Predicts 2021: Technological Innovation Becomes a Business Imperative

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Initiatives: Technology Innovation

Organizations face an uncertain future, but one that will demand the ability to deliver new business offerings and experiences rapidly. Enterprise architecture and technology innovation leaders must foster innovation in order to create the necessary resilience, adaptability and digital experiences.

Additional Perspectives

- Summary Translation: Predicts 2021: Technological Innovation Becomes a Business Imperative
  (28 January 2021)

More on This Topic

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- Over 100 Data and Analytics Predictions Through 2025

Overview

Key Findings

- Many digital business offerings are inhibited by the coverage or performance of their customers' internet access.
- Enterprises are rapidly deploying more edge computing resources in support of Internet of Things (IoT) and immersive use cases. This will increase enterprises' IT carbon footprint.
- Organizations needing to accelerate combinatorial innovation must create an architecture supportive of systems that are agile, flexible and resilient.
- The next major evolution of the IoT will be from smart devices to smart collaborations.
- The digital workplace after COVID-19 will require new ways to combine office and home working.

Recommendations

Enterprise architecture and technology innovation leaders aiming to support the discovery of strategic and emerging technology trends should:

- Anticipate the availability of low earth orbit (LEO) satellite services by creating a roadmap and a schedule for when satellite connectivity will impact or extend their regions of operation.
- Monitor and account for energy usage at all levels of their IT infrastructure, including both centralized and edge technologies.
- Enhance agility and resilience by deploying new digital workloads on cloud-native platforms.
- Create innovative IoT products and services by combining networked smart devices and artificial intelligence (AI) to enable swarm intelligence.
- Deliver new digital workplace capabilities that combine home and office environments using immersive technology.

Strategic Planning Assumptions

Low earth orbit (LEO) satellites will connect 10 million internet users by 2025, and 1 billion by 2029, up from zero in 2020.

By 2025, the enterprise edge will account for one-third of enterprises' electricity usage for information and communication technology worldwide.

By 2024, cloud-native platforms will serve as the foundation for more than three-quarters of new digital workloads.

By 2025, one-fifth of Internet of Things devices could possess swarm intelligence, enabling them to serve as autonomic decision makers via AI systems and social networks, up from less than 5% in 2020.

By 2024, one-quarter of large enterprises will use immersive technology to help enable flexible working arrangements, up from less than 1% in 2020.

Analysis

What You Need to Know

The world is becoming a more uncertain place, with a wide range of external forces disrupting long-term plans and creating a need for innovation, as illustrated in Figure 1.

Figure 1: Factors Creating a Need for Innovation

In 2020, this point has been highlighted by the coronavirus pandemic, which has caused dramatic shifts in where and how we work, and in the economic landscape. Even if this proves to be the most dramatically disruptive development of our lifetimes, it won't be the only disruption we will have to deal with during the next five years. Unwelcome disruptions — but also potential opportunities — will continue to arise at a fast rate.

Innovation, and particularly combinatorial innovation, will be key to creating the capabilities needed to deal with the challenges posed by these disruptions and to exploiting the associated opportunities. A single emerging technology, or technological innovation, or any other kind of disruption or trend can lead to multiple further innovations. It can lead to continuous evolution of existing capabilities or disruptive changes to assets, processes and capabilities. An innovation strategy should therefore be envisaged through a combinatorial innovation lens. It will be important to consider individual trends and innovation ideas together, from an enterprise-level, use-case perspective, and to break down internal silos. Collaboration and combination will deliver the best results.

Innovation will be key to organizational survival and prosperity in an uncertain world. Enterprise architecture and technology innovation leaders will play a key role in identifying innovations and creating the architectures and skills required to adopt them.

