ZTE Green Technology Innovations White Paper

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ZTE中兴 中兴通讯股份有限公司
ZTE CORPORATION

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Technology Innovation is Fundamental for a Greener Environment and Power Saving

Global Energy Consumption Trend and Challenges

Climate change in the form of global warming is becoming one of the most compelling challenges for the environment and development in the 21st century. According to practical statistics, the average temperature of the earth's surface has risen up by 0.74℃ in last hundred years (1906 ~ 2008), and continues to do so at an ever increasing rate. As a result, the global sea level rose by 20cm, and worryingly, following the current trend, the figure will be as high as 100cm by the end of this century. According to the IEA (International Energy Agency) 2010 report, global energy consumption increased by 75% between 1973 and 2008, with a corresponding CO2 emissions increase of 80% and rising with an annual growth rate of 2.1%.

Energy crisis, abnormal climate, environmental deterioration, etc., are considerable and urgent challenges to be handled as we are step into the 21st century. Green solutions and environmental protection become the common issue of the era, and energy saving becomes the unavoidable responsibility of industry and enterprises. The search for low carbon development is no doubt the only choice for mankind.

For the global telecoms industry, a green plan is becoming an overwhelming action. As an active member of the telecoms industry, ZTE has set up a green strategy with a focus on multi-level technology innovations for cutting CO2 emissions. We categorize green telecom into two main aspects. One is that modern telecommunication technologies utilizing ICT methods can reduce CO2 emissions for the whole of society. These green network services are provided by carriers. And the other aspect is the reduction of the telecom sector's own emissions which are produced during the operation of carriers' network. It is necessary for carriers and vendors to work together to promote the green technology innovations for the network.

In this article, our main points of discussion are power saving and green technologies in the telecom network sector.

The Value and Effect of ICT for a Green Future

Telecom industry technologies and applications have great potentials for emission reduction. It is forecast that ICT could deliver approximately 7.8 Gt CO2 of emissions savings in 2020. And it is expected that areas of cloud computing, smart logistics, smart working and intelligent applications have more energy saving effects than those non-materialized ICT applications.

Obviously, ICT provides a more intelligent method for CO2 emissions reduction. While beyond this intuitive knowledge, more problems must be handled, such as the ICT sector's own emissions:, the rise in demand for ICT applications rise, will therefore result in more CO2 emissions. Nevertheless, there is no doubt that ICT is an important ingredient for a low carbon future.

If we can push forward ICT applications in the field of emissions reduction in the right way, it will help society to head for a healthy and smarter future. Otherwise, we will be at risk of a high CO2 emissions world.

Power Saving in Telecommuni cation Networks

Telecom enterprises provide various services that can reduce society's carbon footprint, but they are also required to increase their own power efficiency and cut their carbon footprint. In this white paper, we focus on power saving in telecommunication networks.

Overall Analysis and Strategy of ZTE's Green Technology Innovation

As one of the world's leading telecommunication vendors, ZTE Corporation emphasizes its corporate social responsibility and dedicates its effort to furthering green activities.

The CEO of the company has stated, 'With its green commitment, ZTE Corporation will be based on sustainable growth, ceaseless innovations that face these challenges, by devoting all efforts to construct green networks together with our customers and develop a healthy society.' We are promoting green manufacturing, green culture, green management and green value chains within

the company. Innovation, Convergence and Green solutions are the three main strategies of ZTE Corporation, in which green solutions are the motivation for the other two. ZTE's green strategy has been executed in all of the company's operation processes including standards development, R&D, procurement, production, logistics and engineering.

In order to provide highly efficient, power-saving and environment-protecting network solutions, ZTE has set up a green strategy with a focus on multi-level technology innovations for cutting CO2 emissions.

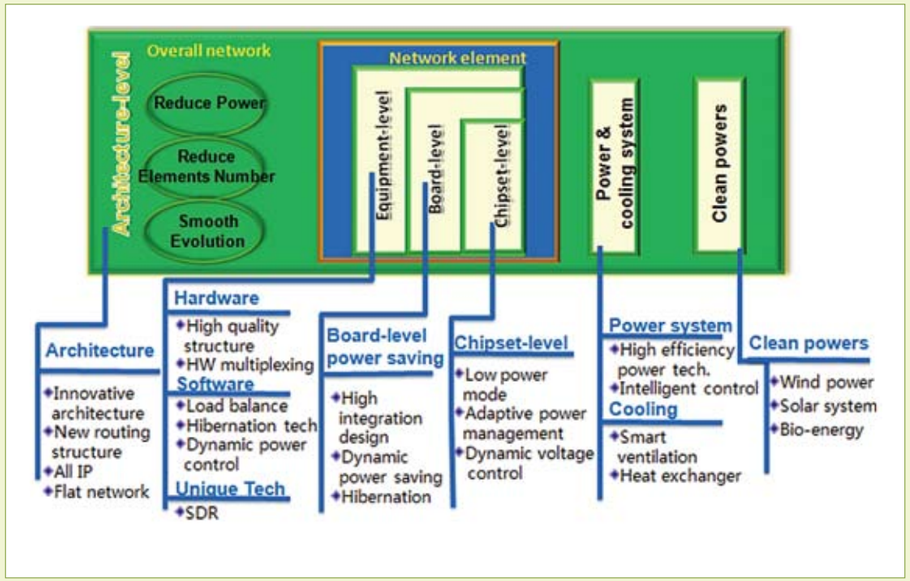


Figure 1 Overall analysis of power saving technologies

From the perspective of the whole telecommunication network, we divide power saving solutions into four levels: Architecture-level; equipment-level; board-level and chipset-level solutions. At the architecture-level power saving is achieved by restructuring the network on a large scale to optimize the organization of network elements in order to meet green objectives. The other three level solutions pay attention to energy saving within network elements, fulfilling green objectives through chip-set, board and equipment level innovations.

