

AIS Wireless Network Assessment - Energy Saving

5G

A diagram illustrating a 5G network. The large "5G" text is on the left. A series of green lines representing data paths connect several circular icons: a 5G tower with a lightning bolt, a Wi-Fi symbol, a smartphone with signal waves, a cloud with a Wi-Fi symbol, and a speedometer. The background features a faint city skyline and a green landscape with rolling hills.

Build the Best-in-Class Network

RAN Energy Efficiency Optimization_ Scoring

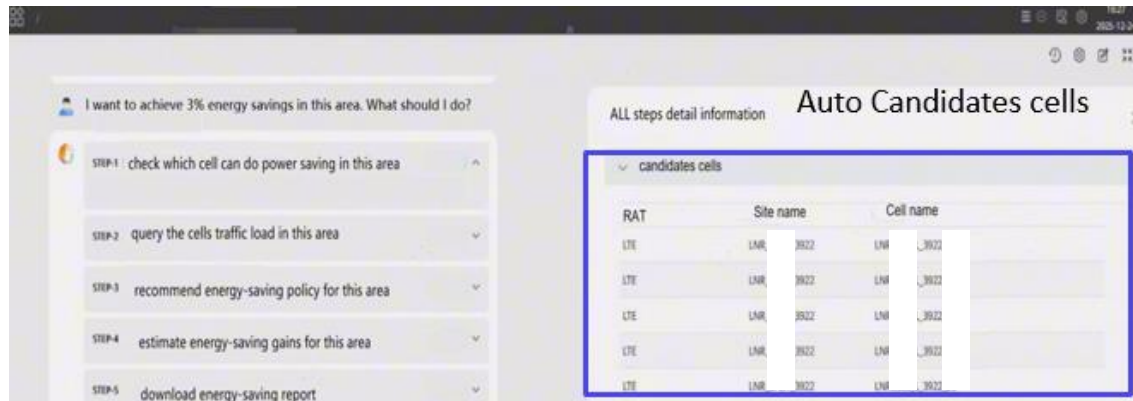
Process Flow	Cognitive Activity	Service Capability	Weight	Question	Method: Average																		
					Criteria				Sub-scenario 1			Percent age	20%	Sub-scenario 2			Percent age	40%	Sub-scenario 3			Percent age	40%
					Option A	Option B	Option C	Option D	Answer	Original score	Compensated score	Overall Score	Answer	Original score	Compensated score	Overall Score	Answer	Original score	Compensated score	Overall Score			
RAN Energy Efficiency Optimization	Intent	Intent Translation	15%	How does the System translate the RAN Energy saving intent to the RAN energy saving related control information?	4	3	0	0	A	4	4	4.00	A	4	4	4.00	A	4	4	4.00			
		Intent Fulfillment & Evaluation	10%	How does the System evaluate RAN energy saving intent fulfilment?	4	3	0	0	A	4	4		A	4	4		A	4	4				
	Awareness	RAN Energy Saving Information Collection	10%	How does the System collect RAN energy saving related information?	3	2	1	0	A	3	4		A	3	4		A	3	4				
	Analysis	RAN Energy Saving Issues Identification	10%	How does the System identify energy saving issues?	4	3	2	0	A	4	4		A	4	4		A	4	4				
		RAN Traffic & Performance Prediction	10%	How does the System predict traffic load and network performance that can be used for energy saving solutions?	4	3	2	0	A	4	4		A	4	4		A	4	4				
		RAN Energy Saving Issues Demarcation & Root Cause Analysis	10%	How does the System demarcate energy saving & performance issues and analyze their root cause?	4	3	2	0	A	4	4		A	4	4		A	4	4				
		Solution Generation	15%	How does the System generate the recommended RAN energy saving solutions to solve the identified energy saving issues?	4	3	2	0	A	4	4		A	4	4		A	4	4				
	Decision	Solution Evaluation & Decision Making	10%	How does the System evaluate energy saving solutions and decide on the best solution to be implemented?	4	3	2	0	A	4	4		A	4	4		A	4	4				
	Execution	Solution Implementation	10%	How does the System implement solution that can resolve identified energy saving issues?	2	1	0	0	A	2	4		A	2	4		A	2	4				

Cognitive Activity_ Intent (Intent Translation)

