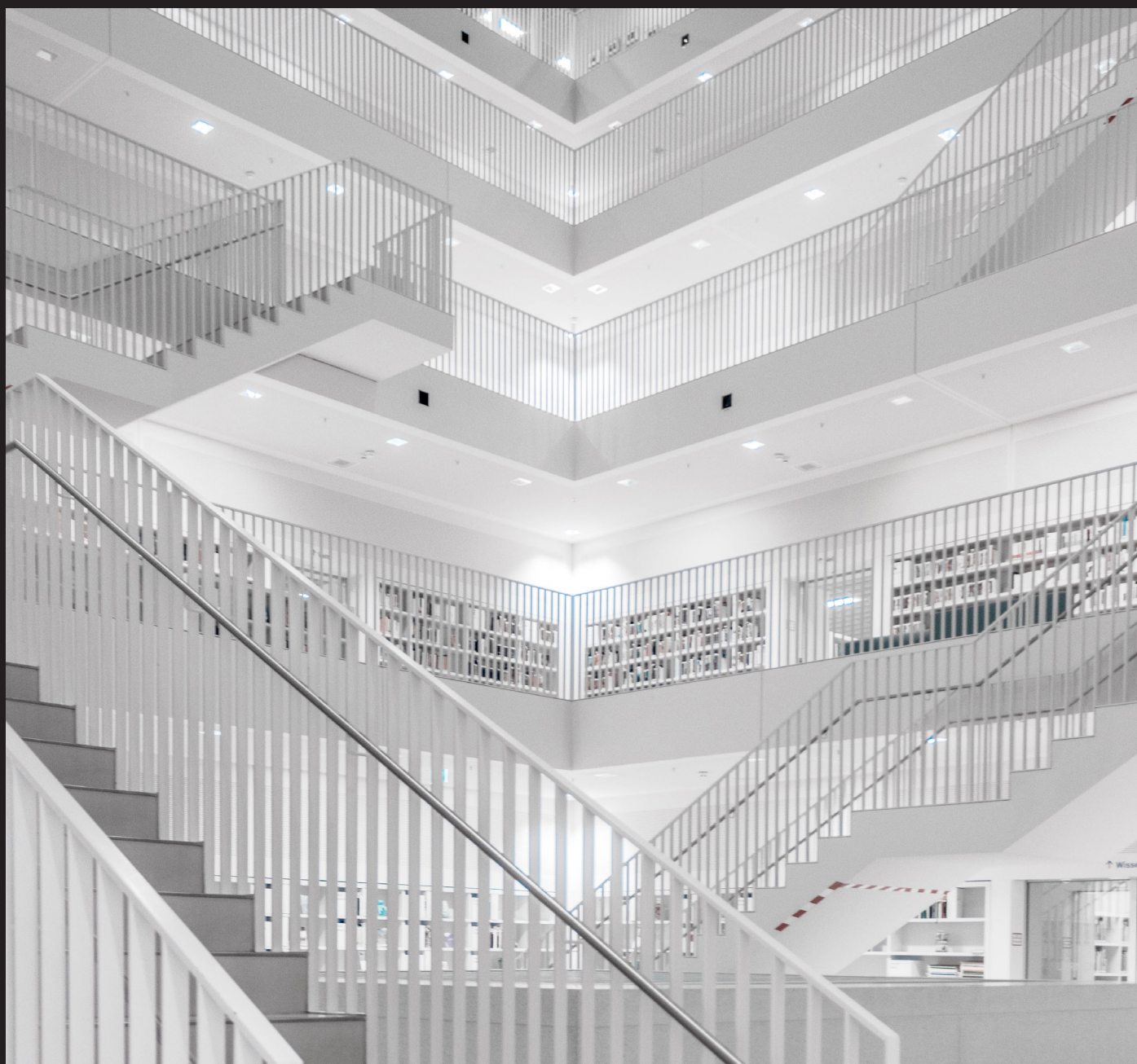451 Research's

2022 Research Agendas

Key topics, coverage and planned deliverables

451 Research

S&P Global
Market Intelligence

Your radar into **market disruption, innovation** and **digital transformation** in the IT space.

451 Research, a technology research group within S&P Global Market Intelligence, provides a holistic view of innovation across the entire enterprise IT landscape through a combination of expert analyst insight, backed by differentiated data. Our analysts interact with key industry decision-makers every day to deliver the essential intelligence necessary to understand the pivotal role that digital transformation is playing in reshaping our world.

Our research spans nine channels that align with the prevailing issues driving IT innovation, helping clients implement, invent and invest in digital transformation. The research agenda for each channel outlines key topics, analyst coverage and planned deliverables to support our clients' critical business decisions. The pace and extent of this transformation means that many trends span multiple channels; our research approach encourages analyst collaboration both within and between channels, allowing us to surface emerging trends before anyone else. Additionally, for a higher-level perspective on the key trends that will drive digital transformation in 2022 at a strategic level, please refer to our latest **Big Picture report**.

Please select a channel below to view the 2022 Research Agenda.

Applied Infrastructure & DevOps

Cloud & Managed Services Transformation

Cloud Native

Customer Experience & Commerce

Data, AI & Analytics

Datacenter Services & Infrastructure

Information Security

Internet of Things

Workforce Productivity & Collaboration

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Applied Infrastructure & DevOps

The Applied Infrastructure and DevOps sector plays a critical role in enabling digital transformation. The hybrid IT journey underway continues to push IT operating models toward cloud-native technologies, and DevOps and continuous integration/continuous deployment (CI/CD) design philosophy is having a dramatic impact on the design and engineering of on-premises infrastructure.

