Cognizanti

Part III

Digital Business 2020:

Getting there from here!

Internet of Things

From Strategy to Action:
Driving IoT to
Industrial Scale

Cognizant

From Strategy to Action: Driving IoT to Industrial Scale

By Mary Murphy-Hoye

Full IoT value cannot be realized by connecting a few devices. Organizations need to get beyond instrumentation, and focus on the impact these technologies can have on their business strategies, which will require leadership, vision and partnership.

"Modern technology is not just a collection of more or less independent means of production. Rather it is becoming an open language for the creation of structures and functions in the economy. Slowly, at a pace measured in decades, we are shifting … to technologies whose main character is that they can be combined and configured endlessly for fresh purposes."[1]

— *W. Brian Arthur*

The market phenomenon known as the Internet of Things (IoT) must be understood as a technology collective, as it is built from previously existent technologies, and benefits from the convergence of commercially available components. The Internet itself is the culmination of multiple technologies, and the multi-tier architecture common to most IoT solutions (edge devices and sensors, gateways, cloud) is built on the progression of hardware and software that has powered the computing revolution for years.

However, while the vision for interconnected networks of "things" has existed for decades, execution has been hampered by an inability to craft end-to-end solutions and, perhaps more importantly, the lack of a pressing and financially-viable business case for wide-scale adoption.

The IoT's building blocks have continually evolved over decades of research into pervasive and ubiquitous computing, culminating in a seamless connection between the digital and physical worlds. As a result, consumer and industrial adoption of Internet Protocol (IP)-powered devices is increasing, as many industries find creative and even transformative ways to exploit the "data exhaust," or Code Halo™, surrounding people, processes, products and operations.

The list of potential IoT examples grows by the day – and their application is seemingly limitless. When it comes to a company's product portfolio, almost everything in it appears up for grabs. We see endless opportunities to build smart products, smart processes and smart places that enable business transformation across the extended value chain (see Quick Take, next page). Smart, connected products can provide insight into how customers actually use a product, how well the product performs and a new perspective into overall customer satisfaction.

transformation models will emerge. Order-of-magnitude improvements will take shape as business intelligence drives efficiency, waste reduction, predictive maintenance and other forms of value.

Companies will take for granted that ambient data captured from the physical world will inform their products, processes and customer services. The conversation will be less about how to connect "things" and more about the insights resulting from instrumentation of large parts of the value chain. IoT tech-

IoT technologies will be a commodity, and the real value will be in the analytics performed on the voluminous streams of contextual data emitted by the "digital heartbeat" of the value chain.

Capital-intensive products can be sold for the first time "as-a-service," shared among a pool of customers and handled as an OpEx item rather than a more expensive CapEx investment. IoT opens the door to a whole new way of building and conceptualizing products, and serving customers with a sustained engagement model, as companies that may have interacted with customers only at the initial sale of capital equipment can now create an ongoing relationship that continues over time.

Future Promise

First, a prediction for the near future: In a few years, the term "IoT" will disappear from our vernacular, and discussions will revolve around the *purpose* of IoT – the business transformation that results when physical assets, production processes and inhabited spaces are connected as a "system of systems" whose components inform and feed upon one another to drive new business value. Entirely new business models, products-as-a-service, smart cities, intelligent buildings, remote patient monitoring capabilities and industrial

nologies will be a commodity, and the real value will be in the analytics performed on the voluminous streams of contextual data emitted by the "digital heartbeat" of the value chain. IoT will be inherent in how products operate and how physical business processes transpire, and the instrumentation-to-insights continuum will become the standard way of doing business. But we are some years away from this vision, and we need to explore what it takes to get there.

Today's Reality

Much of today's market discussion around the IoT is focused on the component ingredients. New and established companies saturate the market with individual, and sometimes isolated, pieces of the IoT solution. Several platform leaders are emerging, as well. But even as the ingredients mature, sustainable success will require more than neatly stitching them together. As the hype around IoT rises, many organizations will easily overlook the massive level of change – on both a technological and business level – they must overcome.

Creating Value through Scaled-Up IoT

Businesses are embarking on their IoT journey from different perspectives; some begin with investigations into new sensing technologies, while others start by exploring their existing and advanced data sources through new data mining techniques. As their products take on new characteristics through the application of IoT instrumentation, businesses can re-imagine their products and create valuable new services for their customers. Here are some examples of what we've seen in our work with clients on scaling up IoT:

- **Industrial equipment rental company:** This business is reducing downtime and minimizing lost revenue through new track-and-trace capabilities that improve the utilization of machine rentals. New business opportunities are also emerging, with the addition of key IoT end-to-end ingredients, including an array of mobile applications that feed behavioral data on a variety of end customers into a highly-scalable analytics platform.

