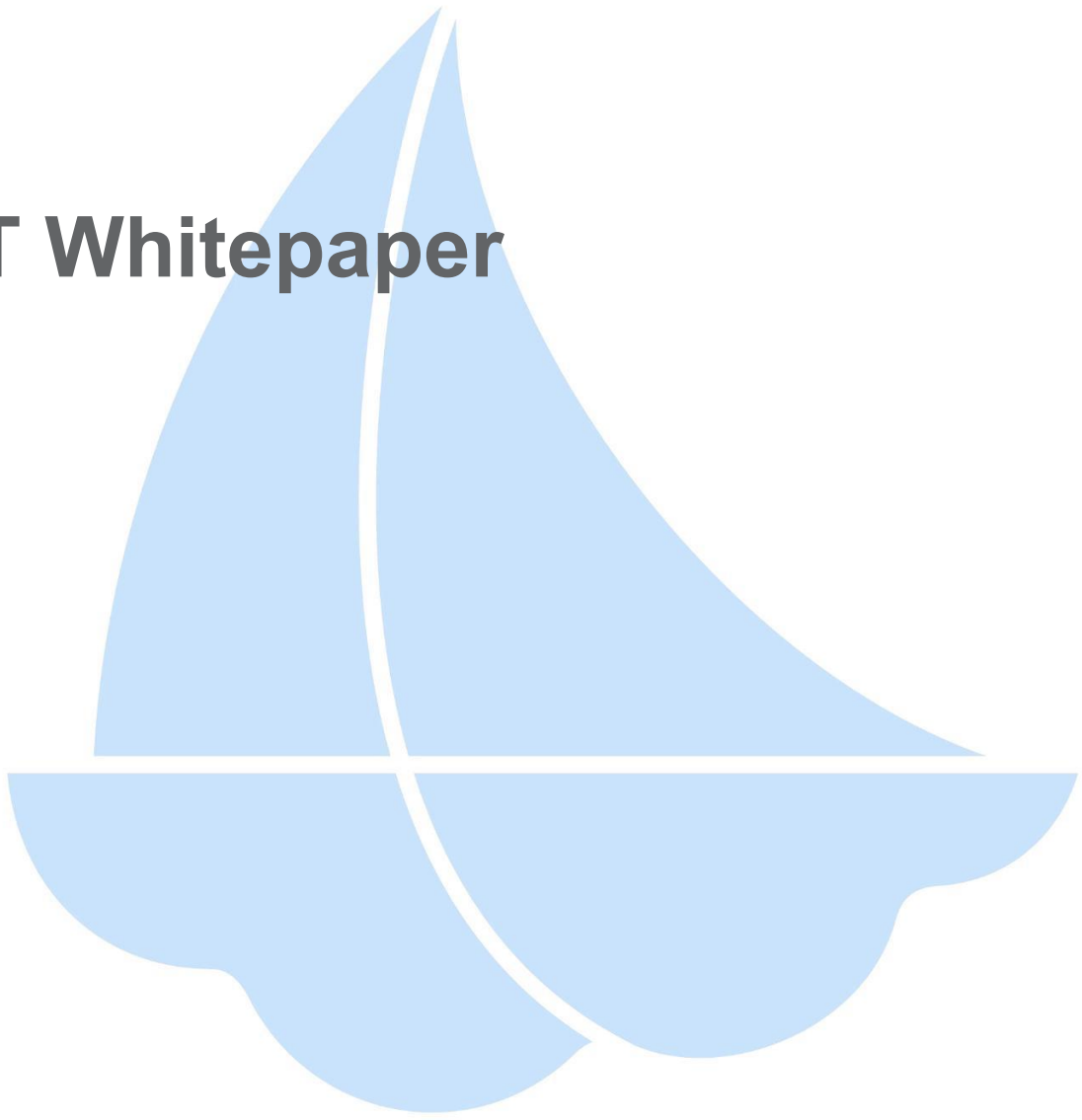
LightWAN

LTT Whitepaper



Beijing Qingwang Technology Co., Ltd.

