


Centralized Intelligent Protection Prototype

—BY PROF.LIN
HUST

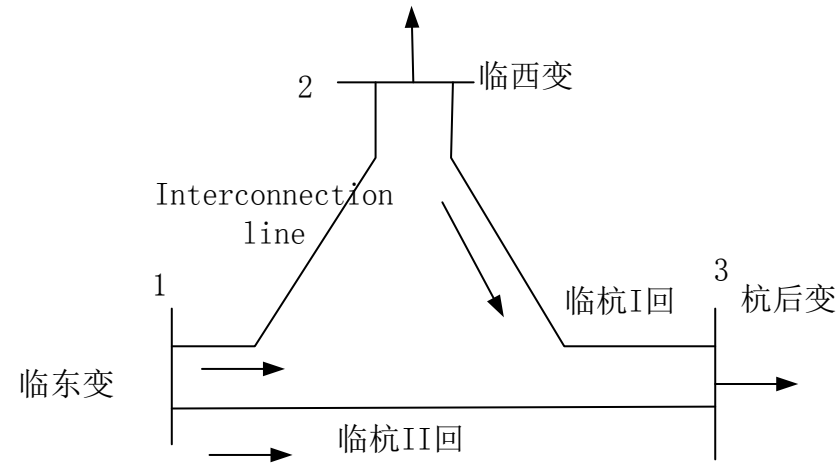
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- Problems Brought up by New Distribution Network
 - The Demand Analysis of Centralized Intelligent Protection
 - The Foundation of Protection Information Platform

THE DEMAND ANALYSIS OF CENTRALIZED INTELLIGENT PROTECTION

Problems Brought up by New Distribution Network

Routine Operation With Closed Ring

- To fulfill the requirement for power supply reliability, the future distribution network may operate with closed ring as a routine mode in many circumstances;
- During operation with closed ring, there would be at least 2 power sources in distribution network, which is **beyond the capability** of traditional local protection.



Routine Operation With Closed Ring

Problems Brought up by New Distribution Network— New Energy Integration

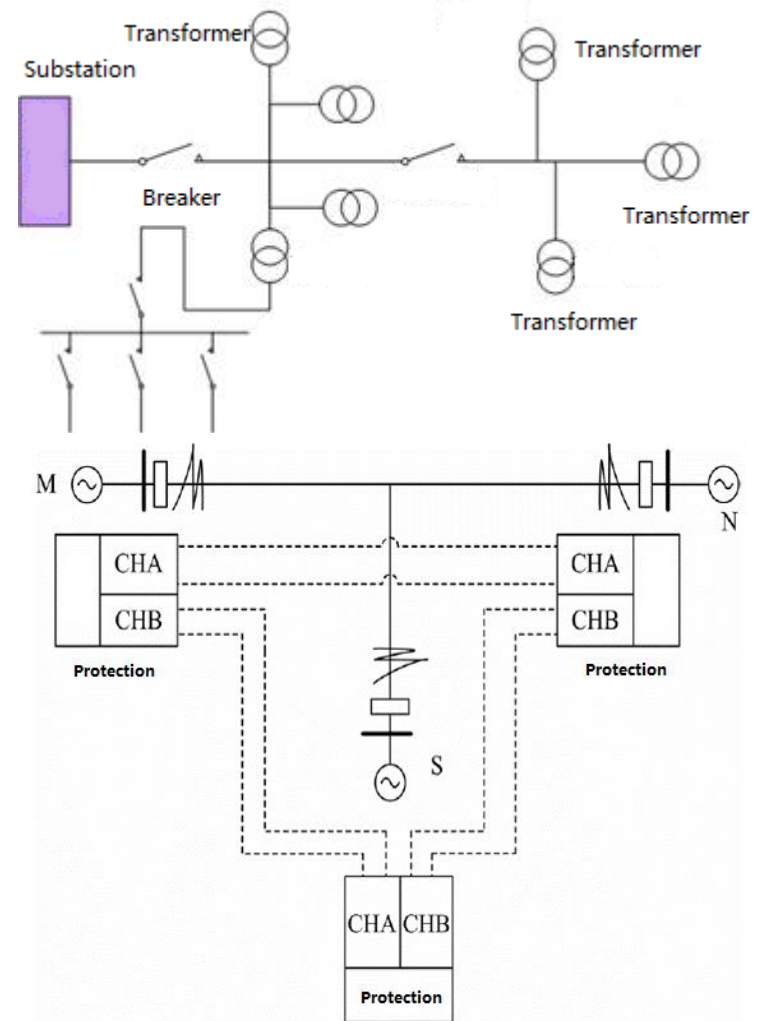
- The high penetration of distributed new energy generation would increase the number of power sources, leading to big obstacle of traditional protection setting and cooperation



New Energy Integration

Problems Brought up by New Distribution Network—Complicity of Topology

- The situation of “T” connection, multiple lines and so on has increased much, which makes the topology of distribution network more complicated;
- The quickness and selectivity of traditional protection could not meet the requirement.