The architecture level power saving solution guides the direction for power saving within network elements; on the other hand, chip-set, board and equipment level solutions provide strong support for architecture-level green innovations and evolution.

Additionally, reliable telecom network operation requires efficient power and cooling systems. So, we also make an effort with green innovations for these parts of the network

Green Innovations for Network Architecture-level and Network Element-level Power Saving

ZTE Corporation utilizes a Life Cycle Analysis (LCA) methodology for telecom networks and products, and applies green concepts to the whole process of product development. Power saving in telecom networks relies on innovations of architecture, equipment, board and chipset, as well as power systems, new energy sources and other facilities, to achieve end-to-end green telecommunications.

ZTE Corporation regards architecture-level innovation as the most important part of the construction of green networks. Evolution featured by All-IP and a flatter-structure can promote network power saving. And for the Access Network, which accounts for most of the network power consumption,

C-RAN (for wireless access network) and FTTx (for wire-line broadband access) architectures are to be applied for large-scale reduction of network carbon footprint. The deployment of these innovative architectures can help to save network power consumption by as much as 60%-80%.

To provide strong support for architecture-level innovations, ZTE Corporation has invested heavily in the research and development of network element power saving technologies, which also help to reduce the carbon footprint. On the equipment-level, innovations like SDR, ATCA platform, dynamic power control, software optimization and a new exchange structure can reduce the power consumption by up to 50%. And, on the board and chipset-levels, green technologies such as high-efficiency devices, low-power module design, highly integrated chipsets, and dynamic voltage control also play an important role in creating a green network.

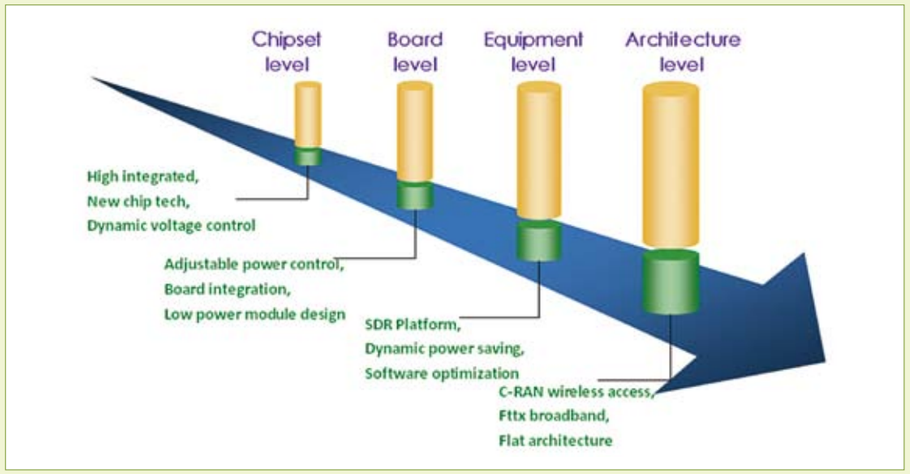


Figure 2 Highlights of power saving Innovations by ZTE

Green Energy and Green Facilities

Network power saving also requires the operation supporting systems that include clean energy and green facilities. With abundant research and successful experience world-wide, ZTE Corporation is capable of providing stable and highly efficient green support systems for telecom networks.

ZTE provides ‘zero carbon footprint’s clean energies such as wind power, solar power, hybrid power and corresponding MPPT (Maximum Power Point Track) controllers for our global customers.

The highlights of ZTE’s green facilities innovation include high-efficiency power systems, intelligent cooling for site rooms, and eco-friendly Fe-Li accumulator battery systems.

Green Technology Innovation for Networks

ZTE's view is that green technology innovation occurs at two levels: one is network architecture level innovation, and the other is at the network element level. The network element level then can be divided into three sub levels: equipment level, board level and chipset level. ZTE believes that the network architecture innovation is the most important, which can lead to 60%-80% power saving. On the other hand, the network architecture innovation needs support from network element level innovation.

Network Architecture Level Green Technologies

The network architecture decides the scale of network energy consumption. ZTE recommends starting with a network architecture optimized for power saving. ZTE has already implemented such a philosophy in our solutions as following:

In the Access Network: the innovative wireless access architecture of C-RAN and green FTTx for fixed broadband;
In the Core network & data centers: innovative architecture of data centers for converged core networks;
In the Transport network: a converged and flatter architecture for power saving.

• C-RAN: 'Large capacity,fewer site room architecture enables Green RAN deployment

When creating mobile broadband services for customers, it is a priority to lower the cost per bit. The network deployment strategy of 'Large capacity,fewer site rooms' can provide a greener and lower-cost network for operators. C-RAN is developed as a new generation RAN solution meeting the technical trend of RAN evolution and requirements of network deployment. C-RAN has four key features: centralized processing; collaborative radio; real-time cloud computing infrastructure; and is an environmentally clean system.