Contents

Light TCP Tunnel (LTT) is a tunneling protocol technology. Qingwang Technology (“LightWAN Technology”) has integrated this tunneling technology into the self-operated SD-WAN network service platform, LightWAN, which covers the entire globe. The tunnel serves as an SD-WAN overlay, carrying office application traffic for enterprise customers.

1 Why LightWAN Technology Develop LTT Tunneling?

Most SD-WAN products in the industry typically use conventional tunneling technologies such as IPSec, SSL, GRE or VxLAN as the SD-WAN overlay tunneling, while LightWAN Technology have chosen to develop LTT tunneling for the following reasons.

1.1 Gain Excellent Network Transmission Efficiency

In general, the higher the efficiency of network data transmission, the better the response efficiency and user experience of upper-layer applications. However, conventional tunneling technologies, like IPSec, often encounter issues related to low transmission efficiency and instability, particularly in remote or cross-border transmission scenarios, resulting in a subpar user experience. To provide enterprise customers with the best possible transmission quality in various complex network environments, LightWAN Technology has forsaken traditional tunneling technologies and adopted LTT tunneling technology. This innovative approach combines WAN optimization with multi-sending and selective receiving optimization technology, resulting in ultimate transmission efficiency.

1.2 Achieve the Real Global Network Coverage

To establish a global SD-WAN backbone, it's essential to strike a balance between available link resources, link quality, and bandwidth costs. In general, developed regions offer a wealth of high-quality dedicated link resources at lower bandwidth costs. In contrast, developing areas face scarcity when it comes to available link resources, and even fewer high-quality dedicated links to choose from. Pursuing high-quality dedicated line connections involves substantial investments in terms of bandwidth costs. These investments will ultimately impact the pricing that enterprise customers must bear when utilizing SD-WAN services. In some extremely underdeveloped areas, there might be a complete absence of high-quality dedicated lines, posing a challenge in delivering high-quality SD-WAN backbone access services to enterprise customers.

The LTT tunnel, with its exceptional transmission capabilities, serves as the cornerstone of LightWAN Technology's solution to these challenges. In regions lacking high-quality dedicated link resources or plagued by prohibitively expensive connections, the LTT tunnel's remarkable transmission capabilities empower

LightWAN Technology to construct a backbone network using moderately-priced and lower-cost dedicated or Internet links, all while still meeting the quality demands of enterprise applications. In certain usage scenarios where wired link access is unavailable, LightWAN Technology can even deliver backbone network access services that meet basic usage requirements by utilizing resources such as 4G/5G mobile networks and satellite links.

With the transmission capabilities of LTT, LightWAN Technology makes networks a truly global reach.

1.3 Ensure Data Transmission Security

Enterprise customers typically access SD-WAN backbone network services through their existing internet links at office sites via encrypted tunneling technology, based on comprehensive considerations such as cost, efficiency, and flexibility. If the enterprise office site uses traditional IPSec tunneling technology to access the SD-WAN backbone network, the traffic within an IPSec tunnel needs to be decrypted when it reaches the PoP node on the SD-WAN backbone network. This is necessary so that the user traffic, which arrives at the PoP and is encapsulated inside the tunnel, can be routed and matched for the next hop. Once the next hop path is determined, the user traffic will enter the next tunnel. When user traffic needs to pass through multiple PoP nodes to reach its destination, this "decrypting-encrypting" process occurs multiple times.[1]This "decrypting-encrypting" process greatly increases the risk of enterprise critical business data being leaked or tampered with when using SD-WAN backbone network services.

To eliminate this risk and ensure the security of enterprise data during transmission, LightWAN Technology has implemented "end-to-end encryption" technology in its proprietary LTT tunnel. Enterprise user traffic in the LTT tunnel is encrypted by the LightWAN CPE deployed in the enterprise office network, and does not require decryption at any LightWAN PoP node along the path until it reaches the LightWAN CPE deployed in the destination enterprise office network.

