



## INDUSTRY 4.0

### *A Digital Revolution*

Embracing the Power of Smart Manufacturing  
with the Industrial Internet of Things

## Executive Summary

Imagine a factory where internet connected sensors embedded in devices at every stage of production spit out terabytes of data on critical metrics of production such as energy usage, wear and tear and parts inventory. Now imagine the terabytes of data being seamlessly analyzed in real time with high performance computers, cloud connectivity and big data analytics to deliver these insights to the factory floor in real-time. A new production revolution driven by the Industrial Internet of Things (IIoT) has arrived and forward thinking manufacturers are in the midst of digitizing their operations. Recent breakthroughs in a number of advanced technologies makes this dream a reality today. Gartner predicts that by 2021 one million IoT devices will be purchased and installed every hour!<sup>1</sup> Given the vast scale of this technology, manufacturing firms need to strategize for this new normal or risk becoming targets for digital disruption.

*“By 2021 one million IoT devices will be purchased and installed every hour.”*

Beginning in 2011, German government, commercial and academic circles began promoting an idea they dubbed Industry 4.0 — a strategic initiative to integrate advanced technologies such as big data analytics into industrial production. German manufacturers and other stakeholders know that to preserve their edge, they must harness the power of information technology in new ways. Industry 4.0 practitioners are not simply working on the margins to optimize efficiency or yield in a single factory. The potential is much larger than that. Envisioned benefits to efficiency, safety and sustainability are being heralded as a fourth industrial revolution.

Recent innovations allowing for economical application of information technology in factories are changing industrial production not just in Germany, but all over the world. After revolutionizing other areas of the economy, digital disruption is now making waves in manufacturing. A number of rapidly advancing technologies such as predictive analytics, machine learning and cloud computing are converging to form the foundation of Industry 4.0, but chief among these areas of innovation is IIoT. This paper will focus on IIoT application in today's quickly digitizing manufacturing sector, the benefits it provides, best practices, use cases and major potential stumbling blocks.

Overhauling operations overnight is not realistic for any firm, but Emerging Strategy has identified a few areas where a smart IIoT deployment can yield real benefits in the short term. Predictive maintenance, production optimization and supply chain (SC) optimization stand out as three starting points for generating ROI on IIoT solutions. The possibilities for manufacturers to leverage physical data into real, tangible value by increasing yields or decreasing costs is limitless. As more and more firms embrace IIoT, implementation strategy must be centered on what type of data to collect and how those data streams can improve decisions.

<sup>1</sup> Gartner, "Top Strategic Predictions for 2016 and Beyond: The Future Is a Digital Thing", 2 October 2015.

## The IIoT is the Gateway to Industry 4.0

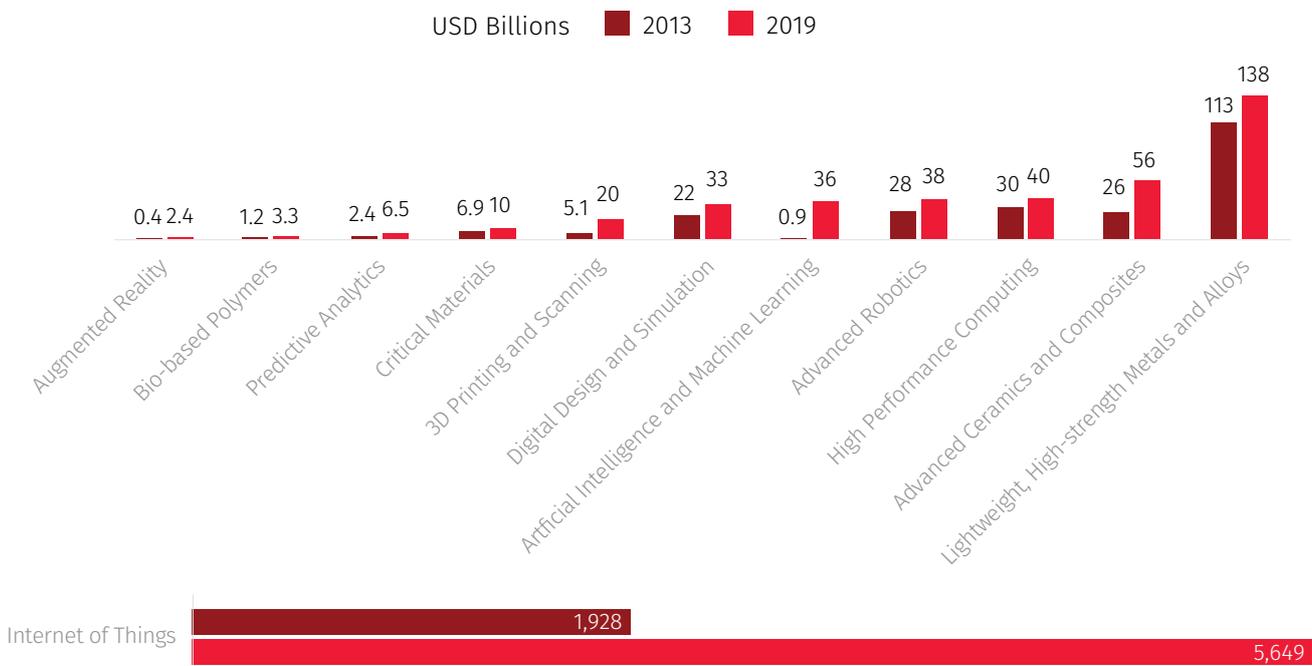
### The Manufacturing Sector's IIoT Transformation is Underway