DevOps and CI/CD, digital automation platforms, hybrid integration platforms, unified infrastructure management platforms, discrete and converged infrastructure platforms (storage, networking and servers) and chip-level hardware accelerators all have a part to play in making hybrid IT a reality and enabling the development of agile real-time applications and data-driven decision-making.
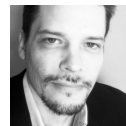
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Key Research Topics and Themes for 2022

- **5G telco network cloudification**

  Network 'cloudification' describes the ongoing transition from vertically integrated, monolithic systems to virtualized, disaggregated and increasingly open cloud-native platforms, which can run virtualized network functions on standard off-the-shelf servers located in telecom datacenters; edge locations, such as service access points and customer premises; or the public cloud.

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- **5G monetization: strategy, progress, challenges**

  Now that we've entered the second phase of 5G market development, the focus shifts from consumers to enterprises. The ROI of 5G depends on enterprises using the platform to support digital transformation. With billions spent on 5G spectrum and infrastructure, the next five years will be critical for 5G stakeholders to develop new value chain positions and business models that take advantage of cloud-native 5G.

  LEARN MORE >

- **The evolution of application networking**

  Application networking has always been at the forefront of enterprise networking. Whether it was applying quality of service to network traffic or deploying a web of application load balancers to manage and secure incoming traffic, the application has always come first. In today's cloud-native, distributed, microservices world, the emphasis on application networking has shifted to interconnecting application components securely, reliably and quickly.

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- **Network automation imperatives**

  DevOps strategies and multicloud application deployments are driving IT's requirement to automate the entire network lifecycle, make self-service networking available to stakeholders on-premises and in the cloud, and maintain governance controls.

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- **Securely and reliably interconnecting the edge**

  Edge computing requires reliable connectivity to tie together devices, applications, services and users. The edge network will have to be secure, reliable, predictable and fast enough to support edge demands.

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- **Outcome-oriented approaches to observability**

  IT practitioners enjoy a wealth of options for monitoring infrastructure and applications, though tight integration between tools and within software development lifecycles is vital to delivering actionable value, rather than the simple projection of metrics, traces and logs on a pane of glass.

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- **Total automation: the future of intelligent enterprise execution**

  Total automation is an emerging enterprise managerial discipline focused on continuous improvement of execution efficiency and greater levels of autonomous business and IT operations. It is enabled by a combination of process and task discovery technologies, business and robotic process automation (RPA) platforms, and hybrid integration services – all orchestrated as a uniform intelligent automation platform to improve enterprise performance intelligence and enable successful business outcomes.

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- **Storage as a service (STaaS) revolutionizes array lifecycle management**

  STaaS has emerged as a flexible opex consumption model disrupting the status quo for storage infrastructure spending that has traditionally centered on capex purchases of on-premises equipment and software. In a STaaS delivery model, the infrastructure vendor has ownership of the assets and is responsible for day-to-day maintenance of the systems, which are typically deployed in a customer's datacenter or in a colocation facility.

  LEARN MORE >

Hybrid cloud and the evolution of workload deployment strategies

Hybrid cloud technologies increasingly merge the best of on-premises and public clouds, in turn evolving workload and infrastructure deployment strategies. We explore the factors influencing today's workload deployments and decisions to deploy hybrid architectures to support modern business requirements.

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Enterprise edge infrastructure: innovation and opportunity

Edge is now a critical piece of modern enterprise IT strategies, driven by opportunities generated from the capture, processing and analysis of data in remote environments. This momentum continues to impact the infrastructure landscape, which is rapidly expanding to accommodate a growing range of edge use cases. Success in this market will ride heavily on the ability to match infrastructure and services with those use cases on multiple levels.

LEARN MORE >

Assessing workload venues for AI: the rise of the edge

Machine learning model generation involves three basic stages – data gathering/prep, model training and model inference. These can happen in the cloud, in corporate datacenters, on on-premises machines and edge devices. The distribution of these jobs is changing, and we will explore its evolution in 2022.

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Semiconductor innovations and disruptions

The silicon industry faces unprecedented disruptions and opportunities. A shift in focus from general-purpose computing toward specialists' silicon optimized for specific workloads has attracted massive capital and laid the foundation for intelligent edge infrastructures. In vertical markets such as consumer transportation, cars are now datacenters on wheels and moving to a new ECU architecture. Global supply chain challenges require significant evolution to meet high demand.

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The shift to data and business-driven DevOps

DevOps, which has been in the enterprise for more than a decade, has historically been focused on faster software releases and efficient IT management, but with the addition of data analytics, AI and ML (aka AIOps), enterprises are focusing on not only improving internal processes, but also business objectives such as user experience and customer satisfaction.

LEARN MORE >

The implications of rapid Kubernetes expansion

Kubernetes has emerged as the de facto standard for managing application containers at scale. It is also aligned with enterprise use of hybrid and multicloud infrastructure since it is a distributed application platform. There is a reason the open source project has had such an impact on the industry with benefits around speed, efficiency and portability, but Kubernetes also comes with significant challenges including complexity, security and lack of skills.

LEARN MORE >

Enterprise utility and readiness for a quantum computing future

Quantum computers are anticipated to provide an exponential speedup to certain classes of workloads. Identifying business problems suitable for quantum computers and devising algorithms to convey those problems as quantum hardware develops is essential to extract value from this emerging technology, as is scoping out potential security implications of a quantum future.

LEARN MORE >

Cloud & Managed Services Transformation

We are entering an era when cloud will no longer be seen as a separate IT category: quite simply, it is IT. Cloud plays a key role in enterprise IT's evolution toward the 'as a service' approach to technology delivery and consumption. The cloud operating model is taking hold, and organizations have choices for how they buy IT, where it gets deployed, how it gets integrated and managed, and how it gets used to drive the business forward. As the worlds of hardware, software, managed services, applications and distribution converge, all IT industry players are service providers now. The Cloud & Managed Services Transformation Channel tracks not only how enterprises are reinventing their IT environments but also how cloud is transforming an industry now tasked with delivering optimized IT experiences anywhere and everywhere.

