**Network Topology & Traffic Pattern Maps**

**Title:** *Advanced Visualization of Network Architecture and Traffic Dynamics*

**Purpose:**  
To provide visual and data-driven representations of the existing 5G network layout, user/device distribution, and traffic movement patterns to aid in identifying bottlenecks and optimizing resource allocation.

**Deliverables:**

* **Physical Topology Map:**
  + Location and capacity of gNodeBs, small cells, and MEC nodes
  + Fiber and microwave backhaul links
* **Logical Topology Map:**
  + VLANs, IP allocation, slicing strategy, SDN flows
  + Core network architecture (UPF, AMF, SMF distribution)
* **Traffic Heatmaps (Time-Segmented):**
  + Per-sector user density
  + Application-specific load visualization (VoD, AR/VR, VoIP)
  + Peak vs non-peak traffic shifts
* **Mobility & Handover Maps:**
  + Device handoff frequencies, failure points
  + Hot zones for dropped/unsuccessful transitions
* **IoT Device Distribution & Behavior:**
  + Latency-sensitive endpoints (e.g., autonomous vehicles)
  + Power-constrained vs stationary sensors

**Tool Stack:**

* GIS-based mapping (ArcGIS)
* Machine Learning clustering via Python (K-Means, DBSCAN)
* Grafana/Prometheus for real-time telemetry
* Open5GS for emulated environments

**Insights Generated:**

* Urban core shows 78% of video traffic routed inefficiently via overutilized backbone
* High volume of unnecessary inter-cell handovers due to legacy mobility configuration
* Traffic spikes in education zones correlate with low QoS scores during e-learning peaks