Problems Brought up by New Distribution Network— —the Occupation Problem of Urban Substation

- In conventional design, substations are equipped with master-control room for secondary system;
- Due to the existence of master-control room, a typical substation needs to occupy sizable extra space;
- The land resources of urban area become more and more scarce. In this case, the problem of land acquisition is becoming the obstacle in substation construction.




Urban substation

The Demand Analysis of Centralized Intelligent Protection System

- To sum up, the development of distribution network would bring a lot of technical and practical problems to protection system, which cannot be tackled in existing protection schemes.
- A protection system based on the information of whole distribution network is able to solve above problems to a great extent.
- In order to optimize the protection performance on an overall perspective, a protection system with strong communication capability is needed.

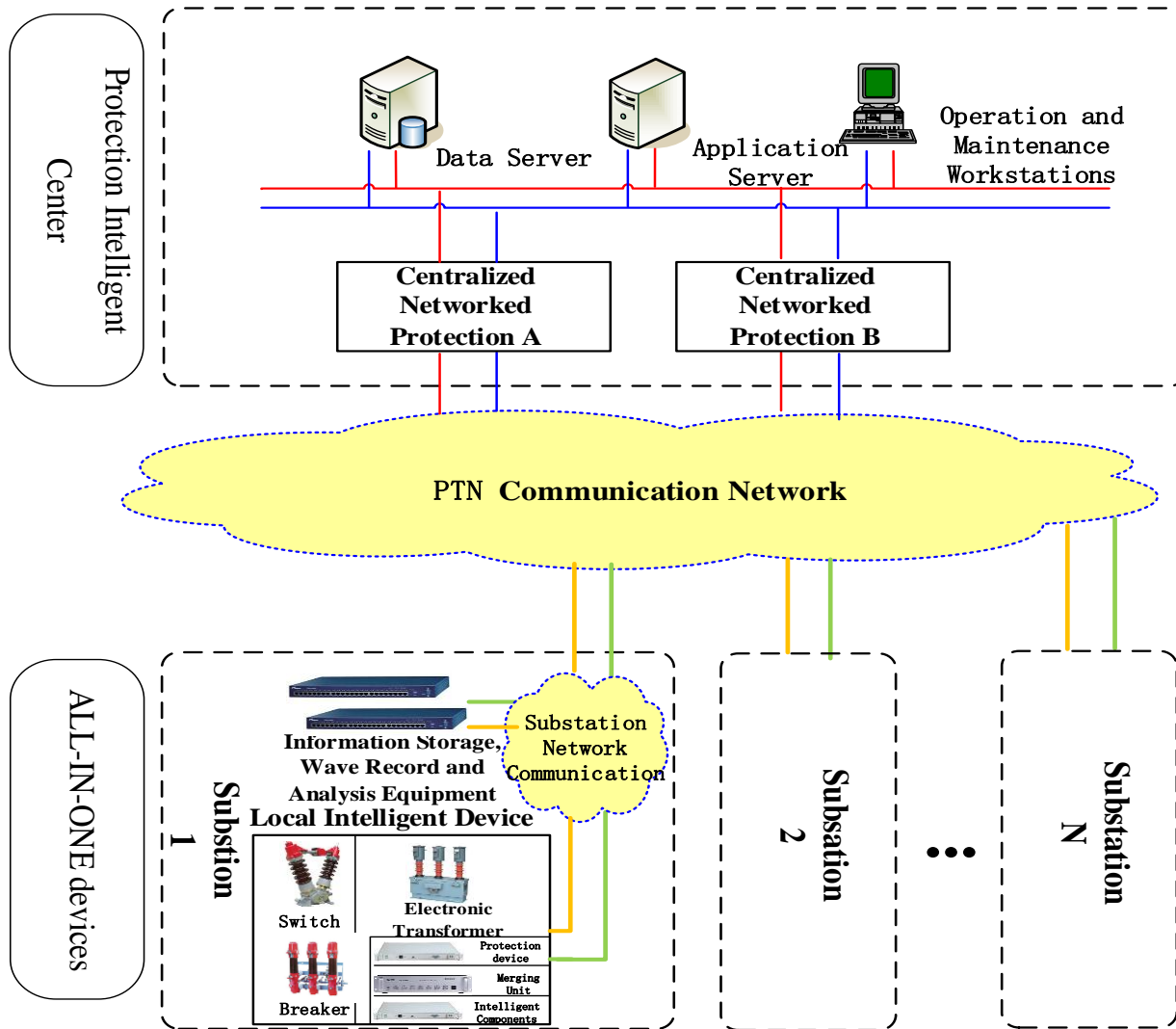


Centralized Intelligent Protection System is a feasible way to achieve the goal.

