New IT Energy Efficiency Incentives:

Opportunities Hiding in Plain Sight

A Cirrant **Green** Paper

by Frank A. Coluccio

February 16, 2012

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Exordium

We present a new category of energy efficiency incentives and architectures for Enterprise and Institutional Information Technology (IT) Networks, beneficial to power producers and consumers alike.

The network architectures discussed have significant benefits for organizations beyond energy savings. Simplicity of design and enhanced agility enable networks to qualify for utility market demand-side initiatives, such as demand-response and time-of-day load shifting. Benefits are achieved through a virtual dematerialization of assets, similar to virtualization of servers in cloud computing. Dematerialization is made possible through the lightweight and transmission distance characteristics of optical fiber, along with wireless technologies and the optimal usage of copper builds.

This brief is tailored for utility executives, regulators, government officials, and C-Level business executives. It is the first in a series on this subject by Cirrant Partners Inc. It is a compendium of Cirrant white papers, articles, technical briefs and application notes exposing what we have dubbed the IT "**scotoma**"[1] , or blind spot. In such areas, energy is wasted due to scaling characteristics of legacy all-copper networks. Utilities and regulators have not raised consciousness about, or created financial incentives tailored for energy efficiency in networks; as a result, end-users are not aware of the opportunities we will describe.

The total IT energy consumption in the US in 2011 is estimated to be slightly more than 100 Billion kWh[2]. (This is based on the energy consumption being 80% of the 2007 projection.) The actual consumption may be lower due to the economic times. Energy costs vary per state and usage classification and contract agreements. At a commercial national average price of 10.77 cents per kWh,[3] the total IT energy consumption cost is estimated to be $10.77 Billion. **Annually, *Billions of kWh of IT energy go unmonitored and largely unmanaged. A large part of the consumption is inefficiently-used energy by local area networks and supporting infrastructure.***

IT Network Infrastructure energy savings are the new low hanging fruit.

To this end, we introduce the economics and operating characteristics of hybrid local area network (LAN) configurations that would enable energy consumers to capitalize on new energy efficiency incentives programs, and realize substantial CAPEX and OPEX savings.

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[1] A scotoma (Greek for darkness; plural: "scotomas" or "scotomata") is an area of partial alteration in one's field of vision consisting of a partially diminished or entirely degenerated visual acuity which is surrounded by a field of normal - or relatively well-preserved - vision.

[2] Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431, August 2, 2007

[3] US Energy Information Administration Electricity Monthly

The Case for New Energy Efficiency Incentives Related to IT Network Infrastructure Optimization

The IT Network infrastructure in office buildings and campuses has long been overlooked as a target for energy efficiency programs. The data center has been the focus and primary beneficiary of existing energy efficiency programs: largely spurred by both real and imagined stimuli. Real, in the sense that the amount of power consumed in big-box data centers is indeed significant and deserves every bit of attention that it has received. Imagined, in that, it has become clear recently that the data center is NOT the single largest power consuming IT component of the enterprise. It ranks behind networks and user hardware systems.

As reported recently by James Hamilton in his Perspectives blog[4], at the European Data Center Summit 2011 in Zurich, Google Senior VP Urs Hoelzle spoke about why IT infrastructure energy efficiency is important both economically and socially. Hoelzle pointed out that the breakdown of the power consumed by IT Infrastructure is roughly as follows: 14% for data centers, 37% for network infrastructure, and 49% for client devices[5] as shown in Figure 1.

The focus of this paper is on the ***network part*** of US IT energy consumption, approximately 37 Billion kWh, but actually could be higher, and rising.

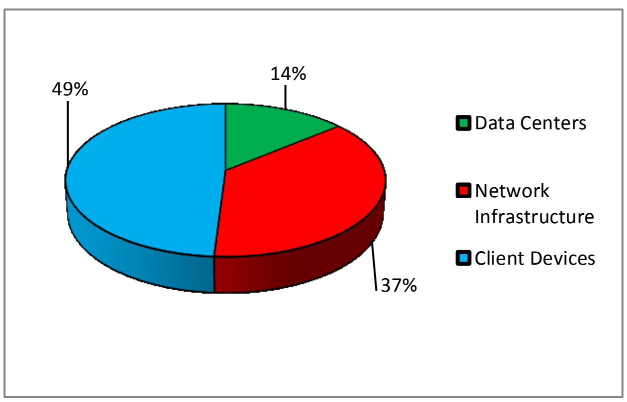


Figure 1 - IT Infrastructure Energy Consumption

[4] James Hamilton's Blog - Perspectives - 05/25/2011 - 2011 Data Center Summit
5 Urs Hoelzle - 2011 Data Center Efficiency Summit Introduction Speech: Video