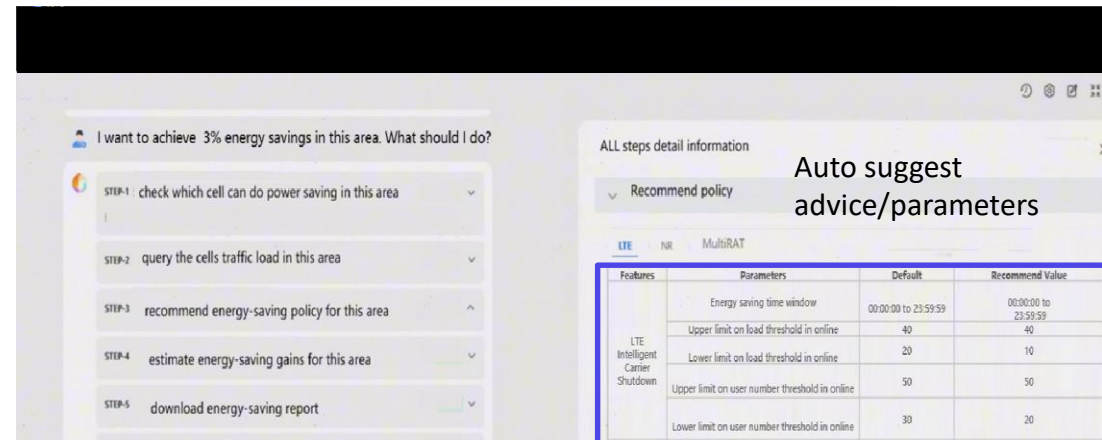
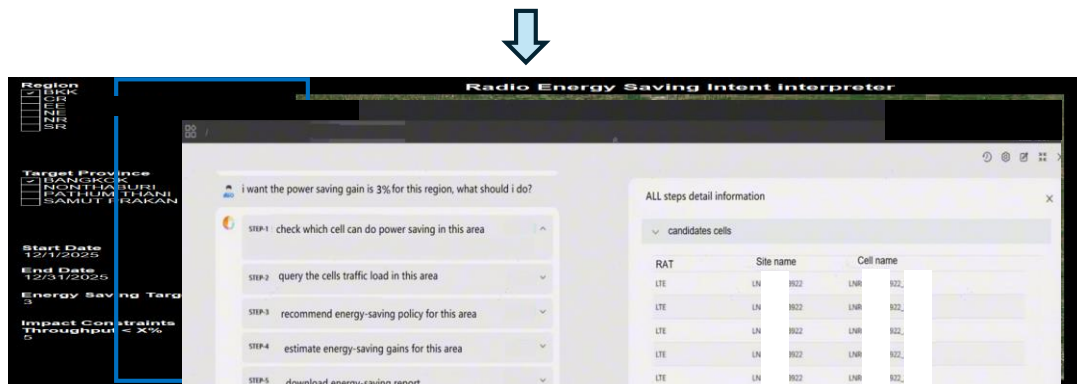
Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
						Intra-RAT intra-frequency multi-Site energy saving	Intra-RAT inter-frequency multi-Site energy saving	Inter-RAT multi-Site energy saving
						20%	40%	40%
Intent	Intent Translation	How does the System translate the RAN Energy saving intent to the RAN energy saving related control information? RAN energy saving intent includes RAN energy saving targets and performance targets (including but not limited to RAN UE Throughput Targets). Note1: Human defined policies can overwrite the automated selection of energy saving candidate objects	Based on RAN energy saving Intent defined by Human, the System automatically selects candidate energy-saving objects (e.g. NE/CELL) and generates the RAN energy saving related control information based on the RAN energy saving intent, without Human Intervention. The system can automatically explore the energy saving gains and performance impacts to support human continuous adjustment of intent targets to achieve optimal energy saving effect and performance.	The System can automatically generate RAN energy saving related control information through the execution of predefined Rules. Human manually select candidate energy-saving objects (e.g. NE/CELL) and confirm the RAN energy saving related control information based on the RAN energy saving intent.	RAN energy saving related control information are manually defined based on expertise	A	A	A

Evidence:

Intent translation



the system will do intent translation, and based on the intent input, auto provide the candidates cells, and create the tasks, and then generate the power saving policy /parameters.



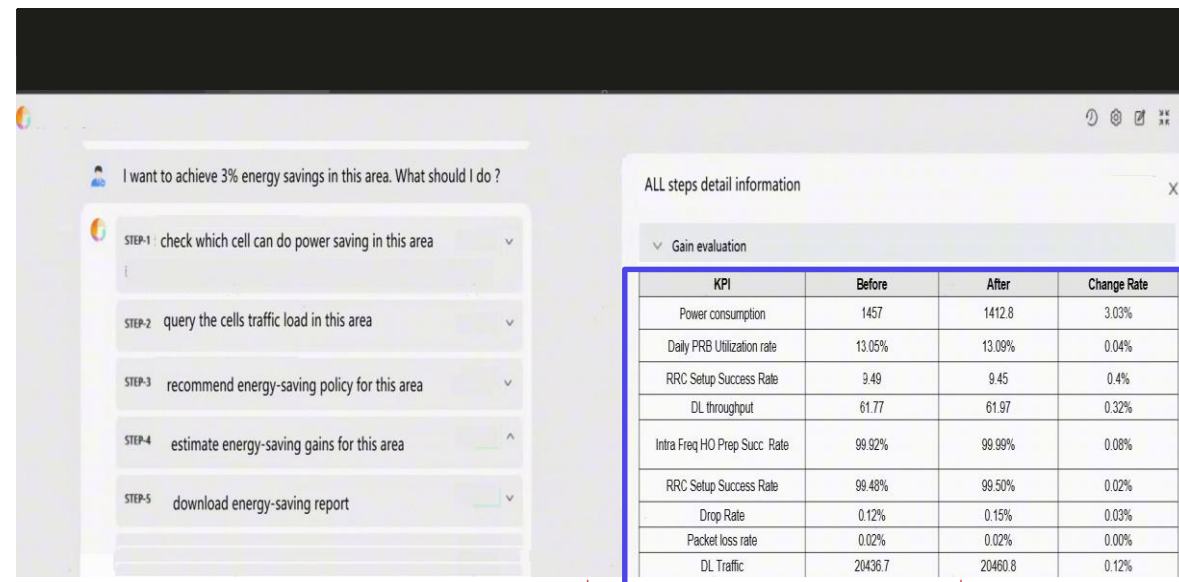
Cognitive Activity_ Intent (Intent Fulfillment & Evaluation)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
						Intra-RAT intra-frequency multi-Site energy saving 20%	Intra-RAT inter-frequency multi-Site energy saving 40%	Inter-RAT multi-Site energy saving 40%
						Intent	Intent Fulfillment evaluation	How does the System evaluate RAN energy saving intent fulfillment?

