

TM Forum

ANLAV Report

Vodafone Türkiye

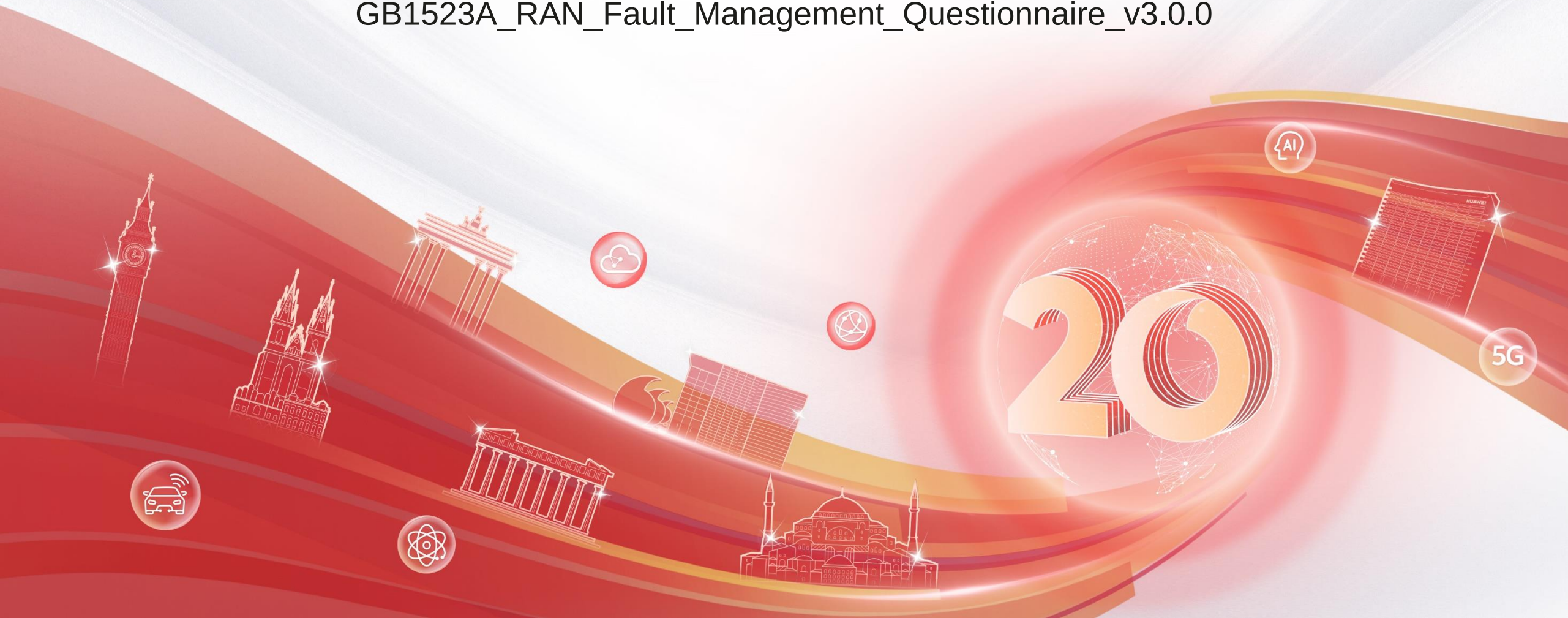
GB1523A – RAN Fault Management

Version: 3.0.0

Score: 3.4 (3.38)

Vodafone Türkiye RAN Fault Management ANL Assessment

GB1523A_RAN_Fault_Management_Questionnaire_v3.0.0



RAN Fault Management ANL Assessment Overall Score

Cognitive Activity (IAADE)	Service Capability	Weight	Sub-Scenario Answer (refers to 3GPP TS 28.111)					Final Score
			Equipment	Processing Error	Communications	Environmental	Security	
			(should include but not limit to Transceiver problem, Receiver Failure)	(should include but not limit to Invalid parameter, Software Environment Problem)	(should include but not limit to Fronthaul error, Backhaul error, IP/GPS clock error, Antenna feeder error)	(should include but not limit to External power supply failure, External equipment failure)	(should include but not limit to Key Expired, Authentication Failure, Unauthorised Access Attempt)	
			15%	15%	30%	30%	10%	
Intent	Intent-driven	10%	B	B	B	B	B	3.4
Awareness	Data collection & Alarm filtering	10%	A	A	A	A	A	
	Fault Prediction	15%	C	B	C	B	B	
Analysis	Fault identification & Impact analysis	20%	A	A	A	A	A	
	Demarcation & Locating	20%	A	A	B	A	A	
	Solution generation	10%	A	A	A	A	A	
Decision	Evaluation and decision-making	10%	A	A	A	A	A	
Execution	Solution implementation	5%	B	B	B	B	B	



Intent-driven

Service Capability	Weight	Question	Option A	√ Option B	Option C	Option D
Intent-driven	10%	Does the wireless network fault management system have the capability of automatically generating fault management task targets, policies and evaluating the implementation effect based on intent? Note: Based on the specified fault management intent (such as the out-of-service duration), the system determine the fault management targets (such as the proportion of pre-event trouble tickets and fault locating duration) and fault management policy (such as redundancy backup).	The system automatically generates fault management task targets and policies based on intent by using intelligent model. Fault management targets and policies need to be manually confirmed. The system automatically evaluates the implementation effect.	The system automatically generates fault management task targets based on predefined rules. Fault management targets and policies need to be manually defined. The effect is manually evaluated after the intent is implemented.	Fault management task targets and policies are manually defined based on expertise. Manually evaluate the effect after the intention is implemented, assisted by tools and system.	Manually set fault management task targets and evaluate the effect.

Equipment	Processing Error	Communications	Environmental	Security
B	B	B	B	B



Intent-driven

Evidence :

For alarm aggregation

For auto diagnosis & auto RCA

Incident Settings

Incident Enable ☒

NE Management

Frequent Incident Policies

Alarm Priority Policies

Correlation Policies

Troubleshooting Policies

Incident Filtering Policies

Switch Settings

Troubleshooting Policies

Aggregation Time Window Settings

Incident Update Policy Settings

MBTS inter-RAT Aggregation Settings

Northbound Forwarding Policy Settings

Diagnosis Scenario Settings

...

* Association time period (minutes)

5

?

* Forcible aggregation termination period (minutes)

30

?

Alarm Aggregation Period Settings ?

Set by Alarm ID Set by NE Type

Enter a keyword

Q

Delete

Create

☐	Alarm ID	Alarm Name		Forcible aggregation termination period (...)	Operation
☐	12300	Board Hardware Failure Alarm	Equipment	3	Edit Delete
☐	26811	Configured Capacity Limit Exceeding Licensed Limit	Processing Error	0	Edit Delete
☐	26234	BBU CPRI Interface Error	Communications	5	Edit Delete
☐	26504	RF Unit CPRI Interface Error	Communications	5	Edit Delete
☐	28003	AC Input Power Failure	Environmental	5	Edit Delete
☐	21030	Imminent Certificate Expiry	Security	0	Edit Delete

MBTS inter-RAT Aggregation Settings

Northbound Forwarding Policy Settings

Fault Clearance Policy Settings

Diagnosis Scenario Settings

...

Policy Name

NE Disconnection & Out of Service

Cell Fault

User Operation

Fronthaul Network Fault

Backhaul Network Fault

Clock Fault

Antenna Feeder System Fault

RF Unit Fault

BBU Board Fault

BTS Software Fault

Peripheral and Environment Faults

2G Fault

Policy Status

☒

☒

☒

☒

☒

☒

☒

☒

☒

☒

☒

The System provide the capabilities for user to configure a certain criteria (include Equipment/Processing Error/Communications/Environmental/Security) to carry out automation such as aggregate the alarm, auto diagnose the root



Data collection & Alarm filtering

Service Capability	Weight	Question	√ Option A	Option B	Option C	Option D
Data collection & Alarm filtering	10%	Does the wireless network fault management system support automatic data collection & alarm filtering in various fault scenarios?	The system automatically collects data (alarm, configuration, and performance data etc.), and correlates alarms. All data required are automatically collected, no need for additional manually collected data.	The system collects data (alarm, configuration, and performance data etc.), and correlates alarms based on manually defined rules	Manually selects and uses the system to collect data and correlate alarms.	

Equipment	Processing Error	Communications	Environmental	Security
A	A	A	A	A



Data collection & Alarm filtering

Evidence:

Alarm data collection & correlation(Alarm data)

Equipment - A

☐	Operation	Category ↑↓	Incident Name ↑↓	NE Name ↑↓	Occurred On ↓	Diagnosis Status	Self-Healing Status	B	
✓	☐		BBU Board Fault	Board Hardware Abn...	GL [REDACTED] EPE...	2026-05-11 23:41:00	Diagnosis succeeded	Repairable	-

Description: AFFECTED_RAT: U-L-N, Board Hardware Abnormal-Board Hardware Fault: Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, Specific Problem=Other

Alarms | Root Causes | Comments

The system automatically collects data and correlates alarms.

Severity ↑↓	Alarm ID	Name ↑↓	Source Obj
Major	26200	Board Hardware Fault	GL 27 Y907

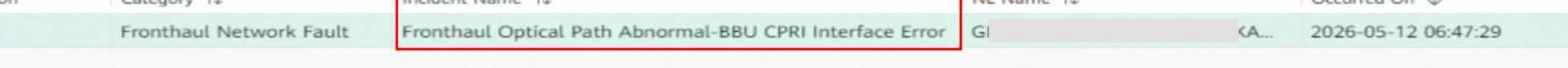
The system automatically collects data and correlates alarms.

Processing Error - A

☐	Operation	Category TL	Incident Name TL	NE Name TL	Occurred On ↓	Diagnosis Status	Self-Healing Sta
	☐	BTS Software Fault	License Abnormal-License on Trial	GL [REDACTED] FLA...	2026-05-11 10:13:19	Diagnosis succeeded	Unrepairable
Description: AFFECTED_RAT: N, License Abnormal-License on Trial: Function Type=gNodeB Function, Trial Reason=Expired License, Grace Period Expire Date=2026-07-07							
The system automatically collects data and correlates alarms.							
<u>Alarms</u>	Root Causes	Comments					
Severity TL	Alarm ID	Name TL	Source Obj				
Major	26817	License on Trial	GL01 V903				

The system automatically collects data and correlates alarms.

Communications - A



The system automatically collects data and correlates alarms.

The system automatically collects data and correlates alarms.



Data collection & Alarm filtering

Evidence:

Alarm data collection & correlation(Alarm data)

Environmental - A

☐

Operation

Category

↑↓

Incident Name

↑↓

NE Name

↑↓

Occurred On

↓

Diagnosis Status

Self-Healing Status

✓

✎

🔔

RF Unit Fault

RF Unit Power Suppl...

GL3

2026-05-11 21:10:07

Diagnosis succeeded

Unrepairable

Description: **AFFECTED_RAT: U-L, RF Unit Power Supply Abnormal-RF Unit External Power Supply Insufficient: Cabinet No.=0, Subrack No.=82, Slot No.=0, Power Port=NULL, Board Type=MRRU, Specific Problem=Cabinet Power Supply Abnormal**

Alarms

Root Causes

Comments

Severity

↑↓

🔍

Alarm ID

🔍

Name

↑↓

🔍

Source Object Name

Minor

26546

🔔 RF Unit External Powe...