Current PUC Incentive Policy

A 2007 report from the international consulting firm McKinsey and Co. found that improving energy efficiency in buildings, appliances and factories could offset almost all of the projected demand for electricity in 2030 and largely negate the need for new power plants. McKinsey estimates that one-third of the U.S. greenhouse gas reductions by 2030 could come from electricity efficiency, and be achieved at negative marginal costs. The cost of the efficient equipment would quickly pay for itself in energy savings.

A primary approach to achieving these savings, in buildings where legacy all-copper network infrastructure designs are utilized, is through the process of dematerialization. It is "doing more with less". Dematerialization is enabled by exponential improvements in optical and wireless data transmission devices, which are designed in accordance with *existing standards*.

The Web sites DSIRE (http://www.dsireusa.org/) and ACEEE (http://www.aceee.org/sector/state-policy) are two comprehensive sources of information on state, local, utility and federal incentives and policies that promote renewable energy and energy efficiency. Most states, under varied frameworks, offer energy reduction incentives that include, but are not limited to the re-commissioning, optimization, or outright replacement of: lighting systems; heating, ventilation, and air conditioning (HVAC); refrigeration; elevators; data centers; building controls and automation systems. There is no known energy efficiency policy applied explicitly to network infrastructure.

The following salient points concerning incentives programs are universally accepted:

- It is less expensive to pay customers to use less power, than to build new power generation facilities.
- Federal and state agencies have varied mandates/guidelines in place to reduce costs and support the environment.
- Current incentive programs address the data center, lighting, building controls and HVAC systems, primarily. To our knowledge, programs that specifically target enterprise building and campus network infrastructure are non-existent, or must be retrofitted to the contours of programs designed for other purposes.

Not so generally understood, however, is the importance of new efficiency incentives tailored to the scotoma zones.

Enhancements Needed to the Existing Energy Efficiency Incentives

The IT network infrastructure and workgroup contribution to the total energy cost are far more significant than the data center, perhaps by as much as several multiples. Yet, the energy consumption within the scotoma zone is not measured to the same degree of rigor as the data center. It follows then, that the energy efficiency is unmanaged there as well.

New incentives are needed to promote Network infrastructure savings which will result in an improved Return on Investment (ROI) for utilities, a lower Total Cost of Ownership (TCO) for customers, and reductions in greenhouse gas emissions.

There is work still to be done in this area in terms of defining its various components and the contributions made by each component. For example, no universally accepted taxonomy of IT infrastructure enclosure types currently exists at the granularity necessary to define the boundaries for mindshare and budget dollars of Facilities Managers, Chief Information Officers (CIOs) and Chief Financial Officers (CFOs). Therefore, CFOs have little basis for accounting precisely where, throughout IT, energy dollars are being spent: a "*scotoma*".

LAN Infrastructure: Legacy Economics and Optimization Design

A principal motivation for reexamining existing LANs lies in terms of basic scale economics. The existing IT paradigm for building LAN infrastructure is driven by the 100 meter length limitation[6] of copper cabling. It is based on a 3 tier architecture, requiring a minimum of one or more Technology Equipment Rooms (TERs) on every floor to support the energy consuming LAN switches. As this copper-based infrastructure scales linearly, the TCO scales inefficiently with regard to cost effectiveness and operational manageability. The most egregious elements in the cost structure of LANs are not only the wires, switches, controllers and appliances, but the combined costs of secondary support systems consisting of real estate, power and air conditioning required for the containment and cooling of those network devices, and administration. Figure 2 is an illustration of legacy LAN features. A deeper treatment of LAN Economics is the subject of a separate white paper.