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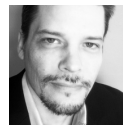Research Analyst
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Key Research Topics and Themes for 2022

● **Implementation approaches, uses cases and management strategies for multicloud/hybrid begin to take shape**

As hybrid (on- and off-premises; private and public cloud) and multicloud (multiple public cloud environments) architectures become increasingly common, we will analyze why, how and where organizations are taking this approach to their IT environments and evolution of the use cases.

LEARN MORE >

● **'Cloud anywhere' and the convergence of on-premises private cloud, on-premises public cloud, edge, and cloud native**

The cloud operating model (flexible, on-demand infrastructure managed independently of the applications on top) once applied only to public cloud. Now that the flexible deployment model is extending to on-premises, the edge and the application layer, location becomes yet another vector in enterprises' workload placement decisions.

LEARN MORE >

● **The evolving landscape of cloud ecosystems**

While hyperscalers are positioned at the center of cloud discussions, cloud does not happen in a vacuum. Multiple entities participate in the emerging 'cloudverse' – in cloud marketplaces as buyers, sellers and enablers; through technology, solution development and go-to-market partnerships; and as integrators offering advisory, implementation and optimization services. The balance of power and competitive dynamics of cloud ecosystems are changing, and we will explore this evolution in 2022.

LEARN MORE >

● **Outcome-oriented approaches to observability**

IT practitioners enjoy a wealth of options for monitoring infrastructure and applications, but tight integration between tools and within software development lifecycles is vital to delivering actionable value, rather than simply projecting metrics, traces and logs on a pane of glass.

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● **From cloud management to control planes**

The cloud management market keeps evolving – with waves of innovation and consolidation – as requirements for building, operating, securing and optimizing workloads 'here, there and everywhere' expand exponentially with the advent of cloud-native and multicloud. Cloud providers, systems vendors and ISVs are trying to solve this resulting complexity in the hope of winning the ultimate prize: hosting the management plane that enables visibility and control of distributed applications across heterogeneous environments.

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● **Managed and professional services assume a key role in the execution of enterprise cloud strategies**

As a hybrid, multicloud mix of venues and vendors becomes a common enterprise cloud strategy, and as cloud service portfolios continue to expand, service providers offering managed and professional services for public cloud work to position themselves as key partners for organizations looking to overcome complexity and execute on business and IT outcomes.

LEARN MORE >

● **The next wave: app modernization in the enterprise**

Updating application architectures to take advantage of cloud services, reduce costs and increase adaptability has become a competitive necessity. Many enterprises have already picked the low-hanging fruit of cloud transformation – the easy wins in terms of ROI. The next phase – decomposing big, gnarly legacy applications by carving away functional blocks that can be maintained independently – is tougher. This won't be easy or straightforward, but vendors and ISVs are tackling the challenge with modern techniques that promise to reduce the toil and speed ROI.

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Pricing model evolution: shift to 'as a service' brings new billing methods

Hardware vendors and service providers are implementing usage-based billing to better compete with the pay-as-you-go cost-efficiency of public cloud service offers. Meanwhile, as cloud deployments grow, customers are struggling to keep costs under control and take advantage of commitment discounts without leaving resources on the table.

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Will cloud suppliers win the edge?

The edge computing market has been born out of necessity and a healthy degree of speculation of demand to come. Many actors are competing for a central role in this new edge application stack and there are no clear winners yet – so what is the opportunity for the cloud suppliers? There are key questions left to be answered around core technologies, standards, business models and ROI.

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Alternative cloud infrastructure vendors and their evolving prospects in a market dominated by a handful of hyperscalers

Roughly a quarter of the public cloud infrastructure market is made up of a longer tail of dozens of smaller companies (such as smaller cloud infrastructure companies, former hosting companies, and adjacent businesses with cloud offerings). These tend to provide a core subset of the total hyperscaler capabilities with an emphasis on simplicity, ease of use, and lower cost.

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Verticalization and the rise of industry-led approaches to cloud transformation

Cloud is a priority for organizations across industry segments, but how enterprises approach transformation and handle roadblocks around governance, compliance, security and customer experience are unique according to sector. Hyperscalers, ISVs and other service providers play a key role in bringing enterprises in financial services, healthcare, retail, supply chain and manufacturing along a transformation journey that elevates how they serve customers, both internal and external, while ensuring regulatory compliance and data privacy.

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Cloud Native

Every organization is, or is becoming, a digital service provider, raising its software IQ to transform and compete in the digital economy – a process accelerated by the COVID-19 pandemic. Cloud native is now the prevailing mindset and methodology for delivering the application architecture to support this new norm. Cloud 'nativity' and developer enablement are strategic priorities for most enterprises undertaking application development and modernization, as well as for sectors such as telco that are transforming wholesale. Hence, there has been a Cambrian explosion of cloud-native goods and services entering the market. Collectively, these offerings have moved the addressable layer of infrastructure from the server and the VM up and into the application, which allows a lot of new and great things to happen: continuous delivery, faster time to value, scaling to meet actual demand and, ultimately, a better customer experience. The Cloud Native channel provides the application-level view of this market, in relation to the Cloud & Managed Services Transformation channel's infrastructure-level view.

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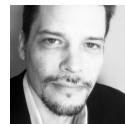
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Key Research Topics and Themes for 2022

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Cloud native as de facto enterprise mindset and methodology

The re-platforming to cloud native will take some years, and it presents a golden opportunity for suppliers that can assist. The market remains fragmented, with customers facing numerous vendor options. But the re-platforming to cloud-native constructs – containers, service mesh, serverless, etc. – continues to accelerate. What is being used to reduce this complexity while delivering the benefits of speed, agility and scale? Reports will profile competitors in specific major segments with a graphical display of the market and key segments in the form of a 451 Research Market Map™. Analysis includes key attributes for each segment and a view of each vendor's solution.

