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Power Management of Cell Sites

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Abstract:- This paper presents Power management of Cell Sites. The method makes use of GSM modem. The GSM modem which gives the instant message about the mains power supply to the cell sites. The temperature sensors and relay will sense the temperature of the room and if the main fails the GSM module will send the message to the master mobile which is already set in the system. The cell site base transreciever station (BTS) which are operated by Diesel generator, when the power is off we can switch on the Diesel generator by sending the SMS command like (DG ON) or we can switch of the generator with the command (DG OFF). The method can greatly improve the developing efficiency, reduces the delay and fuel consumption. The proposed one has better performance and involves less hardware complexity. This is a single comprehensive solution that remotely controls and monitors the subsystems inside each base station site and enables network operators to coordinate and manage the conditions at all base station sites across their network.

Keywords:- GSM module, base transreciever station (BTS), diesel generator, sensors.

I. INTRODUCTION

Cellular towers form the backbone of our modern communications infrastructure. According to the phrase that the best energy is the one which is not used, the best way to make a base station is to use equipment with the lowest possible energy consumption. No base station can work without power, but the utilization of highly efficient technology helps to save energy as well. Besides energy savings, other facts have to be considered for a base station also such as low emissions of pollution and low noise. Each tower is supported by a power plant with batteries, air-conditioning unit, a diesel generator and tank for backup power, and a power conditioning unit. Sites that are not supported by utility power sometimes rely on hybrid power sources like solar power plants. The sensors that monitor batteries, temperature, and diesel fuel levels. Our paper is a single comprehensive solution that remotely controls and monitors the subsystems inside each base station site and enables network operators to coordinate and manage the conditions at all base station sites across their network. Remote operating and monitoring Cell Sites consists of two main components. The Remote Controller Unit (RCU) is a rackmounted solution deployed at base station site throughout the network and can manage and monitor up to 88 individual subsystems. Each RCU feeds into a centrally-located Control Management System (CMS) that enables operators to remotely manage and monitor thousands of individual base station sites or more.

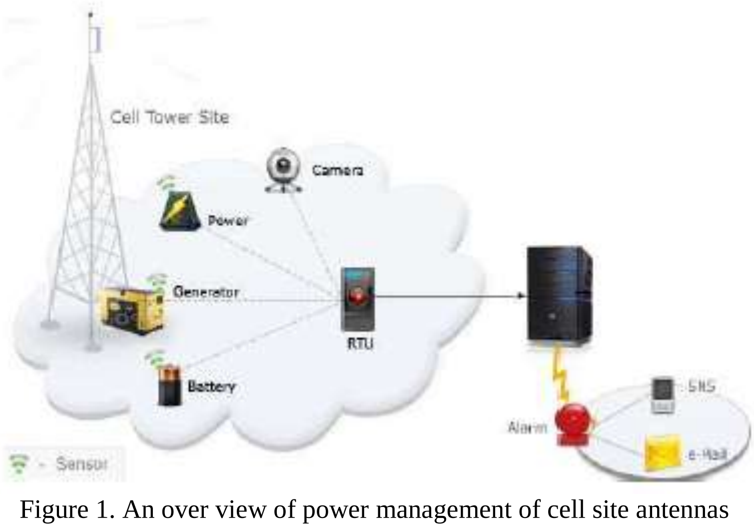

Figure 1. An over view of power management of cell site antennas

II. THE PRICIPLES OF CELL SITE

Remote operating and monitoring cell sites protects your network, tracks and measures cell site performance for peak operation, identifies performance problems with Speed and Precision and enables efficient. On-demand Intervention in Site failures or breakdowns, since the best problems are those successfully avoided. Our paper has introduced the Remote operating and monitoring which enables the wireless operators to monitor cell sites remotely for performance degradation before it affects network integrity. Our paper mainly works on: 1. Controls multiple individual subsystems per base station site and thousands or more base station sites across your network. 2. Alerts users immediately when smoke and fire alarms are triggered to prevent or reduce damage to cell sites 3.Reduces energy consumption through automatic maintenance and monitoring of temperature and humidity. 4. Deters theft and vandalism by monitoring and controlling remote cameras, motion detection alarms, and door sensors. 5. Dramatically reduces site visits and turns your entire network a deeper shade of green. High-efficiency rectifier modules convert the mains AC to a 48V DC voltage for the radio equipment. High-efficiency technology reduces losses of the AC/DC and DC/DC power conversion to a minimum and also contributes to the reduction of the requested air conditioning power. A Free-Cooling air conditioning system reduces the energy consumption of the base station additionally, in comparison to traditional solutions.

