A White Paper from the Experts
in *Business-Critical Continuity*™

Wireless LTE Deployment:
How It is Changing Cell Site Energy and Infrastructure Design

by Paul Misar, Director, Product Management, Energy Systems

Emerson Network Power

Summary

Mobile broadband is becoming part of the daily life of an increasing number of individuals, especially as the internet generation has become accustomed to immediate broadband access at home, in the office and on the road.

Introduction

Today, business-minded persons use their mobile devices for voice, email and internet connections, focusing on a higher level of business productivity. In fact, data applications, such as video, presentations and multimedia applications, have surpassed voice as the primary wireless transmission. As this new business society relies more and more on this mobile connectivity, greater demands have been placed on the wireless infrastructure to support these transactions. In conjunction, handset manufacturers are releasing a greater number of smart devices to the market. These rely heavily on a myriad of data-intensive applications well beyond the standard voice application of just five years past. The result is an explosive amount of data moving through the wireless infrastructure, with certainly more to come.

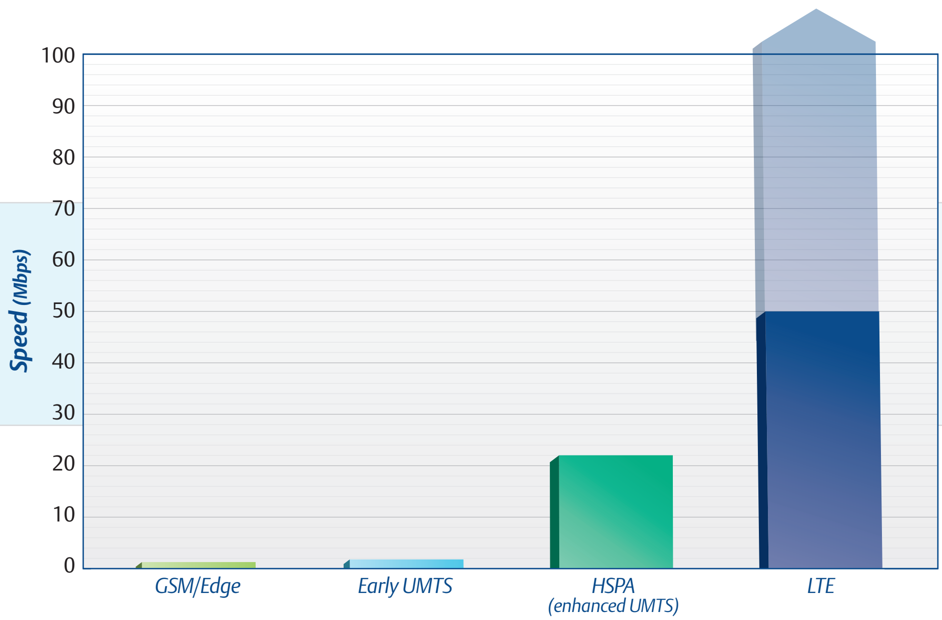

Figure 1. Mobile Network Technology

As smart technology devices gain increased acceptance in the wireless marketplace, the overall infrastructure has been forced to evolve and meet the demand of the new data-centric consumer. The current broadband system has become overburdened in its ability to process the sheer amount of data that is transmitted by the end users, especially in larger urban areas. This evolution has quickly outpaced the use of standard voice transmissions in the mobile arena both domestically and globally. Newer applications such as mobile video place even greater demands on the current third-generation system.

To meet the increasing demand of the consumer for faster data connections, the industry has responded with two new wireless platforms—WiMAX and Long Term Evolution (LTE)—as the next-generation wireless platform technologies. WiMAX primarily has been deployed in areas where little or no wireless broadband connectivity has been previously served or where a new player has emerged into a specific market. LTE quickly is becoming the choice of existing mobile service providers globally. Giving existing service suppliers the advantage, LTE can be built on the existing infrastructure platform of previous mobile radio systems. Further investigation of this implementation can determine how LTE affects the overall mobile network infrastructure today [**Figure 1**].