LAN optimization via dematerialization requires consolidating in centralized main distribution locations the LAN switches, routers and WLAN controllers, along with all other sundry forms of networking and application devices that presently occupy TERs on each floor, to either the main data center of a building or two or more

[6] Anixter Standards Reference Guide PDF File

spatially-separated, load-sharing enclosures. Otherwise, the diseconomies referenced above will only become more acute as the number of LAN segments and LAN enclosures continues to increase, regardless of which media are used for individual, horizontal segments. Figure 3 is an illustration of optimized LAN features.

Many LANs today reached first-order diseconomies during relatively early stages of their lifecycles. That this fact continues to go almost universally unnoticed or ignored is a manifestation of the scotoma effect. It can also be due to the uncertainty concerning the ownership of the responsibility for the proper placement, design and ongoing administration of the TERs. Who pays the supporting electric bill, and even more fundamentally, who has the last say in whether those enclosures should be built out for LAN equipment at all? The last point becomes murkier still, considering that, today's office buildings and skyscrapers, due to the inherited 100 meter trait of Category n-type cabling, are designed with a minimum of one or more TERs on every floor as structural extensions to the cores of base building designs. The ambiguity offsets a best practice of defining clear ownership of fiduciary responsibilities as they relate to electric power consumption and real estate. From an organizational perspective, these capital costs and operating expenses must be factored directly into the total cost of ownership, an accounting practice which may not be done today. The implications of not factoring in these costs become especially pronounced where LAN underpinnings are based exclusively on copper constructs. To highlight the above, here follows an excerpt of a 2009 interview of the author by Gordon Cook for the *Cook Report on Internet* wherein he speaks to this topic:

> *"Allow me to read for you a passage from Uptime Institute [7] founder, Ken Brill, who addresses the issue of dependence on C-Level management in meeting green objectives, which are applicable in my opinion to everything else we've been discussing today, as well:*
>
> *'The commitment of the C-Suite is absolutely essential to driving these needed changes through the organization. As pointed out ... without C-Suite leadership and backing, the necessary cross-discipline management cooperation will not take place, and the necessary initiatives to reduce energy consumption will not be undertaken. IT, Facilities, and Corporate Real Estate executives must mandate and model the cooperation needed to make the necessary changes. Symposium 2008 brings these key players together to forge the commitment to organizational change and reduced energy consumption.'*
>
> *The C-Suite, itself, isn't always optimally arranged for this purpose, since lines of reporting within upper management don't always align with the prescription cited above."*

When aggregated, the facilities-related costs that can be attributed to the choice of wire, which dictates the architecture design, like that of power and cooling infrastructure costs in large data centers, often equate to

[7] Uptime Institute Home Page

some multiple of the first installed costs of the IT infrastructure itself. Nevertheless, costs associated with LAN equipment areas seldom, if ever, receive the same attention as that devoted to data centers.

Air conditioning energy is a significant controllable load and is one of the main targets of the utility industry efficiency programs. The elimination of AC equipment, consistent with the design of reengineered, flattened network architecture has a direct and proportional positive impact on capital expenditures (CAPEX) and operating expenses (OPEX). Stated another way, the air conditioning load currently specified on every floor represents one of the most overlooked opportunities to effect energy efficiencies. With respect to real estate and power consumption issues related to the LAN, the total costs to the enterprise are no longer sustainable in the face of rising energy costs and green imperatives. A hybrid LAN architecture, in a new arrangement, will be consuming power, but at a far lesser rate than the legacy design, due to dematerialization. Figure 4 shows estimated percentage savings per number of users for cooling and power, CAPEX, OPEX, and TCO for a hybrid LAN architecture against the costs of a copper based LAN Architecture.

In the data center domain, decision makers today within both IT and Facilities have begun making use of yardsticks designed to assess energy efficiency. Examples of those metrics include: Power Usage Effectiveness (PUE); Data Center Efficiency (DCE); and Data Center Infrastructure Efficiency (DCIE). Of major interest here is that these metrics should also be applied in office building LAN TERs with comparable urgency to that of data centers, if they are not being applied already.

This LAN TER/Data Center oversight disparity should be of particular interest in light of the fact that a growing number of enterprise TERs are today being built to the specifications that approach the infrastructure profiles normally associated with "Tier" rated data centers, from the perspective of resiliency to operating anomalies and concurrent maintainability during component outage events.

