Top 10 Trends in 2018 Driving the Utility Industry Toward a Decarbonized, Distributed, Digital and Democratized Future

Published: 4 April 2018 **ID:** G00354874

Analyst(s): Zarko Sumic, Nicole Foust, Ethan Louis Cohen, Keith Harrison

A confluence of socioeconomic drivers and technology innovation is forcing utilities to transform into digital enterprises. Utility CIOs should evaluate these trends as input to digital innovation and considerations for future digital business and operating models in the utility sector.

Key Findings

- In the years to come, utility business will be driven by four forces: digitalization, decentralization, decarbonization and democratization.
- Technology innovation at the grid edge is disrupting the utility sector, forcing policymakers and utility leaders to explore new regulatory frameworks, and to enable new business and operating models for more sustainable energy provisioning.
- Major technology forces such as the digital twin, AI or blockchain will impact utilities. However, the implications and opportunities for different utility archetypes (landlords, survivalists, explorers and pioneers) will be different.
- Digital business will require a host of new information and technology capabilities that can be logically clustered into various digital technology platforms.
- Utilities' innovation postures may differ, depending on the corporate archetype; however, in all cases, CIOs must create and foster a robust process for repeatable and sustainable innovation.

Recommendations

Utility CIOs who are focused on transforming into a digital utility should:

- Define IT investment strategies by aligning their focus with the most relevant trends for their operating environment and corporate strategy.
- Invest in projects that include new technologies underpinning digital business by increasing focus on general-purpose technologies, such as AI and blockchain.

- Make robust investments in foundational technologies by focusing on areas such as digital twins and distributed energy resource management systems (DERMSs).
- Establish an innovation function by employing Mode 2 of bimodal to identify and pursue opportunities from transformational technologies.

Table of Contents

List of Figures

Analysis

In this research, we explore the key business and technology trends that will shape the global utility sector in 2018, as well as their effect on business and technology investments. Utility CIOs should use these trends as key input to the overall information and technology strategy planning process. They can also be used to discern external change impacts, and as input to both digital innovation initiatives and considerations regarding future digital business and operating models for utility companies.

The IT organization's role in utility companies should be as a business enabler. This requires a good understanding of the environment in which utilities operate, including socioeconomic drivers, policymaking and regulatory settings, business models, and changing consumer attitudes and demographics. In addition, IT leaders must have a good grasp of emerging technologies — utility-specific as well as general-purpose — in order to identify those that drive and are capable of addressing current and future business needs.

In 2018, the global utility sector will continue to be challenged by a number of factors, including an ongoing search for a sustainable energy provisioning business model. The challenges and opportunities for utilities can be summed up as four Ds: digitalization, decentralization, decarbonization and democratization. These are key forces that will be driving transformation in utility sectors for years to come. The business and technology trends explored in this research are direct outcomes of or contributors to the forces of those four Ds.

The advent of prosumers, the most significant disruption in the utility sector — driven by energy technology consumerization (see the Energy Technology Consumerization Accelerates Utilities' Digital Transformation section) — is creating challenges to the existing utility business model. This is the key outcome of the decentralization, decarbonization and democratization push that is forcing regulators and policymakers to consider new market models (see the Electricity Markets Morph as Distributed Energy Changes Everything section). The emergence of prosumers will require a new operating model that will effectively integrate and orchestrate the contribution of prosumer-owned distributed energy sources in new energy markets (see the Transactive Energy Emerges as a Framework for Effective DER Integration section). Disruption coming from the edge of the grid, driven by the fast pace of innovation of exponential technologies, is moving the nexus of innovation in the utility sector toward the edge of the grid (see the Innovation in the Utilities Sector Is Driven by Digital Disruption at the Edge section).

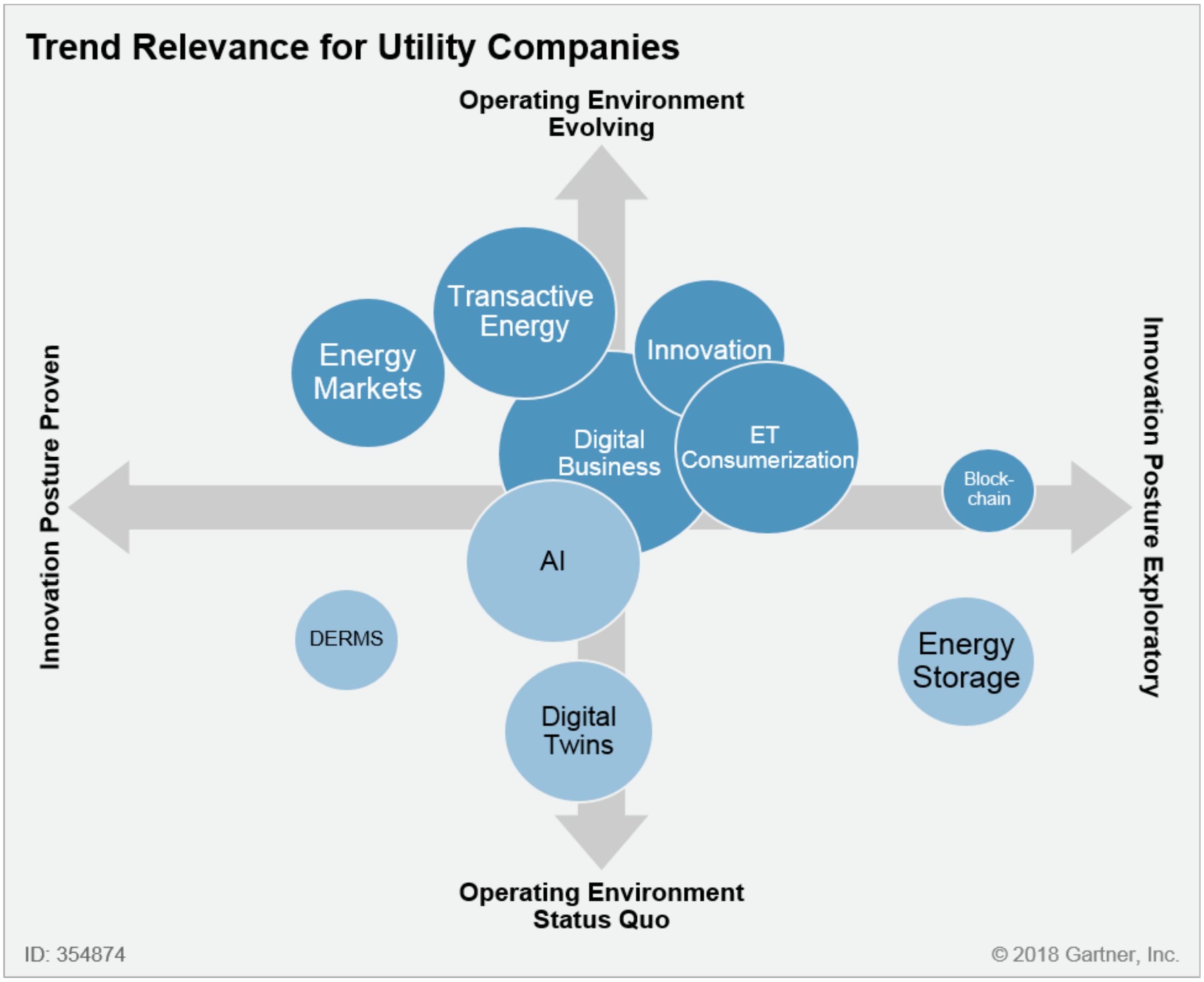
General-purpose technologies advancing rapidly in other sectors are enabling the creation of new business designs. Although utilities trail other sectors in scaling digital business (see the Utilities Struggle to Scale Digital Business Initiatives section), digital is progressing. It is enabling the reinvention of the sector, thereby making new information-centric and decentralized energy provisioning business models possible. An example of digital technology that may disintermediate or change the role of utilities and contribute to sector democratization is blockchain (see the Blockchain Enables Democratization of Energy Provisioning section).

