
STEC泰科
EPON Solutions to Electric Power Distribution Automation Systems in Smart Grid

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"Smart grid", also called "Grid 2.0", generally refers to a class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers -- mostly seen in big improvements in energy efficiency on the electricity grid and in the energy users' homes and offices.

Situation of the Grid Communication System

The traditional grid communication system has greatly hindered the development of electric power distribution automation systems, because many techniques (such as GPRS/CDMA, 230MHz wireless broadcasting stations, power private optical fibers, PSTN and PLC) in the traditional grid communication system expose obvious disadvantages in functions. For instance, the single point failure is likely to occur in the transmission link, which impairs the capacity of service protection. The communication medium and service interfaces are hard to manage and maintain, as they are so complicated. With the narrow transmission bandwidth, the key date transmission cannot be guaranteed and the integrated service is difficult to expand. Besides, the internal information security in the electric power sector may be under threat, as GPRS/CDMA is supported by the operator network platform.

By contrast, Electric Power Distribution Automation not only improves all the deficiencies in traditional grid communication system, but is more efficient. Therefore, upgrading the grid communication system is on the top of the top priority in constructing a modern Smart Grid.

Electric Power Distribution Automation is consisted of several systems such as

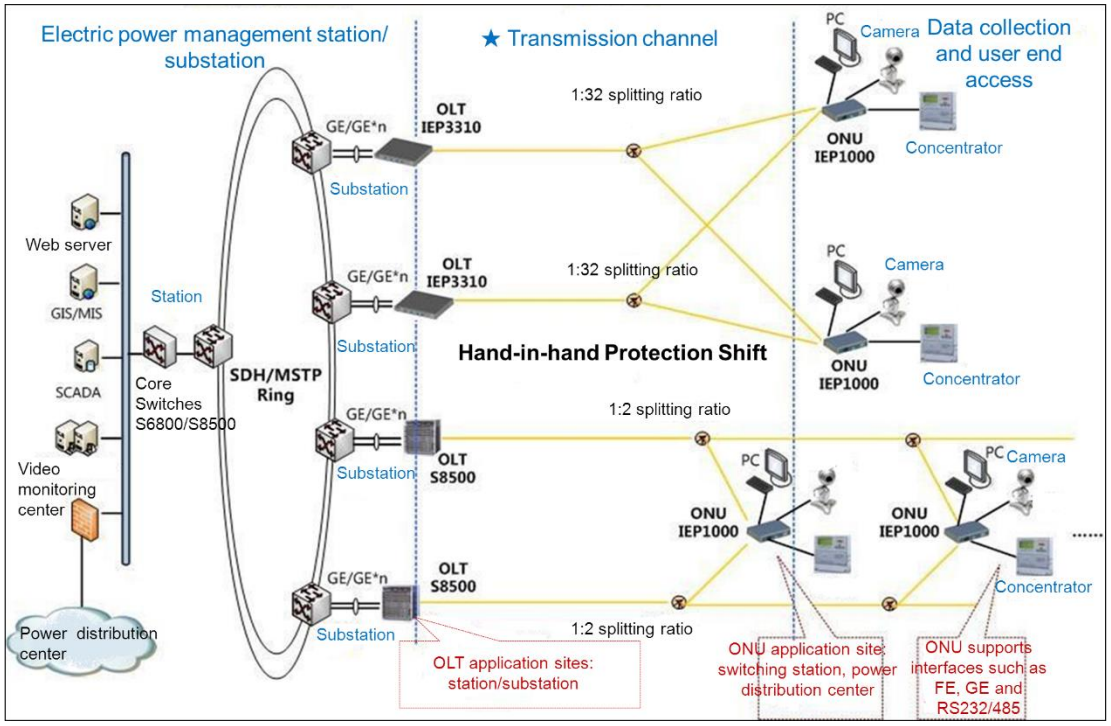
Supervisory Control and Data Acquisition (SCADA), Substation Automation (SA) and Distribution Automation (DA).