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- Centralized Intelligent Protection system
 - ALL-IN-ONE devices
 - Protection Intelligent Center
 - Communication Backbone Network of Centralized Intelligent Protection system

**WHAT IS CENTRALIZED
INTELLIGENT PROTECTION ?**

Centralized Intelligent Protection System



The Centralized Intelligent Protection system consists of three parts:

- ALL-IN-ONE devices
- Protection Intelligent Center.
- PTN communication network.

ALL-IN-ONE devices

Functions of all-in-one devices:

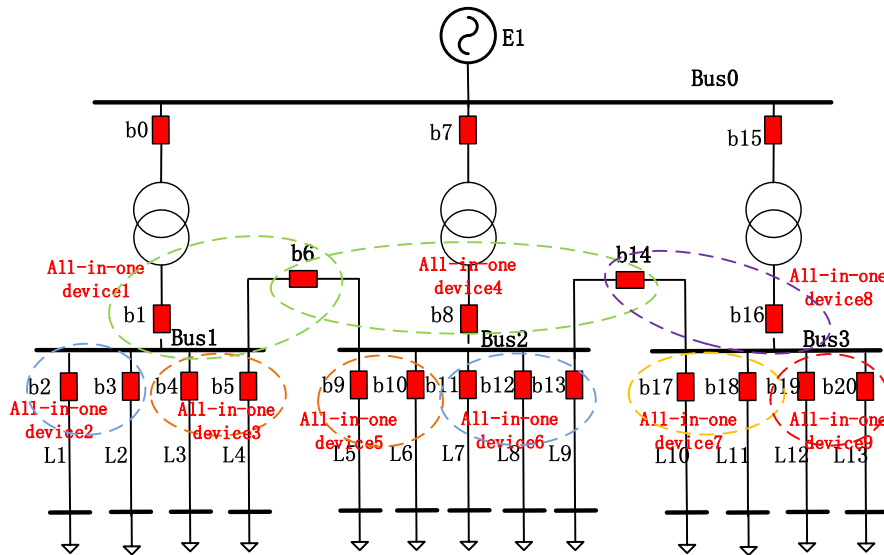
ALL-IN-ONE devices would cover several merging units, collect the information of which and realize local bay-based protection and multi-bay based protection, information communication, and so on.

Settlement of ALL-IN-ONE devices:

ALL-IN-ONE devices are located among those subordinate merging units(MU). it can be placed near primary equipment, or underground. So It won't take up additional land.

As a result, the master-control room can be cancelled.

ALL-IN-ONE devices

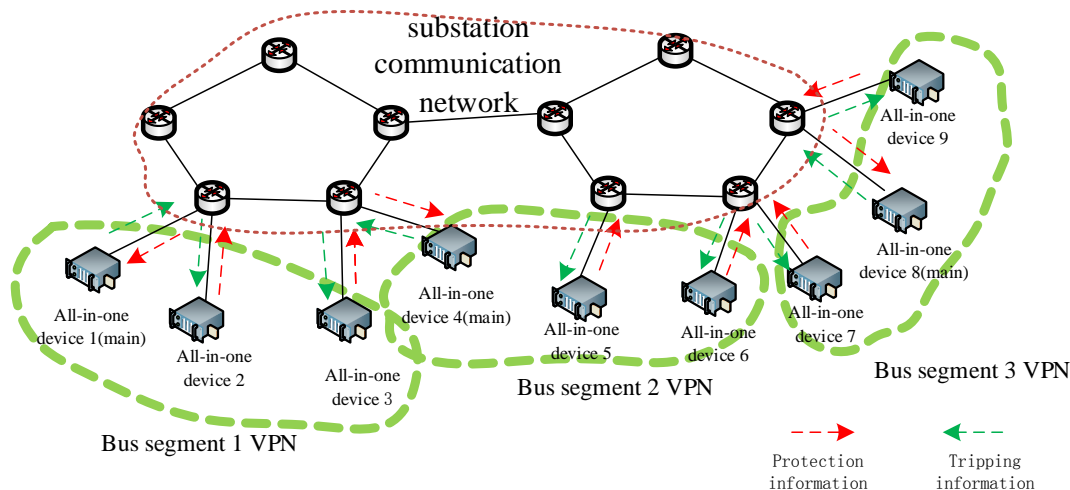


Local bay-based protection:

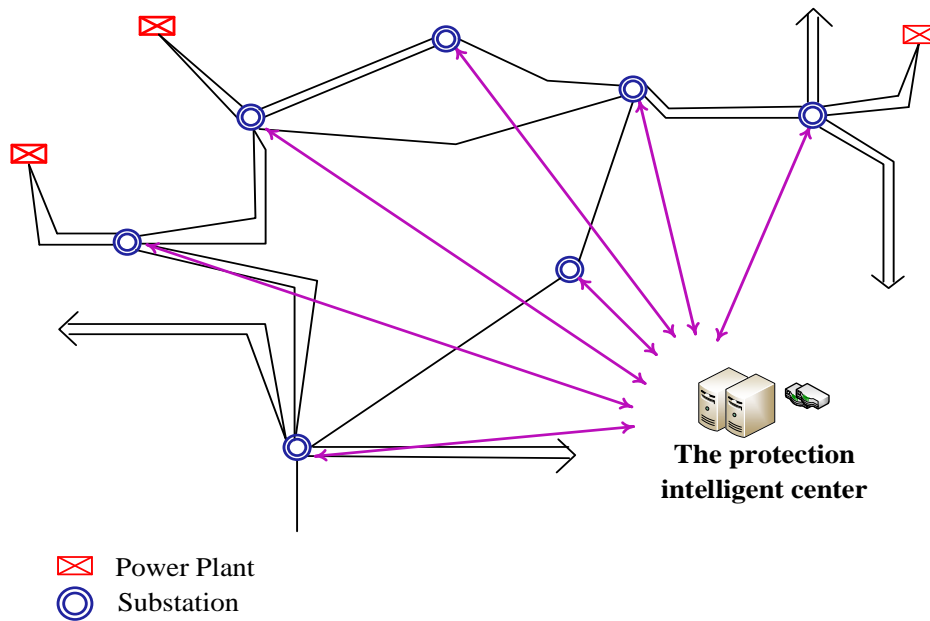
ALL-IN-ONE devices can collect sampling value from subordinate MUs and give out tripping signal after processing procedure in its integrated protection module.

Multi-bay based protection:

such as transformer protection or bus bar protection, it is possible that a single all-in-one device cannot cover the whole protection area. to tackle this problem, several ALL-IN-ONE devices could cooperate together as a multi-bay based protection via VPN network.



Protection Intelligent Center



- ✓ Protection Intelligent Center duplicates the protection functions already implemented in ALL-IN-ONE devices of all substations.
- ✓ Implement the fast protection functions of all sections along main feeders the and tie lines between substations, leading to the great improvement of protection performance
- ✓ Be deployed in a highly reliable bunker independently to take precautions against natural calamities

Protection Intelligent Center



centralized protection and control devices

accomplish fast main protections of all components within the protected zones and comprehensive wide area protection and control function, realize integrated design of the three defensive lines of power grid.



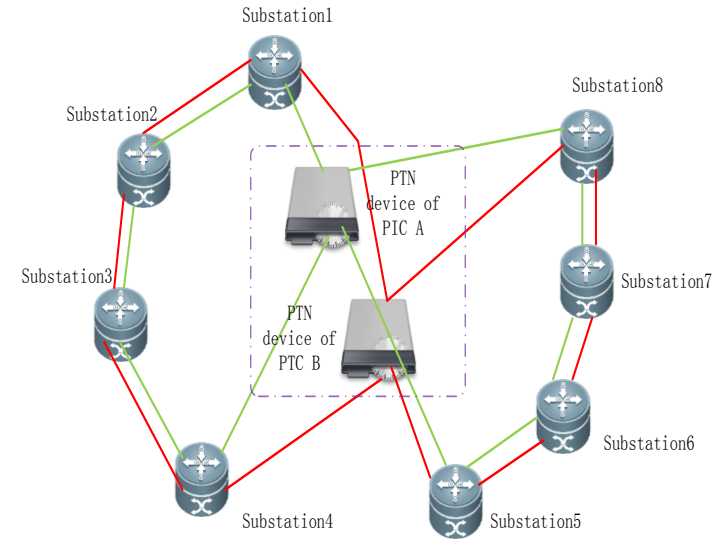
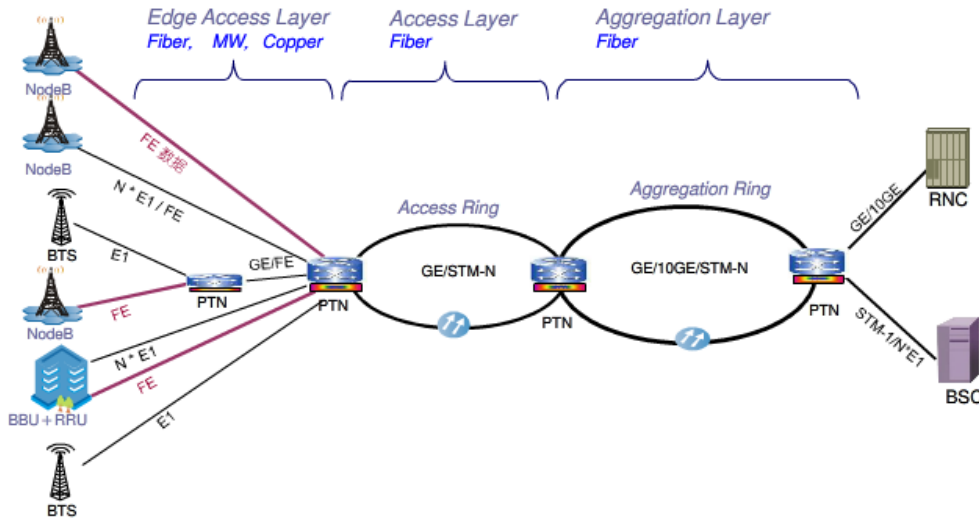
Operation and Maintenance Workstations

achieve functions of operation monitoring, system configuring, equipment maintenance and off-line analysis.

