Scheduling of Graph-based End-to-End Tasks for Distributed Multi-criticality Systems

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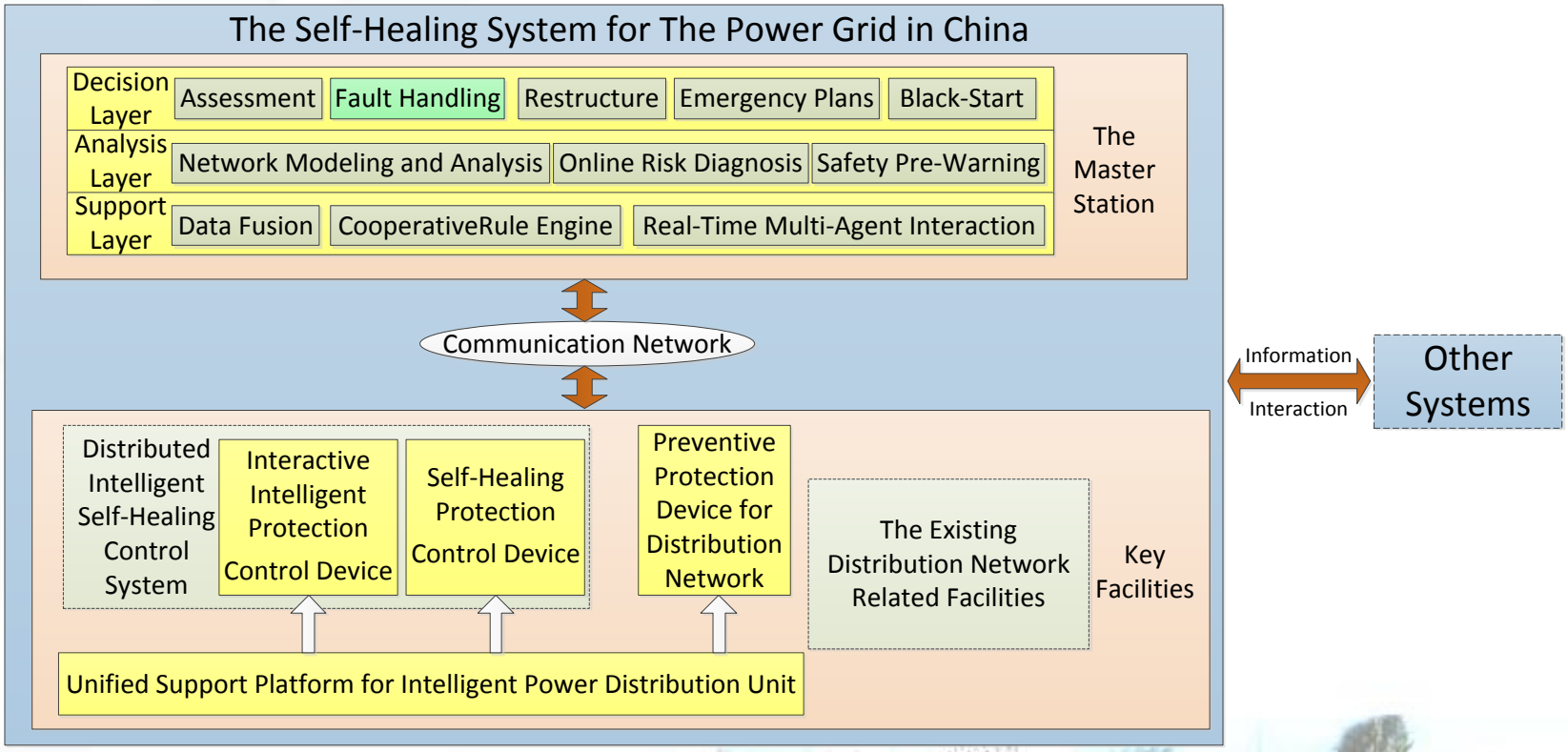
Motivation

