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□ Omnitouch □□□□□□

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2. RAN Monitor □□□
3. □□□□
4. Web UI □□
5. □□ Grafana □□
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RAN Monitor □□□□□ Nokia AirScale □□□ 3GPP LTE □ 5G □□□□□□□□□□□□□□□□□□ RAN □□□□□□□□□□□□□□□□□

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- **Web □□□** - □□□□ Web UI □□□□□□□□□
- **Grafana □□** - □□□□□□□□□□□

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RAN Monitor □□□	□□□□□□□□□□□□	□□□□
Nokia NE3S □□	Nokia AirScale PM/config/alarm webhook □□□	http://<server>:9076
Casa PM □□	Casa femtocell PM □□□□□ (□ Casa PM □□)	http://<server>:9077
Baicells Poller	□□ Baicells eNB `/fsmoam/` API (□ Baicells □□)	outbound → cell :443
Web UI □□□□	□□□□□□□	https://<server>:9443
MySQL □□□	□□□□□□□□□	□□
InfluxDB	□□□□□□□□	http://<server>:8086
Grafana	□□□□□□□□	http://<server>:3000
TCE NSNTI □□□	□□□□□□□	TCP □□ 49151
TCE TZSP □□□	□□□□□□□ Wireshark	UDP □□ 37008

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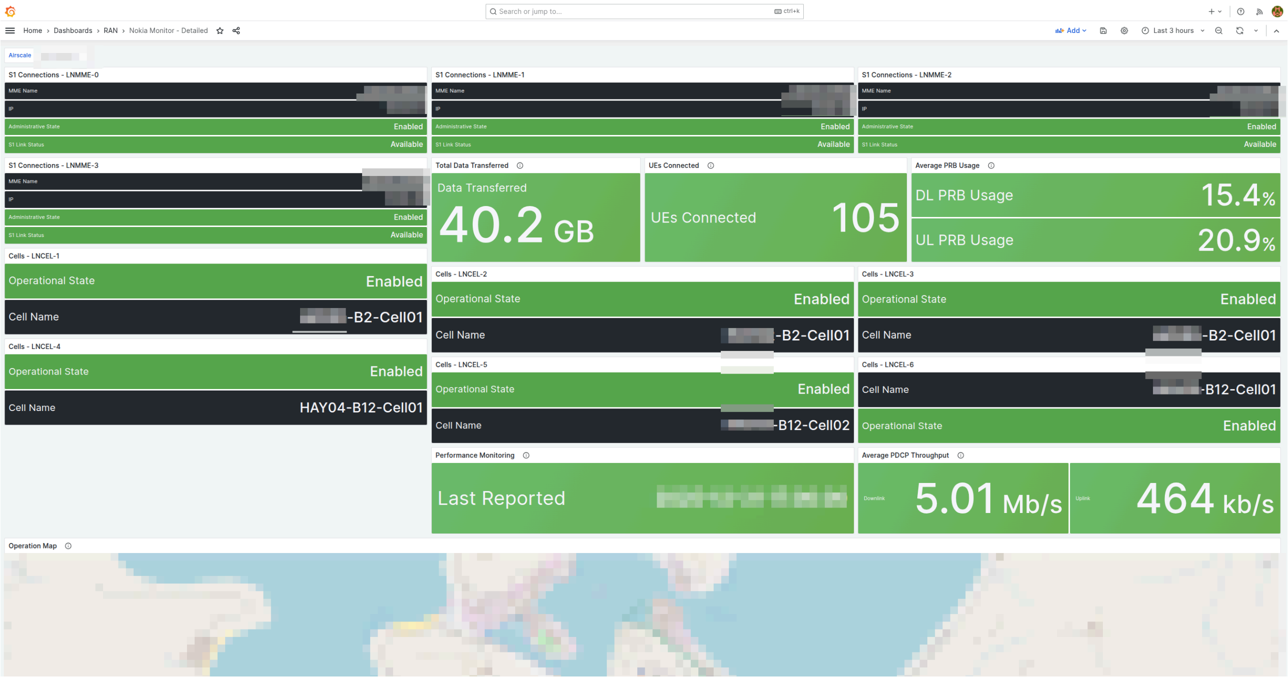

[redacted]

S1 Connections - LNMME-0
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

S1 Connections - LNMME-1
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

S1 Connections - LNMME-2
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

S1 Connections - LNMME-3
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

Total Data Transferred
Data Transferred 40.2 GB

UEs Connected
UEs Connected 105

Average PRB Usage
DL PRB Usage 15.4%
UL PRB Usage 20.9%

Cells - LNCEL-1
Operational State Enabled
Cell Name [redacted]-B2-Cell01

Cells - LNCEL-2
Operational State Enabled
Cell Name [redacted]-B2-Cell01

Cells - LNCEL-3
Operational State Enabled
Cell Name [redacted]-B2-Cell01

Cells - LNCEL-4
Operational State Enabled
Cell Name HAY04-B12-Cell01

Cells - LNCEL-5
Operational State Enabled
Cell Name [redacted]-B12-Cell02

Cells - LNCEL-6
Cell Name [redacted]-B12-Cell01
Operational State Enabled

Performance Monitoring
Last Reported [redacted]

Average PDCP Throughput
Downlink 5.01 Mb/s
Uplink 464 kb/s

Operation Map

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RAN Monitor □□□

RAN Monitor □□□□□□□□□□

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5. □□□□□□ - □□□□□□□□□□□□□
6. □□□□□ - □□ Web UI □ Grafana □□□□□□

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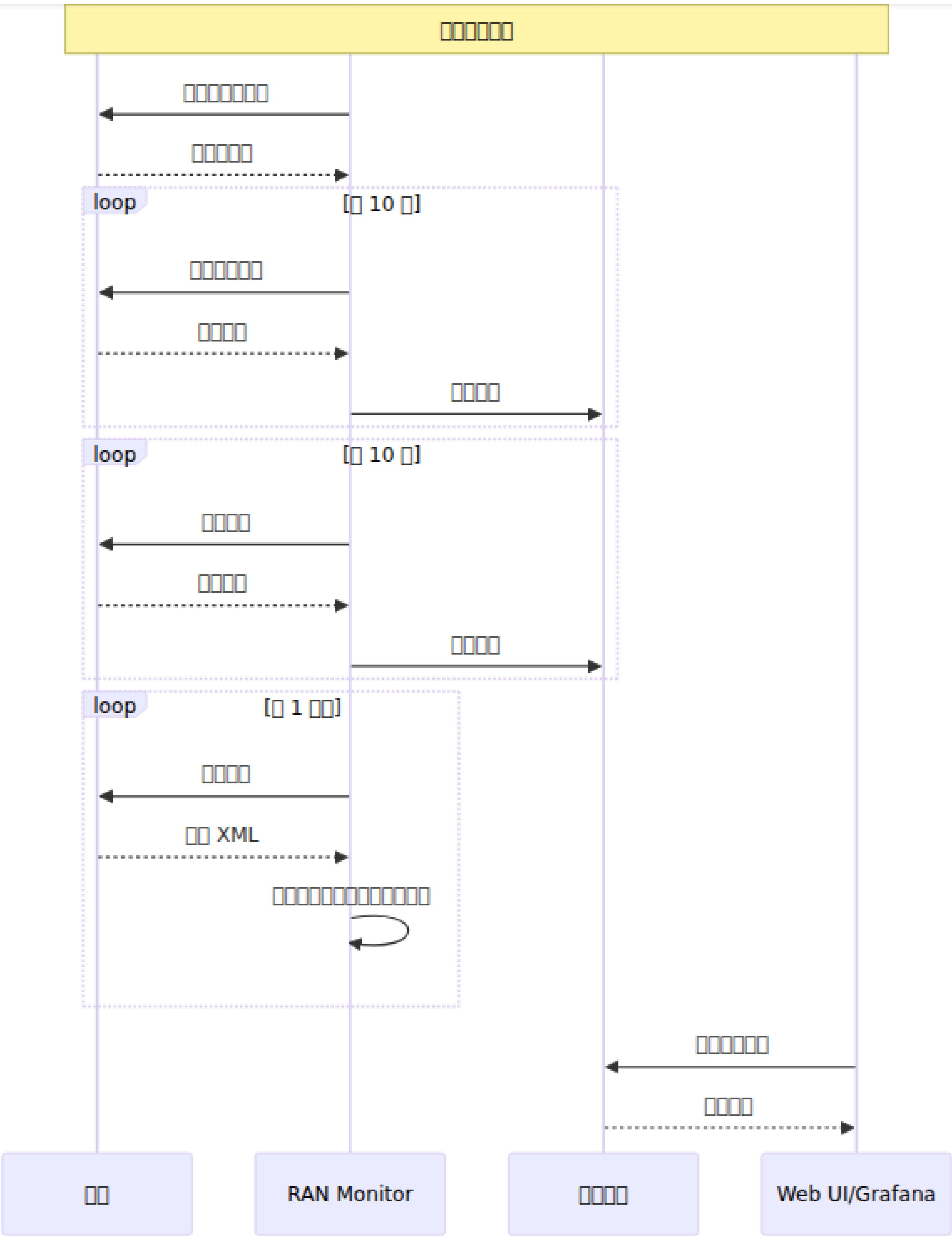
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- [illegible]/[illegible]
- [illegible]PRB [illegible]
- [illegible]
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- [illegible] XML [illegible]
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[illegible] [illegible][illegible]

[illegible] Nokia [illegible][illegible]

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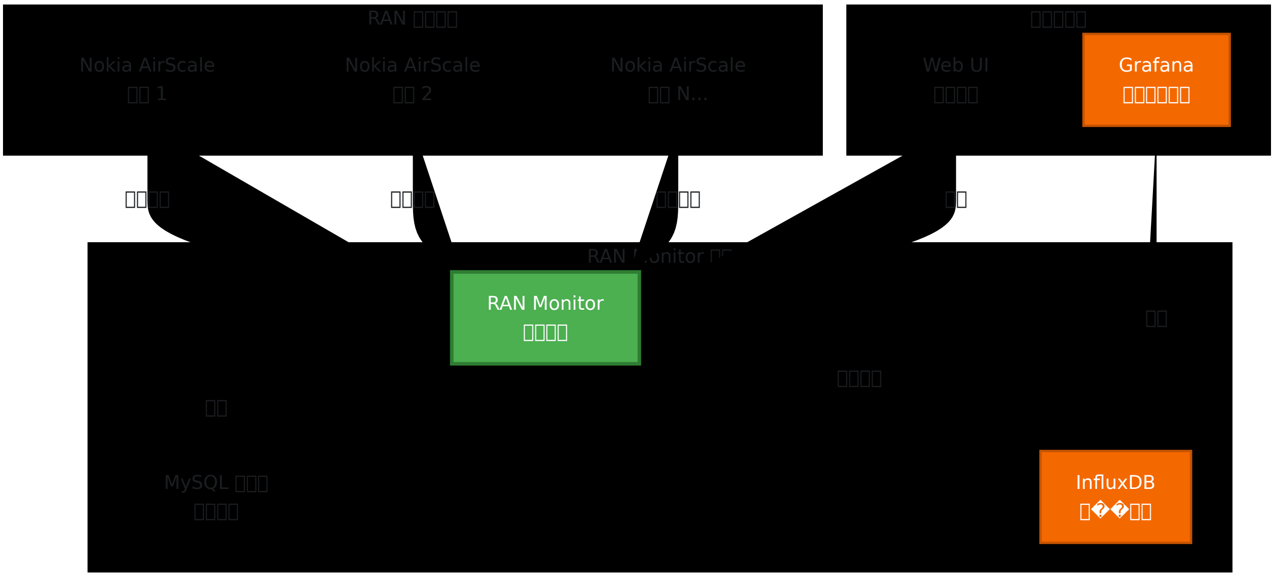
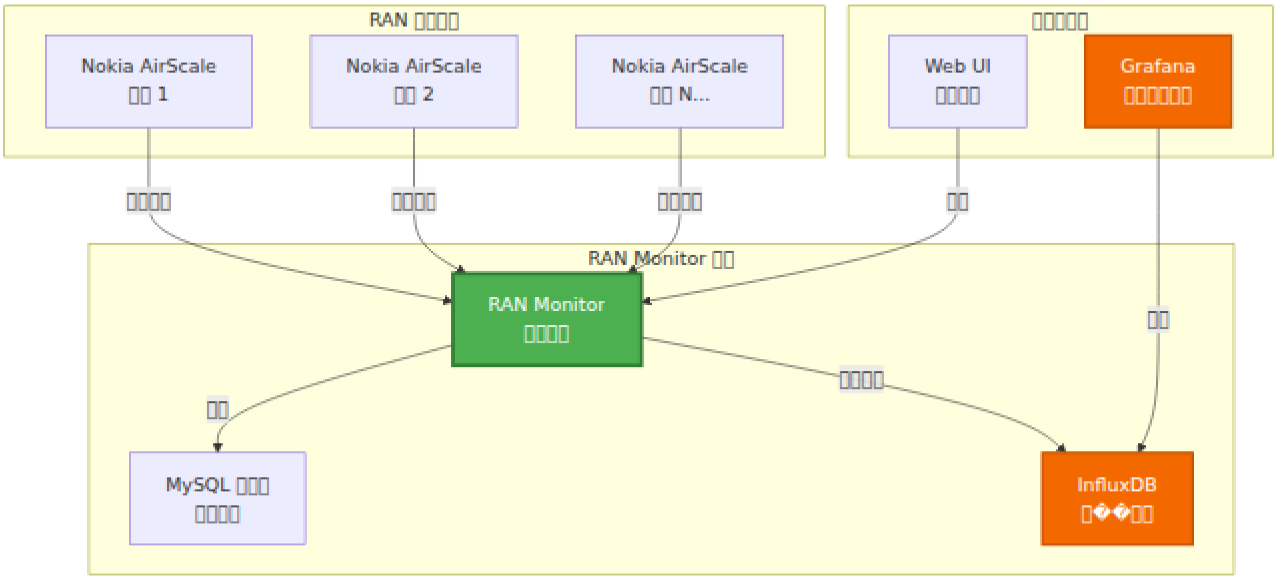

RAN
Nokia AirScale
1
Nokia AirScale
2
Nokia AirScale
N...
Web UI
Grafana
RAN Monitor
InfluxDB
MySQL

[illegible]


RAN
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Web UI
Grafana
RAN Monitor
RAN Monitor
MySQL
InfluxDB

[illegible] [illegible]

[illegible] (TCE)

RAN Monitor [illegible] LTE/5G [illegible] RF [illegible]

[illegible] TCE[illegible]

[illegible] Nokia AirScale [illegible]

- **S1-AP** [illegible] - eNodeB [illegible] EPC [illegible]
- **RRC** [illegible] - [illegible]
- **NAS** [illegible] - [illegible]
- [illegible] - PDCP [illegible]

[illegible]

[illegible]

- [illegible] RF [illegible]
- [illegible]
- [illegible]RSRP[illegible]RSRQ[illegible]SINR[illegible]
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RF [illegible]

- PCI [illegible]
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[illegible] Wireshark [illegible] **TCE MDT [illegible]**[illegible]

Web UI [illegible]

RAN Monitor [illegible] Web UI[illegible]

[illegible] `https://<ran-monitor-ip>:9443`

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3. [illegible] [illegible] ID [illegible]
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[illegible] Web UI [illegible] - [illegible] [illegible] [illegible][illegible]

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Web UI [illegible] - [illegible]

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[illegible] Web UI [illegible] Grafana [illegible]

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Grafana [illegible]

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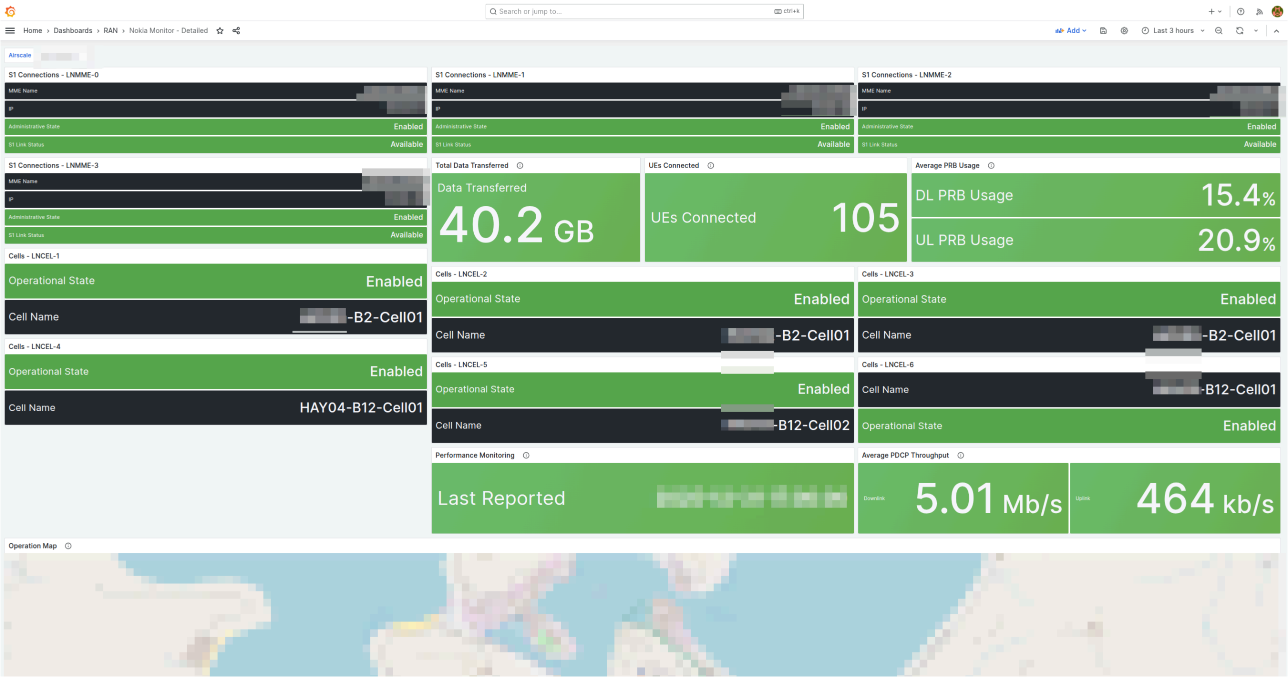

S1 Connections - LNMME-0
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

S1 Connections - LNMME-1
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

S1 Connections - LNMME-2
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

S1 Connections - LNMME-3
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

Total Data Transferred
Data Transferred 40.2 GB

UEs Connected
UEs Connected 105

Average PRB Usage
DL PRB Usage 15.4%
UL PRB Usage 20.9%

Cells - LNCEL-1
Operational State Enabled
Cell Name [redacted]-B2-Cell01

Cells - LNCEL-2
Operational State Enabled
Cell Name [redacted]-B2-Cell01

Cells - LNCEL-3
Operational State Enabled
Cell Name [redacted]-B2-Cell01

Cells - LNCEL-4
Operational State Enabled
Cell Name HAY04-B12-Cell01

Cells - LNCEL-5
Operational State Enabled
Cell Name [redacted]-B12-Cell02

Cells - LNCEL-6
Cell Name [redacted]-B12-Cell01
Operational State Enabled

Performance Monitoring
Last Reported [redacted]

Average PDCP Throughput
Downlink 5.01 Mb/s
Uplink 464 kb/s

Operation Map

□□ Grafana □□□□□□□□□□□□□□□□□□□□□

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Nokia AirScale □□□□□□

- PRB □□□□DL/UL□
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Grafana □□□□ - □□□□□□□□□□□

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1. □□ Web UI □□□
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2. □□□□□□ eNodeB □□□□□□□
3. □□□□□□ `config/runtime.exs`
4. □□ RAN Monitor
5. □□□□□□□□□□□□
6. □□□□□□ InfluxDB

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1. [illegible]
2. [illegible] `config/runtime.exs` [illegible]
3. [illegible]
4. [illegible] RAN Monitor
5. [illegible] Grafana [illegible]

[illegible]

1. [illegible]
2. [illegible] `config/runtime.exs` [illegible]
3. [illegible] RAN Monitor
4. [illegible]

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[illegible] - [illegible]

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1. [illegible] [illegible] - [illegible]
2. [illegible] [illegible]
3. [illegible] [illegible] → [illegible] ID
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8. [illegible] [illegible]1 [illegible]

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[illegible] AirScale [illegible][illegible]

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[illegible]

RAN Monitor [illegible]

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Grafana [illegible]	[illegible]	[illegible]
[illegible]	RAN Monitor [illegible] Prometheus [illegible]	[illegible]
Nokia [illegible]	[illegible]	[illegible]
AirScale [illegible]	[illegible]	[illegible]
DHCP [illegible]	[illegible] DHCP [illegible]	[illegible] DHCP [illegible] 43 [illegible]
TCE MDT [illegible]	MDT [illegible] Wireshark [illegible]	[illegible]
API [illegible]	REST API [illegible]	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

[illegible] **RAN Monitor**[illegible]

1. [illegible] Web UI [illegible] [illegible]
2. [illegible] [illegible] [illegible]
3. [illegible] [illegible] [illegible]
4. [illegible] [illegible] [illegible]

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1. □□ Grafana □□□□ □□□□□□
2. □□ Nokia □□□□□ □□□□□
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□□	**URL**	□□
Web UI □□□	`https://<server>:9443`	□□□□□□□
Grafana	`http://<server>:3000`	□□□□□□□□
InfluxDB	`http://<server>:8086`	□□□□□□□□□□□□□□□

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`config/runtime.exs`	□□□□□□□□□□□□□□□□□
`priv/cert/`	HTTPS Web UI □ SSL □□
`priv/external/nokia/`	□□□□□□□□□
`priv/airscale_configs/`	□□□□□□□□□ XML □□□

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- RAN Monitor [illegible]
- [illegible]
- [illegible] 30 [illegible]
- [illegible] MySQL [illegible]

[illegible]

- [illegible] 10 [illegible]
- [illegible] 10 [illegible] + [illegible] webhook [illegible]
- [illegible] 1 [illegible]
- [illegible] InfluxDB [illegible]

[illegible]

- [illegible]720 [illegible]30 [illegible]
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- [illegible] Web UI [illegible]

[illegible] [illegible][illegible]

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1. [illegible] Web UI → [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

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1. Web UI → [illegible] → [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

6. □□□□□□□

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2. □□ `config/runtime.exs`
3. □□□□□□ airscales □□
4. □□ RAN Monitor
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1. □□□□□□ → □□□□
2. □□□□□□□`ping <device-ip>`
3. □□ `config/runtime.exs` □□□□
4. □□□□□□□□□□

Grafana □□□□□□

1. □□□□□□□□□□□□□□
2. □□ InfluxDB □□□□□□□□□□
3. □□ InfluxDB □□□
4. □□ Grafana □□□□□

Web UI □□□□□

1. □□□□ 9443 □□□□□
2. □□□□□□□□□ HTTPS □□
3. □□ SSL □□□□□□
4. □□□□□□□□□ Web UI □□□□

□□□□□□□□□□□□□□□ □□□□□□□

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- □□□□□□□□□□
- □□□□□□□□□/IP□
- □□□□□□□
- RAN Monitor □□□□□□□

□□□

□□ RAN Monitor □□□□

- Omnitouch □□□□□□
- □□□□□□□□□
- □□□□□□□□□□□□
- □□□□□□□□

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1. □□ □□□□□□

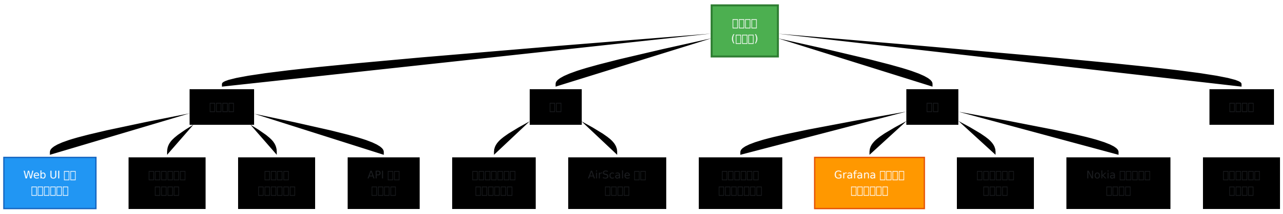
2. □□□□□□□□□□□□□

3. □□□□□□□□□

4. □□□□□□□□□□

5. □□□□□□□□

□□□□


□□□□
(□□□)
Web UI □□
□□□□□□
API □□
□□□□
AirScale □□
□□□□
Grafana □□□□
□□□□□□
Nokia □□□□□
□□□□

Nokia AirScale [illegible]

[illegible] **RAN** [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible] WebLM [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]

[illegible]

[illegible] RAN [illegible] Nokia AirScale [illegible] RAN [illegible] Nokia Web Element Manager (WebLM) [illegible]

[illegible] (PMCADM) [illegible]

[illegible]

[illegible] Nokia AirScale [illegible] **Omnitouch** [illegible]

- [illegible]
- [illegible]
- [illegible]
- ���[illegible]

[illegible] **Omnitouch** [illegible] **Omnitouch** [illegible]

[illegible] Nokia Counter Reference[illegible] Runtime Configuration Guide[illegible]

[illegible]

[illegible]

- [illegible] - [illegible]
- [illegible] - [illegible]
- **RAN [illegible]** - RAN [illegible] IP [illegible]
- [illegible] - [illegible] Nokia AirScale [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
RAN [illegible] IP [illegible]	RAN [illegible] IP	10.179.2.139
RAN [illegible]	[illegible] ([illegible]: 9076)	9076
[illegible]	[illegible]	60 [illegible]

[illegible] WebLM [illegible]

[illegible] 1[illegible] Web Element Manager

1. [illegible]
2. [illegible]

```
http://<base-station-ip>/
```

□

```
https://<base-station-ip>/
```

3. □□□□□□□□□□

□□ 2□□□□□□□□

□□□□

1. □□□□□□□□ **Configuration**
2. □□□□���□□□ **Configuration Management**
3. □□ **Parameter Editor** □□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□□

□□ 1□□□ OAM TLS

□□□ □□□□□□□□□□□□□□□□□ OAM TLS □□□□□□□□`oamTls` □□□□□□ `forced`□□□□□
□□□□□□□□□□□□

□□□□□□□ (□□□) □□

1. □□ **Current BTS configuration**
2. □□ **CURRENT_BTS_CONF-1**
3. □□ **MRBTS-X** (□□ X □□□□□ ID)
4. □□ **oamTls** □□□□
5. □□□ `forced` □□□ `off`

□□	□□□	□□□
oamTls	forced	off

[illegible] [illegible] RAN [illegible] `forced` [illegible] TLS [illegible]

[illegible] 2[illegible] PMCADM [illegible]

[illegible] ([illegible]) [illegible]

1. [illegible] **Current BTS configuration**
2. [illegible] **CURRENT_BTS_CONF-1**
3. [illegible] **MRBTS-X** ([illegible] X [illegible] ID)
4. [illegible] **MNL-1** ([illegible])
5. [illegible] **MNLENT-1** ([illegible])
6. [illegible] **PMCADM-1** ([illegible])

[illegible] PMCADM-1 [illegible]

[illegible] 3[illegible]

[illegible] **Structure 1** [illegible]

[illegible]

□□	□□	□□□
TLS □□□□□□□	□□□□□□	RSA (□□□ TLS)
□□□□□□□□□□□□	RAN □□□ IP □□	□□ RAN □□ IP (□□□10.179.2.139)
□□□□□□□□□□□□□	RAN □□□□□□□	9076 (□□)
□□□□□□□□□□	□□□□□□□□□□	60s (□□□□□□)
□□ **TLS**	□□□□□□	false (□□□□□□)

□□□□□

□□	□□	□□□
SDL □□□□□□□□	□□□□□□	1
SDL □□□	□□□□□□□□	12345678
□□□□□□□□□	□□□□ 0 □□□□	false (□□□□□□□□)

□□ 4□□□□□□□□

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1. □□□□□□ - □□□□ IP □□□□□□□□□
2. □□□□□□□
    - **□□□□□ Create Plan □□**
    - □□□□□□□□□
    - □□□□□□□ ID
3. □□□□□
    - **□□ Validate Plan □□**

   - □□□□ ID
   - □□□□□□
   - □□□□□□□□

4. □□□□□

   - □□ **Activate Plan** □□
   - □□□□ ID
   - □□□□
   - □□□□□□□□

□□□XML □□

□□□□□□□□□□□□□□□□□ XML □□ PMCADM □□□□□□□□□□□□□□□□□□□□□□

```xml
<managedObject class="com.nokia.srbts.mnl:PMCADM" distName="MRBTS-132/MNL-1/MNLENT-1/PMCADM-1" version="MNL25R1_2420_110" operation="create">
  <p name="act3gppXmlEnrichment">false</p>
  <p name="reportingIntervalPm">5min</p>
  <p name="sdlMaxUploadFileNumber">1</p>
  <p name="sdlPrimaryDestIp">10.179.2.139</p>
  <list name="rTPmCollEntity">
    <item>
      <p name="certTypeForTlsAuth">RSA</p>
      <p name="rTPmCollEntityHost">10.179.2.139</p>
      <p name="rTPmCollEntityPortNum">9076</p>
      <p name="rTPmCollInterval">60s</p>
      <p name="tlsEnabled">false</p>
    </item>
  </list>
</managedObject>
```

XML □□□□□□□

- `rTPmCollEntityHost` - □□□□□ RAN □□ IP □□
- `rTPmCollEntityPortNum` - □□□ 9076 (□□ webhook □□)
- `rTPmCollInterval` - □□□□ (□□ 60s)
- `tlsEnabled` - □□□□□□□□ false

- `sdlPrimaryDestIp` - □□□□□ RAN □□ IP □□

□□□ □ `10.179.2.139` □□□□□□□ RAN □□ IP □□□□□□□□□□ ID □□ `MRBTS-132`□

□□□□□□

LNBTS □□□□□

LNBTS (LTE NodeB) □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ PM □□□□□□

actL1PM - □□□ 1 □□□□□

□□	□
□□	actL1PM
□□	NOKLTE:LNBTS □□□□
□□	□□□ (true/false)
□□	false
□□	RTWP □□□ (M8005C306-339)

□□□ □□□ 1 □ (□□□) □□□□□□□□□□□□ RTWP (□□□□□□□)□□□□□□□□□□ RTWP□□□□□□□□□□□□

□□□□□□□□

- M8005C306-309: AVG_RTWP_RX_ANT_1 □ AVG_RTWP_RX_ANT_4
- M8005C310-313: AVG_RTWP_RX_ANT_5 □ AVG_RTWP_RX_ANT_8
- M8005C314: MAX_RTWP
- M8005C317-325: UL_IOT_PUSCH □□□
- M8005C326-335: AVG_SIR □□□

□□ XML □□□

```xml
<managedObject class="NOKLTE:LNBTS" distName="MRBTS-XXXX/LNBTS-XXXX" operation="update">
  <p name="actL1PM">true</p>
</managedObject>
```

□□ WebLM □□□

1. □□□ Configuration > Configuration Management > Parameter Editor
2. □□ MRBTS-X > LNBTS-X
3. □□ `actL1PM` □□
4. □□□□□ `true`
5. □□□□□□□□□□□□

actPCMDReport - □□□□□□□□□□□

□□	□
□□	actPCMDReport
□□	NOKLTE:LNBTS □□□□
□□	□□□ (true/false)
□□	false
□□	□□□□□□□

□□□ □□□□□□□□□ (PCMD) □□□□□□□□□□□□□□□□□

□□ XML □□□

```xml
<managedObject class="NOKLTE:LNBTS" distName="MRBTS-XXXX/LNBTS-XXXX" operation="update">
  <p name="actPCMDReport">true</p>
</managedObject>
```

PMCADM-1 [illegible]

PMCADM ([illegible]) [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

PMCADM [illegible]

reportingIntervalPm - PM [illegible]

[illegible]	[illegible]
[illegible]	reportingIntervalPm
[illegible]	com.nokia.srbts.mnl:PMCADM [illegible]
[illegible]	[illegible]
[illegible]	5min, 15min, 30min, 60min
[illegible]	5min [illegible] 15min [illegible]

[illegible] [illegible]

[illegible]

- **5min** - [illegible]
- **15min** - [illegible]
- **60min** - [illegible]

[illegible] XML [illegible]

```xml
<managedObject class="com.nokia.srbts.mnl:PMCADM" distName="MRBTS-XXXX/MNL-1/MNLENT-1/PMCADM-1" operation="update">
  <p name="reportingIntervalPm">5min</p>
</managedObject>
```

□□ WebLM □□□

1. □□□ Configuration > Configuration Management > Parameter Editor
2. □□ MRBTS-X > MNL-1 > MNLENT-1 > PMCADM-1
3. □□ `reportingIntervalPm` □□
4. □□□□□□□□□□ (□□□`5min`)
5. □□□□□□□□□□□□

□□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□

certTypeForTlsAuth - TLS □□□□□□□

- □□□ □□ (RSA, DSA, ECDSA)
- □□□ □□□□ TLS □□□□□□
- □□□ RSA
- □□□ □□ tlsEnabled = true □□□

rTpmCollEntityHost - □□□□□□

- □□□ IP □□ (IPv4 □ IPv6)
- □□□ □□□□□□□ IP □□
- □□□ □
- □□□ 10.179.2.139
- □□□ □□□□□□□□□□□□□

rTpmCollEntityPortNum - □□□□□□□

- □□□ □□ (1-65535)
- □□□ □□□□□□□ TCP □□

- □□□ 9076
- □□□ □□□ RAN □□□□□□

rTpmCollInterval - □□□□

- □□□ □□ (□)
- □□□ □□□□□□□□□
- □□□ 15s, 30s, 60s, 300s, 900s, 1800s
- □□□ 60s
- □□□ □□□□□□ 60s□□□□□□□□□ 15s

tlsEnabled - □□ TLS

- □□□ □□□ (true/false)
- □□□ □□□□□□□□□□
- □□□ false
- □□□ □□□□□□□□□□□□□□□

sdlMaxUploadFileNumber - SDL □□□□□□□□

- □□□ □□
- □□□ □□□□□□□□□□
- □□□ 1
- □□□ □□□□□□□□□

sdlNonce - SDL □□□

- □□□ □□□ (8 □□□)
- □□□ SDL □□□□□□□□□□
- □□□ 12345678
- □□□ □□□□□□□□□□□□

suppressZeroValueCount - □□□□□□□

- □□□ □□□ (true/false)
- □□□ ���□□□□□□□□□□□□
- □□□ false

- □□□ □□□ false □□□□□□□□□□□□□□□

□□

□□□□□□□□□□□□□□□□□□□□ RAN □□□

□□ RAN □□ Web UI

1. □□ RAN □□ Web UI: `http://<ran-monitor-ip>:4000/`
2. □□□ **BTS Status** □□
3. □□□□□□□□□□□□
4. □□□□□□□ **Connected** (□□□□□) — □□□□□□□□□□□□□□□□□□□□□□□□□ PM □□
5. □□□□□□□ **Waiting for PM Data**□□□□□□□□□□□□□□□□□□□□□□□ (□□□□□ 15 □□□ PM □□)

□□□□□

- □□□ Connected (□□)
- □□□ □□

- [illegible] [illegible] IP [illegible]
- [illegible] [illegible]

[illegible] **Pending**[illegible]

[illegible]

[illegible]

- [illegible] ID [illegible]
- RAN [illegible]
- [illegible]

[illegible]

[illegible] RAN [illegible]

□□□□□□

- PMCADM □□□□ IP □□□□□
- □□□□□□
- □□□□□□□ 8080
- RAN □□□□□□□

□□□□□□

□□ InfluxDB □□□

1. □ RAN □□ Web UI □□□□□ **InfluxDB Status**
2. □□□□□□□□□□
3. □□ **Performance Metrics** □□□□□□□
4. □□ **Last Update** □□□□□□□

[illegible]

- **Performance Metrics**[illegible] [illegible]
- **Configuration**[illegible] [illegible]
- **Alarms**[illegible] [illegible] 0

[illegible]

1. [illegible] **Data Retention Policy** [illegible]
2. [illegible]
3. [illegible] **Performance Metrics**[illegible]**Configuration** [illegible] **Alarms** [illegible]

[illegible]

[illegible] RAN [illegible]

[illegible] [illegible] BTS [illegible]

[illegible]

1. [illegible]

   ```
   ping <base-station-ip>
   ```

2. [illegible] **RAN** [illegible]
   - [illegible] `config/runtime.exs`
   - [illegible] IP [illegible]
   - [illegible]

3. [illegible] **RAN** [illegible]

   - [illegible] **Live Logs** [illegible]
   - [illegible]
   - [illegible]

4. [illegible]

   - [illegible] WebLM [illegible] PMCADM-1 [illegible]
   - [illegible] RAN [illegible] IP [illegible]
   - [illegible] 9076

[illegible]“Pending”[illegible]

[illegible] [illegible]“Pending”

[illegible]

1. [illegible]

   - [illegible] RAN [illegible] ID [illegible]
   - [illegible]

2. [illegible]

   - [illegible] runtime.exs [illegible]
   - [illegible]/[illegible]

3. [illegible]

   - [illegible] 30-60 [illegible]
   - [illegible]

[illegible]

[illegible] “[illegible]enetunreach”[illegible]

[illegible]

1. □□□□□□□
   - □□□□□ RAN □□□□□
   - □□□□□
   - □□ VLAN/subnet □□□□□□
2. □□□□□□□□
   - □□□□ 9076 □□ (□□□□□□□□)
   - □□□□ 8080 □□ (□□ SOAP API □□)
   - □□□□ ACL □□□□
   - □□ RAN □□□□□□□ iptables □□
3. □□ **RAN** □□□□□□□□

```
# □□ SOAP API □ webhook □□
netstat -tlnp | grep -E '8080|9076'
```

□□ RTWP □□ 1 □□□□

□□□ □□□□□□□□□□ InfluxDB □□□ RTWP □□□ (M8005C306-339)

□□□ LNBTS □□□□ `actL1PM` □□□□□ `false`□□□□□□ 1 □□□□□□

□□□□□

1. □□□□□□□
   - □□□□□□
   - □ LNBTS □□□□ `actL1PM`
   - □□□□ `false`□□□□□
2. □□□ **1** □ **PM**□
   - □□□□□□ WebLM
   - □□□ MRBTS-X > LNBTS-X
   - □ `actL1PM` □□□ `true`
   - □□□□□□□□□□□□

3. [illegible]
    - [illegible] ([illegible] 60 [illegible])
    - [illegible] InfluxDB [illegible] M8005C306-309 [illegible]
    - RTWP [illegible]

[illegible]

- `actPCMDReport` - [illegible] ([illegible])

InfluxDB [illegible]

[illegible] [illegible]

[illegible]

1. [illegible]
    - [illegible] PMCADM-1 rTpmCollInterval [illegible]
    - [illegible]
    - [illegible] InfluxDB [illegible]
2. [illegible] **InfluxDB** [illegible]
    - [illegible] InfluxDB [illegible]
    - [illegible]“Connected”[illegible]
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3. [illegible] **RAN** [illegible]
    - [illegible] InfluxDB [illegible]
    - [illegible]
    - [illegible] API [illegible]���[illegible]

TLS/[illegible]

[illegible] [illegible] TLS [illegible]

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   - □□ RAN □□□□□□□ CA □□
2. □□□□□□ **TLS**□
   - □ tlsEnabled □□□ false
   - □□□□□□□□□□
   - □□□□□□□□□□ TLS
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- □□□□□□□ - RAN □□□□□□
- Nokia Counter Reference - □□□□□□□
- Grafana □□ - □□□□□□□□□□□□
- API □□ - □□□□□ REST API □□
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- **config/runtime.exs** - RAN □□□□□□

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1. □□ RAN □□□□□□□□
2. □□□□□□□□□□□ Nokia □□□□
3. □□□□□□□□□□
4. □□□□□□□□□

[illegible]

[illegible]

[illegible]

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2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]

[illegible]

[illegible]“[illegible]”[illegible] AirScale [illegible]RAN Monitor [illegible]

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[illegible] 4G [illegible]/[illegible]/[illegible]

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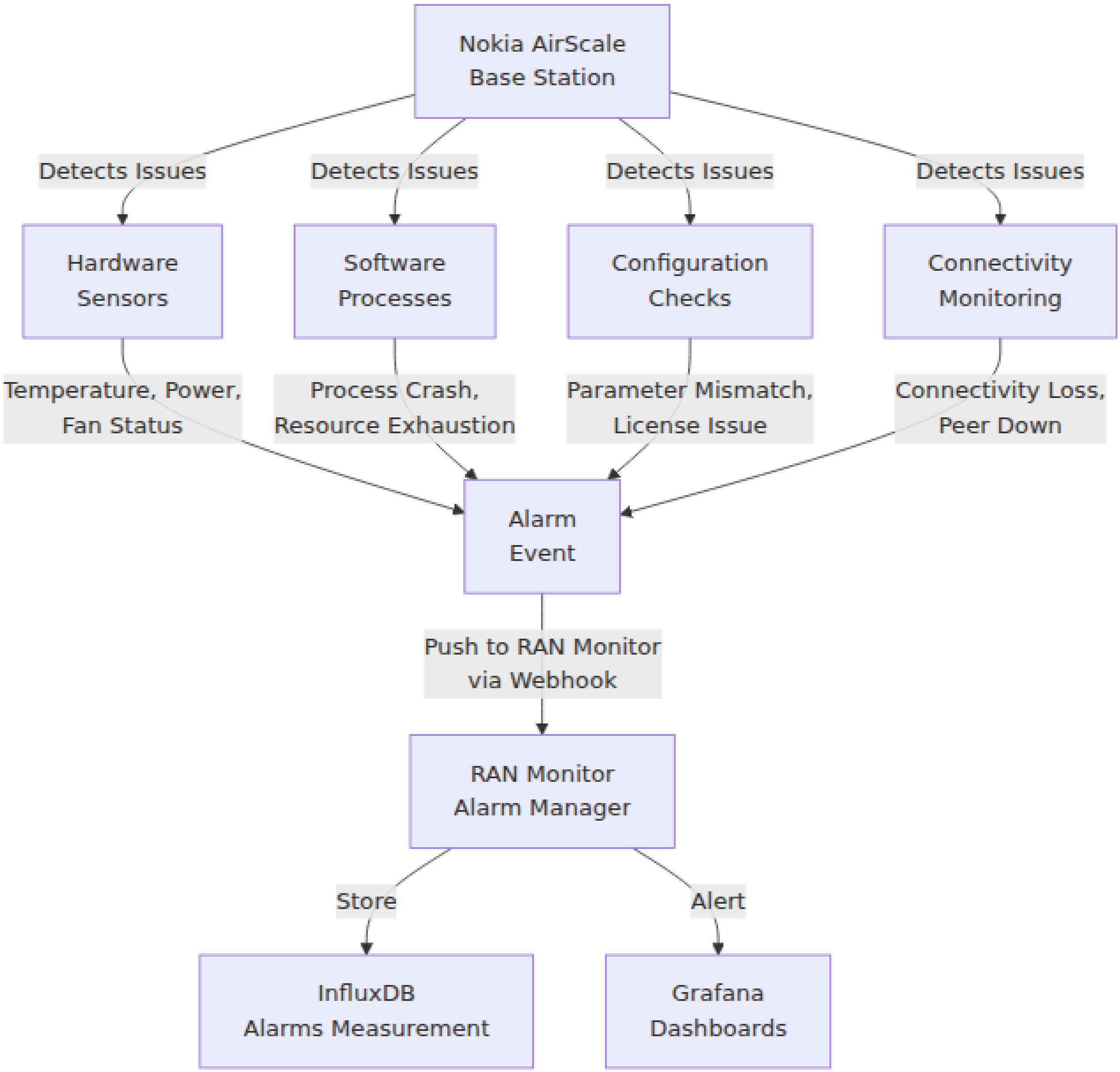
Nokia AirScale Base Station
Detects Issues
Detects Issues
Detects Issues
Detects Issues
Hardware Sensors
Software Processes
Configuration Checks
Connectivity Monitoring
Temperature, Power, Fan Status
Process Crash, Resource Exhaustion
Parameter Mismatch, License Issue
Connectivity Loss, Peer Down
Alarm Event
Push to RAN Monitor via Webhook
RAN Monitor Alarm Manager
Store
Alert
InfluxDB Alarms Measurement
Grafana Dashboards

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□□□□	"S1 □□□□"	□□□□
□□□□□	/BSC-1/BTS-23/Cell-A	□□□□□□□DN□
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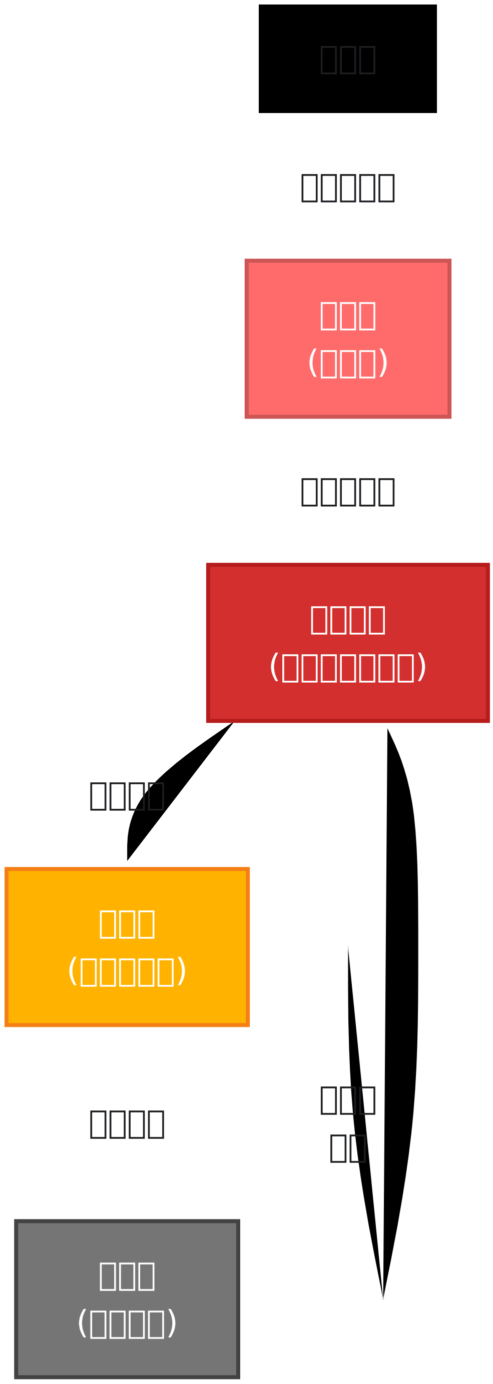

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            └─> [illegible]“S1 [illegible]”[illegible]

14:23:47 UTC - [illegible] RAN Monitor
            └─> NE3S webhook [illegible]
            └─> [illegible] InfluxDB
            └─> [illegible]

14:23:50 UTC - [illegible]
            └─> Grafana [illegible]
            └─> [illegible] NOC [illegible] Slack [illegible]
            └─> [illegible] PagerDuty [illegible]

14:24:15 UTC - [illegible]
            └─> NOC [illegible]
            └─> [illegible]

14:28:35 UTC - [illegible]
            └─> [illegible]
            └─> [illegible]
            └─> RAN Monitor [illegible]“[illegible]”

14:28:36 UTC - [illegible]
            └─> [illegible]5 [illegible] 51 [illegible]
            └─> [illegible] SLA [illegible]
            └─> 30 [illegible]
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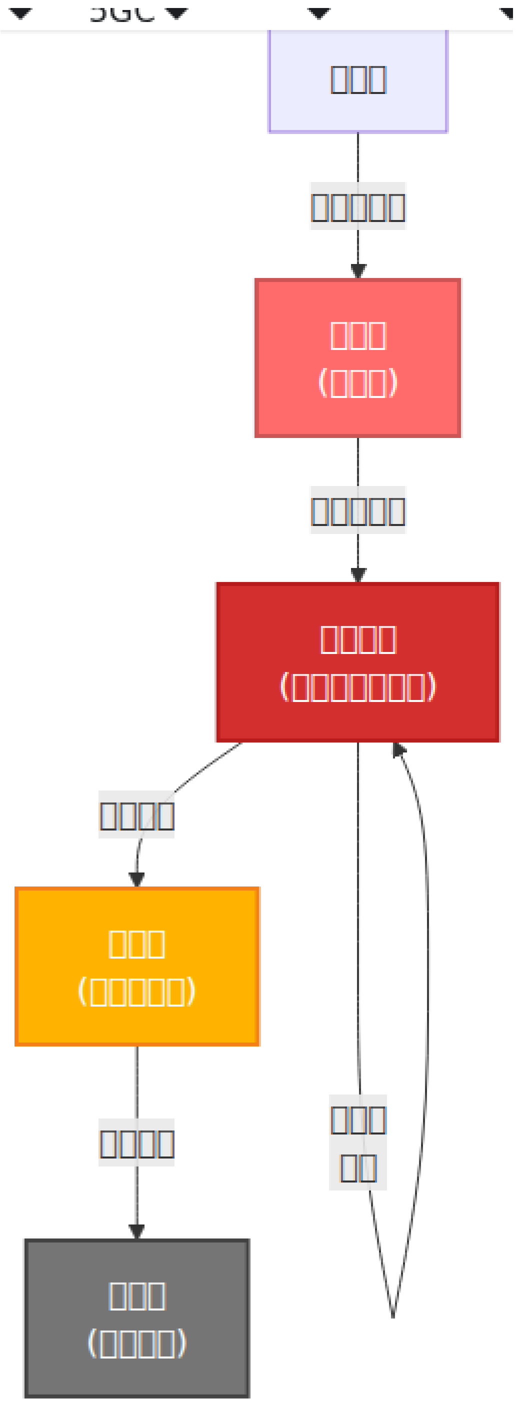
RAN Monitor [illegible]

[illegible]

[illegible] [illegible]