GL3

Minor

26546

🔔 RF Unit External Powe...

GL3

Minor

26546

🔔 RF Unit External Powe...

GL3

The system automatically collects data and correlates alarms.

Security - A

☒

Operation

Category

↕

Incident Name

↕

NE Name

↕

Occurred On

↕

Diagno

✓

✎

🔔

BTS Software Fault

Version or Certificate Abnormal-Certificate Invalid

GL6

IM

2026-05-11 21:13:30

Diagn

Description: **AFFECTED_RAT: G-L, Version or Certificate Abnormal-Certificate Invalid: Certificate Type=Application certificate, Certificate Name=Vodafone.com.cer, Vendor Cert ID=No, Specific Problem=Expired**

Alarms

Root Causes

Comments

Severity

↕

🔍

Alarm ID

🔍

Name

↕

🔍

Source Object Name

Major

26841

🔔 Certificate Inval...

GL6

The system automatically collects data and correlates alarms.



Data collection & Alarm filtering

Evidence:

Alarm data collection & correlation(performance, configuration)

KPI Alarm List

☐	Operation	Severity ↑↓	Alarm ID ↑↓	Name ↑↓	NE Type ↑↓	Alarm ... ↑↓	MO ... ↑↓	Location Information ↑↓ ⊙
☐		Major	21820	GSM KPI Exceed Threshold	BSC6910 G...	BMDPH07	Subrack ...	Subrack No.=1, Slot No.:
☐		Major	21820	GSM KPI Exceed Threshold	BSC6910 G...	BSAMH04	Subrack ...	Subrack No.=1, Slot No.:
☐		Major	21820	GSM KPI Exceed Threshold	BSC6910 G...	BMDPH07	Subrack ...	Subrack No.=1, Slot No.:
☐		Major	22302	KPI Exceed Threshold	BSC6910 U...	RSAMH05	RSAMH...	Subsystem No.=2018, KI

Configuration Data

Reports

NE Report

NE Statistical Report

Link Report

RAN Report

MBTS Relationship Report

RBTS Relationship Report

Enter a keyword.

Query(Q)

Save(S)

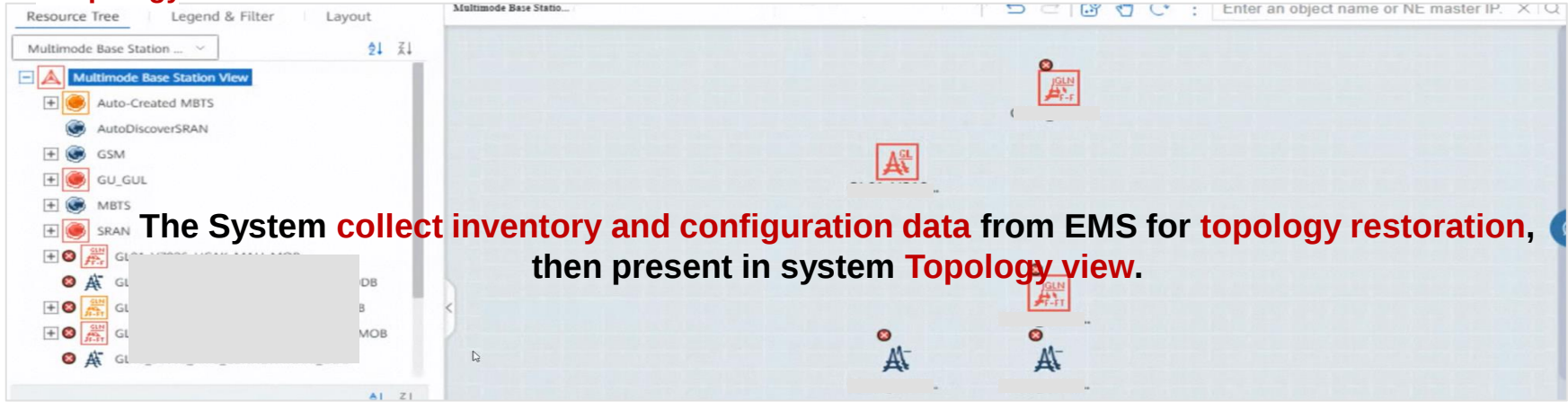
Export BTS Maintenance Region Info(R)

NE Name ↑↓	NE Type ↑↓	IP Address 1 ↑↓	IP Address 2 ↑↓	Version ↑↓ ⊙
GL [redacted] ce	BTSS900	10 [redacted]		BTSS900 V100R021C
GL [redacted] ar	BTSS900	10 [redacted]		BTSS900 V100R021C
GL [redacted] cka_YayL...	BTSS900	10 [redacted]		BTSS900 V100R021C
GL [redacted] layli	BTSS900	10 [redacted] 8		BTSS900 V100R021C
GL [redacted] ?	BTSS900	10 [redacted]		BTSS900 V100R021C
GL [redacted] RICILER	BTSS900	10 [redacted] 74		BTSS900 V100R021C
GL [redacted] I 1	BTSS900	10 [redacted] 6		BTSS900 V100R021C

Total records: 4592

100/pa... < 1 2 3 4 ... 46 > 1 Go

Topology



Multimode Base Station...

Enter an object name or NE master IP.

The System collect inventory and configuration data from EMS for topology restoration, then present in system Topology view.



Data collection & Alarm filtering

Evidence:

Alarm Data Automatically Collecting Logs

```
13686-11 18:40:13.801(154362|255414)000 MedFm: loc=PduInfoIdn=NE=10520,aid=26234, AlarmName=BBU CPRI Interface Error,DevCsn=[REDACTED] Category=Fault,Severity=Minor,alarmType=Hardware,RaiseTime=2026-06-11 18:40:13,RootCauseFlg=1,Location=Cabinet No.=0, Subrack No.=0, Slot No.=4, Port No.=0, Sub Port No.=0, Board Type=UBBP, Specific Problem=Receive Power Too Low,AddText=RAT_INFO=G-L-N, AFFECTED_RAT=DID=NULL, Cumulative Duration(s)=90, RRU Name=NULL, ES=[REDACTED] AddText1=AF_L=[REDACTED]

2026-06-11 18:40:14.025 INFO [3b54b46e-d340-401b-9fba-5c7117a00eb9] [SEND][2021][1]([NE=10520,26234,103107,51005,1781203124000,null,1,null,BBU CPRI Interface Error,BTS5900,RAT_INFO=G-L-N, AFFECTED_RAT=L, DID=NULL, RRU Name=NULL, ESN=2103058626100B110618, eNodeBId=21195, gNodeBId=121195,alarmNotifyTime=1781203213000, TargetMEFDN=null, alarmNotifyUtc=1781192413000, AdditionInfo_1=AF_L=EN28_21195_S1727_GIRESUN_CAVUSOGLU, nativeFmDn=NE=10520, alarmSource=GL28_S1727_GIRESUN_CAVUSOGLU, vflag=0, msgSerialNo=103107, mbscLabel=0, RATType=4])
```

Alarms are reported from NE in real time Automatically

Alarms are received by MAE in real time Automatically

Performance Data Automatically Collecting Logs

```
I169:6-11 04:21:02.477(130588|135844)PmMed: NeReportNotify::pushRstFileReadyMsg[NE=1456|A20260611.0415+0300-0420+0300_EMS-SHORTPERIOD.mrf.bz2]
I169:6-11 04:26:02.383(130588|135838)PmMed: NeReportNotify::pushRstFileReadyMsg[NE=1456|A20260611.0420+0300-0425+0300_EMS-SHORTPERIOD.mrf.bz2]
I169:6-11 04:31:02.380(130588|135836)PmMed: NeReportNotify::pushRstFileReadyMsg[NE=1456|A20260611.0425+0300-0430+0300_EMS-SHORTPERIOD.mrf.bz2]
I169:6-11 04:31:13.332(130588|135839)PmMed: NeReportNotify::pushRstFileReadyMsg[NE=1456|A20260611.0400+0300-0430+0300_EMS-NORMAL.mrf.bz2]
I169:6-11 04:36:02.471(130588|135843)PmMed: NeReportNotify::pushRstFileReadyMsg[NE=1456|A20260611.0430+0300-0435+0300_EMS-SHORTPERIOD.mrf.bz2]
```

PM data are received by MAE in real time Automatically

Configuration Data Automatically Collecting Historical Records

Start Time	End Time	Execution Result
2026-03-04 22:30:02	2026-03-04 22:46:42	Partially successful
2026-03-05 22:30:02	2026-03-05 22:46:17	Partially successful
2026-03-06 22:30:02	2026-03-06 22:46:32	Partially successful

Summary:
Start time: 2026-06-11 22:30:09
End time: 2026-06-11 22:46:40
Execution result: Partially successful
Total: 4837
Succeeded: 4776
Failed: 61

Configuration data are update to MAE Automatically every day



Fault Prediction

Service Capability	Weight	Question	Option A	√ Option B	√ Option C	Option D
Fault Prediction	15%	Does the wireless network fault management system support fault prediction in various fault scenarios?	The system identifies potential risks and predicts the fault occurrence time based on intelligent models without the need for human intervention.	The system identifies potential risks based on intelligent models, but cannot predict the fault occurrence time.	The system identifies potential risks based on manually defined rules. For example, the system can identify potential risks of fronthaul optical modules based on preset optical power thresholds.	Potential risks need to be manually identified based on expertise.

Equipment	Processing Error	Communications	Environmental	Security
C	B	C	B	B



Fault Prediction

Evidence:

Equipment - C

The screenshot shows the 'Alarm Details' window for alarm ID 26520. The alarm name is 'RF Unit TX Channel Gain Out of Range'. The details include:

- Common Alarm Identifier:** NA
- Maintenance Region:**
- Occurred On (NT):** 2026-05-13 10:02:03
- Occurrence Times:** 1
- Severity:** Minor
- Occurrence Notify Time (N...):** 2026-05-13 10:04:33
- Additional Information:** RAT_INFO=G-U-L-N, AFFECTED_RAT=UL, DID=AUTODID_20200721_23a37508-cae6-11ea-8000-005056985, RF Site Name=NULL, RF Unit Name=RruName, Cumulative Duration(s)=150, ESN=2101574, eNodeBId=40899, gNodeBId=140899
- First Occurred (NT):** 2026-05-13 10:02:03
- Subnet:** ROOT/SRAN/Adana
- Alarm Duration:** 0 hours 8 minutes 17 seconds
- Alarm ID:** 26520
- Type:** Hardware system
- NE Virtual Mark:** No
- Location Information:** Cabinet No.=0, Subrack No.=82, Slot No.=0, TX Channel No.=0, Board Type=MRRU, Input Power (0.1 dBfs)=-200, Output Power (0.1 dBm)=417

The bottom of the window shows a summary bar with the alarm ID, name, and NE type.

The system automatically collects potential risk alarms reported based on preset rules.