Meeting mandates for reliable and universal service while preparing for the coming transformation will require different operating mindsets. Such a dual approach is needed to ensure the stability and reliability expected from an entity that provides existential societal services, and to support the innovation required during the quest for the future energy provisioning model. In addition to supporting exploratory digital business transformation, utility CIOs need to maintain technology and application portfolios that support current operating conditions meeting regulatory requirements and customer expectations.

Artificial intelligence (AI) is an example of a transformative digital technology that will deliver speed, cost efficiencies and better data processing for multiple utility functions (see the Deploy AI for Utility Business and IT Optimization section). Digital twin, an outcome of Internet of Things (IoT) and advanced analytics, offers a technology base for significant performance improvement in core utility business processes, such as asset performance management (see the Digital Twins Improve Asset-Related Decision Making section). CIOs of utilities that are responsible for managing linear assets need to ensure that the underlying network infrastructure can withstand new cooperative models with consumer-owned distributed energy resources (DERs; see the Distributed Energy Resource Penetration Is Disrupting Utilities section). On the energy technology side, utilities are realizing the operations benefits of energy storage to improve transmission performance, to buffer renewable intermittency and to enable prosumer market arbitration (see the Energy Storage Raises the Stakes for Utility Digital Business Capability section).

Figure 1 depicts the relevance of a particular trend for utility companies, based on the environment in which they operate as well as their innovation posture. The impact of the trend is represented by the size of the circle, while the color indicates the trend's primary contribution to "performing" goals (light blue) or "transforming" goals (dark blue).

Figure 1. Trends' Impact on Utilities Based on Operating Environments and Innovation Postures



Source: Gartner (April 2018)

Energy Technology Consumerization Accelerates Utilities' Digital Transformation

Analysis by Zarko Sumic and Ethan Louis Cohen

Key Findings

- Utility customers are adopting energy technologies (such as rooftop solar, electric vehicles [EVs] and energy storage), shifting energy technology innovation outside of utilities and creating new ecosystems.
- Consumer technology megavendors have emerged as winners in the energy technology consumer space. Rather than pursuing their own ecosystem strategy, utilities are focusing on becoming part of the megavendors' connected home ecosystem.

- Energy technology consumerization is driving the digital transformation of utilities and enabling new energy provisioning models, such as the sharing energy economy and transactive energy markets.
- The utility customer digital experience gap — the everyday experience customers have with technology versus the experience they have with the utility — may drive mind share and wallet share away from new industry business models.
- Utility IT applications for customer, revenue and commodity processes will need to be replaced or retrofitted to accommodate energy producer consumers (aka prosumers).

Implications

Energy technology consumerization is analogous to the consumerization of IT. In both cases, the influx of technology from the consumer marketplace is forcing companies to be more nimble in supporting unplanned-for technologies that are outside their control. Energy technology consumerization disrupts existing utility business models and creates new opportunities in key utility business processes. Examples of consumer energy technology include smart thermostats, rooftop photovoltaic (PV) systems, microgrids, EVs and energy storage. These exponential technologies result from innovation at the edge of the grid, outside the boundaries of the traditional utility business.

Consumer adoption of energy technologies impacts all utilities, but the intensity of the trend is uneven. Factors elevating the importance of the trend for a utility include regulatory environments that are favorable for renewable energy adoption, including the presence of subsidies. The socioeconomics (for instance, affluent customers investing in technologies like EVs) and cultural factors (such as consumers who want sustainable lifestyles) are contributors as well.

A limited number of utilities have created successful customer energy technology offerings. The vast majority of consumer energy technology is purchased by customers, provisioned by consumer technology megavendors (Google, Apple, Samsung, Tesla) and installed by third parties. This creates interoperability challenges for utilities seeking integration of demand response and grid services (for instance, tapping into smart inverters or energy storage batteries for voltage regulation).

Utilities' initial reaction to energy technology consumerization was to go beyond the meter and offer their own "brand" of consumer energy technology solutions. However, the battle for the connected home and consumer energy technology has been won by consumer technology megavendors. Consequently, instead of peddling their solutions, utilities should consider becoming part of the consumer technology megavendors' ecosystems. By leveraging connected home APIs and/or digital assistants, utilities can address interoperability complexity and concerns.

Consumer adoption of energy technology is also changing customers' relationships with their energy suppliers. Customers are moving from being passive payers of monthly bills to being more proactive and engaged in energy consumption and production. Utilities' ability to create customer profiles that include data about customers' energy technologies is valuable for a range of pursuits. Some examples are better customer service, evaluating opportunities to create innovative service offerings (such as microgrids and fast EV charging stations), and tariff planning and development.

