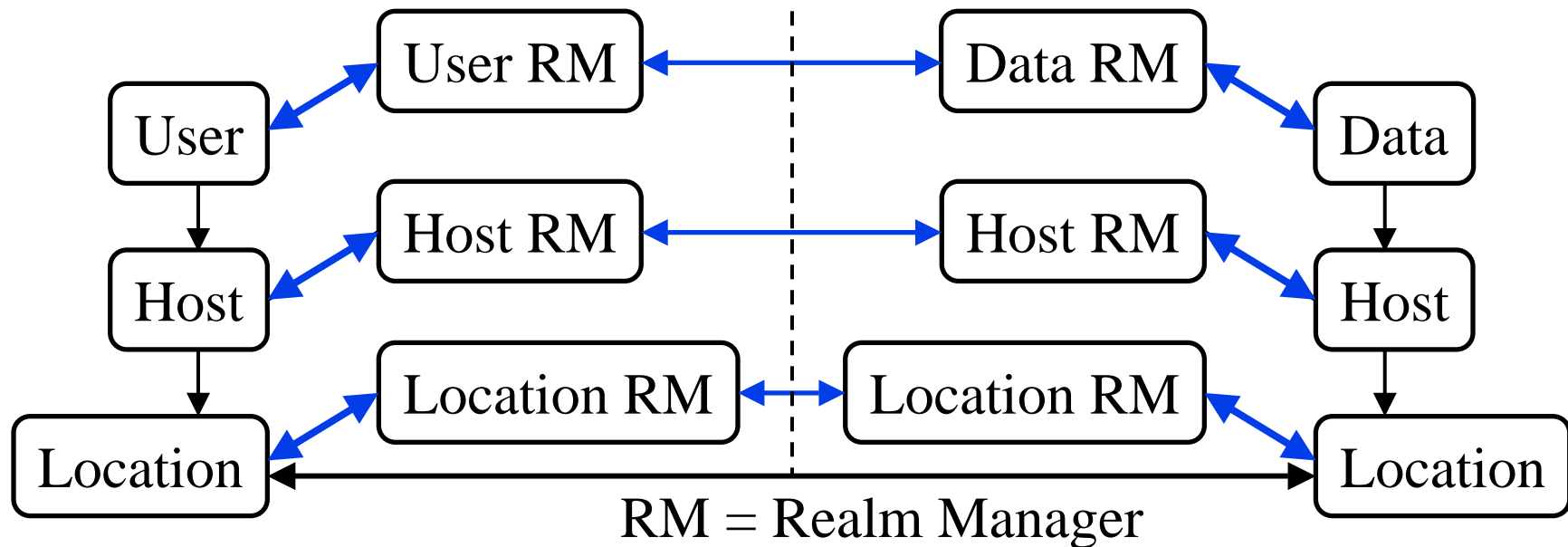- Realm Boundaries: Organizational, Governmental, ISP, P2P,…

Realm = Administrative Group

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User- Host- and Data Centric Models

❑ All discussion so far assumed host-centric communication
  ➢ Host mobility and multihoming
  ➢ Policies, services, and trust are related to hosts
❑ User Centric View:
  ➢ Bob wants to watch a movie
  ➢ Starts it on his media server
  ➢ Continues on his iPod during commute to work
  ➢ Movie exists on many servers
  ➢ Bob may get it from different servers at different times or multiple servers at the same time
❑ Can we just give addresses to users and treat them as hosts? No! ⇒ Policy Oriented Naming Architecture (PONA)

Policy Oriented Naming Architecture

```
User ──► User RM ◄──────► Data RM ◄──► Data
  │          ▲                ▲          │
  ▼          │                │          ▼
Host ◄──► Host RM ◄──────► Host RM ◄──► Host
  │          ▲                ▲          │
  ▼          │                │          ▼
Location ◄──► Location RM ◄──► Location RM ◄──► Location
```

RM = Realm Manager

❑ Both Users and data need hosts for communication

❑ Data is easily replicable. All copies are equally good.

❑ Users, Hosts, Infrastructure, Data belong to different realms (organizations).

❑ Each object has to follow its organizational policies.