Fault Prediction

Evidence:

Processing Error - B

The screenshot shows the iMaster Data Studio console interface. At the top, there's a navigation bar with tabs for 'Overview', 'Task Management', 'Data Management', 'GDM Application', 'UMIS Application', 'LIS Application', 'NIS Application', and 'SMM Application'. The 'Task Management' tab is active, showing a list of tasks. The task 'Export Incremental Scripts' is selected, and its details are displayed in the main panel. The task is in a 'Succeeded' state, as indicated by the green checkmark and the 'Succeeded' label. The console shows the task's basic information, including the user '401-2-IncrementalScript_2020-05-13-10-05-16', the file path '401-2-IncrementalScript_2020-05-13-10-05-16', the file size '1.1 KB', and the file type 'Excel 2007-2019'. The task is associated with the user '401-2-IncrementalScript_2020-05-13-10-05-16' and the file '401-2-IncrementalScript_2020-05-13-10-05-16.xlsx'.

Information						
Information		Detail				
The impacts of script are as follows: NE Name: SHW-PRT_MEW_5G_1144						
Type	TL	NE Name	Operation	Information	File	Affect ... Affect ... Risk Level
High-Risk			Released MOCUpdate VLANMAP(VRFIDx="0",NEXTHORIP="10.6.85.130",MASK="255.255.255.252") Risky parameter(s): VLANID	[Interworking Parameter] The operation might disrupt all the services or OM channels that depend on this VLAN. Modify the peer configuration to ensure that the negotiation is consistent. You are advised to run the CFM CB command to enable configuration data rollback.		e_20 YES YES Major
			Released MOCUpdate VLANMAP(VRFIDx="0",NEXTHORIP="10.5.185.130",MASK="255.255.255.252") Risky parameter(s): VLANID	[Interworking Parameter] The operation might disrupt all the services or OM channels that depend on this VLAN. Modify the peer configuration to ensure that the negotiation is consistent. You are advised to run the CFM CB command to enable configuration data rollback.		e_20 YES YES Major
Total records: 4				10/page		

Information

Detail

Total number of NEs involved in script activation: 1

High-Risk operation NE statistics

High-Risk operation NE	1	Reset risk NE	0	Disconnection risk NE	1
------------------------	---	---------------	---	-----------------------	---

High-Risk operation level statistics

Critical	0	Major	0	Warning	10
----------	---	-------	---	---------	----

High-Risk operation object statistics

The number following an object in the statistics information indicates the number of high-risk records related to the object.)

Operation type	Statistics
Added	BBP(1), RRUCHAIN(3), RRU(3), NRDUCellIntrBand(3)

Sum

1. EMS can identify various high-risk information present in scripts

2. Click on Detail to view detailed information about high-risk alerts

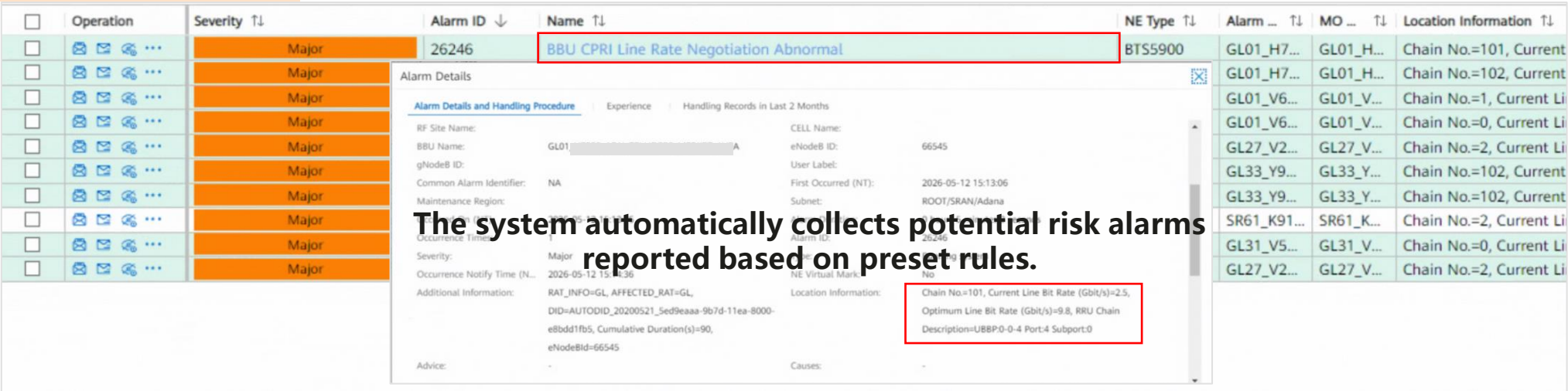
3. When the user triggers the script deployment, the script risk is prompted again, and the script can only be deployed after the user confirms.



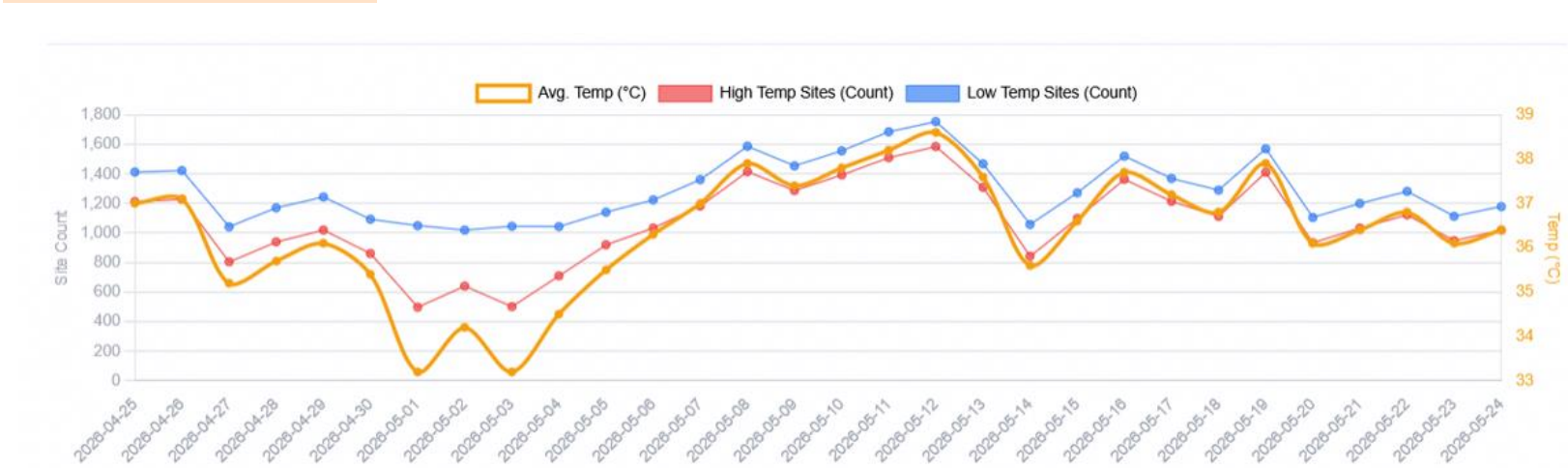
Fault Prediction

Evidence:

Communications - C



Environmental - B



Fault Prediction

Evidence:

Security - B

Operation

Severity

Alarm ID

Name

NE Type

Alarm Source

MO Name

Location Information

Minor

26840

Imminent Certificate Expiry

BTS5900

GL33_E4031_MRS_ORGANIZE_2...

GL33_E4031_MRS_ORGANIZE_2_VI...

Certificate Type=CRL, Certificate N...

Alarm Details

Alarm Details and Handling Procedure

Experience

Handling Records in Last 2 Months

BBU Name:

GI

2-TF

eNodeB ID:

41035

gNodeB ID:

141035

User Label:

Common Alarm Identifier:

NA

First Occurred (NT):

2026-03-04 04:14:56

Maintenance Region:

Subnet:

ROOT/EASY_DEPLOYMENT

Occurred On (NT):

2026-03-04 04:14:56

Alarm Duration:

78 hours 5 minutes 35 seconds

Occurrence Times:

1

Alarm ID:

26840

Severity:

Minor

Type:

Security service or mechanism violation

Occurrence Notify Time (NT):

2026-03-04 04:15:07

NE Virtual Mark:

No

Additional Information:

RAT_INFO=L-N, AFFECTED_RAT=L-N,
DID=AUTODID_20210603_be137f32-c3d5-11eb-8000-fa163e941

Location Information:

Certificate Type=CRL, Certificate Name=mrsorg.crl,
Expire Time=2026-03-10 17:07:00, Vendor Cert ID=No

Advice:

-

Causes:

-

Processing Status

Clearance Status

Acknowledgement Status

Comments

Click to edit comments.

Close

MAE can automatically identify certificate expiration dates and provide notifications 6 days in advance. Based on this type of security certificate prediction.



Fault identification & Impact analysis

Service Capability	Weight	Question	√ Option A	√ Option B	Option C	Option D
Demarcation & Locating	20%	How does the wireless network fault management system support fault identification & fault impact analysis in various fault scenarios?	The system identifies faults and subsequent impact based on intelligent models without the need for human intervention.	The system identifies faults and subsequent impact based on intelligent models, but need human intervention.	The System identifies faults and subsequent impact based on manually defined rules, for example, identifying intermittent faults based on a frequency experience threshold and aggregating periodic alarms based on a period threshold.	Faults and impact need to be manually identified based on human expertise or through the execution of manual written procedures.

Equipment	Processing Error	Communications	Environmental	Security
A	A	A	A	A



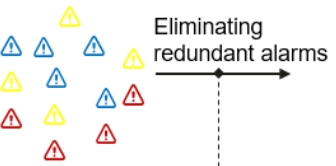
Fault identification & Impact analysis

Evidence:

Fault identification

Collaborate with expert experience of NE fault derivation relationships and fault pattern mining to minimize the number of work orders.

Massive alarms



Eliminating redundant alarms

Valid alarms

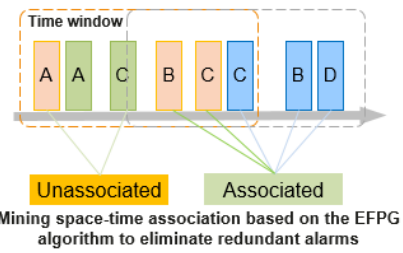


Root alarm and top-layer correlative alarm

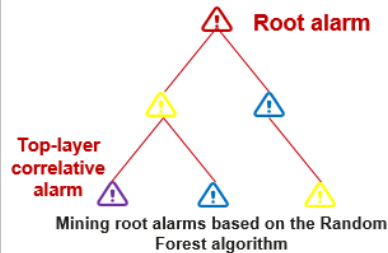
Incidents



Intelligent alarm correlation



Root alarm identification



Intelligent Fault Incident Management

Incident Logs

Incident List

Operation	Category	Incident Name	NE Name	Occurred On	Diagnosis Status
☐	T1	T1	T1	↓	
☐	Fronthaul Network Fault	Fronthaul Optical Path Abnormal-BBU CPRI Interface Error	GL5	MAH 2026-05-12 05:36:04	Diagnosis success

Description: AFFECTED_RAT: G-L, Fronthaul Optical Path Abnormal-BBU CPRI Interface Error: Cabinet No.=0, Subrack No.=0, Slot No.=3, Port No.=1, Sub Port No.=0, Board Type=UBBP, Specific Problem=CPRI Interface Reception Error

Alarms

Alarm List

Severity	Alarm ID	Name	Source Obj
Major	26234	BBU CPRI Interface Er...	GL52_C376
Major	29240	Cell Unavailable	GL52_C376
Major	29240	Cell Unavailable	GL52_C376
Major	29240	Cell Unavailable	GL52_C376

Total records: 4

MAE use intelligent model mining to extract alarm correlation rules for faults, enabling real-time alarms to be automatically aggregated and identified as fault events based on these rules.