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Total integration: the future of hybrid IT interoperability

Total integration is an IT managerial discipline focused on accelerating an enterprise's responsiveness to business change, risk and opportunity. It's enabled by an integration technology framework designed to be both interpretive and adaptive – quickly responding to events as they occur (interpretive), and quickly facilitating interoperability of the distributed and diverse infrastructure, services, applications, data and processes of any type (adaptive) that compose the modern hybrid IT landscape (on-premises and public cloud).

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The evolution of resiliency and disaster recovery

Meeting disaster recovery and business continuity requirements remains a top challenge for organizations under pressure to enhance their infrastructure and application resiliency. Just as the rise of virtualization forced organizations to rethink their data protection strategies, the advent of cloud-native technologies such as containers will drive change and potentially improve infrastructure resiliency.

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Hybrid cloud storage bridges the on-premises to public cloud gap

Hybrid IT, which leverages on-premises and public cloud resources interchangeably, is the desired state for most organizations. A comprehensive approach is required to facilitate efficient resource consumption while keeping in mind the performance and resiliency requirements of production workloads.

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From cloud management to control planes

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5G and edge as 'killer apps' for cloud native

The interconnected world is happening around us. The success of 5G as its core will be determined by the extent to which telecom vendors and their customers can master cloud-native technologies and practices. This is because a radical shift in network service delivery architecture and approach – to cloud native and DevOps – is necessary to fully take advantage of 5G capabilities. Cloud-native design and deployment principles bring an optimal mix of application portability, reusability, time-to-market speed, automation and scale for the next generation of network operations and monetization. 5G – and, by extension, edge – are 'killer apps' for cloud native.

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The shift to data and business-driven DevOps

DevOps, which has been in the enterprise for more than a decade, has historically been focused on faster software releases and efficient IT management. But with the addition of data analytics, AI and ML (aka AIOps), enterprises are focusing not only on improving internal processes, but also on business objectives such as user experience and customer satisfaction.

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Evolution of application networking

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Managed and professional services provide a vehicle for enterprise embrace of cloud native

As enterprises increasingly identify cloud-native skill sets as key to the execution of IT objectives, those skill sets are also becoming more difficult to develop and acquire. Recognizing this need, service providers offering managed and professional services for public cloud are developing capabilities specifically around enabling the cloud-native efforts of their customers.

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Customer Experience and Commerce

2022 will be a year of IT execution as companies accelerate their formal digital transformation strategies and establish a new 'business as usual.' Improving the customer experience (CX) is at the heart of many initiatives, and continuous improvement requires a well-planned approach to business and technology innovation to remain relevant in the eyes of customers. Once-aspirational views of innovative and immersive digital experiences have transitioned into requirements for employees, customers and partners. Our advertising and marketing technology research explores rapid changes in the vendor landscape to enable more intelligent, personalized experiences that use data, analytics and machine learning to enhance the customer relationship. Our research on digital experience technologies investigates how content tools, e-commerce and payments technology will undergo continued architectural disruption. Our customer service technology research focuses on the impact of new forms of digital channels.

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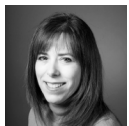
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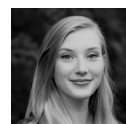
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Key Research Topics and Themes for 2022

Software platforms and the future of the digital economy

Context, collaboration and control drive the rapid investments in fresh approaches to create composable experiences. The acceleration of digitization, cloud and data is underpinning innovation and CX performance. Many SaaS platforms have evolved into operating systems for their customers and are now leveraging their trusted positions as a beachhead to broaden footprints in focused industries, either through M&A or organic development.

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Data-driven experience economy

Over the past year, businesses that allocated a larger portion of their overall IT budgets to digital transformation also accelerated the pace of strategic projects, such as cloud-native technologies and data analytics initiatives, which are needed to support real-time, data-driven goals. Heightened demand for context, collaboration and control in all customer interactions requires investment in new platforms that optimize CX. Individualizing and orchestrating unique customer journeys is key, with only 12% of respondent businesses optimized for real-time customer journeys.

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Digital experience acceleration requires investment in unified commerce

Businesses are doubling down on their CX strategies, with a noticeable shift in dollars being funneled into digital experiences. Keeping up with the sheer velocity of digital experiences amid growing consumer appetites is driving business interests toward a more flexible and iterative technology stack. We see this evolution largely following a microservices, API-first, cloud-native and headless formula.

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Emerging commerce and customer experiences

The onset of Web3 and sub-components such as non-fungible tokens (NFTs), cryptocurrencies and the metaverse have significant implications for the customer experience and commerce. Our research will explore how these trends are evolving and their potential impact on businesses as they look to engage with customers in this burgeoning ecosystem.

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Payment optimization and orchestration

Payments have become a strategic area of focus for high-performing enterprises. We track the strategies, technologies and vendors that leverage payments to increase transaction success rates, drive operational efficiencies and deliver improved commerce experiences.

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Fraud prevention as a growth lever

The first chapter of fraud prevention was about chargeback mitigation. The next chapter is about minimizing chargebacks while driving revenue growth and streamlining the customer experience. Our research focuses on the key fraud challenges facing merchants, fraud trends and the impact of fraud prevention on customer experience.

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The move toward more integrated and diversified buy now, pay later (BNPL) offerings

BNPL is changing the way consumers pay, the way merchants accept payments and the way lenders lend. We've been closely following how this market continues to evolve from multiple perspectives: merchant, consumer, lender and regulatory.

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Service is the new marketing

The human element is becoming more important as business relationships become less transactional between people and more nuanced, tangled interactions between people and the systems and devices they use daily. Using real-time conversation to discover, engage and transact through SMS, video and chat is now the norm. Customer data is also changing the trend for storytelling as businesses strive to connect with customers who demand more personalized and immersive engagements across mobile, social platforms and video channels.