Of course, other factors that are frequently even more distant to the LAN than those found in the local technology equipment room, influence TCO as well. For example, when copper based horizontal run hierarchically-designed LANs and backbone networks designed for in-building use begin to scale, they tend to become equipment intensive and administratively complex. This is because they must be tailored around core, aggregation, distribution and access layer schemes keyed at the root to 100 meter designs. As access switches at the lowest layer of the hierarchy begin to scale, so also do the second tier distribution switches, which extends also to the number of third tier aggregation switches as distribution switches scale. Simultaneously, the number of cascading bottlenecks and choke points scale as well. These switch equipment-heavy designs might have been avoided, if distances greater than 100 meters were supported, with direct connections from a single tier of switches to the client devices. This "flatter" or "collapsed" network design can be implemented utilizing a hybrid approach of fiber, wireless, and copper (HFWC).

The “flatter” architecture, which can support distances of up to 20 kilometers, reduces the need to implement far many more TERs (with attendant AC and UPS) than would be required otherwise. Several degrees of additional diseconomies are also eliminated with the ”flatter” design, not only in the number of stranded or underutilized switches, but also the replication, in every TER, of adjunct appliances that would otherwise be sized more economically if centralized. Reductions in human capital required to administer the complexity of the legacy design will also be realized. Figure 5 pictorially shows characteristics of an all copper infrastructure (legacy LAN) contrasted with a fiber infrastructure (optimized LAN).

It is important to note at this juncture that, production hours (actual hours at work), represent only 35% of the total hours in a year in most workplaces. This translates to at least 65% of LAN Room power being wasted during off hours. From a practical perspective, the cure for this condition is not easily achievable under the present all-copper design constraints. It can be remedied in a dematerialized, reengineered architecture. A future separate application note covers network automation and dynamic power management.

