

# The Growth Game-Changer:

How the Industrial Internet  
of Things can drive progress  
and prosperity

Mark Purdy and Ladan Davarzani

High performance. Delivered.

In the shift from an industrial to a digital economy, many countries are targeting the Industrial Internet of Things (IIoT) as a means to deliver faster growth. But without establishing the right enabling conditions, they will not fully capture the opportunity. To make this happen, countries need to understand their "national absorptive capacity"—their ability to weave innovations into their economic and social fabric—and how that influences their ability to grow.

How can countries get started? To point them toward the right path, Accenture analyzed 20 countries to identify their national absorptive capacity for IIoT-related technologies, products and services. Through economic modeling, we determined the likely gross domestic product (GDP) benefit to their economies if today's investment and policy trends continue on their current path. We discovered a big number: US\$10.6 trillion by 2030 for the 20 nations.

However, the modeling also revealed that increases in investment and intervention by policy and business leaders could add another US\$3.6 trillion to that total. We outline the key steps they need to take to capture these potential economic benefits.



The Internet of Things can be a game-changer for the world's economies—accelerating productivity, overcoming infrastructure gaps and driving innovation."

Chris Allen Vein, Chief Innovation Officer for Global ICT Development, World Bank

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# Seizing the trillion-dollar opportunity

## Can the Industrial Internet of Things (IIoT) be a force for faster growth in an increasingly digital global economy?

Many governments hope the answer is yes. For example, the UK government has staked out a leading position in this “new industrial revolution,” directing nearly US\$125 million to IIoT research.<sup>1</sup> In China, the government has made the IIoT an “emerging strategic industry” and plans to invest some US\$800 million in it by 2015.<sup>2</sup> And Germany plans to use IIoT technology to increase the productivity of its manufacturing industry by 30 percent through its Industry 4.0 initiative.<sup>3</sup> These and many other governments view the IIoT as a means to stimulate national competitiveness and economic growth.

And with good reason: By our estimates, the IIoT can add trillions of dollars to the global economy by 2030 (Figure 1). What is more, 87 percent of the business leaders Accenture surveyed believe that the IIoT will contribute to long-term job growth. (Accenture surveyed 1,400 C-suite executives from 30 countries; see “CEO Briefing 2015: From Productivity to Outcomes—Using the Internet of Things to drive future business strategies”).

Why such optimism? The IIoT can boost productivity, drive the emergence of new markets, and encourage innovation.

Our survey of global business leaders on the IIoT reveals strong agreement that it can deliver benefits for their companies. In fact, nearly two-thirds of the business leaders we surveyed said the IIoT would offer emerging markets the ability to leap-frog developed economies, while 63 percent said it would close the competitive gaps between companies in emerging and mature markets.

The IIoT could deliver massive economic rewards, but only to countries prepared to capitalize on its growth. To understand what is at stake, we worked with Frontier Economics to model the IIoT’s potential impact on the GDPs of 20 developed and emerging economies that generate over three-quarters of the world’s economic output.<sup>4</sup> The model takes into account projected investment levels, national industry structures and the capacities of different countries to absorb IIoT technologies. Our analysis shows that, based on current policy and investment trends, the IIoT could add around US\$10.6 trillion to the cumulative GDP of these economies over the next 15 years. In 2030, under these conditions, the IIoT could result in GDP being 1.0 percent higher than it otherwise would be (under trend forecast).

However, our analysis shows that the potential for growth could be even greater. By taking additional measures to improve their capacity to absorb IIoT technologies and increase IIoT investment, countries could generate up to an estimated US\$3.6 trillion in additional value over and above the indication of current trends, for a total of US\$14.2 trillion. For the countries we studied, this could lift real GDP by 1.5 percent in 2030 over trend projections.

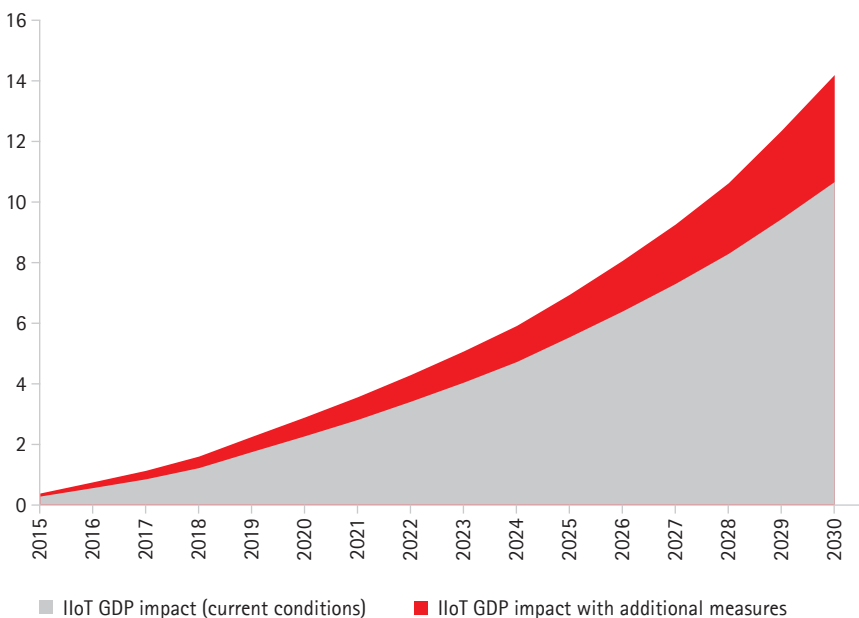
However, these gains won’t become reality without a great deal of hard work. Viewed from the perspective of national economies, it becomes clear that government leaders and policymakers must fully support the IIoT to ensure that their countries readily translate this technological change into economic growth.