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● **Customer success comes of age**

Customer success software is designed to increase renewals, reduce churn, and encourage upselling and cross-selling. As the subscription economy grows, customer success will be an attractive area for investments and acquisitions. It has all the traditional sales, marketing and service elements but blends them in new ways. In the conventional model, the revenue process begins with marketing, continues to sales and ends in service. Under the customer success model, the process starts with customer onboarding, transitions to marketing and finishes with sales when it's time to renew. The customer success market is expected to grow at a CAGR of 42.2% through 2025, resulting in $1.3bn in revenue.

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● **Sales enablement's contribution to top-line revenue growth**

The goal of sales enablement is to shorten the sales cycle. This a broad segment with many approaches but one common goal. Additionally, it is the segment most likely to split into new markets based on use cases. Consequently, sales enablement has become an attractive category for investment and M&A, with more than its share of unicorns.

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● **The future of B2B revenue generation is conversational**

Dialog-driven exchange through an electronic medium is generating significant revenue. This segment is a game changer from a user-interface perspective, and its features will likely trickle into all the other markets over time.

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Data, AI & Analytics

The Data, AI & Analytics sector has a critical role to play in driving digital transformation through the shift toward intelligence-driven decision-making. Data science, machine learning, self-service analytics, DataOps, data governance, cloud databases, data warehouses, data lakes and data marketplaces each have a part to play in making pervasive intelligence a reality and enabling the development of agile real-time applications and data-driven decision-making that will drive the next wave of digital transformation.

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Key Research Topics and Themes for 2022

Vertical alignment: AI/ML current and future use cases in six key industries

As AI adoption gradually takes hold, use cases are often industry-specific, driven by the unique data sets of each organization. We track detailed use cases in six industries: financial services, manufacturing, telecommunications, retail, energy/oil & gas, and healthcare/life sciences, and we expect increasing take-up of more advanced use cases.

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Convergence of data security, data privacy and data governance

No longer distinct or pure categories of functionality, technological overlap is inherent across data security, data privacy and data governance as providers enter the fray with different architectural approaches to meet the needs of similar use cases: primarily facilitating the safe and compliant leverage of data.

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A serverless database really is a matter of 'less is more'

Serverless does not mean no servers. It means there is no server infrastructure for the consumer to manage. A serverless database translates to reduced database administration and a reduction of the challenges that come with managing cloud database infrastructure.

LEARN MORE >

Assessing workload venues for AI – the rise of the edge

Machine learning model generation involves three basic stages – data gathering/prep, model training and model inference. These can happen in the cloud, in corporate datacenters, on on-premises machines and edge devices. The distribution of these jobs is changing, and we will explore its evolution in 2022.

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It's alive! Machine learning models present new management challenges

Machine learning models make predictions based on new data, which is usually similar to the data on which they have been trained. But data can change, and models can evolve and become less effective. MLOps is the set of tools and techniques to manage this process.

LEARN MORE >

Graph technologies target emerging relationship-based data challenges

Graph technologies, which include embedded data platform capabilities and stand-alone databases, are built on a data model that organizes data based on relationships instead of data based on topics in relational tables. This approach caters well to data use cases such as knowledge graphs (object relationships), identity graphs (people and devices) and fraud graphs (criminal relationships).

LEARN MORE >

Pervasive enterprise intelligence requires new roles and techniques

In seeking to establish enterprise-wide data culture, organizations must consistently ensure the availability of high-integrity data as a resource for a vast array of data consumers. Doing so requires a robust data 'supply chain' increasingly supported by specialized roles and techniques that avoid bottlenecks in responsibility or technology.

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Proposed regulations will start to influence enterprise use of AI

AI will eventually become a regulated set of technologies around the world. But we are not at that stage and won't get there for years. However, in 2022, we expect enterprises to begin to take pending regulations in the US, EU, UK and China much more seriously and factor them into their decision-making as they roll out AI-driven applications.

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The data lake is maturing, but is the water getting clearer?

The data lake has evolved considerably since the term was coined over 10 years ago. It has become a key component of enterprise data management strategies, used to store raw data from multiple sources that can be accessed by multiple users for multiple purposes, reducing data migration and movement complexity, and enabling analytic queries to be applied to a combination of structured, semi-structured and unstructured data.

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The evolution of the AI application development process

AI application development is a complex, costly and time-consuming process, and organizations take a variety of approaches to it.

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ESG: How can AI aid sustainability?

How can we use AI and machine learning to help reach and beat sustainability goals? The ability to identify patterns in massive and disparate data sets opens new possibilities and could lead to a more sustainable future.

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Breaking down walls: realizing the value of data exchange and sharing

We often think of business data as a proprietary resource strictly bound by the protective walls of the enterprise. But there is increasing pressure to externally monetize informational assets and share data safely with third parties and partner organizations. Doing so requires consistent controls for data, as well as effective models and technology for data access and navigation.

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Datacenter Services & Infrastructure

The Datacenter Services & Infrastructure Channel focuses on the global datacenter market, with research covering critical metrics such as capacity and utilization, as well as products, technologies, strategies and trends used by companies building and managing advanced, resilient and efficient datacenters. Technologies covered include cooling; connectivity; demand-side energy approaches; IT hardware and software for datacenter management, such as datacenter infrastructure management (DCIM) offerings; prefabricated and modular datacenters; and 'edge' datacenters. Services covered include leased datacenter services, managed services and interconnection. Much of our research is segmented by regions, countries and key city markets. Specific deliverables include profiles of vendors, geo-specific evaluations, examinations of key trends, analysis of M&A activity and tracking of the ongoing expansion activity of datacenter operators and hyperscalers. Aimed at executives from datacenter providers, as well as vendors, investors and real estate professionals, the Datacenter Services & Infrastructure Channel covers the overall size, scope and growth of multiple aspects of the datacenter industry.