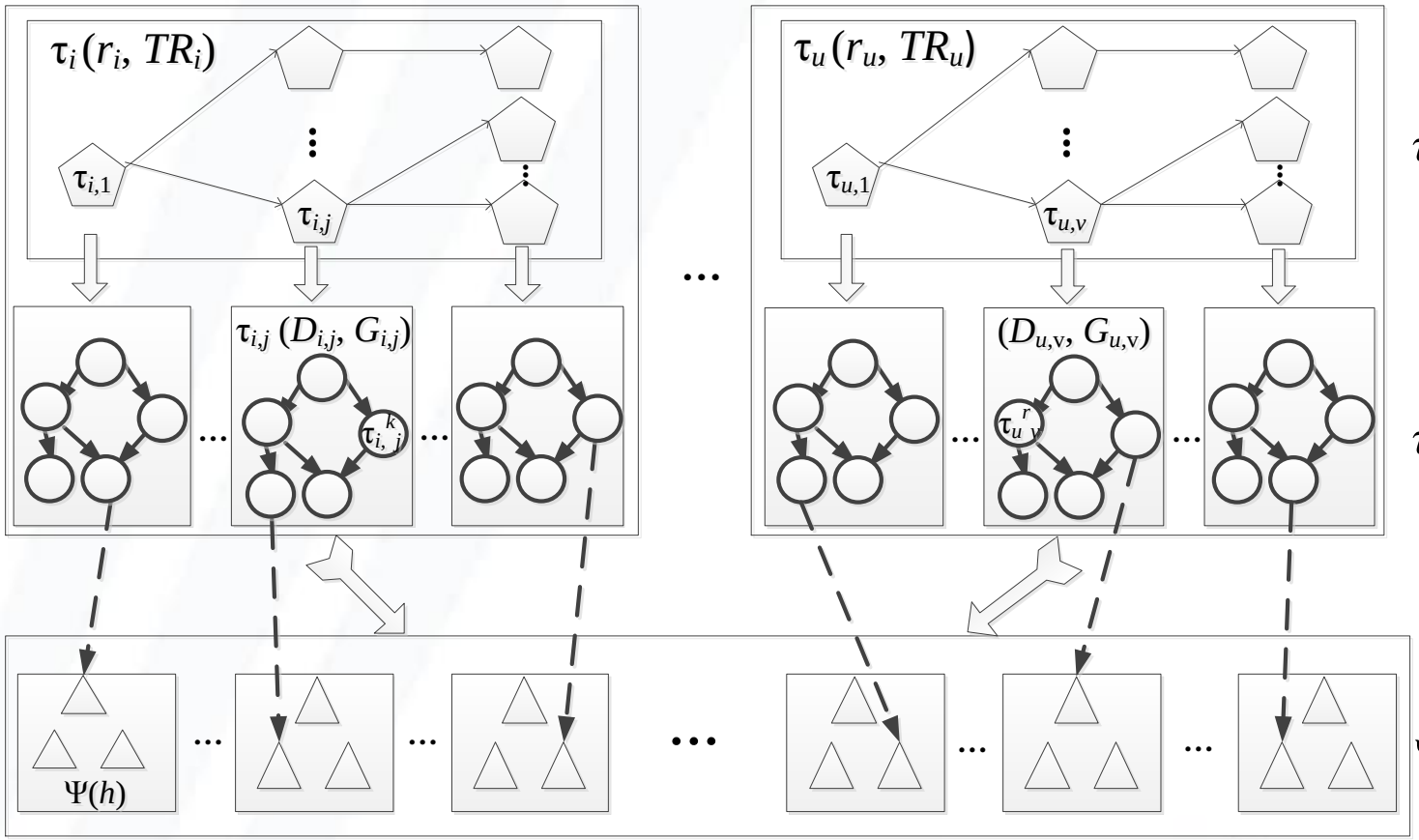
- Fault handling in the self-healing system



Motivation

- The fault-handling elements
  - The fault tree
  - The security operation graph
  - The mappings of the fault nodes to their operation graphs
- The fault-handling goal
  - Real-time execution of security operations with minimum fault spreading degree