## What is the Industrial Internet of Things?

The Industrial Internet of Things is the industrial application of a network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. In manufacturing, connected sensor networks already monitor logistics movements and machines such as mining equipment and entire utility

plants, helping organizations reduce costs through more efficient operations. In agriculture, similar networks deployed across farmlands are improving the use of natural resources and contributing to better harvests. Our analysis also includes some consumer applications such as digital health and "connected lifestyle" products.

Figure 1: Cumulative GDP impact of IIoT (US\$ trillion)



Source: Accenture and Frontier Economics

In the 20 countries we analyzed, current policy and investment trends in IIoT products and technologies point to cumulative real GDP contributions of US\$10.6 trillion by 2030. With greater investment and the enactment of key measures to absorb IIoT technologies, that figure could rise to US\$14.2 trillion.

# The challenge of economic diffusion

Optimism regarding the IIoT's potential to drive economic growth at the global level is relatively high.

However, the prospect of growth becomes less certain at the national level, where some countries have historically outperformed others when it comes to capitalizing on the economic potential of new technologies.

The introduction of electric power in the industrialized world at the turn of the twentieth century offers a clear example of this dynamic in action. While many countries stood at about the same technological starting line in this race, the United States became the world leader in electrification (Figure 2). Why? Because it more rapidly embedded the new technology in the wider economy and altered production and organizational structures to take advantage of it.

Powering factories with electricity illustrates this point. Before electrification, factory workers labored around static workstations, carrying different parts from all over the shop to them until, ultimately,

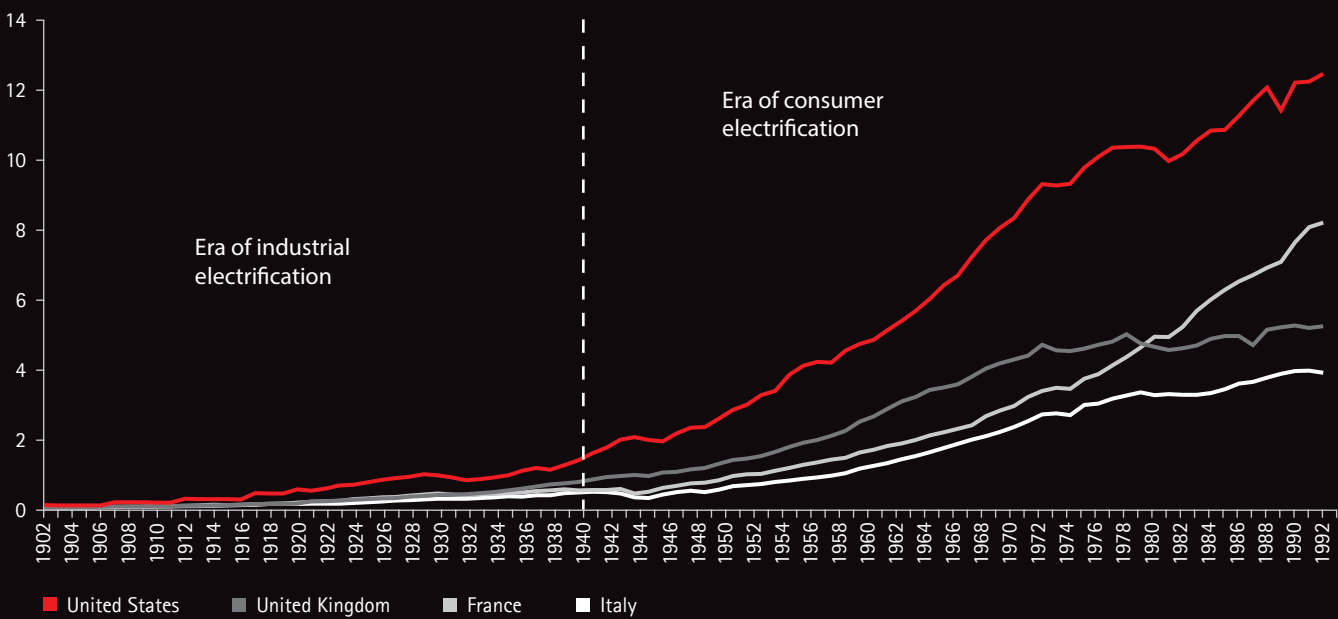
they assembled the product. Electrification turned this concept on its head, enabling the product to move down a powered central assembly line while workers remained at their stations. This innovation saved thousands of hours in labor costs and permitted greater standardization of work practices. By the 1920s, American industries were constructing new all-electric factories in line with the recommendations of industrial engineers and retraining factory workers for this new environment.<sup>5</sup> As the decades progressed, electricity expanded beyond industrial sites to influence the consumer economy. By the 1950s, 94 percent of United States families had electricity in their homes, fueling strong demand for electric household appliances.<sup>6</sup>

The ability of the United States to capitalize on the economic potential of electricity compared with other countries demonstrates how the *technological diffusion* of electricity was not the same

as its *economic diffusion*. While technology diffusion describes a relatively limited process of technology adoption, economic diffusion carries broader implications. It begins with technology diffusion, but also reflects growth, innovation, and financial reward spread across multiple sectors and industries. The entrepreneurial and consumerist culture in the United States, coupled with a favorable business climate, drove the rapid expansion of electrification throughout the economy. In the process, it revolutionized the way individuals, businesses, and governments carried out their daily functions.

We see an equally revolutionary potential with the IIoT. But without the right enabling conditions for its economic diffusion, countries may not reap all its promised rewards.

**Figure 2:** Taking advantage of the technology opportunity - gross output of electric energy per capita in kWh (thousand)



Source: The Cross-country Historical Adoption of Technology (CHAT) dataset, Accenture analysis

While the United States and major European countries started from similar positions with electrification, the United States made more changes throughout its economy to take advantage of this powerful technology. Over time, this allowed the United States economy to generate significantly higher outputs of electricity per capita—an important contributor to overall economic growth.