Fault identification & Impact analysis

Evidence:

Fault identification

Equipment - A

The system identifies hardware faults based on intelligent models without the need for human intervention.

The screenshot shows the 'Incident Logs' interface. A red box highlights the 'Incident List' table with the following data:

Operation	Category T1	Incident Name T1	NE Name T1	Occurred On	Diagnosis Status	Self-Healing Status	B/S
☐	BBU Board Fault	Board Hardware Abn...	C	EPE...	2026-05-11 23:41:00	Diagnosis succeeded	Repairable

Below the table, the 'Alarms' tab is selected, showing an 'Alarm List' table:

Severity T1	Alarm ID	Name T1	Source Obj
Major	26200	Board Hardware Fault	GL27_Y907

Processing Error - A

The system identifies license on trail faults based on intelligent models without the need for human intervention.

The screenshot shows the 'Incident Logs' interface. A red box highlights the 'Incident List' table with the following data:

Operation	Category T1	Incident Name T1	NE Name T1	Occurred On	Diagnosis Status	Self-Healing Status
☐	BTS Software Fault	License Abnormal-License on Trial	C	TLA...	2026-05-11 10:13:19	Diagnosis succeeded

Below the table, the 'Alarms' tab is selected, showing an 'Alarm List' table:

Severity T1	Alarm ID	Name T1	Source Obj
Major	26817	License on Trial	GL01_V903

Communications - A

The system identifies fronthaul faults based on intelligent models without the need for human intervention.

The screenshot shows the 'Incident Logs' interface. A red box highlights the 'Incident List' table with the following data:

Operation	Category T1	Incident Name T1	NE Name T1	Occurred On	Diagnosis Status
☐	Fronthaul Network Fault	Fronthaul Optical Path Abnormal-BBU CPRI Interface Error	G	_KA...	2026-05-12 06:47:29

Below the table, the 'Alarms' tab is selected, showing an 'Alarm List' table:

Severity T1	Alarm ID	Name T1	Source Obj
Minor	26234	BBU CPRI Interface Er...	GL53_V761
Minor	26234	BBU CPRI Interface Error	GL53_V761
Minor	26234	BBU CPRI Interface Error	GL53_V761



Fault identification & Impact analysis

Evidence:

Fault identification

Environmental - A

The system identifies power faults based on intelligent models without the need for human intervention.

The screenshot shows the 'Incident Logs' page in the IFaultCare system. A red box highlights the 'Incident List' table, which contains one entry: 'RF Unit Fault' with a description of 'AFFECTED_RAT: U-L, RF Unit Power Supply Abnormal-RF Unit External Power Supply Insufficient: Cabinet No.=0, Subrack No.=82, Slot No.=0, Power Port=NULL, Board Type=MRRU, Specific Problem=Cabinet Power Supply Abnormal'. Another red box highlights the 'Alarm List' table, which shows three 'Minor' severity alarms with ID 26546, all related to 'RF Unit External Power Supply Insufficient'.

Operation	Category	Incident Name	NE Name	Occurred On	Diagnosis Status	Self-Healing Status
☐	RF Unit Fault	RF Unit Power Suppl...	G	2026-05-11 21:10:07	Diagnosis succeeded	Unrepairable

Severity	Alarm ID	Name	Source Object Name
Minor	26546	RF Unit External Powe...	GL33_E4031_MRS_OI
Minor	26546	RF Unit External Powe...	GL33_E4031_MRS_OI
Minor	26546	RF Unit External Powe...	GL33_E4031_MRS_OI

Security - A

The system identifies certificate invalid faults based on intelligent models without the need for human intervention.

The screenshot shows the 'Incident Logs' page in the IFaultCare system. A red box highlights the 'Incident List' table, which contains one entry: 'BTS Software Fault' with a description of 'AFFECTED_RAT: G-L, Version or Certificate Abnormal-Certificate Invalid: Certificate Type=Application certificate, Certificate Name=Vodafone.com.cer, Vendor Cert ID=No, Specific Problem=Expired'. Another red box highlights the 'Alarm List' table, which shows one 'Major' severity alarm with ID 26841, related to 'Certificate Invalid'.

Operation	Category	Incident Name	NE Name	Occurred On	Diagnosis Status
☒	BTS Software Fault	Version or Certificate Abnormal-Certificate Invalid	GL	2026-05-11 21:13:30	Diagnosed

Severity	Alarm ID	Name	Source Object Name
Major	26841	Certificate Invalid	GL61_Y8187_KADIRALAK

Alarm Data Automatically Collecting Logs and Correlating to fault incident

```
1368-6-11 18:40:13.801(154362|255414)000.MedFm: loc=PduInfo.fdn=NE=10520.aid=26234. AlarmName=BBU CPRI Interface Error.DevCsn=[REDACTED] Category=Fault.Severity=Minor.alarmType=Hardware.RaiseTime=2026-06-11 18:40:13.801.RootCauseFlg=1.Location=Cabinet No.=0, Subrack No.=0, Slot No.=4, Port No.=0, Sub Port No.=0, Board Type=UBBP, Specific Problem=Receive Power Too Low.AddText=RAT_INFO=G-L-N, AFFECTED_RAT=L, DID=NULL, Cumulative Duration(s)=90, RRU Name=NULL, ESN=[REDACTED] AddText1=AF_L=[REDACTED] SOGLU
```

```
2026-06-11 18:40:14.025 INFO [3b54b46e-d340-401b-9fba-5c7117a00eb9] [SEND][202][1]([NE=10520,26234,103107,51005,1781203124000,null,1,null,BBU CPRI Interface Error,BTS5900,RAT_INFO=G-L-N,AFFECTED_RAT=L,DID=NULL,RRU Name=NULL,ESN=[REDACTED],NodeBId=21195,qNodeBId=121195,alarmNotifyTime=1781203213000,TargetMEFDN=null,alarmNotifyUtc=1781192413000,AdditionInfo_1=AF_L=[REDACTED],AVUSOGLU,nativeFmDn=NE=10520,alarmSource=GL[REDACTED],GLU_vflag=0,msgSerialNo=103107,mbscLabel=0,RATType=4)]
```

```
[2026-06-11 18:50:12.423+0300][WARN][0][PoolOutlet-cloudsop_aifm_event_group][ROOT][IncidentMessageSender][114] clustered incidents are [1705864205606400-OPENED=[713933988, 713934344, 713930876, 713929660]]
```

```
[2026-06-11 18:50:14.774+0300][WARN][0][aifm-time-wheel-task][ROOT][IncidentMessageSender][114] clustered incidents are [1705872678100480-OPENED=[713932682]]
```

```
[2026-06-11 18:50:18.776+0300][WARN][0][aifm-time-wheel-task][ROOT][IncidentMessageSender][114] clustered incidents are [1705872711654912-OPENED=[713932697]]
```

```
[2026-06-11 18:50:28.774+0300][WARN][0][aifm-time-wheel-task][ROOT][IncidentMessageSender][114] clustered incidents are [1705872795540992-OPENED=[713932718]]
```

Alarms are reported from NE in real time Automatically

Alarms are received by MAE in real time Automatically

Automatic incident aggregation in real time



☐	Operation	Category	Incident Name	NE Name	Occurred On	Diagnosis Status	Self-Healin...	Description
☒		Cell Fault	4G Cell Out of Service-Cell Unavailable	GL[redacted]_SE	2026-05-11 05:10:18	Diagnosis succeeded	-	AFFECTED_RAT: L

Description: AFFECTED_RAT: G-L, 4G Cell Out of Service-Cell Unavailable: eNodeB Function Name=EN55_50644_M1338_BAT_BAFRA, Local Cell ID=76, Cell FDD TDD indication=FDD, NB-IoT Cell Flag=FALSE, Cell Name=LM133865O555064476, eNodeB ID=50644, Cell ID=76, Specific Problem=RF module abnormal

Alarms | Root Causes | Comments

Root Causes
 1. Fronthaul link:Fronthaul optical fiber fault

	Severity	Alarm ID	Name	Source Object Name	Occurred On	C
	Major	29240	Cell Unavailable	GL[redacted]_SE	2026-05-11 05:12:20	e

Active Alarms Cleared Alarms Acknowledged Alarms 1 0 0 0 1 0

	Alarm ID	Alarm Name	Alarm Source	impacted_subs_mobile	First Occurred On	Duration(hh:mm:ss)
☐	29240	Cell Unavailable	GL[redacted]_A_SE	67	2026/05/11 05:12:20	0:30:46

Evidence:

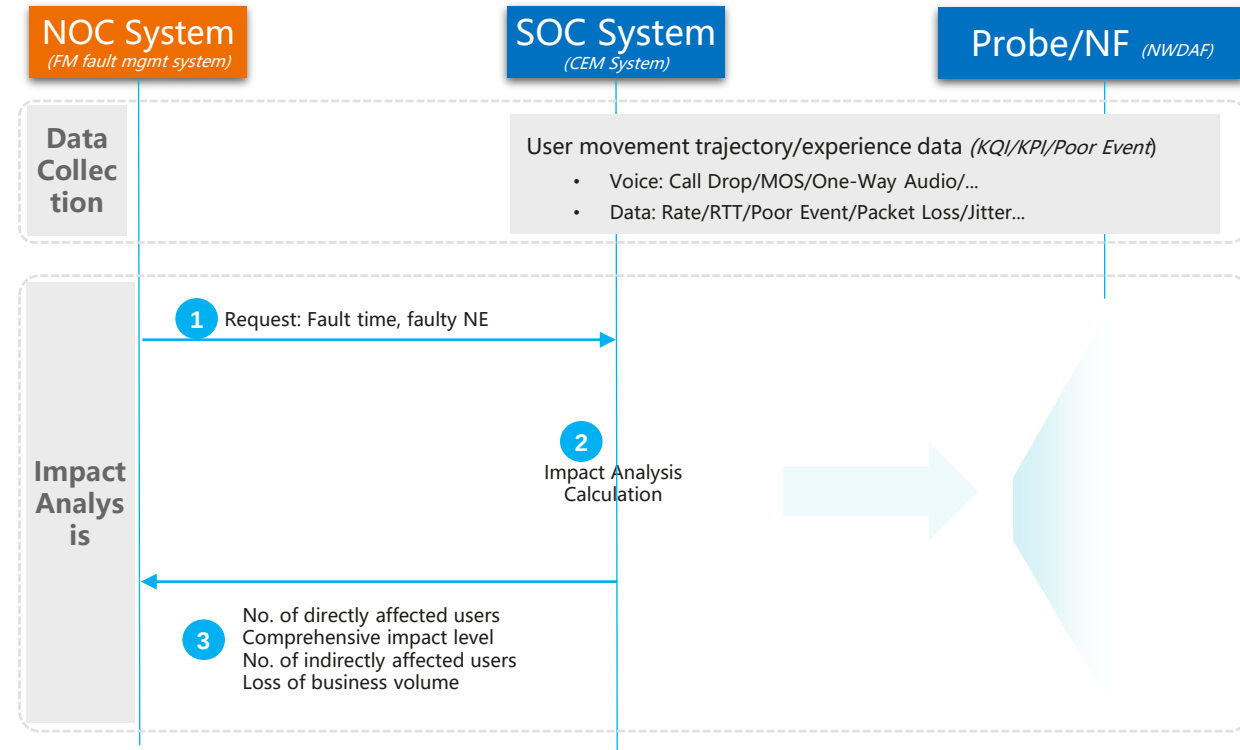
Environmental - A

Security - A



Fault identification & Impact analysis

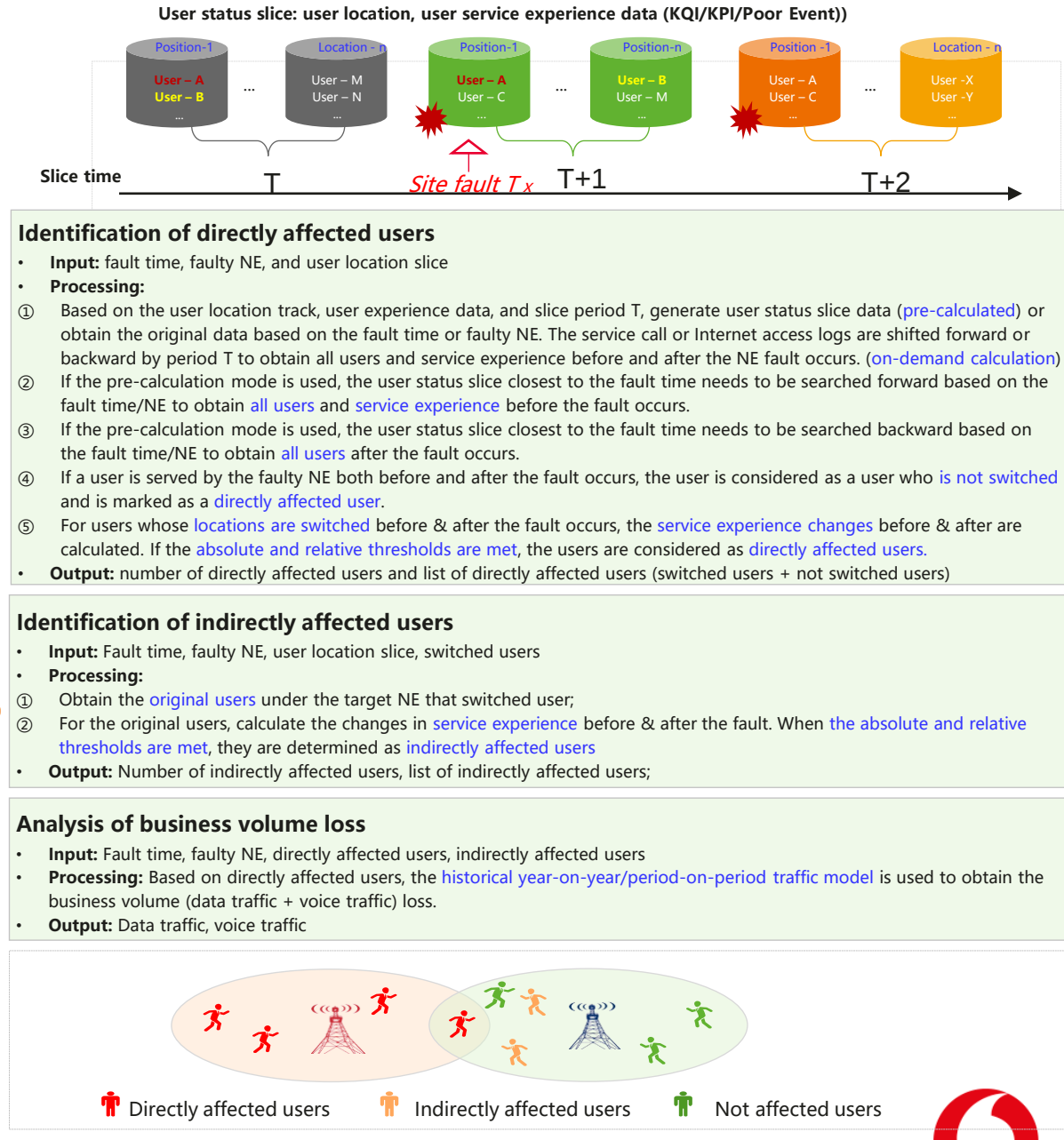
Interaction Process



Service Process

- Task Reporting:** The NOC reports network element fault alarms to the SOC.
- Task Initiation:** The SOC initiates calculations, updates the task status, and performs compensation calculations for tasks with abnormal computations.
- Result Reporting:** The SOC proactively reports the calculation results to the NOC. The reported information includes: comprehensive impact level, number of affected users, predicted loss of business volume, and a list of indicators for the user network element before and after the fault.

Remarks: For alarms reported by NOC, task management will be conducted to achieve on-demand computing, ensure that the same alarm is only computed once, and perform supplementary retries in the event of a computing/reporting failure.



Demarcation & Locating

Service Capability	Weight	Question	√ Option A	√ Option B	Option C	Option D
Demarcation & Locating	20%	Does the wireless network fault management system support root cause diagnosis and fault locating in various fault scenarios? Note: The root cause diagnosis and fault locating should require the ability to locate smallest field replaceable unit, upgradable software modules and connectors so that a repair solution can be quickly determined. e.g, Optical module, fiber optic cable and optical connectors.	The system demarcates and locates faults based on intelligent models without the need for human intervention.	The system demarcates the fault or locates multiple causes based on intelligent models, but the human intervention is required.	The system demarcates and locates faults based on manually defined rules (such as experience-based fault trees and troubleshooting processes) and needs human intervention.	Fault diagnosis needs to be manually performed based on expertise.

Equipment	Processing Error	Communications	Environmental	Security
A	A	B	A	A



Demarcation & Locating

Evidence:

Equipment - A

iMaster MAE IFaultCare Intelligent Fault Incident Management

Filter

Operation	Category T1	Incident Name T1	NE Name T1	Occurred On	Diagnosis Status	Self-Healing Status	
☐	BBU Board Fault	Board Hardware Abn...	GL...	EPE...	2026-05-11 23:41:00	Diagnosis succeeded	Repairable

Description: AFFECTED_RAT: U-L-N, Board Hardware Abnormal-Board Hardware Fault: Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, Specific Problem=Other

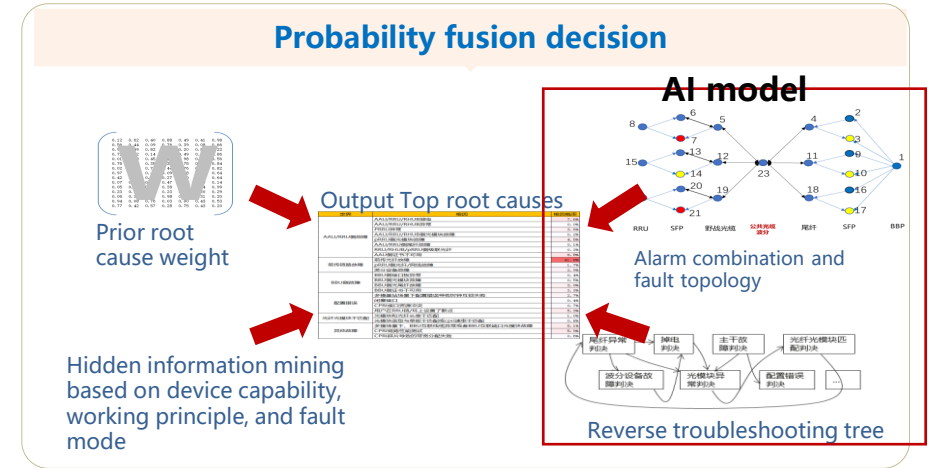
Alarms Root Causes Comments

The fault information caused by the BBU Board root cause has been automatically located.

The system locates the root cause based on intelligent models.

Root Causes

- Hardware - BBU - Faulty board or poor board contact:Board Hardware Fault
Ne Name=GL27..._KAMPUS,Specific parameter{Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, ESN=210305862610P7103393, BOM Code=03058626}



Processing Error - A

iMaster MAE IFaultCare Intelligent Fault Incident Management

Filter

Operation	Category T1	Incident Name T1	NE Name T1	Occurred On	Diagnosis Status	Self-Healing Stat	
☐	BTS Software Fault	License Abnormal-License on Trial	GL...	TLA...	2026-05-11 10:13:19	Diagnosis succeeded	Unrepairable

Description: AFFECTED_RAT: N, License Abnormal-License on Trial: Function Type=gNodeB Function, Trial Reason=Expired License, Grace Period Expire Date=2026-07-07

Alarms Root Causes Comments

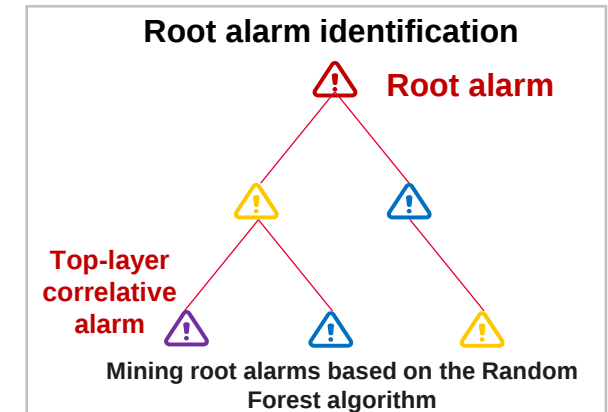
The system automatically locates the fault root cause.

Root Causes

- Software & Certificate:The license is running in trial mode
Ne Name=GL01...AR_GUNEY

Handling Suggestions

For root cause 1: Remote handling: Check whether the license is purchased.



- ✓ Perform causal analysis based on the associated alarms reported for the fault to determine the root cause.



Demarcation & Locating

Evidence:

Communications - B

Operation

Category

Incident Name

NE Name

Occurred On

Diagnosis Status

Self-IP

Cell Fault

4G Cell Out of Service-Cell Unavailable

GL5-SE

2026-05-10 21:39:57

Diagnosis succeeded

-

Description:

AFFECTED_RAT: G-L, 4G Cell Out of Service-Cell Unavailable: eNodeB Function Name=EN, Local Cell ID=76, Cell FDD TDD indication=FDD, NB-IoT Cell Flag=FALSE, Cell Name=LM1338650555064476, eNodeB ID=50644, Cell ID=76, Specific Problem=RF module abnormal

Alarms

Root Causes

Comments

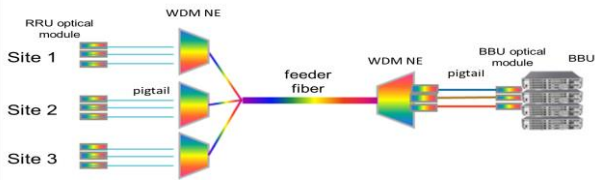
The system demarcates root cause based on intelligent models.