Task Modeling for Fault-Handling



$$\tau_i = \{\tau_{i,j} \mid 1 \le j \le n_i\}$$

$$\tau_{i,j} = \{\tau_{i,j}^{k} \mid 1 \le k \le n_{i,j}\}$$

$$\Psi = \{\Psi(h), 1 \le h \le m\}$$

Node in Fault Tree Security Action Node Agent

Precedence between Sub-tasks of Safety Operation Graphs

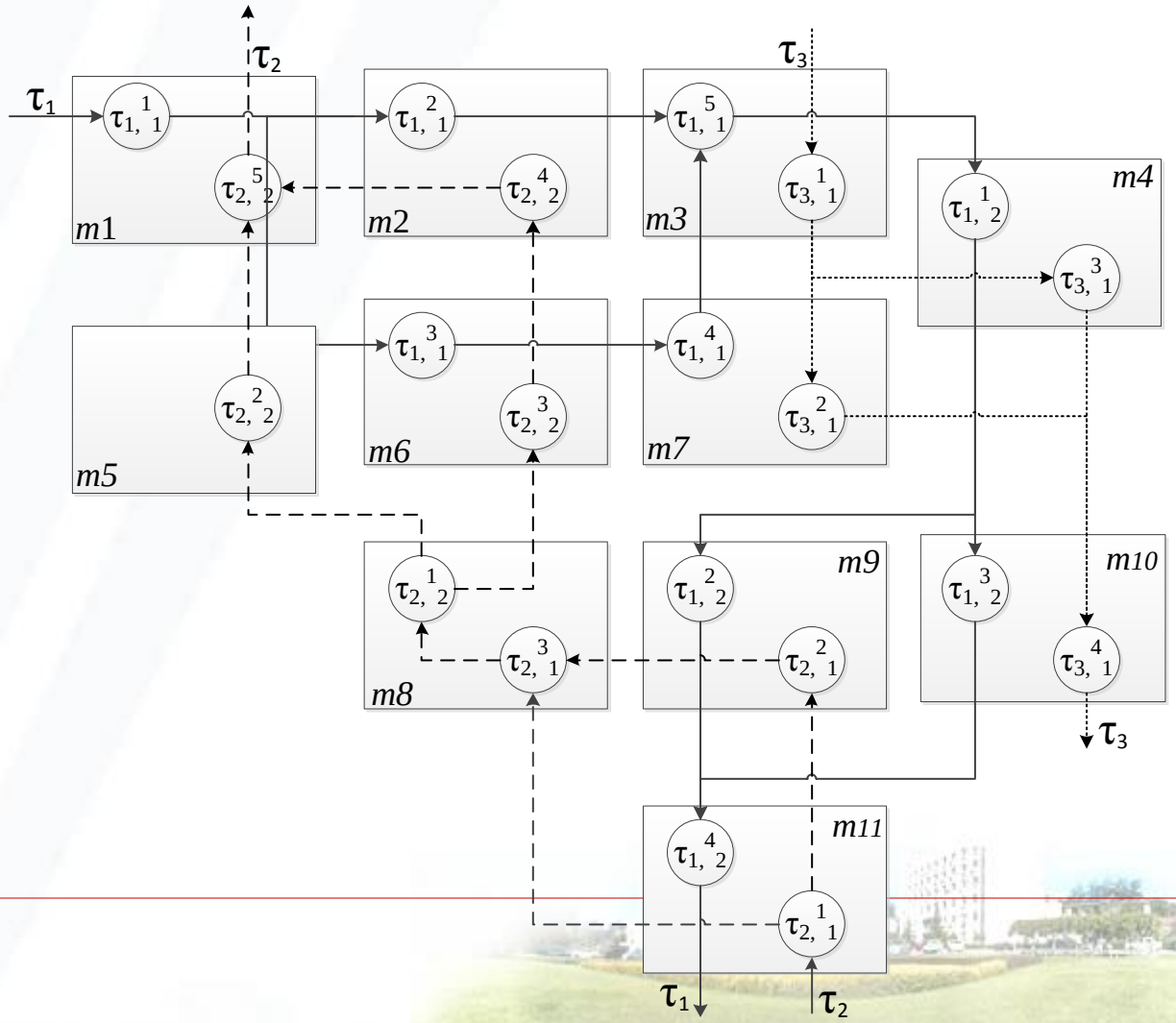
Precedence between Sub-tasks of Safety Operation Graphs

Mapping from Sub-tasks of Safety Operation Graphs to Multi-Agent

The MCE2E Task Model

- The multi-criticality graph-based end-to-end task model
  - The inter-criticality-mode trees
    - Nodes in the tree ← criticality modes
      - Recovery and isolation mechanisms for mode changes
  - The intra-criticality-mode graphs
    - Each node defined by a parallel DAG
      - Subtasks in the DAG are pre-allocated to processors
  - Comparison
    - Variable C_i and D_i → end-to-end tasks
    - Distributed intra-criticality-mode structure with end-to-end deadlines → mixed-criticality tasks

MCE2E Task Examples



MCE2E Scheduling

- Complexity
- The initial criticality modes
  - Local-deadline assignment solution
- Criticality mode changes
  - Recovery
  - Isolation

MCE2E Criticality Mode Changes

- Recovery
  - Degraded execution of best-effort nodes
- Cluster grouping
  - One or minimal amount of critical nodes
  - A subset of best-effort nodes
- Isolation
  - Time partitions within the cluster
    - The critical nodes successfully scheduled
    - The least mode changes for best-effort nodes

Thank you