

Digital Europe: The Rise of the Internet of Things and the Economic Transformation of the EU

Introduction

The EU economy is slowing, productivity is waning, and unemployment remains stubbornly high. The question being raised with increasing urgency is how to rekindle “The European Dream.” The EU owes its success to a forward thinking series of economic and social visions that have motivated member states and the citizenry to continue on a common journey: the Maastrich Treaty, creating a political Union; the introduction of the Euro, to establish a Monetary Union; the enlargement of member states, to create a continental family of nations; and the 20-20-20 goals, to transition into a sustainable low-carbon economy. The EU now finds itself in limbo without a clear vision of the next stage of its journey.

That’s about to change. The European Commission is embarking on a bold new course to create a high-tech 21st Century integrated single market that can unite its 500 million citizens and 28 member states, making Europe potentially the most productive commercial space in the world. The plan is called Digital Europe. The digitalization of Europe involves much more than providing universal broadband, free Wi-Fi, and a flow of Big Data. The digital economy will revolutionize every commercial sector, disrupt the workings of virtually every industry, bring with it unprecedented new economic opportunities, put millions of people back to work, and create a more sustainable low-carbon society to mitigate climate change.

To grasp the enormity of the economic change taking place, we need to understand the technological forces that have given rise to new economic systems throughout history. Every great economic paradigm requires three elements, each of which interacts with the other to enable the system to operate as a whole: new communication technologies to more efficiently manage economic activity; new sources of energy to more efficiently power economic activity; and new modes of transportation to more efficiently move economic activity.

In the 19th century, steam-powered printing and the telegraph, abundant coal, and locomotives on national rail systems gave rise to the First Industrial Revolution. In the 20th Century, centralized electricity, the telephone, radio and television, cheap oil, and internal combustion vehicles on national road systems converged to create an infrastructure for the Second Industrial Revolution.

Today, Europe is laying the ground work for a Third Industrial Revolution. The digitalized communication Internet is converging with a digitalized renewable Energy Internet, and a digitalized automated Transportation and Logistics Internet, to create a super-Internet of Things. In the Internet of Things era, sensors will be embedded into every device and appliance, allowing them to communicate with each other and Internet users, creating an intelligent technology infrastructure for a smart Europe.

Already, 14 billion sensors are attached to resource flows, warehouses, road systems, factory production lines, the electricity transmission grid, offices, homes, stores, and vehicles, continually monitoring their status and performance and feeding big data back to the Communication Internet, Energy Internet, and Transportation and Logistics Internet. By 2030, it is estimated there will be more than 100 trillion sensors connecting the human and natural environment in a global distributed intelligent network. Connecting every thing and every one

via the Internet of Things offers enormous economic benefits. It also raises risks and challenges, not the least of which are guaranteeing network neutrality, preventing the creation of new corporate monopolies, protecting personal privacy, ensuring data security, and thwarting cyber-crime and cyber-terrorism. The European Commission has already begun to address these issues by establishing the broad principle that “privacy, data protection, and information security are complimentary requirements for Internet of Things services.”

The Zero Marginal Cost Phenomenon

In this expanded digital economy, private enterprises can connect to the Internet of Things and use Big Data and analytics to develop algorithms that can speed efficiency, increase productivity, and dramatically lower the marginal cost of producing and distributing an array of physical things, making European businesses more competitive in the global marketplace. (Marginal cost is the cost of producing an additional unit of a good or service, after fixed costs have been absorbed.)

The marginal cost of some goods and services in a digital Europe will even approach zero, allowing nonprofit organizations and millions of prosumers connected to the Internet of Things to produce and exchange things with one another, for nearly free, in the growing sharing economy. Already, a digital generation is producing and sharing music, videos, news blogs, social media, free e-books, and other virtual goods at near zero marginal cost. The near zero marginal cost phenomenon brought the music industry to its knees, shook the television industry, forced newspapers and magazines out of business, and crippled the book publishing market.

While many traditional industries suffered, the zero marginal cost phenomenon also gave rise to a spate of new entrepreneurial enterprises including Google, Facebook, Twitter, and YouTube, who reaped handsome profits by creating the new applications and aggregating the networks that allowed the sharing economy to flourish.