Networking Solution

Instead of traditional GPRS/CDMA or 230MHz networking solution, the EPON networking solution has become the best choice of electric power communication platform. As a pioneer in this field, STEC introduces its own EPON solutions. These solutions involve three parts: Power management substation (such as, 110KV substation), transmission channel and data collection and user-end access.

Here presents four BDOM EPON solutions of Electric Power Distribution Automation Systems in detail: Solution to Electric Power Distribution Automation Systems (1), Solution to Electric Power Distribution Automation Systems (2), Solution to the User Information Collection System, and Solution to Digital Transformer Station.

Solution to Electric Power Distribution Automation Systems (1)

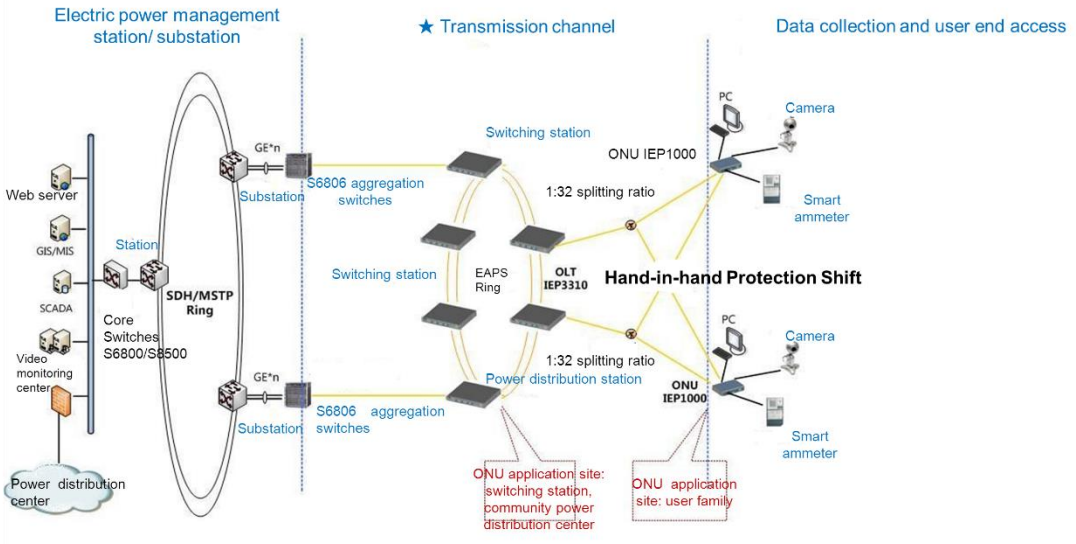


Similar to traditional EPON networking, the EPON system in this solution is also consisted of three parts: OLT, ONU and ODN. The OLTs and ONUs adopted in this solution are laid out respectively between the 110KV substations and the 10KV switching stations. Each OLT of the substation are connected to several ONUs through fibers and passive optical splitters. Each ONU with dual PON interfaces is connected to two OLTs through fibers. Thus, a topology characterized by Hand-in-hand Protection Shift is established.

Each S8500/P3310 OLT and each substation IP/ATM switch is connected by a single gigabit Ethernet link or multiple gigabit Ethernet links. S8500 OLTs and P3310 rack-mounted OLTs can satisfy the need of substations of different scales.

The user network interfaces of ONUs connect to RTUs, TTUs, Networking monitoring ends and PCs. STEC ONUs support multiple interfaces such as FE, GE, RS232/485, among which RS232/485 interfaces can be flexibly set.

Solution to Electric Power Distribution Automation Systems (2)



The OLTs and ONUs adopted in this solution are laid out respectively between the 10KV switching stations and the user side. The substations and the 10KV switching stations (Ring Main Units) are connected through two fibers. The 10KV switching stations constitute a ring network by two fibers, which realize self-healing with EAPS technology. Each OLT of the switching station is connected to ONUs in the user side by fibers and passive optical splitters. Each ONU with dual PON interfaces is connected to two OLTs in the 10KV switching stations through fibers. Thus, a topology characterized by Hand-in-hand Protection Shift is established.