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- [illegible]S1 [illegible]
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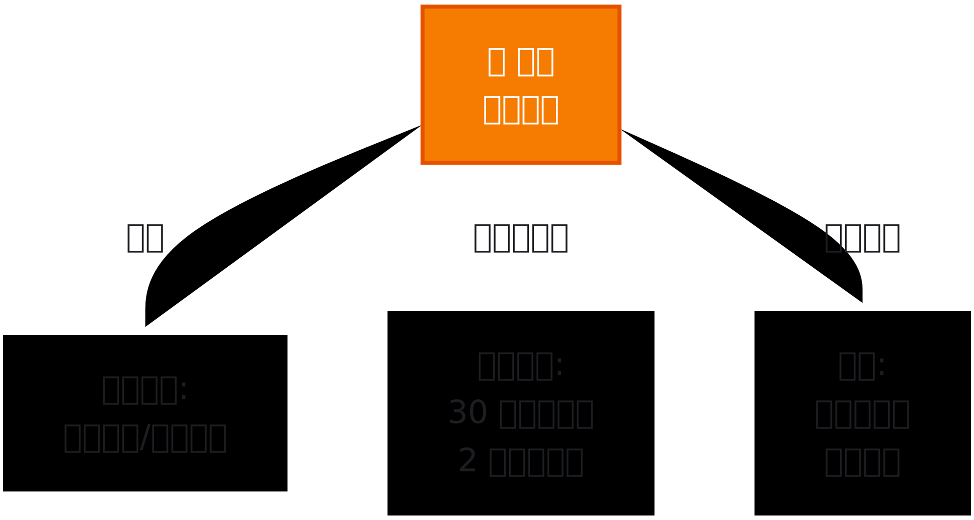

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- □□□□□ < 95%
- DL/UL □□□□□□> 95% □□□□□□
- RLC □□□ > 5%
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- □□□□□E1/T1 □□□□□

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- □□ NOC □□ + □□□□□
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□□ **SLA**□ < 30 □□□□

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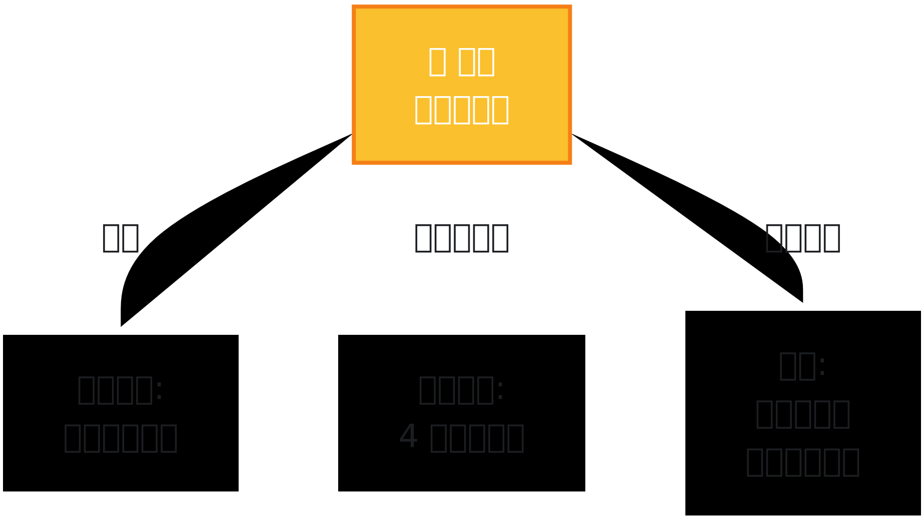

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□□ **SLA**□ □□□□

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- [illegible] 60-70%
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- [illegible]MTTR[illegible]
- [illegible] SLA [illegible]
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  - S1 [illegible]       → MME/SGW [illegible]
  - [illegible]     → IP [illegible]
  - USIM [illegible]���[illegible]     → HSS [illegible]
  - NTP [illegible]     → [illegible]

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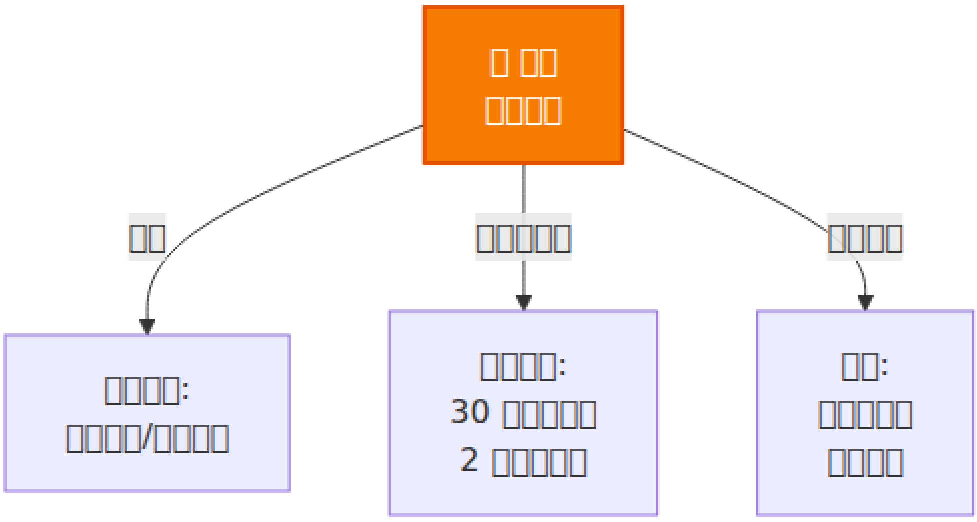

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- Grafana → □□□□□
- InfluxDB → □□□□□□□□

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- □□□ AirScale □□□□□□
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- RAN Monitor □□□□□□□
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- InfluxDB [illegible]

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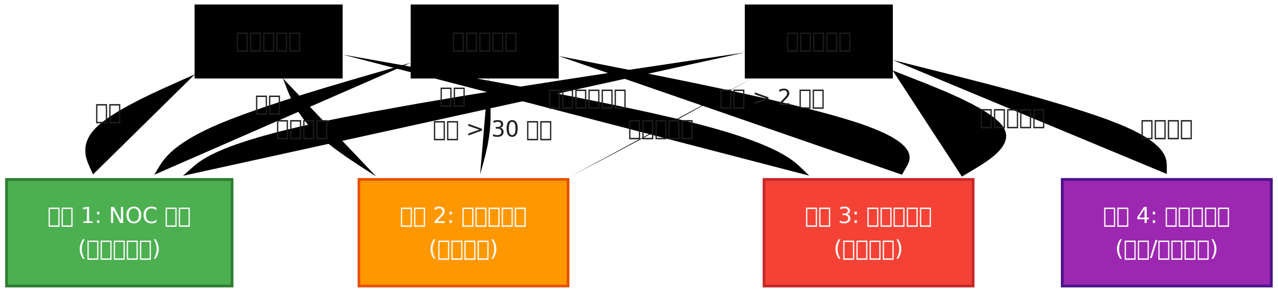

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├─ [illegible]14:23:47[illegible]2 [illegible]← [illegible]
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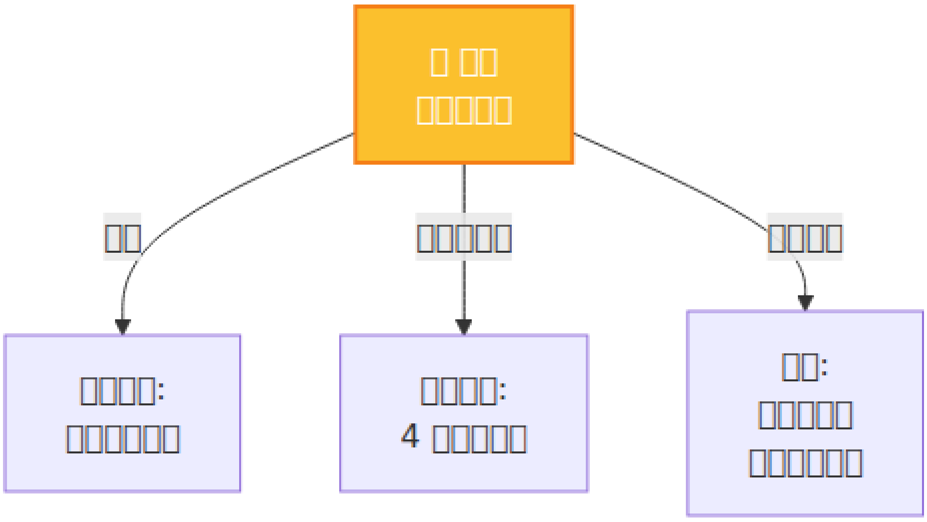

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  - ping □□□ping 192.168.1.100
  - □□□□□□ → □□□□□□

□□ 2□□□□□
  - □□□□□□□□□
  - □□□□□□ LED
  - □□□□□□

□□ 3□□□□□
  - □□□□□□□□□□
  - □□ 60 □□□□
  - □□□□□□□□

□□ 4□□□□□□□
  - □□□□□ 2
  - □□□□□□
  - □□□□

□□□
- □□ > 15 □□ → □□□ [□□□□□]
- □□ > 30 □□ → □□□ [□□□□□]
- □□□□□□ → □□□□□□□

□□□
- □□□□□□□□
```

- [illegible]
- [illegible]

API [illegible]

[illegible] RAN [illegible] REST API

[illegible] API [illegible] RAN [illegible]

[illegible]

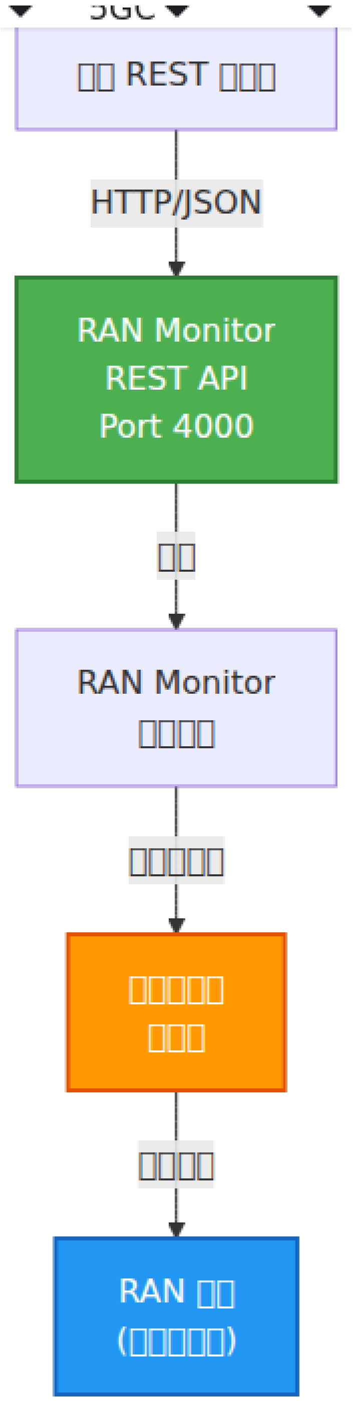
1. [illegible]
2. API [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. API [illegible]

[illegible]

RAN Monitor [illegible] REST API[illegible] RAN [illegible] API [illegible] API [illegible]

- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible]��� - [illegible]

API □□


5GC
□□ REST □□□
HTTP/JSON
RAN Monitor
REST API
Port 4000
□□
RAN Monitor
□□□□
□□□□□
□□□□□
□□□
□□□□
RAN □□
(□□□□□)

API □□

- **RESTful □□** - □□ HTTP □□ (GET, POST, PUT, DELETE)
- **JSON □□** - □□□□□□□□□ JSON
- □□□□□ - □□□□□□□□□□□□ API
- □□□□□ - □□□□□□□□□□

- [illegible] - [illegible]
- [illegible] - [illegible]

[illegible]

[illegible]

[illegible] RAN Monitor [illegible] RAN Monitor [illegible]

[illegible]

1. [illegible]/[illegible] API ��[illegible]
2. [illegible]
3. [illegible]
4. [illegible]

API [illegible]

[illegible]RAN Monitor API [illegible]

- [illegible]
  - [illegible] API [illegible]`Authorization: Bearer <api-key>`
  - OAuth2 [illegible]
  - [illegible]/VPN[illegible]
- [illegible]
  - [illegible]
  - [illegible]
- [illegible]
  - [illegible] API [illegible]/[illegible]
  - [illegible]

API □□

REST API □□

RAN Monitor API □□□□□□□□□□□

```
/api/v1/
├── /devices                   # □□□□
│   ├── GET                    # □□□□□□
│   ├── POST                   # □□□□□
│   └── /:id                   # □□□□
│       ├── GET                # □□□□□□
│       ├── PUT                # □□□□□□
│       ├── DELETE             # □□□□
│       ├── /sessions          # □□□□
│       ├── /config            # □□□□
│       ├── /alarms            # □□□□
│       ���── /metrics           # □□□□
│
├── /operations                # □□□□
│   ├── /get                   # □□□□
│   ├── /set                   # □□□□
│   └── /search                # □□□□
│
└── /health                    # □□□□
    ├── /status                # □□□□
    └── /devices/:id/ping      # □□□□□
```

□□ URL

```
http://<ran-monitor-ip>:4000/api/v1
```

[illegible]

[illegible]

[illegible]

```
GET /api/v1/devices
```

[illegible]

```json
{
  "data": [
    {
      "name": "SITE_A_BS1",
      "address": "192.168.1.100:8080",
      "registration_status": "registered",
      "session_status": "active",
      "bts_status": "connected",
      "vendor": "Nokia",
      "agent_type": "AirScale",
      "software_release": "BSC-2250.5.0",
      "hardware_version": "2.0",
      "agent_unique_id": "airscale-001",
      "manager_vendor": "Nokia",
      "manager_release": "NE3S-5.0",
      "license_required": false,
      "retention_hours": 720,
      "last_connected_at": "2025-12-10T14:30:00Z",
      "disconnected_at": null,
      "last_error_code": null,
      "last_error_string": null,
      "data": {
        "pm_points": 45320,
        "pm_last_write": "2025-12-10T14:15:00Z",
        "config_points": 1200,
        "config_last_write": "2025-12-10T14:30:00Z",
        "alarm_points": 15
      },
      "pm_warning": null
    }
  ],
  "meta": {
    "total": 50,
    "page": 1,
    "per_page": 25,
    "total_pages": 2
  },
  "status_counts": {
    "total": 50,
    "connected": 45,
    "waiting_for_pm": 2,
    "pending": 1,
    "registering": 0,
    "disconnected": 2
  }
}
```

□□□□□□

```
GET /api/v1/devices/:id
```

□□□

```
{
  "device": {
    "id": "nokia_bs1",
    "name": "SITE_A_BS1",
    "vendor": "Nokia",
    "address": "192.168.1.100",
    "registration_status": "registered",
    "registration_key": "base64_encoded_key",
    "session_id": "nonuniquesession",
    "session_expiry": "2025-12-11T14:30:00Z",
    "device_info": {
      "type": "AirScale",
      "software_release": "5.0.0",
      "hardware_version": "2.0",
      "agent_unique_id": "airscale-001"
    }
  }
}
```

□□□□

```
PUT /api/v1/devices/:id/register
Content-Type: application/json

{
  "address": "192.168.1.100:8080",
  "web_username": "admin",
  "web_password": "password",
  "webhook_url": "http://manager.example.com:9076/webhook",
  "private_key_path": "/etc/certs/private.key",
  "public_key_path": "/etc/certs/public.key"
}
```

[illegible]

```json
{
  "result": "Success",
  "registration_key": "base64_encoded_nonce",
  "device_id": "nokia_bs1",
  "message": "[illegible]"
}
```

[illegible]

- `200` - [illegible]
- `400` - [illegible]
- `409` - [illegible]
- `500` - [illegible]

[illegible]

```
DELETE /api/v1/devices/:id
```

[illegible]

```
{
  "result": "Success",
  "message": "[illegible]",
  "device_id": "nokia_bs1"
}
```

[illegible]

[illegible]

```
PUT /api/v1/devices/:id/sessions
Content-Type: application/json

{
  "session_id": "session_unique_identifier"
}
```

[illegible]

```
{
  "result": "Success",
  "session_id": "session_unique_identifier",
  "session_timeout": 86400,
  "expires_at": "2025-12-11T14:30:00Z"
}
```

[illegible]

- [illegible]24 [illegible]
- [illegible]
- [illegible] 20 [illegible]

[illegible]

```
GET /api/v1/devices/:id/sessions
```

[illegible]

```json
{
  "session": {
    "active": true,
    "session_id": "session_unique_identifier",
    "expires_at": "2025-12-11T14:30:00Z",
    "time_remaining_seconds": 82400,
    "last_activity": "2025-12-10T14:30:00Z"
  }
}
```

[illegible]

```
POST /api/v1/devices/:id/sessions/keep-alive
```

[illegible]

```json
{
  "result": "Success",
  "new_expiry": "2025-12-11T14:30:00Z"
}
```

[illegible]

[illegible]

[illegible]

```
PUT /api/v1/devices/:id/config/upload
Content-Type: application/json

{
  "filter": {
    "uploadType": "configuration",
    "objects": [
      {
        "sdn": "/BSC-1/BTS-23/*",
        "depth": 100
      }
    ],
    "objectClass": ""
  }
}
```

□□□

```json
{
  "result": "Success",
  "configuration": {
    "timestamp": "2025-12-10T14:30:00Z",
    "device_id": "nokia_bs1",
    "parameters": {
      "/BSC-1/BTS-23": {
        "BtsBasics": {
          "BtsName": "CELL_A",
          "BtsType": "MACRO",
          "EnvironmentalSpecifications": {
            "TemperatureRange": "Industrial"
          }
        },
        "CarrierAggregation": {
          "CarrierAggregationCapability": true,
          "MaxUECarriers": 5
        }
      }
    }
  }
}
```

[illegible]

[illegible]��[illegible]

```
PUT /api/ne3s/function/provision
Content-Type: application/json

{
  "airscale_name": "nokia_bs1",
  "config_file": "/path/to/config.xml",
  "take_fallback": true,
  "block_local_changes": false
}
```

[illegible]

```json
{
  "status": "success",
  "operation": "provision",
  "plan_id": "plan_1741484400000000000",
  "data": "<provisionResponse>...</provisionResponse>"
}
```

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
airscale_name	[illegible]	[illegible]	-	[illegible]
config_file	[illegible]	[illegible]	-	[illegible] XML [illegible]
take_fallback	[illegible]	[illegible]	true	[illegible]
block_local_changes	[illegible]	[illegible]	false	[illegible]

[illegible]

- `INVALID_FILE` - config_file [illegible]

- `TRANSPORT_ERROR` - [illegible]
- `SESSION_ERROR` - [illegible] NE3S [illegible]
- [illegible] SOAP [illegible]

[illegible]

```
PUT /api/v1/devices/:id/config/set
Content-Type: application/json

{
  "parameter_path": "/BSC-1/BTS-23/BtsBasics/BtsName",
  "value": "NEW_CELL_NAME",
  "value_type": "string"
}
```

[illegible]

```json
{
  "result": "Success",
  "parameter": "/BSC-1/BTS-23/BtsBasics/BtsName",
  "old_value": "CELL_A",
  "new_value": "NEW_CELL_NAME",
  "applied_at": "2025-12-10T14:30:45Z"
}
```

[illegible]

□□	□□	□□	□□
BtsName	□□□	"SITE_A_Cell_1"	□□/□□□□□
MaxUEsServed	□□	256	□□□□ UEs
CellTXPower	□□	40 (dBm)	□□□□□□
EnableCarrierAgg	□□	true	□□□□□□
HandoverHysteresis	□□	3 (dB)	□□□□□

□□□□□□

```
GET /api/v1/devices/:id/config/history?limit=10&days=7
```

□□□

```
{
  "history": [
    {
      "timestamp": "2025-12-10T14:30:45Z",
      "change_type": "parameter_modified",
      "parameter": "/BSC-1/BTS-23/BtsBasics/BtsName",
      "old_value": "CELL_A",
      "new_value": "NEW_CELL_NAME",
      "reason": "□□□□□□□"
    }
  ]
}
```

□□□□

□□□□□□

□□□□□□□□□□

```
PUT /api/v1/devices/:id/metrics/upload
Content-Type: application/json

{
  "filter": {
    "uploadType": "measurement",
    "objects": [
      {
        "sdn": "*",
        "depth": 100
      }
    ]
  }
}
```

□□□

```json
{
  "result": "Success",
  "metrics": {
    "timestamp": "2025-12-10T14:30:00Z",
    "measurement_interval": 300,
    "counters": [
      {
        "id": "M1C1",
        "name": "DL □□□□□",
        "value": 125.4,
        "unit": "Mbps",
        "cell_dn": "/BSC-1/BTS-23/Cell-1"
      },
      {
        "id": "M1C2",
        "name": "UL □□□□□",
        "value": 89.2,
        "unit": "Mbps",
        "cell_dn": "/BSC-1/BTS-23/Cell-1"
      }
    ]
  }
}
```

[illegible]

```
PUT /api/v1/devices/:id/alarms/upload
Content-Type: application/json

{
  "filter": {
    "uploadType": "active_faults"
  }
}
```

[illegible]

```json
{
  "result": "Success",
  "alarms": [
    {
      "alarm_id": "a1b2c3d4",
      "severity": "Critical",
      "probable_cause": "[illegible]",
      "specific_problem": "[illegible]",
      "affected_dn": "/BSC-1/BTS-23/Cell-1",
      "event_time": "2025-12-10T14:15:30Z",
      "description": "[illegible] 1 [illegible]"
    }
  ]
}
```

[illegible]

```
PUT /api/v1/devices/:id/topology/upload
Content-Type: application/json

{
  "filter": {
    "uploadType": "topology",
    "objects": [
      {
        "sdn": "*",
        "depth": 100
      }
    ]
  }
}
```

□□□

```json
{
  "result": "Success",
  "topology": {
    "device_dn": "/BSC-1",
    "managed_elements": [
      {
        "name": "BTS-23",
        "type": "□□□□□□",
        "dn": "/BSC-1/BTS-23",
        "cells": [
          {
            "name": "Cell-1",
            "type": "EUtranCell",
            "physical_cell_id": 100,
            "frequency": 2110
          }
        ]
      }
    ]
  }
}
```

[illegible]

Ping [illegible]

```
PUT /api/v1/devices/:id/ping
```

[illegible]

```json
{
  "result": "Success",
  "device_id": "nokia_bs1",
  "latency_ms": 45,
  "status": "[illegible]"
}
```

[illegible]

```
GET /api/system-metrics
```

[illegible]PM [illegible] InfluxDB [illegible]

[illegible]

```json
{
  "data": {
    "batch_writer": {
      "queue_depth": 120,
      "queue_max": 50000,
      "flush_count": 8452,
      "points_written": 1250000,
      "bytes_written": 89000000
    },
    "pm_spool": {
      "pending_files": 3,
      "files_processed": 1420,
      "files_failed": 0,
      "points_written": 980000,
      "points_filtered": 4200000,
      "bytes_read": 650000000,
      "last_file_ms": 245,
      "started_at": "2025-12-10T08:00:00Z"
    },
    "influxdb_stats": [
      {
        "name": "2045_Booker",
        "total": 12500,
        "last_write": "2025-12-10T14:15:00Z",
        "performance_metrics": 11000,
        "configuration": 1200,
        "alarms": 300
      }
    ],
    "system": {
      "memory_total": 524288000,
      "memory_processes": 312000000,
      "memory_binary": 89000000,
      "memory_ets": 45000000,
      "process_count": 1250,
      "run_queue": 0
    }
  }
}
```

□□□□□□

```
GET /api/v1/health/status
```

[illegible]

```
{
  "status": "healthy",
  "devices": {
    "total": 50,
    "registered": 48,
    "active_sessions": 45,
    "unreachable": 2
  },
  "database": {
    "influxdb": "connected"
  },
  "timestamp": "2025-12-10T14:30:00Z"
}
```

[illegible]

[illegible]

Nokia eNodeB [illegible]

```
/SystemFunctions
├── /BSC-1 (□□□□□)
│   └── /BTS-23 (□□□□□□)
│       ├── BtsBasics (□□□□□□□□)
│       ├── /Cell-1
│       │   ├── CellCommonData
│       │   ├── CellAdvanced
│       │   └── CarrierAggregation
│       └── /Cell-2
│           └── ...
└── /Connectivity
    ├── S1Interface
    ├── X2Interface
    └── NetworkConfiguration
```

□□□□□□

□□/□□□□

```json
{
  "parameter_path": "/BSC-1/BTS-23/Cell-1/CellCommonData/AdminState",
  "value": "UNLOCKED",
  "value_type": "enum"
}
```

□□□□□`LOCKED`, `UNLOCKED`, `SHUTTING_DOWN`

□□□□□□

```json
{
  "parameter_path": "/BSC-1/BTS-23/Cell-1/CellAdvanced/CellTXPower",
  "value": "35",
  "value_type": "integer"
}
```

□□□0-46 dBm□□□□□□

[illegible]

```json
{
  "parameter_path": "/BSC-1/BTS-23/Cell-1/CellAdvanced/HandoverHysteresis",
  "value": "3",
  "value_type": "integer"
}
```

[illegible]dB[illegible]0-8 dB

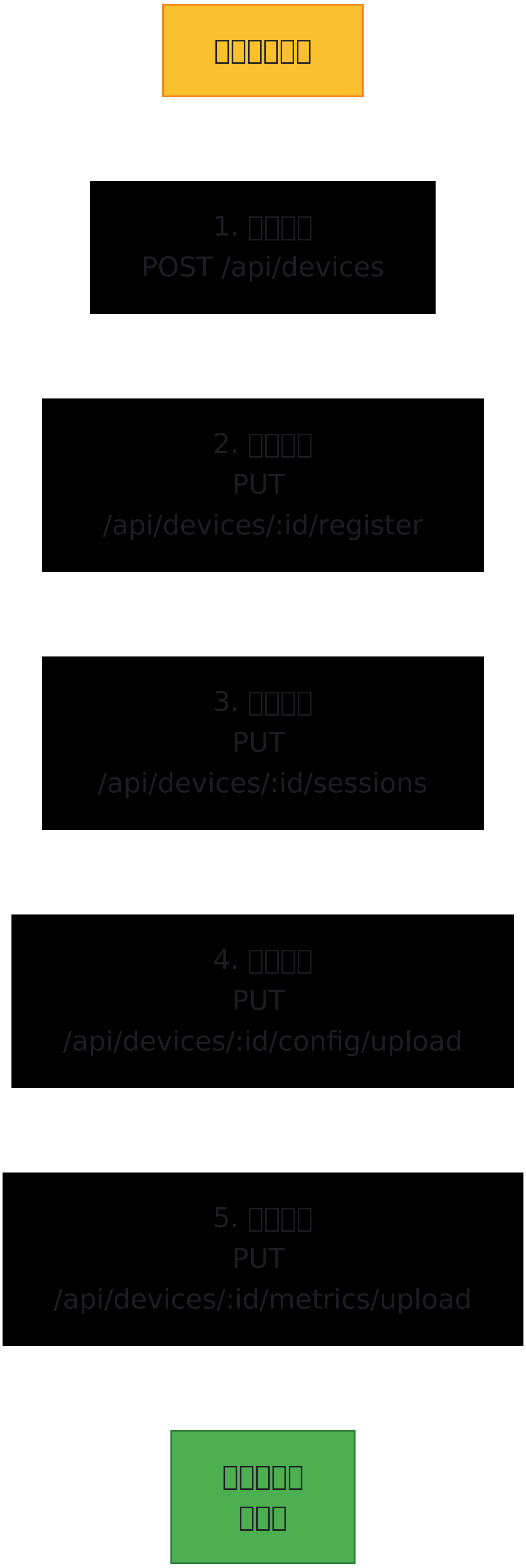
[illegible]

```json
{
  "parameter_path": "/BSC-1/BTS-23/MaxUEsServed",
  "value": "256",
  "value_type": "integer"
}
```

[illegible]

[illegible]

[illegible] 1[illegible]


1.
POST /api/devices
2.
PUT
/api/devices/:id/register
3.
PUT
/api/devices/:id/sessions
4.
PUT
/api/devices/:id/config/upload
5.
PUT
/api/devices/:id/metrics/upload

```
# 1. □□□□□□
curl -X POST http://localhost:4000/api/v1/devices \
  -H "Content-Type: application/json" \
  -d '{
    "id": "site_a_bs1",
    "name": "SITE_A_BS1",
    "vendor": "Nokia",
    "address": "192.168.1.100:8080",
    "credentials": {
      "username": "admin",
      "password": "password"
    }
  }'

# 2. □□□□□
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/register \
  -H "Content-Type: application/json" \
  -d '{
    "webhook_url": "http://manager.example.com:9076/webhook"
  }'

# 3. □□□□
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/sessions \
  -H "Content-Type: application/json" \
  -d '{"session_id": "session_001"}'

# 4. □□��□
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/config/upload \
  -H "Content-Type: application/json" \
  -d '{
    "filter": {
      "uploadType": "configuration",
      "objects": [{"sdn": "*", "depth": 100}]
    }
  }'
```

□□□ 2□□□□□

```
# 1. □□□□□
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/config/upload \
  -H "Content-Type: application/json" \
  -d '{
    "filter": {
      "uploadType": "configuration",
      "objects": [{"sdn": "/BSC-1/BTS-23/Cell-1", "depth": 10}]
    }
  }' | jq '.configuration.parameters["/BSC-1/BTS-23/Cell-1"]'

# 2. □□□□
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/config/set \
  -H "Content-Type: application/json" \
  -d '{
    "parameter_path": "/BSC-1/BTS-23/Cell-
1/CellAdvanced/CellTXPower",
    "value": "38",
    "value_type": "integer"
  }'

# 3. □□□□
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/config/upload \
  -H "Content-Type: application/json" \
  -d '{
    "filter": {
      "uploadType": "configuration",
      "objects": [{"sdn": "/BSC-1/BTS-23/Cell-1/CellAdvanced",
"depth": 5}]
    }
  }' | jq '.configuration.parameters["/BSC-1/BTS-23/Cell-
1/CellAdvanced/CellTXPower"]'
```

□□□ 3□□□□□

```
# □□□□□□□□□□□□
#!/bin/bash

DEVICE="site_a_bs1"
INTERVAL=300  # 5 □□

while true; do
  # □□□□
  METRICS=$(curl -s -X PUT
http://localhost:4000/api/v1/devices/$DEVICE/metrics/upload \
    -H "Content-Type: application/json" \
    -d '{
      "filter": {
        "uploadType": "measurement",
        "objects": [{"sdn": "*", "depth": 100}]
      }
    }')

  # □□□□□□
  DL=$(echo $METRICS | jq '.metrics.counters[] |
select(.id=="M1C1") | .value')
  CELLS=$(echo $METRICS | jq '.metrics.counters | length')

  echo "$(date): DL=$DL Mbps, Cells=$CELLS"

  # □□□□
  ALARMS=$(curl -s -X PUT
http://localhost:4000/api/v1/devices/$DEVICE/alarms/upload \
    -H "Content-Type: application/json" \
    -d '{
      "filter": {
        "uploadType": "active_faults"
      }
    }' | jq '.alarms | length')

  if [ "$ALARMS" -gt 0 ]; then
    echo "□□□$ALARMS □□□□□"
  fi
  sleep $INTERVAL
done
```

[illegible]

HTTP [illegible]

[illegible]	[illegible]	[illegible]
`200`	[illegible]	[illegible]
`201`	[illegible]	[illegible]
`400`	[illegible]	[illegible] JSON [illegible]
`401`	[illegible]	[illegible]/[illegible] API [illegible]
`404`	[illegible]	[illegible]
`409`	[illegible]	[illegible]
`500`	[illegible]	[illegible]
`503`	[illegible]	[illegible]

□□□□□□

```json
{
  "error": {
    "code": "DEVICE_NOT_FOUND",
    "message": "□□ 'site_a_bs1' □□□",
    "details": {
      "device_id": "site_a_bs1",
      "timestamp": "2025-12-10T14:30:00Z"
    }
  }
}
```

□□□□

□□□□□□

```json
{
  "error": {
    "code": "NOT_REGISTERED",
    "message": "□□□□□□□□□□□",
    "solution": "□□□□ PUT /api/devices/:id/register"
  }
}
```

□□□□□

```json
{
  "error": {
    "code": "SESSION_EXPIRED",
    "message": "□□□□□□□",
    "solution": "□□ PUT /api/devices/:id/sessions □□□□□"
  }
}
```

□□□□□□□

```
{
  "error": {
    "code": "INVALID_PARAMETER",
    "message": "□□□□□□□",
    "details": {
      "parameter": "/BSC-1/BTS-23/Cell-1/CellAdvanced/CellTXPower",
      "value": "99",
      "valid_range": "0-46 dBm"
    }
  }
}
```

API □□

Python □□□□□

```
import requests
import json

class RanMonitorClient:
    def __init__(self, base_url="http://localhost:4000/api/v1"):
        self.base_url = base_url
        self.session = requests.Session()

    def register_device(self, device_id, address, username,
password):
        """□□□□□"""
        url = f"{self.base_url}/devices/{device_id}/register"
        payload = {
            "address": address,
            "web_username": username,
            "web_password": password,
            "webhook_url": "http://manager:9076/webhook"
        }
        response = self.session.put(url, json=payload)
        return response.json()

    def get_config(self, device_id, sdn="*", depth=100):
        """□□□□□□"""
        url = f"{self.base_url}/devices/{device_id}/config/upload"
        payload = {
            "filter": {
                "uploadType": "configuration",
                "objects": [{"sdn": sdn, "depth": depth}]
            }
        }
        response = self.session.put(url, json=payload)
        return response.json()

    def set_config(self, device_id, parameter_path, value,
value_type="string"):
        """□□□□□□"""
        url = f"{self.base_url}/devices/{device_id}/config/set"
        payload = {
            "parameter_path": parameter_path,
            "value": value,
            "value_type": value_type
        }
        response = self.session.put(url, json=payload)
        return response.json()

    def get_metrics(self, device_id):
        """□□□□□□"""
        url = f"
{self.base_url}/devices/{device_id}/metrics/upload"
        payload = {
            "filter": {
                "uploadType": "measurement",
                "objects": [{"sdn": "*", "depth": 100}]
            }
        }
        response = self.session.put(url, json=payload)
        return response.json()

# □□□□
client = RanMonitorClient()

# □□□□
result = client.register_device(
    device_id="site_a_bs1",
    address="192.168.1.100:8080",
    username="admin",
    password="password"
)
print(f"□□□{result}")

# □□□□
config = client.get_config("site_a_bs1")
print(f"□□□{json.dumps(config, indent=2)}")

# □□□□
update = client.set_config(
    "site_a_bs1",
    "/BSC-1/BTS-23/Cell-1/CellAdvanced/CellTXPower",
    "38",
    "integer"
```

```
)
print(f"□□□{update}")
```

cURL □□

□□□□□

```
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/register \
  -H "Content-Type: application/json" \
  -d '{
    "address": "192.168.1.100:8080",
    "web_username": "admin",
    "web_password": "password",
    "webhook_url": "http://manager:9076/webhook"
  }'
```

□□□□□□□

```
curl -X GET http://localhost:4000/api/v1/devices/site_a_bs1
```

□□□□□

```
curl -X PUT
http://localhost:4000/api/v1/devices/site_a_bs1/config/upload \
  -H "Content-Type: application/json" \
  -d '{
    "filter": {
      "uploadType": "configuration",
      "objects": [{"sdn": "/BSC-1/*", "depth": 50}]
    }
  }' | jq '.'
```

Baicells □□

Baicells eNB □□□□□ + KPI □□□□□□□□

Baicells eNB □ RAN Monitor □□ Nokia AirScale □ Casa □□□□□□□□□□□□□——□□□□ PM □ RAN Monitor——Baicells QAFA □□□□ PM □□□□□□□ RAN Monitor □□ □□□□□□□ Web API□□□□□□□□□□□□□□□□□□□□□□□□□□

□□

Baicells Nova □□ eNB□□□ pBS4200□□□ `BaiBS_QAFA_*`□□ `https://<cell>/fsmoam/` □□□□□□□□□ □□□ □□□/□ API□Gargoyle Web UI □□□□□□□□ □□□□□□/PM □□□□□□□□□□——□□□□□□□□□□□□□□□□□□□□ 32.435 □□□□

RAN Monitor □ `Baicells.Scheduler` □□□□□□□□□□□□□□□□□□□/RF/□□/WAN/UE/□□□/□□□□□□□ `/fsmoam/`□□□□□□□ InfluxDB□□□□□□□□□□□□□□GPS□OMC���WAN□□□□□ `0/1` □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□	□
□□	□□□□□□ — `GET /fsmoam/...`□□□□□□□
□□□□	`config :ran_monitor, :baicells, interval_ms:`□□□ 60s□
InfluxDB □□	`BaicellsPerformanceMetrics`
□□□	eNB id / □□□□□□□
□□/□□	□□□ — □□□□□□□ `set.*` □□

> □□□□□□□□ TCP 443□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

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```
RanMonitor.Baicells.Scheduler         (GenServer, □□ interval_ms □
□)
   └─ □□□□□□□□□□
        RanMonitor.Baicells.Collector (□□□□□□)
          ├─ RanMonitor.Baicells.Fsmoam     GET /fsmoam/get.
<oid>?...□□□□□
          ├─ □□□□□□□□□/□□/GPS/OMC/WAN/RF/□□□
          └─ □□ InfluxDB □□BaicellsPerformanceMetrics□
        → RanMonitor.EnhancedInfluxDbConnection.write
        → RanMonitor.Database.InfluxDbStats.record_write
        → RanMonitor.Baicells.Ingest□□□□□□□□□□□□□□□
```

□□□□□

□□	□□
Fsmoam	`/fsmoam/` □□ API □□□□□□/□□□
Collector	□□□□ → □□□□ + InfluxDB □□□
Scheduler	□□□□□□ → Influx + □□ + Ingest
Cells	□□□□□□□□□□
Ingest	□□□□□□□□□□□□□□□□□□□□□□□□
Baicells □□□□	"Baicells □□" □□

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□□□□□□**0/1** □□□□□ `CELL.OpStateUp`□`CELL.Synced`□`CELL.GpsInPosition`□`CELL.OmcConnected`□ `CELL.WanLinkUp`□`FM.ActiveAlarms`

□□□□□□□□□□□□□□□ `RRC.ConnMean`□□□ UE□□`DRB.PdcpSduBitrateDl` / `DRB.PdcpSduBitrateUl` □kbps□□`RRU.RssiUl`□`RRU.MaxTxPowerDbm`□`CARR.EarfcnDl`□`CARR.PhyCellId`

□□□□□□ `BaicellsPerformanceMetrics`□□`counterValue` □□□ □□ `metricCounter, enbName, enbId, site, host, metricMcc, metricMnc, vendor="Baicells", recordType`□

□□

```
config :ran_monitor, :baicells,
  interval_ms: 60_000,
  cells: [
    %{
      name: "baicells-nova-pbs4200",
      enb_id: "1202000091183FP0178",   # □□□ / eNB id□enbId □□ + □□□□
      site: "Apex Lifestyle Lab",
      host: "10.7.15.70",
      scheme: "https"                   # □□ https
    }
  ]
```

□□□RAN Monitor → Baicells □□ □□ **TCP 443**□□□□□□□□□□□□□□□

Web UI

Baicells □□ (`/baicells/status`) — □□□□□□□□□□□□□□□ □□□□/□□□□□□`DISP` = □□□□□GPS□OMC/ACS□WAN□□□ UE□□□/□□ □□□□□□ RSSI□EARFCN/PCI□□□ TX □□□□□□□□□□ □□□□□□□□□□□□□□□□ 5 □□□□□□□□

□□ Baicells □□□□□□□□□——□□□ ~13 □□□□□□ □□□□□□□□□□□□□□ Casa □ ~1065 □□□□□□□□□□

□□

```
# □□ fsmoam □□□□□□□□□□——□□□□
curl -sk "https://10.7.15.70/fsmoam/get.0x08010005.0?
ModuleType:+SoftwareVersion:+SerialNumber"

# InfluxDB □□□□□
influx -database 'nokia-monitor' \
  -execute 'SELECT last("counterValue") FROM
"BaicellsPerformanceMetrics" GROUP BY "metricCounter"'
```

□□□□□□□`[Baicells.Scheduler] <name> (<host>): up=<bool> ue=<n> wrote <N> metric(s)`□ □□□ **Baicells** □□ □□□

> □□□□□□□□□□□/□□□□□□□□□ `phyCellId` □□ → `cellUnavailableAlarm`□□□□ UE/□□□/RSSI □□□□□□□ □□□ `CELL.*` □□□□ + □□——□□□□□□□

□□□□

- **Casa PM Collection** — □□□□□□□□□□□“□□□□□”□□□
- **Getting Started** — □□□□
- **Grafana Integration** — □□□
- **Operations Guide** — □□□□

Casa PM □□

Casa Systems femtocells □□□□□□□□□□□□□□

RAN Monitor □□□□□□□Casa Systems □ eNB □ Nokia AirScale □ Baicells □□□□□ Casa femtocells □□□□ — □□□□□□□□ PM □□□□□□RAN Monitor □□□□□□□□□□□□□□□□□□ IP□□□□□□□□□□□ SSH □□□□□□□□□□□□□□□□□□□□ PM □□□□□□□□□□□□□□□□□□□□□□SSH □□□□□□

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2. □□
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5. □□□□ (KPI □□)
6. □□□□
7. □□□
8. □□□□□
9. Web UI
10. API
11. □□□□
12. □□
13. □□□□

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Casa eNB □□□□□□ `kpi_agent`□□□□□□ 3GPP TS 32.435 PM XML □□□□□ HTTP□□□□□ libcurl□□□ □□ □□□□□ `serverURL`□RAN Monitor □□ InfluxDB□

[illegible] Casa [illegible] [illegible] [illegible]

- [illegible] PM [illegible] [illegible] [illegible] **IP** [illegible] — [illegible] IP[illegible]
- [illegible] + IP [illegible]RAN Monitor [illegible] SSH [illegible] PM [illegible] [illegible] SSH [illegible]

[illegible] **[illegible] / [illegible] / ECID [illegible]** — [illegible] IP [illegible]

[illegible]

[illegible]	[illegible]
[illegible]	`http://<ran-monitor>:9077/api/casa/pm/upload`
[illegible] (PM)	HTTP [illegible] POST (Casa `kpi_agent`)
[illegible] ([illegible])	SSH (Erlang `:ssh`, [illegible] Dropbear [illegible])
PM [illegible]	3GPP TS 32.435 (60s [illegible])
[illegible]	`/var/lib/ran_monitor/casa_pm_spool`
InfluxDB [illegible]	`CasaPerformanceMetrics`
��[illegible]	[illegible] ([illegible] PM [illegible])
[illegible] IP	[illegible]
[illegible]	`priv/casa_cell_registry.etf` ([illegible])
[illegible]	`priv/casa_configs/<serial>/` ([illegible])

□□

```
Casa eNB kpi_agent
   │  HTTP multipart POST (32.435 PM XML)
   ▼
RanMonitor.Web.Casa.Endpoint            (port 9077)
   └─ Router → PmController.upload
        │  parse serial from filename, learn mgmt IP from source
addr
        ├─ RanMonitor.Casa.CellRegistry   record serial → mgmt IP
(self-register)
        ▼
RanMonitor.Casa.PmSpool
/var/lib/ran_monitor/casa_pm_spool
        ▼
RanMonitor.Casa.PmSpoolWorker            (polls every 1s)
   ├─ RanMonitor.Casa.PmParser           32.435 → point maps
(drops empty tags)
   ├─ RanMonitor.Casa.PmFilterStore      keep only selected
counters
   └─ RanMonitor.EnhancedInfluxDbConnection → InfluxDB
"CasaPerformanceMetrics"

SSH management (RanMonitor.Casa.Ssh — Erlang :ssh, legacy
algorithms):
   ├─ RanMonitor.Casa.ConfigBackup       periodic femtoconfig.ini
backup → ConfigStorage
   ├─ RanMonitor.Casa.Reachability       staggered SSH probe →
CellRegistry
   └─ RanMonitor.Casa.KpiBootstrap       push kpi_agent.ini +
restart (onboarding)
```

□□□□ (`lib/ran_monitor/casa/`):

[illegible]	[illegible]
`pm_spool.ex` / `pm_spool_worker.ex`	[illegible] → [illegible] → [illegible] → [illegible]
`pm_parser.ex`	32.435 [illegible] → InfluxDB [illegible]
`cell_registry.ex`	[illegible] → [illegible] IP + [illegible]/[illegible]/ECID [illegible]
`ssh.ex`	[illegible] Erlang `:ssh` [illegible] SSH [illegible] Dropbear [illegible]
`config_storage.ex` / `config_backup.ex`	[illegible] SSH [illegible] `femtoconfig.ini` [illegible]
`reachability.ex`	[illegible] SSH [illegible]
`kpi_bootstrap.ex`	[illegible] `kpi_agent.ini` PM [illegible] + [illegible]
`pm_filter_store.ex`	ETS + [illegible]

[illegible]

PM [illegible] [illegible] — [illegible]

[illegible]

```
# config/config.exs — [illegible] runtime.exs [illegible]
config :ran_monitor, :casa_ssh,
  username: "root", password: "<casa-root-pw>", port: 22,
connect_timeout_ms: 15_000

config :ran_monitor, :casa_monitor_ip, "10.4.2.250"   # serverURL
[illegible]
config :ran_monitor, :casa_backup, enabled: true, interval_ms:
3_600_000
config :ran_monitor, :casa_reachability, enabled: true,
interval_ms: 600_000, stagger_ms: 3_000
```

> [illegible] `:casa` [illegible] `runtime.exs` [illegible] `config :ran_monitor, casa: %{cells: [...]}` [illegible] `:casa` [illegible] — [illegible] `:casa` [illegible]

[illegible]

`config :ran_monitor, :casa, cells:` [illegible] UI/API [illegible] `mcc`/`mnc` [illegible] `general: %{mcc: "313", mnc: "380"}` [illegible]

[illegible] / [illegible]

- Casa eNB → RAN Monitor: [illegible] **TCP 9077** (PM [illegible])
- RAN Monitor → Casa eNB: [illegible] **TCP 22** (SSH [illegible])
- RAN Monitor → InfluxDB: [illegible] 8086

[illegible]

[illegible] PM [illegible] `CellRegistry` [illegible] `serial → {mgmt IP, first seen, last push}` [illegible]

[illegible] — [illegible] IP [illegible]

- □□ — □□□□□□□□ `DUTB41CASA03`□
- □□ — □□ / ���□□□□ `Ptarmigan Road, Unalaska AK 99685`□
- **ECID** — □□ RF □□□ E-UTRAN □□ ID□□□□□□□□□□□□

□□□□□□□ □□ □□□ API □□□□□

```
PUT /api/casa/cells/<serial>
{ "name": "DUTB41CASA03", "site": "Ptarmigan Road...", "enb_id":
"43573" }
```

□□ IP □ UI □□□□□□□□□□□□□□□□□□□□□□□□□□□□□ IP □□□□□□ RF □□□□□□□□□□□□□□□□□□□

□□□□ (KPI □□)

□□□□□□□□□□□□ `serverURL`□□□□□□□□□□□□□□□□□□□□□ API□□□□ □□ **KPI** □□□□□□□□□□ IP□ RAN Monitor □□ SSH □□□□□□□□ `kpi_agent.ini`□□□□□ `http://<monitor-ip>:9077/api/casa/pm/upload` □□□□□□□□□□□□□□□

```
POST /api/casa/bootstrap
{ "ip": "10.101.16.22" }          # □ { "serial": "<serial>" } □□□
□□□□ IP
```

> □□□□□ `kpi_agent` □□□□□□□□□□□□□□□□□□□□□□ 1 □□□□□□□□□□□□□□□□□ `/config` □
> □□□□□□□□□□□□□□□□□□□□□□□□□□□□□ 2 □□□□□ PM □□□□□□

□□��□□□□□□□□□□□□□□ `kpi_agent` □ `serverURL` □□□□□□□□PM □□□□□□□□□□□□□□□□□ □□□□□□□`..._Accessibility_<serial>.xml`□□□□□□□□□□□□□□

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`ConfigBackup` □□□□ SSH □□□□□□□□□□□□□ `ConfigStorage` □□□ `/config/l3/femtoconfig.ini` — □□□□□□□□□□□□□□□□□□□□□□

`priv/casa_configs/<serial>/` [illegible] `POST /api/casa/configs/<serial>/backup`[illegible] API [illegible]

[illegible]

`Reachability` [illegible] SSH [illegible] `reachable` / `last_probe`[illegible]/API [illegible] SSH [illegible] `:casa_reachability` [illegible]

[illegible]

Casa [illegible] PM [illegible] 1065 [illegible] [illegible] [illegible] InfluxDB[illegible]

- [illegible] `priv/casa_pm_metrics.csv`
- [illegible] `priv/casa_pm_counters.csv`
- [illegible] ETS[illegible] `priv/casa_pm_filters.etf`

[illegible] **Casa [illegible]** [illegible] PM [illegible] `metricCounter` [illegible]

Web UI

Casa [illegible] (`/casa/status`)

[illegible]

- PM [illegible] / [illegible] / [illegible] / [illegible] PM
- [illegible] / [illegible] / ECID[illegible] IP
- SSH [illegible] / [illegible] / [illegible]
- [illegible] + [illegible]

- □□□□□□□□□□/□□/ECID□□□□□□□□□□□□□
- □□□□□□□ **KPI** □□ □□□□□□ IP □□□□

□□□□□□□□□□ `□□□`□

Casa □□□□□ (`/casa/pm-filters`)

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API

□□□□□□□□ UI □□□□□□

□□ + □□	□□
`GET /api/casa/devices`	□ PM □□□□□□□□□□□□□
`GET /api/casa/cells`	□□□□□□□□□□□□□□ IP□□□□□□□/□□/ECID
`PUT /api/casa/cells/:serial`	□□/□□□□□□□□ECID□□□□□□□□
`GET /api/casa/configs`	□□□□□□□□□□
`GET /api/casa/configs/:serial`	□□□□□□□
`GET /api/casa/configs/:serial/current`	□□□□□ femtoconfig
`POST /api/casa/configs/:serial/backup`	□□□□□□
`POST /api/casa/bootstrap`	□ PM □□□□□□□□`ip` □ `serial`□□□□

□□□□

□□ `(counter, 60s bucket)` □□ `CasaPerformanceMetrics` □□□□ InfluxDB □□

```
fields:  counterValue (float), measurementStart, measurementStop
(ISO8601)
tags:    metricCounter, metricJob, enbName, enbId, metricInterval,
         metricMcc, metricMnc, vendor="Casa",
recordType="performanceMetric"
         (site / host □□□□□□□□□□□)
timestamp: start-of-bucket (ns)
```

> □□□□□□□□ InfluxDB □□□□□□□□□□`missing tag value`□□□□□□□□□□□□□□□□□/□□□
> □□□□□□□□□□□□□□ `site=`/`host=`□□□□□□□□□□□□□□□□□□□□□□

Casa □ `nokia-monitor` InfluxDB □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