In the longer term, consumer adoption of energy technologies will enable energy provisioning transformation, and drive opportunities for utilities to transform into digital businesses. Consumer energy technologies also create opportunities for new providers to enter energy markets, and for existing energy service providers (such as energy efficiency advisors) to grow. Many of these players have a direct interest in energy consumption data, thereby creating a need for data governance policies such as sharing customer energy data with third parties. It also creates a need for data integration between consumer technology and other utility systems.

Recommendations

Utility CIOs who are focused on transforming into a digital utility should:

- Prepare for continued energy technology consumerization by accelerating investment in customer engagement to achieve more visibility in consumer energy technology investment.
- Pursue standards for integrating with customer energy technologies by enabling data sharing with customers and, in the near future, with things.
- Work with the business to identify and pursue partnership opportunities in key consumer energy technologies (such as smart inverters or EV charging) by identifying leading consumer energy technology ecosystems.
- Become part of the consumer technology vendor connected home platform ecosystem by leveraging APIs and/or digital assistant integration capabilities.
- Identify opportunities to create innovative services with consumer energy technologies, and seek business backing to scale from proofs of concept (POCs) to full-scale service offerings.

Electricity Markets Morph as Distributed Energy Changes Everything

Analysis by Keith Harrison

Key Findings

- Policymaker and regulator intervention in wholesale and retail markets increases as the issues of reliability, availability, price and cost become influenced by the decentralization of energy.
- The electrification of final energy consumption is rising as industry and transportation increasingly seek to reduce the emissions associated with hydrocarbons. This is driving new solutions for both grid and grid edge energy production and storage, which need to be factored into market design.
- Traditional power markets are evolving in response to decentralization and prosumers, in line with a rise in market participants with distributed energy assets and community energy programs.
- The information requirements associated with physical and financial transactions in decentralized energy markets challenge the viability of the utility business model as well as traditional utility processes, systems and capabilities.

Implications

As the number and range of electricity production and energy storage facilities grow in line with the prevailing trend of energy decentralization, this presents several issues for policymakers and regulators. In a centralized electricity supply model, the electricity market is relatively straightforward. In wholesale we have physical and financial/forward power and associated commodity markets. Governance/control is provided by regulatory bodies on both the physical side and the financial side.

Things change in the new era of distributed energy. In this context, utilities may no longer be at the center of the relationship between the producer, the consumer and the regulator of electricity. Technology is enabling and empowering producers and consumers and aggregators of both supply and demand. This decentralization of electricity production, trading and control will benefit and enable prosumers, energy exchanges, brokers and intermediaries.

On one level, as energy provisioning decentralizes, prosumers will look to utilities more purely as a balancing agent or a backup. In this case, the prosumer may expect to pay for a net-metered supply at a lower cost (fewer units of energy drawn from the utility as they utilize their own generation/storage facilities). Many utilities are experiencing a drop in traditional commodity sale revenue, as less of the energy they produce is consumed by prosumers. The consumer without access to their own generation facilities could find their utility bills rising substantially to meet the utilities operating costs and national subsidies. This could become a heated political issue in the coming years. Indeed, this could lead to the reversal of market deregulation and the renationalization of the electricity distribution infrastructure in some regions to allow for the investment required to upgrade networks to meet demand.

A number of national and regional/state initiatives are underway to address this fundamental change in energy provisioning and markets. In the U.S., the New York (State) Reforming Energy Vision initiative and in the U.K. the Future Power Systems Architecture (National) are examples of work underway. In the EU, the issue of market redesign is also underway at a transnational level as the nations of the EU look toward an "Internet of Energy" across the regions connected national networks and markets.

A less dramatic but nevertheless strategic consideration for utilities will be determining how to accommodate the rapid growth in DERs, from both asset management and commercial perspectives.

For utility CIOs, this means the evolution of the major software application suites or foundational technologies of the utility. These range from energy trading and risk management (ETRM) solutions in wholesale markets, to solutions linked to managing assets on the distribution network, such as advanced distribution management systems (ADMSs). Solutions associated with retail markets will also be impacted, as customer information system (CIS) and CRM solutions evolve to accommodate increasingly diverse products and services associated with a decentralized electricity market model.

Recommendations

Utility CIOs seeking to optimize foundational technologies should:

- Familiarize themselves with the range of market change scenarios in their regions by both referring to state, national and regional energy policy and regulatory developments, and having direct discussion with internal regulatory functions.
- Identify, prioritize and estimate the cost of the system impact of a range of market scenarios by scenario planning with business and regulatory leadership (and vendors as needed).
- Leverage the opportunity provided by any market-related change requirements by using this as a vehicle to introduce additional IT initiatives, or to address wider issues such as governance or shadow IT concerns.

Transactive Energy Emerges as a Framework for Effective DER Integration

Analysis by Zarko Sumic and Ethan Louis Cohen

Key Findings

- Transactive energy is a framework for managing the generation, consumption and flow of electric power through the use of economic or market-based constructs while considering grid reliability constraints.
- Economic incentives are needed as a control lever to optimize the distribution network for the benefit of all participants. Information about energy consumption will play an important role by enabling price transparency for the operation of local energy markets.
- Transactive energy can be an effective mechanism to integrate and orchestrate DERs into local energy markets. It can allow for a variety of operating models, including distribution networks, as an open access platform (aka the Internet of Energy).
- A distributed platform in the transactive world is expected to scale well. However, deployment of DERs, and the related software that controls grid devices, has not yet reached maturity where transaction performance can be assessed and validated at scale.

Impacts

The future of utility business is distributed. As the network architecture transforms from a centralized radial structure into a decentralized geodesic architecture, it will require a new operating model. That operating model will be much more information-centric and leverage dynamic consumption, congestion and pricing information. Consumption information will be useful for establishing different commercial relationships with energy consumers/prosumers. But, even more importantly, it will become a control lever to optimize the use of energy distribution networks. This will be done by creating local energy markets that will congregate prosumers, energy service providers, aggregators, utility companies, and market operators and engaging them in an atomistic and decentralized energy-provisioning model. The model should include information about the cost of grid-provided energy based on production and local congestion prices and asset operation costs. It should include customer incentive pricing that will drive consumer behaviors, such as when to charge an EV, rely on grid power or use on-site DERs.

Transactive energy is a set of economic and control mechanisms that allows the dynamic balance of supply and demand across the distribution network, using price as a key operational parameter. The transactive energy approach offers a broad array of benefits to utilities and customers, but the cost and capability to access benefits is not equal for all market participants. Benefits such as better utilization of grid assets and greater resilience and grid reliability will generally accrue to the utility. Other benefits, such as electricity source choice and the inclusion of renewable energy resources, tend to mount up for the consumer. Still other benefits, such as active demand response — in addition to presenting benefits to electricity producers, transmission and distribution utilities, and consumers — also provide wider societal benefits.

