- **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。

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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。

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2 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。

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3 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。

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4 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。

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5 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。

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6 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。

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7 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.