RAN [illegible]

[illegible] (RAN) [illegible]

[illegible] Omnitouch [illegible]

[illegible]

1. [illegible]
2. RAN [illegible]
3. [illegible]
4. Web UI [illegible]
5. [illegible] Grafana [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]

[illegible]

RAN [illegible] Nokia AirScale [illegible] 3GPP LTE [illegible] 5G [illegible] RAN [illegible]

[illegible]

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

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RAN □□□□□	□□□□□□□□□□□□□□	□□□□
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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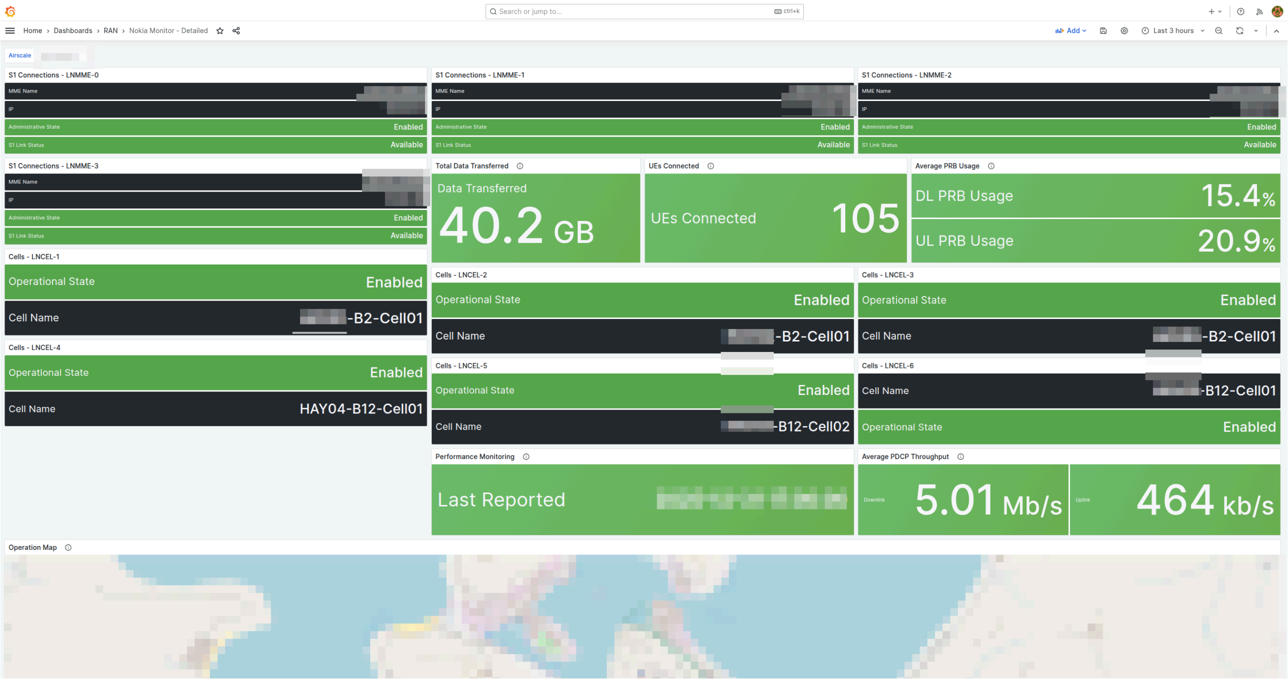

S1 Connections - LNMME-0
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

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

□□□□□□□□□ LNMME □ S1 □□□□□□□□□□□□□□□□□□□□□□□□□□ PRB □□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

RAN □□□□□

RAN □□□□□□□□□□□□

1. □□□□□ - □□□ Nokia □□□□□□□□
2. □□□□□□ - □ 10 □□□□□ KPI□□□□□
3. □□□□ - □□□□□□□□□□
4. □□□□ - □□□□□□□□□□□
5. □□□□□□ - □□□□□□□□□□□□□
6. □□□□□ - □□ Web UI □ Grafana □□□□□□

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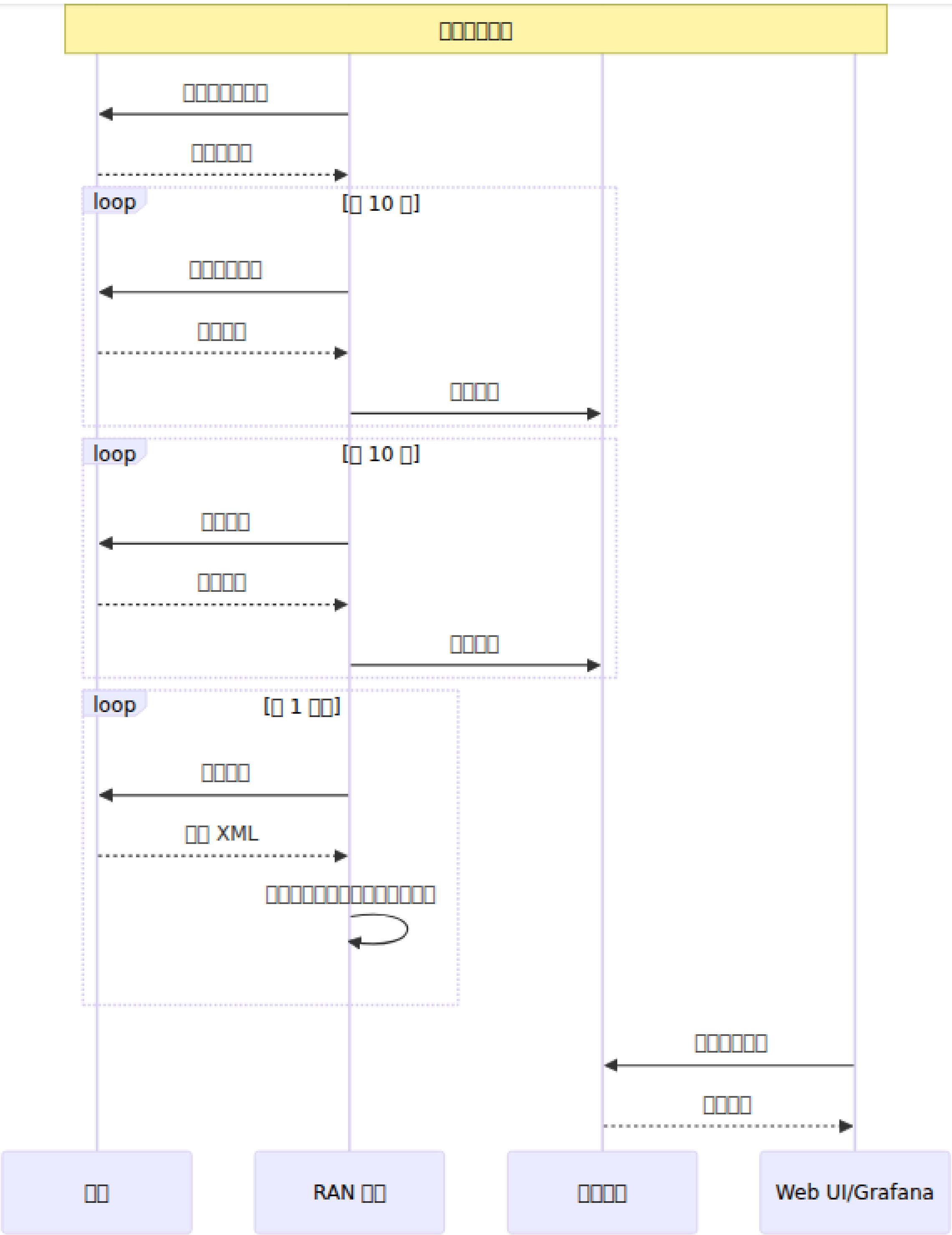
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loop
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RAN □□
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Web UI/Grafana

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

[illegible]

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

[illegible]

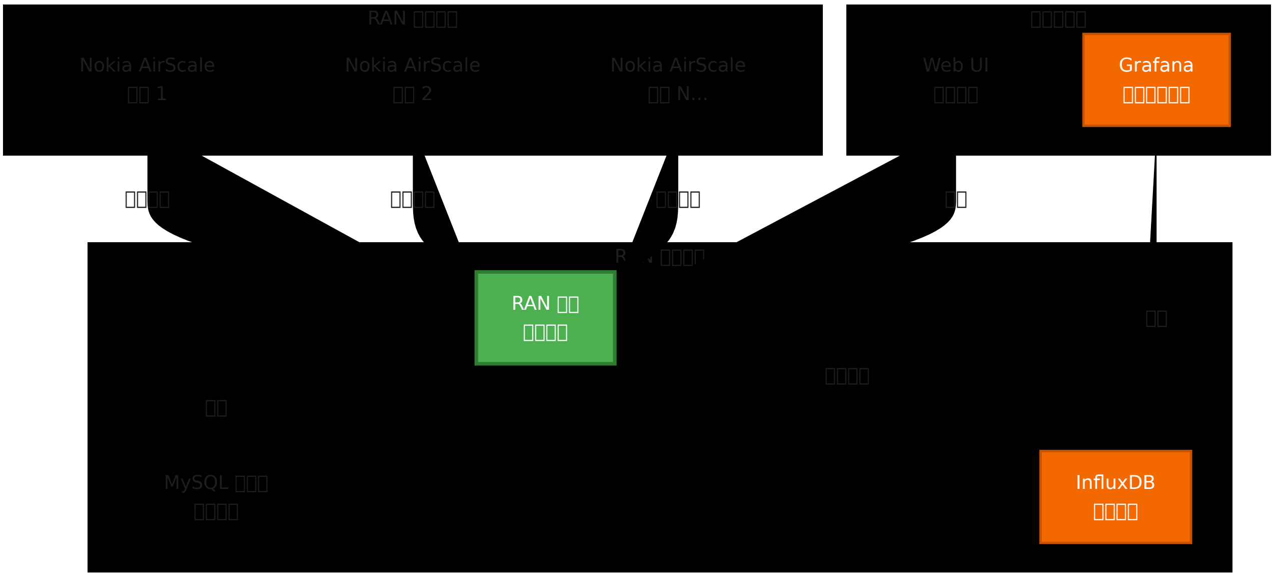
- [illegible] XML [illegible]
- [illegible]
- [illegible]
- [illegible] 10 [illegible]

[illegible] [illegible][illegible]

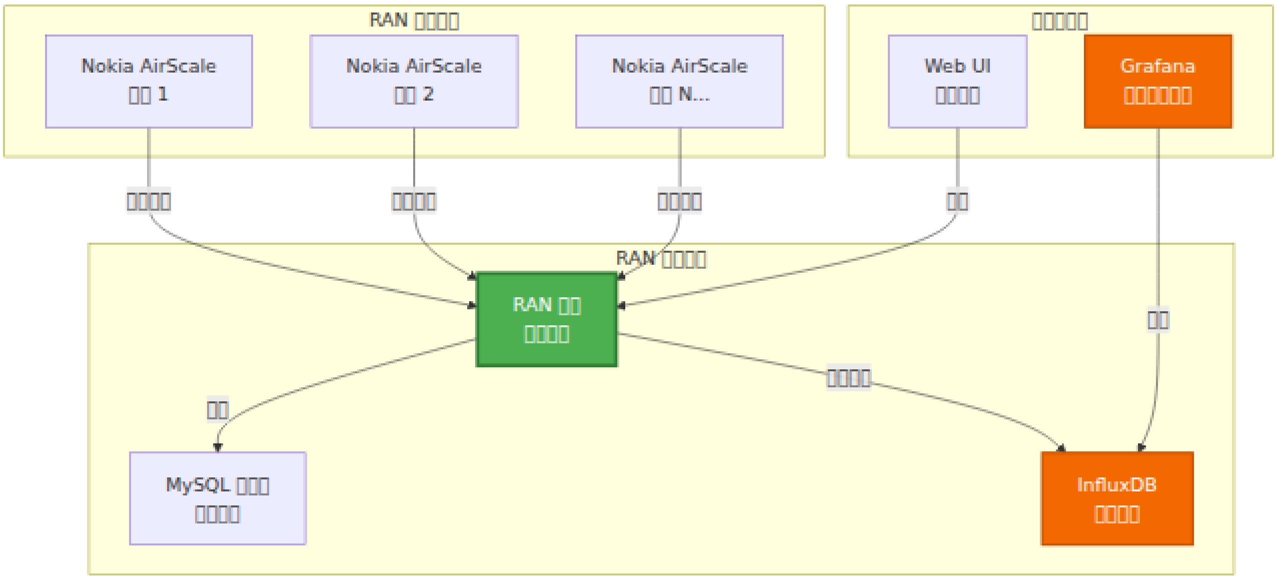
[illegible] Nokia [illegible][illegible]

[illegible]

[illegible]


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

[illegible]


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

[illegible]

□□□□□□ (TCE)

RAN □□□□□□□□□□□□□□□□□□□□□□□ LTE/5G □□□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□ TCE□

□□□□□□□□□□ Nokia AirScale □□□□□□□□□□□

- **S1-AP** □□ - eNodeB □ EPC □□□□□□□□□
- **RRC** □□ - □□□□□□□□
- **NAS** □□ - □□□□□□
- □□□□□□ - PDCP □□□□□□

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- □□□□□□□RSRP□RSRQ□SINR□
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- PCI □□□□
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□□□□□□□□□□□□ Wireshark □□□□□□ **TCE MDT □□□□□□**□

Web UI [illegible]

RAN [illegible] Web UI[illegible]

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

[illegible]

[illegible]

[illegible]

[illegible]

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

[illegible] **5** [illegible]

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

[illegible] [illegible][illegible]

[illegible]

[illegible]

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

[illegible]

[illegible] [illegible]

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

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□□□□ eNodeB

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

[illegible]

[illegible]

[illegible] InfluxDB [illegible]

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

[illegible] [illegible][illegible]

InfluxDB □□

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[illegible] Web UI [illegible]

[illegible] Web UI [illegible]

Web UI [illegible] - [illegible]

[illegible] Grafana [illegible]

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

[illegible] Grafana[illegible]

Grafana [illegible]

- [illegible]/[illegible]/[illegible]
- [illegible] KPI [illegible]
- [illegible]
- [illegible]

- □□□□□□ SLA □□
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Web UI □□□□

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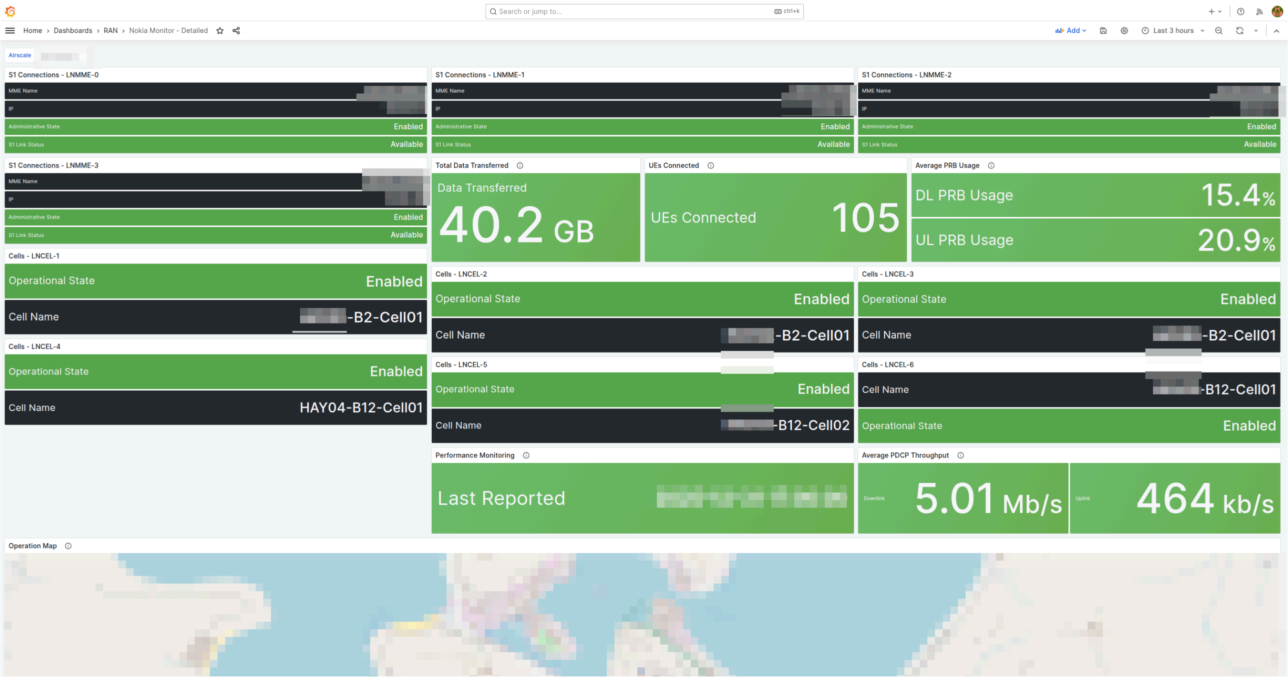

S1 Connections - LNMME-0
MME Name [redacted]
IP [redacted]
Administrative State Enabled
S1 Link Status Available

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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NOC [illegible]

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

[illegible]

- [illegible]
- [illegible]SINR[illegible]RSRP [illegible]
- [illegible]RLC [illegible]RRC [illegible]
- [illegible]
- [illegible]

Nokia AirScale [illegible]

- PRB [illegible]/[illegible]
- [illegible]PDCP [illegible]
- [illegible] UE [illegible]
- [illegible]
- [illegible]
- RSSI [illegible]
- RRC [illegible]
- [illegible] VSWR
- [illegible]

[illegible]

Grafana [illegible] - [illegible]

Nokia [illegible] - [illegible]

[illegible]

[illegible]

[illegible]**5-10** [illegible]

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

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

[illegible]

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

[illegible] [illegible][illegible]

[illegible]

[illegible]

1. [illegible]
2. [illegible] eNodeB [illegible]
3. [illegible] `config/runtime.exs`
4. [illegible] RAN [illegible]
5. [illegible]
6. [illegible] InfluxDB

[illegible]

1. □□□□□□□□□□□□□
2. □ `config/runtime.exs` □□□□□□□□□
3. □□□□□□□□□□□□□□□
4. □□ RAN □□
5. □□ Grafana □□□

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1. □□□□□□□□
2. □ `config/runtime.exs` □□□□□
3. □□ RAN □□
4. □□□□□□□□

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1. [illegible] [illegible] - [illegible]
2. [illegible] [illegible]
3. [illegible] [illegible] → [illegible] ID
4. [illegible] **ID** [illegible] → [illegible]
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6. [illegible] [illegible]
7. [illegible] [illegible] 15-30 [illegible]
8. [illegible] [illegible]1 [illegible]

[illegible] [illegible]

[illegible] [illegible]

[illegible] AirScale [illegible][illegible]

[illegible] [illegible][illegible]

[illegible]

RAN [illegible]

[illegible]NOC[illegible]

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

[illegible]

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

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□□□□ **RAN** □□□

1. □ Web UI □□ □□□□□□
2. □□ □□□□□□ □□□□□□□
3. □□ □□□□□□ □□□□□
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1. □□□ Grafana □□□□ □□□□□□
2. □□ Nokia □□□□□ □□□□□
3. □□ □□□□□□□□ □□□□□□□

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

[illegible]

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

[illegible]

[illegible]

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

[illegible] [illegible][illegible]

[illegible]

[illegible]

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

[illegible]

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

[illegible]

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

[illegible]

[illegible]

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

[illegible]

[illegible]

1. [illegible] → [illegible]
2. [illegible]`ping <device-ip>`
3. [illegible] `config/runtime.exs` [illegible]
4. [illegible]

Grafana [illegible]

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

Web UI [illegible]

1. [illegible] 9443 [illegible]
2. [illegible] HTTPS [illegible]
3. [illegible] SSL [illegible]
4. [illegible] Web UI [illegible]

[illegible] [illegible]

[illegible]

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- [illegible]
- [illegible]
- [illegible]/IP[illegible]
- [illegible]
- RAN [illegible]

[illegible]

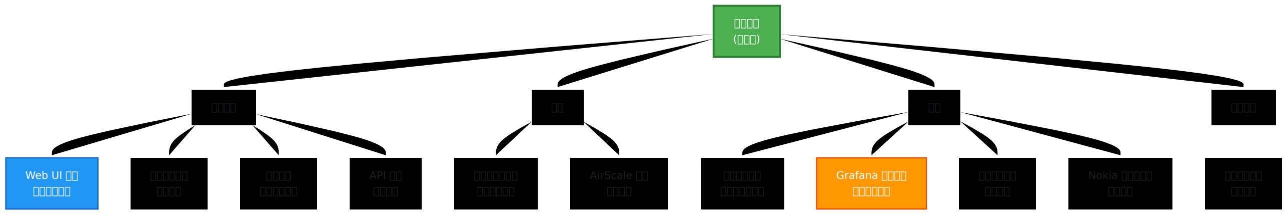
[illegible] RAN [illegible]

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

[illegible]

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

[illegible]



Web UI
API
AirScale
Grafana
Nokia

Nokia AirScale □□□□

□ RAN Monitor □□□□□□

□□

1. □□
2. □□□□
3. □□ WebLM □□
4. □□□□□□
5. □□□□□□
6. □□
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□□□ RAN Monitor □□□ Nokia AirScale □□□□□□□□□□□□□□□□□□□□□□□□□□ RAN Monitor □□□□□□□□□□□ Nokia Web Element Manager (WebLM) □□□□□□

□□□□□□□□□□□□□□□□ (PMCADM) □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

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

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□□□□ Omnitouch □□□□□□□□□ Omnitouch □□□□□□□□□□□□□

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

[illegible]

[illegible]

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

[illegible]

[illegible]	[illegible]	[illegible]
RAN Monitor IP [illegible]	RAN Monitor [illegible] IP	10.179.2.139
RAN Monitor [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** □□

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□□ 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

□□□ □ RAN Monitor □□□□□□□□□□□□□□□□□□□□□□□□□□ `forced` □□□□□□□□□ TLS □□□

□□ 2□□□ PMCADM □□□□

□□□□□□□ (□□□) □□

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

□□□□□□□□ PMCADM-1 □□□□□

□□ 3□□□□□□□□□

□□□□□ **Structure 1** □□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□

[illegible]	[illegible]	[illegible]
TLS [illegible]	[illegible]	RSA ([illegible] TLS)
[illegible]	RAN Monitor [illegible] IP [illegible]	[illegible] RAN Monitor IP ([illegible] 10.179.2.139)
[illegible]	RAN Monitor [illegible]	9076 ([illegible])
[illegible]	[illegible]	60s ([illegible])
[illegible] **TLS**	[illegible]	false ([illegible])

[illegible]

[illegible]	[illegible]	[illegible]
SDL [illegible]	[illegible]	1
SDL Nonce	[illegible]	12345678
[illegible]	[illegible] 0 [illegible]	false ([illegible])

[illegible] 4[illegible]

[illegible]

1. [illegible] - [illegible] IP [illegible]
2. [illegible]
    - [illegible] **Create Plan** [illegible]
    - [illegible]
    - [illegible] ID
3. [illegible]