Evidence:

For the intra-RAT intra-frequency multi-site energy saving scenario, and intra-RAT inter-frequency multi-site energy saving scenario and inter-RAT multi-site energy saving scenario(LNR),the system will automatically report the KPI and gains based on the intent.

based on the intent, the system will also give the KPI comparison and gains before and after for all Sub-scenarios. The network main wireless KPIs (Drop rate, Throughput , Access rate, handover rate, traffic, etc) related to the all sub-scenarios will be evaluated by the system, including the power consumption gain which correspond to the user intent.



Cognitive Activity_ Awareness (RAN Energy Saving Information Collection)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving	Intra-RAT inter-frequency multi-Site energy saving	Inter-RAT multi-Site energy saving
							20%	40%	40%
Awareness	RAN Energy Saving Information Collection	How does the System collect RAN energy saving related information?	The System continuously collects RAN energy saving related information, without human intervention	The System continuously collects RAN energy saving related information, but requires human intervention (e.g.: for data quality checks)	The System continuously collects RAN energy saving related information based on predefined rules.	RAN energy saving related information are collected based on expertise	A	A	A

Evidence:

RAN data auto collection

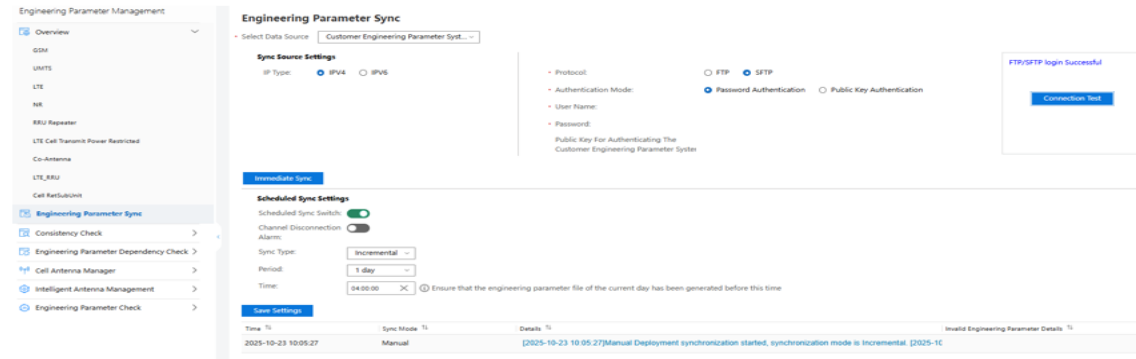
NE sites Performance data (counters), CHR data and Configuration data will Periodically (hourly) update to Access sever, and the Auto power saving system will collect these data periodically



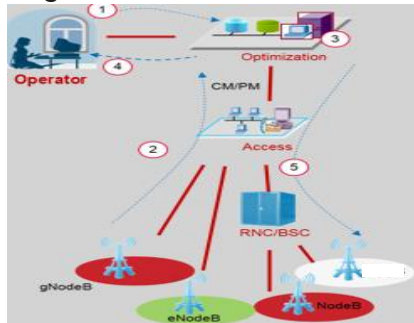
Engineer parameters auto collection



These auto collection procedures can be applied to all the three sub-scenarios

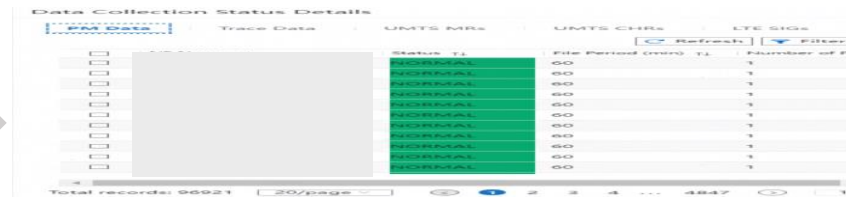


NE Counter/Chr/Config are the RAN Energy Saving information for all sub-scenarios. It are continuously collected from enodeB/gnodeB after the user create the energy saving task. The overall automatic collection process is shown in the follow left figure.



[Start phase]
 [2025-10-31 18:32:19] Start optimization,
 [2025-10-31 18:32:23] Start sync CM data.
 [2025-10-31 18:32:47] Finish sync CM data.
 [2025-10-31 18:33:30] All optimization objects subscribed to successfully.
 [2025-10-31 18:33:30] Start collecting data.

When entering the collection phase, the run log will provide a prompt



The results of automatic collection will be displayed on the GUI.

