# Challenges with 4G Router in PQ Monitoring

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# TOPICS

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# Introduction to 4G Routers in Power Quality Monitoring

Understanding the Role of Technology in PQ Monitoring

**Introduction to 4G Technology:**

4G technology enhances data rates, providing improved capacity and reduced latency; essential for applications requiring real-time PQ monitoring in varying environment.

| Generation | Speed | Technology | Features |
|---|---|---|---|
| 2G | 9.6/14.4 kbps | TDMA, CDMA | 2G capabilities are achieved by allowing multiple users on a single channel via multiplexing. 2G enabled mobile phones can be used for data along with voice communication. |
| 3G | 3.1 Mbps (peak)<br>500-700 Kbps | CDMA 2000 (1XRTT, EVDO)<br>UMTS, EDGE | 3G provides amazing internet browsing speeds. Opens the door to a whole bag of oppurtunities with video calling, video streaming, etc. In 3G, universal access ad portability across different device types are made possible. (Telephone & PDA's) |
| 3.5G | 14.4 Mbps (peak)<br>1-3 Mbps | HSPA | 3.5G supports even higher speeds and enhances higher data needs. |
| 4G | 100-300 Mbps (peak)<br>3-5 Mbps | WiMAX<br>LTE | Speeds for 4G are increased to lightning fast in order to keep up with data access demand used by various services. It also supports HD streaming. HD phones can be fully utilized on a 4G network. |

# Key Applications & Benefits:

**Power Quality Analysis:** 4G-enabled devices can analyze power quality parameters like voltage, current, frequency, power, and energy, including high-order harmonics. They can also log power quality disturbance events.

**Remote Monitoring and Control:** 4G facilitates remote access to power quality data, allowing for analysis, troubleshooting, and even control actions (like adjusting settings) from a central location.

- **Real-time monitoring:** Enables immediate awareness of power system conditions.
- **Remote access:** Allows for monitoring and management from any location with 4G coverage.
- **Data analysis:** Facilitates in-depth analysis of power quality parameters and identification of potential issues.
- **Improved efficiency:** Helps optimize power system performance and reduce downtime.

# Challenges with 4G Routers in PQ Monitoring

Understanding the Obstacles of Implementing 4G technology

**Overview of Key Challenges:** An overview of the key challenges in 4G for PQ monitoring, which include bandwidth limitations, signal integrity, and vulnerability to various cyber threats, all have a major impact on data accuracy.

**Impact of Data Integrity and Monitoring:** The impact of data integrity and monitoring can be compromised when routers experience connectivity issues. This can result in lapses in monitoring and real-time decision-making capabilities.

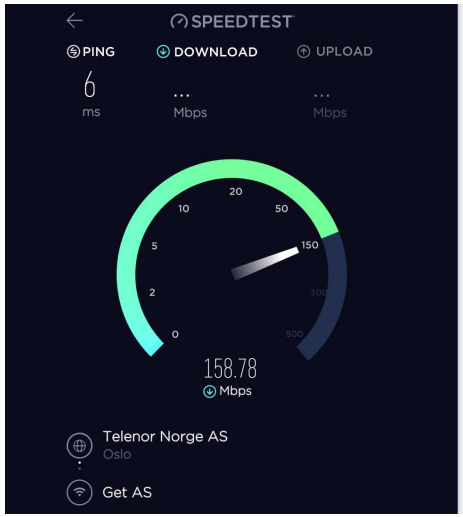
# Bandwidth and Reliability Issues

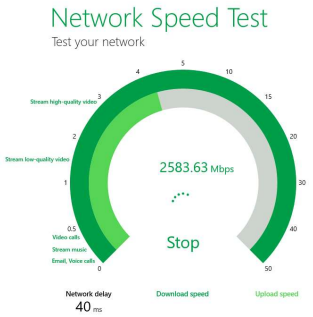
Addressing the Limitations of 4G Technology

**Limited Bandwidth in 4G Networks:** 4G networks provide a limited bandwidth capacity, which can constrain the volume of data that can be transmitted simultaneously, potentially leading to bottlenecks in data flow.

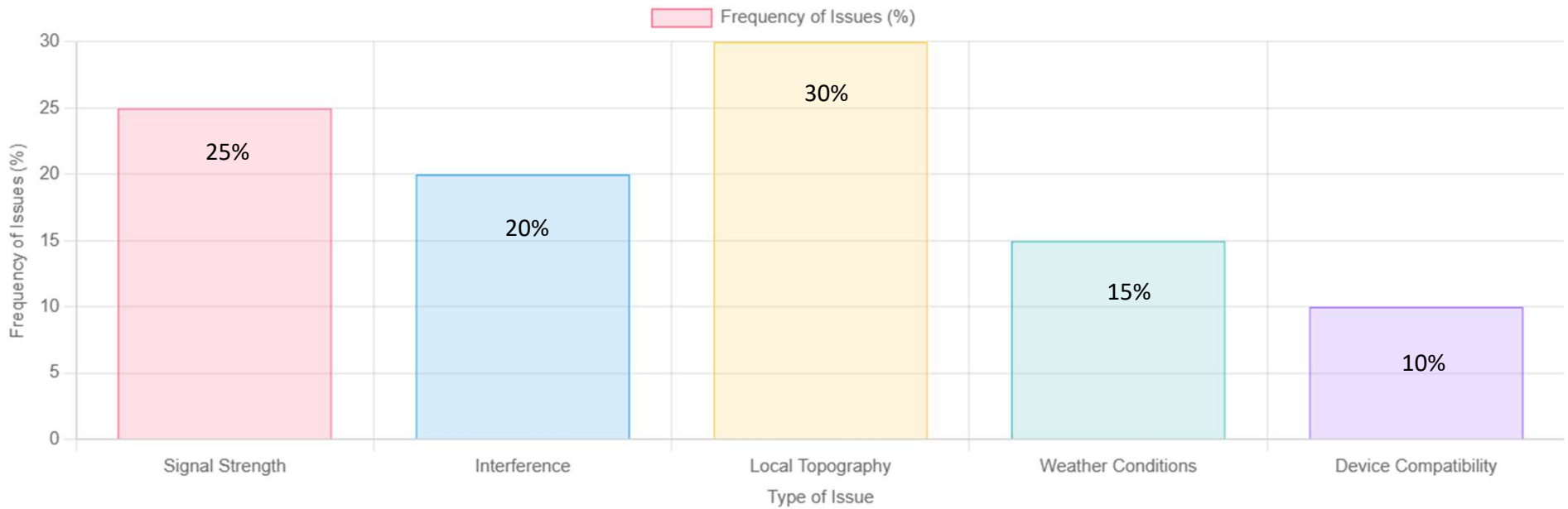
**Intermittent Connectivity and Signal Dropouts:** The performance of 4G routers is affected by time varying conditions, leading to signal dropouts and intermittent connectivity and further diminishing data reliability.

**Challenges in Remote Areas with Poor Signal:** Certain geographical regions lack robust infrastructure of 4G, posing challenges for reliable data collection in power quality monitoring applications.



# Common Issues Faced When Using Best WiFi Router With SIM Card in Rural Areas




*Source URL: https://www.tianjierouter.com/blog/common-issues-using-best-wifi-router-sim-card-4g-rural-areas/#future-trends-in-rural-internet-solutions-beyond-4g-technology*

# Understanding the Impact of Local Topography on 4G Wi-Fi Connectivity

It's crucial to consider the impact of the local landscape and structures on your connectivity.

By examining the surroundings, you can determine the optimal spot for setting up your router to maximize coverage and eliminate interference.

# Mobile experience in Switzerland, by geographic area

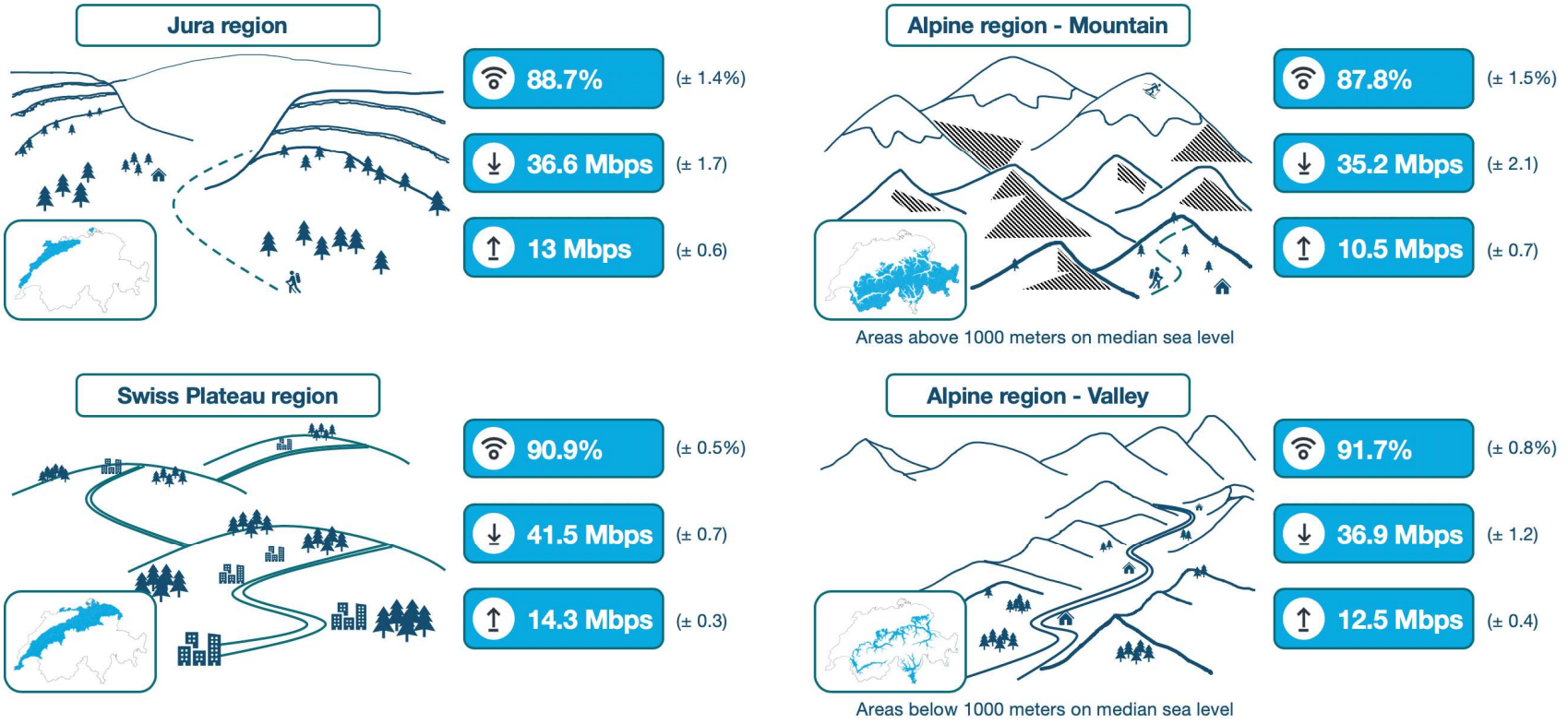
OPENSIGNAL

Data collection period: June 1, 2019 — August 30, 2019

4G Availability

Download Speed Experience

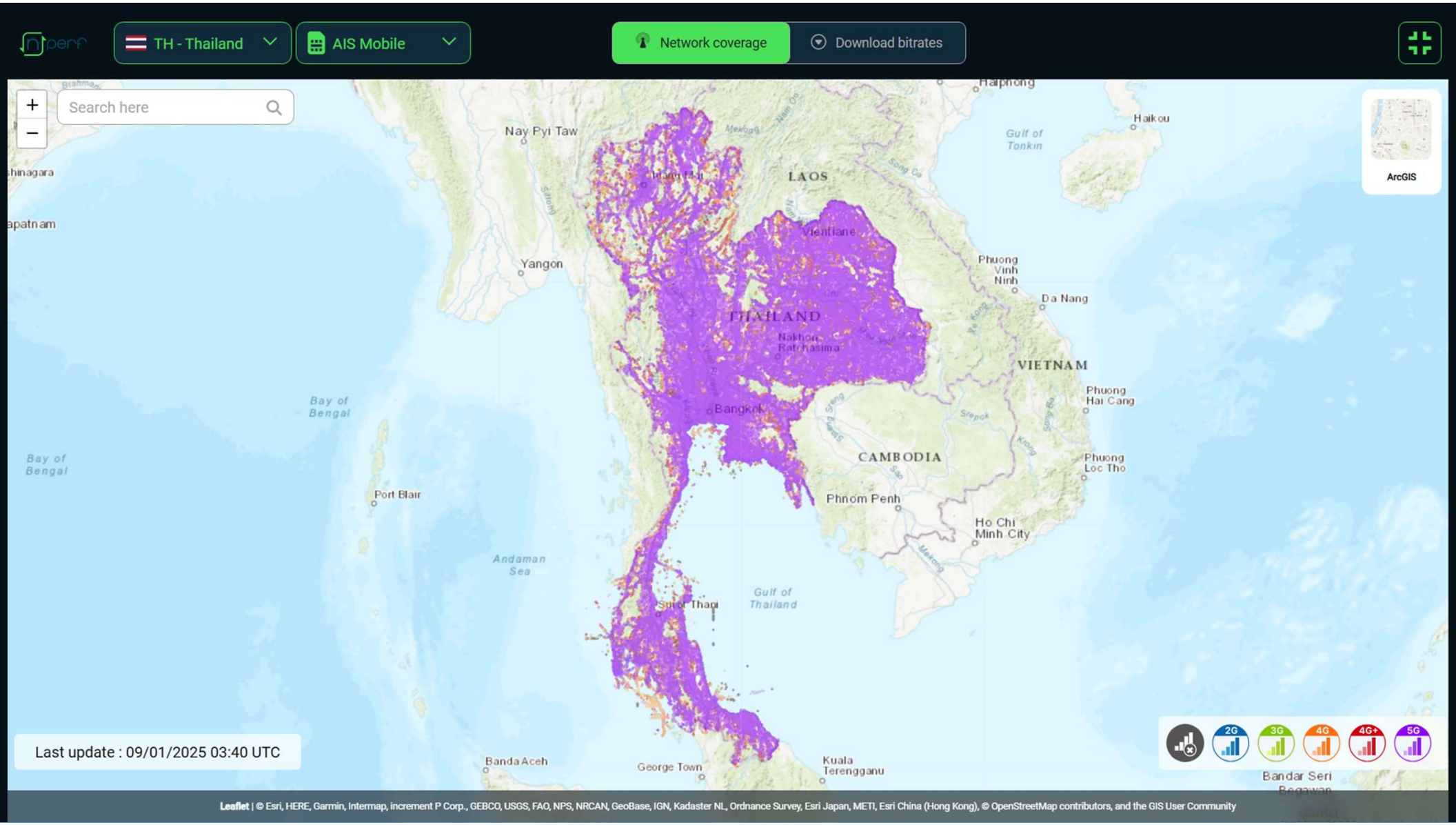
Upload Speed Experience




*Source image: https://www.opensignal.com/2019/10/09/switzerlands-topography-hardly-impacts-mobile-experience*



*dtac and TrueMove H were merged into True Corporation. They still have different infrastructure and some different services.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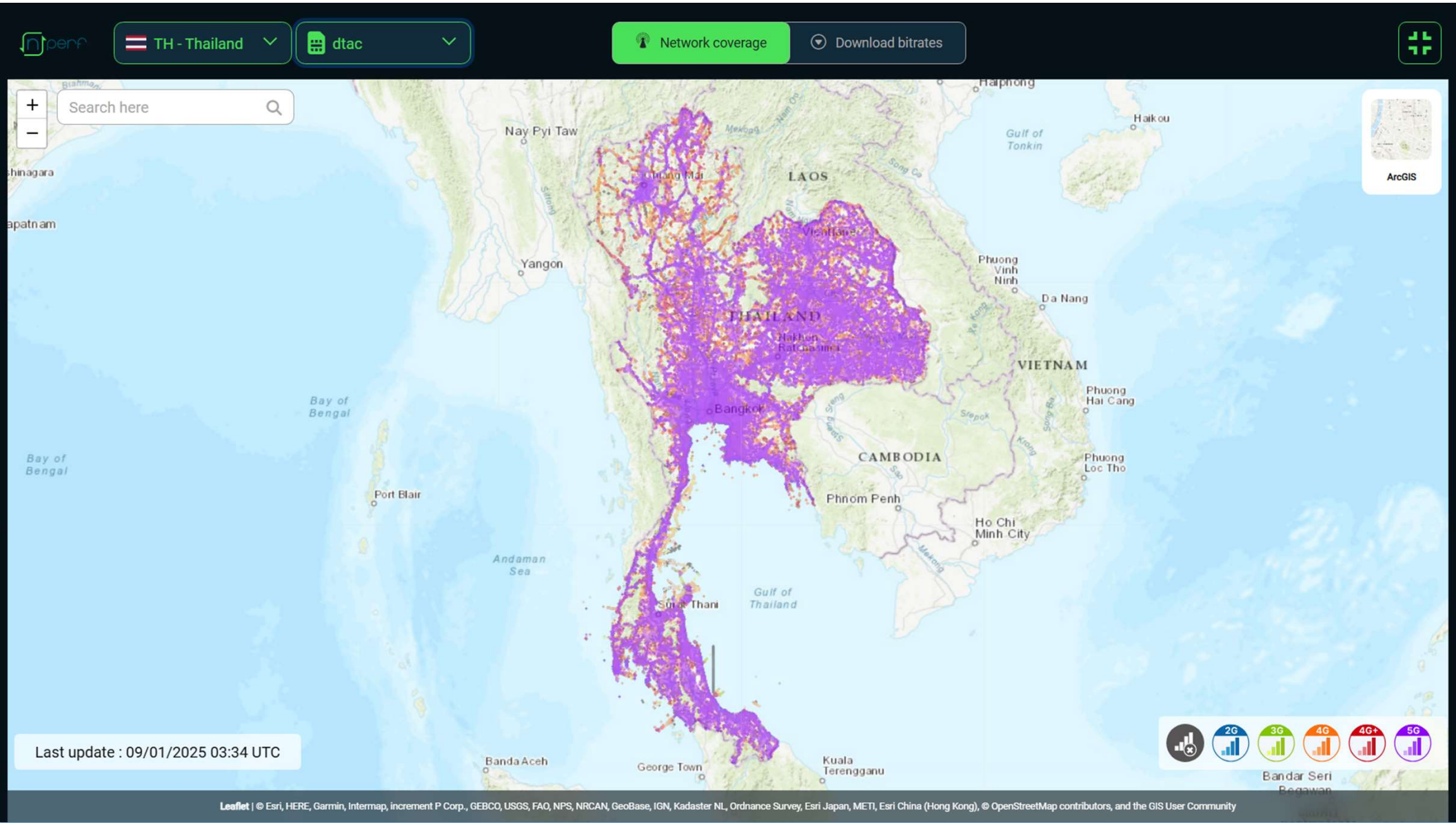
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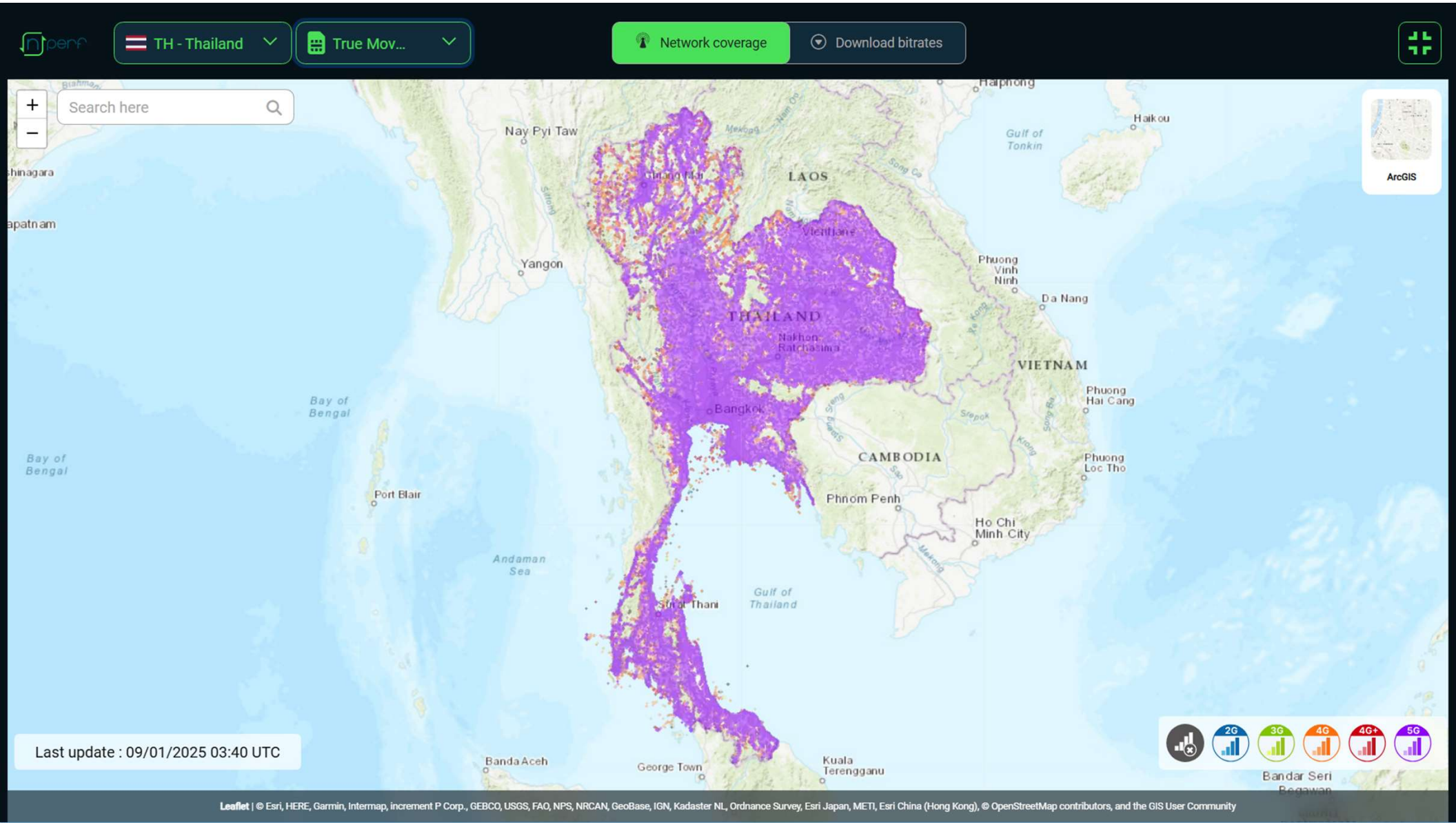
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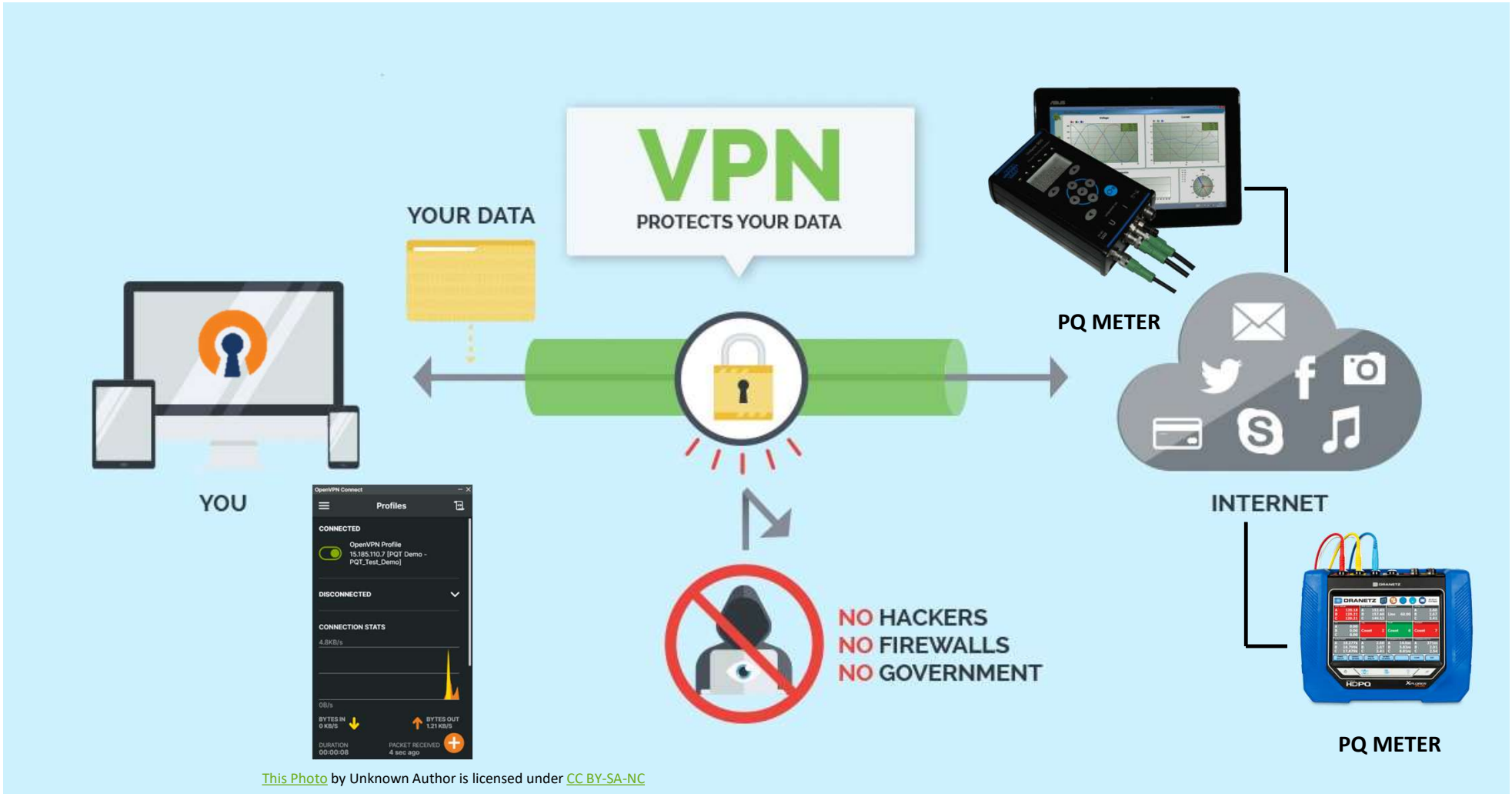
# Security Vulnerabilities in 4G Networks

Examining Risks Associated with Data Security

**IP-related Vulnerabilities:** The architecture of 4G technology leaves its vulnerable to various Internet Protocol (IP) related attacks that can jeopardize data integrity and network privacy.

**Mobile-to-Mobile Attacks:** Mobile devices connected over the 4G network can be targets of malicious attacks; necessitating robust defenses to protect sensitive data from interception during transmission.

**Need for Robust Encryption and Authentication:** It is essential to implement advanced encryption protocols alongside stringent authentication measures to safeguard data transmission from potential threats.



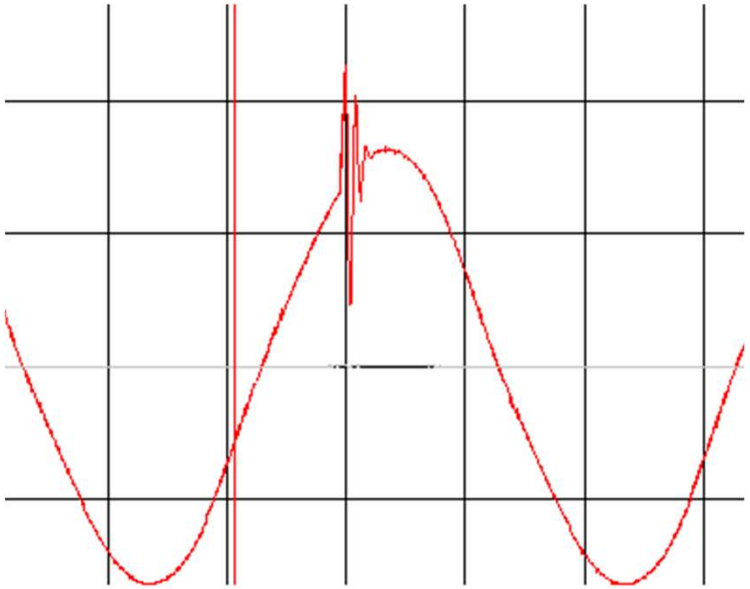
# Power Quality Issues Affecting 4G Routers

Examining External Factors Impacting Router Functionality

**Susceptibility to Voltage Sags and Swells:** Fluctuations in voltage can lead to failures or restarts in 4G routers, which subsequently affects the reliability of data collected for power quality monitoring.

**Integration Challenges with Power-Sensitive Equipment:** Integrating 4G routers with existing infrastructures presents challenges, particularly when sensitive equipment is involved that cannot tolerate significant power quality issues.

**Importance of Grounding and Protection:** Proper grounding and surge protection are critical for 4G routers to ensure operational reliability and reduce the impact of power quality disturbances.



## EMC EMISSIONS & IMMUNITY

| | |
|---|---|
| **Standards** | EN 55032:2015 + A1:2020<br>EN 55035:2017 + A11:2020<br>EN IEC 61000-3-2:2019<br>EN 61000-3-3:2013 + A1:2019<br>EN 301 489-1 V2.2.3<br>EN 301 489-17 V3.2.4<br>EN 301 489-52 V1.2.1 |
| **ESD** | EN 61000-4-2:2009 |
| **Radiated Immunity** | EN IEC 61000-4-3:2020 |
| **EFT** | EN 61000-4-4:2012 |
| **Surge Immunity (AC Mains Power Port)** | EN 61000-4-5:2014 + A1:2017 |
| **CS** | EN 61000-4-6:2014 |
| **DIP** | EN 61000-4-11:2020 |

# Remote Management and Maintenance Challenges

Overcoming Hurdles Related to Accessibility and Costs

**Limited Physical Access to Routers:** Physical access to many 4G routers for troubleshooting or maintenance may be difficult due to their location, leading to a need for remote management efforts.

**Increased Operating Costs in Developing Regions:** In remote or developing regions, the cost of maintaining 4G routers can be significantly higher, leading to an increase in operating costs.

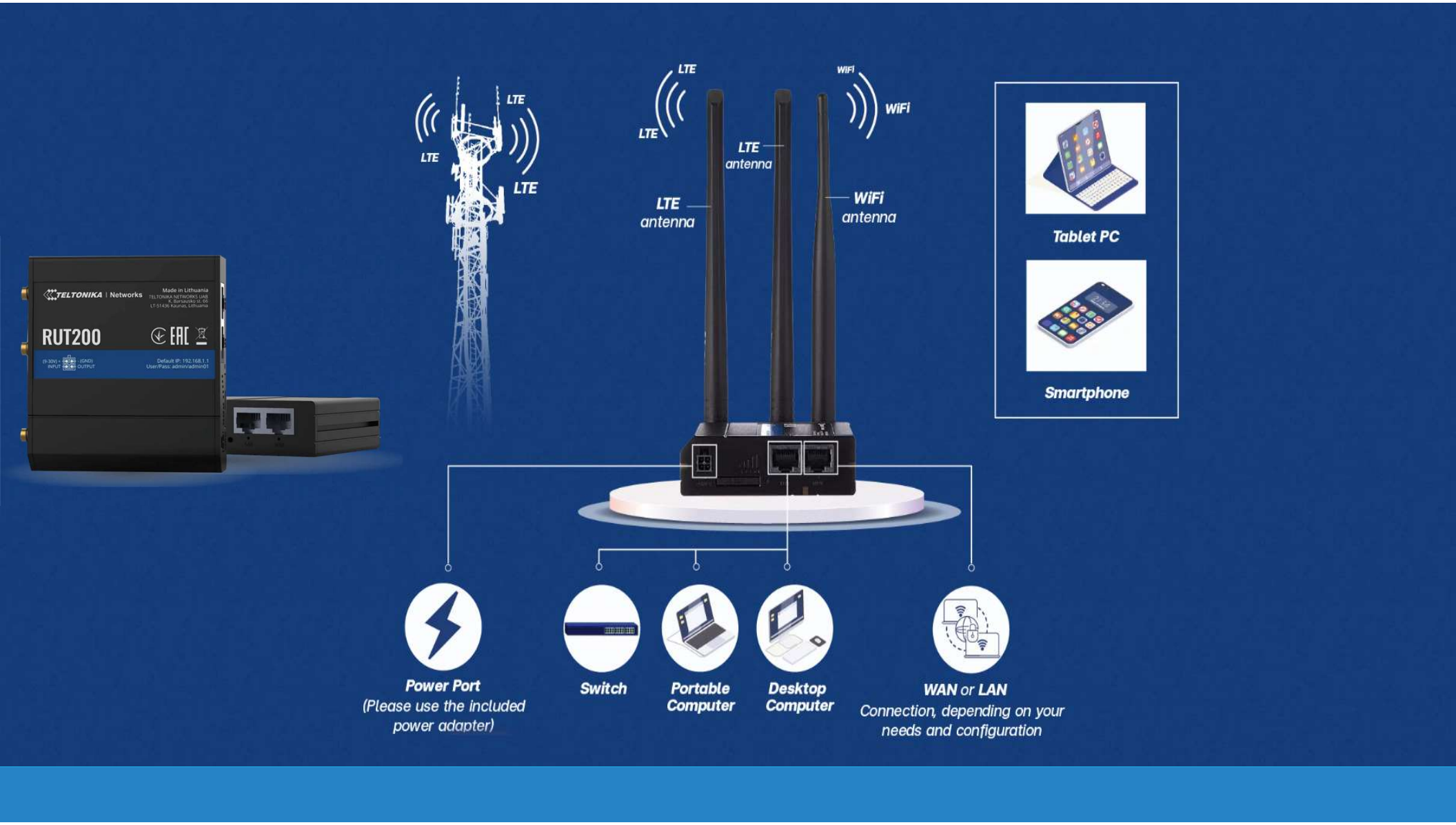
# Mitigation Strategies for 4G Routers

Implementing Solutions to Enhance Reliability

**Implementing Redundancy and Backup Connections:** Creating backup connections, such as utilizing alternative communications paths, ensures continued monitoring in the event of primary connection loss.

**Utilizing Secure Communication Protocols:** Employing secure communication methods helps safeguard data integrity and maintain confidentiality during transmission across 4G network.

**Employing Remote Management Tools:** Integrating advanced remote management tools facilitates troubleshooting, systems checks and updates without requiring physical access to the router.


TELTONIKA | Networks
Made in Lithuania
RUT200
Default IP: 192.168.1.1
User/Pass: admin/admin01
LTE
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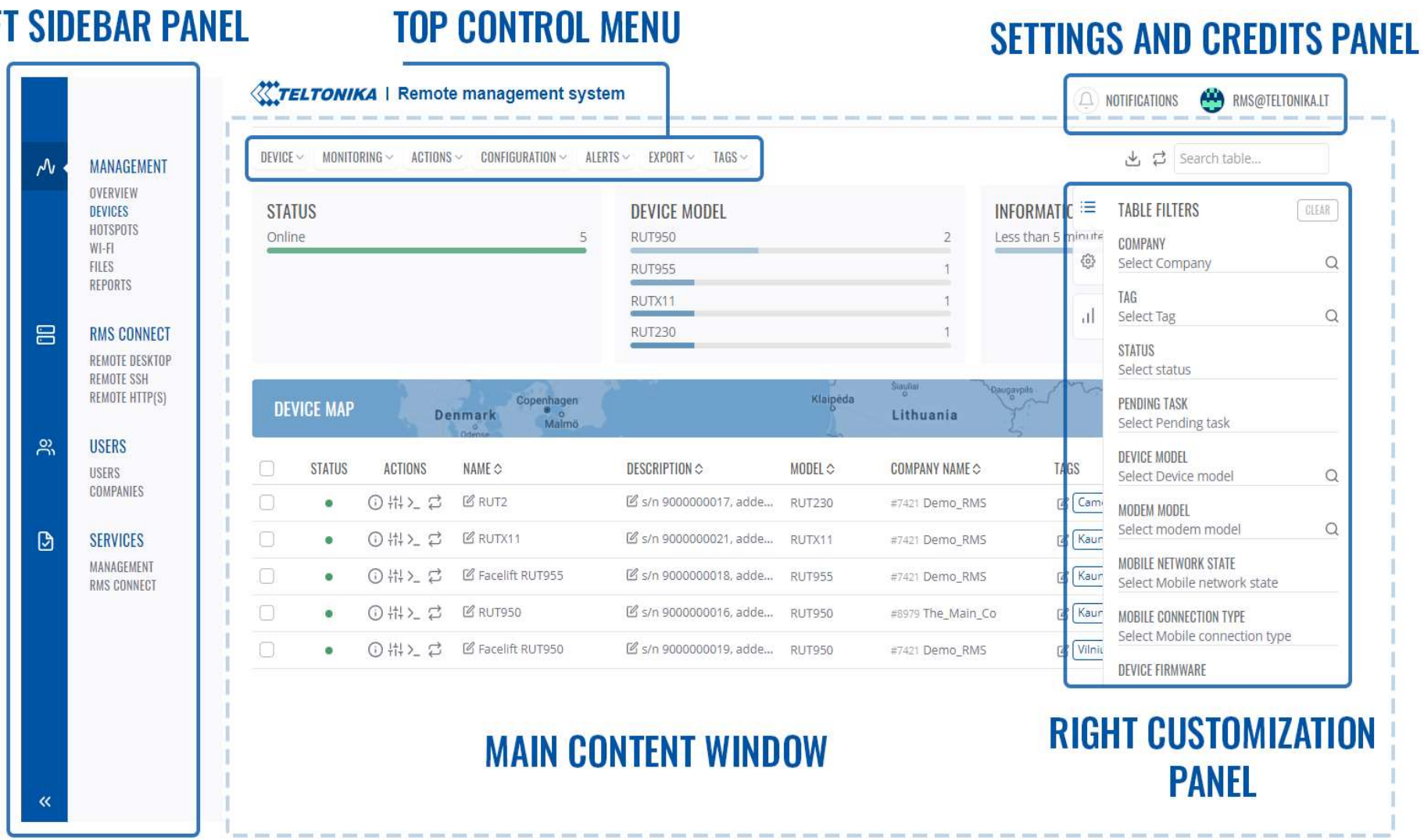
antenna
LTE
antenna
WiFi
WiFi
WiFi
antenna
Tablet PC
Smartphone
Power Port
(Please use the included
power adapter)
Switch
Portable
Computer
Desktop
Computer
WAN or LAN
Connection, depending on your
needs and configuration

## SECURITY

| | |
|---|---|
| **Authentication** | Pre-shared key, digital certificates, X.509 certificates, TACACS+, Internal & External RADIUS users authentication, IP & login attempts block, time-based login blocking, built-in random password generator |
| **Firewall** | Preconfigured firewall rules can be enabled via WebUI, unlimited firewall configuration via CLI, DMZ, NAT, NAT-T, NAT64 |
| **Attack prevention** | DDOS prevention (SYN flood protection, SSH attack prevention, HTTP/HTTPS attack prevention), port scan prevention (SYN-FIN, SYN-RST, X-mas, NULL flags, FIN scan attacks) |
| **VLAN** | Port and tag-based VLAN separation |
| **Mobile quota control** | Mobile data limit, customizable period, start time, warning limit, phone number |
| **WEB filter** | Blacklist for blocking out unwanted websites, Whitelist for specifying allowed sites only |
| **Access control** | Flexible access control of SSH, Web interface, CLI and Telnet |
| **SSL certificate generation** | Let's Encrypt and SCEP certificate generation methods |
| **802.1x** | Port-based network access control server |


LEFT SIDEBAR PANEL
TOP CONTROL MENU
SETTINGS AND CREDITS PANEL
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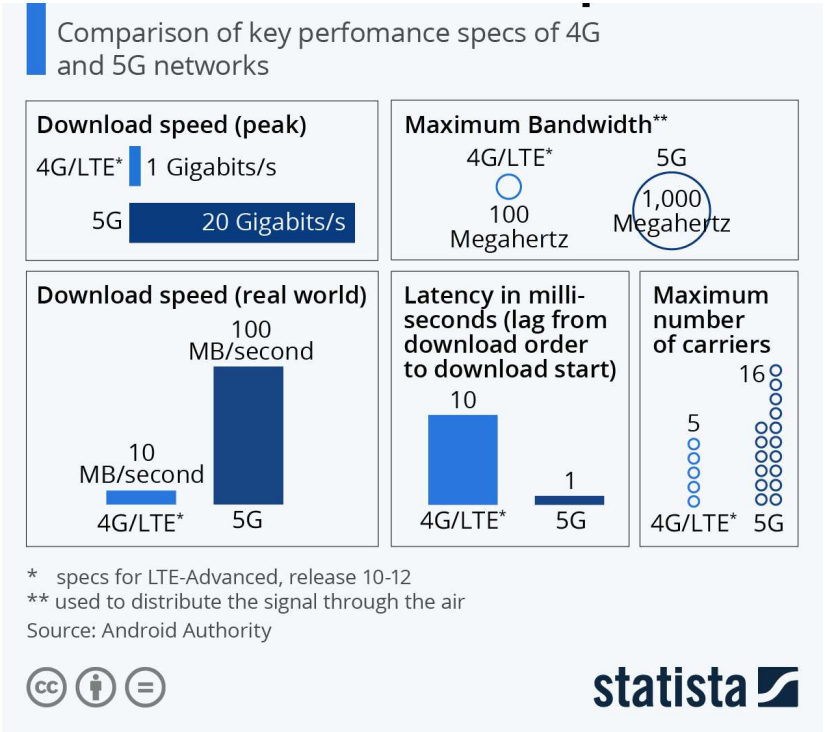
DEVICE MODEL
Select Device model
MODEM MODEL
Select modem model
MOBILE NETWORK STATE
Select Mobile network state
MOBILE CONNECTION TYPE
Select Mobile connection type
DEVICE FIRMWARE
MAIN CONTENT WINDOW
RIGHT CUSTOMIZATION PANEL

# Beyond 4G Technology

When considering internet solutions for rural areas, it's crucial to keep an eye on emerging technologies like 5G and satellite systems. Their connection could be faster and more reliable than what we're currently experiencing.

The growth of 4G LTE is still ongoing today. It has the capacity to support most IoT applications today due to its outstanding speed and sufficient bandwidth. 4G LTE and 5G networks will coexist in the next decade, as applications start to move, and 5G networks and applications will eventually surpass 4G LTE.



# THANK YOU

References


- https://teltonika-networks.com/products/routers/rut200
- https://teltonika-networks.com/products/rms
- https://www.statista.com/chart/17506/5g-and-4g-comparison/
- https://www.opensignal.com/2019/10/09/switzerlands-topography-hardly-impacts-mobile-experience
- https://www.nperf.com/en/
- https://www.tianjierouter.com/blog/common-issues-using-best-wifi-router-sim-card-4g-rural-areas/#future-trends-in-rural-internet-solutions-beyond-4g-technology