ENERGY EFFICIENCY IN CAMPUS NETWORKS

WHITE PAPER

INTRODUCTION

During the industrial revolution and later, as the world became more dependent on machines to increase economic growth and prosperity, power consumption was not a major consideration; the main issue was the generation of sufficient power where it was needed.

With electrification came the ability to distribute large amounts of "clean" power to almost any location but that power was only clean at the point of consumption and little consideration was given to the resources consumed and pollution generated at the source. During the latter decades of the 20th century the Information Technology (IT) industry grew alongside traditional industries and has become one of the major consumers of electricity and in some areas, where large corporate offices and data centres are located, demand has increased exponentially. Despite increases in efficiency the growth of IT has meant that power consumption has significantly increased over several decades and the pressure to reduce electricity usage and adopt strategies that indirectly cut carbon emissions has never been greater.

THE NEED FOR IT TO BE GREEN

Mark P. Mills of the Digital Power Group estimates that Information and Communications Technology (ICT) systems now use in excess of 1,500 terawatt-hours of power per year. That amount represents more than 10 percent of the world's total electricity generation and about 50 percent more energy than is used to power all of the aircraft in the aviation industry. Society shows little appetite to slow down the deployment of IT services that deliver organizational efficiency gains and new revenue opportunities. Clearly, organizations need to look at ways to reduce the power consumption of the IT devices they use on a daily basis.

More optimistically, IT trends are moving in the right direction: The energy used per unit of processing power is decreasing by 20 percent per year and networking products are following the same power improvement curve. However, even with increases in efficiency the constant drive for increased performance and greater capacity means that the overall energy consumed by IT is growing by 18 percent compounded per year, so there is clearly no room for complacency.

Figure 1 shows the percentage of power consumed by various IT equipment types. Although networking consumes a small proportion of the overall amount, it still incurs a significant cost that must be addressed as part of a coordinated power reduction strategy.

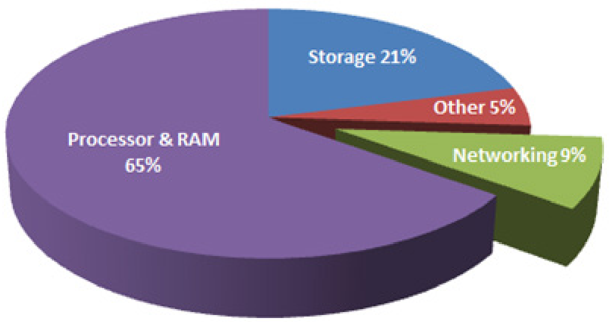

Figure 1: Power Consumption Distribution by Key Function Source: Wikibon 2011 and EPA 2007.

A key motivator for implementing power-saving strategies is the drive for organizations to be increasingly seen as "green," a vital part of any Corporate Social Responsibility policy. However, the most compelling stimulus is the opportunity to reduce costs and improve profitability.

Cutting power consumption reduces the cost of running IT hardware, but it also reduces the heat that is generated and the amount of cooling that is needed to keep equipment functioning efficiently and to maintain working environments at a comfortable temperature. A 1 watt (W) saving when using a piece of IT equipment can result in the reduction in energy consumption of approximately 2.8 watts throughout the facility. In other words, if you cut 1 W from the consumption of an IT component, such as an Ethernet switch, it represents only 35 percent of the total savings that are realized when you factor power distribution and cooling into the equation.

The motivation to do more to cut the power consumption of networking systems has never been greater.

POWER REDUCTION STRATEGIES

As with all broad-based problems, businesses can pursue multiple strategies in the search for a solution. For the past few years, data centers have been the primary target for reducing power consumption due to their very visible high concentration of power-hungry, heat-generating IT systems. By contrast, the highly distributed nature of campus networks means that they often go unnoticed. Yet, because many campus networks contain hundreds (and sometimes thousands) of edge switches they provide an opportunity for significant savings.

There are a number of areas that can be targeted for efficiency gains, some well understood and others which are more recent innovations.