But innovation alone won't be sufficient. Organizations must become more agile, resilient and flexible in order to rapidly identify and adopt those innovations that will enable them to succeed. In this report, we present select predictions for five areas in which technological innovation will create opportunities, pose challenges or provide foundation platforms for the necessary flexibility and agility. The five areas are:

- **Global connectivity:** LEO satellites will dramatically expand the number of potential customers and enable greater connectivity for innovative IoT devices ("things").
- **Sustainability:** CEOs will require CIOs to manage IT's carbon footprint across an enterprise's entire infrastructure and operations.
- **Foundation platforms:** Cloud-native platforms that will provide a foundation for flexible and agile systems.
- **Swarm intelligence:** This will power the next generation of the IoT, enabling the creation of things that demonstrate not just individual but collective intelligence.
- **Anywhere operations:** Augmented reality and virtual reality will support hybrid working and "anywhere operations" within agile enterprises.

Strategic Planning Assumptions

Analysis by: Bill Ray

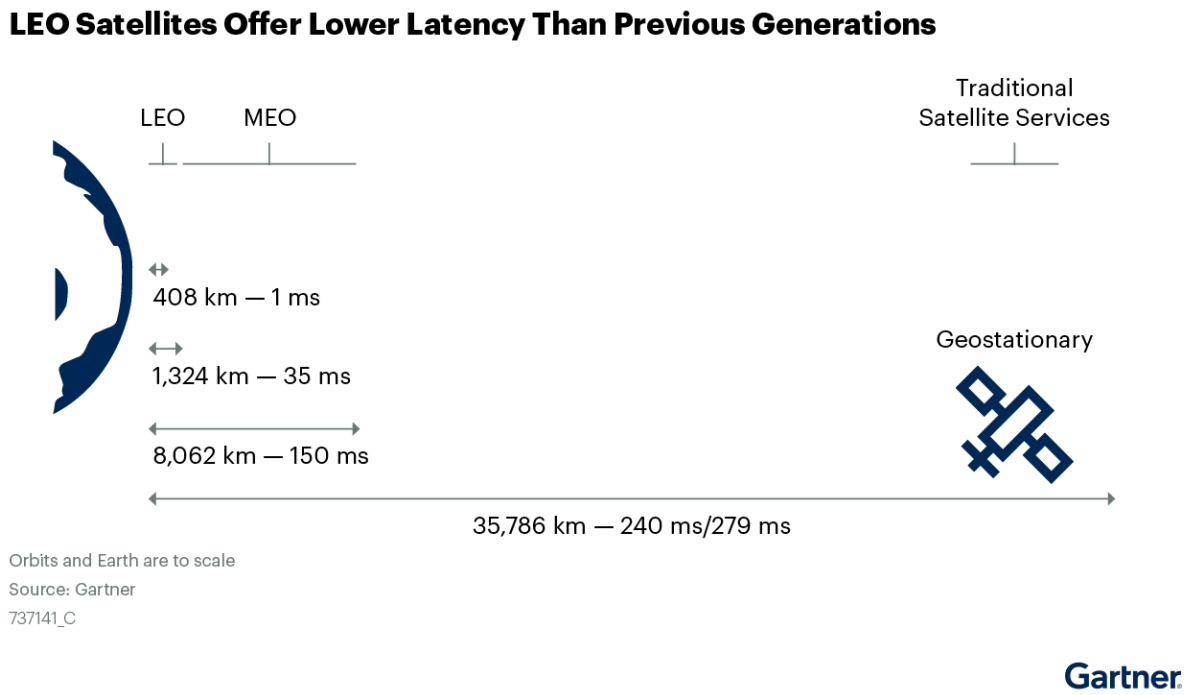
Key Findings:

Over 40% of the world's population lacks internet access, at a time when the coronavirus pandemic has highlighted the importance of connectivity for work, leisure and commerce. Requirements such as "anywhere operations" — highlighted in Gartner's list of top strategic technology trends for 2021 — will demand ubiquitous high-performance connectivity.

Broadband internet access over satellite constellations deployed in LEO are already a reality. Starlink has demonstrated that low-latency, high-speed, communication is practicable from LEO, providing it has access to government subsidies and lucrative defense contracts. In addition to the existence of constellations from OneWeb and Telesat, the certainty that competition will increase is illustrated by Amazon's recent announcement that it will invest $10 billion in its own constellation.