While many observers have focused on consumer facing applications of IoT such as self-driving cars or smart appliances, a quiet transformation is underway in factories all over the world. Driven by smaller, cheaper sensors and actuators to measure performance and cheaper methods of transmitting and analyzing those data streams to yield actionable insight, the physical world of industrial production and the digital world of information technology are becoming increasingly intertwined. Manufacturers are realizing that information technology must be an increasingly central aspect of their end-to-end production process in order for them to maintain competitiveness. Firms which are embracing the power of data are remaking themselves into more information technology savvy enterprises.

*“The physical world of industrial production and the digital world of information technology are becoming increasingly intertwined.”*

IIoT, unlike other advanced manufacturing technologies, applies to a very broad swath of industries and operations. From monitoring equipment performance to managing inventory, this disruptive technology trend will affect industries responsible for 62% of GDP among G20 countries, according to Oxford Economics.<sup>2</sup> Estimates on the impact IoT vary wildly, and a precise definition is lacking, but one estimate from Deloitte compares the market sizes of promising advanced manufacturing technologies and the results are striking — the IoT market is projected to reach a staggering 5.6 trillion dollars by 2019.<sup>3</sup> Manufacturing firms no matter which industry vertical or geographic location they operate in must be cognizant of the imminent impact this transformative technology will have on their businesses.

### Promising Advanced Manufacturing Technologies Market Size in 2013 & 2019E<sup>3</sup>



<sup>2</sup> Oxford Economics, 2015

<sup>3</sup> Deloitte, "Advanced Technologies Initiative: Manufacturing & Innovation", December 2015

## No Winner Yet in Nascent Efforts to Develop IIoT Market

With the world's leading players in manufacturing and information technology just recently beginning to focus investment in this area, the IIoT is still in an early stage of development. The Industrial Internet Consortium (IIC) was formed by AT&T, Cisco, Intel, GE and IBM just 2 years ago but now boasts 251 members across 30 countries — including Siemens and Bosch, two German manufacturing powerhouses which joined in March 2016.<sup>4</sup> These large firms have all invested heavily in amassing digital data from their own production lines in order to pull out useful feedback to improve processes. Now these firms are turning their attention to the wider IIoT market. Industrial powerhouses such as GE and Bosch are accelerating the spread of IIoT by offering their own software platforms to partners to build customized applications. A diverse array of players from technology companies to manufacturing firms are vying for a piece of the potentially lucrative IIoT services market. Industrial firms are adding software and services and IT companies are trying to get into the physical space. According to Bosch CEO, Volkmar Denner, the race is “completely open”. Opportunities to add value by leveraging data in the manufacturing process are everywhere, making it important to examine how firms are targeting their initial IIoT investments.