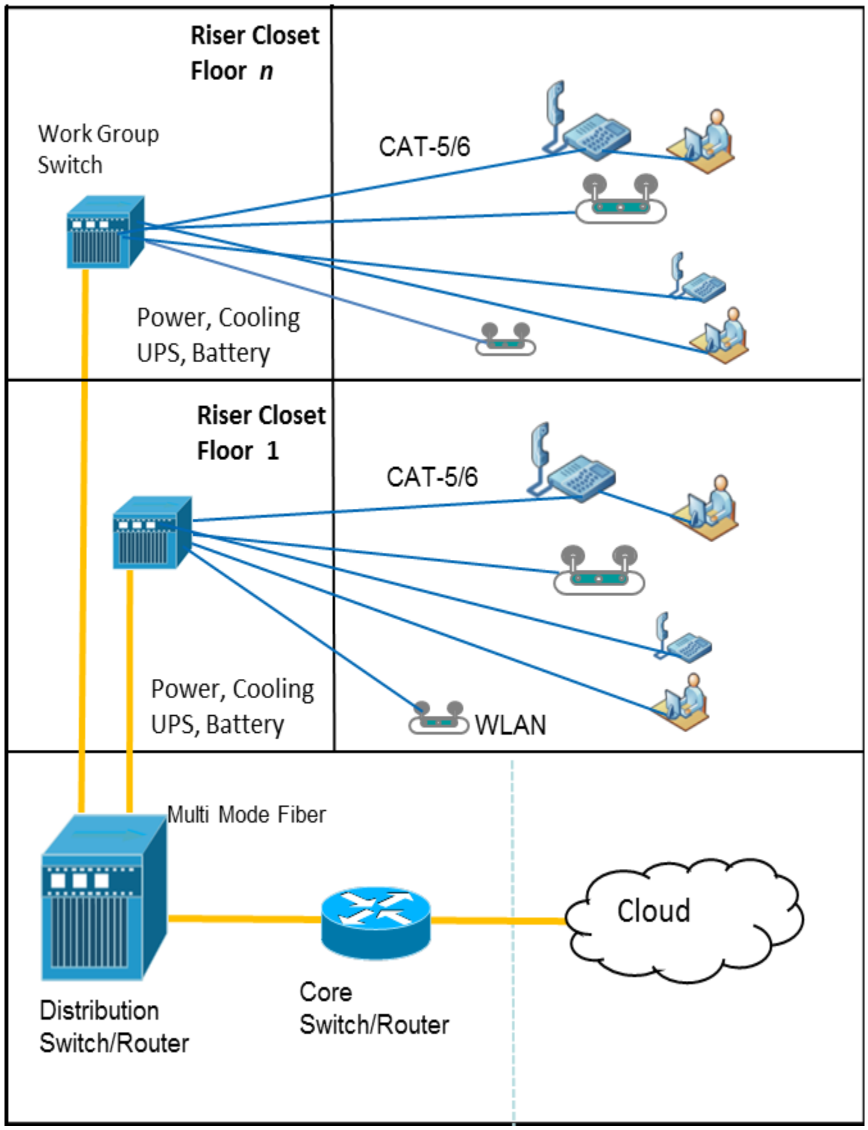


Figure 2 - Legacy LAN Features

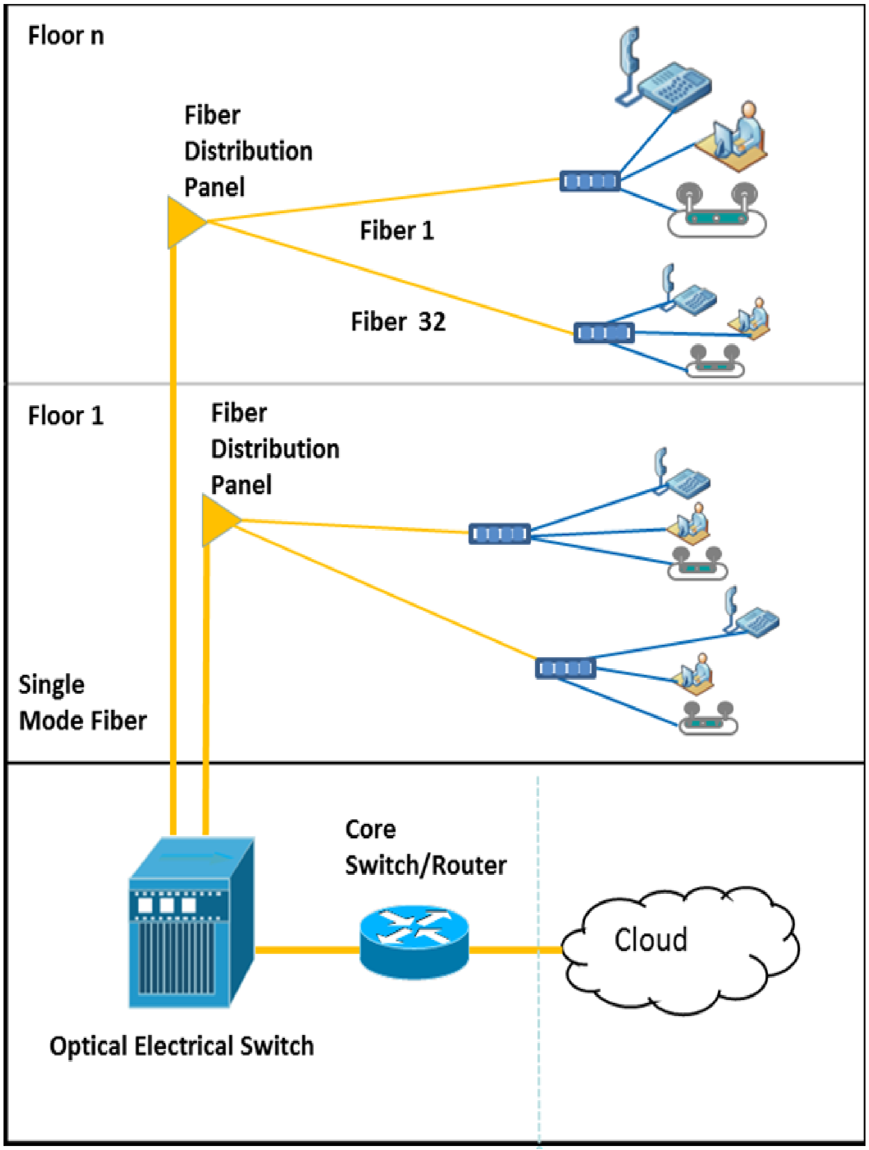


Figure 3 - Optimized LAN Features

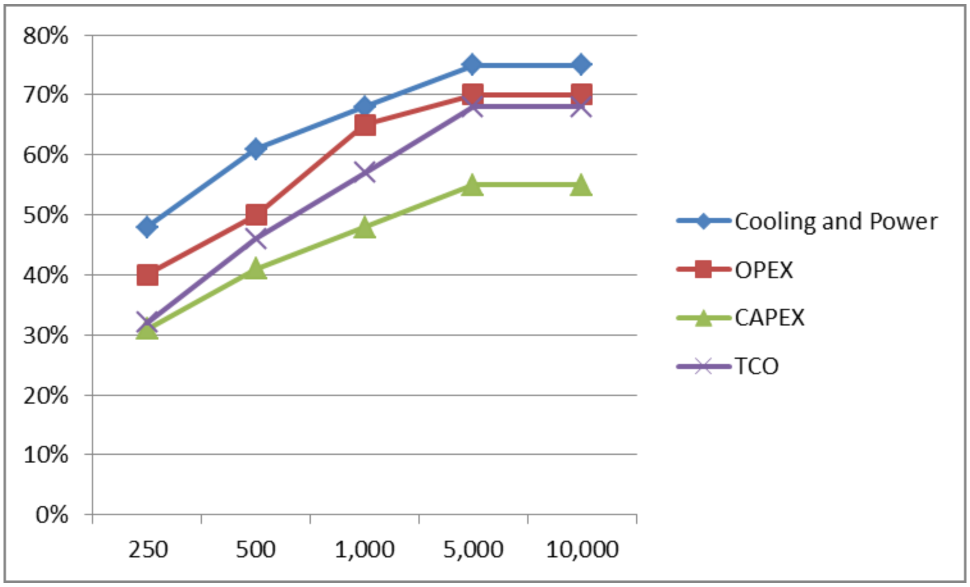


Figure 4 - Graph of Optimized LAN % Savings per Number of User Locations

Source: Motorola Mobility

Note: for the sake of brevity, the diagrams, photos, graphs and case studies described in this paper reflect the attributes and performance characteristics of Passive Optical Network (PON) constructs. Other topologies, such as point-to-point Active Optical Network (AON) and Hybrid Fiber-Wireless (HFW) are also discussed in a companion paper scheduled for release in January 2012.