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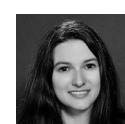
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Key Research Topics and Themes for 2022

Sustainability requirements will transform the datacenter industry

As enterprises look more closely at their infrastructure and focus on improving sustainability, leased datacenters that are newer and more efficient may well have an edge over enterprise-owned facilities. We expect that the environmental footprint will become a key element of enterprise infrastructure strategy, along with more traditional criteria such as cost and performance.

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AI will enhance datacenter management

Enhanced datacenter management software and AI-enabled DCIM analyze data from as many datacenters as possible to determine when components are likely to fail or how a facility's energy use could be improved. As the AI systems become better trained and this approach is proven in a wide variety of situations, it will become more widespread and capable of automating more elements of datacenter management.

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To each a cloud: How public cloud adoption varies by market in Asia-Pacific

Public cloud adoption is increasing throughout Asia-Pacific, but at different rates in different countries. This has implications for the cloud market and for datacenter infrastructure in each area.

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Edge computing will provide growth opportunities for datacenter operators

Edge computing will provide growth opportunities for datacenter operators as enterprises seek to place workloads outside the cloud not only for low-latency purposes, but also for reasons tied to governance, costs and data gravity. Operators will need to satisfy requirements for low maintenance and tight power conservation, and network innovations will impact what data will be processed and stored at the edge and what can be moved elsewhere.

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Cloud providers will continue to launch availability zones in new countries, boosting demand for wholesale datacenter space wherever they go

Public cloud providers are adding availability zones and larger-scale deployments in countries around the world. Some of the latest include Italy, Spain, Poland, Indonesia, Thailand, the Philippines, New Zealand, Chile, and countries in Africa such as South Africa, Nigeria and Kenya.

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Which datacenter markets will see the fastest growth, and why?

The team tracks datacenter markets all over the world and analyzes what is happening within those markets and how they compare with each other.

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How the top datacenter providers differentiate themselves

As the datacenter industry matures, datacenter providers are seeking new ways to differentiate and adjust their business models.

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Blockchain and cryptocurrency: Pros and cons for the datacenter industry

The cryptocurrency mining industry has one thing in common with typical leased datacenter customers: the need for space and power. However, following dramatic cryptocurrency price crashes, some datacenter operators that had leased space to cryptocurrency 'miners' saw their customers go bankrupt.

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● **Growth will continue in the Chinese datacenter market despite challenges**

The datacenter market in China has been growing dramatically, even as certain cities such as Beijing and Shanghai start to limit datacenter development. The government also includes datacenter development in its plans and recommendations, with regulations at different levels in support of carbon-neutrality and digital economy development, which may impact where datacenters are built longer-term.

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● **Technical innovations will support adoption of liquid cooling**

The time might finally be right for liquid cooling to become a mainstream datacenter cooling option. Cooling IT infrastructure is becoming more challenging as chips and infrastructure use more energy in smaller spaces. Sustainability and infrastructure efficiency are also becoming much more important. Liquid cooling can be more efficient with cooling infrastructure that puts off lots of heat in more spaces, but there have been challenges incorporating it into standard datacenters.

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Information Security

Information security has always been a high priority for organizations. From the evolution of IT and cloud-native technology to the continued advancement of AI/ML and the increased adoption of managed and professional services, we see the priority of information security reflected again and again across multiple aspects of 451 Research insights.

In 2022, cybersecurity assumes even greater proportions. The scope of risk has expanded, with numerous high-profile ransomware attacks and other threats already evident in the IT supply chain. Cybersecurity is also a significant factor in international relations on many fronts. 451 Research plans to track the evolution of technologies and services that enhance resilience, threat detection and incident response across a hugely diverse and growing attack surface.
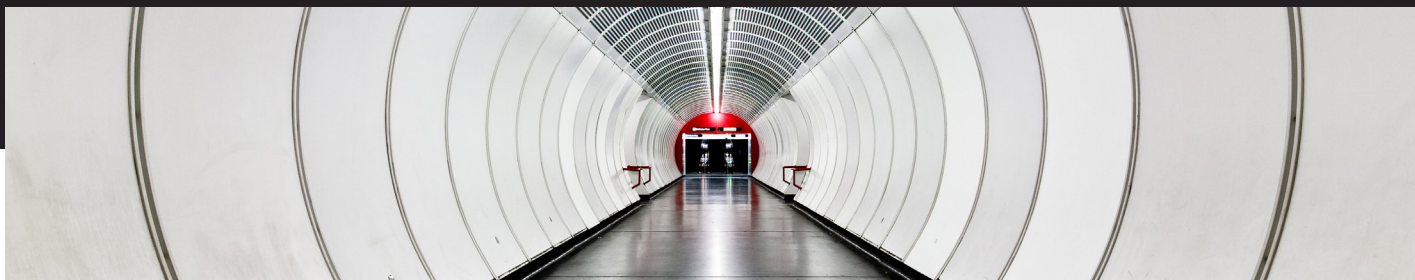
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Key Research Topics and Themes for 2022

● **A new architecture for security operations**

With the rise of a host of technologies extending threat detection and response across multiple sources of telemetry, approaches to security analytics, operations and response are being challenged. Anchors in security information and event management (SIEM), security orchestration, automation and response (SOAR) and threat intelligence face disruption from the rise of new approaches to threat detection and response (TDR) and the emergence of new segments in 'outside-in' visibility that give defenders a better grasp of the attacker's view of targets. We explore how new approaches to security operations (SecOps) technologies are being forged by these transformations.

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● **IAM evolves to meet emerging needs and new demands**

Identity and access management (IAM) remains the front line of defense for hardening resilience against cyber exploits. Trends from an explosion in online users requiring more scalable and usable approaches in realms such as consumer IAM (CIAM) to cloud identity entitlements management (CIEM) to advances in 'zero trust' access and greater refinement of privileged access management (PAM) are reshaping the nature of IAM for 2022 and beyond.

