The Internet of Everything and the Connected Athlete: This Changes… Everything
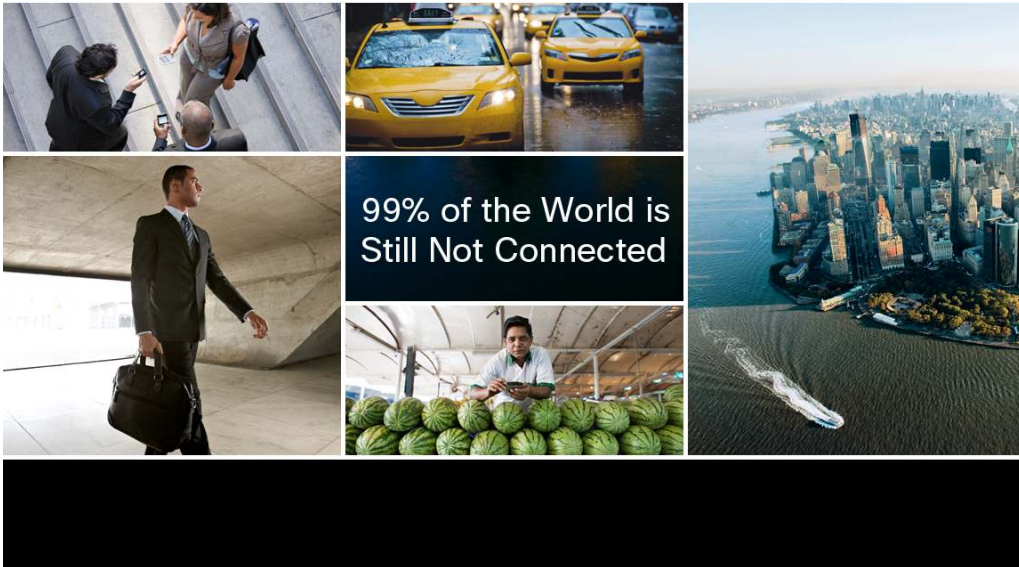
Amazing Things Happen When You Connect the Unconnected

99% of the World is Still Not Connected

Today, we talk about our "connected" world, but imagine:

- More than 99 percent of our world is not connected to the Internet.
- 2.5 billion new people will come online by 2020.
- 37 billion new things will be connected by 2020.

Amazing things happen when you connect the unconnected.

Overview

Cisco® Connected Athlete showcases the endless possibilities that can happen when you connect the unconnected. Building upon the Internet of Things, the Connected Athlete is a real-world application that moves us into the limitless next era of the Internet - the Internet of Everything. By adding network intelligence, convergence, orchestration, and analytics with a secure connection between devices, the Internet of Everything promises to augment the exponential growth and power of the Internet.

Here, you will see this tangible next step of the Internet through the Connected Athlete, which turns the athlete's body into a distributed network of sensors and network intelligence. This breakthrough application couples real-time network analytics with policy control - all orchestrated by the Cisco intelligent network, both in the network cloud and in a distributed big-data computing environment. When the human body uses the Connected Athlete's network of sensors, the athlete becomes more than just a competitor - he or she becomes a Wireless Body Area Network, or WBAN.

The rise of the Connected Athlete is not an isolated event, however. The rapid proliferation of low-cost sensors will allow us to monitor limitless kinds of physical objects, from fruit shipments (sniffing for signs of spoilage) to jet engines (tracking wear to predict when maintenance is needed), fueling the full realization of the Internet of Everything. Our use of low-cost sensors in this new era of big data will make it possible to gather, track, and analyze new sets of data, all in a timely fashion. We will also have the ability to make better and more orchestrated decisions based on this new data through integrated programming of the Cisco intelligent network.

In the following sections, we trace our path from the Internet of Things era - where many of us are today - to the Internet of Everything, where the Internet can be a stronger force for good for the earth, people, and governments. Not only will you see the real-world applications of the Cisco Connected Athlete solution, you'll see the powerful ways the Connected Athlete solution can act as a gateway to the Connected Patient, moving us from WBAN to MBAN (Medical Body Area Network), and paving the way for new medical advances. To move into this era of new possibilities, however, we must rely on a networking, computing, and storage platform that is distributed, virtualized, and application-centered. Cisco is the supplier of that solution, in partnership with ACM Systems, developer of the ACM Systems state-of-the-art sensors.