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```
# □□□□□□ — □□□□□□□ + □
bin/ran_monitor rpc 'RanMonitor.Casa.CellRegistry.all() |>
Enum.each(fn c ->
  {pts, _} =
RanMonitor.Database.InfluxDbStats.get_stats("CasaPerformanceMetrics",
c.serial)
  IO.puts("#{c.name || c.serial}  ip=#{c.mgmt_ip}  pts=#{pts}
reachable=#{inspect c.reachable}")
end)'
```

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```
[Casa.PmController] Accepted PM push: 1 file(s) spooled
[Casa.PmSpoolWorker] Processed <file>: <N> points written, <M>
filtered
```

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□□□ = 0□`... N filtered`□□□□□□□ 400 □□□ InfluxDB □□□□□□□□□□□□□□□□□ `site=`/`host=` □□□□□ `missing tag value` — □□□□□□□□□□□□□□□□□□□□□□□□□□□

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□□□□ `□□□` □□□□□□□□□□□□□□ □□ □□□□ `PUT /api/casa/cells/:serial`□□□□□□□□□□ □/□□/ECID□

□□□□□ `□□□` □□□□□□□ **PM** PM □□□□□ → :9077□□ SSH□□□□ → :22□□□□□□□□□□□□□□□□ □□□/□□ SSH□□□□□□□□□□□□□□□□□□/□□□□ SSH □□□

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□□□□□□□□ / `failed/` □□□ □□□□□□□□□□□□□□□□□□□□□ `/var/lib/ran_monitor/casa_pm_spool/failed/` □□□□□□□

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- **Baicells □□** — Baicells□□□□□□
- **PM □□□□** — Nokia PM □□
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- **Grafana □□** — □□□

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AirScale □□□□□□□□□□□□□□□

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- □□□□ - □□□□□□□□□□□□
- □ **InfluxDB □□** - □□□□□□□□□□□□□□□
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[illegible]

[illegible] RAN Monitor [illegible]

```
priv/airscale_configs/
└── <airscale-name>/
    ├── current.xml                                    # [illegible]
    ├── ONS-Lab-Airscale_config_20251230_143522.xml   # 2025[illegible]12[illegible]30
[illegible] 2:35pm [illegible]
    ├── ONS-Lab-Airscale_config_20251229_120000.xml   # [illegible]
    ├── ONS-Lab-Airscale_config_20251228_093045.xml   # [illegible]
    └── ...                                            # [illegible]
100 MB [illegible]
```

[illegible] `<AirScaleName>_config_YYYYMMDD_HHMMSS.xml`

[illegible] AirScale [illegible]

[illegible]

- [illegible] [illegible] `current.xml`
- [illegible] [illegible]
- [illegible] [illegible] 100 MB [illegible]
- [illegible] [illegible] Web UI [illegible]`current.xml` [illegible]
- [illegible] [illegible]
- [illegible] [illegible]

[illegible]���

[illegible]

[illegible] [illegible] [illegible]

- [illegible] [illegible] 100 MB[illegible]
- [illegible] [illegible]

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- □□□□□□ □□□□ `current.xml` □□□□□□□
- □□□□ □□□□□ 145KB □□□ ~690 □□□□□□□□□□□□□

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1. □□□□□ - □□□□ `<AirScale>_config_YYYYMMDD_HHMMSS.xml`
2. □□□□ - `current.xml` □□□□□□□
3. □□□□ - □□□□□□□□□□□□□□
4. □□□□□ - □□□□□ > 100 MB□□□□□□□□□□□□□□
5. □□□□ - □□□□□□□□□

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```
□□□□□□□ 95 MB□655 □□□□□□ 145KB□
├── ONS-Lab-Airscale_config_20240101_100000.xml  <- □□□145KB□
├── ONS-Lab-Airscale_config_20240102_100000.xml  (145KB)
├── ... (□□ 653 □□□)
└── ONS-Lab-Airscale_config_20251230_100000.xml  <- □□□145KB□

□ 2025-12-31 10:00:00 □□□□□□□145KB□

□□□
1. □□□ONS-Lab-Airscale_config_20251231_100000.xml□145KB□
2. □□□□□□95 MB + 145KB = 95.14 MB□□□ 100 MB □□□□
3. □□□□□
4. □□□656 □□□□□□ 95.14 MB

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1. □□□ONS-Lab-Airscale_config_20251231_150000.xml□500KB□
2. □□□□□□95.14 MB + 500KB = 95.64 MB□□□□□□□
3. □□□□□
4. □□□657 □□□□□□ 95.64 MB

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□□□□□99.8 MB□685 □□□□

□□□□200KB
1. □□□□□
2. □□□□□□100 MB□□□□□□
3. □□□□□□□□□□□ < 100 MB
4. □□□□□"□□□ 3 □□□□□□□ 435 KB"
5. □□□682 □□□□□□ 99.6 MB
```

[illegible]

[illegible]

- [illegible] [illegible] 100 MB
- [illegible] [illegible]
- [illegible] [illegible]
- [illegible] [illegible]
- [illegible] [illegible]

[illegible]

[illegible]

```
# [illegible]
du -sh priv/airscale_configs/
# [illegible]215M[illegible]3 [illegible] 70 MB[illegible]

# [illegible]
du -sh priv/airscale_configs/*/
# [illegible]
# 95M     priv/airscale_configs/ons-lab-airscale/
# 68M     priv/airscale_configs/sector-1/
# 52M     priv/airscale_configs/sector-2/

# [illegible]
find priv/airscale_configs -maxdepth 1 -type d -exec du -sm {} \;
| awk '$1 > 90 {print $2 " is at " $1 "MB (approaching 100MB
limit)"}'
```

[illegible]

[illegible]

Web UI[illegible] [illegible] Nokia → [illegible]

URL[illegible] `https://<ran-monitor-ip>:9443/nokia/config-archive`

[illegible]

[illegible]

[illegible]

1. [illegible]

- [illegible] - [illegible] AirScale [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]

2. [illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]UTC[illegible]
[illegible]	[illegible]`config_20251230_143522.xml`[illegible]
[illegible]	[illegible]KB [illegible] MB[illegible]
[illegible]	[illegible]��“2[illegible]”[illegible]“3[illegible]”[illegible]
[illegible]	[illegible]

[illegible] [illegible]

[illegible] `current.xml` [illegible]

3. [illegible]

[illegible]

- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

4. [illegible] [illegible] [illegible]
5. [illegible]`<AirScaleName>_config_YYYYMMDD_HHMMSS.xml`[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible] [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible] [illegible] [illegible]
5. [illegible]
6. [illegible]

[illegible]

- [illegible] `current.xml`[illegible]
- [illegible]���[illegible]
- [illegible]

[illegible]

[illegible] [illegible]

[illegible]

1. [illegible]
2. [illegible] XML [illegible]`xmldiff`[illegible]`Beyond Compare`[illegible]`WinMerge`[illegible]

3. [illegible]

[illegible]

```
# [illegible]
wget https://<server>:9443/download/config/ONS-Lab-Airscale/ONS-Lab-Airscale_config_20251230_143522.xml
wget https://<server>:9443/download/config/ONS-Lab-Airscale/ONS-Lab-Airscale_config_20251229_120000.xml

# [illegible] diff [illegible]
diff ONS-Lab-Airscale_config_20251229_120000.xml ONS-Lab-Airscale_config_20251230_143522.xml

# [illegible] xmldiff [illegible]
xmldiff ONS-Lab-Airscale_config_20251229_120000.xml ONS-Lab-Airscale_config_20251230_143522.xml
```

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]

[illegible]

```
□□□□□□
- ONS-Lab-Airscale_config_20251230_143522.xml (143KB) - □□
- ONS-Lab-Airscale_config_20251228_091045.xml (142KB) - 2 □□
- ONS-Lab-Airscale_config_20251225_180000.xml (142KB) - 5 □□

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- □□□ 142KB □□□ 143KB □ 12 □ 30 □
- □□ 12 □ 28 □□ 12 □ 30 □□□□□□□□□
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[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]/[illegible]
2. [illegible] XML [illegible]
3. [illegible]
4. ���[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

```
<!-- [illegible] -->

<!-- [illegible] 1[illegible] -->
<parameter>
    <name>cellId</name>
    <value>1</value>
</parameter>

<!-- [illegible] 2[illegible] -->
<parameter><name>cellId</name><value>1</value></parameter>
```

[illegible]

[illegible] [illegible] 145 KB[illegible] AirScale [illegible]

[illegible]

[illegible]	[illegible]	[illegible] **145KB**[illegible]	[illegible]
10	100 MB	~690	1 GB
50	100 MB	~690	5 GB
100	100 MB	~690	10 GB
500	100 MB	~690	50 GB
1000	100 MB	~690	100 GB

[illegible]

- [illegible] 100 MB[illegible]
- [illegible] ~690[illegible] 145KB[illegible]
- [illegible] [illegible] current.xml [illegible] 145KB[illegible]
- [illegible] [illegible] 100 MB [illegible]
- [illegible] [illegible]

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- □□□□ `current.xml`□□□□□□
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□□□□□□□ 1 □□□3,600,000 □□□□□□□ Omnitouch □□□□□□□□□□□□

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- 30 □□□`1_800_000`
- 1 □□□`3_600_000`□□□□
- 2 □□□`7_200_000`
- 4 □□□`14_400_000`
- 24 □□□`86_400_000`

□□□□□□□□□□□□□ RAN Monitor□

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- □□□□□□□□“0 □□□”
- □□□□□□□□

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1. □□□□□
   - □□□□□□
   - □□□□□□“□□□”□□
   - □□□□□□□□□□□□□□□
2. □□□□□
   - □□□□□□□□
   - □□□□□□□“□□”
   - □□□□□□□
3. □□□□□□
   - □□□□□□□□□□□
   - □□□□□□ `Kernel.send(Process.whereis(RanMonitor.Nokia.Airscale.Manager), :get_airscale_config)`
4. □□□□□□
   - □□ `priv/airscale_configs/` □□□□□□
   - □□ RAN Monitor □□□□□□□□
   - □□□□□□□□□□□□□□□□□

□□□□ 404 □□

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- □□□□□□“□□□□□□□”
- □□□□□ 404 □□

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1. □□□□□□□
   - □□□□□□□□□□□□□□□□□□□
   - □□ `priv/airscale_configs/` □□□□□□□□
2. □□□□□
   - □□□□□□□□□□□□□□□□□
   - □□□□□□□□□□□□□
3. □□□□
   - □□ Web □□□□□□□□□□□□□□□
   - □□□□□□□□□□□□

□□□□□

```
# □□□□□□□□
ls -la priv/airscale_configs/

# □□□□□□□□
ls -la priv/airscale_configs/<device-name>/

# □□□□□□□□□
chmod 755 priv/airscale_configs/
chmod 644 priv/airscale_configs/*/*.xml
```

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- □□□ `current.xml`□□□□□
- □□□□□□□□□□□ 1

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1. □□□□□□
   - □□□□□□□□□□□□□
   - □□□□□`Configuration unchanged, no new version created`
2. □□□□□
   - □□□□□□□□□□□□□□□
   - □□□□□□□□□□□□□
   - □□□□□□□□□□□□□
3. □□□□□□□□
   - □□□□□□□□□□□□□□□
   - □□□□□□□□□□□

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```
# □□□□□□□□□□□
grep "process_configuration" <log-file>

# □□□□□□□□
# □ IEx □□□□□
Kernel.send(Process.whereis(RanMonitor.Nokia.Airscale.Manager),
:get_airscale_config)
```

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```
#!/bin/bash
# backup-configs.sh - □□□□□□□□□□□

BACKUP_DIR="/backup/ran-monitor/configs"
CONFIG_DIR="priv/airscale_configs"
DATE=$(date +%Y%m%d)

# □□□□□□□□□□
mkdir -p "$BACKUP_DIR/$DATE"

# □□□□□□
rsync -av "$CONFIG_DIR/" "$BACKUP_DIR/$DATE/"

# □□□□ 30 □
find "$BACKUP_DIR" -type d -mtime +30 -exec rm -rf {} +

echo "□□□□□$BACKUP_DIR/$DATE"
```

□□ cron □□□

```
0 2 * * * /path/to/backup-configs.sh
```

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1. □□□□□□□□□□□□□□
2. □□□□□□□□□□□□□□□□□
3. □□□□□□□□□□□□□□□□□□

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```
# config_changes.log

2025-12-30 14:35:22 - ONS-Lab-Airscale
□□□□John Smith
□□□□□□□□□□□□ 1 □□□□
□□□txPower □ 40dBm □□□ 43dBm
□□□□
□□□2025-12-30 14:40:00
□□□□□□□□□□□□□□

2025-12-28 09:10:45 - ONS-Lab-Airscale
□□□□Jane Doe
□□□□□□□□□□□□□□□□□□
□□□□□□□□□ 10□11□12
□□□□
□□□2025-12-28 09:15:00
□□□□□□□□□
```

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□□□□□□□□□

```
# □□□□□□□□
du -sh priv/airscale_configs/

# □□□□□□□
du -sh priv/airscale_configs/*/

# □□□□□□□□□
find priv/airscale_configs/ -name "*.xml" | \
  sed 's|/[^/]*\.xml||' | uniq -c
```

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- □□□□□□□□□□□□��500MB□□□□□□□
- □□□□□□□□□□□□□□□□□□□□
- □□□□□□□□ 10% □□□□□□□□

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- □□□□□□□□ `current.xml`
- □□□□□□□□“□□”□□□□□□□□□□

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- □□□□□□□□
- □□ → □□ → □□□□□□
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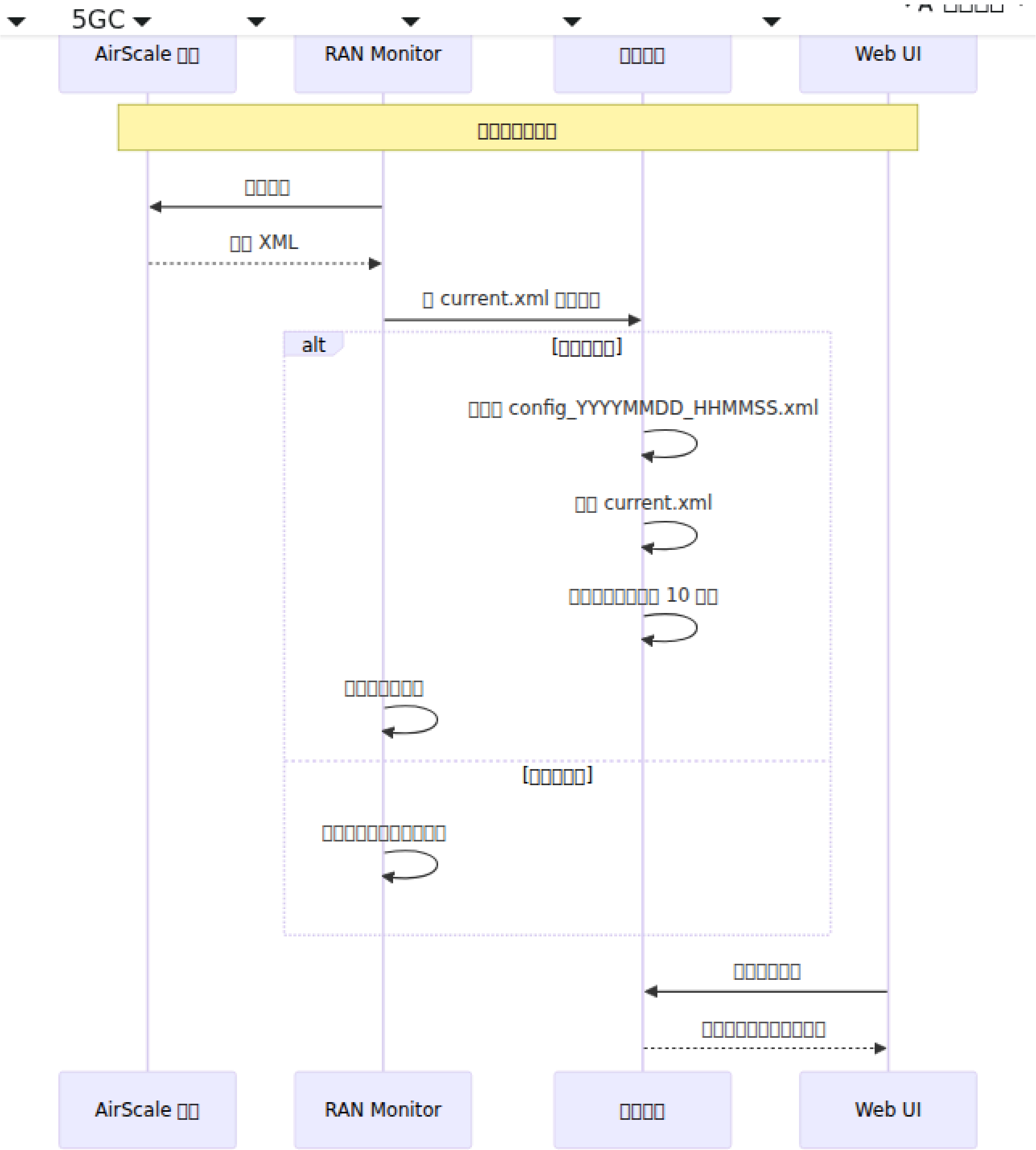
5GC
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AirScale □□
RAN Monitor
□□□□
Web UI
□□□□□□□
□□□□
□□ XML
□ current.xml □□□□
alt
[□□□□□]
□□□ config_YYYYMMDD_HHMMSS.xml
□□ current.xml
□□□□□□□□ 10 □□
□□□□□□□
[□□□□□]
□□□□□□□□□□□
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□□□□□□□□□□□
AirScale □□
RAN Monitor
□□□□
Web UI

API □□

□□□□□□□□□□ Web UI □□□□□□□□□□□ HTTP □□□□□□□

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```
curl -k "https://<server>:9443/download/config/<airscale-name>/current.xml" \
  -o current_config.xml
```

□□□□□

```
curl -k "https://<server>:9443/download/config/<airscale-name>/ONS-Lab-Airscale_config_20251230_143522.xml" \
  -o ONS-Lab-Airscale_config_20251230_143522.xml
```

□□□ URL □□ AirScale □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□

□□□□□□□ IEx □□□□□

```
# □□□□□□□□□
RanMonitor.Nokia.Airscale.ConfigStorage.list_config_versions("ONS-
Lab-Airscale")

# □□□□□□□□
{:ok, xml} =
RanMonitor.Nokia.Airscale.ConfigStorage.get_current_config("ONS-
Lab-Airscale")

# □□□□□□
RanMonitor.Nokia.Airscale.ConfigStorage.count_versions("ONS-Lab-
Airscale")
# □□□655

# □□□□□□□□□□
RanMonitor.Nokia.Airscale.ConfigStorage.max_storage_bytes()
# □□□104857600□100 MB □□□□□□□

# □□□□□□□□□□
RanMonitor.Nokia.Airscale.ConfigStorage.get_storage_usage("ONS-
Lab-Airscale")
# □□□99614055□□□□

# □□□□□□□□□□□
RanMonitor.Nokia.Airscale.ConfigStorage.get_storage_stats("ONS-
Lab-Airscale")
# □□□%{version_count: 655, total_size_bytes: 99614055, ...}

# □□□□□□□□ 50 MB □□□
RanMonitor.Nokia.Airscale.ConfigStorage.cleanup_old_versions("ONS-
Lab-Airscale", 50 * 1024 * 1024)
# □□□{:ok, 345, 50000000} - □□ 345 □□□□□□ 50MB

# □□□□□□□□100 MB□
RanMonitor.Nokia.Airscale.ConfigStorage.cleanup_old_versions("ONS-
Lab-Airscale")
# □□□{:ok, 0, 0} - □□□□□□□□□□□□□
```

[illegible]

- **Web UI [illegible]** - [illegible]
- **AirScale [illegible]** - [illegible]
- **[illegible]** - [illegible]
- **[illegible]** - [illegible]

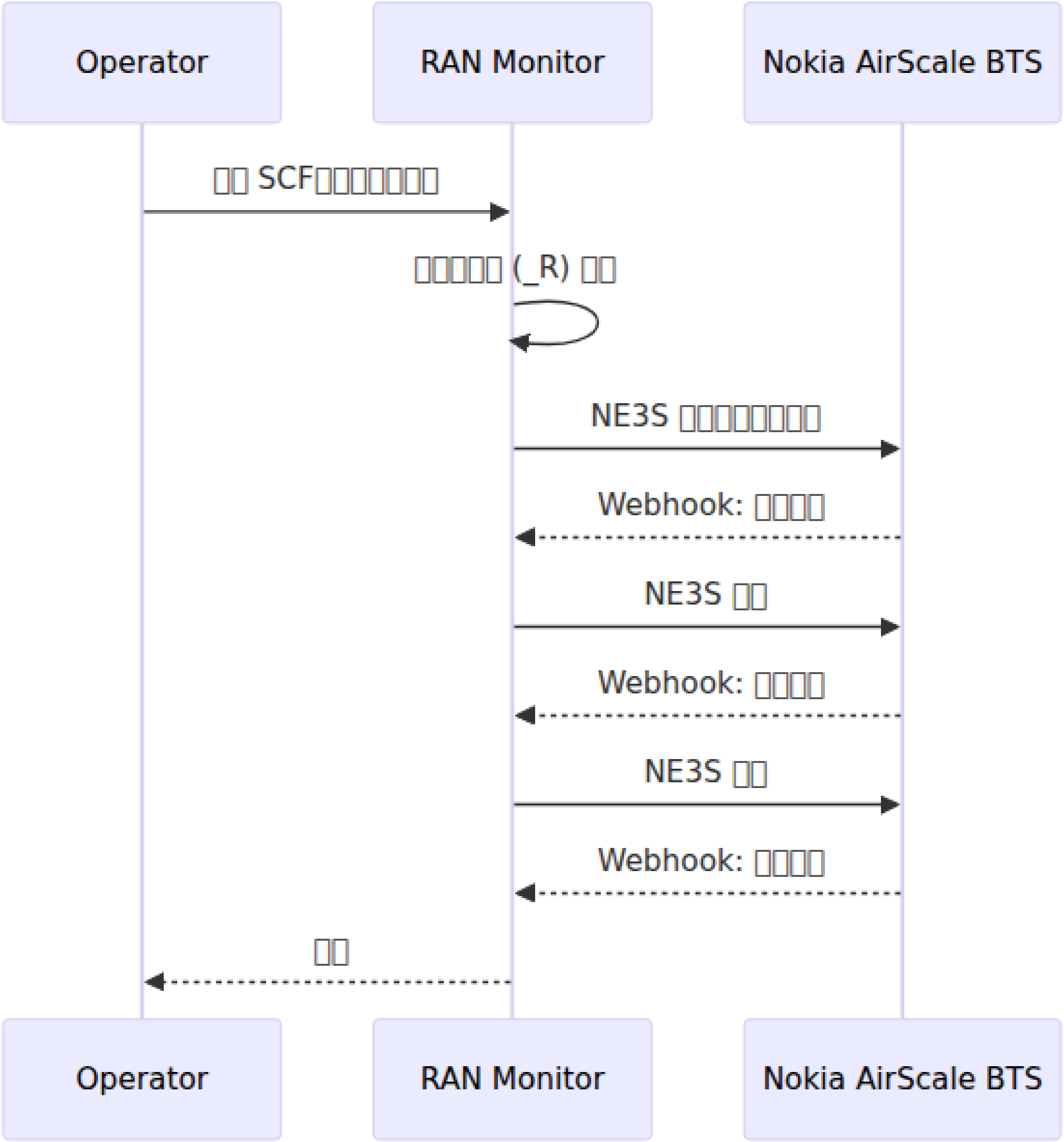
[illegible]

[illegible] RAN Monitor [illegible] Nokia AirScale [illegible]

[illegible]

RAN Monitor [illegible] NE3S [illegible] Nokia AirScale [illegible] RAML 2.1 XML [illegible] SCF[illegible] BTS [illegible] RAN Monitor [illegible]

[illegible] BTS [illegible] **SCF**[illegible] BTS [illegible]


Operator
RAN Monitor
Nokia AirScale BTS
□□ SCF□□□□□□□
□□□□□ (_R) □□
NE3S □□□□□□□□
Webhook: □□□□
NE3S □□
Webhook: □□□□
NE3S □□
Webhook: □□□□
□□
Operator
RAN Monitor
Nokia AirScale BTS

SCF XML □□

□□□□□□□□ RAML 2.1 XML □□□□□□□□□□

```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>

<!-- [illegible] -->

</cmData>
</raml>
```

[illegible] `<managedObject>` [illegible]

```xml
<managedObject class="NOKLTE:LNBTS" distName="MRBTS-256/LNBTS-256"
operation="update">
<p name="enbName">MY-SITE-NAME</p>
</managedObject>
```

[illegible]

[illegible]	[illegible]
`class`	Nokia [illegible] `NOKLTE:LNCEL`[illegible]`com.nokia.srbts.tnl:IPIF`[illegible]
`distName`	[illegible] — [illegible]
`operation`	`create` [illegible] SCF [illegible]`update` [illegible]

[illegible]

`distName` [illegible]

```
MRBTS-{bts_id}                                        # BTS [illegible]
MRBTS-{bts_id}/LNBTS-{bts_id}                         # LTE eNodeB
MRBTS-{bts_id}/LNBTS-{bts_id}/LNCEL-{cell_id}         # LTE [illegible]
MRBTS-{bts_id}/GNBTS-{gsm_id}                         # GSM BTS
MRBTS-{bts_id}/GNBTS-{gsm_id}/GNCEL-{cell_id}         # GSM [illegible]
MRBTS-{bts_id}/MNL-1/MNLENT-1/PMCADM-1                # PM [illegible]
MRBTS-{bts_id}/EQM-1/APEQM-1                          # [illegible]
```

[illegible] SCF [illegible]

[illegible] SCF [illegible]

[illegible] SCF [illegible] BTS [illegible] 100-200 [illegible] `operation="create"`[illegible] [illegible]

[illegible] [illegible]

[illegible] [illegible] SCF [illegible]/IP [illegible] BTS [illegible] 3-5 [illegible]

[illegible]

[illegible] SCF [illegible] `operation="update"`[illegible] `<p>` [illegible]

[illegible] [illegible]PM [illegible]

[illegible] [illegible]

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	□□ **SCF**	□□□□
□□□□	`operation="create"`	`operation="update"`
□□□□□	□□□□□□□	□□□□□□
□□□□□	□□□□□□□□□	□□□□□□
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□□□□	□□□□	□□□□

□□□□□□□□

□□ BTS □□□□□

□□□□□□□□□□□□□□□□ BTS □□□□□□□□□□ □□ **3-5** □□□

□□	□□□
□□ / **IP**	`TNL`□`ETHIF`□`ETHLK`□`IPIF`□`IPADDRESSV4`□`IPRT`□`IPRTV6`□`VLANIF`□`L2SWI`□`BRGPRT`□`IBRGPRT`□`IPNO`□`ETHSVC`□`TNLSVC`□`IPSECC`□`FIREWALL`
□□ / □□	`MRBTS`□`SMOD`□`BBMOD`
□□□□	`MPLANENW`□`CLOCK`□`SYNC`□`NTP`
□□ / □□	`SECADM`□`CERTH`□`CERTHENT`□`CMP`□`CMPECDSA`□`CMPFH`

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
LTE [illegible]	`LNCEL`[illegible]`LNCEL_FDD`[illegible]`LNBTS`[illegible]`LNBTS_FDD`	[illegible]
GSM [illegible]	`GNBTS`[illegible]`GNCEL`[illegible]`GNBCF`	
[illegible]	`PMCADM`[illegible]`PMMNL`[illegible]`PMCCP`[illegible]`PMPLM`[illegible]`PMRNL`[illegible]`PMTNLINT`	
[illegible]	`FEATCADM`[illegible]`FEATGADM`[illegible]`FEATLADM`	
ANR / [illegible]	`ANR`[illegible]`ANRPRL`	
RRC / DRX	`DRX`[illegible]`SDRX`[illegible]`SIB`	
S1 / [illegible]	`SCTP`[illegible]`TRSNW`[illegible]`LNMME`	
[illegible]	`ALARMSUPP`[illegible]`REDRT`[illegible]`CAGENB`[illegible]`CADPR`[illegible]`QOS`	

[illegible]

[illegible] `_R` [illegible] [illegible] BTS [illegible] RAN Monitor [illegible] `EQM_R`[illegible]`APEQM_R`[illegible]`LNCEL_R`[illegible]`TNL_R`[illegible]`ETHIF_R`[illegible]

□□□□□□

□□ eNB □□

□□□□□□□□□

```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="NOKLTE:LNBTS" distName="MRBTS-256/LNBTS-256" operation="update">
<p name="enbName">NICK-LAB-AIRSCALE</p>
</managedObject>
</cmData>
</raml>
```

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```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="NOKLTE:LNCEL" distName="MRBTS-256/LNBTS-256/LNCEL-256" operation="update">
<p name="cellName">TRI-B5-1</p>
</managedObject>
</cmData>
</raml>
```

□□□□□□ ID

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```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="NOKLTE:LNCEL_FDD" distName="MRBTS-256/LNBTS-256/LNCEL-256/LNCEL_FDD-256" operation="update">
<p name="physCellId">120</p>
</managedObject>
</cmData>
</raml>
```

□□ EARFCN □□□

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```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="NOKLTE:LNCEL_FDD" distName="MRBTS-256/LNBTS-256/LNCEL-256/LNCEL_FDD-256" operation="update">
<p name="earfcnDL">1400</p>
<p name="dlChBw">10 MHz</p>
</managedObject>
</cmData>
</raml>
```

□□ PM □□□□

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```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="com.nokia.srbts.mnl:PMCADM" distName="MRBTS-256/MNL-1/MNLENT-1/PMCADM-1" operation="update">
<p name="rTPmCollInterval">60s</p>
</managedObject>
</cmData>
</raml>
```

[illegible]

[illegible] SCF [illegible] eNB [illegible]

```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="NOKLTE:LNBTS" distName="MRBTS-256/LNBTS-256" operation="update">
<p name="enbName">NICK-LAB-AIRSCALE</p>
</managedObject>
<managedObject class="NOKLTE:LNCEL" distName="MRBTS-256/LNBTS-256/LNCEL-256" operation="update">
<p name="cellName">TRI-B5-1</p>
<p name="pMax">331</p>
</managedObject>
</cmData>
</raml>
```

[illegible] IP [illegible]

[illegible]/IP [illegible] **BTS**[illegible] 3-5 [illegible]

```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="actual" scope="all" domain="ALL">
<header>
<log dateTime="2026-03-21T00:00:00+00:00" action="created"></log>
</header>
<managedObject class="com.nokia.srbts.tnl:IPADDRESSV4"
distName="MRBTS-256/TNL-1/IPNO-1/IPIF-1/IPADDRESSV4-1"
operation="update">
<p name="localIpAddr">10.7.15.66</p>
</managedObject>
</cmData>
</raml>
```

□□ Web UI □□□□

1. □□□□□□□□□ **BTS** □□
2. □□□□□□□□ □□□□
3. □□□□□□ SCF XML □□□□□□□□□
4. □□ □□□□□□□□
5. RAN Monitor □□□□□□□□□□□□□□□□□□□□□□
6. □□□□□□□□□□□□□□□□

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□□ API □□□□

```
PUT /api/ne3s/function/provision
Content-Type: application/json

{
  "airscale_name": "ons-Lab-Airscale",
  "config_file": "/path/to/partial-config.xml"
}
```

`config_file` □□□□□□□ RAN Monitor □□□□□□□□□□□□□□□□□□□□□□

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```json
{
  "status": "success",
  "operation": "provision",
  "plan_id": "plan_1774041772721652742",
  "data": "<activateResponse>...</activateResponse>"
}
```

□□□□□

```json
{
  "status": "error",
  "code": "PROVISION_FAILED",
  "message": "validate failed: Validation error details..."
}
```

API □□

□□	□□	□□	□□	□□
`airscale_name`	□□□	□	-	RAN Monitor □□□□□□□□
`config_file`	□□□	□	-	RAN Monitor □□□□ SCF XML □□□□□□□

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1. □□□□□□□□ □□ Web UI □ "□□□□" □□□ API □□□□□□□□□□□□□□
2. □□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□
3. □□□□□□□ **`operation="update"`**□ `operation="create"` □□□□□□ SCF □□□□□□□□ □□□□□□□□

4. □□□□□□□□□□□□ □□□□ SCF □□□□□□□□□□□□□□□□□□□□BTS □□□□□□□□□□□□□□□□

5. □□ **`distName`** □□□ **BTS** □□□ MRBTS ID□LNBTS ID □□□ ID □□□□□□□□□□□□□□□□□ `distName`□BTS □□□□□□□□□□□

6. □□□□□□□□□□□□□□ □□□□□□□□□□□□□□EARFCN□���□□PCI□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□

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□□□□□□□□□□□ `Duplicated object MRBTS-256/EQM_R-1`

□□□SCF □□□□□□□`_R`□□□□□□□□□ BTS □□□□□□□□□□□□□□

□□□□□□RAN Monitor □□□□□□ `_R` □□□□□□□□□□□□□□□□□□□□□□ RAN Monitor □□□□□□□□□□□□□ BTS□

□□□□□□□□□□□□

□□□□□□□□□□□ `Operation could not execute because of operation conflict, RequestOperationType = {activate}, OngoingOperationType = {validate}`

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□□□□□□RAN Monitor □□ □NetAct□WebLM□□□□□□□ BTS □□□□□□

BTS □□□□

□□□□□□□□□ BTS □□□ping □ 3-5 □□□□□□□

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□□□□□□BTS □□ 3-5 □□□ □□□□

[illegible]

[illegible] `Processing of attachment detail property file failed in agent`

[illegible] BTS [illegible]

[illegible] 30 [illegible] Web UI [illegible] "[illegible]" [illegible] NE3S [illegible]

[illegible]

[illegible]

RAN Monitor [illegible] [illegible] [illegible] InfluxDB [illegible] [illegible] [illegible]

[illegible] [illegible]

[illegible]

1. [illegible] [illegible]: `https://localhost:9443`
2. [illegible] [illegible]
3. [illegible] eNodeB [illegible]

[illegible]

1. [illegible] eNodeB
2. [illegible]“[illegible]”[illegible]
3. [illegible]
4. [illegible]

[illegible]

1. [illegible] [illegible] [illegible]
2. [illegible] [illegible] [illegible] eNodeB [illegible]

[illegible]

[illegible] eNodeB ���[illegible]

[illegible] [illegible]

[illegible]

- [illegible]: 720 [illegible]30 [illegible]
- [illegible]: [illegible] `config/config.exs` [illegible]
- [illegible]: [illegible] eNodeB

[illegible] **eNodeB** [illegible]

- [illegible]: [illegible] eNodeB [illegible]
- [illegible]: [illegible] `airscales` [illegible]
- [illegible]: [illegible]

[illegible]

- [illegible]: [illegible]
- [illegible]: `RanMonitor.Data.RetentionCleanupWorker`
- [illegible] **eNodeB**: [illegible]
- [illegible]: [illegible]

[illegible]

- [illegible]: [illegible]
  - [illegible]
  - [illegible]
  - [illegible]
- [illegible]: [illegible] eNodeB [illegible]
- [illegible]: [illegible]

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```
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│  │ □□□□: ✓ □□□□□□□□□                         │ │
│  └─────────────────────────────────────────────────────────┘  │
│                                                                 │
│  ┌─────────────────────────────────────────────────────────┐  │
│  │ eNodeB □□□□                                         │ │
│  │                                                         │  │
│  │ ┌─ SITE-01 ────────────────────────────────────────┐ │  │
│  │ │ □□: □□□                                         │ │ │
│  │ │ □□: 720 □□□30 □□                              │ │ │
│  │ │                                                   │ │  │
│  │ │ □□□□:                                           │ │ │
│  │ │   □□□□: 250,000                                 │ │ │
│  │ │   □□: 5,000                                     │ │ │
│  │ │   □□: 15,000                                     │ │ │
│  │ │   ────────────────────                           │ │ │
│  │ │   □□: 270,000                                     │ │ │
│  │ │                                                   │ │ │
│  │ │ [□□□□□] [□□□□□□]                        │ │ │
│  │ └───────────────────────────────────────────────────┘ │  │
│  │                                                         │  │
│  │ (□□ eNodeB □□□...)                                  │ │
│  └───────────────────────────────────────────────────────��┘ │
└──────────────────────────────────────────────────────────────┘
```

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- □□ **(✓)**: eNodeB □□□□□□□□□□□□□
- □□ **(✗)**: eNodeB □□□□□□□□□
- □□: □□□□□□□□ eNodeB □□□

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□□ `config/config.exs`:

```
config :ran_monitor,
  ecto_repos: [RanMonitor.Repo],
  generators: [context_app: :ran_monitor],
  data_retention_hours: 720  # 30 □□□□□□
```

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1 □	24	1	□□□□
7 □	168	7	□□□□
14 □	336	14	□□□□□
30 □	720	30	□□□□□□□□
90 □	2160	90	□□□□
180 □	4320	180	□□□□□
1 □	8760	365	□□□□

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```
export DATA_RETENTION_HOURS=1440  # 60 □
mix phx.server
```

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```
1. □□□□
   ├─ □□□□ → InfluxDB
   ├─ □□□□ → InfluxDB
   └─ □□ → InfluxDB

2. □□□□□□□□□
   ├─ RetentionCleanupWorker □□
   ├─ □□□ eNodeB□
   │  ├─ □□□□□□□□□ eNodeB □□□□
   │  ├─ □□□□□□□
   │  └─ □□□□□□□□□□□
   └─ □□□□

3. □□□□□□□□
   ├─ □□□ UI □□□□□
   ├─ □□□□□□
   ├─ □□□□□□
   └─ □□□□/□□□□

4. □□
   └─ □□□□□ UI □□□
```

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□□ eNodeB □□□□□□

```
effective_retention = case airscale.retention_hours do
  nil -> Config.data_retention_hours()      # □□□□□720h□
  hours -> hours                             # □□□□ eNodeB □□□□□
end
```

□□□

- □□□□□720 □□□30 □□

- eNodeB "SITE-01" □□□□168 □□□7 □□
- eNodeB "SITE-02" □□□□nil → □□□□ 720 □□

□□□□

```
□□□□□ = □□ - (retention_hours * 3600 □)

□ 30 □□□□□□
├─ □□: 2025-12-11 10:00:00
├─ □□: 720 □□□30 □□
├─ □□: 2025-11-11 10:00:00
└─ □□□□□□□ < □□ □□□
```

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```
[RetentionCleanupWorker] □□□□□□□□□□
[RetentionCleanupWorker] □□□□ SITE-01 □□□□□□: 720h□
[RetentionCleanupWorker] □□□ SITE-01 □ 15,000 □□□
[RetentionCleanupWorker] □□□□□□□5 □□□□0 □□□□□□□□ 75,000 □
```

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1. □□□□□□□□□
2. □□□□ eNodeB □□□□□□□□□□□
3. □□“□□”□□□□□

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- □□□□□□□□□□□□□

- [illegible] InfluxDB [illegible]
- [illegible]

[illegible] [illegible]

[illegible]

[illegible]���[illegible]

```
alias RanMonitor.Data.RetentionPolicy
alias RanMonitor.Database.Nokia

# [illegible] eNodeB [illegible]
airscale = Nokia.get_airscale!(1)
hours = RetentionPolicy.get_retention_hours(airscale)
# => 720[illegible]

# [illegible] eNodeB [illegible]
counts = RetentionPolicy.get_record_counts("SITE-01")
# => %{"PerformanceMetrics" => 250000, "Configuration" => 5000,
"Alarms" => 15000}

# [illegible]
total = RetentionPolicy.get_total_record_count("SITE-01")
# => 270000

# [illegible]
{:ok, deleted_count} = RetentionPolicy.delete_old_records("SITE-
01", 720)
# => {:ok, 50000}  [illegible] 50k [illegible]

# [illegible] eNodeB [illegible]
{:ok, deleted_count} = RetentionPolicy.clear_all_records("SITE-
01")
# => {:ok, 270000}  [illegible] 270k [illegible]
```

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□□□□□□□□ 1 □□□3,600,000 □□□□□□□□□□□□□□ 30 □□□1,800,000 □□□□□□□□ Omnitouch □ □□□□□□□□

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```sql
SELECT name, retention_hours FROM airscales;
```

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```sql
UPDATE airscales
SET retention_hours = 168
WHERE name = 'SITE-01';
```

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□□□□	30-60 □	□□□□
□□□□	90 □	□□□□
□□□□	180-365 □	□□□□
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- 1000 □□□ ≈ 1-5 KB□□□□□□□□□
- 100 □□□□ ≈ 1-5 GB
- □□□□ × □□□□ = □□□

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```
# □□ InfluxDB □□□□□
influx bucket list

# □□□□□□□□□
df -h /path/to/influxdb/data
```

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- □□□□□□□□ □□□□□□
- □□□□ □□ InfluxDB □□□□
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1. □□□□□ **InfluxDB** □□□□
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1. □□□□□□□□□□□□`ps aux | grep mix`

2. [illegible] `RetentionCleanupWorker` [illegible]
   - [illegible] `[RetentionCleanupWorker] Starting`
3. [illegible] InfluxDB [illegible]
   - [illegible] InfluxDB [illegible]`https://localhost:9443/nokia/influx`
4. [illegible]
   - [illegible] `config/config.exs` [illegible] `data_retention_hours`

[illegible]

[illegible]

- [illegible]“[illegible]”[illegible]
- [illegible]

[illegible]

1. [illegible] InfluxDB [illegible]
   - [illegible]
2. [illegible]
   - [illegible]“[illegible]”���[illegible]
3. [illegible]
   - [illegible] `[RetentionPolicy]` [illegible]
4. [illegible] eNodeB [illegible]
   - [illegible] BTS [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

1. [illegible]
2. [illegible] 5-10 [illegible]
3. [illegible]

    - □□ `@cleanup_interval_ms`□□□ 1 □□□
4. □□□□□□ eNodeB □□□□□

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- □□□□□ InfluxDB UI □□□
- “□□□□□”□□□□□□□

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- **Web UI** □□ - □□□□□□□□□
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- **Grafana** □□□□ - □□□□□□

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- □□□□□□□: `https://localhost:9443/nokia/retention`
- **BTS** □□: `https://localhost:9443/nokia/status`
- **InfluxDB** □□: `https://localhost:9443/nokia/influx`

- □□□□: `https://localhost:9443/nokia/logs`

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- □□< 100k□□< 1 □
- □□100k-1M□□1-10 □
- □□> 1M□□10-60+ □

[illegible]

[illegible] [illegible] UI[illegible] InfluxDB CLI [illegible] API[illegible]

[illegible] InfluxDB [illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible] [illegible]

[illegible]

[illegible] eNodeB [illegible] `config/config.exs` [illegible] UI [illegible] eNodeB [illegible]

[illegible]

RetentionPolicy [illegible]

- `get_retention_hours(airscale)` - [illegible]
- `get_record_counts(airscale_name)` - [illegible]
- `get_total_record_count(airscale_name)` - [illegible]
- `delete_old_records(name, hours)` - [illegible]
- `clear_all_records(name)` - [illegible]

RetentionCleanupWorker GenServer[illegible]

- `start_link(opts)` - [illegible]
- `init(:ok)` - [illegible]
- `handle_info(:cleanup, state)` - [illegible]

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1. □□□□□

   ```
   mix ecto.migrate
   ```

2. □□□□���□□

   ```
   mix phx.server
   ```

3. □□□□□

   - □□□ `https://localhost:9443/nokia/retention`
   - □□□□□□□□□□□

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2. □□□□□□□□□□□
   - □ `config/config.exs` □□□□□□□
   - □□□ UI □□□□ eNodeB
3. □□□□□
   - □□□□□□ `[RetentionCleanupWorker]` □□
   - □□□□□□□□□□□

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1. □□□□□ □□ `[RetentionPolicy]` □ `[RetentionCleanupWorker]` □□
2. □□□□□□ □□□□□□□□□□□□□□□□□
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- UI □□□□□□□□□
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- **InfluxDB v2.x**: □□□□□□□□□□□□□□
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- InfluxDB □□
- Elixir GenServer □□
- Phoenix LiveView

Nokia AirScale DHCP □□□□

□□ DHCP □□□□□□□□□

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4. DHCP □□□□□
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Nokia AirScale □□□□□□ DHCP □□□□□□□□ RAN Monitor□□□□□□□□□□□□□□□□□□ DHCP □□□DHCP □□□□□□□□ IP □□□□□□ **DHCP □□ 43**□□□□□□□□□□□ RAN Monitor □□□□□□

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□□□ □□ Nokia AirScale □□□□□□ Omnitouch □□□□□□□□□□□□□□□□□□□□□□□□□□

- □□□□□□□□□ DHCP □□□□
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- **DHCP □□□** — □□□□□□□□ DHCP □□□□MikroTik□ISC DHCP□dnsmasq □□
- **RAN Monitor** — □□□□□□□□□□□□□□□ RAN Monitor □□
- □□□□ — □□ OAM □□□ DHCP □□□□□□□ 2 □□□

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RAN Monitor IP	RAN Monitor □□□ IP □□	10.179.2.139
□□□□	□□□□□□□□□	10.7.15.64/26
□□ IP	□□□□□□□□□	10.7.15.65
DNS □□□	DNS □□□ IP	10.7.15.65

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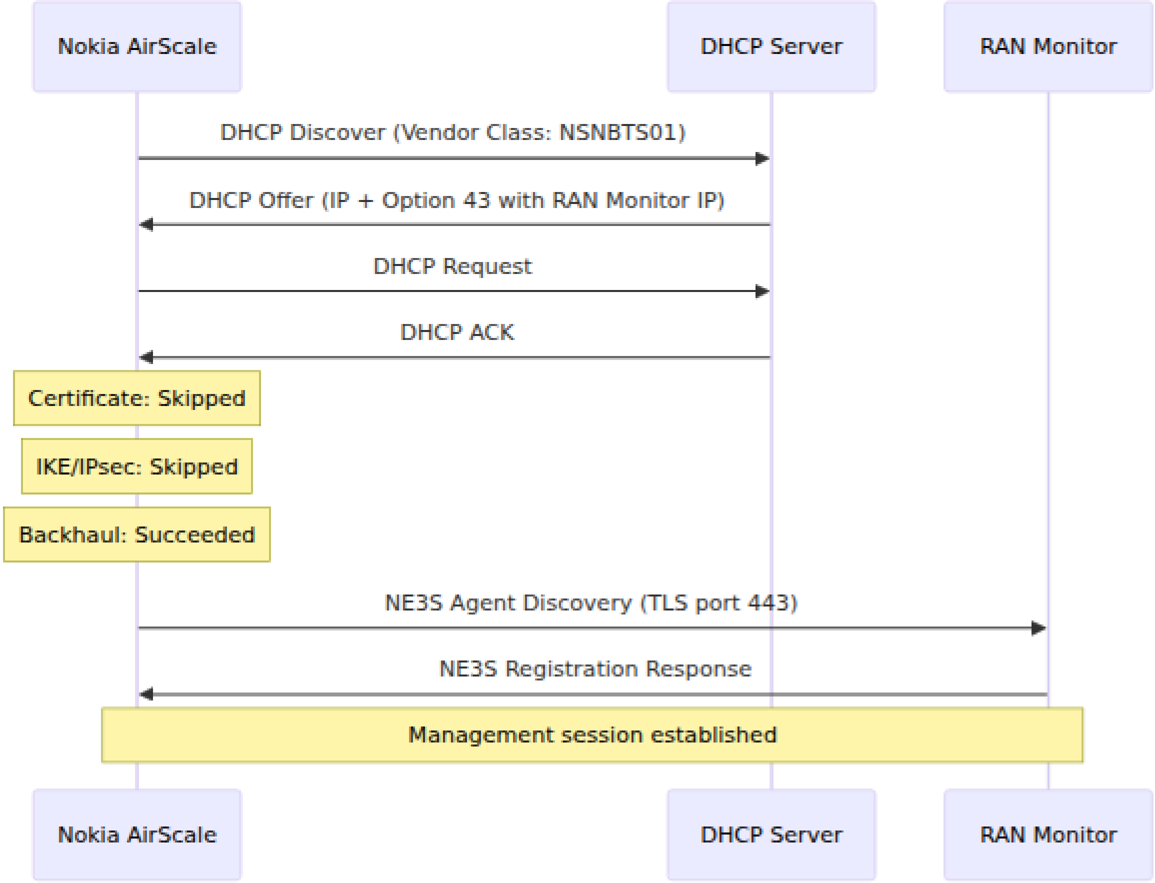
Nokia AirScale
DHCP Server
RAN Monitor
DHCP Discover (Vendor Class: NSNBTS01)
DHCP Offer (IP + Option 43 with RAN Monitor IP)
DHCP Request
DHCP ACK
Certificate: Skipped
IKE/IPsec: Skipped
Backhaul: Succeeded
NE3S Agent Discovery (TLS port 443)
NE3S Registration Response
Management session established
Nokia AirScale
DHCP Server
RAN Monitor

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DHCP	□□	□□ IP □□□ RAN Monitor □□
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IKE	□□	□□□ IPsec □□□□□□□
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DHCP □□□□□

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Nokia AirScale □□□□ DHCP □□ 43□□□□□□□□□□□□ RAN Monitor IP □□□□□ □□ □□□□□□□□ 43 □ DHCP □□□

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□□□□ RAN Monitor IP □□□□□□□□ DHCP □□□□□□□□□□□□□

```
#!/bin/bash
# generate-nokia-option43.sh
# Usage: ./generate-nokia-option43.sh <ran-monitor-ip>
IP="${1:?Usage: $0 <ran-monitor-ip>}"
IFS='.' read -r a b c d <<< "$IP"
H=$(printf "%02x%02x%02x%02x" $a $b $c $d)
S=$(echo -n "$IP" | xxd -p)
L=$(printf "%02x" ${#IP})
echo "0x0104${H}0104${H}08${L}${S}0904706b69780b0101"
```

□□ □□ `10.179.2.139`□

```
$ ./generate-nokia-option43.sh 10.179.2.139
0x01040ab3028b04040ab3028b080c31302e3137392e322e3133390904706b69780b0
```

□□□□□□□ DHCP □□□□□□□ `value`□

MikroTik RouterOS 7

```
/ip dhcp-server option
add code=43 name=nokia-oms
value=0x01040ab3028b04040ab3028b080c31302e3137392e322e3133390904706b6

/ip dhcp-server option sets
add name=nokia-set options=nokia-oms

/ip dhcp-server network
set [find address=10.7.15.64/26] dhcp-option-set=nokia-set dns-
server=10.7.15.65 gateway=10.7.15.65
```

[illegible]