Cognitive Activity_Analysis (RAN Energy Saving Issues Identification)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving	Intra-RAT inter-frequency multi-Site energy saving	Inter-RAT multi-Site energy saving
							20%	40%	40%
Analysis	RAN Energy Saving Issues Identification	How does the System identify RAN energy saving issues?	The System intelligently identifies energy saving issues, without human intervention.	The System intelligently identifies energy saving issues, but requires human intervention for issue confirmation	The System identifies energy saving issues based on predefined rules.	Energy saving issues are manually identified.	A	A	A

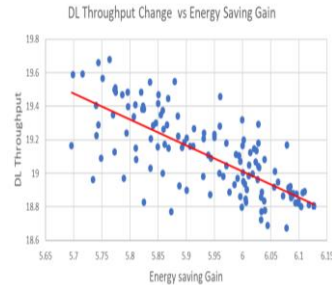
Evidence:

intra-RAT intra-frequency multi-site energy saving scenario and intra-RAT inter-frequency multi-site energy saving scenario

➤ RAN Energy Saving Issues --Insufficient energy saving issue

• 1st step: Preliminary Selection of Energy Saving Cells

both intra-RAT intra-based on the collected vels of potential energy-measure that still meets



• 2nd step: Energy saving effect simulation

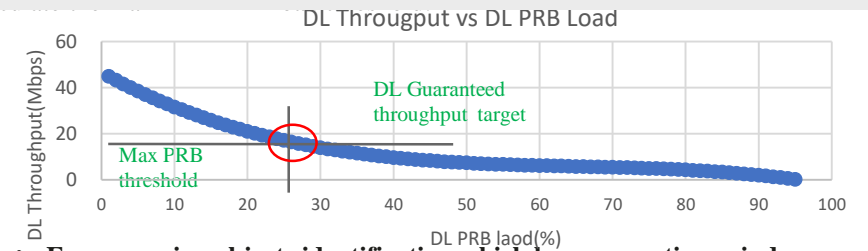
strategies.

• Last step: identify the cells with Insufficient energy saving issue

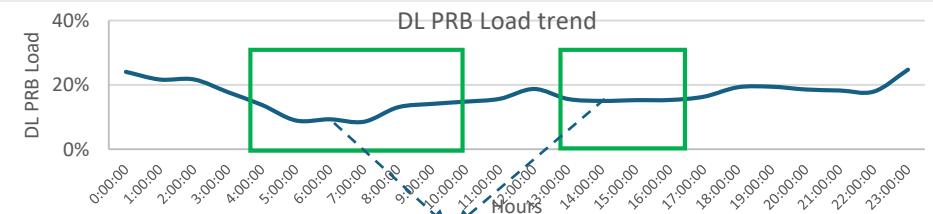
inter-RAT multi-Site energy saving scenario

➤ RAN Energy Saving Issues --Insufficient energy saving issue

• 1st step: MAX LTE PRB threshold calculation for LNR carrier shutdown



• 2nd step: Energy saving objects identification which has proper time windows



All proper time window which has insufficient energy saving issue

Cognitive Activity_Analysis (RAN Energy Saving Issues Identification)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving	Intra-RAT inter-frequency multi-Site energy saving	Inter-RAT multi-Site energy saving
							20%	40%	40%
Analysis	RAN Energy Saving Issues Identification	How does the System identify RAN energy saving issues?	The System intelligently identifies energy saving issues, without human intervention.	The System intelligently identifies energy saving issues, but requires human intervention for issue confirmation	The System identifies energy saving issues based on predefined rules.	Energy saving issues are manually identified.	A	A	A

Evidence:

after enable the power saving task, for the all sub-scenarios, the system will automatically check which cells can do power saving based on conditions, usually the user can get these cells in the log(OPT_LOCATION_OPTIMIZATION_DATA\xx\Optimization\issuecells.csv).