Electricity changed nearly everything about the way we live and work—and that scale of transformation is possible with the Internet of Things.”

Ian Goldin, Director of Oxford Martin School, University of Oxford

# Driving economic diffusion

The lessons of history tell us that achieving economic diffusion comes down to how well a country can weave innovations into its economic and social fabric.

As a result, understanding the factors that underpin this process—which we call a country's "national absorptive capacity" (NAC)—becomes a central challenge for countries seeking to unlock the economic potential of the IIoT.

Based on our research into previous eras of technological revolution and interviews with experts from the technology, economics and business disciplines, we have identified the four pillars that underlie a country's NAC (Figure 3). The impact and strength of the IIoT's economic diffusion depends on the relative strength of these four pillars:





Figure 3: Realizing the economic potential of the Industrial Internet of Things

Government leaders cannot assume that their nations will automatically enjoy economic growth thanks to the IIoT. To make growth possible, they must shift their attention away from the technology itself and toward the conditions that convert technology diffusion into economic diffusion. The four-pillar model below reveals the elements that help countries derive the greatest benefits from the IIoT.



**Business commons**

- Communications infrastructure
- Human capital
- Quality of governance and institutions
- Access to capital
- Economic openness



**Take-off factors**

- Government support and spending on R&D
- STEM talent
- Quality of scientific research institutions
- Standards setting
- Urbanization
- Expanding middle class



**Transfer factors**

- Formal and informal knowledge transfers
- Organizations' ability to embrace new technologies within organization
- Consumer willingness to adopt new technologies
- Data privacy and security concerns



**Innovation dynamo**

- Entrepreneurial culture
- "Makerism" movement
- University–industry collaboration in R&D
- Development of technology clusters
- Organizations' focus on customer needs





## Business commons

The business commons describes the business climate and pool of resources on which companies can draw to carry out their operations.<sup>7</sup> Key elements of a healthy business commons include an educated workforce, a reliable financial system, and a robust network of local suppliers and distributors—all bounded by good governance policies and the rule of law.

Today, having strong telecommunications and Internet infrastructure plays a key role in determining the strength of the business commons, since it connects these

various elements. In fact, business leaders we surveyed see poor information and communication technology infrastructure, alongside limited access to capital, as the most significant obstacles to developing the IloT in their countries. Countries with a weak business commons may be able to compensate with strengths in other pillars. But for many, establishing this commons with investments in the technological infrastructure of the IloT and business-friendly policies can be key to the IloT's economic diffusion.



## Take-off factors

Take-off factors help to transform a technological advance into usable applications, products and services beyond niche markets and players. With the technological foundation established, entrepreneurs, large businesses and the general public start taking advantage of the new technology, in turn driving increased innovation and scaling.

For instance, once an electrical infrastructure began to proliferate, new inventions such as radio and television emerged, helping many of the world's economies "take off" and increasing the economic diffusion of electricity. The presence of leading hi-tech firms, the strength of the science, technology,

engineering and mathematics (STEM) workforce and government support in research and development (R&D) for the IloT are key supply-side elements that can foster growth in this area. On the consumer side, urbanization and the growing middle class can drive demand for IloT goods and services.

We can see these elements coming together as connected products move into the consumer sphere and technology firms race to develop products and services to meet increasing demand. The IloT's ability to piggyback on existing telecommunications infrastructure should speed up this process: 85 percent of the IloT is based on legacy infrastructure.<sup>8</sup>



The Internet of Things is blurring the boundaries between virtual and physical objects, enabling entirely new market segments and business models."

Amit Jasuja, Senior Vice President of Development,  
Java and Identity Management Products, Oracle



## Transfer factors

Transfer factors enable a technology to become far more deeply ingrained in an economy—inducing wider changes in the behavior of businesses, consumers and society. At this point, change is less about the technology itself and more about the organizational and social transformations that it enables to take place. For example, the economic diffusion of the Internet over the past two decades is clearly illustrated by the technology's evolution from offering relatively limited applications in e-mailing and file sharing to becoming the foundation for how business is done and how many consumers conduct their daily lives.

Key transfer factors include the exchange of knowledge as well as shifts in social and company norms that make harnessing the new technologies possible. These factors can differ across regions. For instance, research reveals that European firms have seen far fewer benefits from the proliferation of ICT than their United States counterparts. European companies could not adapt their organizational structures and management styles to take advantage of the change as quickly.<sup>9</sup> We believe that adapting successfully to the IIoT can test the competitiveness of a nation's business sectors to an even greater extent.



## Innovation dynamo

The innovation dynamo is when a technology produces self-sustaining innovation and development. When this happens, innovators combine technological advances in other areas with the core technology's newfound ubiquity, producing a "multiplier effect" by building once unimaginable complementary goods.

For example, electronics led to modern computing, which, when combined with telecommunications, led to today's Internet and the IIoT. The quality of a country's

research ecosystem, the presence of technology clusters, and a strong culture of entrepreneurialism are just some of the factors contributing to the growth of the innovation dynamo. "Makerism"—essentially a tech-based extension of do-it-yourself culture focused on breakthroughs like 3D printing—will be a key feature of a mature IIoT economy. Today, "makers" are contributing to the global economy by creating homegrown IIoT applications, and by bringing their innovations to market.



Leading in the Internet of Things won't be just about technology—it will also be about the enabling institutions."

