

Cellular Connections: A Database for Network Topology Management

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INTRODUCTION

In the rapidly evolving field of telecommunications, the ability to effectively manage and analyze cellular network topology data is necessary. This database has been developed to serve as a comprehensive resource for storing and querying data related to cellular network configurations, signal quality, and coverage areas. It aims to support researchers in understanding network behaviors. By aggregating detailed network data and providing tools for deep analytical insights, this database is positioned to be an essential tool in the ongoing efforts to improve cellular network infrastructure and service delivery.

BACKGROUND

As mobile technologies evolve and new standards such as 5G become widespread, the complexity of network infrastructure grows. This complexity requires advanced tools and methodologies for monitoring, analyzing, and optimizing network performance. The cellular network topology database was developed to address these needs by systematically organizing data from various network tests and evaluations. By integrating detailed information about network performance, device specifics, and environmental conditions, the database serves as a foundational tool for both immediate analytical needs and long-term strategic planning.

Key objectives include:

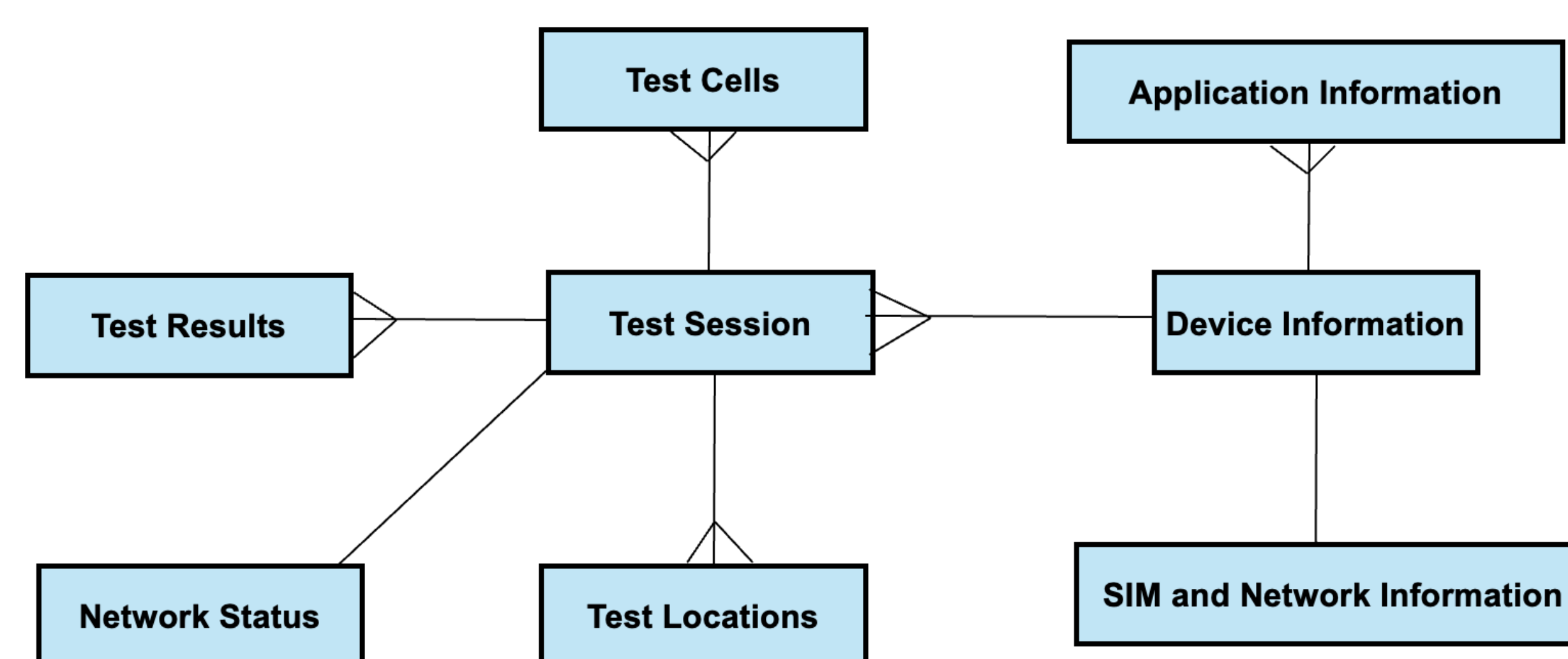
- **Enhanced Visibility:** To provide a clear view of network behavior under different locations and identify patterns that might affect performance.
- **Optimization Opportunities:** To pinpoint potential areas for network enhancement and support decision-making processes with data-driven insights.
- **Future-Proofing Networks:** To aid in preparing for next-generation mobile technologies by understanding current network capabilities and limitations.