   - □□ **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 Monitor IP □□
- `rTPmCollEntityPortNum` - □□□ 9076 (□□ webhook □□)
- `rTPmCollInterval` - □□□□ (□□ 60s)

- `tlsEnabled` - □□□□□□□□ false
- `sdlPrimaryDestIp` - □□□□□ RAN Monitor IP □□

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

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LNBTS □□□□□□

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

actL1PM - □□□ 1 □□□□

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

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

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- 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 □□□□

PMCADM (□□□□□□□□) □□□□□□□□□□□□□□□□□□□□□□□□

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- □□□□□□□□□□□

PMCADM □□□□

reportingIntervalPm - PM □□□□

□□	□
□□	reportingIntervalPm
□□	com.nokia.srbts.mnl:PMCADM □□□□
□□	□□
□□	5min, 15min, 30min, 60min
□□	5min □ 15min □□□□□□

□□□ □□

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- **5min** - □□□□□□□□□□□□
- **15min** - □□□□□□□□□□□□□□□□□
- **60min** - □□□□□□□□□

□□ XML □□□

```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. □□□□□□□□□□□□

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certTypeForTlsAuth - TLS □□□□□□□

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

rTpmCollEntityHost - □□□□□□

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

rTpmCollEntityPortNum - □□□□□□□

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

- □□□ 9076
- □□□ □□□ RAN Monitor □□□□

rTpmCollInterval - □□□□

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

tlsEnabled - □□ TLS

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

sdlMaxUploadFileNumber - SDL □□□□□□□□

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

sdlNonce - SDL Nonce

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

suppressZeroValueCount - □□□□□□□

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

- □□□ □□□ false □□□□□□□□□□□□□□□

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□□□□□□□□□□□□□□□ RAN Monitor □□□□□

□□ RAN Monitor Web UI

1. □□ RAN Monitor Web UI: `http://<ran-monitor-ip>:4000/`
2. □□□ **eNodeB Status** □□
3. □□□□□□□□□□□□
4. □□□□□□□ **Connected** (□□□□)
5. □□ **Session** □□□ **Active**

□□□□□

- □□□ Connected (□□)
- □□□ Active
- □□□ □□□ IP □□

- □□□ □□□□□□

□□□□□□□ Pending□

□□□□□□□□□□□□□□□□□□□

□□□□□□

- □□□ ID □□□□□□□□
- RAN Monitor □□□□□□□□□
- □□□□□□

□□□□□□□□□□□

□□□□□□ RAN Monitor□

[illegible]

- PMCADM [illegible] IP [illegible]
- [illegible]
- [illegible] 8080
- RAN Monitor [illegible]

[illegible]

[illegible] **InfluxDB** [illegible]

1. [illegible] RAN Monitor Web UI [illegible] **InfluxDB Status**
2. [illegible]
3. [illegible] **Performance Metrics** [illegible]
4. [illegible] **Last Update** [illegible]

[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]

□□□□

□□□□□□ RAN Monitor □

□□□ □□□□□□ eNodeB □□□□

□□□□□

1. □□□□□□□

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

2. □□ **RAN Monitor** □□□

   - □□□□□□□□ `config/runtime.exs`
   - □□ IP □□□□□□□
   - □□□□□□

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

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

4. [illegible]

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

[illegible]“Pending”[illegible]

[illegible] [illegible]“Pending”

[illegible]

1. [illegible]

   - [illegible] RAN Monitor [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 Monitor □□□
   - □□□□□
   - □□ VLAN/subnet □□□□□□
2. □□□□□□□□
   - □□□□ 9076 □□□□ (□□□□□□□□)
   - □□□□ 8080 □□□□ (□□ SOAP API □□)
   - □□□□ ACL □□□□
   - □□ RAN Monitor □□□□□ iptables □□
3. □□ **RAN Monitor** □□□□□□

   ```
   # □□ 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. □□□□□□

   - □□□□□□□□□ (□□□ 60 □)
   - □□ InfluxDB □□ M8005C306-309 □□□
   - RTWP □□□□□□□□

□□□□□

- `actPCMDReport` - □□□□□□□ (□□□□□□□)

InfluxDB □□□□□

□□□ □□□□□□□□□□□□□□□

□□□□□

1. □□□□□□□

   - □□ PMCADM-1 rTpmCollInterval □□
   - □□□□□□□□□□□□□
   - □□ InfluxDB □□□□

2. □□ **InfluxDB □□□**

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

3. □□ **RAN Monitor □□□**

   - □□ InfluxDB □□□□
   - □□□□□□□□
   - □□ API □□□□□□□□

TLS/□□□□

□□□ □□ TLS □□□□□

[illegible]

1. [illegible]
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   - [illegible] RAN Monitor [illegible] CA [illegible]
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   - [illegible] TLS
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- [illegible] - [illegible] RAN Monitor [illegible]
- [illegible] - RAN Monitor [illegible]
- Nokia Counter Reference - [illegible]
- Grafana [illegible] - [illegible]
- API [illegible] - [illegible] REST API [illegible]
- [illegible] - [illegible]

[illegible]

- **config/runtime.exs** - RAN Monitor [illegible]

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[illegible]

1. [illegible] RAN Monitor [illegible]
2. [illegible] Nokia [illegible]
3. [illegible]
4. [illegible]

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6. [illegible]
7. [illegible]
8. [illegible]

[illegible]

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

[illegible]

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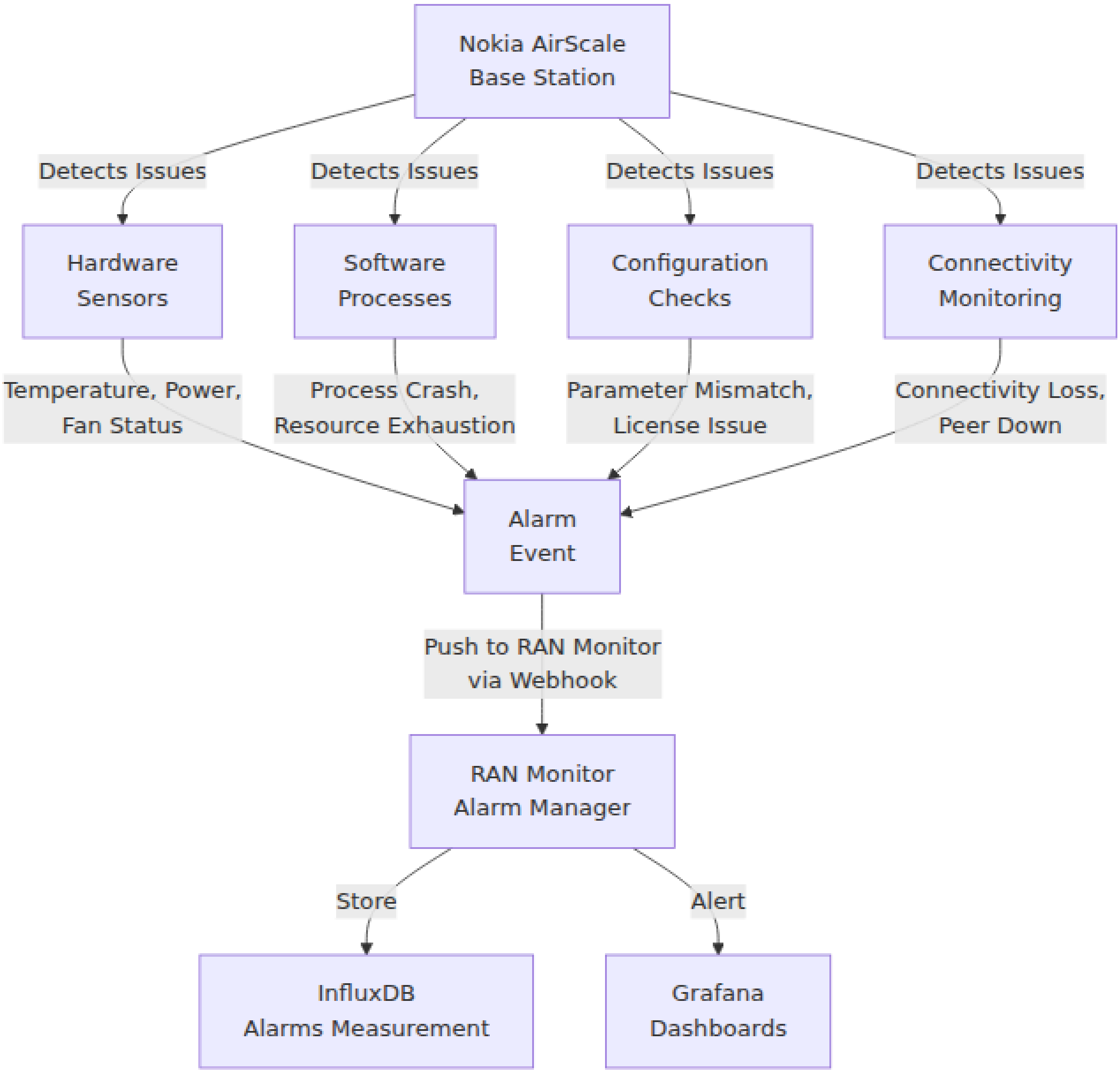
Nokia AirScale
Base Station
Detects Issues
Detects Issues
Detects Issues
Detects Issues
Hardware
Sensors
Software
Processes
Configuration
Checks
Connectivity
Monitoring
Temperature, Power,
Fan Status
Process Crash,
Resource Exhaustion
Parameter Mismatch,
License Issue
Connectivity Loss,
Peer Down
Alarm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

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[illegible]	[illegible]	[illegible]
[illegible] **ID**	a1b2c3d4-e5f6-...	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	"[illegible]"	[illegible]
[illegible]	"S1 [illegible]"	[illegible]
[illegible]	/BSC-1/BTS-23/Cell-A	[illegible]DN[illegible]
[illegible]	2025-12-10 14:23:45	[illegible]
[illegible]	[illegible] / [illegible]	[illegible]

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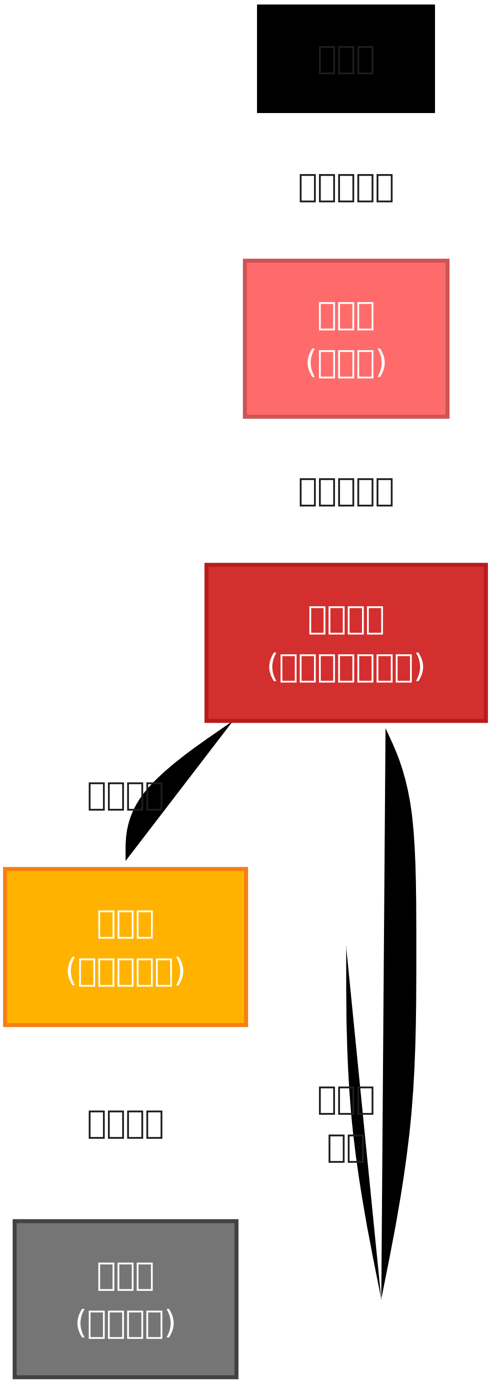

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14:23:45 UTC - [illegible]
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            └─> [illegible]“S1 [illegible]”[illegible]

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]
            └─> [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]

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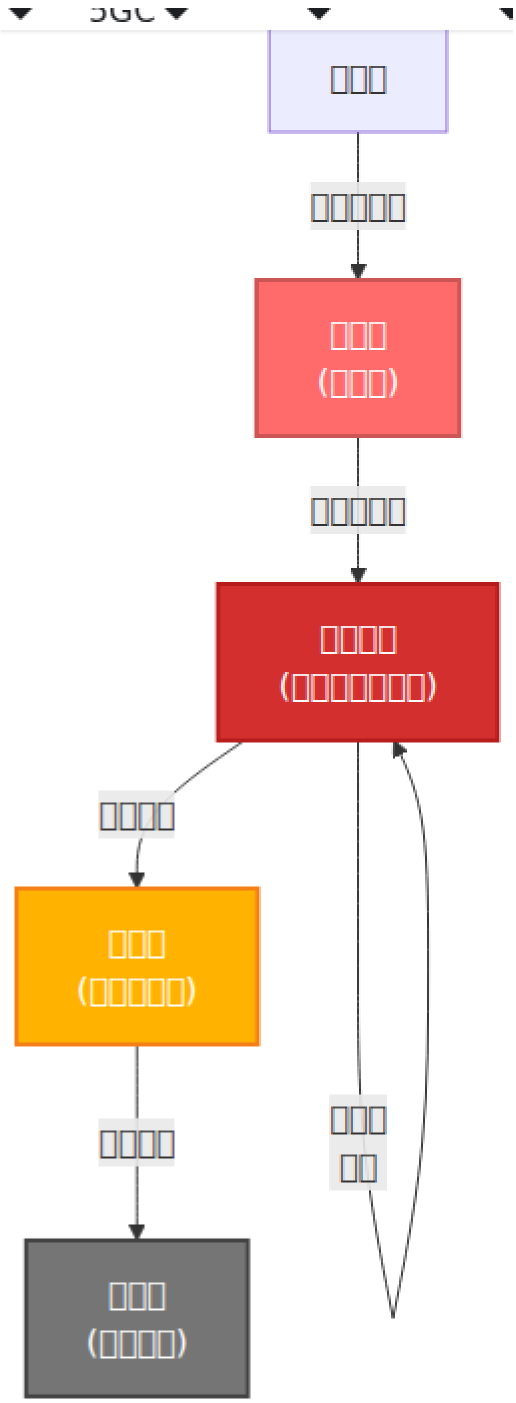
[illegible] [illegible]



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- [illegible]S1 [illegible]
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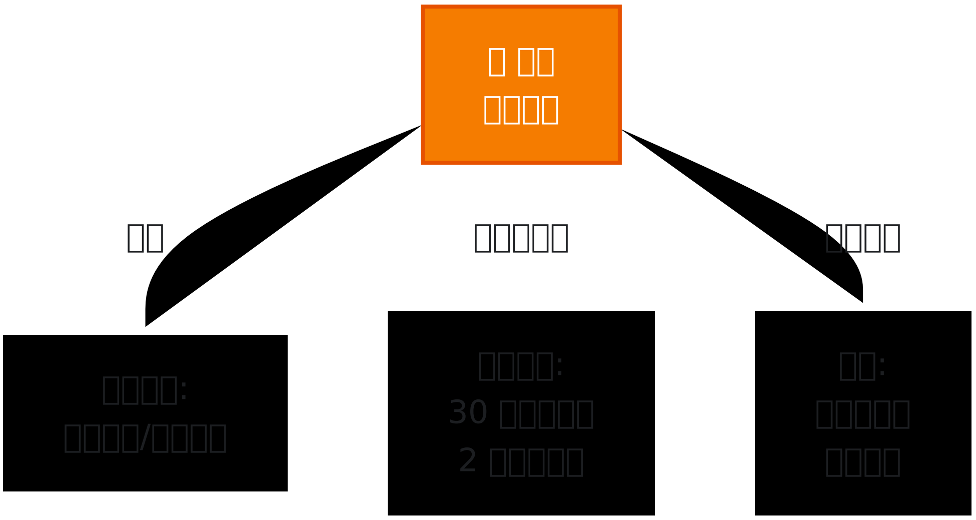
- [illegible] SLA [illegible]

[illegible] **SLA**[illegible] < 15 [illegible]

[illegible]

[illegible] [illegible]



[illegible]

- [illegible] < 95% [illegible] 15 [illegible]
- [illegible] < 95%
- DL/UL [illegible]> 95% [illegible]
- RLC [illegible] > 5%
- [illegible]
- [illegible]E1/T1 [illegible]

[illegible]

- [illegible] NOC [illegible] + [illegible]
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- [illegible] 30 [illegible]
- [illegible]/[illegible]

[illegible] **SLA**[illegible] < 30 [illegible]

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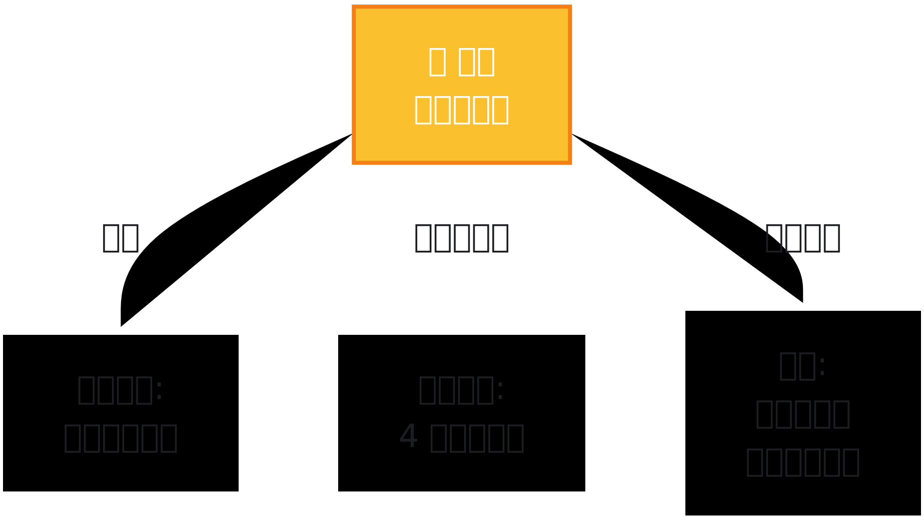

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- [illegible]
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- [illegible]< 5 [illegible]/[illegible]

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[illegible] **SLA**[illegible]

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- □□ SLA □□□□
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[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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  - [illegible]        → UPS/PSU [illegible]
  - [illegible]        → [illegible]
  - [illegible]    → [illegible]
  - [illegible]        → [illegible]

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  4. [illegible] CPU [illegible]
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  - □ CPU □□□      → □□□□
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  3. [illegible]
  4. [illegible]
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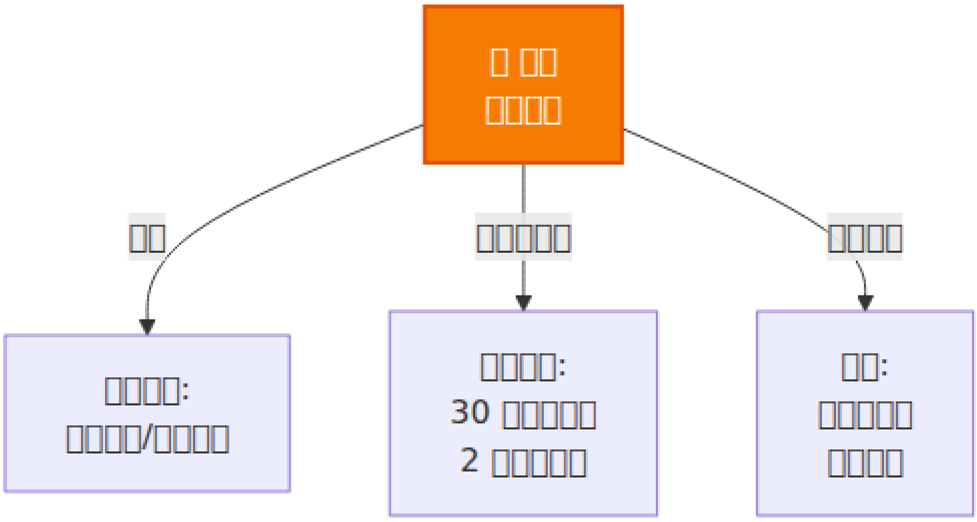

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- Grafana → [illegible]
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- InfluxDB [illegible]

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- RAN Monitor → [illegible]
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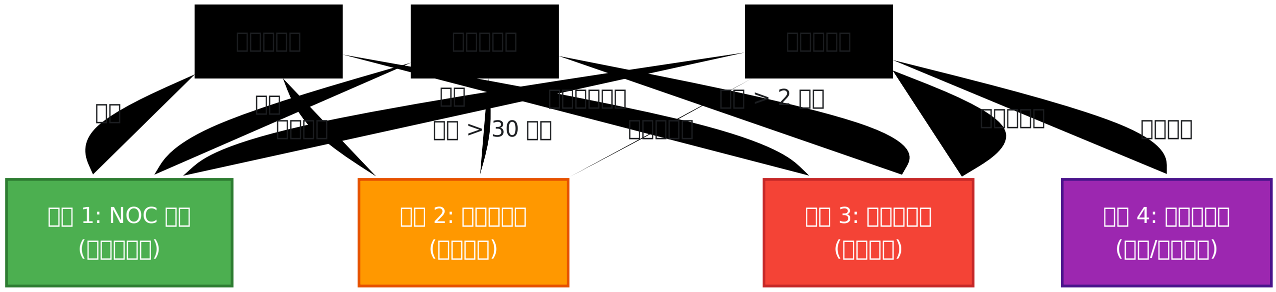

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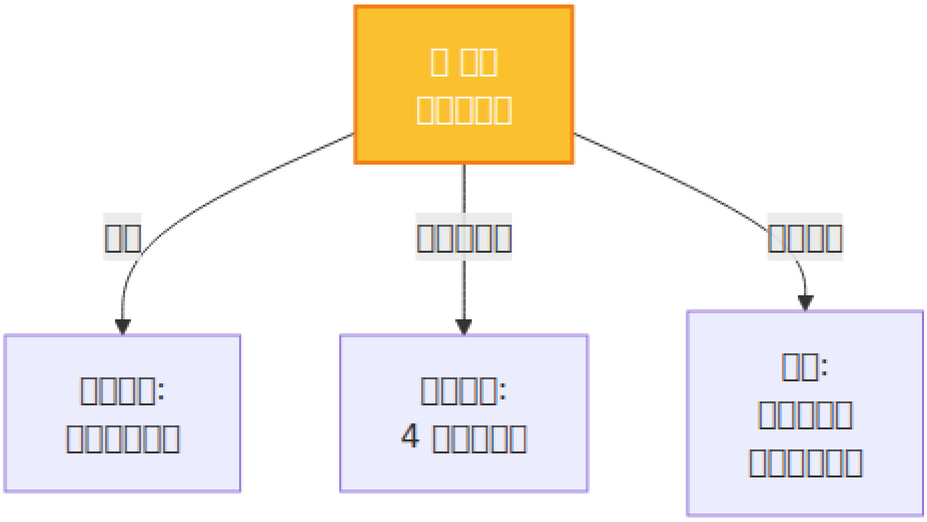

