Assignment Five: 5G New Radio and 5G Core

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1. **(a) Concept of 5G Network Slicing**

5G network slicing is a technique that allows the 5G network to create multiple virtual networks (or "slices") on the same physical infrastructure. Each slice can be tailored to meet specific requirements, enabling different services or applications to operate optimally on the same network. Unlike LTE, where a device could connect to only one network slice at a time, 5G enables a device to connect to up to 8 different core network slices simultaneously. This flexibility allows different types of traffic to be handled more efficiently, optimizing resources based on the unique needs of each service. For example, high-speed broadband, IoT applications, and low-latency services can all have separate slices with tailored network functions to ensure their quality of service. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 459-460)

1. **(b) Benefits for High-Speed Internet Access**

The main benefit of network slicing for high-speed internet access is the ability to allocate resources more efficiently. By dedicating a specific slice to high-speed data, users can experience consistent, high-quality service with reduced latency and increased bandwidth. Additionally, since the network can adapt dynamically, high-speed data services are less likely to experience congestion, resulting in a smoother and faster internet experience. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 459-460)

1. **Basic Concept of the 5G Non-Standalone (NSA) Architecture**

The 5G NSA architecture allows 5G networks to operate alongside existing 4G infrastructure. It relies on the 4G core network for control functions while using 5G base stations to handle the increased data capacity. This approach enables a quicker and more cost-effective rollout of 5G services by leveraging existing 4G infrastructure. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 432-433)

1. **Dynamic Spectrum Sharing (DSS) for Spectrum Refarming**

Dynamic Spectrum Sharing (DSS) enables LTE and 5G NR to share the same spectrum simultaneously, allowing network operators to transition from 4G to 5G without disrupting existing services. By dynamically allocating portions of the spectrum based on demand, DSS facilitates spectrum refarming, enabling the introduction of 5G in bands currently used by LTE. This efficient sharing optimizes spectrum utilization, allowing a gradual shift to 5G while maintaining service continuity. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 410-411)

1. **Concept of the Service-Oriented Architecture for the 5G Core Network**

The 5G core network adopts a service-oriented architecture, where each network function operates as a separate, modular service. This makes the network more flexible, scalable, and easier to adapt or upgrade, as different services can be deployed or modified independently without affecting the entire system. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 383-385)

1. **Differences Between TDD and FDD 5G Air Interface**

* *TDD (Time Division Duplexing):* Uses the same frequency band and same carrier for both uplink and downlink, switching between the two in different time slots. (From GSM to LTE-Advanced Pro and 5G, 2021, p. 399)
* *FDD (Frequency Division Duplexing):* Uses separate frequency bands for uplink and downlink simultaneously. TDD is more common in 5G due to its ability to handle asymmetrical data traffic more efficiently, while FDD is preferred for consistent uplink and downlink requirements. (From GSM to LTE-Advanced Pro and 5G, 2021, p. 399)

1. **What is a Bandwidth Part (BWP)?**

A Bandwidth Part (BWP) is a feature introduced in 5G NR (New Radio) to manage the carrier bandwidth more efficiently. Unlike LTE, which uses a fixed bandwidth of up to 20 MHz, 5G NR can support much wider bandwidths. BWP allows devices to operate on a smaller, more manageable portion of the available spectrum, rather than the entire bandwidth, which reduces power consumption and complexity. This flexibility is particularly useful for devices that don't require the full bandwidth, enabling energy-efficient communication while still supporting high-speed internet when needed. Each 5G device can be assigned multiple BWPs, but typically, only one BWP is active at any given time to optimize resource usage. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 401-403)

1. **What is a CORESET?**

A CORESET (Control Region Set) is a defined set of frequency and time resources within the 5G NR (New Radio) air interface used for carrying control information such as scheduling messages. Unlike LTE, where control channels span the entire bandwidth, in 5G NR, the CORESET is embedded within specific areas of the Bandwidth Part (BWP) to optimize resource utilization. It contains the Physical Downlink Control Channel (PDCCH), which manages how data is sent across the network. This flexibility allows CORESET to adapt to different bandwidth requirements, ensuring efficient handling of control signaling in 5G communication. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 403-405)

1. **What is a Split-Bearer?**

A split-bearer refers to the simultaneous transmission of data over both LTE (4G) and 5G NR networks in a 5G Non-Standalone (NSA) architecture. This approach allows user data to be split between the LTE eNodeB (eNB) and the 5G gNodeB (gNB), enhancing bandwidth and data speeds. It's essential for scenarios where high data rates are needed, as LTE alone might not be sufficient. There are different options (Option 3, 3X, and 3A) for how the data is split and transferred, with the most common being Option 3X, where both LTE and 5G work together to manage and transmit the data stream efficiently. This setup helps provide faster and more reliable data services as 5G coverage continues to expand. (From GSM to LTE-Advanced Pro and 5G, 2021, p. 388)

1. **Difference Between Registration and Session Management**

The difference between Registration and Session Management lies in their roles within the 5G network. Registration manages the process where user equipment identifies itself to the network, becoming recognized and authenticated, allowing access to network services. Meanwhile, Session Management deals with establishing, maintaining, and terminating data sessions that enable the transfer of user data between the user equipment and the network. While registration sets up the initial connection, session management handles the ongoing data communication during the device's network activity. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 385-386)

1. **Difference Between the RRC-Idle and RRC-Inactive State**

* *RRC-Idle:* The device is not actively connected but remains registered with the network, allowing it to quickly re-establish communication when needed. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 454-455)
* *RRC-Inactive*: The device retains some connection information and can transition to active mode faster than from the idle state, reducing latency while saving power. The RRC-Inactive state is more efficient for devices that frequently transmit data but with intermittent gaps. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 454-455)

1. **Purpose of the Container in the 5G Core**

The purpose of the container in the 5G core is to enable a "cloud-native" implementation, allowing for more efficient software development and deployment. Containers offer flexibility, as they separate software from underlying hardware and provide an ideal execution environment. They ensure consistency across different development stages and enable the orchestration of microservices, making it easier to manage complex networks like the 5G core. Additionally, using containers allows for easy scaling, rapid updates, and better resource utilization, making the 5G core more efficient and adaptable to changing network requirements. (From GSM to LTE-Advanced Pro and 5G, 2021, p. 453)

1. **Why Are Two UE Transmitters Required for a 5G Option 3 Split-Bearer Connection?**

In a 5G Option 3 split-bearer connection, two UE transmitters are required because data is transferred over both the LTE and NR (New Radio) air interfaces simultaneously. This allows for the aggregation of bandwidth from both 4G and 5G, significantly improving data rates. However, this setup also means that the UE has to manage separate uplink transmissions for LTE and NR, each with its own scheduling and power requirements. Having two transmitters enables the UE to handle both interfaces effectively, but it can be power-intensive and requires careful coordination to avoid interference, especially when operating at the cell edge or under challenging signal conditions. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 417-418)

1. **Why Can the 4G and 5G Parts of a 5G NSA Bearer Be Handed Over Independently?**

The 4G and 5G parts of an NSA bearer can be handed over independently because they operate on separate network infrastructures. This independence allows each part to switch connections based on network conditions or coverage, ensuring a more flexible and reliable user experience. (From GSM to LTE-Advanced Pro and 5G, 2021, pp. 446-450)

# References

From GSM to LTE-Advanced Pro and 5G. (2021). In M. Sauter, *And Introduction to Mobile Networks and Mobile Broadband* (pp. 15 - 100). Hoboken, New Jersey: John Wiley and Sons Ltd.