1.4 Switch Path Seamlessly Without Interrupting the Application

When enterprise customer traffic flows through the SD-WAN backbone network, there may be situations where a PoP node on the path experiences high loads or abnormal faults, potentially causing interruptions in user traffic. To ensure the normal operation of enterprise office business, the SD-WAN's smart path switching function generally redirects enterprise traffic to other available PoP nodes. However, during the extremely brief path switching process, SD-WAN

[1]Note: In some provider solutions, if a dedicated line is used for interconnection between two backbone PoP nodes, user traffic will directly move in plain text via the dedicated line to the next PoP node.

solutions based on traditional IPSec tunneling technology often cause momentary interruptions in the current traffic. These interruptions can lead to disruptions in user business activities, such as video conferencing, and can impact the user experience.

Recognizing this issue with traditional tunneling technology, LightWAN Technology has implemented seamless path switching in LTT tunneling, ensuring that user traffic does not interrupt and business is not affected during the transmission path switching process, delivering a smooth network experience for users.

1.5 Adapt to Both High-End and Low-End Equipment

LightWAN offers versatile usage options for users in enterprise offices. Users can access LightWAN network by deploying LightWAN CPEs at office sites or conveniently connect the network through software clients installed on smart terminals, such as computers, mobile phones, and tablets, for mobile users. In the enterprise cloud scenario, LightWAN enables users to access its services by deploying virtualized CPE (vCPE) in the cloud.

Additionally, LightWAN's system design extends its support beyond enterprise office scenarios to include industrial Internet and industrial IoT (IIoT) scenarios. In these industrial contexts, traditional CPE, vCPE, and software clients are often impractical, and LightWAN services must be deployed through embedded software.

These different scenarios demand that LightWAN possesses highly adaptable and flexible deployment capabilities on the terminal side. In contrast, conventional technologies like IPSec can present challenges in adapting to diverse practical scenarios due to their high operating system requirements. LTT tunneling technology, from the design stage, thoroughly considers adaptability to various terminal environments, especially those with limited resources, and can be flexibly deployed in a wide range of practical scenarios.

2 LTT Transmission Optimization

LTT primarily ensures its network transmission capabilities through protocol optimization and multi-sending and receiving technology.

2.1 Protocol Optimization

LTT incorporates WAN optimization technology, which is a learning-based TCP acceleration technology. It employs a dynamic algorithm that adapts to network path characteristics through continuous real-time observation and analysis of each TCP connection. This dynamic algorithm allows for more accurate congestion level determination, quicker detection of packet loss, and more efficient congestion handling and packet loss recovery. Unlike static algorithms, which cannot adjust to changing network conditions, the dynamic learning-based algorithm ensures consistent acceleration effectiveness in various network environments, addressing frequent changes in network latency and packet loss characteristics.

LightWAN Technology integrates WAN optimization technology into the LTT tunneling, enabling the LTT tunnel to efficiently transmit data in diverse global network environments. This ensures the timely delivery of enterprise application data and enhances the efficiency and user experience of global business operations.

2.2 Multi-Sending and Selective Receiving

Building on top of WAN optimization technology, LightWAN Technology has developed the multi-sending and receiving transmission optimization technology, bringing LTT's support for enterprise application traffic transmission to the utmost level.

The multi-sending and receiving technology replicates a network packet into identical copies at the sending end and simultaneously sends them through dual LTT paths. The CPE at receiving end deems the transmission successful upon receiving any one of these duplicate network packets. The redundant packets arriving later are discarded by the receiving end, which verifies their duplicity by comparing their serial numbers to previously received packets.

The multi-sending and receiving technology enhances the transmission reliability of critical enterprise applications, preventing interruptions caused by failures in a network segment or the entire transmission path. Since this technology duplicates and transmits the same network packet, it consumes additional network bandwidth. Therefore, it is typically enabled for critical applications to guarantee its transmission.

3 LTT Transmission Security

The LTT tunnel ensures the security of enterprise application data transmission through end-to-end encryption technology.

