Managed Packet Transport Network
by Optimal Control Function Placement

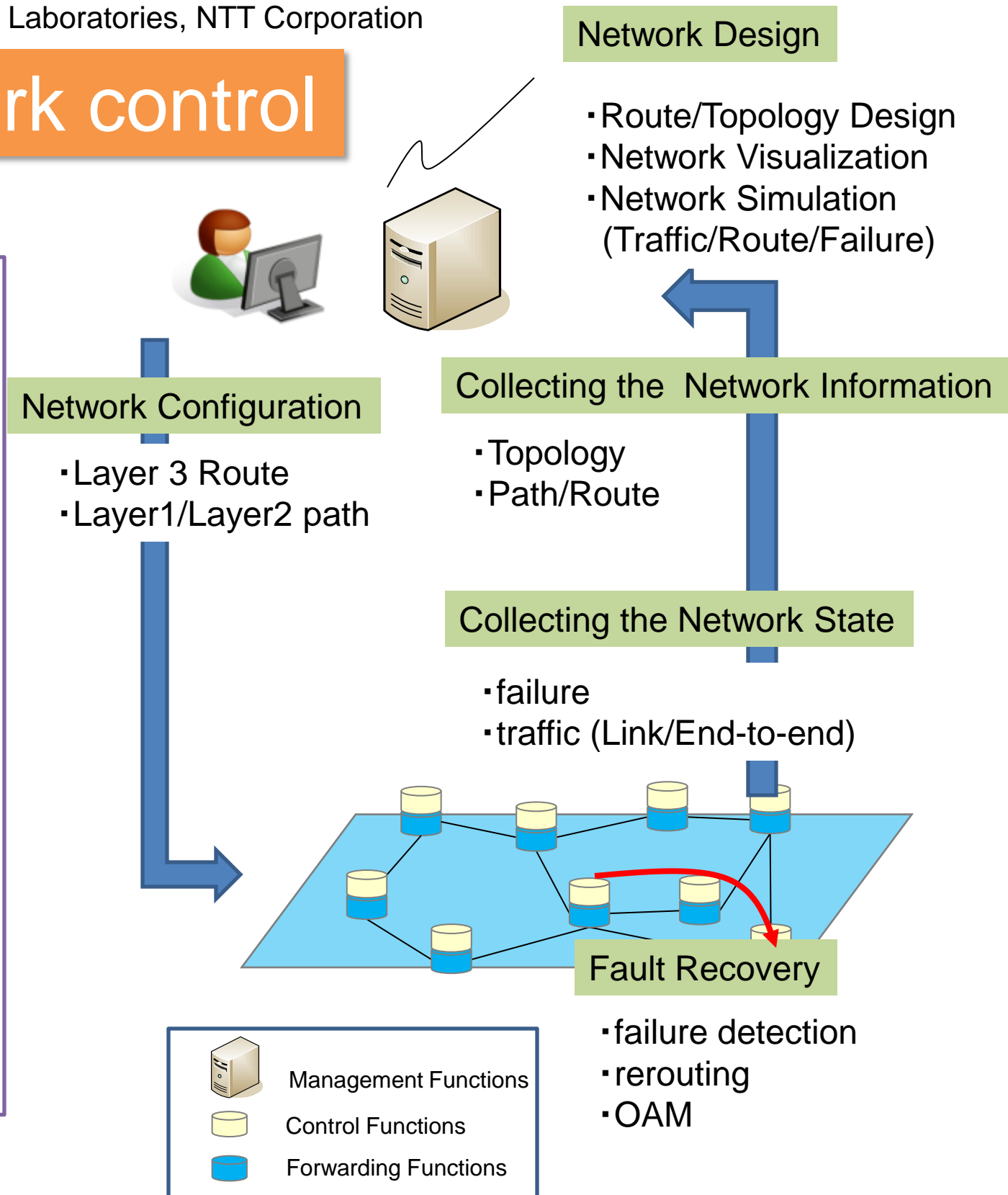Shohei Kamamura[†], Daisaku Shimazaki[†], Takashi Miyamura[†], Kohei Shiomoto[*] and Atsushi Hiramatsu[†]
†NTT Network Service Systems Laboratories, NTT Corporation
*NTT Service Integration Laboratories, NTT Corporation

1. Requirements to network control

Motivation

- Carrier network should not only provide the high quality and high reliability of data plane network, but also satisfy the operational requirements such as the manageability for the large network.

