Distributed Interdomain Management: Domain Composition

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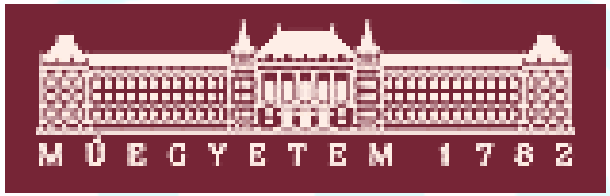

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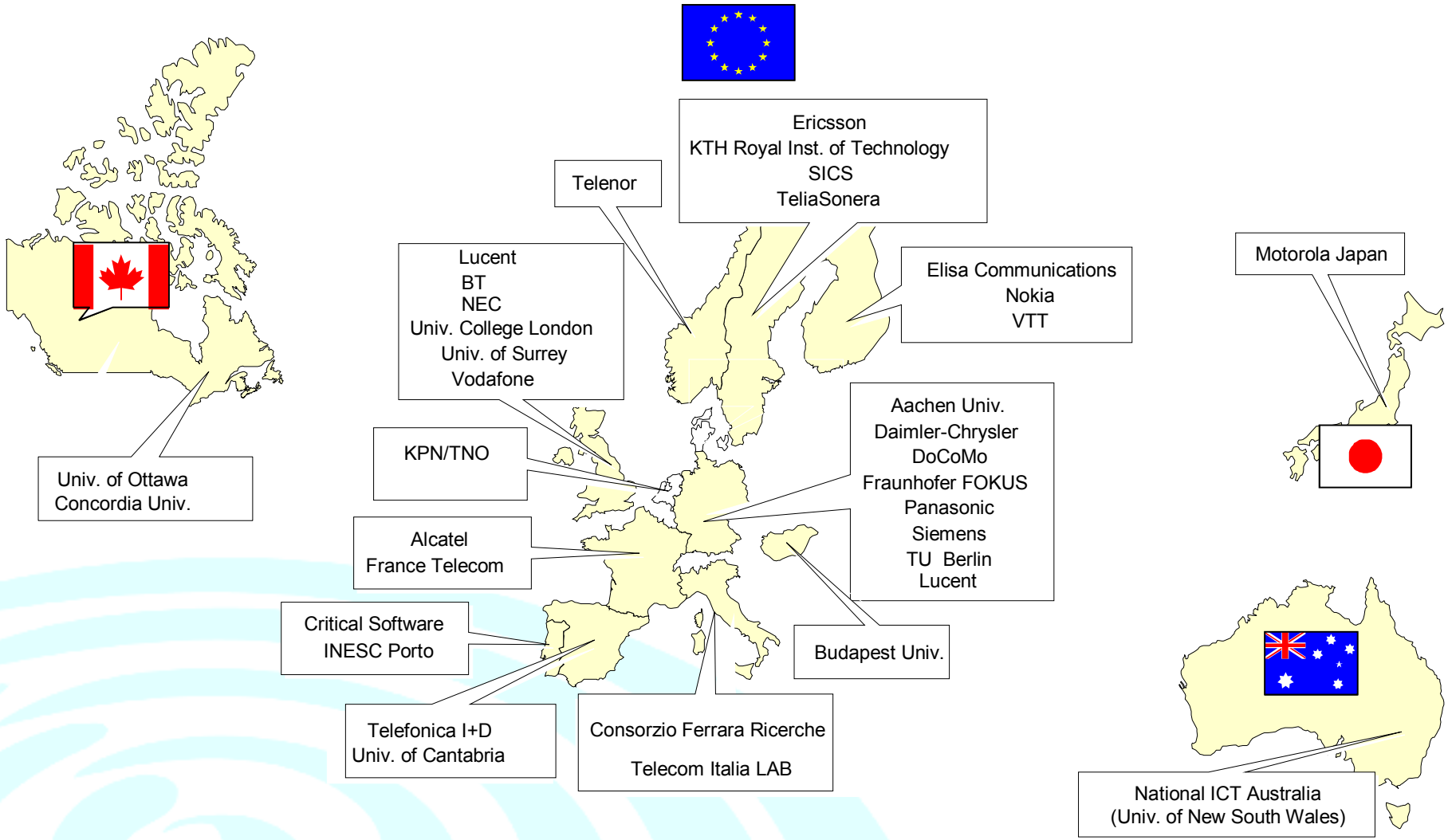
Outline

- Ambient Networks
- P2P Management
- Network Composition

- Outlook

"The AN Group"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Strategic Objectives

- Scalable & Affordable networking supporting the dynamics of wireless access
- Provide rich & easy to use communication services for all in a cost effective manner
- Increase competition and dynamic cooperation of various players
- Allow incremental market introduction of new technologies

Ambient Networks Design Principles

#1: Ambient Networks communicate with each other through an open, feature rich, internetworking interface

#2: The control functions of Ambient Networks form a modular control space with a defined, extensible architecture