Economists acknowledge the powerful impact near zero marginal cost has had on the information goods industries but, until recently, have argued that the productivity advances made possible by the digital economy would not pass across the firewall from the virtual world to the brick-and-mortar economy of energy, and physical goods and services. That firewall has now been breached. The evolving Internet of Things will allow conventional businesses enterprises, as well as millions of prosumers, to make and distribute their own renewable energy and an increasing array of 3D-printed physical products and other goods and services at very low marginal cost in the market exchange economy, or at near zero marginal cost in the sharing economy, just as they now do with information goods.

For example, the bulk of the energy we use to heat our homes and run our appliances, power our businesses, drive our vehicles, and operate every party of the global economy will be generated at near zero marginal cost and be nearly free in the coming decades. That’s already the case for several million early adopters who have transformed their homes and businesses into micro-power plants to harvest renewable energy on-site. After the fixed costs for the installation of solar and wind are paid back—often as little as 2 to 8 years—the marginal cost of the harvested energy is nearly free. Unlike fossil fuels and uranium for nuclear power, in which the commodity itself always costs something, the sun collected on rooftops and the wind travelling up the side of buildings are free. The Internet of Things will enable prosumers to monitor their electricity usage in their buildings, optimize their energy efficiency, and share surplus green electricity with others on the Energy Internet.

Similarly, several million hobbyists and thousands of startup companies are already infacturing their own 3D-printed products using free software, and cheap recycled plastic, paper, metal objects, and other locally available feedstock at near zero marginal cost. By 2020, prosumers will be able to share their 3D printed products with others on the Collaborative Commons by transporting them in driverless electric and fuel cell vehicles, powered by near zero marginal cost renewable energy, on an automated Transportation and Logistics Internet.

The distributed, peer to peer nature of the Internet of Things platform allows millions of disparate players—small and medium sized businesses, social enterprises, and individuals—to come together and produce and exchange goods and services directly with one another, eliminating the remaining middle men that kept marginal costs high in the Second Industrial Revolution. This fundamental technological transformation in the way economic activity is organized and scaled portends a great shift in the flow of economic power from the few to the multitudes and the democratization of economic life.

The transition to a fully digital economy and Third Industrial Revolution results in a leap in productivity far beyond the productivity gains achieved by the Second Industrial Revolution in the 20th century. During the period from 1900 to 1980 in the United States, aggregate energy efficiency—the ratio of useful to potential physical work that can be extracted from materials—steadily rose along with the development of the nation’s infrastructure, from 2.48 percent to 12.3 percent. The aggregate energy efficiency leveled off in the late 1990s at around 13 percent with the completion of the Second Industrial Revolution infrastructure. Despite a significant increase in efficiency, which gave the United States extraordinary productivity and growth, nearly 87 percent of the energy we used in the Second Industrial Revolution was wasted during transmission.

Even if we were to upgrade the Second Industrial Revolution infrastructure, it’s unlikely to have any measurable effect on efficiency, productivity, and growth. Fossil fuel energies have matured and are becoming more expensive to bring to market. And the technologies designed and engineered to run on these energies, like the internal-combustion engine and the centralized electricity grid, have exhausted their productivity, with little potential left to exploit.

New studies, however, including one conducted by my global consulting group, show that with the shift to an Internet of Things platform and a Third Industrial Revolution, it is conceivable to increase aggregate energy efficiency to 40 percent or more in the next 40 years, amounting to an unprecedented increase in productivity in the next half century.

Cisco systems forecasts that by 2022, the Internet of Things will generate \$14.4 trillion in cost savings and revenue. A General Electric study published in November 2012 concludes that the efficiency gains and productivity advances brought on by a smart industrial Internet could resound across virtually every economic sector by 2025, impacting “approximately one half of the global economy.”

The Rise of the Collaborative Commons

While the developing digital infrastructure is making the traditional capitalist market more productive and competitive, it is also spurring the meteoric growth of the sharing economy. In the sharing economy, social capital is as vital as finance capital, access is as important as ownership, sustainability supersedes consumerism, cooperation is as crucial as competition, and “exchange value” in the capitalist marketplace is increasingly supplemented by “shareable value” on the Collaborative Commons. Millions of people are already transferring bits and pieces

of their economic life to the global Collaborative Commons. Prosumers are not only producing and sharing their own information, entertainment, green energy, and 3D-printed products on the Collaborative Commons at near zero marginal cost. They are also sharing cars, homes, and even clothes with one another using social media sites, rentals, redistribution clubs, and cooperatives, at low or near zero marginal cost.