1)The C-RAN solution is based on the separation of the Remote Radio Unit (RRU) and the Baseband Unit (BBU) of the BTS components, therefore this architecture deployment is very flexible:

RRUs are naturally cooled equipment and suitable for deployment on the outdoor tower/rooftop/pole they can be connected to a pool of BBUs located in the central office via a CPRI interface carried

over optical fiber. The C-RAN architecture removes the need for site rooms and associated A/C at the BTS site, saving huge amounts of power consumption. Additionally, RRUs with high receiver sensitivity deployed closer to the antenna can save transmitter power. This means that with the same coverage radius, the C-RAN-based BTS/NodeB can have higher capacity.

2) When BBUs are centralized using BBU pooling, independent BTSs will be evolved to BTS clusters, which will have strong cooperative capability and larger network capacity with the inter-site interference reduced when COMP (cooperative multi-point) technology is introduced.

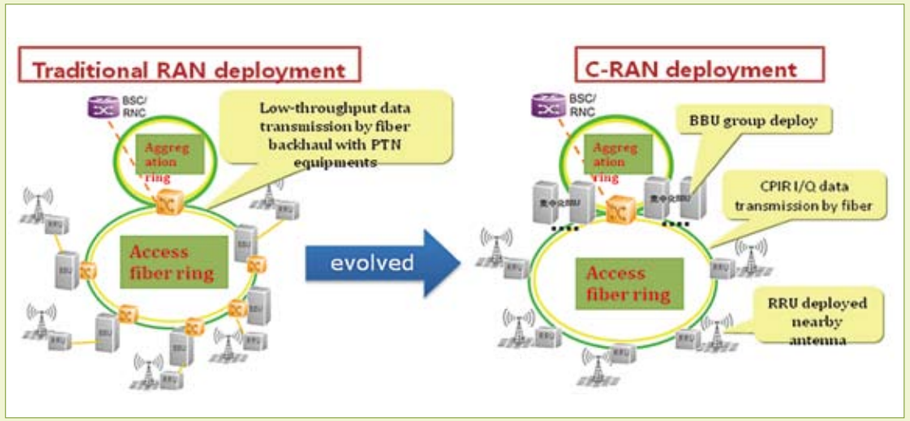


Figure 3 Typical C-RAN Deployment Topology vs. Traditional RAN Mode

Trials have demonstrated that the C-RAN architecture can sharply reduce TCO and power consumption. In some commercial networks, where fiber ducts already exist and only a few new ducts and optical fibers need to be deployed, the C-RAN architecture can reduce RAN CAPEX by up to 20% and reduce its OPEX by around 63%, reducing the 10-year TCO by about 40%, and reducing the construction cycle by 1/3 compared with traditional RAN deployments.

The C-RAN architecture has less CO2 emissions compared with traditional RAN architectures. Shown in table 1, C-RAN has 67%-80% power saving dependent on its deployment scale.

Table 1 Power saving of C-RAN architecture compared with traditional RAN

C-RAN Scale	Power saving effect
Small scale(5-6 sites)	>=67%
Middle scale(15-20 sites)	around 76%
Large scale(>=30 sites)	Up to 80%

FTTx:Building fiber access networks for power saving

ZTE Corporation technology can transform copper-based access networks to fiber-based FTTx networks by using convergent, flat, high bandwidth and large split ratio innovative architectures and technologies. It will greatly reduce network energy consumption saving on operator's OPEX and increasing profits.

FTTx provides converged networks for green access

With the development and convergence of core networks, broadband access and sustainable evolution have become crucial in network construction. As a result, PSTN, NGN and broadband access networks based on DSLAMs have converged into a FTTx network architecture reducing access network complexity and cost.

Figure 4 FTTx Network to make Multi Access Network Convergence

FTTx provides a flatter network for green access

Providing flatter network architecture is the key to reducing network energy consumption. By building large capacity and converged OLT sites, FTTx networks can save a considerable amount of switches.

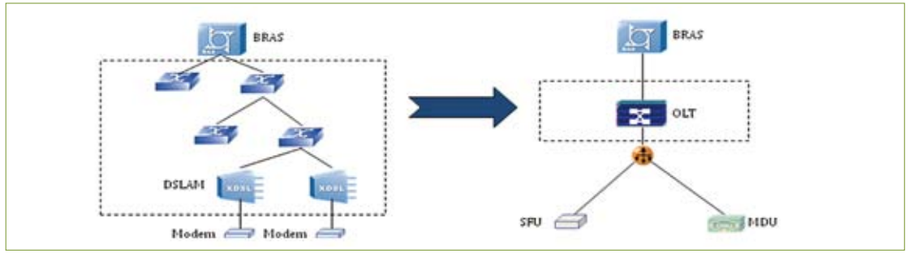


Figure 5 Flat Network reduce layer, equipment and energy consumption

High bandwidth and split ratios greatly reduce unit energy consumption

With the requirements of rapidly increasing bandwidth, building 10G GPON FTTx networks to raise capacity is an effective way to reduce network energy consumption. With 10G GPON, per MByte energy efficiency can be raised by 30% compared to GPON technology with higher bandwidth and split ratios. It can enhance access network energy conservation efforts.

