* **1. Introduction to Mobile Networks Architecture / 移动网络架构简介**
* **English:** This section introduces the evolution of mobile networks from 2G to 5G, highlighting key components and architectures in each generation.
* **中文：** 本章节介绍了从2G到5G移动网络的发展历程，强调了每一代技术中的关键组件和架构。
* **2. GSM-EDGE Radio Access Network (GERAN) Architecture / GSM-EDGE无线接入网架构**
* **English:** GERAN is the 2G radio access network, consisting of Mobile Station (MS), Base Station Subsystem (BSS), and core network domains (Circuit Switch Domain and Packet Switch Domain).
  + **Base Transceiver Station (BTS):** Handles transmission and reception of radio signals.
  + **Base Station Controller (BSC):** Manages radio resources and handovers within cells.
* **中文：** GERAN是2G的无线接入网，包括移动终端（MS）、基站子系统（BSS）和核心网络域（电路交换域与分组交换域）。
  + **基站（BTS）：** 负责无线信号的发送和接收。
  + **基站控制器（BSC）：** 管理无线资源并协调小区间切换。
* **3. UMTS Terrestrial Radio Access Network (UTRAN) Architecture / UMTS地面无线接入网架构**
* **English:** UTRAN forms the backbone of 3G networks, incorporating Node B (base stations) and Radio Network Controllers (RNCs). It improves on 2G by introducing soft handovers and higher data rates.
  + **Node B:** Manages the physical layer and power control.
  + **RNC:** Coordinates multiple Node Bs and handles admission control and handovers.
* **中文：** UTRAN构成了3G网络的骨干，包含Node B（基站）和无线网络控制器（RNC）。与2G相比，UTRAN引入了软切换和更高的数据速率。
  + **Node B：** 负责物理层管理和功率控制。
  + **RNC：** 协调多个Node B，管理接入控制与切换。
* **4. Mobility Procedures in GERAN/UTRAN / GERAN和UTRAN中的移动性过程**
* **English:**
  + **Hard Handover (GSM):** The MS switches from one BTS to another when the new cell's signal quality exceeds the current cell.
  + **Soft Handover (UMTS):** Adds a new radio link before breaking the existing one, ensuring uninterrupted connection.
* **中文：**
  + **硬切换（GSM）：** 当新小区的信号质量超过当前小区时，MS从一个BTS切换到另一个。
  + **软切换（UMTS）：** 在断开现有连接之前，添加一个新的无线链路，确保连接不中断。
* **5. LTE Architecture / LTE架构**
* **English:** LTE simplifies the core network by introducing a flat architecture.
  + **Key Innovations:**
    - Removal of RNC (Radio Network Controller).
    - Integration of eNodeBs with the core network.
  + **EPC (Evolved Packet Core):** Handles both LTE and other 3GPP/non-3GPP networks.
* **中文：** LTE通过引入扁平化架构简化了核心网络。
  + **主要创新：**
    - 移除了无线网络控制器（RNC）。
    - 将eNodeB（基站）与核心网络集成。
  + **演进分组核心网（EPC）：** 同时处理LTE和其他3GPP/非3GPP网络。
* **6. Femto Cells and Small Cells / Femto Cells与小型基站**
* **English:** Small, low-cost base stations designed for indoor environments.
  + **Benefits:** Enhanced indoor coverage, better quality of service, reduced macro network load.
  + **Challenges:** Managing interference and ensuring low-cost deployment.
* **中文：** 针对室内环境设计的小型低成本基站。
  + **优势：** 提升室内覆盖，改善服务质量，减少宏网络负载。
  + **挑战：** 干扰管理和低成本部署。
* **7. 5G and Virtualization / 5G与虚拟化**
* **English:** 5G leverages virtualization for enhanced flexibility and scalability.
  + **Key Features:** Ultra-low latency, high throughput, and integration with cloud infrastructure.
  + **Challenges:** Frequency allocation, infrastructure interoperability, and cost efficiency.
* **中文：** 5G利用虚拟化实现更高的灵活性和可扩展性。
  + **主要特点：** 超低延迟、高吞吐量，与云基础设施的集成。
  + **挑战：** 频谱分配、基础设施互操作性和成本效益。
* **8. Comparison and Transition Highlights / 对比与过渡亮点**
* **English:**
  + **From GERAN to UTRAN:** Increased complexity with Node B and RNC integration.
  + **From UTRAN to LTE:** Introduction of flat architecture and enhanced data handling.
  + **Towards 5G:** Promise of massive IoT support and enhanced mobile broadband.
* **中文：**
  + **从GERAN到UTRAN：** 节点复杂性增加，Node B和RNC更紧密集成。
  + **从UTRAN到LTE：** 引入扁平化架构，提升数据处理能力。
  + **迈向5G：** 支持大规模物联网并增强移动宽带能力。