LTE has led service providers to rethink their current deployment strategies in order to provide the highest data speed throughout their networks. Highest data speeds are attained when the antennas are closest to the user or consumer. Therefore, one of the main strategies has been to move to a more “mesh” or “nodal” infrastructure throughout the network to achieve this end goal. This deployment strategy involves a greater number of sites, with lower power requirements through the network and at each broadcast site. In many cases, a single cell site services multiple antenna sites, drastically reducing the overall infrastructure build. This topology promises to increase the reliability of the network and decrease the overall power requirement at each site, and throughout the network as a whole. The approach is also attractive to many service providers that are focused on reducing the overall power budget spent throughout their network.

The promise of LTE’s smaller powered sites imposes an overall shift in the network topology as well as the system requirements at each cellular site. Cell sites will become smaller as higher density electronics require less power and a more remote base transceiver system (BTS) solution, as well as nodal approach, is taken. These two changes drastically reduce the amount of DC power required at each site, reduce the overall cooling requirements, and ultimately reduce the total site footprint. All of these factors combined produce long-term savings to service providers in both infrastructure spend and annual operational cost.

> *A balance must be considered between initial infrastructure costs, debt and possible loss of revenue because of competitive pressure.*

It is noteworthy to mention that as the convergence of data, voice and video networks moves forward, the wireless, wireline and cable networks are also converging. These platforms cannot exist without each other, as greater data use and greater LTE efficiencies require more data to be processed by the wired network. LTE is pushing the fusion of the networks, and within the next three to five years there will emerge a completely different topology from that which exists today.

However, service providers must face the cost of entry when considering an LTE upgrade, which may be beyond their means. Yet, basing the decision to upgrade purely on infrastructure costs may be a flawed approach to network enhancement.

The “big three” U.S. providers are capable of launching LTE technology through self-funding. Small providers have access to low interest loans through the U.S.-based “Broadband Initiative” in order to provide high speed internet services to communities that have limited or no coverage today. Mid-sized, second and third tier regional providers who do not have high cash flow and profitability or access to government funding will most likely struggle with the decision to move to LTE.

While the cost of investment is initially high, several factors drive providers to quick implementation. A balance must be considered between initial infrastructure costs, debt and possible loss of revenue because of competitive pressure. If such pressure exists, the move to LTE will be forced sooner; if there is limited competition, the choice to wait and implement is possible.

Waiting for implementation allows for eventual price reductions and system optimization. Some providers may choose to sit on the sidelines, allowing those with deep pockets to vet the process and drive prices down.

The Mobile Drive Toward Data

Of the approximately 3.5 billion mobile subscribers today, worldwide, 3G (third generation wireless networks) accounts for 350 million with an additional 35 million added every quarter. It is estimated that by the year 2015, 3G subscribers will surpass 2G (second generation wireless networks) subscribers. This move took five years less than it took 2G to surpass traditional analog wireless networks.[1]

LTE is forecasted to reach 32.6 million subscribers globally by 2013, with Asia-Pacific leading the charge, followed by Western Europe with 9.9 million subscribers, North America with 6.7 million subscribers and Eastern Europe with 1.5 million subscribers.[2]

What are the drivers for the implementation of a new wireless platform? It could easily be argued that many of the existing service providers have struggled to successfully deploy the current 3G infrastructure in the network today. With limited additional spectrum availability and high infrastructure costs, it may appear on the surface that a viable business model does not exist for implementation of a new network overlay. But today's service providers are driven by two specific market trends. Smart mobile devices and their subsequent application-driven platforms have placed an increasing data-centric model on mobile providers in recent years. Also, the current generation of users, who were initially accustomed to voice only and M2M (message to message) applications are slowly being replaced with a new generation of smart users who insist on mobile social networking and YouTube-style video applications. As a result, the trend over the past few years alone has evolved toward a data-centric wireless network.