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● **The ascendancy of data security, privacy and governance**

The focus on data as a central organizational asset has brought about a multifaceted approach to governance and risk management in disciplines of security, identity and privacy. Among the topics we see shaping our coverage are technologies addressing key management, post-quantum security, encryption in use, the developer experience and the application of AI/ML in implementing and assuring these priorities.

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● **Cloud security: specialization or convergence?**

The definition of products and services in cloud security has largely proceeded along two parallel lines: those integrated natively into cloud provider platforms, and those offered by third parties either as emerging techniques or to satisfy multicloud priorities or other requirements that cloud providers themselves may not address. More than a few tools in the latter category are exhibiting their usefulness in a variety of use cases. But are these cases necessarily separate segments of the market? Or do they represent a convergence of functionality in tools and vendors that can span multiple segments and broaden opportunities for vendors and their customers alike? If the latter is true, how can that convergence be described in ways that help the industry rather than muddy the waters?

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● **DevSecOps, 'shift left' and the evolution of application protection**

The move toward greater integration of security into developer pipelines continues to advance, as developers and security teams approach parity in the use of application security tools (AST). The integration of security testing into continuous integration and code construction becomes a factor as organizations seek to coordinate their preferred tools to the needs of their specific enterprises.

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Internet of Things

The Internet of Things (IoT) Channel focuses on the critical opportunity to virtualize the physical world into insightful, actionable digital representations created by connecting the data endpoints and analyzing the massive data flows captured from enterprise devices, machines and business processes. Enterprise IoT deployments encompass a range of infrastructure technologies including IoT sensors, edge compute, enterprise platforms, datacenters and the cloud, while serving as the launchpad for IT innovations including AR/VR visualization, AI and machine learning, private and public 5G networks, digital twins/digital threads, computer vision analytics, and autonomous robots and vehicles. But the ultimate goal of enterprise IoT isn't just on the data captured and managed, but also on the business-altering insights and use cases it can deliver. To that end, the IoT Channel is keenly focused on delivering a view into sector-specific digital transformation enabled by enterprise adoption of IoT technologies and solutions in industries including manufacturing, energy, transportation, healthcare, public sector, retail and more.

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Key Research Topics and Themes for 2022

● **As edge expands, what becomes of the IoT edge?**

Now that the edge isn't just IoT, what is the IoT edge? An endpoint-out view of the massive data flows driven by IoT deployments and complementary technologies like 5G and edge compute – and their ongoing impact on enterprise infrastructure and digital transformation.

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● **5G as a critical enterprise IoT enabler**

The ROI of 5G and edge have a critical dependency on enterprises using the platform to support digital transformation. With billions spent on 5G spectrum and infrastructure the next 5 years will be critical for 5G stakeholders to develop new value chain positions and business models that take advantage of cloud-native 5G.

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● **IoT platform market update**

Just a few years ago, IoT platforms sat at the center of the IoT market as the most critical piece of enabling technology – with hundreds of vendors vying for enterprise attention. Much has changed – how has the IoT platform market evolved with it?

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● **The IT/OT impact of digital engineering**

By ensuring that there is no border between IT and OT technologies, digital engineering will transform the way hardware-intensive systems are built and acquired by applying digital twins along a digital thread life cycle. This is an emerging space where the full disruptive market implications are only being glimpsed. The extent to which it will be dominated by the traditional OT service players such as GE, Phillips, Schneider Electric and Siemens on the one hand, or challenged by IT service system integrators on the other, partly depends on control of product data.

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● **Reaching the mid-market for IoT services**

Smaller enterprises (those with 500 to 1,000 employees) are often priced out of implementing IoT enabled services, an opportunity that many vendors have spotted and hope to address with their portfolios.

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● **Industrial/manufacturing: The industrial metaverse**

The metaverse has significant industrial use cases powered by industrial IoT instrumentation enabling full digital twins. This digital evolution sits on top of IIoT, AI, edge and cloud developments still ongoing across industrial digital transformation. This research looks at the spectrum from the most basic instrumentation to a fully realized digital twin in the metaverse for areas such as the manufacturing industry.

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● **Transportation: Vehicle electrification**

With environmental sustainability becoming a priority for consumers and enterprises alike, the popularity of electric vehicles is expected to grow rapidly. We will provide an overview of the demand among consumers and commercial transportation companies for EVs, explain technology enabling the move to electrification, and track hurdles to adoption.

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● **Auto sector: The software-defined vehicle**

Examining the momentum, drivers and players behind the software-defined vehicle, including the abstraction of hardware and software layers, bringing the concept of CI/CD to vehicles, and how IoT and vehicle electrification can help that concept become reality.

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Transportation and logistics: Comprehensive supply chain visibility

Shippers and carriers seek comprehensive supply chain visibility to keep track of vehicles, drivers and cargo at all times. With technology deployment and integration a top inhibitor to IoT adoption in commercial transportation, vendors must combine their own offerings with voluminous partnerships to get enterprises closer to that full view.

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Energy: Digital wind

Wind energy plays an important role in the energy transition, but wind turbines also generate vast amounts of data. In the spotlight, we look at the impact this has on datacenter capacity and connectivity.

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Energy: Digital decarbonization

The industry narrative is changing from using IoT and AI/ML for predictive maintenance to reducing carbon emissions. What should the priorities be for the industry?

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Smart city: Resilient infrastructure and climate adaptation

Cities are aiming to add a connected layer to their critical infrastructure in the face of extreme weather events. Public Wi-Fi, infrastructure integrity sensors and 5G network availability each contribute to resilience in the face of climate change.

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Smart building: Sensor-equipped buildings and the new world of work

As companies plan return-to-work strategies, smart building technologies such as sensors offer a safe option for people-counting and space management. Intelligent building operations platforms and management systems will play a central role in the future of work and in the strategies companies use to optimize employee experience and safety. What accommodations can companies and property managers make to ensure the safety of those who return to the office?