FTTx networks will not only help reduce network complexity, but also increase power consumption savings as a converged architecture reduces the amount of active equipment needed at the access layer. It can be shown through lab tests, modelling and deployment that FTTx network can greatly reduce energy consumption. Results show that architecture innovation can help to build a green telecommunication network.

Core network data center: converged core network and innovative data center architecture for power saving

Many network elements and equipments, such as data storage, service provision, etc, are concentrated in the core network. This is the most critical part of the whole network for operators, requiring huge investment. In the core network facility room, there is a huge volume and variety of equipments.

Due to these characteristics, ZTE believes that using the innovative settlement architecture for data centre to provide the core network functionality represents the best way to save energy. ZTE recommends using two indices for measuring the level of energy consumption: PUE (Power Usage Effectiveness), and DCIE (Data Center Infrastructure Efficiency), both indices take into account energy consumption from electricity, air conditioning and IT infrastructure.

PUE = Total data centre energy consumption/IT infrastructure energy consumption; PUE is ratio; the baseline value is 2, the closer to 1, the better.

DCIE = IT infrastructure energy/total data center energy consumption x100%, DCiE is a percentage value, the bigger, the better.

ZTE is proposing a total green design for data centers with bladed and virtualized IT equipment to lower server energy consumption, which can save up to 30% compared with traditional implementations. ZTE has also adopted DC technology that gains savings of around 10%-20%; liquid cooling systems, to provide cooling as close as possible to the main heat generating source, in this way, energy saving can reach 30%—50% or even higher; another technology called “accurate winding” directs cool air to the heat generating parts of the server, which can save 20%-40% energy. ZTE is also using a modular or container design style, integrated in all data center sub-systems, which can also improve the PUE and DCIE indices.

Transport: converged and flatter architecture for power saving

A simple structure with fewer layers is the trend for future transmission networks, which is also an important measure to achieve energy saving.

The traditional transmission network is divided into the core layer, the aggregation layer and the access layer. With growing network scale and the explosive increase of traffic, the amount of equipment for each layer is ever increasing, and the network is becoming more complex with constantly rising power consumption. ZTE equipment enables a flatter structure for the transmission network, in which the aggregation layer is removed. The equipment in the core layer can be directly connected with ones in the access layer. This two-layer structure can achieve an energy saving of about 30%.This flatter network structure decreases the equipment requirements such as aggregation equipment links, ports, routing and room space. Additionally, cluster routers reduce equipment links and improve the network scalability. This structure also reduces failure rates, equipment air conditioning requirements, lessens network delay and jitter and so reduces network operation costs.

With the rapid development of the Internet, IP networks are facing an increasingly heavy traffic burden. Traditional expansion methods add to network costs, while having little effect on traffic

congestion while raising energy consumption. With regard to the low cost and power consumption of the optical equipment, the extensive integration of IP and optical networks in the data plane, the control plane and the management plane is another important trend for future transmission networks.

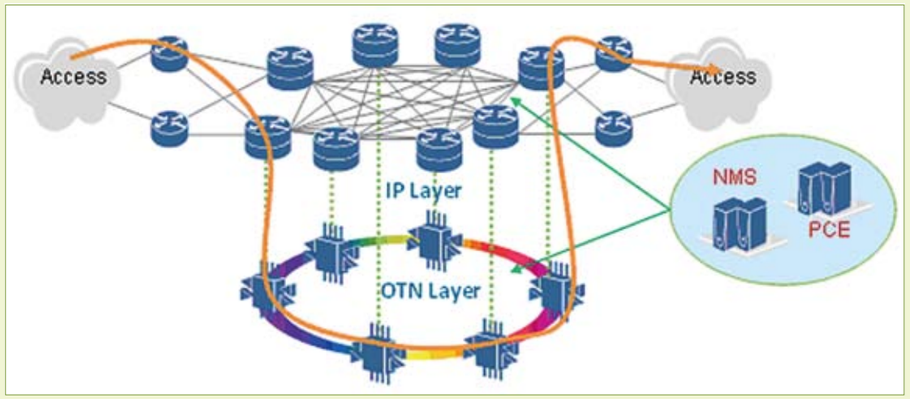


Figure 6 Integrated-bearer solution for IP layer and OTN layer

In ZTE's view, the collaborative planning of both the IP backbone layer and the OTN layer helps to improve resource utilization and traffic throughput. The two layers can share information, optimize transmission paths, achieve quick service deployment and fault tracking. With this solution, the energy consumption of transmission networks can be reduced by about 25%.

Network Element Level Green Technologies

Network element level power saving technology provides the foundation for network architecture energy saving implementations. ZTE has achieved significant success in green technology innovation in three different levels for network elements: equipment level, board level and chipset level.

• Equipment Level Green Technologies

Wireless equipment green technology

SDR based wireless equipment for converged wireless networks

Building and upgrading a mobile cellular network is a huge project, the major challenge for operators are facing is the deployment of different technologies (GSM/WCDMA/LTE) and multiple frequency resources (900M/1800M/2100M), which brings serious problem with overlaid networks: multiple Capex investment and multiple energy consuming networks.