Broadband subscriptions are expected to reach 3.4 billion by 2014, with about 80 percent of consumers being mobile broadband users. **Figure 2** details the explosive growth in mobile broadband over the past few years. It also projects the number of fixed broadband users will remain nearly static over the same timeframe. Fixed broadband is defined as DSL or cable modem, or, basically, a wired connection. This information alone seems to be a major driver for today's mobile service providers to adopt greater broadband coverage within their respective networks. Additionally, **Figure 3** shows how data within a typical mobile broadband network has increased dramatically over typical voice transactions from 2007 through 2009. This is attributed directly to the increase in use of smart mobile devices.

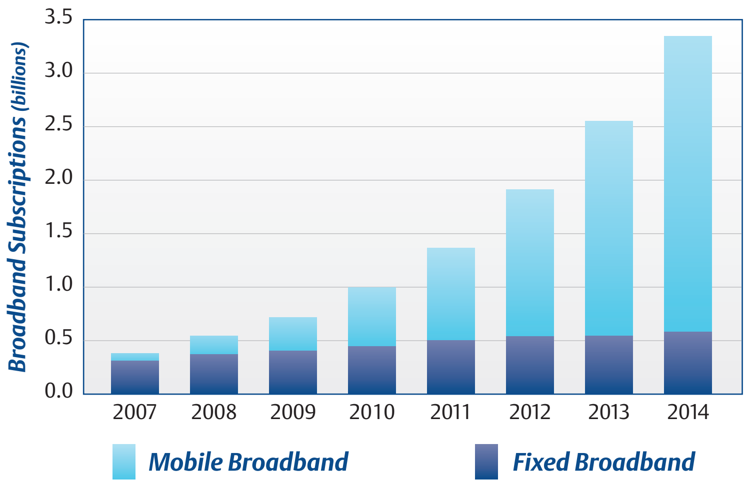

Figure 2. Ericsson White Paper "LTE-An Introduction". June 2009.

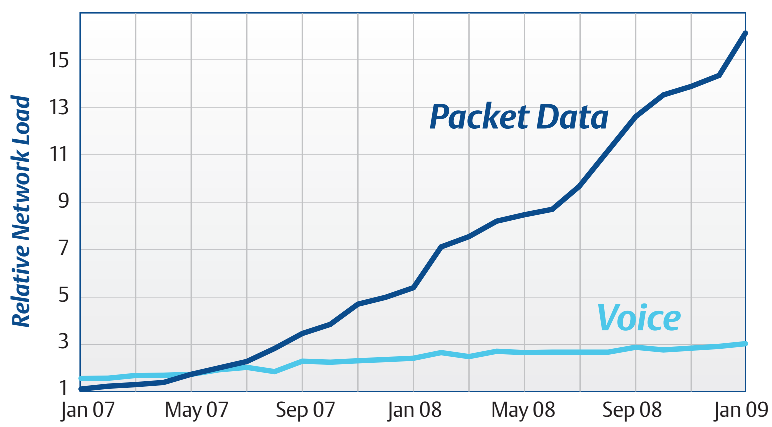

Figure 3. Ericsson White Paper "LTE-An Introduction". June 2009.

Initially, device providers were driven by the mobile network's ability to carry data. But with the evolution of third-generation mobile networks in recent years, the consumer's quest for faster and more data-intensive devices and applications have placed smart device manufacturers in the driver's seat, providing a suite of data-intensive products driven by third-party applications. This trend has contributed to the extensive mobile broadband use over standard wired broadband throughout the world, and will continue to move the trend forward. This trend is also evident in regions worldwide that have very limited access to traditional wired networks. In many developing areas around the globe, it is both easier and cheaper to deploy a mobile network than a traditional network.

The Evolution of Wireless Backhaul

In response, mobile providers have been forced to develop a long-term solution to meet increasing and evolving network capabilities. Service providers demanded unified network enhancements such as, more efficient spectrum usage capable of reusing the existing network, increased speed and capacity at the edge of each cell and seamless global access. To meet ever-increasing data speeds and the needs of the service providers, the OEM community developed the new LTE standard. LTE promises to provide:

- An all-IP network, flat architecture
- Efficient spectrum usage, scalable from 1.4 to 20 MHz (one size fits all)
- An open standard, capable of interfacing with existing 2G/3G devices
- Capability to re-use the existing radio infrastructure
- High network security
- Initial capacities of 100 Mbps data upstream and 300 Mbps data downstream

With data-centric standards such as LTE, the need for a more robust backhaul in the network must be considered. But the backhaul of data to the wired network has its own set of challenges with the overlay of LTE into the network. Greater data use and greater efficiencies promised by LTE means that more data is processed back to the wired network. In the past, wireless networks relied heavily on the use of T1 backhaul at each wireless site. These were primarily copper-based systems that were very limited and many times unreliable in their ability to process data back to the network. In many cases, the T1 lines became the weakest link at the cellular site due to poor reliability of the points.