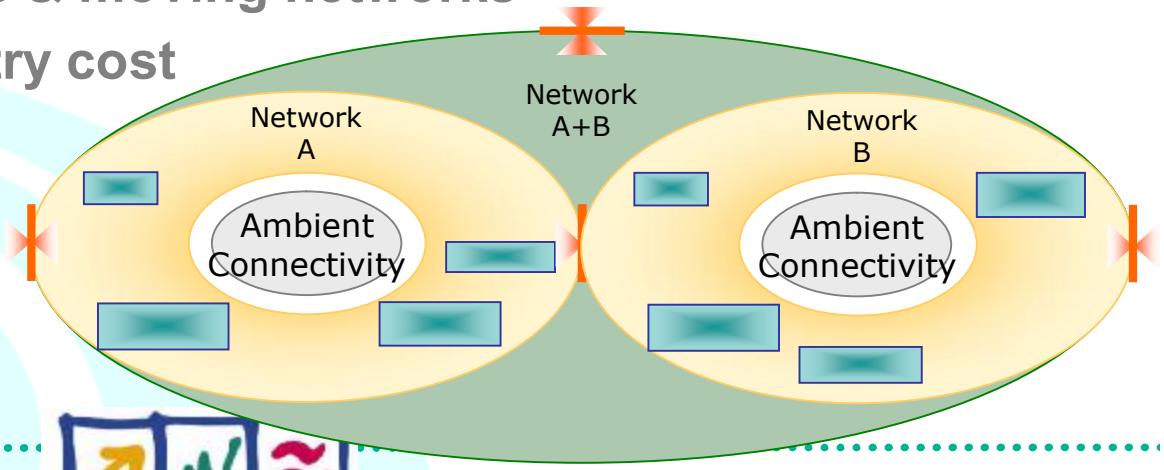
#3: Ambient Networks can operate over any type of connectivity infrastructure

#4: Ambient Networks support open interfaces for service creation and deployment

#5: Ambient Networks configure and manage themselves and their relationships

AN Concepts & Management Challenge

- AN project is establishing a handful basic concepts on which to base the AN architecture
  - **More powerful control layer within the network**
  - **No special end-nodes (i.e. terminals) all nodes are network nodes**
  - **Network composition**
  - **Self configuration, self management**
  - **Inherent & integrated security infrastructure**
  - **Mobility – sessions & moving networks**
  - **Scalability- low entry cost**
  - **Overlay network**



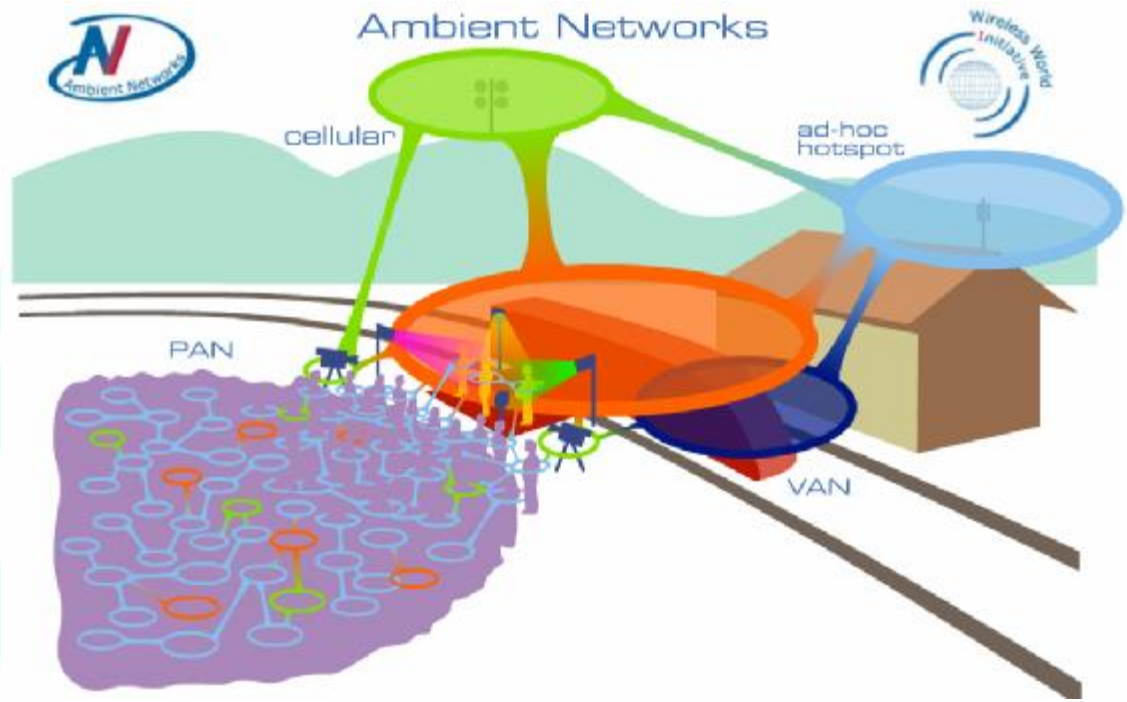
Peer-to-peer Paradigms for Network Management