1. **1. Telco Cloud and its Components / 电信云及其组件**

* **English:** Telco Cloud is a private cloud managed by telecom operators to host network and mobile infrastructure. Key components include:
  + **Compute:** Virtualized workloads on Linux servers.
  + **Networking:** Software-controlled, enabling dynamic resource allocation.
  + **Network Functions:** Such as firewalls, DNS, caching, and monitoring.
* **中文：** 电信云是由电信运营商管理的私有云，用于承载网络和移动基础设施。主要组件包括：
  + **计算：** 基于Linux服务器的虚拟化工作负载。
  + **网络：** 软件控制，支持动态资源分配。
  + **网络功能：** 包括防火墙、DNS、缓存和监控。

1. **2. Software Defined Networking (SDN) / 软件定义网络**

* **English:** SDN separates the control plane from the data plane:
  + **Controller:** Centralized management using protocols like OpenFlow.
  + **Switches/Routers:** Execute forwarding rules from the controller.
  + Enables hardware independence, improves network performance, and reduces costs.
* **中文：** SDN将控制平面与数据平面分离：
  + **控制器：** 使用OpenFlow等协议进行集中管理。
  + **交换机/路由器：** 执行控制器下发的转发规则。
  + 实现硬件独立性，提高网络性能并降低成本。

1. **3. IP Multimedia Subsystem (IMS) / IP多媒体子系统**

* **English:** IMS integrates IP and telecom services:
  + **Goals:** Converge various access networks into a unified core, offer multimedia services (e.g., VoLTE, VoWiFi).
  + **Standardization Bodies:** 3GPP, IETF, OMA, TISPAN.
* **中文：** IMS整合了IP和电信服务：
  + **目标：** 将不同接入网络整合到统一核心网，提供多媒体服务（如VoLTE、VoWiFi）。
  + **标准化机构：** 3GPP、IETF、OMA、TISPAN。

1. **4. IMS Architecture / IMS架构**

* **English:**
  + **Core Components:**
    - **P-CSCF:** Proxy for SIP messages, compresses/decompresses signaling.
    - **I-CSCF:** Directs SIP messages within the network.
    - **S-CSCF:** Core server for session management, authentication, and routing.
    - **HSS:** Stores user identities, preferences, and authentication data.
  + **Application Servers (AS):** Deliver services like SIP-based presence, push-to-talk.
* **中文：**
  + **核心组件：**
    - **P-CSCF：** 代理SIP消息，负责信令的压缩和解压。
    - **I-CSCF：** 网络内部SIP消息的转发。
    - **S-CSCF：** 会话管理核心服务器，负责认证和路由。
    - **HSS：** 存储用户身份、偏好和认证数据。
  + **应用服务器（AS）：** 提供基于SIP的服务，如状态展示、推对讲。

1. **5. Session Initiation Protocol (SIP) / 会话初始协议**

* **English:**
  + **Purpose:** Initiate, modify, and terminate multimedia sessions.
  + **Key Messages:**
    - **REGISTER:** User registration.
    - **INVITE:** Initiates a call.
    - **BYE:** Terminates a session.
  + **Responses:**
    - **200 OK:** Session accepted.
    - **401 Unauthorized:** Indicates authentication failure.
* **中文：**
  + **目的：** 用于初始化、修改和终止多媒体会话。
  + **关键消息：**
    - **REGISTER：** 用户注册。
    - **INVITE：** 发起呼叫。
    - **BYE：** 结束会话。
  + **响应：**
    - **200 OK：** 会话被接受。
    - **401 Unauthorized：** 表示认证失败。

1. **6. IMS Evolution and Benefits / IMS的演进与优势**

* **English:** IMS supports seamless integration of multimedia services across access networks.
  + **Benefits:**
    - Unified billing and authentication.
    - Simplified deployment of new applications.
    - Supports IPv6 and QoS for enhanced reliability.
* **中文：** IMS支持多媒体服务在接入网络间的无缝集成。
  + **优势：**
    - 统一的计费和认证。
    - 简化新应用程序的部署。
    - 支持IPv6和QoS，提升可靠性。