Typically, when optimizing transmission paths using the SD-WAN backbone network, solutions based on traditional IPSec and other tunneling technologies can only employ 'segmented encryption' for encrypting enterprise application data during transmission. 'Segmented encryption' necessitates the decryption and encryption of enterprise application data at each PoP node along the pathway, which introduces the risk of data leakage or tampering.

Unlike 'segmented encryption,' LightWAN Technology's LTT tunneling employs 'end-to-end encryption' to secure enterprise application data during transmission. In this mode, data is encrypted at the CPE in the sending office site and remains encrypted until it reaches the CPE in the receiving office site, with no decryption occurring at any PoP node along the pathway.

To achieve 'end-to-end encryption,' the LTT tunnel employs a dual-layer encapsulation tunnel design. The outer layer encapsulation is responsible for establishing the Overlay path, utilizing label switching for forwarding network packets between PoP nodes along the route. The inner layer encapsulation focuses on 'end-to-end' data encryption. When packets traverse a PoP node, only the outer layer encapsulation's header is examined. Once the next hop PoP node is identified, the destination IP field within the outer layer encapsulation's packet header is modified to reflect the IP address of the next hop before the packet is forwarded. To ensure the utmost security for enterprise application data transmission via LTT, PoP nodes refrain from any interaction with the inner layer encapsulation. This is primarily due to the fact that the cryptographic key is established through negotiation between the CPEs at both ends, rendering PoP nodes incapable of decrypting the inner layer's encryption.

4 LTT Seamless Path Switching

Our goal is to provide enterprises with the highest quality SD-WAN backbone network transmission. In certain situations, such as when a PoP node along the path is overloaded, faulty, or when the current path no longer meets SLA requirements, real-time backbone network path switching may become necessary.[2]

LTT has implemented seamless path switching to ensure uninterrupted enterprise application performance. This function is designed to make enterprise applications resilient to path switching, delivering a seamless and uninterrupted user experience.