Root Causes

1. Fronthaul link:Fronthaul optical fiber fault

Ne Name=GL-RA_SE.BBU(Cabinet No.=0, Subrack No.=0, Slot No.=2, Port No.=4, ESN=02-2219, BOM Code=03022HEJ)

Fronthaul topology restoration



Construct the connection relationship between RRU and BBU ports based on the configuration

Restore the WDM device grouping based on the wavelength information of the optical module

Construct the RRU site grouping relationship based on the neighbor relationship and fiber length

Probability fusion decision

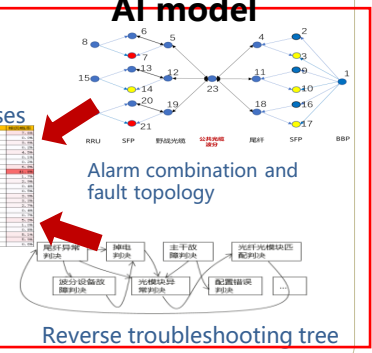


Prior root cause weight

Output Top root causes

Hidden information mining based on device capability, working principle, and fault mode

AI model



Alarm combination and fault topology

Reverse troubleshooting tree

Environmental - A

IFaultCare

Home

Incident Logs

09:46

2026-05-13

Filter

Export

Operation

Category

Incident Name

NE Name

Occurred On

Diagnosis Status

Cell Fault

4G Cell Out of Service-Cell Unavailable

2026-05-10 15:39:16

Diagnosis succeeded

Description:

AFFECTED_RAT: U-L, 4G Cell Out of Service-Cell Unavailable: eNodeB Function Name=EN, Local Cell ID=81, Cell FDD TDD indication=FDD, NB-IoT Cell Flag=FALSE, Cell Name=LK8356150555062581, eNodeB ID=50644, Cell ID=81, Specific Problem=Power supply failure

Alarms

Root Causes

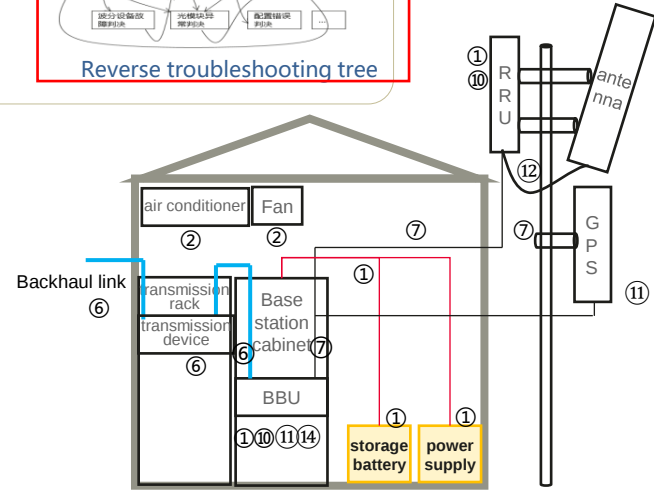
Comments

Identify power supply anomalies in the equipment by monitoring voltage trends on the device side.

Root Causes

1. Power and environment - Power supply:AAU/RRU/RHUB power failure

Ne Name=G-LA_L.BBU(Cabinet No.=0, Subrack No.=0, Slot No.=4, Port No.=0, ESN=2102312BSJ9WLA001978, BOM Code=02312BSJ), RRU(Cabinet No.=0, Subrack No.=80, Slot No.=0, ESN=2102312BSJ9WLA001978, BOM Code=02312BSJ)



✓ The BBU monitors the change of the backup power voltage.



Demarcation & Locating

Evidence:

Security - A

Filter

Operation	Category	Incident Name	NE Name	Occurred On	Dia
☒	BTS Software Fault	Version or Certificate Abnormal-Certificate Invalid	SR:_____TLAR	2026-05-12 04:15:39	Dia

Description: AFFECTED_RAT: L, Version or Certificate Abnormal-Certificate Invalid: Certificate Type=Trust certificate, Certificate Name=VF-SUBCA-PROD.cer, Specific Problem=Expired

Alarms | **Root Causes** | Comments

Root Causes

1. Software & Certificate:Certificate Invalid

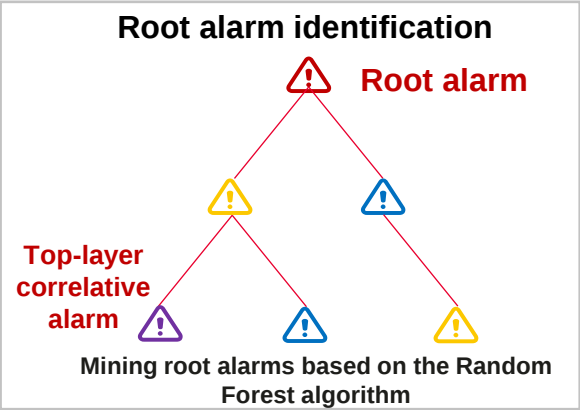
Ne Name=SR_____AR,Specific parameter{Certificate Type=Trust certificate, Certificate Name=VF-SUBCA-PROD.cer, Specific Problem=Expired}

Handling Suggestions

For root cause 1: Check and update the device certificate, trust certificate, cross certificate, certificate revocation list, and digital certificate trustlist in sequence, or contact a professional department.

Automatic locating the root cause of key expired.

The system locates the root cause based on intelligent models.



✓ Perform causal analysis based on the associated alarms reported for the fault to determine the root cause.



Solution generation

Service Capability	Weight	Question	√ Option A	Option B	Option C	Option D
Solution generation	10%	Does the wireless network fault management system support generation of fault recovery solutions in various scenarios?	The system generates one or multiple possible fault recovery or fault rectification solutions based on intelligent model without the need for human intervention.	The system generates multiple possible fault recovery or rectification solutions based on intelligent model, but need human intervention.	The system generates one or multiple possible fault recovery or rectification solutions based on manually defined rules and need human intervention.	Fault recovery or rectification solutions needs to be manually generated based on expertise.

Evaluation and decision-making

Service Capability	Weight	Question	Option A	Option B	Option C	Option D
Evaluation and decision-making	10%	Does the wireless network fault management system support evaluation and decision-making in various scenarios?	The system evaluates multiple possible recovery or rectification solutions and determines the optimal recovery or fault rectification solution based on intelligent models without the need for human intervention.	The system evaluates multiple possible recovery or rectification solutions and determines the optimal recovery or fault rectification solution based on intelligent models, but need human intervention.	The system evaluate and decide the fault recovery or fault rectification solution based on manually defined rules and need human intervention.	The fault recovery or fault rectification solution is manually evaluated and decided.

Equipment	Processing Error	Communications	Environmental	Security
A	A	A	A	A



Solution generation & Evaluation and decision-making

Evidence:

Equipment - A

☐ Operation

Category $\uparrow\downarrow$

Incident Name $\uparrow\downarrow$

NE Name $\uparrow\downarrow$

Occurred On $\downarrow$

Diagnosis Status

Self-Healing Status

☒  

BBU Board Fault

Board Hardware Abn...

2026-05-11 23:41:00

Diagnosis succeeded

Repairable

Description: AFFECTED_RAT: U-L-N, Board Hardware Abnormal-Board Hardware Fault: Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, Specific Problem=Other

Alarms | Root Causes | Comments

Root Causes

1. Hardware - BBU - Faulty board or poor board contact:Board Hardware Fault
Ne Name=GL2...MPUS,Specific parameter{Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, ESN=210305862610P7103393, BOM Code=03058626}

Handling Suggestions

For root cause 1: 1. Remotely reset the device. If the fault persists, replace the device.
Reference MML Command for Self-Healing:
MML: RST BRD:CN=0, SRN=0, SN=4;
Impact: Resetting a board will interrupt the services carried on the board and reinitialize the board. Before the initialization is complete, the board is unavailable.
Recovery duration: 1800s.

Based on fault diagnosis and intelligent analysis, select the optimal one-time on-site solution.

Generate and evaluate the optimal solution.

Processing Error - A

☐ Operation

Category $\uparrow\downarrow$

Incident Name $\uparrow\downarrow$

NE Name $\uparrow\downarrow$

Occurred On $\downarrow$

Diagnosis Status

Self-Healing S

☒  

BTS Software Fault

License Abnormal-License on Trial

2026-05-11 10:13:19

Diagnosis succeeded

Unrepairable

Description: AFFECTED_RAT: N, License Abnormal-License on Trial: Function Type=gNodeB Function, Trial Reason=Expired License, Grace Period Expire Date=2026-07-07

Alarms | Root Causes | Comments

Root Causes

1. Software & Certificate:The license is running in trial mode
Ne Name=G...GUNEY

Handling Suggestions

For root cause 1: Remote handling: Check whether the license is purchased.

Based on fault diagnosis and intelligent analysis, select the optimal one-time solution.

Generate and evaluate the optimal solution.



Solution generation & Evaluation and decision-making

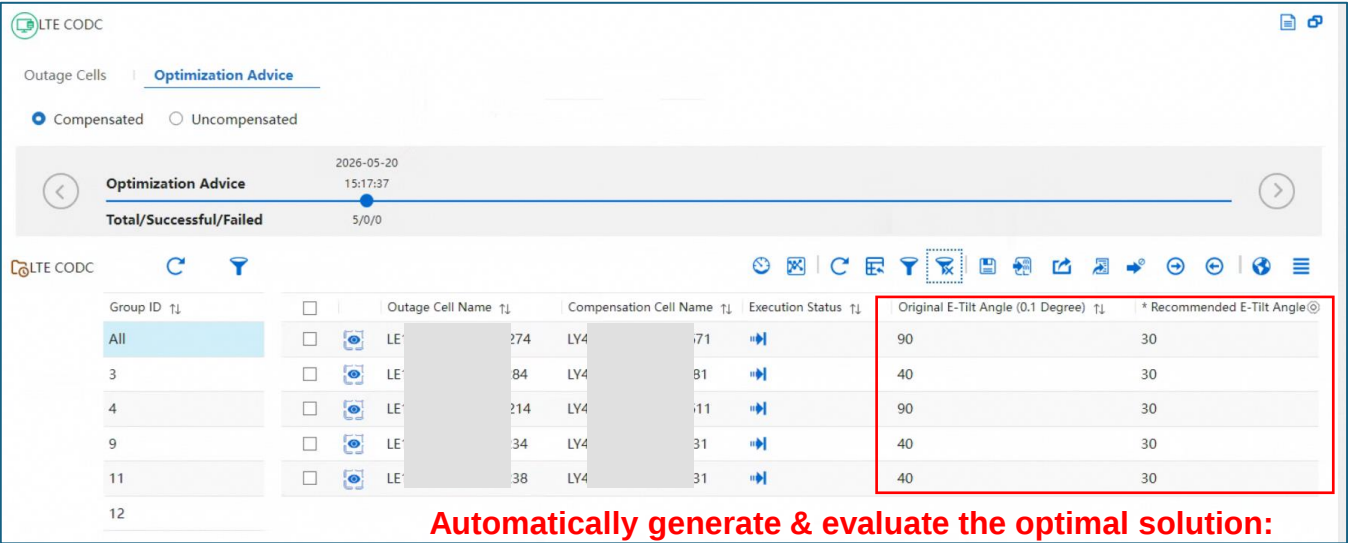
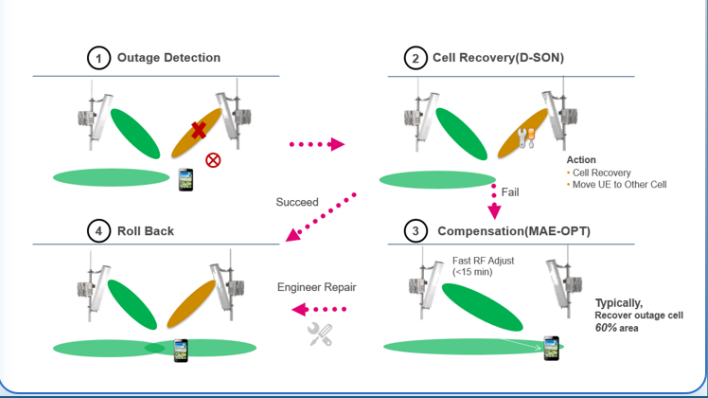
Evidence:

Communications - A

Environmental - A

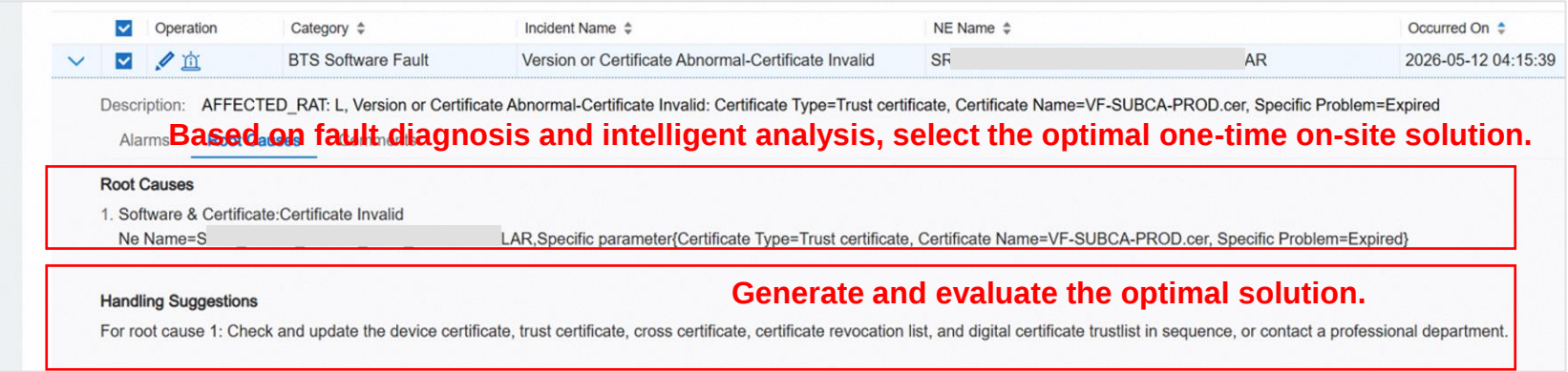
Example : Cell Outage Detection and Compensation (CODC) – based on Cell Unavailable

- UE distribution in an outage cell identified based on TA
- Identifying Compensation Neighboring Cells Based on Outage Cell Coverage Environment Detection
- Compensation cell and traffic center detection to get the best compensation cell
- Adjustment parameters: Pattern(scenario + azimuth + downtilt), SSB power offset)



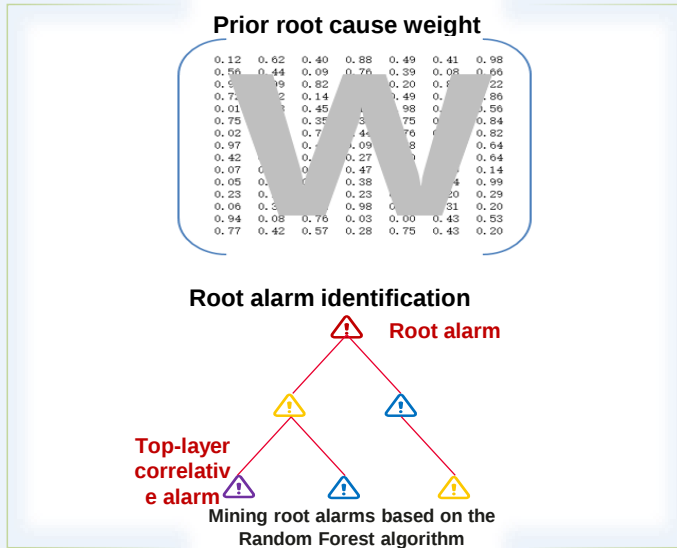
Automatically generate & evaluate the optimal solution:
compensation for out-of-service cell by adjusting the electrical tilt angle

Security - A



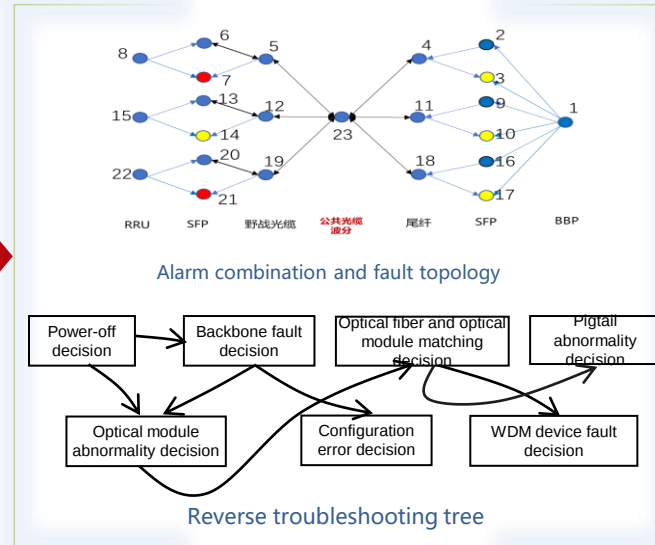
Demarcation & Locating, Solution generation & Evaluation and decision-making

Multi-dimensional input data source



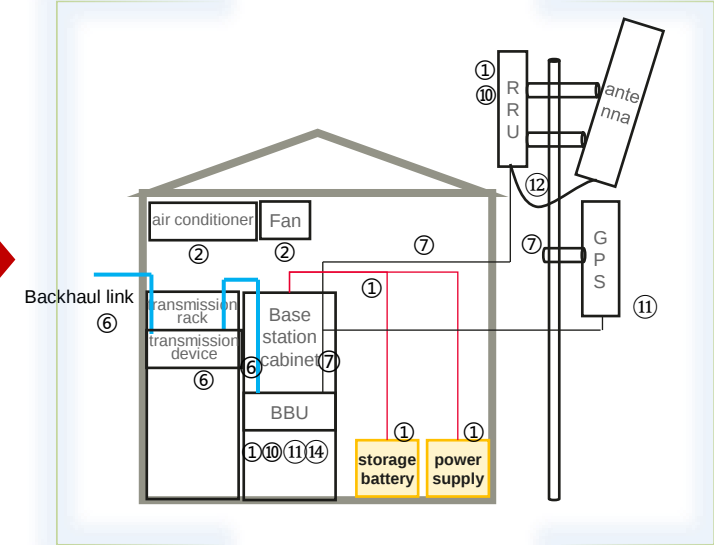
AI model

Root Cause Diagnosis Driven by Knowledge Graph and Data Collaboration



Top N root causes and solutions

14 categories, 200+ root causes and handling suggestions



① Incident diagnosis begins

2026-06-11 18:50:17.930 INFO 106271 [scheduler-1][ROOT][[c.h.o.i.p.MessageWarehouse 212] Incident in diagnosis, csn=1705872678100480

2026-06-11 18:50:17.946 INFO 106271 [threadPool_incidentActive#diagnosis task process-2][ROOT][[c.h.o.i.s.ForwardAlarmDiagnosisService 388] post alarmRootCause success, incidentCsn=1705872678100480, resultSize=1]

remoteResult=[{"fdn":"NE=10520", "alarmId":"26234", "rootCauses":["11":{"description":"AAU/RRU/RHUB power off.", "mo": "", "solution": "1) Run RST BRDPWROFF command to reset the AAU/RRU/RHUB. 2) Check the power supply of AAU/RRU/RHUB. 3) Check the power monitoring device."}, {"alarmCsn":0, "specificProblem":"CPRI port receiving exception & Ethernet communication exception over the CPRI port & receive no signal.", "notAlarmRCAlnfoResult": false, "originalProbability":0.0, "unifyProbability":0.0, "12":{"description":"AAU/RRU/RHUB abnormal.", "mo": "", "solution": "1) Run RST BRDPWROFF command to reset AAU/RRU/RHUB. 2) Replace the AAU/RRU/RHUB. "}, {"alarmCsn":0, "specificProblem":"CPRI port receiving exception & Ethernet communication exception over the CPRI port & MAC error frames exceeding the threshold & no signal received & receive power too low.", "notAlarmRCAlnfoResult": false, "originalProbability":0.0, "unifyProbability":0.0, "13":{"description":"AAU/RRU/RHUB optical fiber fault.", "mo": "", "solution": "1) Check optical fiber."}, {"alarmCsn":0, "specificProblem":"CPRI port receive abnormal & CPRI port Ethernet communication abnormal & MAC error frames exceeding threshold & no signal received & receive power too low & system power over threshold & no signal received & receive power too low.", "notAlarmRCAlnfoResult": false, "originalProbability":0.0, "unifyProbability":0.0, "21":{"description":"AAU/RRU/RHUB optical fiber fault.", "mo": "", "solution": "1) Check optical fiber."}, {"alarmCsn":0, "specificProblem":"CPRI port receive abnormal & CPRI port Ethernet communication abnormal & MAC error frames exceeding threshold & no signal received & receive power too low.", "notAlarmRCAlnfoResult": false, "originalProbability":0.0, "unifyProbability":0.0, "22":{"description":"BBU optical module fault.", "mo": "", "solution": "1) Plug optical module. 2) Replace optical module."}, {"alarmCsn":0, "specificProblem":"CPRI port receive abnormal & CPRI port Ethernet communication abnormal & MAC error frames exceeding threshold & no signal received & receive power too low & exceed the maximum rate & receive power too high.", "notAlarmRCAlnfoResult": false, "originalProbability":0.0, "unifyProbability":0.0, "23":{"description":"BBU optical module fault.", "mo": "", "solution": "1) Plug optical module. 2) Replace optical module."}]}

② Analyze all possible causes and solution generation

2026-06-11 18:50:30.016 INFO 106271 [threadPool_incidentActive#diagnosis task process-1][ROOT][[c.h.o.i.s.ForwardNonBrokenService 499] incidentCsn=1705872678100480, exclude scene=2.1a, reason=nonBroken, comment=

2026-06-11 18:50:30.016 INFO 106271 [threadPool_incidentActive#diagnosis task process-1][ROOT][[c.h.o.i.s.ForwardNonBrokenService 534] incidentCsn=1705872678100480, exclude scene=1.4, 2.1, 2.2, 3.3, reason=nonBroken, comment=

2026-06-11 18:50:30.017 INFO 106271 [threadPool_incidentActive#diagnosis task process-1][ROOT][[c.h.o.i.s.ForwardNonBrokenService 762] [opticalPowerMinusResultOverThreshold] parse optical power error. java.lang.NumberFormatException: For input string: "NULL"

③ Exclude untrusted causes and solution with weight of different root causes and handling suggestions inferred based on the model