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- □□ > 15 □□ → □□□ [□□□□□]
- □□ > 30 □□ → □□□ [□□□□□]
- □□□□□□ → □□□□□□□

□□□
- □□□□□□□□
```

- [illegible]
- [illegible]

API [illegible]

[illegible] RAN [illegible] REST API

[illegible] API [illegible] RAN [illegible]

[illegible]

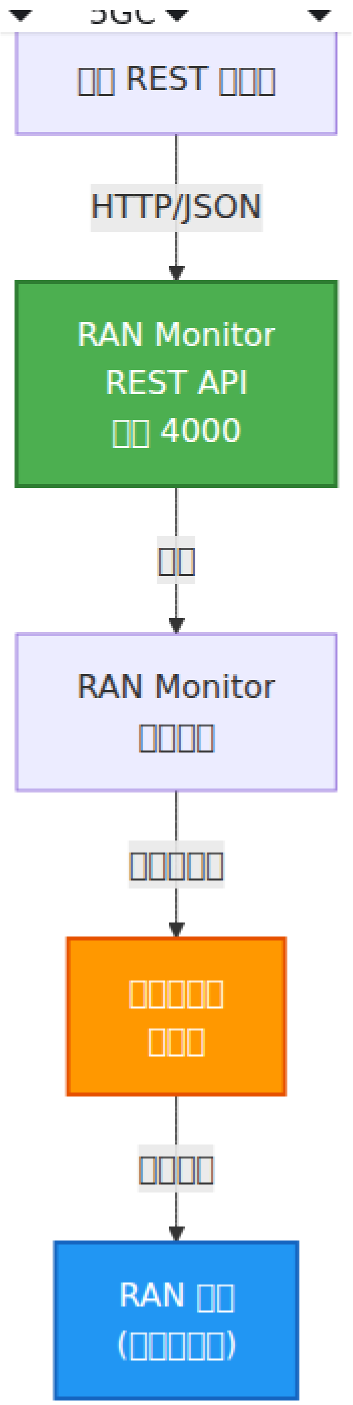
1. [illegible]
2. API [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. API [illegible]

[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
□□ 4000
□□
RAN Monitor
□□□□
□□□□□
□□□□□
□□□
□□□□
RAN □□
(□□□□□)

API □□

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

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□□□□□□□□□□□□□□□ RAN Monitor □□□□□□□□□ RAN Monitor □□□□□□□□□□□□□□□□□□□□□□□□□□

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1. □□□□□□□□/□□□ API □□□□□□□□
2. □□□□□□□□□□□□□□
3. □□□□□□□□□□□□
4. □□□□□□□□

API □□□□

□□□RAN Monitor API □□□□□□□□□□□□□□□□□□□□□

- □□□□□□□
  - □□□□ API □□□`Authorization: Bearer <api-key>`
  - OAuth2 □□□□□□□□
  - □□□□□□□□□□□□□/VPN□
- □□□□□
  - □□□□□□□□□□□□□
  - □□□□□□□□□□□
- □□□□□
  - □□ API □□□□□□□□□□□□/□□□□□
  - □□□□□□□□□□□□□

API [illegible]

REST API [illegible]

RAN Monitor API [illegible]

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

[illegible] URL

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

[illegible]

[illegible]

[illegible]

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

[illegible]

```
{
  "devices": [
    {
      "id": "nokia_bs1",
      "name": "SITE_A_BS1",
      "vendor": "Nokia",
      "address": "192.168.1.100",
      "port": 8080,
      "status": "registered",
      "registered_at": "2025-12-10T14:30:00Z",
      "session_active": true,
      "software_version": "BSC-2250.5.0",
      "license_required": false
    }
  ]
}
```

[illegible]

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

[illegible]

```
{
  "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"
}
```

□□□

```
{
  "result": "Success",
  "registration_key": "base64_encoded_nonce",
  "device_id": "nokia_bs1",
  "message": "□□□□□□"
}
```

□□□□

- `200` - □□□□
- `400` - □□□□□□□□□
- `409` - □□□□□
- `500` - □□□□

□□□□

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

□□□

```
{
  "result": "Success",
  "message": "□□□□□",
  "device_id": "nokia_bs1"
}
```

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

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

□□□

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

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- □□□□□□□□□
- □ 20 □□□□□□

□□□□□□

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

□□□

```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": ""
  }
}
```

[illegible]

```
{
  "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
        }
      }
    }
  }
}
```

□□□□

□□□

```
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
}
```

□□□

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

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□□	□□	□□	□□	□□
airscale_name	□□□	□	-	□□□□□□
config_file	□□□	□	-	□□□□ XML □□□□□□□
take_fallback	□□	□	true	□□□□□□□□□□□□□□
block_local_changes	□□	□	false	□□□□□□□□□□□

□□□

- `INVALID_FILE` - config_file □□□□□□□□□□
- `TRANSPORT_ERROR` - □□□□□□□□□□
- `SESSION_ERROR` - □□□□ NE3S □□
- □□□ SOAP □□□□□□□□□□□□□□□

□□□□□□

```
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]

```
{
  "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]

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

[illegible]

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

[illegible]

```json
{
  "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": "□□□□□□"
    }
  ]
}
```

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□□□□□□

□□□□□□□□□□

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

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

□□□

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

□□□□□□

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

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

□□□

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

□□□□□□

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

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

□□□

```
{
  "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
          }
        ]
      }
    ]
  }
}
```

□□□□

Ping □□

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

□□□

```
{
  "result": "Success",
  "device_id": "nokia_bs1",
  "latency_ms": 45,
  "status": "□□"
}
```

□□□□□□

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

□□□

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

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□□□□□□

Nokia eNodeB □□□□□□□□□□

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

□□□□□□

□□/□□□□

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

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

□□□□□□

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

□□□0-46 dBm□□□□□□

□□□□□□

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

□□□dB□□□□□□0-8 dB

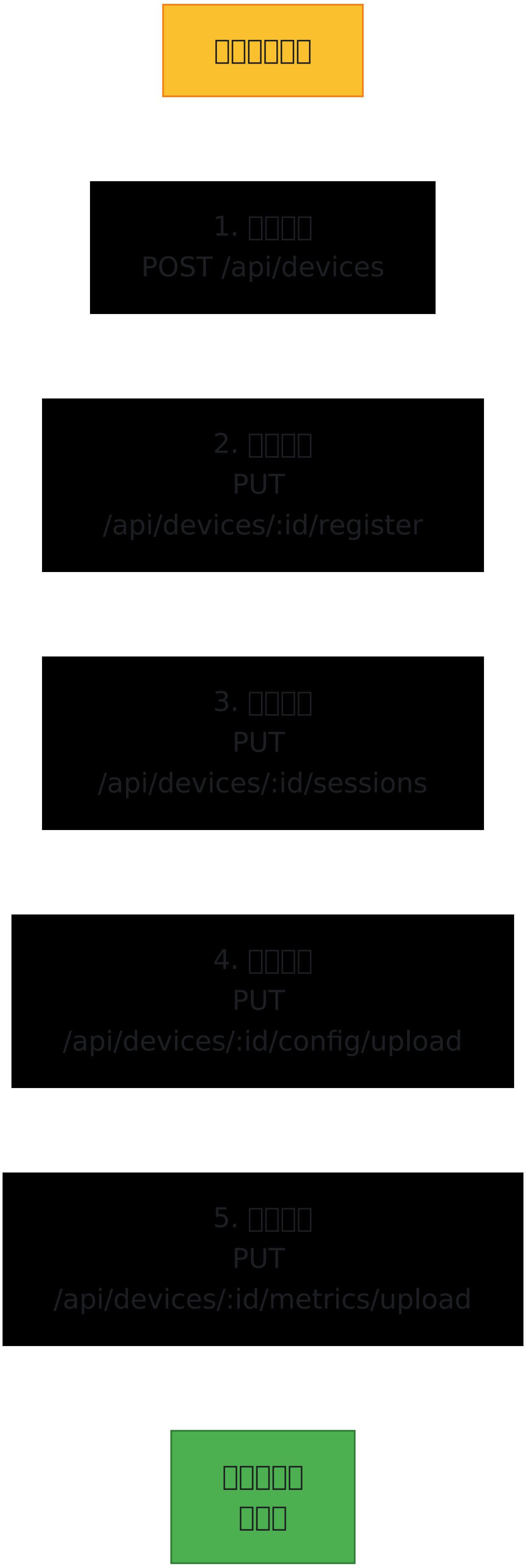
□□□□□□□□□

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

□□□□□□□

□□□□□

□□□ 1□□□□□


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

[illegible]

```
# 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]

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

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

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

□□□□□□□

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

API □□

Python □□□□□

```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 '.'
```

[illegible]

AirScale [illegible]

[illegible]

[illegible] AirScale [illegible] InfluxDB [illegible] XML [illegible]

[illegible]

- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible] 100 MB[illegible] ~690 [illegible]
- **Web** [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] **InfluxDB** [illegible] - [illegible]
- [illegible] - [illegible]

[illegible]

[illegible]

[illegible] AirScale [illegible]

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

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□□□□□ RAN Monitor □□□□□□□□□

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

□□□□□□ `<AirScaleName>_config_YYYYMMDD_HHMMSS.xml`

□□□□□ AirScale □□□□□□□□□□□□□□□□□□□□□

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

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1. □□□□□ - □□□□ `<AirScale>_config_YYYYMMDD_HHMMSS.xml`
2. □□□□ - `current.xml` □□□□□□□
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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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```
# □□□□□□□
du -sh priv/airscale_configs/
# □□□215M□3 □□□□□ 70 MB□

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

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

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Web UI□ □□□ Nokia → □□□□

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

[illegible]

[illegible]

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1. [illegible]

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

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

[illegible]

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

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[illegible] [illegible]

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

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```
# □□□□□□
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

# □□ diff □□□□
diff ONS-Lab-Airscale_config_20251229_120000.xml ONS-Lab-Airscale_config_20251230_143522.xml

# □□□ xmldiff □□□□□□□□□
xmldiff ONS-Lab-Airscale_config_20251229_120000.xml ONS-Lab-Airscale_config_20251230_143522.xml
```

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```
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- 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 □□

□□□
- □□□ 142KB □□□ 143KB □ 12 □ 30 □
- □□ 12 □ 28 □□ 12 □ 30 □□□□□□□□□
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```

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```xml
<!-- □□□□□□□ -->

<!-- □□ 1□□□□□□□ -->
<parameter>
    <name>cellId</name>
    <value>1</value>
</parameter>

<!-- □□ 2□□□□ -->
<parameter><name>cellId</name><value>1</value></parameter>
```

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□□□□□□□ ~145 KB □□□□□□□□□ AirScale □□□

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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

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- □□□□□□□□□ □□□□□□ current.xml □ 145KB□
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□□□□□ ConfigStorage □□□□□□

```
# □ lib/ran_monitor/nokia/airscale/config_storage.ex □
# □□□□□□□□□
@max_storage_bytes 100 * 1024 * 1024  # □□ 100 MB

# □□□□□□□□□
@max_storage_bytes 50 * 1024 * 1024   # 50 MB□□□ ~345 □□□□
@max_storage_bytes 200 * 1024 * 1024  # 200 MB□□□ ~1380 □□□□

# □□□□□□□□□□
def cleanup_old_versions(airscale_name, max_size_bytes \
@max_storage_bytes)
```

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```
mix compile
# □□ RAN Monitor □□□□□
```

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□□□□□ 1 □□□3,600,000 □□□

□□□□□□□□

□□ `lib/ran_monitor/nokia/airscale/manager.ex`□

```
defp schedule_get_airscale_config do
  # □ 1 □□□□□□□3,600,000 ms□
  Process.send_after(self(), :get_airscale_config, 3_600_000)
end
```

□□□□□

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

□□□□□□□□□□□ RAN Monitor□

□□□□

□□□□□□□□

□□□

- □□□□□□□□“0 □□□”
- □□□□□□□□

□□□□□

1. □□□□□

    - □□□□□□
    - □□□□□□“□□□”□□
    - □□□□□□□□□□□□□

2. □□□□□

    - □□□□□□□□
    - □□□□□□□“□□”
    - □□□□□□□

3. □□□□□□

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

4. □□□□□□

    - □□ `priv/airscale_configs/` □□□□□□
    - □□ RAN Monitor □□□□□□□
    - □□□□□□□□□□□□□□□

□□□□ 404 □□

□□□

- □□□□□□“□□□□□□□”
- □□□□□ 404 □□

□□□□□

1. □□□□□□□

    - □□□□□□□□□□□□□□□□□□□
    - □□ `priv/airscale_configs/` □□□□□□□□

2. □□□□□

   - [illegible]
   - [illegible]

3. [illegible]

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

[illegible]

```
# [illegible]
ls -la priv/airscale_configs/

# [illegible]
ls -la priv/airscale_configs/<device-name>/

# [illegible]
chmod 755 priv/airscale_configs/
chmod 644 priv/airscale_configs/*/*.xml
```

[illegible]

[illegible]

- [illegible] `current.xml` [illegible]
- [illegible] 1

[illegible]

1. [illegible]

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

2. [illegible]

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

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

[illegible]

```
# [illegible]
grep "process_configuration" <log-file>

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

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

```
#!/bin/bash
# backup-configs.sh - [illegible]

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

# [illegible]
mkdir -p "$BACKUP_DIR/$DATE"

# [illegible]
rsync -av "$CONFIG_DIR/" "$BACKUP_DIR/$DATE/"

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

echo "[illegible]$BACKUP_DIR/$DATE"
```

[illegible] cron [illegible]

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

[illegible]

[illegible] [illegible]

[illegible]

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

[illegible]

```
# 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
□□□□□□□□□
```

□□□□

□□□ □□□□□□□□□□

□□□□□□□□□

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

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

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

□□□□□

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

[illegible]

[illegible]

[illegible]

[illegible]

- [illegible] `current.xml`
- [illegible]“[illegible]”[illegible]

[illegible]

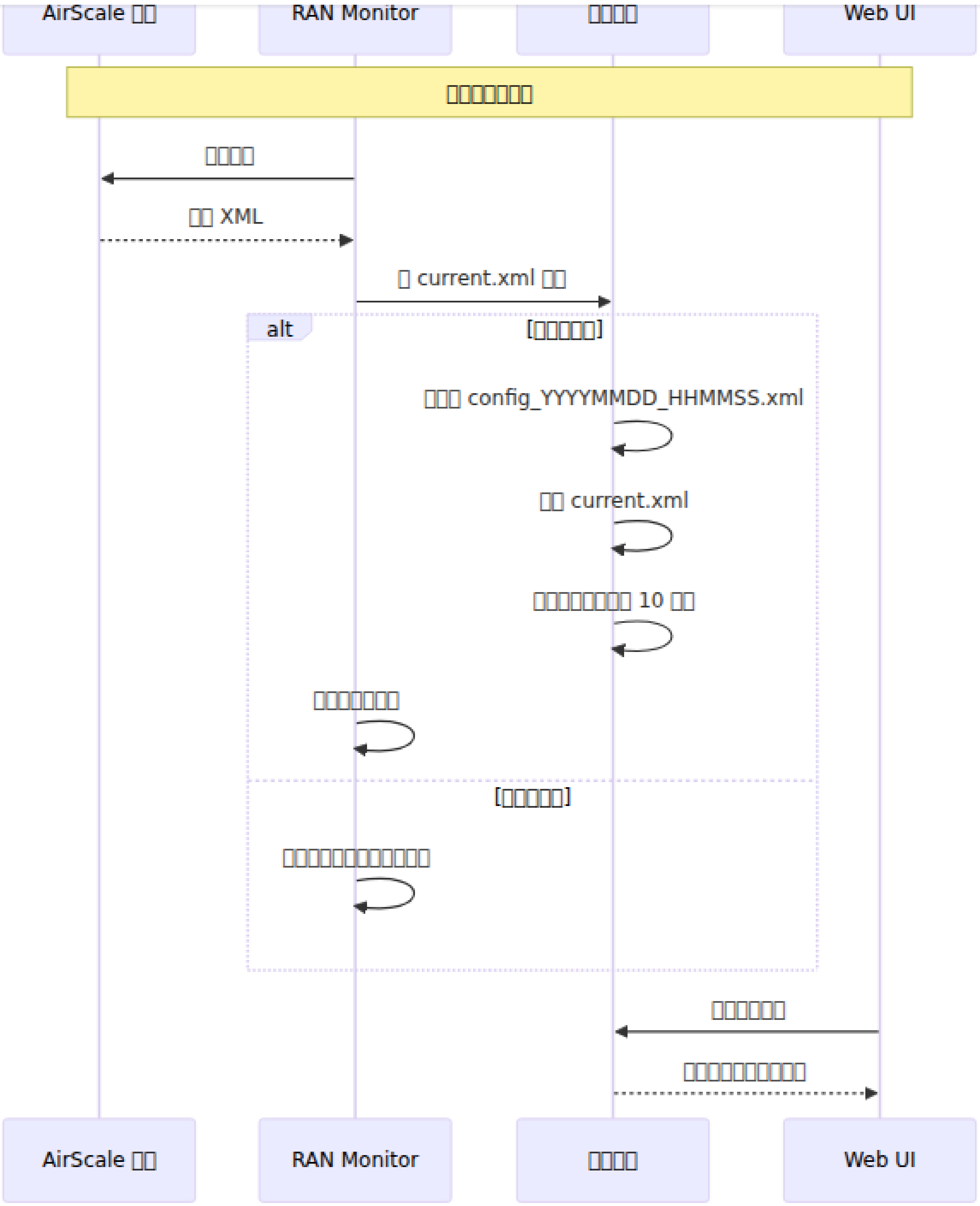
- [illegible]
- [illegible] → [illegible] → [illegible]
- [illegible]

[illegible]

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

[illegible]

5GC


AirScale [illegible]
RAN Monitor
[illegible]
Web UI
[illegible]
[illegible]
[illegible] XML
[illegible] current.xml [illegible]
alt
[[illegible]]
[illegible] config_YYYYMMDD_HHMMSS.xml
[illegible] current.xml
[illegible] 10 [illegible]
[illegible]
[[illegible]]
[illegible]
[illegible]
[illegible]
AirScale [illegible]
RAN Monitor
[illegible]
Web UI

API [illegible]

[illegible] Web UI [illegible] HTTP [illegible]

[illegible]

[illegible]

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

[illegible]

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

[illegible] URL [illegible] AirScale [illegible]

[illegible]

[illegible] IEx [illegible]

```
# □□□□□□□□□
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]

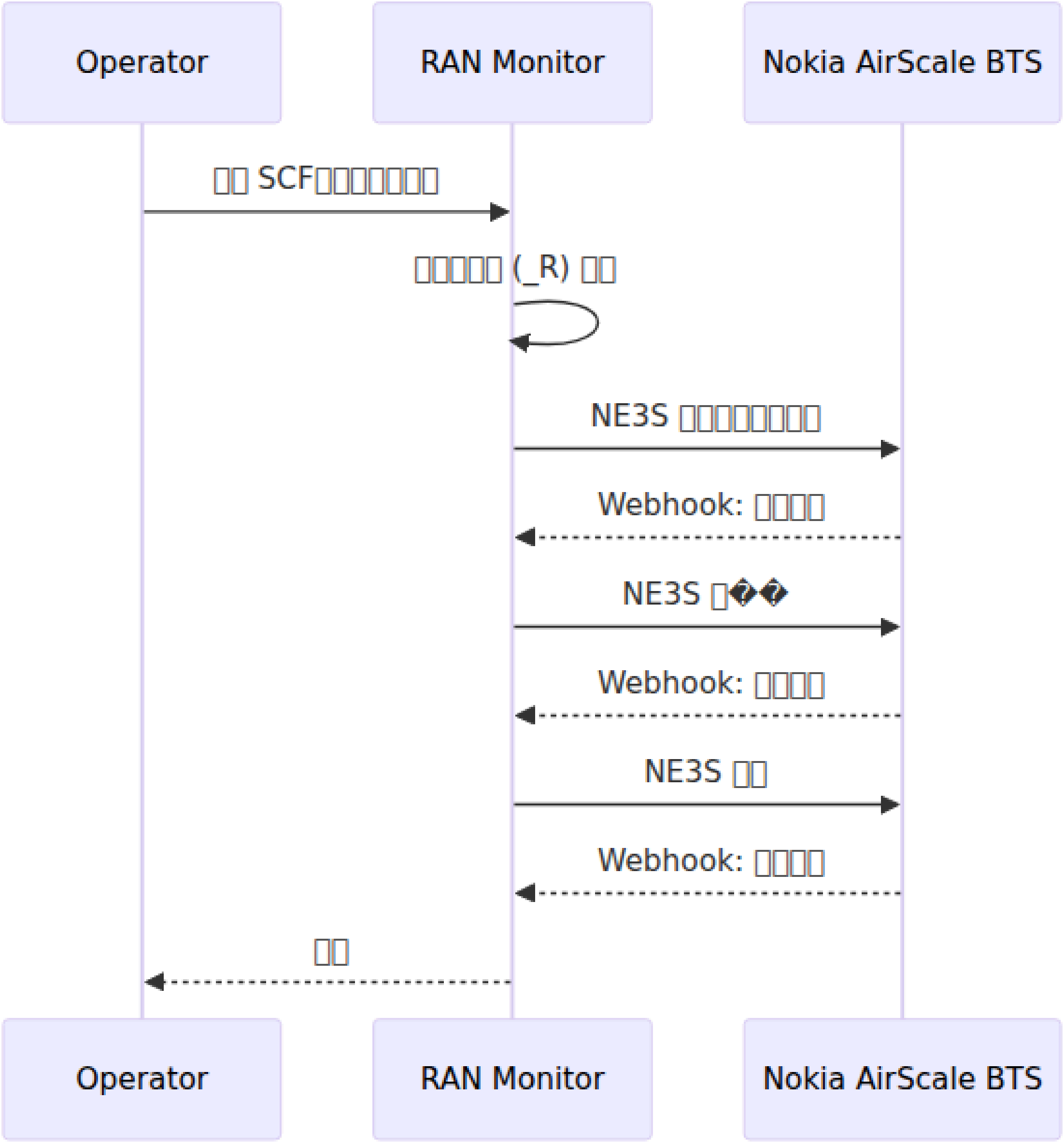
[illegible]

[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] [illegible]RAN Monitor [illegible]

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

<!-- □□□□□□□ -->

</cmData>
</raml>
```

□□□□□□□□□□ `<managedObject>` □□□

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

□□□□

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

□□□□□□

`distName` □□□□□□□

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

□□ SCF □□□□□□□

□□ SCF □□

□□ SCF □□ BTS □□□□□□□□□□□□ 100-200 □□□□□□□□□□□□□□ `operation="create"`□□□□□□□□□□

□□□□□ □□□□□□□□□□□□□□□□□□□□□□□

□□□ □□□□ SCF □□□□□□/IP □□□□□□□ BTS □□□□□□□□ 3-5 □□□

□□□□

□□ SCF □□□□□□□□□□□□□□□□□□ `operation="update"`□□□□□□□□□□ `<p>` □□□

□□□□□ □□□□□□□□□□□□□□□□□PM □□□

□□□ □□□□□□□□□□□□□□□□□□□

□□□□

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

□□□□□□□□□□□

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

[illegible]