In the mobile and wireless sector, ZTE provides the innovative SDR based wireless solution, which can solve these problems for operators. ZTE's SDR based wireless solution can support multiple technologies and frequencies within the same equipment platform. The total network energy saving can be 50% by deploying the ZTE SDR based solution for mobile networks.

Figure 7 ZTE unified SDR Platform

High sensitivity receiver technology for wireless equipment

The best way to reduce energy consumption for wireless networks is to reduce the number of base stations, especially in low traffic areas, such as rural regions where coverage is more important. ZTE is developing technologies to improve network coverage and reduce the total energy consumption.

One very important technology is High sensitivity receiver technology. The sensitivity of base station receivers has a direct impact on their coverage, and thus the number of base stations needed. In rural areas, a 3dB increase can increase the coverage radius by 22%, which means a 45%

coverage increase. This corresponds to a reduction in the number of base stations by about 30%, and a network energy saving of at least 25%.

RNC equipment dynamic power saving technology

For telecom networks, the traffic patterns vary over time, very high volume traffic in business hours and very low volume traffic in non-busy hours. ZTE's RNC equipment has the functionality to automatically and dynamically reduce power consumption according to traffic patterns.

If the RNC equipment is not operating at its full capacity, some function boards can be shut down automatically; if the capacity is not enough for busy hour scenarios, these function boards can be restarted. In this way, ZTE's RNC equipment can significantly reduce energy consumption.

Wireless equipment with a wider range of working temperature

Normal base station equipment relies on air conditioning due to strict working temperature requirements. ZTE's wireless equipment such as the ZXSDR BBU adopt a much wider working temperature range design, from -10℃ to +55 ℃, this significantly lowers the dependency on air conditioning, and is suitable for most indoor scenarios. This capability can save energy by reducing air conditioning usage.

Fixed access network equipment green technologies

As a main part of the transition from copper based to fiber based networks, FTTx PON equipment is widely used. It reduces power consumption levels with the deployment of more passive components in the access network and other key energy saving technologies.

Dynamic power savings technologies have been implemented with Sleep and Auto Laser Shutdown (ALS) functions on PON cards. At the OLT and ONU sides, there are 4 possible energy saving modes. These are the Fast Sleep Power Saving Technique, Dozing Power Saving Technique, Deep Sleep Power Saving Technique and Power Shedding. For example, the Deep Sleep Power Saving Technique is realized at the ONU side. It will save energy by turning off one or all services on the ONU and just keep running a minimum activity checking function. When a service request such as off-hook, data request, local timer timeout, is requested, the ONU will be awaken for normal operation.

ZTE's fixed access network equipment energy consumption levels are far below the EU's CoC V4 2011 requirements through the use of energy saving features, such as power spectrum adjustment, adjustable fan speed and fan-less pizza-box design.

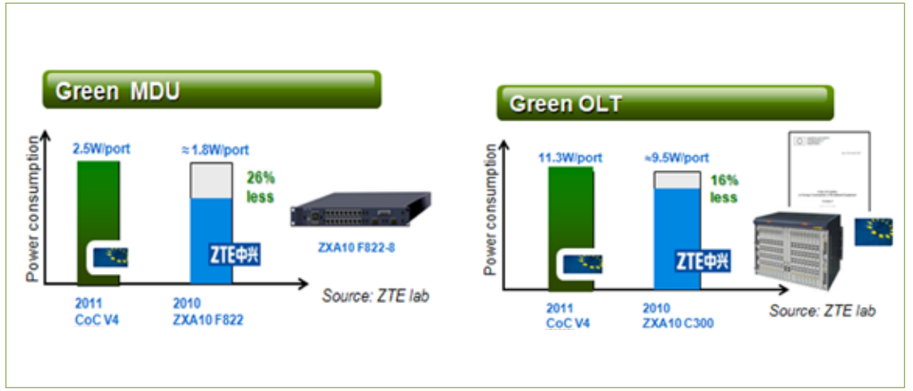


Figure 8 ZTE OLT,MDU energy consumption compare with CoC V4 2011

IPTV CDN and set-top box equipment green technologies

ZTE Corporation's IPTV CDN equipment uses innovative green technologies. By using high-performance and low power consumption blade media servers and adding smart power saving control modules, power consumption can be lowered by 30%. With the use of high voltage DC power supply technology, power efficiency can be raised by 10-12% compared with the traditional system architecture.

The innovative design of ZTE's IPTV set-top box reduces equipment power consumption. The design includes the use of highly efficient power conversion chipsets, design optimization, and

a reduction of discrete components by using integrated chipsets. Using these methods, the total equipment power consumption is lowered by 50% to less than 5W. The box management software also uses green design, for example, when there is no operation for a long time period, it will pop up the tip box on the TV screen to inform the user that the set-top box will be placed in standby mode, if there is no response standby mode will be initiated. In standby mode, the box energy consumption reduces to less than 2W from 5W; a power saving of 60%. Hard disc standby mode, initiated by a hard disc control function, can achieve more than 88% power saving reducing hard disc power consumption from 1.8W to 0.2W.

• Switch equipment green technologies

ZTE switch equipment uses an advanced system architecture to reduce energy consumption through the rationalization of the product design and reduction of redundancy. Cross-bar based space division switching matrix and NP architecture technologies are used in high-end and mid-range equipment. It uses a multi-bus integration architecture in the low-end equipment.