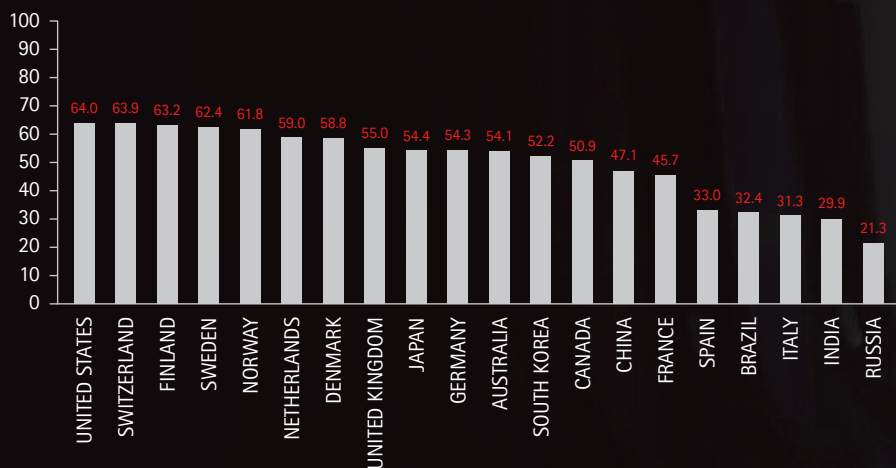
Carlota Perez, Centennial Professor of International Development, London School of Economics

## Assessing country performance on the NAC Index

Leaders can assess a nation's economic diffusion potential from the NAC Index, which shows the potential for economic diffusion of the IIoT in a given country. Nations in higher positions on the index are more likely to reap the rewards of IIoT diffusion. In association with Frontier Economics, we created the NAC Index drawing on the Oslo Manual, which features guidelines established by the Organization for Economic Co-operation and Development (OECD) for collecting and measuring data on technology innovation.<sup>10</sup>

We then adapted this information to focus specifically on the IIoT. Combining our own historical research and a series of interviews with experts, we examined 55 indicators from sources such as the World Bank, the World Economic Forum and the International Telecommunication Union. We then integrated these quantitative proxies into our four-pillar model.

NAC SCORE



Source: Accenture and Frontier Economics

### The NAC Index

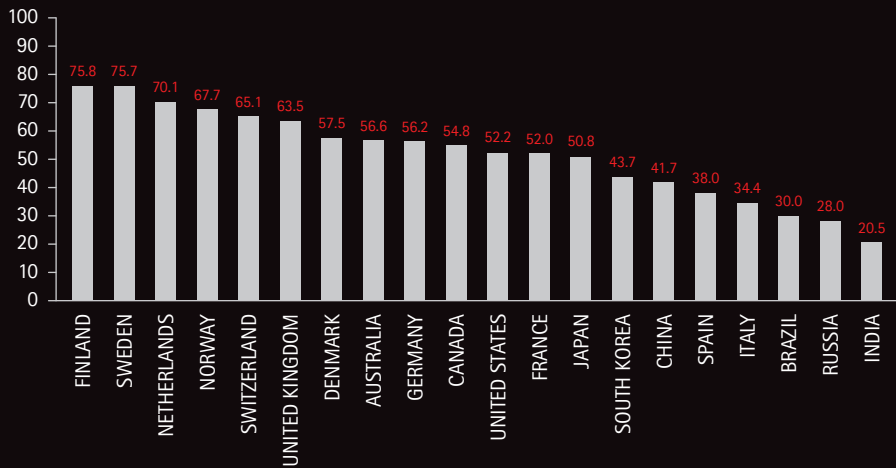
A country with a NAC score of 100 would be the top performer on each of the 55 indicators compared to the other study countries. Overall, our results show that no one country has achieved this level of NAC. In other words, everyone has work to do. The United States, Switzerland and three Nordic countries are the furthest ahead in terms of their NACs, but they

also exhibit room for improvement within each of the four pillars.

Our results suggest that if each of the 20 countries invested the same amount of capital in the IIoT, countries higher on the NAC Index will gain more economic benefit from the investment, *ceteris paribus*.



NAC SCORE



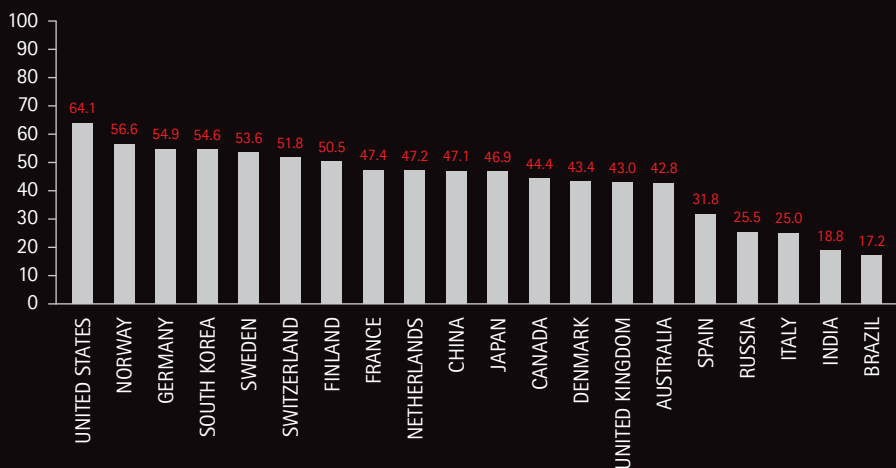
Source: Accenture and Frontier Economics

Business commons

Business commons measures the extent to which countries have the technological and institutional foundations for IIoT growth. The Nordic countries in our study performed well on this metric. For the most part, emerging markets have room for improvement. The United States, the top

performer on the overall NAC Index, lags behind other developed markets on human capital and broadband infrastructure. For example, the average Internet speed of Nordic countries is almost four times faster than those in the United States.