1. **7. Challenges and Deployment / 挑战与部署**

* **English:**
  + **Challenges:**
    - High deployment costs (e.g., IPv6 migration).
    - Complex interconnection with legacy systems.
    - Competition from OTT players like Google and Facebook.
  + **Deployment:** Examples include Orange Spain's VoWiFi and VoLTE services.
* **中文：**
  + **挑战：**
    - 高部署成本（如IPv6迁移）。
    - 与传统系统的复杂互联。
    - 面临Google和Facebook等OTT玩家的竞争。
  + **部署：** 例如，Orange西班牙的VoWiFi和VoLTE服务。
* **1. What are the technical names for 2G, 3G, 3G+, 4G networks?**
* **2G:** GSM (Global System for Mobile Communications)
* **3G:** UMTS (Universal Mobile Telecommunications System)
* **3G+:** HSPA (High-Speed Packet Access), including HSDPA and HSUPA.
* **4G:** LTE (Long-Term Evolution)
* **2. What are the main entities in the GSM architecture?**
* **Mobile Station (MS):** User equipment, such as mobile phones.
* **Base Station Subsystem (BSS):** Includes:
  + **BTS (Base Transceiver Station):** Handles radio transmission.
  + **BSC (Base Station Controller):** Manages radio resources and handovers.
* **Network Switching Subsystem (NSS):** Includes:
  + **MSC (Mobile Switching Center):** Call control and mobility management.
  + **HLR (Home Location Register):** Stores user data and location.
  + **VLR (Visitor Location Register):** Temporary user information for roaming.
* **Authentication Center (AUC):** Manages security and encryption.
* **Equipment Identity Register (EIR):** Tracks equipment identity.
* **3. What is a handover? How does it work in 3G?**
* **Definition:** Handover is the process of transferring an ongoing call or data session from one cell to another.
* **How it works in 3G:**
  + **Soft Handover:** Adds a new radio link before breaking the old one (make-before-break).
  + **Softer Handover:** Within the same Node B but different sectors.
  + Controlled by the **RNC (Radio Network Controller)** in the 3G architecture.
* **4. What does LTE stand for? How does it simplify 3G’s core network? Is it capable of handling voice calls?**
* **LTE (Long-Term Evolution):**
  + Simplifies the core network by introducing a flat architecture (Evolved Packet Core or EPC).
  + Removes RNC, directly integrating eNodeBs with the core network.
  + Supports voice calls through **VoLTE (Voice over LTE)**, a service built on IMS (IP Multimedia Subsystem).
* **5. How is Telco Cloud different from a regular Cloud? What are the components?**
* **Differences:**
  + Telco Cloud hosts telecom-specific workloads (e.g., virtualized network functions).
  + Focuses on low-latency, high-reliability services for telecom operators.
* **Components:**
  + **Compute:** Virtualized workloads on Linux servers.
  + **Networking:** Software-defined, supporting dynamic resource allocation.
  + **Network Functions:** Firewalls, DNS, NAT, Deep Packet Inspection, etc.
* **6. What is the intelligent part of SDN? What protocols does it use?**
* **Intelligent Part:**
  + The **SDN Controller** centralizes the management, providing programmable network control.
  + Controllers use policies to manage routers and switches.
* **Protocols:**
  + **OpenFlow:** For communication between controllers and switches.
  + **NetConf:** For device configuration.
  + **FORCES:** For control and management.
* **7. What does IMS stand for? What is it used for? Who are the Standard Developing Organizations (SDOs) involved?**
* **IMS:** IP Multimedia Subsystem.
* **Purpose:** Provides multimedia services such as VoLTE, VoWiFi, and video calls across multiple networks.
* **SDOs Involved:**
  + **3GPP:** Defines IMS standards.
  + **IETF:** Develops SIP and Diameter protocols used in IMS.
  + **OMA:** Focuses on service-layer standards.
* **8. Mention 4 of the main architectural components of IMS.**
* **P-CSCF (Proxy Call Session Control Function):** Handles SIP signaling and compresses messages.
* **I-CSCF (Interrogating CSCF):** Directs SIP messages within the IMS network.
* **S-CSCF (Serving CSCF):** Core server for session management, user authentication, and service routing.
* **HSS (Home Subscriber Server):** Stores user identities and preferences.
* **9. What is the difference between SIP and RTP/RTCP protocols?**
* **SIP (Session Initiation Protocol):**
  + Manages signaling for session initiation, modification, and termination.
  + Example use: Establishing a call.
* **RTP/RTCP (Real-Time Transport Protocol/Control Protocol):**
  + Transports real-time media (e.g., voice and video).
  + Ensures synchronization and quality control for multimedia streams.
* **10. Give 3 messages from a SIP session and explain them.**
* **REGISTER:** Allows a user to register with the IMS network.
* **INVITE:** Initiates a session or call.
* **BYE:** Terminates an ongoing session.
* **11. What is the code for accepting an incoming session?**
* **200 OK:** Indicates successful acceptance of a session.
* **12. What is the code for unauthorized subscriber? Sent by whom? Based on which information?**
* **401 Unauthorized:** Sent by the IMS network to request authentication credentials.
  + Based on the subscriber's private identity and credentials stored in the HSS.
* **13. To whom is the Femtocell offer targeted?**
* **Target Audience:**
  + Residential users seeking improved indoor coverage.
  + Businesses needing enhanced service quality for employees.
* **14. How does Virtualization and software impact 5G architecture?**
* **Impact:**
  + Enables **Network Function Virtualization (NFV):** Reduces reliance on hardware, allowing dynamic deployment of network functions.
  + Supports **network slicing:** Allocates dedicated network resources for specific use cases.
  + Accelerates deployment and scalability through cloud-native designs.