Spontaneous interaction network architecture

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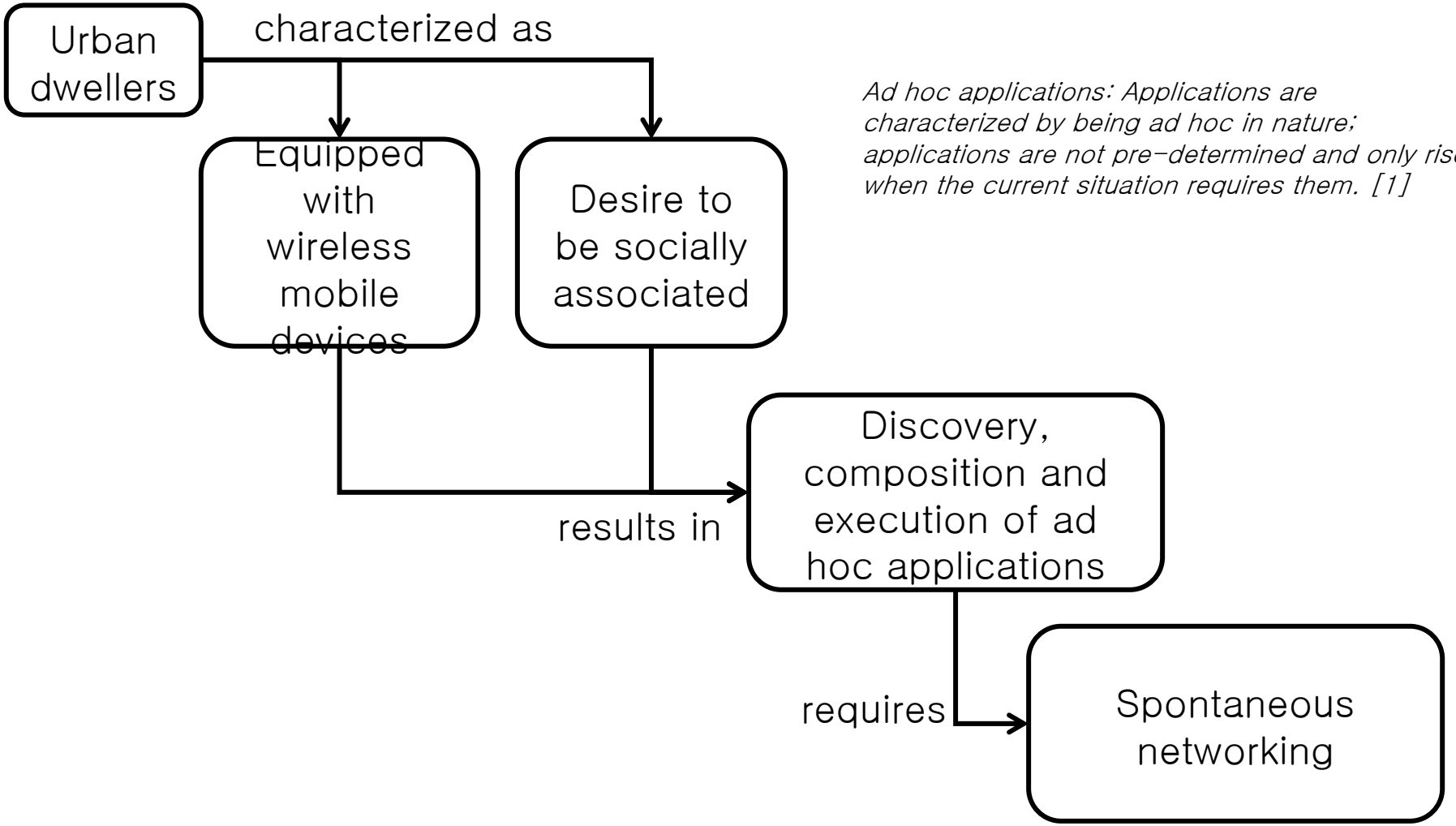
Background

- Status quo of MANET and its application
  - Predefined goals
    - Predefined applications / members + Flexibility in configuration
    - ➔ E.g. fire fighting
  - Human level negotiation
    - Predefined applications / members + Flexibility in configuration
    - ➔ E.g. photo exchange between mobile phones
- What about urban public spaces?