III. BUILDING BLOCKS OF THE ELECTRICAL SYSTEM[2]

The power supply system of the Cell site BTS consists of various elements which all have to contribute to energy savings, reduction of C02 emissions and have to be de-signed in a way which allows easy disassembling and component separation for recycling. The electrical system building blocks are listed below:

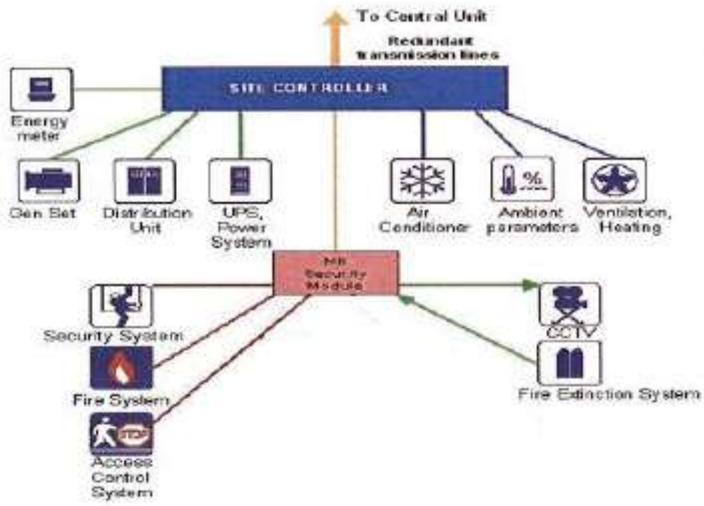

Figure 2. The building blocks of the electrical system

3.1. HIGH-EFFICIENCY RECTIFIERS

Modern High-Efficiency rectifier technology can contribute to energy savings in various ways. Compared to traditional rectifier technology with a maximum efficiency of approximately 92%, high-efficiency products convert AC to DC power with an efficiency of more than 95% over a wide load range and even above 96% under optimum load conditions. This means a reduction of electrical energy losses to half of the value compared to traditional switch mode rectifier technology. Half the electrical losses also means half of waste heat dissipation from the rectifier‟s power conversion. Therefore it is also possible to reduce the size of air-conditioning equipment and to save a significant amount of the energy which is needed to get rid of the heat losses from the equipment, compared to a tradi-tional BTS. If smart modern air-conditioning is combined with High-Efficiency rectifier technology, energy savings will pay back the higher investment costs compared to tra-ditional systems in short time – usually within less than 2 years.

3.2. BATTERY BACKUP

Nevertheless, batteries are a part of the BTS concept. They are needed to make the power feeding of the telecom load uninterruptable, if a mainsfailure occurs the load completely or are still in standby mode and need time to start up as it might happen with a backup battery. The battery can be automatically switched on by sending an SMS battery ON. When the battery is going to completely discharge, the sensor technology will again send the percentage of power remaining in the back up battery to the operator through GSM technology. Once by knowing the charging of the battery, the operator will decide whether to switch on the diesel generator or not. As once the power is gone the back battery can be automatically switched on, but by using the GSM technology the operation can decide whether to switch on the diesel generator or the battery. Depending on the time constraint there is necessity of switching on the diesel generator, as the backup battery cannot supply the sufficient power to the cell sites for a long time. Backup batteries are sensitive to extreme temperatures and their lifetime depends a lot on their operational temperature, number of charge and discharge cycles and they require some maintenance during their lifecycle. This has to be considered in the planning phase of the BTS and will have an influence on the decision of the air-conditioning system.

