Hype Cycle for Utility Industry IT, 2023

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Initiatives: Energy and Utilities Digital Transformation and Innovation; Energy and Utilities Technology Optimization and Modernization

Utility organizations face continuous disruption. To gain resilience and agility, lower risk and better capitalize opportunities, organizations are enabling intelligent operations. This Hype Cycle gives utility CIOs insights to effectively align technology investments with strategic business goals.

More on This Topic

This is part of an in-depth collection of research. See the collection:

- 2023 Hype Cycles: Deglobalization, AI at the Cusp and Operational Sustainability

Analysis

What You Need to Know

Due to continued disruption, utilities are faced with evolving challenges and opportunities with increasing urgency. These include: challenges and pressures caused by the energy transition, rising climate adversity, changing customer expectations, and current business impacts of today's triple squeeze (economic and supply chain pressure, scarce and expensive talent). The industry must now rapidly deliver maximum impact from digital investments (see Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023). These priorities are driving utility organizations to make technology investments to derisk and adjust standard business and operating models to become more agile, which are better enabled by intelligent operations.

This Hype Cycle reflects the modernization investments of the "digitalized utility," which focused on goals to improve operational excellence and customer experience. These technologies are maturing — see Figure 1 to review the cluster of technologies toward the trough and climbing the Slope of Enlightenment of the Hype Cycle. Newer digital utility initiatives leverage the Industrial Internet of Things (IIoT), and analytics to integrate process-oriented information across business domains and extend to include the ecosystems of external participants.

CIOs are expected to provide technology expertise and align investments with strategic business goals to accelerate their delivery. Mastering the foundational technologies in the mature regions of the Hype Cycle drives strong performance across business optimization opportunities. Selective adoption of embryonic and emerging technologies may accelerate early transformation opportunities toward a sustainable future and improve the likelihood of successful business transformation.

The Hype Cycle

The Gartner 2023 CIO and Technology Executive Agenda: A Utility Industry Perspective reveals a majority of utility respondents expect revenue and IT budget to increase, adjusting to disruptions and plan to rebalance their technology portfolios. CIOs must evaluate technology maturity and mitigate deployment and operational risks. To progress on the intelligent operations journey, utility organizations need to master the distinct innovations highlighted in this Hype Cycle (such as edge and IoT capabilities and software-defined assets). Organizations must build on the momentum of composability from 2022 and focus on technology investments that expose latent capabilities embedded in the current monolithic system of records, via APIs, and make them available as virtual packaged business capabilities.

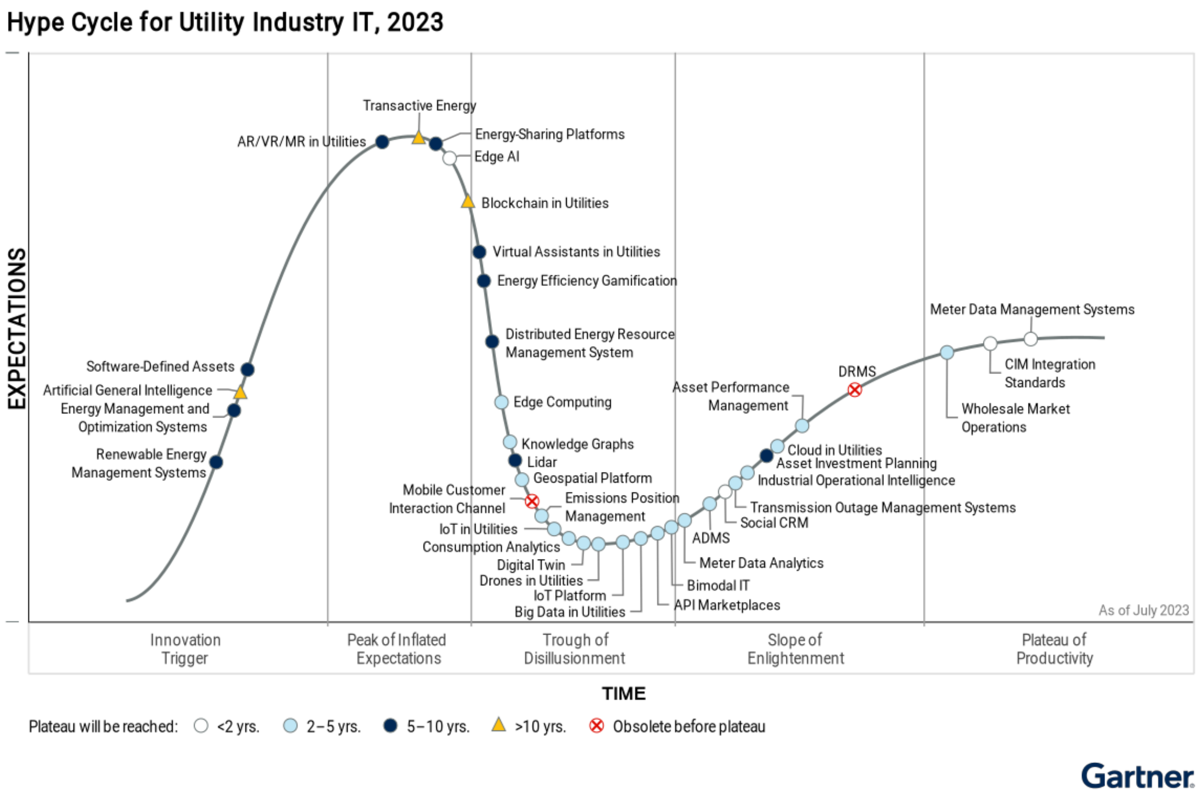
Technologies on the Slope of Enlightenment and moving to Plateau of Productivity are "run-the-business" technologies (e.g., meter data management) that enable utility organizations to cost-effectively operate standardized and established processes day to day.

Technologies moving from the Peak of Inflated Expectations to the Trough of Disillusionment are emerging technologies that digitize processes and increase organizations' capability to manage assets and support interactions with business partners and customer engagement during energy transition. These technologies (e.g., virtual assistants in utilities, energy efficiency gamification, DERMS) are used to deliver specialist and utility expert capabilities. Technologies of note with significant progression include drones in utilities, edge computing and knowledge graphs. Progression of these technologies is driven by advancements in technology capability and use-case expansion as a result of their broad applicability.

Technologies nearing or at the peak show promise in providing new and potential breakthrough capability, enabling intelligent utility, but they are not proven nor standardized to yield breakthrough efficiencies. They can, for example, assist field workers to improve productivity and effectiveness, such as AR/VR/MR for remote assistance. We recommend deploying these technologies in an exploratory, minimum viable product mode at the innovation layer of a PACE architecture. Technologies of note with significant progression include artificial general intelligence, driven by advancements and applicable utility use cases in generative AI.

In addition to this Hype Cycle our companion utility focused document, the Hype Cycle for Digital Grid Transformation Technologies, 2023 provides insight on critical technologies for digital grid transformation.

Figure 1: Hype Cycle for Utility Industry IT, 2023



The Priority Matrix

The matrix below categorizes technologies in this Hype Cycle in four benefit areas: transformational, high, moderate and low. Many of the technologies included could be transformative or have a high impact for organizations to thrive and survive in modern and more environmentally sustainable energy and water operations (see Table 1). Some technologies will bring disruption, some can better support new business models and others enable intelligent operations working toward greater levels of automation.

For transformational technology, IoT in utilities has already had an impact in the industry, driving big data use cases. Digital twins are also expected to have transformational impact within the next two to five years. Renewable energy management systems will mature over a five-to-10-year time frame. Artificial general intelligence along with transactive energy are also expected to have a transformational impact on the utility sector, reaching mainstream adoption in more than 10 years.

Edge AI and meter data management have a high benefit rating and are expected to reach mainstream adoption in less than two years. Big data plus advanced analytics have high benefits, as they enable intelligent operations within the sector. Together, they enable utilities to combine and manage data from a wide range of sources for a wide range of use cases. These sources include meters, sensors, weather, information about customers (beyond meter consumption) and data from distribution network operations.

Intelligent devices (things) are starting to act for customers. Integrationing operations across these domains is challenging to mobilize resources and support new operating models. IoT platforms are expected to be of high benefit to utility organizations and will likely reach mainstream adoption in the next two to five years across all utility industry subsectors. Although utility organizations trail enterprises in other industries in deploying IoT platforms, utility CIOs will be required to evaluate how to leverage IoT and assess its impact on application architecture and security, and for the broader utility digital operations as they progress on their intelligent operations journey.

Table 1: Priority Matrix for Utility Industry IT, 2023

(Enlarged table in Appendix)

Benefit	*Years to Mainstream Adoption*			
↓	*Less Than 2 Years* ↓	*2 - 5 Years* ↓	*5 - 10 Years* ↓	*More Than 10 Years* ↓
Transformational		Digital Twin IoT in Utilities	Renewable Energy Management Systems	Artificial General Intelligence Transactive Energy
High	Edge AI Meter Data Management Systems	ADMS Asset Performance Management Big Data in Utilities Bimodal IT Cloud in Utilities Drones in Utilities Edge Computing Emissions Position Management Geospatial Platform Industrial Operational Intelligence IoT Platform Knowledge Graphs Wholesale Market Operations	Distributed Energy Resource Management System Energy Management and Optimization Systems Energy-Sharing Platforms Software-Defined Assets Virtual Assistants in Utilities	Blockchain in Utilities
Moderate	CIM Integration Standards Social CRM	API Marketplaces Consumption Analytics Meter Data Analytics Transmission Outage Management Systems	AR/VR/MR in Utilities Asset Investment Planning Lidar	
Low			Energy Efficiency Gamification	

Source: Gartner (July 2023)

Off the Hype Cycle

- **Advanced Metering Infrastructure** — Removed from this Hype Cycle as it has now achieved mainstream adoption
- **DRMS** — Obsolete before plateau because its value as a system-based capability is diminishing and newer technologies such as advanced distribution management systems (ADMS) and DERMS are maturing to address a broader range of distribution network management needs
- **Digital Business Technology Platforms** — Still relevant to utilities but reached maturity beyond the Plateau of Productivity and have been retired from this Hype Cycle
- **Mobile Customer Interaction Channel** — Obsolete before plateau as mobile and other interaction capabilities are nearly ubiquitously embedded in enterprise applications and integrated with packaged business capabilities

On the Rise

Renewable Energy Management Systems

Analysis By: Nicole Foust

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Emerging

Definition:

Renewable energy management systems (REMS) are emerging technologies designed to orchestrate and optimize renewable energy (RE) production and operations. Key functionalities include complex data collection, monitoring, managing and controlling asset operations by orchestrating RE sources, and optimizing their performance. REMS can dynamically reconfigure operational states across discrete assets, from unit to fleet level, across geographies and markets.

Why This Is Important

Renewable resources must dominate power producers' asset portfolios by providing 70% of world energy supply in 2050. However, RE owners/operators find it difficult to operate current fleets with legacy siloed information technology/operational technology (IT/OT) systems. Energy companies that own and/or operate large-scale renewable energy assets can use REMS to better orchestrate and optimize RE production and operations.

Business Impact

RE asset owners/operators will need to prepare for dynamic real-time event-driven business operations and maintenance, by establishing business capabilities and performance levels of RE assets. This will improve operational decisions and production coordination. Energy companies have opportunities to unlock new capabilities through IT/OT alignment and integration to support business operations of large-scale renewable energy by coherent funding of REMS functionality on the RE strategic roadmap.

Drivers

- The International Energy Agency's (IEA's) Net Zero by 2050 scenario calls for the scaling up of solar and wind energy generation rapidly during this decade. The goal is a 500% increase in renewable energy resource capacity from almost 12% penetration in 2021 (see World Energy Outlook 2022, IEA).

- Renewable energy sources are expected to be cheaper to deploy and operate than coal and gas in most regions before 2030.
- Energy companies are now facing scalability changes, challenges and opportunities. Among these are climate change and the energy transition, which are interrelated and are driving industry adaptation pain, but also creating opportunities for untapped economic return.
- Organizations need to maximize energy production to bring down the cost of energy to remain relevant and competitive. Traditional energy capabilities will need to accelerate the scope and scale of the rollout and integration of large-scale renewable energy within their portfolios, across both asset and commodity life cycle.
- As the energy transition progresses and accelerates, REMS is an important tool to scale and optimize the mix of renewable sources in the grid, and to enable available, affordable, acceptable energy.
- Disruption at the grid edge and renewable energy assets are driving the need for grid modernization.

Obstacles

- A major challenge of power system operation and control is deployment of appropriate analytical tools to integrate and holistically manage the new technologies. This will account for system restructuring, while using existing resources optimally.
- RE owners/operators need a larger toolbox to enable asset management automation, including big data and predictive analytics, cloud computing, composable architecture, intelligent solutions, and system security.
- REMS require robust capabilities and data, which are supported by complementary and third-party tools. This often leads to integration complexity and business capability gaps.

User Recommendations

- Use strategic roadmaps to maximum effect and benefit to articulate current-state capabilities, gaps, and the future state, that will enable the organization to reach improved performance and outcomes.
- Optimize the value of a REMS by improving the digital footprint to gather, organize, integrate, store and analyze information across the enterprise.

- Industrialize business capabilities regardless of whether your organization is an existing or new RE generator. This will create the foundation to work across an ecosystem of partners to deliver the volume of renewable energy assets required to support the energy transition.
- Modernize the grid to mitigate potential disruptions at the grid edge and from renewable energy assets. Investments for electricity network resilience must be made via modeling simulation and directed operations. Therefore, modernizing energy data process capabilities in new IT/OT products with specific capabilities is essential.

Sample Vendors

BaxEnergy; CGI; Envision Digital; General Electric; Mahindra Teqo; Power Factors; SparkCognition

Gartner Recommended Reading

Quick Answer: What Functional Capabilities Can Extend the Value of a Renewable Energy Management System Platform?

Quick Answer: What Are the Corporate Renewable Energy Procurement Options in the Pathway to Net Zero?

The Impacts of Exponential Renewable Generation Growth Across the Energy Ecosystem

Energy Companies Must Transform Asset Life Cycle Capabilities to Drive New Business Value From Renewable Energy

Market Guide for Renewable Energy Management Solutions

Artificial General Intelligence

Analysis By: Pieter den Hamer

Benefit Rating: Transformational

Market Penetration: Less than 1% of target audience

Maturity: Embryonic

Definition:

Artificial general intelligence (AGI) is the (currently hypothetical) intelligence of a machine that can accomplish any intellectual task that a human can perform. AGI is a trait attributed to future autonomous AI agents that can achieve goals in a wide range of real or virtual environments at least as effectively as humans can. AGI is also called “strong AI.”

Why This Is Important

As AI becomes more sophisticated and powerful, with recent great advances in generative AI in particular, a growing group of people see AGI as no longer purely hypothetical. Improving our understanding of at least the concept of AGI is critical for steering and regulating AI’s further evolution. It is also important to manage realistic expectations and to avoid prematurely anthropomorphizing AI. However, should AGI become real, its impact on the economy, (geo)politics, culture and society cannot be underestimated.

Business Impact

In the short term, organizations must know that hype about AGI exists today among many stakeholders, stoking fears and unrealistic expectations about current AI’s true capabilities. This AGI anticipation is already accelerating the emergence of more AI regulations and affects people’s trust and willingness to apply AI today. In the long term, AI continues to grow in power and, with or without AGI, will increasingly impact organizations, including the advent of machine customers and autonomous business.

Drivers

- Recent great advances in applications of generative AI and the use of foundation models and large language or multimodal models drive considerable hype about AGI. These advances have been enabled largely by the massive scaling of deep learning, as well as by the availability of huge amounts of data and compute power. To further evolve AI toward AGI, however, current AI will need to be complemented by other (partially new) approaches, such as knowledge graphs, multiagent systems, simulations, evolutionary algorithms, causal AI, composite AI and likely other innovations yet unknown.

- Vendors such as Google, IBM, NNAISENSE, OpenAI and Vicarious are actively researching the field of AGI.

- Humans' innate desire to set lofty goals is also a major driver for AGI. At one point in history, humans wanted to fly by mimicking bird flight. Today, airplane travel is a reality. The inquisitiveness of the human mind, taking inspiration from nature and from itself, is not going to fizzle out.

- People's tendency to anthropomorphize nonliving entities also applies to AI-powered machines. This has been fueled by the humanlike responses of ChatGPT and similar AI, as well as AI being able to pass several higher-level education exams. In addition, more complex AI systems display behavior that has not been explicitly programmed. Among other reasons, this results from the dynamic interactions between many system components. As a result, AI is increasingly attributed with humanlike characteristics, such as understanding. Although many philosophers, neuropsychologists and other scientists consider this attribution as going too far or being highly uncertain, it has created a sense that AGI is within reach or at least is getting closer. In turn, this has triggered massive media attention, several calls for regulation to manage the risks of AGI and a great appetite to invest in AI for economic, societal and geopolitical reasons.

Obstacles

- The current issues regarding unreliability, hallucinations, lack of transparency and lack of reasoning or logic capabilities in generative AI-powered chatbots (one possible direction toward AGI), are not easy to overcome with the intrinsically probabilistic approach of deep learning. More data or more compute power for ever bigger models are unlikely to resolve these issues. Better or curated training data, improved prompt interpretation and engineering or more domain-specific foundation models may help to improve reliability, but not sufficiently.

- There is little scientific consensus about what “intelligence” and related terminology like “understanding” actually mean, let alone how AGI should be exactly defined and interpreted. Flamboyant representations of AGI in science fiction create a disconnect from reality. Scientific understanding about human intelligence is still challenged by the enormous complexity of the human brain and mind. Several breakthrough discoveries are still needed before human intelligence is properly understood at last. This in turn is foundational to the “design” or at least validation of AGI, even when AGI will emerge in a nonhuman, nonbrainlike form. Moreover, once AGI is understood and designed, further technological innovations will likely be needed to actually implement AGI. For these reasons, strong AI is unlikely to emerge in the near future. This may be sooner if one would settle for a more narrow, watered-down version of AGI in which AI is able to perform not all but only a few tasks at the same level as humans. This would no longer really be AGI as defined here.

- If AGI materializes, it is likely to lead to the emergence of autonomous actors that, in time, will be attributed with full self-learning, agency, identity and perhaps even morality. This will open up a bevy of legal rights of AI and trigger profound ethical and even religious discussions. Moreover, the (anticipated) emergence of AGI and the risk of human life being negatively impacted by AGI, from job losses to a new, AI-triggered arms race and more, may lead to a serious backlash and possibly regulatory bans on the development of AGI.

- The anticipated possible emergence of AGI urges governments to take measures before its risks can no longer be mitigated. Regulations to ban or control AGI are likely to emerge in the near future.

User Recommendations

- Today, people may be either overly concerned about future AI replacing humanity or overly excited about current AI's capabilities and impact on business. Both cases will hamper a realistic and effective approach toward using AI today. To mitigate this risk, engage with stakeholders to address their concerns and create or maintain realistic expectations.
- Stay apprised of scientific and innovative breakthroughs that may indicate the possible emergence of AGI. Meanwhile, keep applying current AI to learn, reap its benefits and develop practices for its responsible use.
- Although AGI is not a reality now, current AI already poses significant risks regarding bias, reliability and other areas. Adopt emerging AI regulations and promote internal AI governance to manage current and emerging future risks of AI.

Sample Vendors

AGI Innovations; Google; IBM; Kimera Systems; Microsoft; New Sapience; NNAISENSE; OpenAI; Vicarious

Gartner Recommended Reading

The Future of AI: Reshaping Society

Innovation Insight for Generative AI

Innovation Insight: AI Simulation

Applying AI — Key Trends and Futures

Innovation Insight for Artificial Intelligence Foundation Models

Energy Management and Optimization Systems

Analysis By: Lauren Wheatley

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Energy management and optimization systems (EMOS) are modular platforms that allow commercial and industrial (C&I) customers to better manage their energy use. An EMOS combines a holistic view of the main energy consumption sources with advanced optimization capabilities to interact with automation systems and production goals. It consumes data from meters and sensors and communicates with an energy supplier, grid operator or market to orchestrate operational use cases.

Why This Is Important

Volatility in energy cost and supply is hurting business and driving inflation. Commercial and industrial (C&I) companies need to proactively mitigate immediate energy price and security concerns while still making meaningful progress toward emissions reduction goals, such as net zero. Managing energy costs will require C&I consumers to increase investment in energy management and optimization technologies.

