New report outlines how network technology must increase efficiency to meet rising energy demands

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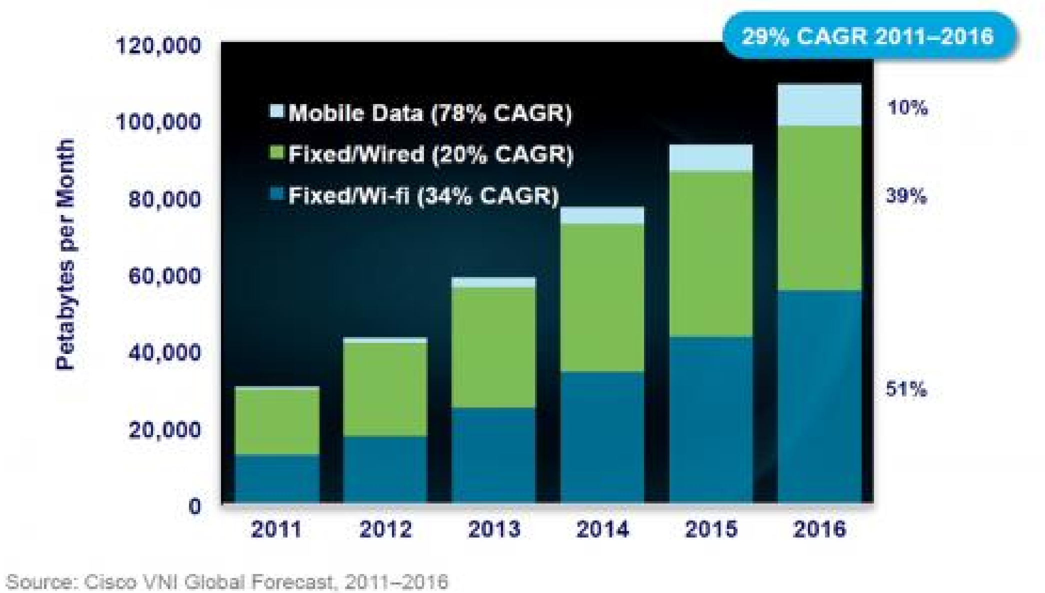

Cisco estimates that an additional 19 billion devices will be connected to global networks, average broadband speeds will increase 4x, and Internet users will total 3.4 billion. This growth results in a 29 percent annual increase in network traffic with an increasing shift toward mobile users. Credit: Cisco

The collective power consumption of core networks is outpacing technological advancements in energy efficiency, putting a strain on growth in the IT and telecommunications industry—and potentially on global energy resources.

To address this problem, the Institute for Energy Efficiency at University of California, Santa Barbara, convened industry leaders at a technology roundtable earlier this year to identify the needed technological and architectural advancements in transmission, switching, and routing to develop next-generation energy efficient core networks.

The results of this two-day roundtable—which was attended by leaders from academia, government, and the telecommunications industry —were recently published in a report titled "ICT Core Networks: Towards a Scalable, Energy-Efficient Future." The report is available to download at iee.ucsb.edu/ICT2013/Report.

"New solutions—from industry, research, and academia—are urgently needed to prevent energy consumption by core networks from becoming a runaway problem as we see exponential growth in energy demands," said John Bowers, director of the Institute. The report recommends component-level and whole-network advancements to meet energy efficiency goals.

Roundtable discussions focused on the core, or backbone telecommunications networks and their related infrastructure, through which all data is relayed at high speeds from one end of the global network to the other. The group came up with a list of recommendations that are driven by various disciplines and industries with the common goal of staying ahead of a crisis in energy demand.

Telecommunications is currently estimated to consume about two percent of the world's energy, from core networks to wireless access networks at the edge. It's a fairly small percentage now, said Adel Saleh, professor of electrical and computer engineering at UC Santa Barbara, but the explosion in the demand for bandwidth as computer processing power continues to increase. As smartphones get smarter and the technology becomes accessible to more people, this will lead to a concurrent explosion in the demand for energy—one that may become unsustainable in the near future.

"The growth of telecommunications networks is so huge because we are loading the network with things it did not have before," said Saleh. Newer concepts, like cloud computing, and continuous backup of data for instance, are straining the capacities of today's networks and data centers, which have to respond by working harder while trying to stay cooler. All of that takes energy.

Telecommunications networks are now hitting the limits of Moore's law as well, the effect of which has been not to increase energy consumption, even as the performance of devices and computers doubles about every 18 months. As the demand for bandwidth strains the physical limits of the hardware, energy efficiency becomes paramount.

"We've seen in the past that energy consumption per bit has gone down continuously. But now it's starting to go up as transmission speeds increase from 10 Gb/s to 100 Gb/s and beyond. That's a very worrisome trend," said Saleh, whose industry experience comes from three decades at Bell Labs.

One important research area identified in the report is the field of optics, particularly photonics integration, which is one of UCSB's main thrusts of research.

"Optics is viable now," said Bowers. "At data rates of 10 Gbps, a single laser is sufficient to handle the communication." In the near future there will be the need to transmit at higher data rates—in the billions or trillions of bytes per second— which would require hundreds of lasers, modulators, and photodetectors, which would need to be integrated into a photonic integrated circuit (PIC) to be reliable, cost effective and small, Bowers added.

Other top recommendations involved rethinking the approach to the core network itself, including a more holistic approach that would optimize the entire system, as opposed to individual components or subsystems. Advanced monitoring and control would offer continuous data on power usage, efficiency in processing, and the scalability needed to accommodate the increased demand for speed and capacity.

Liquid or another form of advanced cooling is an option that has been on the backburner for most core networks but considered now because of the need to mitigate the increased heat from more densely packed transmission and switching equipment.

The report's conclusion acknowledges that, because of rapid growth, it could make economic sense to approach energy efficient network technology with a clean slate. "This approach may work well for new deployments, but the economic reality is that we must focus on evolving existing network architectures, on engineering innovative components or overlaid control architectures," said Rod Alferness, Dean of the UCSB College of Engineering and former Chief Scientist at Bell Labs.

"Moving forward, there needs to be cooperation between academic researchers, carriers, government agencies, and hardware and software vendors to make this happen," he added.

Provided by University of California - Santa Barbara