Communication Backbone Network of Centralized Intelligent Protection System


ALL-IN-ONE devices

Protection intelligent center



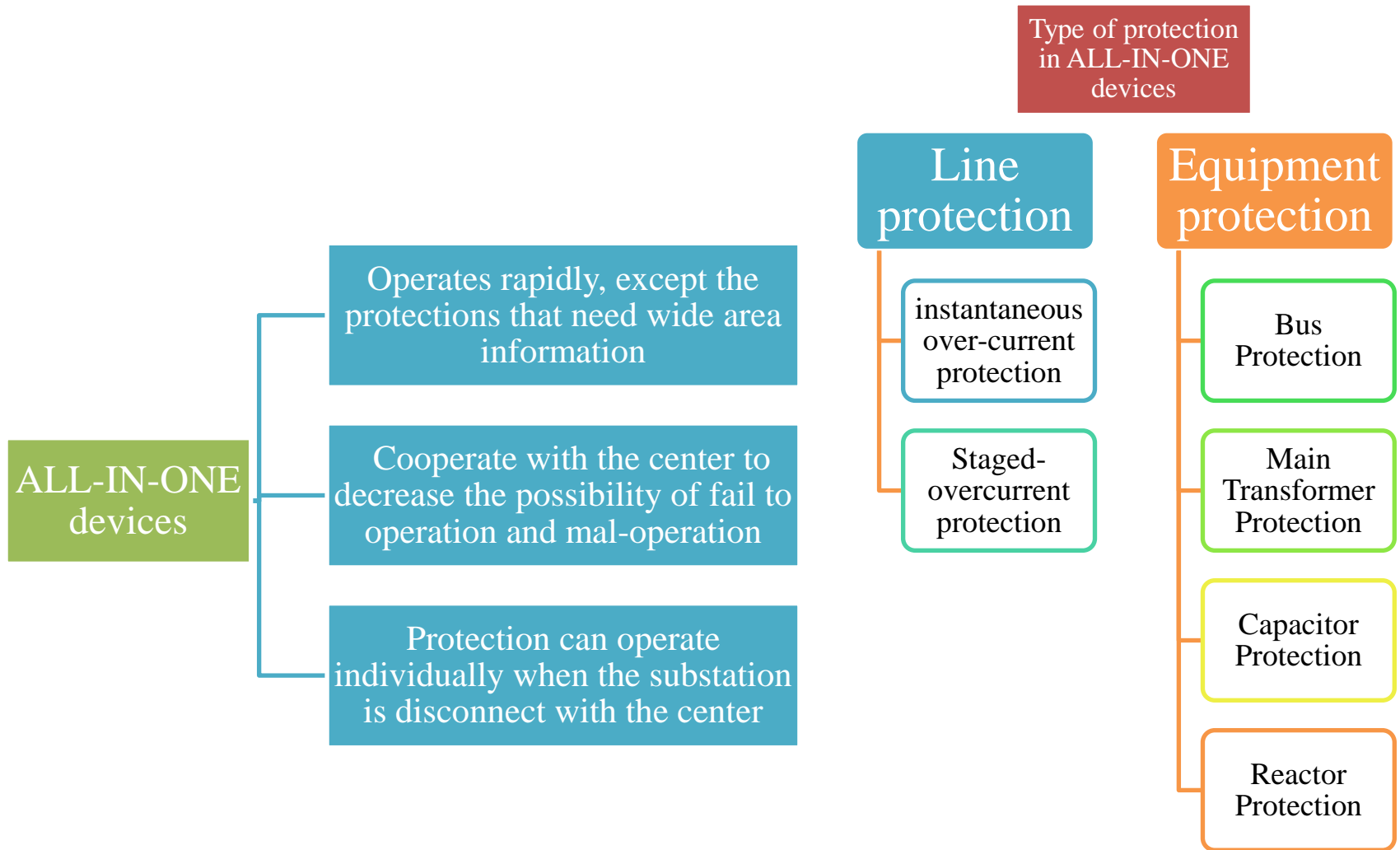
Mature PTN scheme guarantees high speed and reliable communication between substations and center.