The underlying economic model and control theory for transactive energy markets are not new and unproved. They have been successfully used to operate transmission networks across the globe for more than two decades. Technology innovations — such as IoT architecture, cloud, edge analytics, blockchain and a host of other digital technologies — hold the promise to support production-scale transactive energy. However, there are few proof points and even less real-world experience, not to mention lack of best practices and standards, for the deployment of transactive energy.

Control and governance of a decentralized electricity system marketplace is arguably the most important hindrance to quick regulatory resolution. It is also the biggest gating factor for the volume and flow of investment into transactive energy. Emerging blockchain technology is perceived as an alternative way to address DER integration via a peer-to-peer (P2P) construct due to its decentralized, security and chain-of-custody transparency features. However, blockchain platforms may not be able to manage problems such as overall orchestration of the market, including congestion, power quality and reliability. Given the multidimensionality and varying parameterization of analysis required for these new operating models, utilities cannot assume that their role and obligations in transactive energy will become instantly clear.

As a highly centralized distribution device control system moves toward a more decentralized system, the role of market participants in overseeing and governing such a platform has not been articulated. Policymakers and regulators are lacking in their understanding of the risks and benefits of transactive energy.

Despite technical immaturity and unclear regulatory posture, now is the time for market participants (including utilities) to experiment and innovate with transactive energy. This will allow utilities to not only validate the technical feasibility of the new energy provisioning paradigm, but also explore new business and operating models. Those models are driven by the digital transformation of the utility sector and disruption emerging from the edge of the grid.

Recommendations

Utility CIOs who are focused on transforming into a digital utility should:

- Prepare for the distributed energy future by evaluating transactive energy markets and the alternative models that will support both effective integration of DER and the new digital transformation of energy provisioning.

- Drive democratization of energy with corresponding digital business models by participating in the development and publishing communication standards that are necessary for transactive energy markets.
- Expand the utility's potential for influence and orchestration of transactive energy markets by developing advanced analytics that enable real-time communication and market optimization capabilities.

Innovation in the Utilities Sector Is Driven by Digital Disruption at the Edge

Analysis by Zarko Sumic and Keith Harrison

Key Findings

- Technology innovation and uptake at the grid edge present the major disruptions to traditional utility business, while at the same time opening new opportunities.
- Sourcing and cultivating innovation in utilities have taken many paths. Examples are the establishment of internal innovation functions, crowdsourcing, leveraging academia and external providers, or investing in technology startups.
- Utility leadership in digitally enabled innovation has invariably involved the CIO, but is not always led by the CIO. The 2018 Gartner CIO Survey found that only 38% of utility CIOs lead the innovation function (see "2018 CIO Agenda: A Utility Perspective").
- Utilities' innovation postures differ, ranging from a focus on proven industry technologies to more exploratory exponential technologies.

Implications

Technology innovation and uptake continue steadily in utilities. Maintaining smooth, uninterrupted performance while preparing to support transformative business needs (driven by combinatorial technology innovation) forces utility CIOs to balance and blend priorities. Above all, this trend places new requirements on CIOs to lead digital-technology-enabled innovation.

Nowhere is the pace of innovation in energy supply more acute than at the grid edge. This results from consumers of all sizes seeking alternative solutions as a means of reducing costs, relying on grid-supplied power or meeting sustainability targets. The material impact of this decentralization of energy production and management can be seen on many utility income statements. Revenue from traditional commodity supply to consumers drops, putting further pressure on already-tight retail supply business margins.

Digitally enabled innovation poses unique challenges for utilities in terms of talent, structure, innovation process and the role the CIO plays. Some utilities externalize innovation activities through the establishment of innovation businesses or new-venture businesses. In some cases, these businesses aim to invest in startup businesses relevant to the utilities operation — typically in the asset management or retail energy product/service domains. This approach can deliver value on multiple fronts, from the potential return on investment in these startups to the benefits of early adoption as the sponsored innovations gain a foothold in the core utility operations. In other cases, a separate innovation business can focus on the delivery of pilots and prototypes for the utility. The aim should be to move the successful candidates to production and owning the innovation, as opposed to owning a stake in it per the previous example.

Depending on the operating environment and the utility innovation posture, expectations of what the outcome of an innovation initiative should be can differ significantly (see the Innovation Posture sections in "Utility Scenario: Explorers Must Focus on Pragmatic Innovation" and "Utility Scenario: Pioneers Are Settling New Digital Frontiers").

Utilities that Gartner characterizes as "landlords" innovate to minimize disruptions to their existing business models, while utilities that we characterize as "survivalists" innovate to extend their existing business environments. In both cases, these utilities do so by leveraging proven vertical technologies and relying on their peers or technology partners for co-innovation.

Utilities that Gartner characterizes as "explorers" or "pioneers" tend to have a corporate innovation posture that is externally focused, favoring emerging general-purpose technologies and combinatorial innovation. The goal of their innovation initiatives is to come up with new business and operating models. Instead of focusing on proven technologies and vertical vendors' solutions, they look outside the utility sector for different approaches and different technology solutions. In some cases, they attempt to create a platform for digital sector transformation.

Regardless of the particular innovation posture or operating environment, all utility CIOs must create and foster a robust process for repeatable, sustainable innovation. To that end, the scope, track, rank, evaluate, evangelize, transfer (STREET) process provides a useful framework for utilities to manage innovation. CIOs should also use Gartner research tools to proactively scan for disruptive technologies and trends. In addition, they should evaluate for applicability some examples from other industries that share common attributes with utilities (such as asset-centric or highly regulated). The candidate industries should have achieved digital transformation through network economy platforms or new digital service delivery.

Innovation management should become a core competence for utility CIOs. Innovation programs can engage internal and external participants through specialist groups and brainstorming workshops, or through broader activities relating to "idea jams," events, challenges, crowdsourcing and open innovation. Innovation management needs to include mechanisms for capturing and aggregating the outcomes of these forms of engagement. That should include the ability to sift, filter, organize and systematically assess the risks and rewards of different options; and to align these options with specific business priorities.

Recommendations

Utility CIOs who are focused on transforming into a digital utility:

- Create an innovation culture by involving both IT and business leadership to leverage the opportunities created by exponential technology-driven disruption.
- Learn from other industries by examining successful innovation strategies in related industry segments and adapting them, as appropriate.

