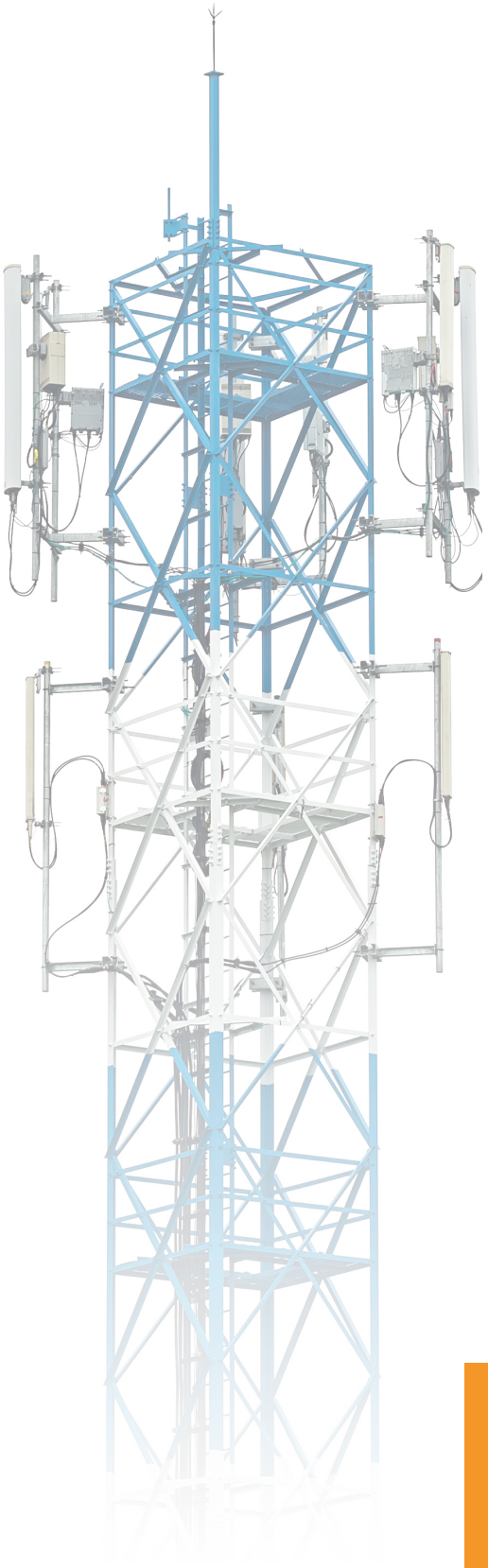
2operate



ECO-RAN

SOLUTION DESCRIPTION

2operate A/S

2operate

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Introduction

2operate has developed ECO-RAN, where the primary aim is to save power in 4G RAN. The solution has been developed, tested, and trialed in a mobile network before launch of the product. The solution has proven that an operator can gain significant savings of power and maintain a good quality in the RAN. From production in a live network, it has been proven that the solution saves around 5% of power without degradation of the quality.

ECO-RAN solution platform

The solution is developed to be a multivendor solution, where the solution uses Network features available for all major RAN vendors.

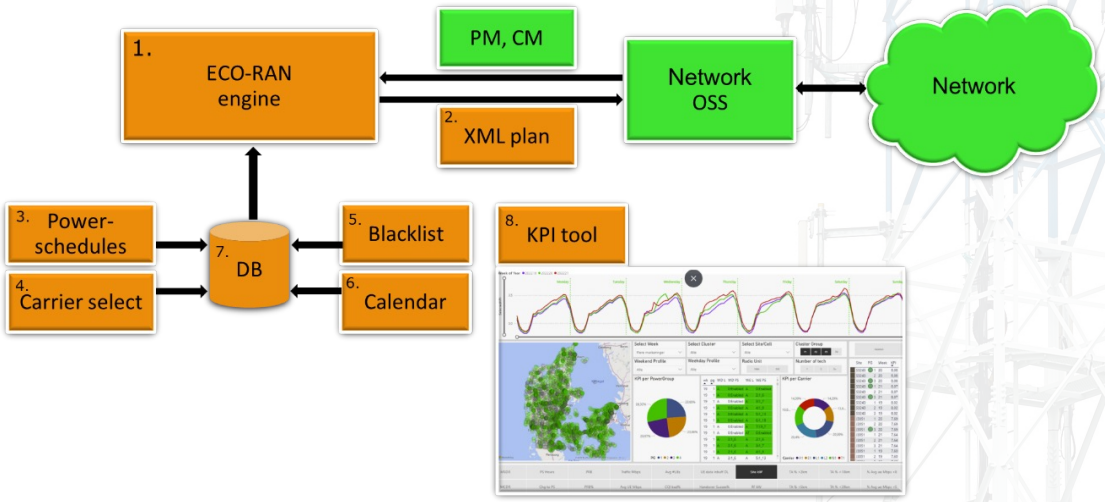


Figure 1 *Architecture of ECO-RAN*

1. ECO-RAN engine is the central calculation functionality. Based on KPI measurements from the network, network hardware configurations (radio modules) and ECO-RAN configuration data, network configuration parameters are calculated automatically. Basically, the engine calculates which power schedule to allocate to each carrier in the network.