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

□□□□□□

□□□□□□□□□

```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

□□□□□□□□□□□□□□

```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 □□□

□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□

```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 □□□□

□□□□□□□□□□□□□□□□

```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>
```

[illegible] Web UI [illegible]

1. [illegible] **eNodeB** [illegible]
2. [illegible] [illegible]
3. [illegible] SCF XML [illegible]
4. [illegible] [illegible]
5. RAN Monitor [illegible]
6. [illegible]

[illegible] [illegible]/[illegible]/[illegible] [illegible]

[illegible] API [illegible]

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

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

`config_file` [illegible] RAN Monitor [illegible]

[illegible]

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

[illegible]

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

API [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`airscale_name`	[illegible]	[illegible]	-	RAN Monitor [illegible]
`config_file`	[illegible]	[illegible]	-	RAN Monitor [illegible] SCF XML [illegible]

[illegible]

1. [illegible] Web UI [illegible]“[illegible]”[illegible] API [illegible]

2. [illegible]

3. [illegible] **`operation="update"`**[illegible] `operation="create"` [illegible] SCF [illegible]

4. [illegible] [illegible] SCF [illegible]BTS [illegible]

5. [illegible] `distName` [illegible] **BTS** [illegible] MRBTS ID[illegible]LNBTS ID [illegible] ID [illegible] `distName`[illegible]BTS [illegible]

6. [illegible] [illegible]EARFCN[illegible]PCI[illegible]

[illegible]

[illegible]

[illegible] `Duplicated object MRBTS-256/EQM_R-1`

[illegible]SCF [illegible]`_R`[illegible] BTS [illegible]

[illegible]RAN Monitor [illegible] `_R` [illegible] RAN Monitor [illegible] BTS[illegible]

[illegible]

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

[illegible]BTS [illegible]

[illegible]RAN Monitor [illegible]NetAct[illegible]WebLM[illegible] BTS [illegible]

BTS [illegible]

[illegible] BTS [illegible]ping [illegible] 3-5 [illegible]

[illegible]/IP[illegible]

[illegible]BTS [illegible] 3-5 [illegible]

[illegible]

[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]

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□□□□□□□□□□□ eNodeB □□□□□□□□□□

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- □□□□□□□: 720 □□□30 □□
- □□□: □ `config/config.exs` □□□
- □□: □□□□□□□□□□□□□□ eNodeB

□□ **eNodeB** □□□

- □□□□: □□□ eNodeB □□□□□□□
- □□□□□: □□□□ `airscales` □□
- □□: □□□□

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- □□: □□□□□□□
- □□□□□: `RanMonitor.Data.RetentionCleanupWorker`
- □□ **eNodeB**: □□□□□□□□□
- □□: □□□□□□□□□□□□□□□□

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- □□□: □□□□ eNodeB □□□□
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[illegible]

[illegible]

[illegible] eNodeB [illegible]

[illegible]

```
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│  │                                                        │ │
│  │ □□□□: 30 □  | □□□: 1.2M                       │ │
│  │ □□□□: ✓ □□□□□□□□□□                     │ │
│  └────────────────────────────────────────────────────────┘ │
│                                                              │
│  ┌────────────────────────────────────────────────────────┐ │
│  │ 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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⚙ □□

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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 □□	1	0.04	□□□□□
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
```

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- □□□□□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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- □□□□□ InfluxDB □□□□□□
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```
alias RanMonitor.Data.RetentionPolicy
alias RanMonitor.Database.Nokia

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

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

# □□□□□
total = RetentionPolicy.get_total_record_count("SITE-01")
# => 270000

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

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

□□□□□

□□ `lib/ran_monitor/data/retention_cleanup_worker.ex`:

```
# □ 1 □□□3600000ms□□□□ 30 □□□1800000ms□
@cleanup_interval_ms 1800000  # 30 □□
```

□□□□□□□

```
mix compile
```

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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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[illegible]7-30 [illegible]

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

[illegible]> 30 [illegible]

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

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	7-14 [illegible]	[illegible]
[illegible]	30-60 [illegible]	[illegible]
[illegible]	90 [illegible]	[illegible]
[illegible]	180-365 [illegible]	[illegible]
[illegible]	[illegible]	[illegible]/[illegible]

[illegible]

[illegible]

- 1000 [illegible] ≈ 1-5 KB[illegible]
- 100 [illegible] ≈ 1-5 GB
- [illegible] × [illegible] = [illegible]

[illegible]

```
# □□ 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. □□ `RetentionCleanupWorker` □□□□□□
   - □□□□□□ `[RetentionCleanupWorker] □□`
3. □□ InfluxDB □□□
   - □□ InfluxDB □□□□□`https://localhost:9443/nokia/influx`
4. □□□□□□□□□□□□
   - □□ `config/config.exs` □□ `data_retention_hours`

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   - □□“□□”□□□
3. □□□□□□□□□□□
   - □□ `[RetentionPolicy]` □□□□
4. □□ eNodeB □□□□□□
   - □□ eNodeB □□□□

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- [illegible]

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1. [illegible]
2. [illegible] 5-10 [illegible]
3. [illegible]
   - [illegible] `@cleanup_interval_ms`[illegible] 1 [illegible]
4. [illegible] eNodeB [illegible]

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- [illegible] InfluxDB UI [illegible]
- “[illegible]”[illegible]

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1. [illegible]“[illegible]”[illegible]
2. [illegible] InfluxDB [illegible]
   - [illegible]
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   - InfluxDB [illegible]
4. [illegible] eNodeB [illegible]
   - [illegible]

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

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

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[illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

- [illegible]< 100k[illegible]< 1 [illegible]
- [illegible]100k-1M[illegible]1-10 [illegible]
- [illegible]> 1M[illegible]10-60+ [illegible]

[illegible]

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

[illegible] **InfluxDB** [illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

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`lib/ran_monitor/database/nokia/airscale.ex`	□□ `retention_hours` □□
`lib/ran_monitor/config/config.ex`	□□ `data_retention_hours()` □□□
`config/config.exs`	□□□□□□□□□□□□□
`lib/ran_monitor/application.ex`	□□□□□□□□□□□□

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`lib/ran_monitor/data/retention_policy.ex`
`lib/ran_monitor/data/retention_cleanup_worker.ex`
`lib/ran_monitor/web/live/retention_policy_live.ex`
`priv/repo/migrations/20251211065257_add_retention_hours_to_airscales.`

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RetentionPolicy □□□

- `get_retention_hours(airscale)` - □□□□□□
- `get_record_counts(airscale_name)` - □□□□□□

- `get_total_record_count(airscale_name)` - □□
- `delete_old_records(name, hours)` - □□□□□
- `clear_all_records(name)` - □□□□

RetentionCleanupWorker GenServer□

- `start_link(opts)` - □□□□□□□
- `init(:ok)` - □□□□□□
- `handle_info(:cleanup, state)` - □□□□□□

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1. □□□□□

   ```
   mix ecto.migrate
   ```

2. □□□□□□□

   ```
   mix phx.server
   ```

3. □□□□□
   - □□□ `https://localhost:9443/nokia/retention`
   - □□□□□□□□□□□

[illegible]

1. [illegible]

   - [illegible]720 [illegible]
   - [illegible] eNodeB [illegible]

2. [illegible]

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

3. [illegible]

   - [illegible] `[RetentionCleanupWorker]` [illegible]
   - [illegible]

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

Nokia AirScale DHCP [illegible]

[illegible] **DHCP**

[illegible]

1. [illegible]
2. [illegible]
3. [illegible]
4. DHCP [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible] 43 [illegible]

[illegible]

Nokia AirScale [illegible] DHCP [illegible] RAN Monitor[illegible] DHCP [illegible]DHCP [illegible] IP [illegible] **DHCP** [illegible] **43**[illegible] RAN Monitor [illegible]

[illegible] DHCP [illegible] DHCP [illegible] RAN Monitor IP [illegible] NE3S [illegible]

[illegible]

[illegible] Nokia AirScale [illegible] Omnitouch [illegible]�������[illegible]

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

- □□□□ DHCP □□□□□□□□□

□□□□ Omnitouch □□□□□□□□□ Omnitouch □□□□□□□□□□ DHCP □□□

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□□□ DHCP □□□□□□□□□□□□

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

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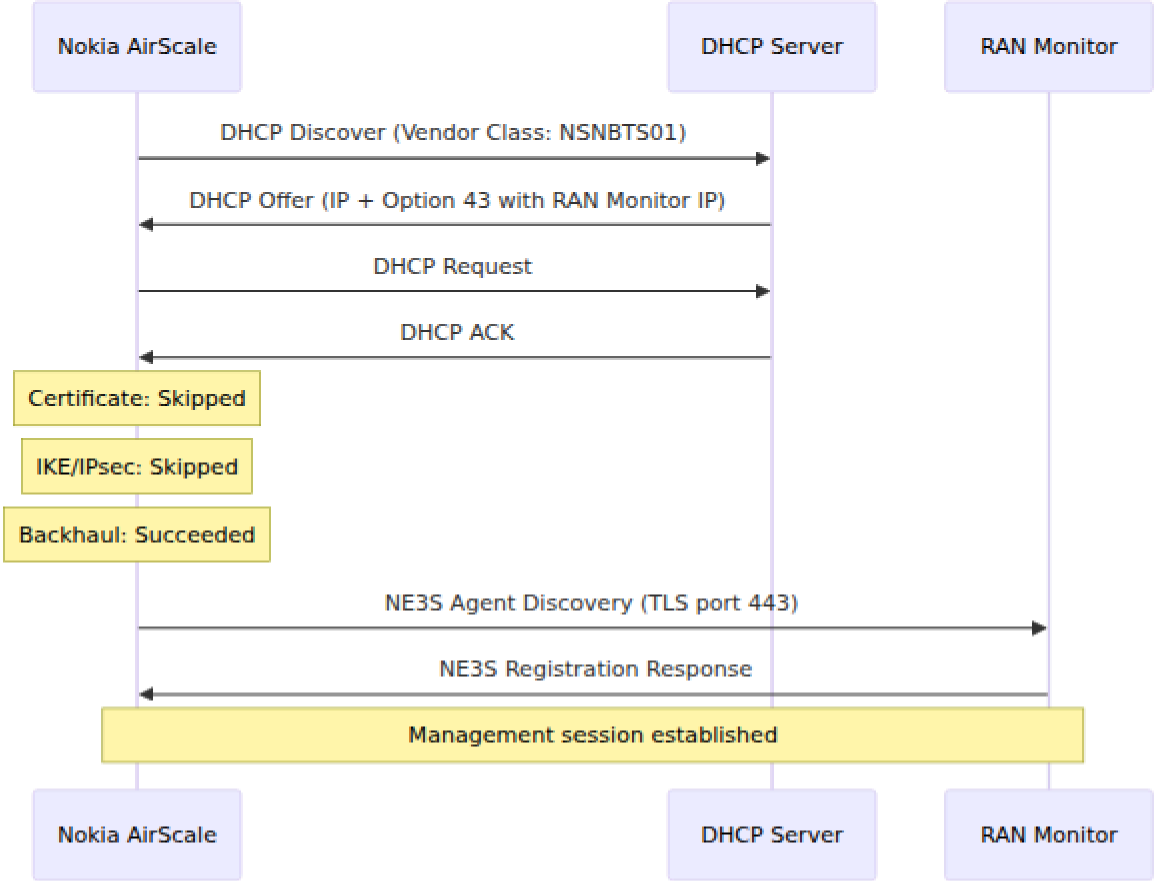
□□	□□	□□
RAN Monitor IP	RAN Monitor □□□ IP □□	10.179.2.139
□□□□	□□□□□□□□□	10.7.15.64/26
□□ IP	□□□□□□□□□	10.7.15.65
DNS □□□	DNS □□□ IP	10.7.15.65

[illegible]


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

[illegible]

[illegible] DHCP [illegible]

[illegible]	[illegible]	[illegible]
DHCP	[illegible]	[illegible] IP [illegible] RAN Monitor [illegible]
[illegible]	[illegible]	[illegible]
IKE	[illegible]	[illegible] IPsec [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] RAN Monitor [illegible] NE3S [illegible]

DHCP □□□□□

□□ 43 □□

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

□□□□ 43 □

□□□□□□□□□□ 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
0x01040ab3028b04040ab3028b080c31302e3137392e322e3133390904706b69780b
```

□□□□□□□ 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:
```

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□□□□□□□ □ **DHCP** □□□□□ □□□□□ Web □��□□□□□□□□

1. □□□□ Web □□□□□□□□□ `https://<base-station-ip>/`
2. □□□ □□□□□
3. □ □□ □□□ □ **DHCP** □□□□□
4. □ □□□□□□□ □□□ □

□□□□□□□ □□□□□□□ □□ □□□□ 43 □□□□□□ DHCP □□□

□□□□□

□□□□□ OAM□□□□□□□□□□□□□□□□□ DHCP□□ SBTS □□□□□□□□□□ **SystemModuleEIF3** □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□

OAM □□□□□□□□□□ DHCP □□□□□□□□□□□□□□□□□□ VLAN □□ — □□□□□□□□□□□□□□□□ DHCP□□□□□□□□□□□□□□□ VLAN □□□

□□

DHCP □□

□□ DHCP □□□□□□□□□□□□□□□□□ MikroTik □□

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

□□□ MAC □□□□□ `78:F9:B4`□Nokia Solutions and Networks□□

□□□□

□□□□□□□□□□□□ Web □□□□□□□□□□□□

```
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. □□□ **eNodeB** □□
2. □□□□□□□□ □□□ □ □□
3. □□ □□□□ NE3S □□□□□□□

□□□□

□□□□□ DHCP

□□□ □□□□□□ DHCP Discover□□□□□□□□□

□□□□□□□□

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

“□□□□□□□□□□□”

□□□ DHCP □□□□□□□□□□□ RAN Monitor□

□□□

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

- [illegible] RAN Monitor [illegible]

[illegible]

- Nokia AirScale [illegible] — [illegible]
- [illegible] — RAN Monitor [illegible]
- [illegible] — [illegible]

[illegible]

[illegible] **AirScale** [illegible]

[illegible]

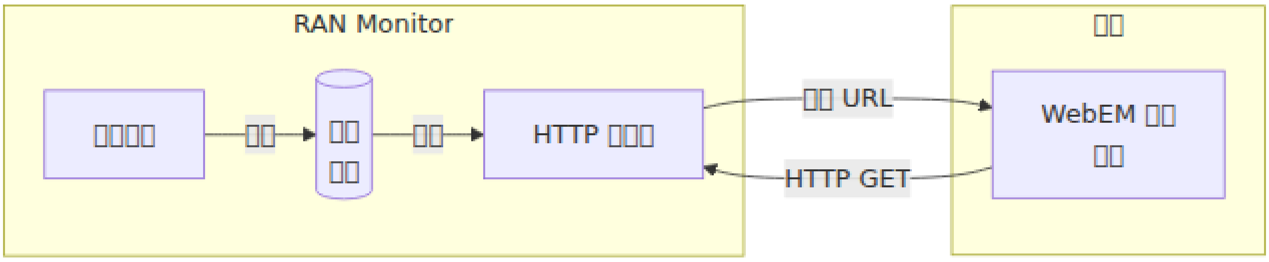
[illegible]

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

[illegible]

- [illegible] - [illegible] AirScale .zip [illegible]
- **HTTP** [illegible] - [illegible] HTTP URL [illegible]
- **MD5** [illegible] - [illegible]
- **URL** [illegible] - [illegible] WebEM [illegible] URL
- [illegible] - [illegible]

[illegible]


RAN Monitor
HTTP
URL
HTTP GET
WebEM

[illegible]

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

□□: □□□□□□□ > □□

□□□□□□□□□□□□□□□□□□□□□

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□□□□□□□ RAN Monitor □□□□□□□□□

```
/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
└── ...
```

□□□□□□□□□□□□□□□

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

□□□□□□□

□ `config/runtime.exs` □□□□□□□□□□

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

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
`firmware_storage_path`	[illegible]	[illegible]	`/var/firmware/nokia`	[illegible]

[illegible]

[illegible] `priv/firmware/nokia`[illegible]

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]
[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.mc
```

`.md5` □□□□□□□□□□□□□□

```
a1b2c3d4e5f6789012345678abcdef01
```

□□

□□ MD5 □□□□□□□□□□□□□□□

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
```

□□□□□□□□□□

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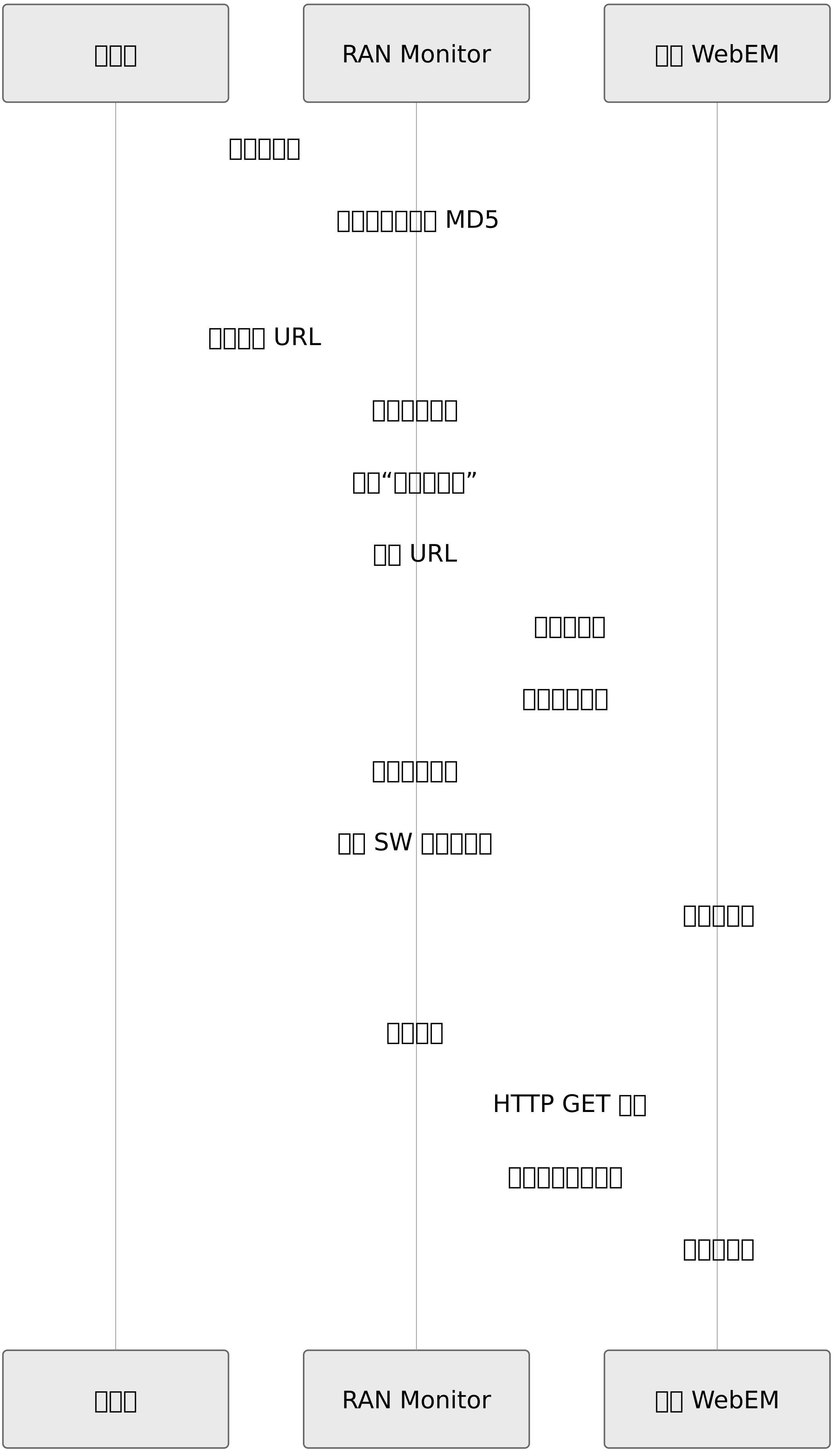
- □□□□□□□ RAN Monitor
- □□□ RAN Monitor □□□□□□□
- □□□□ WebEM □□

□□□□


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

□□□��

1. □□□□□ RAN Monitor

□□□□□□□□□□□□□□□□

- □□ `https://<ran-monitor-ip>:9443/nokia/firmware`
- □□ `.zip` □□□
- □□□□□□□□□□□□□□□□□□ MD5

2. □□□□ URL

□□□□□□□ □□ **URL**□URL □□□□

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

3. □□ WebEM □□□□

□□□□□ WebEM □□□

- □□□ □□□□ > □□□□
- □□□□ BTS □□□□□□□□□□□

4. □□□□□□□

□ WebEM □“□□□□□□□□□□□□□”□□□

1. □□ □□□□□
2. □□□□ URL □□□ **URL** □□
3. □□ □□□□□

WebEM □□□ RAN Monitor □□□□□□□□

5. □□□□□□□□□

1. □ □□□□ □□□□□□□□□□□
2. □□□□□ □□ **SW** □□□□□ □□□□□□
3. □□□□□□□□□□□□ □□□□□□□

4. [illegible] [illegible] [illegible]

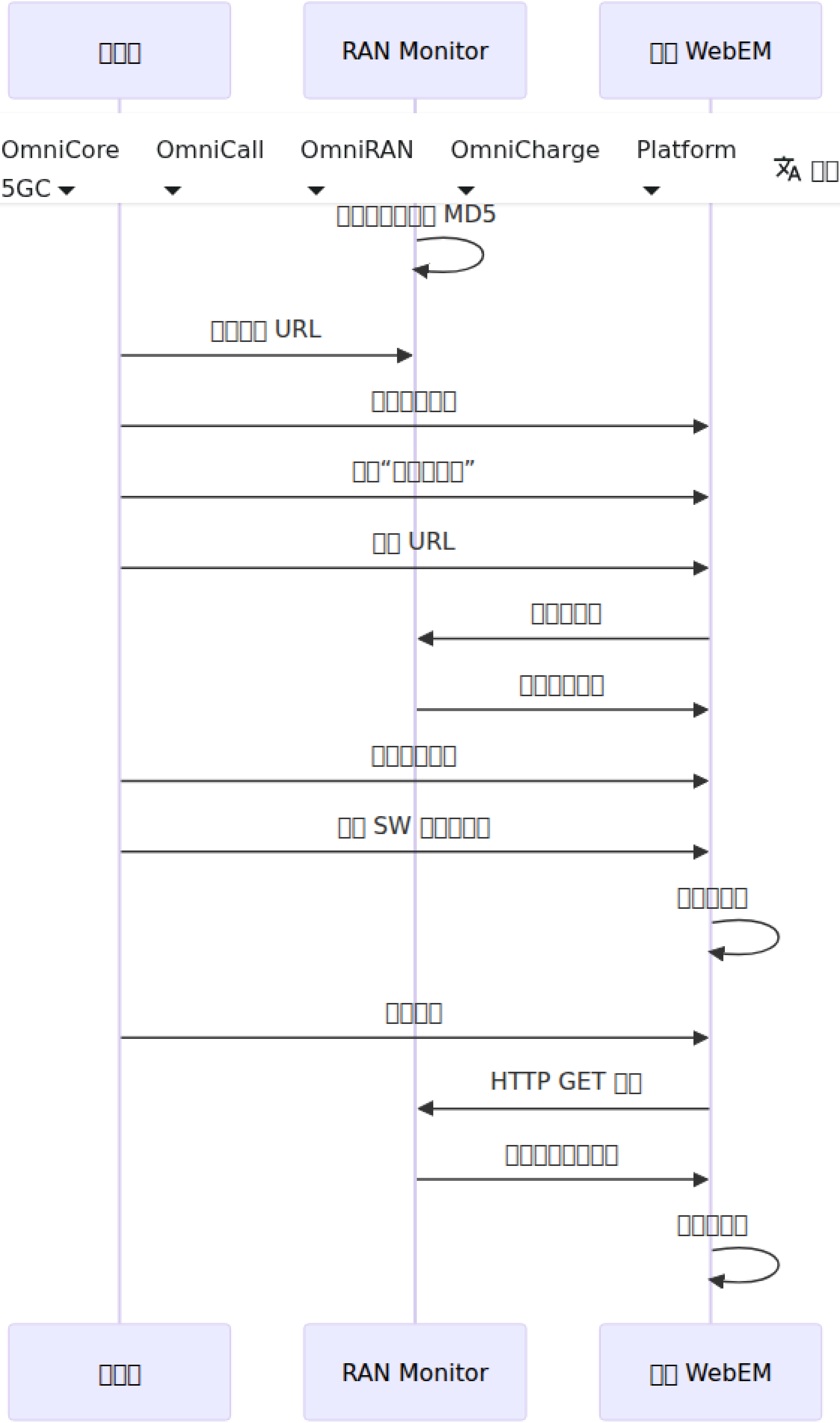
[illegible]

[illegible]

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

[illegible]���[illegible]

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


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

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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. □□ □□ □□□□□

□□□□□□□□□□□□□

□□□□

□□□□□□□□□□□□□□□□□□□□ 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_dowr
      "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_E
      "metadata": {
        "release": "SBTS25R1",
        "build": "0000_001046_000000",
        "variant": "release",
        "suffix": "A54",
        "type": "BTS □□"
      }
    }
  ],
  "stats": {
    "file_count": 3,
    "total_size": 3221225472,
    "total_size_formatted": "3.0 GB",
    "storage_path": "/var/firmware/nokia"
  }
}
```