- Create an ecosystem by leveraging external partners' (such as trade organizations, academia and technology vendors) contributions to your innovation process.
- In the case of utilities with external R&D units, establish value-adding processes with the innovation organization by reducing investment risk and/or the adoption of any successful innovations.

Utilities Struggle to Scale Digital Business Initiatives

Analysis by Zarko Sumic and Keith Harrison

Key Findings

- The majority of digital business initiatives in the utility sector tend to be focused on digitization initiatives (that is, improving existing business processes via digital technology).
- Digital transformation of the utility sector will drive the emergence of future utility business models.
- The future utility business model will have to address and leverage current realities, such as clean energy supply and delivery constraints; the emergence of prosumers; and hyperconnected assets, people and businesses.
- Digital business will require a host of new information and technology capabilities that can be logically clustered into various digital technology platforms.
- As per 2018 Gartner CIO Survey findings, although utilities have invested in POCs, the lack of definition and demonstration of value slows the scaling of digital compared with other industries (see "2018 CIO Agenda: A Utility Perspective").

Implications

Digital business is the creation of new business designs that blur the digital and physical worlds by combining things, people and businesses. Consequently, they are able to communicate, transact and even negotiate with one another. Many companies view digital business as simply using digital technology to automate and provide incremental improvements to existing processes. This approach, aka "digitization," continues to reflect the current state of affairs in the utility industry. "Digitalization," on the other hand, is the reinvention of business models, which is made possible as entire functional areas are redesigned with digital technologies.

Digital business is impacting all aspects of the traditional utility value chain. Digital twins, modeled on operational technology (OT) data streams, are improving asset performance and utilization in generation domains. Synchrophasors are increasing situational awareness, making up for a loss of dispatchability of renewable sources. In the delivery domain, the impact of digitalization is being felt as the increased number of DERs makes network operation more complex. The smart meter deployment initiatives have provided utility, customer and societal benefits, while simultaneously exposing utility CIOs to new digital business challenges and opportunities.

In retail operations, the impact of digitalization is at its most acute. Edge-of-the-grid market developments — including energy technology consumerization, as well as technology giant ecosystems and virtual digital assistants — are increasingly tempting retail customers to explore new energy provisioning models and provider interactions. Digital business will play a key role in energy provisioning transformation. In addition to empowering consumers and addressing renewable integration challenges, it will require new utility operating models.

Utility CIOs face a daunting and complex task. For them, the context of digital entails collaborating with business executives to identify optimization opportunities. CIOs are also ascending into more strategic roles to support the transformation of the operating model, driven by digital disruption emanating from the edge of the grid. In doing so, they must wrestle with a variety of technical and nontechnical challenges.

As digitalization starts to transform the utility sector, "ownership" of assets will no longer be the only, or even the primary, means of generating economic value. We are now facing a new "economics of connections" that extend the basic principles of Metcalfe's Law (network effect). The sharing economy, as exemplified by companies such as Airbnb and Uber, is the epitome of digital business. It relies on information processing acumen, rather than ownership of production or delivery assets, to enable distribution, access, and the sharing of excess capacity in goods and services. An example of digital business is for utilities to become a platform provider for a sharing energy economy. Such a platform would enable the integration of prosumer-owned DERs into energy markets by exposing them directly to consumers. By managing an information exchange platform, utilities will enable value exchange (by leveraging data, analytics and algorithms) among parties, and be able to capture a share of the created value.

A digital business requires much more than technology (for example, leadership, talent and skills, and new business models). However, from a technology perspective, many will expect the CIO and the IT team to lay out the technology foundation. At a minimum, the IT organization must be able to design the "big picture" of all the new information and technology capabilities required to support digital business. IT can then work with the rest of the organization to define who — if not IT — will build/fund/support/own these major components, which can be structured into five digital technology platforms. Those digital technology platforms are: customer experience, IoT, IT, analytics and ecosystem.

Recommendations

Utility CIOs who are focused on transforming into a digital utility:

- Provide the CEO (or chief digital officer [CDO]) with the vision of future energy provisioning by exploring options such as platform business (and the ecosystems that will develop), on which a new digital utility can be built.
- Build the digital business technology foundation by identifying the new and improved information and technology capabilities required to support digital business, and by architecting digital technology platforms.

- Explore digital utility business transformation impacts, risks and promises by integrating business moments — that is, transient opportunities that are exploited dynamically — into your thinking about future energy provisioning models.
- Scale digital business by using Gartner digital business models and digital business key performance indicators (KPIs) to help in the assessment of digital business initiatives, and by understanding the implications of their scaling.

Blockchain Enables Democratization of Energy Provisioning

Analysis by Zarko Sumic

Key Findings

- Blockchain continues on its journey of hype, inflated expectations, misinformation, misunderstanding and questionable immediate value. There are wrong assumptions, created by media and vendors, that blockchain is already being actively deployed across enterprises, and that a larger transformation is underway.
- While virtual currencies and blockchain technology in the financial services industry have been the subject of significant debate, blockchain applications in the utility sector have received comparatively less attention.
- Blockchain's potential is in its ability to disrupt the existing business environment and enable democratization of the business processes that are traditionally managed by a central authority.
- Blockchain is not a "better mousetrap" and should not be used to improve existing business processes. However, the fear of missing out (FOMO) sometimes forces utility CIOs to initiate blockchain POCs that do not exploit real blockchain potential.
- As a distributed ledger technology, blockchain intuitively lends itself for use in P2P energy exchanges, although additional diverse blockchain use cases are being pursued via pilot projects.

Implications

Blockchain, the underlying technology behind cryptocurrencies such as bitcoin, is the globally distributed ledger of digital currency transactions. While originally considered only a financial tool, it has the potential to enable digital innovation across various industry sectors. This is particularly valid for those that rely on a central authority to track the exchange of goods or services. Examples of authorities that keep a central ledger of transactions would be banks, governments or utilities. Blockchain is an effective mechanism for achieving distributed consensus in the face of a dynamic collection of untrusted participants.

Blockchain is the authoritative record of bitcoin transactions, and is not stored in, or controlled by, a central server. Instead, the data is replicated across a global P2P network. The elegance and breakthrough from Satoshi Nakamoto's work in 2008 was to create blocks of records and chain them by combining older technologies into one architectural approach. Those were: digital signatures (1976), Secure Hash Algorithm (SHA)-256 (2001), Merkle trees (1979), Practical Byzantine Fault Tolerance (1999), distributed communications networks (1964), and complementary currencies (4,000 Before Common Era [BCE])/digital currency (1983).