Since LTE brings dramatic increases in data-carrying capability in the network, the ability to process data will become a key distinction of each carrier. Traditional voice service will be converted to data, increasing the load on the backhaul. Data, not voice, will ultimately become the revenue stream for the service providers. This leads to four specific areas that must be considered.

Cost:

Dramatic increases in data traffic require additional bandwidth back into the system. Traditional copper-based T1 systems become easily eclipsed in their ability to handle large data flows, unless large numbers of T1 Lines (10+) are installed at each site. The cost of leasing these lines back to the local wired network provider could exceed $10,000 (U.S.) per month. Transition to an Ethernet-based fiber backhaul system or high speed microwave backhaul becomes the clear choice for LTE in order to better manage data traffic efficiently through the network in a more cost effective manner. Rather than rely on the local exchange for backhaul services, the wireless provider is now capable of maintaining the link back to the wired network, further increasing reliability and reducing overall infrastructure costs.

Convergence:

The backhaul environment must be capable of interfacing seamlessly with both 2G/3G applications as well as LTE.

Flexibility:

The backhaul must be flexible enough to reliably handle all types of existing and future infrastructures at the point of connection into the network. This could consist of second generation voice only networks, as well as third generation/LTE radio solutions.

Reliability:

The backhaul traditionally is the weakest link in the network and reliability must be increased dramatically as demand grows. To ensure success, backhaul spend will increase as providers work to deliver more robust backhaul systems.

In review, several possible future trends become apparent in the management of data from the LTE mobile network:

- Data will or already is the dominant player in mobile networks; voice is secondary.
- Providers that manage data securely and quickly though their networks will become the dominant players in each respective market, especially for secure and reliable business transactions.
- Voice-only wireless service providers will become the low end providers, while those who manage the backhaul/transport systems will become the dominant force in the future mobile broadband. In fact, voice-only services may become a “free” service as part of bundled data packages.

Overall, ownership of the networks will slowly evolve to one or two dominant network management providers that sell and manage the broadband networks. The front end of the business will evolve into service providers that sell mobile, advanced data products and have few or no ties back into the managed data network. In the near future, this will cause a major revolution in the market as well as affect the overall site infrastructure.

The Effect of LTE on the Wireless Infrastructure

How will these business models affect the overall infrastructure of the wireless network from an outside plant, DC power and services standpoint? As LTE evolves, all of the service providers will move toward a data-only network, carrying voice-over in the Internet in packet data form – or standard VoIP format. This will force providers to charge a flat fee to compete initially with fixed-wire suppliers on the data side. In order to do so, great pressure will be placed on the overall cost model of the infrastructure side. As the unified standard of LTE is adopted, a more unified approach to cellular deployments may occur, with a strong focus on doing more with less from an outside plant, DC power and site layout.

All in all, cost pressure will be imposed on the infrastructure suppliers in the coming years at a much greater level than has been seen in the past. This will be in the form of providing solutions that can do more in a smaller, more cost-effective manner at "greenfield" sites, and utilizing the preexisting infrastructure at established sites. Some deployments that make use of more efficient scenarios are:

- DAS or Distributed Antenna Systems
- Remote Node B Solutions

Although the traditional wireless site will not disappear, LTE will force providers to move toward less traditional methods in order to extend the network closer to the subscriber. The mobile user may not necessarily be physically moving, but is never in the same static place continuously. Also, as LTE evolves, "smart technology" homes will become more prevalent, using wireless to provide energy conservation through smart metering, full HD wireless television, phone service and high speed internet capable of exceeding the fastest wired DSL currently available.