  This company is an example of an early leader reinventing its capital-intensive business and bringing greater transparency to field operators, as the people operating the equipment can obtain more data on machine status in-real-time, while they are using the equipment. Through mobile apps and instrumentation, the field operator can know more about the machine state. Eventually, after achieving a level of significant scale with this solution across sites, this company will be able to offer new data-driven services that enable new leasing and equipment-sharing models that better serve customers and increase its addressable market.

- **Leading healthcare organization:** This company has implemented a remote patient monitoring solution that reduces the need for patients to visit clinics when measuring routine vitals, increasing patient satisfaction and reducing operating costs. The ability to generate continuous data and insights about patients in a home setting also provides healthcare professionals with an early warning system about each of their individual patients and could also provide new insights across many patients with similar conditions. When it rolls out remote patient monitoring at scale, on a state or national level, the company, its customers and the patient could realize enormous value.

- **Oilfield services company:** This business instrumented its submersible pumps to more effectively extract petroleum from the ground. Instrumentation can also reduce maintenance costs, eliminating the need to send a technician to the site by enabling remote monitoring and even remote upgrade services. The company is now beginning to think through the potential of the "connected oilfield" and needs to identify and remove obstacles to scale to fulfill the vision of the digital oilfield across all sites.

IoT scaling also unleashes a tsunami of new forms of data, posing a challenge to existing infrastructure, algorithms and applications.

The most advanced organizations are deploying experimental pilots and prototypes and, in many cases, are focusing exclusively on the instrumentation ingredient of IoT. (For more on how organizations are assessing IoT's potential, please read "Transcending the Hype: A Transformative IoT Emerges," *Cognizanti* Vol. 8, Issue 1, 2015). While this early experimentation is necessary, most companies fail to realize that prototypes don't expose the complexity of IoT at scale, and it is only through scale that business value potential can be realized. IoT scaling also unleashes a tsunami of new forms of data, posing a challenge to existing infrastructure, algorithms and applications. To take advantage of this torrent of data, organizations need to reinvent and reimagine their own products and processes (see Figure 1, next page).

The Differences with IoT Delivery

Adding connectivity, computation and interactivity directly into everyday things requires organizations to consider new types of challenges, such as radio interference, power, physical access and ruggedized design. IoT, therefore, requires critical understanding of industry business problems, new instrumentation technologies and techniques, and the physical nature of the environment being instrumented.

IoT solutions are typically defined by a three-tier architecture, including:

- Physical instrumentation via sensors and/or devices.

- An edge gateway, including communication protocol translation support, edge monitoring and analysis of the devices and data.

- Private/public/hybrid cloud-based data storage and complex big data analytics integrated with enterprise back-end systems.