• Router equipment green technologies

With the most advanced design philosophy and architecture, ZTE's router products won industry awards for the lowest power consumption in the industry. As a result, they greatly reduce operator's maintenance costs.

Through the use of low power hardware and effective thermal design, such as the rational distribution of the air cooling duct, ZTE's router equipment requires fewer cooling fans further reducing energy consumption.

Power efficiency can be increased by using sub-regional power supplies within equipment, providing savings of 30-50W. Using card power management to turn cards on and off, can save 100-300W for each unused card. Adjusting channel switch planes according to equipment traffic status, 100W can be saved per switch plane.

• WDM equipment green technologies

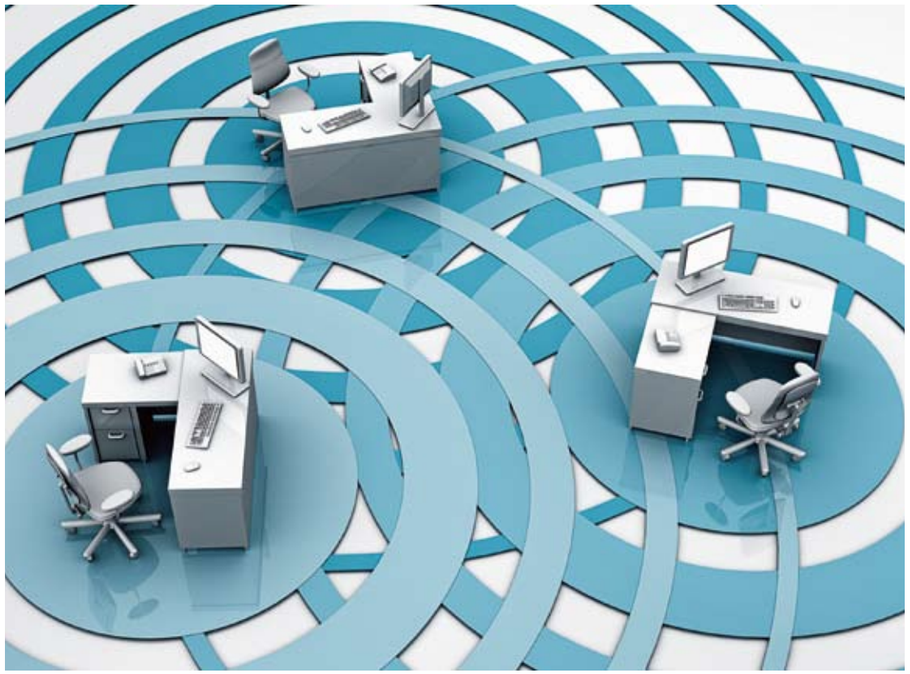
ZTE Corporation can achieve 80λ OTM site configuration in a single shelf by using highly integrated design. In addition, some cards only occupy half a slot height further raising integration and saving site room space and overall power consumption.

For 40G services, through the use of ROADM technology to distribute wavelengths, 40G transmission equipment combined with ROADM can lower power consumption by 30% compare to 40G transmission equipment used in conjunction with a cross-connect..

Ultra long-haul transmission solutions can reduce the need for OLA and REG sites in the transmission span providing considerable CAPEX/OPEX savings and reducing the system energy consumption.

• PTN equipment green technologies

ZTE Corporation has released the industries first self-cooling PTN equipment. It breaks through the bottleneck of traditional design by using a fan-less dual layer sub-rack architecture. Using a fan-less design can, in theory, reduce the equipment noise to 0db, and removing the fan and fan control cards reduces the power consumption by 5W. For a single equipment a power saving of 876KWh can be achieved and over the whole life cycle of the equipment a reduction of 700Kg in CO_2 emissions.



Board Level Green Technologies

• High efficiency PA for green operation

ZTE believes that a key part to reducing the whole wireless network energy consumption is at the base station. The base station has almost 65% of the total energy consumption. To achieve low power consumption, the most effective way is to enhance the power amplifier efficiency of the base station.

Take the 45% PA efficiency for example; indoor macro UMTS S111 base station power is 385W. If we still use the 30% efficiency PA, that number could be 550W.

Compared to traditional 30% efficiency PA, the 45% efficiency PA can save energy by about 43%. The advantages of high efficiency PA not only effect on the base station, at the same time, it can also reduce power consumption for the facility equipment like power, battery and air conditioner.

• Baseband board intelligent power shut off technology

ZTE's ZXSDR BBU hardware platform uses the uTCA architecture; all boards are controlled by the CMM module, which also controls the switching on and off of power to all of the function boards.

Based on flexible allocation and management for the baseband pool, flexible resource allocation is possible of the whole resource pool for each individual user. Central command can collect all the requirement information and then allocate one or more baseband boards as required. When traffic is low, the idle baseband boards can be shut down or placed in the dormant state, when traffic increases to a certain threshold, they can be switched back on.

The more baseband boards in the baseband pool, the greater the power saving effect. Shut down for one baseband board can save about 50W. Taking as an example a BBU with S999 configuration, during the night when traffic is low, with 2 baseband boards shut down the power saving is around 60%.