Figure 2 illustrates the location of, and latency offered by, LEO satellites, compared with those that provide traditional satellite services.

Figure 2: LEO Satellites Offer Lower Latency Than Previous Generations



LEO constellations are inherently global, or near global. Countries in which LEO constellations are not providing services represent lost revenue, since LEO satellites are passing over them anyway, so there is strong incentive to extend services as widely as possible. Limits on services are imposed by operating licenses (which may require compliance with local censorship or privacy laws) and access to radio spectrum (which incumbent operators may oppose).

Technical advances in antenna and radio design are reducing the cost and complexity of access equipment. Gartner expects that phased-array antennas suitable for communication with fast-moving LEO satellites will fall dramatically in price over the next five years, to below $500 (from more than $2,500 in 2020). Furthermore, radio frequency (RF) techniques will enable less-directional antennas to make use of LEO communications, where spectrum availability makes this practical.

Near-Term Flag:

LEO broadband services will start in limited geographies, providing packaged products to consumers and communities in rural areas, and including backhaul for cellular deployments. Oceanic internet provision will be rapidly added, including for defense purposes. Satellites over oceans have unutilized capacity, and face few restrictions on radio spectrum, so access for cruise ships and aircraft carriers will represent an important market as the constellations spread to more (land) geographies and markets.

Market Implications:

Ubiquitous availability of communication services removes “connectivity” as a limiting factor on the geographic location of businesses and people. The shift to remote working, accelerated by the 2020 pandemic, further facilitates dispersion of workers and industries. Suburbs will extend beyond the range of daily commutes. Satellite villages (in both senses of the word “satellite”) will spring up around major cities. Companies will also be free to relocate, with remote regions and countries becoming more attractive.

As the cost of connectivity falls, the addition of billions of newly connected citizens and things will have a profound impact on the internet in terms of culture and content. Developing countries already make heavy use of open-source software and are ramping up projects to encourage participation. Over time, the addition of such a large population to software development efforts will impact both the quantity and quality of open-source platforms.

Recommendations:

- Exploit the rapid development of LEO services by adding satellite connectivity to strategic plans.
- Prepare for international availability of LEO services by liaising with local regulators and resellers.
- Prepare for disruption by identifying which communications services you use (or provide) could benefit (or face competition) from satellite routing.
- Identify where costs could be saved, or productivity improved, by replacing point-to-point connections with satellite routing.

Related Research:

Market Trends: LEO Satellites Will Provide Practical Connectivity to Remote and Mobile Offices

Emerging Technologies: LEO Mega Constellations — Market Disruption Ahead

Market Trends: Thousands of New Satellites Will Provide New Services to Disrupt the CSP Industry

Market Trends: New Satellite Constellations Will Provide Revolutionary Opportunities for Connecting the IoT

Analysis by: George Brocklehurst

Key Findings:

- Over the next three years, half of large enterprises will deploy at least six edge computing initiatives in support of immersive or IoT use cases. These use cases drive more content and demand lower end-to-end latencies. Consequently, more resources are required at the edge, in edge servers and endpoints, thus increasing an enterprise's IT carbon footprint while making it much less visible and controllable.
- Edge use cases drive compound growth in energy consumption as more things are served with more capabilities. Managing, monitoring and reducing energy consumption becomes increasingly challenging as the edge becomes more diverse and widely distributed, as is the case in asset-heavy organizations and those with field operations.

- Endpoints will double over the next five years in support of a broadening array of IoT use cases. Off-grid (battery-operated) endpoints will grow rapidly as greater scale and flexibility are needed to meet business objectives. Off-grid endpoints entail complications in terms of optimizing energy as their activity is less predictable and more trade-offs must be made between features and power consumption.