- the network should provide easiness and transparency of operation for typical network events: collecting the network information, collecting the network state, network design, network configuration, and fault recovery.

Network Design

- ・Route/Topology Design
- ・Network Visualization
- ・Network Simulation (Traffic/Route/Failure)

Network Configuration

- ・Layer 3 Route
- ・Layer1/Layer2 path

Collecting the Network Information

- ・Topology
- ・Path/Route

Collecting the Network State

- ・failure
- ・traffic (Link/End-to-end)

Fault Recovery

- ・failure detection
- ・rerouting
- ・OAM

Management Functions

Control Functions

Forwarding Functions

2. Problem Statement

Current packet transport architectures (distributed/centralized) have drawbacks and advantages

- Distributed IP Network (e.g. current Internet)
  - robust and scalable
  - lack of the manageability (basic design and protocol design are needed)
- Centralized control network (e.g. OpenFlow, PCE)
  - central server control each NE
  - high manageability (e.g. direct control of path)
- has vulnerability of control-plane
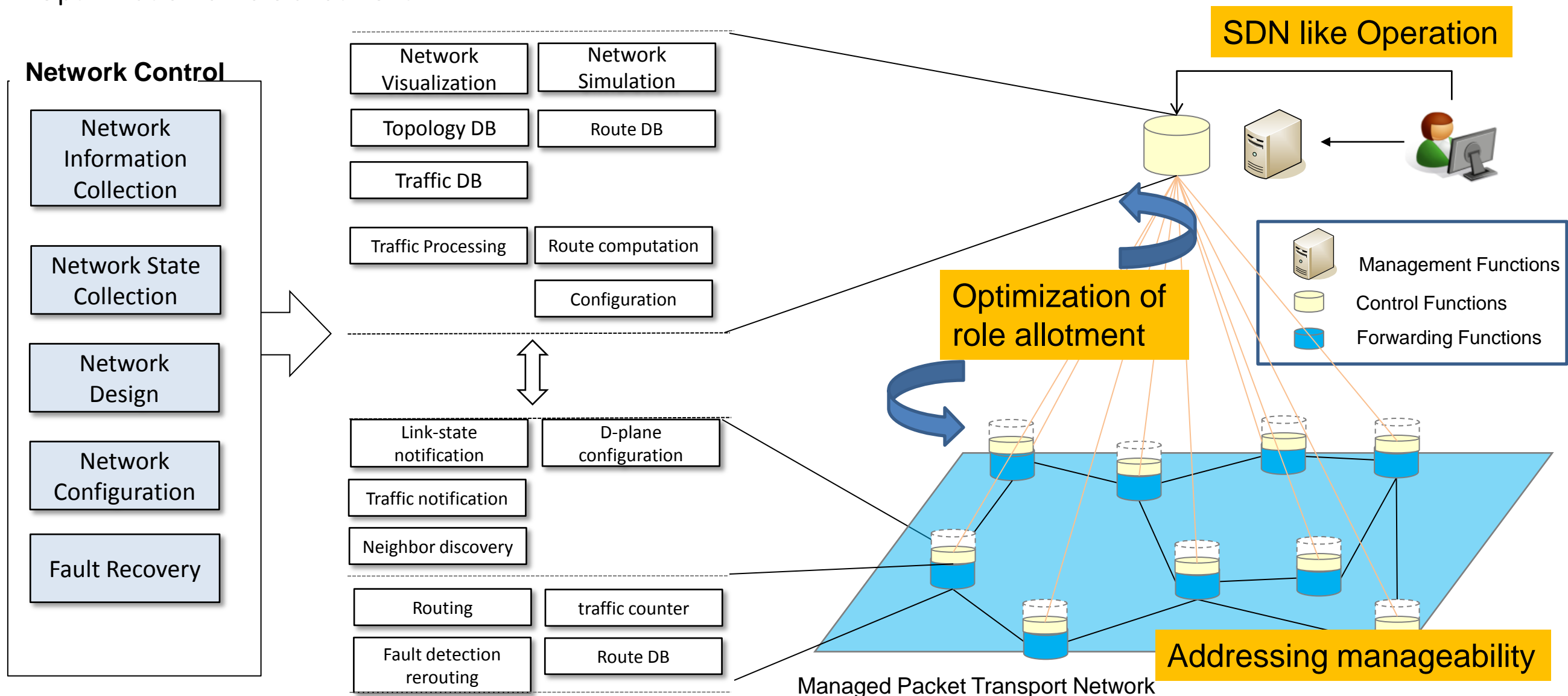 - crash of single controller means the crash of control-plane of whole networ