□□□□□□

□□□ `GET /firmware/nokia/<filename>`

□□□ □□□□□□□□`Content-Type: application/zip`

□□□□

□□ URL □□

□□□□□□□□□□□□□□ URL□

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

□□	□□	□□	□□	□□
`firmware_base_url`	□□□	□	`http://localhost:4000`	□□□□ URL □□□□□ □ URL□□□□□□ RAN Monitor □□□ □□□□□□□□□/IP□

□□□□□□□ Web UI □□□□ URL □ API □□□ URL□□□□□□□□□□□□□□□□ HTTP □□□

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- □□□□ 15 GB □□□□
- □□□□ `.zip` □□
- □□□□□□□□□□

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

[illegible]

1. [illegible]

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

[illegible]

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

[illegible]

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

□□□□ RAN Monitor

RAN Monitor □□□□□□□□□□□□

□□□□□□□□□□□□□□□ RAN Monitor

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□□□□□□□□□ RAN Monitor □□□□□□□□□□□□□□□□□□□□□

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- ✓ □□□□□□□□□□MySQL□InfluxDB□
- ✓ □□□□□□□□□□□□ RAN Monitor
- ✓ □□ RAN Monitor □□□□
- ✓ □□□□□□□ Nokia AirScale □□
- ✓ □□□□□□□ InfluxDB
- ✓ □□ Web UI □□□

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□□□ RAN Monitor □□□□□□□□□□□□□□

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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□

- RAN Monitor → MySQL□□□ 3306□
- RAN Monitor → InfluxDB□□□ 8086□
- □□□ → RAN Monitor Web UI□□□ 9443□

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

Nokia □□□□

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- **IP □□** - □□□□□□□□□□
- □□ - □□□□□□□□□□ 8080□
- □□ - □□ WebLM □□□□□□□□□□□
- □□□□ - □□□□□□□ping □□□□
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- □□ - □□□□□□□□□□PEM □□□
- □□□□ - □□□□□□□□DER □□□
- □ Nokia □□□□□ OpenSSL □□

Grafana□□□□□□□

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

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□ 1 □□□□□□□□

1.1 □□ MySQL □□□

□ RAN Monitor □□□□□□

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

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```
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□□□□□ bucket□

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

□□□□□□□□□□□ API □□□InfluxDB 2.x□□

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

□□□□□□□□□□□

1.3 □□□□□□

□□□□□□□□□□□□□

```
# □□□□□□□□□□
ping 10.7.15.66

# □□□□□□□□□□□
telnet 10.7.15.66 8080
```

□□ MySQL □ InfluxDB □□□□□□

```
# □□ MySQL □□□
telnet <mysql-host> 3306

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

□ 2 □□□□ RAN Monitor

□□□□□□ `config/runtime.exs` □□□□□□

2.1 □□□□□

□□ `config/runtime.exs` □□□ MySQL □□□

```
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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[illegible] 3 [illegible]

[illegible] RAN Monitor[illegible]

3.1 [illegible]

[illegible]

```
mix ecto.migrate
```

[illegible]

3.2 [illegible] RAN Monitor

[illegible]

```
mix phx.server
```

[illegible]

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

3.3 [illegible]

[illegible]

```
[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
```

[illegible]

- Web □□□□□
- □□□□□□□□
- InfluxDB □□□□□
- □□□□□□

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□ 4 □□□□□□

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4.1 □□ Web UI □□□

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

□□□□□ RAN Monitor □□□□□

4.2 □□□□□□

□ Web UI □□

1. □□□ □□ □□
2. □□□□□□□□□□□□□□
3. □□□□□□“□□□”□□□□
4. □□□□□□“□□□”
5. □□□□□□□□□□□□□□□□

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4.3 □□□□□□□ InfluxDB

□ Web UI □□

1. □□□ **InfluxDB** □□ □□
2. □□□□□□□□
3. □□□□□□□□
4. □□“□□□□”□“□□”□“□□”□□

□□□□□□□ 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 □□

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

□□□□□□□ `mix phx.server` □□□□□□□□□□□□

4.5 □□□□□□□□

□ Web UI □□

1. □□□□□□□□□□□
2. □□□
    - □□□□□□□□□

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

[illegible]

[illegible] RAN Monitor [illegible]

[illegible]

1. [illegible]

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

2. [illegible] **Grafana** [illegible]

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

3. [illegible]

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

4. [illegible]

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

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- □□ Web UI □□ □□□□□□□
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- □□□□□□□□□ Web UI
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- □ Grafana □□□□□□□□
- □□□□□□□□□□□
- □□□□□□□Slack□□□□□□PagerDuty□

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- □ CA □□□□□□□□□□□□
- □□□□□□□□□
- □□ `config/runtime.exs` □□□□□
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- [illegible] 24 [illegible]
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[illegible]

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

[illegible]

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

[illegible]

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

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

- [illegible] 8080 [illegible]
- [illegible]

InfluxDB [illegible]

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

Web UI [illegible]

- [illegible] HTTPS [illegible] 9443 [illegible]
- [illegible] SSL [illegible]
- [illegible] Web [illegible]
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- **Web UI** [illegible] - [illegible]
- [illegible] - [illegible]
- [illegible] - [illegible]
- **AirScale** [illegible] - [illegible]
- **Grafana** [illegible] - [illegible]
- [illegible] - [illegible]
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- [illegible] - [illegible]

Grafana [illegible]

[illegible] RAN [illegible]

Grafana [illegible] KPI [illegible]

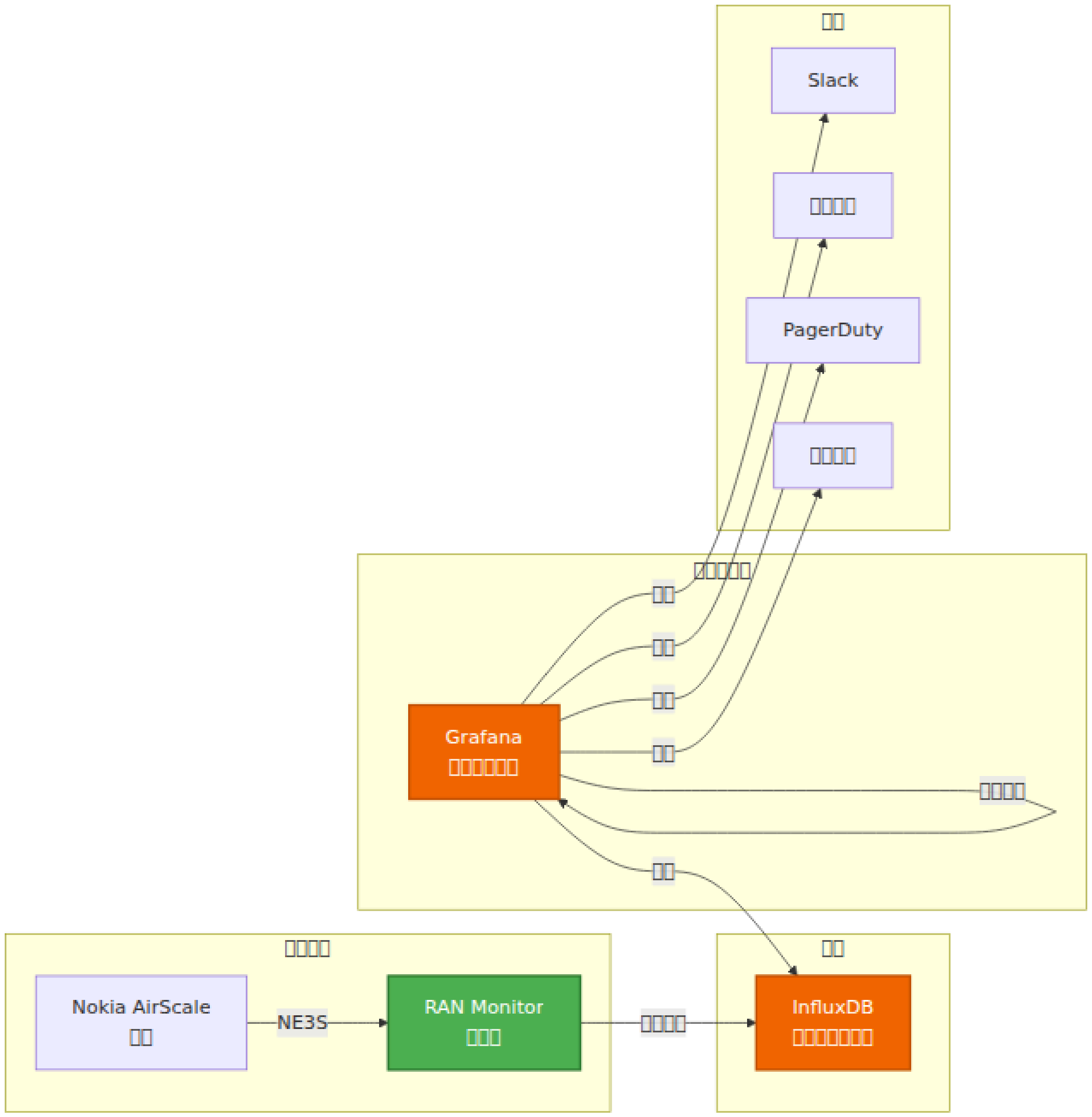
[illegible]

1. [illegible]
2. Grafana [illegible] InfluxDB [illegible]
3. [illegible]
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]

[illegible]

Grafana [illegible] RAN [illegible]

[illegible]


Slack
PagerDuty
Grafana
Nokia AirScale
NE3S
RAN Monitor
InfluxDB

Grafana [illegible]

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

[illegible]

[illegible] [illegible] [illegible]/**NOC (ONS)** [illegible] [illegible]KPI [illegible] [illegible] Grafana [illegible]

[illegible]

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

ONS [illegible]

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- [illegible]

[illegible] [illegible]

Grafana [illegible] InfluxDB [illegible]

[illegible]

[illegible]

- InfluxDB 2.0+[illegible] RAN Monitor [illegible]
- [illegible] InfluxDB API [illegible]
- Grafana [illegible] InfluxDB [illegible]

Docker Compose [illegible]

```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 □□□□□

1. □□□□□
    - Grafana → □□ → □□□
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    - □□“□□□□□”
    - □□“InfluxDB”
3. □□□□

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□□	RAN Monitor	Grafana □□□□□□
URL	`http://influxdb:8086`	□□□□□ Grafana □□
□□	□□□□□□□	Grafana □□□□□□□
□□	omnitouch	□□ InfluxDB □□
□□	□API □□□	□□ API □□□□
□□□□□	ran_metrics	RAN Monitor □□□□□
□□□□□□	10s	□□□□□□

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    - □□“□□”□□
    - □□□“□□□□□□□”

□□□ InfluxDB □□□□□URL□□□□□□□□□□□□□ RAN Monitor □□□□□□□ InfluxDB □□□□□□□□□□□ □□□□□□□ □ AirScale □□ □□□□□□□□□□

Flux [illegible]

Grafana [illegible] Flux [illegible] InfluxDB[illegible]

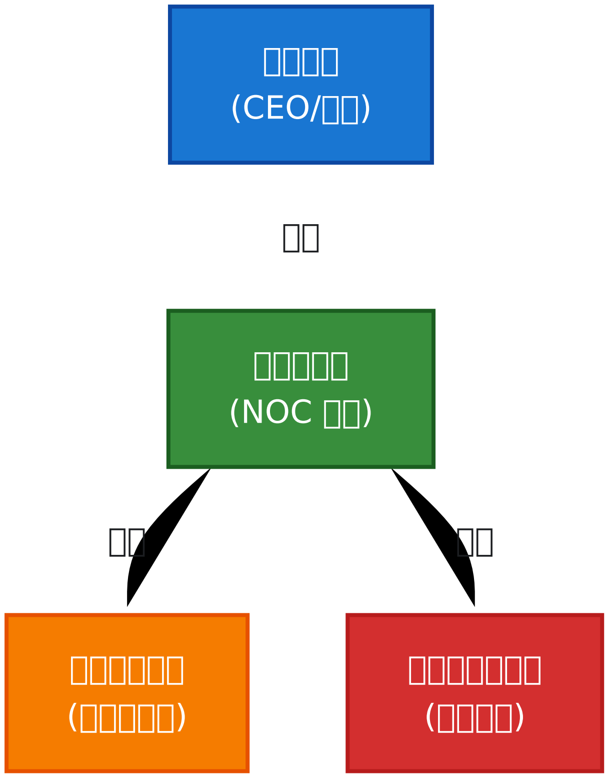
```
from(bucket:"ran_metrics")
  |> range(start: -7d, stop: now())
  |> filter(fn: (r) => r._measurement == "PerformanceMetrics")
  |> filter(fn: (r) => r.device == "SITE_A_BS1")
  |> group(by: ["_field"])
  |> aggregateWindow(every: 1h, fn: mean)
```

[illegible]

- `from()` - [illegible]
- `range()` - [illegible]
- `filter()` - [illegible]
- `group()` - [illegible]
- `aggregateWindow()` - [illegible]

[illegible]

[illegible]


[illegible]
(CEO/[illegible])
[illegible]
[illegible]
(NOC [illegible])
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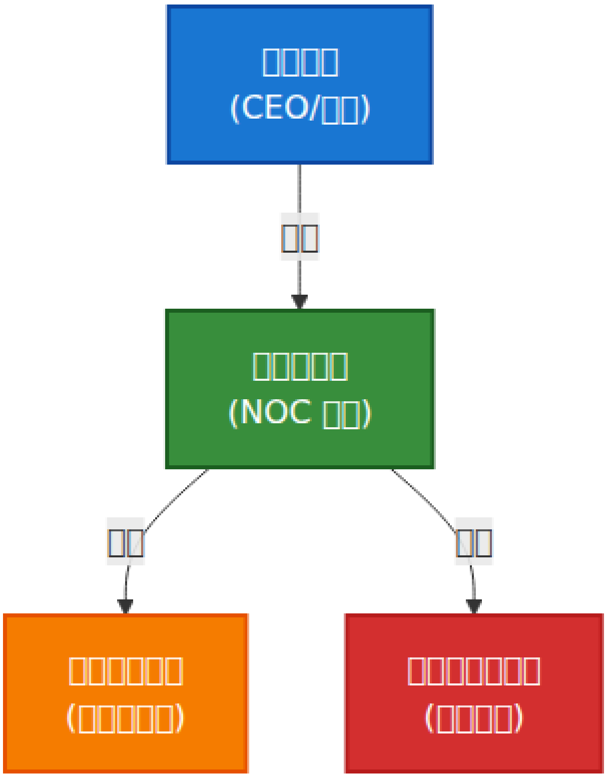

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```
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│ □□□□□□                                   │
├──────────────┬──────────────┬──────────────────┤
│ □□□□     │ □□□□     │ □□□□□□□   │
│ 48/50 (96%)  │ 3 □□□□□ │ 98.5%            │
├──────────────┴──────────────┴──────────────────┤
│ □□□□□ [2□□□] □□□                   │
└─────────────────────────────────────────────────┘
```

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- □□/□□□□□□□□□□□

- [illegible]

[illegible]

[illegible]

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

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[illegible]

```
┌──────────────────────────────────────────────────┐
│ [illegible]                          │
├───────┬──────────────┬────────────┬─────────────┤
│ [illegible] │ [illegible]           │ [illegible]        │ [illegible]    │
├───────┼──────────────┼────────────┼─────────────┤
│ [illegible]    │ SITE_A_BS1   │ [illegible]   │ 45 [illegible]   │
│ [illegible]    │ SITE_B_BS2   │ [illegible]       │ 2 [illegible]    │
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```

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- [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% □□□

□□□□□□□□7 □□

```
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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```
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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```
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")
```

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```
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")
```

[illegible]

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

[illegible]

```
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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- [illegible]
- [illegible]

[illegible]

[illegible]

```
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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```
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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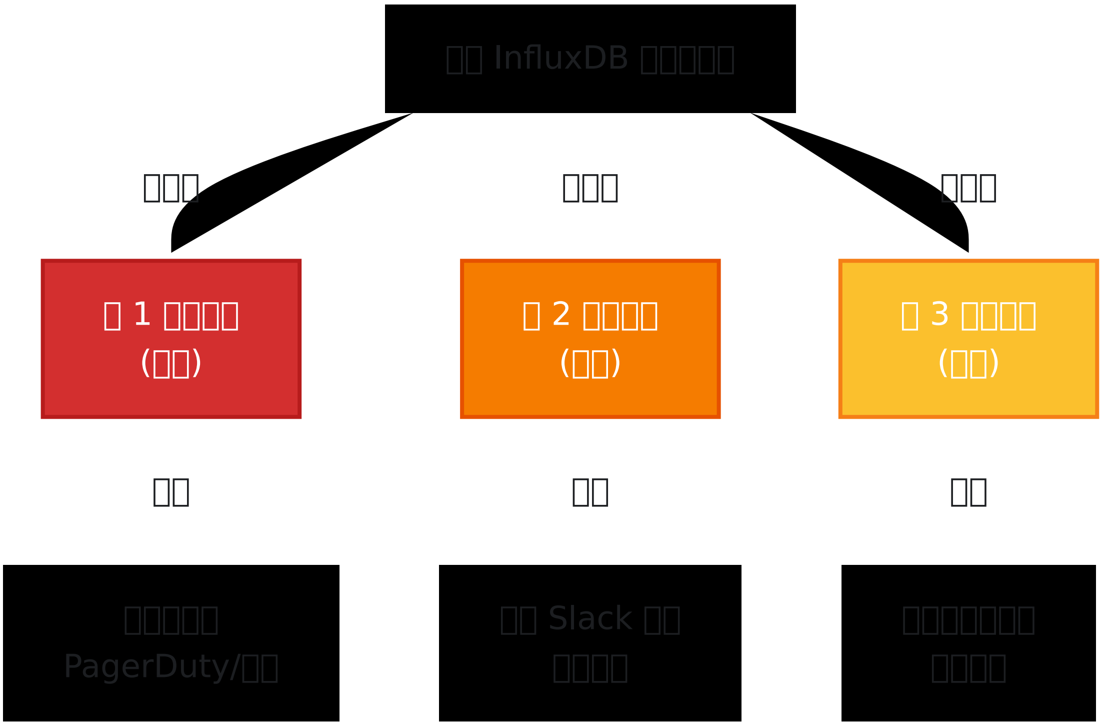
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PagerDuty/□□
□□ Slack □□
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```
□□□CellAvailability < 95%
□□□□□15 □□
□□□□□□ 1 □□
□□□□□ 15 □□
```

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- 15 □□□□□□□□□□□□□□□
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```
□□□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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- □ 5 □□□□□□□□□□□

□ 3 □□□□□□□□

1. □□“□□□□”
2. □□□□□□□□Slack□□□□□□PagerDuty □□
3. □□□□□□

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

{{ .RuleUrl }}
```

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- **SLA□** < 15 □□□□□

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- □□□□□ 15-30 □□
- □□□ Slack + □□□□ + PagerDuty
- □□□□ NOC □□ + □□□□□
- **SLA□** < 30 □□□□□

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- **SLA□** □□□□

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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. □□□□□□
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```

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```
1. [illegible] Grafana [illegible] SMTP
2. [illegible] → [illegible]
3. [illegible]“[illegible]”[illegible]
4. [illegible]
5. [illegible] CSV [illegible]
```

[illegible]

[illegible] 1[illegible]

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[illegible] 5 [illegible]
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[illegible]

1. [illegible]**4** [illegible]
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    - [illegible]
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    - [illegible]Gbps[illegible]
2. [illegible]
    - [illegible]7 [illegible]
    - [illegible]7 [illegible]
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3. [illegible]
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4. [illegible]

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[illegible]PRB [illegible]

[illegible] 2[illegible]NOC [illegible]

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[illegible] 10 [illegible]
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[illegible]

1. [illegible]
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2. [illegible]
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   - [illegible] %[illegible]

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    - □□□ 24 □□□□□
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   - SINR □□□□□□□
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   - RLC [illegible]
   - RRC [illegible]
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5. [illegible]

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

[illegible]

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□□□ 5□Nokia AirScale □□□□

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```
// □□ 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 □□"})
```

□□□□ □□□□□□□□□

- □□□0-70%
- □□□70-85%
- □□□85-100%

□□ 2□□□□□□□□□□□□

□□ 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"})
```

□□□□□□□

- **M8018C1** - □□ eNB □□□ UE □□□□□□

□□ 4□□□□□□□□□□□□□□□□□□

□□□□□□□□□□□□□□□

```
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,
      "□□□□□": 100.0 * r.M8020C3 / (r.M8020C6 - r.M8020C4)
    }))
```

□□□□□□□

- **M8020C3** - □□□□□□□□
- **M8020C6** - □□□□□□□
- **M8020C4** - □□□□□□□□□□□

□□□□□ □□□□□ < 99%

□□ 5□□□□ PRB □□□□□□□□□□□□

□□□□□□□□□□□□□□□□□