NAC SCORE



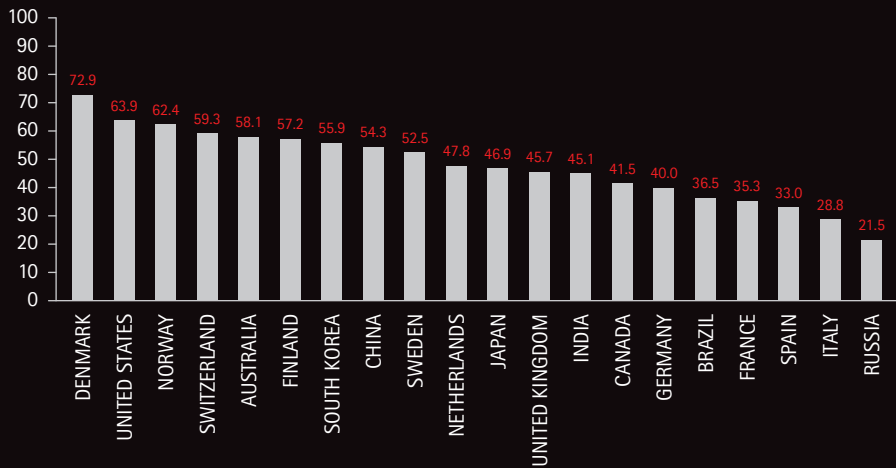
Source: Accenture and Frontier Economics

Take-off factors

Take-off factors assess a country's ability to scale technology and encourage the spread and uptake of new technology offerings. This index relies on both supply- and demand-side factors. In general, the gap in the ranking between supply and demand factors is not wide, except in the cases of Norway and South Korea. Norway is boosted by its strong demand capacities.

However, low levels of STEM skills combined with insufficient spending on R&D limits its supply-side factors in this area. South Korea—well known for its high-tech firms and investments in smart cities—has robust supply-side factors due to the availability of skilled labor and large investments in R&D, but could do better on the demand side such as raising its GDP per capita.

NAC SCORE



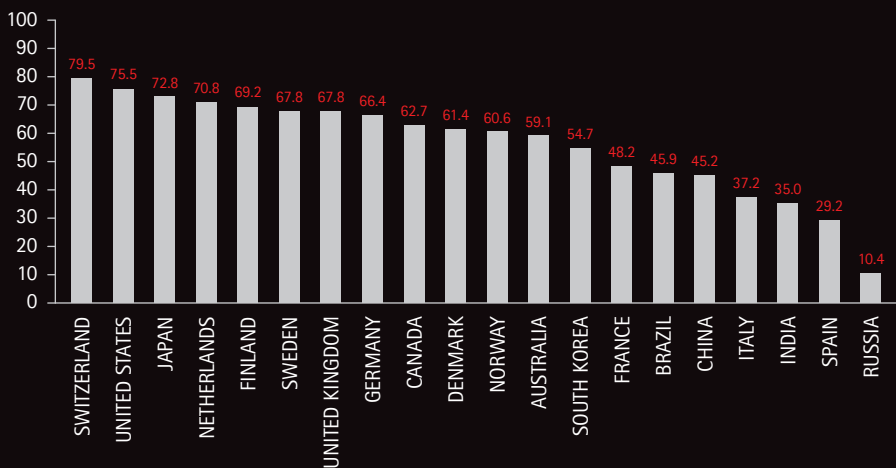
Source: Accenture and Frontier Economics

### Transfer factors

Transfer factors gauge the extent of social and organizational transformation in a society. Advanced economies generally perform well on their access to formal and informal knowledge. On the other hand, emerging markets demonstrate a high willingness to embrace new technological innovations compared with other countries in the index.

Chinese consumers and firms in particular appear to be open to new technologies. This may be due to China’s fast-growing economy: affordable smart phones encourage consumers to spend their newfound wealth on technology devices, and businesses often make large investments in the technology sector.

NAC SCORE



Source: Accenture and Frontier Economics

### Innovation dynamo

Innovation dynamo measures a country’s capacity to generate innovations from new technology. Advanced industrialized economies tend to have more sophisticated research and business ecosystems, which position them higher on this index.

The emerging markets—Brazil, China and India—are among the countries where most new businesses are started, and this is often to seize new opportunities in the market.

## How do the NACs affect the economic potential of the Industrial Internet of Things?

In association with Frontier Economics, we modeled the potential GDP impact of the IloT for 20 developed and emerging economies. To illustrate how the NACs affect the economic potential of the IloT, we compared the results of two different scenarios generated by the model: "economic impact of the IloT under current conditions" and "economic impact of the IloT with additional measures."

A country's current position on the NAC Index and projected investment levels represents the former scenario. Our results show that under these conditions, the IloT would add around US\$10.6 trillion to cumulative GDP by 2030 for our 20 selected countries.

In the latter scenario, we extrapolated an IloT development trajectory by assigning a country a higher score on the NAC Index and increasing investment in IloT technologies, products and services by 50 percent. Here, we found that the value would jump to US\$14.2 trillion during the same period.