Our problem is establishing the optimal architecture under the carrier network control operation

Distributed IP Network

Centralized Control Network
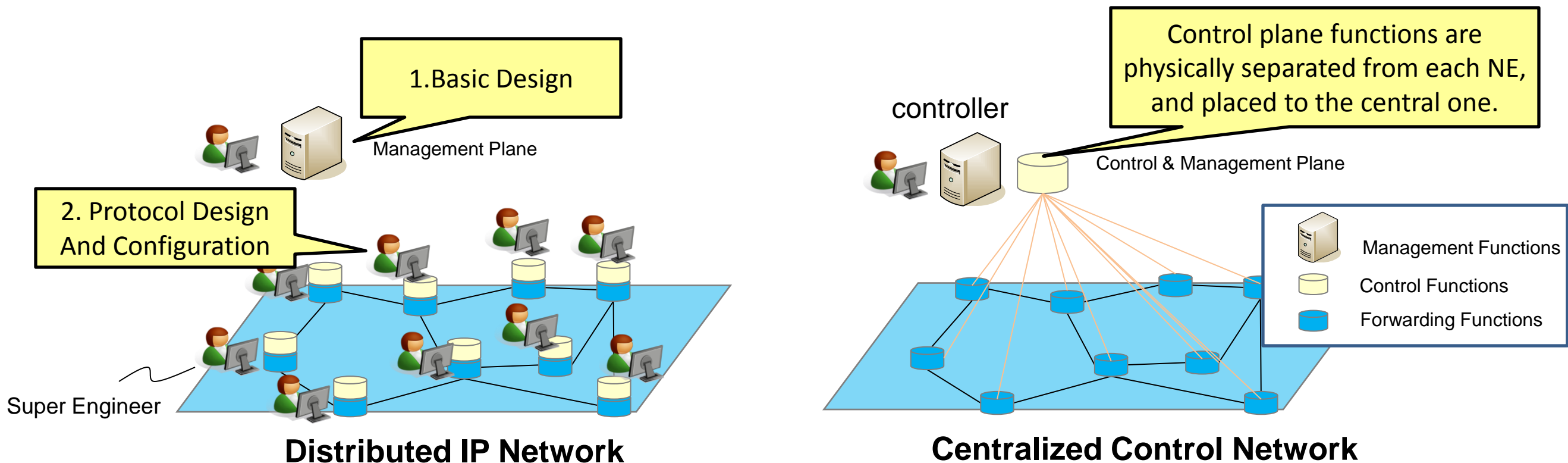
3. Managed Packet Transport Network

we focus on the intermediate solution between the distributed and wholly centralized approach