The complexity of the individual technologies and their integration is why many early IoT pilots focus either on sensor selection and the challenges of instrumentation, or big data analytics of existing telematics environments. Without an equal emphasis on instrumentation and actionable insight, however, the solution will not be positioned to deliver business value.
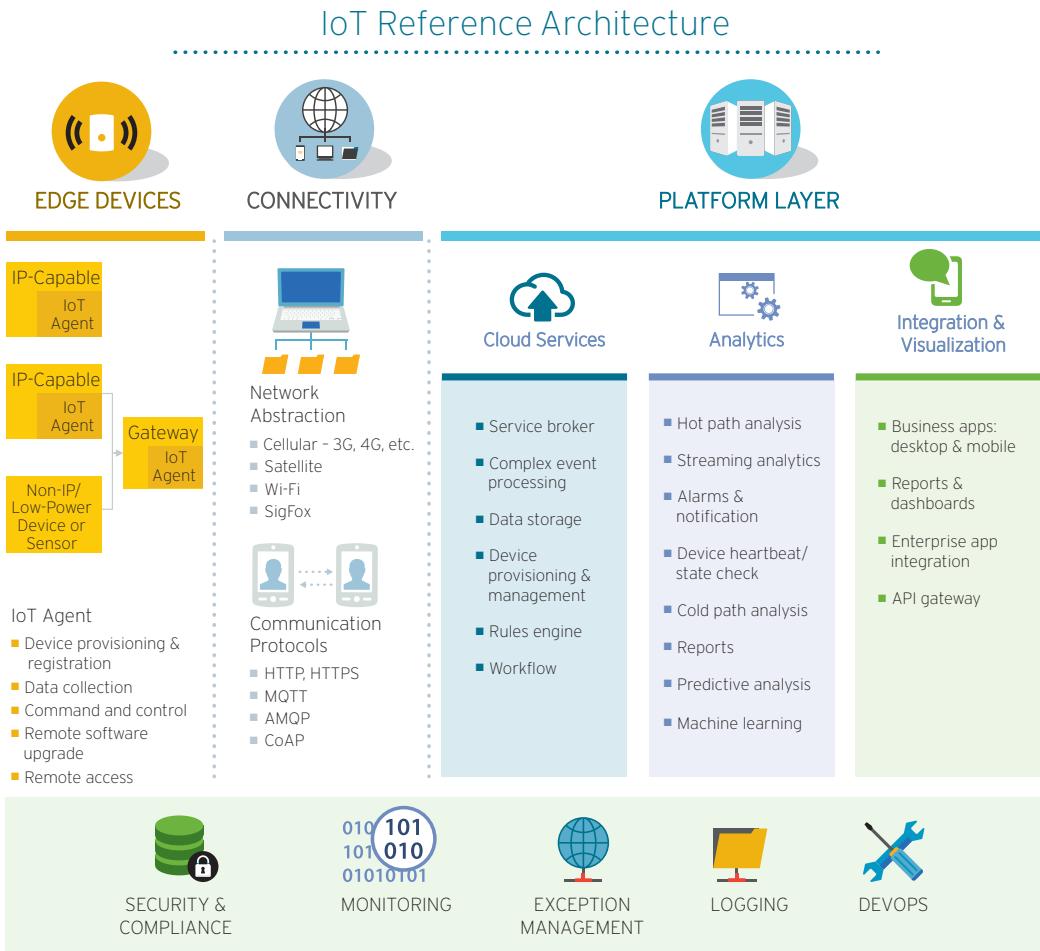
Successful business transformation initiatives apply basic IoT building blocks to a specific industry challenge to gain market advantage, and are fitted to the constraints of the characteristic-sensing infrastructure (e.g., RFID tags and readers in retail inventory tracking vs. vibration sensors in manufacturing for predicting equipment failures). Finally, these IoT integrations must then be tuned to the actual physical environments in which the instrumentation technology will be deployed and aligned with the business focus areas for each company. This often requires companies to seek outside expertise or leverage a complementary set of ecosystem partnerships.

Additional scalability challenges include:

- The large number of autonomous heterogeneous sensors and devices.

- The high volume/velocity/variety of data needing spatial and temporal context.

- The new forms of end-to-end IoT security, distributed device management and distributed data analysis.

- The physical installation/support services needed to support IoT system deployments at scale.

- The need for continuous critical assessment of potential partner capabili-

Connecting the IoT Dots

A scalable IoT architecture typically comprises three tiers:
edge devices and sensors, connectivity and a platform layer.

IoT Reference Architecture

EDGE DEVICES

IP-Capable IoT Agent

IP-Capable IoT Agent

Non-IP/ Low-Power Device or Sensor

Gateway IoT Agent

IoT Agent
- Device provisioning & registration
- Data collection
- Command and control
- Remote software upgrade
- Remote access

CONNECTIVITY

Network Abstraction
- Cellular – 3G, 4G, etc.
- Satellite
- Wi-Fi
- SigFox

Communication Protocols
- HTTP, HTTPS
- MQTT
- AMQP
- CoAP

PLATFORM LAYER

Cloud Services
- Service broker
- Complex event processing
- Data storage
- Device provisioning & management
- Rules engine
- Workflow

Analytics
- Hot path analysis
- Streaming analytics
- Alarms & notification
- Device heartbeat/ state check
- Cold path analysis
- Reports
- Predictive analysis
- Machine learning

Integration & Visualization
- Business apps: desktop & mobile
- Reports & dashboards
- Enterprise app integration
- API gateway

SECURITY & COMPLIANCE   MONITORING   EXCEPTION MANAGEMENT   LOGGING   DEVOPS

To realize IoT's business benefits, organizations must design and implement each layer of the architecture at-scale, with hooks across company functions to ensure tight integration with run-the-business legacy systems. Our reference architecture illustrates how large volumes of device and sensor data can be collected and then fed into an analytics platform. From there, structured data is passed to an integration and visualization layer, through which enterprise applications such as ERP and CRM applications can access streams of data in real-time. Lastly, dashboard applications can be plugged into this architecture to help business leaders make more informed operational and strategic decisions.

Figure 1

Pilots illuminate how IoT connectivity works, but they often fall short of revealing the potential for waste reduction, efficiency, productivity or creative new business models.

ties and technology evolution to incorporate best-of-breed ingredients. Prioritizing criteria such as scalability and longevity is key, particularly because the IoT uses nascent technologies from an emerging and rapidly changing ecosystem, with startups emerging almost daily.