An Era Is Born: The Internet of Things

The answer to one simple question - "What fuels the Internet?" - has evolved dramatically in a relatively short period of time. At the advent of the Internet, the answer was unmistakable: people drove the Internet. While our computers and technologies were connected, the Internet was uniformly dependent on human beings for the input and sharing of information.

Over time, however, we felt a powerful shift. As we have developed our smart technologies - or "things" such as smartphones and tablets - to capture and share information about us, the Internet has become less dependent on humans. In fact, every day, millions of devices are connected to the Internet, both gathering and disseminating information, all without any help from us.

As this shift occurred, one critical milestone officially ushered in the Internet of Things era: the moment when our "things" outnumbered the global population of humans.

The true value of that moment is actually measurable by Metcalfe's Law, which states that the value of a network increases proportionately to the square of the number of users. With things now acting as independent users, and numbering in the trillions, the power of the Internet has accelerated exponentially.

What does this mean for us in real-world terms? In short, by combining people, process, data, and things, the exponential power of the Internet will allow us to create exponential responses to the extraordinary challenges faced by individuals, businesses, and nations.

A New Era Emerges: The Internet of Everything

Even with all of our advances through 2013, one fact must be kept on mind: just one-third of the Earth's population has access to the Internet today. Clearly, we have many more connections to make.

In the coming years, people will continue to increase their connections through devices like smartphones, PCs, and tablets, as well as through social networks such as Facebook, LinkedIn, and Twitter. But even as many people continue to connect things to the Internet, we are looking to the next phase, the Internet of Everything.

With the Internet of Everything, connected things add powerful new capabilities like contextual awareness, increased processing power, and energy independence. The net result: the added information gathering and sharing will allow for faster, more intelligent decision-making by people and machines.

All of this, however, will only be made possible through the existence of networking intelligence that allows convergence, orchestration, and visibility across previously disparate systems.

At Cisco, we define the Internet of Everything as bringing together people, process, data, and things to make networked connections more relevant and valuable than ever before, turning information into actions that create new capabilities, richer experiences, and unprecedented economic opportunity for businesses, individuals, and countries.

- **Critical technologies:** The explosion of new connections joining the Internet of Everything is propelled by the development of IP-enabled devices, the increase in global broadband availability, the emergence of fourth-generation (4G) mobile networks, and the advent of IPv6. The net result is the oncoming proliferation of billions of low-power sensors that will fuel big data growth.
- **Critical issues:** As we move into this new era of the Internet, we must confront important issues, including include privacy, security, energy consumption, and network congestion.