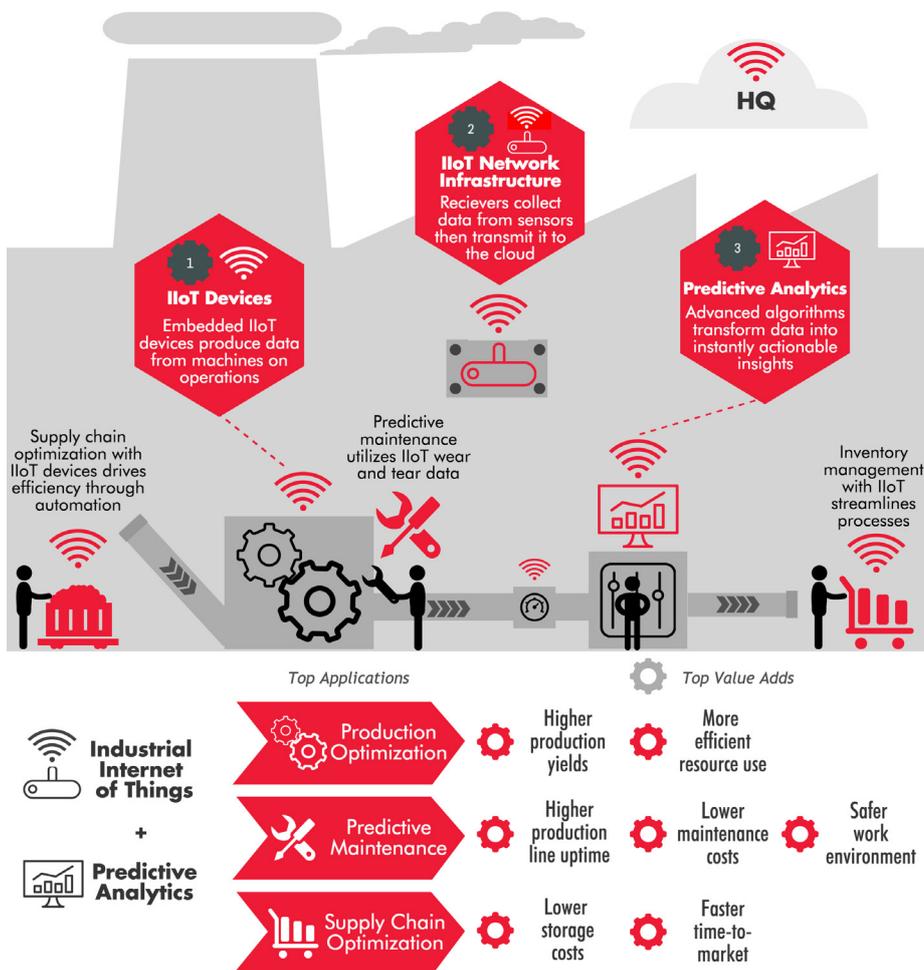
*“Industrial firms are adding software and services and IT companies are trying to get into the physical space.”*

<sup>4</sup> Wall Street Journal, “Bosch's New U.S. Deal Cuts Costs at Smart Factory”, 10 March 2016

# Value Add Options with IIoT

## Notch a Quick Win with Targeted IIoT Investment

At a basic level, the IIoT is mainly about two things – embedding sensors and/or actuators to collect data, and channeling that data to make better decisions. IIoT is generating immediate ROI for manufacturers. Over the short term there are three application areas in particular where value can easily be captured with a first time foray into the IIoT. Predictive maintenance, production optimization and SC optimization are all areas ripe for IIoT value adds, but only with the right mix of outsourced partners, well considered strategy and internal support can these pilot efforts realize their true potential.



## Predictive Maintenance Boosts Factory Uptime, Lowers Costs

By collecting equipment usage data from device sensors, maintenance teams can more efficiently schedule equipment repairs and replacements. Changing the dynamics of equipment repair from reactive to proactive, where problems are anticipated and prevented, can significantly increase the uptime of production lines. Analyzing diverse and complex data sets with advanced algorithms and cloud connectivity makes this possible on a large scale today for the first time. Lower maintenance costs, increased uptime for production lines and a safer work environment are some of the tangible value adds achievable through applying this technology. The resulting gains in operational effectiveness can be significant as these solutions are spread across enterprise.