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Retail: The arrival of the connected store

E-commerce, smartphones and mobile apps have disrupted traditional retail – and with it, consumer demands and requirements. But for IoT- and digital-savvy retailers, something much better lies ahead: new opportunities and a renewed digital lease on life.

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Healthcare: Big tech players join the fray

2020 US healthcare spending was over $4 trillion. Large, fast-growing tech companies have been seeking success in this market, which has accelerated over the last two to three years.

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Healthcare: Securing medical patient data

The growth of IoT is driving more connected devices within the healthcare system, while COVID-19 is driving the growth of remote patient monitoring outside it. This increasing number of IoT devices in multiple locations is exposing healthcare to security vulnerabilities.

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Healthcare: Wearables vs. medical devices

The healthcare market is witnessing two parallel trends: 1) Medical device makers are turning to services. As IoT and services take a bigger role in the healthcare system and the home, traditional medical device manufacturers transition to service provision, opening these companies to new competition from startups, system integrators and consultants. 2) Consumer medical wearables are proliferating in the home. Fitness trackers, smartwatches and dedicated medical wearables are becoming more prominent devices in the home, driven by existing trends and by the COVID-19 pandemic.

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Workforce Productivity and Collaboration

The pandemic has fundamentally and permanently changed the way we work, creating enormous space for innovation across every aspect of the employee experience. What's more, workplace technologies have a clear and growing influence not just on employee productivity, but on other corporate goals such as operational agility, business resilience, talent recruitment and retention, and overall employee engagement. There has never been more innovation here, as businesses grapple with a new cultural, operational and technological landscape.

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Key Research Topics and Themes for 2022

The maturing of employee experience (EX) strategies

2020 and 2021 were marked by huge disruption, with companies scrambling to support remote and hybrid work models, address issues raised by social justice movements, and adjust to a more turbulent talent market. In 2022, these stresses will require businesses to rethink their EX strategies, focusing on more material efforts and investments to drive employees' engagement, satisfy their aspirations and support the sense of belonging and purpose they are increasingly looking for at work. Businesses are looking to new workforce strategies and technologies to help them with this reframing.

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A new era of immersive productivity will shape the future of SaaS

A radical rethinking of employees' software is beginning as more visually engaging experiences are taking hold. Going beyond basic conversation, task management and workflow automation, the leading edge of SaaS applications is aggregating important context, high-value collaboration and coordination around business goals. As users become accustomed to more seamless and integrated software experiences, this is set to have a foundational impact on the design of the next era of SaaS applications. For many vendors, this will impact their product design, market positioning, technology partnerships and channel relationships.

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The changing focus and investments of the HR department

Over the past few years, the human resources function has evolved into a more strategic business partner for organizations, as market dynamics and needs around HR-specific software and technology tools have changed. Core HR tools for processes including payroll, benefits and workforce management are still essential. But HR buyers are also maturing their investments in the employee experience and across the employee lifecycle in areas such as employee engagement, learning and development, and performance management. At the same time, HR skill sets are becoming more data-driven and focused on optimizing the processes under its control. Meanwhile, the mass shift to remote and distributed work has introduced new challenge vectors with ripple effects that will be felt throughout the entire HR arena and will subsequently impact its buying cycle and strategy.

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New work hubs emerge to improve workforce coordination and engagement

Many technology and business operations leaders and employee experience strategists are rethinking their long-term workforce technology strategies, giving more thought to the overall experience they provide users across their estate of technologies. More specifically, they are reconsidering how to integrate their different applications within that experience.

Businesses are therefore rethinking what constitutes a strategic hub that can give employees a personalized view of the resources they need to coordinate work effectively, and which applications are spokes that support that coordination. This is a key macro trend that will influence the direction of a significant number of productivity and collaboration software categories.

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Innovation across the project, portfolio and work management categories

Project, portfolio and work management tools are among the more dynamic productivity software categories. This remains the case with strategic M&A, product innovations, a raft of new vendors, a widening set of buyers, growing partner and channel ecosystems, and widening competition as categories overlap. This space will continue to grow in strategic importance as vendors position their offerings as a central part of knowledge workers' everyday toolkit.

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Businesses adopt more agile planning cycles

Businesses no longer have the luxury of annual planning cycles. With the disruption of the past two years and ongoing turbulence in the labor market and supply chains, there are too many variables at play for organizations to plan that far into the future with any degree of certainty. Organizational agility is paramount, and it depends, in part, on a more agile and fluid planning cycle. For some businesses, a quarterly plan is sufficient, but others may need to plan month to month. As such, businesses will increasingly be looking for technologies that can help them forge connections across their divisions – as collaboration is key to increasing fluidity and agility – and provide more continuous management of their plans.

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The disruptive potential of CPaaS for business processes

The rapid growth of CPaaS – a platform-based approach for real-time communications – has the potential to be highly disruptive, not just for separate categories of business communications technologies such as unified communications, but to supplement a wide range of other business processes. While key CPaaS vendors have been focused primarily on customer experience opportunities, there is a huge greenfield territory among knowledge, task and service workers whose workflows would benefit from embedded communications. The breadth of both these CX and EX use cases will continue to fuel the growth and strategic importance of CPaaS in enterprise software.

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ESG mandates will begin to inform workforce strategies and technology choices

How to effectively treat environmental, social and governance (ESG) issues is shaping up to be one of the most significant business agendas of our time. There is growing bottom-up pressure from employees, as well as growing downward pressure from investors and regulators, to commit to ESG initiatives.

This pressure has intensified over the past two years, with concerns over furloughs; workplace safety; diversity, equity and inclusion (DEI); talent attrition; and operational culture. Businesses need to better reflect the breadth and significance of these and other issues in the experience they provide their employees.

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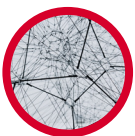
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