- **Duplicated PTN looped network structure can realize circuitous communication channel.**
- **Equipped with the network traffic control strategy, it can guarantee the quality of communication.**

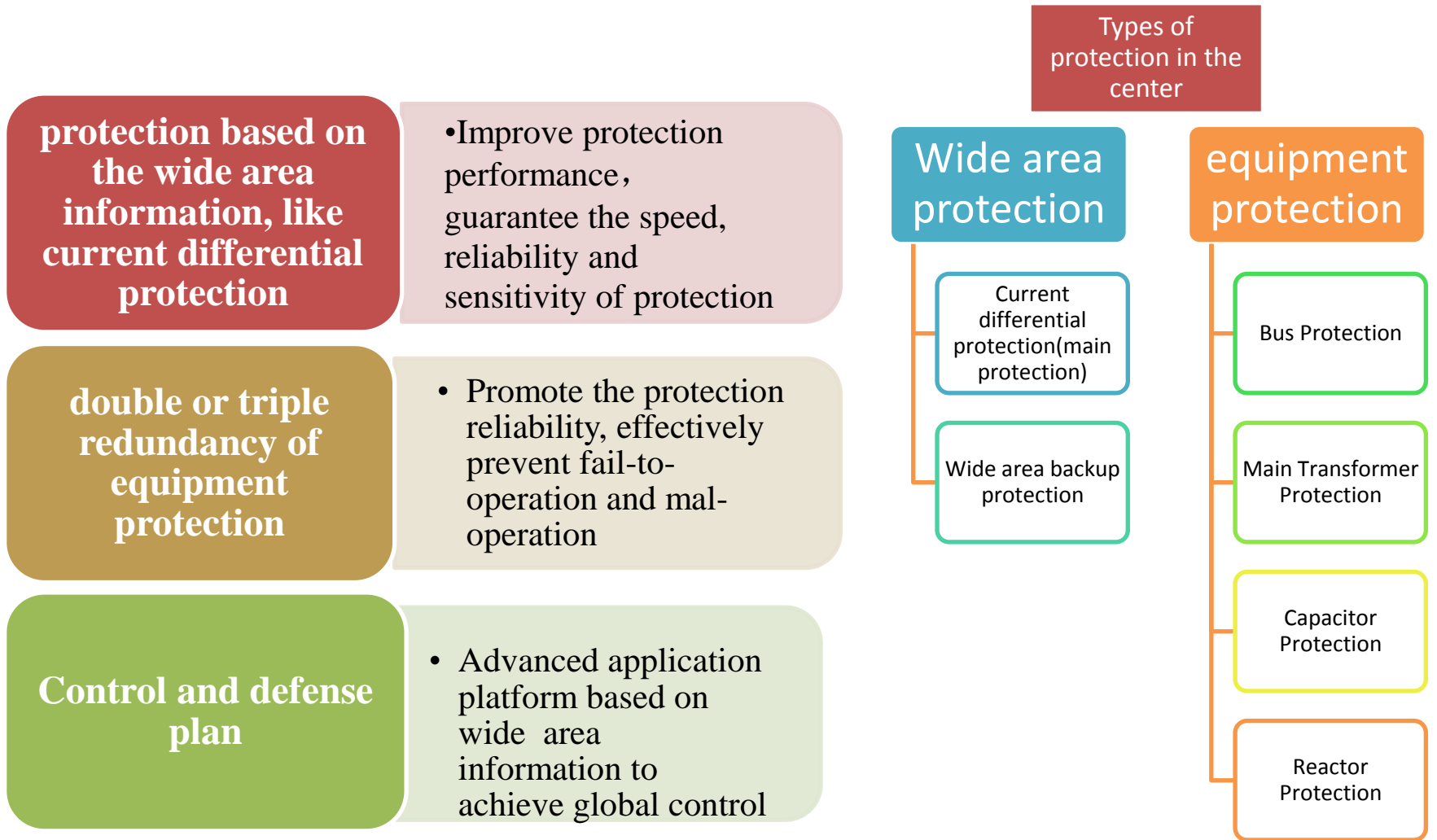
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- Function Deployment of ALL-IN-ONE devices
 - Function Deployment of Protection Intelligent Center