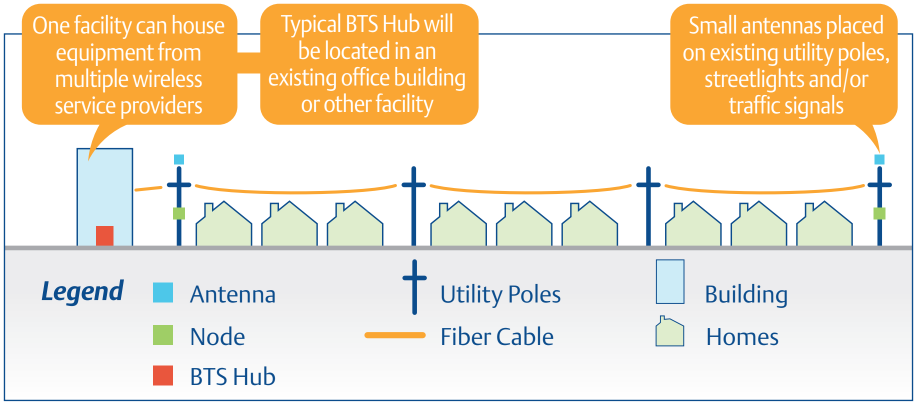

Figure 4. DAS Network

Because data speeds decrease dramatically as distance increases from the antenna, the wireless network must move closer to the consumer to attain the speeds capable of providing these data intensive services, especially as we migrate toward the wireless 'smart' home. One method involves providing neighborhood DAS-style networks [**Figure 4**]. DAS places multiple antennas throughout the neighborhood to provide extensive coverage fed by a main DAS "hotel" located in the network.

- The main DAS hotel contains incoming utility power, DC rectification, radio systems, fiber splitter and fiber management, node splitters electronics and battery backup. This main hotel can be housed in a walk-in enclosure or a series of small outside plant cabinets. Site style will depend on availability and cost of property, as well as the need for growth. Sites that do not require large growth potential are best served with several outside plant cabinets. Growth areas are best served with walk-in enclosures that can easily add radios, carriers, DC power and battery backup.
- The traditional sector antennas are split up, or duplicated among several antennas fed via fiber, generally strung along existing utility wires.
- At each antenna node, power is fed by the existing utility company via a point of demarcation.
- Site nodal electronics are powered by approximately 200 watts of DC power at the site and usually do not have any DC battery backup.

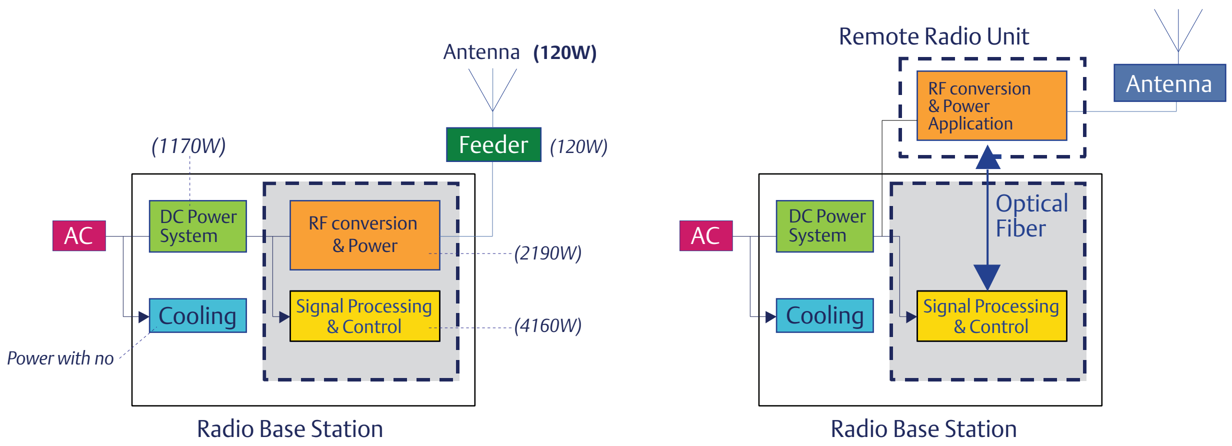

Figure 5. Nodal Wireless Solution

DAS network sites, in general, are capable of three times the coverage of a traditional wireless site with the same number of carriers. Main DAS hotel sites do not require large DC power plants and large battery backup, as little or no amplification is needed to send the signal through the fiber network. Hotel sites can easily use less than half the current DC power and battery backup. From an infrastructure standpoint, sites require less AC power and less overall infrastructure footprint.