3.3. SOLAR POWER FOR BTS

The idea of the BTS includes the utilization of alternative and renewable energy sources. Depending on the region where the BTS is installed, solar power can provide an important contribution for the power supply. The highest power demand in a typical BTS is based on 48Vdc voltage. Therefore it is beneficial to use DC/DC converters that can directly convert the unregulated DC-outut voltage and current from a solar panel to a regulated output voltage for the BTS-equipment. A smart regulation and control unit is required, to allow a direct parallel power feed from solar converters and other rectifier or DC/DC converter technology on the same power bus. As long as there is solar energy available, the solar converters contribute to the BTS feed and if possible even charge the battery. But there are some disadvantages to be considered. Solar converters can deliver power only during sunshine hours. During the night or on cloudy days, other energy sources have to cover the power demand of the BTS. Large solar panels are expensive and take up considerable space. That is the reason why solar energy is only useful for applications with low DC-power demand with less than 2kW. There has to be enough space for the solar panel and no item around which might cause shadow or pollution. Depending on the region, snow could also become an issue. Besides the technical restrictions it is also important to protect solar panels from theft in unmanned locations. In summary it can be said, that solar power is a good add-on to save mains energy but solar power is an unreliable source for BTS applications in cell sites.

3.4. INVERTER AND STATIC SWITCH

Some equipment in the BTS may depend on uninterrupted AC power. Therefore a highly efficient inverter is needed which converts the DC voltage from the load and battery to the requested AC-voltage. A typical AC consumer in a BTS is the active air-conditioning system, which only works under extreme temperature conditions. Some 3G radio equipment also has direct AC feed and depends on inverters as well. One target for BTS should be to avoid consumers that depend on AC power. This would allow one to design systems which just use DC and avoid the additional conversion step from DC to AC including its losses. As long as the most air-conditioning systems use some AC power, inverters will still be in place. If there is a public mains supply available, AC loads are usually directly fed from the mains to reduce conversion losses. A static switch unit monitors the mains voltage and if the mains power fails, the AC loads will be connected to the output of the inverter modules. This offline mode reduces losses which are generated from the DC to AC conversion process in the inverter. In off-grid BTS sites there is no static switch. In BTS site with mains supply, the inverter serves as a redundant AC source to the public mains. The AC load has to be considered when the backup time and energy consumption during a mains outage period is calculated.

3.5. CONTROL UNIT OF THE POWER SYSTEM

The control unit of the power system is the brain of a complex control, regulation and communication system. On the one hand it has to control and communicate with the power system building blocks as there are rectifiers, converters. On the other hand the system control unit has to communicate with a remote NMS (Network Man-agement System) for alarm management, remote monitoring and remote control. For the internal communication, digital bus systems or small networks are used (e.g. CAN). For the remote interface, wireless GSM modems or network so-lutions are the most common communication units. Besides the control functions, alarm memory capabilities are of high importance. The complete control, monitoring, regulation and interaction between the different power blocks have to be managed from this control unit. But the control unit may not become a single point of failure which can cause the whole system to collapse if it fails. So there must be a strategy and emergency function in all active power building blocks, to guarantee an emergency mode, which provides power to the connected equipment. A video surveillance is also provided in the BTS room, to view the room and get the instantaneous information. The remote interface, wireless GSM modems are mainly operated by either controllers or processor. When the power is off then the operator will receive a message from the control unit. Then the operator can switch on the diesel generator by sending the commands. The sensors that are kept in the BTS room will report the temperature in the room, so that the operator can switch on the air conditioning unit in the BTS room.

3.6. AIR-CONDITIONING SYSTEM

The decision for the air-conditioning system has a very important influence on the power demand of the BTS. Free cooling of the BTS during the major part of the year saves a lot of energy compared to traditional aircon equipment. Depending on the temperature and power profile of the location, power savings of approximately 80% are possible compared to traditional air-conditioning solutions. In many cases it is not possible, just to work with fee cooling systems. This means that for periods of extreme temperature, active heating or cooling is required. For this reason we can find a combination of fee cooling and active air-conditioning in the most cases. Unfortunately this is the most expensive solution according to invest costs, but may gain back the money with reduced energy costs within only a few years of operation, depending on the given conditions. Target is to use the fee cooling mode as much as possible and to reduce the active airconditioning time to the very lowest limit. This requires that the installed equipment needs to have a wide range of operating tem-perature. The smaller the operating temperature range of the equipment, the more often active regulation and active air-conditioning is required. So it is a challenge for all component and equipment manufacturers to design their products for a wide temperature range. If this is fulfilled, fee cooling can give all benefits and possible energy savings. Additionally, modem air-conditioning systems are noise reduced compared to older models, which is also a contribution to the environmentally friendly.