Introduction

- New networking era
  - Ubiquitous and ambient networking
  - Interconnecting heterogeneous, intelligend and autonomous networks
- New requirements
  - self organization, self management
  - dynamic network composition
- Several self-organization models have been proposed for routing, p2p networks, etc..
  - Clustering
  - Overlay networks

Proposed Management Architecture for Ambient Networks

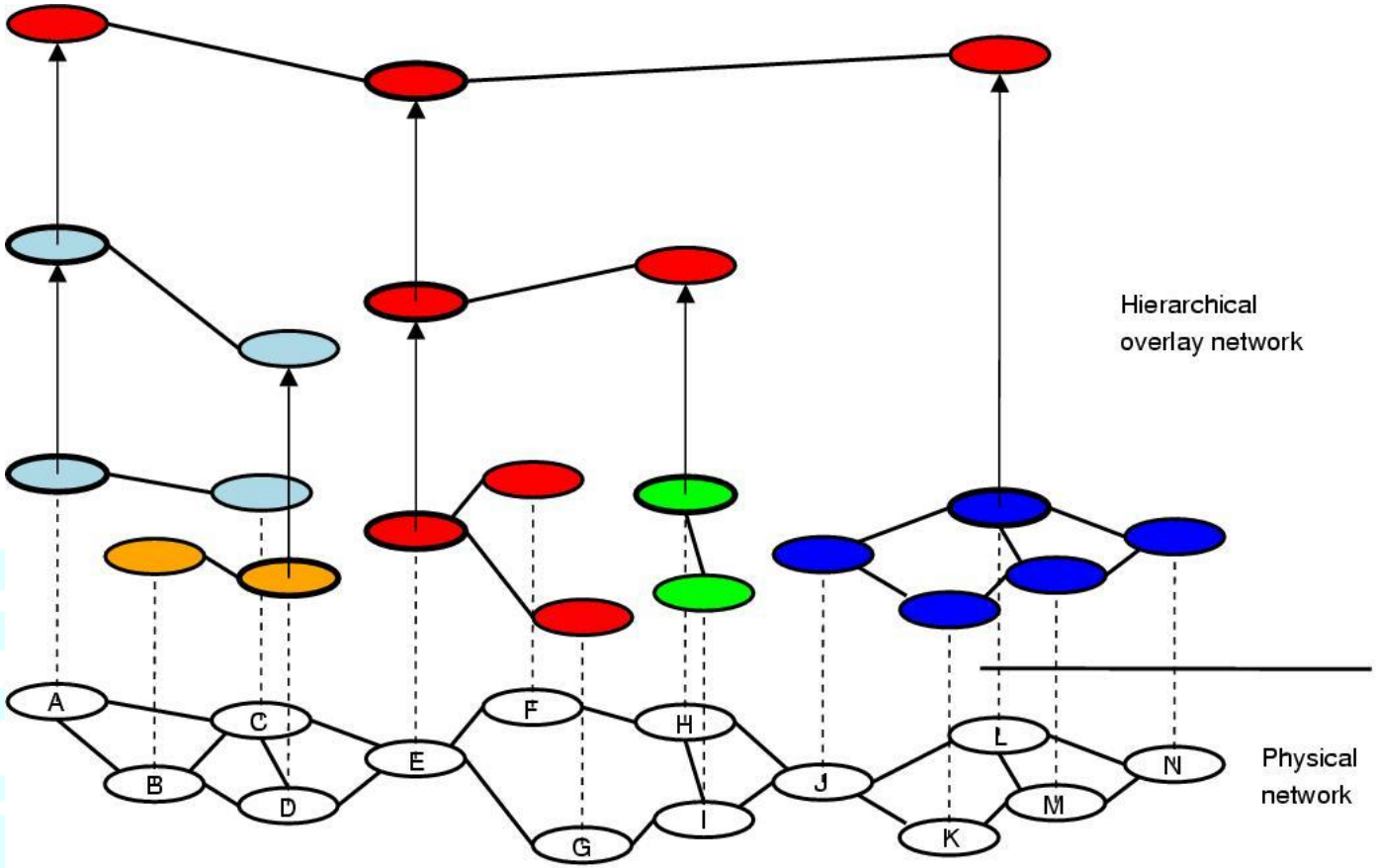
- Hierarchical overlay networks
  - Graph model describing “static” structure of the network from a management point of view
- Network composition primitives
  - Define dynamic behavior of the network
  - Specify the evolution and alteration of the overlay network



Hierarchical Overlay Network Model I.