- SDN like operation
  - Common control functions are placed to the central server while some tightly-coupled functions are still on NE.
  - Real time processing such as fault recovery are autonomously performed on NE
- Addressing manageability
  - IP-based addressing whose addresses are editable compared to the HW addresses (e.g. MAC address)
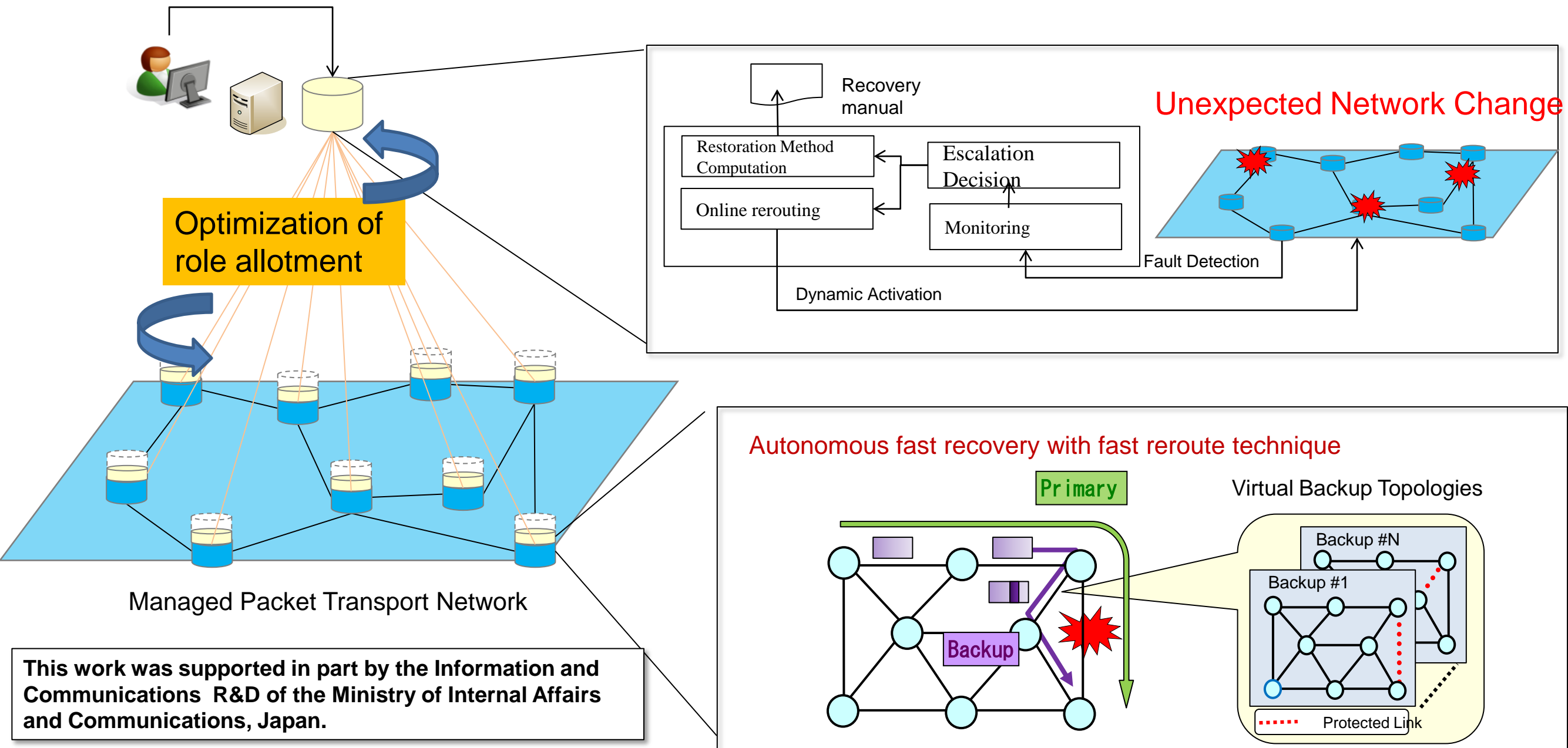- Optimization of role allotment

Network Control

| Network Information Collection |
| Network State Collection |
| Network Design |
| Network Configuration |
| Fault Recovery |

Network Visualization	Network Simulation
Topology DB	Route DB
Traffic DB	

| Traffic Processing | Route computation |
| | Configuration |

Link-state notification	D-plane configuration
Traffic notification	
Neighbor discovery	

| Routing | traffic counter |
| Fault detection rerouting | Route DB |

SDN like Operation

Optimization of role allotment

Management Functions
Control Functions
Forwarding Functions

Addressing manageability

Managed Packet Transport Network

4. Example: Optimization of role allotment

Simple failures are autonomously recovered by network element without a central controller

- Realizing hot standby rerouting with precomputed backup routes

Unexpected failures such as disaster are dynamically recovered with a central controller

- Central controller dynamically configures the paths/routes/traffic policing

Optimization of role allotment

Managed Packet Transport Network

Recovery manual

Restoration Method Computation

Online rerouting

Escalation Decision

Monitoring

Dynamic Activation

Fault Detection

Unexpected Network Change

Autonomous fast recovery with fast reroute technique

Primary

Virtual Backup Topologies

Backup #N

Backup #1

Backup

Protected Link