SWITCH POWER EFFICIENCY

Unlike consumer products, commercial networking devices are not rated for their power consumption; in other words, they are not subjected to EnergyStar or similar certification programs. As a result, in the past the networking industry was not as strongly motivated to optimize the power efficiency of Ethernet switches. Yet, as the focus on energy saving moves beyond the data center, campus switches are receiving more attention.

Ruckus takes great care when designing campus network switches to ensure that all components are optimized so that power consumption for a given configuration or load is not greater than necessary. Ruckus continuously innovates to achieve optimal energy efficiency within its products, focusing on these key factors when designing a new switch platform:

- Optimized power supplies that are efficient and the right size for the device such as different power supplies for Power over Ethernet (PoE) versus non-PoE versions of the same switch model
- Ensuring that the maximum number of PoE devices are supported per switch
- Providing features that enable user-driven power reduction strategies

You can see the result of this attention to detail in the power consumption performance for the Ruckus ICX switch portfolio, which can consume up to 40 percent less power than similar products from other vendors. These savings have a direct impact on Operating Expenses (OpEx) and hence the Total Cost of Ownership (TCO) of a network.

Furthermore, the “cascade effect” of the reduced power consumption of Ruckus switches results in downstream savings in power distribution, cooling, and Uninterruptible Power Supply (UPS) provision—which amplifies the TCO benefits.

RE-ARCHITECTING THE NETWORK

Traditional network architectures typically required large power-hungry chassis-based devices in the aggregation and core layers of a campus network. These were necessary in order to provide the required resiliency and scale, but they were often underutilized within a compromised network design. This resulted in increased operational costs that mainly could be attributed to disproportionately high power consumption, often as a result of an underutilized chassis with empty slots and over specified power supplies. To address the limitations of mid-range chassis solutions, Ruckus ICX switches employ scale-out networking which exploits the Distributed Chassis architecture.

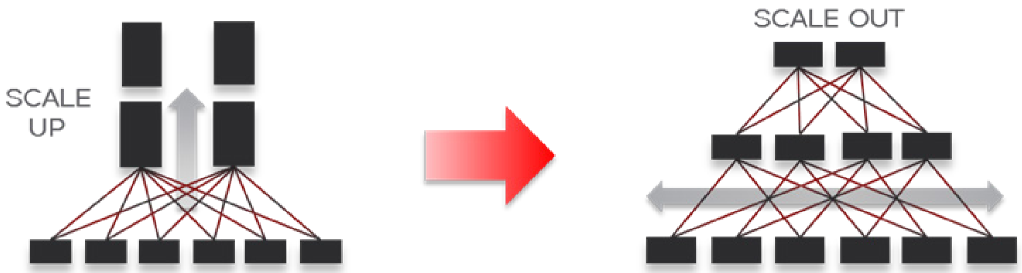

Figure 2: Evolving the Network—Scale-Up vs. Scale-Out

Scale-out networking delivers flexible deployment options through the use of the Ruckus ICX 7750, which is an optimized fixed configuration 10 GbE/40 GbE switch that can be interconnected to create a unified system. Such a system delivers the single point of management of a chassis-based system, but with greater scalability. Furthermore, as there are no empty slots or wasted power supply capacity in a Distributed Chassis solution, its power consumption footprint is closely aligned with the number of ports deployed which is rarely the case with over-specified chassis systems. The net result is significantly lower power consumption, which in turn lowers operational expenses.

When the deployment of a network is optimized to ensure that it is precisely sized for the application without compromising scalability or performance, the impact on the overall power consumption of the system is significant. Ruckus continues to innovate in this arena, ensuring that the network is always optimized for both performance and energy efficiency.

POWER OVER ETHERNET (POE) AND DC MICROGRIDS

Within many commercial buildings, many of the electrical devices that are installed—such as telephones, computers, sensors for building control, LED lighting, security systems, and so on—utilize Direct Current (DC) power. However, since all existing power distribution systems use Alternating Current (AC), every device must perform its own AC-to-DC conversion, resulting in considerable inefficiencies. In addition, local renewable energy sources, such as photovoltaic panels on the roof of a building, generate DC power that is then converted to AC for local distribution, resulting in further inefficiencies.