[illegible]	[illegible]
`code=43`	DHCP [illegible] 43[illegible]
`value=0x...`	[illegible] RAN Monitor IP [illegible] 43 [illegible]
`dhcp-option-set=nokia-set`	[illegible] DHCP [illegible]

dnsmasq

```
dhcp-
option=43,01:04:0a:b3:02:8b:04:04:0a:b3:02:8b:08:0c:31:30:2e:31:37:39
```

ISC DHCP

```
option vendor-encapsulated-options
01:04:0a:b3:02:8b:04:04:0a:b3:02:8b:08:0c:31:30:2e:31:37:39:2e:32:2e:
```

[illegible]

[illegible]

[illegible] [illegible] **DHCP** [illegible] Web Element Manager [illegible]

1. [illegible] Web Element Manager[illegible] `https://<base-station-ip>/`
2. [illegible] [illegible]
3. [illegible] [illegible] [illegible] [illegible] **DHCP**
4. [illegible] [illegible] [illegible] [illegible]

[illegible] [illegible] [illegible] [illegible] 43 [illegible] DHCP [illegible]

[illegible]

[illegible] OAM[illegible] DHCP[illegible] SBTS [illegible] **SystemModuleEIF3** [illegible]

OAM [illegible] DHCP [illegible] VLAN [illegible] — [illegible] DHCP[illegible] VLAN [illegible]

[illegible]

DHCP [illegible]

[illegible] DHCP [illegible] MikroTik [illegible]

```
/ip dhcp-server lease print where server=<dhcp-server-name>
```

[illegible] MAC [illegible] `78:F9:B4`[illegible]Nokia Solutions and Networks[illegible]

[illegible]

[illegible] Web Element Manager [illegible]

```
Dhcp offer Accepted
Identification Server Ip1: 10.179.2.139
Certificate Skipped
Ike Skipped
BTS backhaul connection Succeeded
Started agent discovery with identification IP: 10.179.2.139
```

RAN Monitor

□ RAN Monitor Web UI □□

1. □□□ **BTS** □□
2. □□□□□□□□□□□□
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   - □□□□□□□□ — NE3S □□□
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□□□□□ DHCP

□□□ □□□□□□ DHCP Discover□□□□□□ Offer□

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1. □□ **43** **□□□□□ DHCP □□□** — □□□□□□□ `dhcp-option-set` □□□□□□□□□□
2. □□□□□□□“**□□□□□ DHCP”**□ — □□ Web Element Manager □□□□□□□
3. **RAN Monitor IP** □□□□□□ — □□□□□□□ RAN Monitor □□□□□

“□□□□□□□□□□□”

□□□ DHCP □□□□□□□□□□□ RAN Monitor□

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- □□□ RAN Monitor □□□ 443 □□□□□□
- □□□□□□ RAN Monitor □□□□□□

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- Nokia AirScale □□□□ — □□□□□□□□□□
- □□□□□□□ — RAN Monitor □□□□
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□□□ AirScale □□□□

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- □□□□ — □□□□□ HTTP □□□□□□□□□□□□□□ WebEM □“□□□□□”□□□□□□□□□□□□□□□ □□□□□□□□□□ □ □□□□□□□□□□□□□□□

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- □□□□□□□ - □ RAN Monitor □□□□□□□□□□□□□□□□□□□□
- □□□□□ - □□□□□□□□□□□□□□□□□□
- **HTTP □□□□** - □□□□□□ HTTP URL □□□□
- **MD5 □□□** - □□□□□□□□□□□□□□□
- **URL □□** - □□□□ WebEM □□□□□ URL
- □□□□ - □□□□□□□□□□□□

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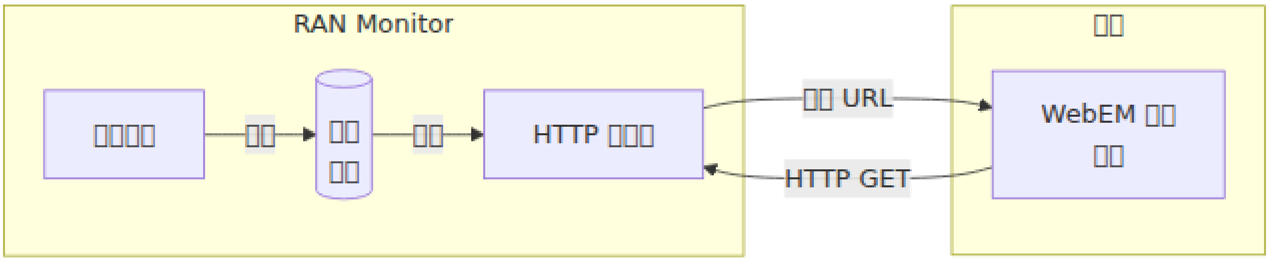
RAN Monitor
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□□
HTTP □□□
□□ URL
HTTP GET
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WebEM □□
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[illegible]

URL: `https://<ran-monitor-ip>:9443/nokia/firmware`

[illegible]: [illegible] > [illegible]

[illegible]

[illegible]

[illegible]

[illegible] RAN Monitor [illegible]

```
/var/firmware/nokia/
├── SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zi
├── SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zi
├──
SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip.me
├── SBTS24R1_ENB_0000_001093_000000_release_BTSSM_downloadable_A52.zi
├── SBTS24R1_ENB_0000_001093_000000_release_BTSSM_downloadable_A52.zi
├──
SBTS24R1_ENB_0000_001093_000000_release_BTSSM_downloadable_A52.zip.me
└── ...
```

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- `.zip` - □□□
- `.md5` - □□□ MD5 □□□
- `.metadata.json` - □□□□□□□□□□□

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□ `config/runtime.exs` □□□□□□□□□□

```
config :ran_monitor,
  firmware_storage_path: "/data/firmware/nokia"
```

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`firmware_storage_path`	□□□	□	`/var/firmware/nokia`	□□□□□□□□□□□□□□□□□□□□□□□□□□□

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Web UI [illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible] AirScale [illegible]

1. [illegible] `.zip` [illegible]
2. [illegible]
3. [illegible] [illegible] [illegible]

[illegible]

[illegible] [illegible] `.zip` [illegible]

[illegible] 15 GB

[illegible]

- [illegible]15.37 MB/s[illegible]
- [illegible]
- [illegible] / [illegible]
- [illegible]ETA[illegible]

[illegible] [illegible]

```
SBTS<release>_ENB_<build>_<variant>_release_BTSSM_downloadable_<suffi
```

[illegible] `SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip`

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]SBTS25R1[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
MD5	MD5 [illegible]
[illegible]	[illegible]
[illegible]	[illegible] URL[illegible]

[illegible]

[illegible] [illegible] [illegible]

[illegible]

[illegible]	���[illegible]
[illegible]	[illegible]
[illegible]	[illegible]SBTS25R1[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible] RAN Monitor [illegible]
[illegible]	[illegible]FTM_SBTS25R1_2025.05.27_0097[illegible]
PS [illegible]	[illegible]
[illegible]	Linux [illegible]
LTE [illegible]	LTE [illegible]FL19A[illegible]
WCDMA [illegible]	WCDMA [illegible]WBTSFP20C[illegible]
[illegible]	[illegible]ASCE[illegible]ASCF[illegible]FCTJ [illegible]
MD5 [illegible]	[illegible]
[illegible] **URL**	[illegible] URL

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible] **URL**	[illegible] URL [illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible] **URL** [illegible]

[illegible] URL[illegible]

```
http://<ran-monitor-ip>:4000/firmware/nokia/<filename>.zip
```

[illegible] URL [illegible] WebEM [illegible]“[illegible]”URL [illegible]

MD5 [illegible]

[illegible]

[illegible]MD5 [illegible] `.md5` [illegible]

[illegible]

[illegible] `.md5` [illegible]

```
/var/firmware/nokia/
├── SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zi
└──
SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip.m
```

`.md5` [illegible]

```
a1b2c3d4e5f6789012345678abcdef01
```

[illegible]

[illegible] MD5 [illegible]

Linux/macOS:

```
md5sum
SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip
```

Windows (PowerShell):

```
Get-FileHash -Algorithm MD5
SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip
```

[illegible]

RAN Monitor [illegible] — [illegible] WebEM[illegible]RAN Monitor [illegible]

[illegible]

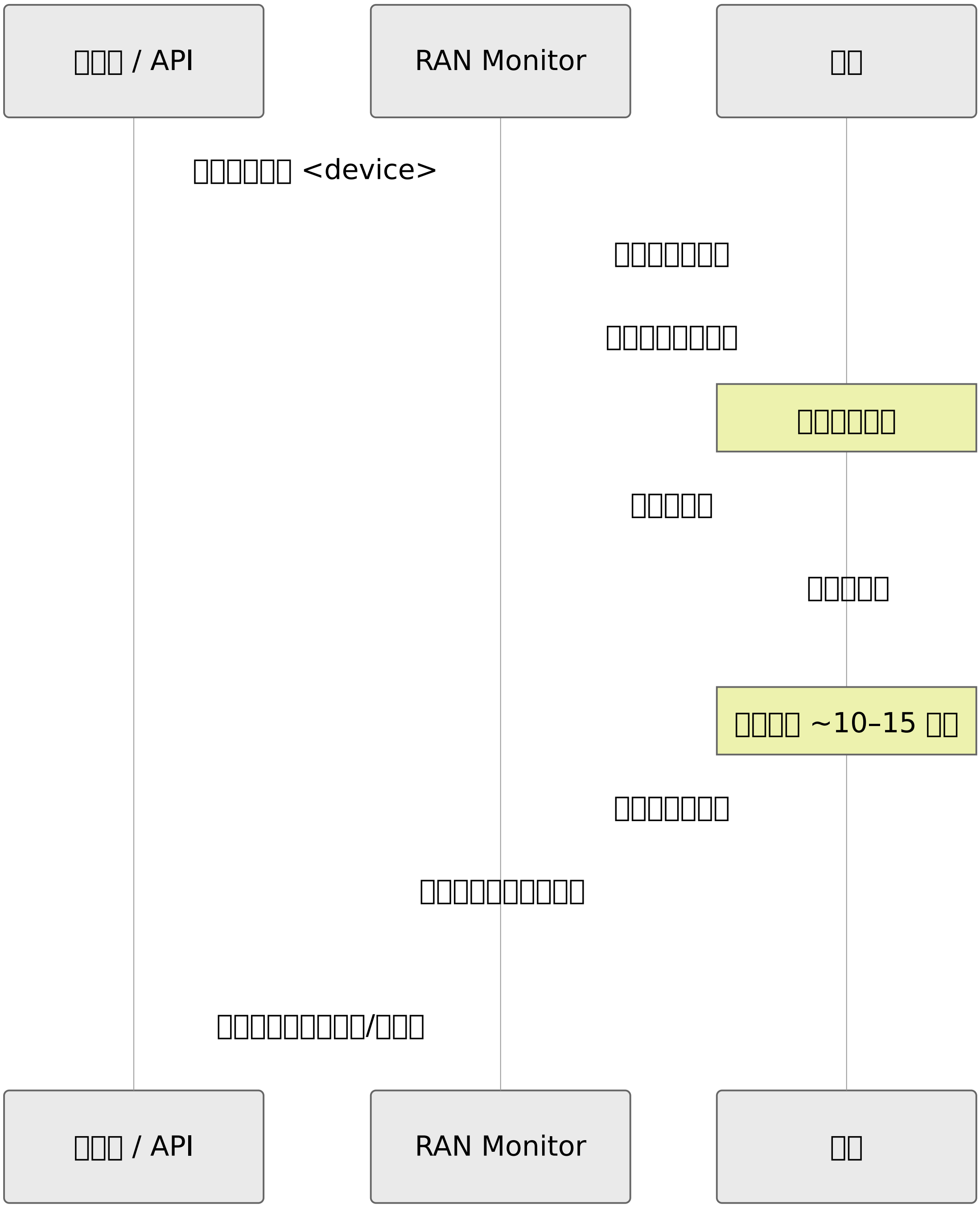
- [illegible] Web UI [illegible] — [illegible] Web UI[illegible]
- [illegible] **JSON API** — [illegible] API[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] — [illegible]
[illegible]	[illegible]	[illegible] 10-15 [illegible]

[illegible] — [illegible]


[illegible] / API
RAN Monitor
[illegible] <device>
[illegible] ~10–15 [illegible]
[illegible] / API
RAN Monitor

[illegible]

[illegible] [illegible] — [illegible]

[illegible]

[illegible]RAN Monitor [illegible] [illegible] [illegible] [illegible] [illegible] — [illegible]

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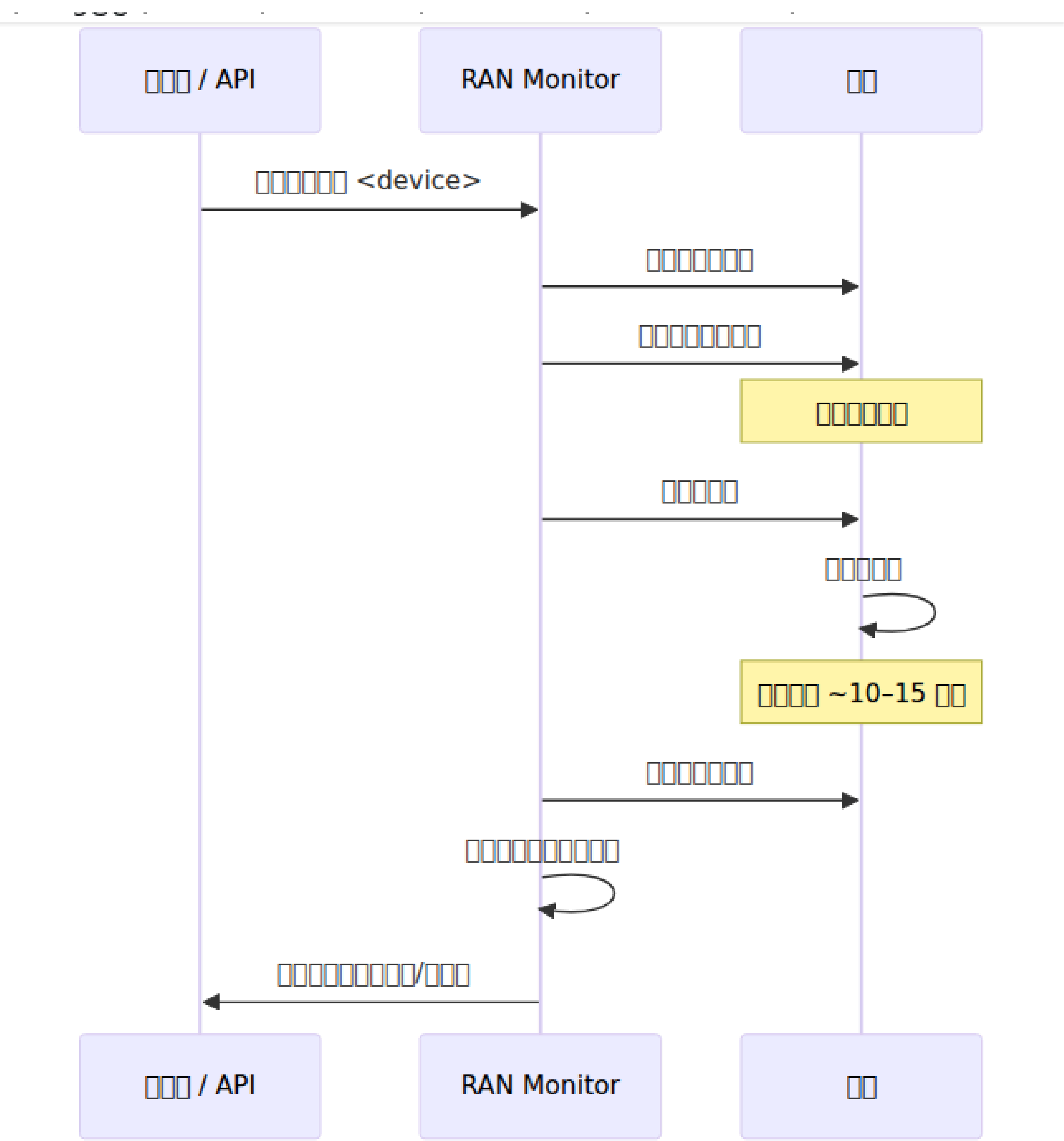
□□□ / API
RAN Monitor
□□
□□□□□□ <device>
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□□□ / API
RAN Monitor
□□

[illegible]	[illegible]
`running`	[illegible]/[illegible]
`validating`	[illegible]RAN Monitor [illegible]
`succeeded`	[illegible]��[illegible]
`failed`	[illegible] `error` [illegible]

[illegible] Web UI

[illegible] [illegible][illegible]

1. [illegible] [illegible]
2. [illegible] [illegible]
3. [illegible]
   - [illegible] **BTS** — [illegible]
   - [illegible] **BTS** [illegible] — [illegible]
   - [illegible] — [illegible]
4. [illegible] — [illegible] RAN Monitor [illegible]“[illegible]”[illegible]
5. [illegible]

> [illegible] [illegible] 10-15 [illegible]

[illegible] API

`/api/nokia/firmware` [illegible] RAN Monitor API[illegible] `8443`[illegible] HTTPS [illegible] Web UI [illegible]

[illegible]

[illegible] `.zip` [illegible]

[illegible] `POST /api/firmware/upload?filename=<name>.zip`

```
curl -k -X POST \
  --data-binary
@SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip \
  "https://<ran-monitor-ip>:9443/api/firmware/upload?
filename=SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A
```

□□ (200):

```
{
  "ok": true,
  "path":
"/var/firmware/nokia/SBTS25R1_ENB_0000_001046_000000_release_BTSSM_do
  "bytes": 9602426993
}
```

□□	□□	□□	□□	□□
`filename`	□□□□□□□	□	-	□□□□□□□□□□□□□ `.zip` □□□□□□□□□□□□□□□□□□□□□□□□ `409 already_exists`□

□□□□

□□□ `POST /api/nokia/firmware/install`

```
curl -k -X POST "https://<ran-monitor-
ip>:8443/api/nokia/firmware/install" \
  -H "Content-Type: application/json" \
  -d '{
    "device": "2057_Guymon_TOY",
    "filename":
"SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip",
    "activate": true
  }'
```

□□ (202 Accepted):

```
{
  "data": {
    "id": "6f1c8b2a-9d0e-4f3a-8c11-2b7e5a9d4c30",
    "status": "running",
    "device": "2057_Guymon_TOY",
    "filename":
"SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip",
    "activate": true,
    "status_url": "/api/nokia/firmware/install/6f1c8b2a-9d0e-4f3a-
8c11-2b7e5a9d4c30"
  }
}
```

□□	□□	□□	□□	□□
`device`	□□□	□	-	□ RAN Monitor □□□□□□□□□
`filename`	□□□	□	-	□□□□□□□□□ `.zip` □□□□
`activate`	□□□	□	`true`	□□ `true` □□□□□□□□□□□□□□□□ `false` □□□□□□□ □□□□□□□□□□□□□□□□□

□□□□□□□□□□ `status_url` □□□□□□□□□□□□ `{ "error": { "code", "message" } }` — □□ `404 FIRMWARE_NOT_FOUND` □ `404 DEVICE_NOT_FOUND`□

□□□□

□□□ `POST /api/nokia/firmware/rollback`

```
curl -k -X POST "https://<ran-monitor-
ip>:8443/api/nokia/firmware/rollback" \
  -H "Content-Type: application/json" \
  -d '{ "device": "2057_Guymon_TOY" }'
```

□□ (202 Accepted): □□□□□□□□□□□ `"operation": "rollback"`□

□□	□□	□□	□□	□□
`device`	□□□	□	-	□□□□□□□□□□□□□□□□□□���□

□□□□□□

□□□ `GET /api/nokia/firmware/install/<id>`

```
curl -k "https://<ran-monitor-ip>:8443/api/nokia/firmware/install/6f1c8b2a-9d0e-4f3a-8c11-2b7e5a9d4c30"
```

□□ (200):

```json
{
  "data": {
    "id": "6f1c8b2a-9d0e-4f3a-8c11-2b7e5a9d4c30",
    "operation": "install",
    "status": "validating",
    "device": "2057_Guymon_TOY",
    "filename": "SBTS25R1_ENB_0000_001046_000000_release_BTSSM_downloadable_A54.zip",
    "activate": true,
    "step": "validating",
    "progress": 100,
    "status_line": "waiting for BTS to reboot onto SBTS25R1_ENB_0000_001046_000000",
    "validated": { "active": "SBTS25R1_ENB_0000_001046_000000", "expected": "SBTS25R1_ENB_0000_001046_000000", "ok": true },
    "error": null
  }
}
```

□□	□□
`operation`	`install` □ `rollback`□
`status`	□□□□□`running`□`validating`□`succeeded` □ `failed`□
`step`	□□□□□□□ `transfer`□`validating`□□
`progress`	□□□□□□□□□0–100□□
`status_line`	□□□□□□□□□□
`validated`	□□□□□□`active`□□□□□□□□□□`expected`□□□□□□□ `ok`□□□□□□□□□
`error`	□ `status` □ `failed` □□□□□□□□□□ `null`□

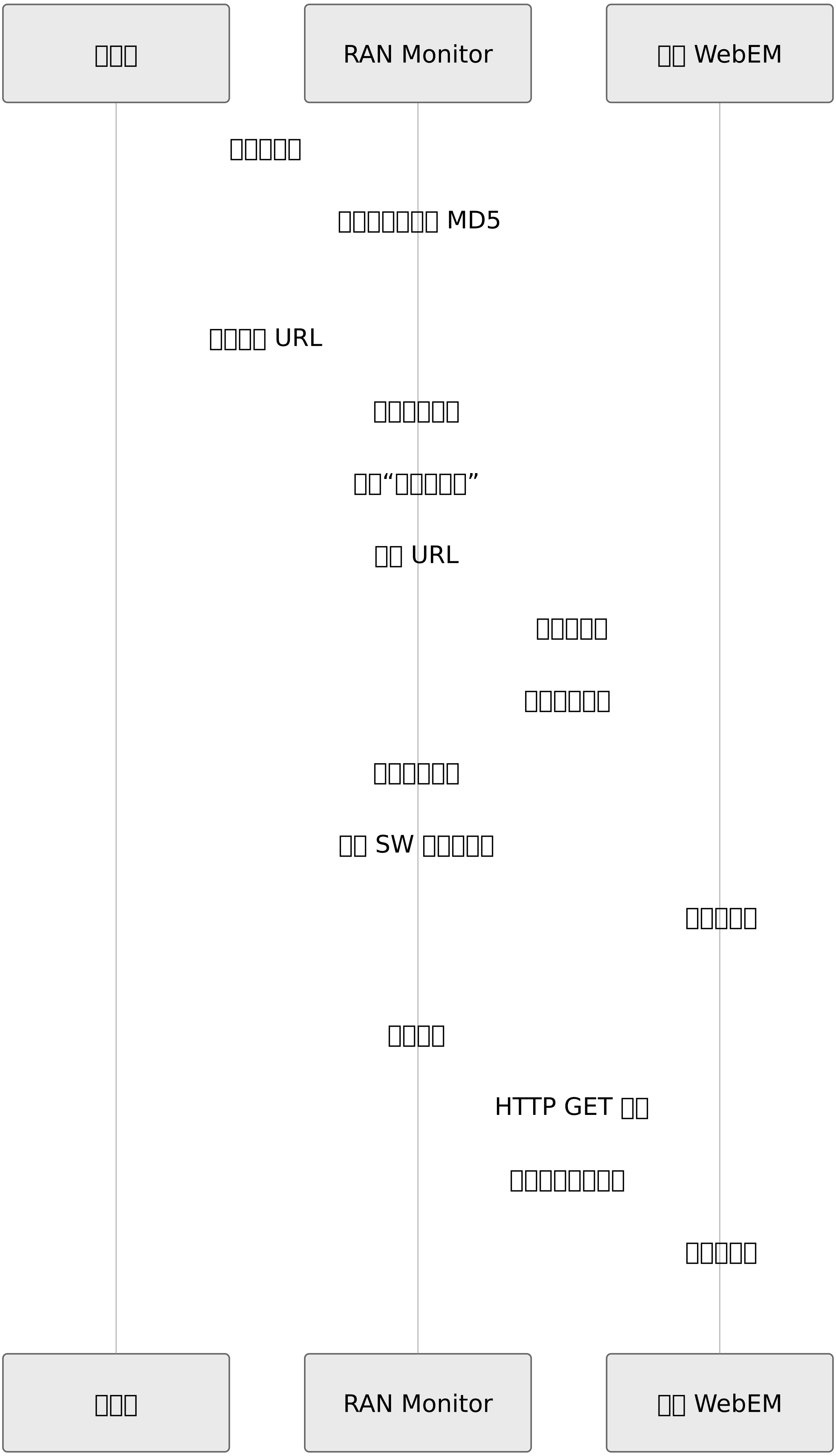
□□□□□□□□

> □□□□ □□□□ □□□□□□□□□□□□□□□□□□□□□ WebEM□□□□□□□□□□□□□□□□□□□□□

□□□□

- □□□□□□□ RAN Monitor
- □□□ RAN Monitor □□□□□□□
- □□□□ WebEM □□

□□□□


RAN Monitor
WebEM
MD5
URL
URL
SW
HTTP GET
RAN Monitor
WebEM

[illegible]

1. [illegible] RAN Monitor

[illegible]

- [illegible] `https://<ran-monitor-ip>:9443/nokia/firmware`
- [illegible] `.zip` [illegible]
- [illegible]��[illegible] MD5

2. [illegible] URL

[illegible] [illegible] **URL**[illegible]URL [illegible]

```
http://<ran-monitor-ip>:4000/firmware/nokia/<filename>.zip
```

3. [illegible] WebEM [illegible]

[illegible] WebEM [illegible]

- [illegible] [illegible] > [illegible]
- [illegible] BTS [illegible]

4. [illegible]

[illegible] WebEM [illegible]“[illegible]”[illegible]

1. [illegible] [illegible]
2. [illegible] URL [illegible] **URL** [illegible]
3. [illegible] [illegible]

WebEM [illegible] RAN Monitor [illegible]

5. [illegible]

1. [illegible] [illegible] [illegible]
2. [illegible] [illegible] **SW** [illegible] [illegible]
3. [illegible] [illegible]

4. [illegible] [illegible] [illegible]

[illegible]

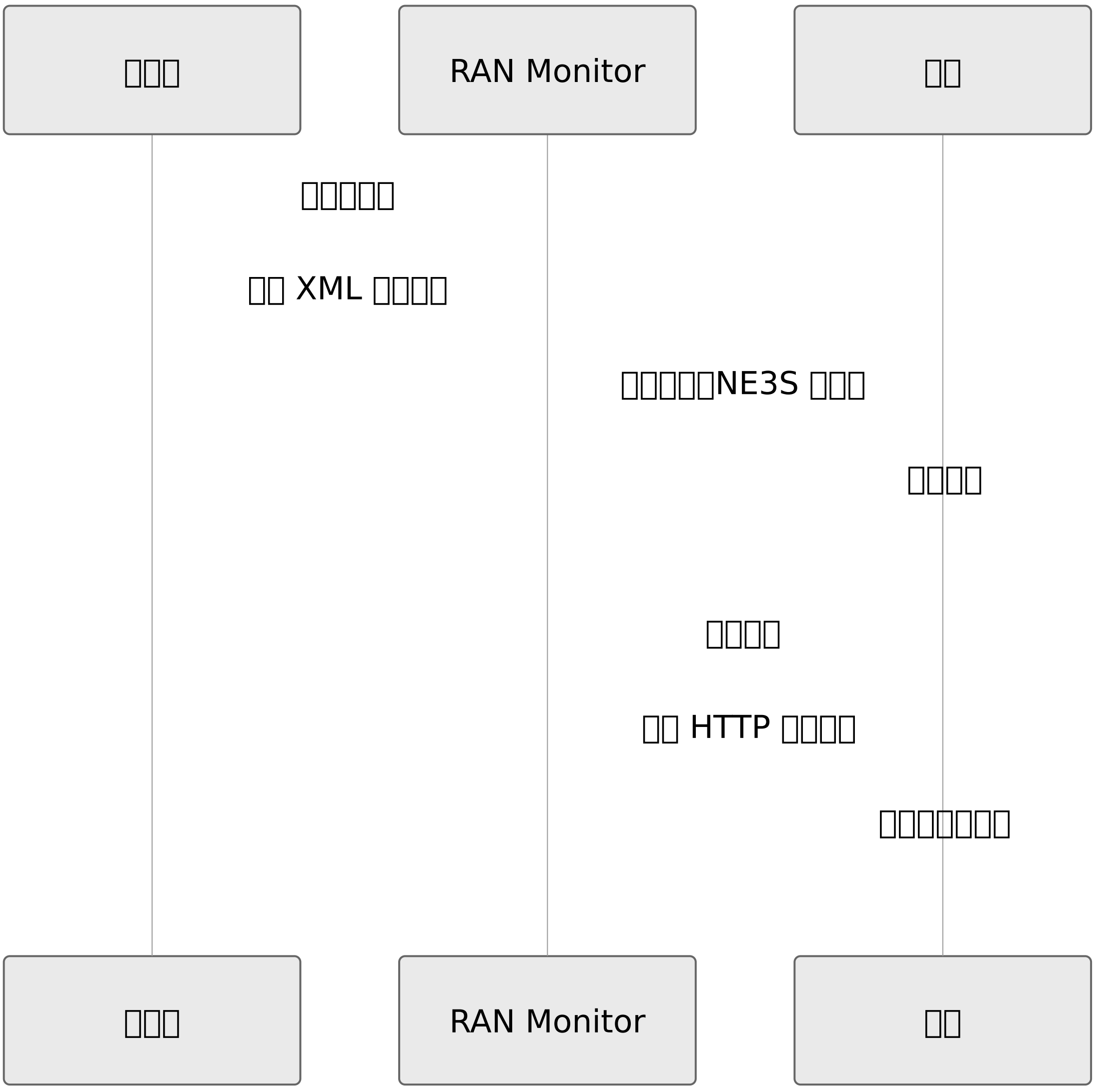
[illegible]

1. [illegible] WebEM [illegible] [illegible]
2. [illegible] RAN Monitor [illegible]
3. [illegible] KPI [illegible]

[illegible]

[illegible] RAN Monitor [illegible]

□□□□


□□□
RAN Monitor
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□□□□□
□□ XML □□□□
□□□□□NE3S □□□
□□□□
□□□□
□□ HTTP □□□□
□□□□□□□
□□□
RAN Monitor
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□□□□ XML □□□□□□□□□□□□□□□□□□□□□□□□□□□ URL □□□□□

□□□`sw_update.xml`

```xml
<?xml version="1.0" encoding="UTF-8"?>
<raml xmlns="raml21.xsd" version="2.1">
<cmData type="plan" scope="changes">
<managedObject class="com.nokia.srbts.btsswm:BTSSWM" distName="MRBTS-
operation="update">
  <p name="swPkgUrl">http://{ran-monitor-
ip}:4000/firmware/nokia/SBTS25R1_ENB_0000_001046_000000_release_BTSSM
  <p name="swPkgActivate">true</p>
</managedObject>
</cmData>
</raml>
```

□□□

- `{site_id}` - □□□□□ MRBTS ID□□□□`256`□`2057`□
- `{ran-monitor-ip}` - □□□□□□ RAN Monitor □ IP □□□□□□

□□□□

1. □□□ RAN Monitor □□□□□□□□
2. □□ □□□□ □□□□□□□
3. □□ `sw_update.xml` □□
4. □□ □□ □□□□��
5. □□ □□ □□□□□

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□□□□□□□□□□□□□□□□□□□□ XML □□□□□□□□ MRBTS ID□□□□□ RAN Monitor □□□□□□□□□
□ API □□□□□□□

[illegible]

[illegible]	[illegible]
`swPkgUrl`	[illegible] HTTP URL
`swPkgActivate`	[illegible] `true` [illegible]

[illegible]

RAN Monitor [illegible]

[illegible]

[illegible]

[illegible]	[illegible]
IP [illegible]	[illegible] IP [illegible]
[illegible]	[illegible] AirScale [illegible]
[illegible]	[illegible]

[illegible]

[illegible] [illegible] [illegible] IP [illegible]

[illegible]

API □□

□□□□□□

□□ REST API □□□□□□□

□□□ `GET /api/firmware/nokia`

□□□

```
{
  "firmware": [
    {
      "filename": "SBTS25R1_ENB_0000_001046_000000_release_BTSSM_dow
      "size": 1073741824,
      "size_formatted": "1.0 GB",
      "modified": "2025-01-15T10:30:00Z",
      "download_url": "http://ran-monitor:4000/firmware/nokia/SBTS25R1_ENB_0000_001046_000000_release_
      "metadata": {
        "release": "SBTS25R1",
        "build": "0000_001046_000000",
        "variant": "release",
        "suffix": "A54",
        "type": "BTS Software"
      }
    }
  ],
  "stats": {
    "file_count": 3,
    "total_size": 3221225472,
    "total_size_formatted": "3.0 GB",
    "storage_path": "/var/firmware/nokia"
  }
}
```

□□□□□□

□□□ `GET /firmware/nokia/<filename>`

[illegible] [illegible]`Content-Type: application/zip`

[illegible]

[illegible] **URL** [illegible]

[illegible] URL[illegible]

```
config :ran_monitor,
  firmware_base_url: "http://ran-monitor.example.com:4000"
```

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`firmware_base_url`	[illegible]	[illegible]	`http://localhost:4000`	[illegible] URL [illegible] URL[illegible] RAN Monitor [illegible]/IP[illegible]

[illegible] Web UI [illegible] URL [illegible] API [illegible] URL[illegible] HTTP [illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

- [illegible] 15 GB [illegible]
- [illegible] `.zip` [illegible]
- [illegible]

- [illegible]

[illegible]

1. [illegible] 15 GB [illegible]
2. [illegible] `.zip`
3. [illegible]`df -h /var/firmware/nokia`
4. [illegible]`ls -la /var/firmware`

[illegible]

[illegible] WebEM “[illegible]”[illegible]

[illegible]

- [illegible] RAN Monitor [illegible]
- [illegible] HTTP [illegible] 4000
- URL [illegible] IP [illegible]

[illegible]

1. [illegible] ping RAN Monitor
2. [illegible] 4000 [illegible]
3. [illegible] URL [illegible] IP/[illegible]
4. [illegible] URL

MD5 [illegible]“[illegible]…”

[illegible] MD5 [illegible]“[illegible]…”[illegible]

[illegible]

- [illegible]
- [illegible] `.md5` [illegible]

[illegible]

1. [illegible]

2. [illegible] ��[illegible]

3. [illegible]

[illegible]

[illegible]“[illegible]”[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

RAN Monitor [illegible]

RAN Monitor [illegible]

[illegible] RAN Monitor [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

[illegible]

[illegible] RAN Monitor [illegible]

[illegible]

[illegible]

- ✓ [illegible]MySQL, InfluxDB[illegible]
- ✓ [illegible] RAN Monitor
- ✓ [illegible] RAN Monitor [illegible]
- ✓ [illegible] Nokia AirScale [illegible]
- ✓ [illegible] InfluxDB
- ✓ [illegible] Web UI [illegible]

[illegible] [illegible] 30-60 [illegible]

□□□□

□□□ RAN Monitor □□□□□□□□□□□□□□

□□□□□□

MySQL □□□□□□

- □□□MySQL 5.7+ □ MariaDB 10.3+
- □□□□□ RAN Monitor □□□□□□□□
- □□□CREATE, SELECT, INSERT, UPDATE, DELETE □□
- □□□□□ RAN Monitor □□□□□□□
- □□□□□□□□□□□□□

InfluxDB □□□□□□□

- □□□InfluxDB 1.8+ □ 2.0+
- □□□□□ RAN Monitor □□□□□□□□
- Bucket/□□□□□□□□□□□□□□□□
- API □□□□□□□□□□□□InfluxDB 2.x□
- □□□□□□□□□□□□□□□□□□□

RAN Monitor □□□

- □□□□□Linux□Ubuntu 20.04+□CentOS 8+ □□□□
- RAM□□□ 4GB□□□ 8GB
- CPU□□□ 2 □□□□□ 4+ □□
- □□□□□□□□□□□□ 20GB
- □□□□□□□MySQL □ InfluxDB □□□

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- RAN Monitor → Nokia AirScale □□□□□ 8080□
- Nokia □□ → RAN Monitor□□□ 9076 □□ Webhook□

- Casa femtocells → RAN Monitor□□□ 9077 □□ PM □□□— □□ Casa PM Collection
- RAN Monitor → Baicells eNBs□□□ 443□□□□□□— □□ Baicells Collection
- RAN Monitor → MySQL□□□ 3306□
- RAN Monitor → InfluxDB□□□ 8086□
- □□□ → RAN Monitor Web UI□□□ 9443□

□□□□□

- □□□□ 8080 □□□□□□□□□
- □□□□ 9076 □□□□Webhook □□□□
- □□□□ 9443 □□□□HTTPS Web UI□
- □□□□□ MySQL □ InfluxDB

Nokia □□□□

□□□□□□□

- **IP □□** - □□□□□□□□□□
- □□ - □□□□□□□□□□ 8080□
- □□ - □□ WebLM □□□□□□□□□□□
- □□□□ - □□□□□□ping □□□□
- □□□□ - □□□□□□□

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- □□ - □□□□□□□□□□PEM □□□
- □□□□ - □□□□□□□□DER □□□
- □ Nokia □□□□□ OpenSSL □□

Grafana□□□□□□□

- □□□Grafana 8.0+
- □□□□ InfluxDB □□□□□
- □□□□□□□□□□□

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1.1 □□ MySQL □□□

□ RAN Monitor □□□□□□

```
CREATE DATABASE ran_monitor CHARACTER SET utf8mb4 COLLATE
utf8mb4_unicode_ci;
```

□□□□□□□□□□□□□□

```
CREATE USER 'ran_monitor_user'@'%' IDENTIFIED BY
'secure_password';
GRANT CREATE, SELECT, INSERT, UPDATE, DELETE ON ran_monitor.* TO
'ran_monitor_user'@'%';
FLUSH PRIVILEGES;
```

□□□□ RAN Monitor □□□□□□□

```
mysql -h <mysql-host> -u ran_monitor_user -p ran_monitor
```

1.2 □□ InfluxDB

□□ InfluxDB 1.x□□□□□□□

```
influx -execute 'CREATE DATABASE "nokia-monitor"'
```

□□ InfluxDB 2.x□□□□□□□

```
influx bucket create -n nokia-monitor -o your-org
```

□□□□□□□□□ API □□□InfluxDB 2.x□□

```
influx auth create --org your-org --write-buckets
```

[illegible]

1.3 [illegible]

[illegible]

```
# [illegible]
ping 10.7.15.66

# [illegible]
telnet 10.7.15.66 8080
```

[illegible] MySQL [illegible] InfluxDB [illegible]

```
# [illegible] MySQL [illegible]
telnet <mysql-host> 3306

# [illegible] InfluxDB [illegible]
curl http://<influxdb-host>:8086/ping
```

[illegible] 2 [illegible] RAN Monitor

[illegible] `config/runtime.exs` [illegible]

2.1 [illegible]

[illegible] `config/runtime.exs` [illegible] MySQL [illegible]

```
config :ran_monitor, RanMonitor.Repo,
  username: "ran_monitor_user",
  password: "secure_password",
  hostname: "mysql-host",
  database: "ran_monitor",
  stacktrace: true,
  show_sensitive_data_on_connection_error: true,
  pool_size: 10
```

2.2 InfluxDB □□

□□ InfluxDB □□□

```
config :ran_monitor, RanMonitor.InfluxDbConnection,
  auth: [
    username: "monitor",
    password: "influx_password"  # □ InfluxDB 2.x □ API □□
  ],
  database: "nokia-monitor",
  host: "influxdb-host"
```

2.3 Web □□□□

□□ Web □□□

```
# □□□□□ SOAP/API □□
config :ran_monitor, RanMonitor.Web.Endpoint,
  http: [ip: {0, 0, 0, 0}, port: 8080],
  check_origin: false,
  secret_key_base: "generate_with_mix_phx_gen_secret",
  server: true

# □□□□ Web UI□HTTPS□
config :control_panel, ControlPanelWeb.Endpoint,
  url: [host: "0.0.0.0", port: 9443, scheme: "https"],
  https: [
    ip: {0, 0, 0, 0},
    port: 9443,
    keyfile: "priv/cert/omnitouch.pem",
    certfile: "priv/cert/omnitouch.crt"
  ]

# □□□□□ Webhook □□
config :ran_monitor, RanMonitor.Web.Nokia.Airscale.Endpoint,
  url: [host: "0.0.0.0"],
  http: [ip: {0, 0, 0, 0}, port: 9076],
  server: true
```

2.4 Nokia □□

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```
config :ran_monitor,
  general: %{
    mcc: "001",  # □□□□□□□□
    mnc: "001"   # □□□□□□□□
  },
  nokia: %{
    ne3s: %{
      webhook_url: "http://<ran-monitor-ip>:9076/webhook",
      private_key: Path.join(Application.app_dir(:ran_monitor,
"priv"), "external/nokia/ne.key.pem"),
      public_key: Path.join(Application.app_dir(:ran_monitor,
"priv"), "external/nokia/ne.cert.der"),
      reregister_interval: 30
    },
    airscales: [
      %{
        address: "10.7.15.66",
        name: "Site-A-BS1",
        port: "8080",
        web_username: "admin",
        web_password: "password"
      }
    ]
  }
```

2.5 □□ SSL □□□□□□□□

□□ HTTPS Web UI□□□ SSL □□□

```
# □□□□□□□□□/□□
openssl req -newkey rsa:2048 -nodes -keyout
priv/cert/omnitouch.pem \
  -x509 -days 365 -out priv/cert/omnitouch.crt
```

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□□□□□□□□ RAN Monitor□

3.1 □□□□□□□

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```
mix ecto.migrate
```

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3.2 □□ RAN Monitor

□□□□□□□

```
mix phx.server
```

□□□□□□□□

```
MIX_ENV=prod mix release
_build/prod/rel/ran_monitor/bin/ran_monitor start
```

3.3 □□□□□□

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```
[info] Running RanMonitor.Web.Endpoint with cowboy
[info] Running ControlPanelWeb.Endpoint with cowboy
[info] Running RanMonitor.Web.Nokia.Airscale.Endpoint with cowboy
[info] Starting RAN Monitor Manager
[info] Connecting to InfluxDB...
[info] InfluxDB connection established
[info] Attempting registration with device: Site-A-BS1
[info] Successfully registered with Site-A-BS1
```

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- Web [illegible]
- [illegible]
- InfluxDB [illegible]
- [illegible]

[illegible]

[illegible] 4 [illegible]

[illegible]

4.1 [illegible] Web UI [illegible]

[illegible]

```
https://<ran-monitor-ip>:9443
```

[illegible] RAN Monitor [illegible]

4.2 [illegible]

[illegible] Web UI [illegible]

1. [illegible] [illegible] [illegible]
2. [illegible]
3. [illegible] "[illegible]"[illegible]
4. [illegible] "[illegible]"
5. [illegible]

[illegible]/[illegible]

- [illegible]
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4.3 □□□□□□□ InfluxDB

□ Web UI □□

1. □□□ **InfluxDB** □□ □□
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□□□□□□□ InfluxDB□

```
# InfluxDB 1.x
influx -database 'nokia-monitor' -execute 'SELECT COUNT(*) FROM
PerformanceMetrics'

# InfluxDB 2.x
influx query 'from(bucket:"nokia-monitor")
  |> range(start: -1h)
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> count()'
```

4.4 □□□□□□

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□ Web UI □□

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2. □□ "□□" □□
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□□□□□□□ `mix phx.server` □□□□□□□□□□□□

4.5 □□□□□□□□

□ Web UI □□

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□□ RAN Monitor □□□□□□□□□□□□□□□□

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   - □□ InfluxDB □□□
   - □□□□□□□□
   - □□ Grafana □□□□
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- □□□□□□□Slack□□□□□□PagerDuty□

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- □□ `config/runtime.exs` □□□□□
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- [illegible]

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- [illegible]
- [illegible] Grafana [illegible]
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[illegible]

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- Web UI [illegible] - [illegible]
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- [illegible] - [illegible]
- AirScale [illegible] - [illegible]

[illegible]

[illegible]

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- [illegible]

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InfluxDB □□□□□

- □□ InfluxDB □□□□□□
- □□□□□□□□□
- □□ API □□□□□□□□
- □□□□□`curl http://<influxdb-host>:8086/ping`

Web UI □□□□□

- □□ HTTPS □□ 9443 □□□□
- □□ SSL □□□□□□
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- **Web UI □□** - □□□□□□□□
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- **AirScale □□** - □□□□
- **Casa PM Collection** - Casa femtocell PM □□□□□□
- **Baicells Collection** - Baicells eNB □□□□□□□□
- **Grafana □□□□** - □□□□□□
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Grafana [illegible]

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Grafana [illegible] KPI [illegible]

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7. [illegible]
8. [illegible]

[illegible]

Grafana [illegible] RAN [illegible]

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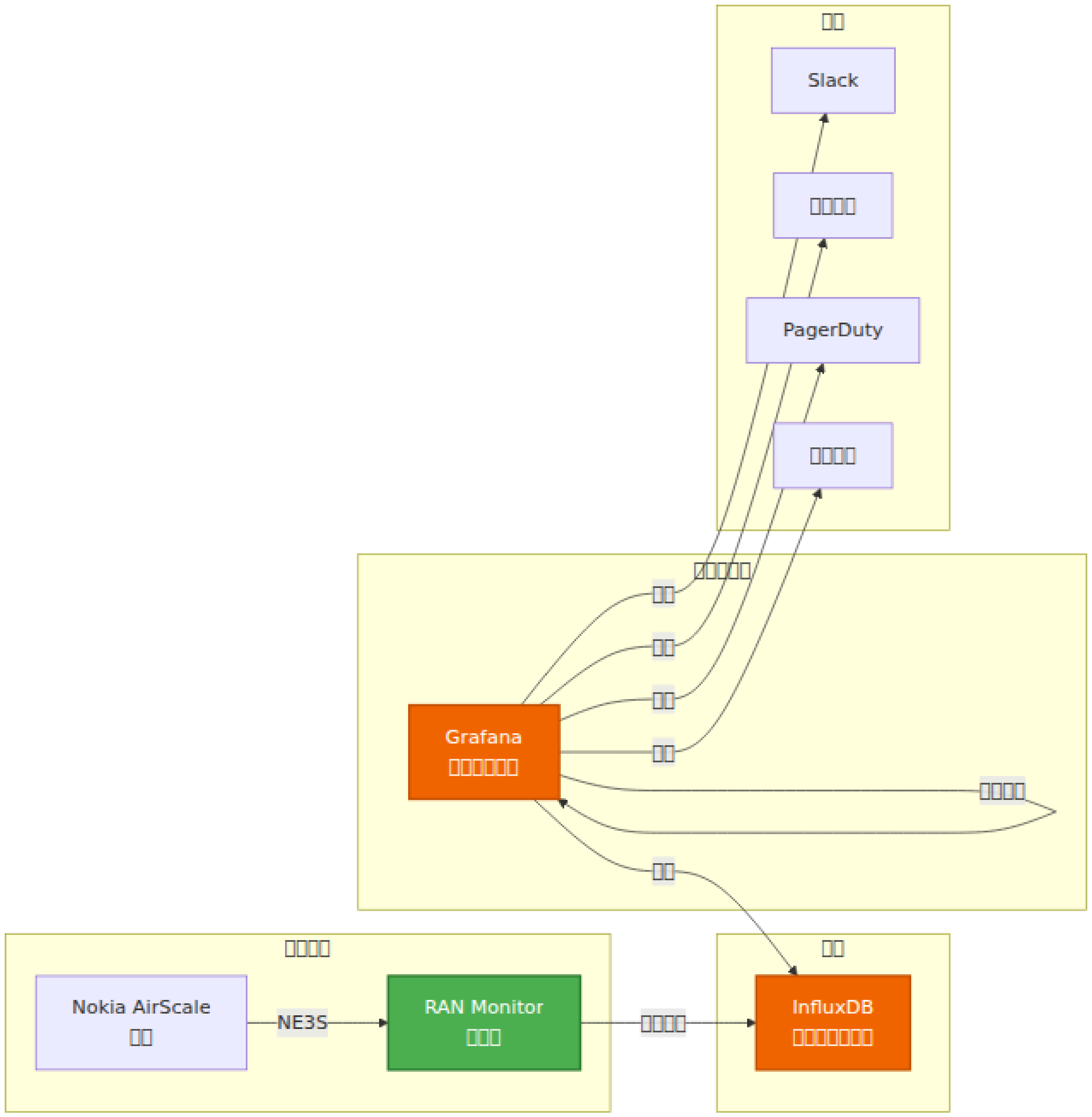
Slack
PagerDuty
Grafana
Nokia AirScale
NE3S
RAN Monitor
InfluxDB

Grafana [illegible]

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ONS □□□□□□

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Grafana □ InfluxDB □□

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- InfluxDB 2.0+□□ RAN Monitor □□□□□□
- □□□□□□□ InfluxDB API □□
- Grafana □ InfluxDB □□□□□□□

Docker Compose □□□

