TELECOMMUNICATION AND INFORMATION ENGINEERING

GROUP 4

OOP ASSIGNMENT 2: PRODUCT ORIENTED PROJECT

1. SYSTEM DESIGN

1.1 Overall Architecture

The simulator is designed using object-oriented design that models a simplified 5G mobile network. It separates networking concerns into location modeling, network infrastructure, and user devices, simplifying extendibility and maintainability.

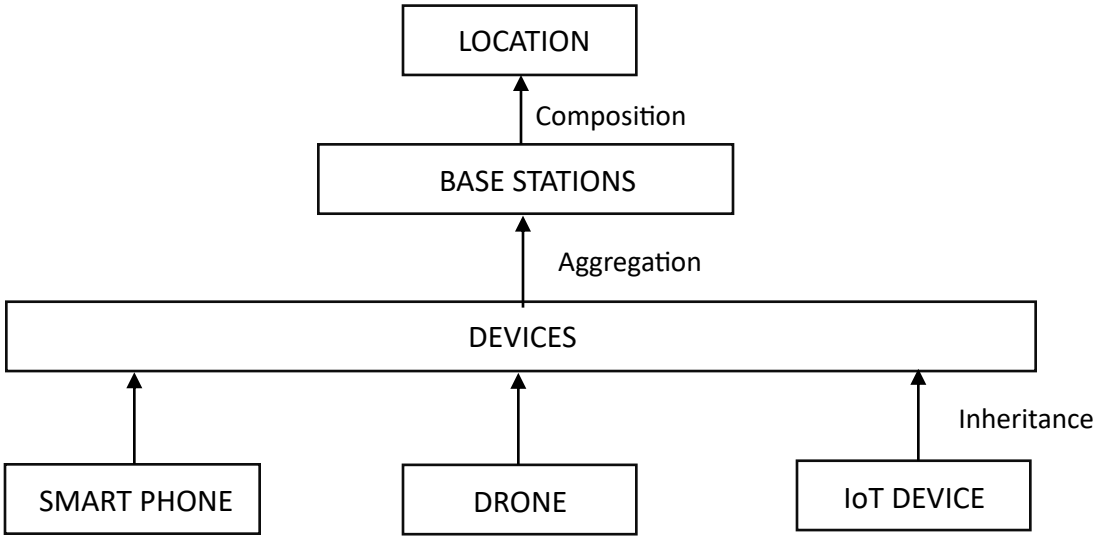
Main Design Layers

1. Spatial Layer – Handles positions and distance calculations which will be taken as Location.

2. Network Layer – Manages connectivity and signal behavior which will be taken as the base stations.

3. Device Layer – Represents mobile users and endpoints taken as device and subclasses.

CLASS FLOW DIAGRAM



1.2 Object-Oriented Design Approach

- **Abstraction**

Complex network behavior such as signal calculation, connection validation, and handover logic is hidden behind simple high-level methods such as connect(), move(), send_data() allowing users of the simulator to interact with the system without knowing internal networking details.

- **Inheritance**

A base Device class captures common properties such as Identity, Location, Battery level and Network connection. Specialized devices (SmartPhone, IoTDevice and Drone) inherit this behavior and only override what is different, promoting code reuse and consistency.

- **Encapsulation**

Critical internal data such as battery level, device ID and signal strength is not accessed directly but instead exposed in a controlled manner through the string of code:

_get_encapsulated_attrs()

This protects internal state and enforces safe interaction.

- **Polymorphism**

Different device types transmit data differently using a common interface “send_data()”. Internally, each device executes its own “_perform_send()” method, allowing, High-speed calls on a SmartPhone, Low-power telemetry in the IoTDevice and High-bandwidth video in the Drone

2. PRODUCT FEATURES

2.1 Multi-Device Support

The simulator supports different categories of devices:

Smartphones - voice and data traffic

IoT devices - sensor-based, low power

Drones - high-mobility, high-bandwidth

Where each device behaves differently while using the same network infrastructure.

2.2 Distance-Based Coverage Model

Signal availability depends on the physical distance between a device and a base station. Devices outside the coverage radius cannot connect. Signal strength degrades linearly with distance simulating realistic radio propagation behavior.

2.3 Load-Aware Signal Strength

Signal strength is also affected by number of connected devices and base station capacity.

As load increases, signal quality reduces, mimicking network congestion.

2.4 Automatic Mobility & Handover

Devices can move dynamically in the 2D space implemented by the “move()” and specified by device.move(x, y). If the signal is lost the device automatically disconnects and attempts reconnection to another available base station.

2.5 Capacity & Overload Handling

Each base station has a fixed capacity of connections beyond which are rejected and clear error.

2.6 Polymorphic Data Transmission

All network devices use the send_data() but the transmitted data differs by device type functions such as calling for the smart phone, sensor uploads for the IoT device and live video streaming for the drone reflecting diversity in the code traffic.

2.7 Encapsulation & Security Awareness

The simulator restricts direct access to sensitive attributes, demonstrating secure design principles commonly used in real systems.

2.8 Extensibility

This design allows for extensions to be easily made for example we can add new device types e.g. PCs, add battery drain simulation add latency or even replace console output with GUI

3. DESIGN ASSUMPTIONS

The following assumptions were made in order to make the system simple

1. Linear signal degradation
2. Flat 2D environment
3. Circular base station coverage
4. Best-effort handover
5. Console-based interaction

4. PRODUCT APPLICATION

The product is applicable in; Demonstrating mobile networking connections, Teaching OOP principles and Simulating 5G connectivity and mobility.