Telecommunications Assignment

# 1. Low-Power Wide-Area Network for Agricultural IoT

Comparison of FDMA, CDMA, and LoRaWAN:  
  
FDMA (Frequency Division Multiple Access) assigns a dedicated frequency band to each user, which leads to poor spectral efficiency and high power usage for bursty data. CDMA (Code Division Multiple Access) allows multiple users to share the same spectrum using unique codes, but it struggles with interference and complexity when scaled to many devices.  
LoRaWAN (Long Range Wide Area Network), in contrast, is designed for low-power, wide-area use cases. It supports thousands of devices per gateway, uses unlicensed bands, and allows devices to transmit intermittently, making it ideal for agricultural sensors.

Recommendation: LoRaWAN  
Justification:

* - Optimized for low-power, long-range communication  
  - Uses unlicensed ISM bands, lowering cost  
  - High battery life (up to 10 years)  
  - Excellent for sporadic data transmission in rural environments

# 2. Urban 4G Network with Multipath and Co-channel Interference

Proposed solution:

* - Cell Splitting and Sectoring: Reduces interference by dividing large cells into smaller ones and directing signals more precisely  
  - Massive MIMO: Enhances spectral efficiency using beamforming to focus signal strength  
  - OFDMA: Allocates subcarriers dynamically, improving multipath resilience and efficiency

Benefits:

* - Improved coverage and signal reliability in dense urban environments  
  - Higher network capacity due to frequency reuse and antenna technology  
  - Cost-effective when focused on congested areas and using existing infrastructure

# 3. Deployment of 10,000 IoT Sensors Using 5G

5G Features for IoT:

* - mMTC: Supports dense deployments with up to 1 million devices/km²  
  - URLLC: Enables low-latency, high-reliability data transmission  
  - Network Slicing: Allocates resources efficiently for different service types

Challenges and Solutions for Mobile Sensors:

* - Handover Management: Use dual connectivity and mobile edge computing (MEC)  
  - Beamforming: Maintains strong links even for fast-moving nodes

Security Risks and Mitigations:

* - Weak authentication → Use mutual authentication and ECC  
  - Firmware attacks → Implement secure OTA updates  
  - Physical tampering → Use tamper-proof hardware  
  - Data privacy → Encrypt data end-to-end