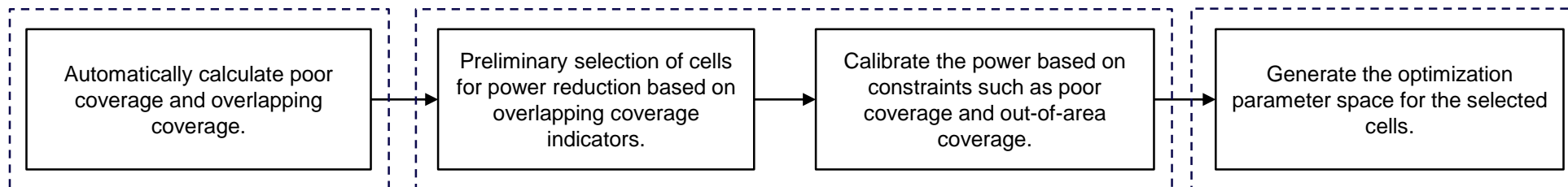


issue cellist

CGI	gNodeBId	cellId	r6	inOverlapRatio	outOverlapRatio	poorCoverageRatio
520-03-5103	5103	5103	0.9898842823204	0.27883729750230263	1.625399577396119	9.579955784
520-03-5102	5102	5102	0.9850437862885	0.303513288	2.516606984632963	3.345538352
520-03-5101	5101	5101	0.9939554612937	0.37047576256801956	0.001547601	5.837224816
520-03-5103	5103	5103	0.9753615425816	0.22405100830367733	0.10757710557532	0
520-03-5108	5108	5108	0.9817340905095	0.26674658827779874	0.00211847	8.848578697
520-03-5102	5102	5102	0.9834999206726	0.4077086280056577	0.074611033	8.119707690
520-03-5108	5108	5108	0.9690407198413	0.24953226834433273	0.017825201998335	3.710024486
520-03-5101	5101	5101	0.9851857266425	0.23999065470948727	0.01911830778354	1.580099772
520-03-5101	5101	5101	0.9858861688838	0.19588548302480702	0.024604661620323	3.164556962
520-03-5101	5101	5101	0.9760360239852	0.25859035079271975	0.05802481	6.725656276
520-03-5103	5103	5103	0.9751434034416	0.35022184056104194	0.067482467	0.00187207
520-03-5102	5102	5102	0.9821309088016	0.3367968801639236	0.05531099213433	4.463123442
520-03-5102	5102	5102	0.9813108038914	0.12066822474899994	0.1102955979797	1.837222120
520-03-5101	5101	5101	0.9712643678150	0.2870967741935484	0.10942928039702	0
520-03-5104	5104	5104	0.9717400198725	0.2602410454330016	0.010754508	0.00100746
520-03-5101	5101	5101	0.9834510763750	0.1820966927820572	0.034235301863152	6.31319277

For the Candidates Cells, when all the poorCoverageRatio/ outOverlapRatio/ inOverlapRatio vau are n't equal to 0, will be the issues cells

Issue cells auto judgement process



Cognitive Activity_Analysis (RAN Energy Saving Issues Demarcation & Root Cause Analysis)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving 20%	Intra-RAT inter-frequency multi-Site energy saving 40%	Inter-RAT multi-Site energy saving 40%
Analysis	RAN Energy Saving Issues Demarcation & Root Cause Analysis	How does the System demarcate energy saving & performance issues and analyze their root cause (e.g., performance issues caused by which energy saving actions)?	The System intelligently demarcates energy saving & performance issues and analyze their root cause, without human intervention	The System intelligently demarcates energy saving & performance issues and analyze their root cause, but requires human intervention to confirm the root causes	The System identifies energy saving issues, based on predefined rules The root cause is analyzed by expert	Energy saving & performance issues demarcation and root cause analysis are performed manually	A	A	A

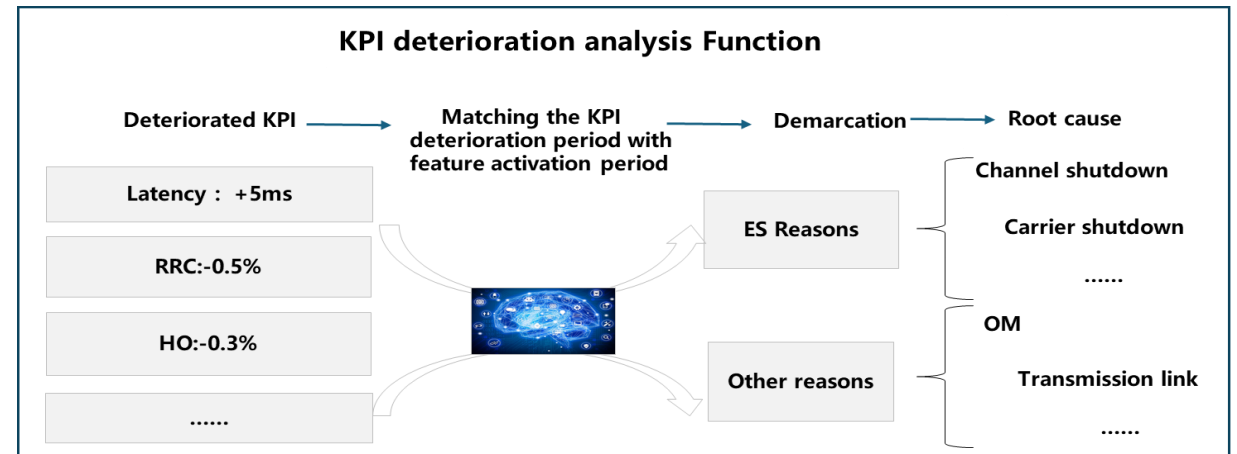
Evidence:

➤ Performance issues caused by energy saving

In intra-RAT intra-frequency multi-site energy saving scenario, and intra-RAT inter-frequency multi-site energy saving scenario and inter-RAT multi-site energy saving scenario(LNR), the system could identify the cells with performance issues due to energy-saving actions.

(1)The system has a built-in KPI deterioration analysis model that establishes the correlation between KPIs and energy-saving features. The system can identify whether the KPI deterioration is caused by specific energy saving actions by analyzing the correlation between the KPI deteriorated time and the activation time periods of energy-saving features implemented the previous day that may affect these KPIs.

(2) The system will show the root cause related with energy saving actions on the GUI



Cell: 3RNCTWA8H_LMTMM, Only power saving scripts run, so handover rate degradation was caused by power saving, the scripts rollback 1 day later.