The Internet of Everything Changes… Everything

As we enter the era of the Internet of Everything, many concepts we take for granted today will begin to change as we create new ways to connect and to share and use information.
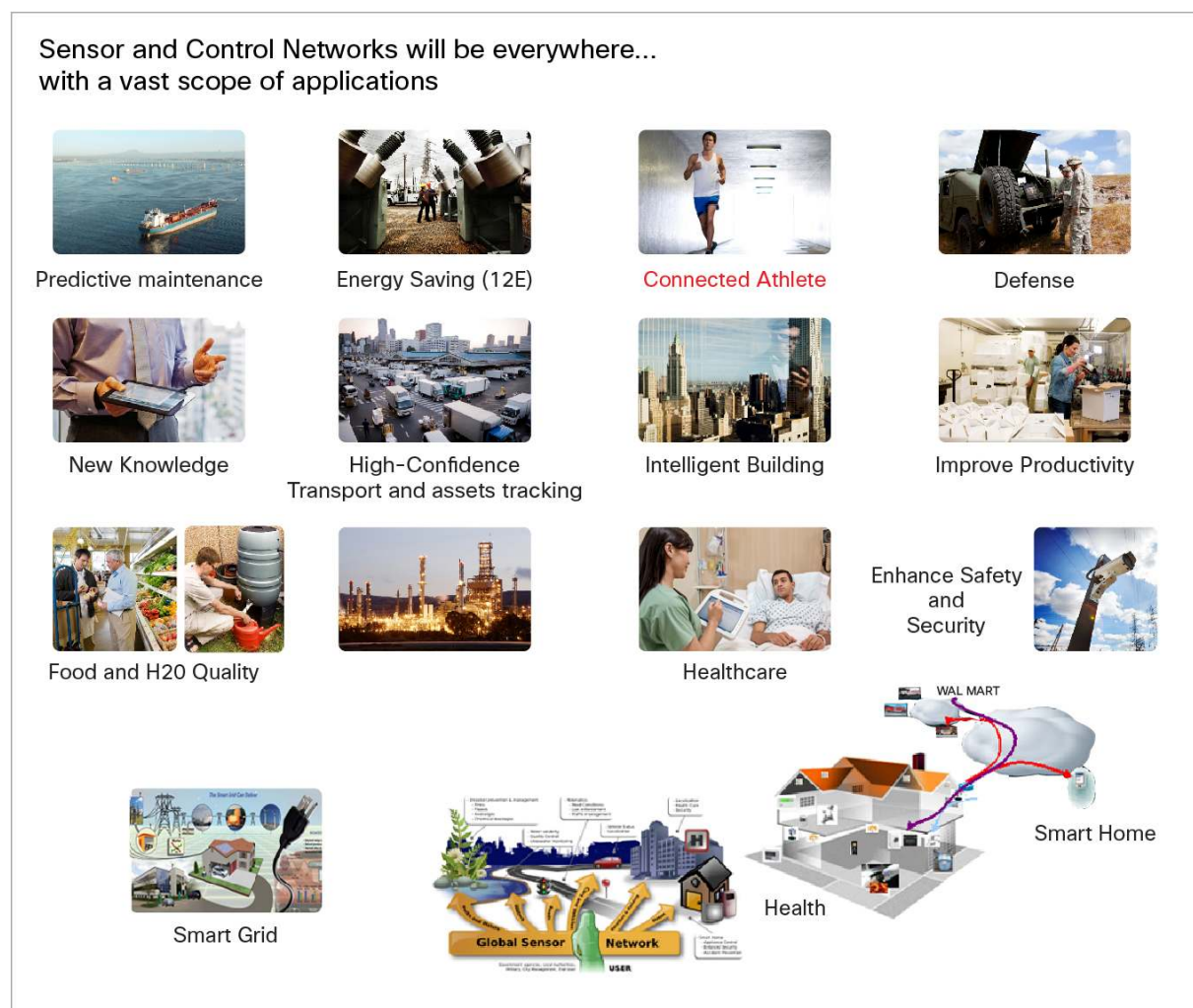
Changing Interactions

As the Internet of Everything emerges, the interaction of people on the Internet will evolve. For example, it may become common to wear sensors on our skin or in our clothes that collect and transmit data to healthcare providers. Some analysts even suggest that people may become individual nodes that produce a constant stream of static data.

Changing Processes

Technological, business, and organizational processes will have to change to manage and, to a large extent, automate the rapid growth in connections. The accumulation, analysis, and communication of data will be inevitable in the Internet of Everything, and we will have to change how we manage data to make it effective. Processes will also play an important role in how each of these entities - people, data, and things - interact with each other within the Internet of Everything to deliver societal benefits and economic value (Figure 1).

Figure 1.   Sensor and Control Networks

Sensor and Control Networks will be everywhere... with a vast scope of applications

Predictive maintenance

Energy Saving (12E)

Connected Athlete

Defense

New Knowledge

High-Confidence Transport and assets tracking

Intelligent Building

Improve Productivity

Food and H20 Quality

Healthcare

Enhance Safety and Security

Smart Home

Health

Smart Grid

Global Sensor Network

USER

Changing Things

Items like sensors, meters, actuators, and other measuring devices are the next wave of connected things. These things can be attached to any object, connecting that object to the network and sharing information. Not only will these devices sense and deliver more data, they will respond to control inputs and provide more information to help people and machines make better decisions.

These things can include smart meters that communicate energy consumption, assembly-line robots that automate factory floor operations, smart transportation systems that adapt to traffic conditions, and connected vehicles that communicate through Digital Short Range Communications (DSRC) to other vehicles (V2V) or to infrastructure (V2I).

Changing Data

Today, devices typically gather data and stream it over the Internet to a central source, where it is analyzed and processed. Yet, although the size of this data set is expected to surpass today's largest social media data set by another order of magnitude, much of this data has very transient value. In fact, its value vanishes almost as quickly as it is created. As a result, not all generated data can be or should be stored.

