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Innovative Application of IP Microwave in Broadband GPON (PON) Network

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Abstract: ***Municipal renovation is frequent, often resulting in the main trunk of broadband communities being excavated. The construction site is complex, the repair time is long, and there are often repeated failures. If the site conditions do not meet the requirements for emergency access, some failures can be interrupted for up to a week. Broadband users in the community are offline for a long time, leading to upgrade complaints and poor customer perception. This project adopts the technical principles of PON/GPON protocol, Ethernet protocol, wireless microwave protocol, and data signal interaction technology to achieve temporary communication of broadband community backbone. The communication scenario is not affected by on-site construction, and the deployment is simple and convenient, which is conducive to shortening the fault time and improving user perception.***

Keywords: IP microwave; PON/GPON; Solar cell; Signal interaction.

1. TECHNICAL BACKGROUND

With the requirements of urban supporting renovation and civilized city standards, municipal renovation in various residential areas is frequent [1]. The backbone of broadband residential areas is often excavated, the construction site is complex, the repair time is long, and there are often repeated failures. If the on-site conditions do not meet the requirements for emergency access, some failures can be interrupted for up to a week [2]. Broadband users in residential areas are offline for a long time, causing upgrade complaints and poor customer perception. Passive repair often increases maintenance costs significantly [3].

2. APPLICATION PLAN

2.1 Existing technical shortcomings

One is that the fault surface is large, the construction site is complex, and temporary emergency services often result in being destroyed again. Secondly, in order to seize business opportunities, temporary communication, repair, or multiple repairs and cutovers may be carried out, resulting in high maintenance costs and labor costs; Personnel need to be arranged to provide on-site supervision at all times, requiring a significant investment of manpower and time. Thirdly, the business interruption time is relatively long and the interruption frequency is high, resulting in multiple complaints from users and poor user perception. The fourth issue is temporary communication services, with poor construction techniques and poor perception of network quality [4].

2.2 Technical Features

This project belongs to the field of technological innovation, aimed at solving the problem of traditional IP microwave being unable to be used in PON optical network environment. Therefore, in the scenario of broadband cell backbone fiber optic cable interruption, traditional wireless transmission methods cannot replace broadband cell backbone fiber optic cables [5]. This is because PON (GPON) passive optical network transmission mode is single fiber bidirectional optical signal, while IP wireless microwave wired access is bidirectional optical signal [6]. Therefore, the interconnection between the two needs to be solved through a new way. This technology converts PON/Ethernet signals through PON system, carries IP microwave Ethernet signals, and achieves line communication between broadband cell PON users and OLT, which can temporarily solve the problem of network access for users in the faulty cell [7]. After the physical line is fully connected, the original line can be restored. The Ethernet data sent by broadband community customers is converted into Ethernet/PON signals through PON devices and sent to PON aggregation devices [8]. As the business interruption part of the line carries PON signals, when adding IP microwave devices, it is necessary to convert PON signals into Ethernet signals before borrowing IP microwave carriers. Therefore, a PON (such as Huawei 5680t) device needs to be configured on the user side, connected through the GPON board of the PON device, and then connected to the IP microwave through the

upstream GE port of the PON device. The Ethernet signal of the IP microwave is connected to the ETHB board of the business interaction PON device to achieve signal conversion and business communication. This plan consists of three parts: first, the user side PON signal conversion equipment, second, the IP microwave equipment, and third, the Ethernet to PON signal access board. For example, the Huawei 5680t device used in this testing plan is powered by AC and equipped with a 220V small solar panel for power supply; The IP microwave equipment uses RTN 900 split type IP microwave, which is powered by a 220V small solar panel; The Ethernet to PON signal access board is a Huawei ETHB access board [9].