Background (cont.)

- Urban public spaces
  - Most activities are serendipitous.
    - No predefined goal
    - No predefined application
    - E.g. MOSOSO
  - Multitude of participants
    - Human users
    - Network chances (PAN, WLAN, WAN)
    - Services / resources

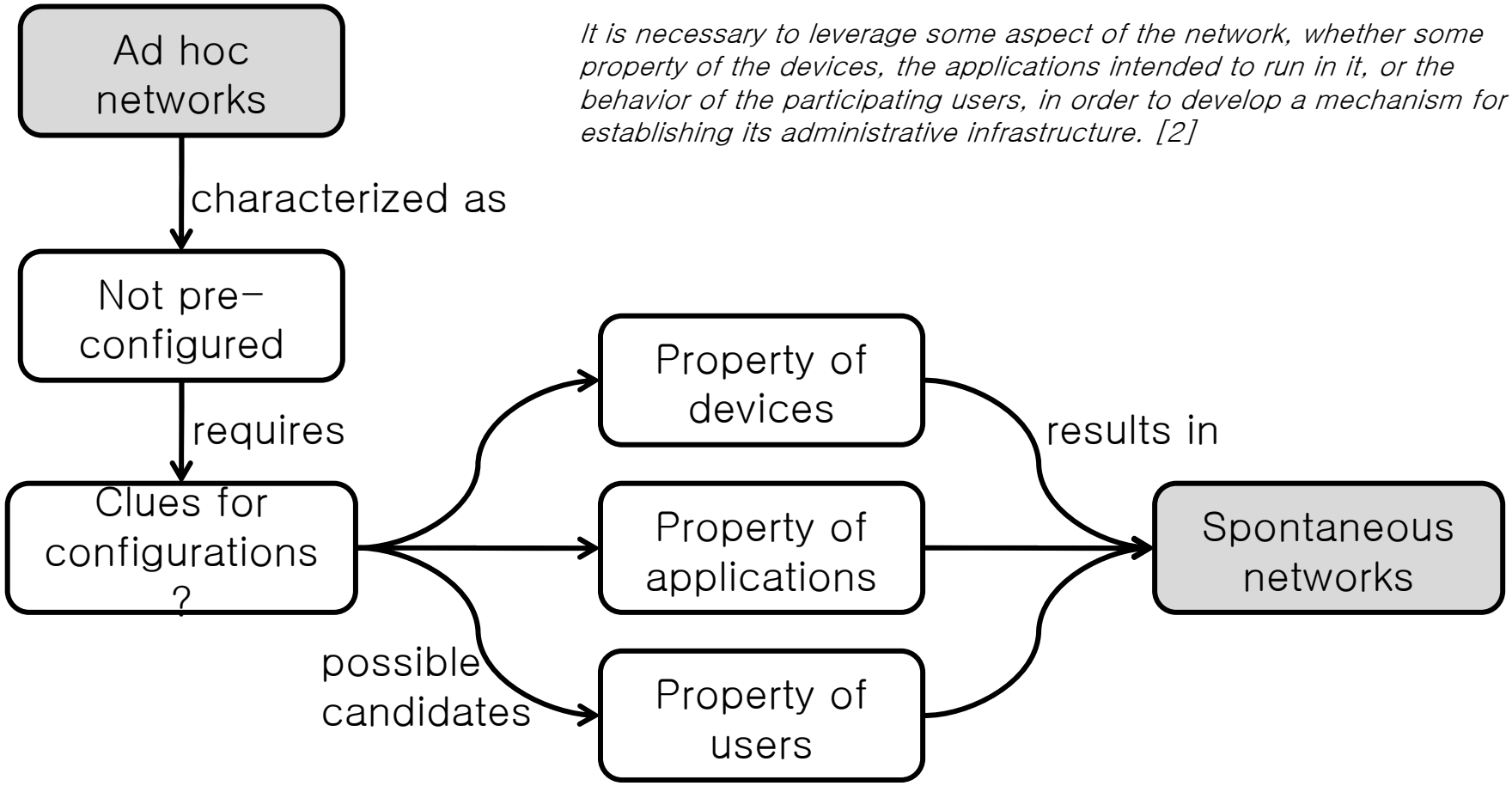
Motivation



Ad hoc applications: Applications are characterized by being ad hoc in nature; applications are not pre-determined and only rise when the current situation requires them. [1]