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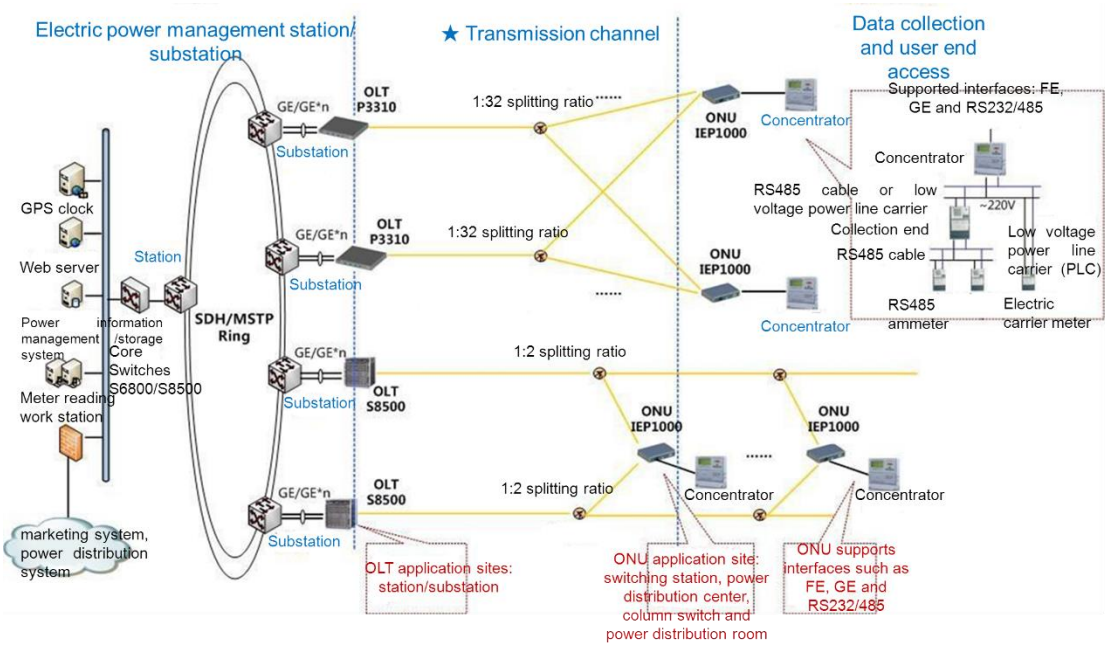
Solution to the User Information Collection System



The OLTs and ONUs adopted in this solution are laid out respectively between the 110KV substations and the 10KV switching stations. Each OLT of the substation are connected to several ONUs through fibers and passive optical splitters. Each ONU with dual PON interfaces is connected to two OLTs through fibers. Thus, a topology characterized by Hand-in-hand Protection Shift is established.

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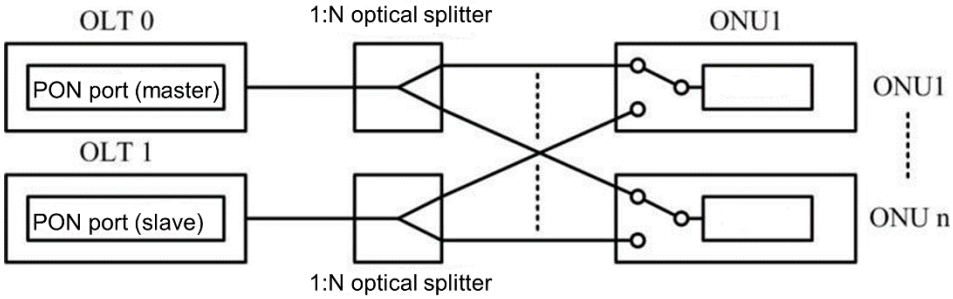
The user network interfaces of ONUs connect to RTUs, TTUs, Networking monitoring ends and PCs. STEC ONUs support multiple interfaces such as FE, GE, RS232/485, among which RS232/485 interfaces can be flexibly set.