A solution to this problem that is fast gaining market acceptance is DC microgrids. With DC microgrids, AC-to-DC conversion is performed in bulk in a central location, and DC power is distributed locally on a per-floor or per-building section basis. Also, any locally generated power from renewable sources can be directly delivered into the DC system, which further increases efficiency.

PoE is not a new technology, but recent innovations mean that it is fast becoming a major component in the development of new power distribution systems. Thus PoE is perfectly placed to play a central role in the DC microgrid revolution. Once confined to powering IP phones and wireless Access Points (APs), the applications for PoE are now expanding rapidly. It is now the motive force for Public Address (PA) systems, retail Point of Sale (PoS) terminals, building access terminals and, more recently, LED lighting and higher power consumption applications, such as Virtual Desktop Infrastructure (VDI) terminals and digital signage.

Ruckus Ethernet switches deliver optimized PoE solutions that offer a range of power outputs to support a broad variety of applications, as shown in Table 1.

PoE Type	Standard	Power at Source (PSE)	Power at Device (PD)	Ruckus ICX Switch Support	Typical Applications
PoE	802.3af	15.4W	Up to 12.95W	ICX 7150, ICX 7250, ICX 7450, ICX 7650	IP telephones, PoS scanners, badge swipes, WLAN APs
PoE+	802.3at	30W	Up to 25.5W	ICX 7150, ICX 7250, ICX 7450, ICX 7650	WLAN APs, security cameras, PA systems, electronic door locks, LED lighting
PoE Overdrive*	N/A	45W	Up to 38W	ICX 7150-Z Series, ICX 7650	Large WLAN APs (4:4x4)
PoE++	802.3bt (due 2018)	60W	Up to 51W	ICX 7150-Z Series ICX 7450, ICX 7650	VDI terminals, outdoor security cameras, picocells, LED lighting
PoH	802.3bt (due 2018)	90W	Up to 71W	ICX 7150-Z Series ICX 7450, ICX 7650	Digital signage, media players, LED lighting

* PoE Overdrive allows powered devices to negotiate greater than 30W power allocation via LLDP. This provides more granular power allocation within the switch and therefore improved optimization of the power consumption of the overall system.

Table 1: Power Over Ethernet Technologies and Applications.

A great strength of PoE is its combination of power and data delivery, which means that it is ideally placed to participate in energy optimization plans. Scheduling power delivery on a per-port basis means that network managers can fine-tune their network power consumption for devices that are not required to be available at all times. For example, a retail outlet does not need PoS terminals, Wi-Fi, or telephones when the store is closed. Such devices can be selectively powered off, leaving only essential services still functioning. In an office space that might be occupied only five days a week, the power consumed by PoE devices that are not required when there is no occupancy can be reduced by 50 percent.

To simplify and automate the management of PoE on Ruckus switches a centralized management system can be employed to perform a range of functions:

- Enable and disable power on a per port basis (manual or timed configuration)
- Create and monitor power thresholds
- Determine configured, consumed and available PoE capacity
- Determine PoE power allocation
- Determine power consumed by PoE devices
- Create real-time and historical charts of power consumption

By deploying Ruckus switches that deliver higher-power PoE, coupled with centralized automation and control, the applications and benefits of the solution are increased significantly, as are the environmental and cost-saving gains.

ENERGY EFFICIENT ETHERNET (EEE)

For many years the Central Processing Unit (CPU) within computing platforms has supported frequency scaling. This feature allows the speed of the chip to be dynamically altered in order to conserve power and reduce the amount of heat generated, which in turn allows the system cooling fans to be slowed. In this way, noise levels are reduced and power consumption is lowered. EEE brings this concept to the Ethernet ports on a device by managing port performance based on link activity.

When an EEE-enabled switch determines that there is no data to be sent, it can instruct the port to enter a Low Power Idle (LPI) state. LPI symbols are then sent to inform the device at the far end of the change in state. Refresh signals are sent periodically to maintain the link data integrity. Also, when there is information to be transmitted, signals are sent to alert the receiving device before transmission commences. The impact on latency created by the wake signals and associated wait timers is negligible for most applications, as they do not exceed 16.5 microseconds (μsec) on a 1 Gigabit Ethernet (GbE) link and 8 μsec at 10 GbE.