Bosch contracted with Cisco to connect their industrial tools to an IIoT architecture to improve production quality and worker safety. The solution has enabled Bosch to automate routine tasks, such as replacing worn out drill bits, and usage data from connected tools is used to measure and track things like torque applied, or even whether or not the right tool is being used, leading to higher levels of quality and safety.<sup>5</sup>

### IIOT SUPPLIER SPOTLIGHT

*GE has made significant investment into IT development due to its wide ranging application across its business units. It opened the Global Software Center near San Francisco and now employs 1,200 developers there. Approximately 10,000 more developers are employed in GE's business units, which highlights industrial software's strategic importance there. In 2015, GE launched its primary initiatives into IIoT, a platform called Predix, and a cloud-based developer ecosystem, predix.io, to support the development of IIoT applications. This IIoT solution has recently been made available to external parties such as Boeing, claiming to deliver the same 10-20% bump in productivity that GE itself has realized with internal IIoT applications. GE's Chief Digital Officer, Bill Ruh, has talked of an "emerging industrial app economy" which poses an unprecedented opportunity to transform industries.*

*GE's transportation facility in Grove City, PA has reduced unplanned downtime by 10-20% by equipping machines with sensors to monitor operating conditions and relaying and analyzing that data to improve performance.*

<sup>5</sup> Cisco, "Digital Transformation with the Internet of Everything: Manufacturing Customer Stories", 2015

## Rich Opportunities Loom for Optimizing Production with IIoT

Today's factories produce enormous amounts of data, but many data streams aren't sufficiently integrated and therefore aren't as useful as they could be. Combining available production data in an integrated software solution and developing the right analytical tools to make those data streams useful for decision making is critical. Optimizing production with an IIoT solution first requires firms to identify what type of data they need, and second, to identify from where it can capture that data. The next step is to develop or outsource IIoT infrastructure and associated software applications to bring those data streams to life. Of course, internal support of IIoT efforts from pilot stage to later stage scaling up is necessary to capture the full value of optimization. Identifying areas to improve production in the average manufacturing facility and crafting an IIoT strategy must be a collaborative effort, combining the process expertise of manufacturers with the IT expertise of IIoT supplier firms to achieve best results.

### IIOT SUPPLIER SPOTLIGHT

*Intel's position as a leading chip maker, and a founding member of the Industrial Internet Consortium, has prepared them to make a strong push into the IIoT supplier space. In fact, the company formed an IIoT business group in early 2015 to focus on strategy and initiatives. Its latest offering is the SmartLink Technology platform — a hardware/software stack specifically designed to be used with any type of machinery — announced in March 2016. It acts as a management and security proxy for unconnected, legacy devices, does light analytics and data transformation. The platform is fully customizable through a Java-based software developer kit.*

*Intel deployed an in-house IIoT solution in one of their semiconductor plants in Malaysia to troubleshoot its IIoT infrastructure before making it commercially available. The factory was fitted with sensors to collect data, gateways to transmit it and analytics software to deliver real-time insight from their CPU modules, devices used in the final steps of the assembly process. The result was a reduction in the number of machine failures and an increase in assembly line uptime, which have resulted in higher yields.*

## Opportunities to Unlock Value with SC Optimization Abound

Gains in productivity by streamlining inventory management and distribution processes can quickly add up to sustainable competitive advantage in a manufacturing industry where tiny performance margins can be the difference between success and failure. Companies are collaborating with third party vendors to design innovative systems leveraging IIoT to automate and optimize critical parts of their supply chains in an effort to achieve crucial gains in operational efficiency.

Wurth USA, an automotive parts supplier, implemented a system called “iBins” that uses smart camera technology to monitor supply levels to inform an inventory management system which automatically reorders supplies as they are depleted. Such IIoT-enabled inventory tracking systems can save on costs associated with inventory management and storage.

*“Companies are collaborating with third party vendors to design innovative systems leveraging IIoT to automate and optimize critical parts of their supply chains in an effort to achieve crucial gains in operational efficiency.”*

### IIOT SUPPLIER SPOTLIGHT

*Cisco's strength in networking equipment and architecture has solidified their position as an IIoT supplier, however they are actively pursuing a strategy to become more a competitive one. In early 2016, it acquired Jasper Technologies, an IoT services firm with a large customer base and experience managing and automating the lifecycle of IoT services solutions. Cisco's IIoT offering is comprised of the Connected Factory, Connected Machines and the Connected Supply Chain, all of which leverage Cisco's proficiency in network connectivity and security. With the addition of their recent acquisition, expect Cisco to improve and expand their service offering in the IIoT space in the near future.*

*Stanley Black & Decker fully connected an entire production line in Mexico with the help of Cisco and AeroScout Industrial. They developed a Real Time Location System by attaching small Wi-Fi Radio Frequency Identification Devices (RFID) tags to materials, tools or virtually any object, giving workers real time information about location and status of critical materials. The system has allowed Stanley Black & Decker to gain more insight into how to increase efficiency and lower storage and inventory management costs.*