3.7. TRANSCEIVER EQUIPMENT

The most important equipment form the view of the Telecom Operators is of course the transceiver equipment, which is the main load of the described power equipment. The transceiver equipment can also contribute to the BTS. Highly efficient equipment is an important base for energy savings and to reduce the size and power consumption of the air-conditioning system. High integration density and smart solutions help to reduce the size of the transceiver equipment, and with that the space demands for such transceiver stations. Modern BTS can be much smaller than those that we know from earlier years. Transceivers for Microcells are so small that they can be installed almost everywhere with very little optical impact on the environment. Modern transceiver equipment has a wide operating temperature range which allows the installation in rooms without temperature regulation, as long as extreme temperatures can be avoided. Air-conditioning systems can be designed much more efficiently and just need to be active for short periods. Reduced size and weight of the transceiver equipment reduces packaging and freight logistic resources which contributes to environmental care as well. Clever design which uses materials and construction ele-ments that can easily be recycled round up the image of the transceiver equipment.

IV. HYBRID SYSTEM WITH MAINS POWER

The BTS has mains supply via rectifiers, solar-power, battery, inverter, fee-cooling and active air conditioning. Various operation modes are possible.

4.1. *Type 1: Mains On, Load < Power*

In Mode 1 there is more power available from solar than the load demands. This is the ideal case to save mains energy. The control unit is responsible for power management which keeps the mains rectifiers in a standby mode and DC power is only provided from the solar converters. The backup battery is in a standby-mode, always prepared to start within about 15 seconds. AC consumers are directly fed from the mains. In this mode all DC power is generated from alterative sources. If the DC power of the solar and wind converters drops below the load request, the backup battery supports the load feed. If the battery is discharged to a certain level, mains rectifiers are started and support the power feed of the loads.

4.2. Type 2: Mains On, Load> Power

In Mode 2 there is more power demand from the loads than available power from solar energy. In this case the mains rectifiers work in parallel with the power sources on the same DC power bus, sharing the load in such a way that as much energy is used as possible. If there is no solar energy available at all, the mains rectifiers deliver the full DC power and recharge the battery, if this is necessary. AC consumers are fed directly via the static switch from the mains. As soon as there is more energy available than load demanded, the rectifiers go back into a standby mode and Mode I (see 4..1) is active again.

4.3. Type 3: Mains Off, Load < Power

In Mode 3 mains power is not available but solar energy is sufficient to feed the BTS. The AC consumers are fed from the inverter. As soon as the mains power is back, the system is switched to Mode I (see 4.1) immediately.

4.4. Type 4: Mains Off, Load> Power

In Mode 4 mains power is not available and solar energy is not sufficient to feed the loads. This is the time to start the battery. The battery output is connected to the same DC-power bus as the solar converters. Now all regenerative power sources are working in parallel, managed by the central control unit and share the load with their capabilities. Priority is to use as much energy from sun as possible, and to reduce hydrogen consumption to a minimum. As soon as mains is available again, the battery will return into the standby mode and the system will return into Mode 2 (see 4.2).

4.5. Type 5: Emergency Mode

If there is a critical problem with the central control unit, the system has to be switched to the Emergency Mode. In this mode, an alarm will be set off and rectifiers and DC/DC converters will operate in a default setting. The output voltage of the rectifiers is set a little bit above the voltage of the solar converters. So the rectifiers will take the load as long as there is mains power available. If mains power fails as well during this condition, solar converters can take the load. If the load is too high and the battery gets discharged to a certain value, automatically and contribute to the power. The power management is no more optimised to save hydrogen resources, but the system will still feed the load. Therefore it is a failsafe mode for the uninterruptable power.

V. CONCLUSION

All telecommunications are dependant of reliable power supply systems. With this paper we can develop low cost, real-time system which can monitor and control the operation of cell sites. We also believe that the described control and maintenance system will be an important tool in our efforts to create a better total availability for the power feeding of our different telecommunication systems. Implementing the system into service has enabled the creation of the open platform for the whole infrastructure integration in one monitoring system.

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