Business Impact

C&I enterprises are prioritizing cost and environmental impact in their energy-related decision making and are looking to proactively control energy sourcing and consumption. This has resulted in growing markets for energy services by subscription. The move toward service-based models requires the rapid adoption of digitalized products by E&U companies such as offering EMOS capabilities to help customers conserve energy, save money, manage GHG emissions and comply with regulatory mandates.

Drivers

- C&I and community-entity energy customers are increasingly seeking greater control of their energy supply chains to control costs and build energy resiliency.
- There are growing markets for energy technology, energy services and energy-as-a-subscription services.
- Industrial digitalization is instrumenting the asset base, enabling EMOS platforms to proactively optimize energy loads.
- EMOSs require an ecosystem of partners, data, hardware and software that may be provided by multiple vendors. This gives energy company CIOs the opportunity to work with vendors to deploy a composable EMOS platform that aligns most closely with their energy and sustainability strategy.
- Increasing investments in smart grids and smart energy meters allows connection and coordination of all of an enterprise's equipment and devices, enabling continued advancement of EMOSs. By using IoT data and applying tools such as AI and predictive maintenance, EMOS products can provide intelligent operations capabilities, a strategy where physical systems are represented, configured and controlled by intelligent software.
- Volatility and rising energy prices mean that technologies, such as digital twins and AI to enable bidirectional coordination and automation that weren't financially feasible and lacked technical maturity just a few years ago, are now viable.
- The drive toward digital business is about rethinking what is possible, and for E&U companies, how their customers can engage with distributed energy resources in the future. This is particularly important where exponential innovation beyond the meter has delivered consumer energy technology and consequent grid parity, challenging existing energy supply assumptions creating new business models and new opportunities.

Obstacles

- C&I companies seek low-risk solutions that can be easily scaled with a limited management overhead and capital investment, allowing them to focus on critical business activities. However, EMOS system implementation and integration can require energy management expertise and a sophisticated understanding of the financial and risk implications of various purchasing options.
- When creating new business models and opportunities, be aware of the internal challenges faced by customers and align with C&I enterprises' priorities such that they can execute at a lower cost point and unlock additional opportunities.
- C&I business leaders do not trust the data they have to support ROI calculations, agree on priorities or support the digital solutions.
- While there is a myriad of vendors entering the market, many have limited capabilities focused predominantly on dashboarding and reporting rather than insights and energy optimization.

User Recommendations

- Prepare to support an energy services business by factoring EMOS functionality and solutions into deployment roadmaps.
- Invest early to enable commercial success by establishing energy consumption data and information management strategies that will support an energy services business that delivers cost reduction programs and environmental management goals to C&I enterprises. Establish a roadmap to consolidate enterprise real-time data by integrating IoT infrastructure from edge to cloud.
- Align business and digital strategies with changing C&I enterprise drivers. For years, E&U customer engagement focus has been on customer service while managing a narrow scope of commodity transactions, but during this era of transition, customer experience will define the breakout enterprise. CIOs must design customer experience/total experience (CX/TX) that is fit for purpose across the energy transition.

Sample Vendors

C3 AI; Dametis; Energy21; EnergyCAP; GE; Honeywell; IMS Evolve; METRON; Schneider Electric; Siemens

Gartner Recommended Reading

Market Guide for Energy Management and Optimization Systems

Quick Answer: How Electric Utility CIOs Can Respond to Changing Customer Expectations

2022 Sustainability Survey: Energy CIOs Can Help to Retain C&I Enterprises as Customers

Software-Defined Assets

Analysis By: Lloyd Jones

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A software-defined asset (SDA) encapsulates and virtualizes its hardware capabilities to manage its unique local constraints, by optimizing and modifying its capabilities, behaviors and/or states across control, automation, function and topology to meet global optimization goals. SDAs may orchestrate with other assets and/or systems to meet their assigned goals within a delegated decision envelope.

Why This Is Important

SDAs operationalize reactive and predictive analytics to control and operate cyber-physical systems (CPS). SDAs enable adaptive and orchestrated operations. SDAs dynamically change their control and automation patterns to achieve physical process goals with global optimizations such as lower production costs, and reduced defects or operator errors. SDAs are the building block that will open up machine-to-machine ecosystems across business boundaries.

Business Impact

CPSs need global and local optimizations. SDAs deliver the capabilities to meet a wide range of scheduling outcomes by coordinating CPS outcomes across asset classes and ecosystem participants. Intelligent operational practices across business boundaries will become common as SDAs optimize and orchestrate operations (and production), across operational and contractual envelopes. Orchestrated SDAs may optimize physical flow by changing topology and/or control and automation configurations.

Drivers

- Digital twin capabilities are maturing and have expanded beyond siloed use cases and are becoming truly composite, able to support a wide range of use cases across operations, asset management and performance optimizations.
- R&D developments are positioning distributed digital twins as edge capabilities.
- Intelligent operational practices are evolving away from setpoint optimization of a fixed process toward a dynamic reoptimization and even reconfiguration of an asset control loop.
- Distributed digital twins hosted on the edge with compute capabilities either at gateway and/or asset level, will become a critical lever — able to optimize exposed automation and control variables through software as operational contexts shift.
- Organizations are moving toward adopting intelligent operational practices by exploring AI and machine learning, to systematically orchestrate production (or operations) resources. Examples include distributed energy resources such as electric vehicles (EVs) and rooftop solar systems, and oil well control and coordination.

Representative industry applications:

- The energy transition is pushing utilities to become orchestrators of distributed resources (which are SDAs) owned by multiple participants. Utilities are stabilizing the grid by asking SDAs to orchestrate their operational envelopes to meet multiple and/or conflicting objectives. Use cases include smart chargers, smart thermostats, and solar PV.
- Oil and gas companies need to optimize vast collector networks assembled from discrete assets in remote locations that are hard to reach. These assets can become SDAs able to parallel and serialize their topologies to protect physical flows while enduring disruption, through local coordination and reconfiguration, to return to a preferred operating state, or seamlessly coordinate to align product delivery to market opportunity.

Obstacles

- Legal concerns around decision responsibility have so far constrained AI and edge AI deployment, leaving a person in the loop.
- The standards that will bring together the capabilities of industrial control systems, Industrial Internet of Things (IIoT) and digital twins to enable autonomous intelligent operations by the SDA are still in development.
- Examples of constraints that need to be resolved before operationalizing SDAs and their AI include authorizations, control, bounding, defining, testing, deploying, retiring, retesting and retraining.
- SDAs may not be delivered on a unified platform. In fact, we can expect that the design, deployment and even operation of SDAs will be composable, particularly for industry-specific use cases.
- Horizontal scale-out in some industry applications come with cyber-physical system security concerns.
- SDAs could be perceived as replacing field technicians, requiring human change management to resolve job displacement fears.

User Recommendations

- Invest in advanced analytics and digital twin competencies to help enable this transition.
- Accept that SDA capabilities will not be rolled out across all assets, but will be an essential precursor to intelligent assets. Over time SDAs will evolve into intelligent assets with no central supervision.
- Transition incrementally by investing in discrete digital twins for individual equipment classes one by one and invest in composite digital twins for individual operations one by one. Over time, this will expand your portfolio of capabilities to increasingly build out more resilient grid capabilities.
- Raise your demands of OEM suppliers by specifying digital services that encapsulate asset capabilities in a structured manner to support SDAs.
- Leverage the lessons learned in your own and other asset-intensive industries.

Gartner Recommended Reading

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Quick Answer: What Are Intelligent Assets and Why Are They Important?

Quick Answer: What Are the Digital Checkpoints to Achieve Intelligent Operations?

At the Peak

AR/VR/MR in Utilities

Analysis By: Nicole Foust

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

Augmented reality (AR), virtual reality (VR) and mixed reality (MR) are different, yet related, technologies. VR creates computer-generated 3D environments to immerse users in a virtual environment, such as a room-based system. AR overlays digital information on the physical world in order to enhance it and guide action. MR is the merging of real and virtual worlds, where physical and graphical objects appear to interact and integrate naturally.

Why This Is Important

Utility-focused AR/VR/MR can enable and support a wide range of utility needs, such as crew location, visual display, training, video recording, and asset information such as machine health, location and maintenance history. These technologies can be extremely useful for simulating high-cost, high-risk, high-insurance or otherwise high-consequence situations in industrial settings that help employees do their job more efficiently, effectively and safely.

Business Impact

AR/VR/MR can complement and supplement existing systems, especially the systems of record that are used to manage the life cycle of their assets and infrastructure. Benefits can include cost reduction, task efficiency and effectiveness, and improved design cycle time. Transmission and distribution planning, engineering design, network operations, asset management, field service, property management, and generation plant licensing will be impacted.

Drivers

- AR/VR/MR can help in providing ways for the utility to be more productive and efficient through improved location capabilities, task efficiency and effectiveness, and safer work environments with visual display and training capabilities.

- The energy transition, coupled with advancing consumer-grade computing, are pressuring utility organizations' operation improvements, and influencing utility user expectations and requirements for industrial applications.
- We have moved this profile toward the Peak of Inflated Expectations to balance out the forward momentum of these technologies with the long maturity horizon expected.
- Technology improvements and advancements such as metaverse, object occlusion, edge processing, and high-bandwidth, low-latency networks, provide the stepping stones to more sophisticated experiences.
- Product maturity and utility-specific use cases will continue to increase over the next five years. Vendors are gaining traction by targeting specific utility environments and use cases, such as training and checklists for operations and maintenance, and remote telestration in "see-what-I-see" video collaborations.
- Advancements and decreasing costs of head-mounted display (HMD) hardware (lighter, more durable, safer, etc.) will provide more compelling hands-free use cases for AR. We expect technology adoption among utility organizations to increase, as more industrial-grade and proven AR-/VR-/MR-driven applications become available and showcase utility return on investment.

Obstacles

- AR, VR and MR markets are fragmented, as many industry-specific applications, though expanding, are still exploratory and embryonic.
- Current technology is best suited for purpose-built, specialized solutions, which limits scalability and may carry increased cost over benefit value.
- The market is challenged with mismatched expectations (vendors promising solutions beyond current capabilities) and poor implementations (for example, solutions delivered without immersive development knowledge, workflow integration, or mapping to business value or need).
- Interacting with both physical and digital elements requires a mix of "vocabularies" of different interface modalities (speech, motion, touch, gesture, etc.) that need to be defined and standardized to make interactions intuitive.
- Ease of access to experiences and form factors limit capabilities, scalability and value (e.g., handheld devices deliver a poor user experience for extended usage).

User Recommendations

- Work with engineering and operations teams to determine what business problems or issues can be solved with AR/VR/MR, including human to computer adaptivity.
- Explore AR/VR/MR benefits, and identify use cases by initiating proof-of-concept trials with a collection of devices and AR/VR/MR applications, before choosing a provider.
- Set benchmarks against unaugmented solutions to understand risks and benefits, and determine ROI before choosing a provider.
- Develop innovative vendor partnerships by focusing initially on the field service management, enterprise asset management and geospatial information systems (mobile workforce management/field service management [MWM/FSM], enterprise asset management [EAM] and GIS) application domains.
- Build in-house expertise for AR/VR/MR experiences by hiring developers with immersive skills (such as 3D modeling and UI design).
- Use AR/VR/MR opportunities to build your Mode 2 delivery capabilities by empowering small teams to fail fast and often, while accelerating your organization's learning.

Sample Vendors

Apple; Librestream Technologies; Microsoft; Motive.io; OverIT; PIXO VR; Softengi; Taqtile

Gartner Recommended Reading

2023 CIO and Technology Executive Agenda: A Utility Industry Perspective

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Market Guide for Mobile Workforce Management Software for Utilities

Market Guide for Geospatial Information Systems for Energy and Utilities

Emerging Technologies: Tech Innovators in Augmented Reality — Augmentation and Spatial Interaction Layer

Transactive Energy

Analysis By: Lloyd Jones

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Definition:

Transactive energy (TE) is a set of techniques to manage the generation, consumption and control of electric power within an electric power system using economic or market-based signals to move energy and account for grid reliability constraints. TE is an economic-value-based network control concept that shares benefits and responsibilities. It is an effective enabling mechanism to exchange information to integrate and orchestrate distributed energy resources (DERs) into local energy markets.

Why This Is Important

Traditional business models for electric utilities and legacy economic constructs are being challenged by the growth and diversity of distributed energy resources. As the network architecture transforms into a decentralized geodesic architecture, utilities are adopting new information-centric business and operating models and leveraging dynamic consumption, congestion and pricing information. TE information constructs apply from local to national networks.

Business Impact

The underlying economic model and control theory for TE markets are not new. Similar methods have been used successfully to operate transmission networks. Utilities that are seeing rising penetration of DERs should start early on understanding TE and its benefits and risks. Operations executives tasked with minimizing network congestion, managing peak loads or integrating responsive loads should work with their system vendors to understand how they are addressing TE requirements.

Drivers

- Transactive energy is being adopted by industry leaders as a path forward. TE is a consequence of energy transition, which is a structural change in energy systems driven by four “D” forces — decarbonization, decentralization, digitalization and democratization. The TE framework is intended to develop new economic constructs that accurately capture the value of energy transactions in a nodal model with locational marginal pricing (LMP).

- The introduction of market economics as an additional control mechanism to manage and optimize short-term energy transactions and long-term investment in the production and delivery asset has proven to be a viable model in wholesale market and transmission operation. A similar construct, applied on the distribution network level, will create a more collaborative environment that will address challenges introduced by the four “D” forces. It will also provide utilities with new business and operating models that may address energy reduction leading to revenue loss as prosumerization reduces net loads.

- Activities on defining a common set of transactive services to be exercised by DERs, via IEEE 1547, under the auspices of working group P825, and include work on IEEE 2030.5 and IEC 61850 standards.

- The development of a TE framework has become a global effort. Examples include the U.S. Department of Energy, GridWise Architecture Council and the EU-SysFlex published in 2021.

Obstacles

- The concept of TE is not new, since it mirrors the identification of flow gates and LMP for open access to transmission resources, however, the application at distribution level is difficult to define, measure and value action mechanisms for grid services.
- TE defines cost of delivery at a certain point as “LMP + D,” capturing both energy costs and distribution grid costs.
- Market redesign and the development of new operational systems, on top of existing infrastructure, are complex and require the active participation of stakeholders.
- The information flows within TE markets must be optimized for high-speed transmission of information about energy supply and demand, quantities, and prices.
- Economic and market contexts vary considerably from country to country (and even from state to state in the U.S.) with fragmented regulations and operational practices.
- TE is a conceptual framework, with vendors getting involved and including market-driven economic constructs in energy dispatch products.

User Recommendations

- Promote education and understanding of transactive energy concepts. Rather than looking for an off-the-shelf TE product, buyers should look for products that are built on and can incorporate a TE framework appropriate for their market.
- Work on developing communications standards for future transactive markets actively.
- Explore the feasibility of transactive-energy-enabling technologies, such as blockchain, DER management systems (DERMS), demand response management systems (DRMS), virtual power plants, and advanced distribution management systems (ADMS), by creating proofs of concept and early innovation initiatives.

Sample Vendors

GE Digital (Opus One Solutions); Integral Analytics; Itron; Octopus Energy Group (Kraken Tech); Open Access Technology International (OATI); Oracle

Gartner Recommended Reading

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Market Guide for Distributed Energy Resource Management Systems

Utility Scenario: Pioneers Are Settling New Digital Frontiers

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

Energy-Sharing Platforms

Analysis By: Lauren Wheatley, Auria Asadsangabi

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

The energy-sharing platform (peer-to-peer [P2P] energy exchange) leverages sharing economy principles to enable P2P energy trades. It is a dual platform — online-to-offline (O2O) — architected to effectively integrate prosumers into energy markets in a controlled way. In addition to providing revenue opportunity to a commercial online platform provider, it provides network owners and operators with visibility into transactions over their infrastructure, and new means to monetize energy assets.

Why This Is Important

Energy-sharing platforms enable integration of prosumer-owned distributed energy resources (DERs) into markets by exposing available capacity directly to customers. Utilities face increased need for flexibility, reliability and resilience, as a result of greater renewables penetration and changing energy security needs. By becoming providers of energy-sharing platforms, utilities can supplement existing revenue and compensate for loss of revenue caused by customers’ self-generation.

Business Impact

Energy-sharing online platforms impact revenue management, customer engagement and consumption analytics. The offline digital distribution platform impacts network operation, requiring a combination of traditional network control functions and economic-based control mechanisms, such as congestion management via distribution marginal prices.

Drivers

- The growing volume of prosumers is driving the market. Energy-sharing platforms turn individual consumers from passive to active managers of their networks. These marketplaces can relieve constraints on the electricity network and offer an alternative to costly grid reinforcements.

- Energy-sharing platforms can provide flexibility services to the main power grid, resulting in improved balancing and congestion management through better operation of DERs.

- The energy-sharing platform is an effective way to integrate prosumers into energy markets in a controlled manner. As a result, consumers will become better acquainted with their energy systems and marketplaces.

- By leveraging economies of connection and digital disruption at the edge of the grid, the energy-sharing platform creates new revenue opportunities for utilities. The energy-sharing platform is a sharing or networked economy (e.g., Airbnb, Uber) that relies on information-processing acumen, rather than ownership of production or delivery assets, to enable distribution, access and sharing of excess capacity in goods and services.

- The energy-sharing economy requires two distinct platforms, also referred to as O2O platforms. The online platform deals with virtual-world transactions by processing information, such as selecting products, placing them in the virtual cart and processing payment. The offline platform deals with delivering actual physical products or services in the real world, and considers availability, distance, traffic congestion and other physical-world constraints.

Obstacles

- Sustainable business models, capital investment and legal provision must be addressed.
- Platform reliability, good customer service and a reliable grid are key to success. Energy management and optimization system (EMOS) solutions will be an integral component.
- While energy-sharing platforms can address DER disruptions on incumbent energy providers, their adoption is hampered by regulatory barriers, such as opening access to grid infrastructure to nonutility participants.
- In the regulated utility sector, local distribution companies and network operators are addressing the disruptive impact of prosumerization on revenue by adding fixed connection charges for consumer self-generating capabilities. This creates an adoption barrier for consumer renewable sources and slows energy utility sector decarbonization.
- Regulating frequency and flow of electricity across the network requires investment in grid edge information technology/operating technology (IT/OT) infrastructure.

User Recommendations

- Work with business leaders to explore the implications of energy-sharing platforms in markets with growing levels of prosumer penetration.
- Ensure the provision of assets and capabilities for an energy-sharing platform business, such as app development platforms for consumer-/prosumer-facing apps, microtransaction billing and settlement systems, APIs for integration with digital distribution platforms, and analytical capabilities for discovery, bidding, negotiation and matching.
- Ensure the platform is designed to generate revenue by orchestrating prosumer integration into energy markets, to monetize use of energy assets at the grid edge, to create more visibility into transactions over utility-operated assets, and to address flexibility needs introduced by intermittent renewable sources.
- Decide whether to provide both parts of the platform, or to partner with sharing economy platforms from other sectors. Weigh implementation timelines in light of solution functionality and maturity.

Sample Vendors

Decentralised Energy Exchange (deX); ENTRNCE; LO3 Energy; Piclo; Powerledger; SunContract; TroonDx; UrbanChain

Gartner Recommended Reading

Market Guide for Advanced Distribution Management Systems

Market Guide for Energy Management and Optimization Systems

Quick Answer: How Are Electricity Markets Changing as the Energy Transition Accelerates?

Quick Answer: How Electric Utility CIOs Can Respond to Changing Customer Expectations

Edge AI

Analysis By: Eric Goodness

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Adolescent

Definition:

Edge AI refers to the use of AI techniques embedded in non-IT products, IoT endpoints, gateways and edge servers. It spans use cases for consumer, commercial and industrial applications, such as autonomous vehicles, enhanced capabilities of medical diagnostics and streaming video analytics. While predominantly focused on AI inference, more sophisticated systems may include a local training capability to provide optimization of the AI models at the edge.