- Basic components
  - Peers, Super-peers, Overlays
- Super-peers form further overlays at upper levels
- Unlimited number of hierarchy levels
- Relative hierarchy levels
- Graph model
  - vertices ➔ peers, super-peers
  - undirected edges ➔ neighborhood relationships
  - directed edges ➔ pointing to upper level overlays

Hierarchical Overlay Network Model II. (Example)



Network Composition Principles

- Assumption(s)
  - Physical network composition
    - Service composition is not considered in the first place
- Different composition types decided by peer-to-peer negotiations based on policies
  - absorption
  - gatewaying
  - interworking
- Bottom-up composition principle

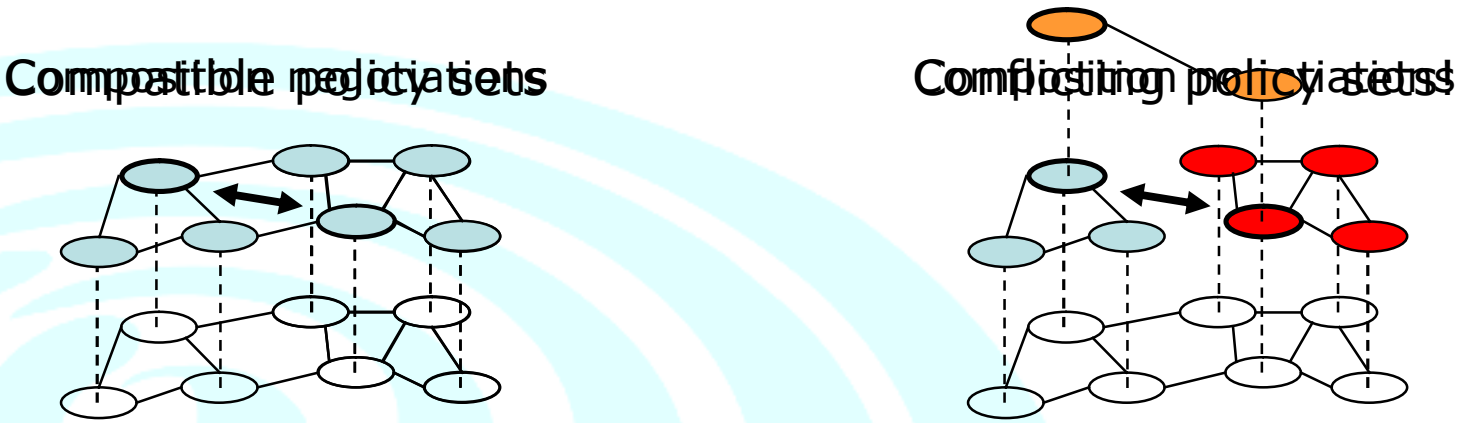
Basic Composition Types

Absorption

- Mutually acceptable policies
- Creation of a common management domain
- One new super-peer

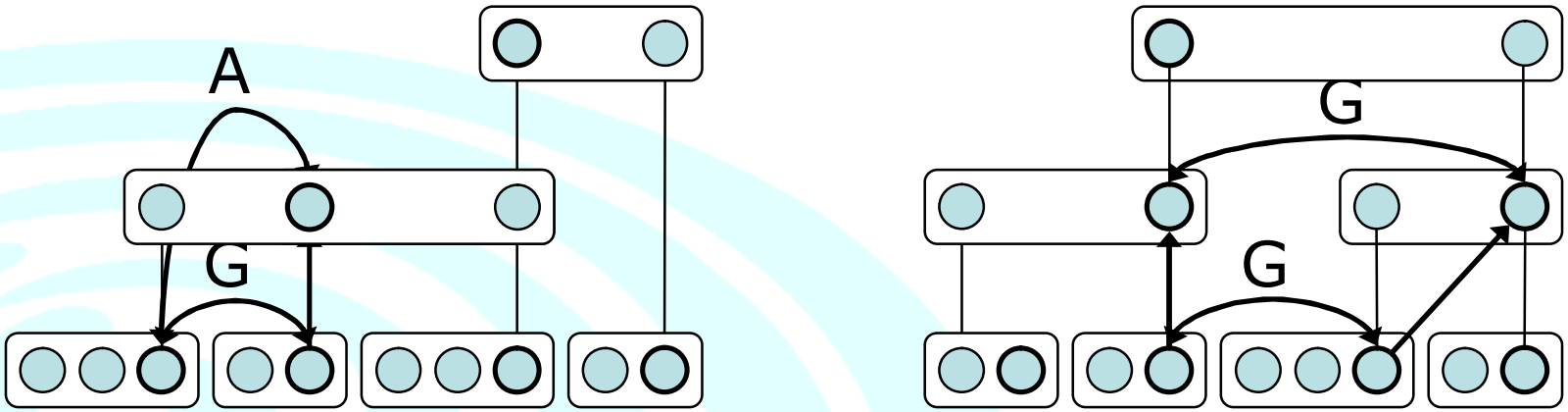
Gatewaying

- (partly) conflicting policies
- Separate management domains are preserved
- Creation of upper level overlay