PONA (Cont)

❑ User and data realms are higher level than host realms

❑ Most communication is user-data communication

❑ User, Host, and Data can move independently

  ➢ Hosts move from one location to next

  ➢ Users and data can move from one host to the next

❑ User ID $\Rightarrow$ Host ID $\Rightarrow$ Host Location = Address

❑ User realm managers provide User ID to Host ID translation

❑ Realm managers enforce organizational policies

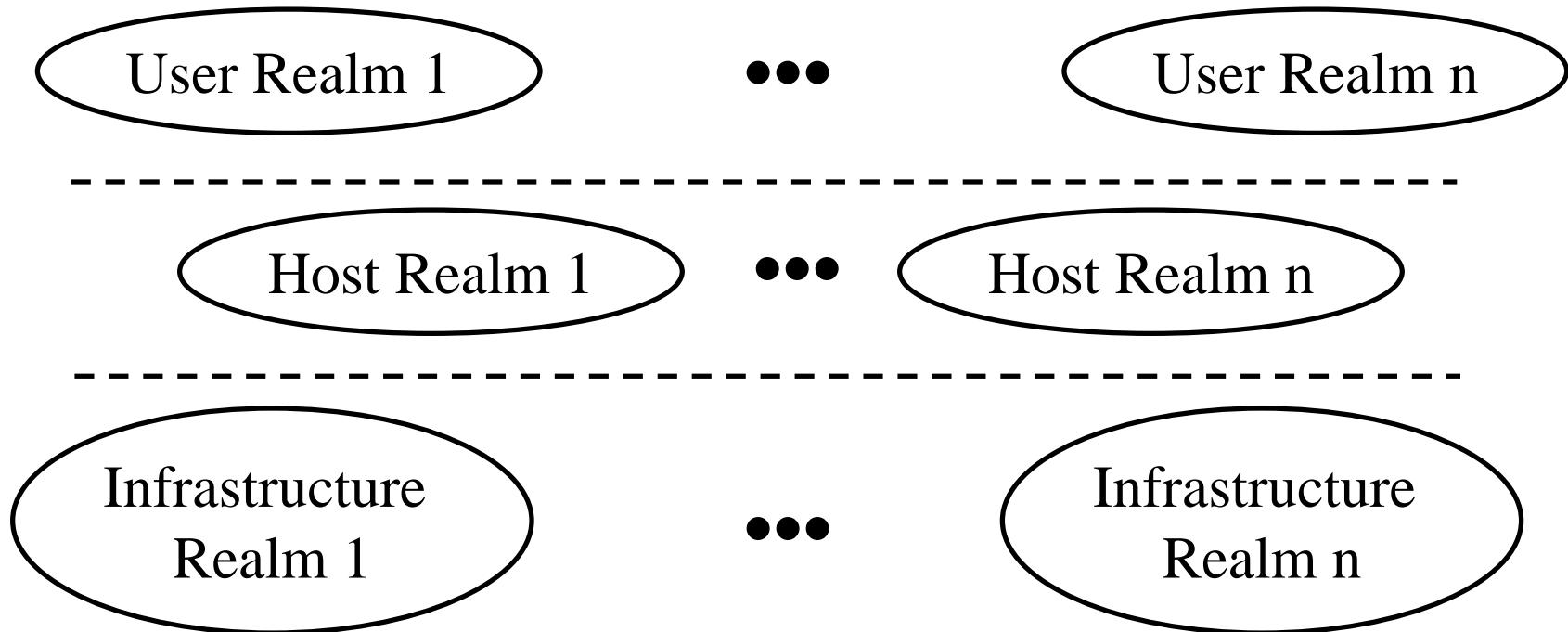❑ Realm managers setup trust relationships between organizations