6 Tata Consulting Services, “Internet of Things: The Complete Reimaginative Force”, July 2016

7 McKinsey Global Institute, “The Internet of Things: Mapping the Value Beyond the Hype”, June 2015

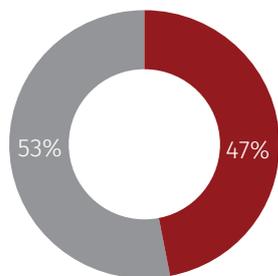
## Beware the Common Challenges to IIoT Strategy

### Considering Risks and Mitigation Strategies is Paramount

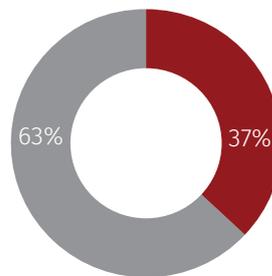
Manufacturers face formidable obstacles standing in the way of Industry 4.0 implementation. Although the pace of technology innovation is accelerating, concerns over data security, rigid organizational structures and a lack of available talent pose significant challenges to IIoT strategies. Just under half of firms say they have made substantial progress in the last year toward implementing an Industry 4.0 application or strategy, according to a survey by McKinsey Consulting.<sup>8</sup> Firms wishing to invest in IIoT solutions must take these challenges into consideration and ask the right questions to mitigate the risks these challenges pose to successful IIoT rollouts.

### Progress Made in the Last Year Toward Implementing Industry 4.0 Applications/Strategies<sup>8</sup>

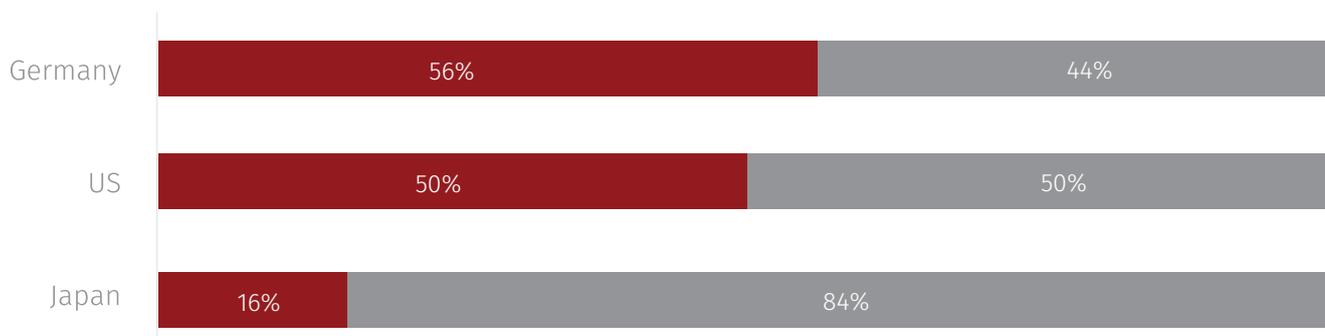
■ Good or substantial progress    ■ Limited or no progress



Technology Suppliers



Manufacturers



<sup>8</sup> McKinsey Consulting Group, "Industry 4.0 Global Expert Survey", October 2015

## Security, Privacy & Ownership Concerns Impede IIoT Growth

The risk of businesses losing control of their proprietary data or software looms large over the discussions of IIoT. Companies digitizing their factories realize the importance of securing wireless networks to prevent all manner of cyber attacks including theft of intellectual property or trade secrets, hostile manipulation of data and malicious denial of control attacks. Third party providers of IIoT infrastructure and services are keenly aware of this reality and often emphasize network security to assuage customer concerns. However, bad actors are not the only concern when it comes to protecting manufacturers' increasingly valuable data. Many manufacturers are reluctant to provide access to company data and software to third party firms due to concerns over network security on the partner side. Confidentiality and privacy between manufacturers and third party partners are also key concerns.

Questions over data ownership also cloud the landscape. It is unclear which entity owns the data produced by devices in a factory: the factory owner, the equipment owners, the company manufacturing products or the third party IIoT suppliers. These questions remain largely unresolved by regulators — even in developed countries — prompting many firms to wait on the sidelines for clarity on the finer points of data ownership.