As the capabilities of things connected to the Internet continue to advance, we must overcome the limits of traditional batch-oriented data analysis by combining data into more useful, real-time information. Rather than just reporting raw data, connected things will soon send higher-level information and insights back to machines, computers, and people in real time for further evaluation and decision-making. The intelligent network touches everything - and it is the only place where it is possible to build the scalable intelligence required to meet and use this new wave of data in motion. This transformation made possible by the emergence of the Internet of Everything will allow faster, more intelligent decision-making by people and machines, as well as more effective control over our environment.

The real value of the Internet of Everything lies in the value of connections among people, processes, data and things.

The Connected Athlete

The Cisco Connected Athlete solution is a real-world application of the Internet of Everything. This solution combines the Cisco Intelligent Network and ACM Systems' sensor-fueled analytics to optimize athletic performance for amateurs and professionals alike. Now athletes can get real-time data on pace, power, drive, and more. The result? Competitive athletes can step up their game with objective data and the analytics that are critical to boosting performance.


The Connected Athlete uses sensors in shoes or other nonobtrusive places to collect and stream force and motion data in real time to the Cisco Intelligent Network. This wireless body area network then sends feedback to the athlete through the Cisco Mobile Packet Core network or a Cisco Stadium Wi-Fi solution. What's more, the body sensors can feed connectivity and data to each other through Zigbee, Z-wave, 6lowpan, DASH7, or other solutions. All data can then be aggregated on the body using a device built into the athletic equipment, such as a belt, armband, or helmet, allowing a final uplink through 4G or Wi-FI connections.

Sharing of the data is just as remarkable. A hardened Cisco 819 Long-Term Evolution (LTE) Integrated Services Router, complete with onboard contextual analytics, can securely feed all data back to the Cisco cloud services. Or the data could be shared using a Cisco high-definition stadium wireless network, allowing sports teams to monitor and respond to real-time feedback, improving coaching, performance, and fan engagement. A Cisco managed router from an in-home service provider could also aggregate the data and send it to secure mobile health (mHealth) applications, allowing greater real-time monitoring of vital signs.

Cisco's Internet of Everything platform and ACM Systems' smart insole technology helps coaches, trainers, and athletes improve performance on the court and in the field, while reducing the chance of injury with real-time and historical analytics of motion and pressure data (Figure 2).

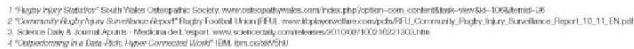**Figure 2.** Cisco Connected Athlete
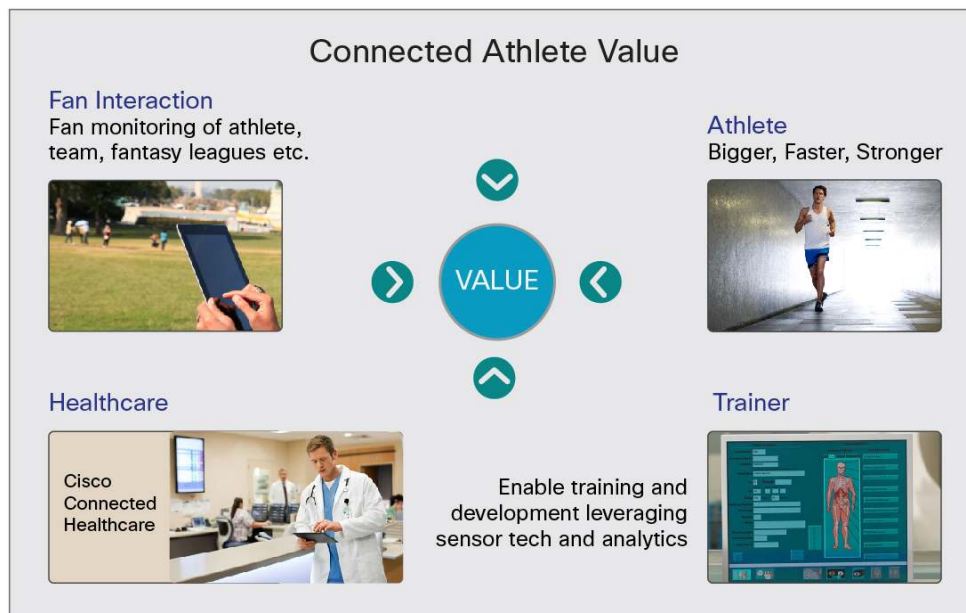
Fan Immersion

The "Connected Athlete" demonstration allows people, processes and data to work together and interact with Wireless Body Area Networks (WBAN) and Medical Body Area Networks (MBAN) to monitor an athletes' biometric performance, such heart and respiratory rates, blood oxygen and carbon dioxide levels, glucose and lactate concentrations in the blood, and use this data to accurately assess the athlete's in-position physical condition and energy expenditure.