Market Implications:

- Technology innovation leaders will be responsible for edge IT energy, regardless of where it is used (although they may delegate this responsibility to infrastructure and operations leaders). The demand for this type of data reporting will increase and should be factored into technology roadmaps and procurement decisions. As the edge grows to become a significant share of an enterprise's information and communication technology energy budget, it will become a key factor in disclosures at a corporate level.
- Monitoring and managing energy consumption may be more challenging for off-grid edge devices, although in many cases these are smaller IoT things that contribute only modestly to an organization's overall consumption. However, off-grid endpoints will draw attention to the use of batteries. A full life cycle view of batteries (including recycling) must be taken when considering an enterprise's carbon footprint. Other factors to consider include the nature of the materials used, as batteries contain toxic and rare materials, sometimes from conflict zones. New battery chemistries are emerging to help reduce these problems.

Recommendations:

- Anticipate future environmental, social and corporate governance (ESG) reporting requirements by working with your executive leadership team to monitor and measure edge computing technology, processes and life cycle footprint.
- Build a sustainable edge by identifying and aligning the right enabling power and energy technologies through your hardware supply chain, according to your use-case needs.
- Combine a total cost of ownership (TCO) approach with a system view when evaluating your strategy for sustainability. For example, assess whether a battery can be substituted for a capacitor if the use case allows frequent charging.

Related Research:

Sustainability: What to Do When Stakeholders Want You to Save the World

Cool Vendors in Technology Innovation Through Power and Energy Electronics

Hype Cycle for Enabling Power and Energy Electronics, 2020

Forecast: Internet of Things, Endpoints and Communications, Worldwide, 2019-2029

Analysis by: Arun Chandrasekaran

Key Findings:

- The rapid pace of innovation in cloud infrastructure and platform services is turning the cloud into the de facto platform for new digital services.
- Distributed cloud services, which decouple services from centralized physical locations, will enable cloud providers to expand their addressable market for new digital workloads.
- Advances in containers and serverless computing are enabling fast software development, increased business agility and reduced operational overheads, making them preferred abstractions for building new digital workloads.

Market Implication:

Cloud computing is becoming the center of innovation for the infrastructure and platform services that are powering the next generation of digital services. The term “cloud native” refers to workloads that are native to a cloud provider’s environment or that are built using declarative APIs, which often follow a pattern of continuous software delivery and are mostly packaged as modular but tightly scoped application units such as containers or serverless functions. Technology innovation leaders (including CTOs) are keen to architect elastic, modular, self-healing and secure digital workloads, an approach that lends itself to cloud-native software architectural patterns.

Use of the public cloud, as we know it today, involves moving applications and data to the centralized regions that cloud providers operate. Although this deployment pattern may suit most new workloads, a growing set of workloads may not suit this pattern, due to privacy, cost, control and latency constraints. The advent of distributed cloud services from hyperscale providers — such as Amazon Web Services (AWS) Outposts, Microsoft Azure Arc and Google Anthos — enables organizations to deploy cloud services close to users or to where data is being generated. This can allay data privacy concerns or reduce latency, while abstracting the maintenance and governance of services back to the public cloud providers. This will lead to further expansion of cloud locations to proximal cities, service provider edges, hosting facilities and customers' data centers.

Enabling developer productivity and enhancing software velocity are key imperatives for CTOs. Cloud-native platforms consisting of technologies such as containers, Kubernetes and serverless functions will play an important role in enabling new application architecture patterns (such as microservices) that can enable better application elasticity, software agility, resiliency, better security controls and low operational overheads for these new workloads. However, to succeed in this transition will require a DevOps culture and a new development and operating model for applications, with better collaboration and more sharing of responsibilities across application, platform engineering, security, enterprise architecture and IT operations teams.

Recommendations:

- Revise your cloud strategy by accommodating new industry developments in the areas of cloud-native platforms and distributed cloud services.
- Identify and pilot use cases for digital workloads with new computing abstractions, such as containers and serverless functions, in order to gain skills, gauge use-case fit and accelerate business agility.
- Create a cloud center of excellence to formulate best practices across workload selection, governance, operations, and organizational skills and know-how.