• Intelligent carrier technology

The wireless network traffic varies considerably between day and night, in the busy hours during the day, typically a S333 configuration is required to handle the traffic, at night, S111 maybe sufficient. Using intelligent carrier technology to switch the carrier capacity on and off as required, high traffic demands can be met in the daytime and power saved during the lower capacity requirement periods at night.
The operator can configure its own threshold values for switching carriers on and off dependent upon different scenarios.

Intelligent time slot technology

For wireless communication systems, when the traffic is low the total available capacity is not required. ZTE utilizes technology that can consolidate all of the active user timeslots into a smaller number of timeslots and shut down the unused timeslots, dependent upon traffic volume.

From ZTE's experimental data, for a TD-SCDMA/TDD-LTE system, shutting down one time slot can save 4% RRU power consumption, and shutting down 2 timeslots can save 8%.

High Integration

ZTE Corporation continuously improves the level of card integration by choosing highly integrated chipsets to increase board density and lower power consumption. For example, a WDM tributary unit can realize IP/TDM/SAN access in one card, saving on the number of service cards and power consumption.

Another example is WDM OTM card. One OMU80 and one ODU80 can replace two OMU40, two ODU40 and two OCI cards which saves 20% of the rack slots and 20-50% power consumption.

Simplified PCB design

By using QSGMII instead of SGMII, clock speeds can be increased and 4-ports can be accommodated in a single line transceiver reducing the number of lines and difficulties in PCB layout. Using simplified PCB design in switch product, can reduce PCBs to 2 layers and save 55% power consumption.

Chipset Level Green Technologies

Using D-PT technology in PA module

One of the technical characteristics of the PA (Power Amplifier) is that maximum efficiency occurs only at full output power. For lower output powers, the PA efficiency declines. But in most scenarios, base stations need not work at the maximum output power level. Improving PA efficiency at low output power levels is of considerable value.

ZTE's D-PT(Dynamic-Power Tracking) technology, tracks the real-time workload and adjusts PA supply voltage , keeping the PA operation at the most efficient level for different workload conditions, therefore optimizing the PA efficiency even under low output power. This technology realizes a power consumption reduction of 12%.

Power saving for RF components

For the RF components, improvements such as the introduction of advanced LDMOS class amplifier tubes, adopting DPD and Doherty technologies, greatly enhance the PA efficiency.

As an example, the early devices using Class AB components in 2.3 GHz frequency band output an average power 30W with power consumption 127.7W. Its PA efficiency is only 23%. By adopting the new class components and advanced DPD, Doherty technologies, the PA efficiency improves to 44.3% and the power consumption is only 67.7W, reducing 50% compared to early ones.

ZTE developed green chips

ZTE devotes a lot to research and development on energy saving chips. For example, self-developed cross-chips used in WDM devices, remove outsourcing redundancy, optimize integration and significantly reduce system power consumption. By replacing specific chips with FPGA logic chips, the power consumption is only about 20W per 10G bandwidth, 30%~40% lower than the standard industry level.

In addition, these chips support sleep modes that avoid power consumption when the chips are not in operation. Through the classification of power supply solutions, 9 chip types operating at a variety of voltage levels are supported, so that each type of chip can work in the best voltage conditions to realize energy saving.

Green Energy

Under the pressure of rising energy prices and environment protection requirements, advanced low cost Solar and Wind power generation, are becoming increasingly important for telecoms supply. ZTE has extensive experience in the field of renewable energy supply. ZTE provides mature supply solutions including pure solar, hybrid solar and oil, hybrid wind and solar electricity solutions. ZTE also provides customized schemes and flexible configurations based on local environmental conditions, realizing energy savings that help our customers reduce TCO and improve ROI.

In a number of new energy schemes, hybrid wind and solar solutions could be the most environmentally friendly and operable solutions for zero emissions.

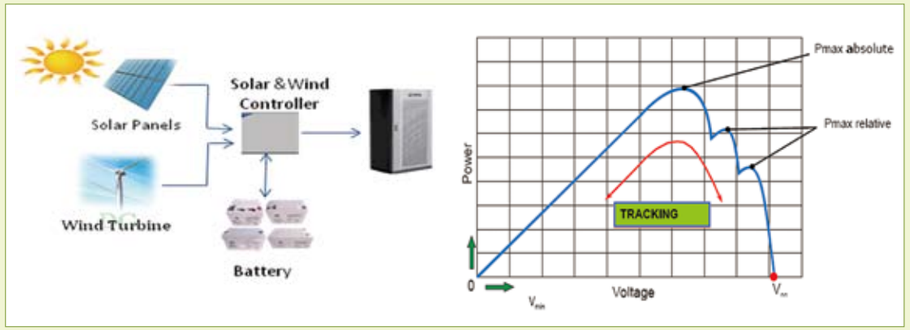


Figure 9 Hybrid wind and solar system with MPPT controller state

ZTE provides efficient solar photovoltaic matrices, low speed and high reliability wind turbines, MPPT power controllers and other components.

ZTE offers self-developed solar controllers, using advanced MPPT (Maximum Power Point Tracking) technology to maximize the use of solar energy. Compared to traditional ones, the new controllers help to save 10%~ 20% in investment reducing equipment transport, land acquisition and civil work costs, thereby shortening financial returns. The same design is applied in ZTE's solar controllers and wind converters, featuring modular architecture, hot-pluggable, scalable designs (50A-800A), which guarantee customers with reliable, green power supply equipment.