Analytics

In professional rugby, coaches, trainers, and athletes work together to reduce injuries, improving team records and reducing the human costs. The principles behind Cisco Connected Athlete can help this effort (Figure 3). One of the most successful rugby teams in the United Kingdom recently adopted predictive analytics to proactively reduce injuries. The goal is to avoid physical and mental fatigue, which are chief causes of muscle and ligament tears and joint dislocations. More professional sports teams are using sensors and analytics to gain a competitive advantage.

Figure 3.   Analytics in Professional Rugby

The Internet of Everything uses data from these analytics in multiple ways. The players wear small sensors during games to measure the intensity of their activity. The sensors transmit data wirelessly back to the analytics system. The sports science team records information on every event involving a player: collisions, leaps, kicks, and sprints. The team can then anticipate when players will become fatigued, which is a good indication of potential injury risk.

The Internet of Everything requires the ability to provide continuous real-time event analytics, contextual analytics, and predictive analytics, all taking full advantage of a distributed collection and normalization of this massive data. The ability to program, analyze, and orchestrate responses to these real-time analytics will be increasingly important.

Healthcare: From Connected Athlete to Connected Patient

The wireless body area network, or WBAN, used in the Connected Athlete is closely related to the idea of an MBAN, or Medical Body Area Network (Figure 4).

Figure 4. WBAN to MBAN

Connected Athlete and Healthcare WBAN to MBAN

Cisco

FCC will allocate 40mhz band in 2360 to 2400 MHz

· Realtime and historical monitoring

· Infection control

· Geofencing and Vertical alarming

· Low-cost disposable monitors

· Patient identification and tracking

Healthcare is a key field for the Internet of Everything. A simple improvement possible with an MBAN is the ability to eliminate the complexity of wires that often literally tie patients to their hospital beds today. These fixed wires can complicate patient care and pose potential infection risks. New wireless sensors could potentially allow for remote monitoring by doctors to check on patients wherever they are, creating "the connected patient."

Imagine the possibilities:

- The MBAN network could potentially alert doctors to problems before the patient's condition becomes critical, thus triaging care to the appropriate location/specialist.
- The lack of a "spider web" of fixed wires may make it easier for hospital staff to mobilize the patient.
- Hospital personnel or home caregivers could add or remove sensors as medical conditions warrant.
- Health service providers could potentially receive and analyze in-home data in a secure, HIPAA-compliant cloud using LTE or fiber connectivity to access a Cisco in-home managed service provider gateway.
- Imagine if elderly patients could enjoy increased safety through a "connected slipper" - a sensor-embedded slipper that could send a text alert when he or she crosses a defined location, or geo-fence. Imagine if these slippers could also sense vertical positioning, sending an alert of a possible harmful fall.

Sensing a World of Good

Not be overlooked, the Internet of Everything can also provide compelling solutions to maintain, protect, and predict a better planet. In the same vein as the Connected Athlete's body-centric sensors, we have the newfound ability to place low-cost sensors in the ground, water, and air, allowing us to identify planetary issues before they become a problem.

At the forefront of this frontier is Planetary Skin, a research and development collaboration between Cisco and NASA. Planetary Skin tracks the global "nervous system," collecting vast amounts of data through millions of sensors that monitor interactions among the planet's systems of land, air, water, and life. With this new data set, we are better equipped to address the complexities of climate change or a move to a low-carbon-dioxide world economy. For example, this global sensor and analysis network allows us to better understand what happens to the Earth when a forest is razed or energy use soars. Ultimately, Planetary Skin will allow us to convert this geophysical and biological data into information that can guide better, more impactful policy and management decisions.

Conclusion

These examples just illustrate the beginning of the possibilities of the Internet of Everything.

The Internet of Everything demands a networking, computing, and storage platform that is distributed, virtualized, and application-centered - one that connects things in ways that just weren't possible, or even imaginable, before. The upsurge of new connections depends on IP-enabled devices and more broadband access around the world, including wireless 4G, cloud, and IPv6 technology. The Cisco network provides an intelligent, manageable, highly secure infrastructure that can scale to support billions of connected devices.

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Printed in USA   C11-711705-00   01/13