Why This Is Important

Many edge computing use cases are latency-sensitive and data-intensive, and require an increasing amount of autonomy for local decision making. This creates a need for AI-based applications in a wide range of edge computing and endpoint solutions. Examples include real-time analysis of edge data for predictive maintenance and industrial control, inferences and decision support where connectivity is unreliable, or video analytics for real-time interpretation of video.

Business Impact

The business benefits of deploying edge AI include:

- Real-time data analysis and decision intelligence
- Improved operational efficiency, such as manufacturing visual inspection systems that identify defects, wasted motion, waiting, and over- or underproduction
- Enhanced customer experience, through feedback from AI embedded within products
- Connectivity cost reduction, with less data traffic between the edge and the cloud
- Persistent functions and solution availability, irrespective of network connectivity
- Reduced storage demand, as only prioritized data is passed on to core systems
- Preserved data privacy at the endpoint

Drivers

Overall, edge AI has benefited from improvements in the capabilities of AI. This includes:

- The maturation of machine learning operationalization (MLOps) and ModelOps tools and processes support ease of use across a broader set of features that span the broader MLOps functions. Initially, many companies came to market with a narrowcast focus on model compression.
- The improved performance of combined ML techniques and an associated increase in data availability (such as time-series data from industrial assets).

Business demand for new and improved outcomes solely achievable from the use of AI at the edge, which include:

- Reducing full-time equivalents with vision-based solutions used for surveillance or inspections.
- Improving manufacturing production quality by automating various processes.
- Optimizing operational processes across industries.
- New approaches to customer experience, such as personalization on mobile devices or changes in retail from edge-based smart check-out points of sale.

Additional drivers include:

- **Increasing number of users upgrading legacy systems and infrastructure in "brownfield" environments.** By using MLOps platforms, AI software can be hosted within an edge computer or a gateway (aggregation point) or embedded within a product with the requisite compute resources. An example of this is AI software deployed (TinyML) deployed to automotive or agricultural equipment to enhance asset monitoring and maintenance.

- **More manufacturers embedding AI in the endpoint as an element of product servitization.** In this architecture, the IoT endpoints, such as in automobiles, home appliances or commercial building infrastructure, are capable of running AI models to interpret data captured by the endpoint and drive some of the endpoints' functions. In this case, the AI is trained and updated on a central system and deployed to the IoT endpoint. Examples of the use of embedded (edge) AI are medical wearables, automated guided vehicles and other robotic products that possess some levels of intelligence and autonomy.

- **Rising demand for R&D in training decentralized AI models at the edge for adaptive AI.** These emerging solutions are driven by explicit needs such as privacy preservation or the requirement for machines and processes to run in disconnected (from the cloud) scenarios. Such models enable faster response to changes in the environment, and provide benefits in use cases such as responding to a rapidly evolving threat landscape in security operations.

Obstacles

- Edge AI is constrained by the application and design limitations of the equipment deployed; this includes form factor, power budget, data volume, decision latency, location and security requirements.
- Systems deploying AI techniques can be nondeterministic. This will impact applicability in certain use cases, especially where safety and security requirements are important.
- The autonomy of edge AI-enabled solutions, built on some ML and deep learning techniques, often presents questions of trust, especially where the inferences are not readily interpretable or explainable. As adaptive AI solutions increase, these issues will increase if initially identical models deployed to equivalent endpoints subsequently begin to evolve diverging behaviors.
- The lack of quality and sufficient data for training is a universal challenge across AI usage.
- Deep learning in neural networks is a compute-intensive task, often requiring the use of high-performance chips with corresponding high-power budgets. This can limit deployment locations, especially where small form factors and lower-power requirements are paramount.

User Recommendations

- Determine whether the use of edge AI provides adequate cost-benefit improvements, or whether traditional centralized data analytics and AI methodologies are adequate and scalable.
- Evaluate when to consider AI at the edge versus a centralized solution. Good candidates for edge AI are applications that have high communications costs, are sensitive to latency, require real-time responses or ingest high volumes of data at the edge.
- Assess the different technologies available to support edge AI and the viability of the vendors offering them. Many potential vendors are startups that may have interesting products but limited support capabilities.
- Use edge gateways and servers as the aggregation and filtering points to perform most of the edge AI and analytics functions. Make an exception for compute-intensive endpoints, where AI-based analytics can be performed on the devices themselves.

Sample Vendors

Akira AI; Edge Impulse; Falkonry; Imagimob; Litmus; MicroAI; Modzy; Octonion Group; Palantir

Gartner Recommended Reading

Building a Digital Future: Emergent AI Trends

Emerging Technologies: Neuromorphic Computing Impacts Artificial Intelligence Solutions

Emerging Technologies: Edge Technologies Offer Strong Area of Opportunity — Adopter Survey Findings

Emerging Tech Impact Radar: Edge AI

Blockchain in Utilities

Analysis By: Ethan Cohen

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Definition:

A blockchain is an expanding list of cryptographically signed, irrevocable, transactional records shared by all participants in a network. Each record contains a time stamp and reference links to previous transactions. With this information, anyone with access rights can trace back a transactional event, at any point in its history, belonging to any participant. A blockchain is one architectural design of the broader concept of distributed ledgers.

Why This Is Important

Blockchain is an effective mechanism for achieving distributed consensus on data in the face of an unsafe, unreliable networked environment with a dynamic collection of untrusted participants. As utility business becomes more collaborative as a consequence of grid parity achieved in many markets, blockchain is an example of a technology that enables democratization of the utility sector and lessens dependence on utilities as owners and maintainers of commodity transaction records.

Business Impact

Blockchains enable democratization of energy provisioning, such as managing microenergy transactions between prosumer-owned DERs and consumers. Another important use-case domain is decarbonization and carbon certificates. Blockchains can enable virtual retail operation, renewable energy certificate tracking, carbon tracking and trading, wholesale energy exchanges, and DER integration. Blockchains can realize automated billing for consumers and distributed generators. Water utilities can utilize blockchain for commodity, asset and service management.

Drivers

- Democratization and decentralization of the utility marketplace is a key driver for blockchain consideration and adoption. The most common use cases include keeping track of transactions in peer-to-peer (P2P) exchanges and transactions among parties in transactive energy markets, such as nonutility distributed energy resources (DERs) owners and consumers. Blockchains might also enable sponsor companies to offset their pollution with consumer clean-energy investments via tokenization.

- Tokens are emerging as the primary mechanism to represent value in precursor metaverse applications, enabling virtual goods to be bought, sold or exchanged within or across applications. Some key use-case domains include enabling carbon offset marketplaces and compliance with government emissions standards.

- Sustainability initiatives are tokenizing solar energy, carbon credits and green bonds to provide the asset verifiability and transparency needed to enable market buy-in, regulatory compliance and scalable adoption.

- The blockchain is enabling a new way of managing how energy is distributed, accounted for and secured. For example, microgrids could become more resilient with P2P communications managed via blockchain. 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, giving rise to new business models and applications for many distributed energy sources and increasing the network's security and reliability.

- Numerous trials have emerged to investigate and leverage blockchain for creating cryptographically secure, distributed P2P energy exchanges.

Obstacles

- Blockchain adoption in P2P energy exchanges will be implicitly controlled by regulation. Blockchain requires either a distribution open-access regulatory posture or an operating model in which the distribution system operator's revenue is tied to a number of connected customers rather than the amount of kWh sold. For that reason, though promising as a concept, the actual deployment hasn't yet crossed from the proof of concept (POC) experimental phase to the actual production systems.

- Similarly, in many other areas, the blockchain hype in utilities has subdued, indicating the technology has started to slide toward the Trough of Disillusionment.

User Recommendations

- Understand that the terminology surrounding blockchain is in flux. This uncertainty masks the potential suitability of technology solutions to meet business use cases. Consequently, use extreme caution when interacting with vendors who have ill-defined/nonexistent offerings.

- Set reasonable expectations when embarking on energy-related blockchain initiatives. The blockchain technology used outside of the financial sector as a mechanism for enabling the operation of distributed assets is in the embryonic stage. As such, expected initial operational benefits are low.

- Learn more about blockchain technology, regardless of its immaturity, as it is an example of a disruptive general-purpose technology that can have a major long-term impact on the sector. The potential impact may be high, particularly in markets facing high penetration of consumer-owned DERs. Utilities operating in those markets should assess potential risks, operational costs and their execution capabilities when considering the use of blockchain.

Sample Vendors

CarbonX; Electron; Energy Web; Ethereum; Grid Singularity; GridPlus; LO3 Energy; Nori; PONTON; Power Ledger

Gartner Recommended Reading

Promising and Ambitious Blockchain Initiatives for Digital Transformation in Water Utilities

Sliding into the Trough

Virtual Assistants in Utilities

Analysis By: Ethan Cohen

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Virtual assistants (VAs) help people with tasks previously handled by humans. VAs use semantic and deep learning models, natural language processing, prediction models, recommendations and personalization to interact with people via voice or text conversations. They also automate processes and workflows. VAs learn from people and system behaviors, build data models, and recommend and complete actions. VAs can be deployed in simple and complex use cases, including interactions with other VAs.

Why This Is Important

Efficient, conversational interactions are appealing to utility customers and employees. The ability to engage easily with machine systems is a natural extension of many human-to-human interactions. VAs support both business or consumer business value outcomes. VAs have the potential to completely transform customer and workplace experience.

Business Impact

VAs and hyperautomation increasingly enable utility automation. VAs use contextual multiturn conversations to progress digital business workflows within and across applications. Conversational AI solutions for chatbots and VA initiatives range from technical build-your-own, through low-code platform-based to fully managed SaaS targeted services. Expanded integration with enterprise applications and utility operational expert systems will enhance VAs addressing complex tasks and tap opportunities for increasing value.

Drivers

- Achieving higher quality, efficient, low-cost customer and employee engagement and interaction

- Meeting growing utility customer and employee expectations for anytime, anywhere access to information and business services
- Addressing increasing demand for technology that is easy to understand and engage even in multisimultaneous user interface environments
- A strong desire by utilities to automate business workflows and processes wherever automation can deliver value to the business
- Providing capability to extend AI from discrete use cases into composable applications that deliver more complex analysis and transaction capabilities spanning multiple systems and business processes
- The evolution of VA technology that supports more natural human-machine interactions via multimodal interfaces processing text, voice graphics, video and gaze
- The emergence of voice-to-action VAs for interacting with IoT devices and mobile applications

Obstacles

- Inadequate AI platforms that do not have the capabilities needed to deliver virtual assistants. Many of these platforms lack the ability to handle complex transactions, context switching, multi-intent utterances, strong integration, process automation, and other functionalities needed for desired virtual assistance and automation capabilities.
- Gap or incomplete integration with enterprise applications and expert systems that are information sources or transactional result systems for VAs.
- Lack of strategy, policy, governance, or design authority in utilities for scaling AI and VA and for testing the quality and measuring the impact of VA minimum viable products (MVPs).
- Operations gaps that are not aligned with enterprise security and change control processes.
- Lack of commitment to iterative growth built up from proof of concept (POC) scaling to MVP launches enabling chatbot solutions that are further improved as adoption grows.

User Recommendations

- Expand your chatbot capabilities by integrating with enterprise applications for business functionality.
- Ready your IT organization for the rapid evolution of technologies that support the creation and deployment of increasingly capable VAs and the technology that underpins these.
- Prepare to deliver significant levels of application integration and business process automation in conjunction with VA capability as the platforms become increasingly sophisticated.
- Seek opportunities to use VAs to make employees more productive with their business applications or services by integrating VAs with BPA to enable conversational triggered business processes in well-defined use cases.
- Anticipate that VAs will rapidly shift focus from being transaction-centric to user- or people-centric, and event-centric. VAs will increasingly incorporate user profiles and use contextual data that must be managed.
- Incorporate analytics to measure the impact of VAs on behavior and performance. Closely monitor VA use and align to VA platform development to support business service requirements.

Sample Vendors

[24]7.ai; Amelia; Apple; Google; Microsoft; Nuance; NVIDIA; Openstream.ai

Energy Efficiency Gamification

Analysis By: Sruthi Nair

Benefit Rating: Low

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

Energy efficiency gamification applies game mechanics to drive ongoing consumer engagement in energy and water conservation, either as part of data and analytics or as a stand-alone program/application. Typical strategies include contests and rewards for conserving energy and water; social media elements, such as communities; and indicators of status and success, like badges and leaderboards. Yet, it is not a rewards program, but a strategy to design approaches to solve environmental concerns.

Why This Is Important

Low consumer interest and engagement in energy efficiency and management are utility industry challenges, especially for utilities tasked with achieving end-user energy efficiency improvements. Gamification applies game mechanics to motivate people and change behavior. Utilities can use gamification to improve customer engagement in energy efficiency programs and also reduce their overall emissions.

Business Impact

Energy efficiency gamification can be used by demand-side management departments as a niche conservation measure that engages a subset of customers. Incorporating consumption data from meter data management systems improves programs, and integration with utility customer information systems and/or CRM systems can help track and manage customer participation. Gamification can also be used by competitive energy retailers to support customer acquisition and retention efforts.

Drivers

- The need to ensure energy affordability concerns, reduce fossil-fuel-based energy consumption, coupled with energy efficiency and energy saving requirements, is driving utilities to adopt several energy and water conservation measures. These are outlined by the American Council for an Energy-Efficient Economy (ACEEE) in the U.S. and EnerGAware in the EU. While utilities are investing efforts in reducing greenhouse gas emissions, the efforts and adoption are driven primarily by mandates of regulatory bodies.

- EnerGAware is a research project started in the EU with an objective to achieve 15% to 30% energy consumption and emissions reduction in a social housing pilot, and increase the social tenants' understanding and engagement in energy efficiency.

- The fifth ACEEE International Energy Efficiency Scorecard of 2022 evaluated the efficiency policies and performance of 25 of the most energy-consuming countries globally. The evaluation was conducted based on 36 parameters to score each country's efforts to save energy and reduce greenhouse gas emissions across four categories: buildings, industry, transportation, and overall national energy efficiency progress. France topped the list given their adoption of electric vehicles, and by enacting policies aimed at reducing energy use in the buildings sector. Rounding out the top five were the United Kingdom, Germany, the Netherlands and Italy.

- Energy efficiency gamification in the EU was also promoted via the FEEdBACk Project. It stimulates and delivers energy efficiency through behavioral change.

- Country commitments to net zero greenhouse gas emissions are a catalyst for utilities to focus on reducing their emissions through effective energy efficiency programs.

Obstacles

- Interest in energy efficiency gamification is growing, but the takeup remains relatively small. Gamification initiatives are propelled by regulatory bodies and accordingly generated by utilities. Once the push from the regulatory side stops, there might be a halt or pause in such initiatives due to lack of incentives.

- The unprecedented events such as energy market volatility caused by the geopolitical crisis, extreme weather-related events and other uncertainties are major hindrances to the adoption of such initiatives. In 2020, there was limited adoption of energy efficiency initiatives through gamification, as the focus shifted to mitigating health and economic impacts of the COVID-19 pandemic. Multiple energy jobs were also lost due to the same.

User Recommendations

- Investigate energy efficiency gamification and compare it with other energy efficiency measures as a means to reduce emissions or achieve energy efficiency mandates.

- Keep in mind that the body of evidence for energy efficiency gamification results is still evolving, including analysis of persistence (that is, long-term conservation) and rebound (the tendency for consumption to increase once the program is no longer in place).

- Evaluate third-party solutions if your organization has little or no experience with design and management of games. To be successful, gamification programs need program managers, marketers and IT personnel.

Sample Vendors

Bidgely; GreenCom Networks; Intelen; JouleBug; Oracle; Uplight

Gartner Recommended Reading

2022 Sustainability Survey: Energy CIOs Can Help to Retain C&I Enterprises as Customers

2023 Utility Trend: Growth of Energy Poverty — Focus on Relief, Revival and Renewable Energy

Quick Answer: How Electric Utility CIOs Can Respond to Changing Customer Expectations

2023 Utility Trend: Sustainability Is a Double-Edged Sword for Utilities

Distributed Energy Resource Management System

Analysis By: Lloyd Jones

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

A distributed energy resource management system (DERMS) is an emerging set of utility software applications that manage distributed energy resources (DERs), which are connected to the electric distribution grid. DERMS makes DERs more accessible and beneficial for all stakeholders, including consumers/prosumers, aggregators, grid owners and operators, and energy market coordinators, by orchestrating DER across different roles, and group DERs to provide services from energy to flexibility.

Why This Is Important

As energy transition gains momentum, DERs are penetrating all areas of the grid, contributing to the decentralization and democratization of energy provisioning. DER deployment is rising globally and utilities now have an urgent need to integrate and orchestrate DERs to maintain network operations resilience and achieve higher levels of flexibility through the market and dispatch of DERs to balance energy.

Business Impact

DERMS addresses the uncertainties created by high levels of penetration of DERs, such as rooftop solar, by turning DERs into additional control levers to manage distribution network operation and commodity management. It also offers benefits to transmission network operations and flexibility markets. A DERMS will also be relevant to DER aggregators that plan to offer various services to distribution-level energy service markets (as they develop), as well as use it for wholesale market arbitrage.

Drivers

- DERMS, as a software application, addresses the complexity of high levels of DER penetration by turning these resources into useful contributors for energy commodity management, distribution network operation and end-user energy efficiency programs.
- DERMS are most applicable for utilities where renewable generation (in particular, those deployed by consumers or prosumers), energy storage, and electric vehicle adoption are rising rapidly.
- According to the National Renewable Energy Laboratory report, significant operational impacts develop when DER capacity on the systems reaches 15% of the annual peak load (see An Overview of Distributed Energy Resource (DER) Interconnection: Current Practices and Emerging Solutions).
- DERs impact multiple aspects of the utility business and create several possible use cases for DERMS. Examples are mitigating the impact of inertialess renewable sources on frequency control on the operational technology (OT) side, creating the need for flexible markets on the energy commodity management side, using DER as controllable resources to manage grid congestion and acting as a contributing resource to individual consumer energy efficiency.

Obstacles

- DERMS products have emerged with different focus points, such as to manage and analyze DERs' impact on the grid advanced distribution management systems (ADMS), or to manage and integrate DER into local and wholesale energy markets demand response management system (DRMS) or the virtual power plant (VPP).
- Vendors with broad-scope ambitions are forming wider partnerships, further complicating market boundaries and resulting in a lack of common understanding (or outright misunderstanding) about DERMS.
- Misalignment between expectations and reality.
- Too few client case studies and not enough proof of realized ROI.
- Immature DERMS offerings built mostly as an extension of adjacent products, such as ADMS, DRMS/VPP and energy efficiency, using legacy protocols, such as OpenADR.
- A reluctance to embrace newer standards such as IEEE 2030.5 across software, equipment, communications and security.

User Recommendations

DERMS implementation is a significant undertaking. A DERMS initiative is commonly led by the business or operations side, the IT effort required in DERMS deployment is significant.

- Control value delivery and reduce execution risk by building an extensive change management map across operations, customer service, network design, commodity management and control center operations.
- Specify how DERMS should communicate with individual devices at the distribution grid edge, as a universally adopted standard/protocol has not emerged yet. Utilities also need to select data integration models (such as Common Information Model [CIM] or MultiSpeak) to determine how a DERMS can inform other enterprise systems, particularly ADMS, about available operational actions.
- Give clarification to users about the product roadmap and vendor credibility, as vendor products are immature with a narrow focus, leaving adjacent use cases that will be required in the near term unmet.

Sample Vendors

GE Digital (Opus One Solutions); Generac Grid Services (Enbala); mPrest; Schneider Electric (AutoGrid); Siemens; Yokogawa Group (PXiSE)

Gartner Recommended Reading

The Impacts of Exponential Renewable Generation Growth Across the Energy Ecosystem

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Market Guide for Distributed Energy Resource Management Systems

Edge Computing

Analysis By: Evan Zeng, Leo Li, Kevin Ji

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Adolescent

Definition:

The edge computing market in China provides the hardware, software and services to extend agile digital capabilities to the edge, enabling lower latency and semiautonomous computing. It must connect seamlessly and enable compute capabilities where needed in the distributed computing value stream, from simple filtering to rich machine learning. Edge computing can be delivered as a service or through hardware and software deployed in the path of data flow at or near the edge.