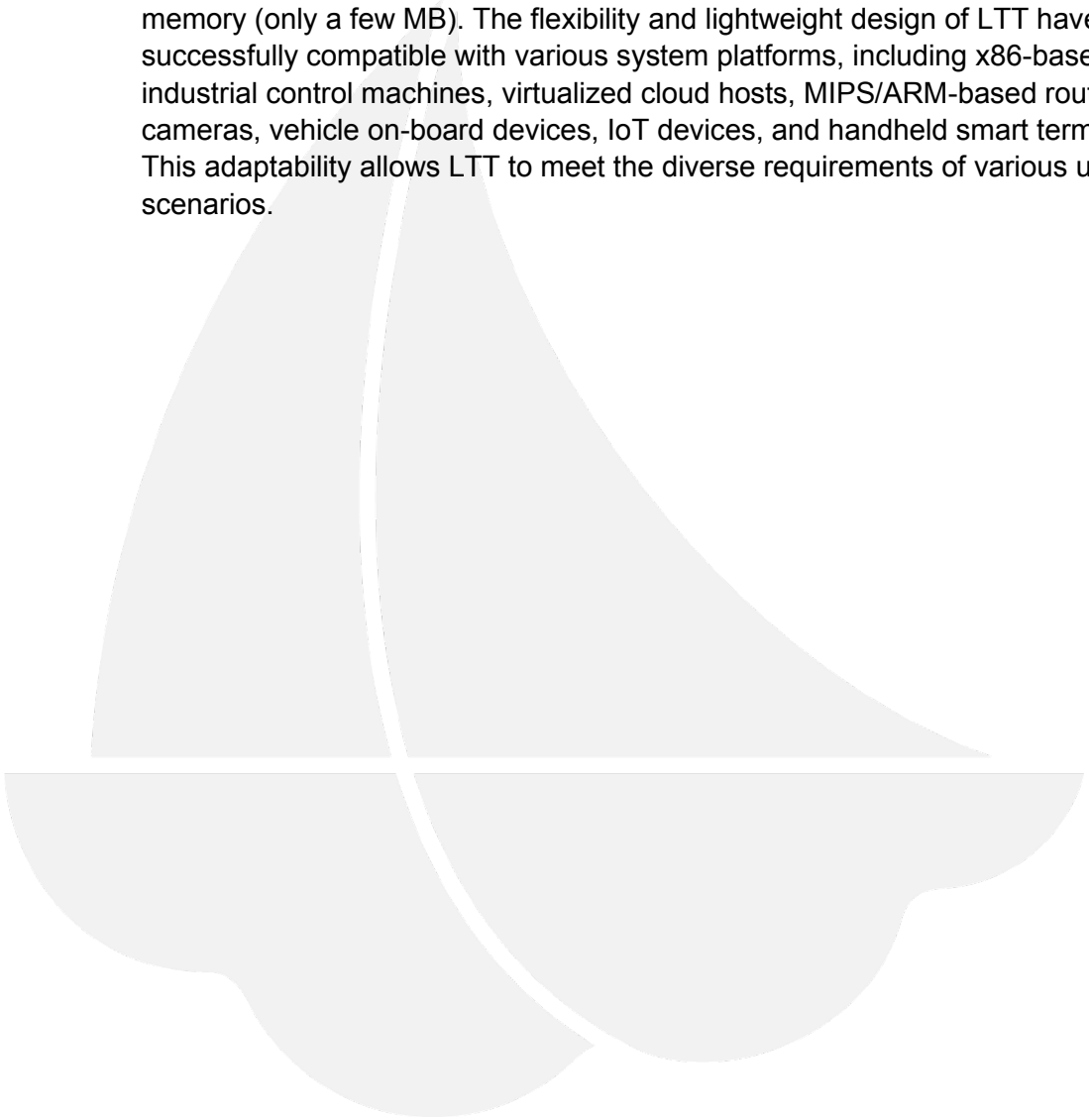
Seamless path switching is made possible through the dual-layer tunnel encapsulation of LTT. In practical terms, the outer layer of LTT's tunnel is composed of segmented tunnels along the hop-by-hop path. The inner layer of the LTT tunnel is established as an 'end-to-end' tunnel, carried by the outer layer, while the traffic of enterprise applications flows within this inner tunnel.[3] When a path switch occurs, the outer layer tunnel reconfigures itself by splicing together new segment tunnels based on the latest routing instructions to complete the switch. The inner tunnel, on the other hand, remains entirely unaffected by the path switch as long as the two endpoints remain unchanged. With the inner tunnel remaining constant, the flow of enterprise application traffic within it remains entirely unaffected by the outer path switching process. To put it in a more concrete analogy, the outer and inner tunnels, along with the data traffic of enterprise applications, can be likened to railway tracks, trains, and passengers, respectively: railway tracks switch at turnouts, while trains remain completely unaware of the turnout operation. Similarly, as long as the starting and ending stations remain unchanged, the train schedule remains consistent, and passengers inside the carriages are oblivious to changes in the railway tracks.

[2] LightWAN Orchestrator typically automates real-time path switching based on real-time network monitoring results.

[3] 'End-to-end' refers to the tunnel extending from one CPE to another.

5 LTT Portability

LTT is a highly adaptable and lightweight solution designed to function on a wide range of hardware platforms. It can run on high-end industrial control machine hardware with multi-core, high-frequency processors, ample memory (hundreds of GB), and support for up to 40 Gbps traffic throughput per device. Furthermore, it can be installed on IoT terminals with low-frequency processors and limited memory (only a few MB). The flexibility and lightweight design of LTT have made it successfully compatible with various system platforms, including x86-based industrial control machines, virtualized cloud hosts, MIPS/ARM-based routers or cameras, vehicle on-board devices, IoT devices, and handheld smart terminals. This adaptability allows LTT to meet the diverse requirements of various usage scenarios.



Beijing Qingwang Technology Co., Ltd.

Address: Room 101 (No. 1) Floor 6, Building 24 (Block C),
68 Beiqing Road,
Haidian District,
Beijing, China.

Website: https://www.lightwan.com

Email: marketing@lightwan.com

Tel: 010-60605942

LightWAN