Forty percent of the US population is actively engaged in the sharing economy. For example, millions of Americans are now using car sharing services like Uber, Lyft, and RelayRides. Each car share vehicle eliminates 15 personally owned cars. Concurrently, millions of apartment dwellers and home owners are sharing their living quarters with millions of travelers, at near zero marginal cost around the world, using online services like Airbnb and Couchsurfing. In New York City alone, Airbnb's 416,000 guests who stayed in houses and apartments between 2012 and 2013 cost the New York hotel industry 1 million lost room nights.

In a fully-digitalized economy, extreme productivity, brought on by the optimization of aggregate energy efficiency and the reduction of marginal cost toward zero across every sector of the economic value chain, decreases the amount of information, energy, material resources, labor and logistics costs, necessary to produce, distribute, consume, and recycle economic goods and services, once fixed costs are absorbed. The partial shift from ownership to access in a growing sharing economy also means more people are sharing fewer items, significantly reducing the number of new products sold, resulting in fewer resources being used up and less global warming gases being emitted into the earth's atmosphere. In other words, the headlong push to a near zero marginal cost society and the sharing of nearly free green energy and an array of redistributed goods and services on the Collaborative Commons is the most ecologically efficient economy achievable. The drive to near Zero Marginal Cost is the ultimate benchmark for establishing a sustainable future for the human race on earth. The Internet of Things infrastructure enables Europe to achieve its long-term 2020, 2030, and 2050 goals of creating a low-carbon society and mitigating climate change.

Recent surveys underscore the broad economic potential of the Collaborative Commons. A comprehensive study found that 62 percent of Gen Xers and Millennials are attracted to the notion of sharing goods, services, and experiences in Collaborative Commons. These two generations differ significantly from the baby boomers and World War II generation in favoring access over ownership. When asked to rank the advantages of a sharing economy, respondents to the survey listed saving money at the top of the list, followed by impact on the environment, lifestyle flexibility, the practicality of sharing, and easy access to goods and services. As for the emotional benefits, respondents ranked generosity first, followed by a feeling of being a valued part of a community, being smart, being more responsible, and being a part of a movement.

How likely is it that the sharing economy will play an ever larger role in the economic life of society in the coming decades? According to an opinion survey conducted by Latitude Research, "75% of respondents predicted their sharing of physical objects and spaces will increase in the next five years." Many industry analysts agree with these optimistic forecasts. *Time* magazine declared collaborative consumption to be one of its "10 ideas that will change the world."

The Digital Economy and the Integration of the EU Single Market

The European Union is potentially the largest internal market in the world, with 500 million consumers, and an additional 500 million consumers in its associated partnership regions, stretching into the Mediterranean and North Africa. The build-out of an Internet of Things platform for a Third Industrial Revolution, connecting Europe and its partnership regions in a single integrated economic space, will allow business enterprises and prosumers to produce and distribute information, renewable energy, 3D printed products, and a wide range of other products and services at low marginal cost in the conventional marketplace, or at near zero marginal cost in the sharing economy, with vast economic benefits for society.

Erecting the Internet of Things infrastructure for a digital Third Industrial Revolution economy will require a significant investment of public and private funds, just as was the case in the first and second industrial revolutions. European investment on infrastructure-related projects totaled \$741 billion in 2012, much of it to shore up a second industrial revolution general purpose technology platform that is outmoded, and whose productivity potential has long since been reached. If just twenty five percent of these funds were redirected and earmarked in every region of the European Union to assemble an Internet of Things infrastructure, the Digital Union could be phased in between now and 2040.