Motivation

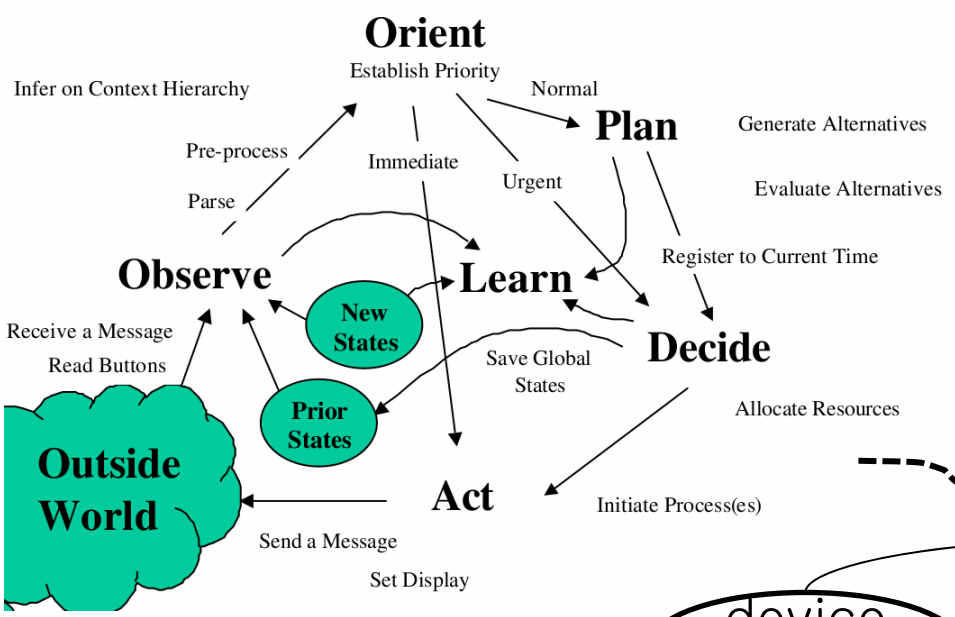
Ad hoc vs. spontaneous networks



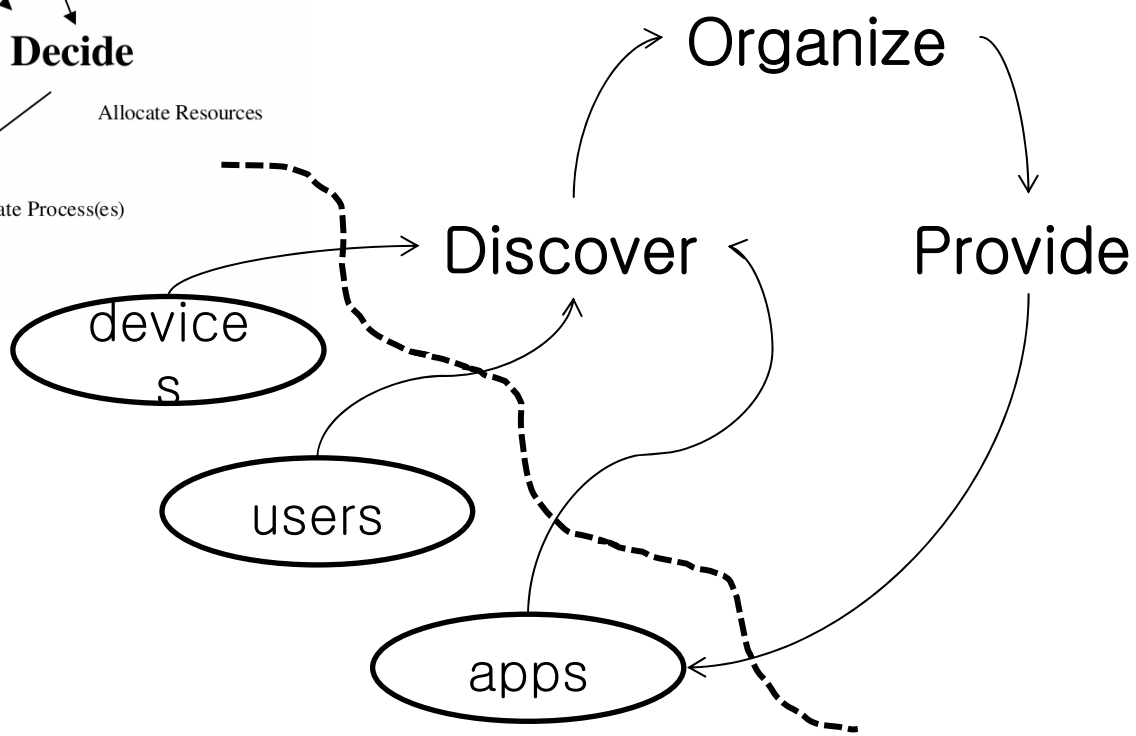
It is necessary to leverage some aspect of the network, whether some property of the devices, the applications intended to run in it, or the behavior of the participating users, in order to develop a mechanism for establishing its administrative infrastructure. [2]