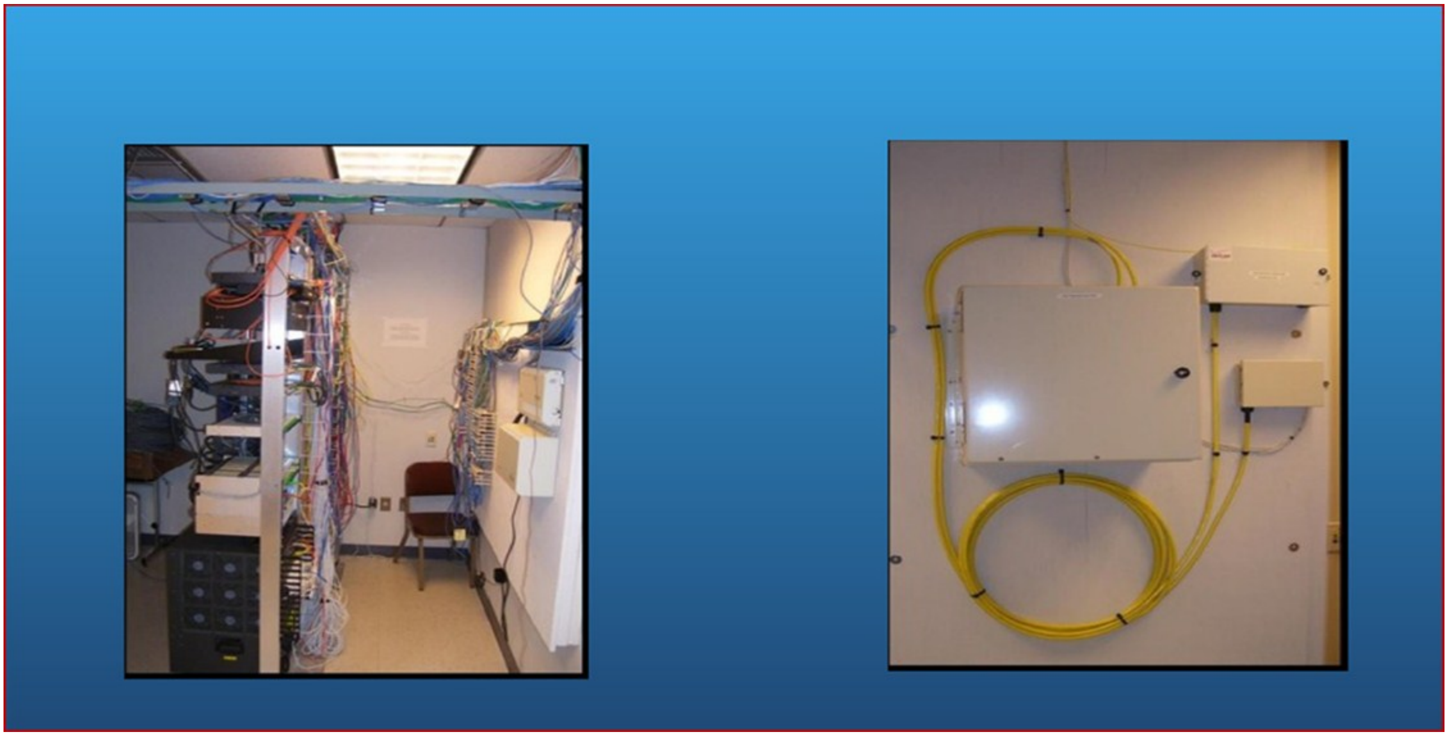


Figure 5 - Copper Infrastructure contrasted with Fiber Infrastructure

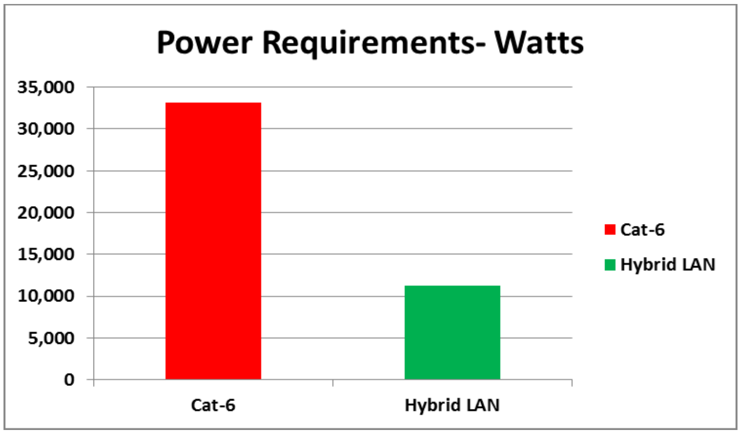
Source: Motorola Mobility

Case Study

The Power Requirement savings and the CAPEX savings shown in the charts below pertain to a project for a new construction of a 39 story hotel, comprised of a combination of hotel rooms and condominiums. The original plans called out for the construction of 1 Main Distribution Room (MDR) and 6 TERs. LAN switches with Power over Ethernet (POE), a copper infrastructure, and 864 drops were specified in the bid package.

An alternative proposal of a Hybrid LAN infrastructure was accepted for the project. The implementation of the Hybrid LAN solution resulted in the elimination of the 6 TERs, and associated dedicated power, UPS, A/C and equipment racks. A planned coaxial infrastructure, and the copper infrastructure to support switch to device connections was replaced by a fiber optic infrastructure.

The implementation of the Hybrid LAN instead of the copper based infrastructure resulted in power requirement savings of 66% and CAPEX savings of 33% - see Figure 6. Additionally, savings due to a reduction in the cabling infrastructure build out time, 96 man weeks to 24 man weeks, were achieved.