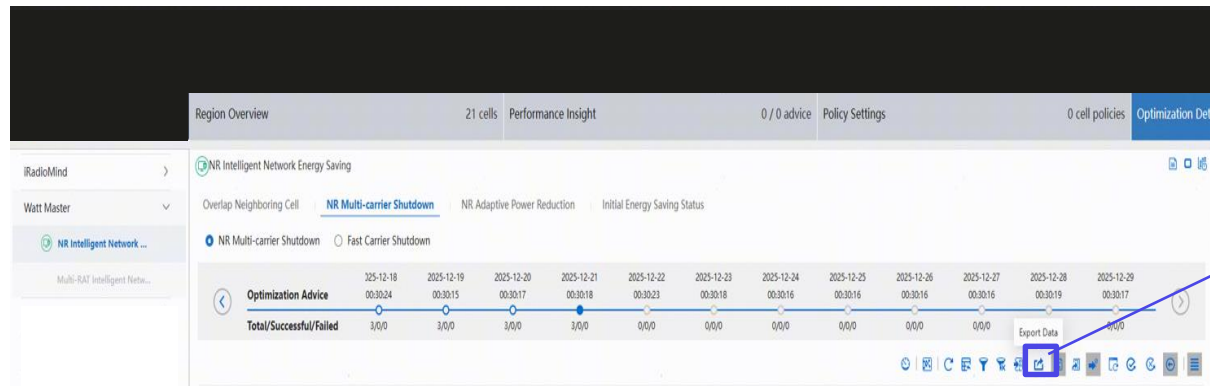
Generated On	Rollback Time	Rollback Related KPI	Failure Cause
06:3...	08:3...		
Intra-RAT HO success rate (%):Before optimization:99.75,After :97.88;			

Cognitive Activity_Analysis (RAN Energy Saving Issues Demarcation & Root Cause Analysis)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving 20%	Intra-RAT inter-frequency multi-Site energy saving 40%	Inter-RAT multi-Site energy saving 40%
Analysis	RAN Energy Saving Issues Demarcation & Root Cause Analysis	How does the System demarcate energy saving & performance issues and analyze their root cause (e.g., performance issues caused by which energy saving actions)?	The System intelligently demarcates energy saving & performance issues and analyze their root cause, without human intervention	The System intelligently demarcates energy saving & performance issues and analyze their root cause, but requires human intervention to confirm the root causes	The System identifies energy saving issues, based on predefined rules The root cause is analyzed by expert	Energy saving & performance issues demarcation and root cause analysis are performed manually	A	A	A

Evidence:

for all sub-scenarios, the system will auto provide the root cause for different KPI deterioration if it was caused by auto power saving features optimization, as it show in the follow screen shot, the CQI(0-6) rate was caused by the carrier shutdown, and the follow advice was delivered failure, and will rollback to improve the KPI.



batch number	optimi	execution status	failure cause
1765927839	936	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	1615	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	929	Automatic delivery failed	Energy The following KPIs has deteriorated: Average Downlink Throughput, so that the cell is under KPI penalty.
1765927839	931	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	934	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	939	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	1412	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	1414	Automatic delivery failed	Energy The following KPIs has deteriorated: Average Downlink Throughput, so that the cell is under KPI penalty.
1765927839	1217	Automatic delivery failed	Energy The following KPIs has deteriorated: Average Downlink Throughput, so that the cell is under KPI penalty.
1765927839	1221	Automatic delivery failed	Energy The following KPIs has deteriorated: Average Downlink Throughput, Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	1345	Automatic delivery failed	Energy The following KPIs has deteriorated: Average Downlink Throughput, so that the cell is under KPI penalty.
1765927839	1154	Automatic delivery failed	Energy The following KPIs has deteriorated: Weak-coverage MR Proportion, so that the cell is under KPI penalty.
1765927839	1150	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, Weak-coverage MR Proportion, so that the cell is under KPI penalty.
1765927839	1175	Automatic delivery failed	Energy The following KPIs has deteriorated: Average Downlink Throughput, so that the cell is under KPI penalty.
1765927839	1438	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	1441	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.
1765927839	1401	Automatic delivery failed	Energy The following KPIs has deteriorated: Proportion of CQIs 0 to 6, so that the cell is under KPI penalty.

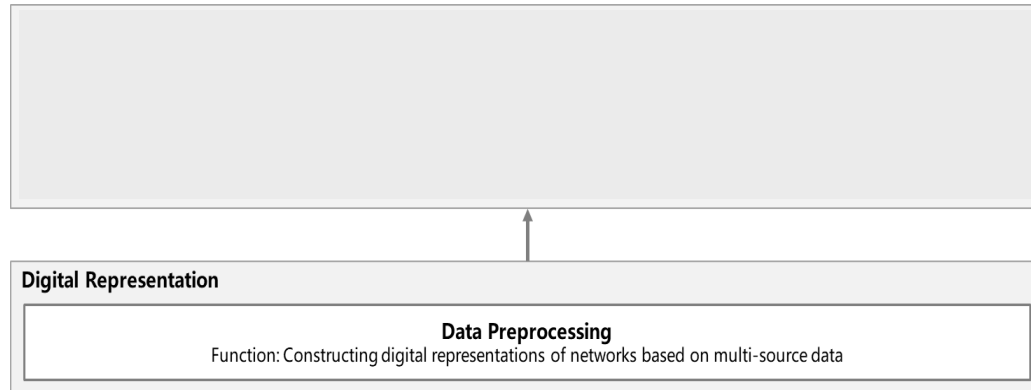
Export the root cause data in GUI for power saving features