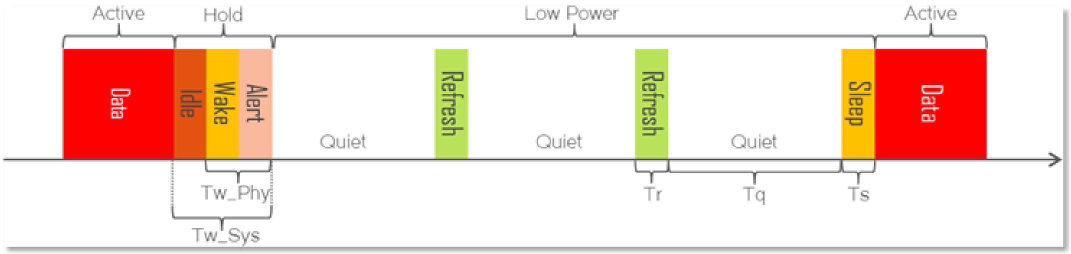

Figure 3: Energy Efficient Ethernet Link Protocol (IEEE 802.3AZ).

Because of the need for bidirectional signaling, both devices at either end of a connection must support the EEE that is defined in the 802.3az specification. Once enabled, per-port power savings are typically in the range of 5 to 10 percent, which further increases the power efficiency of network devices and their connected systems.

Ruckus has implemented EEE on all of the copper ports of the ICX 7250, ICX 7450 and ICX 7650 switches, and the feature can be enabled globally or on a per-port basis, as required.

MEASURING THE IMPROVEMENTS

The monitoring and measurement of consumption is vital in order to show where power saving strategies may be most effectively deployed and also to determine their impact. For network components, this is most naturally done within a central network management platform.

For a complete picture of the power consumed by IT systems (including the impact on a building's power and cooling systems in addition to direct power consumption) measurement should be integrated into an organization's building control and facilities management platforms. This can be achieved via either data transfer, inline measurement, or direct access through Simple Network Management Protocol (SNMP).

TCO IMPACT

When assessing the cost of a network prior to acquisition, organizations often put great emphasis on the cost of acquisition. Yet in addition to this, the operating cost should also be considered when determining TCO. Power consumption is a major influencer of the TCO of a network.

The holistic approach to network design and operation provided by Ruckus makes it far simpler to increase TCO over the life of the network than is possible with competitive solutions. In the example shown in Table 2, the advantages of the Ruckus Distributed Chassis technology—together with a lower overall power consumption—results in significantly lower power and cooling costs compared to equivalent chassis-based solutions from the closest competitors.

	Ruckus	Competitor A	Competitor B
Acquisition Costs	$240,000	$385,980	$399,756
Service and Support	$72,250	$161,097	$152,172
Power and Cooling	$45,168	$69,116	$49,175
Floor Space	$35,300	$35,300	$35,300
Total (5 years)	**$392,718**	**$651,493**	**$636,403**

Table 2: Calculated TCO for a 1,000 Port PoE Enable Campus Network over 5 years.

To calculate the comparative TCO for your network go to www.ruckuswireless.com/icx-tco.

STRATEGIES FOR A GREEN CAMPUS NETWORK

The primary role of a campus network is to provide connectivity for devices at the edge of the network. Because unlike data centers it cannot be moved to locations where there is cheap renewable energy, it must remain close to the users it serves. As a result, an organization looking to reduce its carbon footprint and energy bills must consider the campus network as a primary target for savings.

As part of a complete green-IT strategy, organizations should look at the whole network—together with the connected devices—to determine which capabilities will provide the greatest returns. Such capabilities must be part of an integrated approach that encompasses not only the power consumption of individual components but also how to ensure that those components work in concert for optimal efficiency. Furthermore, the campus network should be considered part of an integrated in-building power distribution system that is optimized for the 21st-century working environment.

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