```yaml
version: '3.8'
services:
  influxdb:
    image: influxdb:2.7
    environment:
      INFLUXDB_DB: ran_metrics
      INFLUXDB_ADMIN_USER: admin
      INFLUXDB_ADMIN_PASSWORD: change_me
    ports:
      - "8086:8086"
    volumes:
      - influxdb_data:/var/lib/influxdb2

  grafana:
    image: grafana/grafana:latest
    environment:
      GF_SECURITY_ADMIN_PASSWORD: change_me
    ports:
      - "3000:3000"
    depends_on:
      - influxdb
    volumes:
      - grafana_data:/var/lib/grafana
      - ./provisioning:/etc/grafana/provisioning

volumes:
  influxdb_data:
  grafana_data:
```

□□ InfluxDB API □□

1. □□ InfluxDB UI□□□ 8086□
2. □□□ API □□
3. □□□□□□□□□□□□��
   - □□□□□□□`ran_metrics`□□□□□□□
4. □□□□□
5. □ Grafana □□□□□□□□

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□ Grafana □□□ InfluxDB □□□□□

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□□	RAN Monitor	Grafana □□□□□□
URL	`http://influxdb:8086`	□□□□□ Grafana □□
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Flux □□□□

Grafana □□ Flux □□ InfluxDB□□□□□□

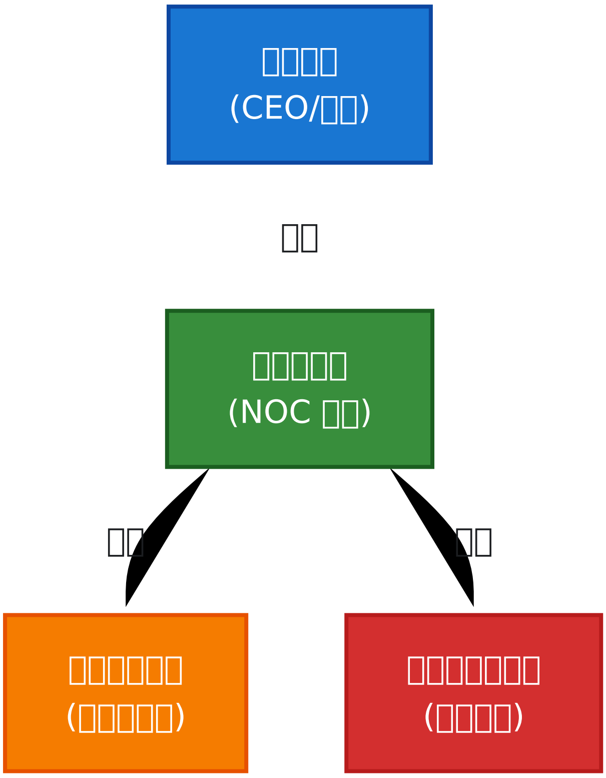
```
from(bucket:"ran_metrics")
  |> range(start: -7d, stop: now())
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r.device == "SITE_A_BS1")
  |> group(by: ["_field"])
  |> aggregateWindow(every: 1h, fn: mean)
```

□□□□□

- `from()` - □□□□□
- `range()` - □□□□
- `filter()` - □□□□
- `group()` - □□□□
- `aggregateWindow()` - □□□□□

[illegible]

[illegible]


[illegible]
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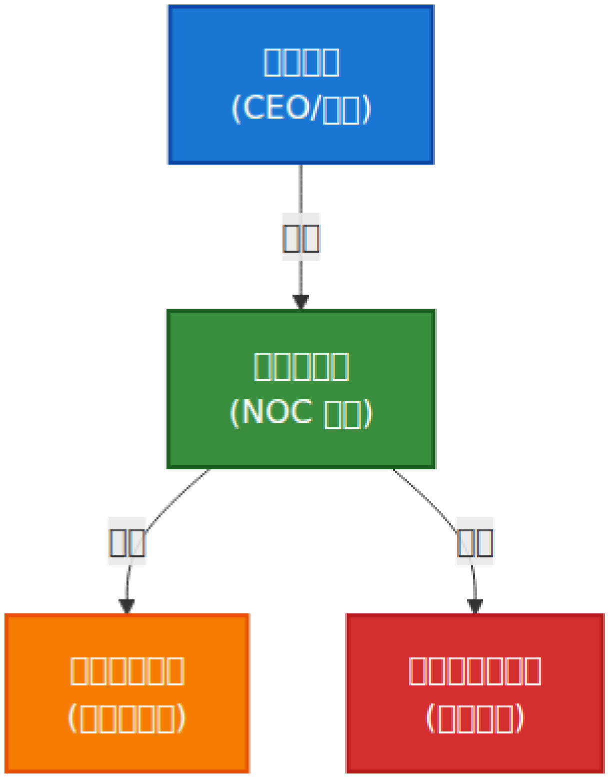

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```

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[illegible]

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```
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│ [illegible]7 [illegible]                          │
│ [[illegible]/[illegible]]                  │
│ [illegible]250 Gbps[illegible] 2 [illegible]              │
│ [illegible]80 Gbps[illegible] 3 [illegible]                │
└──────────────────────────────────────────────────┘
```

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[illegible]

```
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│ [illegible]    │ SITE_A_BS1   │ [illegible]    │ 45 [illegible]    │
│ [illegible]    │ SITE_B_BS2   │ [illegible]        │ 2 [illegible]     │
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```
from(bucket:"ran_metrics")
  |> range(start: -24h)
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r._field == "CellAvailability")
  |> group(by: ["device"])
  |> aggregateWindow(every: 1h, fn: mean)
  |> yield(name: "cell_availability")
```

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- □□□> 99.5% □□□

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```
from(bucket:"ran_metrics")
  |> range(start: -7d)
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r._field =~ /Throughput.*/)
  |> group(by: ["device", "_field"])
  |> aggregateWindow(every: 10m, fn: mean)
  |> yield(name: "traffic_trend")
```

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- [illegible]
- [illegible]

[illegible]

```
from(bucket:"ran_metrics")
  |> range(start: -1h)
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r._field == "DLResourceUtilization")
  |> filter(fn: (r) => r.device == "SITE_A_BS1")
  |> aggregateWindow(every: 10s, fn: last)
  |> yield(name: "dl_resource")
```

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- [illegible]
- [illegible] 80% [illegible]95% [illegible]
- [illegible]

[illegible]

[illegible] 24 [illegible]

```
from(bucket:"ran_metrics")
  |> range(start: -24h)
  |> filter(fn: (r) => r._measurement == "Alarms")
  |> filter(fn: (r) => r.status == "active")
  |> group(by: ["severity"])
  |> count()
  |> yield(name: "alarm_count")
```

[illegible]

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- [illegible]
- [illegible]

[illegible]

```
from(bucket:"ran_metrics")
  |> range(start: -7d)
  |> filter(fn: (r) => r._measurement == "Alarms")
  |> group(by: ["severity"])
  |> aggregateWindow(every: 1h, fn: count)
  |> yield(name: "alarm_rate")
```

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```
from(bucket:"ran_metrics")
  |> range(start: -7d)
  |> filter(fn: (r) => r._measurement == "Alarms")
  |> group(by: ["alarm_description"])
  |> count()
  |> sort(columns: ["_value"], desc: true)
  |> limit(n: 10)
  |> yield(name: "top_alarms")
```

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```
from(bucket:"ran_metrics")
  |> range(start: -30d)
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r._field == "CellAvailability")
  |> filter(fn: (r) => r.device == "SITE_A_BS1")
  |> aggregateWindow(every: 1h, fn: mean)
  |> statefulWindow(every: 1h, period: 24h)
    |> map(fn: (r) => ({r with _value: float(v: r._value)}))
    |> reduce(fn: (r, acc) => ({
        x: acc.x + [float(v: r._time)],
        y: acc.y + [r._value]
      }),
      initial: {x: [], y: []})
    |> yield(name: "availability_forecast")
```

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- □□ SLA □□□□□□□□
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```
from(bucket:"ran_metrics")
  |> range(start: -7d)
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r._field =~ /HandoverSuccess|Traffic/)
  |> group(by: ["device", "_field"])
  |> aggregateWindow(every: 1h, fn: mean)
  |> pivot(rowKey: ["_time"], columnKey: ["_field"], valueColumn:
"_value")
  |> map(fn: (r) => ({r with correlation: float(v:
r.HandoverSuccess) * float(v: r.Traffic)}))
  |> yield(name: "ho_traffic_correlation")
```

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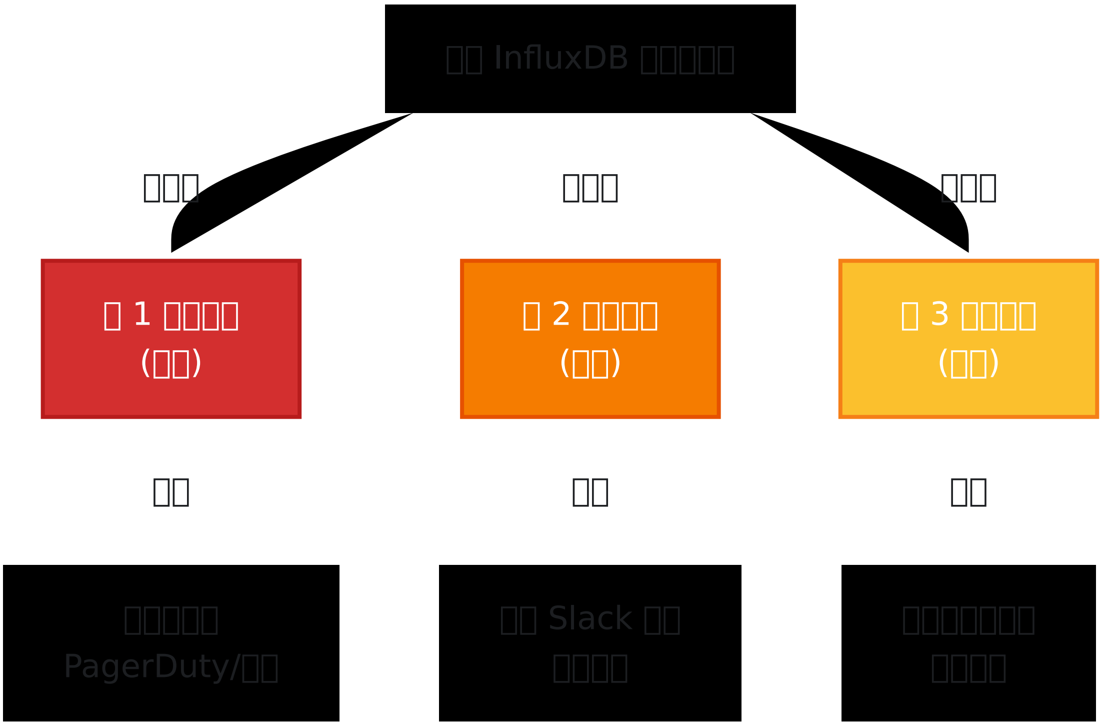
- [illegible]

[illegible]

[illegible]



[illegible] InfluxDB [illegible]
[illegible]
[illegible]
[illegible]
[illegible] 1 [illegible]
([illegible])
[illegible] 2 [illegible]
([illegible])
[illegible] 3 [illegible]
([illegible])
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PagerDuty/[illegible]
[illegible] Slack [illegible]
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[illegible]

[illegible] Grafana [illegible]

[illegible] 1 [illegible]

1. [illegible]
2. [illegible]
3. [illegible] → [illegible]
4. [illegible] → [illegible] → [illegible]

[illegible] 2 [illegible]

[illegible] 1[illegible]

```
□□□CellAvailability < 95%
□□□□□15 □□
□□□□□□ 1 □□
□□□□□ 15 □□
```

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- □ 95% □□□□□□ SLA □□□99.5%□□□□□□□
- 15 □□□□□□□□□□□□□□□
- □□□□□□□□□□

□□ 2□□□□□□□

```
□□□count(active_alarms) > 10
□□□□□5 □□
□□□□□□ 2 □□
□□□□□ 5 □□
```

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- 10 □□□□□□□□□□□□
- □□ 5 □□□□□□□□□□
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```
□□□DLResourceUtilization > 90%
□□□□□30 □□
□□□□□□ 5 □□
□□□□□ 30 □□
```

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- 30 □□□□□□□□□□□□□□□□□
- □ 5 □□□□□□□□□□□

[illegible] 3 [illegible]

1. [illegible]“[illegible]”
2. [illegible]Slack[illegible]PagerDuty [illegible]
3. [illegible]

[illegible]

```
[illegible]{{ .AlertRuleName }}
[illegible]{{ .Severity }}
[illegible]{{ .Labels.device }}
[illegible]{{ .EvalMatches[0].Value }}
[illegible]{{ .StartsAt }}

{{ .RuleUrl }}
```

[illegible]

[illegible] 1 [illegible]

- [illegible] [illegible]SLA [illegible]
- [illegible] [illegible]1-5 [illegible]
- [illegible] [illegible] + [illegible] + Slack + PagerDuty
- [illegible] [illegible]
- **SLA**[illegible] < 15 [illegible]

[illegible] 2 [illegible]

- [illegible] [illegible]
- [illegible] 15-30 [illegible]
- [illegible] Slack + [illegible] + PagerDuty
- [illegible] NOC [illegible] + [illegible]
- **SLA**[illegible] < 30 [illegible]

[illegible] 3 [illegible]

- [illegible] [illegible]
- [illegible] 1+ [illegible]

- □□□ Slack + □□□
- □□□□ □□□□ / □□
- **SLA□** □□□□

□□□□

Slack □□

```
1. □□□□□□□ Slack □□
2. □□□□□□ URL
3. □ Grafana □□ → □□□□
4. □□“Slack”□□
5. □□□□□□ URL
6. □□□□
```

Slack □□□□□

```
□ □□□□□□□ - SITE_A_BS1_Cell1
□□□□□45 □□
□□□~2000 □□□
□□□□□□□□□ 2:15

[□□] [□□] [□□□]
```

PagerDuty □□

```
1. □ PagerDuty □□□□□□□
2. □ Grafana □□ → □□□□
3. □□“PagerDuty”□□
4. □□□□□□
5. □□□□□□□□
   - □□ → □□□□
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   - □□ → □□□□□□□
```

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```
1. □ Grafana □□□□□ SMTP
2. □□□ → □□□□
3. □□“□□□□”□□
4. □□□□□□□
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```

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1. □□□□□**4** □□□□□□
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   - □□□□□□□□%□
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2. □□□□□□□□□□
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   - □□ 7 □□□□□□□□
4. □□□□□□□□□□

  - [illegible]
  - [illegible] → [illegible] → [illegible]

[illegible]

[illegible] PRB [illegible]

[illegible] 2 [illegible] NOC [illegible]

[illegible] [illegible]
[illegible] 10 [illegible]
���[illegible] [illegible]

[illegible]

1. [illegible]

  - [illegible]
  - [illegible]

2. [illegible]

  - [illegible] %[illegible]
  - [illegible] %[illegible]

    - □□□ CPU %

3. □□□□□□□□□

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    - □□□ 24 □□□□□
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4. □□□□□□□□□

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5. □□□□□□□□□□

    - □□□□□IP□□□□□□/□□□
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6. □□□□□□□□□□

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[illegible] 4G [illegible]

[illegible] 3[illegible]

[illegible] [illegible]
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[illegible] [illegible]

[illegible]

1. [illegible]
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   - [illegible] + [illegible]
   - [illegible]
2. [illegible]
   - SINR [illegible]
   - RSRP [illegible]
   - [illegible]
3. [illegible]

  - RLC [illegible]
  - RRC [illegible]
  - [illegible]

4. [illegible]

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5. [illegible]

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  - [illegible]

[illegible] 4[illegible]

[illegible] [illegible]
[illegible] 5 [illegible]
[illegible] [illegible]

[illegible]

1. [illegible]

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2. [illegible]

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3. [illegible]

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4. [illegible]

   - [illegible] 4 [illegible]
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5. [illegible]

   - [illegible] 30 [illegible]
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   - [illegible]

6. [illegible]

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[illegible] 5[illegible]Nokia AirScale [illegible]

[illegible] RF [illegible]
[illegible] 30 [illegible]
[illegible] [illegible] Nokia [illegible] KPI

[illegible] Nokia [illegible] AirScale [illegible] Nokia [illegible]

[illegible] **1**[illegible]

[illegible] PRB[illegible]

```
// □□ PRB □□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8011C37")
  |> filter(fn: (r) => r._field == "counterValue")
  |> group()
  |> mean()
  |> map(fn: (r) => ({ r with _value: r._value / 10.0}))  // □□□□□
□
  |> rename(columns: {_value: "□□ PRB □□"})

// □□ PRB □□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8011C24")
  |> filter(fn: (r) => r._field == "counterValue")
  |> group()
  |> mean()
  |> map(fn: (r) => ({ r with _value: r._value / 10.0}))  // □□□□□
□
  |> rename(columns: {_value: "□□ PRB □□"})
```

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- □□□0-70%
- □□□70-85%
- □□□85-100%

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□□ PDCP □□□□□□□□□□□

```
// □□□□□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8012C26")
  |> filter(fn: (r) => r._field == "counterValue")
  |> map(fn: (r) => ({ r with _value: r._value / 1000.0}))  // □□□
Mbps
  |> rename(columns: {_value: "□□ Mbps"})

// □□□□□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8012C23")
  |> filter(fn: (r) => r._field == "counterValue")
  |> map(fn: (r) => ({ r with _value: r._value / 1000.0}))  // □□□
Mbps
  |> rename(columns: {_value: "□□ Mbps"})
```

□□□□□□□

- **M8012C26** - PDCP □□□□□□□□□□□/□□
- **M8012C23** - PDCP □□□□□□□□□□□/□□

□□ 3□□□ UE □□□□□□□□

□□□□□□□□□□

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8018C1")
  |> filter(fn: (r) => r._field == "counterValue")
  |> rename(columns: {_value: "□□□ UE"})
```

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- **M8018C1** - [illegible] eNB [illegible] UE [illegible]

[illegible] 4[illegible]

[illegible]

```
import "strings"

from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8020C3" or
                       r["metricCounter"] == "M8020C6" or
                       r["metricCounter"] == "M8020C4")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> pivot(rowKey:["_time"], columnKey: ["metricCounter"],
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "[illegible]": 100.0 * r.M8020C3 / (r.M8020C6 - r.M8020C4)
    }))
```

[illegible]

- **M8020C3** - [illegible]
- **M8020C6** - [illegible]
- **M8020C4** - [illegible]

[illegible] [illegible] < 99%

[illegible] 5[illegible] PRB [illegible]

[illegible]

```
import "strings"

// □□ PRB □□□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8011C24")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> map(fn: (r) => ({ r with _value: r._value / 10.0}))
  |> rename(columns: {"_value": "□□□□ PRB □□"})

// □��� PRB □□□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8011C37")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> map(fn: (r) => ({ r with _value: r._value / 10.0 }))
  |> rename(columns: {"_value": "□□□□ PRB □□"})
```

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PDCP □□□□□□□□□

```
import "strings"

// □□ PDCP □□□□□□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8012C26")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> rename(columns: {"_value": "□□ PDCP □□□"})

// □□ PDCP □□□□□□
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8012C23")
  |> filter(fn: (r) => r._field == "counterValue")
  |> group()
  |> rename(columns: {"_value": "□□ PDCP □□□"})
```

□□ 7□RSSI□□□□□□□□□□□□□□□□□□□

□□□□□□□□□□□

```
import "strings"

// □□ RSSI
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8005C0")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> rename(columns: {"_value": "□□ RSSI"})

// □□ RSSI
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8005C2")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> rename(columns: {"_value": "□□ RSSI"})

// □□ RSSI
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8005C1")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> rename(columns: {"_value": "□□ RSSI"})
```

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- **M8005C0** - PUCCH □□ RSSI□dBm□
- **M8005C1** - PUCCH □□ RSSI□dBm□

- **M8005C2** - PUCCH □□ RSSI□dBm□

□□ 8□□□□□□□□□

PDCP SDU □□□□□

```
import "strings"

from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8001C2")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> rename(columns: {"_value": "□□"})
```

□□□□□□□

- **M8001C2** - PDCP SDU □□□□ DTCH □□□□□□

□□ 9□RRC □□□□□□□□□□□□□□□□

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```
import "strings"

from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8013C5" or
                       r["metricCounter"] == "M8013C17" or
                       r["metricCounter"] == "M8013C18" or
                       r["metricCounter"] == "M8013C19" or
                       r["metricCounter"] == "M8013C34" or
                       r["metricCounter"] == "M8013C31" or
                       r["metricCounter"] == "M8013C21" or
                       r["metricCounter"] == "M8013C93" or
                       r["metricCounter"] == "M8013C91")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> pivot(rowKey:["_time"], columnKey: ["metricCounter"],
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "□□□□□": 100.0 * r.M8013C5 / (r.M8013C17 + r.M8013C18 +
r.M8013C19 + r.M8013C34 + r.M8013C31 + r.M8013C21 + r.M8013C93 +
r.M8013C91)
    }))
```

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- **M8013C5** - □□□□□□□□
- **M8013C17-M8013C93** - □□□□□□□□

□□□□□ □□□□□ < 95%

□□ 10□□□□ VSWR□□□□□□□□□□□□□

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```
import "strings"

from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M40001C0")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr: 
"${RadioKey}"))
  |> map(fn: (r) => ({
      r with
      "DN": strings.split(v: r["DN"], t: "/")[5],
      "VSWR": r._value / 10.0
    }))
  |> group()
  |> pivot(rowKey: ["_time"], columnKey: ["DN"], valueColumn: 
"VSWR")
```

[illegible]

- **M40001C0** - [illegible] VSWR[illegible]0.1 [illegible]

[illegible] VSWR > 2.0

[illegible] **11**[illegible]

[illegible]

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["recordType"] == "performanceMetric")
  |> filter(fn: (r) => r["basebandName"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M40002C2")
  |> filter(fn: (r) => r._field == "counterValue")
  |> group()
  |> map(fn: (r) => ({ r with _value: r._value / 100000.0 }))
  |> rename(columns: {"_value": "[illegible]"})
```

[illegible]

- **M40002C2** - [illegible] 100000[illegible]

[illegible]

[illegible] Grafana [illegible]

- **${Airscale}** - [illegible]
- **${CellKey}** - [illegible]
- **${RadioKey}** - VSWR [illegible]

[illegible]

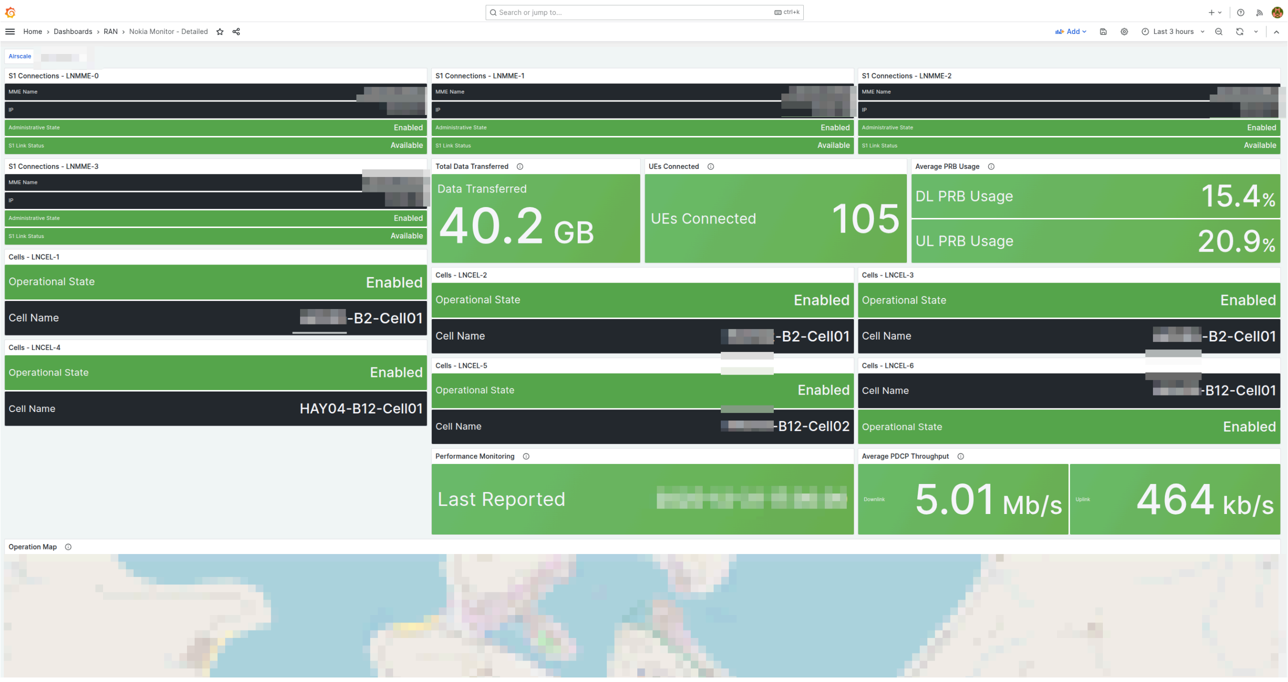
1. [illegible] **PRB** [illegible] - [illegible] DL [illegible] UL PRB > 85% [illegible] 5 [illegible]
2. [illegible] - [illegible] < 99% [illegible] 10 [illegible]
3. [illegible] - [illegible] RRC [illegible] < 95% [illegible] 5 [illegible]
4. [illegible] **VSWR** - [illegible] VSWR > 2.0 [illegible] 15 [illegible]
5. [illegible] - [illegible] > 20% [illegible]

[illegible]

1. [illegible] - [illegible] PRB [illegible]
2. [illegible] - [illegible] RSSI[illegible]
3. [illegible] - [illegible] VSWR [illegible]
4. [illegible] - [illegible] SLA [illegible]

[illegible] Nokia [illegible] [illegible]

[illegible] - [illegible]



S1 Connections - LNMME-0
MME Name [redacted]
IP [redacted]
Administrative State: Enabled
S1 Link Status: Available

S1 Connections - LNMME-1
MME Name [redacted]
IP [redacted]
Administrative State: Enabled
S1 Link Status: Available

S1 Connections - LNMME-2
MME Name [redacted]
IP [redacted]
Administrative State: Enabled
S1 Link Status: Available

S1 Connections - LNMME-3
MME Name [redacted]
IP [redacted]
Administrative State: Enabled
S1 Link Status: Available

Total Data Transferred
Data Transferred: 40.2 GB

UEs Connected
UEs Connected: 105

Average PRB Usage
DL PRB Usage: 15.4%
UL PRB Usage: 20.9%

Cells - LNCEL-1
Operational State: Enabled
Cell Name: [redacted]-B2-Cell01

Cells - LNCEL-2
Operational State: Enabled
Cell Name: [redacted]-B2-Cell01

Cells - LNCEL-3
Operational State: Enabled
Cell Name: [redacted]-B2-Cell01

Cells - LNCEL-4
Operational State: Enabled
Cell Name: HAY04-B12-Cell01

Cells - LNCEL-5
Operational State: Enabled
Cell Name: [redacted]-B12-Cell02

Cells - LNCEL-6
Cell Name: [redacted]-B12-Cell01
Operational State: Enabled

Performance Monitoring
Last Reported [redacted]

Average PDCP Throughput
Downlink 5.01 Mb/s
Uplink 464 kb/s

Operation Map

Nokia Monitor □□□□□□□□ S1 □□□□□□□□□□□□□□□□□□□□□□□□ PRB □□□□□□□□□□□□□□□□□□□□

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RSSI [illegible]/[illegible]/[illegible]RRC [illegible] VSWR[illegible]RMOD[illegible]

[illegible] - [illegible]

[illegible] RRC [illegible]VSWR RMOD [illegible]

[illegible] - [illegible] VSWR [illegible]

[illegible] VSWR RMOD-2 [illegible]ANTL-1[illegible]ANTL-2[illegible]ANTL-3[illegible]ANTL-4[illegible]

[illegible]

[illegible]

[illegible]

- [illegible]“[illegible]”
- [illegible]

[illegible]

```
1. [illegible] InfluxDB [illegible]
2. [illegible] InfluxDB [illegible]
3. [illegible]
4. [illegible]
```

[illegible]

- [illegible] InfluxDB UI [illegible]
- [illegible] 24 [illegible]

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- □□ AirScale □□ □□□□
- □□ eNodeB □□□□

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- **Nokia □□□□□** - □□□□□□□□□□
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- **AirScale □□** - □□□□□□□

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□□ **RAN** □□□□□

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[illegible]

[illegible] Nokia AirScale [illegible]

��[illegible] 1[illegible]

[illegible]

```
# [illegible]
ping <base-station-ip>

# [illegible]
telnet <base-station-ip> 8080
```

[illegible] [illegible] ping [illegible] telnet [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible] 2[illegible]

[illegible]

□□	□□	□□□□
IP □□	10.7.15.67	□□□□□□□□□
□□	8080	□□□ Nokia AirScale □ 8080
□□□□	Site-B-Tower-1	□□□□□□□□
□□□	admin	□□□□□□
□□	password123	□□□□□□

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- □□□□□□□□□□□□□□□□□□
- □□□`NYC-SiteA-BS1`□`LAX-Tower-Main`□`CHI-Indoor-DAS`

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1. □□ Web UI: `https://<ran-monitor-ip>:9443`
2. □□□ □□□□ **eNodeBs** □□
3. □□□□□ IP □□□□□ ID
4. □□□□□□□□□□ ID

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□□ `config/runtime.exs` □□□□□□□□ `airscales` □□□□

```
config :ran_monitor,
  nokia: %{
    ne3s: %{
      # ... □□ ne3s □□ ...
    },
    airscales: [
      # □□□□
      %{
        address: "10.7.15.66",
        name: "Site-A-BS1",
        port: "8080",
        web_username: "admin",
        web_password: "password1"
      },

      # □□□
      %{
        address: "10.7.15.67",          # □□□□ IP □□
        name: "Site-B-Tower-1",          # □□□□□
        port: "8080",                    # □□□□
        web_username: "admin",           # WebLM □□□
        web_password: "password123"      # WebLM □□
      }
    ]
  }
```

□□□ □□ Elixir □□□□ - □□□□□□□□□□□□□□□

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```
elixir -c config/runtime.exs
```

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- [illegible] `{` [illegible] `[` [illegible]
- ��[illegible]
- [illegible]

[illegible] 6[illegible] RAN [illegible]

[illegible]

```
# [illegible]
# [illegible] Ctrl+C [illegible]
mix phx.server

# [illegible]
systemctl restart ran_monitor

# [illegible]
/path/to/ran_monitor/bin/ran_monitor restart
```

[illegible] 7[illegible]

[illegible]

1. [illegible]

   ```
   [info] [illegible]Site-B-Tower-1
   [info] [illegible] Site-B-Tower-1
   ```

2. [illegible] **Web UI**[illegible]

   - [illegible] [illegible] [illegible]
   - [illegible]
   - [illegible] "[illegible]"[illegible]
   - [illegible] "[illegible]"

3. [illegible]

   - [illegible]

    - [illegible]
    - [illegible] "[illegible]" [illegible]

4. [illegible] **InfluxDB** [illegible]

    - [illegible] **InfluxDB** [illegible] [illegible]
    - [illegible]
    - [illegible]

[illegible] 8[illegible]

[illegible]

1. [illegible] [illegible] [illegible]
2. [illegible]
3. [illegible] "[illegible]" [illegible]
4. [illegible]

[illegible] [illegible][illegible]

[illegible] 9[illegible] Grafana [illegible]

[illegible] Grafana [illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible] Grafana [illegible][illegible]

[illegible]

[illegible]

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□□ B□□□□□

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- □□ InfluxDB □□
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□□ `config/runtime.exs` □□ `airscales` □□□□□□□□□□□□□□□□□

```
airscales: [
  %{
    address: "10.7.15.66",
    name: "Site-A-BS1",
    port: "8080",
    web_username: "admin",
    web_password: "password1"
  },

  # □□□□ - □□□□□□□□
  # %{
  #   address: "10.7.15.67",
  #   name: "Site-B-Tower-1",
  #   port: "8080",
  #   web_username: "admin",
  #   web_password: "password123"
  # }
]
```

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1. □ Web UI □□□□ □□□□ □□
2. □□□□□□□□
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□□ 4□□□ RAN □□

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```
systemctl restart ran_monitor
# □
mix phx.server
```

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3. □□ **InfluxDB**□
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[illegible] 6[illegible] Grafana [illegible]

[illegible] Grafana [illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible]

[illegible] RAN [illegible]

[illegible] 1[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

[illegible] 2[illegible]

[illegible] `config/runtime.exs` [illegible]

```
airscales: [
  %{
    address: "10.7.15.66",
    name: "Site-A-BS1",
    port: "8080",
    web_username: "admin",
    web_password: "new_password_here"  # [illegible]
  }
]
```

□□ 3□□□ RAN □□

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```
systemctl restart ran_monitor
```

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   ```
   [info] □□□□□□□□□□Site-A-BS1
   [info] □□□□□ Site-A-BS1
   ```

2. □□ **Web UI**□

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[illegible] 2[illegible]

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- [illegible]��[illegible]

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- [illegible]10 [illegible] = [illegible] 8,640 [illegible]
- [illegible] InfluxDB [illegible]

[illegible]

- [illegible] = RAN [illegible] CPU [illegible]
- [illegible]

[illegible] 3[illegible]

[illegible]

1. [illegible] [illegible]
2. [illegible]
   - RAN [illegible] CPU [illegible]
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   - InfluxDB [illegible] I/O [illegible]
3. [illegible]
   - [illegible] InfluxDB [illegible]
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4. [illegible]
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   - [illegible]

[illegible]

[illegible] RAN [illegible]

[illegible]

[illegible] Web UI [illegible] - [illegible]

[illegible]

1. [illegible] [illegible]
2. [illegible] [illegible]
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4. [illegible] [illegible] ID [illegible]
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- [illegible] 15-30 [illegible]
- [illegible]

[illegible]

[illegible] RAN [illegible]

[illegible]

[illegible]

1. [illegible] Web UI [illegible]

```
https://<ran-monitor-ip>:9443
```

2. [illegible]

- [illegible]
- [illegible]
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3. [illegible]

- [illegible]

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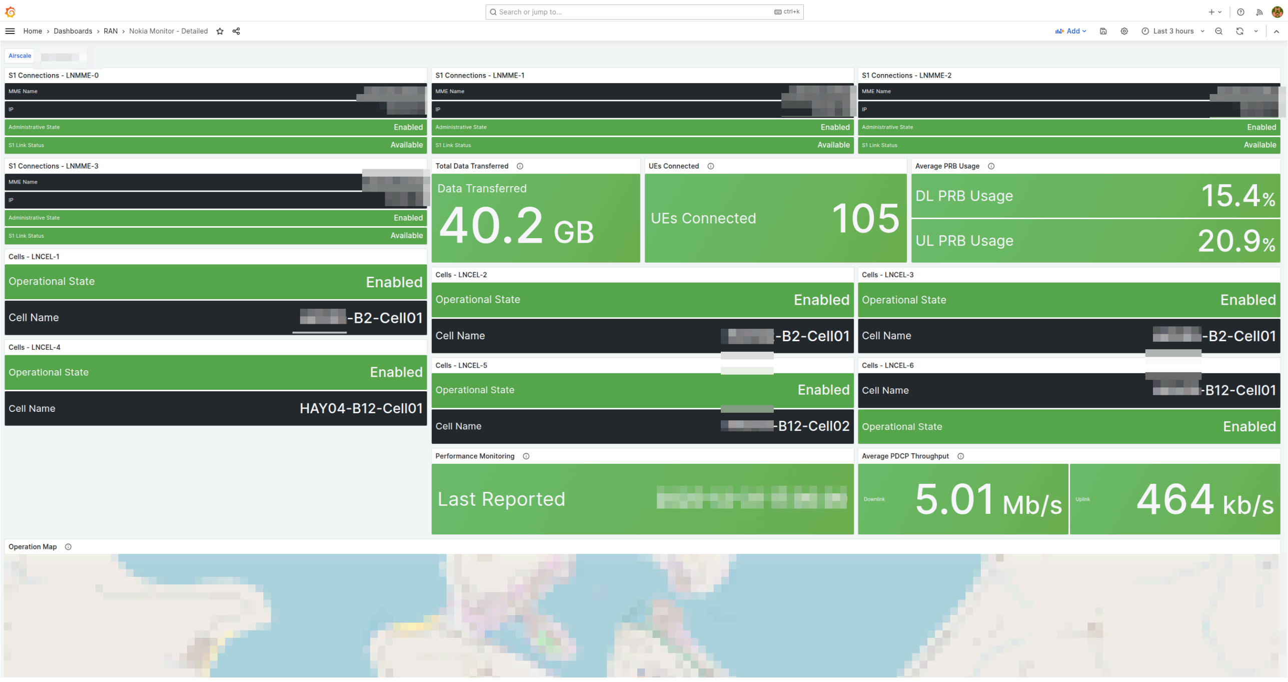
□□□Grafana □□□□□



Search or jump to...

Home › Dashboards › RAN › Nokia Monitor - Detailed

Last 3 hours

Airscale [redacted]

S1 Connections - LNMME-0

MME Name [redacted]

IP [redacted]

Administrative State Enabled

S1 Link Status Available

S1 Connections - LNMME-1

MME Name [redacted]

IP [redacted]

Administrative State Enabled

S1 Link Status Available

S1 Connections - LNMME-2

MME Name [redacted]

IP [redacted]

Administrative State Enabled

S1 Link Status Available

S1 Connections - LNMME-3

MME Name [redacted]

IP [redacted]

Administrative State Enabled

S1 Link Status Available

Total Data Transferred

Data Transferred 40.2 GB

UEs Connected

UEs Connected 105

Average PRB Usage

DL PRB Usage 15.4%

UL PRB Usage 20.9%

Cells - LNCEL-1

Operational State Enabled

Cell Name [redacted]-B2-Cell01

Cells - LNCEL-2

Operational State Enabled

Cell Name [redacted]-B2-Cell01

Cells - LNCEL-3

Operational State Enabled

Cell Name [redacted]-B2-Cell01

Cells - LNCEL-4

Operational State Enabled

Cell Name HAY04-B12-Cell01

Cells - LNCEL-5

Operational State Enabled

Cell Name [redacted]-B12-Cell02

Cells - LNCEL-6

Cell Name [redacted]-B12-Cell01

Operational State Enabled

Performance Monitoring

Last Reported [redacted]

Average PDCP Throughput

Downlink 5.01 Mb/s

Uplink 464 kb/s

Operation Map

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1. [illegible]

- [illegible] Grafana [illegible]
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2. [illegible]

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- MySQL [illegible]
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3. [illegible]

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4. [illegible]

- RAN [illegible] CPU [illegible]
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5. [illegible]

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[illegible] 30-45 [illegible]

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□□□□□□ InfluxDB□□

```
# □□□□□□□□□
influx -database 'nokia-monitor' -execute '
  SELECT * FROM PerformanceMetrics
  WHERE basebandName='''Site-A-BS1'''
  AND time > now() - 7d
' -format csv > export.csv
```

□□ Grafana □□□

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```
# □□□□□□□
cp config/runtime.exs backups/runtime.exs.$(date +%Y%m%d)

# □□□□□□□□
tar -czf backups/config-$(date +%Y%m%d).tar.gz config/
```

2. □□□□

- □□ Web UI □□□□□□□□□
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3. MySQL [illegible]

```
# [illegible]
mysqldump -u ran_monitor_user -p ran_monitor >
backups/ran_monitor-$(date +%Y%m%d).sql
```

4. InfluxDB [illegible]

```
# InfluxDB 1.x [illegible]
influxd backup -portable -database nokia-monitor
/backups/influx-$(date +%Y%m%d)

# InfluxDB 2.x [illegible]
influx backup /backups/influx-$(date +%Y%m%d)
```

5. SSL [illegible]

```
cp priv/cert/* backups/certificates-$(date +%Y%m%d)/
```

[illegible]

[illegible]

- MySQL [illegible]
- [illegible]

[illegible]

- InfluxDB [illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible]

1. [illegible] RAN [illegible]

   ```
   systemctl stop ran_monitor
   ```

2. [illegible]

   ```
   cp backups/runtime.exs.20251230 config/runtime.exs
   ```

3. [illegible]

   ```
   elixir -c config/runtime.exs
   ```

4. [illegible] RAN [illegible]

   ```
   systemctl start ran_monitor
   ```

5. [illegible]

[illegible]

1. [illegible] RAN [illegible]

   ```
   systemctl stop ran_monitor
   ```

2. [illegible] MySQL [illegible]

   ```
   mysql -u ran_monitor_user -p ran_monitor < backups/ran_monitor-
   20251230.sql
   ```

3. [illegible] RAN [illegible]

```
systemctl start ran_monitor
```

4. □□□□□□□□□

5. □□□□□□□□

6. □□□□□□□□ InfluxDB □

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3. [illegible]

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4. [illegible]

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2. [illegible]

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- [illegible] SSL [illegible]

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- [illegible]

[illegible]

1. SSL [illegible]

- [illegible] SSL [illegible]

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[illegible]

- [illegible] - [illegible]
- **Web UI** [illegible] - [illegible]
- [illegible] - [illegible]
- **AirScale** [illegible] - [illegible]
- [illegible] - [illegible]
- **Grafana** [illegible] - [illegible]
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- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]

Prometheus [illegible]

[illegible] RAN Monitor [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. InfluxDB [illegible]
5. InfluxDB [illegible]
6. [illegible]
7. PM [illegible]
8. Webhook [illegible]
9. [illegible]
10. BTS [illegible]
11. PM [illegible]
12. [illegible]
13. [illegible] Prometheus [illegible]
14. [illegible]

[illegible]

RAN Monitor [illegible] Prometheus [illegible]

- [illegible] - [illegible] InfluxDB [illegible]
- [illegible] - [illegible] AirScale [illegible]��[illegible]
- **Webhook** [illegible] - [illegible] SOAP webhook [illegible]
- [illegible] - Erlang VM [illegible]

[illegible] RAN [illegible]

Prometheus [illegible] RAN Monitor [illegible] - [illegible]

InfluxDB [illegible] AirScale [illegible] RAN [illegible]PM [illegible]
Grafana [illegible] [illegible] InfluxDB [illegible]

[illegible]

URL: `GET http://<host>:4000/metrics`

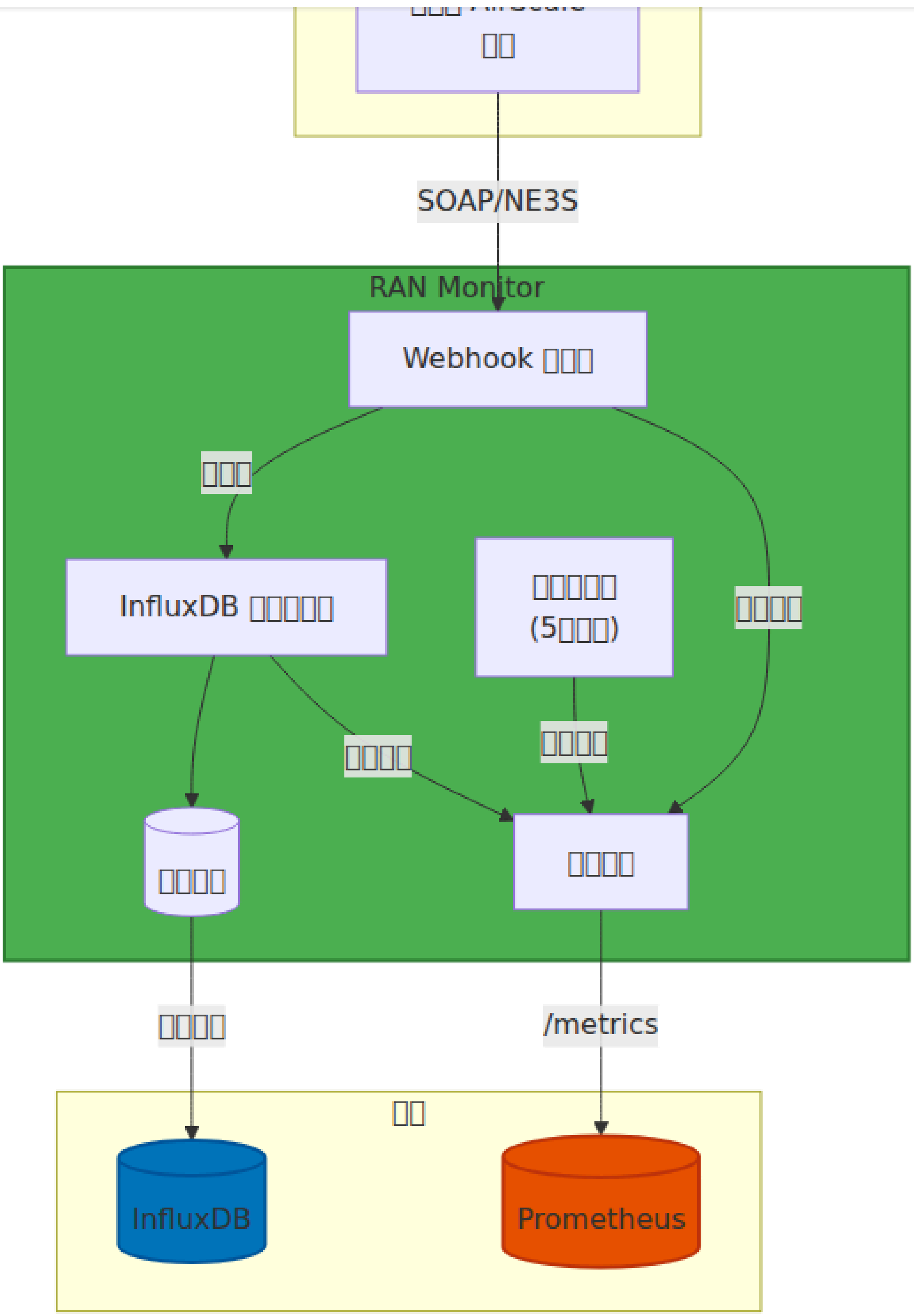
[illegible]**:** Prometheus [illegible]

[illegible]**:** [illegible]

[illegible]

```yaml
# prometheus.yml
scrape_configs:
  - job_name: 'ran_monitor'
    static_configs:
      - targets: ['ran-monitor.internal:4000']
    scrape_interval: 15s
    scrape_timeout: 10s
```

[illegible]


AirScale
SOAP/NE3S
RAN Monitor
Webhook
InfluxDB
(5
/metrics
InfluxDB
Prometheus

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	MetricsUpdater [illegible]	[illegible] 5 [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

InfluxDB [illegible]

[illegible] InfluxDB [illegible]

influxdb_queue_depth

[illegible]: [illegible]

[illegible]: [illegible] InfluxDB [illegible]

[illegible]: [illegible]

[illegible]: [illegible] InfluxDB [illegible]

[illegible]:

- [illegible]: < 5,000 [illegible]
- [illegible]: > 10,000 [illegible]
- [illegible]: > 40,000 [illegible]

---

influxdb_queue_max

[illegible]: [illegible]

[illegible]��: [illegible]���[illegible] 50,000 [illegible]

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---

influxdb_queue_overflow_drops_total

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`agent_name`	□□□□□□□□□`2045_Booker`□`2057_Guymon_TOY`□

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InfluxDB □□□□□□

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influxdb_write_duration_milliseconds

□□: □□□

□□: InfluxDB □□□□□□□□□□□□□□□□□□□□

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`status`	□□□□□`success` □ `error`

□: 10, 25, 50, 100, 250, 500, 1000, 2500, 5000 □□

□□: □□□□□□□□□□□□□□□□ InfluxDB □□□□□□□□□□

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influxdb_points_written_total

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□□: □□□□ InfluxDB □□□□□□□

□□:

□□	□□
`measurement`	□□□□□`pm`□□□□□□□`config` □ `alarm`

□□: □□□□□□□□□□□□□□□□��□□□□□□

---

influxdb_bytes_written_total

□□: □□□

□□: □□□□□ InfluxDB □□□□□□

□□: □

□□: □□□□□□□□□□□□□□□□□□

---

influxdb_flush_count_total

□□: □□□

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□□: □

□□: □□□□□□□□ points_written □□□□□□□□□□□□

[illegible]

[illegible]

influxdb_points_written_by_agent_total

[illegible]: [illegible]

[illegible]: [illegible] InfluxDB [illegible]

[illegible]:

[illegible]	[illegible]
`agent_name`	[illegible]`2045_Booker`[illegible]
`measurement`	[illegible]`pm`[illegible]`config` [illegible] `alarm`

[illegible]: [illegible]

---

influxdb_bytes_written_by_agent_total

[illegible]: [illegible]

[illegible]: [illegible] InfluxDB [illegible]

[illegible]:

[illegible]	[illegible]
`agent_name`	[illegible]

[illegible]: [illegible]

---

influxdb_write_duration_by_agent_milliseconds

[illegible]: [illegible]

[illegible]: [illegible] InfluxDB [illegible]

[illegible]:

[illegible]	[illegible]
`agent_name`	[illegible]
`status`	[illegible]`success` [illegible] `error`

[illegible]: 10, 25, 50, 100, 250, 500, 1000, 2500, 5000 [illegible]

[illegible]: [illegible]

PM [illegible]

[illegible]PM[illegible]

pm_points_filtered_total

[illegible]: [illegible]

[illegible]: [illegible] PM [illegible]

[illegible]: [illegible]

[illegible]: [illegible]

---

pm_points_kept_total

[illegible]: [illegible]

□□: □□□□□□□□□ PM □□□□□□

□□: □

□□: □□□□□□□ PM □□□□

---

pm_filter_allowed_count

□□: □□

□□: □□□□□□□□□□ PM □□□□□□

□□: □

□□: □□□□□□□□□□□□□□ UI □□□□□□

□□: □ `priv/pm_counters.csv` □□□□□ PM □□□□ □□□□□

---

config_points_filtered_total

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□□:

□□	□□
`agent_name`	□□□□□

□□: □□□□□□□□□□□□□□□□□□□□□ - □□□□□□□□□□□

---

config_filter_allowed_count

□□: □□

[illegible]: [illegible]

[illegible]: [illegible]

[illegible]: [illegible]

[illegible]: [illegible] `priv/config_keys.csv` [illegible]

Webhook [illegible]

[illegible] AirScale [illegible] SOAP webhook [illegible]

webhook_processing_duration_milliseconds

[illegible]: [illegible]

[illegible]: [illegible] webhook [illegible]

[illegible]:

[illegible]	[illegible]
`airscale_name`	[illegible]
`message_type`	[illegible]`PM`[illegible]`Config`[illegible]`Alarm` [illegible] `Feedback`

[illegible]: 10, 50, 100, 250, 500, 1000, 2500, 5000, 10000 [illegible]

[illegible]: [illegible] webhook [illegible]

---

webhook_processing_total

[illegible]: [illegible]

[illegible]: [illegible] webhook [illegible]

□□:

□□	□□
`airscale_name`	□□□□□
`message_type`	□□□□□□□`PM`□`Config`□`Alarm` □ `Feedback`
`status`	□□□□□`success` □ `error`

□□: □□□□□□□ webhook □□□□□□

□□□□□□□□

□□□□□□□□□ AirScale □□□□□□□□□□□□

nokia_devices_registered

□□: □□

□□: □□□□□ RAN Monitor □□□□□□□□□

□□: □

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nokia_devices_session_active

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□□: □□□□□□□□ `nokia_devices_registered` □□□□□□□□□□□□

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nokia_device_state

□□: □□

□□: □□□□□□□□□□□□□

□□:

□□	□□
`device_name`	□□□□□□□□□`2045_Booker`□

□:

□	□□
1	□□□□□□□□□□□□
0	□□□

□□: □□□□□□□ 0 □□□□□□□□□□□□□□□□□□

BTS □□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□□��□□ MetricsUpdater □ 5 □□□□

bts_status_total

□□: □□

□□: □□□ BTS □□□□□

□□: □

---

bts_status_connected

□□: □□

□□: □□□□□□□□□□ PM □□□□□□□ BTS □□□

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---

bts_status_waiting_for_pm

□□: □□

□□: □□□□□□□□□□□□□□□□□□□□ PM □□□ BTS □□□

□□: □

□□: □□□□□□□□□□□□□□□ 15 □□□ PM □□□□□□□□□□□□□□□□ 30 □□□□□□ eNodeB □ PM □□□

---

bts_status_pending

□□: □□

□□: □□□□□□□□□□□□□□□□□□□□□□□□ PM□□ BTS □□□

□□: □

---

bts_status_registering

□□: □□

□□: □□□□□□□□□□□ BTS □□□

□□: □

---

bts_status_disconnected

[illegible]: [illegible]

[illegible]: [illegible] BTS [illegible]

[illegible]: [illegible]

[illegible]: [illegible]

PM [illegible]

[illegible] PM [illegible]��[illegible] PM [illegible]

pm_spool_pending_files

[illegible]: [illegible]

[illegible]: [illegible] PM [illegible]

[illegible]: [illegible]

[illegible]: [illegible] PM [illegible]

[illegible]:

- [illegible]: < 10 [illegible]
- [illegible]: > 50 [illegible]
- [illegible]: > 200 [illegible]

---

pm_spool_files_processed_total

[illegible]: [illegible]

[illegible]: [illegible] PM [illegible]

[illegible]: [illegible]

[illegible]: [illegible]

---

pm_spool_points_written_total

[illegible]: [illegible]

[illegible]: [illegible] InfluxDB [illegible] PM [illegible]

[illegible]: [illegible]

[illegible]: [illegible] PM [illegible]

[illegible]

[illegible] Erlang VM [illegible]

vm_memory_bytes

[illegible]: [illegible]

[illegible]: Erlang VM [illegible]

[illegible]:

[illegible]	[illegible]
`type`	[illegible]`total`[illegible]`processes`[illegible]`binary`[illegible]`ets`

[illegible]: [illegible]

[illegible]:

- `total`: [illegible] > 80% [illegible] RAM[illegible]
- `binary`: [illegible]

- `ets`: [illegible]

---

vm_process_count

[illegible]: [illegible]

[illegible]: VM [illegible] Erlang [illegible]

[illegible]: [illegible]

[illegible]: [illegible]

[illegible] Prometheus [illegible]

[illegible]

```
influxdb_queue_depth / influxdb_queue_max * 100
```

[illegible]5 [illegible]

```
sum(rate(influxdb_write_duration_milliseconds_count{status="error"}[5m]))
/ sum(rate(influxdb_write_duration_milliseconds_count[5m])) * 100
```

[illegible]

```
sum(rate(influxdb_points_written_total[5m]))
```

95th [illegible]

```
histogram_quantile(0.95,
sum(rate(influxdb_write_duration_milliseconds_bucket[5m])) by
(le))
```

[illegible]

```
count(nokia_device_state == 0)
```

[illegible] Webhook [illegible]

```
sum by (airscale_name) (
  rate(webhook_processing_total{status="error"}[5m])
) / sum by (airscale_name) (
  rate(webhook_processing_total[5m])
) * 100
```

[illegible]���

```
sum(rate(influxdb_queue_overflow_drops_total[5m]))
```

[illegible]

```
vm_memory_bytes{type="total"}
```

BTS [illegible]

```
bts_status_total - bts_status_connected
```

PM □□□□

```
pm_spool_pending_files
```

PM □□□□□□

```
rate(pm_spool_files_processed_total[5m])
```

PM □□□□□□

```
pm_points_filtered_total / (pm_points_filtered_total +
pm_points_kept_total) * 100
```

□□□□

□□: □□□□

```yaml
alert: InfluxDBQueueDrops
expr: increase(influxdb_queue_overflow_drops_total[5m]) > 0
for: 0m
labels:
  severity: critical
annotations:
  summary: "□□□□□□□□□□□□"
  description: "{{ $value }} □□□□□ 5 □□□□ {{ $labels.agent_name }}
□□"
```

□□: □□□□□

```yaml
alert: NokiaDeviceDisconnected
expr: nokia_device_state == 0
for: 5m
labels:
  severity: critical
annotations:
  summary: "□□□□□ {{ $labels.device_name }} □□□"
  description: "□□□□□□□□□ 5 □□"
```

□□: □□□□

```yaml
alert: InfluxDBQueueHigh
expr: influxdb_queue_depth / influxdb_queue_max * 100 > 50
for: 5m
labels:
  severity: warning
annotations:
  summary: "InfluxDB □□□□□□ 50%"
  description: "□□□□ {{ $value }}% □□□□□□ InfluxDB □□□□□□□"
```

□□: □□□□□

```yaml
alert: InfluxDBWriteLatencyHigh
expr: histogram_quantile(0.95,
sum(rate(influxdb_write_duration_milliseconds_bucket[5m])) by
(le)) > 1000
for: 5m
labels:
  severity: warning
annotations:
  summary: "InfluxDB □□□□□□ 1 □□p95□"
  description: "□ 95 □□□□□□□□ {{ $value }}ms"
```

□□: Webhook □□□□

```yaml
alert: WebhookProcessingErrors
expr: sum(rate(webhook_processing_total{status="error"}[5m])) >
0.1
for: 5m
labels:
  severity: warning
annotations:
  summary: "□□□ Webhook □□□□"
  description: "{{ $value }} □□□□□□ 5 □□□"
```

□□: PM □□□□

```yaml
alert: PmSpoolBacklog
expr: pm_spool_pending_files > 50
for: 5m
labels:
  severity: warning
annotations:
  summary: "PM □□□□□□"
  description: "{{ $value }} □□□□□□□□□□□□□□□□□"
```

□□: □□□□ PM

```yaml
alert: BtsSitesWaitingForPm
expr: bts_status_waiting_for_pm > 0
for: 30m
labels:
  severity: warning
annotations:
  summary: "{{ $value }} □□□□□ PM □□□□ 30 □□"
  description: "□□□□□���□□□□□□□□□ PM □□□□□ eNodeB PM □□□"
```

□□: □□□□□

```yaml
alert: HighMemoryUsage
expr: vm_memory_bytes{type="total"} > 4e9
for: 10m
labels:
  severity: info
annotations:
  summary: "Erlang VM □□□□□□ 4GB"
  description: "□□□□□□□□□: {{ $value | humanize1024 }}B"
```

□□□□

- **Grafana □□** - RAN □□□□□□□□□□□
- **PM □□□□** - □□□□□□ PM □□□
- □□□□ - □□□□□□□□□
- □□□□□□□ - □□□□

[illegible] LTE [illegible]

[illegible] AirScale/FlexiRadio [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]
10. [illegible] QoS [illegible]
11. [illegible]
12. [illegible] Grafana [illegible]
13. [illegible]

[illegible]

[illegible] LTE [illegible]AirScale, FlexiRadio[illegible]

[illegible]

[illegible]���[illegible]

- [illegible]
- [illegible]

- [illegible]
- [illegible]
- [illegible]

[illegible]

[illegible] LTE [illegible]

□□□□□□ (M8xxx)

□□	□□	□□□□□	□□□□□
M8000	S1 □□	33	□□□□□□□□S1 □□/□□□UE □□□
M8001	□□□□	336	PDCP □□□RACH□□□□□MCS □□
M8004	X2 □□	4	X2 □□□□eNB □□□□□
M8005	□□□□□	237	RSSI□SINR□□□□□□□AMC
M8006	EPS □□	54	□□□□/□□/□□
M8007	□□□□□□□	14	DRB □□□□□
M8008	RRC □□□□	14	□□□□□□□□□
M8009	□□□□	8	□□□□□□
M8010	CQI □□	27	□□□□□□□□□
M8011	□□□□□	55	PRB □□□□□□□
M8012	□□□	121	PDCP □□□□□□□□□
M8013	□□□□	21	RRC □□□□□□/□□
M8014	eNB □□□□□	14	□□ X2 □□□□□
M8015	eNB □□□□	13	□□□□□□
M8016	CS □□	18	□□□□□□□□
M8017	□□□□□	10	□□□□□ RAT□3G/2G□
M8018	eNB □□	8	□□ UE □□□□□□□

[illegible]	[illegible]	[illegible]	[illegible]
M8019	NACC	4	[illegible]
M8020	[illegible]	7	[illegible]
M8021	[illegible]	17	[illegible]
M8022	X2 [illegible]	2	X2 [illegible]
M8023	[illegible]	36	[illegible] PDCP SDU [illegible]

[illegible] (M5xxx)

[illegible]	[illegible]	[illegible]	[illegible]
M5112	IP [illegible]	112	[illegible]
M5113	[illegible] RX	21	[illegible]

[illegible] (M4xxxx)

[illegible]	[illegible]	[illegible]	[illegible]
M40001	[illegible]	[illegible]	VSWR[illegible]RF [illegible]
M40002	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

```
M<measurement><type>C<counter>
```

[illegible]M8011C24

- **M** - [illegible]“[illegible]”
- **8011** - [illegible]
- **C** - [illegible]“[illegible]”
- **24** - [illegible] PRB [illegible]

[illegible]

[illegible]

- **Sum** - [illegible]
- **Average** - [illegible]
- **Min** - [illegible]
- **Max** - [illegible]
- **Current** - [illegible]
- **Denominator** - [illegible]

[illegible]

[illegible]

[illegible]

- M8011Cxx - PRB [illegible]
- M8018Cxx - [illegible] UE [illegible]
- M8012Cxx - [illegible]

[illegible]

- M8001Cxx - [illegible]
- M8005Cxx - RSSI[illegible]SINR

- M8013Cxx - [illegible]

[illegible]

- M8020Cxx - [illegible]
- M8049Cxx - [illegible]

[illegible]

- M8005Cxx - [illegible]
- M8001Cxx - [illegible]
- M8013Cxx - [illegible]

[illegible]

M8011 - [illegible]

[illegible]PRB[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8011C24	[illegible] TTI [illegible] PRB [illegible]	[illegible]���[illegible] PRB [illegible]	0.1%	[illegible]	[illegible] 10 [illegible]
M8011C37	[illegible] TTI [illegible] PRB [illegible]	[illegible] PRB [illegible]	0.1%	[illegible]	[illegible] 10 [illegible]

[illegible] **PRB** [illegible]

- [illegible]**PRB**[illegible] LTE [illegible]
- **TTI**[illegible] = LTE [illegible] 1 [illegible]
- [illegible] = [illegible]
- 100% [illegible]

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- 0-1000□□□ 0.0% □ 100.0%□
- □□□□□□□ 10 □□□□□
- □□□□□□□ 453 = 45.3% PRB □□□

□□□□□□□□□□

- < 50% - □□□□□□□
- 50-70% - □□□□□□□
- 70-85% - □□□□□□□□
- > 85% - □□□□□□□□□□□/□□

Grafana □□□□□

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M8011C37")
  |> filter(fn: (r) => r._field == "counterValue")
  |> map(fn: (r) => ({ r with _value: r._value / 10.0}))  // □□□□□
□
```

□□□□□

M8012 - □□□□□□□

□□□□□□□ PDCP□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□	□□	□□	□□	□□	□□□□
M8012C23	PDCP □□□□□□□	□□□□ PDCP □□□	kbit/s	□□	□□ UE □□□ PDCP SDU □
M8012C26	PDCP □□□□□□□	□□□□ PDCP □□□	kbit/s	□□	□□ UE □□ PDCP SDU □

□□ PDCP □□□□

- **PDCP** □□□□□□□□□□□□
- □□□□□□□□□□kbit/s□□□□□□
- □□□□□□□□□□□□□□□
- □□□□□□

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- □ 1 □□□□□□□□□□□□
- □□□□□□□□□□□
- □□ VoLTE □□□□□

□□□□□

□□□M8012C26□□

- < 10 Mbps - □□□/□□□
- 10-50 Mbps - □□□□
- 50-100 Mbps - □□□/□□□□□□
- > 100 Mbps - □□□□□□□□□□□□□

□□□M8012C23□□

- < 5 Mbps - □□□
- 5-20 Mbps - □□□□
- 20-40 Mbps - □□□
- > 40 Mbps - □□□□

Grafana □□□□□

```
from(bucket: "nokia-monitor")
  |> range(start: -1h)
  |> filter(fn: (r) => r["metricCounter"] == "M8012C26")
  |> filter(fn: (r) => r._field == "counterValue")
  |> map(fn: (r) => ({ r with _value: r._value / 1000.0}))  // □□□
Mbps
```

□□□□□□□□□

M8018 - eNB □□□□

□□□□□□□□□□□□□□□□□□□□□□UE□□□□

□□□	□□	□□	□□	□□	□□□□
M8018C1	□□ eNB □□□ UE □□□	□□ eNodeB □□□ UE □□□□	□□	□□	1 □

□□ UE □□□

- **□□ UE** = □□□□□□□□□□□□□□SRB□□□□□□□□□□□□□□□□DRB□□□□
- □ 1 □□□□□□□□□□□□□□
- □□□□□□□□□□□

□□□□□

[illegible] **UE**	[illegible]	[illegible]
0-50	[illegible]	[illegible]
50-100	[illegible]	[illegible]
100-150	[illegible]	[illegible]
> 150	[illegible]	[illegible]

[illegible]

- [illegible]
- [illegible] AirScale [illegible] 150-250 [illegible] UE
- [illegible] UE [illegible]

[illegible]

M8020 - [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8020C3	[illegible]	[illegible]	[illegible]	[illegible]	~10 [illegible]
M8020C4	[illegible]	[illegible]	[illegible]	[illegible]	~10 [illegible]
M8020C6	[illegible]	[illegible]	[illegible]	[illegible]	~10 [illegible]

[illegible]

```
[illegible] % = 100.0 × M8020C3 / (M8020C6 - M8020C4)
```

[illegible]

- **M8020C3** - [illegible]
- **M8020C6** - [illegible]
- **M8020C4** - [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
> 99.9%	[illegible]	[illegible] SLA
99.0-99.9%	[illegible]	[illegible]
95.0-99.0%	[illegible]	[illegible]
< 95.0%	[illegible]	[illegible] - [illegible]

Grafana [illegible]

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M8020C3" or
                       r["metricCounter"] == "M8020C6" or
                       r["metricCounter"] == "M8020C4")
  |> pivot(rowKey:["_time"], columnKey: ["metricCounter"],
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "[illegible]": 100.0 * r.M8020C3 / (r.M8020C6 - r.M8020C4)
    }))
```

[illegible]

M8005 - [illegible]

[illegible]RSSI[illegible]SINR[illegible]

RSSI [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8005C0	PUCCH [illegible] RSSI	[illegible] RSSI	dBm	[illegible]
M8005C1	PUCCH [illegible] RSSI	[illegible] RSSI	dBm	[illegible]
M8005C2	PUCCH [illegible] RSSI	[illegible] RSSI	dBm	[illegible]

[illegible] RSSI[illegible]

- **RSSI** = [illegible]
- **PUCCH** = [illegible]
- [illegible] dBm[illegible]
- [illegible] UE [illegible] RSSI [illegible]

RSSI [illegible]

RSSI [illegible]	[illegible]	[illegible]
> -70 dBm	[illegible]	[illegible]
-70 [illegible] -85 dBm	[illegible]	[illegible]
-85 [illegible] -100 dBm	[illegible]	[illegible]
-100 [illegible] -110 dBm	[illegible]	[illegible]
< -110 dBm	[illegible]	[illegible]

[illegible]

- [illegible] - [illegible] RSSI [illegible]
- [illegible] - [illegible] RSSI [illegible]
- **RF** [illegible] - [illegible]

[illegible]

M8013 - [illegible]

[illegible] RRC[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8013C5	[illegible]	[illegible] RRC [illegible]	[illegible]	[illegible]
M8013C17	[illegible] MO-S	[illegible] - [illegible]	[illegible]	[illegible]
M8013C18	[illegible] MT	[illegible] - [illegible]	[illegible]	[illegible]
M8013C19	[illegible] MO-D	[illegible] - [illegible]	[illegible]	[illegible]
M8013C21	[illegible]	[illegible]	[illegible]	[illegible]
M8013C31	[illegible]	[illegible]	[illegible]	[illegible]
M8013C34	[illegible]	[illegible]	[illegible]	[illegible]
M8013C91	[illegible] MO-V	[illegible] - [illegible]	[illegible]	[illegible]
M8013C93	[illegible] MT-[illegible]	[illegible]���[illegible] - MT [illegible]	[illegible]	[illegible]

[illegible]

```
□□□□□ % = 100.0 × M8013C5 / (M8013C17 + M8013C18 + M8013C19 +
M8013C34 + M8013C31 + M8013C21 + M8013C93 + M8013C91)
```

□□□□□

- **M8013C5** - □□□□□□□□ RRC □□□□□□□
- □□□□□□□□ - □□□□□□□□□□□

□□□□□

- **MO-S (M8013C17)** - □□□□□□□□□□□□□□□
- **MT (M8013C18)** - □□□□□□□/□□□
- **MO-D (M8013C19)** - □□□□□□□□□□□□
- **MO-V (M8013C91)** - □□□□□□□VoLTE □□□
- □□ **(M8013C21)** - □□□□□911□112□

□□□□□

□□□	□□	□□
> 99%	□□	□□□□
95-99%	□□	□□□□□□
90-95%	□□	□□□□
< 90%	□□	□□□□ - □□□□

□□□□□□□

- □□□□□□□□□
- □□□□□□□□□□
- □□□□
- □□□□
- □□

□□□ QoS □□□

M8001 - □□□□□□

□□□	□□	□□	□□	□□
M8001C2	□□ DTCH □□ PDCP SDU □□□□	eNB □□□ PDCP SDU □□□□□□□	ms	□□

□□□□□

- **PDCP SDU** = □□□□□□□□□□□□□□□□□□□□□
- □□ = □□□□□□□□□□□□□□
- □□ **DTCH** = □□□□□□□□□□□□□□□□
- □□□ = □□□□

□□□□□

□□	□□	□□□□
< 10 ms	□□	□□□ VoLTE□□□□□□□□
10-20 ms	□□	□□□□□□□□□
20-50 ms	□□	□□□□□□□□□
> 50 ms	□□	□□□□□□

□□□□□□□

- □□□□□□□□□□
- □□□□□□□
- □□□□□□□□□□□□
- □□□□

S1 □□□□□

M8000 - S1 □□□□

□□□□□□□ eNodeB □ MME□□□□□□□□□□□ S1 □□□□□□□□□□□S1 □□□□□□□□□□

□□□	□□	□□	□□	□□
M8000C0	□□□□□□□□□	□□□□□□□□□□□□	□□	□□
M8000C1	□□□□□□□□□	□□□□□□□□□□	□□	□□
M8000C2	□□□□ - □□□□□	□□□□□□□□□□□□□□	□□	□□
M8000C3	□□□□ - □□	□□□□□□□□□□□□	□□	□□
M8000C6	S1 □□□□	S1 □□□□□□	□□	□□
M8000C7	S1 □□□□	□□□ S1 □□	□□	□□
M8000C11	S1 □□□□	□□ MME □□□□□	□□	□□
M8000C12	UE □□ S1 □□□□	□□□□ UE □□□ S1 □□	□□	□□
M8000C29	□□ NAS □□	□□□ MME □ NAS □□	□□	□□
M8000C30	□□ NAS □□	□ MME □□□ NAS □□	□□	□□

□□ **S1** □□□

- **S1** □□□□ eNodeB □ EPC□□□□□□□□
- □□□□□□□ □□□ UE □□□□□□□
- **S1** □□ □ eNodeB □ MME □□□□□□□
- **NAS**□□□□□□ □□□□□□□□□□

□□□□□□

```
S1 [illegible] = 100 × M8000C7 / M8000C6
[illegible] = 100 × M8000C1 / M8000C0
```

[illegible]

- S1 [illegible]> 99%
- [illegible]> 95%

EPS [illegible]

M8006 - EPS [illegible]

[illegible] E-UTRAN [illegible]E-RAB[illegible] EPS [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8006C0	EPS [illegible]	[illegible]	[illegible]	[illegible]
M8006C1	EPS [illegible]	[illegible]	[illegible]	[illegible]
M8006C2-C5	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] **EPS** [illegible]

- [illegible] = UE [illegible]
- [illegible] = [illegible]
- [illegible] = [illegible] QoS [illegible]VoLTE[illegible]

[illegible]

- [illegible]
- [illegible]

- □□□□□□□ QoS □□□□

□□□□□

M8009 - □□□□□□

M8014 - eNB □□□□□□□

M8015 - eNB □□□□□□

M8021 - □□□□□□□

□□□□□□□□□□□ - □ UE □□□□□□□□□□□□□□□□□□□□□□□

□□□□□

□□	□□	□□□
eNB □□	□□□□□□□□□□	M8015
eNB □□	□□□□□□□□□□□X2□	M8014
□□□	□□□□□□□□□	M8021
□□□	□□□□□□□□LTE→3G/2G□	M8017

□□□□□

[illegible]	[illegible]	[illegible]
M8009	[illegible]	[illegible]
M8014	[illegible]X2[illegible]	[illegible]
M8015	[illegible]	[illegible]
M8021	[illegible]	[illegible]

[illegible]

```
HO Success Rate = 100 × (HO Executions) / (HO Prep Attempts)
```

[illegible]

- [illegible]eNB[illegible]> 99%
- [illegible]eNB[illegible]> 98%
- [illegible]> 95%

[illegible]

- [illegible]
- [illegible]
- [illegible]UE[illegible]
- [illegible]

[illegible]

M8010 - CQI[illegible]

[illegible]UE[illegible]CQI[illegible]

[illegible]CQI[illegible]

- **CQI** = UE□□□eNodeB□□□□□□□
- □□□ CQI 0□□□□□CQI 15□□□□
- ��□□ □□□□□□□□□□MCS□□□□□□□□□
- □□□□□ □□□□□□□□□□□□□□

CQI□□□□□□□□

CQI□□	□□□□	□□□□□□	□□
0-3	□□□	< 1 Mbps	QPSK
4-6	□	1-5 Mbps	QPSK
7-9	□□	5-15 Mbps	16-QAM
10-12	□□	15-40 Mbps	64-QAM
13-15	□□	40-150 Mbps	64-QAM

M8010□□□□

- M8010C0 - M8010C15□□□□□□0-15□□CQI□□□□

□□□□□

```
Average CQI = Σ(CQI_level × M8010C[level]) / Σ(M8010C[level])
```

□□CQI□□□

- **□CQI□10-15□□** □□□□□□□□□□
- **□□CQI□7-9□□** □□□□□□□□□□
- **□CQI□0-6□□** □□□□□□□□□□□

CS□□□□□

M8016 - CS□□□□

□□□□□□□□□□□□□□CSFB□□□□□□LTE UE□□□2G/3G□□□□□□□□□

□□CSFB□

- □□□ □□□VoLTE□□□□□□□□□□
- □□□ UE□LTE□ → □□□□ → □□□□□2G/3G → □□LTE
- □□□ □□□□□□□□□□□LTE□□

□□□□□□

□□□	□□	□□
M8016C0	□□□□□□CSFB□□	□□□□□□□□CSFB
M8016C1	□□□□□CSFB□□	□□□□□□□CSFB

CSFB□□□

1. □□□□ UE□LTE□□□□□□□2G/3G□□□□□□□□□□□□
2. □□□ □LTE□2G/3G□□□□□□□□□□□□

□□□□□

- CSFB□□□ = □□□□ / □CSFB□□
- □□□> 98%

□□□□□□

M8023 - PDCP SDU□□□□□

□□□□□□□□□□□□□□□□□□□□□□□□

[illegible]

- [illegible]
- [illegible]QCI[illegible]
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- QoS[illegible]

[illegible]M8012[illegible]

- **M8012**[illegible] [illegible]kbit/s[illegible]
- **M8023**[illegible] [illegible]

X2[illegible]

M8004 - X2[illegible]

M8022 - X2[illegible]

[illegible]eNodeB[illegible]X2[illegible]eNB[illegible]

M8004 - X2[illegible]

- [illegible]eNodeB[illegible]
- [illegible]X2[illegible]

M8022 - X2[illegible]

- **M8022C0**[illegible] X2[illegible]
- **M8022C1**[illegible] X2[illegible]��

[illegible]X2[illegible]

- [illegible] [illegible]eNodeB[illegible]
- [illegible] [illegible]
- [illegible] [illegible]

X2[illegible]

```
X2 Setup Success Rate = 100 × M8022C1 / M8022C0
```

[illegible] > 95%

[illegible]

M8007 - [illegible]DRB[illegible]

[illegible]DRB[illegible]

[illegible]

- DRB[illegible]
- DRB[illegible]
- [illegible]

M8008 - RRC[illegible]

[illegible]RRC[illegible]

[illegible]

- [illegible]PRB[illegible]
- [illegible]UE[illegible]
- [illegible]
- [illegible]

M8019 - [illegible]NACC[illegible]

[illegible]NACC[illegible]LTE[illegible]GSM[illegible]

[illegible] [illegible]UE[illegible]GSM[illegible]

[illegible]

M5112 - IP[illegible]

M5113 - [illegible]RX[illegible]

[illegible]

M5112 - IP[illegible]112[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

M5113 - [illegible]RX[illegible]21[illegible]

- [illegible]���
- [illegible]
- [illegible]CRC[illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

M40001 - [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M40001C0	[illegible]VSWR	[illegible]	0.1	[illegible]	[illegible]10

[illegible]VSWR[illegible]

- **VSWR** = [illegible]
- [illegible]
- [illegible]/[illegible]
- [illegible] = [illegible]

VSWR[illegible]

VSWR	[illegible]	[illegible]
1.0-1.5	[illegible]	[illegible]
1.5-2.0	[illegible]	[illegible]
2.0-3.0	[illegible]	[illegible]
> 3.0	[illegible]	[illegible]/[illegible] - [illegible]

[illegible]VSWR[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]

Grafana[illegible]

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M40001C0")
  |> filter(fn: (r) => r._field == "counterValue")
  |> map(fn: (r) => ({ r with "VSWR": r._value / 10.0}))
```

M40002 - □□□□

□□□	□��	□□	□□	□□	□□
M40002C2	□□	□□□□	100000□□	□□	□□100000

□□□□□

- □□□□□□□□
- □OPEX□□□□□□□□□
- □□□□□/□□□□□□□□□□

Grafana□□□□□

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M40002C2")
  |> filter(fn: (r) => r._field == "counterValue")
  |> map(fn: (r) => ({ r with "Power": r._value / 100000.0}))
```

□Grafana□□□□□□

□□□□□□□□

1. □□□□□□□□□

□□M8011C24□M8011C37□□□□/□□PRB□□□□□

```
// [illegible]PRB[illegible]
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M8011C24")
  |> map(fn: (r) => ({ r with _value: r._value / 10.0}))
  |> rename(columns: {"_value": "[illegible]PRB %"})

// [illegible]PRB[illegible]
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M8011C37")
  |> map(fn: (r) => ({ r with _value: r._value / 10.0}))
  |> rename(columns: {"_value": "[illegible]PRB %"})
```

2. [illegible]

[illegible]

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] == "M8012C23" or
r["metricCounter"] == "M8012C26")
  |> map(fn: (r) => ({ r with _value: r._value / 1000.0}))  // [illegible]
Mbps
  |> pivot(rowKey: ["_time"], columnKey: ["metricCounter"],
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "[illegible] Mbps": r.M8012C23,
      "[illegible] Mbps": r.M8012C26
    }))
```

3. [illegible]

[illegible]

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] =~ /M8020C(3|4|6)/)
  |> pivot(rowKey: ["_time"], columnKey: ["metricCounter"], 
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "□□□ %": 100.0 * r.M8020C3 / (r.M8020C6 - r.M8020C4)
    }))
```

4. □□□□□□□□

□□RRC□□□□□

```
from(bucket: "nokia-monitor")
  |> range(start: v.timeRangeStart, stop: v.timeRangeStop)
  |> filter(fn: (r) => r["metricCounter"] =~ 
/M8013C(5|17|18|19|21|31|34|91|93)/)
  |> pivot(rowKey: ["_time"], columnKey: ["metricCounter"], 
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "□□□□ %": 100.0 * r.M8013C5 / (r.M8013C17 + r.M8013C18 + 
r.M8013C19 + r.M8013C34 + r.M8013C31 + r.M8013C21 + r.M8013C93 + 
r.M8013C91)
    }))
```

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- □□□□□ - □□□□□□□□□PRB□□□□□
- □□ - □□□□□□□□□□□
- □□□□□□ - □□□□□□□□UE□
- □□ - □□□□□RSSI□□□

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- □□□□□□□□□
- □□□□□□□□□□□

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- PRB□□□□□□<70%□□□70-85%□□□>85%
- □□□□□□>99%□□□95-99%□□□<95%
- □□□□□□□>99%□□□95-99%□□□<95%

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- □□□□□□□□□□/□□□□
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- □□□□ - RAN□□□□□□□□□
- Grafana□□□□ - □□Grafana□□□
- □□□□□□□ - □□RAN□□
- AirScale□□□□ - □□□□
- □□□�� - InfluxDB□□□□

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
M8011C24	[illegible]PRB[illegible]	[illegible]	0.1%
M8011C37	[illegible]PRB[illegible]	[illegible]	0.1%
M8012C23	PDCP[illegible]	[illegible]	kbit/s
M8012C26	PDCP[illegible]	[illegible]	kbit/s
M8018C1	[illegible]UE[illegible]	[illegible]	[illegible]
M8020C3	[illegible]	[illegible]	[illegible]
M8020C6	[illegible]	[illegible]	[illegible]
M8013C5	[illegible]	[illegible]	[illegible]
M8005C0	RSSI[illegible]	[illegible]	dBm
M8005C2	RSSI[illegible]	[illegible]	dBm
M8001C2	PDCP[illegible]	[illegible]	ms
M40001C0	VSWR	[illegible]	0.1[illegible]

[illegible]

- Nokia FlexiRadio LTE[illegible]
- Nokia AirScale[illegible]
- 3GPP LTE[illegible]

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□□□□Nokia KPI□□□□□□□□1,186□Nokia LTE□□□□□□□□□□□□□

```
=====================================================================
NOKIA LTE PERFORMANCE COUNTER COMPLETE REFERENCE
=====================================================================

---------------------------------------------------------------------
Measurement Group: M8000
---------------------------------------------------------------------
M8000C0         | Initial Context Setup requests
M8000C1         | Initial Context Setup completions
M8000C2         | Initial Context Setup failures due to
M8000C3         | Initial Context Setup failures due to
M8000C4         | Initial Context Setup failures due to
M8000C5         | Initial Context Setup failures due to
M8000C6         | S1 setup requests
M8000C7         | S1 setup completions
M8000C8         | S1 setup failure due to timer expiration
M8000C9         | S1 setup failure due to MME rejection
M8000C11        | S1 Paging requests
M8000C12        | Number of UE-associated logical S1-
M8000C13        | Global S1 Reset initiated by the eNB
M8000C14        | Global S1 Reset initiated by the MME
M8000C15        | Partial S1 Reset initiated by the eNB
M8000C16        | Partial S1 Reset initiated by the MME
M8000C23        | UE Context modification attempts
M8000C24        | UE Context modification attempts due
M8000C25        | UE Context modification failures
M8000C29        | Number of Uplink NAS Transport
M8000C30        | Number of Downlink NAS Transport
M8000C31        | UE Context modification attempts due
M8000C32        | E-RAB Setup Requests for IMS
M8000C33        | E-RAB Setup Completions for IMS
M8000C34        | E-RAB setup failures for IMS
M8000C35        | Number of Location Reporting Control
M8000C36        | Number of Location Report messages
M8000C37        | Number of successful X2 IP address
M8000C38        | Number of attempted X2 IP address
M8000C39        | Number of WRITE-REPLACE
M8000C40        | Number of WRITE-REPLACE
M8000C41        | Number of KILL REQUEST messages
M8000C42        | Number of KILL RESPONSE

---------------------------------------------------------------------
Measurement Group: M8001
```

```
--------------------------------------------------------------------
M8001C0         | PDCP SDU delay on DL DTCH Min
M8001C1         | PDCP SDU delay on DL DTCH Max
M8001C2         | PDCP SDU delay on DL DTCH Mean
M8001C3         | PDCP SDU delay on UL DTCH Min
M8001C4         | PDCP SDU delay on UL DTCH Max
M8001C5         | PDCP SDU delay on UL DTCH Mean
M8001C6         | RACH setup attempts for small size
M8001C7         | RACH setup attempts for large size
M8001C8         | RACH setup completions
M8001C9         | Transmitted TBs on PCH
M8001C10        | Transmitted TBs on BCH
M8001C11        | Transmitted TBs on DL-SCH
M8001C12        | HARQ retransmissions on DL-SCH
M8001C13        | Correct non-duplicate UL-SCH TB with
M8001C14        | Correct UL-SCH TB with re-reception
M8001C15        | Erroneous UL-SCH TB receptions
M8001C16        | PUSCH transmissions using MCS0
M8001C17        | PUSCH transmissions using MCS1
M8001C18        | PUSCH transmissions using MCS2
M8001C19        | PUSCH transmissions using MCS3
M8001C20        | PUSCH transmissions using MCS4
M8001C21        | PUSCH transmissions using MCS5
M8001C22        | PUSCH transmissions using MCS6
M8001C23        | PUSCH transmissions using MCS7
M8001C24        | PUSCH transmissions using MCS8
M8001C25        | PUSCH transmissions using MCS9
M8001C26        | PUSCH transmissions using MCS10
M8001C27        | PUSCH transmissions using MCS11
M8001C28        | PUSCH transmissions using MCS12
M8001C29        | PUSCH transmissions using MCS13
M8001C30        | PUSCH transmissions using MCS14
M8001C31        | PUSCH transmissions using MCS15
M8001C32        | PUSCH transmissions using MCS16
M8001C33        | PUSCH transmissions using MCS17
M8001C34        | PUSCH transmissions using MCS18
M8001C35        | PUSCH transmissions using MCS19
M8001C36        | PUSCH transmissions using MCS20
M8001C37        | PUSCH transmissions using MCS21
M8001C38        | PUSCH transmissions using MCS22
M8001C39        | PUSCH transmissions using MCS23
M8001C40        | PUSCH transmissions using MCS24
M8001C41        | PUSCH transmissions using MCS25
M8001C42        | PUSCH transmissions using MCS26
```

```
M8001C43        | PUSCH transmissions using MCS27
M8001C44        | PUSCH transmissions using MCS28
M8001C45        | PDSCH transmissions using MCS0
M8001C46        | PDSCH transmissions using MCS1
M8001C47        | PDSCH transmissions using MCS2
M8001C48        | PDSCH transmissions using MCS3
M8001C49        | PDSCH transmissions using MCS4
M8001C50        | PDSCH transmissions using MCS5
M8001C51        | PDSCH transmissions using MCS6
M8001C52        | PDSCH transmissions using MCS7
M8001C53        | PDSCH transmissions using MCS8
M8001C54        | PDSCH transmissions using MCS9
M8001C55        | PDSCH transmissions using MCS10
M8001C56        | PDSCH transmissions using MCS11
M8001C57        | PDSCH transmissions using MCS12
M8001C58        | PDSCH transmissions using MCS13
M8001C59        | PDSCH transmissions using MCS14
M8001C60        | PDSCH transmissions using MCS15
M8001C61        | PDSCH transmissions using MCS16
M8001C62        | PDSCH transmissions using MCS17
M8001C63        | PDSCH transmissions using MCS18
M8001C64        | PDSCH transmissions using MCS19
M8001C65        | PDSCH transmissions using MCS20
M8001C66        | PDSCH transmissions using MCS21
M8001C67        | PDSCH transmissions using MCS22
M8001C68        | PDSCH transmissions using MCS23
M8001C69        | PDSCH transmissions using MCS24
M8001C70        | PDSCH transmissions using MCS25
M8001C71        | PDSCH transmissions using MCS26
M8001C72        | PDSCH transmissions using MCS27
M8001C73        | PDSCH transmissions using MCS28
M8001C74        | PUSCH transmission nacks using
M8001C75        | PUSCH transmission nacks using
M8001C76        | PUSCH transmission nacks using
M8001C77        | PUSCH transmission nacks using
M8001C78        | PUSCH transmission nacks using
M8001C79        | PUSCH transmission nacks using
M8001C80        | PUSCH transmission nacks using
M8001C81        | PUSCH transmission nacks using
M8001C82        | PUSCH transmission nacks using
M8001C83        | PUSCH transmission nacks using
M8001C84        | PUSCH transmission nacks using
M8001C85        | PUSCH transmission nacks using
M8001C86        | PUSCH transmission nacks using
```

```
M8001C87        | PUSCH transmission nacks using
M8001C88        | PUSCH transmission nacks using
M8001C89        | PUSCH transmission nacks using
M8001C90        | PUSCH transmission nacks using
M8001C91        | PUSCH transmission nacks using
M8001C92        | PUSCH transmission nacks using
M8001C93        | PUSCH transmission nacks using
M8001C94        | PUSCH transmission nacks using
M8001C95        | PUSCH transmission nacks using
M8001C96        | PUSCH transmission nacks using
M8001C97        | PUSCH transmission nacks using
M8001C98        | PUSCH transmission nacks using
M8001C99        | PUSCH transmission nacks using
M8001C100       | PUSCH transmission nacks using
M8001C101       | PUSCH transmission nacks using
M8001C102       | PUSCH transmission nacks using
M8001C103       | PDSCH transmission nacks using
M8001C104       | PDSCH transmission nacks using
M8001C105       | PDSCH transmission nacks using
M8001C106       | PDSCH transmission nacks using
M8001C107       | PDSCH transmission nacks using
M8001C108       | PDSCH transmission nacks using
M8001C109       | PDSCH transmission nacks using
M8001C110       | PDSCH transmission nacks using
M8001C111       | PDSCH transmission nacks using
M8001C112       | PDSCH transmission nacks using
M8001C113       | PDSCH transmission nacks using
M8001C114       | PDSCH transmission nacks using
M8001C115       | PDSCH transmission nacks using
M8001C116       | PDSCH transmission nacks using
M8001C117       | PDSCH transmission nacks using
M8001C118       | PDSCH transmission nacks using
M8001C119       | PDSCH transmission nacks using
M8001C120       | PDSCH transmission nacks using
M8001C121       | PDSCH transmission nacks using
M8001C122       | PDSCH transmission nacks using
M8001C123       | PDSCH transmission nacks using
M8001C124       | PDSCH transmission nacks using
M8001C125       | PDSCH transmission nacks using
M8001C126       | PDSCH transmission nacks using
M8001C127       | PDSCH transmission nacks using
M8001C128       | PDSCH transmission nacks using
M8001C129       | PDSCH transmission nacks using
M8001C130       | PDSCH transmission nacks using
```

```
M8001C131       | PDSCH transmission nacks using
M8001C132       | RLC SDUs on DL DTCH
M8001C133       | RLC SDUs on DL DCCH
M8001C135       | RLC SDUs on UL DTCH
M8001C136       | RLC SDUs on UL DCCH
M8001C137       | RLC PDU first transmissions
M8001C138       | RLC PDU re-transmissions
M8001C139       | RLC PDU reception
M8001C140       | DL RLC C-PDUs transmitted the first
M8001C141       | DL RLC Data PDUs transmitted first
M8001C142       | UL RLC PDUs received
M8001C143       | Duplicate UL RLC PDU received
M8001C144       | UL RLC PDU retransmission requested
M8001C145       | UL RLC PDUs discarded
M8001C146       | DL RLC SDU From PDCP
M8001C147       | Average number of UEs with buffered
M8001C148       | Max number of UEs with buffered data
M8001C150       | Average number of UEs with buffered
M8001C151       | Max number of UEs with buffered data
M8001C153       | PDCP SDUs in Uplink
M8001C154       | PDCP SDUs in Downlink
M8001C155       | Discarded PDCP SDUs in downlink
M8001C156       | Failed Transmission PDSCH MCS0
M8001C157       | Failed Transmission PDSCH MCS1
M8001C158       | Failed Transmission PDSCH MCS2
M8001C159       | Failed Transmission PDSCH MCS3
M8001C160       | Failed Transmission PDSCH MCS4
M8001C161       | Failed Transmission PDSCH MCS5
M8001C162       | Failed Transmission PDSCH MCS6
M8001C163       | Failed Transmission PDSCH MCS7
M8001C164       | Failed Transmission PDSCH MCS8
M8001C165       | Failed Transmission PDSCH MCS9
M8001C166       | Failed Transmission PDSCH MCS10
M8001C167       | Failed Transmission PDSCH MCS11
M8001C168       | Failed Transmission PDSCH MCS12
M8001C169       | Failed Transmission PDSCH MCS13
M8001C170       | Failed Transmission PDSCH MCS14
M8001C171       | Failed Transmission PDSCH MCS15
M8001C172       | Failed Transmission PDSCH MCS16
M8001C173       | Failed Transmission PDSCH MCS17
M8001C174       | Failed Transmission PDSCH MCS18
M8001C175       | Failed Transmission PDSCH MCS19
M8001C176       | Failed Transmission PDSCH MCS20
M8001C177       | Failed Reception PUSCH MCS0
```

```
M8001C178       | Failed Reception PUSCH MCS1
M8001C179       | Failed Reception PUSCH MCS2
M8001C180       | Failed Reception PUSCH MCS3
M8001C181       | Failed Reception PUSCH MCS4
M8001C182       | Failed Reception PUSCH MCS5
M8001C183       | Failed Reception PUSCH MCS6
M8001C184       | Failed Reception PUSCH MCS7
M8001C185       | Failed Reception PUSCH MCS8
M8001C186       | Failed Reception PUSCH MCS9
M8001C187       | Failed Reception PUSCH MCS10
M8001C188       | Failed Reception PUSCH MCS11
M8001C189       | Failed Reception PUSCH MCS12
M8001C190       | Failed Reception PUSCH MCS13
M8001C191       | Failed Reception PUSCH MCS14
M8001C192       | Failed Reception PUSCH MCS15
M8001C193       | Failed Reception PUSCH MCS16
M8001C194       | Failed Reception PUSCH MCS17
M8001C195       | Failed Reception PUSCH MCS18
M8001C196       | Failed Reception PUSCH MCS19
M8001C197       | Failed Reception PUSCH MCS20
M8001C199       | RRC Connected UEs Avg
M8001C200       | RRC Connected UEs Max
M8001C202       | Failed Transmission PDSCH MCS21
M8001C203       | Failed Transmission PDSCH MCS22
M8001C204       | Failed Transmission PDSCH MCS23
M8001C205       | Failed Transmission PDSCH MCS24
M8001C206       | Failed Transmission PDSCH MCS25
M8001C207       | Failed Transmission PDSCH MCS26
M8001C208       | Failed Transmission PDSCH MCS27
M8001C209       | Failed Transmission PDSCH MCS28
M8001C210       | Minimum queue length DL SRB
M8001C211       | Average queue length DL SRB
M8001C212       | Maximum queue length DL SRB
M8001C213       | Minimum queue length DL DRB
M8001C214       | Average queue length DL DRB
M8001C215       | Maximum queue length DL DRB
M8001C216       | Average number of available PRBs per
M8001C217       | Average number of available PRBs per
M8001C218       | RLC SDUs on BCCH
M8001C219       | RLC SDUs on DL CCCH
M8001C220       | RLC SDUs on PCCH
M8001C222       | RLC SDUs on UL CCCH
M8001C223       | Active UE per Cell average
M8001C224       | Active UE per Cell max
```

```
M8001C227       | UEs with buffered DL data for DRB with
M8001C228       | UEs with buffered DL data for QCI2
M8001C229       | UEs with buffered DL data for QCI3
M8001C230       | UEs with buffered DL data for QCI4
M8001C231       | Number of primary ETWS notifications
M8001C232       | Number of secondary ETWS
M8001C233       | Number of CMAS notifications
M8001C235       | UEs with buffered DL data for non-GBR
M8001C254       | Number of lost PDCP SDUs in UL
M8001C255       | Number of lost PDCP SDUs in UL for
M8001C256       | Number of lost PDCP SDUs in UL for
M8001C257       | Number of lost PDCP SDUs in UL for
M8001C258       | Number of lost PDCP SDUs in UL for
M8001C259       | Number of lost PDCP SDUs in DL
M8001C260       | Number of lost PDCP SDUs in DL for
M8001C261       | Number of lost PDCP SDUs in DL for
M8001C262       | Number of lost PDCP SDUs in DL for
M8001C263       | Number of lost PDCP SDUs in DL for
M8001C264       | Sum of Active UEs with buffered data in
M8001C265       | Denominator for Active UEs with
M8001C266       | Sum of Active UEs with buffered data in
M8001C267       | Denominator for Active UEs with
M8001C269       | Mean PDCP SDU delay on DL DTCH
M8001C270       | Mean PDCP SDU delay on DL DTCH
M8001C271       | PDCP SDU delay on DL DTCH Mean
M8001C272       | PDCP SDU delay on DL DTCH Mean
M8001C273       | PDCP SDU delay on DL DTCH Mean
M8001C286       | RACH setup attempts for dedicated
M8001C305       | PDCP SDU UL QCI 1
M8001C306       | PDCP SDU UL QCI 2
M8001C307       | PDCP SDU UL QCI 3
M8001C308       | PDCP SDU UL QCI 4
M8001C314       | PDCP SDU DL QCI 1
M8001C315       | PDCP SDU DL QCI 2
M8001C316       | PDCP SDU DL QCI 3
M8001C317       | PDCP SDU DL QCI 4
M8001C318       | Sum of RRC Connected UEs per cell
M8001C319       | Denominator for RRC Connected UEs
M8001C320       | Sum of Active UEs per cell
M8001C321       | Denominator for Active UEs per cell
M8001C323       | PDCP SDU discarded DL QCI 1
M8001C324       | PDCP SDU discarded DL QCI 2
M8001C325       | PDCP SDU discarded DL QCI 3
M8001C326       | PDCP SDU discarded DL QCI 4
```

```
M8001C419       | UEs with buffered UL data for DRB with
M8001C420       | UEs with buffered UL data for non-GBR
M8001C421       | Number of PDCCH order attempts
M8001C422       | Number of initial PDCCH order
M8001C423       | Number of successful PDCCH orders
M8001C424       | Unavailability of dedicated preamble
M8001C425       | Unavailability of dedicated preamble for
M8001C426       | Unavailability of dedicated preamble for
M8001C427       | Number of UE state transitions from
M8001C428       | Average number of UEs in UL-In-Sync
M8001C429       | Average number of UEs with unlimited
M8001C430       | UE UL-Out-Of-Sync time T in the range
M8001C431       | UE UL-Out-Of-Sync time T in the range
M8001C432       | UE UL-Out-Of-Sync time T in the range
M8001C433       | UE UL-Out-Of-Sync time T in the range
M8001C434       | UE UL-Out-Of-Sync time T larger than
M8001C435       | First transmissions on PUSCH using
M8001C436       | First transmissions on PUSCH using
M8001C437       | First transmissions on PUSCH using
M8001C438       | First transmissions on PUSCH using
M8001C439       | First transmissions on PUSCH using
M8001C440       | First transmissions on PUSCH using
M8001C441       | First transmissions on PUSCH using
M8001C442       | First transmissions on PUSCH using
M8001C443       | First transmissions on PUSCH using
M8001C444       | First transmissions on PUSCH using
M8001C445       | First transmissions on PUSCH using
M8001C446       | First transmissions on PUSCH using
M8001C447       | First transmissions on PUSCH using
M8001C448       | First transmissions on PUSCH using
M8001C449       | First transmissions on PUSCH using
M8001C450       | First transmissions on PUSCH using
M8001C451       | First transmissions on PUSCH using
M8001C452       | First transmissions on PUSCH using
M8001C453       | First transmissions on PUSCH using
M8001C454       | First transmissions on PUSCH using
M8001C455       | First transmissions on PUSCH using
M8001C456       | First transmissions on PUSCH using
M8001C457       | First transmissions on PUSCH using
M8001C458       | First transmissions on PUSCH using
M8001C459       | First transmissions on PUSCH using
M8001C460       | First transmission NACKs on PUSCH
M8001C461       | First transmission NACKs on PUSCH
M8001C462       | First transmission NACKs on PUSCH
```

```
M8001C463       | First transmission NACKs on PUSCH
M8001C464       | First transmission NACKs on PUSCH
M8001C465       | First transmission NACKs on PUSCH
M8001C466       | First transmission NACKs on PUSCH
M8001C467       | First transmission NACKs on PUSCH
M8001C468       | First transmission NACKs on PUSCH
M8001C469       | First transmission NACKs on PUSCH
M8001C470       | First transmission NACKs on PUSCH
M8001C471       | First transmission NACKs on PUSCH
M8001C472       | First transmission NACKs on PUSCH
M8001C473       | First transmission NACKs on PUSCH
M8001C474       | First transmission NACKs on PUSCH
M8001C475       | First transmission NACKs on PUSCH
M8001C476       | First transmission NACKs on PUSCH
M8001C477       | First transmission NACKs on PUSCH
M8001C478       | First transmission NACKs on PUSCH
M8001C479       | First transmission NACKs on PUSCH
M8001C480       | First transmission NACKs on PUSCH
M8001C481       | First transmission NACKs on PUSCH
M8001C482       | First transmission NACKs on PUSCH
M8001C483       | First transmission NACKs on PUSCH
M8001C484       | First transmission NACKs on PUSCH
M8001C485       | Failed Reception PUSCH MCS21
M8001C486       | Failed Reception PUSCH MCS22
M8001C487       | Failed Reception PUSCH MCS23
M8001C488       | Failed Reception PUSCH MCS24
M8001C494       | Average number of DL carrier
M8001C495       | Average number of UEs with a
M8001C496       | Average number of UEs with an

--------------------------------------------------------------------
Measurement Group: M8004
--------------------------------------------------------------------
M8004C0         | X2 data volume per eNB, incoming
M8004C1         | X2 data volume per eNB, outgoing
M8004C2         | Incoming u-plane X2 data volume per
M8004C3         | Outgoing u-plane X2 data volume per

--------------------------------------------------------------------
Measurement Group: M8005
--------------------------------------------------------------------
M8005C0         | RSSI for PUCCH Min
M8005C1         | RSSI for PUCCH Max
M8005C2         | RSSI for PUCCH Mean
```