The EU communication network will have to be upgraded with the inclusion of universal broadband and free Wi-Fi. The energy infrastructure will need to be transformed from fossil fuel and nuclear power to renewable energies. Millions of buildings will need to be retrofitted and equipped with renewable energy harvesting installations, and converted into micro power plants. Hydrogen and other storage technologies will have to be built into every layer of the infrastructure to secure intermittent renewable energy. The electricity grid of the European Union will have to be transformed into a smart digital Energy Internet to accommodate the flow of energy produced by millions of green micro power plants. The transportation and logistics sector will have to be digitalized and transformed into an automated GPS-guided driverless network running on smart roads and rail systems. The introduction of electric and fuel cell transportation will require millions of electric refueling outlets, connected to the Energy Internet. Smart roads, equipped with millions of sensors, feeding real-time information on traffic flows and the movement of freight will have to be installed.

The establishment of the Third Industrial Revolution Internet of Things infrastructure will necessitate the active engagement of virtually every commercial sector, spur commercial innovations, promote Small and Medium Sized Enterprises (SME's), and employ millions of workers over the next forty years. The power and electricity transmission companies, the telecommunication industry, the construction industry, the ICT sector, the electronics industry, transportation and logistics, the manufacturing sector, the life-sciences industry, and retail trade will all need to be brought into the process. Many of today's leading companies, as well as new commercial players, will help establish and manage the Internet of Things platform, allowing millions of others—small, medium, and large sized businesses, nonprofit enterprises, and prosumers—to produce and use renewable energy, transportation and logistics, and a panoply of other goods and services at low marginal cost in the exchange economy or at near zero marginal cost in the sharing economy. Semi-skilled, skilled, professional, and knowledge workers will need to be employed across every region of Europe to construct and service the three Internets that make up the digital platform of a Third Industrial Revolution economy.

In summary, the scale up of a smart digitalized Internet of Things infrastructure across the European Union, and its partnership regions, will put Europe back to work, generate new business opportunities in both the market economy and the sharing economy, dramatically

increase productivity, and create an ecologically oriented post-carbon society. The employment of millions of workers will also stimulate purchasing power and generate new business opportunities and additional employment to serve increased consumer demand. Infrastructure investment always creates a multiplier effect that reverberates across the economy as a whole.

The alternative, staying entrenched in the sunset of the Second Industrial Revolution, with fewer economic opportunities, a slowing of GDP, diminishing productivity, rising unemployment, and an ever-more polluted environment is unthinkable, and would set Europe on a long-term course of economic contraction and decline in the quality of life of its citizenry.

Lest skeptics think such a proposition utopian and unrealizable, China is already making it a reality in Asia. Premier Li Keqiang and the new leadership of China has embraced the Internet of Things platform and the Third Industrial Revolution economic vision. In September 2013, the Xinhua News Agency reported that Premier Li Keqiang had read *The Third Industrial Revolution* book that I authored with great interest and had instructed the National Development and Reform Commission and the Development Research Center of the State Council to read the book and follow up with a thorough study of the ideas and themes it puts forth. Subsequently, I traveled to China for an official visit for two weeks in September 2013, where I met with Vice Premier Wang Yang, Science and Technology Minister Wan Gang, and various other key government officials to discuss the Chinese transition into a Third Industrial Revolution economy. Following my visit in September of 2013, the government of China announced a four year initial commitment to lay out a digital Energy Internet across China, so that millions of Chinese people and thousands of Chinese businesses can produce their own solar and wind generated green electricity and share surpluses with each other. Plans are also afoot to establish a Pan-Asian Internet of Things platform that will stretch across the continent, allowing 2.7 billion people, or nearly forty percent of the human race, to produce and share information goods, renewable energy, and transportation and logistics in a digitalized single market.

The European Union's plan to establish an Internet of Things platform for a digital economy opens up the prospect of joint collaboration with China in the creation of a digitalized integrated economic space across the Eurasian landmass to foster the transition into a Third Industrial Revolution. In recent months, Chairman Xi and Premier Li of China have called for a new high-tech Eurasian Silk Road Economic Belt to connect the Eurasian land mass in a seamless integrated market from Shanghai to the Irish Sea. The build-out of a digitalized Internet of Things infrastructure across Eurasia could usher in a new age of deep collaboration, bringing much of the human family together for the first time in history.

We are on the cusp of a promising new economic era, with far reaching benefits for humankind. What's required now is an EU commitment to phase in the Internet of Things platform to facilitate the transition to a digitalized Zero Marginal Cost Society, if we are to create a more just, humane, and ecologically sustainable society.

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