The data acquisition system in power distribution automation is mainly in charge of:

- Data acquisition (the acquired data include the electric energy data, the AC analog value, the work state data, the electric energy over-threshold statistics data, the event record data, etc.);
- Data management (including data reasonability checkup and data calculating/analyzing/storing);
- Control functions (including control of the rated power, rated electric energy, rated fee ratio, remoteness, electric fee hand-in aid);
- Comprehensive applications (automatic meter's data acquisition control, prepaid fee control, orderly power consumption control, power usage statistics analysis, abnormal power usage analysis, electric energy quality statistics, line-loss and value-added services);
- Operation and maintenance management (system’s time checkup, permission and password control, terminal control, file control, communication and routing control, working status control, maintenance and trouble record, report form control);
- System interface (connecting the marketing system, the schedule system and other systems).

Solution Characteristics

Powerful and flexible network construction mode: Its topology adopts the hand-in-hand safety rotation mechanism, secure and reliable. The link between station and electric power distribution terminal has the “1+1” protection function and a protective shift of less than 50ms, so the electric power distribution network can run reliably. Moreover, other topologies, such as tree, hand-in-hand link and ring, can be applied according to different actual network structures.



The hand-in-hand protection switching mechanism mainly adopts the above-mentioned model: OLTO and OLTI can either be two independent OLT devices or two PON boards of the modularized OLT devices. The active PON interface and the passive PON interface are in working state, the service information is synchronously backed up, and during the protection switching process the passive PON interface remains the service features of ONU. Both OLT and ONU have the link-state detecting mechanism, so protection switching can be realized through the auto or forced mode and automatic recovery can be conducted after the protection switching fault is removed.

PON transmission network: The optical fiber is used as the transmission media and there is no source in the whole transmission, so it runs stably and reliably. The bidirectional high-bandwidth services can be realized on a single fiber with a downlink/uplink rate of 1.25Gbps.

QoS guarantees for multi-services: The QoS mechanism, based on ITU-T Y.1291, is supported, including priority labeling, queue schedule, flow shaping, congestion limit and

cache management. Different users and services have different delays, jitters, guaranteed bandwidths and maximum bandwidths, and the DBA mechanism is supported so that the uplink bandwidth of each ONU can be distributed and limited.

Advanced system architecture: The whole series of products is based on the modularized design, supports multiple access modes and various bandwidths, guarantees smooth network expansion and upgrade; its modularized structure of the power supply can provide various power supply modes according to clients' requirements, such as DC12V/DC24/DC-48/AC220V power supply.

Various Ethernet functions: Multiple technologies are supported, such as VLAN isolation, port protection, MAC binding, IP binding, port limit, queue and flow control, so the combination of multiple services can be developed without technical bottleneck and upgraded smoothly.

Unified and versatile network management system: The network management system is service oriented and it provides the unified network transmission and networking protocol, address management, domain management, security management, user access management and so on. It has rich OAM functions such as configuration, alarm, performance monitoring, trouble isolation and security management. At the same time, it supports the CLI/GUI management, which is easy to use.

Industrial-level design suitable to the electric power industry: ONU has two PON uplinks and provides interfaces for services like GEPON, FE and RS232/485.It is suitable to different harsh environments for they can run in the temperature from -40℃ to 85℃, prevent thunderbolt and powerful electromagnetic interference and comply with the requirements of IEC61850 electromagnetic compatibility.