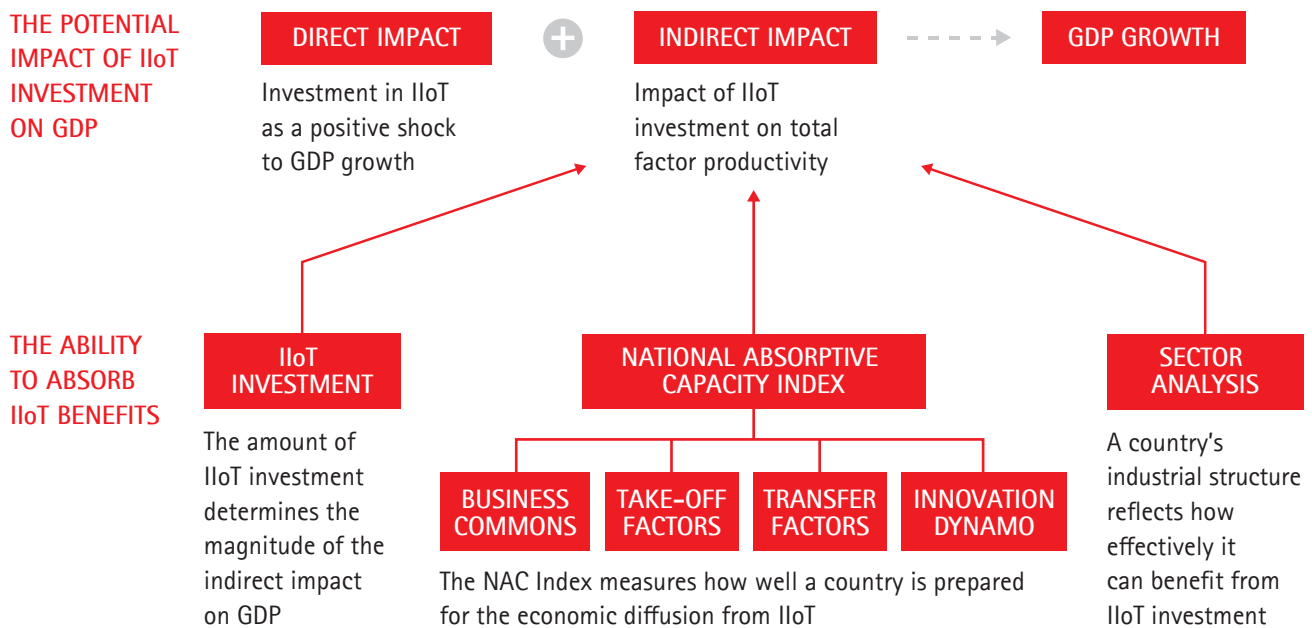
To move to a higher position on the index, business and government leaders can take actions to improve any of the four NAC pillars. The choice depends on their country-specific circumstances. A short-term strategy might require a government to increase its procurement of IloT-related technology. A long-term strategy could focus on improving the country's system of education and workforce skills to align with the needs of an IloT economy.



## Measuring the economic potential of IIoT: The model in brief

We measured the potential direct and indirect impact of IIoT investments on GDP growth, which we then adjusted to take into account each country's ability to absorb IIoT benefits.

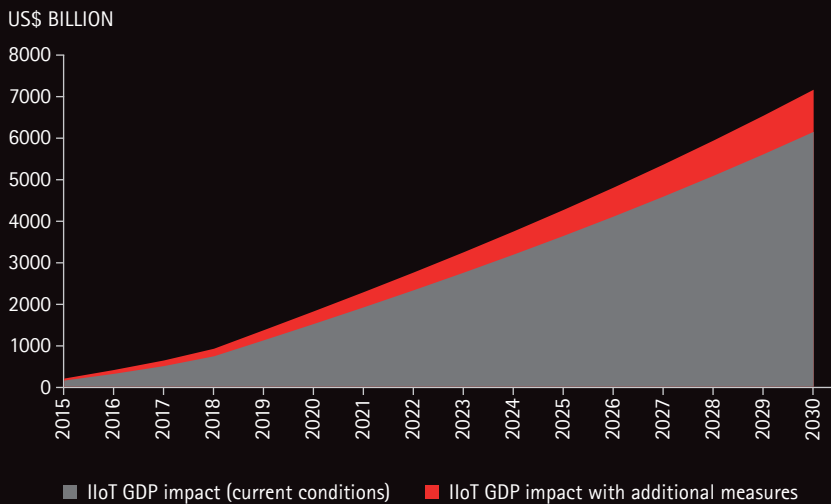
By combining these, we were able to project the potential GDP growth that results from the IIoT by 2030 for each country.



*Note: IIoT investment levels and forecast were drawn from International Data Corporation (IDC) data on Internet of Things (IoT) spending for each of the 20 countries. IDC defines the IoT as "a network of networks of uniquely identifiable end points (or things) that communicate without human interaction (by either wired or wireless access) using IP connectivity—be it locally or globally."*

## The IIoT's potential impact on national growth

The results for a selection of countries illustrate how NACs and IIoT investments could affect national GDP. For additional country spotlights see [www.accenture.com/internetofthingsGDPimpact](http://www.accenture.com/internetofthingsGDPimpact).

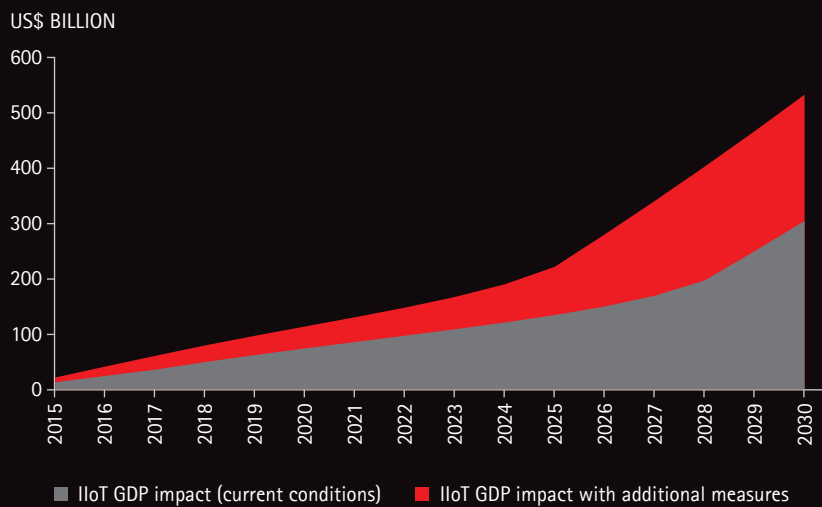


■ IIoT GDP impact (current conditions) ■ IIoT GDP impact with additional measures

Source: Accenture and Frontier Economics

### United States

In our model, the IIoT is projected to add US\$6,132 billion to United States' GDP in the next 15 years under current conditions. However, by taking additional measures such as improving the country's broadband infrastructure, this figure could grow to US\$7,146 billion.