Why This Is Important

The edge computing market is rapidly evolving as vendors in existing markets modify their offerings to support new requirements, and as new technologies and vendors fill gaps. Edge computing will complement the hyperscale public cloud. China is seeing increased building of edge facilities, including the rollout of the national 5G network. Edge computing will enable digital business scenarios requiring computation capabilities at locations closer to users, things and data, especially in utilities, energy, media and manufacturing.

Business Impact

Edge computing is mostly used in real-time processing scenarios (data or business functions) that are distributed to multiple physical locations to achieve planned business outcomes.

Drivers

Edge computing provides computing resources to complement cloud services. The drivers are diversified across the areas below:

- Vertical industries, such as utilities, energy, media and manufacturing
- Specific use cases, such as real-time data processing and function response
- Unique interactions, such as interactions between people, things and businesses
- Specific business improvements, such as improving the customer experience
- Operations improvements, such as factory automation

Many technology requirements for edge computing will span verticals. Requirements within enterprises will also extend from the customer-facing storefront edge to the factory edge, the smart-building edge and the workplace edge. This will increase requirements on holistic, horizontal processes and technologies to improve integration and security and reduce costs.

Obstacles

- The diversity of use cases leads to many solutions that are first-of-a-kinds or highly customized.
- There is a lack of compatibility between edge technologies and platforms.
- The lack of industrial standards for hardware and software is an obstacle that increases costs and creates technical silos.
- Network and edge computing infrastructures are highly integrated but hard to implement with limited enterprise delivery budgets. Chinese carriers have the privilege of building and operating foundational national network services and are achieving aggressive penetration in the edge computing market, but edge computing delivery capabilities are lacking. Cloud providers, in contrast, have strong edge computing solutions and delivery ecosystems.

User Recommendations

CIOs responsible for edge innovation should:

- Develop an edge strategy to support enterprise digital transformation by leveraging their cloud strategies and redeveloping them for edge scenarios.
- Identify initial edge use cases for their enterprises by focusing on real business outcomes. For example, the mining industry requires ultralow latency compute infrastructure on data analytics at the edge.
- Develop a plan to reskill IT teams with new edge skills, such as IT and operational technology (OT) convergence at the edge.
- Build a special team to focus on edge innovation. This can be a virtual or physical team. The team can work together regularly to build edge architecture, identify edge use cases, and create edge strategies, among other tasks related to edge innovation.

Sample Vendors

Alibaba Cloud; Amazon Web Services (AWS); China Mobile; China Telecom; China Unicom; Huawei; IEIT Systems; Microsoft; Tencent; Volcano Engine

Gartner Recommended Reading

Market Guide for Edge Computing

Building an Edge Computing Strategy

Top Practices for Building Edge Computing Solutions in China

Knowledge Graphs

Analysis By: Afraz Jaffri

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

Knowledge graphs are machine-readable representations of the physical and digital worlds. They include entities (people, companies, digital assets) and their relationships, which adhere to a graph data model — a network of nodes (vertices) and links (edges/arcs).

Why This Is Important

Knowledge graphs capture information about the world in an intuitive way yet are still able to represent complex relationships. Knowledge graphs act as the backbone of a number of products, including search, smart assistants and recommendation engines. Knowledge graphs support collaboration and sharing, exploration and discovery, and the extraction of insights through analysis. Generative AI models can be combined with knowledge graphs to add trusted and verified facts to their outputs.

Business Impact

Knowledge graphs can drive business impact in a variety of different settings, including:

- Digital workplace (e.g., collaboration, sharing and search)
- Automation (e.g., ingestion of data from content to robotic process automation)
- Machine learning (e.g., augmenting training data)
- Investigative analysis (e.g., law enforcement, cybersecurity or financial transactions)
- Digital commerce (e.g., product information management and recommendations)
- Data management (e.g., metadata management, data cataloging and data fabric)

Drivers

- The need to complement AI/ML methods that detect only patterns in data (such as the current generation of foundation models) with the explicit knowledge, rules and semantics provided by knowledge graphs.
- Increasing awareness of the use of knowledge graphs in consumer products and services, such as smart devices and voice assistants, chatbots, search engines, recommendation engines, and route planning.
- The emerging landscape of Web3 applications and the need for data access across trust networks, leading to the creation of decentralized knowledge graphs to build immutable and queryable data structures.
- Improvements in graph DBMS technology that can handle the storage and manipulation of graph data structures at scale. These include PaaS offerings that take away the complexity of provisioning and optimizing hardware and infrastructure.
- The desire to make better use of unstructured data held in documents, correspondence, images and videos, using standardized metadata that can be related and managed.
- The need to manage the increasing number of data silos where data is often duplicated, and where meaning, usage and consumption patterns are not well-defined.
- The use of graph algorithms and machine learning to identify influencers, customer segments, fraudulent activity and critical bottlenecks in complex networks.

Obstacles

- Awareness of knowledge graph use cases is increasing, but business value and relevance are difficult to capture in the early implementation stages.
- Moving knowledge graph models from prototype to production requires engineering and system integration expertise. Methods to maintain knowledge graphs as they scale — to ensure reliable performance, handle duplication and preserve data quality — remain immature.
- The graph DBMS market is fragmented along three properties: type of data model (RDF or property), implementation architecture (native or multimodal) and optimal workload (operational or analytical). This fragmentation continues to cause confusion and hesitation among adopters.
- Organizations want to enable the ingestion, validation and sharing of ontologies and data relating to entities (such as geography, people, events). However, making internal data interoperable with external knowledge graphs is a challenge.
- In-house expertise, especially among SMEs, is lacking, and identifying third-party providers is difficult. Often, expertise resides with vendors of graph technologies.

User Recommendations

- **Create a working group of knowledge graph practitioners and sponsors** by assessing the skills of D&A leaders and practitioners and business domain experts. Highlight the obstacles to dependable and efficient data delivery for analytics and AI, and articulate how knowledge graphs can remove them.
- **Run a pilot to identify use cases that need custom-made knowledge graphs.** The pilot should deliver not only tangible value for the business, but also learning and development for D&A staff.
- **Create a minimum viable subset that can capture the information of a business domain to decrease time to value.** Assess the data, both structured and unstructured, needed to feed a knowledge graph, and follow Agile development principles.
- **Utilize vendor and service provider expertise** to validate use cases, educate stakeholders and provide an initial knowledge graph implementation.
- **Include knowledge graphs within the scope of D&A governance and management.** To avoid perpetuating data silos, investigate and establish ways for multiple knowledge graphs to interoperate and extend toward a data fabric.

Sample Vendors

Cambridge Semantics; Diffbot; eccenca; Neo4j; Ontotext; Stardog; TigerGraph; TopQuadrant; Trace Labs

Gartner Recommended Reading

How to Build Knowledge Graphs That Enable AI-Driven Enterprise Applications

3 Ways to Enhance AI With Graph Analytics and Machine Learning

Working With Graph Data Stores

How Large Language Models and Knowledge Graphs Can Transform Enterprise Search

Lidar

Analysis By: Nicole Foust, Lloyd Jones

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Lidar (light detection and ranging) is an optical remote-sensing technique for precisely scanning surfaces from a distance with laser light. Lidar systems use an active optical sensor that transmits laser beams, and calculates the range and precise position of the target. Measurements are combined into a point cloud dataset, which is registered to a 3D-coordinate system.

Why This Is Important

Lidar can be used to perform mapping, surveying, site planning and asset inspections more safely, efficiently and more frequently than human workers. Capabilities such as cloud computing, advanced analytics and drones are increasing functions and use cases, expanding opportunities to perform important tasks in utility organization operations.

Business Impact

Transmission and distribution (T&D) facilities and assets use lidar to track vegetation growth and rate transmission capacity, generate wide-area digital elevation models to aid in flood risk assessment, and mitigate service interruptions. It is used in renewable energy wind measurement and yields, and in solar planning and land management to ensure compliance with rental contracts and avoid easement violations. It is also deployed in water/wastewater pipeline inspection and modeling.

Drivers

- The use of lidar by utility organizations with transmission assets expanded dramatically, due to regulations passed in some regions.
- Lidar offerings include more advanced capabilities, such as feature recognition and drone-based data collection.
- The owners of the plant and linear asset may use lidar for autonomous asset inspection via self-driving vehicles.
- Rapidly changing consumer innovations, such as micro-electromechanical systems (MEMS) lidar and flash lidar, reduce both complexity and price. Apple's decision to embed a lidar into every iPhone (and iPad) increases interest, providing manufacturers with a reference design and developers with a platform, with which to explore the technology.
- Lidar data acquisition options continue to expand due to innovation and decreasing costs of autonomous vehicle systems, unmanned aerial systems (drones), and security systems.
- Traditional vendors of computer-aided engineering (CAE) and computer-aided design (CAD) software offer lidar data management tools to support 3D engineering and building information modeling (BIM) processes.
- Geographic information system (GIS) vendors offer geospatial service platforms that can support end-user processing of 3D models and point clouds.

Obstacles

- Lidar technology is still relatively expensive compared with other safety sensors, including radar and cameras, which limits use. In the use case that drove price performance improvement, autonomous vehicles are losing their position to alternative technology, such as AI-based computer vision.

- Data management infrastructure can be extensive because lidar datasets are large, and some processing steps may be required for certain applications. Most transmission design, CAD and GIS applications support viewing and analysis of 3D point clouds. In many cases, this data can be repurposed to meet other business needs, such as vegetation and property management, requiring further data governance.

- Lidar data must be consolidated with data in other systems, such as structure locations, access roads, aerial orthophotography, landbase data and property data. Standard data extraction techniques and integration methods will be needed to integrate spatial data types from the lidar datasets, GIS data and CAD/CAE files into other systems.

User Recommendations

- Integrate lidar-generated data according to tested enterprise data integration methods.

- Source support from business unit leaders by asking them to create a roadmap of how lidar can augment complementary operations systems and activities.

- Evaluate opportunities across operations to optimize lidar use to capitalize on total opportunity benefits.

- Establish how lidar can be used to limit the need for human activities, such as with drone inspections.

Sample Vendors

GeoCue; GeoDigital; Geograma; Hexagon; RIEGL Laser Management Systems; Teledyne Optech; Topcon Positioning Systems; Vaisala; ZX Lidars

Gartner Recommended Reading

Market Guide for Geospatial Information Systems for Energy and Utilities

How Utility CIOs Can Unlock the Business Value of Geospatial Information Systems

2023 CIO and Technology Executive Agenda: A Utility Industry Perspective

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Market Guide for Renewable Energy Management Solutions

Geospatial Platform

Analysis By: Nicole Foust, Lloyd Jones

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Geospatial platforms are platform as a service (PaaS) and data as a service (DaaS) offerings in the context of spatial data processing, such as web mapping, mobile geospatial apps, location services, imagery services, analytics and geoevent processing. They also include other features such as digital marketplaces with subscription-based licensing and revenue-sharing mechanisms, for partner- and customer-generated apps and content.

Why This Is Important

Location and time are important items of information for contextualizing operational, transactional, mobile and sensor data. Analyzing operational data in the context of location can uncover spatial trends, dependencies and patterns that are otherwise undetectable. Asset-intensive organizations (especially those with spatially distributed assets) are expanding capabilities to manage and optimize spatial location data, which is essential for the optimization of an enterprise.

Business Impact

A geospatial platform will help asset-intensive organizations with a pace-layered strategy toward intelligent operations, deploying innovative applications that leverage time- and event-stamped locational transactions. Geographic information system (GIS) developers in IT organizations and “citizen developers” in business units can easily develop web and mobile applications that access geospatial services. Maps can be easily put to business use in an agile delivery model to improve transactional data quality and timing.

Drivers

- Organizations seek to capture the value of location to understand and engage customers, improve sustainability capabilities and initiatives (such as climate risk modeling), optimize supply chains and asset usage, develop and interact with a broader ecosystem, and improve operational efficiencies.
- Investments in the Internet of Things (IoT), cloud, analytics, edge capabilities and more, are driving greater adoption, broader utilization, and new use cases and services. In these investments, ecosystem partners are building capabilities to augment platform products and expand opportunities further.
- Geospatial platforms are foundationally a spatial information system of record. Core geospatial functions are expressed as web services, and interfaces are expressed as restful APIs and HTML5-based applications that consume these services. The web map has become the digital expression and real-time operational view of geospatial content.
- Geospatial platforms can support real-time modeling; visualize electrical, gas, and/or water and pipeline networks; model geological and surface feature relationships; and depict the relationship between assets and the environment. These can support the creation and management of the geospatially referenced plant and network models necessary for the planning, design, construction, and operations of the locations and the specification of assets.
- Energy and utility organizations are expanding the geospatial platform footprint to reduce the time to value for geospatial application development, and simplify end-user collaboration across departmental or company boundaries.
- In addition, geospatial platforms are evolving faster than industry-specific GIS applications, making them ideal for organizations that are adopting a pace-layering approach to geospatial application development.

Obstacles

- Accessing data in legacy GIS can be difficult without the help of GIS analysts, and the cost of application development and maintenance can be substantial. The quality, storage and management of spatial data can be a challenge for many organizations. However, modern applications leverage geoprocessing workflow capabilities with low-cost, commercial data layers, satellite imagery, aerial photogrammetry and mobile GPS.
- Business and software silos are an ongoing challenge in digitalization journeys. Increasingly, public, private or hybrid GIS deployment options are available, which create significant collaboration opportunities both inside and outside the enterprise.
- Asset, network and field mobile applications, when integrated with geospatial and enterprise systems, can further improve operational capability, data quality and business performance.
- Supplementing a GIS with improved land-based data, aerial photography, location-based services and customer engagement applications can make GIS useful for a wider variety of users.

User Recommendations

- Identify a comprehensive geospatial platform that meets the geospatial application requirements of multiple business units, and that supports cross-enterprise collaboration and workflow mapped to specific business goals.
- Resolve barriers to geospatial platform adoption by addressing licensing, security, architecture and information governance early on. Cloud-based deployments may be appropriate for managing the sharing of maps and metadata outside the organization.
- Evaluate the benefits and costs at an ecosystem level, when concerns about vendor lock-in and pricing arise. As with other software platforms, the investment and relationship are with the overall ecosystem, not just the platform provider. Business owners can explore subscription licensing and business partner relationships that can lower the total cost of ownership.

Sample Vendors

Bentley Systems; CARTO; Esri; General Electric; Hexagon; QGIS; Supergeo Technologies; SuperMap Software; TatukGIS; Trimble

Gartner Recommended Reading

Market Guide for Geospatial Information Systems for Energy and Utilities

How Utility CIOs Can Unlock the Business Value of Geospatial Information Systems

Digital-Outcome-Driven Metrics for Utilities

Market Guide for Enterprise Asset Management Software

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Mobile Customer Interaction Channel

Analysis By: Ethan Cohen

Benefit Rating: Moderate

Market Penetration: More than 50% of target audience

Maturity: Obsolete

Definition:

The mobile customer interaction channel enables utilities to deliver information and services to customers using smartphones, tablet computers and electronic wearables. It also includes responsive design websites that render well on mobile devices as well as native applications for leading mobile operating systems, including Apple iOS and Google Android.

Why This Is Important

Many utilities have deployed mobile applications to meet select customer service and experience needs. Utilities are struggling to provide the application reliability, functionality and stickiness that keeps customers informed, engaged and satisfied. The opportunity to reach, engage, transact and positively influence the experience of customers is increasing in importance and as such mobile applications are now embedded capabilities in enterprise systems, including customer information systems.

Business Impact

Mobile customer interaction channels impact customer experiences. They can:

- Support customer billing and collections.
- Enable and enhance customer self-service.
- Become an important part of energy services provisioning; for example, in electric vehicle charging and other location-based services.
- Enable and facilitate customer interest in programs, promotions or new products and services, for example, affinity incentive programs.
- Deliver essential and helpful information, including notification and communication of adverse events.
- Support regulatory compliance.

Drivers

Digital has created customers with a high bar of sometimes differing expectations. Mobile customer interaction channels have allowed utilities to:

- Serve customers and quickly evolve to meet changing customer needs regarding their utility commodity, energy and water services.
- Meet the specific needs of certain, few revenue and mission-critical customer segments such as large commercial and industrial customers at a reasonable cost.
- Address the common needs of many customers in residential and small commercial consumption and service segments in a cost and impact optimized manner.
- Provision new capabilities for customer engagement and experience business operations.
- Connect and orchestrate work-siloed employees and disconnected business processes in customer service, field service and asset operations and total experience.
- Meet customer expectations and satisfy needs across a variety of key contexts including personal, home, mobility and environment.
- Offer premium services and generate new revenue and revenue premiums.

Obstacles

- The mobile customer interaction channel is obsolete before reaching the plateau, as mobile and other interaction capabilities are nearly ubiquitously embedded in enterprise applications and integrated with packaged business capabilities.
- Customers have high expectations about how they want to interact with utilities. Yet too often, organizations have been focused on individual channels or applications, overlooking the aggregate impact of the user experience across the digital user journey.
- Utility customer service strategy, operations capability and practice is dominated by the limited concept of comparative service satisfaction and not customer experience and engagement excellence.
- Utilities don't have well-defined customer experience and engagement strategies that are aligned to improved operations outcomes including lower cost, higher efficiency and productivity, lower risk, and creation of new revenue or freed-up capital.
- Utilities have been slow to invest in advanced virtual assistants.

User Recommendations

- Make mobile customer interaction channels a part of a broad digital customer experience strategy and total experience by developing it as a pillar in the customer experience and engagement digital platform.
- Shift investments away from traditional channels and channel-focused teams by reimagining customer relationships and user journeys based on effortless experience design across digital touchpoints and interaction modalities.
- Design new multiexperience journeys for customers by implementing a mesh application and service architecture.
- Design mobile customer interaction channels by including an array of contemporary technologies and approaches including responsive web design, conversational agents, virtual assistants and other AI in solutions.
- Expand the functionality of mobile interaction channels by connecting to relevant utility systems of record such as customer information systems and field and asset management systems.
- Incorporate enterprise, architecture and technology composability in the development of mobile customer interaction channels.

Sample Vendors

CGI; Octopus Energy (Kraken Technologies); Oracle; PlanetEcosystems; Salesforce; SAP

Emissions Position Management

Analysis By: Sruthi Nair

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Emissions position management solutions for greenhouse gasses (GHGs) track emissions and manage emissions certificates' associated trades. More complete solutions provide reports for verification and can factor in market prices for emissions to provide a financial perspective. Emissions position management is linked with emissions-monitoring solutions, which map the volume and type of fuel used in generation units, and factors associated with the unit's operation, to assess the emissions.

Why This Is Important

Growing pressure to reduce emissions is forcing utilities to adopt control measures. Generators track and manage emissions certificate inventories using spreadsheets, while some use environmental, health and safety (EH&S) solutions for emissions management. The cap-and-trade market uses energy trading and risk management systems (ETRMS) to manage certificate inventories and record-related trades. Stack-monitoring solutions are used to assist in managing emissions position data.

Business Impact

The primary affected area is the supply domain, with impacts on environmental compliance and ETRMS functions. Because these documents can involve multiple inputs from separate business functions, there is the risk of user error. Given such risk, CIOs and IT leaders should be active in monitoring the process of emissions report production. Supporting a wide variety of internal and external reports of historic, current and future emissions levels is a key capability that is required.

Drivers

- Energy sustainability is an increasingly urgent challenge as people, enterprises and governments search for ways to balance energy-intensive lifestyles and environmental impact — especially GHG emissions from fossil fuels.

- The carbon accounting and reporting pressure on enterprises varies by region (for example, the U.S. and Western Europe are rapidly proposing regulations, driven by investors, consumers, businesses and governments, to toughen their stance on carbon emissions), and by industry segment (physical goods manufacturing, storage, movement versus services entities, or financial services investors).

- Faced with climate change and stakeholder pressures, energy companies must satisfy fast-growing energy demand from developing countries, while simultaneously reducing their commitment toward net-zero goals.

- Many generators with fossil fuel assets track and manage emissions certificate inventories using spreadsheet-based solutions. Some use EH&S solutions for emissions position management. Where a cap-and-trade market for GHGs exists, the use of ETRMS to manage certificate inventories and record-related trades continues to grow. GHGs include carbon dioxide, sulfur dioxide, nitrous oxide and particulates. Stack-monitoring solutions can be used to assist in managing emissions position data.