Solution to Digital Transformer Station

1) Overview

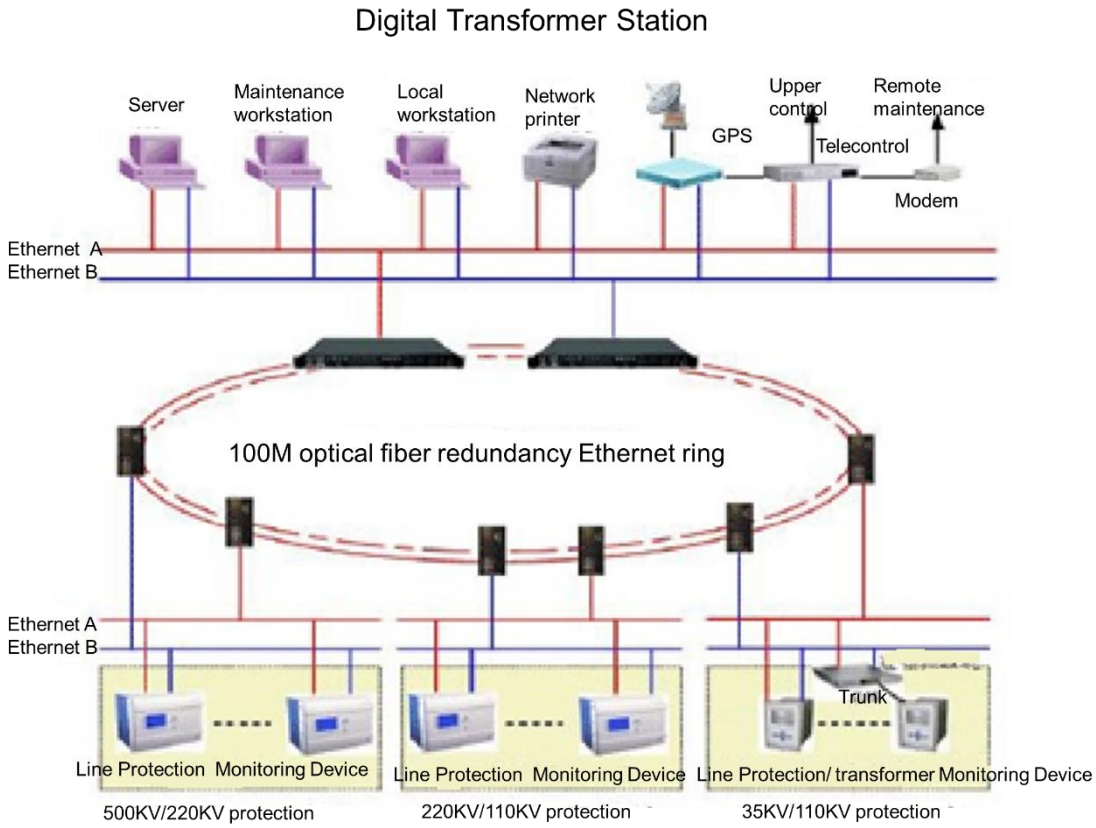
The digital automatic transformer system is a 35kV to 500kV comprehensive system involving protection, control, monitoring, measurement and other automatic functions, which can be divided into three layers: the isolation layer, the communication layer and the

transformer layer.

As to the communication layer, its adopting the standard communication regulations makes sure of its interconnection with devices of different manufacturers, while it's adopting dual industrial Ethernets as its communication mode guarantees its high reliability.

2) Network Requirements

The digital automatic transformer system, since it adopts the dual industrial Ethernets as its communication mode, can provide two independent communication networks for all installations. Both networks can be used for communication so that communication is more reliable. Of cause, you can also apply one network for communication and the other one for recording fault wave. Communication devices have to meet harsh industrial environment such as high temperature, strong electromagnetic interference and heavy humidity, and at the same time they have to comply with requirements of IEC61850-3.



3) Product Application

TOM1000, TCC4100 and TNM4000 of MRD can be widely applied to the digital automatic transformer systems of 110Kv, 220kV and 500kV.

Collecting Information about Electricity

1) Overview

The intelligent grid, consisting of the super-high-tension power system and all levels of power system and integrating technologies of advanced communication, information and control, characterizes information, automation and interaction. The typical hardware logic structures of the SCADA power distribution system mainly include the computer nodes, communication devices and other assistant devices.