```
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 □□"})
```

□□ 6□□□□□□□□□□□□□□□□

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"})
```

□□□□□□□

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

- **M8005C2** - PUCCH [illegible] RSSI[illegible]dBm[illegible]

[illegible] 8[illegible]

PDCP SDU [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"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8001C2")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> rename(columns: {"_value": "[illegible]"})
```

[illegible]

- **M8001C2** - PDCP SDU [illegible] DTCH [illegible]

[illegible] 9[illegible]RRC [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"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M8013C5" or
                       r["metricCounter"] == "M8013C17" or
                       r["metricCounter"] == "M8013C18" or
                       r["metricCounter"] == "M8013C19" or
                       r["metricCounter"] == "M8013C34" or
                       r["metricCounter"] == "M8013C31" or
                       r["metricCounter"] == "M8013C21" or
                       r["metricCounter"] == "M8013C93" or
                       r["metricCounter"] == "M8013C91")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr:
"${CellKey}"))
  |> group()
  |> pivot(rowKey:["_time"], columnKey: ["metricCounter"],
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "[illegible]": 100.0 * r.M8013C5 / (r.M8013C17 + r.M8013C18 +
r.M8013C19 + r.M8013C34 + r.M8013C31 + r.M8013C21 + r.M8013C93 +
r.M8013C91)
    }))
```

[illegible]

- **M8013C5** - [illegible]
- **M8013C17-M8013C93** - [illegible]

[illegible] [illegible] < 95%

[illegible] 10[illegible] VSWR[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"] == "${Airscale}")
  |> filter(fn: (r) => r["metricCounter"] == "M40001C0")
  |> filter(fn: (r) => r._field == "counterValue")
  |> filter(fn: (r) => strings.containsStr(v: r["DN"], substr: 
"${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")
```

□□□□□□□

- **M40001C0** - □□□□□□□ VSWR□0.1 □□□

□□□□□ VSWR > 2.0

□□ 11□□□□□□□□□

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```
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": "□□"})
```

□□□□□□□

- **M40002C2** - □□□□□□ 100000□

□□□□□□

□□□□□□ Grafana □□□□□□□□□□□

- **${Airscale}** - □□□□□□□□□□□
- **${CellKey}** - □□□□□□□□□□□□□□□□□
- **${RadioKey}** - VSWR □□□□□□□□□□□□□□

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

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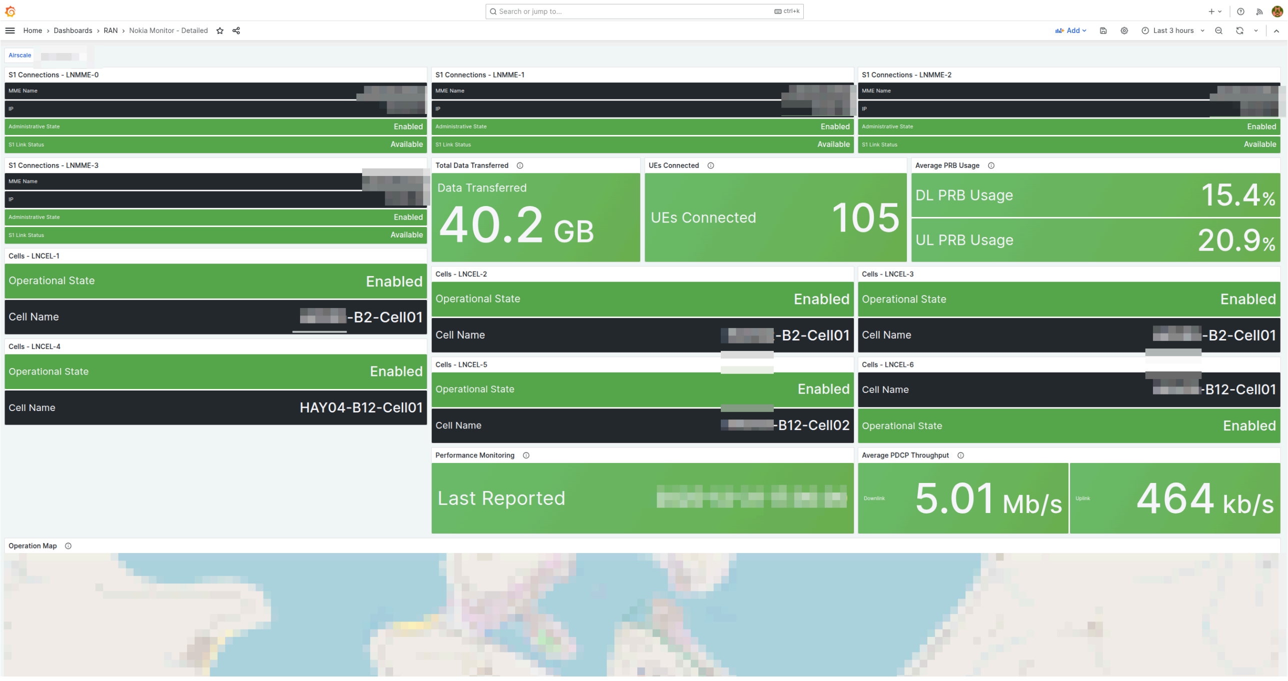
1. □□□□ - □□ PRB □□□□□□□□□□□□□
2. □□□□□□ - □□ RSSI□□□□□□□□□□□□□
3. □□□□ - □□ VSWR □□□□□□□□□□
4. □□□□ - □□□□□□□□□□□□ SLA □□

□□□ Nokia □□□□□ □□□□□□□□□□□□□□□□□

□□□□□ - □□□□□



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

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

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□□□□□□□□□□ LNCEL□□LTE PRB □□□□□ TTI□□□/□□□□□ PDCP □□□□□□□□□□□□□□□□□

□□□□□□ - RSSI□□□□□□□ RRC□

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]

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

[illegible]

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

[illegible]

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

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

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- [illegible] > 5 [illegible]
- [illegible]

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```
1. [illegible]> 8[illegible]
2. [illegible]/[illegible]
3. InfluxDB [illegible]
4. [illegible]
```

[illegible]

- [illegible]
- [illegible]24 [illegible] vs. 1 [illegible]
- [illegible] InfluxDB [illegible]
- [illegible] InfluxDB CPU/[illegible]
- [illegible]

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- [illegible]

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- □□□□□□□□□□□□□ URL/□□
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- □□ aggregateWindow □□□□□/□□/□□□
- □ InfluxDB □□□□□□□□
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- □□□□□□□□□ eNodeB □□□□□

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

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

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[illegible] RAN [illegible]

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1. [illegible]
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5. [illegible]
6. [illegible]
7. [illegible]
8. [illegible]
9. [illegible]
10. [illegible]

[illegible]

[illegible] RAN [illegible] NOC [illegible]

[illegible]

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

[illegible] [illegible]

[illegible]

[illegible] Nokia AirScale [illegible]

[illegible] 1[illegible]

[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

□□□□□□□□□□□□□□ RAN □□□

□□ 4□□□□□□□

□□ `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]

[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]

[illegible] 9[illegible] Grafana [illegible]

[illegible] Grafana [illegible]

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

[illegible] Grafana [illegible][illegible]

[illegible]

[illegible]

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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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1. □□□□□□□
   - □□□□□□□□□□□□□
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3. □□ **InfluxDB**□
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□ Grafana □□□□□□□□

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□□ `config/runtime.exs` □□□□□□

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

[illegible] 3[illegible] RAN [illegible]

[illegible]

```
systemctl restart ran_monitor
```

[illegible] 4[illegible]

[illegible]

1. [illegible]

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

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

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

[illegible]

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

[illegible]

[illegible] RAN [illegible]

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□□□□□□□□□□□□□□□□□□□ runtime.exs □□□□□□□□□□□□□□□□□□□□□□

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- □□□□□`lib/ran_monitor/nokia/airscale/manager.ex`

- [illegible]`lib/ran_monitor/nokia/airscale/manager.ex`
- [illegible]`lib/ran_monitor/nokia/airscale/manager.ex`

[illegible] [illegible] Omnitouch [illegible]

[illegible] 2[illegible]

[illegible]

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- [illegible] × [illegible] × [illegible] = [illegible]
- [illegible] = [illegible]
- [illegible]

[illegible]

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

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

[illegible] 3[illegible]

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

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1. □□ Web UI □□□

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

2. □□□□□□

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4. □□□□□□

- □□□ InfluxDB □□□□
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5. □□□□□□□

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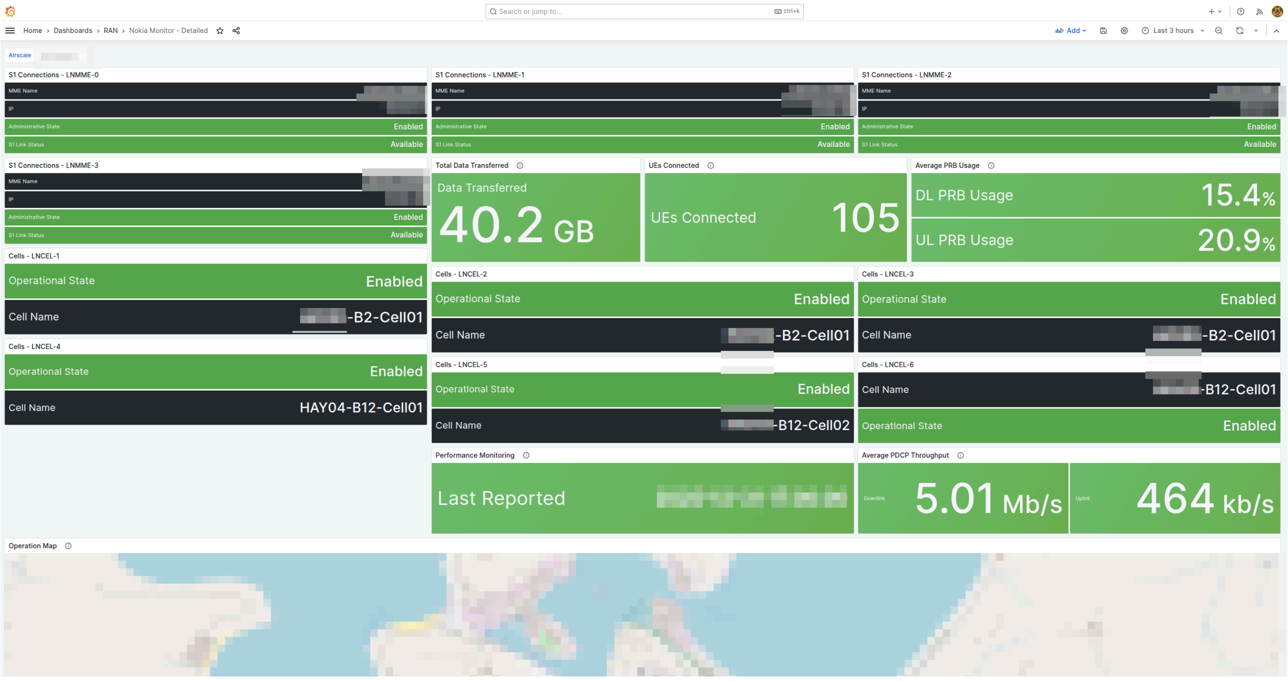
□□□**Grafana** □□□□□



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

[illegible] LNMME [illegible] S1 [illegible] UEs[illegible] PRB [illegible]

[illegible]

[illegible]

1. [illegible]

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

2. [illegible]

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

3. [illegible]

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

4. [illegible]

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

5. [illegible]

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

[illegible] 30-45 [illegible]

[illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

- [illegible]
- [illegible]

[illegible]

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

[illegible]

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

[illegible]

- [illegible] InfluxDB [illegible]
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[illegible]

[illegible]

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

4. □□□□□□□□□□

□□□□□□□ 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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1. □□□□

```
# □□□□□□□
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 □□□

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

4. InfluxDB □□

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

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

5. SSL □□

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

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- MySQL □□□□□□□□□
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- InfluxDB □□□□□□□□□□□
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1. □□ RAN □□

   ```
   systemctl stop ran_monitor
   ```

2. □□□□□□

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

3. □□□□

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

4. □□ RAN □□

   ```
   systemctl start ran_monitor
   ```

5. □□□□□□□□

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1. □□ RAN □□

   ```
   systemctl stop ran_monitor
   ```

2. □□ MySQL □□□

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

3. □□ RAN □□

```
systemctl start ran_monitor
```

4. □□□□□□□□□

5. □□□□□□□□

6. □□□□□□□ InfluxDB □

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1. □□□□□□□□□□ RAN □□
2. □□□□□□
3. □□ MySQL □□□
4. □□ InfluxDB □□
5. □□ SSL □□
6. □□ RAN □□
7. □□□□□□□□□□
8. □□□□□□□□□

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1. □□□□

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2. □□□□

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- [illegible]

3. [illegible]

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

4. [illegible]

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

[illegible]

1. [illegible]

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

2. [illegible]

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

3. [illegible]

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

[illegible]

1. SSL [illegible]

- [illegible] SSL [illegible]

- [illegible]

2. [illegible]

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

3. [illegible]

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

[illegible]

[illegible]

1. [illegible]
    - [illegible]
    - [illegible] Grafana [illegible]
2. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]
3. [illegible]
    - [illegible]
    - [illegible]
    - [illegible]
4. [illegible]
    - [illegible]
    - [illegible]

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5. □□□□□□□

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6. □□□□□

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- **□□□□** - □□□□□□
- **Web UI □□** - □□□□□□□□
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- **AirScale □□** - □□□□
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- **Grafana □□□□** - □□□□□□
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[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[illegible]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	HO □□□□
M8010	CQI □□	27	□□□□□□□□□
M8011	□□□□□	55	PRB □□□□□□□
M8012	□□□	121	PDCP □□□□��□□□□
M8013	□□□□	21	RRC □□□□□□/□□
M8014	eNB □□□□□	14	□□ X2 □□□□□
M8015	eNB □□□□	13	□□□□□□
M8016	CS □□	18	□□□□□□□□
M8017	□□□ HO	10	□□□□□ RAT□3G/2G□
M8018	eNB □□	8	□□ UE □□□□□□□

□□	□□	□□□□□	□□□□□
M8019	NACC	4	□□□□□□□□
M8020	□□□□□	7	□□□□□□□□□□
M8021	□□□ HO	17	□□□□□□□
M8022	X2 □□	2	X2 □□□□
M8023	□□□	36	PDCP SDU □□□□□□□□□

□□□□□□ (M5xxx)

□□	□□	□□□□□	□□□□□
M5112	IP □□□□	112	□□□□□□□□□□□□
M5113	□□□ RX	21	□□□□□□□□□□

□□□□ (M4xxxx)

□□	□□	□□□□□	□□□□□
M40001	□□□□□	□□	VSWR□□□□□□RF □□
M40002	□□	□□	□□□□

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```
M<measurement><type>C<counter>
```

□□□M8011C24

- **M** - □□□□□□□“□□”
- **8011** - □□□□□□□□□
- **C** - □□□□□□□□“□□□”
- **24** - □□□□□□□□□□ PRB □□□□□□

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- M8011Cxx - PRB □□□
- M8018Cxx - □□ UE □□
- M8012Cxx - □□□□□

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- M8001Cxx - □□□□□
- M8005Cxx - RSSI□SINR

- M8013Cxx - □□□□□

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- M8020Cxx - □□□□□
- M8049Cxx - □□□□

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- M8005Cxx - □□□□□□□
- M8001Cxx - □□□□
- M8013Cxx - □□□□

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M8011 - □□□□□□

□□□□□□□□□□□□□PRB□□□□□□□□□□□□□□□□□□□

□□□	□□	□□	□□	□□	□□
M8011C24	□□ TTI □□□ PRB □□□□□	□□□□□□□□□□□□□ PRB □□	0.1%	□□	□□ 10 □□□□□
M8011C37	□□ TTI □□□ PRB □□□□□	□□□□□□□□□□□□□ PRB □□	0.1%	□□	□□ 10 □□□□□

□□ PRB □□□□

- □□□□□□**PRBs**□ □ LTE □□□□□□□□□□□□
- **TTI**□□□□□□□□ = LTE □□ 1 □□
- □□□□□□ = □□□□□□□□□□□□
- 100% □□□□□□□□□□□

[illegible]

- 0-1000[illegible] 0.0% [illegible] 100.0%[illegible]
- [illegible] 10 [illegible]
- [illegible] 453 = 45.3% PRB [illegible]

[illegible]

- < 50% - [illegible]
- 50-70% - [illegible]
- 70-85% - [illegible]
- > 85% - [illegible]/[illegible]

Grafana [illegible]

```
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}))  // [illegible]
[illegible]
```

[illegible]

M8012 - [illegible]

[illegible] PDCP[illegible]���

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M8012C23	PDCP □□□□□□□	□□□□ PDCP □□□	kbit/s	□□	□□ UE □□□ PDCP SDU □
M8012C26	PDCP □□□□□□□	□□□□ PDCP □□□	kbit/s	□□	□□ UE □□ PDCP SDU □

□□ PDCP □□□□

- **PDCP** □□□□□□□□□□□□
- □□□□□□□□□□kbit/s□□□□□□
- □□□□□□□□□□□□□□□
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- □□ VoLTE □□□□□

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□□□M8012C26□□

- < 10 Mbps - □□□/□□□
- 10-50 Mbps - □□□□
- 50-100 Mbps - □□□/□□□□□□
- > 100 Mbps - □□□□□□□□□□□□□

□□□M8012C23□□

- < 5 Mbps - □□□
- 5-20 Mbps - □□□□
- 20-40 Mbps - □□□
- > 40 Mbps - □□□□

Grafana [illegible]

```
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}))  // [illegible] Mbps
```

[illegible]

M8018 - eNB [illegible]

[illegible]UE[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8018C1	[illegible] eNB [illegible] UE [illegible]	[illegible] eNodeB [illegible] UE [illegible]	[illegible]	[illegible]	1 [illegible]

[illegible] UE [illegible]

- [illegible] **UE** = [illegible]SRB[illegible]DRB[illegible]
- [illegible] 1 [illegible]
- [illegible]

[illegible]

[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)
```

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- **M8020C3** - □□□□□□□□□□
- **M8020C6** - □□□□□□
- **M8020C4** - □□□□□□□□□□□□□□

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□□□	□□	□□
> 99.9%	□□	□□□□□□□ SLA
99.0-99.9%	□□	□□□□
95.0-99.0%	□□	□□□□
< 95.0%	□□	□□ - □□□□□□□□

Grafana □□□□□

```
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,
      "□□□□□": 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] - [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] - 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□

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> 99%	□□	□□□□
95-99%	□□	□□□□□□
90-95%	□□	□□□□
< 90%	□□	□□□□ - □□□□□□

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[illegible] QoS [illegible]

M8001 - [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8001C2	[illegible] PDCP SDU [illegible]	eNB [illegible] PDCP SDU [illegible]	ms	[illegible]

[illegible]

- **PDCP SDU** = [illegible]
- [illegible] = [illegible]��[illegible]
- **DL DTCH** = [illegible]
- [illegible] = [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
< 10 ms	[illegible]	[illegible] VoLTE[illegible]
10-20 ms	[illegible]	[illegible]
20-50 ms	[illegible]	[illegible]
> 50 ms	[illegible]	[illegible]

[illegible]

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

S1 [illegible]

M8000 - S1 [illegible]

[illegible] eNodeB [illegible] MME[illegible] S1 [illegible]S1 [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M8000C0	[illegible]	[illegible]	[illegible]	[illegible]
M8000C1	[illegible]	[illegible]	[illegible]	[illegible]
M8000C2	[illegible] - [illegible]	[illegible]	[illegible]	[illegible]
M8000C3	[illegible] - [illegible]	[illegible]	[illegible]	[illegible]
M8000C6	S1 [illegible]	S1 ���[illegible]	[illegible]	[illegible]
M8000C7	S1 [illegible]	[illegible] S1 [illegible]	[illegible]	[illegible]
M8000C11	S1 [illegible]	[illegible] MME [illegible]	[illegible]	[illegible]
M8000C12	UE [illegible] S1 [illegible]	[illegible] UE [illegible] S1 [illegible]	[illegible]	[illegible]
M8000C29	[illegible] NAS [illegible]	[illegible] MME [illegible] NAS [illegible]	[illegible]	[illegible]
M8000C30	[illegible] NAS [illegible]	[illegible] MME [illegible] NAS [illegible]	[illegible]	[illegible]

[illegible] S1 [illegible]

- **S1** [illegible] eNodeB [illegible] EPC[illegible]
- [illegible] UE [illegible]
- **S1** [illegible] eNodeB [illegible] MME [illegible]
- **NAS**[illegible]

[illegible]

```
S1 □□□□□ = 100 × M8000C7 / M8000C6
□□□□□□□□ = 100 × M8000C1 / M8000C0
```

□□□□□

- S1 □□□□□□> 99%
- □□□□□□□□□> 95%

EPS □□□□□

M8006 - EPS □□□□

□□□□□□□ E-UTRAN □□□□□□□E-RAB□□ EPS □□□□□□□□□□□□□□

□□□□□□

□□□	□□	□□	□□	□□
M8006C0	EPS □□□□□□	□□□□□□	□□	□
M8006C1	EPS □□���□□□	□□□□□□□	□□	□
M8006C2-C5	□□□□□□□□□□	□□□□□□□□	□□	□

□□ **EPS** □□□

- □□ = UE □□□□□□□□□□□□□□
- □□□□ = □□□□□□□□□□□□□□□
- □□□□ = □□□□□□□□□□ QoS □□□VoLTE□□□□□

□□□

- □□□□□□□□□
- □□□□□□□□□

- [illegible] QoS [illegible]

[illegible]

M8009 - [illegible]

M8014 - eNB [illegible]

M8015 - eNB [illegible]

M8021 - [illegible]

[illegible] - [illegible] UE [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
eNB [illegible]	[illegible]	M8015
eNB [illegible]	[illegible]X2[illegible]	M8014
[illegible]	[illegible]	M8021
[illegible]	[illegible]LTE→3G/2G[illegible]	M8017

[illegible]

□□□□	□□□	□□□□□
M8009	□□□□□□	□□□□□□□□□□□□□
M8014	□□ X2 □ HO	□□□□□□□□□□
M8015	□□□ HO	□□□□□□□□□□
M8021	□□□ HO	□□□□□□□□

□□□□□□□□

```
□□□□□ = 100 × (□□□□) / (□□□□□□)
```

□□□□□

- eNB □□ HO □□□□> 99%
- eNB □□ HO □□□□> 98%
- □□□ HO □□□□> 95%

□□□□□□□□□

- □□□□□□□□□□□□□□
- □□□□□□□□□□□
- □□□□□□UE □□□□□□□
- □□□□□□□□□□□□□

□□□□□□

M8010 - CQI□□□□□□□□□□□

□□□□□□□□□ UE □ CQI □□□□□□□□□□□□□□□□□□□

□□ CQI□

- **CQI** = UE [illegible] eNodeB [illegible]
- [illegible] CQI 0[illegible] CQI 15[illegible]
- [illegible] [illegible] MCS[illegible]
- [illegible] [illegible]

CQI [illegible]

CQI [illegible]	[illegible]	[illegible]	[illegible]
0-3	[illegible]	< 1 Mbps	QPSK
4-6	[illegible]	1-5 Mbps	QPSK
7-9	[illegible]	5-15 Mbps	16-QAM
10-12	��[illegible]	15-40 Mbps	64-QAM
13-15	[illegible]	40-150 Mbps	64-QAM

M8010 [illegible]

- M8010C0 - M8010C15[illegible]0-15[illegible] CQI [illegible]

[illegible]