Related Research:

Top 10 Trends in PaaS and Platform Innovation, 2020

The Future of Cloud in 2025: From Technology to Innovation

A CIO's Guide to Serverless Computing

CTO's Guide to Containers and Kubernetes — Answering the Top 10 FAQs

Innovation Insight for the Cloud Center of Excellence

Analysis by: Arun Chandrasekaran and Gilbert Van Der Heiden

Key Findings:

- Gartner forecasts that there will be almost 6 billion installed IoT devices by the end of 2020, and 11.7 billion by the end of 2025.
- Every IoT device could become part of a "swarm." However, to have "swarm intelligence," IoT devices must not only be connected. They must also combine embedded monitoring capabilities with abilities to alter their behavior based on swarm interactions, and have (near) real-time access to a swarm controlling analytics and decision engine, either in the cloud or at the edge.
- Although today's edge AI focuses on AI inferencing, IoT devices are starting to be embedded with local training capabilities to enable in situ optimization of AI models.
- Swarm intelligence is nascent at present, but will evolve due to the development of algorithms better optimized to run on lean infrastructure in a low-code fashion.

Market Implications:

As the name implies, swarm intelligence mimics behavior seen in the animal kingdom to achieve collective outcomes vastly superior to the autonomous decisions that each individual member of a swarm can make. Common examples of amazing swarm behavior in the animal kingdom include that of ants, locusts and starlings. In contrast to the animal kingdom, technological swarm intelligence does not involve *movement* of a swarm, but rather behavioral decisions based on the swarm's objectives in relation to its context. For example, consider how a swarm of smart electricity and gas meters might collaborate with window sensors to automatically adjust power or gas outlets based on storm trajectory data. For swarm intelligence to be feasible at scale, advanced AI concepts such as agent-based modeling and orchestration management will be crucial (see Decision Intelligence Is the Near Future of Decision Making: A Gartner Trend Insight Report).

Gartner predicts that IoT-embedded transformation capabilities will expand as connectivity and bandwidth technology evolves (particularly with more pervasive adoption of 5G), and as cloud and edge analytics capabilities become more sophisticated and widely available at lower cost. IoT devices will then be able to make autonomic decisions through collective intelligence, due to more sophisticated algorithms, agent-based modeling, federated machine learning and interaction with other IoT devices.

Although most enterprise data is currently generated inside centralized data centers or cloud regions, this pattern will change dramatically. We predict that, by 2025, 75% of data will be generated outside these centralized facilities. As demand grows to process this data at the point of creation, in order to gain real-time insights, applications and AI training and inferencing will need to move closer to edge environments near IoT endpoints with advanced feature management capable of handling data on a massive scale. Today, IoT endpoints have limited intelligence and are mostly viewed as data-generating devices, with that data being processed and inferred in a centralized location. There are a few challenges with a centralized AI training and inferring approach:

- Data is becoming more distributed, and the proliferation of more intelligent IoT devices will compound this problem.
- Moving data can be time-consuming and expensive, and can violate security and privacy requirements.
- The length of time to insight may not meet business requirements in certain scenarios.

One solution to these challenges is to improve the embedded capabilities of IoT devices, ensure reliable IoT connectivity and architect a federated approach to AI. The success of swarm intelligence is predicated on the following:

- Diffusion of swarm algorithms (such as ant colony optimization [ACO] algorithms; see Cool Vendors in Supply Chain) into IoT devices.
- Federated machine learning, whereby models can be trained locally without the need to share data.
- Robust connectivity between endpoints.
- Proliferation of standard protocols, such as MQTT, for reliable communication between endpoints.

Swarm intelligence can provide better accuracy and stringent data privacy by federating privacy protocols from a single updated device to the rest of the swarm. However, the integrity and security of endpoints must be ensured to prevent rogue behavior and protect the ability to achieve a high degree of collective efficiency.