- Despite the availability of robust emission position management software, ETRMS and EH&S software solutions, many utilities still rely on spreadsheets for carbon emissions tracking and tracing. This could be attributed to the utility teams finding the interface and functionalities of spreadsheets much easier to use than these solutions.

Obstacles

- Lack of standardization and inaccuracy in carbon data collection and measurement are looming concerns that need to be addressed by utilities.
- Lack of clarity in functionalities of emissions position management systems, given its confluence with ETRMS, carbon accounting and other carbon management systems such as greenhouse gas emissions management solutions (GEMS).
- Substantial issues remain over the precise contents and details the disclosures should encompass.
- Part of the difficulty is in the fact that GHG measuring and monitoring is at the same time very broad, touching every utility in some manner, but also quite specific. The GHG emissions challenges that utilities face can vary significantly, based on their commodity geographic location and other factors.

User Recommendations

- Examine EH&S solutions to determine whether GHG monitoring functionality is available and can be applied to fossil-fuel-generation operations. Many ETRMS vendors offer certificate inventory management capabilities, and explore the possibilities of migrating certificate management and trading to any ETRMS. This may enable enterprises to consolidate emissions position management and trading activities onto a single platform.
- Ensure that the accountability for the production and control of emissions-related information is documented and understood.
- Identify alternative methods for emissions management and trading, and leverage blockchain technologies that are emerging in established markets.

Sample Vendors

acQuire Technology Solutions; Envision Group; Locus; S&P Global (IHS Markit); Wolters Kluwer

Gartner Recommended Reading

Market Guide for Energy Trading and Risk Management Systems

Market Guide for Environmental, Health and Safety Management Software

Market Guide for Gas Emissions Management Solutions

IoT in Utilities

Analysis By: Nicole Foust, Zarko Sumic

Benefit Rating: Transformational

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Definition:

Internet of Things (IoT) is the network of dedicated physical objects with embedded and edge technology to communicate and sense or interact with their internal states and/or the external environment. IoT is an enabler of digital business and a core building block of digital platforms. Vertical utility IoT examples include advanced metering infrastructure (AMI), and connected operational technology such as supervisory control and data acquisition (SCADA).

Why This Is Important

IoT is an essential component for digital business transformation, intelligent operations, and composable business initiatives. Utility organizations view IoT in favor of a more business-operations-centric approach. Use cases are found in all parts of the utility business. These include advanced metering infrastructure, asset management and work management activities, distributed energy resource management systems (DERMS), and consumer technologies (such as smart thermostats).

Business Impact

IoT helps connect utility operational technology (OT), IT, consumer technology (CT) and engineering technology (ET). Use cases include:

- **Increased engagement:** Experiences of consumers/prosumers that improves loyalty and lifetime value.
- **Resource conservation:** Energy efficiency and pollution reduction.
- **Cost optimization:** Lower inventory spoilage and theft.
- **Optimized operations:** Improved productivity and efficiency, logistics and coordination.

- **Optimized assets:** Asset utilization, health monitoring, reliability and maintenance.

Drivers

- IoT is transformational in utilities as they progress further into the decade of deep redesign. Therefore, we have progressed this technology by one position on this Hype Cycle, driven by continued market investment, activity and use cases.
- In Gartner's 2023 CIO and Technology Executive Agenda: A Utility Industry Perspective, 29% of utility respondents indicate increasing investment in IoT, with enterprises varying widely on their IoT maturity. Larger utilities have ongoing IoT-enabled initiatives for use cases, ranging from incremental benefits (e.g., asset optimization or regulatory reporting) to transformative benefits (e.g., dynamic operations of renewable assets).
- Organizations need a "system of systems" that pulls together the proliferation of IoT platforms, data islands and siloes.
- The falling costs of technology, large number of vendors, and relative ease of deployment for new use cases and experimentation, are factors that are accelerating IoT adoption.
- IoT reference architecture and capabilities are becoming aligned with current vertical industry requirements for remote measurement, monitoring and control. Due to a larger addressable market and R&D funding, price/performance of IoT solutions is improving faster than utility vertical solutions, such as AMI or SCADA. Therefore, we see increased interest from buyers in open IoT solutions that address utility monitoring and control needs.
- The energy transition is impacting the current energy provisioning business model, and driving the need for tighter integration of consumers/prosumers and their assets, such as consumer energy technology, DER and smart appliances in utility markets. This contributes to IoT adoption.
- Consequently, the use of stand-alone IoT such as drones, augmented reality/virtual reality and wearables continues to grow, and general-purpose IoT are becoming established. This creates additional opportunities for utilities.

Obstacles

Utility CIOs and business leads should ensure due diligence in planning for initiatives in common challenge areas, such as:

- Confusing vendor marketing (most vendors leverage IoT in delivering IoT-enabled business solutions).
- IoT implementation and expansion (e.g., end-to-end integration complexity and alignment meet specific business outcomes).
- The need to bridge cultural divides between IT and operations and across business units.
- Legacy investment in OT approaches that may carry technical debt.
- Security concerns and requirements of the IoT solutions, which remain an area of caution to meet security and reliability requirements of legacy SCADA installations.
- The historical emphasis on industry's need for high levels of reliability and safety, along with very large existing investments in legacy operational technologies such as SCADA and AMI, which can conflict with affordability and relative ease of deployment.

User Recommendations

- Discern that IoT is not a single technology or solution. It is a broad-based expansion of related technologies that can be applied to a wide range of use cases and purposes.
- Review IoT uses ranging from the tactical, such as improving a specific business process (e.g., theft detection), or operational procedure (e.g., pipeline inspection), all the way to a strategic enabler of digital utility business.
- Evaluate existing operations for opportunities to leverage IoT, such as drones for infrastructure inspection and wearables for worker safety monitoring.
- Assess IoT initiatives in light of organizations' KPIs and alignment with specific business objectives.
- Incorporate IoT into your industry vision as an enabler of composable business. Educate business stakeholders on the potential of IoT.
- Build a plan and establish champions and superusers to help OT employees adapt their business processes and culture to the large amount of data that IoT will generate.

Sample Vendors

ABB; Accruent; AVEVA; GE Digital; Itron; Landis+Gyr; Oracle; SAP; Siemens; Vodafone Group

Gartner Recommended Reading

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

2022 Sustainability Survey: Energy CIOs Can Help to Retain C&I Enterprises as Customers

Magic Quadrant for Global Industrial IoT Platforms

2022 Strategic Roadmap for Asset Management

2022 Strategic Roadmap for Composable Utility Customer Information Systems

Consumption Analytics

Analysis By: Sruthi Nair, Zarko Sumic

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Consumption analytics provide utility customers with energy usage insights. Techniques include benchmarking customer comparisons, trend analysis, correlations with energy usage patterns, weather trends and disaggregation to estimate contributors to overall consumption. Energy consumption disaggregation is the use of analytics to infer the main categories of consumption. This technology can be used to enhance customer relationships and generate energy efficiency tips and recommendations.

Why This Is Important

Customer satisfaction and engagement are key utility metrics. Utilities leverage consumption analytics in enhancing customer engagement, and they can be combined with expert rule engines to autogenerate consumer usage insights, conservation tips and efficiency recommendations. Granular interval consumption data from smart meters opens new possibilities. Given the volatility in energy prices, utilities are taking measures to shield consumers from facing the brunt of high utility bills.

Business Impact

Consumption analytics help utilities meet energy efficiency targets by using AI and data analytics to understand customer behaviors and preferences. Utilities can encourage consumers to adopt clean energy, invest in energy-efficient appliances, help customers select the best tariff based on historical consumption and validate energy efficiency improvements. It can also make utility customers aware of load patterns and insights about peak and off-peak hours. Utilities must expect integration with CX solutions.

Drivers

- Consumption analytics solutions can assist utilities in focusing on energy efficiency, behavioral consumption analytics and demand response by creating marketing programs incentivizing customers based on their load patterns.
- Utilities' sales volumes are stagnant or declining due to customers having multiple choices and change in usage patterns, using energy more efficiently and sophisticated complex "prosumer" technologies offsetting energy purchases.
- The evolving utility business model has emerged from more liberal energy policies and deregulation, and has introduced new market competitors with the objective of reducing customer service costs and improving customer relations.
- Increasing focus on customer satisfaction and the drive toward providing real-time information about energy usage will drive utilities to provide detailed insights to its customers.
- Utility-digitalized commodity products have value propositions that leverage a digital product construct by including information about price, timing and location to create products that take advantage of the physical grid to create new sustainable provisioning models.
- Bidirectional trading has improved energy management with demand response, and has extended the energy ecosystem to new participants (prosumers) who are customers with distributed energy resources. Consumption analytics will play a key role in the creation of the utility-digitalized commodity products.

Obstacles

- Utilities must be aware of customer concerns around how personal data is collected and safeguarded. Utilities need to be successful in ensuring consumer trust and understanding of data collection.
- In some countries, due to the regulatory environment, customers do not have the capability to act on those insights. Additionally, in case of regulated utilities, customers can't choose their provider, thus acting on the insights would still be a hindrance for the adoption of analytics.
- Utilities must be aware of the customer's right to consumption data and follow stringent data privacy rules to avoid monetization via third-party services.
- There are increasing data volumes from multiple sources and sensors, and challenges in segregating relevant insights.
- Growing demand for personalized individual customer-level insights is a difficult task for utilities to provide.

User Recommendations

- Incorporate consumption analytics as a key component of overall efficiency programs. Be prepared to gather and integrate data from multiple sources.
- Create tradable energy blocks with tradable value (in capacity and intermittent energy markets) by aggregating CX-driven behavior use cases, supported by voice-enabled agent use cases.
- Deliver analytics through multiple customer communication channels, including paper billing statements and secure customer portals, to broaden your reach and drive engagement.
- Pursue solutions that leverage profile data, including property characteristics or types of fuel, to enable more accurate benchmark comparisons, and to develop customer segmentation models in support of broader customer engagement objectives.
- Invest in separate data analytics infrastructure where customer information system solutions struggle to extend to support consumption analytics requirements.
- Factor consumption analysis into the list of potential use cases for AI.

Sample Vendors

Bidgely; C3.ai; ONZO; PlotWatt; Uplight

Gartner Recommended Reading

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

2023 Utility Trend: Growth of Energy Poverty — Focus on Relief, Revival and Renewable Energy

Market Guide for Utility Customer Information Systems

Taking a Deeper Dive Into Top Tech Trend Total Experience: Energy and Utilities

Quick Answer: How Electric Utility CIOs Can Respond to Changing Customer Expectations

Digital Twin

Analysis By: Alfonso Velosa, Marc Halpern, Scot Kim

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Definition:

A digital twin is a software-enabled proxy that mirrors the state of a thing, such as an asset, person, organization or process to meet business outcomes. There are three types of digital twins: discrete, composite and organizational. Digital twin elements include a model, data, a one-to-one association and monitorability. Digital twins are built into a range of software: analytics, 3D models, CRM and IoT. Data on the state of the thing must be sourced via telemetry or application state changes.

Why This Is Important

Enterprises are using digital twins to create virtual representations of previously opaque or time-lagged things. Digital twins can help meet business outcomes such as process optimization, improved visibility or new business models. Specific examples include improving supply chain decisions via better supply and demand visibility, and reducing downtime by monitoring equipment state. Tech providers are increasing value by building domain-specific templates and integration to data sources.

Business Impact

Enterprises are implementing digital twins to:

- Gain visibility into things such as equipment or customer state that enable people to make better maintenance or marketing decisions.
- Assess, simulate and reduce the complexities of designing and developing innovative products and new service models.
- Improve patient outcomes, employee safety and customer transactions by using digital twins of people.
- Drive new data monetization models and contribute to product-as-a-service business approaches.

Drivers

- Enterprises are accelerating their adoption of digital twins to support a broad variety of business outcomes. These business outcomes include reducing the cost structure through improved monitoring of assets and optimizing equipment and processes by aligning asset digital twins into a range of solutions, such as predictive analytics and field service management. They also include product differentiation by engaging consumers and controlling assets, and integrating data silos into one central visualization.
- Asset-intensive sectors — for example, oil and gas, transportation, manufacturing and buildings — are leading in using digital twins to optimize business processes such as product development, supply chain and operations.
- Leading OEMs are exploring how digital twins can help add long-term annuity streams to their regular revenue.
- Leading-edge enterprises are implementing digital twins to model book-to-bill status, foreign exchange risk and supply chain processes. They do so to optimize costs and improve processes.
- Technology providers — from large cloud vendors to startups — are identifying potential ways to serve and charge customers using digital-twin-enabling product portfolios. In particular, they are developing template libraries to demonstrate domain knowledge and to shorten time to value for enterprise customers.
- Standards organizations such as IEEE, Eclipse, ITU and consortia (including the Digital Twin Consortium) contribute to establishing digital twin standards, architectures, ontologies and improving visibility.

Obstacles

- Few enterprises understand what they are trying to achieve, let alone the metrics for digital-twin-based projects. This lack of vision limits project scope and investment into new business processes that can take advantage of digital twins.
- Few enterprises have the cross-functional fusion teams — across business, finance, operations and IT — that are required to achieve business outcomes powered by digital twins.
- Digital twins present a technical challenge for most enterprises due to the blend of operational and information technologies required to develop and maintain them.
- Pricing remains an art, and most vendors focus on their technology differentiation, even though customer organizations are looking for business value outcomes when purchasing digital twin offerings.
- Standards bodies remain emergent. Most vendors use proprietary formats. There is a lack of standards for a broad range of digital twin technical areas such as data source and model integration and metadata management.

User Recommendations

- Co-create the digital twin strategy with the enterprise business unit to identify opportunities and challenges and establish clear success metrics. Further, the business must select sponsors and super users, create a budget and build a roadmap that starts small and scales up.
- Avoid digital twin projects that lack a business sponsor as this is key to success. Lack of internal sponsorship will waste IT resources.
- Identify IT organization technology, governance and skills gaps and build a plan to resolve them.
- Protect intellectual property by working with procurement to ensure that digital twin data and custom models belong to the enterprise.
- Develop an architectural, security and governance framework to manage large numbers of discrete digital twins, as well as composite and organizational digital twins.
- Select vendors not just for their technology portfolio, but more importantly, for the intellectual property (IP) they have in your vertical market. The IP should be demonstrated in libraries of prebuilt digital twin precursor models.

Sample Vendors

Akselos; Esri; GBTEC Group; Mavim; Nstream; Sight Machine; Toshiba; TwinThread; Vanti; visCo

Gartner Recommended Reading

Quick Answer: What Is a Digital Twin?

Emerging Tech: Tool — Digital Twin Business Value Calculator

Life Cycle Management of Software-Defined Vehicles: Step 3 — Vehicle Digital Twin 2.0

Quick Answer: Privacy Basics for a Digital Twin of a Customer

Emerging Tech: Tech Innovators for Digital Twins — Digital Business Units

Drones in Utilities

Analysis By: Nicole Foust, Zarko Sumic

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Unmanned aerial vehicles (UAVs, commonly known as drones) are small rotary-wing, fixed-wing or hybrid aircraft with no onboard human pilot. Piloted remotely, with varying degrees of autonomy, they are equipped with sensor payloads to acquire visual and other data at remote locations. Depending on their type, they can hold a stationary position, follow predefined routes or patrol freely within geographic boundaries. The degree of autonomy varies from minimal to fully autonomous.

Why This Is Important

Drones offer important benefits to utility field operations. They can perform inspection and other tasks safely, faster, more frequently and consistently than human workers, gathering more and better quality data. Their use is particularly important in locations that are hard to reach or operate on. Increasing autonomy and residency, global remote drone operation, swappable payloads, and integration with other services are expanding capabilities.

Business Impact

Drones can acquire larger volumes of data more reliably and rapidly in inaccessible or hazardous environments than on-site humans. This improves:

- Asset inspection and surveillance, enhancing performance, and improving safety and operational efficiency at reduced cost.
- Planning efficiency from site surveys.
- Regulatory compliance and sustainability by reducing emissions.
- Situational awareness in emergencies.
- Safety from continuous or regular site surveillance.

Drivers

- Continued pursuit of greater safety, reduced cost, improved productivity and operational excellence continue to drive utility companies to reduce the number of workers on-site at assets and field locations.

- Related trends spurring expansion include advances in AI, edge technologies, camera and video imaging, lidar, 3D mapping and modeling, GPS capabilities, flash memory, gyroscopes, and improved mathematical algorithms. These will continue to increase their capability in complex environments.

- More time on station, longer flight time, wider ranges of sensors and greater autonomy will continue to enhance capabilities, especially as regulation becomes more mature and permissive.

- Some commercial providers now offer remote drone control from global locations, reducing the number of drone operators and inspection personnel needed in the field.

- Electric utility organizations can use UAVs for regular inspections of transmission towers and insulators, checking field conditions, monitoring protected species, assessing lines and poles following severe ice/wind storms, and performing aerial assessments of easement violations along transmission corridors.

- Independent power producers will use UAVs for inspecting renewable systems such as solar panels, wind turbines and hydroelectric plants. Drones are also used to inspect hard-to-reach equipment at thermal-generation plants, such as boilers and cooling towers.

- Utilities will find increasing UAV usage among emergency management organizations and public responders. In dry climates, UAV deployment can assist with assessing the threat of wildfires.

- Utility engineering departments or engineering contractors can deploy UAVs for professional civil surveys before commencing development projects. UAV data can be used to accurately estimate volumetric computations for cut-and-fill operations, and for a visual record of day-to-day changes during large construction projects.

Obstacles

- Drone systems are increasingly gaining traction, requiring better integration of drone-generated data into utility companies' IT and operational technology (OT) systems.
- In most jurisdictions, drone use is tightly regulated. Generally, flight permits (and sometimes pilot qualification) must be obtained, adding effort and cost to missions.
- Drones can be used maliciously to damage assets or disrupt operations. Drone malfunction or failure also have the potential to harm people, assets and the environment, and these risks must be mitigated.
- Drones deliver most value from automated data processing and the application of analytics to acquired data. Evaluate cloud hosting to access the data and results without interaction with enterprise IT systems.
- Data acquisition, transmission and storage must be made secure against hacking and cyberthreats.
- Autonomous, resident and integrated drone systems are new and complicated, and require more complex technologies, which increase risks and costs.

User Recommendations

- Engage with business asset and engineering teams to forecast usage and understand evolving needs for data aggregation, analytics, and other IT system integration.
- Provision tools to support data analysis along with governance and security guidelines, especially where there is any integration with enterprise systems.
- Plan for the long term by monitoring the regulatory environment for changes that accelerate adoption, and outlining architectures for integrated data processing and analytics for drone survey data.
- Review IT governance policies and standards for fitness to maximize the operational benefits, while minimizing risks.
- Ensure drone-generated data is registered to a geographical coordinate system within an enterprise GIS to have maximum usefulness.
- Work with IT leaders to balance the prospect of UAV usage against the availability of other possible commercial alternatives.

Sample Vendors

Cyberhawk; DJI; Hawkeye Systems; Hexagon; Motorola Solutions; Pix4D; PrecisionHawk; Teledyne FLIR; Trimble

Gartner Recommended Reading

2023 CIO and Technology Executive Agenda: A Utility Industry Perspective

Market Guide for Geospatial Information Systems for Energy and Utilities

How Utility CIOs Can Unlock the Business Value of Geospatial Information Systems

IoT Platform

Analysis By: Alfonso Velosa, Eric Goodness, Scot Kim

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

An Internet of Things (IoT) platform enables the connection and capture of data from IoT-enabled assets to develop, deploy, and manage business solutions that improve operations such as monitoring remote assets or optimizing maintenance. Capabilities include device management, integrated data management, analytics, application enablement and management, and security. It may be delivered as edge or on-premises software, or cloud IoT platform as a service, or a hybrid combination.

Why This Is Important

Enterprises continue adding IoT capabilities to assets and products, to achieve benefits such as cost optimization, process optimization, improved customer experience, sustainability and new opportunities such as product as a service. The complexity, scale and business value of these IoT solution requirements call for specialized technology resources, most often implemented as an IoT platform.