```
[illegible] CQI = Σ(CQI_level × M8010C[level]) / Σ(M8010C[level])
```

[illegible] CQI [illegible]

- **[illegible] CQI[illegible]10-15[illegible]** [illegible]
- **[illegible] CQI[illegible]7-9[illegible]** [illegible]
- **[illegible] CQI[illegible]0-6[illegible]** [illegible]

CS [illegible]

M8016 - CS [illegible]

[illegible]CSFB[illegible] LTE UE [illegible] 2G/3G [illegible]

[illegible] CSFB[illegible]

- [illegible] [illegible] VoLTE [illegible]
- [illegible] UE [illegible] LTE → [illegible] → [illegible] 2G/3G → [illegible] LTE
- [illegible] [illegible] LTE [illegible]

[illegible]

[illegible]	[illegible]	[illegible]
M8016C0	[illegible] CSFB [illegible]	[illegible] CSFB
M8016C1	[illegible] CSFB [illegible]	[illegible] CSFB

CSFB [illegible]

1. [illegible] UE [illegible] LTE [illegible] 2G/3G[illegible]
2. [illegible] [illegible] LTE [illegible] 2G/3G [illegible]

[illegible]

- CSFB [illegible]��[illegible] = [illegible] / [illegible] CSFB [illegible]
- [illegible]> 98%

[illegible]

M8023 - PDCP SDU [illegible]

[illegible]

□□□□□

- □□□□□□□□□□□
- □ QCI□□□□□□□□□□□□□□□
- □□□□□□□□□

□□□

- □□□□□□
- □□□□□□□□□□□□
- □□□□□□□□□
- QoS □□□□□

□ M8012□□□□□□□□□

- **M8012□** □□□□□□□kbit/s□
- **M8023□** □□□□□□□□□

X2 □□□□□

M8004 - X2 □□□□□

M8022 - X2 □□□□

□□□□□□□ eNodeB □□□ X2 □□□□□ eNB □□□□□□□□□□□

M8004 - X2 □□□□

- □□□□□□□□ eNodeB □□□□□□□
- □□□□ X2 □□□□□

M8022 - X2 □□□

- **M8022C0□** X2 □□□□
- **M8022C1□** X2 □□□□

[illegible] X2 [illegible]

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

X2 [illegible]

```
X2 [illegible] = 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 - [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M40002C2	[illegible]	[illegible]	100000 [illegible]	[illegible]	[illegible] 100000

[illegible]

- [illegible]
- [illegible] OPEX [illegible]���[illegible]
- [illegible]/[illegible]

Grafana [illegible]

```
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}))
```

[illegible] Grafana [illegible]

[illegible]

1. [illegible]

[illegible] M8011C24 [illegible] M8011C37 [illegible]/[illegible] PRB [illegible]

```
// □□ PRB □□
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": "□□ PRB %"})

// □□ PRB □□
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": "□□ PRB %"})
```

2. □□□□□□

□□□□□□□□□

```
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}))  // □□□
Mbps
  |> pivot(rowKey: ["_time"], columnKey: ["metricCounter"],
valueColumn: "_value")
  |> map(fn: (r) => ({
      _time: r._time,
      "□□ Mbps": r.M8012C23,
      "□□ Mbps": r.M8012C26
    }))
```

3. □□□□□□

□□□□□□□□□□□

```
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)
    }))
```

□□□□□□□

□□□□□□□□□□□□

- □□□□□ - □□□□□□□□□PRB □□□
- □□ - □□□□□□□□□□□
- □□□□□□ - □□□□□□□□ UE□
- □□ - □□□□□RSSI □□□

□□□□□□□□□

- □□□□□□□

- [illegible]
- [illegible]

[illegible]

- PRB [illegible] < 70%[illegible] 70-85%[illegible] > 85%
- [illegible] > 99%[illegible] 95-99%[illegible] < 95%
- [illegible] > 99%[illegible] 95-99%[illegible] < 95%

[illegible]

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

[illegible]

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

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
M8011C24	[illegible] PRB [illegible]���[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]
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]

- [illegible] FlexiRadio LTE [illegible]
- [illegible] AirScale [illegible]
- 3GPP LTE [illegible]

[illegible]

[illegible] KPI [illegible] 1,186 [illegible] LTE [illegible]

```
====================================================================
□□□ LTE □□□□□□□□□
====================================================================

--------------------------------------------------------------------
□□□□M8000
--------------------------------------------------------------------
M8000C0         | □□□□□□□□□                               | □
M8000C1         | □□□□□□□□□                            | □        |
M8000C2         | □□□□□□□□□□□□□□□□□□                        | □
M8000C3         | □□□□□□□□□□□□□□□□                        | □
M8000C4         | □□□□□□□□□□□□□□□□□□                        | □
M8000C5         | □□□□□□□□□□□□□□□□□□                        | □
M8000C6         | S1 □□□□
M8000C7         | S1 □□□□                                         |
M8000C8         | □□□□□□□□□□ S1 □□□□                     | □        |
M8000C9         | □□ MME □□□□□ S1 □□□□                        | □
M8000C11        | S1 □□□□                                           |
M8000C12        | UE □□□□□ S1 □□□□                          | □
M8000C13        | □ eNB □□□□□ S1 □□                         | □
M8000C14        | □ MME □□□□□ S1 □□                         | □
M8000C15        | □ eNB □□□□□ S1 □□                        | □
M8000C16        | □ MME □□□□□ S1 □□                        | □
M8000C23        | UE □□□□□□□                             | □        |
M8000C24        | □□□□□□□□□ UE □□□□□□□                         | □
M8000C25        | UE □□□□□□□                             | □        |
M8000C29        | □□ NAS □□                               | □
M8000C30        | □□ NAS □□                             | □        |
M8000C31        | □□□□□□□□□ UE □□□□□□□                         | □
M8000C32        | IMS □ E-RAB □□□□                                 |
M8000C33        | IMS □ E-RAB □□□□                              | □
M8000C34        | IMS □ E-RAB □□□□                                 |
M8000C35        | □□□□□□□□□                         | □        | □□
M8000C36        | □□□□□□□□□                           | □        | □
M8000C37        | □□□ X2 IP □□□□                           | □
M8000C38        | □□□ X2 IP □□□□                            | □
M8000C39        | WRITE-REPLACE □□□
M8000C40        | WRITE-REPLACE □□□
M8000C41        | KILL □□□□□□□                              | □
M8000C42        | KILL □□□□□                                      |

--------------------------------------------------------------------
□□□□M8001
```

```
--------------------------------------------------------------------
M8001C0         | □□ PDCP SDU □□□□□                                |
M8001C1         | □□ PDCP SDU □□□□□                                |
M8001C2         | □□ PDCP SDU □□□□                               | □
M8001C3         | □□ PDCP SDU □□□□□                                |
M8001C4         | □□ PDCP SDU □□□□□                                |
M8001C5         | □□ PDCP SDU □□□□                               | □
M8001C6         | □□ RACH □□□□                           | □        |
M8001C7         | □□ RACH □□□□                           | □        |
M8001C8         | RACH □□□□                                       |
M8001C9         | □ PCH □□□□ TB □□
M8001C10        | □ BCH □□□□ TB □□
M8001C11        | □ DL-SCH □□□□ TB □□
M8001C12        | □ DL-SCH □□ HARQ □□                               |
M8001C13        | □□□□□□ UL-SCH TB □□                         | □
M8001C14        | □□□ UL-SCH TB □□□□                          | □
M8001C15        | □□□ UL-SCH TB □□��□                               |
M8001C16        | □□ MCS0 □ PUSCH □□                               |
M8001C17        | □□ MCS1 □ PUSCH □□                               |
M8001C18        | □□ MCS2 □ PUSCH □□                               |
M8001C19        | □□ MCS3 □ PUSCH □□                               |
M8001C20        | □□ MCS4 □ PUSCH □□                               |
M8001C21        | □□ MCS5 □ PUSCH □□                               |
M8001C22        | □□ MCS6 □ PUSCH □□                               |
M8001C23        | □□ MCS7 □ PUSCH □□                               |
M8001C24        | □□ MCS8 □ PUSCH □□                               |
M8001C25        | □□ MCS9 □ PUSCH □□                               |
M8001C26        | □□ MCS10 □ PUSCH □□                              |
M8001C27        | □□ MCS11 □ PUSCH □□                              |
M8001C28        | □□ MCS12 □ PUSCH □□                              |
M8001C29        | □□ MCS13 □ PUSCH □□                              |
M8001C30        | □□ MCS14 □ PUSCH □□                              |
M8001C31        | □□ MCS15 □ PUSCH □□                              |
M8001C32        | □□ MCS16 □ PUSCH □□                              |
M8001C33        | □□ MCS17 □ PUSCH □□                              |
M8001C34        | □□ MCS18 □ PUSCH □□                              |
M8001C35        | □□ MCS19 □ PUSCH □□                              |
M8001C36        | □□ MCS20 □ PUSCH □□                              |
M8001C37        | □□ MCS21 □ PUSCH □□                              |
M8001C38        | □□ MCS22 □ PUSCH □□                              |
M8001C39        | □□ MCS23 □ PUSCH □□                              |
M8001C40        | □□ MCS24 □ PUSCH □□                              |
M8001C41        | □□ MCS25 □ PUSCH □□                              |
M8001C42        | □□ MCS26 □ PUSCH □□                              |
M8001C43        | □□ MCS27 □ PUSCH □□                              |
M8001C44        | □□ MCS28 □ PUSCH □□                              |
M8001C45        | □□ MCS29 □ PUSCH □□                              |
M8001C46        | □□ MCS30 □ PUSCH □□                              |
M8001C47        | □□ MCS31 □ PUSCH □□                              |
M8001C48        | □□ MCS32 □ PUSCH □□                              |
M8001C49        | □□ MCS33 □ PUSCH □□                              |
M8001C50        | □□ MCS34 □ PUSCH □□                              |
M8001C51        | □□ MCS35 □ PUSCH □□                              |
M8001C52        | □□ MCS36 □ PUSCH □□                              |
M8001C53        | □□ MCS37 □ PUSCH □□                              |
M8001C54        | □□ MCS38 □ PUSCH □□                              |
M8001C55        | □□ MCS39 □ PUSCH □□                              |
M8001C56        | □□ MCS40 □ PUSCH □□                              |
M8001C57        | □□ MCS41 □ PUSCH □□                              |
M8001C58        | □□ MCS42 □ PUSCH □□                              |
M8001C59        | □□ MCS43 □ PUSCH □□                              |
M8001C60        | □□ MCS44 □ PUSCH □□                              |
M8001C61        | □□ MCS45 □ PUSCH □□                              |
M8001C62        | □□ MCS46 □ PUSCH □□                              |
M8001C63        | □□ MCS47 □ PUSCH □□                              |
M8001C64        | □□ MCS48 □ PUSCH □□                              |
M8001C65        | □□ MCS49 □ PUSCH □□                              |
M8001C66        | □□ MCS50 □ PUSCH □□                              |
M8001C67        | □□ MCS51 □ PUSCH □□                              |
M8001C68        | □□ MCS52 □ PUSCH □□                              |
M8001C69        | □□ MCS53 □ PUSCH □□                              |
M8001C70        | □□ MCS54 □ PUSCH □□                              |
M8001C71        | □□ MCS55 □ PUSCH □□                              |
M8001C72        | □□ MCS56 □ PUSCH □□                              |
M8001C73        | □□ MCS57 □ PUSCH □□                              |
M8001C74        | □□ MCS58 □ PUSCH □□                              |
M8001C75        | □□ MCS59 □ PUSCH □□                              |
M8001C76        | □□ MCS60 □ PUSCH □□                              |
M8001C77        | □□ MCS61 □ PUSCH □□                              |
M8001C78        | □□ MCS62 □ PUSCH □□                              |
M8001C79        | □□ MCS63 □ PUSCH □□                              |
M8001C80        | □□ MCS64 □ PUSCH □□                              |
M8001C81        | □□ MCS65 □ PUSCH □□                              |
M8001C82        | □□ MCS66 □ PUSCH □□                              |
M8001C83        | □□ MCS67 □ PUSCH □□                              |
M8001C84        | □□ MCS68 □ PUSCH □□                              |
M8001C85        | □□ MCS69 □ PUSCH □□                              |
M8001C86        | □□ MCS70 □ PUSCH □□                              |
M8001C87        | □□ MCS71 □ PUSCH □□                              |
M8001C88        | □□ MCS72 □ PUSCH □□                              |
M8001C89        | □□ MCS73 □ PUSCH □□                              |
M8001C90        | □□ MCS74 □ PUSCH □□                              |
M8001C91        | □□ MCS75 □ PUSCH □□                              |
M8001C92        | □□ MCS76 □ PUSCH □□                              |
M8001C93        | □□ MCS77 □ PUSCH □□                              |
M8001C94        | □□ MCS78 □ PUSCH □□                              |
M8001C95        | □□ MCS79 □ PUSCH □□                              |
M8001C96        | □□ MCS80 □ PUSCH □□                              |
M8001C97        | □□ MCS81 □ PUSCH □□                              |
M8001C98        | □□ MCS82 □ PUSCH □□                              |
M8001C99        | □□ MCS83 □ PUSCH □□                              |
M8001C100       | □□ MCS84 □ PUSCH □□                              |
M8001C101       | □□ MCS85 □ PUSCH □□                              |
M8001C102       | □□ MCS86 □ PUSCH □□                              |
M8001C103       | □□ MCS87 □ PUSCH □□                              |
M8001C104       | □□ MCS88 □ PUSCH □□                              |
M8001C105       | □□ MCS89 □ PUSCH □□                              |
M8001C106       | □□ MCS90 □ PUSCH □□                              |
M8001C107       | □□ MCS91 □ PUSCH □□                              |
M8001C108       | □□ MCS92 □ PUSCH □□                              |
M8001C109       | □□ MCS93 □ PUSCH □□                              |
M8001C110       | □□ MCS94 □ PUSCH □□                              |
M8001C111       | □□ MCS95 □ PUSCH □□                              |
M8001C112       | □□ MCS96 □ PUSCH □□                              |
M8001C113       | □□ MCS97 □ PUSCH □□                              |
M8001C114       | □□ MCS98 □ PUSCH □□                              |
M8001C115       | □□ MCS99 □ PUSCH □□                              |
M8001C116       | □□ MCS100 □ PUSCH □□                              |
M8001C117       | □□ MCS101 □ PUSCH □□                              |
M8001C118       | □□ MCS102 □ PUSCH □□                              |
M8001C119       | □□ MCS103 □ PUSCH □□                              |
M8001C120       | □□ MCS104 □ PUSCH □□                              |
M8001C121       | □□ MCS105 □ PUSCH □□                              |
M8001C122       | □□ MCS106 □ PUSCH □□                              |
M8001C123       | □□ MCS107 □ PUSCH □□                              |
M8001C124       | □□ MCS108 □ PUSCH □□                              |
M8001C125       | □□ MCS109 □ PUSCH □□                              |
M8001C126       | □□ MCS110 □ PUSCH □□                              |
M8001C127       | □□ MCS111 □ PUSCH □□                              |
M8001C128       | □□ MCS112 □ PUSCH □□                              |
M8001C129       | □□ MCS113 □ PUSCH □□                              |
M8001C130       | □□ MCS114 □ PUSCH □□                              |
M8001C131       | □□ MCS115 □ PUSCH □□                              |
M8001C132       | □□ MCS116 □ PUSCH □□                              |
M8001C133       | □□ MCS117 □ PUSCH □□                              |
M8001C134       | □□ MCS118 □ PUSCH □□                              |
M8001C135       | □□ MCS119 □ PUSCH □□                              |
M8001C136       | □□ MCS120 □ PUSCH □□                              |
M8001C137       | □□ MCS121 □ PUSCH □□                              |
M8001C138       | □□ MCS122 □ PUSCH □□                              |
M8001C139       | □□ MCS123 □ PUSCH □□                              |
M8001C140       | □□ MCS124 □ PUSCH □□                              |
M8001C141       | □□ MCS125 □ PUSCH □□                              |
M8001C142       | □□ MCS126 □ PUSCH □□                              |
M8001C143       | □□ MCS127 □ PUSCH □□                              |
M8001C144       | □□ MCS128 □ PUSCH □□                              |
M8001C145       | □□ MCS129 □ PUSCH □□                              |
M8001C146       | □□ MCS130 □ PUSCH □□                              |
M8001C147       | □□ MCS131 □ PUSCH □□                              |
M8001C148       | □□ MCS132 □ PUSCH □□                              |
M8001C149       | □□ MCS133 □ PUSCH □□                              |
M8001C150       | □□ MCS134 □ PUSCH □□                              |
M8001C151       | □□ MCS135 □ PUSCH □□                              |
M8001C152       | □□ MCS136 □ PUSCH □□                              |
M8001C153       | □□ MCS137 □ PUSCH □□                              |
M8001C154       | □□ MCS138 □ PUSCH □□                              |
M8001C155       | □□ MCS139 □ PUSCH □□                              |
M8001C156       | □□ MCS140 □ PUSCH □□                              |
M8001C157       | □□ MCS141 □ PUSCH □□                              |
M8001C158       | □□ MCS142 □ PUSCH □□                              |
M8001C159       | □□ MCS143 □ PUSCH □□                              |
M8001C160       | □□ MCS144 □ PUSCH □□                              |
M8001C161       | □□ MCS145 □ PUSCH □□                              |
M8001C162       | □□ MCS146 □ PUSCH □□                              |
M8001C163       | □□ MCS147 □ PUSCH □□                              |
M8001C164       | □□ MCS148 □ PUSCH □□                              |
M8001C165       | □□ MCS149 □ PUSCH □□                              |
M8001C166       | □□ MCS150 □ PUSCH □□                              |
M8001C167       | □□ MCS151 □ PUSCH □□                              |
M8001C168       | □□ MCS152 □ PUSCH □□                              |
M8001C169       | □□ MCS153 □ PUSCH □□                              |
M8001C170       | □□ MCS154 □ PUSCH □□                              |
M8001C171       | □□ MCS155 □ PUSCH □□                              |
M8001C172       | □□ MCS156 □ PUSCH □□                              |
M8001C173       | □□ MCS157 □ PUSCH □□                              |
M8001C174       | □□ MCS158 □ PUSCH □□                              |
M8001C175       | □□ MCS159 □ PUSCH □□                              |
M8001C176       | □□ MCS160 □ PUSCH □□                              |
M8001C177       | □□ MCS161 □ PUSCH □□                              |
M8001C178       | □□ MCS162 □ PUSCH □□                              |
M8001C179       | □□ MCS163 □ PUSCH □□                              |
M8001C180       | □□ MCS164 □ PUSCH □□                              |
M8001C181       | □□ MCS165 □ PUSCH □□                              |
M8001C182       | □□ MCS166 □ PUSCH □□                              |
M8001C183       | □□ MCS167 □ PUSCH □□                              |
M8001C184       | □□ MCS168 □ PUSCH □□                              |
M8001C185       | □□ MCS169 □ PUSCH □□                              |
M8001C186       | □□ MCS170 □ PUSCH □□                              |
M8001C187       | □□ MCS171 □ PUSCH □□                              |
M8001C188       | □□ MCS172 □ PUSCH □□                              |
M8001C189       | □□ MCS173 □ PUSCH □□                              |
M8001C190       | □□ MCS174 □ PUSCH □□                              |
M8001C191       | □□ MCS175 □ PUSCH □□                              |
M8001C192       | □□ MCS176 □ PUSCH □□                              |
M8001C193       | □□ MCS177 □ PUSCH □□                              |
M8001C194       | □□ MCS178 □ PUSCH □□                              |
M8001C195       | □□ MCS179 □ PUSCH □□                              |
M8001C196       | □□ MCS180 □ PUSCH □□                              |
M8001C199       | RRC □□□ UE □□□
```

PM [illegible]

[illegible]

PM [illegible]PM[illegible] InfluxDB [illegible] AirScale [illegible] **22,000** [illegible] **PM** [illegible]

[illegible]

[illegible]

[illegible] PM [illegible]

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

[illegible]

[illegible]

[illegible]	[illegible]
[illegible] **PM** [illegible]	[illegible] InfluxDB [illegible]
[illegible]	[illegible] 22,000+ [illegible]

[illegible]

PM [illegible]

□□	□□□□	□□	□□
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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□□□□□□□ `priv/pm_counters.csv` □□□□□□□□□□□□□□□□□□□□□□□□

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- □□□□RRC □□□□/□□
- **PRB**□□□□□□□□□
- □□□□□□/□□□□□□□
- **RRC**□RRC □□□□
- **ERAB**□E-RAB □□□□□□□□
- **PDCP**□PDCP □□□
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1. □□□□□□ □ `priv/pm_filters.etf`
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InfluxDB □□□□□□□□□□□□□□□□□/□□□□□□□□□□□□

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- □□□ **ID**□□□□`M8012C23`□
- □□□□□□□□□`□□□`□`□□`□`RSRP`□

[illegible]

[illegible]	[illegible]	[illegible]
M8012C23	LTE	[illegible]
M8012C26	LTE	[illegible]
M8001C2	LTE	PDCP SDU [illegible]
M8011C24	LTE	[illegible] PRB [illegible]
M8011C37	LTE	[illegible] PRB [illegible]
M8013C17	LTE	RRC [illegible]
M8020C3	LTE	[illegible]
M40001C0	5G	[illegible]

[illegible]

pm_counters.csv

[illegible]

```
# [illegible],[illegible],[illegible]
M8012C23,[illegible],[illegible]
M8012C26,[illegible],[illegible]
M8001C2,[illegible],[illegible]
...
```

[illegible]`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]

[illegible]

- [illegible] - PM [illegible]
- Grafana [illegible] - [illegible] PM [illegible]
- InfluxDB [illegible] - [illegible] PM [illegible]

[illegible]

- **PM** [illegible] `https://localhost:9443/nokia/pm-filters`
- [illegible] `https://localhost:9443/nokia/retention`
- **InfluxDB** [illegible] `https://localhost:9443/nokia/influx`

RAN □□□□□□□□□

□□ config/runtime.exs

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1. □□
2. □□□□□
3. Web □□
4. □□□□□□
5. □□□□□
6. InfluxDB □□
7. □□□□□□

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`config/runtime.exs` □□□ RAN □□□

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- □□□□□□MySQL□
- Web □□□□□□□□
- □□□□□□□□□
- InfluxDB □□□□□□□
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```
config/runtime.exs
```

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MySQL/MariaDB □□