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Virtualizable Network Concept
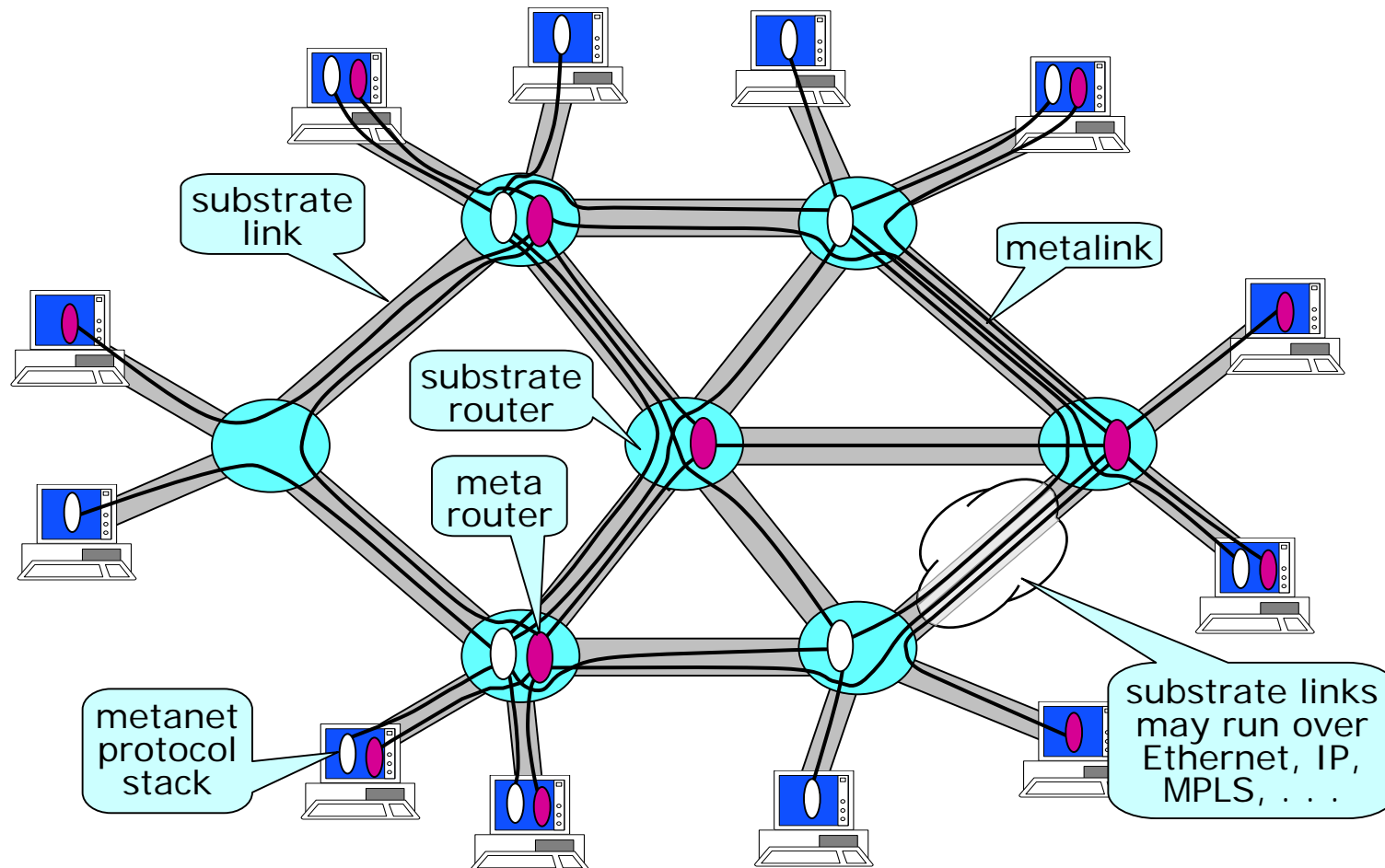
Ref: T. Anderson, L. Peterson, S. Shenker, J. Turner, "Overcoming the Internet Impasse through Virtualization," Computer, April 2005, pp. 34 – 41.
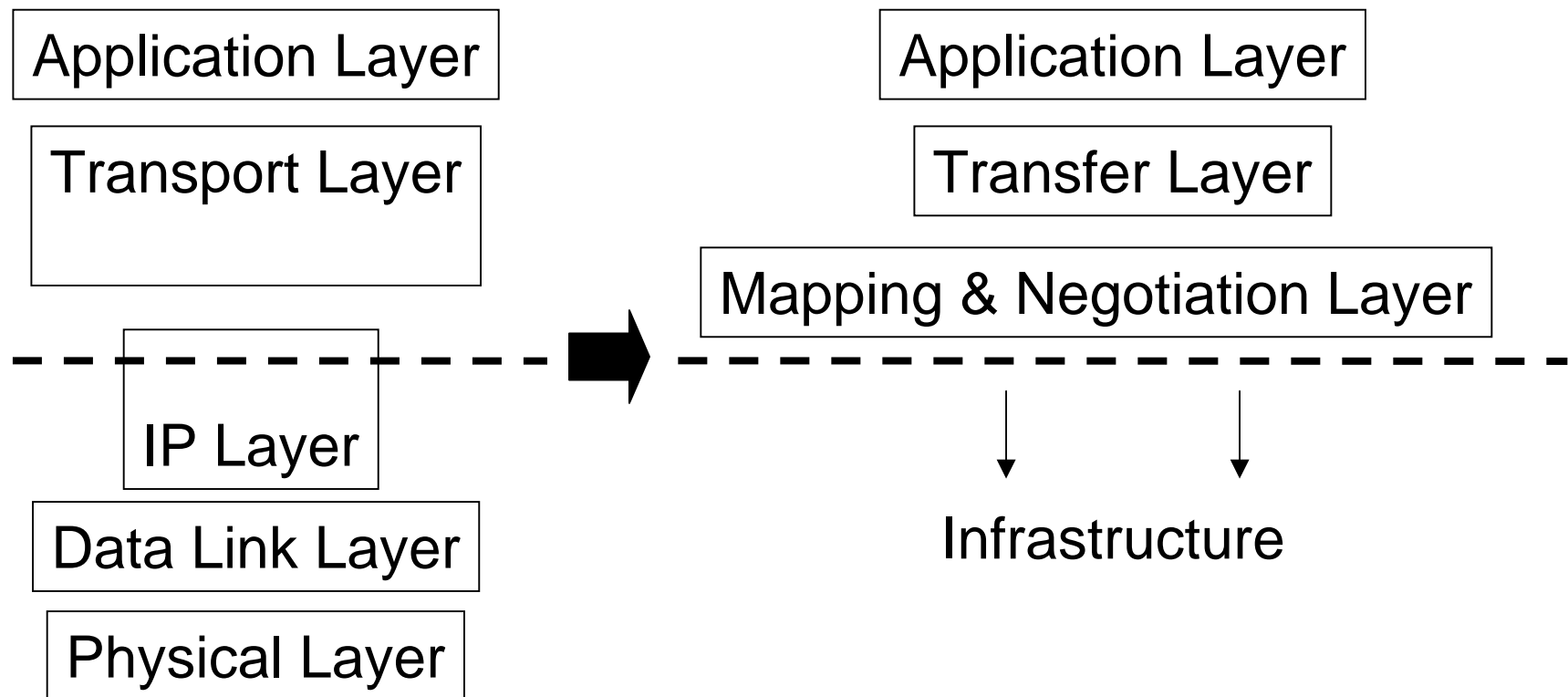
Slide taken from Jon Turner's presentation at Cisco Routing Research Symposium