THE FUNCTION DEPLOYMENT OF CENTRALIZED INTELLIGENT PROTECTION

Function Deployment of ALL-IN-ONE devices



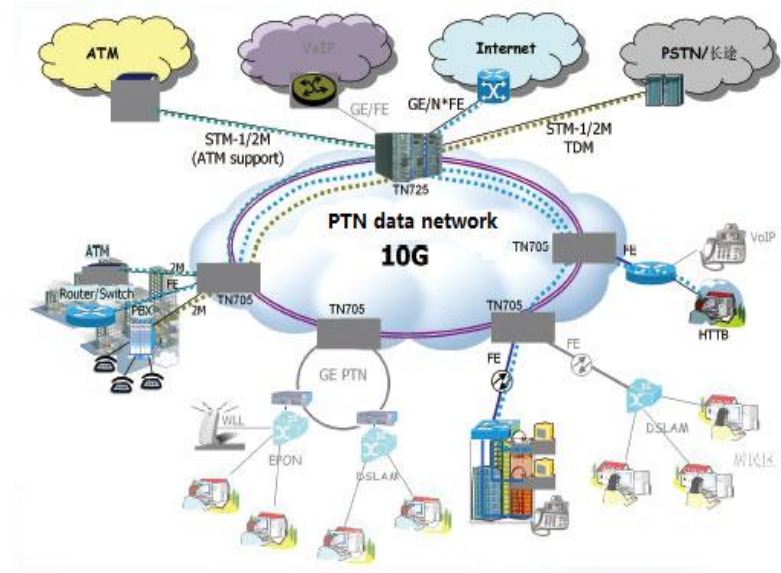
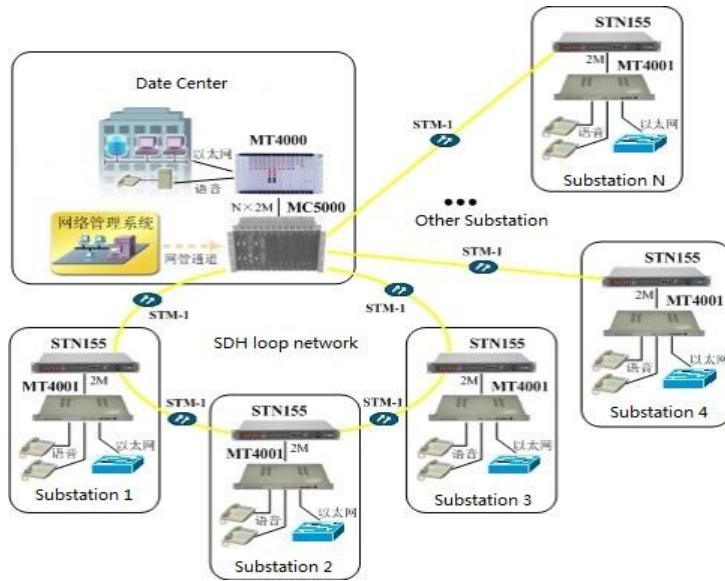
Function Deployment of Protection Intelligent Center



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- Strong Communication Network
 - PMU & WAMS

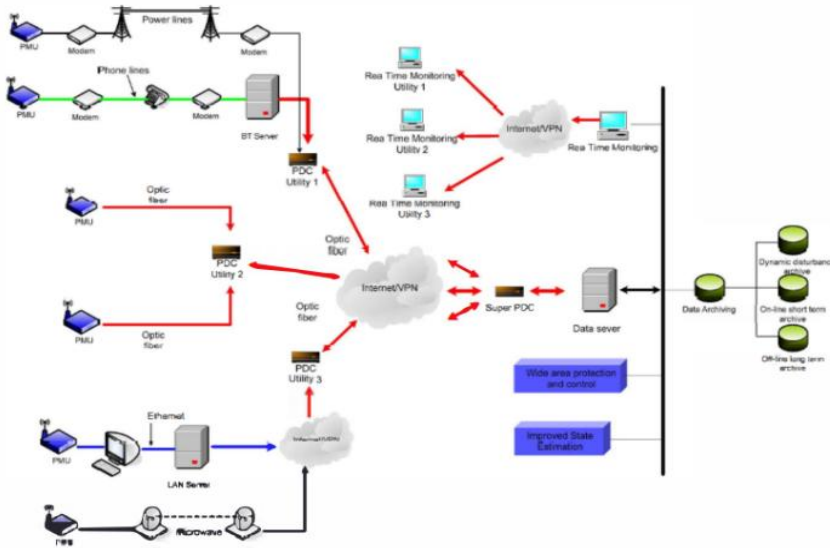
FEASIBILITY OF CENTRALIZED INTELLIGENT PROTECTION SYSTEM

Feasibility of Centralized Intelligent Protection System — Strong Communication Network



- Performance indexes of communication network such as bandwidth, time lag and stability have been improved a lot while the construction cost decreased significantly;
- The construction and operation experience of SDH can support the design of protection comprehensive information platform;
- Packaged communication solutions such as PTN and EPON can be used directly in construction.

Feasibility of Centralized Intelligent Protection System —PMU & WAMS



PMU technology with GPS precise timing is mature already, wide area protection and control system such as PLSS (Canada), WACS(USA), DRS and Syclopes system (France) can support the construction and operation of Wide Area Protection System.

In China

- ▶ In May, 2008, the Wide Area Protection and control System was test in Guangzhou. This is the first engineering application of such system;
- ▶ In July, 2013, the Wide Area Protection and control System of 110kV power grid in Licheng achieved functions such as protection optimization and fast load-balanced control.