Business Impact

IoT platforms are required to implement IoT-enabled solutions to make better business decisions from the data generated by connected assets. Goals include:

- Differentiated smart products
- Cost optimization strategies centered on improved maintenance
- Optimizing output by coordinating asset health with process health
- Opportunities to sell new services and data products or adopt new business models such as product servitization
- Sustainability improvements and reporting

Drivers

- Asset-intensive (oil and gas, manufacturing) and asset-light industries (healthcare, insurance) are implementing IoT-enabled projects to meet business objectives.
- IoT platforms help enterprises accelerate time to market for smart products while consolidating and structuring the data.
- Enterprises are finding IoT platforms already incorporated in their equipment by their OEMs to help them lower operating costs, reduce waste, minimize carbon footprint, avoid unplanned downtime and enhance worker safety.
- Technology providers' are increasing their focus on business outcomes, encouraging enterprise customers to implement IoT projects. Tech provider investments in improved ecosystems and channel partners make it easier for clients to achieve business value.
- In parallel, technology providers continue to improve their technology, user experience and vertical market templates, to ensure they can deliver business solutions, such as reduced waste, for their customers.

Obstacles

- IoT platforms still require extensive customization to achieve business outcomes for large-scale deployments, driving up cost and schedule.
- Many enterprises approach IoT projects as technology projects, instead of business projects that use IoT platforms to achieve business outcomes.
- Many enterprises operate in siloed fashions, adopting different IoT platforms for each use case, limiting their ability to scale and adding complexity.
- Enterprise leaders often underinvest in culture change processes or in training key employees. This leads employees to underuse or reject the data produced by the IoT platform, leading the project to underperform against its objectives.
- Gaps in enterprise IT and operational skills to address IoT technical needs and complexity often create project delays.
- Technology providers have yet to clearly demonstrate they can deploy and support their platforms at a large scale on a global basis.

User Recommendations

- Start small. Treat initial IoT platform projects as IT and business capability programs to acquire implementation lessons, identify challenges and opportunities, and verify alignment with business KPIs and needs.
- Develop a scenario analysis for the probability IT will have to assume IoT platform budget and long-term management.
- Identify the differing enterprise needs for IoT platforms and establish an IT team to establish a multiplatform architecture. These include simple projects with new assets using new protocols versus complex projects in legacy plants that connect to heterogeneous assets and protocols.
- Use a skills gap for IoT platforms to build an improvement plan for IT team capabilities such as integration or digital twin development or security.
- Evaluate vendors across criteria such as vertical market expertise, proof of value projects, the ability to drive large-scale deployments, technology portfolio and partner ecosystem.

Sample Vendors

Alleantia; Alibaba; Arduino; AVEVA Group; Covacsis Technologies; Haier Group; Intelligent Plant; NEC; Panasonic; Vodafone Group

Gartner Recommended Reading

Magic Quadrant for Global Industrial IoT Platforms

Technology Opportunity Prism: Internet of Things

Competitive Landscape: IoT Service Providers

Infographic: IoT Use-Case Prism for Sustainability and ESG

Big Data in Utilities

Analysis By: Ethan Cohen

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Big data is high-volume, high-velocity and/or high-variety of information assets demanding cost-effective, innovative forms of structured information processing that enable enhanced insight, decision making and process automation. In the utility context, the ability to acquire, organize, analyze and deliver data across IT, OT, IoT and consumer domains will be a critical requirement for sector digital business transformation.

Why This Is Important

Historically, big data has focused primarily on the volume issues of extremely large datasets generated from technology practices in OT, cloud ecosystems and streaming event sources. We are seeing utilities starting to address data in context and in process. In utilities, as in most asset-centric organizations, OT and machine data are essential to operations. Big data is a precursor to but not a requirement of some utility AI use cases.

Business Impact

Utility and technology business leaders should recognize and act upon:

- The variable nature of big data connections within and across enterprise business units and business processes.
- The smart grid/network data deluge and integrate grid/network modernization initiatives.
- Big data critical domains in advanced analytics and ML analysis, including data preprocessing, model engineering, hyperparameter tuning, feature engineering, data and model management, forecasting, and visualization.

Drivers

- Practices are developing quickly in the energy and utility sector. Big data has emerged from the bottom of the Trough of Disillusionment, as conflicting concepts of what it is and how organizations can benefit from its management and analysis continue.
- Given the megatrend of decentralization and technology consumerization in the utility sector and extension of the grid/network perimeter by inclusion of IoT devices, the number of devices connecting to both the grid/network and data networks is set to grow exponentially.
- Smart metering deployments, with the overwhelming amount of data they provide, usually trigger big data initiatives in customer-facing and network operation activities.
- The increased deployment of renewables and the need to process weather-related data to anticipate its impact on renewable energy output also require adoption of more advanced solutions that combine spatial and temporal weather data with asset performance data.

Obstacles

- Traditional technology-first analytic approaches struggle to extract important relationships between business domains and process entities, leaving useful datasets neglected and underleveraged.
- The need to utilize a variety of data — in particular, transactional data stored in the internal IT systems as well as data obtained from OT systems and by IoT sensors — creates a significant interest in systems that can provide advanced business insight.
- High demand combined with relatively low maturity and lack of internal skills impedes maturation progress and slows down access to and achievement of outcomes and value.

User Recommendations

- Prepare for the increased volume of data generated by physical-asset-embedded sensors, sensing devices monitoring network parameters data generated by edge devices.
- Respond to smart grid/network and commodity market inversion that is producing a different variety of data, such as temporal, spatial, transactional, streaming, structured and unstructured.
- Explore the volume, variety and velocity of data. If volume is increasing as described, variety is expanding or velocity is creating temporal and contextual challenges in data, then you have a big data transformation opportunity that merits investment.

Sample Vendors

Amazon Web Services; Cloudera; Dassault Systèmes; Dell EMC; Hewlett Packard Enterprise (HPE); IBM; SAS; Teradata

API Marketplaces

Analysis By: Andrew Humphreys

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Definition:

An API marketplace is a platform to share APIs. Consumers, mainly developers, use API marketplaces to discover APIs and, in some cases, may purchase access to them. They can be either public commercial marketplaces with APIs from multiple providers, public with APIs from a single provider, or private marketplaces for promoting an organization's internal APIs.

Why This Is Important

API marketplaces enable organizations to publicize their APIs. Marketplaces are usually associated with external marketplaces, which share APIs with a community of developers and enable partners to implement solutions using the APIs. However, as most APIs are meant for consumption by teams within an organization, marketplaces are more frequently internal. They make it easier to find APIs internally, helping with wider sharing of capabilities between different business units and product and development teams.

Business Impact

API marketplaces increase developer visibility and consumer mind share, drive API usage, and, by extension, increase business impact. API consumers can use marketplaces to simplify finding and comparing different APIs when they are looking for specific functionality but have not selected exactly which API to use. There is typically a cost involved with listing in a public API marketplace, but the benefits include exposure to a larger number of API consumers and access to features to enable monetisation.

Drivers

- The number of APIs within an organization is climbing, driving the need for developers to more easily discover which APIs and services are available.
- Composable business, including composable commerce, relies on the use of API marketplaces to share APIs and packaged business capabilities.
- Increased use of low-code platforms, integration platforms, robotic process automation (RPA) and analytics tooling enables more citizen development using APIs that may be sourced from API marketplaces.

Obstacles

- Public API marketplaces that provide a public directory of APIs from multiple providers have had disappointing results, as developers are more likely to go directly to API providers to sign up for APIs. This has resulted in API marketplaces in the Trough of Disillusionment. However, internal API marketplaces have had more success, since they enable developers to share APIs across multiple teams.
- API portals provided as part of API management platforms are typically basic in nature, resulting in significant customization work to create a customer-oriented API marketplace based on such an API portal.
- New open-source platforms, such as Backstage from Spotify, are driving the creation of internal API catalogs as part of larger developer hubs. If your developers are collaborating on solutions around their APIs already, then a simple catalog may be sufficient and a full marketplace is probably overkill.

User Recommendations

API providers:

- Create an internal API marketplace, focused on the needs of software engineers to share APIs across the organization.
- Examine billing terms to understand what the cost of using the marketplace is when considering commercial API marketplaces.
- When considering a commercial API marketplace, examine listing fees and value to your organization before committing.

API consumers:

- Ensure that you use APIs from trusted marketplaces and trusted API providers, examining usage agreements, licensing and billing terms carefully.
- Investigate whether consuming an API directly from the API provider offers better pricing or usage terms than consuming the API via a marketplace.

Sample Vendors

Achieve Internet; Bump; Postman; Pronovix; Readme; Smartbear (Swagger); Spotify (Backstage); Stoplight

Gartner Recommended Reading

Innovation Insight for Internal Developer Portals

Reference Model for API Management Solutions

Bimodal IT

Analysis By: Ethan Cohen

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Bimodal IT refers to having two modes of IT, each designed to develop and deliver information- and technology-intensive services in different ways. Mode 1 emphasizes safety, stability and reliability, and usually is associated with the “run the business” part of the IT portfolio. Mode 2 emphasizes speed and agility for transformational, even experimental, business aspects, such as supporting innovative digital transformation initiatives in the utility sector.

Why This Is Important

Many utility CIOs are challenged to deliver stability for critical IT applications that support the core utility business and to support energy transition innovation at a faster pace. Utility CIOs continue to plan the return on their IT investments with long payback periods, typically five years or more. However, energy and water transition initiatives have much faster life cycles, requiring agile, composable and iterative development and performance that is obtainable in bimodal IT and composability.

Business Impact

Utility CIOs who enable their organizations to run bimodally are best positioned to balance legacy modernization and innovation at scale. Delivering IT services for new digital business operations while retaining the operational efficiency and resiliency is critical. When coupled with composable architecture, bimodal service delivery enables an optimum that is fit-for-purpose in enterprises and in the market with technology service providers and digital ecosystems.

Drivers

- Addressing transformation needs during energy and water transitions requires much faster cycle times and a more agile approach to seize new opportunities.
- The disruption experienced in the sector as a result of the decarbonization push — combined with grid/network edge disruption resulting from the exponential innovation of Internet of Things (IoT), AI, cloud and blockchain — are the main drivers for bimodal IT.
- The movement toward composability to address uncertainty introduced by energy transition is driving more modular and faster-to-deploy packaged business capabilities. In turn, these capabilities are driving bimodal and, in particular, Mode 2 operation.

Obstacles

- Mode 2 practices are wrongly perceived by senior business executives as a simple “relaxing of the governance rules,” which can lead to a reluctance to support or adopt within their organizations.
- The regulatory treatment of IT investments in the regulated utility sector favors Mode 1-type investments. Those tend to be proven, predominantly treated as capital expense and categorized as long-term investment with low risk.
- Mode 2-type investments are harder to get regulatory approval and tend to be heavily scrutinized, forcing investor-owned utilities to finance Mode 2 projects as unregulated activities through shareholder equities.

User Recommendations

- Adopt bimodal IT by managing two separate, coherent modes of IT delivery — one focused on stability and the other on agility.
- Support the performing aspect of the utility business with Mode 1, which is predictable and sequential, emphasizes safety and accuracy, and addresses traditional utility needs to supply reliable commodity services to consumers. A project example is replacing the customer information system (CIS).
- Support the transforming aspect of the utility business with Mode 2, which is exploratory and nonlinear, emphasizes agility and speed, and supports the quest for new energy-provisioning models. Project examples include building new digital customer experience (CX) and total experience (TX) platforms.

Gartner Recommended Reading

2023 Utility Trend: Composable Architecture Delivers Business Agility

Climbing the Slope

Meter Data Analytics

Analysis By: Lloyd Jones

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Meter data analytics (MDA) leverages advanced metering infrastructure (AMI)-generated consumption and event data to provide insights into the operational performance of metering systems and distribution networks (such as hot socket, meter tampering or last gasp). MDA can indicate anomalies in consumption patterns and energy theft, and is increasingly being used to provide insights into network asset loading to help anticipate abnormal events and avoid asset failures.

Why This Is Important

MDA is a technology market that is separate, although adjacent, from meter data management systems (MDMS). Some MDMS vendors have extended their products to provide analytical capabilities such as outage insights if data is streamed. The majority of MDA products are postevent, generating business insights such as consumption, forecasts, feeder balancing and theft insights.

Business Impact

Consumption data is moving from its traditional, siloed use in the “meter to cash” process into an enterprise IT asset data role. MDA can improve network operations (such as distribution network management and asset load management) and commodity management (for example, demand response and load forecasting). MDA offers revenue management, bill alerts, fraud detection, customer service and new consumption-based product offerings in competitive energy markets with nonintrusive load insights.

Drivers

- Many utilities, globally, have deployed smart metering. Consequently, they now have a large amount of consumption data, basic service supply quality measurements (such as voltage level and fluctuation) and event notifications at their disposal.

- Smart metering is a vertical instance of the Internet of Things (IoT) and a key enabler of digital business transformation in the utility sector. Smart metering deployment is the main contributor to utilities' perception of the smart grid data deluge and prompts utilities' interest in big data projects and consequently, meter data analytics deployment.
- AMI deployments increase metering data volume by five orders of magnitude compared to monthly breads. The trend toward shorter measurement intervals can quadruple AMI data volumes. The increased volume of data generated by edge devices (such as smart meters and smart thermostats) challenges data storage capability and requires streaming analytic approaches.
- Vendors are leveraging advanced analytical algorithms based on machine learning and pattern recognition to generate near-time operational insights.
- The continuing push to leverage smart metering data and justify costly investment in AMI has resulted in the fast adoption of advanced analytics in the utility sector.
- Finer granularity and reduced latency consumption data open up the possibility for numerous use cases along utility core business process life cycles (asset, commodity, customer and revenue), and enable the move from historical reporting to predictive and prescriptive business insight.
- As consumption data interval size continues to drop, meter data analytics capability is improving. Examples are providing consumer device "fingerprinting" via nonintrusive load monitoring and identifying particular devices, such as electric vehicles (EVs) or abnormal device operation.

Obstacles

- Smaller utilities, with a limited budget and limited access to internal technical resources, are unable to afford qualified resources and depend on external providers to derive benefits from meter data analytics.
- In many markets, smart metering deployment was driven by regulatory mandates to either facilitate the opening of the competitive retail sector or enable end-user energy efficiency programs; use for broader analytic use cases came as an afterthought. Thus, utilities must define the entire data and analytic strategy, from selecting tools for data ingestion and persistence to sourcing development of the proprietary algorithm.

- Diversity of providers, lack of internal talent, and lack of the shell offering maturity of meter data analytics algorithms make meter data analytics projects expensive and thus slow down adoption.

User Recommendations

- Track new vendors who are entering the MDA space, with promises of lower costs. Look for MDA vendors with prebuilt modules, enterprise vendors with in-memory analytics solutions, analytical platform vendors' offerings (combined with vertical data models) and niche cloud meter analytics providers.
- Evaluate all alternatives against your needs before committing to a solution by including technical performance as well as prepackaged functionality. Carefully consider sourcing options, deployment architecture (cloud or on-premises), time to deploy, vendor's viability and their long-term commitment to the utility sector.
- Ignore the generative AI hype and ensure that the common sense use cases for revenue management and asset insights are deliverable on your data and able to step past your data quality issues. MDA vendors will continue to invest in advanced analytical technologies, such as machine learning and pattern recognition to extract actionable, don't get dazzled.

Sample Vendors

C3 AI; Landis+Gyr; Nokia; Oracle; SAS; Siemens; Xylem Analytics

Gartner Recommended Reading

2023 CIO and Technology Executive Agenda: A Utility Industry Perspective

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Market Guide for Meter Data Management Systems

ADMS

Analysis By: Lloyd Jones

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Advanced distribution management systems (ADMS) are a decision support environment executing against a network model with a common user experience for all roles that monitor, secure, control and optimize the operations of the distribution grid. ADMS functions include state estimation, fault location, isolation and restoration, volt/volt-ampere reactive optimization, outage management, voltage reduction, peak demand management, and impact assessment of distributed energy resources (DERs).

Why This Is Important

Operators of electric distribution networks use ADMS for both regular operations and abnormal (storm recovery) modes of operation. ADMS integrates the decision support for network operators across outage management, power network analysis and network operation needs.In the past, outages were addressed via a separate product outage management system (OMS). OMS is considered to be a legacy application subsumed by ADMS.

Business Impact

ADMS shorten outage restoration and improve availability. ADMS can be leveraged to improve business performance across network operations, customer service and asset management with accurate prediction of restoration times, distribution reliability, and optimization of network configurations. ADMS can analyze rising DERs' impacts and suggest control actions to an adjacent DER management system (DERMS) to control DERs. ADMS may defer new investment in grid assets.

Drivers

- As the global utility sector experiences the energy transition, utilities must modernize their energy delivery networks to resolve current operational challenges, and enable new business and operating models that monetize the use of the digital grid's expanding services. To safely and effectively manage the delivery infrastructure, utilities need a solution that serves as the "brain" and "nerve center" of the digital grid.

- The solution must consolidate and integrate the necessary software into a real-time platform. This platform will orchestrate how all the functional network components and parties from the extended ecosystem (including consumers and DERs) can operate, coexist, and interact in the new democratized energy markets.

- Given these requirements, utilities need a comprehensive enterprise application suite — ADMS that address a wide range of distribution operations scenarios. To meet new requirements, ADMS need to extend across traditionally separated IT and operational technology (OT) domains, as well as support the extension of monitoring and control capabilities with integration of smart devices in the consumer technology (CT) domain.

- ADMS also need to provide a single user experience (single pane of glass) and common network models for monitoring, operation, restoration, analysis, and optimization of the modern energy delivery network. The same integrated environment must support network operators managing the grid under normal operating conditions and support emergency restoration following a storm.

Obstacles

- The ADMS market continues to be a mix of commercial off-the-shelf (COTS) and customized, project-specific implementations. This is a reflection that most ADMS vendors have OT backgrounds and have slowly adopted best practices to support composable orchestratable modular architectures.
- Vendor offerings are maturing, but some project setbacks can still be expected. ADMS project deployments are challenged by requirements for high-quality network models (typically sourced from GISs). Integration requirements across many systems (including customer information systems, meter data management systems, supervisory control and data acquisition [SCADA], and DERMS) make delivery challenging.
- Many buyers in regions with large secondary networks expect ADMS to provide a full model and the same standard set of algorithms on secondary networks. Vendors do not offer that, and instead offer limited functionality with limited insight in secondary network operation.

User Recommendations

- Acknowledge that ADMS can be adapted to different objectives and use cases. Selecting the best ADMS vendor is an important decision. It is a critical factor for achieving success in the targeted use cases. ADMS are complex production environments that are data-intensive, and implementations can take two to three years or longer. Vendor choices are not easily reversed.
- Evaluate implementation challenges upfront and take steps to mitigate project risks. Although a range of comprehensive ADMS products are now available across global markets, most implementations still involve some custom development; buyers should plan accordingly.
- Acknowledge and be aware of limited options for ADMS implementation and dependence on product vendors, which introduces added risk.

Sample Vendors

Emerson Electric (Open Systems International [OSI]); ETAP; General Electric; Indra (Minsait ACS); Oracle; Schneider Electric; Siemens; Survalent

Gartner Recommended Reading

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Market Guide for Advanced Distribution Management Systems

Market Guide for Distributed Energy Resource Management Systems

The Energy Transition Question: Do We Need the Grid?

Social CRM

Analysis By: Sruthi Nair, Zarko Sumic

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

In the utility context, social CRM is the use of social media to support customer and stakeholder interactions. This improves performance in key areas such as customer engagement, communications during outages, energy efficiency, billing and reputation management.

Why This Is Important

CRM is a key performance metric for utilities. Most utilities have a presence in popular social media channels to serve as a customer interaction channel. Utilities have also implemented social media monitoring programs to protect their brand reputation and track public sentiment on key issues. Social CRM tools facilitate the management of utility social channels, including internal teamwork and collaboration, to scale channel participation when necessary, such as during large-scale outages.

Business Impact

Social CRM can improve customer relationships by providing communications during outages and customer service delivery, such as status updates on restoration activities. Utilities can drive energy conservation with social media to realize cost-effective energy-efficiency measures, or meet regulatory targets and promote programs to incentivize customers to reduce emissions. Competitive energy retailers can also leverage social media for customer acquisition, such as referral reward programs.