Although a nodal site with antennas requires DC power, AC demarcation and outside plant cabinets, these components pale in size and energy compared to an equal primary radio site [**Figure 5**]. In many cases, the nodal side is connected to the utility grids with no DC back up. This may evolve based on the critical nature of the data being transferred and the types of businesses or individuals served by the network provider.

Existing providers will initially deploy LTE within the current infrastructure, especially if the radio frequencies are available. Based on scalability and interoperability of LTE, the most cost-effective solution is to add an LTE radio system at an existing cellular site utilizing the existing radio infrastructure. This can be accomplished by:

- Deployment of the LTE radio at the site, either adding an outside plant cabinet to an existing outdoor site or indoor radio to an existing walk-in enclosure.
- Deployment of RxAIT equipment at the site, capable of combining existing WCDMA and LTE onto existing coax and site antenna systems. This saves considerable money and time at each site because new coax cables and antennas are not deployed. In many cases, existing frequencies are reused.
- Utilization of existing DC power and DC backup at the site. Overall, most mobile sites have existing DC power and battery backup that has been oversized to the current site power loads. This is not always the case, but with the rollout of 3G, many service providers oversized DC power plants and DC backup at the mobile site, having been caught with limited DC growth potential in the past. In addition, many OEM radio suppliers conservatively overstated the power draw at each site. In reality, most sites only draw a fraction of the DC power provided at the site, leaving additional power for new LTE sites. This provides considerable margin at each site for growth, allowing new LTE radio systems to tap this reserve.

The speeds required at existing sites to maintain a “digital house” will never be attained unless antennas are placed close to the subscribers. This will become an issue as more mobile broadband is required by fixed home or business users. As the fixed mobile

DAS network sites, in general, are capable of three times the coverage of a traditional wireless site with the same number of carriers.

requirements grow at each cellular site, so will the issues of moving the antennas closer to the broadband subscriber to optimize speeds at the network's fringe. Although increasing penetration through signal amplification may be a viable solution, the cost of added amplification equipment and DC power requirements may be outweighed by placing a distributed node antenna system closer to the subscriber. Ultimately, nodal sites may be the solution to distribute signals effectively through the network.

The Energy Factor

Energy cost reductions in wireless networks are key to service providers. As infrastructure cost is pushed downward, so will the need to minimize the amount of energy consumed at each site. Current estimates show that nearly one percent of global energy use is consumed by telecommunication networks. Many prime telecommunication providers are focused on reducing the amount of energy used within the network as well as at each cell site. With more than four million cell sites deployed globally, the impact of energy savings is significant.

Optimization of each cellular site is key to the reduction of energy absorbed by the mobile network. To date, the focus has been primarily on the amount of energy consumed by the radio system and the overall amplification of the signal at each site. Many greenfield deployments now utilize remote radio heads, or Node B configurations, at the primary cell site. These configurations place the amplification and antenna at the top of the tower, while leaving the radio, DC power and energy backup at the base. This configuration can cut the amount of DC energy and utility power by as much as 50 percent at the site, directly affecting the amount of DC power, outside plant and AC distribution at each site by a factor of one half. Although these components are still required at each site, the amount and size is drastically reduced due to the overall efficiency of the radio distribution.

A more recent development that allows providers to dramatically reduce grid energy consumption at each site is the use of hybrid control systems that enable the deployment of renewable energy sources. In addition to utilizing grid power, plus a DC generator or DC batteries as standard backup, renewables incorporate power from solar, wind or fuel cells at each LTE site, reducing grid-generated power consumption.