2026-06-11 18:50:30.027 INFO 106271 [threadPool_incidentActive#diagnosis task process-1][ROOT][[c.h.o.i.s.ForwardAlarmDiagnosisService 314] calculate unify probability, incidentCsn=1705872678100480, totalProbability=0.10344827586206896, rootCauses=[{"13":{"description":"AAU/RRU/RHUB optical module fault.", "mo": "", "solution": "1. Take the corresponding optical module to the site. Preferentially remove and insert the optical module to rectify the fault. 2. If the fault persists, replace the optical module."}, {"alarmCsn":0, "specificProblem":"CPRI interface Reception Error/CPRI Port Ethernet Communication Failure&MAC Excessive Frame Error Rate&Receive No Signal&Receive Power Too Low&Receive Power Too High", "originalProbability":0.03444827586206896, "unifyProbability":0.03444827586206896, "14":{"description":"BBU optical module fault.", "mo": "", "solution": "1) Plug optical module. 2) Replace optical module."}]}

2026-06-11 18:50:30.043 INFO 106271 [threadPool_incidentActive#diagnosis task process-1][ROOT][[c.h.o.i.s.MoiQueryService 54] [queryStockAndConfFromFMACommon] params: [{"fdn":"NE=10520", "mo": "", "solution": "1. Take the corresponding optical module to the site. Preferentially remove and insert the optical module to rectify the fault. 2. If the fault persists, replace the optical module."}, {"alarmCsn":0, "specificProblem":"CPRI interface Reception Error/CPRI Port Ethernet Communication Failure&MAC Excessive Frame Error Rate&Receive No Signal&Receive Power Too Low&Receive Power Too High", "originalProbability":0.03444827586206896, "unifyProbability":0.03444827586206896, "14":{"description":"BBU optical module fault.", "mo": "", "solution": "1) Plug optical module. 2) Replace optical module."}]}

④ Identify the ultimate root cause & solution

Note: The demarcation & locating, solution generation & evaluation, and decision-making are performed using the overall algorithm. Therefore, this page provides a unified description.

Demarcation & Locating, Solution generation & Evaluation and decision-making

1. **Algorithms:** Root Cause Diagnosis Driven by Knowledge Graph and Data Collaboration

1) Involved algorithms: Knowledge Graph and Graph Neural Network combined with GCN-RCA. Key sub-technologies: Knowledge Graph (KG), Graph Neural Network (GCN).

2) Reasons for this choice:

1. Why choose [Graph Neural Network (GNN)]?

Fault propagation often follows network topology or dependency relationships (e.g., base station -> transmission network -> core network). GNNs (such as GCN, GAT, GraphSAGE) can effectively aggregate information from neighboring nodes and capture global dependencies, which traditional machine learning methods (e.g., XGBoost) cannot achieve.

Advantages: Can handle non-Euclidean data (i.e., irregular graph structures) and directly utilize entities and relationship edges in the knowledge graph.

2. Why introduce [Knowledge Graph (KG)] instead of purely data-driven methods?

Interpretability: Pure data models are black boxes and cannot easily explain to O&M personnel "why" a particular device has failed. KG provides clear causal paths (A leads to B, B leads to C), making it easier for manual verification and trust.

Prior knowledge injection: KG includes expert experience, device dependencies, and historical cases. When data is sparse or new devices are introduced (cold start), KG can provide necessary structural constraints to prevent the model from overfitting to noisy data.

Generalization capability: By matching similar subgraphs in the graph, known fault patterns can be transferred to similar new scenarios.

3. Why emphasize [data collaboration] (multi-modal/time-series data fusion)?

Reason: To compensate for the static nature of KG and improve real-time diagnostic accuracy.

KG is typically static or updates slowly, while there is a large amount of dynamic metrics at the fault site (e.g., CPU utilization, packet loss rate, alarm logs).

Collaboration mechanism: Time-series data is transformed into node features (Node Embedding) and then integrated with the structural information of the KG, preserving the topological logic while incorporating real-time state changes.

Note: The demarcation & locating, solution generation & evaluation, and decision-making are performed using the overall algorithm. Therefore, this page provides a unified description.



Solution implementation

Service Capability	Weight	Question	Option A	√ Option B	Option C
Solution implementation	5%	Does the wireless network fault management system support automatic execution of troubleshooting solutions in various scenarios?	1) The system automatically executes the commands/ scripts for the fault that can be remotely recovered. 2) The system support intelligent on-site instruction for the faults that on-site handling is necessary, including support of: - Human leverages natural language to guide Copilot in query optimal troubleshooting checklists. - Human leverages natural language to guide Copilot to automatically verify that the fault is resolved and alarms are cleared, generate the fault repair report (including fill out the trouble ticket record).	Humans use the system to execute instructions. 1)The system executes commands/ scripts for the fault that can be remotely recovered with human confirmation. 2)The on-site handling are assisted by tool, but still requires assistance from NOC.	The recovery solution needs to be manually implemented 1) The recovery solution need to be manually implemented. 2) On-site handling is guided by NOC.

Equipment	Processing Error	Communications	Environmental	Security
B	B	B	B	B



Solution implementation

Evidence:

Equipment - B

Operation

Category

Incident Name

NE Name

Occurred On

Diagnosis Status

Self-Healing Status

BBU Board Fault

Board Hardware Abn...

G...

2026-05-11 23:41:00

Diagnosis succeeded

Repairable

Description: AFFECTED_RAT: U-L-N, Board Hardware Abnormal-Board Hardware Fault: Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, Specific Problem=Other

Alarms

Root Causes

Comments

Root Causes

1. Hardware - BBU - Faulty board or poor board contact:Board Hardware Fault
Ne Name=GL27...AMPUS,Specific parameter{Cabinet No.=0, Subrack No.=0, Slot No.=4, Board Type=UNKNOWN, ESN=210305862610P7103393, BOM Code=03058626}

Handling Suggestions

For root cause 1: 1. Remotely reset the device. If the fault persists, replace the device.

Reference MML Command for Self-Healing:
MML: RST BRD:CN=0, SRN=0, SN=4;

Impact: Resetting a board will interrupt the services carried on the board and reinitialize the board. Before the initialization is complete, the board is unavailable.

Recovery duration: 1800s.

Based on MML commands, achieve board restart and fault clearance.

Processing Error - B

Operation

Category

Incident Name

NE Name

Occurred On

Diagnosis Status

Cell Fault

4G Cell Capability Degraded-Cell Capability Degraded

Si...ZA

2026-05-11 01:10:07

Diagnosis succeeded

Description: AFFECTED_RAT: U-L, 4G Cell Capability Degraded-Cell Capability Degraded: eNodeB Function Name=EN!... Local Cell ID=82, Cell FDD TDD indication=FDD, NB-IoT Cell Flag=FALSE, TX Channel Numbers In The Cell=1, RX Channel Numbers In The Cell=2, Cell Name=LM2647250555065382, eNodeB ID=50653, Cell ID=82, Specific Problem=Baseband resource derating

Alarms

Root Causes

Comments

Root Causes

1. Configuration - Incorrect configuration:Baseband resource derating
Ne Name=Si...ZA,Specific parameter{ Local Cell ID=82, Cell Name=LM2647250555065382, Cell ID=82}

Handling Suggestions

For root cause 1: Check and modify the cell configuration based on the network plan.

Reference MML Command for Self-Healing:
MML: RST BRDPWROFF: CN=0, SRN=84, SN=0;

Impact: Resetting a board through power-off will cause the services carried on the board to be lost and reinitialize the board. Before the initialization is complete, the board is unavailable.

Recovery duration: 960s.

Based on MML commands, achieve board power off restart and self-healing.



Solution implementation

Evidence :

Communications - B

Operation

Category

Incident Name

NE Name

Occurred On

Diagnosis Status

▼

Fronthaul Network Fault

Fronthaul Optical Path Abnormal-RF Unit Maintenance Link Failure

GL31_

_ODB

2026/5/6 16:39:51

Diagnosis succeeded

Description:

AFFECTED_RAT: L-N, Fronthaul Optical Path Abnormal-RF Unit Maintenance Link Failure: Cabinet No.=0, Subrack No.=80, Slot No.=0, Board Type=MRRU, Specific Problem=Other

Alarms

Root Causes

Comments

Root Causes

1. Fronthaul link:Fronthaul optical fiber fault

Handling Suggestions

For root cause 1: 1. Check the fiber fault point and rectify the fault.

Reference MML Command for Self-Healing:

MML: RST BRDPWROFF: CN=0, SRN=0, SN=4;

Impact: Resetting a board through power-off will cause the services carried on the board to be lost and reinitialize the board. Before the initialization is complete, the board is unavailable.

Recovery duration: 1200s.

Auto Diagnosis

- After the execution of the diagnosis, the command will be executed based on different scenarios as defined in the pre-defined rules.

Environmental - B

Operation

Category

Incident Name

NE Name

Occurred On

Diagnosis Status

▼

RF Unit Fault

RF Unit Power Supply Abnormal-RF Unit External Power Supply Insufficient

GL31_

YET_GT

2026-05-11 12:49:08

Diagnosis succeeded

Description:

AFFECTED_RAT: L-N, RF Unit Power Supply Abnormal-RF Unit External Power Supply Insufficient: Cabinet No.=0, Subrack No.=70, Slot No.=0, Power Port=NULL, Board Type=AIRU, Specific Problem=Cabinet Power Supply Abnormal

Alarms

Root Causes

Comments

Root Causes

1. Power and environment - Power supply:Cabinet Power Supply Abnormal

Ne Name=GL_ JRIYET_GT,BBU{Cabinet No.=0, Subrack No.=0, Slot No.=1, Port No.=0, ESN=2102312BSJ9WNA300663, BOM Code=02312BSJ}, RRU{Cabinet No.=0, Subrack No.=70, Slot No.=0, ESN=2102312BSJ9WNA300663, BOM Code=02312BSJ}

Handling Suggestions

For root cause 1: Check whether the power module and mains supply system are normal. If the alarm persists, replace the RF unit.

Reference MML Command for Self-Healing:

MML: RST BRDPWROFF: CN=0, SRN=80, SN=0;

Impact: Resetting a board through power-off will cause the services carried on the board to be lost and reinitialize the board. Before the initialization is complete, the board is unavailable.

Recovery duration: 1200s.

Based on MML commands, achieve board power off restart and fault clearance.



Solution implementation

Evidence:

Security - B

Key Expired fault

☒ Operation	Category ▾	Incident Name ▾	NE Name ▾	Occurred On ▾
☒  	BTS Software Fault	Version or Certificate Abnormal-Certificate Invalid	SR: _AR	2026-05-12 04:15:39

Description: AFFECTED_RAT: L, Version or Certificate Abnormal-Certificate Invalid: Certificate Type=Trust certificate, Certificate Name=VF-SUBCA-PROD.cer, Specific Problem=Expired

AlarmsRoot CausesComments

Root Causes

1. Software & Certificate:Certificate Invalid
Ne Name=SR80__AR,Specific parameter{Certificate Type=Trust certificate, Certificate Name=VF-SUBCA-PROD.cer, Specific Problem=Expired}

Handling Suggestions

For root cause 1: Check and update the device certificate, trust certificate, cross certificate, certificate revocation list, and digital certificate trustlist in sequence, or contact a professional department.

It is not possible for Key Expired fault to be executed without manual intervention to restore.



Thank you.