Since about 2012, various technology evangelists have usurped these original concepts and rebranded the offering as "blockchain," and more recently as "blockchain 2.0." Many discussions make blockchain technology seem magical, especially relating to advanced features, such as the ability to store data and/or processing logic (algorithms). Although those dynamic capabilities lead to exciting potential use cases, they are several years away from being put into production.

In the utility sector, blockchain has the potential to enable new methods for managing how energy is distributed, accounted for and secured. For example, on the operational side, microgrids could become more resilient with direct P2P interaction among assets or participants. P2P enables intelligent electronic devices to share information directly, without the need for a centralized system. Also, data about the asset activity (and, hence, the value) can be exchanged instantaneously 24/7. Consequently, this is giving rise to new business models and applications for many distributed energy sources, as well as increasing the security and reliability of the grid.

Numerous blockchain POCs have already been attempted and reported in the utility sector (see "Blockchain in Utilities: Promise and Reality"). The most popular use case on the commercial side is blockchain as an enabler of P2P energy exchanges (see "Industry Vision: Utilities as Platform Providers for the Energy-Sharing Economy"). The energy-sharing platform can be implemented as a permissioned blockchain by either a utility or a "born digital" pioneer company (see "Utility Scenario: Pioneers Are Settling New Digital Frontiers").

The POCs involving tracking and trading of the renewable certificates, wholesale market trading (European project Enerchain), EV charging and eliminating energy retailers via blockchain have been reported. The U.S. Department of Energy has awarded a project to a consortium whose goal is to secure DERs and increase the trustworthiness, integrity, control and monitoring of energy exchanges. The distributed nature of blockchain technology and its ability to require coordination and consensus among distributed nodes could provide cybersecurity benefits beyond the capabilities of other technologies.

Although most of these examples are in an early stage, they indicate the potential impact that blockchain may have in sector digital transformation, particularly on energy provisioning democratization.

Recommendations

Utility CIOs who are focused on transforming into a digital utility:

- Initiate blockchain discussions with business executives by explaining the potential and sharing examples of early use cases.
- Reduce blockchain hyperenthusiasm coming from the provider side by setting realistic expectations for its limitations, technology immaturity and technology risks. The vendor market is immature; consequently, technology investments could be risky because products/support could evaporate.

- Resist FOMO by evaluating the disruptive nature of your initiative and assessing whether it needs a distributed and consensus-based processing environment.
- Focus initial efforts on discovering the capabilities and shortcomings of blockchain by examining relevant use cases, such as a digital platform for P2P energy exchange or tracking renewable certificates.

Deploy AI for Utility Business and IT Optimization

Analysis by Ethan Louis Cohen and Nicole Foust

Key Findings

- AI is a transformative digital technology that will deliver speed and cost-efficiencies and better data processing.
- Skills are one of the top challenges in AI deployment. Technical skills for deep neural nets (DNNs) remain limited and are still evolving.
- Utilities will need new or updated digital strategies that include plans for AI at enterprise scale.

Implications

Utility CIOs must factor AI into strategies now. AI technologies are reaching a tipping point. Gartner expects a transformative change in business processes to follow widespread AI deployment. Furthermore, utilities that can take advantage of AI opportunities have a better chance of thriving in their chosen utility scenario (see "Use Utility Scenarios to Prepare for Change").

AI use cases that are being developed across the utility value chain include:

- **Ultra-accurate, AI load forecasts** that enable the integration of both additional renewable energy and excess power into the grid. Enhancing demand and supply prediction, assessing reliability, and automating demand-side response are central AI use cases in reducing energy and economic waste.
- **Pattern recognition and machine learning for predictive outage,** and preventive maintenance can aid grid and generation planning. In a predictive forecasting strategy, AI and machine learning are emerging in software that can "learn" what imminent failure looks like.
- **Robotic process automation (RPA) use cases:** Using AI in combination with other technologies including optical character recognition (OCR) and intelligent business process management (iBPM), lays the critical foundation for future enterprise automation.
- **Utility customer experience transformation with consumption tailoring and automation:** Automating customer service with virtual agents and tailoring suppliers and services to consumers' preferences increase customer satisfaction while lowering customer service costs.

AI use cases are about delegating decision making to software. Software is becoming better at decision making because machine learning tools have become better at predicting outcomes. In limited, well-defined contexts, delegation of decision making to AI can deliver better business process accuracy, policy compliance and higher volume of work completed.

Skills are one of the top challenges in AI deployment. Technical skills, especially for DNNs, are limited and have just recently been included in university education and research institutes. Even with a solid educational background, experts cannot consistently and reliably configure a DNN to deliver useful results because the corpus of technical knowledge and domain expertise is immense.

The long turnaround time in DNN training results in a long AI business case evaluation cycle. It also sets a high threshold for business case ROI. Making matters more complex, outstanding questions about how to implement AI, and whether to use a provider site in the cloud, loom large. As DNN development becomes more routine and cost-efficient, utility CIOs can expect that demand for AI will rise, along with expectations that IT deliver both AI technology and related business benefits.

Forward-looking utility CIOs can act decisively to foster an internal culture of AI learning and experimentation by taking a Mode 2 approach to address initial AI implementation. Additionally, they can establish exchange programs with vendors with the goal of increasing in-house skill in data acquisition and data quality practices, which are essential for training AI. Working with vendors can also accelerate knowledge of how AI is being embedded in vendor applications and platforms, including via APIs and cloud services. This knowledge will be critical in scaling AI.

RPA tools are software applications designed to replace or assist in manual tasks, and mimic the same "manual" path a human takes through an application. By responding to process triggers, they can pull data together to improve employee performance, reduce errors and cut operating costs. RPA is a good example of how utility CIOs should "get tactical" in using new machine technologies for optimization. The case for RPA is a good analog for AI machine capability projects that improve quality and process efficiency. The ability to rapidly deploy new machine technology and efficiently handle process and talent change is a hallmark of digital business effectiveness.