2.3 Relevant technical principles

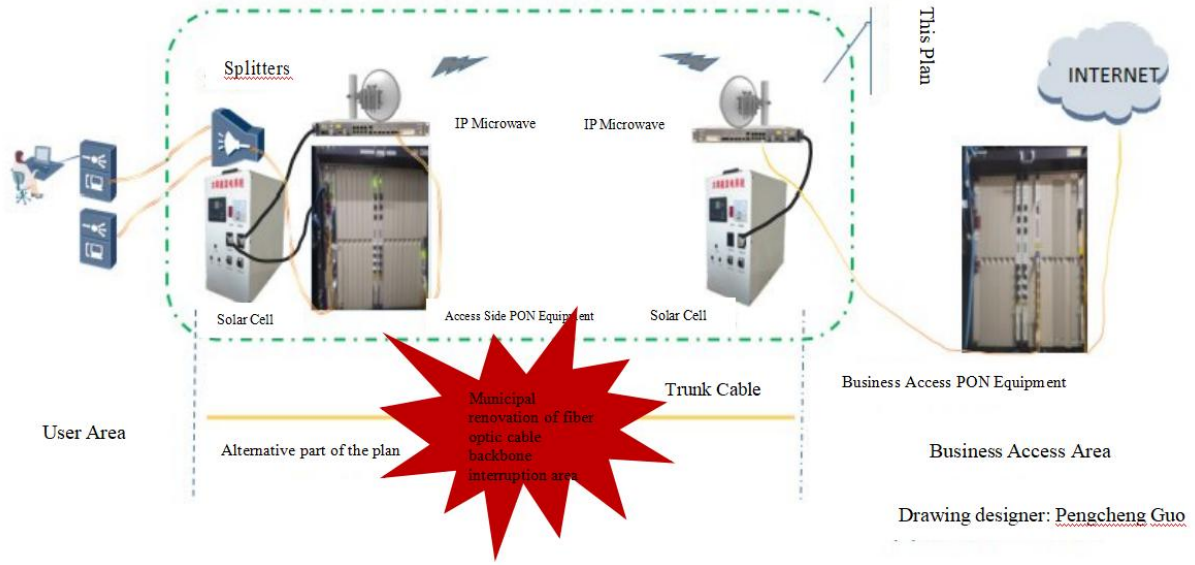
PON (Passive Optical Network) is a passive optical network with a point to multipoint (P2MP) architecture. The mainstream PON technologies currently include GPON, EPON (Ethernet Passive Optical Network), and BPON (Broadband Passive Optical Network) [10]. GPON technology is currently the most widely used mainstream optical access technology for passive optical networks. Its network uses a single optical fiber to connect OLT equipment, splitters, and ONTs (Optical Network Terminals) in series, and the upstream and downstream data carriers are implemented using different wavelengths. The upper wavelength ranges from 1290nm to 1330nm, while the lower wavelength ranges from 1480nm to 1500nm. The GPON system is based on the principle of wavelength division multiplexing, which transmits data on the same optical network through different wavelengths in the uplink and downlink. The downlink sends data through broadcasting, while the uplink uploads data based on time slots using TDMA (Time Division Multiple Access) [11]. Because the downlink data of GPON system is sent through broadcasting, some illegally accessed ONTs can also receive downlink data from other ONTs, which poses a security risk. Therefore, the GPON system solves this security issue through line encryption technology [12]. The GPON system uses AES-128 encryption algorithm to encrypt plaintext transmitted data messages, and the data is transmitted in ciphertext to ensure transmission security. In addition, the encryption algorithm used in the GPON system does not add additional overhead, so it has little impact on bandwidth efficiency. Similarly, enabling and using encryption functions in GPON systems will not increase transmission latency. Ethernet Passive Optical Network EPON technology. Using a single optical fiber with different wavelengths to transmit bidirectional 1.25Gbps digital signals, the uplink wavelength is 1310nm and the downlink wavelength is 1490nm. The technical characteristics of EPON, like GPON, are long-distance, high bandwidth, flexible networking, and passive network nodes. The encapsulation technology used by BPON, ATM encapsulation, was initially used to carry ATM services. As ATM technology gradually exited the historical stage, BPON technology was rarely used again.

