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Lab 2 – 5G Technologies

I. Ethernet Transport Services in 5G (6.24)

A. Precise Synchronization Mechanisms for Ethernet Transport in 5G

First, it is necessary to understand the 3GPP context. Precise synchronization is essential for supporting Ethernet services, especially in scenarios requiring coordinated communication. There are several synchronization protocols like IEEE 1588v2 Precision Time Protocol (PTP) and Synchronous Ethernet (SyncE). IEEE 1588v2 enables precise synchronization by distributing accurate timing information over packet-switched Ethernet networks. SyncE complements this by synchronizing physical layer frequency across network nodes. These two enhance overall timing accuracy and reliability.

B. Local Breakout and Edge Computing for Efficient Ethernet Frame Routing

Part of the 5G Standard: “Ethernet transport services must efficiently handle frame transportation from user equipment (UE) directly to an Ethernet network within data networks (DN)”. By routing data directly to local networks rather than traversing a centralized data center, local breakout reduces latency and bandwidth consumption significantly, thus enhancing network efficiency and user experience. Multi-access Edge Computing (MEC) further improves this local processing capability. MEC infrastructure moves computational resources closer to the network edge, allowing data to be processed near its origin. This lowers latency, improves response times, and boosts system efficiency. This is important for latency-sensitive applications like autonomous driving, healthcare, and real-time remote control operations. By integrating local breakout and MEC, 5G networks optimize Ethernet frame routing. This improves the capability to handle real-time data streams and maintain high-performance standards across the network.

C. Ultra-Low Latency and QoS for Non-IP Ethernet Frames in 5G LANs

Part of the 5G Standard: “The 5G network shall be able to provide the required Quality of Service (QoS) (e.g., reliability, latency, and bandwidth) for non-IP packet (e.g., Ethernet frame) for private communication between UEs within a 5G LAN-type service”. For non-IP Ethernet frame transport, 5G networks use Time-Sensitive Networking (TSN). TSN ensures deterministic communication capabilities, this guarantees minimal latency and meets industrial and network demands. Combined with enhanced QoS policies, TSN helps 5G networks deliver Ethernet frames reliably and with little latency. This allows 5G networks to achieve the ultra-low latency required for private communication between UEs in LAN-type configurations.

II. 5G LAN-Type Service (6.26)

A. 5G LAN-Type Services Over Wide-Area Mobile Networks

Part of the 5G Standard: “The 5G system shall support 5G LAN-type service over a wide area mobile network.” and “The 5G LAN-VN shall support member UEs that are subscribed to different PLMNs”. 5G LAN-type services enable LAN, which is like a VPN, communication over wide-area mobile networks. This allows organizations to connect multiple far locations easily, providing reliable and secure connectivity across far regions, even internationally. By supporting UEs subscribed to different Public Land Mobile Networks (PLMNs), 5G

LAN-Virtual Networks (LAN-VNs) improve Ethernet services. This allows enterprises to have better network operations across different countries. 5G LAN-type services significantly improve traditional LAN capabilities, opening more possibilities for global enterprises.

B. Seamless Handover in 5G LAN-Type Networks

Part of the 5G Standard: “The 5G network shall support service continuity for 5G LAN-type service…” and “The 5G system shall support use of unlicensed as well as licensed spectrum”. Seamless service delivery is important in modern mobile environments. 3GPP clearly outlines the importance for uninterrupted LAN-type service continuity. Leveraging mobility management components, such as the Access and Mobility Management Function (AMF) and Session Management Function (SMF), 5G networks provide seamless handovers, preserving ongoing sessions as UEs move within the network coverage. 5G incorporates spectrum flexibility by using both licensed and unlicensed frequency bands, improving service and reliability during movement. Using MEC improves this, providing local data caching and computation capabilities that further minimize handover delays and service disruptions. This allows 5G LAN-type services to offer mobile devices a stable and uninterrupted network experience.

C. On-Demand, Secure 5G LAN-VNs

Part of the 5G Standard: “A 5G system shall support 5G LAN-VNs with member UEs numbering between a few to tens of thousands.” and “The 5G system shall support on-demand establishment of UE to UE, multicast, and broadcast private communication…” and “The 5G system shall enable the same service regardless of public base stations, small cells, or relay UEs”. 5G LAN-VNs support networks from a few to thousands of UEs, providing on demand communication capabilities such as UE-to-UE, multicast, and broadcast communications. These services are accessible by public base stations, small cells, and relay UEs. This approach simplifies network management, enhances security with strict access controls and isolation, and delivers reliable services. 5G LAN-VNs provide efficient and adaptable network architectures.

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