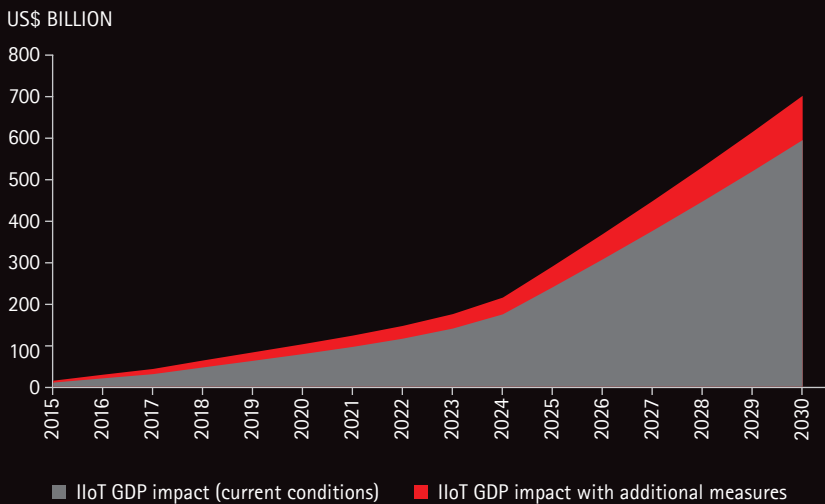


■ IIoT GDP impact (current conditions) ■ IIoT GDP impact with additional measures

Source: Accenture and Frontier Economics

### United Kingdom

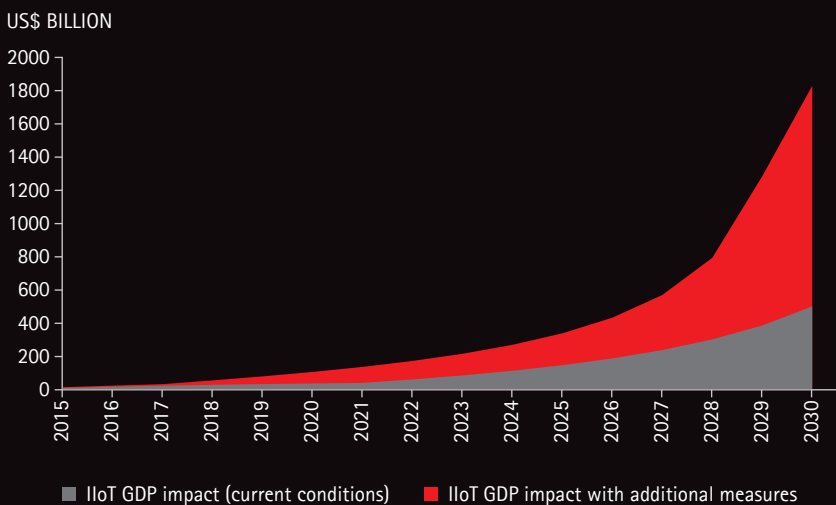
For the United Kingdom economy, the IIoT is estimated to add US\$303 billion to GDP in the next 15 years under current conditions. However, with additional measures such as companies hiring more people with skills related to the IIoT, this figure could grow to US\$531 billion. The UK's current potential is limited by its structural bias towards financial services.



Source: Accenture and Frontier Economics

### Germany

The IloT is projected to add US\$593 billion to Germany's GDP in the next 15 years under current conditions. However, with additional measures, such as the government encouraging consumer trust in IloT offerings, Germany's GDP could grow by US\$700 billion. Germany's relative strength in manufacturing—a sector ripe for IloT applications—is an important factor driving its IloT-led growth.



Source: Accenture and Frontier Economics

### China

Under current conditions, the IloT is estimated to add US\$497 billion to China's GDP in the next 15 years. However, with additional measures, for instance, by improving its research ecosystem, this figure could grow to US\$1,824 billion.

# Five ways to win

The NAC Index provides country leaders with insight into the areas that are hindering their IloT growth prospects. Such an analysis can help policy and business leaders direct their investments to the right areas. In addition, there are some guiding principles that can help nations to get a head start in IloT-led growth.

## Play to a country's strengths

Does the economy have a strong high-tech industrial sector or is it largely agrarian? Answers to such questions can help policy-makers pursue appropriate investment strategies given inevitable resource constraints. For instance, India has become an agriculture powerhouse in recent years. Through its "Digital India" initiative, the Indian government is seeking to build on this momentum. Its "smart agriculture" program allows farmers to utilize IloT technology to monitor online the temperature of grain bins and receive alerts when temperatures for crops reach dangerous levels.<sup>11</sup>

## Create a chain reaction across industries

The IloT has the potential to create new ecosystems that cut across traditional industry boundaries and value chains. The move to product-service hybrids, for instance, has led farm equipment makers to team up with fertilizer suppliers and insurance providers to offer integrated bundles. However, our survey suggests that only 13 percent of business leaders see the IloT as a means to generate new revenue streams through new products and services. As a result, policymakers need to encourage businesses to look beyond their own industries and build new partnerships that enable the creation of new products, services and business models.



Adequate infrastructure along with digital literacy and skills will be of fundamental importance in supporting the Internet of Things."

Hal Varian, Chief Economist, Google



Policymakers need to strike a balance with Internet of Things regulation: policy should catalyze the system rather than impose costs on it."

Daniel Caprio, Senior Strategic Advisor, McKenna Long & Aldridge

### Combat resource deficiencies

In their efforts to realize the IloT's economic diffusion, many economies may discover deficiencies in skills, capital and technology. Policymakers must decide whether to "make-or-buy" these capabilities. They can develop talent within the existing workforce ("make"). For example, China's IloT hub, Wuxi, is nurturing IloT professionals through its "IoT Talent Golden Harbor" program.<sup>12</sup> But it may be speedier to address skill gaps by tailoring immigration policies to attract skills from abroad ("buy"). Equally, countries can address technology deficiencies by attracting foreign direct investment and encouraging technology transfers.