Drivers

- Energy price volatility has instilled a fear of nonpayment of bills among utility consumers, and consequently, a fear in utilities of losing out customers. Utilities must use social media and other digital channels to communicate and update customers about such unprecedented events, energy efficiency initiatives, adverse weather-related events, pandemics, and other uncertainties.
- Utilities must develop their social media strategy to communicate effectively and efficiently with Generation X and millennials, who belong to the major chunk of the population that uses social media.
- Utilities must use social CRM solutions to enhance customer relationships and increase customer satisfaction to ensure long-term customer retention and loyalty.
- Social CRMs must also assist utilities in quicker responses to customer queries, and provide updates and alerts about planned and unplanned outages.
- Social CRM can educate and make customers aware of topics such as energy saving and management, advantages of smart meters, and industry trends.
- It also provides utilities with an opportunity to build and manage their brands, and align customer sentiments and loyalties toward the brand.

Obstacles

- Utilities must address the challenges around cultural change that their employees might face and educate, train, and support employees through the transition journey.
- Utilities must be aware of the customer's data consumption rights and follow stringent data privacy rules to avoid monetization via third-party services.
- Increasing data volumes from multiple sources and sensors create challenges in segregating relevant insights for their customers.

User Recommendations

- Establish enterprisewide governance of social CRM and pilot social CRM tools that provide productivity through automation.
- Integrate mobile and social media into your outage management and customer service processes, and cross-train customer service personnel to scale social channel support during times of crisis.
- Implement a proactive social media monitoring program, and provide timely reports to marketing and corporate communications, to act on negative and positive sentiment.
- Build a following for your social media efforts by publicizing your presence to customers. Let your customers know what they can get from your social media properties that they cannot get elsewhere, and encourage customers to invite others to participate.

Sample Vendors

AGENT511; DataCapable; KUBRA; Salesforce; Uplight

Gartner Recommended Reading

Quick Answer: How Electric Utility CIOs Can Respond to Changing Customer Expectations

Market Guide for Utility Customer Information Systems

Market Guide for Social Monitoring and Analytics

Transmission Outage Management Systems

Analysis By: Lloyd Jones

Benefit Rating: Moderate

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Transmission outage management systems (TOMS) coordinate planned outages across the grid. TOMS' stakeholders include transmission and generator utilities who collect outage requests to assess scheduling options, in light of expected network conditions. TOMS outage data is valuable for market participants. TOMS' are distinct from outage management systems (OMS) that focus on emergency restoration activities in the distribution network.

Why This Is Important

TOMS use workflows that are accessible by all stakeholders within the planned outages domain from reliability coordinators, transmission operators or merchant generators. TOMS serve as a central hub for planning, submitting and tracking outage scheduling requests. They also provide automated notification to internal and external parties for outage entry and state transitions. While TOMS' focus is on the proactive management of planned outages, solutions may also address the management of forced outages.

Business Impact

TOMS manage the supply and delivery domains for independent system operators, who are responsible for transmission system availability and generation resource adequacy. TOMS users range from outage coordinators; power grid dispatchers; power line technicians; protection, control and safety engineers; control center staff; and corporate management. TOMS production workflow helps them to communicate and share relevant information, making quicker decisions with more confidence.

Drivers

- Decarbonization of the power sector and increased share of renewable generation have introduced operational complexities in transmission network and wholesale energy market operations. These require a solution that can provide accurate insight in grid availability, both for the long-term and short-term operations planning.
- Most TOMS solutions in production today are used by independent system operator and transmission system operator organizations, addressing their need for a solution to ensure transfer capacity, and share outage data to market participants to ensure a level trading field.
- TOMS solutions were originally either custom-developed, in-house systems; extensions of the incumbent energy management system vendor's product; or leveraged solutions provided by specialized consultants.
- The increased need for coordination among multiple entities in energy markets is pushing maturation of TOMS toward commercial off-the-shelf (COTS) solutions.

Obstacles

- The biggest obstacle for faster maturation of this niched vertical utility technology is the relatively small size of the addressable market, such as a small number of transmission system operators (TSOs) and the limited market participants who may need these solutions.
- Regional differences regarding gathering and disseminating information on planned generation and grid outages to various market participants, and the lack of globally accepted best practices, are slowing the speed of TOMS through the Hype Cycle.
- The diversity of market rules and requirements are contributing to market fragmentation, which slows down the emergence of mature COTS product offerings.

User Recommendations

The TOM market is maturing, though with no industrywide accepted set of function points due to the limited number of addressable markets. IT leaders must:

- Ensure business requirements are clearly defined, since little COTS software is available.
- Involve external and internal stakeholders, since this business process will bridge organizational boundaries.

- Ensure that integration and coordination processes required by market operators can be addressed with those products, as COTS products begin to emerge.

- Make sure TOM interfaces with other systems, including independent system operators (ISOs), regional transmission organizations (RTOs), and market participants, using industry-standard APIs and web services.

- Ensure that cross-platform automated notifications enable continuous and secure exchange of system messages and alerts between all designated members of a workgroup, whether they are in a control room or on a remote site.

Sample Vendors

Equinox Software Design; Hitachi Energy; MCG Energy Solutions; Open Access Technology International; Sun-Net

Gartner Recommended Reading

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

The Impacts of Exponential Renewable Generation Growth Across the Energy Ecosystem

Industrial Operational Intelligence

Analysis By: Nicole Foust

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Industrial operational intelligence (OI) combines capabilities formerly found within other siloed operations systems. Capabilities include the ability to capture, store and visualize time series data (from historian software); model assets and processes for business user context; provide situational awareness and initiate field actions; provide operations-focused analytics; and offer support for asset management.

Why This Is Important

Industrial OI is a platform to monitor and add context to large volumes of sensor data and information from diverse OT sources into an Operational Data Lake that can host more tools and integrate IT data sources. OI manages operational performance within a broader business context than legacy siloed systems, such as SCADA or other plant and control center applications. Industrial OI combines capabilities from these more mature applications into one integrated decision support platform augmented by AI/ML.

Business Impact

Industrial OI supports operational decision making across plants and networked assets operations. A key capability is the ability to define and maintain persistent functional and operational models (or relationships) to create business context for users. Example benefits include:

- Dynamic grid stability
- More efficient and effective operations for quality and switching
- Better optimization of asset utilization and investments

Drivers

- The role of industrial OI in industries such as utilities has been elevated by edge technologies and AI, which dictates a new focus on analytics and managing big data. The development of industrial OI is occurring across multiple industrial sectors. The size of the market opportunity has attracted the interest of more-generic OI platform vendors.
- Industrial OI can suggest changes to operational performance in the context of multiple constraints and a changing business environment and can help mitigate operational risk.
- More timely management of data streams coming from historians and real-time production systems, combined with advanced and augmented analytics, will help organizations to uncover potential problems and develop better predictive capabilities.
- Industrial OI will support real-time situational awareness, predictive “what if” capabilities and event-driven collaboration.

Obstacles

- Broader adoption still faces a number of barriers, including the limitations of existing solutions; poor integration and alignment of IT and OT; and cultural resistance to work across silos in a cohesive way and technology limitations for information sharing.
- Stand-alone legacy systems have not moved as quickly regarding the requirement to create and manage multiple data models; use data mining and discovery tools; and leverage advanced analytics.

User Recommendations

- Establish a governance for deploying industrial OI to mitigate both OT and IT impacts. This should be undertaken as part of a broader initiative that converges and aligns IT and OT.
- Create more value from OT data by investing in industrial OI solutions. Sometimes, your existing vendors are building out the necessary capabilities. However, remember the limitations of legacy architectures, and don't rule out using more generic OI platforms. To justify your OI investments, focus on specific benefit opportunities and identify suitable use cases for your industry.
- Start small and expand over time to leverage both OT and IT data sources and to provide a closed loop that links operational and business performance to deliver operational improvements.
- Identify which users need what information and when to support advanced decision making.
- Ensure that your industrial OI supports information usage, value and dissemination that match the speed of operations and support just-in-time decision making.

Sample Vendors

AVEVA; Bentley Systems; Dassault Systèmes; Hitachi Energy; PTC; SAP; Schneider Electric; Splunk

Gartner Recommended Reading

Implement a Design Authority Across Utility IT and OT to Drive Alignment

2022 Strategic Roadmap for IT/OT Alignment

Survey Analysis: IT/OT Alignment and Integration

How IT Standards Can Be Applied to OT

Asset Investment Planning

Analysis By: Nicole Foust, Kristian Steenstrup

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Definition:

Asset investment planning (AIP) tools support decision making and produce plans for investing capital in large-scale physical infrastructure, such as utilities, oil and gas, and transportation systems, over extended time horizons. AIP takes data from asset management systems on asset condition, failure forecasts, maintenance costs, criticality, budgets and risks, and analyzes it to identify optimal investment plans, including asset upgrades, refurbishment, replacement or new infrastructure.

Why This Is Important

With AIP, organizations can improve and optimize investment plans by assessing the risk of equipment and infrastructure failure, and incorporating this analysis into reliability forecasting and budgeting.

Client benefits and use cases include defendable asset investment plans and short- and long-range investment requirements to:

- Maintain reliability
- Optimize investments
- Balance budgets
- Give regulators a long-range investment requirement to maintain reliability
- Rate impact and risk tolerance
- Align asset investments with strategic corporate objectives

Business Impact

Implementing AIP systems helps optimize investments of mission-critical assets in asset-intensive industries by:

- **Informing** better asset investment decisions based on asset condition data, maintenance costs, criticality, budgets and risks
- **Analyzing** the data to produce capital investment plans over extended time horizons as opposed to rules of thumb or past experience
- **Providing** consistent processes and methodology for organizations to prioritize capital and maintenance spending to align with corporate strategies, giving stakeholders a common understanding of the business risk effects of cost-cutting initiatives

Drivers

- Capital investment decisions to rethink or replace critical business assets often have relied on historical practice, rules of thumb and manufacturers' recommendations put into spreadsheets. These legacy processes are increasingly ineffective (too expensive, too slow and often leading to the wrong answer) and can potentially introduce more risk.

- AIP is particularly important for both larger organizations with a significant asset base, and regulated entities whose long-term capital investment plans must be submitted and approved well before implementation. AIP is also critical for organizations such as utilities, since regulators increasingly scrutinize capital investment as it impacts utility rates. Proving that you have explored alternatives makes it easier to obtain approval for capital investment in asset replacement. AIP can support better asset investment decisions assuming good quality data, which could lead to more accurate estimates of project costs. It can help prioritize spending plans, and identify and communicate the associated risk arising from unfunded projects.

- AIP continues to expand across utilities with higher adoption rates and maturity, and is proliferating to other industries, such as oil and gas, transportation, facilities, and telecom. Market takeup of AIP has increased in recent years, in part, spurred by complementary technologies advancing, such as asset performance management (APM) and enterprise asset management (EAM) solutions. In addition, advanced analytics provide more insights, allowing organizations to adjust their asset management strategies using tools such as AIP software.

- Unlike generic tools, AIP incorporates asset condition, criticality, impacts of time, and other factors to create alternative investment scenarios. In many regions, regulators favor performance-based or outcome-based systems, forcing organizations to rethink the way they manage their asset bases.

Obstacles

- **Access to sufficient data and required quality —** Quality data is critical to define when deciding whether to go with a commercial off-the-shelf (COTS) or custom implementation solution.
- **Availability of degradation models —** Some organizations create these in-house; others outsource them or buy COTS software.
- **Change management —** Organizations must assess the value of their data input and other nontechnical aspects of implementing AIP solutions.
- **Vendor selection (asset-centric versus project-centric) —** Many vendors focus primarily on asset management, while others concentrate on project and portfolio management (PPM), which can include asset planning.
- **Poorly implemented EAM systems —** High-quality asset data is foundational for all effective AIP deployments. Ideally, the EAM system is populated with accurate historical data; however, if it is not, data cleansing may be required.

User Recommendations

- Create a systematic and repeatable investment planning process using AIP tools. AIP is becoming a core system of record for capital investment decisions within many industrial companies.
- Discern whether the AIP tools focus on an asset-centric approach to investment planning or come from the PPM continuum. Asset-centric AIP helps clarify what decision should be made, then informs the project-centric AIP side or a PPM tool for execution and optimization of projects.
- Ensure project success by assessing AIP solutions against business goals, project success prerequisites and business outcomes.
- Help business owners optimize asset-related capital spending by evaluating and investing in appropriate AIP tools to create a systematic, repeatable investment planning process.
- Choose the appropriate AIP solution (rethinking versus replacing) by evaluating current offerings and vendors in light of your specific organizational requirements.

Sample Vendors

Arcadis Gen; CGI; Copperleaf Technologies; Cosmo Tech; DIREXYON Technologies; Ovarro; PowerPlan

Gartner Recommended Reading

2022 Strategic Roadmap for Asset Management

Market Guide for Asset Investment Planning Solutions for Energy and Utilities

Market Guide for Enterprise Asset Management Software

Market Guide for Asset Performance Management Software

2023 CIO and Technology Executive Agenda: A Utility Industry Perspective

Cloud in Utilities

Analysis By: Ethan Cohen

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

Cloud computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using internet technologies. Utilities have an increasing number of choices to make between benefits and trade-offs with cloud services, including the regulatory stance and financial treatment as well as the potential for improved business capability and flexibility.

Why This Is Important

Utilities are increasing their adoption of cloud-based applications even in the face of capital finance rule making. Utilities, where practicable and fit for purpose, are becoming more proactive with cloud motivated by lower cost of capability and the opportunity for comprehensive service management. Driven by composable architecture initiatives, flexible business capability needs across customer experience, B2B application content sharing and intelligent operations, utility cloud market dynamics and usage are evolving.

Business Impact

Utilities can use the cloud to get technical and business services. Cloud vendors promise vertical-specific products, lower cost, faster deployment and enhanced application security. Utilities have difficulty judging vendor claims and experience adoption challenges with interoperability, latency, regulatory compliance and difficult migration of mission-critical applications. Notwithstanding, cloud is an important component of utility composable architecture and an essential digital orchestration technology.

Drivers

- The maturation of core vertical solution offerings from leading enterprise application vendors.
- The need to achieve IT modernization.
- Modernizing OT and building new cyberphysical capabilities.
- Freeing up the budget for the design and delivery of the next stage of intelligent operations.

Obstacles

- Regulators' position on cost drivers and in different regions accounting treatment of capital expenditure (capex) and operating expenditure (opex) presents challenges for utility investment and use of cloud.
- Utility technology services delivery is not well-orchestrated and not integrated, creating repeated rethink and rework.
- A strong template or pattern for the utility cloud business case is not established or supported across the business. Cloud investments are evaluated and dispositioned case by case.
- Utility cloud provider selection has sometimes preceded architectural modernization, and a multicloud design and service catalog have not yet developed.
- Vendors still have not addressed utility-industry-specific technical concerns for cloud interoperability, latency, regulatory compliance, reliability and security, though advances have been made in select technology providers.
- Vendors are not yet delivering to utilities-industry-specific cloud data and analytics, hybrid solutions, edge computing capabilities or access to cross-industry innovation tailored to utility-industry-specific operational needs.

User Recommendations

- Identify and track cloud trends and disruptions caused by digital business by collaborating with utility business and operations leaders to understand what response is needed in provisioning the right cloud policies and solutions.
- Define and build a cloud strategy to meet enterprise needs by adopting best practices in cloud selection, adoption and development to change utility business and operating models.
- Create scalable capability in IT and the business to broker cloud services, particularly when setting up a cloud operating framework, enabling line-of-business leaders to both consume and deliver cloud services to the organization as part of a hybrid IT strategy.
- Pursue new cloud use cases by incorporating solutions for cyberphysical security and distributed cloud that allow you to maximize the versatility and value of your preferred strategic cloud provider and environments including partner environments.
- Leverage the disruptive nature of cloud computing by delivering composable packaged cloud services in technology solutions to quickly deliver capability and innovation to the business.

Sample Vendors

Amazon Web Services (AWS); Energy Exemplar; Google; IBM; Microsoft; OATI; Oracle; Salesforce; SAP

Gartner Recommended Reading

Executive Essentials: Modernization of Infrastructure and Operations and Cloud

Asset Performance Management

Analysis By: Nicole Foust, Kristian Steenstrup

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Definition:

APM systems are business applications for optimizing reliability and availability of operational assets (such as plant and infrastructure) essential to the operation of an enterprise. It uses data capture, integration, visualization and analytics to improve asset maintenance activities. APM includes capabilities and functionality to support asset strategy, risk management, predictive maintenance, reliability-centered maintenance and financially optimized maintenance activities.

Why This Is Important

APM is an important technology for asset-intensive organizations to enable business outcomes with strategic asset maintenance decision support. Organizations invest in APM tools and technologies to reduce unplanned repair work, improve asset availability and safety, minimize maintenance costs and reduce the risk of failure for critical assets. Realizing the business can move beyond the key use case of equipment reliability, organizations leverage APM to improve overall business operations.

Business Impact

APM is an important investment area for asset-intensive industries and can deliver measurable benefits:

- Asset availability (reducing maintenance and inventory carrying costs)
- Improved uptime and cost savings can be substantial (benefits measured in millions of dollars per year)
- Improved scheduling of maintenance and planned outages
- Reliable data quality
- Effective alarm management
- Reduced manual data entry hours per month
- Optimized resources to monitor spatially distributed assets

Drivers

- With the increased focus on the overall availability of their assets in asset-intensive industries (not just breakdowns and repair costs), organizations need better solutions to deliver enhanced asset insights. Innovation in enabling technologies such as cloud, IoT and AI/ML are widening the scope and decreasing the deployment cost, aiding more awareness and use of APM.
- As operations take advantage of newer sensors (e.g., acoustic), drones and bots, APM has access to increased data volumes of better quality and granularity (or reduced latency) and accuracy, yielding richer use cases and more robust capabilities.
- Business processes supported by APM software are becoming an important core business capability for asset-intensive organizations. CIOs are increasingly realizing benefits that aid the market transition beyond the use of APM focused on equipment reliability to increasingly leveraging APM to also help improve overall business operations.
- Most APM projects are executed on the premise that data-driven decisions will improve equipment reliability and, therefore, reduce operational risk.
- The potential of reduced maintenance cost and downtime, coupled with higher levels of operational reliability, is attracting other industries; however, all are progressing at a varied pace.

Obstacles

- Limited availability of good-quality, consistent and the right asset data to support a more advanced maintenance capability.
- Limited adoption of asset management standardization (such as ISO 55000) as well as digital business immaturity constrains organizational ability to support advanced asset maintenance capabilities.
- Whether the vendor and product have proven capabilities for your desired asset maintenance activities and classes of assets within your industry, and if they align with your asset management strategy.
- Integration to your EAM to be able to execute APM recommendations, which may be complicated if they are from two different vendors.

User Recommendations

- Assess the maturity of your EAM system and have an integration plan with your APM before investing in APM, as CIOs should not expect to get all APM capabilities from the EAM vendors themselves.
- Identify the combination of asset maintenance capabilities to support your asset types and situations across the business. Most vendors do not offer all levels of APM maintenance capabilities across all industries and asset types. Thus, organizations may need more than one APM product, depending on the complexity of their businesses, the types of assets and their asset maintenance goals.
- Ensure IoT and operational technology (OT) systems compatibility by getting involved in the planning of IoT monitoring of plants and equipment.
- Source good data — that is, historical service and operational data — organizations looking to invest in APM should also expect to make investments in information management infrastructure to capture operational data where it doesn't exist today.

Sample Vendors

ARMS Reliability (a Baker Hughes company); AVEVA; Bentley Systems; Cognite; Detechtion Technologies; GE Digital; Hitachi Energy; IBM; SAP; SAS

Gartner Recommended Reading

2022 Strategic Roadmap for Asset Management

Market Guide for Enterprise Asset Management Software

Market Guide for Asset Performance Management Software

Use a Step Program to Orchestrate Maintenance and Reliability Technology

DRMS

Analysis By: Ethan Cohen

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Obsolete

Definition:

Demand-response management systems are applications for managing utility electricity demand-response programs. Capabilities include enrolling customers and their load resources, and planning, executing, measuring and generating settlement payment amounts for DR events. DRMS can address some aspects of distributed energy resource orchestration and integration, particularly at lower DER penetration levels, and can individually meet requirements of energy retailers with commodity-based offerings.

Why This Is Important

Demand response (DR) is an important resource that can be used to maintain demand and supply balance for electricity grid operations and wholesale markets. As demand goes up, less efficient and often higher-carbon-emitting electricity generators are utilized. Demand-response management systems (DRMS) are obsolete and have been supplanted by distributed energy resources management systems (DERMS).