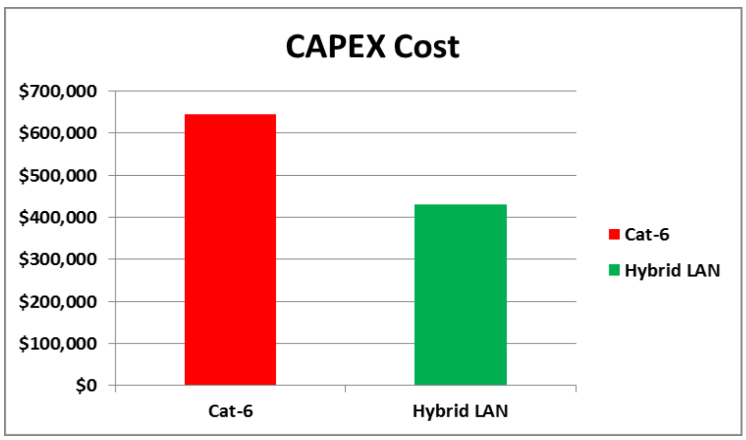


Figure 6 - Power Requirement and CAPEX Cost Savings

LAN Infrastructure Optimization Benefits

A network infrastructure optimization can save money, improve performance, save energy, and allow companies to receive tax incentives and rebates. The Network Infrastructure optimization should take into account the applicability of all **`standards based`** connectivity combinations, such as Hybrid Copper Fiber Wireless (HCFW), or Hybrid Fiber Wireless (HFW). The hybrid LAN configurations do not have the distance limitations of the legacy all-copper implementations and they reduce the overall number of technology equipment rooms required, along with their attendant air conditioning and UPS systems.

The optimized Network Infrastructure design, and the realized benefits and cost reductions will vary with each individual site. The major cost reductions and benefits of dematerialization are listed below.

- Reduction of HVAC Requirements
    - Power Consumption Reduction
    - Power Demand Reduction
    - HVAC CAPEX and OPEX Savings
    - Elimination of Ventilation Ducting and Air Changers

- Reduction of Power Distribution Infrastructure Requirements
    - Electrical Wiring and Cabling Reductions – CAPEX and OPEX savings
    - Building Electrical Plant Reductions, (e.g. Power Distribution Units, Uninterruptible Power Supplies, etc.) – CAPEX and OPEX savings
    - Grounding and Bonding Systems (One per TER)

- Reduction of Space Requirements
    - Reduction in Technology Room Requirements
    - Reduction of Cabling Pathway Utilization (Conduits, Raceways, Risers, etc.)
    - Capital Cost Reduction

- Benefits
    - Revenue Potential through Freed Up Usable Real Estate
    - Revenue Potential through Energy Market Opportunities That Can Be Monetized
    - Annual Utility Savings and Long Term Permanent Demand Reduction
    - Total Cost of Ownership Reduction
    - Provides Grid Relief with Reduced Future Capacity Requirements
    - Recycle Value of the Dematerialization (This will hold Quantifiable Monetary Value)

- Reduced Carbon Footprint
- Conversion of Brownfield to Greenfield with New Technology and all Related Benefits
- Network infrastructure Energy Efficiency Incentives

Summary

The enterprise best practices today, for the build out of LAN infrastructure, are locked into a copper cabling medium with a 100 meter limitation necessitating switching hardware based on a three tier architectural design. This copper based design, while it has served the industry well over the last 20 years along with the growth of the Internet, has scalability that results in diseconomies.

This paper highlights the "scotoma" of the existing IT Network energy management model and provides a perspective to the future paradigm in IT Network Infrastructure. This unmanaged energy, a large amount of which is presently being consumed unnecessarily, due to insufficient incentives, represents 86% of the US IT power budget.

Standards based technologies are available which can be used to dematerialize much of the hardware that is currently manifested in the 3-tier architectural design, via a hybrid design consisting of fiber, wireless, and copper. This new design can diminish the need of wiring closets throughout a building and significantly reduce the power consuming HVAC, TER real estate space, and administrative costs. Dematerialization by itself will result in significant CAPEX and OPEX savings.

It is essential that the policies currently applied to Data Center enclosures be extended by the regulatory agencies to cover the building TERs, by providing incentives to reap the energy efficiencies that can be achieved. These incentives will provide significant financial benefits on top of the dematerialization savings. Billions of kWh of energy are now ready for harvesting, which will only occur if the necessary cross-discipline management practices and the right incentives are in place.

Contact us with your thoughts and for information that is more detailed: info@cirrant.com

Frank Coluccio is the founder and CEO of CIRRANT Partners Inc. He would like to acknowledge the contributions made to this paper by CIRRANT associates Karl Wummer and Plato Demos, and the technical editing and other assistance provided by Russell Stump, PE of Cirrant partner firm, Alternegy Solutions Group. Acknowledgements also go to Motorola Mobility INC. and Advanced Media Technologies for the infrastructure pictures and the optimized LAN savings data, and to QYPSYS for the Case Study data.