This database is not only a repository of information but also a platform that enables ongoing research and development. It supports efforts to optimize network deployments and adapt to evolving technological landscapes, ultimately improving the user experience in mobile network environments.

DATA COLLECTION

The data for this project was meticulously gathered from a diverse range of locations across Miami, each chosen to provide a comprehensive view of cellular network behavior in various environments. The primary sites for data collection included Florida International University's Modesto A. Maidique Campus (MMC) and Biscayne Bay Campus (BBC), as well as the Engineering Center. Additional data was collected from Homestead, the Everglades, Miami Beach, Miami International Airport, Downtown Miami, Florida Memorial University, and Miramar. This dataset contains over 24,000 rows and 800 columns of detailed network metrics. The variety in location not only enriches the dataset with a wide range of network performance indicators but also reflects the typical and atypical user experiences in different urban and rural settings.

DATABASE SCHEMA



USE CASES

```
SELECT operator, networkType, COUNT(*) AS Count
FROM sigcapData
GROUP BY operator, networkType;
```

| operator | networkType | Count |
|----------|-------------|-------|
| AT&T | LTE | 2 |
| T-Mobile | NR | 1 |
| Verizon | LTE | 4 |
| T-Mobile | LTE | 2 |
| T-Mobile | NR-NSA | 2 |
| AT&T | NR-NSA | 3 |
| Verizon | NR-NSA | 1 |

Verizon has the highest number of LTE sessions, while T-Mobile and AT&T show more diversified technology adoption with both NR and NR-NSA types represented.

```
SELECT operator, AVG(ltePrimaryRsrp) AS Avg_LTE_RSRP
FROM sigcapData
GROUP BY operator;
```

| operator | Avg_LTE_RSRP |
|----------|--------------|
| AT&T | -89.8000 |
| T-Mobile | -102.0000 |
| Verizon | -108.4000 |

AT&T shows the strongest average LTE RSRP, indicating better network signal strength compared to T-Mobile and Verizon.



```
SELECT operator, COUNT(*) AS Total_Sessions, SUM(CASE WHEN nrStatus = 'TRUE' THEN 1 ELSE 0 END) AS NR_Available_Sessions
FROM sigcapData
GROUP BY operator;
```

| operator | Total_Sessions | NR_Available_Sessions |
|----------|----------------|-----------------------|
| AT&T | 5 | 0 |
| T-Mobile | 5 | 0 |
| Verizon | 5 | 0 |

The results indicate that none of the test sessions across AT&T, T-Mobile, and Verizon had New Radio (NR) technology available, suggesting an absence of 5G coverage in the tested areas during these sessions.

```
SELECT operator, deviceModel, networkType, dateCollected, ltePrimaryRsrp
FROM sigcapData
WHERE ltePrimaryRsrp < -100;
```

| operator | deviceModel | networkType | dateCollected | ltePrimaryRsrp |
|----------|-------------|-------------|---------------------|----------------|
| Verizon | g0q | LTE | 2023-11-10 11:44:39 | -105 |
| Verizon | g0q | LTE | 2023-11-10 11:51:39 | -105 |
| T-Mobile | g0q | LTE | 2023-11-10 13:37:51 | -107 |
| Verizon | g0q | LTE | 2023-11-10 15:49:48 | -113 |
| Verizon | g0q | LTE | 2023-11-10 15:52:48 | -111 |
| T-Mobile | Galaxy S22+ | NR-NSA | 2023-11-21 09:54:41 | -105 |
| AT&T | Galaxy S22+ | NR-NSA | 2023-11-21 10:54:02 | -111 |
| Verizon | Galaxy S22+ | NR-NSA | 2024-03-13 14:35:28 | -108 |

This query highlights test sessions where the LTE signal strength was notably poor (RSRP below -100 dBm), affecting various devices across different network types and operators.

FUTURE WORK

Continued development and refinement of the database aims to enhance its capability to process and manage extensive datasets effectively. The transition from a static model to a dynamic, live database is a primary goal. This transformation will allow for real-time data processing and immediate data availability, crucial for timely and accurate analysis. Enabling live updates and access will serve as a significant resource for researchers, allowing direct interaction with the database, enabling queries, and data retrieval as it is collected. This accessibility is expected to foster a collaborative environment where insights are shared and utilized promptly. Future development will focus on ensuring the database can handle the increasing volume of data without compromising performance. It will be optimized to sustain thousands of rows and numerous columns of data, ensuring robustness and scalability. By achieving these objectives, the database will support current research needs and adapt to future demands.

ACKNOWLEDGMENTS

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