### Join the dots to connect and collaborate

To spur innovation in the IloT, governments can draw on their powerful networks of stakeholders (such as industry, academia and non-government organizations) to share ideas and best practices, and identify areas of mutual interest for further research. Governments can also play a part in increasing collaboration and partnerships among global and large regional companies, small and medium enterprises, and start-ups. For example, the South Korean government's "creative economy" initiative has brought together large companies and municipalities to establish innovation centers with IloT capabilities. It is also working with small businesses and regional firms to help them modernize their operations with IloT technologies.<sup>13</sup> Facilitating and being part of such collaborations can also help to ensure that policymakers design regulation in a way that does not stifle innovation.

### Shorten the investment lag

While 79 percent of the business leaders we surveyed have developed strategies for the IloT, just a little over one-third are investing in them. Business and policymakers can work to turn strategy into reality by promoting experimental, pilot and demonstration projects in IloT applications. For example, Singapore, which has been experimenting with driverless cars for several years, is welcoming industry and academia to run pilot tests with citizens' participation.<sup>14</sup> Such programs can help raise business awareness of the benefits—and mutual growth prospects—for both traditional and new service industries. What is more, stakeholders should share early success stories throughout the business community to spur other companies—and entrepreneurs—into action.

For nations seeking breakthrough growth in the digital age, the advent of the IloT could be a game-changer. But without the critical enabling conditions, that opportunity may not materialize. Nations can make the right start by understanding the pillars of national absorptive capacity and how they can catalyze IloT-led economic growth. Armed with such knowledge, they can set their economies on a better path for economic progress and prosperity.

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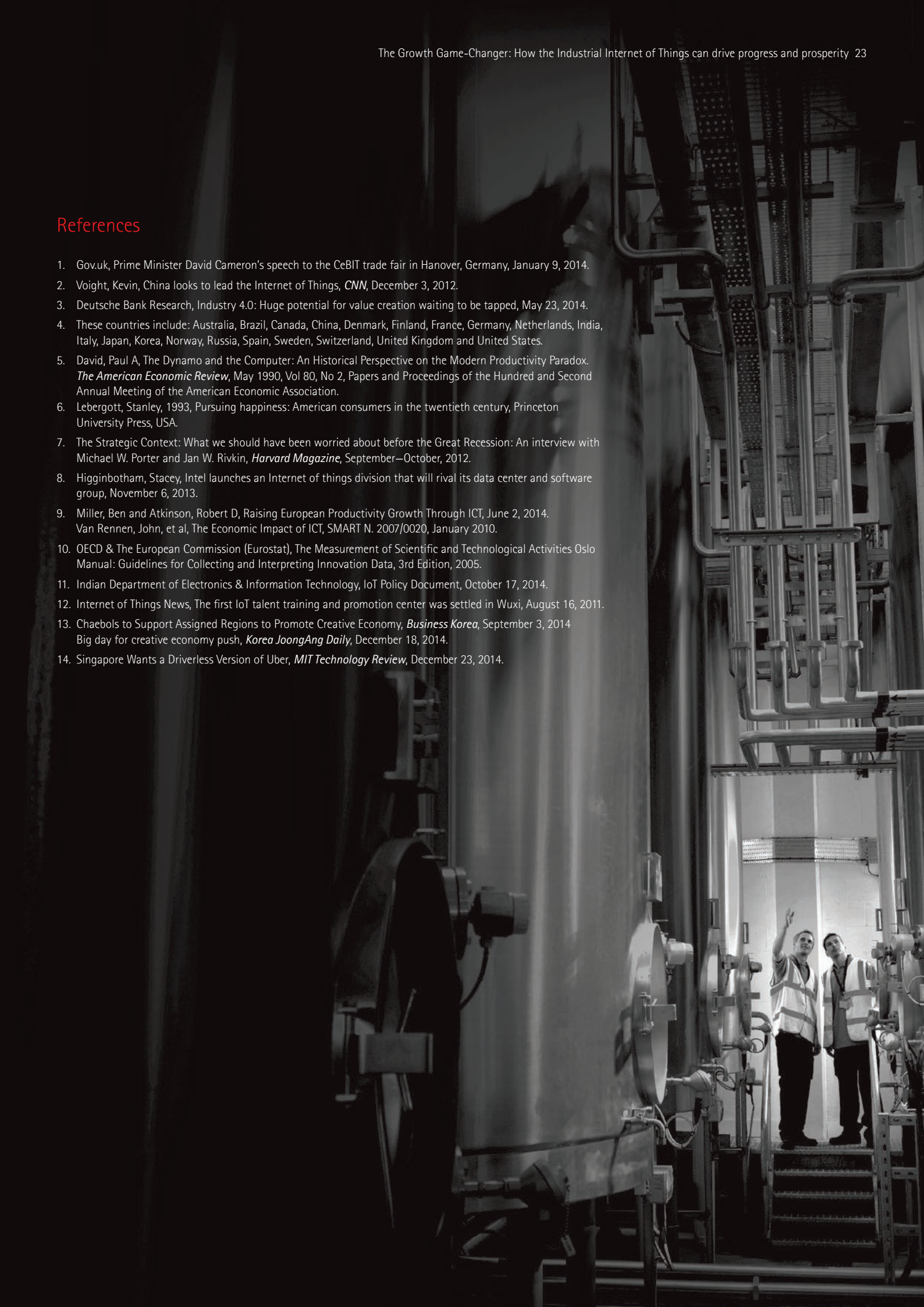
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