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M8005C3         | RSSI for PUSCH Min
M8005C4         | RSSI for PUSCH Max
M8005C5         | RSSI for PUSCH Mean
M8005C6         | RSSI for PUCCH Level 01
M8005C7         | RSSI for PUCCH Level 02
M8005C8         | RSSI for PUCCH Level 03
M8005C9         | RSSI for PUCCH Level 04
M8005C10        | RSSI for PUCCH Level 05
M8005C11        | RSSI for PUCCH Level 06
M8005C12        | RSSI for PUCCH Level 07
M8005C13        | RSSI for PUCCH Level 08
M8005C14        | RSSI for PUCCH Level 09
M8005C15        | RSSI for PUCCH Level 10
M8005C16        | RSSI for PUCCH Level 11
M8005C17        | RSSI for PUCCH Level 12
M8005C18        | RSSI for PUCCH Level 13
M8005C19        | RSSI for PUCCH Level 14
M8005C20        | RSSI for PUCCH Level 15
M8005C21        | RSSI for PUCCH Level 16
M8005C22        | RSSI for PUCCH Level 17
M8005C23        | RSSI for PUCCH Level 18
M8005C24        | RSSI for PUCCH Level 19
M8005C25        | RSSI for PUCCH Level 20
M8005C26        | RSSI for PUCCH Level 21
M8005C27        | RSSI for PUCCH Level 22
M8005C28        | RSSI for PUSCH Level 01
M8005C29        | RSSI for PUSCH Level 02
M8005C30        | RSSI for PUSCH Level 03
M8005C31        | RSSI for PUSCH Level 04
M8005C32        | RSSI for PUSCH Level 05
M8005C33        | RSSI for PUSCH Level 06
M8005C34        | RSSI for PUSCH Level 07
M8005C35        | RSSI for PUSCH Level 08
M8005C36        | RSSI for PUSCH Level 09
M8005C37        | RSSI for PUSCH Level 10
M8005C38        | RSSI for PUSCH Level 11
M8005C39        | RSSI for PUSCH Level 12
M8005C40        | RSSI for PUSCH Level 13
M8005C41        | RSSI for PUSCH Level 14
M8005C42        | RSSI for PUSCH Level 15
M8005C43        | RSSI for PUSCH Level 16
M8005C44        | RSSI for PUSCH Level 17
M8005C45        | RSSI for PUSCH Level 18
M8005C46        | RSSI for PUSCH Level 19
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  M8005C47        | RSSI for PUSCH Level 20
  M8005C48        | RSSI for PUSCH Level 21
  M8005C49        | RSSI for PUSCH Level 22
  M8005C54        | UE Power Headroom for PUSCH Level
  M8005C55        | UE Power Headroom for PUSCH Level
  M8005C56        | UE Power Headroom for PUSCH Level
  M8005C57        | UE Power Headroom for PUSCH Level
  M8005C58        | UE Power Headroom for PUSCH Level
  M8005C59        | UE Power Headroom for PUSCH Level
  M8005C60        | UE Power Headroom for PUSCH Level
  M8005C61        | UE Power Headroom for PUSCH Level
  M8005C62        | UE Power Headroom for PUSCH Level
  M8005C63        | UE Power Headroom for PUSCH Level
  M8005C64        | UE Power Headroom for PUSCH Level
  M8005C65        | UE Power Headroom for PUSCH Level
  M8005C66        | UE Power Headroom for PUSCH Level
  M8005C67        | UE Power Headroom for PUSCH Level
  M8005C68        | UE Power Headroom for PUSCH Level
  M8005C69        | UE Power Headroom for PUSCH Level
  M8005C70        | UE Power Headroom for PUSCH Level
  M8005C71        | UE Power Headroom for PUSCH Level
  M8005C72        | UE Power Headroom for PUSCH Level
  M8005C73        | UE Power Headroom for PUSCH Level
  M8005C74        | UE Power Headroom for PUSCH Level
  M8005C75        | UE Power Headroom for PUSCH Level
  M8005C76        | UE Power Headroom for PUSCH Level
  M8005C77        | UE Power Headroom for PUSCH Level
  M8005C78        | UE Power Headroom for PUSCH Level
  M8005C79        | UE Power Headroom for PUSCH Level
  M8005C80        | UE Power Headroom for PUSCH Level
  M8005C81        | UE Power Headroom for PUSCH Level
  M8005C82        | UE Power Headroom for PUSCH Level
  M8005C83        | UE Power Headroom for PUSCH Level
  M8005C84        | UE Power Headroom for PUSCH Level
  M8005C85        | UE Power Headroom for PUSCH Level
  M8005C87        | UE Power Headroom PUSCH Min
  M8005C88        | UE Power Headroom PUSCH Max
  M8005C89        | UE Power Headroom PUSCH Mean
  M8005C90        | SINR for PUCCH Min
  M8005C91        | SINR for PUCCH Max
  M8005C92        | SINR for PUCCH Mean
  M8005C93        | SINR for PUSCH Min
  M8005C94        | SINR for PUSCH Max
  M8005C95        | SINR for PUSCH Mean
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M8005C96        | SINR for PUCCH Level 1
M8005C97        | SINR for PUCCH Level 2
M8005C98        | SINR for PUCCH Level 3
M8005C99        | SINR for PUCCH Level 4
M8005C100       | SINR for PUCCH Level 5
M8005C101       | SINR for PUCCH Level 6
M8005C102       | SINR for PUCCH Level 7
M8005C103       | SINR for PUCCH Level 8
M8005C104       | SINR for PUCCH Level 9
M8005C105       | SINR for PUCCH Level 10
M8005C106       | SINR for PUCCH Level 11
M8005C107       | SINR for PUCCH Level 12
M8005C108       | SINR for PUCCH Level 13
M8005C109       | SINR for PUCCH Level 14
M8005C110       | SINR for PUCCH Level 15
M8005C111       | SINR for PUCCH Level 16
M8005C112       | SINR for PUCCH Level 17
M8005C113       | SINR for PUCCH Level 18
M8005C114       | SINR for PUCCH Level 19
M8005C115       | SINR for PUCCH Level 20
M8005C116       | SINR for PUCCH Level 21
M8005C117       | SINR for PUCCH Level 22
M8005C118       | SINR for PUSCH Level 1
M8005C119       | SINR for PUSCH Level 2
M8005C120       | SINR for PUSCH Level 3
M8005C121       | SINR for PUSCH Level 4
M8005C122       | SINR for PUSCH Level 5
M8005C123       | SINR for PUSCH Level 6
M8005C124       | SINR for PUSCH Level 7
M8005C125       | SINR for PUSCH Level 8
M8005C126       | SINR for PUSCH Level 9
M8005C127       | SINR for PUSCH Level 10
M8005C128       | SINR for PUSCH Level 11
M8005C129       | SINR for PUSCH Level 12
M8005C130       | SINR for PUSCH Level 13
M8005C131       | SINR for PUSCH Level 14
M8005C132       | SINR for PUSCH Level 15
M8005C133       | SINR for PUSCH Level 16
M8005C134       | SINR for PUSCH Level 17
M8005C135       | SINR for PUSCH Level 18
M8005C136       | SINR for PUSCH Level 19
M8005C137       | SINR for PUSCH Level 20
M8005C138       | SINR for PUSCH Level 21
M8005C139       | SINR for PUSCH Level 22
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M8005C140       | UL AMC upgrades
M8005C141       | UL AMC downgrades
M8005C206       | Minimum of cell-wide RSSI on PUCCH
M8005C207       | Maximum of cell-wide RSSI on PUCCH
M8005C208       | Mean of cell-wide RSSI on PUCCH
M8005C209       | Cell-wide RSSI on PUCCH level 1
M8005C210       | Cell-wide RSSI on PUCCH level 2
M8005C211       | Cell-wide RSSI on PUCCH level 3
M8005C212       | Cell-wide RSSI on PUCCH level 4
M8005C213       | Cell-wide RSSI on PUCCH level 5
M8005C214       | Cell-wide RSSI on PUCCH level 6
M8005C215       | Cell-wide RSSI on PUCCH level 7
M8005C216       | Cell-wide RSSI on PUCCH level 8
M8005C217       | Cell-wide RSSI on PUCCH level 9
M8005C218       | Cell-wide RSSI on PUCCH level 10
M8005C219       | Cell-wide RSSI on PUCCH level 11
M8005C220       | Cell-wide RSSI on PUCCH level 12
M8005C221       | Cell-wide RSSI on PUCCH level 13
M8005C222       | Cell-wide RSSI on PUCCH level 14
M8005C223       | Cell-wide RSSI on PUCCH level 15
M8005C224       | Cell-wide RSSI on PUCCH level 16
M8005C225       | Cell-wide RSSI on PUCCH level 17
M8005C226       | Cell-wide RSSI on PUCCH level 18
M8005C227       | Cell-wide RSSI on PUCCH level 19
M8005C228       | Cell-wide RSSI on PUCCH level 20
M8005C229       | Cell-wide RSSI on PUCCH level 21
M8005C230       | Cell-wide RSSI on PUCCH level 22
M8005C231       | Minimum of cell-wide RSSI on PUSCH
M8005C232       | Maximum of cell-wide RSSI on PUSCH
M8005C233       | Mean of cell-wide RSSI on PUSCH
M8005C234       | Cell-wide RSSI on PUSCH level 1
M8005C235       | Cell-wide RSSI on PUSCH level 2
M8005C236       | Cell-wide RSSI on PUSCH level 3
M8005C237       | Cell-wide RSSI on PUSCH level 4
M8005C238       | Cell-wide RSSI on PUSCH level 5
M8005C239       | Cell-wide RSSI on PUSCH level 6
M8005C240       | Cell-wide RSSI on PUSCH level 7
M8005C241       | Cell-wide RSSI on PUSCH level 8
M8005C242       | Cell-wide RSSI on PUSCH level 9
M8005C243       | Cell-wide RSSI on PUSCH level 10
M8005C244       | Cell-wide RSSI on PUSCH level 11
M8005C245       | Cell-wide RSSI on PUSCH level 12
M8005C246       | Cell-wide RSSI on PUSCH level 13
M8005C247       | Cell-wide RSSI on PUSCH level 14
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M8005C248       | Cell-wide RSSI on PUSCH level 15
M8005C249       | Cell-wide RSSI on PUSCH level 16
M8005C250       | Cell-wide RSSI on PUSCH level 17
M8005C251       | Cell-wide RSSI on PUSCH level 18
M8005C252       | Cell-wide RSSI on PUSCH level 19
M8005C253       | Cell-wide RSSI on PUSCH level 20
M8005C254       | Cell-wide RSSI on PUSCH level 21
M8005C255       | Cell-wide RSSI on PUSCH level 22
M8005C256       | Minimum of cell-wide SINR on PUCCH
M8005C257       | Maximum of cell-wide SINR on PUCCH
M8005C258       | Mean of cell-wide SINR on PUCCH
M8005C259       | Cell-wide SINR on PUCCH level 1
M8005C260       | Cell-wide SINR on PUCCH level 2
M8005C261       | Cell-wide SINR on PUCCH level 3
M8005C262       | Cell-wide SINR on PUCCH level 4
M8005C263       | Cell-wide SINR on PUCCH level 5
M8005C264       | Cell-wide SINR on PUCCH level 6
M8005C265       | Cell-wide SINR on PUCCH level 7
M8005C266       | Cell-wide SINR on PUCCH level 8
M8005C267       | Cell-wide SINR on PUCCH level 9
M8005C268       | Cell-wide SINR on PUCCH level 10
M8005C269       | Cell-wide SINR on PUCCH level 11
M8005C270       | Cell-wide SINR on PUCCH level 12
M8005C271       | Cell-wide SINR on PUCCH level 13
M8005C272       | Cell-wide SINR on PUCCH level 14
M8005C273       | Cell-wide SINR on PUCCH level 15
M8005C274       | Cell-wide SINR on PUCCH level 16
M8005C275       | Cell-wide SINR on PUCCH level 17
M8005C276       | Cell-wide SINR on PUCCH level 18
M8005C277       | Cell-wide SINR on PUCCH level 19
M8005C278       | Cell-wide SINR on PUCCH level 20
M8005C279       | Cell-wide SINR on PUCCH level 21
M8005C280       | Cell-wide SINR on PUCCH level 22
M8005C281       | Minimum of cell-wide SINR on PUSCH
M8005C282       | Maximum of cell-wide SINR on PUSCH
M8005C283       | Mean of cell-wide SINR on PUSCH
M8005C284       | Cell-wide SINR on PUSCH level 1
M8005C285       | Cell-wide SINR on PUSCH level 2
M8005C286       | Cell-wide SINR on PUSCH level 3
M8005C287       | Cell-wide SINR on PUSCH level 4
M8005C288       | Cell-wide SINR on PUSCH level 5
M8005C289       | Cell-wide SINR on PUSCH level 6
M8005C290       | Cell-wide SINR on PUSCH level 7
M8005C291       | Cell-wide SINR on PUSCH level 8
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M8005C292       | Cell-wide SINR on PUSCH level 9
M8005C293       | Cell-wide SINR on PUSCH level 10
M8005C294       | Cell-wide SINR on PUSCH level 11
M8005C295       | Cell-wide SINR on PUSCH level 12
M8005C296       | Cell-wide SINR on PUSCH level 13
M8005C297       | Cell-wide SINR on PUSCH level 14
M8005C298       | Cell-wide SINR on PUSCH level 15
M8005C299       | Cell-wide SINR on PUSCH level 16
M8005C300       | Cell-wide SINR on PUSCH level 17
M8005C301       | Cell-wide SINR on PUSCH level 18
M8005C302       | Cell-wide SINR on PUSCH level 19
M8005C303       | Cell-wide SINR on PUSCH level 20
M8005C304       | Cell-wide SINR on PUSCH level 21
M8005C305       | Cell-wide SINR on PUSCH level 22

--------------------------------------------------------------------
Measurement Group: M8006
--------------------------------------------------------------------
M8006C0         | EPS Bearer setup attempts
M8006C1         | EPS Bearer setup completions
M8006C2         | EPS Bearer setup failures due to Radio
M8006C3         | EPS Bearer setup failures due to
M8006C4         | EPS Bearer setup failures due to Radio
M8006C5         | EPS Bearer setup failures due to Other
M8006C6         | EPC initiated EPS Bearer Release
M8006C7         | EPC initiated EPS Bearer Release
M8006C8         | EPC initiated EPS Bearer Release
M8006C9         | EPC initiated EPS Bearer Release
M8006C10        | eNB initiated EPS Bearer Release
M8006C12        | Released E-RABs due to Radio Link
M8006C13        | eNB initiated EPS Bearer Release
M8006C14        | eNB initiated EPS Bearer Release
M8006C15        | eNB initiated EPS Bearer Release
M8006C17        | Initial EPS Bearer setup attempts for
M8006C18        | Initial EPS Bearer setup attempts for
M8006C26        | Additional EPS Bearer setup attempts
M8006C35        | Initial EPS Bearer setup completions
M8006C36        | Initial EPS Bearer setup completions
M8006C44        | Additional EPS Bearer setup
M8006C89        | EPC initiated EPS Bearer Release
M8006C98        | EPC initiated EPS Bearer Release
M8006C107       | EPC initiated EPS Bearer Release
M8006C116       | EPC initiated EPS Bearer Release
M8006C125       | eNB initiated EPS Bearer Release
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M8006C134       | eNB initiated EPS Bearer Release
M8006C143       | eNB initiated EPS Bearer Release
M8006C152       | eNB initiated EPS Bearer Release
M8006C161       | eNB initiated EPS Bearer Release
M8006C162       | Initial EPS Bearer setup attempts for
M8006C163       | Initial EPS Bearer setup attempts for
M8006C164       | Initial EPS Bearer setup attempts for
M8006C165       | Additional EPS Bearer setup attempts
M8006C166       | Additional EPS Bearer setup attempts
M8006C167       | Additional EPS Bearer setup attempts
M8006C168       | Initial EPS Bearer setup completions
M8006C169       | Initial EPS Bearer setup completions
M8006C170       | Initial EPS Bearer setup completions
M8006C171       | Additional EPS Bearer setup
M8006C172       | Additional EPS Bearer setup
M8006C173       | Additional EPS Bearer setup
M8006C174       | Pre-empted GBR bearers
M8006C175       | Pre-empted non-GBR bearers
M8006C176       | Released active ERABs QCI1
M8006C177       | Released active ERABs QCI2
M8006C178       | Released active ERABs QCI3
M8006C179       | Released active ERABs QCI4
M8006C180       | Released active non GBR ERABs
M8006C181       | In-session activity time for QCI1
M8006C182       | In-session activity time for QCI2
M8006C183       | In-session activity time for QCI3
M8006C184       | In-session activity time for QCI4
M8006C185       | In-session activity time for non-GBR

---------------------------------------------------------------------
Measurement Group: M8007
---------------------------------------------------------------------
M8007C0         | Number of Data Radio Bearers
M8007C1         | Number of Data Radio Bearers
M8007C2         | Number of Data Radio Bearers failed to
M8007C3         | Number of released Data Radio
M8007C4         | Number of released Data Radio
M8007C5         | Number of released Data Radio
M8007C6         | Number of released Data Radio
M8007C7         | SRB1 setup attempts
M8007C8         | SRB1 setup completions
M8007C9         | SRB1 setup failures
M8007C10        | SRB2 setup attempts
M8007C11        | SRB2 setup completions
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M8007C12        | SRB2 setup failures
M8007C13        | Radio Bearer Release requests

--------------------------------------------------------------------
Measurement Group: M8008
--------------------------------------------------------------------
M8008C0         | Rejected RRC Connection re-
M8008C1         | RRC Paging requests
M8008C2         | Discarded RRC Paging requests
M8008C3         | RRC Paging messages
M8008C4         | Number of RRC Connection Re-
M8008C5         | Number of successful RRC Connection
M8008C6         | RRC Connection Re-establishment
M8008C7         | RRC Connection Re-establishment
M8008C8         | RRC Connection Re-establishment
M8008C9         | RRC Connection Re-establishment
M8008C10        | Number of Report CGI Requests
M8008C11        | Number of successful CGI Reports
M8008C15        | Number of UEs attempted to redirect to
M8008C16        | Number of RRC Pagings for ETWS or

--------------------------------------------------------------------
Measurement Group: M8009
--------------------------------------------------------------------
M8009C0         | Total not started Handover preparations
M8009C1         | Total Handover decisions
M8009C2         | Intra eNB Handover preparations
M8009C3         | Failed Intra eNB Handover
M8009C5         | Failed Intra-eNB Handover
M8009C6         | Attempted intra eNB HO
M8009C7         | Successful intra eNB HO
M8009C8         | Total intra eNB HO failures due to timer

--------------------------------------------------------------------
Measurement Group: M8010
--------------------------------------------------------------------
M8010C36        | UE Reported CQI Level 00
M8010C37        | UE Reported CQI Level 01
M8010C38        | UE Reported CQI Level 02
M8010C39        | UE Reported CQI Level 03
M8010C40        | UE Reported CQI Level 04
M8010C41        | UE Reported CQI Level 05
M8010C42        | UE Reported CQI Level 06
M8010C43        | UE Reported CQI Level 07
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M8010C44        | UE Reported CQI Level 08
M8010C45        | UE Reported CQI Level 09
M8010C46        | UE Reported CQI Level 10
M8010C47        | UE Reported CQI Level 11
M8010C48        | UE Reported CQI Level 12
M8010C49        | UE Reported CQI Level 13
M8010C50        | UE Reported CQI Level 14
M8010C51        | UE Reported CQI Level 15
M8010C52        | CQI offset Min
M8010C53        | CQI offset Max
M8010C54        | CQI offset Mean
M8010C55        | MIMO Open Loop Diversity Mode
M8010C56        | MIMO Open Loop Spatial Multiplexing
M8010C57        | MIMO Closed Loop Single Codeword
M8010C58        | MIMO Closed Loop Double Codeword
M8010C59        | Open Loop MIMO mode switches
M8010C60        | Closed Loop MIMO mode switches
M8010C61        | PDCCH allocations for PDSCH
M8010C62        | PDCCH allocations for PDSCH

--------------------------------------------------------------------
Measurement Group: M8011
--------------------------------------------------------------------
M8011C12        | UL PRB utilization per TTI Level 1
M8011C13        | UL PRB utilization per TTI Level 2
M8011C14        | UL PRB utilization per TTI Level 3
M8011C15        | UL PRB utilization per TTI Level 4
M8011C16        | UL PRB utilization per TTI Level 5
M8011C17        | UL PRB utilization per TTI Level 6
M8011C18        | UL PRB utilization per TTI Level 7
M8011C19        | UL PRB utilization per TTI Level 8
M8011C20        | UL PRB utilization per TTI Level 9
M8011C21        | UL PRB utilization per TTI Level 10
M8011C22        | UL PRB utilization per TTI Min
M8011C23        | UL PRB utilization per TTI Max
M8011C24        | UL PRB utilization per TTI Mean
M8011C25        | DL PRB utilization per TTI Level 1
M8011C26        | DL PRB utilization per TTI Level 2
M8011C27        | DL PRB utilization per TTI Level 3
M8011C28        | DL PRB utilization per TTI Level 4
M8011C29        | DL PRB utilization per TTI Level 5
M8011C30        | DL PRB utilization per TTI Level 6
M8011C31        | DL PRB utilization per TTI Level 7
M8011C32        | DL PRB utilization per TTI Level 8
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M8011C33        | DL PRB utilization per TTI Level 9
M8011C34        | DL PRB utilization per TTI Level 10
M8011C35        | DL PRB utilisation per TTI Min
M8011C36        | DL PRB utilisation per TTI Max
M8011C37        | DL PRB utilisation per TTI Mean
M8011C38        | CCEs available PDCCH scheduling
M8011C39        | AGG1 used PDCCH
M8011C40        | AGG2 used PDCCH
M8011C41        | AGG4 used PDCCH
M8011C42        | AGG8 used PDCCH
M8011C43        | AGG1 blocked PDCCH
M8011C44        | AGG2 blocked PDCCH
M8011C45        | AGG4 blocked PDCCH
M8011C46        | AGG8 blocked PDCCH
M8011C47        | PRB used UL total
M8011C49        | PRB used PUCCH
M8011C50        | PRB used PUSCH
M8011C51        | PRB used DL total
M8011C54        | PRB used PDSCH
M8011C55        | Average UEs per UL TTI
M8011C56        | Max UEs per UL TTI
M8011C57        | Average UEs per DL TTI
M8011C58        | Max UEs per DL TTI
M8011C59        | Number of subframes with 1 OFDM
M8011C60        | Number of subframes with 2 OFDM
M8011C61        | Number of subframes with 3 OFDM
M8011C62        | Average number of UEs configured for
M8011C63        | Number of UL grants for TTI Bundling
M8011C64        | Short UE retention time in TTI Bundling
M8011C65        | Medium UE retention time in TTI
M8011C66        | Long UE retention time in TTI Bundling
M8011C67        | Number of SCell configuration attempts
M8011C68        | Number of successful SCell
M8011C69        | High cell load Indicator for Load

--------------------------------------------------------------------
Measurement Group: M8012
--------------------------------------------------------------------
M8012C0         | Total volume of original transmissions
M8012C1         | Total volume of correct received UL-
M8012C2         | Total volume of retransmissions of DL-
M8012C3         | Total volume of correct non-duplicate
M8012C12        | RLC data volume on DL DCCH
M8012C16        | RLC data volume on UL DCCH
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M8012C17        | RLC PDU volume received
M8012C18        | RLC PDU volume transmitted
M8012C19        | PDCP SDU data volume on eUu
M8012C20        | PDCP SDU data volume on eUu
M8012C21        | PDCP Throughput UL Min
M8012C22        | PDCP Throughput UL Max
M8012C23        | PDCP Throughput UL Mean
M8012C24        | PDCP Throughput DL Min
M8012C25        | PDCP Throughput DL Max
M8012C26        | PDCP Throughput DL Mean
M8012C27        | MAC PDU volume PDSCH MCS0
M8012C28        | MAC PDU volume PDSCH MCS1
M8012C29        | MAC PDU volume PDSCH MCS2
M8012C30        | MAC PDU volume PDSCH MCS3
M8012C31        | MAC PDU volume PDSCH MCS4
M8012C32        | MAC PDU volume PDSCH MCS5
M8012C33        | MAC PDU volume PDSCH MCS6
M8012C34        | MAC PDU volume PDSCH MCS7
M8012C35        | MAC PDU volume PDSCH MCS8
M8012C36        | MAC PDU volume PDSCH MCS9
M8012C37        | MAC PDU volume PDSCH MCS10
M8012C38        | MAC PDU volume PDSCH MCS11
M8012C39        | MAC PDU volume PDSCH MCS12
M8012C40        | MAC PDU volume PDSCH MCS13
M8012C41        | MAC PDU volume PDSCH MCS14
M8012C42        | MAC PDU volume PDSCH MCS15
M8012C43        | MAC PDU volume PDSCH MCS16
M8012C44        | MAC PDU volume PDSCH MCS17
M8012C45        | MAC PDU volume PDSCH MCS18
M8012C46        | MAC PDU volume PDSCH MCS19
M8012C47        | MAC PDU volume PDSCH MCS20
M8012C48        | MAC PDU volume PUSCH MCS0
M8012C49        | MAC PDU volume PUSCH MCS1
M8012C50        | MAC PDU volume PUSCH MCS2
M8012C51        | MAC PDU volume PUSCH MCS3
M8012C52        | MAC PDU volume PUSCH MCS4
M8012C53        | MAC PDU volume PUSCH MCS5
M8012C54        | MAC PDU volume PUSCH MCS6
M8012C55        | MAC PDU volume PUSCH MCS7
M8012C56        | MAC PDU volume PUSCH MCS8
M8012C57        | MAC PDU volume PUSCH MCS9
M8012C58        | MAC PDU volume PUSCH MCS10
M8012C59        | MAC PDU volume PUSCH MCS11
M8012C60        | MAC PDU volume PUSCH MCS12
```

```
M8012C61        | MAC PDU volume PUSCH MCS13
M8012C62        | MAC PDU volume PUSCH MCS14
M8012C63        | MAC PDU volume PUSCH MCS15
M8012C64        | MAC PDU volume PUSCH MCS16
M8012C65        | MAC PDU volume PUSCH MCS17
M8012C66        | MAC PDU volume PUSCH MCS18
M8012C67        | MAC PDU volume PUSCH MCS19
M8012C68        | MAC PDU volume PUSCH MCS20
M8012C69        | MAC SDU volume on UL-CCCH
M8012C70        | MAC SDU volume on UL-DCCH
M8012C71        | MAC SDU volume on UL-DTCH
M8012C74        | MAC SDU volume on DL-CCCH
M8012C75        | MAC SDU volume on DL-DCCH
M8012C76        | MAC SDU volume on DL-DTCH
M8012C77        | RRC UL volume
M8012C78        | RRC DL volume
M8012C79        | RLC SDU UL-DTCH volume
M8012C80        | RLC SDU DL-DTCH volume
M8012C81        | MAC PDU volume PDSCH MCS21
M8012C82        | MAC PDU volume PDSCH MCS22
M8012C83        | MAC PDU volume PDSCH MCS23
M8012C84        | MAC PDU volume PDSCH MCS24
M8012C85        | MAC PDU volume PDSCH MCS25
M8012C86        | MAC PDU volume PDSCH MCS26
M8012C87        | MAC PDU volume PDSCH MCS27
M8012C88        | MAC PDU volume PDSCH MCS28
M8012C89        | Number of TTIs in UL with at least one
M8012C90        | Number of TTIs in DL with at least one
M8012C91        | IP Throughput volume in UL for QCI 1
M8012C92        | IP Throughput time in UL for QCI 1
M8012C93        | IP Throughput volume in UL for QCI 2
M8012C94        | IP Throughput time in UL for QCI 2
M8012C95        | IP Throughput volume in UL for QCI 3
M8012C96        | IP Throughput time in UL for QCI 3
M8012C97        | IP Throughput volume in UL for QCI 4
M8012C98        | IP Throughput time in UL for QCI 4
M8012C99        | IP Throughput volume in UL for QCI 5
M8012C100       | IP Throughput time in UL for QCI 5
M8012C101       | IP Throughput volume in UL for QCI 6
M8012C102       | IP Throughput time in UL for QCI 6
M8012C103       | IP Throughput volume in UL for QCI 7
M8012C104       | IP Throughput time in UL for QCI 7
M8012C105       | IP Throughput volume in UL for QCI 8
M8012C106       | IP Throughput time in UL for QCI 8
```

```
M8012C107       | IP Throughput volume in UL for QCI 9
M8012C108       | IP Throughput time in UL for QCI 9
M8012C116       | PDCP UL throughput Mean for QCI 1
M8012C117       | IP Throughput volume in DL for QCI 1
M8012C118       | IP Throughput time in DL for QCI 1
M8012C119       | IP Throughput volume in DL for QCI 2
M8012C120       | IP Throughput time in DL for QCI 2
M8012C121       | IP Throughput volume in DL for QCI 3
M8012C122       | IP Throughput time in DL for QCI 3
M8012C123       | IP Throughput volume in DL for QCI 4
M8012C124       | IP Throughput time in DL for QCI 4
M8012C125       | IP Throughput volume in DL for QCI 5
M8012C126       | IP Throughput time in DL for QCI 5
M8012C127       | IP Throughput volume in DL for QCI 6
M8012C128       | IP Throughput time in DL for QCI 6
M8012C129       | IP Throughput volume in DL for QCI 7
M8012C130       | IP Throughput time in DL for QCI 7
M8012C131       | IP Throughput volume in DL for QCI 8
M8012C132       | IP Throughput time in DL for QCI 8
M8012C133       | IP Throughput volume in DL for QCI 9
M8012C134       | IP Throughput time in DL for QCI 9
M8012C143       | PDCP DL throughput Mean for QCI 1
M8012C144       | MAC PDU volume PUSCH MCS21
M8012C145       | MAC PDU volume PUSCH MCS22
M8012C146       | MAC PDU volume PUSCH MCS23
M8012C147       | MAC PDU volume PUSCH MCS24
M8012C151       | PCell RLC data volume in DL via SCell

--------------------------------------------------------------------
Measurement Group: M8013
--------------------------------------------------------------------
M8013C5         | Signaling Connection Establishment
M8013C6         | Signaling Connection Establishment
M8013C7         | Signaling Connection Establishment
M8013C8         | Signaling Connection Establishment
M8013C9         | EPC initiated transitions to ECM-IDLE
M8013C10        | EPC initiated transitions to ECM-IDLE
M8013C11        | EPC initiated transitions to ECM-IDLE
M8013C12        | EPC initiated transitions to ECM-IDLE
M8013C13        | eNB initiated transitions to ECM-IDLE
M8013C15        | eNB initiated transitions to ECM-IDLE
M8013C16        | eNB initiated transitions to ECM-IDLE
M8013C17        | Signaling Connection Establishment
M8013C18        | Signaling Connection Establishment
```

```
M8013C19        | Signaling Connection Establishment
M8013C20        | Signaling Connection Establishment
M8013C21        | Number of Signaling Connection
M8013C24        | Subframes of DRX Active UE
M8013C25        | Subframes of DRX Sleep UE
M8013C26        | Signaling Connection Establishment
M8013C27        | Signaling Connection Establishment
M8013C28        | Pre-empted UE contexts due to pre-

--------------------------------------------------------------------------------
Measurement Group: M8014
--------------------------------------------------------------------------------
M8014C0         | Inter eNB Handover preparations
M8014C2         | Failed Inter eNB Handover
M8014C3         | Failed Inter eNB Handover
M8014C5         | Failed Inter-eNB Handover
M8014C6         | Attempted inter eNB HO
M8014C7         | Successful inter eNB HO
M8014C8         | Number of Inter eNB Handover failures
M8014C14        | Inter eNB S1-Handover preparations
M8014C15        | Failed Inter eNB S1-Handover
M8014C16        | Failed Inter eNB S1-Handover
M8014C17        | Failed Inter-eNB S1-Handover
M8014C18        | Attempted inter eNB S1-HO
M8014C19        | Successful inter eNB S1-HO
M8014C20        | Inter eNB S1-HO failures due to timer

--------------------------------------------------------------------------------
Measurement Group: M8015
--------------------------------------------------------------------------------
M8015C0         | Failed Intra eNB HO preparations per
M8015C1         | Intra eNB HO attempts per neighbor
M8015C2         | Intra eNB HO successes per neighbor
M8015C5         | Number of failed Inter eNB Handover
M8015C6         | Failed Inter eNB Handover
M8015C7         | Failed Inter eNB Handover
M8015C8         | Number of Inter eNB Handover
M8015C9         | Number of successful Inter eNB
M8015C10        | Number of Inter eNB Handover failures
M8015C15        | Intra eNB HO failures per neighbor cell
M8015C16        | Number of Late Handover per neighbor
M8015C17        | Number of Early Handover Type1 per
M8015C18        | Number of Early Handover Type2 per
```

```
--------------------------------------------------------------------
Measurement Group: M8016
--------------------------------------------------------------------
M8016C11        | CS Fallback attempts with redirection
M8016C12        | CS Fallback attempts (UE in
M8016C13        | CS Fallback attempts for emergency
M8016C14        | Inter System Handover preparations
M8016C15        | Failed Inter System Handover
M8016C16        | Failed Inter System Handover
M8016C17        | Failed Inter-System Handover
M8016C21        | Inter System Handover attempts
M8016C23        | Successful Inter System Handover
M8016C25        | Failed Inter System Handover attempts
M8016C26        | Number of NACC from LTE to GSM
M8016C29        | Inter System Handover attempts to
M8016C30        | Successful Inter System Handover
M8016C31        | Failed Inter System Handover attempts
M8016C32        | CS Fallback attempts to UTRAN with
M8016C33        | Inter System Handover attempts to
M8016C34        | Successful Inter System Handover
M8016C35        | Failed Inter System Handover attempts

--------------------------------------------------------------------
Measurement Group: M8017
--------------------------------------------------------------------
M8017C4         | Failed Inter System Handover
M8017C5         | Failed Inter System Handover
M8017C6         | Failed Inter System Handover
M8017C7         | Inter System Handover attempts to
M8017C8         | Successful Inter System Handover
M8017C9         | Failed Inter System Handover attempts
M8017C10        | Inter System Handover preparations
M8017C11        | Inter System Handover attempts to
M8017C12        | Successful Inter System Handover
M8017C13        | Failed Inter System Handover attempts

--------------------------------------------------------------------
Measurement Group: M8018
--------------------------------------------------------------------
M8018C0         | Active UE per eNB average
M8018C1         | Active UE per eNB max
M8018C4         | UE Contexts released due to S1 Reset
M8018C5         | Active UE Contexts released due to S1
M8018C6         | UE Contexts released due to S1 Reset
```

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M8018C7         | Active UE Contexts released due to S1
M8018C8         | Sum of Active UEs per eNB
M8018C9         | Denominator for Active UEs per eNB

--------------------------------------------------------------------
Measurement Group: M8019
--------------------------------------------------------------------
M8019C0         | Number of NACC from LTE to GSM
M8019C3         | Inter System Handover attempts to
M8019C4         | Successful Inter System Handover
M8019C5         | Failed Inter System Handover attempts

--------------------------------------------------------------------
Measurement Group: M8020
--------------------------------------------------------------------
M8020C0         | Number of cell state changes to "cell is
M8020C1         | Number of cell state changes to "cell is
M8020C2         | Number of cell state changes to "cell is
M8020C3         | Samples when the cell is available
M8020C4         | Samples when the cell is planned
M8020C5         | Samples when the cell is unplanned
M8020C6         | Cell availability denominator

--------------------------------------------------------------------
Measurement Group: M8021
--------------------------------------------------------------------
M8021C0         | Number of inter frequency Handover
M8021C1         | Number of inter frequency Handover
M8021C2         | Number of successful inter-frequency
M8021C3         | Number of successful inter-frequency
M8021C4         | Number of Handover failures per cause
M8021C5         | Number of Handover failures per cause
M8021C6         | Handover preparations for IMS
M8021C9         | Failed Handover preparations for IMS
M8021C12        | Handover attempts for IMS emergency
M8021C15        | Successful Handover completions for
M8021C18        | Number of Handover attempts for UEs
M8021C19        | Number of Handover completions for
M8021C20        | Number of Late Handover
M8021C21        | Number of Early Handover Type1
M8021C22        | Number of Early Handover Type2
M8021C23        | Number of load balancing Handover
M8021C24        | Number of successful load balancing
```

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--------------------------------------------------------------------
Measurement Group: M8022
--------------------------------------------------------------------
M8022C0         | Number of X2 Setup attempts
M8022C1         | Number of failed X2 Setup attempts


--------------------------------------------------------------------
Measurement Group: M8023
--------------------------------------------------------------------
M8023C0         | PDCP SDU data volume on eUu
M8023C1         | PDCP SDU data volume on eUu
M8023C2         | PDCP SDU data volume on eUu
M8023C3         | PDCP SDU data volume on eUu
M8023C4         | PDCP SDU data volume on eUu
M8023C5         | PDCP SDU data volume on eUu
M8023C6         | PDCP SDU data volume on eUu
M8023C7         | PDCP SDU data volume on eUu
M8023C8         | PDCP SDU data volume on eUu
M8023C9         | PDCP SDU data volume on eUu
M8023C10        | PDCP SDU data volume on eUu
M8023C11        | PDCP SDU data volume on eUu
M8023C12        | Average Number of active UE of
M8023C13        | Average Number of active UE of
M8023C14        | Average Number of active UE of
M8023C15        | Average Number of active UE of
M8023C16        | Average Number of active UE of
M8023C17        | Average Number of active UE of
M8023C18        | Average Number of active UE of
M8023C19        | Average Number of active UE of
M8023C20        | Average Number of active UE of
M8023C21        | Average number of active UEs of QCI
M8023C22        | Average number of active UEs of QCI
M8023C23        | Average number of active UEs of QCI
M8023C24        | Average number of active UEs of QCI
M8023C25        | Average number of active UEs of QCI
M8023C26        | Average number of active UEs of QCI
M8023C27        | Number of QCI Counter Group
M8023C28        | Average number of active UEs of
M8023C29        | Average number of active UEs of
M8023C30        | Average number of active UEs of
M8023C31        | Average number of active UEs of
M8023C32        | Average number of active UEs of
M8023C33        | Average number of active UEs of
M8023C34        | Average number of active UEs of
```

```
M8023C35        | Average number of active UEs of

------------------------------------------------------------------
Measurement Group: M5112
------------------------------------------------------------------
M51120C0        | ifInPackets15
M51120C1        | ifInOctets15
M51120C2        | ifOutPackets15
M51120C3        | ifOutOctets15
M51120C4        | ifInErrors15
M51120C5        | ifOutDroppedPackets
M51120C6        | ifOutDroppedOctets
M51121C0        | ifOctets_EF
M51121C1        | ifPackets_EF
M51121C2        | ifDroppedOctets_EF
M51121C3        | ifDroppedPackets_EF
M51121C4        | ifOctets_AF4
M51121C5        | ifPackets_AF4
M51121C6        | ifDroppedOctets_AF4
M51121C7        | ifDroppedPackets_AF4
M51121C8        | ifOctets_AF3
M51121C9        | ifPackets_AF3
M51121C10       | ifDroppedOctets_AF3
M51121C11       | ifDroppedPackets_AF3
M51121C12       | ifOctets_AF2
M51121C13       | ifPackets_AF2
M51121C14       | ifDroppedOctets_AF2
M51121C15       | ifDroppedPackets_AF2
M51121C16       | ifOctets_AF1
M51121C17       | ifPackets_AF1
M51121C18       | ifDroppedOctets_AF1
M51121C19       | ifDroppedPackets_AF1
M51121C20       | ifOctets_BE
M51121C21       | ifPackets_BE
M51121C22       | ifDroppedOctets_BE
M51121C23       | ifDroppedPackets_BE
M51121C24       | ifRxOctets_EF
M51121C25       | ifRxPackets_EF
M51121C26       | ifRxOctets_AF4
M51121C27       | ifRxPackets_AF4
M51121C28       | ifRxOctets_AF3
M51121C29       | ifRxPackets_AF3
M51121C30       | ifRxOctets_AF2
M51121C31       | ifRxPackets_AF2
```

```
M51121C32       | ifRxOctets_AF1
M51121C33       | ifRxPackets_AF1
M51121C34       | ifRxOctets_BE
M51121C35       | ifRxPackets_BE
M51123C0        | EthIfInOcts_15
M51123C1        | EthIfOutOcts_15
M51123C2        | EthIfInPkt_15
M51123C3        | EthIfOutPkt_15
M51123C4        | EthIfInPktErr_15
M51123C8        | EthIfInDiscRateLimiting
M51123C16       | ethIfInVlanMismatch
M51123C17       | ethIfOutDiscShaping_Q5
M51123C18       | ethIfOutDiscShaping_Q4
M51123C19       | ethIfOutDiscShaping_Q3
M51123C20       | ethIfOutDiscShaping_Q2
M51123C21       | ethIfOutDiscShaping_Q1
M51123C22       | ethIfOutDiscShaping_Q6
M51123C23       | EthIfInBlocksDiscRateLimiting
M51125C0        | Protected_ESPFramesTx
M51125C1        | Protected_ESPFramesRx
M51125C2        | Discarded_ESPFramesTx
M51125C3        | Discarded_ESPFramesRx
M51125C4        | Bypassed_FramesTx
M51125C5        | Bypassed_FramesRx
M51126C0        | ipRmDroppedPacketsRateLimiting
M51126C1        | ipRmDroppedPacketsFiltering
M51127C0        | ifInPackets15
M51127C1        | ifInOctets15
M51127C2        | ifOutPackets15
M51127C3        | ifOutOctets15
M51127C4        | ifInErrors15
M51127C5        | ifOutDroppedPackets
M51127C6        | ifOutDroppedOctets
M51128C0        | ifOctets_EF
M51128C1        | ifPackets_EF
M51128C2        | ifDroppedOctets_EF
M51128C3        | ifDroppedPackets_EF
M51128C4        | ifOctets_AF4
M51128C5        | ifPackets_AF4
M51128C6        | ifDroppedOctets_AF4
M51128C7        | ifDroppedPackets_AF4
M51128C8        | ifOctets_AF3
M51128C9        | ifPackets_AF3
M51128C10       | ifDroppedOctets_AF3
```

```
M51128C11       | ifDroppedPackets_AF3
M51128C12       | ifOctets_AF2
M51128C13       | ifPackets_AF2
M51128C14       | ifDroppedOctets_AF2
M51128C15       | ifDroppedPackets_AF2
M51128C16       | ifOctets_AF1
M51128C17       | ifPackets_AF1
M51128C18       | ifDroppedOctets_AF1
M51128C19       | ifDroppedPackets_AF1
M51128C20       | ifOctets_BE
M51128C21       | ifPackets_BE
M51128C22       | ifDroppedOctets_BE
M51128C23       | ifDroppedPackets_BE
M51128C24       | ifRxOctets_EF
M51128C25       | ifRxPackets_EF
M51128C26       | ifRxOctets_AF4
M51128C27       | ifRxPackets_AF4
M51128C28       | ifRxOctets_AF3
M51128C29       | ifRxPackets_AF3
M51128C30       | ifRxOctets_AF2
M51128C31       | ifRxPackets_AF2
M51128C32       | ifRxOctets_AF1
M51128C33       | ifRxPackets_AF1
M51128C34       | ifRxOctets_BE
M51128C35       | ifRxPackets_BE
M51129C0        | rxEthernetPackets
M51129C1        | rxEhernetOctets
M51129C2        | txEthernetPackets
M51129C3        | txEthernetOctets

---------------------------------------------------------------------
Measurement Group: M5113
---------------------------------------------------------------------
M51130C0        | rxEthernetPackets
M51130C1        | rxEhernetOctets
M51130C2        | txEthernetPackets
M51130C3        | txEthernetOctets
M51130C4        | EthIfInUnknownVLAN_15
M51131C0        | ethIfOutDiscShaping
M51132C0        | avgRTT_15Min
M51132C1        | maxRTT_15Min
M51132C2        | minRTT_15Min
M51132C3        | lostTwampMessages
M51132C4        | txTwampMessages
```

```
M51136C0        | tacSuccessfulGbrNormal
M51136C1        | tacSuccessfulGbrHandover
M51136C2        | tacSuccessfulGbrEmergency
M51136C3        | tacRejectedGbrNormal
M51136C4        | tacRejectedGbrHandover
M51136C5        | tacRejectedGbrEmergency
M51137C0        | topRxFreqSyncMsg
M51137C1        | topMinFreqSyncError
M51137C2        | topAvgFreqSyncError
M51137C3        | topMaxFreqSyncError
```

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LTE	M8xxx	~5,900	LTE L1/L2/L3 □□□ (ERAB, RRC, □□□)
WCDMA	M5xxx	~885	3G WCDMA □□□ (MAC □, CQI, HSDPA)
5G-NR	M55xxx	~14,500	5G NR □□□ (□□□ MIMO, □□□□□)
5G-□□□	M51xxx	~500	5G □□□□□□
5G-□□	M40xxx	~250	5G □□/□□□□□

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- **PRB**: □□□□□□□□
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- **ERAB**: E-RAB □□□□□□□□
- **PDCP**: PDCP □□□
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1. □□□□□□ □ `priv/pm_filters.etf`
2. □□□□□□□□□□
3. □□□□□□□□□□

InfluxDB □□□□□□□□□□□□□□□□□□/□□□□□□□□□□□□

[illegible]

[illegible]

[illegible] 22,000+ [illegible]

[illegible]	[illegible]
[illegible]	[illegible] ~100-500 GB/[illegible]
[illegible]	[illegible] InfluxDB [illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

1. [illegible]: [illegible]���[illegible]���[illegible]
2. [illegible]: [illegible]
3. [illegible]: [illegible]

[illegible]

[illegible]

“[illegible]”[illegible] Nokia [illegible]

- [illegible] **ID** ([illegible] `M8012C23`)
- [illegible] ([illegible] `[illegible]`, `[illegible]`, `RSRP`)

□□□□□□□

□□□	□□	□□
M8012C23	LTE	□□□□□□□□□□□□
M8012C26	LTE	□□□□□□□□□□□□
M8001C2	LTE	PDCP SDU □□□□□□
M8011C24	LTE	□□ PRB □□□
M8011C37	LTE	□□ PRB □□□
M8013C17	LTE	RRC □□□□□
M8020C3	LTE	□□□□
M40001C0	5G	□□

□□□□

pm_counters.csv

□□□□□□□□□□□□□□

```
# □□: □□□,□□,□□
M8012C23,□□□,□□□□□□□
M8012C26,□□□,□□□□□□□
M8001C2,□□□,□□□□□
...
```

□□: `priv/pm_counters.csv`

pm_metrics.csv

[illegible]

```
# [illegible]: PM_Code,[illegible],[illegible]
M8000C6,LTE,S1_SETUP_ATT
M8000C7,LTE,S1_SETUP_SUCC
...
```

[illegible]: `priv/pm_metrics.csv`

[illegible]

[illegible]

1. [illegible]“[illegible] PM [illegible]”[illegible]
2. [illegible] eNodeB [illegible] PM [illegible] InfluxDB [illegible]
3. [illegible] ID [illegible]

[illegible]

1. [illegible]
2. [illegible] **eNodeB** [illegible] **PM** [illegible] 15 [illegible]
3. [illegible] `[PmFilterStore]` [illegible]
4. [illegible]

[illegible]

1. [illegible] `priv/pm_metrics.csv`
2. [illegible]
3. [illegible] UTF-8 [illegible]

□□□□

- □□□□□□ - PM □□□□□□□□
- Grafana □□ - □□ PM □□□□□□□
- InfluxDB □□ - □□ PM □□

□□□

- **PM □□□□**: `https://localhost:9443/nokia/pm-filters`
- □□□□: `https://localhost:9443/nokia/retention`
- **InfluxDB □□**: `https://localhost:9443/nokia/influx`

RAN [illegible]

[illegible] **config/runtime.exs**

[illegible]

1. [illegible]
2. [illegible]
3. Web [illegible]
4. [illegible]
5. [illegible]
6. InfluxDB [illegible]
7. [illegible]

[illegible]

`config/runtime.exs` [illegible] RAN [illegible]

[illegible]

- [illegible]MySQL[illegible]
- Web [illegible]
- [illegible]
- InfluxDB [illegible]
- [illegible]
- [illegible]

[illegible]

```
config/runtime.exs
```

[illegible]

[illegible] [illegible] RAN [illegible] **Omnitouch** [illegible]

- [illegible]
- [illegible]
- [illegible] [illegible]
- [illegible]

[illegible] **Omnitouch** [illegible] **Omnitouch** [illegible]

[illegible] [illegible][illegible] Grafana [illegible][illegible]

[illegible]

MySQL/MariaDB [illegible]

```
config :ran_monitor, RanMonitor.Repo,
  username: "omnitouch",
  password: "omnitouch2024",
  hostname: "localhost",
  database: "ran_monitor",
  stacktrace: true,
  show_sensitive_data_on_connection_error: true,
  pool_size: 10
```

[illegible] [illegible] MySQL [illegible]

[illegible]

username ([illegible])

- [illegible]
- [illegible]`"omnitouch"`
- [illegible] [illegible] CREATE[illegible]SELECT[illegible]INSERT[illegible]UPDATE[illegible]DELETE [illegible]

- □□□□ □□□□□□□□□□□□□□□□□

password (□□□)

- □□□□□□□□□□□□
- □□□□`"omnitouch2024"`
- □□□□ □□□□□□□□□□□□□□□
- □□□ □□□□□□□□□□

hostname (□□□)

- □□□□□□□□
- □□□□`"localhost"`
- □□□
  - `"localhost"` - □□□□□□□□□���
  - `"127.0.0.1"` - TCP □□□□□□□
  - `"10.179.2.135"` - □□□□□□□□ IP
  - `"db.example.com"` - □□□□□□□□

database (□□□)

- □□□□□□□□□
- □□□□`"ran_monitor"`
- □□□ □□□□□□□□ RAN □□□□□□
- □□□ `CREATE DATABASE ran_monitor CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci;`

stacktrace (□□□)

- □□□□□□□□□□□□
- □□□□`true`
- □□□ `true` - □□□□□
- □□□ `false` - □□□□□□

show_sensitive_data_on_connection_error (□□□)

- □□□□□□□□□□□□

- □□□□`true`
- □□□ `true` - □□□□□□□
- □□□ `false` - □□□□□□□□□□

pool_size (□□)

- □□□□□□□□□□□
- □□□□`10`
- □□□□□
  - 1-5 □□□□`pool_size: 5`
  - 6-20 □□□□`pool_size: 10`
  - 21-50 □□□□`pool_size: 15`
  - 50+ □□□□`pool_size: 20`
- □□□ □□□□□□ 2 □□□ + 5 □□□ Web UI

Web □□

RAN □□□□□□ Web □□□□□□□□□□□

□□ SOAP/API □□