Motivation

Elements of spontaneous networking



Cognition cycle [3]



Related work
Discovery

- L2
  - L3+ aware L1/2 discovery [3]
  - Piggyback L3+ information [4]
- L3+
  - Context aware routing [5]
  - Service discovery [6]
  - Resource monitoring [7]

Related work

Organize

- Cross protocol interoperation
  - Neighborhood information sharing [8]
- Cross network optimization
  - Cooperation between otherwise independent networks [9]
- Network-wide expansion of cognitive radio [10]

Related work

Provide

- Cross network composition / interoperation
  - Multi radio routing [11]
  - Cross overlay [12]
  - Cross heterogeneous networks [13-15]
- Network instantiation
  - Virtual private ad hoc networking [16]

Problem definition

What's missing?

- Cross network collaboration and optimization in spontaneous networks are not yet realized.
- Problems
  - Duplicated L2/3/+ discoveries at all interfaces
    - Waste of energy
    - Increased interference
  - Effective reduction of duplicated discovery overhead requires cross layer / cross network / cross application optmization.

Proposal

- Provides a framework that
  - Aggregates and optimizes the needs across applications as well as across networks,
  - Executes cross layer discovery based on the aggregated needs, and
  - Composes and provides networks on which applications can run.

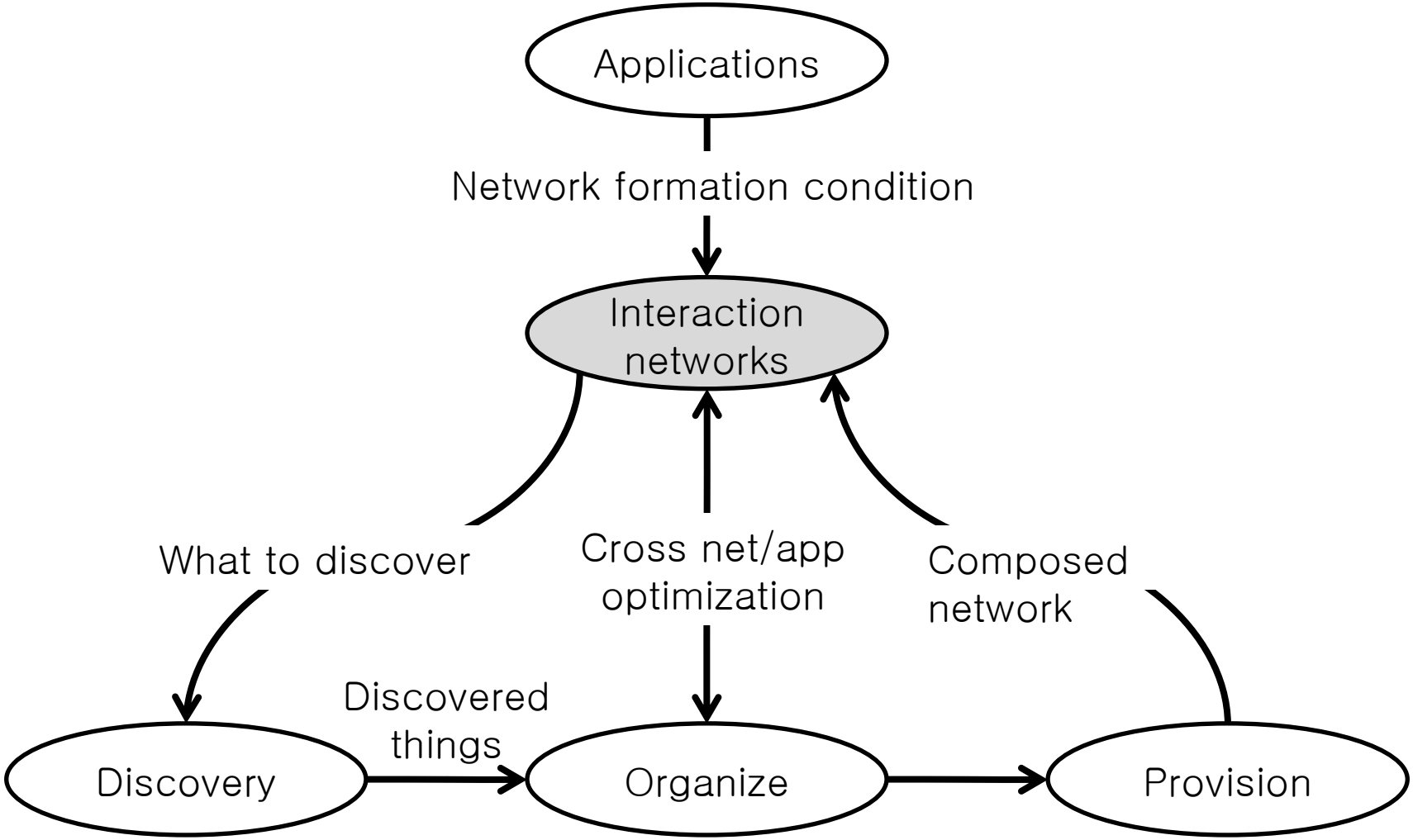
Proposal

Interaction networks

- A network of nodes agreeing to participate in a session
  - Unlike overlay networks, it does not assume underlay networks and is built directly on top of MAC layer.
- Instantiated with network formation constraints (NFC) to discover other nodes
  - NFC := user preference / network constraints / required services / …
  - User preferences are from user profiles stored in devices.
  - Network constraints and required services are defined by applications to execute.