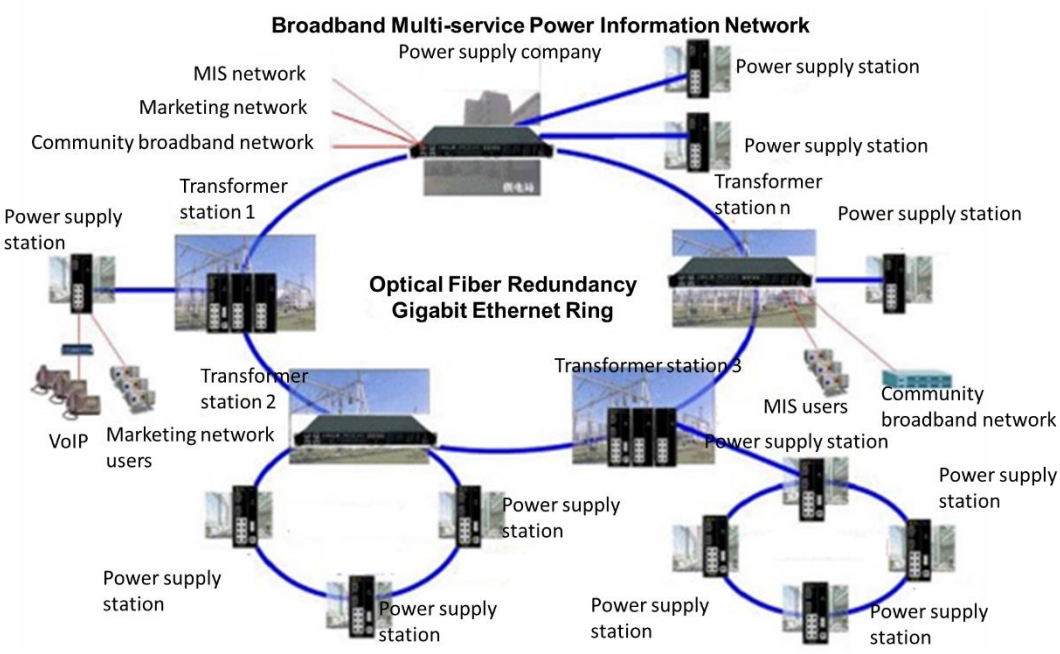
In order to enhance the efficiency and reliability of power distribution, service and information interaction, grids of all places are under construction with focus on power's generation, transmission, transformation, distribution, utilization and schedule, among which automatic power distribution and power-consuming information collection are first undertaken and the industrial Ethernet technology is used to back up the information-based, automatic and interactive intelligent grid.

2) Network Requirements

Automatic power distribution has the following communication requirements:

- High reliability and auto healing at the occurrence of faults
- Flexible internetworking and strong expansibility
- Bidirectional communication
- Real time and high security
- Adopting industrial chips and special interface protection measures (e.g. thunder prevention, electromagnetic interference prevention, static release, and redundant power source)
- The attributes of automatic power distribution are shown below:
- Lots of nodes
- Scattered communication nodes

- Small volume of communication data on each node
- Short communication distance (within several kilometers)
- Harsh environment (mostly outdoors and having strong electromagnetic interference)



3) Product Application

TOM1000 and TCC4100 of MRD can be widely applied at the section of automatic power distribution of the intelligent grid where the real power system and the information platform, strong and reliable and smooth, are framed, the whole production procedure is served, all information about real-time production and operation is collected, analyzed, diagnosed and optimized, complete and delicate diagrams of the power distribution state are provided for grid running and managerial personnel and corrective assistant strategies, solutions and precautions are given, all above guaranteeing more correct, prompt and delicate operation and management of power distribution. The investment of optical-fiber cable or optical network takes a big proportion in the construction of the fiber industrial Ethernet, so the adjustment and upgrade of the optical fiber cable and the optical network

is a thing involving many aspects, long construction term, complexity and long-term and stable operation after being established successfully. The follow-up technical and bandwidth upgrade is better carried out at the device layer. The following figure shows the network topology of electricity-consuming information collection in a city: