

Application Note

Remote Monitoring



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Used symbols



Danger – Information regarding user safety or potential damage to the router.



Attention – Problems that can arise in specific situations.



Information – Useful tips or information of special interest.

Contents

1. Introduction	1
2. Remote Monitoring Possibilities	2
2.1 Identify Inventory	2
2.2 View Operational Status	2
2.3 Monitor Cellular Data Consumption	3
2.4 Traffic Policing	3
2.5 Monitor Service Quality	3
2.6 Track System Health for Preventive Maintenance	4
2.7 Intrusion Detection	4
3. Monitoring Protocols	5
3.1 Web Interface (HTML/HTTP)	5
3.2 SMS Notifications	6
3.3 ICMP Ping	6
3.4 Syslog	6
3.5 SNMP	8
3.6 SNMP Traps	8
3.7 SSH	9
3.8 NetFlow/IPFIX	10
3.9 Custom Agents	10
4. Recommendations	11
4.1 Minimum for Monitoring	11
4.2 Mind the Performance Impact	11
4.3 Mind the Security Impact	11
5. Advantech Monitoring Tools	12
5.1 Router Self-Monitoring	12
5.2 WebAccess/DMP	13
5.3 R-SeeNet	14
6. Third Party Monitoring Tools	15
6.1 Cumulocity IoT	16
6.2 Graylog	17
6.3 PRTG Network Monitor	18
6.4 Zabbix	19
7. Related Documents	20

List of Figures

1 Active and Passive Monitoring	5
2 Router's Web GUI	12

3	WebAccess/DMP Web GUI	13
4	R-SeeNet Web GUI	14
5	Cumulocity Web GUI	16
6	Graylog GUI	17
7	PRTG GUI	18
8	Zabbix GUI	19

List of Tables

1	Events and Facilities per RFC 3164	7
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1. Introduction

Remote monitoring is the process of supervising IT systems (such as network devices, desktops, servers and mobile devices) from a central management server. In general, monitoring improves reliability and security of your network because it facilitates early detection of erroneous conditions.

This document introduces various remote monitoring protocols and tools that can be used to remotely monitor Advantech cellular routers. As there is no single protocol that can monitor everything and there is no tool that supports all protocols, a combination of protocols and/or tools need to be carefully selected based on your needs.

2. Remote Monitoring Possibilities

Remote monitoring tools inform administrators about the overall system health, performance, and potential issues. In general, the monitoring tools use one or more monitoring protocols to retrieve information from the router device and then:

- Display textual and numeric status information.
- Chart historical values of numerical status information.
- Trigger warning / error alerts based on a status value.

As an inspiration, this section provides an overview of monitorable information in various scenarios. There is a performance cost associated with each monitored item, so you should keep the number of monitored items to a reasonable minimum. Only some of these scenarios will be relevant in your environment.

2.1 Identify Inventory

You may want to automatically maintain a list of all the equipment in your network, including various identifiers, such as:

- Product name and serial number.
- System architecture (such as ARMv5 or ARMv8).
- Custom system description.
- Firmware version, possibly indicating routers with unacceptably old firmware.
- Cellular IMEI, ESN, MEID or ICCID.
- Interface MAC addresses.
- SSID of the Wi-Fi Access Point.

2.2 View Operational Status

If your router is integrated into a dynamic environment, you may want to view current or past status information, such as:

- Geographical location and speed.
- Binary I/O status.

2.3 Monitor Cellular Data Consumption

If your router is using a metered cellular connection with a monthly budget (3G, 4G, 5G) you may want to ensure you don't exceed the limit of your SIM card(s). Therefore, you may want to monitor:

- Which SIM card and/or mobile network operator is active?
- Amount of data uploaded and downloaded over each cellular network?

The monitoring system may also predict the data consumption till the end of the period and trigger a warning when the limit is likely to be exceeded.

2.4 Traffic Policing

You may even want to have deeper insights into the traffic passing through your router, such as:

- What clients (IP addresses) connect to what servers?
- Are there any unexpected (suspicious) nodes sending / receiving traffic?
- What clients send the highest amount of traffic?

2.5 Monitor Service Quality

If the connection quality is of a great concern, you may want to monitor various indicators of the service quality, such as:

- System up time.
- Strength and quality of the mobile network signal.
- Operational status and transmission statistics for each interface.

You may also want to trigger warning / error alerts based on a status value, such as:

- Insufficient strength or quality of the mobile signal.
- Connectivity outages (link down, ping failed).
- Excessive traffic over the cellular network.
- Excessive packet loss, error rate or ping latency.
- Clients frequently disconnecting from the Wi-Fi AP.

By comparing these quality indicators across your router feet and over a longer period of time you may discover poorly performing routers, which may be due to:

- Error or misconfiguration (need for maintenance).
- Overload (need for system expansion).

2.6 Track System Health for Preventive Maintenance

If the service continuity is of a great concern, you can collect system statistics over time and identify long term trends even before they reach levels that would trigger an alert. You may want to detect situations such as:

- SSL certification near its expiration time.
- Increasing resource consumption (CPU, memory, storage, number of processes).
- Increasing device temperature.
- Increasing drift of system local time.
- Repeated reboot in a short period of time.
- Decreasing input voltage, when battery is powered.

2.7 Intrusion Detection

You may want to use monitoring as a lightweight Intrusion Detection System (IDS) and discover events such as:

- Unexpected reboot.
- Unsuccessful or unexpected login attempts.
- Unsuccessful firmware upgrade, either manual or automatic.
- Uncommonly opened TCP/UDP listening ports.
- Changes to the router configuration or to other sensitive files (private keys, /etc/passwd).
- Connection and/or disconnection of USB devices.

3. Monitoring Protocols

Remote monitoring protocols are used by the monitoring tools to retrieve status information from the monitored devices, such as routers. The monitoring tools then the display information aggregated from multiple sources, draw charts or trigger alerts when a threshold is exceeded.

In general, there are two approaches to monitoring:

- **Active monitoring**, when the router initiates data transmissions to a monitoring tool.
- **Passive monitoring**, when the router listens for queries initiated from the tool.

Only the host that initiates the transmission may be behind NAT. If a passively monitored router or the server for active monitoring is behind NAT, a port forwarding rule needs to be configured.

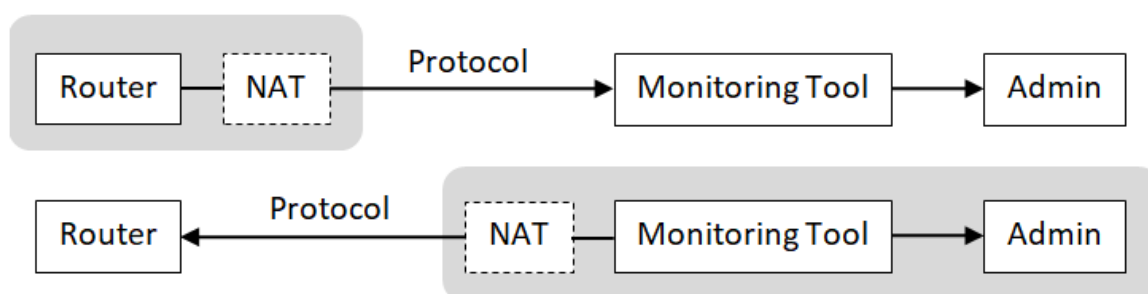


Figure 1: Active and Passive Monitoring



We recommend to deploy the monitoring server to the LAN. Never transport any monitoring protocol unprotected via a public Internet.

The remote monitoring network protocols supported by Advantech routers are listed in the chapters hereunder.

3.1 Web Interface (HTML/HTTP)

The router can be configured using a password-protected Web interface. This interface can also be used for a simple passive monitoring: the administrator connects to the Status pages and reads the information concerning this single routers, such as:

- System information (firmware version, serial number, supply voltage, temperature, local time and uptime).
- Mobile network information (current operator, technology, signal strength and quality, IMEI and ICCID) and connectivity statistics (amount of data received/transmitted, signal quality min/max/average).
- Network interfaces (addresses, status and statistics).
- Active DHCP leases and IPsec tunnels.
- Local syslog entries.

3.2 SMS Notifications

Short Message Service (SMS) is a text messaging service of most cellular telephone networks. When the router is connected to a cellular network, SMS can be used for a simple active monitoring: the router monitors its status and sends a notification SMS to a defined phone number upon significant events, such as:

- On power up.
- On connection / disconnection from a mobile network.
- When data limit has been exceeded.
- When a binary I/O change.

3.3 ICMP Ping

Internet Control Message Protocol (ICMP) is used to send error messages indicating a communication failure, e.g. when a destination host or service could not be reached, and also to test reachability of a host on an IP network by so called Ping.

ICMP Ping carries no data, so no confidentiality nor integrity protection is needed.

To test the router reachability you can:

- Ping the router from a remote machine (passive monitoring), and/or
- Install the *Pinger* Router App and ping a remote machine from the router.

Note that a successful ping does not indicate the router is in a good condition; it only indicates the router can be reached over the network.

3.4 Syslog

System Logging (Syslog) protocol is a standard protocol used to send system log or **event messages** to a specific server. The transmission is initiated by the router (active monitoring).

The basic UDP protocol has no confidentiality nor integrity protection. Use it in secured networks only. Syslog export gets enabled if you set a *Remote IP Address* in your Syslog Configuration. If you need to secure the syslog traffic, install the *Secure Syslog* Router App and use **SSL/TLS** as the transport *Protocol*.

Since firmware 6.3.0 the Advantech cellular routers follow the BSD syslog Protocol defined in the RFC 3164. Each message includes:

- Priority number, which is calculated from:
 - Software type (called facility) that generated the message, see table bellow.
 - Severity level, such as Error(3), Warning(4) or Notice(5).
- Timestamp
- Originating process
- Textual message

For example, info(6) from the auth(4) facility has a priority $38 = 4 \cdot 8 + 6$:

```
<38>Jul 27 13:41:29 https: user 'root' logged in from 192.168.1.1
```

In the local syslog, the priority is omitted and the timestamp has a different, better readable format:

```
2020-07-27 13:41:29 https: user 'root' logged in from 192.168.1.1
```

The following table contains an overview of significant router events and corresponding facility per RFC 3164.

Event	Facility
Firmware update	user(1)
Status changes of router services (dhcp, dns, ...)	daemon(3)
Login success / failures Router configuration changes	auth(4)
Status of the Pluggable Authentication Modules (PAM)	authpriv(10)
Executed FTP commands	ftp(11)

Table 1: Events and Facilities per RFC 3164

3.5 SNMP

Simple Network Management Protocol (SNMP) is a standard protocol for network monitoring. Data entries are exposed as „objects“, each identified with an Object ID (OID). The objects are organized hierarchically into a Management Information Base (MIB). The SNMP can be used by the server to query (passive monitoring), and sometimes even modify, individual objects (scalars) or sub-hierarchies (tables).

The SNMP v1/v2 has no confidentiality nor integrity protection. The SNMP v3 provides both authentication and encryption (privacy).

To use SNMP you need to check the *Enable SNMP agent* box and *Enable SNMPv1/v2 access* or *Enable SNMPv3 access* box in your SNMP Configuration. The SNMP v1/v2 is enabled by default.

The MIB of Advantech cellular routers contain the following **status and inventory** information:

- Basic system information (name, description, admin contact, etc.).
- Hardware identifiers (S/N, IMEI, ICCID number, etc.).
- List of interfaces and related UDP or TCP/IP statistics.
- Hardware status information (temperature, voltage).
- Mobile connectivity status and statistics.
- Geographical location.
- Status of I/O ports.

A detailed list of all values that can be monitored via SNMP is described in the [SNMP Object Identifiers](#) Application Note.

3.6 SNMP Traps

SNMP trap is an asynchronous message triggered by the router either regularly or upon an event. Advantech cellular routers use SNMP traps for continuous regular reporting (active monitoring).

In general, the router does not send traps as alert messages in significant events; the syslog protocol is used instead. However, few router apps, e.g. the [Pinger](#) Router App can be configured to send SNMP Traps in erroneous conditions.

The regular (reporting) using SNMP traps will be enabled if you check *Enable reporting to supervisory system* item in your SNMP Configuration and enter the target *IP Address* and reporting *Period*.

Each SNMP trap contains the following **status information**:

- Very basic interface statistics.
- Mobile connectivity status and statistics.
- Hardware status information (temperature, voltage).

Once in every 24 hours the trap includes also the following **inventory information**:

- Basic system information (name, description).
- Hardware identifiers (S/N, IMEI, ICCID number, etc.).

See section 3 of the [SNMP Object Identifiers](#) Application Note.

3.7 SSH

Secure Shell (SSH) is a cryptographic network protocol used for remote login, remote command execution and secure file transfer (SCP). The connection is initiated by the server (passive monitoring).

The protocol provides both authentication and encryption. It is enabled by default, but it can be disabled in the SSH Configuration.

The monitoring tools use SSH to execute (possibly customized scripts) for retrieval of system level parameters, such as memory or disk consumption. Note that the SSH checks can have a high impact on the performance.



Routers contain a limited version of the shell, so some off-the-shelf scripts might not work.

3.8 NetFlow/IPFIX

NetFlow is a network protocol for collecting IP **traffic information** and monitoring network traffic. The connection is initiated by the router (active monitoring). There are several versions of the NetFlow protocol. The latest (v10) is called IPFIX (IP Flow Information eXport).

The protocol has no confidentiality nor integrity protection. Use it in secured networks only. To use the NetFlow or IPFIX monitoring you need to install a specific Router App. See the [NetFlow/IPFIX Router App](#).

The collected information include:

- Timestamp when the traffic was first seen and last seen.
- Source and destination IP address and port.
- IP address of the next hop (for outbound traffic).
- Number of packets and bytes transmitted.
- Used protocol and TOS.
- Protocol specific details such as TCP flags or ICMP message type.

3.9 Custom Agents

Several monitoring tools such as Zabbix or Nagios offer agents, which can be deployed on the monitored devices. They support both active and passive monitoring. The agents use proprietary protocols that support both authentication and encryption.

They provide detailed OS monitoring, which includes:

- Network reachability.
- System hostname.
- Local time.
- Status of system resources (CPU, memory, storage, OS processes).
- List and status of network interfaces (addresses and packet/error statistics).

In addition to that, the agents can also provide ability to monitor custom values through command execution.

4. Recommendations

4.1 Minimum for Monitoring

You should monitor at least a router availability, so you can detect faults. This can be done either:

- By checking reachability of a LAN device behind the router, e.g. using the ICMP Ping, or
- By checking for unexpected drops of a data throughput, e.g. using the SNMP ipForwDatagrams object (see *SNMP Object Identifiers* Application Note).

Unless the router is deployed in a trusted private environment, we also recommend **monitor system logs** for security relevant events, as described in the *Security Guidelines*. This can be done using Syslog, or using Custom Agents.

4.2 Mind the Performance Impact

When you will extend the set of monitored information beyond the recommended minimum, please mind that extensive monitoring may negatively impact your router performance.

Avoid monitoring too many information. Don't try to do benchmarking. Let the monitoring system to isolate a problem, then do profiling and debugging using specialized tools on the hosts that really require it.

Avoid too frequent checks. Many information don't change very often or very rapidly. Set the refresh rate of each item individually.

Avoid creating too much problem noise by triggering too many alerts. This might overwhelm the user who will then lose focus on the most important metrics. Avoid 'for your information' and 'this looks weird' level triggers.

4.3 Mind the Security Impact

By opening listening ports in the router for passive monitoring you increase the exposure of your router to network attacks. Please make sure that monitoring interface is well secured.

Always use the latest firmware and the latest router apps with custom agents. Security flaws in old software versions might be used by attackers to compromise your router and/or your network.

Never send monitoring protocols that have limited security protection (such as Syslog, SNMP v1/2 or NetFlow/IPFIX) over public Internet (WAN), unless a VPN is used. An unauthorized person might intercept, view or even modify the information.

5. Advantech Monitoring Tools

5.1 Router Self-Monitoring

In the simplest case the monitoring tool is included directly in the router and network administrators access the status information from a Web browser. See the Configuration Manual of your router, section *Status*.

The router can also be configured to send SMS notifications upon significant events, or to accept SMS commands such as "go online" or "reboot". See the Configuration Manual of your router, section *Configuration – Services – SMS*.

Protocols: Web Administration, SMS Notifications

Operating system: Any

Difficulty: Easy

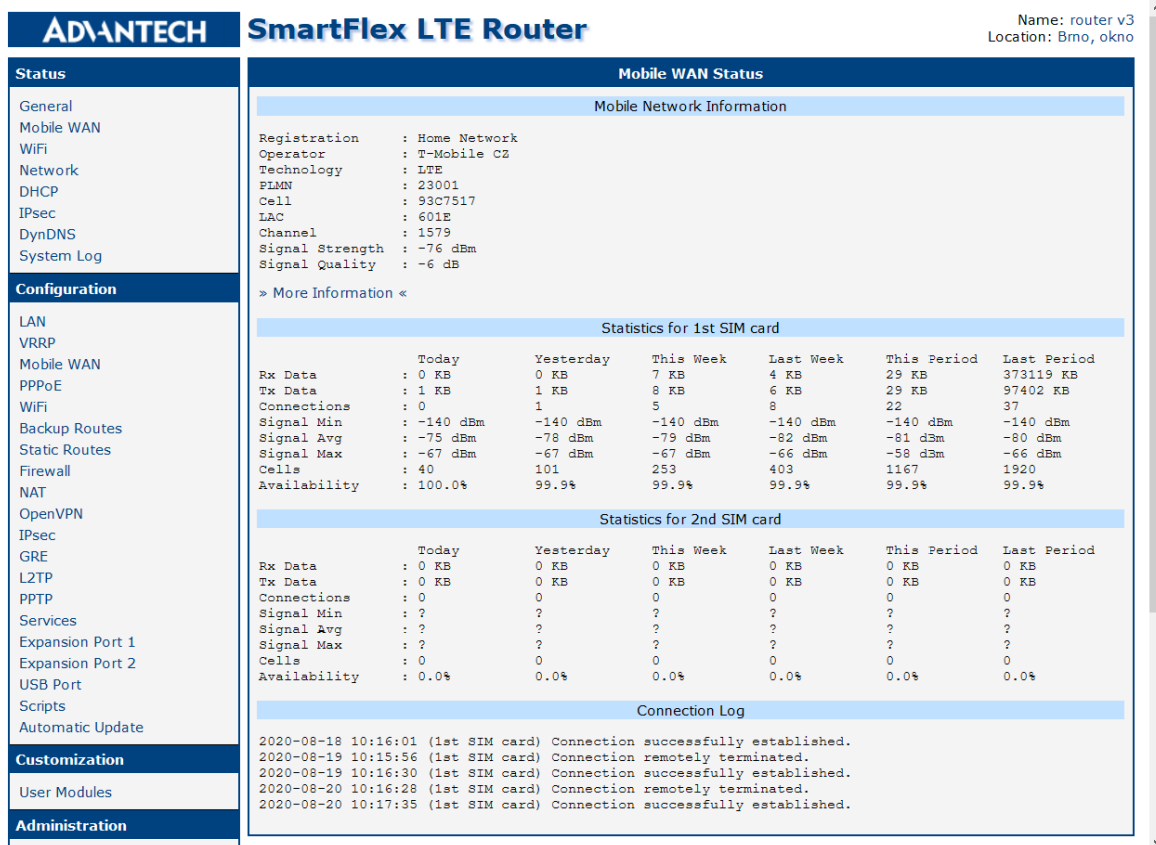


Figure 2: Router's Web GUI

5.2 WebAccess/DMP

WebAccess/DMP Generation 2 is an advanced Enterprise-Grade platform solution for provisioning, monitoring, managing and configuring Advantech routers and IoT gateways. See <https://icr.advantech.com/products/software/webaccess-dmp-gen2> page for more information.

Protocols: Custom Agent, active only

Operating system: Cloud-hosted Solution-as-a-Service

Difficulty: Easy

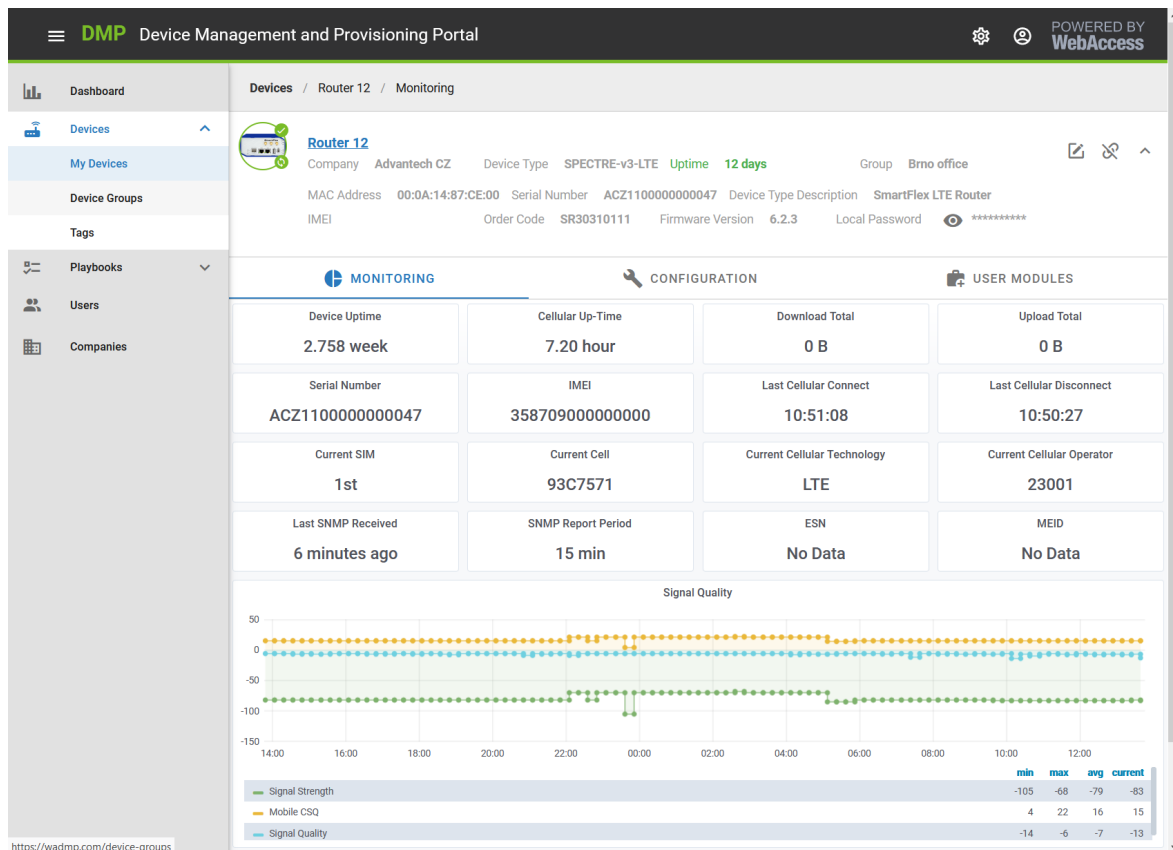


Figure 3: WebAccess/DMP Web GUI

Every remote device has built-in secure health-monitoring status indicators, which are reported to the server and stored in a time-series database. You can view and analyze:

- Device inventory data (type, firmware version, serial number, IMEI).
- Connectivity status (cellular up-time, total upload/download, current technology and operator).
- Chart of cellular data usage and mobile speed (download, upload), signal quality and strength, device temperature and voltage.

5.3 R-SeeNet

R-SeeNet is a software system exclusively for monitoring status of Advantech routers. It displays an inventory list and status information such as the amount of data transferred, signal strength, router availability, number of connections, router temperature or supply voltage. See <https://icr.advantech.com/products/software/r-seenet> page for more information.

Protocols: SNMP or SNMP Traps

Operating system: Linux or Windows

Difficulty: Easy

The screenshot shows the R-SeeNet web interface with a table of router data. The table has columns for Group, Hostname, Status, 2nd Hostname, Description, Device, Total, Level, Firmware, Data Service, SN, Access mode, Temperature, Supply Voltage, and Operation. A summary bar at the bottom indicates 25 devices with 2 green, 0 yellow, 24 red, 0 grey, and 0 blue status indicators.

Group	Hostname	Status	2nd Hostname	Description	Device	Total	Level	Firmware	Data Service	SN	Access mode	Temperature	Supply Voltage	Operation	Device Selection
Cone1	Behind NAT	---	---	PJ 3	LR77-v2	4.7 GB	-99 dBm	6.1.5	LTE	5503456	Trap	43 °C	12.3 V	Report	<input type="checkbox"/>
Knava	62.141.18.60	Ping	---	Knava	LR77-v2	646.3 MB	-98 dBm	5.1.3	LTE	5500097	Polling	40 °C	12.3 V	Report	<input type="checkbox"/>
Advantech	device6	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
EYELEVEL	Behind NAT	Behind NAT	---	SmartStart	SPECTRE-v3-LTE	0 B	-61 dBm	6.1.4	HSDPA	6604796	Trap	37 °C	11.9 V	Report	<input type="checkbox"/>
Advantech	device1	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Advantech	device10	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Default	89.24.1.209	Ping	89.24.1.209	---	SPECTRE-v3-LTE	0 B	-94 dBm	6.1.6	LTE	6201642	Polling	38 °C	12.1 V	Report	<input type="checkbox"/>
Default	Behind NAT	---	---	Bus CSAD CB	LR77-v2	0 B	-82 dBm	5.3.2	LTE	5507374	Trap	40 °C	28.1 V	Report	<input type="checkbox"/>
Advantech	device5	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
EYELEVEL	Behind NAT	---	---	Libratum	LR77-v2L	0 B	-96 dBm	6.1.4	LTE	5825520	Trap	47 °C	12.2 V	Report	<input type="checkbox"/>
Boris_Group	Behind NAT	---	---	boris_KANCL	SPECTRE-RT	0 B	---	5.1.3	---	6000431	Trap	33 °C	12.3 V	Report	<input type="checkbox"/>
Advantech	device9	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Advantech	device4	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
EYELEVEL	Behind NAT	---	---	SmartMotion	BIVIAS-v3LL	0 B	-90 dBm	6.1.4	LTE	6202578	Trap	40 °C	12.1 V	Report	<input type="checkbox"/>
Default	Behind NAT	---	---	---	SPECTRE-v3-LTE	0 B	-84 dBm	6.1.1	LTE	---	Trap	46 °C	12.2 V	Report	<input type="checkbox"/>
Advantech	device8	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Mobilboard	Behind NAT	Behind NAT	---	SAD_LuceneC_1	SPECTRE-v3L-LTE	0 B	-98 dBm	6.1.6	LTE	6602995	Trap	41 °C	25.1 V	Report	<input type="checkbox"/>
Cone1	160.218.189.214	Ping	---	OPTIMATIC-CZ	ER79I	0 B	-72 dBm	3.0.5	EDGE	---	Polling	---	---	Report	<input type="checkbox"/>
Advantech	device3	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Default	Behind NAT	---	---	test_ji_2	SPECTRE-v3L-LTE	0 B	-88 dBm	6.1.2	LTE	6600015	Trap	36 °C	12.5 V	Report	<input type="checkbox"/>
Default	Behind NAT	---	---	---	SPECTRE-v3-LTE	0 B	-99 dBm	6.1.1	LTE	6201573	Trap	41 °C	12 V	Report	<input type="checkbox"/>
Advantech	device7	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Default	Behind NAT	---	---	PJ SmartStart	SPECTRE-v3L-LTE	0 B	-86 dBm	6.1.5	LTE	6600209	Trap	36 °C	12 V	Report	<input type="checkbox"/>
Advantech	device2	Ping	---	---	---	0 B	---	---	---	---	Polling	---	---	Report	<input type="checkbox"/>
Default	Behind NAT	---	---	---	SPECTRE-v3-LTE	0 B	-92 dBm	6.1.2	HSPA+	---	Trap	43 °C	24.3 V	Report	<input type="checkbox"/>
SUM						5.3 GB									

Figure 4: R-SeeNet Web GUI

For more details, please see the *R-SeeNet* Application Note.

6. Third Party Monitoring Tools

Advantech cellular routers have been successfully integrated with several third party monitoring tools. Some examples are provided in the following sections (in alphabetical order).



This list is not exhaustive. Since our routers use standard monitoring protocols (as explained in the previous section), you may use these protocols with any monitoring tool of your choice.

When selecting a monitoring system you should consider:

- Do you want to monitor only Advantech routers, or your entire network?
- Do you want to host the tool on a Linux or a Windows machine?
- Do you want an easy installation, or you want to spend time tailoring the tool to your needs?

6.1 Cumulocity IoT

Cumulocity IoT is a cloud-based subscription service that enables fast visibility and control over remote assets and the data they create. It offers device management features, but also powerful data analytics for Search, Diagnostic and Predictive Analytics. For more information see <https://www.cumulocity.com>.

Protocols: Custom Agent

Operating system: Cloud-hosted Solution-as-a-Service

Difficulty: Medium

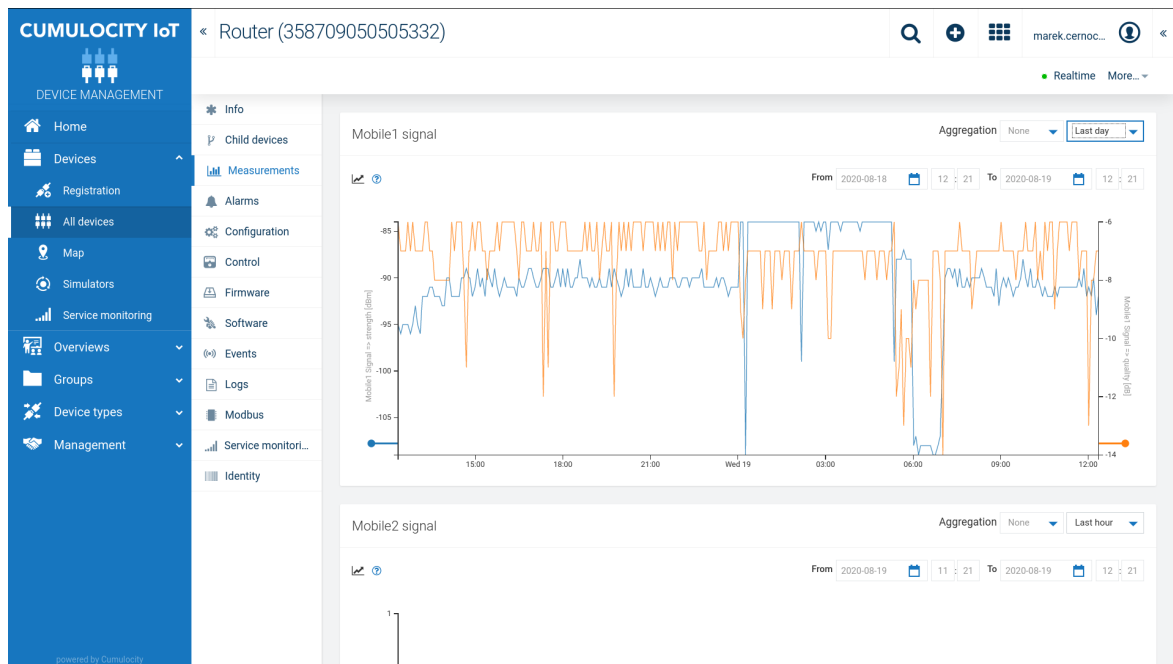


Figure 5: Cumulocity Web GUI

The Cumulocity Router App provides an agent that submits to the Cumulocity IoT the router status information, such as:

- Router inventory information (name, type, model, serial number, IMEI).
- Status information (CPU load, memory and storage usage, power supply voltage, temperature).
- Geographical location, when a GNSS receiver (GPS etc.) is installed.
- Mobile connectivity status (signal strength, amount of data transmitted).

Users can easily implement retrieval of additional information through adding Lua (see <http://www.lua.org>) scripts to the Router App. See the *Cumulocity Agent Router App* for more details.