The business use cases that swarm intelligence could enable include superior fleet management, fuel consumption reductions, more efficient vehicle routing and better network routing optimization. Swarm intelligence could also improve the predictability of production line maintenance, reduce water and energy consumption by consumers, and limit the potential for hazardous situations in field operations.

Recommendations:

- Assess use cases where you could benefit from swarm intelligence at edge locations.
- Ensure that the supporting IT infrastructure, security, reliable network transport and data collection mechanisms (such as publish-subscribe engines) are in place for swarm intelligence at the edge.
- Choose low-code solutions to embed AI in IoT endpoints, in order to avoid costly errors and reduce overall maintenance.

Related Research:

Market Definitions and Methodology: Internet of Things Forecast

Overcoming Challenges in Edge Computing Projects

Machine Learning Engineer — A Role That Bridges the Gap Between Data Science and IT

Top 10 Strategic Technology Trends for 2020: Autonomous Things

Analysis by: Auria Asadsangabi

Key Findings:

- COVID-19 has accelerated organizations' planning and changed employees' expectations for the future of remote working. Gartner predicts that through 2024, around 30% of employees who work remotely will work permanently at home (see Forecast Analysis: Remote Workers Forecast, Worldwide).
- Many organizations struggle to balance flexible working arrangements with their concerns about employees' performance, particularly employees' ability to collaborate, connect and engage. However, Gartner's data suggests that remote and semiremote employees show a 22% increase in discretionary effort and a 54% increase in enterprise contribution (see A Business Case for the Hybrid Workforce).
- Organizations supporting transitions to flexible working arrangements will accelerate the use of immersive technology (augmented-, virtual- and mixed-reality) to improve productivity and employee satisfaction.

Market Implications:

As organizations shift to more remote working,technology innovation leaders must balance short-term responses against long-term implications. For example, 40% of business and IT leaders identify growing emphasis on remote working as the greatest digital priority change due to COVID-19, and 22% of the same respondents report that working from home will continue after the pandemic. [1] It is not just the pandemic driving this, either; it is also general changes in employees' behavior and expectations. There is an overall desire on the part of employees to have more flexibility about where they work from, instead of spending all their time in one specific work location.

Technology innovation leaders supporting the transition to flexible working arrangements should collaborate with business stakeholders to create a digital workplace strategy. This strategy should improve the employee experience, and thus improve performance, retention and attractiveness to new talent. In particular, they should use immersive technology to blend physical and digital environments. Immersive technology involves virtual reality, augmented reality, mixed reality and the head-mounted displays used to deliver these experiences. For organizations with a diverse workforce dispersed across multiple locations, these tools provide a digital space in which employees can collaborate, connect and engage, thus ensuring employee comfort without inhibiting productivity.

Recommendations:

- Capitalize on the portability of work by first determining what parts of the workforce can successfully accomplish their assigned tasks remotely.

- Support a flexible working arrangement by using immersive technology and changing how employees are structured in the work environment.
- Transform traditional human communication by designing virtual environments in which employees can learn through direct experience and connect with one another.
- Increase multisensory engagement to help employees bridge the gap between physical and digital environments.

Related Research:

Virtual Reality and Augmented Reality for Remote Workers

Virtual Reality and Augmented Reality: Using Immersive Technologies for Digital Transformation, Customer Experience and Innovation

How Architecting for Next-Generation Experiences Helps to Deliver Customer and Business Outcomes

Best Practices for Immersive Learning in Education

Emerging Technologies: Top Use Cases for Enterprise Augmented Reality

A Look Back

In response to your requests, we are taking a look back at some key predictions from previous years. We have intentionally selected predictions from opposite ends of the scale — one where we were wholly or largely on target, as well as one we missed.

This topic area is too new to have on-target or missed predictions.

Recommended by the Authors

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Predicts 2021: Combine the Right Skills and Roles to Drive Innovation to Action

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