The deterioration KPIs which related to power saving features auto optimization

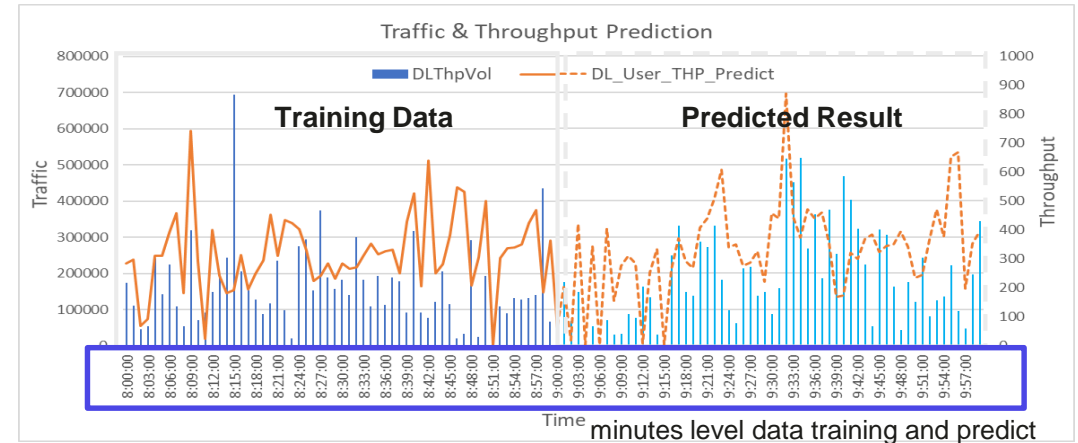
Cognitive Activity_Analysis (RAN Traffic & Performance Prediction)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving 20%	Intra-RAT inter-frequency multi-Site energy saving 40%	Inter-RAT multi-Site energy saving 40%
Analysis	RAN Energy Saving Issues Demarcation & Root Cause Analysis	How does the System predict traffic load and network performance that can be used for RAN energy saving solutions? Traffic load includes but not limited to PRB utilization rate. Network performance includes but not limited to RAN UE throughput	The System intelligently predicts traffic load & network performance that can be used for energy saving solution at the minimum granularity that data is available from the source, without human intervention.	The System intelligently predicts traffic load & network performance that can be used for energy saving solution, without human intervention.	The System predicts traffic load & network performance that can be used for energy saving solution, based on predefined rules.	Traffic load & network performance trend need to be manually established based on human expertise or through the execution of manual written procedures.	A	A	A

Evidence:



- In intra-RAT intra-frequency multi-site energy saving scenario, and intra-RAT inter-frequency multi-site energy saving scenario and inter-RAT multi-site energy saving scenario(LNR) , the core principle of predicting future load and performance (including user throughput) is to build machine learning regression models based on historical network data (e.g., MR, CHR, PM, DT), modeling key features that influence throughput, thereby achieving accurate simulation predictions of user throughput, spectral efficiency, and cell load.



In all three sub-scenarios, the algorithm extracts minute-level KPI data, such as traffic and throughput, based on collected data, Then, it uses the minute-level data to train indicator models and predict the traffic and throughput change follow the auto generate policy. If some power saving features need hourly traffic, the system will combine the minutes level traffic to hourly traffic.

Cognitive Activity_ Analysis (Solution Generation)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving	Intra-RAT inter-frequency multi-Site energy saving	Inter-RAT multi-Site energy saving
							20%	40%	40%
Analysis	Solution Generation	How does the System generate the recommended RAN energy saving solutions to solve the identified energy saving issues?	The System intelligently generates energy saving solutions, adjusted to adapt to RAN Traffic & Performance changes, without human intervention	The System intelligently generates energy saving solutions, without human confirmation	The System generates energy saving solutions based on predefined rules, and requires human intervention.	Energy saving solutions are manually proposed based on expertise.	A	A	A

Evidence:

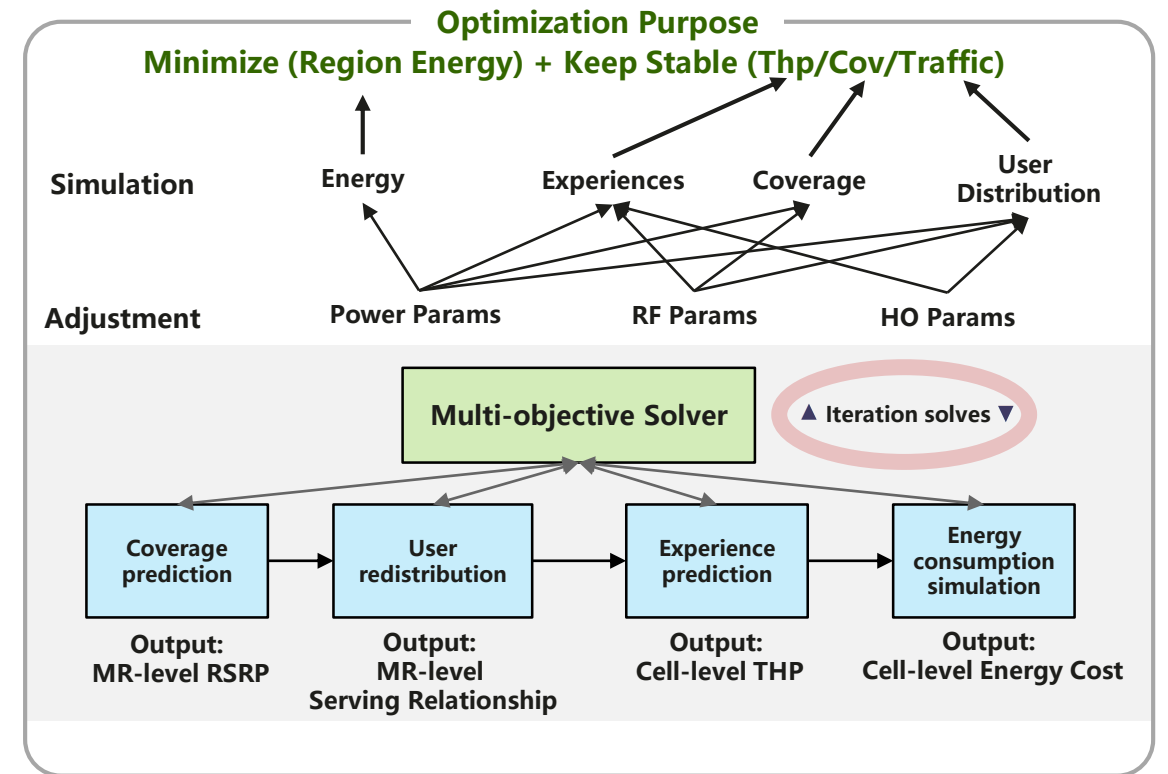
- The system generates multiple rounds of solutions iteratively using AI optimization algorithms based on predicted traffic load and network performance, combined with customer demand scenarios. The final solution is selected based on the benefits of each option. The entire process is fully automated and requires no manual intervention for the intra-RAT intra-frequency multi-site energy saving scenario, and intra-RAT inter-frequency multi-site energy saving scenario and inter-RAT multi-site energy saving scenario(LNR)

- Optimization parameters

NO.	Parameters	Optimization Target	Optimization Target Constraint
1	L2 scheduling parameter	Throughput	Traffic
2	L3 handover parameter	Throughput	Traffic
3	Power parameter	Energy	Throughput&Traffic&Coverage
4	RF parameter	Coverage	Throughput&Traffic&Energy&User

- Part Candidate Energy Saving Strategies (Cell: 3RNCTWA8H_LMTMM, LMTMMN0713)

	MaxPower	CovInterFreqA2RsrpThld	E-AZIMUTH	E-TILT



Cognitive Activity_ Decision (Solution Evaluation & Decision Making)

Cognitive Activity	Service Capability	Question	Option A	Option B	Option C	Option D	Sub-scenario 1	Sub-scenario 2	Sub-scenario 3
							Intra-RAT intra-frequency multi-Site energy saving 20%	Intra-RAT inter-frequency multi-Site energy saving 40%	Inter-RAT multi-Site energy saving 40%
Decision	Solution Evaluation & Decision Making	How does the System evaluate energy saving solutions and decide on the best solution to be implemented?	The System intelligently evaluates energy saving solution when the recommended solutions are generated, and selects the best solution, without human intervention	The System intelligently evaluates energy saving solution and selects the best solution, but requires human confirmation	The System evaluates energy saving solution and selects the best solution based on predefined rules	Energy saving solutions are evaluated and decided based on manual expertise.	A	A	A

Evidence:

For the intra-RAT intra-frequency multi-site energy saving scenario, and intra-RAT inter-frequency multi-site energy saving scenario and inter-RAT multi-site energy saving scenario(LNR):

- When generating alternative solutions, the algorithm calls the simulation prediction module to simulate the parameters of each solution, and then generates predicted values for corresponding KPIs such as DL throughput, traffic, and poor coverage ratio.
- The algorithm calculates and records the comprehensive score for each alternative based on the predicted values and weights of key KPIs.
- Example of Candidate Solution Evaluation (Cell: 3RNCTWA8H_LMTMM, LMTMMN0713)

Parameters	MaxPower	CovInterFreqA2RsrpThld	E-AZIMUTH	E-TILT

↓ KPI Simulation

Results	Energy Consumption	User DL Throughput	Traffic	Poor Coverage Ratio	fitness

Key Factors	Description
Energy Consumption	Primary objective: to achieve the greatest possible energy savings.
User Throughput	Constraint: Do not allow throughput degradation.
Traffic	Constraint: No traffic loss is expected after energy saving.
Poor Coverage Ratio	Constraint: Good coverage remains after implementing energy-saving measures.
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Thank you.