6.2 Graylog

Graylog is a log management software. It centrally captures and stores log messages, and enables real-time search and analysis of machine data from any component in the IT infrastructure and applications. For more information see <https://www.graylog.org/>.

Protocols: Syslog

Operating system: Linux

Difficulty: Medium

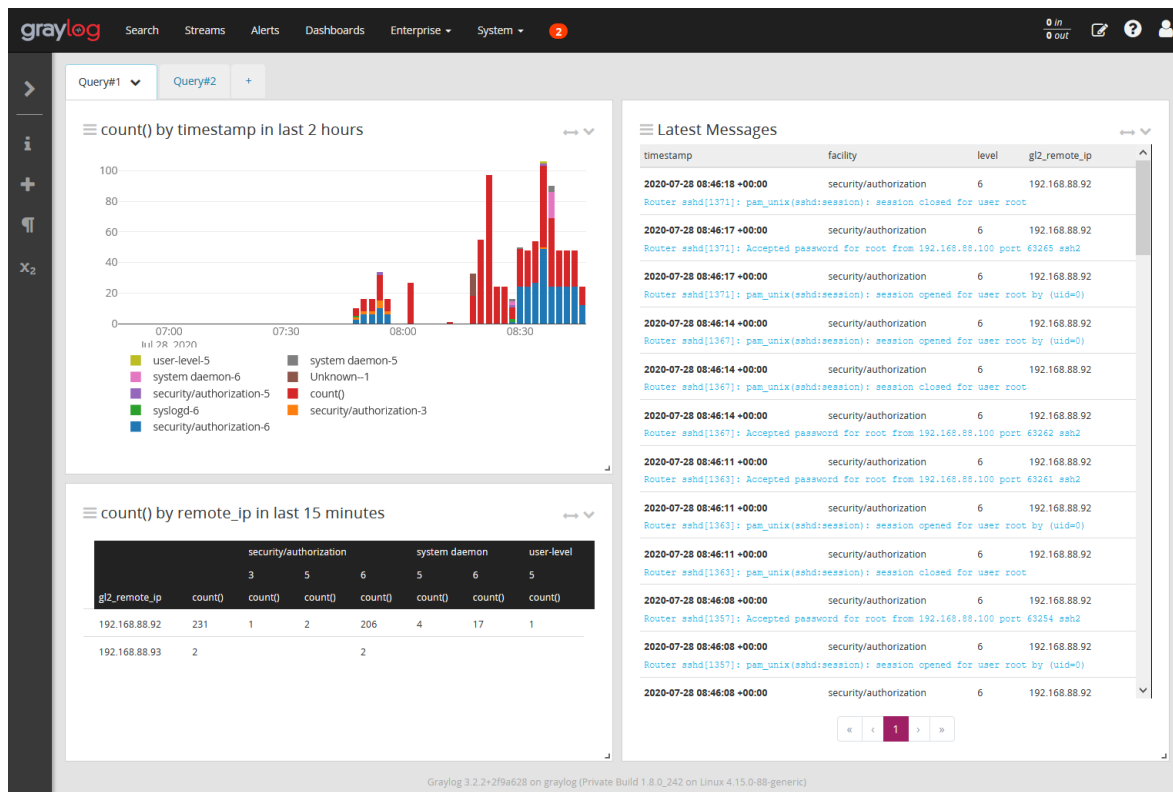


Figure 6: Graylog GUI

Graylog listens on UDP port 1514, so you need to change also the Remote UDP Port in the router Syslog Configuration.



Make sure the current time (clock) of your routers and the clock of the Graylog server match. Messages may get lost if the clock don't match.

6.3 PRTG Network Monitor

PRTG Network Monitor (Paessler Router Traffic Grapher) is an agentless network monitoring software. It can monitor and classify system conditions like bandwidth usage or uptime and collect statistics from miscellaneous hosts as switches, routers, servers and other devices and applications. For more information see <https://www.paessler.com/prtg>.