ZTE's green energy products and solutions have been deployed in more than 40 countries, by 70 operators, including the world's largest solar site application in Africa (more than 800 solar sites), to build a sustainable telecom network.

Green Solutions of Communication Auxiliary Facilities

ZTE has a series of products and green solutions for communication auxiliary facilities for site room and central office deployment. In accordance with different radio standards, transmission topologies and all kinds of application scenarios, a variety of innovative solutions meet operators' requirements for lower costs, power efficiency, and quick site deployment. These solutions can not only improve the implementation of turnkey projects, but also reduce the whole lifecycle TCO of RAN.

High power transfer efficiency technology

The efficiency of power transfer equipment is a key factor impacting BTS power efficiency. The huge power consumption of BTSs can be reduced by improving the efficiency of power transfer equipment. Using high efficiency digital power technology, the efficiency of power transfer modules has been improved by >90%.

Take one site as a example, with a power consumption of around 5000W. When power efficiency is improved by around 5%, 250W can be saved, so 2000KWH can be reduced one year. For a RRU indoor coverage scenario, by using an alternating current solution to reduce AC/DC power transfer, around 10% power consumption can be saved.

Temperature control solutions for indoor base stations

Currently, air conditioning and refrigeration are traditional temperature control solutions applied to indoor communication sites, the reference temperature is set at 25-27℃. This solution ensures normal reliable equipment operation. But there are still some problems including the continuous operation of air conditioning units, high failure rates, and corresponding maintenance costs. The air conditioner energy consumption for each base station is extremely high, consuming up to 20,000 kWh each year on average. It is difficult to meet the different optimum working temperature requirements for a variety of equipment.

As there is a lack of the traditional solutions, ZTE proposes innovative solutions for the indoor sites: Intelligent Ventilation System + Battery Cooling Cabinet.

Of all the equipment in a base station batteries are the bottleneck with regard to temperature control, because their optimum working temperature range of 20-25℃ is much lower than the temperature other communication equipments. With reference to the features above, ZTE proposes the intelligent ventilation system + air conditioned battery cooling cabinet solution for the indoor communication sites, that is, the battery is cooled by air conditioning in the battery cooling cabinet and other equipment is cooled by intelligent ventilation. This solution has the following advantages:

Variable temperature control in different areas of the site room, reducing the site energy consumption by 35%;
Air conditioning is replaced by intelligent ventilation, saving CAPAX of temperature control systems by 25%;
The battery works within its optimum environmental temperature range, maintaining its service life.

High efficiency, low environmental impact battery system

Lead-Acid batteries have been widely deployed in the communication industry, but have many shortcomings, such as: for VRLA the real life is shorter than design specification which impacts application scenarios. Lead-Acid batteries have huge environmental impact. Compared with traditional batteries, Li-Iron batteries have several advantages: 1) They are safer to use and have lower environmental impact. 2) They have the capability to operate normally at higher temperatures and can work normally up to 60 degrees Celsius. The use of Li-iron batteries can eliminate the need for site room A/C and therefore save huge amounts of power. Li-iron batteries will be widely deployed by swapping out traditional batteries in site rooms.

Looking to the Future of Green Telecom

The Green agenda and a low Carbon economy are the trends for the whole of human social development. ZTE believes that technology innovation is ultimately the solution for a green and low Carbon society. We also realize that the ICT industry is very important for a green society, besides its own Carbon emission reduction; ICT technology application has huge potential to reduce the Carbon emissions for other industries. We expect, by 2020, that the whole of society can reduce CO2 by 7.8G tons using ICT technology.

As a world leading telecoms solution provider, ZTE's perspective regarding green technology innovation is that network architecture innovation is most important; at the same time we also need to develop network element level technology innovations. Besides the architecture innovation we mentioned in this paper, we believe that cloud computing will have a revolutionary impact on ICT in terms of architecture innovation. Cloud computing can utilize fast developing broadband technology, optimize the whole of societies computing resource, and therefore reduce the traditional isolated ICT infrastructure. So we believe that cloud computing can significantly reduce Carbon emissions in near future.

ZTE will continue our partnership with customers on the way to a greener world. Based on technology innovation, we will reduce our Carbon footprint and societies Carbon emissions by providing more and more innovative ICT services.

GLOSSARY	
ATCA	Advanced Telecommunications Computing Architecture
BBU	Baseband Unit
C-RAN	C(Centralized, Collaborative, Cloud , Clean) Radio Access Network
D-PT	Dynamic-Power Tracking
FTTx	Fiber to The x(home, office, building…)
GPON	Gigabit-capable Passive Optical Network
ICT	Information and Communication Technologies
LCA	Life cycle analysis
MPPT	Maximum power point track
PUE	Power Usage Effectiveness
RRU	Remote Radio Unit
SDR	Soft Defined Radio
TCO	Total Cost of Ownership
MDU	Multi-Dwelling Unit
OLT	Optical Line Terminal
OTN	Optical Transport Network
PA	Power Amplifier
PON	Passive Optical Network
VRLA	valve-regulated lead-acid battery

ZTE中兴 中兴通讯股份有限公司
ZTE CORPORATION

NO. 55, Hi-tech Road South, ShenZhen, P.R.China Postcode: 518057
Website: www.zte.com.cn Tel: +86-755-26770000