Business Impact

DRMS optimize the peak shaving impact of investments in electricity generation and delivery for integrated utilities. In unbundled markets, these systems help distribution utilities optimize local congestion challenges, and flexibility use cases. Utility operations that can benefit from DRMS include retail, supply and resource adequacy planning. Some advanced distribution management systems (ADMS) can integrate with DRMS to make DR an effective operational measure for targeted distribution network optimization.

Drivers

The desire for keeping utility network reliability high and total costs low drives DR and DRMS. DRMS provide utilities with the opportunity to:

- Meet requirements to develop and manage utility DR programs.
- Get the most out of large-scale advanced metering infrastructure (AMI) deployments and increase economic DR.
- Address regulatory direction for the adoption of DR and increasingly automated demand response (ADR).
- Combine DR and DRMS with consumer energy storage and energy management services.
- Support vehicle-to-grid integration.

- Use DR and demand management to defer some grid upgrades by reducing load at a substation or circuit level.

Obstacles

- DRMS is on the Slope of Enlightenment and has now become obsolete because its value as a system-based capability is diminishing.
- DRMS is becoming subsumed by DERMS before plateau.
- New technologies such as advanced distribution management systems (ADMS) and DERMS are maturing to address a broader range of distribution network management needs.

User Recommendations

- Evaluate whether DRMS are still needed to support company strategy, to fulfill a specific, clear need, or if a focus on ADMS or DERMS is more appropriate to the ambition, business model and operating model of the utility.
- Address the long-term growth in energy technology consumerization, including growth in distributed power generation, electric vehicles and home energy management. This will make more advanced DR capabilities important in some regions.
- Evaluate and consider the OpenADR 2.0 standard to connect directly with load resources for faster and more reliable demand reductions.

Sample Vendors

ABB; AutoGrid; Enel X; GE; Itron; Resource Innovations (Nexant); Schneider Electric; Siemens

Entering the Plateau

Wholesale Market Operations

Analysis By: Sruthi Nair

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Wholesale market operations are defined as market interfaces, settlements, scheduling, bid management or optimization, transmission billing, and forecasting. The existing market structures require trade partners to communicate and transact seamlessly. The changing markets from zonal to nodal and increased flexibility requirements need changes in the settlement windows. This trend must address control, scalability and flexibility needs to meet market changes and regulatory compliances.

Why This Is Important

Wholesale market operations are evolving to a decentralized approach. Given growing market volatility, injection of distributed energy resource (DER) efforts to restructure wholesale market conditions, for example Australia (transition from government owned electricity system to corporatised electricity with decentralized decision making), requires sophisticated wholesale market operations software.

Business Impact

The energy transition and other unprecedented factors will significantly impact the bidding behavior in wholesale electricity markets. The impact will be seen on incentive structures for renewables, contracting and bidding strategies for renewables, ancillary services, and balancing reserve margins. The supply domain is the area of greatest impact — that is, primarily functions associated with market integration and communications, trading, finance, risk, and regulatory and compliance reporting.

Drivers

- The restructuring of electricity markets, energy price volatilities and the development of wholesale energy markets provide benefits like improved reliability, efficient grid dispatch and better price transparency. Fueling the need for solutions and capabilities that can manage the wholesale operations in a sophisticated manner.

- Blockchain in post-trade settlements could be a key driver and an innovation point for improving post-trade settlement processes.
- Large thermal plants are being retired and replaced with low-inertia renewable energy resources like wind and solar. As the overall system inertia drops, the power system's ability to smoothly ride through disturbances created by supply demand imbalance. Independent system operators would require insight into current system performance to foresee upcoming disturbances along with control capabilities to maintain frequency stability in the face of the growth of intermittent renewables. The system should be able to address disturbance from abnormal events that impact stability parameters.
- The complexity of power system management is increasing, consequently requiring advanced learning and computational models which are evolving from predictive to prescriptive to provide look-ahead capabilities to system operators. Control algorithms already issue automated commands and in the future will be capable of improving automation choices. Operational commands can be issued to a wide range of levers ranging across flexible alternating current transmission system devices to switches and resource control loops while acknowledging market and physical constraints, provided high-speed processing is in place.
- Decentralization requires flexibility and a flexible retail market would accommodate uncertainties around variable sources of energy, pricing volatilities and market complexities through effective forecasting techniques, access to real-time market feeds and comprehensive decision-making strategies.
- The optimization of wholesale market operations will minimize costs, maximize revenue and optimize grid operations through efficient transaction mechanisms.

Obstacles

- Operational energy management decisions are managed and executed through the wholesale market by traders based on legacy market designs that assume traditional and controllable dispatchable resources. Lack of capabilities in trading platforms and associated systems to manage different energy transactions from multiple participants is a challenge that utilities must address.
- High penetration of intermittent renewable generation with zero or negative marginal operating cost creates challenges for wholesale market designs. Some generators have high shutdown costs and will need to bid negative prices to stay in-line, avoiding temporary shutdowns during low demand. For financial stability, a mechanism must be in place to pass the fixed capacity costs to the retail rates.

User Recommendations

- Evaluate the business implications of the wholesale power market and align core business processes with the realities of the energy market. For IT functions, wholesale market changes can range in scope from minor system revisions to complete system change outs.
- Anticipate the management of rapid deployment of renewables and DERs, and their impact on the wholesale market operations. Close and ongoing liaisons with regulatory and compliance business functions will maximize the window for change planning and execution. While wholesale power markets and the regulatory requirements on system operators will continue to evolve, the systems used to connect to and transact with system operators are increasingly demonstrating their ability to adapt and respond to changing market requirements.
- Review the impact of flexibility markets on existing wholesale energy trading and risk management solutions. Increases in transaction volumes could precipitate a need for algorithmic trading solutions.

Sample Vendors

ABB; AFRY; CGI; cQuant.io; Energy Exemplar; General Electric; Hitachi Group; NexantECA; Oracle (Lodestar); Siemens

Gartner Recommended Reading

System Operators Must Adapt to Embrace Flexibility Markets

2023 Utility Trend: Evolving Markets Challenging Traditional Energy Trading Tools

Innovation Insight: Power Purchase Agreement Management Solutions for Energy and Utilities

2023 Utility Trend: Growth of Energy Poverty — Focus on Relief, Revival and Renewable Energy

Market Guide for Energy Trading and Risk Management Systems

CIM Integration Standards

Analysis By: Lloyd Jones

Benefit Rating: Moderate

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

The Common Information Model (CIM) is an International Electrotechnical Commission (IEC) standard (primarily contained in standards 61968 for distribution, 61970 for transmission and 62325 for markets). These standards express utility domain objects in the Unified Modeling Language (UML). Utility architects use information modeling tools with the CIM as a canonical data model to standardize conventions and accelerate delivery. These methods are often referred to as “model-driven integration.”

Why This Is Important

Utility application portfolios are constantly evolving as new business needs arise and legacy applications are retired. Successful integration of new applications into existing environments or the extension of business processes to new energy system participants, or outsourcing arrangements requires close attention to business vocabulary. Domain-specific applications invariably describe the same utility “object” in different ways. Vendors have embraced CIM across the business landscape.

Business Impact

CIM reduces the integration effort for utility IT projects. CIM profiles are a subset of the CIM with classes and attributes for a business context to accelerate projects and drive automated message payload design directly from design tools. Cross-functional processes (operations, outage and asset management) and collaborative business transactions (data and model exchange, energy trading, distributed energy resource (DER), customer service) will benefit from CIM-based integration.

Drivers

- CIM is a formal IEC standard IEC 61968 covering electrical distribution systems. The standard sets out information models for a wide range of objects with the aim of improving interoperability through standardization, accelerating software development and improving compliance testing.

- Formal governance of CIM is via the IEC Technical committee 57, working group 14. Other CIM related activities take place within the CIM Users Group and other corresponding standards' coordination efforts such as Electric Power Research Institute or the Smart Electric Power Alliance.

- CIM has been adopted as a core of the EU-SysFlex 2021 that sets out data exchange standards and protocols.

- Utility and vendor adoption of CIM 17 is steadily increasing across the utility value chain, including use cases across operations, advanced metering infrastructure (AMI), work management, asset management, advanced distribution management (ADMS) and more recently distributed energy resources (DER). This includes customer enrollment and operations with distributed energy management systems (DERMS).

- Vendor participation in global interoperability testing continues to increase. CIM compliance is being evidenced across internal product architectures as vendors move to a modular plug-and-play ecosystem. This trend supports the rise of grid architectures where control of the network will be exercised at multiple levels by multiple parties.

- Adoption of CIM in North America has been on a slow but steady rise for years; however, utilities in other nations and continents have shown faster adoption rates. Grid authorities in China, Russia and Europe are mandating the use of CIM, and interest is growing in Australia and South America.

- CIM is being implemented by multiutility organizations to support gas and water with CIM extensions.

Obstacles

- Almost all utilities undertaking model-driven integration for the first time require the assistance of specialized integration consultants to equip their staff with appropriate tools and understanding.
- European markets are currently driving most transmission model exchange extensions and methods, to support flexibility markets by leveraging CIM. This is not yet consistent across all global markets.
- Note all CIM changes are ratified globally before adoption, which does create some lag between emerging use cases and implementation in the CIM.
- Larger utilities tend to extend CIM within their own semantic models, designing their own web services and message payloads to serve emerging use cases. This investment can accelerate benefits in AI work as it imposes data standardization across application objects. However, custom extensions do slowly find their way back into the version-controlled formal model often with some subtle changes. This imposes a maintenance effort on legacy extensions.

User Recommendations

- Adopt CIM to rationalize integration effort across enterprise applications and to reduce costs of integration. Be prepared for a multiyear, disciplined IT focus to implement an enterprise semantic model and associated tools. This can be a significant challenge for smaller utilities.
- Analyze recent additions to the CIM model, including advanced dynamics modeling for renewable asset types and more sophisticated unbalanced network modeling. Recent and future developments include analytics support, weather information, energy storage and asset health.
- Explore the use of MultiSpeak as it can be a more direct solution for smaller utilities in the North American market focused on distribution only and leveraging web services. (National Institute of Standards and Technology [NIST] Smart Grid Conceptual Model has selected MultiSpeak funded by National Rural Electric Cooperative Association [NRECA] targeting distribution only use cases.)

Gartner Recommended Reading

Market Guide for Distributed Energy Resource Management Systems

Market Guide for Utility Customer Information Systems

Meter Data Management Systems

Analysis By: Lloyd Jones

Benefit Rating: High

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Definition:

Meter data management systems (MDMS) are the IT components of the advanced metering infrastructure (AMI) responsible for cleansing, calculating and providing data persistence for the commodity consumption data. MDMS is also responsible for disseminating metered consumption data for internal/external use. MDMS can contain a subset of meter asset information, premises, topology or customer information. However, the key data being tracked is metered commodity consumption and meter-related events.

Why This Is Important

Utilities have used meter data primarily as an input to the monthly billing and settlement process. The energy transition needs better edge visibility — driving a requirement for higher-resolution data. A modern MDMS can disseminate consumption information to internal and external users or to applications with more granular data. MDMS-hosted meter consumption data supports billing, load profiling, forecasting, asset loading, network operation and a variety of analytic use cases.

Business Impact

All subsectors of the utility industry are interested in MDMS because companies in each segment provide a metered commodity at the customer's premises and manage the metered consumption data. However, MDMS requirements are shaped by needs in the electric power utility segment. Affected areas include energy commodity management, load forecasting, distribution asset utilization, network operation, revenue management and customer service.

Drivers

- A shift is still underway from a meter data refresh rate from once a month to daily reads of 15-minute interval consumption data. Utilities are now getting insight into energy consumption closer to the “real time” of many business processes.
- In the past decade, the proliferation of smart metering created vertical solutions for remote meter data acquisition as well as MDMS as a platform for operational algorithms.
- Digital transformation of utilities is driving the need for multipurpose metering data repositories that can meet requirements outside of metering data’s traditional use in a “meter to cash” (revenue management) process.
- There is an emerging set of new requirements to support the energy transition that is impacting metering technology as well as processes and organizational structures.
- These new requirements will elevate metering from simply a component of the revenue-processing life cycle to an enterprise function supporting multiple uses of consumption data in other domains. These include asset management (optimal network configuration and loss minimization), commodity management (load profiling and forecasting) and CRM (customer segmentation based on static load profiles and response to variable pricing signals).
- MDMS is approaching the Plateau of Productivity. This is a phase when successful implementations are common and are followed by case studies that can attest to benefits realization. Additionally, more mature service offerings for product delivery are being developed (in many cases by external partners), which, consequently, reduces the risk of implementation failure.

Obstacles

- The MDMS market has matured and is moving from a "greenfield" market to a replacement market, with an increased number of utilities considering the replacement of legacy client/server on-premises versions.
- Buyers have a better understanding of their needs and have realistic benefit expectations, improving alignment and value realization.
- The legacy smart metering and MDMS markets are an example of a vertical Internet of Things (IoT) market that is being disrupted by technological developments in the horizontal IoT general-purpose market.
- The utility industry has not yet fully embraced the general-purpose IoT, and instead favors niche vertical solutions with deep domain expertise.
- Architecturally MDMS is aligned with current IoT reference architectures. Consequently, MDMS vendors are expanding their offerings to become a generic IoT platform, while general-purpose IoT platform vendors are encroaching on the utility MDMS market.

User Recommendations

- Focus on key capabilities such as the validation estimation and error correction (VEE) library. Scalability is driven by higher sampling rates and demand for consumption analytics, along with the ability to ingest data from field devices other than revenue meters.
- Move beyond meter-to-cash by using metering data to support business improvement initiatives in the commodity management area and to optimize distribution asset utilization.
- Exercise caution in MDMS requirements expansion, especially where real-time data processing is required as some vendors have failed to move to serverless architectures.
- Examine other big data solutions, such as in-memory data analytics, to avoid overloading MDMS with processing tasks that could impede core transactional requirements such as meter-to-cash obligations.
- Expect meters to evolve to become edge compute devices hosting measurement, data gateways and applications. This will drive new expectations for a new generation of MDMS.

Sample Vendors

Honeywell International; Itron; Landis+Gyr; Oracle; SAP; Siemens

Gartner Recommended Reading

Market Guide for Meter Data Management Systems

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Appendixes

See the previous Hype Cycle: Hype Cycle for Utility Industry IT, 2022

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 2: Hype Cycle Phases

(Enlarged table in Appendix)

Phase ↓	Definition ↓
Innovation Trigger	A breakthrough, public demonstration, product launch or other event generates significant media and industry interest.
Peak of Inflated Expectations	During this phase of overenthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the innovation is pushed to its limits. The only enterprises making money are conference organizers and content publishers.
Trough of Disillusionment	Because the innovation does not live up to its overinflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.
Slope of Enlightenment	Focused experimentation and solid hard work by an increasingly diverse range of organizations lead to a true understanding of the innovation's applicability, risks and benefits. Commercial off-the-shelf methodologies and tools ease the development process.
Plateau of Productivity	The real-world benefits of the innovation are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. Growing numbers of organizations feel comfortable with the reduced level of risk; the rapid growth phase of adoption begins. Approximately 20% of the technology's target audience has adopted or is adopting the technology as it enters this phase.
Years to Mainstream Adoption	The time required for the innovation to reach the Plateau of Productivity.

Source: Gartner (July 2023)

Table 3: Benefit Ratings

Benefit Rating ↓	*Definition* ↓
Transformational	Enables new ways of doing business across industries that will result in major shifts in industry dynamics
High	Enables new ways of performing horizontal or vertical processes that will result in significantly increased revenue or cost savings for an enterprise
Moderate	Provides incremental improvements to established processes that will result in increased revenue or cost savings for an enterprise
Low	Slightly improves processes (for example, improved user experience) that will be difficult to translate into increased revenue or cost savings

Source: Gartner (July 2023)

Table 4: Maturity Levels

(Enlarged table in Appendix)

Maturity Levels ↓	*Status* ↓	*Products/Vendors* ↓
Embryonic	In labs	None
Emerging	Commercialization by vendors Pilots and deployments by industry leaders	First generation High price Much customization
Adolescent	Maturing technology capabilities and process understanding Uptake beyond early adopters	Second generation Less customization
Early mainstream	Proven technology Vendors, technology and adoption rapidly evolving	Third generation More out-of-box methodologies
Mature mainstream	Robust technology Not much evolution in vendors or technology	Several dominant vendors
Legacy	Not appropriate for new developments Cost of migration constrains replacement	Maintenance revenue focus
Obsolete	Rarely used	Used/resale market only

Source: Gartner (July 2023)

Evidence

2023 Gartner CIO and Technology Executive Survey. This survey was conducted to help CIOs and technology executives overcome digital execution gaps by empowering and enabling an ecosystem of internal and external digital technology producers. It was conducted online from 2 May through 25 June 2022 among Gartner Executive Programs members and other CIOs. Qualified respondents are each the most senior IT leader (e.g., CIO) for their overall organization or some part of their organization (for example, a business unit or region). The total sample is 2,203 respondents, with representation from all geographies and industry sectors (public and private), including 71 from utilities. Disclaimer: Results of this survey do not represent global findings or the market as a whole, but reflect the sentiments of the respondents and companies surveyed.

Document Revision History

Hype Cycle for Utility Industry IT, 2022 - 20 July 2022

Hype Cycle for Utility Industry IT, 2021 - 21 July 2021

Hype Cycle for Utility Industry IT, 2019 - 26 July 2019

Hype Cycle for Utility Industry IT, 2018 - 31 July 2018

Hype Cycle for Utility Industry IT, 2017 - 31 July 2017

Hype Cycle for Utility Industry IT, 2016 - 22 July 2016

Hype Cycle for Utility Industry IT, 2015 - 16 July 2015

Hype Cycle for Utility Industry IT and Business Processes, 2014 - 23 July 2014

Hype Cycle for Utility Industry IT and Business Processes, 2013 - 26 July 2013

Hype Cycle for Utility Industry IT and Business Processes, 2012 - 27 July 2012

Hype Cycle for Utility Industry IT and Business Processes, 2011 - 21 July 2011

Hype Cycle for Utility Industry IT and Business Processes, 2010 - 2 August 2010

Hype Cycle for Utility Industry IT and Business Processes, 2009 - 24 July 2009

Hype Cycle for Utility Industry IT and Business Processes, 2008 - 27 June 2008

Hype Cycle for Utility Industry IT and Business Processes, 2007 - 2 July 2007

Hype Cycle for Utility Industry IT and Business Processes, 2006 - 30 June 2006

Recommended by the Author

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

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2023 Utility Trend: Composable Architecture Delivers Business Agility

Research Roundup: Top 10 Trends Shaping the Utility Sector in 2023

Top 10 Trends Shaping the Utilities Industry in 2023 — Presentation Materials

Digital-Outcome-Driven Metrics for Utilities

Predicts 2023: Adapting to the Energy Transition

Table 1: Priority Matrix for Utility Industry IT, 2023

Benefit	*Years to Mainstream Adoption*			
↓	***Less Than 2 Years*** ↓	***2 - 5 Years*** ↓	***5 - 10 Years*** ↓	***More Than 10 Years*** ↓
Transformational		Digital Twin IoT in Utilities	Renewable Energy Management Systems	Artificial General Intelligence Transactive Energy
High	Edge AI Meter Data Management Systems	ADMS Asset Performance Management Big Data in Utilities Bimodal IT Cloud in Utilities Drones in Utilities Edge Computing Emissions Position Management Geospatial Platform Industrial Operational Intelligence IoT Platform Knowledge Graphs Wholesale Market Operations	Distributed Energy Resource Management System Energy Management and Optimization Systems Energy-Sharing Platforms Software-Defined Assets Virtual Assistants in Utilities	Blockchain in Utilities

Benefit	*Years to Mainstream Adoption*			
↓	***Less Than 2 Years*** ↓	***2 - 5 Years*** ↓	***5 - 10 Years*** ↓	***More Than 10 Years*** ↓
Moderate	CIM Integration Standards Social CRM	API Marketplaces Consumption Analytics Meter Data Analytics Transmission Outage Management Systems	AR/VR/MR in Utilities Asset Investment Planning Lidar	
Low			Energy Efficiency Gamification	

Source: Gartner (July 2023)

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