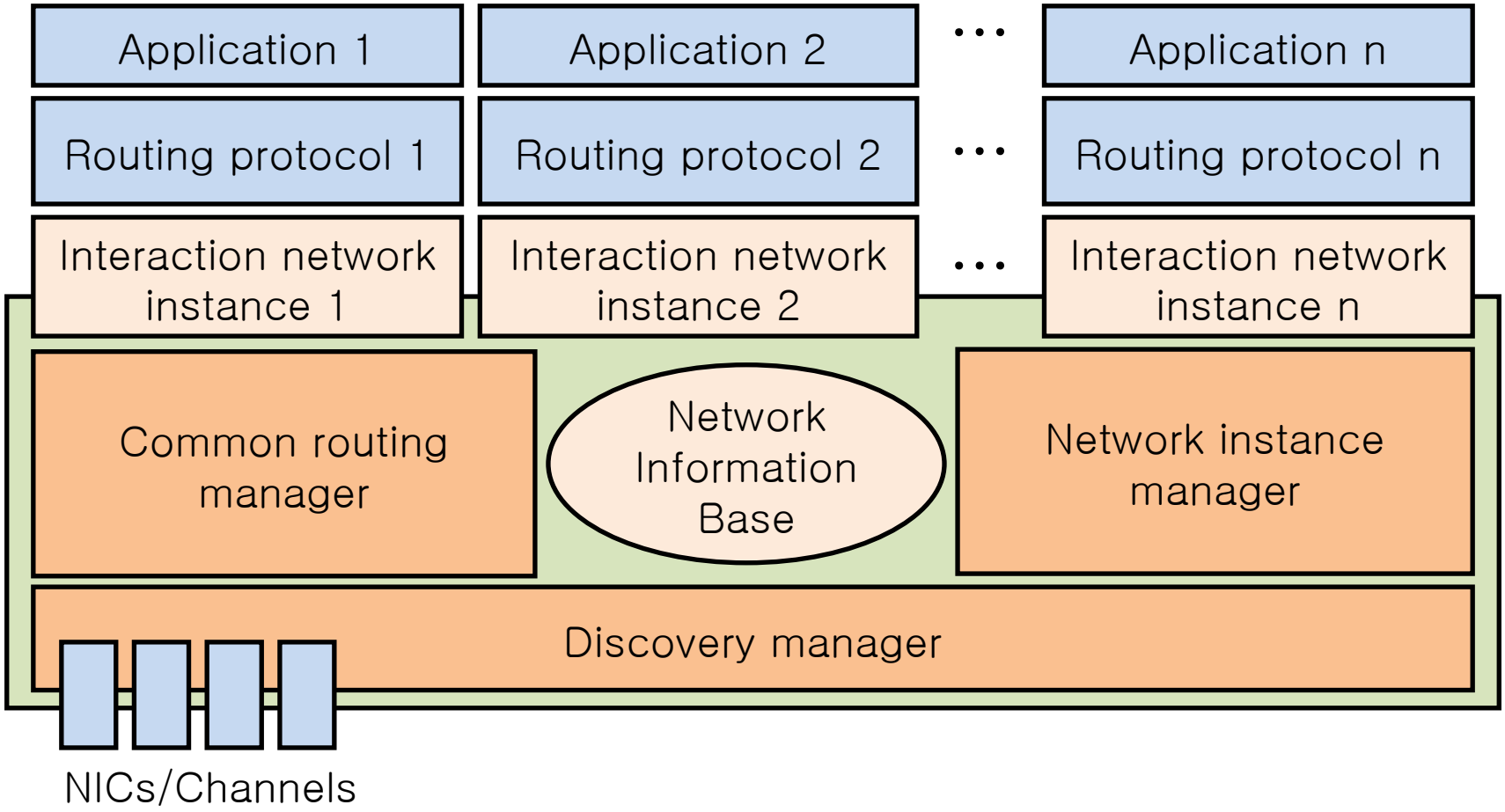
Proposal

Interaction networks



Proposal

An architecture



Proposal
Required/supported features

- Discovery
  - Discovery manager
    - Advertisement and discovery scheduling and scoping
    - Cross layer discovery
    - Cross network discovery
- Organize
  - Network information base
  - Common routing manager
    - Common control packet format
      - Cf. IETF's packet BB
    - Control packet aggregation between protocols
    - Cross network routing
- Provision
  - Network instance manager
    - Network lifecycle management
    - Aggregation of application needs

Discovery manager

- Design goal
  - Fast discovery of neighbor nodes that are candidate member nodes of interaction networks with minimal networking cost
- Design considerations
  - Cost vs. time vs. discoverability
    - Frequency & scope (e.g. TX power control)
  - How to utilize multiple NICs?
    - Using all NICs simultaneously – Using one by one – Using only one
    - Optimize per NIC, node, network, or world?
  - What to embed in beacons? (i.e. cross layer discovery)

Common routing manager

- Design goal
  - Reduction of duplicated control traffic generated by routing protocols running in each interaction network
- Design considerations
  - Share of network information
    - E.g. topology
  - Common control packet format
    - Cross protocol collaboration
  - Control packet aggregation across protocols
  - Tunneling or cross network routing

Network instance manager

- Design goal
  - (To applications) Provides an abstraction of network
  - (To framework) Feeds applications' needs
- Design considerations
  - Merge / split of interaction networks
  - How to aggregate applications' needs
  - How to notify the change in interaction networks to applications

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