Recommendations

Utility CIOs who are focused on transforming into a digital utility:

- Understand where AI delivers the highest value by identifying human-machine interactions in key business processes, and then describe what instructions and data could be used to develop an AI use case.
- Organize and clean your data by becoming proficient at accessing, analyzing and managing data stores. AI can uncover hidden patterns. But trusting AI to make the right decisions will depend on your foundational data management capabilities.
- Start investing in AI by sourcing technical talent from universities and technology startups that focus on machine learning. Retain this in-demand talent by chartering a stake for them in something bigger than just employment in AI/machine learning projects — for example, utility enterprise automation.
- Foster sustainable AI capability and innovation by taking a bimodal approach and pace layering AI deployment across your application portfolio. This will enable your organization to rapidly

plan, test, assess and innovate with AI capabilities developed either in-house, or integrated into vendors' software applications, services and platforms.

Digital Twins Improve Asset-Related Decision Making

Analysis by Nicole Foust

Key Findings

- Much of the current development in digital twins has come from the manufacturing sector (Industry 4.0) as cross-industry use cases continue to develop. Digital twins have been of high interest to few industries, such as utility organizations, in recent years.
- Digital twins, modeled on OT data streams, can improve asset performance and utilization in multiple utility domains (transmission, distribution, generation) and sectors (electricity, gas and water).
- The digital twin is developing as a central feature of IoT-based architectures for monitoring and simulation. It usually begins with a focus on equipment, plant and enterprise in generation, and eventually moves toward the grid.
- In the 2018 Gartner CIO Survey, more than 15% of global utility respondents indicated they have either already invested in digital twins or included digital twins in their short-term plans for digitalization (see "2018 CIO Agenda: A Utility Perspective").

Implications

Recently, the emergence and proliferation of IoT coupled with cloud computing, as well as advanced analytics, have given rise to digital twins. A digital twin is a virtual counterpart of a real object, which enables other software/systems and operators to interact with it rather than the real object directly to improve maintenance, upgrades, repairs and operation of the real object. The minimum elements of a digital twin include the model of the object, data from the object, a unique one-to-one correspondence to the object and the ability to monitor the object. A key benefit of a digital twin comes from the ability to simulate object behaviors to anticipate potentially risky or critical operating conditions. As utility organizations continue to seek greater efficiencies and further their progress toward digital transformation, the ability to predict an asset's performance, evaluate different scenarios, understand trade-offs and enhance efficiency places digital twins high on the list of investment inclusions.

Digital twins enable new methods of enhanced data insights to improve decision making. For example, utility organizations can leverage digital twins for new business models focused on guaranteed outcomes, such as with asset performance. Digital twins can model a complex asset, such as a generator or transformer. By leveraging sensor and historical data, digital twins can be used to predict when and how a failure could occur, which would allow the utility to operate more efficiently. Additional benefits could include the ability to maximize reliability, optimize operating and maintenance costs, and manage assets more efficiently.

Utilities face challenges relating to their network, such as disparate systems, organizational silos and unused data from multiple systems. For challenges like these, a few vendors are conducting POCs. They relate to utility network digital twins providing a single real-time model of the entire network (to include things like equipment, wiring and devices) with the capability to see the current and future states of the network. This could allow grid planners and operators to create a digital twin of their network or power delivery system, and to simulate design changes. For example, by adding in DERs to the network, or in instances of weather (such as storms) and environmental (such as wildfires) changes, you could determine how the changes will impact operations. While the concept of network digital twins is interesting, the maturity of products, the ecosystems and the science behind these POCs are low.

In Gartner's "Hype Cycle for Emerging Technologies, 2017," digital twin was placed in the Innovation Trigger. Since then, Gartner has estimated that, by 2020, two-thirds of asset operators will use digital twins from their component suppliers, up from one-third currently (see "Exploiting Digital Twins to Drive Ecosystem Strategies"). Although digital twins are still an emerging technology, CIOs in utilities and energy companies should expect it to evolve quickly, and should not wait before getting actively involved. Digital twins are transformational and will compel utilities to operate differently. Benefits include superior asset utilization, service optimization and improved user experience.

Recommendations

Utility CIOs who are focused on transforming into a digital utility:

- Work with business leaders to identify and prioritize digital twin use cases by identifying where digital-twin-based simulation and predictive maintenance could deliver value. Together, identify where improvements in product performance, operation or maintenance could drive down costs, create new revenue or improve a process.
- Exploit the disruptive potential of digital twins by leveraging IoT platforms, services and advanced analytical capabilities (including machine learning, event stream processing and operational intelligence).
- Remove barriers to digital twin success (such as culture change) by creating small teams composed of engineers, operations personnel, data scientists and IT professionals, and empower them to fail fast and often, while accelerating your organization's learning.

Distributed Energy Resource Penetration Is Disrupting Utilities

Analysis by Zarko Sumic and Ethan Louis Cohen

Key Findings

- DER penetration levels will continue to rise everywhere, with different catalysts being more pronounced in some markets. These catalysts include renewable mandates, emergence of prosumers and utility digital business model expansion.

- Vendors are doubling down on the development of DER management systems (DERMSs). Successful deployment in DERMSs will require changes across utility operations, from customer service to network design and control center operations. The DERMS ecosystem will expand correspondingly.
- Integrating DERs into electric distribution networks is a significant challenge and has two distinct aspects:
  - **Network management aspect:** DER inclusion in grid operation (both model instantiation and control), which will require new network management technologies and control paradigms.
  - **Commodity management aspect:** DER integration and orchestration to enable DER participation in local energy markets.

Implications

The utility sector continues its journey toward a distributed and democratized future driven by the rise of DERs. This creates a major disruption to the existing energy provisioning business model, while, at the same time, offering opportunities for utilities' new service offerings. In the face of multiple challenges, including competitive threats from new entrants and prosumers' partial and full grid deflection, utilities must also find ways to integrate DERs. The fact that DERs are mostly owned by third parties, and that utilities will need to maintain operational integrity of the grid under new operating conditions, creates additional challenges. Investment in DERMSs, control, monitoring and analytics technology will likely determine utilities' business model agility, and potentially open new opportunities in the not-too-distant future.

DER control complexities require a thorough understanding of the asset's behavior, along with a sophisticated technique for network model instantiation, and new network control algorithms. Since the systems may be engineered by one company, deployed by another and maintained by a third, the integration complexity is high. An overlay of management software and human talent is needed to support the connection of these assets to the distribution grid and their participation in energy markets.