```
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
```

□□□ □□□□□□□□□□□□□□□□ MySQL □□□□□□

□□□□

username (□□□)

- □□□□□□□
- □□□□`"omnitouch"`
- □□□ □□□□ CREATE□SELECT□INSERT□UPDATE□DELETE □□

- [illegible] [illegible]

password ([illegible])

- [illegible]
- [illegible]`"omnitouch2024"`
- [illegible] [illegible]
- [illegible] [illegible]

hostname ([illegible])

- [illegible]
- [illegible]`"localhost"`
- [illegible]
  - `"localhost"` - [illegible]���
  - `"127.0.0.1"` - TCP [illegible]
  - `"10.179.2.135"` - [illegible] IP
  - `"db.example.com"` - [illegible]

database ([illegible])

- [illegible]
- [illegible]`"ran_monitor"`
- [illegible] [illegible] RAN [illegible]
- [illegible] `CREATE DATABASE ran_monitor CHARACTER SET utf8mb4 COLLATE utf8mb4_unicode_ci;`

stacktrace ([illegible])

- [illegible]
- [illegible]`true`
- [illegible] `true` - [illegible]
- [illegible] `false` - [illegible]

show_sensitive_data_on_connection_error ([illegible])

- [illegible]

- □□□□`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}` - □□□□□□□□
    - `{127, 0, 0, 1}` - □□□□□□□□□
    - `{10, 179, 2, 135}` - □□□ IP □□□□□

port (□□)

- TCP □□□
- □□□□`8080`
- □□□ □□□□□□□□□□□□□□□□
- □□□□ □□□□□□□ IP □□

check_origin (□□□)

- □□ WebSocket/HTTP □□□
- □□□□`false`
- □□□ □□ SOAP API □□□ `false`□□□□□□□□ Web UI□

secret_key_base (□□□)

- □□□□□□□□□
- □□□□64 □□□□□□□
- □□□ `mix phx.gen.secret`
- □□□□ □□□□□□□□□□□□□□□□□□□□
- □□□ □□□□□□□□□□□□□□

server (□□□)

- □□□□□□□□□□□
- □□□□`true`
- □□□ □ runtime.exs □□□ `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]
```

□□□□

level (□□)

- □□□□□□□□□□□
- □□□□`:info`
- □□□
  - `:debug` - □□□□□□□□□
  - `:info` - □□□□□□□□□□□
  - `:warning` - □□□□□□
  - `:error` - □□□

□□□□□□□□□

- □□□ `:debug` - □□□□□□□□
- □□□ `:info` - □□□□□□□□□□□□□
- □□□□□ □□□□□ `:debug`□□□□□
- □□□□□□ `:warning` - □□□□□□□□□□□

□□□□□

format (□□□)

- □□□□□□□□□
- □□□□`"$time $metadata[$level] $message\n"`
- □□□
  - `$time` - □□□
  - `$metadata` - □□□□□
  - `$level` - □□□□□info□error □□
  - `$message` - □□□□□□

metadata (□□□□)

- □□□□□□□□□
- □□□□`[:request_id]`
- **request_id:** □□□□□□□□ HTTP □□

[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 [illegible]

```
config :ran_monitor, RanMonitor.InfluxDbConnection,
  auth: [
    username: "monitor",
    password: "sideunderTexasgalaxyview_61"
  ],
  database: "nokia-monitor",
  host: "10.179.2.135"
```

[illegible] [illegible] InfluxDB [illegible]

□□□□

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 [illegible]

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

[illegible]

1. [illegible]

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

2. [illegible]

- [illegible] `[illegible]debug` [illegible]
- [illegible] `[illegible]info` [illegible]
- [illegible]

3. [illegible] RAN [illegible]

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

[illegible]

1. [illegible]

- [illegible] runtime.exs
- [illegible]
- [illegible]��[illegible]
- [illegible] RAN [illegible]

2. [illegible]

```
# 1. [illegible] runtime.exs
vim config/runtime.exs

# 2. [illegible] Elixir [illegible]
elixir -c config/runtime.exs

# 3. [illegible]
systemctl restart ran_monitor
```

3. [illegible]

- [illegible]CPU[illegible]
- [illegible]
- [illegible] 50+ [illegible] InfluxDB [illegible]
- [illegible] MySQL [illegible] InfluxDB [illegible]

[illegible]

[illegible]

```
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 [illegible] TCE

[illegible] (TCE)

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

[illegible] TCE[illegible]

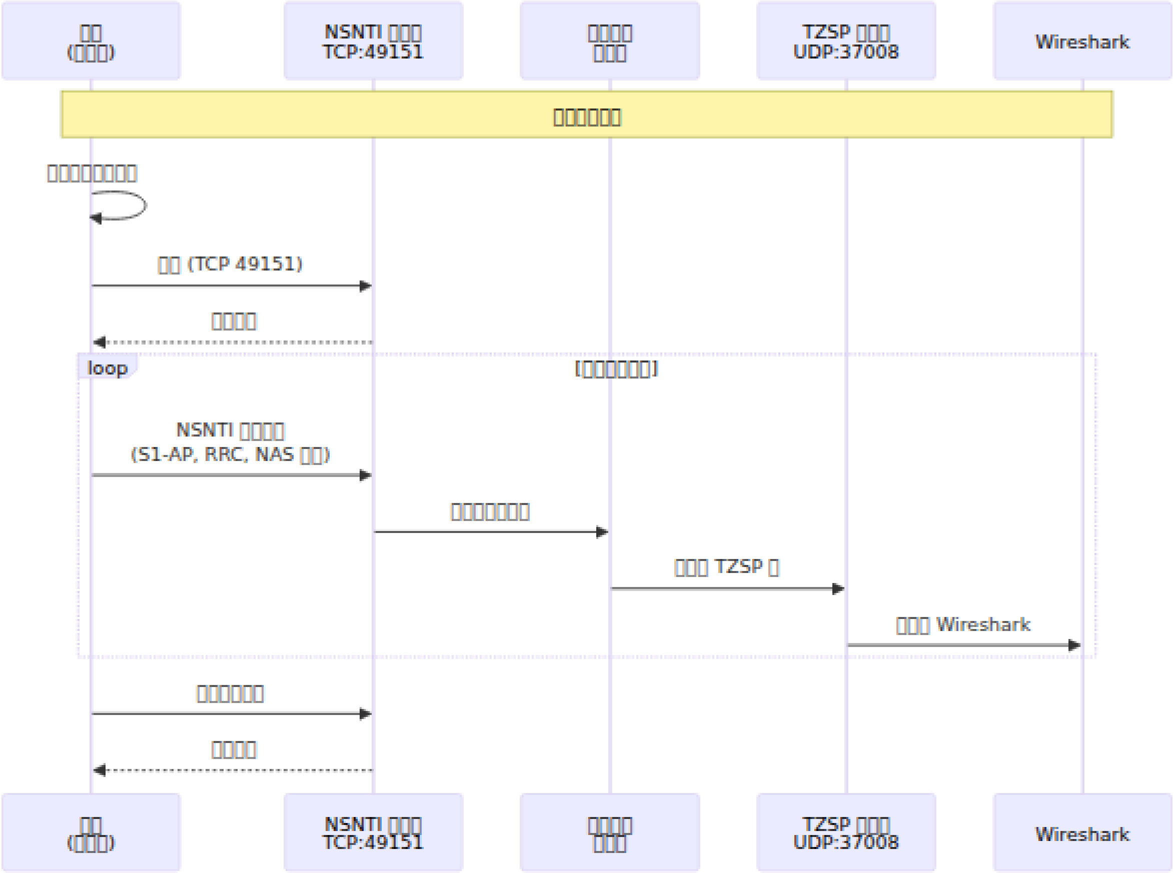
[illegible] AirScale [illegible]

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

TCE [illegible]

[illegible]	[illegible]	[illegible]	[illegible]
NSNTI [illegible]	TCP	49151	[illegible]
TZSP [illegible]	UDP	37008	[illegible] Wireshark [illegible]
[illegible]	ASN.1	-	[illegible] S1-AP [illegible] RRC [illegible]

[illegible]


NSNTI
TCP:49151
TZSP
UDP:37008
Wireshark
(TCP 49151)
loop
NSNTI
(S1-AP, RRC, NAS
TZSP
Wireshark

[illegible]NSNTI [illegible] (49151)[illegible]TZSP [illegible]

[illegible]

1. [illegible] **TCE** [illegible]

   ```
   ss -tlnp | grep 49151
   # [illegible]: LISTEN 0.0.0.0:49151
   ```

2. [illegible]

   - [illegible] IP [illegible] RAN Monitor [illegible]
   - [illegible] 49151
   - [illegible] (S1-AP, RRC, NAS)
   - [illegible]

3. [illegible] **Wireshark**[illegible]

   [illegible]

   - [illegible] TZSP [illegible]
   - [illegible]`udp port 37008`

   [illegible]

   RAN Monitor [illegible] UDP [illegible] RRC [illegible] Wireshark [illegible]“[illegible]”[illegible]

   [illegible] 1[illegible] Wireshark GUI

   i. [illegible] [illegible] → [illegible]...
   ii. [illegible] + [illegible]
   iii. ���[illegible]

□□	□	□□	□□	□□□
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	□□□□□□

□□□□□□□□□

```
# □□□□ TZSP □□□
tzsp

# □□□□□□
s1ap || rrc || mac-lte

# □□□□□ RRC □□
udp.port == 37011 || udp.port == 37012

# □□□□□ RRC □□
udp.port == 37001 || udp.port == 37002

# □□ RRC □□□□
rrc.rrcConnectionRequest || rrc.rrcConnectionSetup

# □□□□□□
s1ap.HandoverRequired || s1ap.HandoverCommand
```

□□

□□□□□

- □□□□□□ RF □□
- □□□□□□
- □□□□□□ (RSRP, RSRQ, SINR)
- □□□□□□

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- □□□□□□□□
- □□□□□□
- □□□□
- □□□□□□

□□□□□

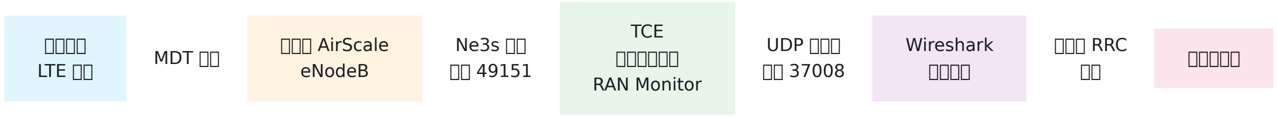
- PCI □□□□
- □□□□□□

- □□□□□□
- □□□□□□□

□□

□□□□□□□ **(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 □□□□□□□□□

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□□□□□

□□□ Airscale □□□□□ □□□□□□□ □□□□□□□□□□□□□□□□□□□□□□□□□

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□□□□

- □□ 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/□□□□□□

□□□□□□

- □□□□□□□□□ (MDT + □□□□□)
- □□□□□□□□□□
- □□□□□□□□ MDT (LTE Release 10+)

□□□□□□□□□□□□□ AirScale □□□□□□□□ ONS□

[illegible]

- ☐ [illegible] MDT [illegible]
- ☐ [illegible] AirScale [illegible] TCE IP (RAN Monitor IP) [illegible] 49151
- ☐ [illegible] RAN Monitor [illegible] TCE
- ☐ [illegible] MDT [illegible]
- ☐ [illegible] Wireshark [illegible] `udp port 37008`
- ☐ [illegible]`lte-rrc.measurementReport`
- ☐ [illegible]

[illegible]

- **Omnitouch [illegible] (ONS)**: [illegible] AirScale [illegible]

□□□□□□

RAN □□□□□□□

□□□□□□□□□□□□□□

□□

1. □□
2. □□□□□□
3. □□□□□□
4. Web UI □□
5. □□□□□
6. □□□□
7. □□□□
8. □□□□
9. □□□□

□□

□□□□□□□□□□□□ RAN □□□□□□□□□□□□□□□□□□□□□□□□□□□□

□□□□□□

1. □□□□

- □□□□□□□□□□
- □□□□□□□
- □□□□□□□□

2. □□□□

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

3. [illegible]

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

4. [illegible]

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

[illegible]

[illegible]

- RAN [illegible] (`ps aux | grep ran_monitor`)
- [illegible] (MySQL, InfluxDB)
- [illegible]
- [illegible]

[illegible]

[illegible]

[illegible]

- [illegible] Web UI [illegible]“[illegible]”

- □□□□□□□□□□□□□□
- □□□□□□□□□□
- □□□□□□□□□□□□

□□□□□

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 → □□□□□□ → □□□□□□□

□□□

- `[error] Authentication failed` → □□□□□
- `[error] Connection refused` → □□/□□□□□
- `[error] Timeout` → □□□□□□
- `[error] Certificate error` → □□□□□/□□□□

□□□□□

□□□□□

1. □□□□□□□□□□□□
2. □□ RAN □□□□□□□□□□□□□
3. □□□□□□□□
   - RAN □□□ → □□□□ 8080
   - □□ → RAN □□□□□ 9076□webhooks□
4. □ RAN □□□□□□□□□□

□□□□□□

1. □□□□□□□ WebLM □□□□□□□
2. □□ `config/runtime.exs` □□□□
3. □□ RAN □□□
4. □□□□□□□□□□□

□□/□□□□□□

1. □□□□□□□□□□□□
2. □□□□□□□□□□
3. □□□□□□□□□`telnet <device-ip> 8080`
4. □□□□□□□□□□

□□□□□/□□□□□

1. □□□□□□□□□
   - `priv/external/nokia/ne.key.pem`
   - `priv/external/nokia/ne.cert.der`
2. □□□□□□□□□□□

3. □□□□□□□□□□ Nokia □□□□
4. □□□□□□□□□□ Nokia □□

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- □□□□□“□□□□”□□
- Web UI □□□□□□��□□□/□□
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Web UI → □□ → □□□□ → □□□□□□□

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2. □□□□□□□□

□ `config/runtime.exs` □□

```
nokia: %{
  ne3s: %{
    reregister_interval: 30  # □□ 30-60 □
  }
}
```

3. □□□□□□□

- □□□□□□□□□□□□
- □□□□□□□`ping <device-ip> -c 100`
- □□□□□□□□□□□□□

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]

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- □□□ Web UI □□□□“□□□”□□□□
- □□ InfluxDB □□□□□□□
- Grafana □□□□□□□□
- InfluxDB □□□□□□□□□□□

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Web UI → □□□

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2. □□ **InfluxDB** □□

Web UI → InfluxDB □□□

- □□□□□□□□□
- RAN □□□□□□□ InfluxDB□

□□□□□

```
# □ RAN □□□□□□
curl http://<influxdb-host>:8086/ping
```

3. □□□□□□□□

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- `[error] InfluxDB write failed` → □□□□□□□
- `[error] Failed to collect metrics` → □□□□□□
- `[info] Metrics collected: 0` → □□□□□□□

4. [illegible] InfluxDB

[illegible] InfluxDB [illegible]

```
# 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()'
```

[illegible]

InfluxDB [illegible]

1. [illegible] InfluxDB [illegible]
2. [illegible] `config/runtime.exs` [illegible]
    - [illegible]
    - [illegible]8086[illegible]
    - [illegible]/[illegible]
    - [illegible]/API [illegible]
3. [illegible] RAN [illegible]
4. [illegible] 8086
5. [illegible] RAN [illegible]

InfluxDB [illegible]

1. [illegible]/[illegible]
2. [illegible] InfluxDB [illegible]
3. [illegible] API [illegible]
4. [illegible] `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 □□□□□□□□□□□□□□
- □□ InfluxDB □□
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- □□ RAN □□□□□□□□□□□□

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- □□ InfluxDB □□□□
- □□□□□□□□□□□□□/□□

Web UI □□

□□□□□□ Web UI

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- □□□□□□□□ https://<ran-monitor-ip>:9443
- □□□□□□□□
- SSL □□□□

□□□□□

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. [illegible]

```
# [illegible]
sudo iptables -L -n | grep 9443

# [illegible]
sudo firewall-cmd --list-ports
```

[illegible]

[illegible]

1. [illegible]

   ```
   sudo firewall-cmd --add-port=9443/tcp --permanent
   sudo firewall-cmd --reload
   ```

2. [illegible]

Web UI [illegible]

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

SSL [illegible]

1. [illegible]

   ```
   ls -l priv/cert/omnitouch.pem
   ls -l priv/cert/omnitouch.crt
   ```

2. [illegible]

   ```
   openssl x509 -in priv/cert/omnitouch.crt -text -noout
   ```

3. [illegible]
4. [illegible] RAN [illegible]

[illegible]

1. [illegible] `config/runtime.exs` [illegible]
2. [illegible]
3. [illegible] `CONTROL_PANEL_HTTPS_PORT` [illegible]

[illegible]Web UI [illegible]

[illegible]

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

[illegible]

1. [illegible]

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

```
airscales: [
  # [illegible]
]
```

2. [illegible]

[illegible] MySQL [illegible]

```
mysql -u ran_monitor_user -p ran_monitor -e "SELECT * FROM
airscales;"
```

3. [illegible]

[illegible]

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□□□□□□

1. □ `config/runtime.exs` □□□□□
2. □□ RAN □□□
3. □□□□□□ Web UI □

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1. □□ MySQL □□□□□□
2. □□ `config/runtime.exs` □□□□□□
3. □□□□□□□
4. □□ RAN □□□

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□□□MySQL □□□□

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- □□□□□□□□□□□□□□□
- Web UI □□□□□□□□□
- “□□□□□□□”□□

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1. □□ MySQL □□□□□□

```
systemctl status mysql
# □
systemctl status mariadb
```

2. □□□□

□ RAN □□□□□□□

```
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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1. □□□□□□□□□□□□□□□□□□
2. □□□□□□
3. □□□□□□□□□ `config/runtime.exs`
4. □□ RAN □□□

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1. □□□ MySQL □□□□□□□□
2. □□□□□□□□□□□ 3306
3. □□ MySQL □□□□□□□□□□□□□□□□□□

□□□□□

1. [illegible] MySQL max_connections [illegible]
2. [illegible] pool_size
3. [illegible] RAN [illegible]

[illegible]

[illegible] CPU [illegible]

[illegible]

- RAN [illegible] CPU [illegible] RAM
- [illegible]
- [illegible]
- [illegible]

[illegible]

1. [illegible]

```
# CPU [illegible]
top -p $(pgrep -f ran_monitor)

# [illegible]
ps aux | grep ran_monitor
```

2. [illegible]

[illegible]

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

3. [illegible]

[illegible]

- [illegible] = [illegible] CPU/[illegible]
- [illegible] 10 [illegible]

4. [illegible]

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

```
pool_size: 10  # [illegible]
```

[illegible]

[illegible]

1. [illegible]
2. [illegible]CPU/RAM[illegible]
3. [illegible]
4. [illegible]

[illegible]

1. [illegible] pool_size
2. [illegible] 2 [illegible] + 5 [illegible] Web UI
3. [illegible] RAN [illegible]
4. [illegible]

[illegible]

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

InfluxDB [illegible]

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

[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]

[illegible]

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

[illegible]

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

[illegible]

[illegible]

[illegible]

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

[illegible]

1. [illegible]

[illegible]

2. [illegible] Webhook [illegible]

Webhook [illegible]

```
netstat -tulpn | grep 9076
```

[illegible]

```
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]

3. □□□□□□□□□□ RAN □□□□□ 9076
4. □□□□□□□□□□□□
5. □□□□□□□□□□`telnet <ran-monitor-ip> 9076`

InfluxDB □□□□□

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

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□□ Web UI □□□

1. □□□□□□□□□□□
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3. □□□□□
4. □□□□□□□□□

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□□□□ systemd □□□□□

```
journalctl -u ran_monitor -f
```

□□□□ mix □□□

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- □□ - □□□□□□
- □□ - □□□□□□

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- □□□□□□□□“Site-A-BS1”□
- “error” □ “failed”
- “InfluxDB” □ “MySQL”
- “registration” □ “session”

InfluxDB □□

□□□□□□□□

```
influx -database 'nokia-monitor' -execute '
  SELECT * FROM PerformanceMetrics
  WHERE basebandName='''Site-A-BS1'''
  AND time > now() - 5m
  LIMIT 10
'
```

□□□□□□□□

```
influx -database 'nokia-monitor' -execute '
  SELECT COUNT(*) FROM PerformanceMetrics
  GROUP BY basebandName
'
```

□□□□□

```
influx -database 'nokia-monitor' -execute '
  SELECT * FROM Alarms
  WHERE time > now() - 1h
'
```

MySQL □□

□□□□□□□□

```
SELECT name, address, port, registration_status
FROM airscales;
```

□□□□□□□□□□

```
mysql -u ran_monitor_user -p ran_monitor -e "SHOW PROCESSLIST;"
```

□□□□

□□□□□

```
# □□□□
ping <device-ip>

# □□□□□□
telnet <device-ip> 8080
nc -zv <device-ip> 8080

# □□□□
traceroute <device-ip>
```

□□□□□□

```
# □□□□
sudo iptables -L -n -v

# □□□□□□
sudo iptables -L -n | grep 8080
```

[illegible]

[illegible]

[illegible]

1. [illegible]

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

2. [illegible]

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

3. [illegible]

- RAN [illegible]
- [illegible]
- [illegible]MySQL[illegible]InfluxDB[illegible]
- [illegible]

4. [illegible]

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

5. [illegible]

- [illegible]
- [illegible]
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[illegible]

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

[illegible]���[illegible]

[illegible]

- Web UI [illegible]
- [illegible]`journalctl -u ran_monitor`
- [illegible]

[illegible]

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

[illegible]

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

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[illegible]

1. [illegible]
2. [illegible]
3. [illegible] Omnitouch [illegible]
4. [illegible]
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   - [illegible]
   - [illegible]

[illegible]

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

Web UI □□

RAN □□□□□□ - □□□□□□

□□ RAN □□□□ Web □□□□□□□□□□□

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10. □□□□□□□□
11. InfluxDB □□□□
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13. PM □□□□□□
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15. □□□□□□
16. Web UI □□□□

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RAN □□□□□□□□□□□ Web □□□□□□□□□□□□□□□□□□□Web UI □□□□□□□□□□□□□□□□□□□□□□□□□

Web UI □ Grafana

Web UI □□□□

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□□ Grafana □□□□□□□□□□ Grafana □□□□□

□□ Web UI

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

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

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Web UI [illegible]

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2. [illegible]“[illegible]”
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4. [illegible] XML [illegible]

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2. [illegible] XML [illegible]
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2. □□□□□□□□ **`config/runtime.exs`**□
   ```
   airscales: [
     %{
       address: "10.7.15.66",
       name: "Site-A-BS1",
       port: "8080",
       web_username: "admin",
       web_password: "password"
     }
   ]
   ```
3. □□ **RAN Monitor** □□□□□□□

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

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

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

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PM [illegible]

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

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WCDMA	M5xxx	3G WCDMA □□□
5G-NR	M55xxx	5G NR □□□
5G-□□□	M51xxx	5G □□□□□
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□□ Nokia AirScale □□□□□□□□□□□□□

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

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1. [illegible] RAN Monitor
2. [illegible] [illegible] **URL** [illegible] URL
3. [illegible] WebEM [illegible] [illegible]
4. [illegible] URL [illegible] [illegible]
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URL: `https://<ran-monitor-ip>:9443/nokia/data`

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ETS [illegible]

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

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Web UI [illegible]

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9. [illegible]

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1. [illegible] eNodeBs [illegible]
2. [illegible] ID [illegible] IP [illegible]
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4. [illegible] RAN Monitor [illegible]
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9. [illegible] Grafana [illegible]

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