```
config :ran_monitor, RanMonitor.Web.Endpoint,
  http: [ip: {0, 0, 0, 0}, port: 8080],
  check_origin: false,
  secret_key_base:
"v5tOS1/QRonjwOky7adGGfkBbrJmiJyXhpesJy/jvSZhqLZkREV+rlo1/pR8lkbu",
  server: true
```

□□□ □□□□□□□□□□□□□ NE3S □□□ SOAP □□□□

ip (□□)

- □□□□□□
- □□□□`{0, 0, 0, 0}`□□□□□□
- □□□

  - `{0, 0, 0, 0}` - [illegible]
  - `{127, 0, 0, 1}` - [illegible]
  - `{10, 179, 2, 135}` - [illegible] IP [illegible]

port ([illegible])

- TCP [illegible]
- [illegible]`8080`
- [illegible] [illegible]
- [illegible] [illegible] IP [illegible]

check_origin ([illegible])

- [illegible] WebSocket/HTTP [illegible]
- [illegible]`false`
- [illegible] [illegible] SOAP API [illegible] `false`[illegible] Web UI[illegible]

secret_key_base ([illegible])

- [illegible]
- [illegible]64 [illegible]
- [illegible] `mix phx.gen.secret`
- [illegible] [illegible]
- [illegible] [illegible]

server ([illegible])

- [illegible]
- [illegible]`true`
- [illegible] [illegible] runtime.exs [illegible] `true`

□□□□ Web UI

```
# □□□□□□□ HTTPS □□□□□□ 9443
https_port =
String.to_integer(System.get_env("CONTROL_PANEL_HTTPS_PORT") ||
"9443")

config :control_panel, ControlPanelWeb.Endpoint,
  url: [host: "0.0.0.0", port: https_port, scheme: "https"],
  https: [
    ip: {0, 0, 0, 0},
    port: https_port,
    keyfile: "priv/cert/omnitouch.pem",
    certfile: "priv/cert/omnitouch.crt"
  ]
```

□□□ □□□□ Web □□□□□ UI □ HTTPS □□□

□□□□□

- **CONTROL_PANEL_HTTPS_PORT** - HTTPS □□□□□□□9443□
  - □□□□□□□□□□□□□□ HTTPS □□
  - □□□`export CONTROL_PANEL_HTTPS_PORT=8443`

url (□□□□□)

- □□ URL □□
- **host:** `"0.0.0.0"` - □□□□□□□□□
- **port:** □□ `https_port` □□□□□ CONTROL_PANEL_HTTPS_PORT □□□
- **scheme:** `"https"` - □□ HTTPS □□

https (□□□□□)

- HTTPS □□□□
- **ip:** `{0, 0, 0, 0}` - □□□□□□
- **port:** □□ `https_port` □□□□□ url □□□□
- **keyfile:** SSL □□□
- **certfile:** SSL □□□

SSL □□□□□

- □□□□□□ SSL/TLS □□
- □□□□□□□□□□□□□
- □□□□□□□ CA □□□□□
- □□□□□□□□
  ```
  openssl req -newkey rsa:2048 -nodes -keyout omnitouch.pem -x509
  -days 365 -out omnitouch.crt
  ```

□□□ AirScale Webhook □□

```
config :ran_monitor, RanMonitor.Web.Nokia.Airscale.Endpoint,
  url: [host: "0.0.0.0"],
  http: [ip: {0, 0, 0, 0}, port: 9076],
  server: true
```

□□□ □□□□□□□ AirScale □□□□□□□□□□

port (□□)

- □□□□`9076`
- □□□ □□□□□ PMCADM □□□□□□□rTpmCollEntityPortNum□□□
- □□□ □□□□□□□□□□□ WebLM □□□□□□□□□□□□□

□□□□□□

```
config :logger,
  level: :info

config :logger, :console,
  format: "$time $metadata[$level] $message\n",
  metadata: [:request_id]
```

[illegible]

level ([illegible])

- [illegible]
- [illegible]`:info`
- [illegible]
  - `:debug` - [illegible]
  - `:info` - [illegible]
  - `:warning` - [illegible]
  - `:error` - [illegible]

[illegible]

- [illegible] `:debug` - [illegible]
- [illegible] `:info` - [illegible]
- [illegible] [illegible] `:debug`[illegible]
- [illegible] `:warning` - [illegible]

[illegible]

format ([illegible])

- [illegible]
- [illegible]`"$time $metadata[$level] $message\n"`
- [illegible]
  - `$time` - [illegible]
  - `$metadata` - [illegible]
  - `$level` - [illegible]info[illegible]error [illegible]
  - `$message` - [illegible]

metadata ([illegible])

- [illegible]
- [illegible]`[:request_id]`
- **request_id:** [illegible] HTTP [illegible]

[illegible]

[illegible] RAN [illegible]

```
config :ran_monitor,
  general: %{
    mcc: "505",
    mnc: "57"
  },
  nokia: %{
    ne3s: %{
      webhook_url: "http://10.5.198.200:9076/webhook",
      private_key: Path.join(Application.app_dir(:ran_monitor, "priv"), "external/nokia/ne.key.pem"),
      public_key: Path.join(Application.app_dir(:ran_monitor, "priv"), "external/nokia/ne.cert.der"),
      reregister_interval: 30
    },
    airscales: [
      %{
        address: "10.7.15.67",
        name: "ONS-Lab-Airscale",
        port: "8080",
        web_username: "Nemuadmin",
        web_password: "nemuuser"
      }
    ]
  }
```

[illegible]

mcc ([illegible])

- [illegible]
- [illegible]`"505"`
- [illegible] [illegible] 3GPP [illegible]
- [illegible] 3 [illegible]

- □□□ ITU-T E.212

mnc (□□□)

- □□□□□□
- □□□□`"57"`
- □□□ □□□□□□□□□□
- □□□ 2 □ 3 □□□

NE3S ��□□□□□ NE3S □□□

webhook_url (□□□)

- □□□□□□□ URL
- □□□□`"http://10.5.198.200:9076/webhook"`
- □□□ `http://<ran-monitor-ip>:<port>/webhook`
- **IP** □□□ □□□ RAN □□□□□ IP □□
- □□□ □□□ `RanMonitor.Web.Nokia.Airscale.Endpoint` □□□9076□□□
- □□□ □□□ `/webhook`

private_key (□□□ - □□□□)

- □□□□□□□□□□
- □□□□`priv/external/nokia/ne.key.pem`
- □□□ PEM □□□□□
- □□□□ □□□□□□□□□□□□□
- □□□ □□□□□□□□□ OpenSSL □□

public_key (□□□ - □□□□)

- □□□□□□□□□□
- □□□□`priv/external/nokia/ne.cert.der`
- □□□ DER □□□□□
- □□□ □□□□□□□□□□
- □□□ □□□ private_key □□

reregister_interval (□□)

- □□□□□□□□□□□□□
- □□□□`30`
- □□□ □□□□□□□□□□□□□□□□□
- □□□ 30-300 □
- □□□ 30 □□□□□□□□

AirScale □□

airscales (□□□□)

- □□□□□□□ AirScale □□□□
- □□□□□□□□□□□

□□□□□□□□□

address (□��□)

- □□□ IP □□
- □□□□`"10.7.15.66"`
- □□□ □□□□□□ IPv4 □□
- □□□ □□□□□ RAN □□□□□□□
- □□□ `ping 10.7.15.66` □□□□

name (□□□)

- □□□□□□□□□
- □□□□`"ONS-Lab-Airscale"`
- □□□ □□□ Web UI□□□□ InfluxDB □□□
- □□□ □□□□□□□□□□□□□□□□□
- □□□
  - `"NYC-Site-A-BS1"`
  - `"LAX-Tower-Main"`
  - `"TestLab-Airscale-01"`

port (□□□)

- □□□□□□□□□□

- □□□□`"8080"`
- □□□ □□□ AirScale □□□□ 8080
- □□□ □□□□□□
- □□□ □□□□□□□□□□□

web_username (□□□)

- WebLM □□□□□□□□
- □□□□`"Nemuadmin"`
- □□□ □□ API □□□□□□□
- □□□ □□□□□□/□□□□□
- □□□ □□□□□

web_password (□□□)

- WebLM □□□□□□□
- □□□□`"nemuuser"`
- □□□□ □□□□□□□□□□□□□□□
- □□□ □□□□□□□□□□

□□□□□□

□□□□□□□□□□ `airscales` □□□□□□□□□

```
airscales: [
  %{
    address: "10.7.15.66",
    name: "ONS-Lab-Airscale",
    port: "8080",
    web_username: "Nemuadmin",
    web_password: "nemuuser"
  },
  %{
    address: "10.7.15.67",
    name: "Site-A-Tower-1",
    port: "8080",
    web_username: "admin",
    web_password: "password123"
  },
  %{
    address: "192.168.100.50",
    name: "Site-B-Indoor",
    port: "8080",
    web_username: "admin",
    web_password: "different_password"
  }
]
```

InfluxDB □□

```
config :ran_monitor, RanMonitor.InfluxDbConnection,
  auth: [
    username: "monitor",
    password: "sideunderTexasgalaxyview_61"
  ],
  database: "nokia-monitor",
  host: "10.179.2.135"
```

□□□ □□□ InfluxDB □□□□□□□□□□□□□□□□□□□□□□□□□

□□□□

auth (□□□□□)

- InfluxDB □□□□□□□
- **username:** InfluxDB □□□□□`"monitor"`□
- **password:** InfluxDB □□□`"sideunderTexasgalaxyview_61"`□
- □□□ □□ InfluxDB 2.x□□□□□ API □□

database (□□□)

- InfluxDB □□□/□□□□□
- □□□□`"nokia-monitor"`
- **InfluxDB 1.x**□ □□□□□
- **InfluxDB 2.x**□ □□□
- □□□ □□□□□ RAN □□□□□□

  ```
  # InfluxDB 1.x
  influx -execute 'CREATE DATABASE "nokia-monitor"'

  # InfluxDB 2.x
  influx bucket create -n nokia-monitor -o your-org
  ```

host (□□□)

- InfluxDB □□□□□
- □□□□`"10.179.2.135"`
- □□□ IP □□□□□□
- □□□ □□ InfluxDB □□□8086□□□
- □□□
  - `"localhost"` - □ RAN □□□□□□□□
  - `"10.179.2.135"` - □□ InfluxDB □□□
  - `"influxdb.example.com"` - □□□

InfluxDB □□□□□□

□□□□□

- RAN □□□□□□□□□ 8086 □□□ InfluxDB □□□
- □□□`curl http://10.179.2.135:8086/ping`

□□□□□

- □□ Web UI □□□□□□□□
- □□□30 □□720 □□□
- □□□□□□□□□

□□□□□

- InfluxDB □□□□□□□□□ 60 □□□□□□
- □□□□□□□□□□□□□□□□
- □□□□ InfluxDB □□□□

[illegible]

[illegible]

1. [illegible]

```
# [illegible]
password: "omnitouch2024"

# [illegible]
password: System.get_env("DB_PASSWORD") || "default_password"
```

2. [illegible]

```
chmod 600 config/runtime.exs
chown ran_monitor:ran_monitor config/runtime.exs
```

3. [illegible]

- [illegible] runtime.exs [illegible] `.gitignore`
- [illegible]
- [illegible]

[illegible]

1. [illegible]

- [illegible]
- [illegible] pool_size
- [illegible] 2 [illegible]

2. [illegible]

- [illegible]
- 60 [illegible]
- [illegible]15 [illegible]

3. InfluxDB □□

- □□□□□□□□□□□□□□
- □□ InfluxDB □□□□
- □□□□□□□□□□□□ InfluxDB □□□

□□□

1. □□□□

- □□□□□□□□□ IP □□
- □□ RAN □□□□□□□□□□□□
- □□□□□□□□□□□
- □□□□□□□□□□

2. □□□□□□

- □□□ `□debug` □□□□□□□□
- □□□ `□info` □□□□□□□
- □□□□□□□□□□□□□

3. □□ RAN □□

- □□□□□□□□□
- □□□□□□□□□
- □□ InfluxDB □□□□□
- □□□□□□□□□□□

□□

1. □□□□

- □□□□□□□□□ runtime.exs
- □□□□□□□□□□
- □□□□□□��□
- □□□□□□□□□□ RAN □□

2. □□□□

```
# 1. □□ runtime.exs
vim config/runtime.exs

# 2. □□ Elixir □□
elixir -c config/runtime.exs

# 3. □□□□□□□□
systemctl restart ran_monitor
```

3. □□□□

- □□□□□□□□□CPU□□□□□□□
- □□□□□□□□□□□□□□□□□
- □ 50+ □□□□□□□□□ InfluxDB □□
- □□ MySQL □ InfluxDB □□□□□

□□□□□□

□□□□□□□□□□□□□□□□□□□□

```
import Config

#
=====================================================================
# □□□□□
#
=====================================================================

config :ran_monitor, RanMonitor.Repo,
  username: System.get_env("DB_USERNAME") || "ran_monitor_user",
  password: System.get_env("DB_PASSWORD") || "change_this_password",
  hostname: System.get_env("DB_HOST") || "localhost",
  database: "ran_monitor",
  stacktrace: false,  # □□□□□□□□□
  show_sensitive_data_on_connection_error: false,  # □□□□□□□
  pool_size: 15  # 6 □□□ * 2 + 3 □□□

#
=====================================================================
# Web □□
#
=====================================================================

config :ran_monitor, RanMonitor.Web.Endpoint,
  http: [ip: {0, 0, 0, 0}, port: 8080],
  check_origin: false,
  secret_key_base: System.get_env("SECRET_KEY_BASE") ||
"generate_with_mix_phx_gen_secret",
  server: true

config :control_panel, ControlPanelWeb.Endpoint,
  url: [host: "0.0.0.0", port: 9443, scheme: "https"],
  https: [
    ip: {0, 0, 0, 0},
    port: 9443,
    keyfile: "priv/cert/server.key",
    certfile: "priv/cert/server.crt"
  ]

config :ran_monitor, RanMonitor.Web.Nokia.Airscale.Endpoint,
  url: [host: "0.0.0.0"],
  http: [ip: {0, 0, 0, 0}, port: 9076],
  server: true
```

```
#
====================================================================
# □□□□□□
#
====================================================================

config :logger,
  level: :info  # □□□□

config :logger, :console,
  format: "$time $metadata[$level] $message\n",
  metadata: [:request_id]

#
====================================================================
# □□□□□
#
====================================================================

config :ran_monitor,
  general: %{
    mcc: "001",
    mnc: "001"
  },
  nokia: %{
    ne3s: %{
      webhook_url: "http://10.179.2.135:9076/webhook",
      private_key: Path.join(Application.app_dir(:ran_monitor, "priv'
"external/nokia/ne.key.pem"),
      public_key: Path.join(Application.app_dir(:ran_monitor, "priv")
"external/nokia/ne.cert.der"),
      reregister_interval: 30
    },
    airscales: [
      # □□ A - □□
      %{
        address: "10.7.15.66",
        name: "Site-A-Main-Tower",
        port: "8080",
        web_username: "admin",
        web_password: System.get_env("BS_SITE_A_PASSWORD") || "passwo
      },
        # □□ A - □□□
        %{
          address: "10.7.15.67",
          name: "Site-A-Backup-Tower",
          port: "8080",
          web_username: "admin",
          web_password: System.get_env("BS_SITE_A_PASSWORD") || "passwo
        },

        # □□ B - □□
        %{
          address: "10.7.16.10",
          name: "Site-B-Indoor-DAS",
          port: "8080",
          web_username: "admin",
          web_password: System.get_env("BS_SITE_B_PASSWORD") || "passwo
        },

        # □□ C - □□
        %{
          address: "192.168.100.50",
          name: "Site-C-Rooftop",
          port: "8080",
          web_username: "admin",
          web_password: System.get_env("BS_SITE_C_PASSWORD") || "passwo
        },

        # □□□ - □□□□
        %{
          address: "10.5.198.100",
          name: "Lab-Test-Airscale-01",
          port: "8080",
          web_username: "Nemuadmin",
          web_password: "nemuuser"
        },

        # □□□ - □□
        %{
          address: "10.5.198.101",
          name: "Lab-Dev-Airscale-02",
          port: "8080",
          web_username: "Nemuadmin",
          web_password: "nemuuser"
        }
```

```
    ]
  }

#
====================================================================
# InfluxDB □□
#
====================================================================

config :ran_monitor, RanMonitor.InfluxDbConnection,
  auth: [
    username: System.get_env("INFLUX_USERNAME") || "monitor",
    password: System.get_env("INFLUX_PASSWORD") || "change_this_passw
  ],
  database: "nokia-monitor",
  host: System.get_env("INFLUX_HOST") || "10.179.2.135"
```

□□□□

- □□□□ - □□□□
- AirScale □□□□ - □□□□
- □□□□□□□□ - □□□□□□□
- Grafana □□ - □□□□□□□□
- API □□ - REST API □□
- □□□□□□ - □□□□□□□□

MDT □□□□□ TCE

□□□□□□ (TCE)

RAN Monitor □□□□□□□□□□□□□□□□□□□□□ LTE/5G □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□ TCE□

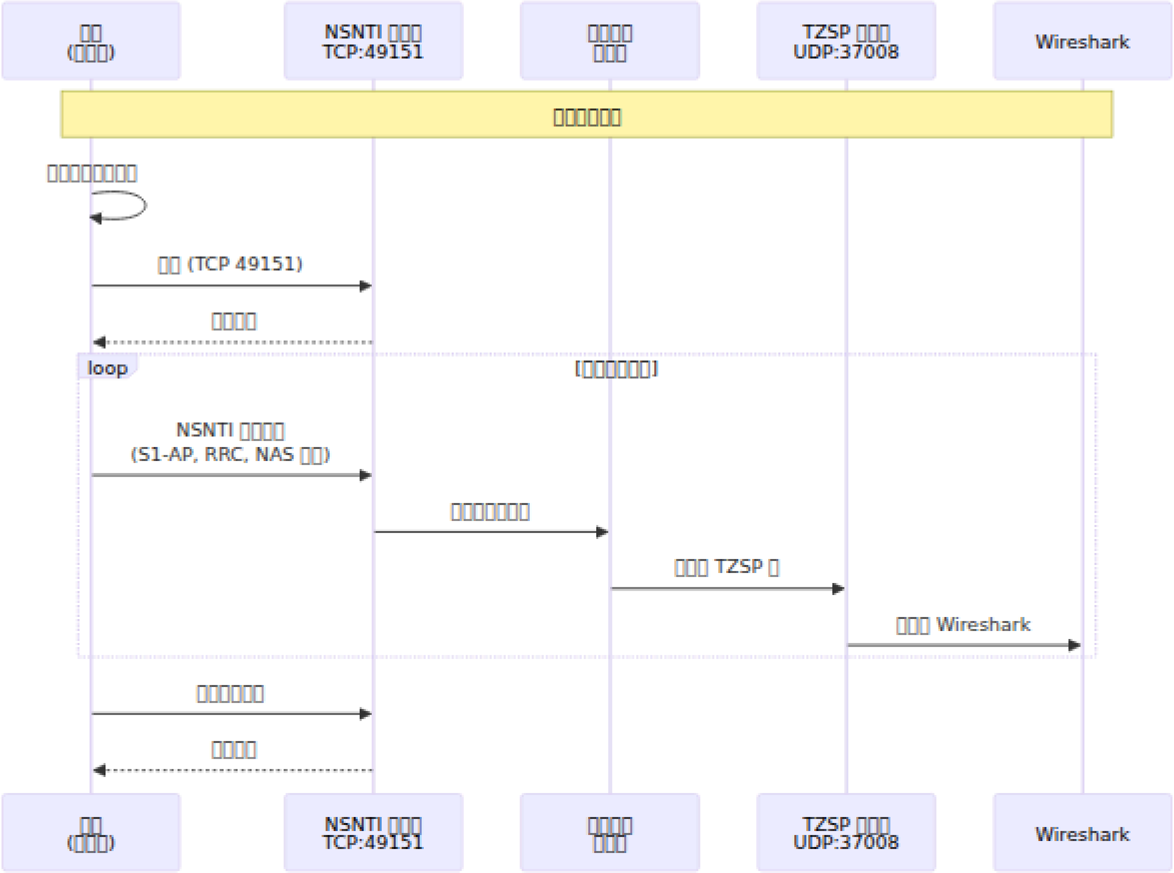
□□□□□□□□□□□□□ AirScale □□□□□□□□□□□

- **S1-AP □□** - eNodeB □ EPC □□□□□□□□
- **RRC □□** - □□□□□□□□
- **NAS □□** - □□□□□□
- □□□□□ - PDCP □□□□□□

TCE □□

□□	□□	□□	□□
NSNTI □□□	TCP	49151	□□□□□□□□□□□
TZSP □□□	UDP	37008	□□□□□□ Wireshark □□□□□□
□□□□□	ASN.1	-	□□ S1-AP □ RRC □□

[illegible]


[illegible]
NSNTI [illegible]
TCP:49151
TZSP [illegible]
UDP:37008
Wireshark
[illegible] (TCP 49151)
loop
NSNTI [illegible]
(S1-AP, RRC, NAS [illegible])
[illegible] TZSP [illegible]
[illegible] Wireshark

□□□□□□□□□□□□□□NSNTI □□□□ (49151)□TZSP □□□□□□□□□□

□□□□□□

1. □□ **TCE** □□□□□

   ```
   ss -tlnp | grep 49151
   # □□□: LISTEN 0.0.0.0:49151
   ```

2. □□□□□□□

   - □□□□□ IP □□□ RAN Monitor □□□
   - □□□□□□□□□□ 49151
   - □□□□□□□□□□ (S1-AP, RRC, NAS)
   - □□□□□□

3. □□ **Wireshark**□

   □□□□□

   - □□□ TZSP □□□□□□□□□□□□
   - □□□□□□□□`udp port 37008`

   □□□□□□□

   RAN Monitor □□□□□ UDP □□□□□□□□□□□□□ RRC □□□□□ Wireshark □“□□□”□□□□□□□□□□□□

   □□ 1□□□ Wireshark GUI

   i. □□ □□ → □□□...
   ii. □□ + □□□□□□□□
   iii. ���□□□□□□□□□□

□□	□	□□	□□	□□□
udp.port	36412	□□	(□)	SCTP
sctp.port	36412	□□	(□)	S1AP
udp.port	37000	□□	(□)	TZSP
udp.port	37001	□□	(□)	LTE RRC (DL-CCCH)
udp.port	37002	□□	(□)	LTE RRC (DL-DCCH)
udp.port	37003	□□	(□)	LTE RRC (BCCH)
udp.port	37004	□□	(□)	LTE RRC (PCCH)
udp.port	37008	□□	(□)	TZSP
udp.port	37011	□□	(□)	LTE RRC (UL-CCCH)
udp.port	37012	□□	(□)	LTE RRC (UL-DCCH)
udp.port	38000	□□	(□)	MAC-LTE
udp.port	38001	□□	(□)	MAC-LTE (DL)
udp.port	38002	□□	(□)	MAC-LTE (BCH)
udp.port	38003	□□	(□)	MAC-LTE (PCH)
udp.port	38011	□□	(□)	MAC-LTE (UL)
udp.port	38012	□□	(□)	MAC-LTE (RACH)

□□ 2□□□ decode_as_entries □□

□□□□□ `~/.config/wireshark/decode_as_entries` (Linux/Mac) □ `%APPDATA%\Wireshark\decode_as_entries` (Windows)□

```
# RAN Monitor TZSP □□□□
decode_as_entry: udp.port,36412,(none),SCTP
decode_as_entry: sctp.port,36412,(none),S1AP
decode_as_entry: udp.port,37000,(none),TZSP
decode_as_entry: udp.port,37001,(none),LTE RRC
decode_as_entry: udp.port,37002,(none),LTE RRC
decode_as_entry: udp.port,37003,(none),LTE RRC
decode_as_entry: udp.port,37004,(none),LTE RRC
decode_as_entry: udp.port,37008,(none),TZSP
decode_as_entry: udp.port,37011,(none),LTE RRC
decode_as_entry: udp.port,37012,(none),LTE RRC
decode_as_entry: udp.port,38000,(none),MAC-LTE
decode_as_entry: udp.port,38001,(none),MAC-LTE
decode_as_entry: udp.port,38002,(none),MAC-LTE
decode_as_entry: udp.port,38003,(none),MAC-LTE
decode_as_entry: udp.port,38011,(none),MAC-LTE
decode_as_entry: udp.port,38012,(none),MAC-LTE
```

□□□□□□□

□□	□□	□□/□□	□□
36412	S1AP	-	□□ S1AP □□□ (eNodeB ↔ EPC)
37000	RRC	□□	□□ RRC □□□□□□□
37001	RRC	DL-CCCH	□□□□□□□□
37002	RRC	DL-DCCH	□□□□□□□□
37003	RRC	BCCH-DL-SCH	□□□□□□ (□□□□)
37004	RRC	PCCH	Paging □□□□
37008	TZSP	-	□□ TZSP □□□□
37011	RRC	UL-CCCH	□□□□□□□□ (RRC □□□□)
37012	RRC	UL-DCCH	□□□□□□□□ (□□□□)
38000	MAC-LTE	□□	□□ MAC □□□□□□□
38001	MAC-LTE	□□	□□□□□□
38002	MAC-LTE	BCH	□□□□
38003	MAC-LTE	PCH	Paging □□
38011	MAC-LTE	□□	□□□□□□
38012	MAC-LTE	RACH	□□□□□□

□□□□□□□□□

```
# [illegible] TZSP [illegible]
tzsp

# [illegible]
s1ap || rrc || mac-lte

# [illegible] RRC [illegible]
udp.port == 37011 || udp.port == 37012

# [illegible] RRC [illegible]
udp.port == 37001 || udp.port == 37002

# [illegible] RRC [illegible]
rrc.rrcConnectionRequest || rrc.rrcConnectionSetup

# [illegible]
s1ap.HandoverRequired || s1ap.HandoverCommand
```

[illegible]

[illegible]

- [illegible] RF [illegible]
- [illegible]
- [illegible] (RSRP, RSRQ, SINR)
- [illegible]

[illegible]

- [illegible]
- [illegible]
- [illegible]
- [illegible]

[illegible]

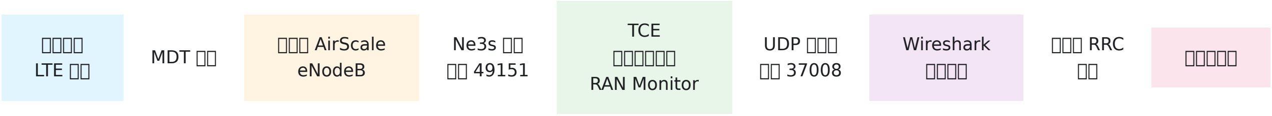
- PCI [illegible]
- [illegible]

- □□□□□□
- □□□□□□□

□□

□□□□□□□ **(MDT)** □□□□□□□□□□□□□□□□ (RSRP, RSRQ, □□□���)□□□□□□□□□□□□□□□□ □□□□□□□ Omnitouch RAN Monitor Web UI □□□□ AirScale □□□□ MDT □□□□ Wireshark □□□□

□□


□□□□
LTE □□
MDT □□
□□□ AirScale
eNodeB
Ne3s □□
□□ 49151
TCE
□□□□□□
RAN Monitor
UDP □□□
□□ 37008
Wireshark
□□□□
□□□ RRC
□□
□□□□□

TCE□□□□□□□□□□□ Omnitouch RAN Monitor □□□□□□□□□ Ne3s □□□□□□□□□□□ Wireshark □□□□□□□□□

□□□□

□□□□□

□□□ Airscale □□□□ □□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□□□□□□□□□□□□□□□□□□□□□□ ONS□

□□□□

- □□ TCE □ Omnitouch RAN Monitor
- □□□□□□□□ Wireshark 3.0+
- □ Wireshark □□□ TCE Lua □□
- □ AirScale □□□□□

□□ MDT □□

RAN Monitor □□□□ TCE □□□□□□□□□□□□□□□ Wireshark □□□□□□□

□ 1 □□□□□□□□□□□

□□ RAN Monitor Web UI □□□□□□□□□□□ TCE□

1. □□ Web UI: `https://<ran-monitor-ip>:9443`
2. □□□ □□ □□
3. □□□□□□□□□□
4. □□ □□□□ □□
5. □□□□□□□□□□
6. □□□□□□□/□□ TCE □□□
   - □□□□□□ **IP**: `<□□ RAN Monitor IP>`
   - □□□□□□□□: `49151`
7. □□□□□□□□
8. □□□□□□□□□□□□
9. □□□□

□□□□□□□□□ AirScale □□□□□□□□□□□ ONS□

□ 2 □□□ AirScale □□□ MDT

□□□□□□□□ MDT □□□□□□□□□□

- □□□□: □□ MDT□□□□□□□ MDT□□□□□□
- □□□□: □□□□□□□□□□□ PLMN □□
- □□□□: □□□□□□□□□□□□□5000ms□
- □□□□: RSRP□RSRQ □□□
- □□□□: □□□□□□□□

□□ ONS □□□□□□□□□□□□□□□□□□□□□□

□ 3 □□□□□□□□

□□□□□□□ AirScale □□□□□□□□□□□□□□ MDT □□□□□ TCE□TCE □□□□□□□□□□□□

□ Wireshark □□□ MDT □□

□□ Wireshark □□

1. □□□□□□□□ Wireshark
2. □ □□□□ □□□□Linux □□ `lo`□macOS □□ `lo0`□Windows □□ `Loopback`□
3. □□□□□□□□`udp port 37008`
4. □□□□

□□ Wireshark □□□□ S1AP □□□□□ (InitialUEMessage, Attach request)□LTE RRC □□ (RRCConnectionReject, RRCConnectionReestablishment) □□□ TCE □□□□□□□□□

□□ MDT □□

□□□□□□□□□□□□□□□

```
# □□□□ RRC □□□□
lte-rrc.measurementReport

# □□□□□□ RRC □□
udp.dstport >= 37011 && udp.dstport <= 37012

# □□ RSRP □□ (< -100 dBm)
lte-rrc.rsrpResult < 40

# □□ RSRQ □□ (< -12 dB)
lte-rrc.rsrqResult < 22
```

□□□□

MDT □□□ **RRC MeasurementReport** □□□□□□□□□□□

- □□□□□□: □□□□□ RSRP □ RSRQ
- □□□□□: □□□□□ RSRP □ RSRQ
- □□ **ID**: □□□□□□□□□ ID
- **GPS** □□: □□□□□□□□□□□□

□ Wireshark □□□ RRC □□□□□□□□□□

```
□□□□□□ (RRC)
└─ UL-DCCH-Message
    └─ message: measurementReport
        └─ MeasurementReport
            └─ measResults
                ├─ measResultServCell (□□□□ RSRP/RSRQ)
                └─ measResultNeighCells (□□□□□)
```

□□□□□□□

□□□□□□□□

1. □□ → □□□□□□□ → □□ **CSV**
2. □□□□: `lte-rrc.rsrpResult`, `lte-rrc.rsrqResult`, `lte-rrc.physCellId`

3. □ Excel□Python □□□□□□□

□□□□

□□□□: □□ RSRP/RSRQ □□□□

```
lte-rrc.rsrpResult < 40 || lte-rrc.rsrqResult < 22
```

□□□□: □□□□□□□□□□□□

```
lte-rrc.MeasResultListEUTRA
```

□□□□: □□□ RSRP □□□ RSRQ □□□□

```
lte-rrc.rsrpResult > 50 && lte-rrc.rsrqResult < 20
```

□□□□

Wireshark □□□□□□

- □□ TCE □□□□□`ps aux | grep beam`
- □□ Wireshark □□□□□□□ `udp port 37008` □□□□
- □□ AirScale □□□□□□□□□□□□
- □□□□□□□□ TCE IP/□□□□□□

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- □□□□□□□□□ (MDT + □□□□□)
- □□□□□□□□□□
- □□□□□□□□ MDT (LTE Release 10+)

□□□□□□□□□□□□□ **AirScale** □□□□□□□□ **ONS**□

□□□□□□□

- ☐ □□ MDT □□□□□□□□□□□□□
- ☐ □ AirScale □□□ TCE IP (RAN Monitor IP) □□□ 49151
- ☐ □ RAN Monitor □□□□□□ TCE
- ☐ □□□□□□ MDT □□□□
- ☐ □□□□□□ Wireshark □□□□□□□ `udp port 37008`
- ☐ □□□□□□□□`lte-rrc.measurementReport`
- ☐ □□□□□□□□□□□

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- **Omnitouch □□□□ (ONS)**: □□ AirScale □□□□□□□□□□□

[illegible]

RAN [illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. Web UI [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]

[illegible]

[illegible] RAN [illegible]

[illegible]

1. [illegible]

- [illegible]
- [illegible]
- [illegible]

2. [illegible]

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- □ Web UI □□□□□□□
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3. □□□□□□

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4. □□□□□□

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- RAN □□□□□□□□□□ (`ps aux | grep ran_monitor`)
- □□□□□□□□□□□ (MySQL, InfluxDB)
- □□□□□□□□□
- □□□□□□□□

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- □□□ Web UI □□□“□□□”

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1. □□□□□□

```
# □□□□□□
ping <device-ip>

# □□□□□□
telnet <device-ip> 8080
```

□□□ □□□ ping □ telnet □□
□□□□□ □□□□ - □□□□□□□□□□□□□

2. □□□□

□ Web UI → □□ → □□□□ → □□□□□

- IP □□□□□□□
- □□□□□□□□□□□ 8080□□
- □□□□□□□□

□ `config/runtime.exs` □□

```
%{
  address: "10.7.15.66",  # □□□ IP□
  name: "Site-A-BS1",
  port: "8080",           # □□□□□□
  web_username: "admin",  # □□□□□□□
  web_password: "password" # □□□□□□
}
```

3. □□□□□□□□

Web UI → □□□□□□ → □□□□□□□

[illegible]

- `[error] Authentication failed` → [illegible]
- `[error] Connection refused` → [illegible]/[illegible]
- `[error] Timeout` → [illegible]
- `[error] Certificate error` → [illegible]/[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible] RAN [illegible]
3. [illegible]
    - RAN [illegible] → [illegible] 8080
    - [illegible] → RAN [illegible] 9076[illegible]webhooks[illegible]
4. [illegible] RAN [illegible]

[illegible]

1. [illegible] WebLM [illegible]
2. [illegible] `config/runtime.exs` [illegible]
3. [illegible] RAN [illegible]
4. [illegible]

[illegible]/[illegible]

1. [illegible]
2. [illegible]
3. [illegible]`telnet <device-ip> 8080`
4. [illegible]

[illegible]/[illegible]

1. [illegible]
    - `priv/external/nokia/ne.key.pem`
    - `priv/external/nokia/ne.cert.der`
2. [illegible]

3. [illegible] Nokia [illegible]
4. [illegible] Nokia [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]“[illegible]”[illegible]
- Web UI [illegible]��[illegible]/[illegible]
- [illegible]

[illegible]

1. [illegible]

Web UI → [illegible] → [illegible] → [illegible]

- [illegible]
- [illegible]
- [illegible]

2. [illegible]

[illegible] `config/runtime.exs` [illegible]

```
nokia: %{
  ne3s: %{
    reregister_interval: 30  # [illegible] 30-60 [illegible]
  }
}
```

3. [illegible]

- [illegible]
- [illegible]`ping <device-ip> -c 100`
- [illegible]

4. [illegible]

```
# [illegible] RAN [illegible]
date

# [illegible]
# [illegible]
```

[illegible]

[illegible]

1. [illegible] `reregister_interval` [illegible] 30 [illegible]
2. [illegible] RAN [illegible]
3. [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]/[illegible]
4. [illegible]

[illegible]

1. [illegible] RAN [illegible] NTP
2. [illegible]
3. [illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

��[illegible]

[illegible]

- [illegible] Web UI [illegible]“[illegible]”[illegible]
- [illegible] InfluxDB [illegible]
- Grafana [illegible]
- InfluxDB [illegible]

[illegible]

1. [illegible]

Web UI → [illegible]

- [illegible]
- [illegible]
- [illegible]

2. [illegible] InfluxDB [illegible]

Web UI → InfluxDB [illegible]

- [illegible]
- RAN [illegible] InfluxDB[illegible]

[illegible]

```
# [illegible] RAN [illegible]
curl http://<influxdb-host>:8086/ping
```

3. [illegible]

[illegible]

- `[error] InfluxDB write failed` → [illegible]
- `[error] Failed to collect metrics` → [illegible]
- `[info] Metrics collected: 0` → [illegible]

4. □□□□ InfluxDB

□□ InfluxDB □□□□□□□□□

```
# InfluxDB 1.x
influx -database 'nokia-monitor' -execute '
  SELECT COUNT(*) FROM PerformanceMetrics
  WHERE basebandName='''Site-A-BS1'''
  AND time > now() - 1h
'

# InfluxDB 2.x
influx query 'from(bucket:"nokia-monitor")
  |> range(start: -1h)
  |> filter(fn: (r) => r.basebandName == "Site-A-BS1")
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> count()'
```

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InfluxDB □□□□□

1. □□ InfluxDB □□□□□□
2. □□ `config/runtime.exs` □□□□□□□
   - □□□□
   - □□□8086□
   - □□□/□□□
   - □□/API □□
3. □ RAN □□□□□□□□□□
4. □□□□□□□□□□□ 8086
5. □□□□□□□ RAN □□□

InfluxDB □□□□□

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2. □□ InfluxDB □□□□□□□□□□□
3. □□□□□□□□□□□ API □□
4. □□□□□□□ `config/runtime.exs`

5. [illegible] RAN [illegible]

InfluxDB [illegible]

1. [illegible]`df -h`
2. [illegible]
3. [illegible]
4. [illegible] [illegible]

[illegible]

1. [illegible]
2. [illegible] webhook URL [illegible]
3. [illegible]
4. [illegible] RAN [illegible] webhook [illegible] 9076[illegible]

[illegible]

[illegible]

[illegible]

- Grafana [illegible]
- [illegible]
- InfluxDB [illegible]

[illegible]

1. [illegible]

��[illegible]

```
# [illegible]
journalctl -u ran_monitor --since "2025-12-29" --until "2025-12-30"
```

2. □□□□□□□□

Web UI → □□ → □□ → □□“□□□□”□□

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3. □□ InfluxDB □□□

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- □□ InfluxDB □□
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RAN □□□□□□

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InfluxDB □□□

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- □□ RAN □□□□□□□□□□□□

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Web UI □□

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- □□□□□□□□ https://<ran-monitor-ip>:9443
- □□□□□□□□
- SSL □□□□

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1. □□ Web UI □□□□□□

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```
[info] Running ControlPanelWeb.Endpoint with cowboy
```

□□□□□

```
ps aux | grep control_panel
netstat -tulpn | grep 9443
```

2. □□□□

□□□□□□□

```
telnet <ran-monitor-ip> 9443
```

□ RAN □□□□□□□□□

```
curl -k https://localhost:9443
```

3. □□□□□

```
# □□□□□□□□
sudo iptables -L -n | grep 9443

# □
sudo firewall-cmd --list-ports
```

□□□□□

□□□□□□

1. □□□□□□□□
   ```
   sudo firewall-cmd --add-port=9443/tcp --permanent
   sudo firewall-cmd --reload
   ```
2. □□□□□□

Web UI □□□□

1. □□ `config/runtime.exs` □□ Web □□□□
2. □□ SSL □□□□□□□□
3. □□□□□□□□□□□□□□□
4. □□ RAN □□□

SSL □□□□□

1. □□□□□□□□□□□□□□
   ```
   ls -l priv/cert/omnitouch.pem
   ls -l priv/cert/omnitouch.crt
   ```
2. □□□□□□□□
   ```
   openssl x509 -in priv/cert/omnitouch.crt -text -noout
   ```

3. □□□□□□□□□□□□□
4. □□ RAN □□□

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1. □□ `config/runtime.exs` □□□□□□
2. □□□□□□□□□□□□
3. □□□ `CONTROL_PANEL_HTTPS_PORT` □□□□

□□□Web UI □□□□□□□□

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- Web UI □□□
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1. □□□□□□

□ `config/runtime.exs` □□□□□□□□□□□

```
airscales: [
  # □□□□□□□□
]
```

2. □□□□□□□

□□□□□□□ MySQL □□

```
mysql -u ran_monitor_user -p ran_monitor -e "SELECT * FROM
airscales;"
```

3. □□□□□□□□

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[illegible]

[illegible]

1. [illegible] `config/runtime.exs` [illegible]
2. [illegible] RAN [illegible]
3. [illegible] Web UI [illegible]

[illegible]

1. [illegible] MySQL [illegible]
2. [illegible] `config/runtime.exs` [illegible]
3. [illegible]
4. [illegible] RAN [illegible]

[illegible]

[illegible]MySQL [illegible]

[illegible]

- [illegible]
- Web UI [illegible]
- “[illegible]”[illegible]

[illegible]

1. [illegible] MySQL [illegible]

```
systemctl status mysql
# [illegible]
systemctl status mariadb
```

2. [illegible]

[illegible] RAN [illegible]

```
mysql -h <mysql-host> -u <username> -p <database>
```

3. □□□□

□ `config/runtime.exs` □□

```
config :ran_monitor, RanMonitor.Repo,
  username: "ran_monitor_user",
  password: "password",
  hostname: "localhost",
  database: "ran_monitor",
  pool_size: 10
```

□□□□□

MySQL □□□□

1. □□ MySQL □□□
   ```
   systemctl start mysql
   ```
2. □□□□□□□□□
3. RAN □□□□□□□□□□

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2. □□□□□□
3. □□□□□□□□□ `config/runtime.exs`
4. □□ RAN □□□

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1. □□□ MySQL □□□□□□□□
2. □□□□□□□□□□□ 3306
3. □□ MySQL □□□□□□□□□□□□□□□□□□

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1. □□ MySQL max_connections □□
2. □□□□□□□□□□□□ pool_size
3. □□ RAN □□□

□□□□

□□□□ CPU □□□□□□

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- RAN □□□□□□□□ CPU □ RAM
- □□□□□□□□□□
- □□□□□□□
- □□□□□□

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1. □□□□□□□□

```
# CPU □□□
top -p $(pgrep -f ran_monitor)

# □□□□□□
ps aux | grep ran_monitor
```

2. □□□□□□□□□

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- □□□□ = □□□□□□□
- □□□□□□□□□□□□

3. □□□□□□

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- □□□ = □□□ CPU/□□□□
- □□□□ 10 □□□□□□□

4. □□□□□□□□□□

□ `config/runtime.exs` □□

```
pool_size: 10  # □□□□□□
```

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1. □□□□□□□□
2. □□□□□□□□CPU/RAM□
3. □□□□□□□□□□
4. □□□□□□□□□□□□

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1. □□□□□□ pool_size
2. □□□□□□□□□ 2 □□□ + 5 □□□ Web UI
3. □□ RAN □□□
4. □□□□□□□□

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2. □□□□□□□□□□□□□□□
3. □□□□□□□□□ RAN □□□
4. □□□□□□□□□□□□

InfluxDB □□□□□

1. □□ InfluxDB □□□□□□
2. □□ InfluxDB □□□□□
3. □□□□□ InfluxDB □□□
4. □□□□□□□□□□□□

[illegible]Web UI [illegible]

[illegible]

- Web UI [illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible]

RAN [illegible]

```
top
free -h
df -h
```

2. [illegible]

[illegible]

```
# MySQL [illegible]
mysql -u root -p -e "SHOW VARIABLES LIKE 'slow_query_log%';"
```

3. [illegible]

[illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]

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1. □□ MySQL □□
2. □□□□□□□□□□□□□□□□
3. □□□□□□□□□□

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2. □□ **Webhook** □□□

Webhook □□□□□□□□□

```
netstat -tulpn | grep 9076
```

□□□

```
tcp  0  0.0.0.0:9076  0.0.0.0:*  LISTEN
```

3. [illegible] Webhook [illegible]

[illegible] webhook URL [illegible] RAN [illegible]

```
http://<ran-monitor-ip>:9076/webhook
```

4. [illegible]

[illegible] webhook [illegible]

5. [illegible] InfluxDB

[illegible]

```
influx -database 'nokia-monitor' -execute '
  SELECT COUNT(*) FROM Alarms WHERE time > now() - 1h
'
```

[illegible]

Webhook [illegible]

1. [illegible] `config/runtime.exs` [illegible] webhook [illegible]
2. [illegible] 9076 [illegible]
3. [illegible] RAN [illegible]
4. [illegible]

[illegible]

1. [illegible]
2. [illegible] webhook URL
3. [illegible]

[illegible]

1. [illegible] RAN [illegible] 9076
2. [illegible]
3. [illegible]`telnet <ran-monitor-ip> 9076`

InfluxDB [illegible]

1. [illegible] InfluxDB [illegible]
2. [illegible]
3. [illegible] InfluxDB [illegible]
4. [illegible]

[illegible]

[illegible]

[illegible] Web UI [illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

[illegible] systemd [illegible]

```
journalctl -u ran_monitor -f
```

[illegible] mix [illegible]

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- [illegible]/[illegible]/[illegible] - [illegible]

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- □□□□□□□□“Site-A-BS1”□
- “error” □ “failed”
- “InfluxDB” □ “MySQL”
- “registration” □ “session”

InfluxDB □□

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```
influx -database 'nokia-monitor' -execute '
  SELECT * FROM PerformanceMetrics
  WHERE basebandName='''Site-A-BS1'''
  AND time > now() - 5m
  LIMIT 10
'
```

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```
influx -database 'nokia-monitor' -execute '
  SELECT COUNT(*) FROM PerformanceMetrics
  GROUP BY basebandName
'
```

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```
influx -database 'nokia-monitor' -execute '
  SELECT * FROM Alarms
  WHERE time > now() - 1h
'
```

MySQL □□

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```
SELECT name, address, port, registration_status
FROM airscales;
```

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```
mysql -u ran_monitor_user -p ran_monitor -e "SHOW PROCESSLIST;"
```

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```
# □□□□
ping <device-ip>

# □□□□□□
telnet <device-ip> 8080
nc -zv <device-ip> 8080

# □□□□
traceroute <device-ip>
```

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```
# □□□□
sudo iptables -L -n -v

# □□□□□□
sudo iptables -L -n | grep 8080
```

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- [illegible]
- [illegible]MySQL[illegible]InfluxDB[illegible]
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4. [illegible]

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5. [illegible]

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- **Web UI [illegible]** - [illegible]
- [illegible] - [illegible]
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- **Grafana [illegible]** - [illegible]
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- Web UI [illegible]
- [illegible]`journalctl -u ran_monitor`
- [illegible]

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- [illegible] Web UI [illegible]
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- InfluxDB [illegible]
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- **Web UI** [illegible] - [illegible]
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- **Grafana** [illegible] - [illegible]
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Web UI □□

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16. Web UI □□□□

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RAN [illegible] Web [illegible]Web UI [illegible]

Web UI [illegible] Grafana

Web UI [illegible]

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[illegible] Grafana [illegible] Grafana [illegible]

[illegible] Web UI

[illegible] HTTPS [illegible]

URL: `https://<ran-monitor-ip>:9443`

[illegible]: 9443[illegible] `CONTROL_PANEL_HTTPS_PORT` [illegible]

SSL [illegible]

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URL: `https://<ran-monitor-ip>:9443/nokia/enodeb`

BTS [illegible]

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2. [illegible]“[illegible]”
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4. [illegible] XML [illegible]

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1. [illegible]“[illegible]”
2. [illegible] XML [illegible]
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1. [illegible] **ID**
2. [illegible] `config/runtime.exs`[illegible]

   ```
   airscales: [
     %{
       address: "10.7.15.66",
       name: "Site-A-BS1",
       port: "8080",
       web_username: "admin",
       web_password: "password"
     }
   ]
   ```

3. [illegible] **RAN** [illegible] [illegible]

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[illegible] InfluxDB [illegible]

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InfluxDB □□□□

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URL: `https://<ran-monitor-ip>:9443/nokia/influx`

InfluxDB [illegible]

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InfluxDB [illegible]	[illegible]2.x[illegible]

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URL: `https://<ran-monitor-ip>:9443/nokia/metrics` *[illegible] InfluxDB [illegible] Airscale [illegible]*

InfluxDB [illegible]

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[illegible] Airscale [illegible] InfluxDB [illegible]

[illegible] InfluxDB [illegible]

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Airscale	[illegible]
[illegible]	[illegible] PM [illegible]
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Erlang VM [illegible]

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PM [illegible]

[illegible] InfluxDB [illegible]PM[illegible] AirScale [illegible] 22,000 [illegible] PM [illegible]

URL: `https://<ran-monitor-ip>:9443/nokia/pm-filters`

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PM [illegible]

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[illegible]“[illegible] PM [illegible]”[illegible] PM [illegible]

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[illegible]	[illegible]
[illegible] **PM** [illegible]	[illegible] InfluxDB [illegible]
[illegible]	[illegible] 22,000+ [illegible]
[illegible]	[illegible] `config_keys.csv`[illegible]

[illegible] PM [illegible]

[illegible] InfluxDB[illegible]

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- [illegible] ID [illegible]
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WCDMA	M5xxx	3G WCDMA □□□
5G-NR	M55xxx	5G NR □□□
5G-□□□	M51xxx	5G □□□□□
5G-□□	M40xxx	5G □□□□□

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- [illegible] `priv/pm_filters.etf` [illegible]
- [illegible]
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InfluxDB [illegible]

- **PM** [illegible] PM [illegible]
- [illegible]/[illegible]

[illegible] PM [illegible][illegible]

[illegible]

[illegible] AirScale [illegible]

URL: `https://<ran-monitor-ip>:9443/nokia/firmware`

[illegible]

[illegible] RAN [illegible] HTTP URL [illegible] WebEM [illegible]“[illegible]”[illegible]

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[illegible]	[illegible]
[illegible]	[illegible] AirScale .zip [illegible]
[illegible] **URL**	[illegible] WebEM [illegible] HTTP URL
MD5 [illegible]	[illegible]
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1. [illegible] RAN [illegible]
2. [illegible] [illegible] **URL** [illegible] URL
3. [illegible] WebEM [illegible] [illegible]
4. [illegible] URL [illegible] [illegible]
5. [illegible]

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URL: `https://<ran-monitor-ip>:9443/nokia/data`

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4. [illegible] ID
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6. [illegible]
7. [illegible]
8. [illegible] 15-30 [illegible]
9. [illegible]

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1. [illegible] eNodeBs [illegible]
2. [illegible] ID [illegible] IP [illegible]
3. [illegible] `config/runtime.exs`
4. [illegible] RAN [illegible]
5. [illegible]
6. [illegible]
7. [illegible] InfluxDB
8. [illegible]
9. [illegible] Grafana [illegible]

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