Utilities expect DERMS products to deliver the capabilities needed to successfully integrate high levels of DERs, as regulators reshape markets and create financial incentives for expansion. Some DERMS solutions rely more on iterative optimization and forecasting algorithms, while others depend on closed-loop control. ADMS vendors also will seek to dominate this market because of their experience with sophisticated network models, and their background with transmission markets. The next-generation-grid digital twin products that can go beyond just tracking DER connectivity and get into the real-time network modeling can be important as well.

Utilities will have to clearly specify how DERMSs should communicate with individual devices, and how they can inform other systems about the operational actions that are available. Functions will include DER representation in system models, logical DER group creation, real-time status monitoring, real and reactive power dispatches, and forecasting. More advanced functions include schedule exchange, voltage set points, regulation services, microgrid control, optimal dispatch, demand response and dynamic voltage stabilization.

Utilities should take no comfort in any notion that customer and prosumer enthusiasm for DER and democratized P2P energy will be tempered by either DER economics or regulatory pondering. The success of residential and small commercial solar PV systems proves the economic sense of DERs. At the same time, the fast evolution of technology and finance is starting to drive up the tempo of favorable legislation. Financial markets' (that is, venture capitalists and hedge funds) recent interest in DERs signals something distinctly different from the ordinary, and begs answers to three key economic questions:

- How will different DER technologies provide scalable energy capacity and ancillary service for both the distribution and bulk power systems?
- What valuation options exist for each type of DER and related benefits, costs and risks?
- What implications will DERs have on the utility perspective of market planning, market design, operation and oversight?

Recommendations

Utility CIOs who are focused on optimizing foundational technologies should:

- Address DER impacts well before DER penetration levels rise by expanding customer service processes (to get visibility into customer-owned DERs), and by enhancing distribution network planning and operational function.
- Remove the remaining barriers to high-penetration DER integration by working closely with regulatory agencies and industry working groups.
- Create hybrid teams by combining operations business analysts and IT leaders to conduct Mode 2 initiatives to extend OT with IT and IoT.
- Start hiring and developing talent by targeting universities with relevant graduate and undergraduate programs, and with combined skills in engineering and software development.

Energy Storage Raises the Stakes for Utility Digital Business Capability

Analysis by Ethan Louis Cohen and Nicole Foust

Key Findings

- Energy storage is reaching high penetration levels in some markets; for example, Australian adoption continues to accelerate rapidly.
- Utilities are realizing the operations benefits of energy storage, which include: (1) improving transmission performance; (2) buffering renewable intermittency; and (3) enabling prosumer market arbitration.

- Energy storage is being designed as a network of physical and digital platforms that integrate power, information and economic services — often beyond the meter and outside the traditional utility business model.
- Utilities are recognizing that energy storage could extend the boundaries of utility business, compete with utility service offerings and challenge regulatory models.

Implications

As energy storage is deployed, there is a high degree of risk and opportunity for all marketplace participants.

Traditional electric utility business, market and regulatory models will be under pressure to evolve, matching the pace of technology progress and falling costs. Future strategies will also vary depending on the scale and type of storage, including: solid-state battery, flow battery, kinetic energy storage, compressed air, liquid air and pumped hydropower.

Integrating energy storage with the existing grid presents many complex business and operational challenges:

- Performance improvement in storage technology is expected to reach a double-digit annual rate in the next few years, adding to disruption at the utility network edge.
- Electricity distribution systems are typically built for one-way power flow, while storage systems designed for two-way flow can now be connected nearly anywhere on the grid.
- In the wider regulatory framework, the classification of storage and its participatory role in capacity and balancing service markets remain almost wholly undefined.
- Utilities' and others' general lack of ability to make storage visible and, thus, monetizable in wholesale settlements markets remains a challenge.
- The nearly universal utility-metered, kilowatt-hour-based revenue mechanism does not recognize or reward storage participation.
- Only a few regulatory jurisdictions require utility investment in energy storage for grid support. The ideal economic model for motivating and rewarding investors and developers has not emerged.
- The connection of storage and DERs beyond the utility meter raises many questions about ownership, control authority, communication standards and cybersecurity.

Sorting these issues will take years. However, it is clear that economic incentives and control approaches will be key factors in shaping the near-term and midterm storylines of energy storage. Utilities understand their customers' resources and energy choices, and have deep experience in grid operations, making them adept at handling the unique control challenges of energy storage. Because of digital prosumer economic trends and falling costs, storage will arrive in high numbers along with, but also in the absence of, utility deployment programs.

The long-term state of a multisided energy storage and DER market, and their related network effects, is difficult to predict. Gartner has examined possible utility business scenarios (see "Use Utility Scenarios to Prepare for Change") and finds that the pioneer scenario is most applicable to shaping utility participation in storage markets. Early indicators of the potential future market profile lie along the separation lines between:

- Asset owner versus asset operator
- Grid applications/services versus consumer applications/services
- Utility operational outcomes versus prosumer experience outcomes
- Economic incentive, the beneficial party(s), and the socialization and/or temporalization of benefits

Recommendations

Utility CIOs who are focused on transforming into a digital utility:

- Address energy storage impacts well before market adoption levels rise exponentially by investing in storage integration that provides operational visibility and control, as well as flexibility, in the face of changing market and regulatory dynamics.
- Engage your enterprise architecture team by tasking it to design a roadmap for how transmission and distribution applications will interact with storage control systems, and to provide guidance on system communications and cybersecurity requirements.
- Assess your readiness to handle widespread deployment of residential energy storage as part of your effort to address the energy technology consumerization trend by reviewing Gartner research on consumer IoT and "Industry Vision: Utilities as Platform Providers for the Energy-Sharing Economy."

Gartner Recommended Reading

Some documents may not be available as part of your current Gartner subscription.

"Industry Vision: Utilities as Platform Providers for the Energy-Sharing Economy"

"Utility Scenario: Explorers Must Focus on Pragmatic Innovation"

"Utility Scenario: Pioneers Are Settling New Digital Frontiers"

"2018 CIO Agenda: A Utility Perspective"

"Information and Technology Strategy Planning Guide for Utility CIOs"

"Predicts 2018: Utilities Get Ready to Scale Your Digital Initiatives"

"Blockchain in Utilities: Promise and Reality"

GARTNER HEADQUARTERS

Corporate Headquarters
56 Top Gallant Road
Stamford, CT 06902-7700
USA
+1 203 964 0096

Regional Headquarters
AUSTRALIA
BRAZIL
JAPAN
UNITED KINGDOM

For a complete list of worldwide locations,
visit http://www.gartner.com/technology/about.jsp