



The Internet of Everything

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The Internet of Things must evolve into the Internet of Everything.

On Gartner's Hype Cycle of Emerging Technologies, the Internet of Things (IoT) reached peak hype in November 2015. The buzzword holds tremendous promise, but it's about to enter the Trough of Disillusionment—a period of uninspiring results compared to high expectations. What does this mean for the future of the IoT? Let's look at several tipping points that warrant the hype.

Decades of nanotechnology research have enabled ultra-small formats and low-cost sensors. Within the next decade, over a trillion new sensors will be deployed per year, particularly for new electronic substrates like stretchable and bendable materials and textiles. Many of these devices will be “energy neutral,” harvesting enough energy from the local environment in the form

of heat, motion, and other natural phenomena to balance computing and communication needs. This will bring data collection to places never before monitored in the history of mankind.

In parallel, Moore's law has reached a point of maturity where data storage is incredibly cheap and big data analytics are at the lowest cost point in history. Just over 10 years ago, it cost \$100 million to sequence the genome, and now a consumer can get a sequence for under \$1,000 and store it for free with a Google Drive account. Wireless communication is at the lowest cost per megabyte in history, with wireless systems becoming pervasive across the globe, even in underdeveloped nations that skipped the “wired economy infrastructure” and went straight to wireless.

All of this already exists in 2017.

To fulfill its potential and avoid falling into the Trough of Disillusionment, the IoT must evolve into the Internet of Everything (IoE). The key to this evolution is the maturing fields of AI, cognitive computing, and machine learning.

These technologies are becoming mainstream, allowing IoT systems to become IoE systems of systems.

Today, a smart farm can navigate self-driving tractors across a field and monitor water and fertilizer levels with drone surveillance. But in the next few years, weather data, satellite imagery, and regular biological tests of plant seedlings will fuse with existing datasets to inform the engineering of the next season's seeds. Plant-by-plant care in the field will improve yields to never-before-seen levels. Data-driven decision making will inform not only today's mechanical, electrical, and software systems, but also the fields of bioengineering and biological hacking.

In our urban centers, wearable health sensors will be standard-issue accessories for first responders, who will apply them to victims in emergency situations. These devices will track individuals in chaotic situations, such as natural disasters or terrorist attacks, and provide personalized emergency care. This will help responders locate and triage victims and will turn all traffic lights green on the route to the best healthcare facility, where doctors will already be waiting for the patient.

Health systems data will be integrated with transportation, transportation data with security systems, security systems with environmental monitors, environmental data with education, and so on. Systems of systems will create a new understanding of the interdependencies within our complex society and offer paths to improve quality of life. We'll discover relationships never before hypothesized, and learn how to steer policy and activity to maximize not only financial return on investment but also health, happiness, sustainability, and safety.

How will we know when we've reached the IoE? A good indicator will be the retirement of the terms we're

using today. Just as we no longer refer to the World Wide Web, we will move beyond "smart shirts" and "wearables" and simply put on our socks and watches. We won't talk about autonomous vehicles, but rather just get into the car. We will no longer "flip the classroom," but instead engage in continuous learning with feedback and feedforward resulting from massive data analytics.

Based on the tipping points described earlier, the requisite technology is largely here today. It will take time for social acceptance to become widespread, particularly through the lens of privacy and security concerns. These are challenges that open new market opportunities for the organizations that choose to solve them.

Unquestionably, IoE applications must provide society with a feeling of safety and comfort. The Third Industrial Revolution brought viruses and cookies and other technology tools that created risk. But those risks were ultimately overwhelmed by the benefits of widespread computing and global connectivity. Although the Fourth

Industrial Revolution—as the IoT has been framed—holds no less risk, it offers much more opportunity for benefit. The data collection routines and AI algorithms are already crunching. It's time to get in the self-driving IoE vehicle and enjoy the ride. ■

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