IP microwave technology is compatible with traditional TDM services such as PDH and SDH, and fully supports access, processing, and air interface frame structure for IP packet based services [13]. The IP microwave intermediate frequency system includes TDM cross matrix and IP packet switching unit, with interface modes including E1, STM-1/4, ATM, FE, GE and other business interfaces. It supports both TDM and Ethernet business processing, as well as MPLS transmission management. IP microwave provides a comprehensive end-to-end QoS guarantee mechanism in service assurance to meet the demand for refined service quality assurance in broadband services [14]. IP microwave technology, commonly used frequency bands are 6-42 GHz, 3.5-112 MHz channel spacing, and ultra-high modulation mode up to 4096QAM. Most IP microwave products can provide multiple business interfaces (E1/SDH/FE/GE/2.5GE/10GE), and a single carrier can support a maximum air interface throughput of 2.5 Gbps. In terms of encryption technology, AES-256 encryption and anti-theft features are generally used to ensure high security. Adopting unique four layer Ethernet frame header compression technology to provide high throughput for IP services [15].

Solar power generation generally refers to a form of energy that can directly convert light energy into electrical energy using semiconductors. The most common form of solar cells is crystalline silicon, which originated in 1839 when Becquerel (France) was the first scientist to discover the photovoltaic phenomenon of liquid electrolytes. Crystalline silicon solar cells are mainly made of silicon semiconductor materials as the substrate to form large-area planar PN junctions. Phosphorus atoms are diffused on a P-type silicon wafer with a specification of about 15 square centimeters through a diffusion furnace to form a thin layer of heavily doped N-type layer, which is then etched to reach PECVD [16]. Then, a layer of anti reflection film and a skull anti reflection film are plated on the entire surface of the N-type layer to reduce the reflection loss of sunlight. Metal gate lines are printed on the diffusion surface as the front contact electrode of the solar cell [17]. Plating a metal film on the etched surface to serve as the back ohmic contact electrode for solar cells, followed by sintering and packaging [18].

When photons of a certain energy are irradiated onto a solar cell, many new electron hole pairs are generated. Due to the continuous absorption of battery materials, the incident light intensity decreases continuously. Along the incident direction, the density of electron hole pairs inside the battery cell will gradually decrease. Under the effect of concentration difference, electron hole pairs will diffuse towards the inside of the battery cell. When the diffusion of electron hole pairs reaches the PN junction boundary, they will be split under the action of the built-in electric field, and the holes and electrons will be forced towards the P and N regions. If the circuit is in an open circuit state at this time, these photo generated electrons and holes will gather around the P and N regions, respectively. Therefore, the P region will receive additional positive charges, and the N region will also receive additional negative charges. Therefore, the accumulated positive and negative charges in the P and N regions will generate a photo generated electromotive force on the PN junction (it should be noted that in reality, solar cells cannot achieve contact between P-type and N-type cells to form a PN junction because it is impossible to achieve molecular level splicing. Therefore, in the actual production process, it is often difficult to achieve this). On the basis of P-type silicon, N-type is produced by single-sided diffusion, If the positive and negative poles of the solar cell are connected at this time, a current will be generated. At this point, a photo generated current is formed inside the PN junction, pointing from the N region to the P region.

2.4 Design drawings



3. CONCLUSION

This technical solution is used to solve the data transmission problem between single fiber bidirectional optical signals and dual fiber bidirectional optical signals. By using IP microwave wireless method to achieve transmission line communication, the impact of physical space construction is solved, and there will be no multiple repair situations, greatly reducing maintenance costs and labor costs. The business interruption time is shorter, the interruption frequency is less, and there will be no multiple complaints from users. User perception is improved, and only a small number of personnel need to be arranged for on-site supervision during work implementation. If the equipment is placed in a temporary computer room, there is no need for personnel supervision, and personnel can be reused. In terms of promoting the plan, due to its simple deployment and low technical requirements for personnel, it has been well promoted and used in local maintenance. This scheme has a simple structure, easy operation, and easy deployment, which can save a lot of construction costs. The equipment can be reused, and it has high efficiency value.

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