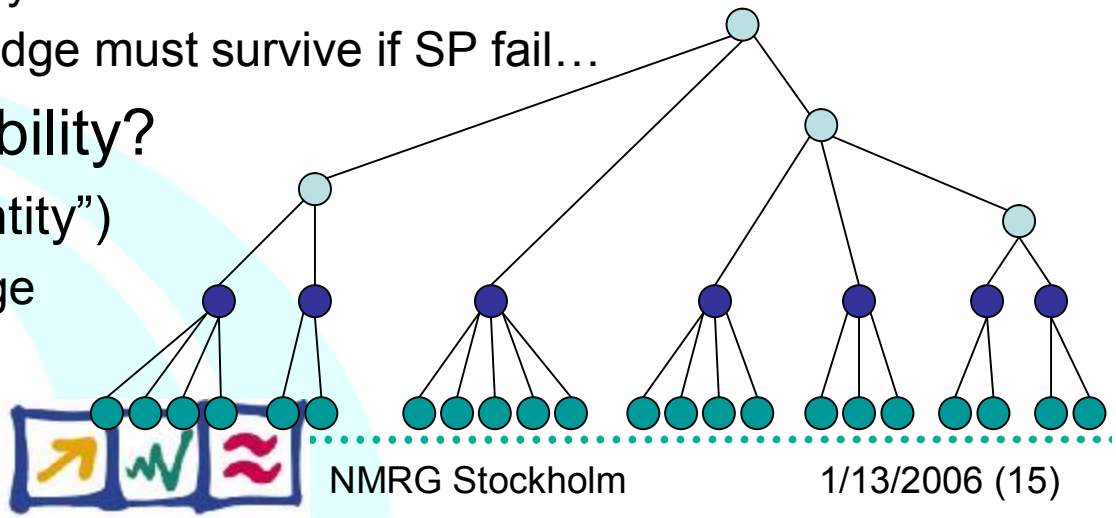
Bottom-up Comp. Principle

- Composition process is started by the bottommost level overlays
- If the negotiation results in gatewaying, the composition process is forwarded to the next upper layer until
  - The top level overlay is reached
  - Composition decision is „absorption” at the upper level



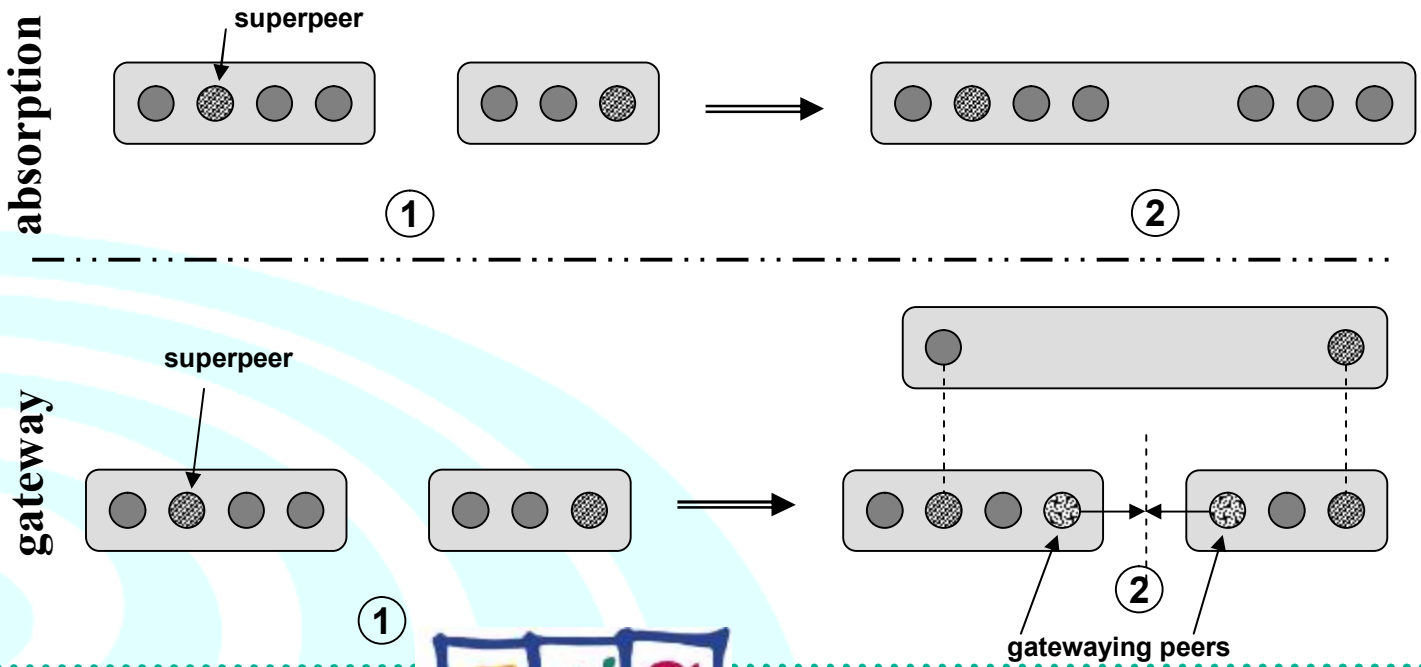
Challenges with Composition

- What controls the composition?
  - Policies
    - But, how to learn policies?
    - How to merge policies?
    - How to subtract policies?
      - *De*composition is *not* the reverse of composition!
- Who controls the composition?
  - Rep. “nodes”, aka: super-peers
    - Must be dynamically elected
    - Community knowledge must survive if SP fail…
- Robustness & scalability?
  - Group security (“identity”)
    - (Redundant) storage and data collection mechanism…
- Naming and addressing?
  - How to address ANs, SPs, nodes?



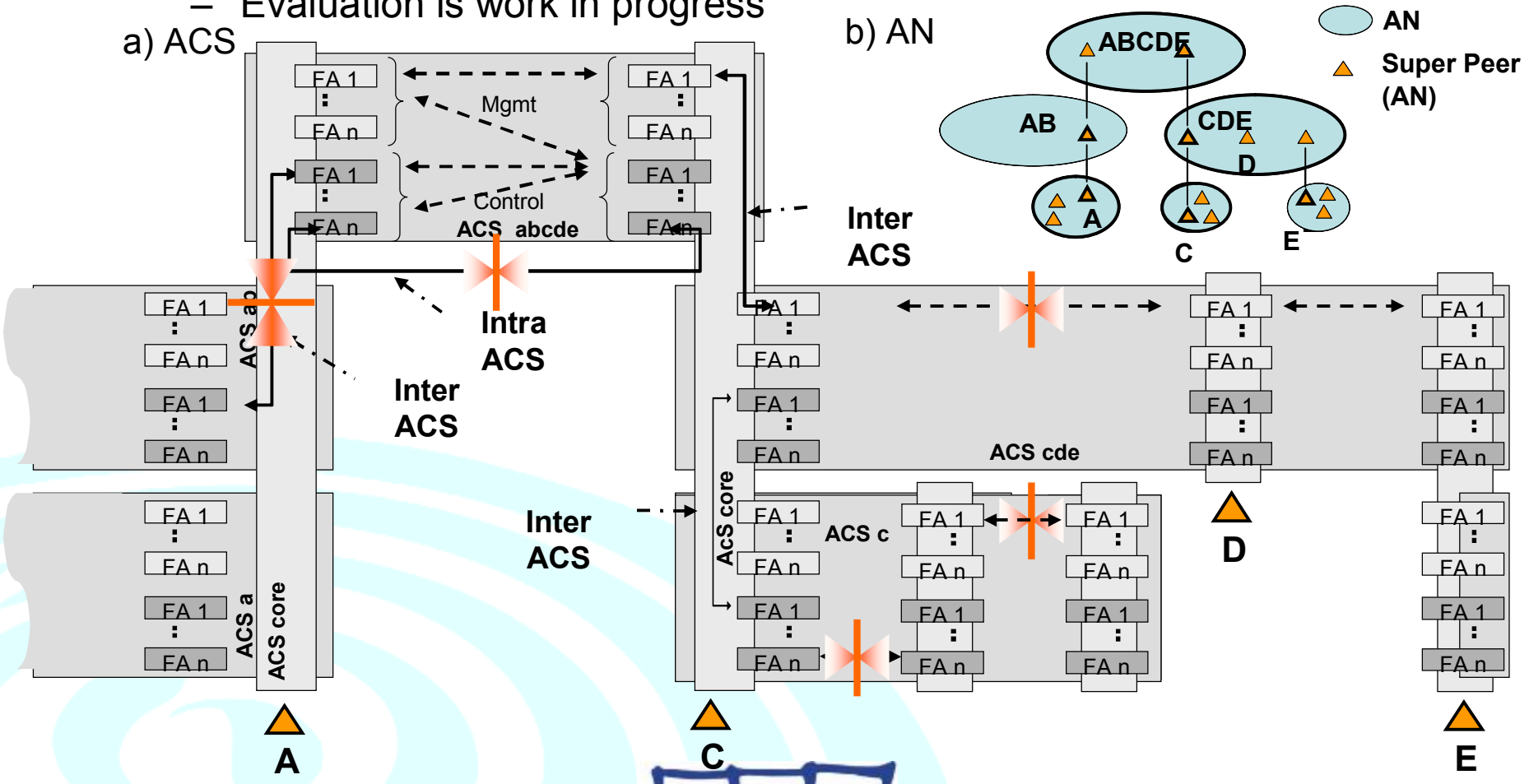
AN Model Revisited

- AN is *atomic* and *autonomous* entity (from mgmt point of view)
  - Physical node
  - Group of nodes (at different overlays)
- Each an has *some part* of an *Ambient Control Space*

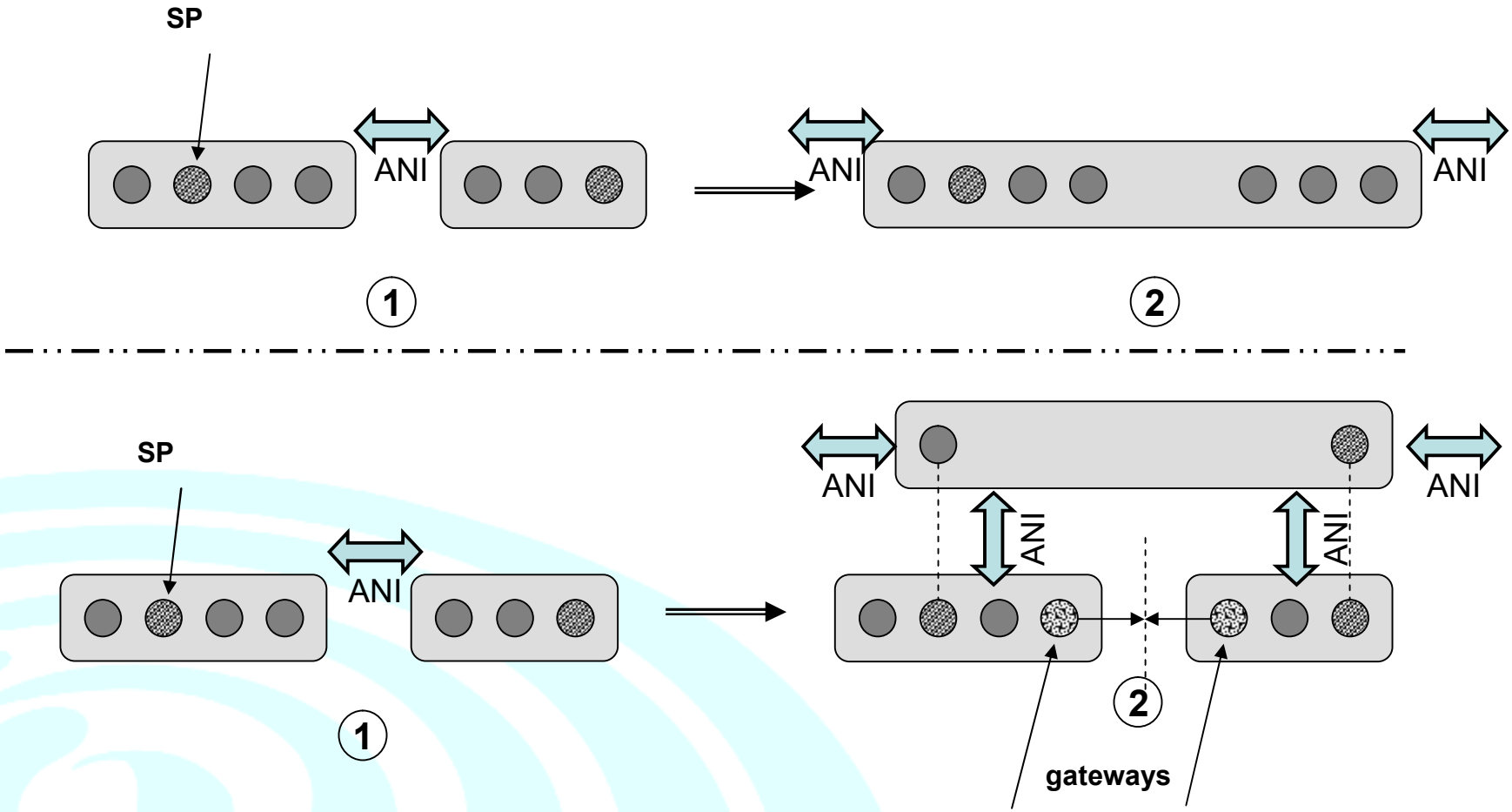


P2p
Ambient Control Space (ACS)

- Designed, prototyped and demonstrated
  - Evaluation is work in progress

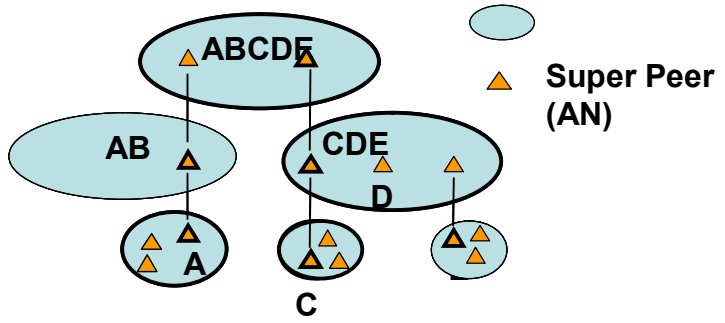


- Interfaces



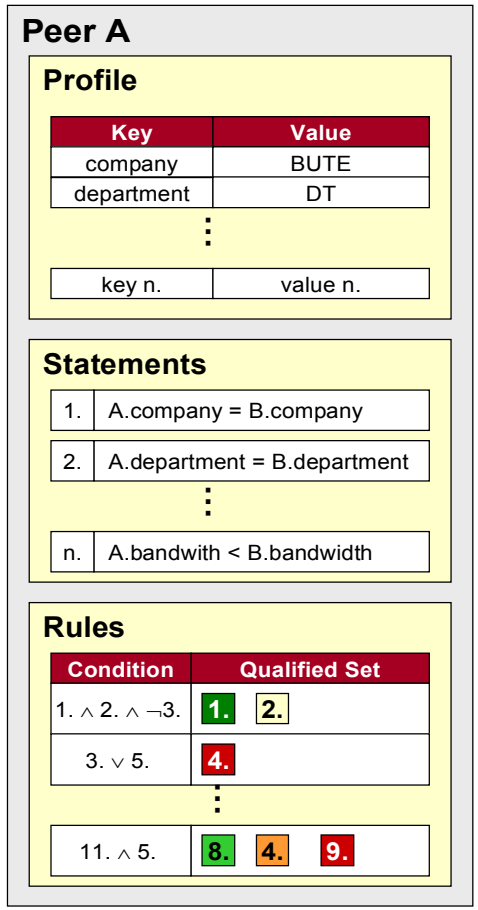
Management Applications

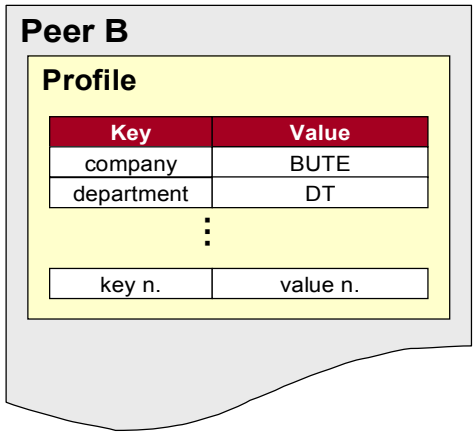
- Composition manager
  - Based on (composition) policies
  - Composition / decomposition
  - Super-peer (re)election
- Topological network monitor
- Naming and addressing service
  - With locator / ID split
    - HIP conform
  - Recursive
    AN ➔ SP ➔ AN ➔ SP …
  - Based on DHTs



Policies

- Defines the intention of the peer on the composition
- Profile (property)
  - Key-Value
- Statement
  - Compare own property with the composing AN's
- Rule
  - Statement is TRUE/FALSE/….





Summary

- Goals
  - To create autonomous, self-organizing Ambient Networks
- Mgmt plane representation of ANs
- A distributed Ambient Control Space (p2p-ACS)
  - Yet another platform, prototyped
    - (Academic license)
- A Composition Manager functional area within the ACS

Future Plans

- Modeling of ANs
  - Social / cooperative networks & game theory…
  - Promise theory?
- Larger scale numerical evaluation
  - Scalability & robustness
- The overlay structure provides a scalable framework for
  - Configuration management (active netw.)
  - Collection of management data (e.g.: patterns)
  - *Service registry*
- P2p ACS Prototype (PAP)
  - Survive as *the* AN prototype

AN Management Vision

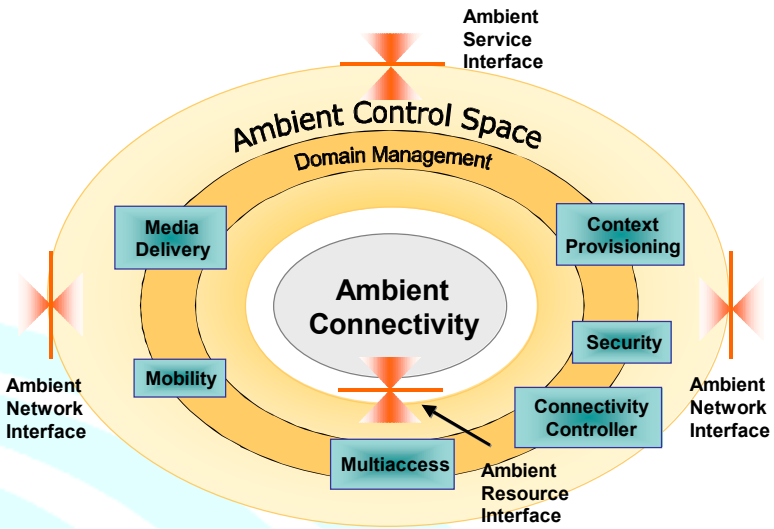
Intelligent Control: (Global and Local)

Collect

Decide

Enforce

Ambient Autonomic Management



Self-awareness Properties: (Global and Local)

Self-contextualisation

Self-programmability

Self-Management

- **Self-organisation**
- **Self-optimisation**
- **Self-policing**
- **Self-configuration**
- **Self-adaptation**
- **Self-healing**
- **Self-protection**