Hybrid site architectures have been used extensively in China and more recently at sites throughout California. They provide a grid energy reduction of approximately 25 to 30 percent per site, presenting the potential for significant energy cost reduction when multiplied by the number of sites. U.S. sites can also realize a 30 percent federal energy tax benefit for utilizing renewable energy sources, and several states offer tax incentives as well. Renewable energy also gives providers an environmental advantage that reinforces their overall sustainability message.

In LTE networks, decreased energy consumption at each site allows for a broader use of renewable and hybrid energy sources. This creates the opportunity for the systems to be packaged for rapid deployment, providing overall economy of scale and flexibility. Payback, based on current electric rates, can be expected to be between three and five years.

Conclusions

Fixed mobile broadband is growing at a rapid pace and will continue to overtake existing wired solutions as speed and efficiencies increase dramatically. The wireless industry believes that LTE is the vehicle to provide this transition. This is evident by the overall growth in the marketplace for smart mobile devices and the applications driving the amount of data, which has surpassed voice and will continue to grow exponentially. As the use and evolution of smart devices increase, so too will the need for faster speeds and a mobile network capable of supporting such data devices. Although wireless networks are focused on mobile users today, it is a matter of time before this application is required at fixed business and fixed residential locations. This will require broader-based distributed antenna solutions that focus on driving the price of each component further down to a commodity scale. What was once regarded as the centerpiece of the cellular network will be viewed as a marginal component of the network; it will be more cost-effective to discard than to fix in the field. The days of high prices and high technology are slowly fading under cost pressure within the market. What will set vendors apart is the ability to provide cost effective, energy efficient, flexible market solutions to the cellular networks. As stated, the focus will shift from cellular infrastructure components to the transport or backhaul portion of the business.

Renewable energy located at LTE sites will provide an eco-friendly solution with economies of scale through a packaged approach. Solar, wind and fuel cells can not only reduce the reliance on grid power by 25 to 30 percent, but offer owners tax advantages and the opportunity to reinforce their sustainability message as they reduce their carbon footprint.

The leaders in the wireless telecommunication infrastructure business will be providers who find unique ways to enhance the robustness of the transport network while maintaining cost effective, energy efficient means.

References

[1] Ericsson White Paper "LTE–An Introduction". June 2009.

[2] Ericsson White Paper "LTE–An Introduction". June 2009.

> *Solar, wind and fuel cells can not only reduce the reliance on grid power by 25 to 30 percent, but offer owners tax advantages and the opportunity to reinforce their sustainability message as they reduce their carbon footprint.*

Emerson (NYSE: EMR), based in St. Louis, Missouri (USA), is a global leader in bringing technology and engineering together to provide innovative solutions for customers in industrial, commercial, and consumer markets through its network power, process management, industrial automation, climate technologies, and tools and storage businesses. For more information, visit: **Emerson.com**.

Emerson Network Power, a business of Emerson (NYSE:EMR), is the global leader in enabling *Business-Critical Continuity*™ from grid to chip for telecommunication networks, data centers, health care and industrial facilities. Emerson Network Power provides innovative solutions and expertise in areas including AC and DC power, precision cooling, embedded computing and power, integrated racks and enclosures, power switching and controls, infrastructure management, and connectivity. All solutions are supported globally by local Emerson Network Power service technicians. For more information on Emerson Network Power's full suite of solutions specifically supporting the communications network infrastructure, including NetSpan™, NetReach™ and NetXtend™ outside plant enclosures and equipment, NetSure® DC power systems, and NetPerform™ Optimization, Design & Deployment services, visit: **EmersonNetworkPower.com/EnergySystems**.

Learn more about Emerson Network Power products and services at: **EmersonNetworkPower.com**.

Emerson Network Power
Energy Systems, North America
4350 Weaver Parkway, Warrenville, IL 60555
Toll Free: 800-800-1280 (USA and Canada)
Telephone: 440-246-6999 **Fax:** 440-246-4876
Web: EmersonNetworkPower.com/EnergySystems

Code: 137W-LTE / 0111