- The context of IoT-generated data (i.e., metadata) exponentially increases the volume, variety and velocity of data that must be collected, handled by the IoT solution and incorporated into legacy enterprise systems.

At a business level, this means companies must look beyond the question of which pilot experiments to run and investigate how to design and implement IoT solutions that scale, even if they start small and evolve toward larger implementations over time.

As with most technology initiatives, the business cases are realized only at scale. Connecting a few devices doesn't really do justice to the power of the IoT to create more meaningful products, processes and places to elevate business performance. Specifically, pilots illuminate how IoT connectivity works, but they often fall short of revealing the potential for waste reduction, efficiency, productivity or creative new business models.

Overcoming the Challenges of IoT Scale

To quickly move from prototyping to real-world deployment, we recommend the following:

- **Focus on the underlying business problem or opportunity.** Change the mindset around IoT from technology

experimentation to business transformation, beginning at the heart of the company's most valuable assets. A coordinated engagement between the COO and CIO, a CFO-ready business plan, product, delivery and customer service is a prerequisite for IoT scale.

- **Understand how IoT amplifies value.** When an object becomes part of the IoT, it gains a unique persistent identity and the ability to share information about its state. As a result, an intelligent object's value is amplified across its lifecycle – from creation, manufacturing, delivery and use, to its demise – as well as across its network of suppliers, producers, partners and customers, whose interactions and access are managed through and by the IoT. When a product's lifecycle and network are taken into account during an IoT exploration, it is possible to realize the potential for structural transformation of processes, networks and even the product itself.

- **Consider the physical nature of the environment.** IoT brings connectivity to everyday objects rooted in a physical place. This results in two critical facets of IoT scaling: an understanding of the interplay between objects, between objects and people, and between objects and the environment (requiring a deep understanding of the setting and how the physical place works), and an understanding of how the physical environments themselves may impact the connectivity and successful interaction of objects. Since IoT is dependent on wireless radio waves to transmit data from objects, any radio interference in a physical environment can affect transmission and needs to be taken into account during system design.

The goal of IoT scale is for individual systems to interact with one another within the physical world and become invisible, embedded and blended into the workplace. It takes an understanding of the inner workings of a place and the ability to translate technology into that environment. For example, a "digital oilfield" IoT concept may bring together oil and gas consultants who understand industry pressures, drilling rig personnel who know the physical nature of day-to-day operations, and IoT technology experts who can instrument and connect the environment.

- **Realize it "takes a village" to unify all IoT ingredients.** IoT is a "system of systems" made up of many different ingredients and expertise, and is dependent on end-to-end systems integration. This is what can revolutionize a business model and enable coordinated initiatives architected for scale. Enrolling partners with the required domain expertise, as well as hands-on experience with integrating IoT technologies, will help your organization chart a long-term roadmap for IoT strategy and implementation.

Realizing Full IoT Value

Progressive organizations will quickly transcend IoT workshops and pilots to build a long-term roadmap that is driven not by technology, but by their business vision for the future.

IoT can be both massively disruptive and valuable across an industry, so while early pilots help companies understand how to bring basic connectivity to life, they still fall short of unlocking the underlying business value that can only be mined at scale.

To create a meaningful difference in the business model, the product and/or operational processes, organizations must tackle IoT in a coordinated way across functions – at scale. This requires vision and leadership, as well as outside expertise and an ecosystem of partners to deliver a successful IoT journey.

Note: Code Halo™ is a trademark of Cognizant Technology Solutions.

Footnotes

1 W. Brian Arthur, *The Nature of Technology: What It Is and How It Evolves*, Free Press, January 2011, http://books.simonandschuster.com/The-Nature-of-Technology/W-Brian-Arthur/9781416544067.

Author

Mary Murphy-Hoye is Vice-President of Cognizant's Internet of Things Services Practice and leads the company's IoT global consulting services organization. Prior to joining Cognizant, Mary held senior leadership positions over her 28-year career at Intel, where she helped companies create and implement large-scale prototypes and solutions in high-volume production environments utilizing disruptive technologies. Mary has worked as trusted advisor across multiple industries, from end-to-end retail, industrial automation, high-tech, oil and gas, through chemical, manufacturing and transportation (including ocean-bound cargo containers and railcars) and logistics. She received a bachelor of science degree in mathematics from University of Arizona and has won numerous awards for her research and innovation. Mary was named one of Connected World's Women of M2M 2014. She can be reached at Mary.Murphy-Hoye@cognizant.com | LinkedIn: www.linkedin.com/pub/mary-murphy-hoye/1/b7/386.

Acknowledgments