The ECO-RAN engine can be controlled by 4 parameters (default settings).

- Penalty score – 3
- Reward score - 1
- Variance factor - 2
- Accepted load – 75%

These parameters control how aggressive the power saving settings for the RAN network are calculated. Parameters can be adjusted to control ECO-RAN to either be more aggressive or conservative.

Allowing the RAN network to enter power save 24/7 has been tested and this results in severe quality problems in the network. So, this cannot be recommended.

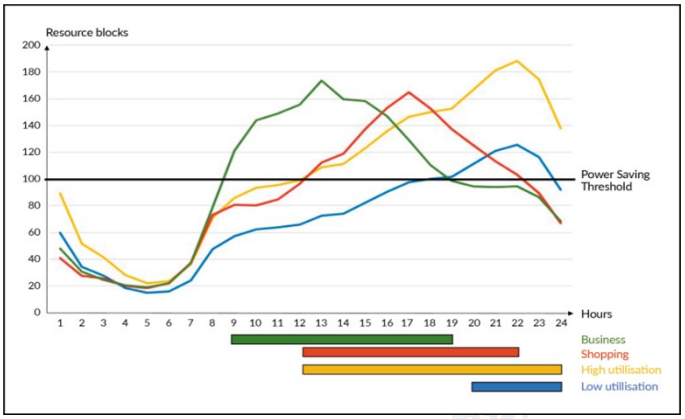


Figure 2. *Example of traffic analyses of a mobile network, where typical traffic profiles are extracted*

	Hours	Start	Stop	Start time
Profile 1	24	00:00	00:00	
Profile 2	5	01:00	06:00	
Profile 3	6	01:00	07:00	
Profile 4	8	01:00	09:00	
Profile 5	12	01:00	13:00	
Profile 6	5	02:00	07:00	
Profile 7	4	03:00	07:00	
Profile 8	17	01:00	18:00	
Profile 9	12	19:00	07:00	
Profile 10	0	PS off	PS off	

00:00 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00

Figure 3. *10 Static power schedules defined*

Based on traffic analyses of the RAN network – see figure 2 - static power schedules can be defined – see figure 3. All cells in the network will have a power schedule assigned by the ECO-RAN engine.

The selection of power schedule is calculated by the ECO-RAN engine based on a best effort method. The algorithm prioritise:

1. How many hours in power save, a full radio module is in power save
2. How many hours in power save, a carrier is in power save
3. If several carriers are in power save, the interference can be used to select which carrier that enters power save first

Two power schedules are found for each carrier – the best fitting schedule for normal business days and the best fitting schedule for weekends.

The schedules are calculated and implemented in the network on a weekly basis. The calculation is based on data from the network from a 14-day period. For vacation periods, data for previous vacation period is included.

2. XML Plan - ECO-RAN calculates a power save plan and produces XML files to configure the RAN network. The XML files are uploaded and deployed in the network by a filesharing mechanism.

3. Power-schedules - the solution will use the defined power schedules for its calculations – see figure 3. Power schedules are defined as the time of the day where a site is allowed to enter power save mode. The solution comes with a proven toolbox of time schedules.

4. Carrier select is used with an integration to Atoll coverage calculation data. This module can prioritise the order of carriers to enter power save based on estimates of interference levels in the network.

5. Blacklist is used to exclude sites from the power saving functionality. If the operator for some reason wishes to exclude a site from power save, it is added to a blacklist.

6. Calendar is used to control configurations during vacation, holiday and event periods as traffic patterns varies during these periods.

7. Database of all the KPIs, nodes, cells, radio modules and more storing all information. The database model will be available for the operator. The operator can integrate information from the database to other solutions if required.

8. KPI tool, is developed as an easy-to-use tool that monitors traffic, quality and power savings in the network to prevent any negative effects on the network quality.

The following KPI's are available in to KPI tool:

Traffic KPI's

- PRB load
- PRB % relative to capacity
- Traffic Mbps
- Avg UE (mobile) Mbps
- Avg # UEs
- % Avg UE Mbps < 8 – number of UE's having less than 8Mbps
- % Avg UE Mbps < 5 – number of UE's having less than 5Mbps