Protocols: ICMP Ping, Syslog, SNMP, SSH, NetFlow/IPFIX

Operating system: Windows

Difficulty: Easy

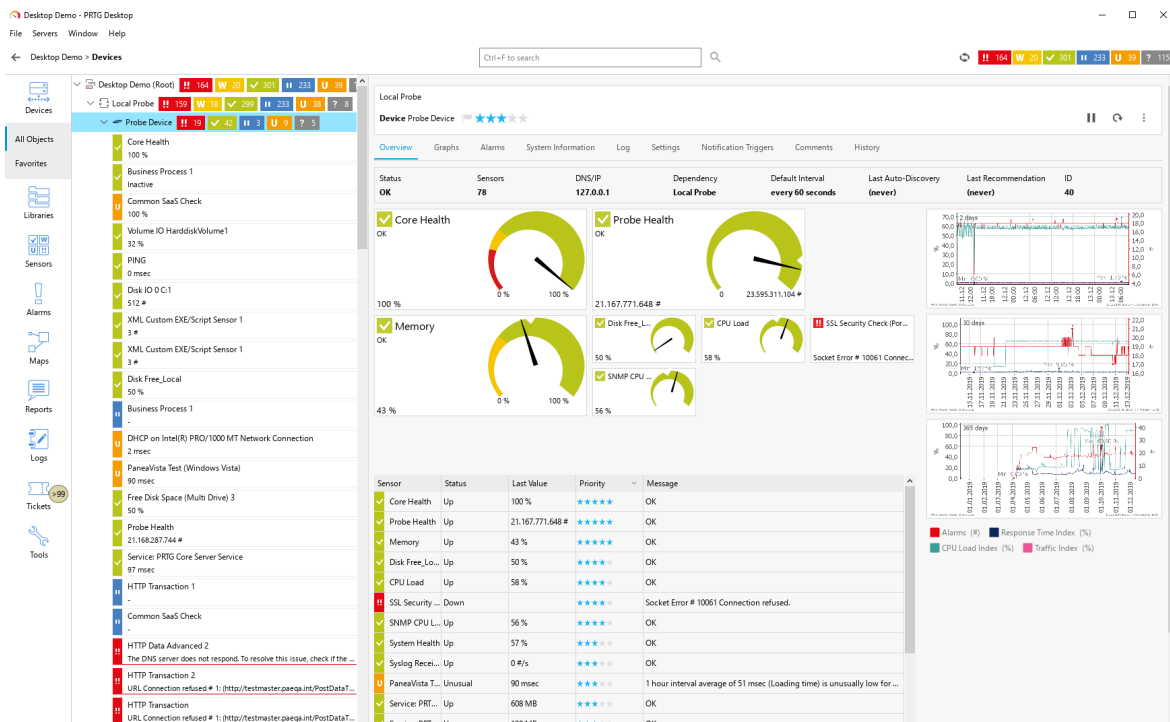


Figure 7: PRTG GUI

Each device is monitored by set of individual probes. Each probe retrieves and monitors one specific characteristic, using one specific protocol. Based on the tests against PRTG 20.3.62, routers support the following probes:

- Ping, Ping Jitter.
- Traceroute Hop Count.
- Syslog Receiver.
- SNMP System Uptime, SNMP Traffic, SNMP Custom Advanced, SNMP Custom String.
- Port.
- SSL Certificate Sensor, SSL Security Check.
- HTTP, HTTP Advanced, FTP, sFTP (service availability).
- SSH Remote Ping, (custom) SSH Script.
- NetFlow/IPFIX.

6.4 Zabbix

Zabbix is an open-source monitoring software tool for diverse IT components, including networks, servers, virtual machines (VMs) and cloud services. It can monitor numerous parameters of a network and the health and integrity of servers. For more information see <https://www.zabbix.com>.

Protocols: ICMP Ping, SNMP, SSH, Custom Agent

Operating system: Linux

Difficulty: Medium

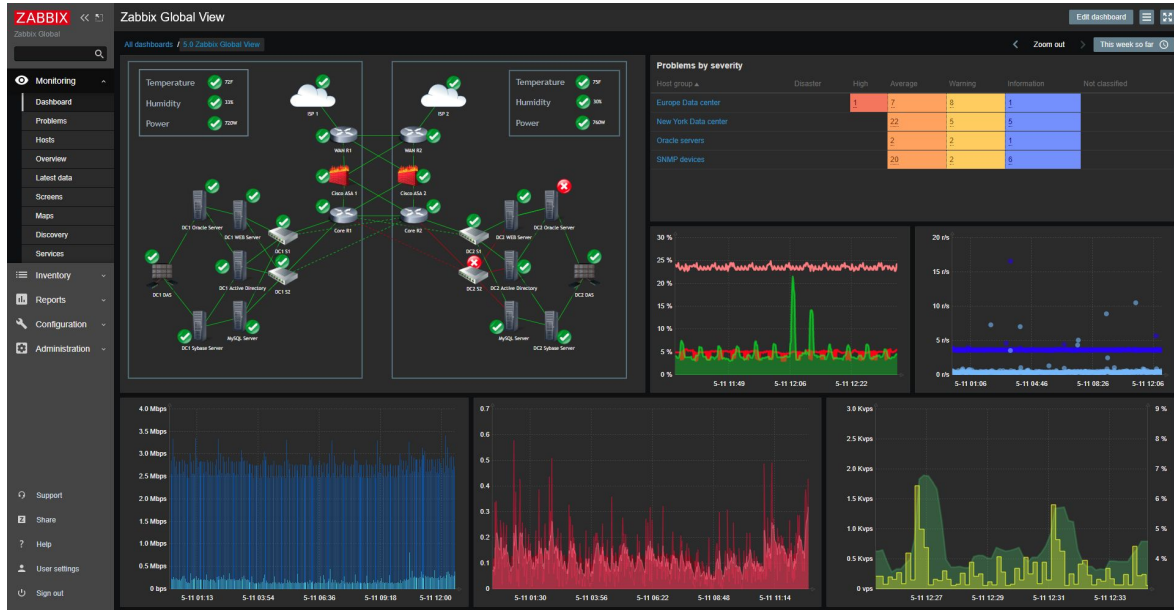


Figure 8: Zabbix GUI

To simplify integration, we offer a Zabbix Agent Router App and a Zabbix template for the Conel MIB, refer to *SNMP Object Identifiers* Application Note. You can download both from the Advantech Engineering Portal at:

<https://icr.advantech.com/products/software/user-modules#zabbix-agent>, refer here to *Zabbix Integration Application Note* for more details.

7. Related Documents

You can obtain product-related documents on the **Engineering Portal** at icr.advantech.com.

To access your router's documents or firmware, go to the [Router Models](#) page, locate the required model, and select the appropriate tab below.

Documents that are common to all models and describe specific functionality areas are available on the [Application Notes](#) page.

The **Router Apps** installation packages and manuals are available on the [Router Apps](#) page.

If you are interested in further options for extending router functionality, either through scripts or custom Router Apps, please see the information available on the [Development](#) page.