## Organizational Silos and a Lack of Tech-Savvy Talent Persist

While global manufacturing leaders such as GE and Bosch invest significant resources to develop in-house IIoT solutions, many smaller firms face a scarce talent pool when hiring for tech-savvy roles which have the ability to develop IIoT solutions, such as data scientists. This dearth of talent forces manufacturers to rely on third party support — not an ideal solution given that ownership and security of proprietary data and intellectual property is such a serious concern today.

As Industry 4.0 and the IIoT continue to merge the physical and digital worlds closer together, cooperation across functions is gaining importance. Traditionally siloed function areas such as R&D, IT and operations must share data and insight with each other to fully realize the value potential of an IIoT solution. For example, data from operations on defect rates could contribute value to R&D efforts in product development. However, collaboration across functions remains a weak point for many organizations. At the dawn of the IIoT era, manufacturers must begin to think and plan like technology companies. This disruptive transformation is knocking down barriers between industries and functions, providing opportunities for nimble organizations to rethink their organizational structures.

*“ It is unclear which entity owns the data produced by devices in a factory: the factory owner, the equipment owners, the company manufacturing products or the third party IIoT suppliers.”*

## Integration Across Devices and Software Remains Challenging

The IIoT starts with sensors and actuators and oftentimes requires coordinating different service providers and different types of devices, all of which have their own standards. Without free-flow of data throughout systems, the full value of an end-to-end IIoT implementation is impossible to realize. Many manufacturers are hesitant to risk significant investment in technology that could lose out to an alternative in a few years. Because third party software platforms are usually not interoperable, costs are higher and there is a risk of redundancy from multiple layered solutions.

To alleviate these concerns, efforts to standardize the way devices and sensors communicate are ongoing. Groups like MTConnect and the aforementioned Industrial Internet Consortium (IIC) are working toward standardization, which would allow devices and software applications from different providers to communicate with one another using common IIoT protocols. The fierce competition between leading IIoT suppliers to become the go-to standard is still in an early stage, making in-depth and timely information on top solutions a must have for decision makers evaluating future strategy to digitize operations with the IIoT.

*“ The fierce competition between leading IIoT suppliers to become the go-to standard is still in an early stage, making in-depth and timely information on top solutions a must have for decision makers evaluating future strategy to digitize operations with the IIoT. ”*

## Next Steps Toward the IIoT

### Conquer IIoT Strategy Development Armed with Information

Adjusting operations to the digital era requires an informed strategy, supported with insights into the competition and the IIoT services market. If the IT world is any indicator, expect this market to evolve quickly. Manufacturers with the foresight to utilize the power of information have the opportunity to change their businesses for the better. An investment in IIoT is a smart bet on technology with myriad uses, but making sure that bet pays off is a more complicated matter. Considering challenges of digitizing operations, selecting the right partner firms and targeting investment where it will have maximum ROI are important factors for any manufacturer venturing into an IIoT implementation in the era of Industry 4.0.

## About Emerging Strategy

*Emerging Strategy is the essential provider of decision support for global B2B companies through targeted, customized and insightful market intelligence. Emerging Strategy partners with executives who need external insights to drive business results and avoid blind spots. Our “On-Request” model provides access to customized top-down market intelligence that is available quickly, conveniently, globally, and in an unlimited amount at a fixed annual investment. Advisory Services are available on a fee-per-project basis for complex projects requiring deep research and analysis in order to arrive at new-to-the-world insights and recommendations. We operate across more than 50 countries in 6 continents and are known for our unique abilities in challenging environments, such as emerging markets and other opaque markets.*

## Global Hub

### Shanghai

153 Jumen Road Block 8, Suite 301  
Huangpu District, Shanghai, China 200023

Tel: (+86) 21 6191 1101

Email: [info@emerging-strategy.com](mailto:info@emerging-strategy.com)

## Connect With Us

Explore our website: [www.emerging-strategy.com](http://www.emerging-strategy.com)

Contact us: [www.emerging-strategy.com/contact](http://www.emerging-strategy.com/contact)

Connect with us on [LinkedIn@Emerging Strategy](#)

Follow us on [Twitter@emerginstategy](#)

## Authors from Emerging Strategy

### Eric Skuse

Research Manager

[eskuse@emerging-strategy.com](mailto:eskuse@emerging-strategy.com)

### Satoko Okamoto

Director

[sokamoto@emerging-strategy.com](mailto:sokamoto@emerging-strategy.com)

### William Bouwman

Consultant

[wbouwman@emerging-strategy.com](mailto:wbouwman@emerging-strategy.com)