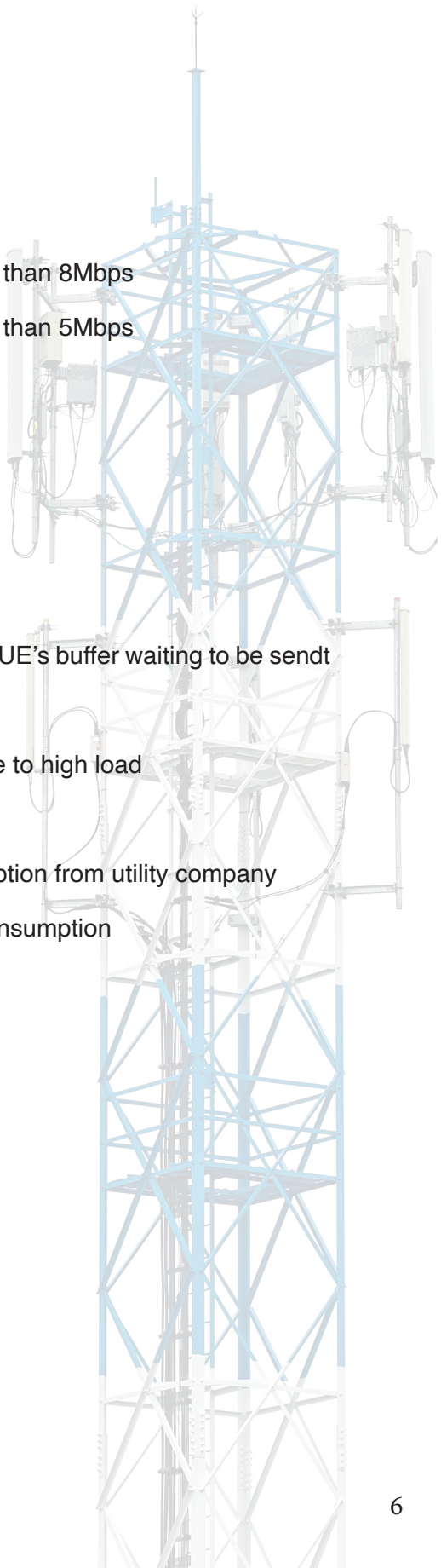
Quality

- **MSDR** – overall success rate of data sessions
- **MCDR** – overall success rate of call sessions
- **PS hours** – hours where power save is active
- **CQI bad** – bad quality index
- **UE data in buffer** – average amount of data in the UE's buffer waiting to be sendt
- **Handover success** %
- **Change to ps** – number of restarts of capacity due to high load

Power saved

- Site kW – hourly measurements of power consumption from utility company
- RF kW – equipment vendors estimate of power consumption

Additional customer specific KPIs can be added.



ECO-RAN operation

Implementing ECO-RAN parameters into the network can be handled in several ways. 2operate has used the process illustrated in figure 4 for the current implementation of ECO—RAN.

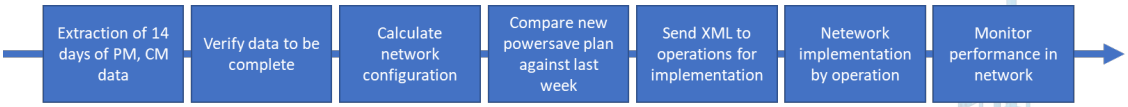


Figure 4: *ECO-RAN workproces*

Implementation

1. The process may be integrated on a weekly basis

   Configuring the network daily is important when handling different traffic patterns, like weekdays and weekends. Dependent on the network an ECO-RAN plan is generated based on the capabilities of the network. ECO-RAN produce configuration files for a week at a time.

2. Configuration and performance data is extracted from a 14-day period.

   The calculation is based on statistics for the last 14 days. This is a trade-off between the ability to follow dynamic traffic changes and statistics.

3. The data is examined to ensure that all data is available and valid.

   A simple monitoring tool is used to see how much of the data is fetched from the network. Often it is not possible to collect 100% of the data. The user examines what data is missing. If needed data can be re-fetched from the network. Typically, a small part data will not affect the ECO-RAN calculation.

4. The ECO-RAN engine is calculating new settings for the network power save feature

   When data is available the ECO-RAN engine calculates the new parameter settings,

based on the configuration parameters of ECO-RAN. ECO-RAN can produce configuration parameters for 100 sites per minute.

5. The new plan is compared to the previous plan, to follow the changes in the plans

   When a new plan is available it can be compared to the previous plan in the KPI tool. Typical most sites have the same configuration from week to week since traffic patterns only change slowly.

6. The XML configuration plans are passed on to operations.

   When the XMLs are created they will be passed on to operation in any preferred way. Any file transfer mechanism can be used.

7. Operations verify the plan and implement the plan in the networ

   When operation receive the plan, operations load the plan into the OSS solution. During this process the XML file will be checked again. Operation will handle the actual implementation in the network going true standard operations change processes.

Monitoring

1. The performance of the plan is monitored using the KPI tool – monitoring traffic, quality and power saved

   At least on a weekly basis the KPI tool should be used to follow the power saving. The tool allows to get a quick overview of the whole network or clusters in the network. Especially the troubleshooting lists are very useful to look for bad performing cells.

A network specialist is needed to find the root cause of a problem.