Realm Virtualization

User Realm 1   ●●●   User Realm n

- -

Host Realm 1   ●●●   Host Realm n

- -

Infrastructure Realm 1   ●●●   Infrastructure Realm n

❑ Old: Virtual networks on a common infrastructure

❑ New: Virtual user realms on virtual host realms on a group of infrastructure realms. 3-level hierarchy not 2-level. Multiple organizations at each level.

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Protocol Stack

Application Layer

Transport Layer

IP Layer

Data Link Layer

Physical Layer

Application Layer

Transfer Layer

Mapping & Negotiation Layer

Infrastructure

❑ M&N Layer provides id-locator split and policy enforcement

Benefits of PONA Architecture

❑ Enforcement of Organizational structure and Policies

  ➢ Hosts/Users/Data/Network Infrastructure may belong to different organizations (realms)

  ➢ Each organization can enforce its policies on its members

❑ Security: Policies for realm boundaries and between objects

❑ Mobility: Hosts/Users/Data can move indendently

❑ Representation of non-electronic end systems: Users and Data

❑ Multi-Layer virtualization

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Summary
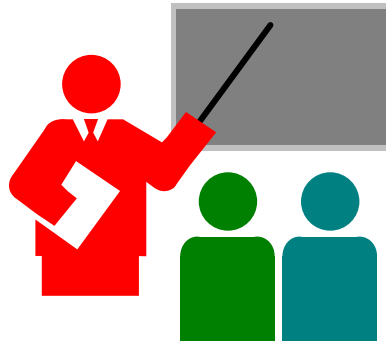
1. The next generation of Internet must be secure, allow mobility, and be energy efficient.

2. Must be designed for commerce
   $\Rightarrow$ Must represent multi-organizational structure and policies

3. Moving from host centric view to user-data centric view
   $\Rightarrow$ Important to represent users and data objects

4. Users, Hosts, and infrastructures belong to different realms (organizations). Users/data/hosts should be able to move freely without interrupting a network connection.

References

1. Jain, R., "Internet 3.0: Ten Problems with Current Internet Architecture and Solutions for the Next Generation," in Proceedings of Military Communications Conference (MILCOM 2006), Washington, DC, October 23-25, 2006, http://www.cse.wustl.edu/~jain/papers/gina.htm

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References: Coming Soon

2. Jianli Pan, Subharthi Paul, Raj Jain, and Mic Bowman, "MILSA: A Mobility and Multihoming Supporting Identifier-Locator Split Architecture for Naming in the Next Generation Internet,," Globecom 2008, Nov 2008.

3. Subharthi Paul, Jianli Pan, Raj Jain and Mic Bowman, "A Survey of Naming Systems: Classification and Analysis of the Current Schemes Using a New Naming Reference Model," to be submitted for publication, 2008.