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- Engineering Condition
 - Demonstration Project Participants
 - Practical Difficulties

DEMONSTRATION PROJECT

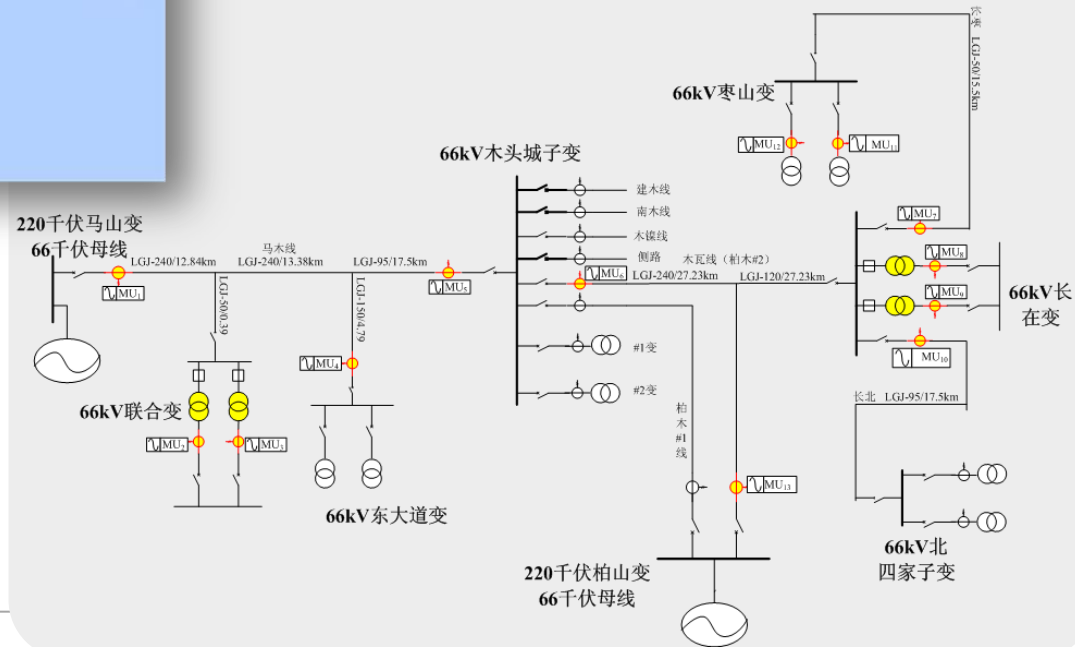
Engineering Condition



- Located in Chaoyang, Liaoning province,
- About 560 miles away From the meeting room

Cover 66kV distribution network and the crucial 10kV outgoing lines:

- 66kV Substation × 6
- 66kV Transformers × 12
- 66kV Lines × 18
- 10kV Lines × 20



Cooperation



RECRUITMENT
PROGRAM OF GLOBAL EXPERTS

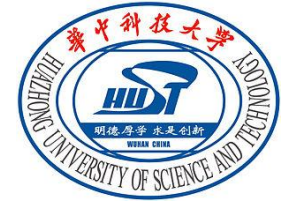


国家电网
STATE GRID

辽宁省电力有限公司
LIAONING ELECTRIC POWER COMPANY

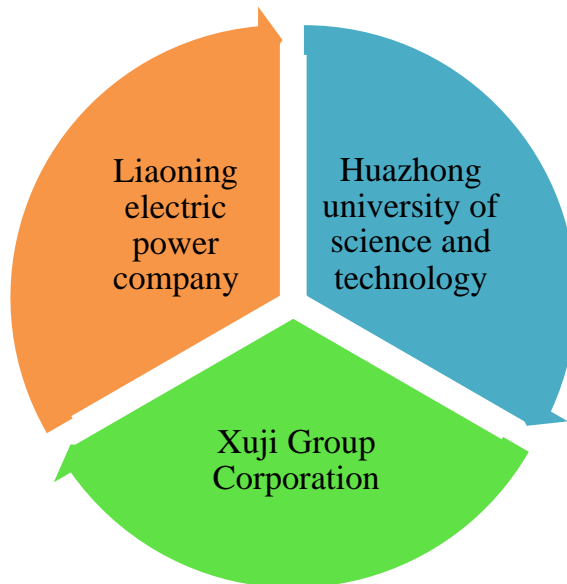


许继集团有限公司
XJ GROUP CORPORATION



➤ A project of The Recruitment Program of Global Experts, funded by State Grid Corporation of China

➤ Cooperation with:



➤ Funds: over 20 million yuans

➤ Time: 2015.6-2016.12



• Practical Difficulties

Previous communication resources:

- After years of development, the electric power communication of Chaoyang district network has covered all the 66 kV substations, formed a complete network coverage, but because of the plan's omission, there are still some weak links.
- Due to the existing cable resources have been used by SDH network, OTN network, PTN network and information network, thus there are only 2 optical fibers can be applied to network construction in the project.

Difficulties and solutions:

- Bandwidth limited
 - Strategy to adjust the protection configuration
- Time setting error between substations
 - time setting tolerance algorithm & multi-source criteria.



thank
you!

Thank you for listening