Special Report

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Using a combination of Long-Term Evolution technologies and Network Element series industrial routers, Huawei has designed a next-generation urban rail Distributed Control System solution that incorporates current trends and future requirements. >>

Urban Rail Solution Speeds Up Industry Changes

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"Railway operators around the world are now more concerned than ever about how to take advantage of innovative Information and Communications Technology (ICT) solutions to maximize their transport capacities and build differentiated competitive advantages based on existing railway networks and infrastructure," said Huawei's Norman Frisch, chairman of the enterprise Long-Term Evolution (eLTE) Industry Alliance, at the 2016 Asia Pacific Rail Show in Hong Kong.

One current trend — urban rail transit — is growing into an ideal mode of transportation due to its ability to transport larger numbers of passengers at faster speeds, improving punctuality and safety, and creating less environmental pollution. Simultaneously, these advantages are being influenced by disruptive communication technologies.

Ground Control

The IEEE 1474-derived Communication-Based Train Control (CBTC) railway signaling system, first developed in the 1990s, uses Automatic Train Control (ATC) functions that can include Automatic Train Operation (ATO) and Automatic Train Supervision (ATS) sub-systems. By leveraging modern wireless communications technologies, CBTC solutions have implemented moving block signaling systems that update calculated stopping distances in real time to enforce the separation between trains. Maintaining safe stopping distances between trains is a component of CBTC systems that control speed, regulate station stop duration, and monitor running times and distance-to-go data between stations. CBTC systems are essential to the safety and smooth operations of contemporary high-speed railroads.

The Data Communications System (DCS) subsystem is a bidirectional link for data exchange between CBTC modules that are both on-train and off. The DCS consists of a train-to-ground wireless communication network and a wired network. Faults within the network will delay or stop the trains from running as scheduled. Huawei CBTC systems have been developed to address a number of longstanding limits.

Challenges for Traditional DCS Systems

Recent DCS solutions have chosen to use 'Wi-Fi + industrial switch' architecture for CBTC train-to-ground communications over public frequency bands that are vulnerable to external interference. In addition to the potential for affecting safe train operations, the disadvantages of using Wi-Fi for CBTC networks include limited coverage, which multiplies the number of deployed devices and numbers of handovers to stationary base stations from passing trains. Wi-Fi networks are more maintenance intensive.

Switches based on traditional Layer 2 technology — stable, easy to maintain, and adaptable within a range of environments — have been the ideal option for DCS wired transmission networks. However, these switches can no longer accommodate the newer requirements of urban rail signaling systems.

The integration of LTE technology into the rail sector requires that the LTE frequency and phase components are synchronized with the system clock of the railway. A Global Positioning System (GPS) antenna is installed at every Base Transceiver Station (BTS) to provide the source for a synchronized time reference. Even when sufficient channels exist, the physical siting of GPS antennas to support BTS pedestals located deep inside rail tunnels is complex, and an RF signal over long cable runs is subject to great attenuation. The problem is, some sites lack channels for GPS antennas.

LTE technology also requires wired networks that support the IEEE 1588v2 Precision Time Protocol (PTP). DCS wired networks should have powerful Layer 3 routing performance and support open, standard Layer 3 interconnection protocols. If traditional industrial switches are used, broadcast storms that render the network unable to transport normal traffic may occur during Layer 2 switching. Outdated Layer 2 network management capabilities cannot support the levels of fine-grained Ethernet management specified by the PTP.

Gaining Momentum

Based on industry experience with urban rail trends and future requirements, Huawei developed a next-generation urban rail DCS solution using LTE technologies and Huawei Network Element (NE) series industrial routers. The following specifies some of the technical improvements that this solution fulfills to meet urban rail network requirements for signaling systems to transform DCS.

LTE uses dedicated frequency bands that offer excellent anti-interference capabilities and ensure the security and reliability of CBTC services. LTE supports hitless, fast, and seamless handovers that equip today's faster metro trains with the latest enhancements.

Fewer LTE base stations are required between stations because of an effective range up to 1.2 kilometers. The combination of a flattened network and fewer BTS sites inside tunnels reduces Operations and Maintenance (O&M) costs by more than 80 percent.

Huawei's innovative ATOM GPS solution transfers GPS clock signals into 1588v2 optical signals. GPS antennas and devices in equipment rooms are connected by optical fibers, so the deployment of GPS antennas is not restricted by distance. From an engineering perspective, this simplifies deployment.

Game-changing Industrial Routers

The DCS wired transmission network relies on Huawei's NE series industrial routers for comprehensive support of the IEEE 1588v2 protocol. The network simultaneously traces multiple clock sources. When an active clock source is faulty, the network immediately synchronizes with a standby clock source. These industrial routers support standard Layer 2 networking, ensuring 50 ms failover and compatibility with traditional networking modes and Internet Protocol/Multiprotocol Label Switching (IP/MPLS) data-carrying technology. This enables strong Layer 3 switching and routing functions that meet the requirements of all routing policies for diverse interconnection telecommunications networks.

MPLS Virtual Private Networks (VPNs) provide the most secure and reliable multiple-service isolation technology in the industry. The MPLS Operations, Administration, and Maintenance (OAM) enables multiple protection switchover technologies. Network switchover time is not affected by the number of nodes.

Huawei's unique, hardware-based Bidirectional Forwarding Detection (BFD) technology transmits packets to check for faults at a minimum interval of 3.3 ms, increasing fault detection accuracy. The IP Flow Performance Measurement (IPFPM) technology greatly improves the accuracy of network performance detection.

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Network performance indicators such as throughput, delay, jitter, and packet loss ratio can be tested without the need for meters and instruments. The uTraffic tool monitors network-wide performance, accurately locates network problems, and produces multi-dimensional reports that reduce O&M workloads and facilitate quicker fault location.

Cutting to the Chase

Huawei's next-generation urban rail DCS solution offers cutting-edge LTE wireless networks and all-IP wired networks. The solution satisfies even the strictest requirements generated by the ever-increasing speeds of moving trains, improves the anti-interference capabilities of communications networks, and simplifies maintenance.

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