Emerging Technologies and Trends Impact Radar: Enterprise Software

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Initiatives: Emerging Technologies and Trends Impact on Products and Services

> Enterprise software is becoming a catalyst for transforming to a composable enterprise. Enterprise software product leaders should continue developing capabilities for product delivery agility and technology productization, and aim those further toward business outcomes and generative readiness.

Overview

Key Findings

- Buyer expectations from enterprise software applications have changed significantly over the past year. Buyers expect their software applications to improve their business agility — the ability to quickly deploy new business strategies and overcome unanticipated disruptions. This objective is often constrained by enterprise software providers' own agility in delivery.
- Software product leaders are using data-driven technologies such as artificial intelligence (AI) and Internet of Things (IoT) to extend their impact beyond automation. Such product leaders aim to accelerate their customers' digital business transformation.
- Enterprise software provider business models are being disrupted, as software markets shift from stand-alone products to packaged solutions offered via the cloud. Software product leaders are beginning to explore developing organizational capabilities to improve collaboration among ecosystem stakeholders to identify, package, and deliver composable solutions.

Recommendations

Product leaders seeking growth in the enterprise software market through emerging technologies and trends' impact on products and services should:

- Improve agility in product delivery by combining foundational capabilities, such as DevOps and low-code platforms, with emerging ones such as intelligent document processing.
- Productize data-driven technologies by embedding them in enterprise software application workflows that impact specific business outcomes. Orchestrating such outcomes using technologies such as hyperautomation and developing capabilities such as converged business and productivity applications enables product leaders to accelerate the transformation to a composable enterprise.
- Start developing generative business solutions by packaging components using capabilities such as AI-powered composite applications, and implementing infrastructure and operating models that support such solutions.

Analysis

The COVID-19 pandemic era has profoundly changed customer expectations about the impact of enterprise software on their business. Enterprise software is no longer in the periphery; it is the catalyst that makes or breaks businesses, and this is increasingly being felt by enterprise IT leaders. Such leaders are increasingly expecting enterprise software to enable specific business outcomes that are required to implement their business strategy. These outcomes can shift rapidly over time as organizations progress on their transformation journeys to a composable enterprise (see Future of Applications: Delivering the Composable Enterprise).

Software product leaders have had to respond quickly to disruptions in order to survive the slowdown in the growth of the global spend on enterprise application software. Improving business agility affects enterprise software product leaders in terms of product scope, and the specific product capabilities they have to deliver across roadmaps and releases (the "what"). Additionally, it is equally related to their infrastructure and product delivery foundation (the "how"). Without the "how," the "what" might come up too little, too late. Without the "what," the "how" will lack relevance to customer needs and competition response.

In this Emerging Technology and Trends Impact Radar, Gartner includes 25 emerging technologies and trends with horizontal impact on enterprise software vendors as related to their ability to pivot forward and accelerate their business opportunities. These 25 technologies and trends cover both the “what” and the “how”: areas for product investment, foundational technologies and nontechnology trends. We have mapped these emerging technologies and trends with three über-themes that have evolved in the last 12 months:

- Optimization of the product delivery foundation to improve business agility
- Software (and other) technology components getting into the fabric of business solutions
- The future of composable enterprise software applications is to deliver generative-style solutions

Improve Business Agility by Optimizing Existing Product Delivery Capabilities

Enterprise software product leaders should improve the agility of their product delivery to fulfill their customers’ increasing expectations about business agility. Such leaders should update their software engineering strategies, development tools, organizational structures and underlying infrastructure to improve agility. Deploying tools that dramatically cut development time and skill set requirements provide a further boost in improving time to market. Since last year, a number of such tools, such as robotic process automation (RPA) and low-code development platforms, have already been widely utilized (see Market Share Analysis: Application Infrastructure and Middleware Software, Worldwide, 2020).

Organizational and team structures are other areas for software providers to make profound changes. Postpandemic, agile and DevOps are understood as business requirements, not as concepts or abstract methodologies. At the same time, their scalable implementation is affected by profound workforce and workplace shifts that affect talent dynamics and supply, such as remote and hybrid work, increased proportion of millennials and Gen Z and total workforce strategies (see Forecast Analysis: Remote and Hybrid Workers, Worldwide).

The following tech profiles should help product leaders improve business agility — DevOps, low-code application platforms, cloud infrastructure and platform services (CIPS), container management, AI-augmented software development, nonvolatile memory express over TCP (NVMe/TCP), and remote collaboration.

Shift From Products to Business Solutions by Packaging Software and (Other) Technology Components

A range of data-driven technologies with related services has become pervasive across software markets through this decade and beyond, driving productization across enterprise software markets. AI, IoT and hyperautomation are great examples of technology diffusion across software markets, with features that directly affect market growth and commercial success of their providers (see Forecast Analysis: Hyperautomation Enablement Software, Worldwide and Forecast Analysis: Artificial Intelligence Software, Worldwide, 2020-2025).

But customer needs are becoming more specific. Since last year, business functions served by software applications are increasingly required to align their requirements and ROI with the specific business instead of functional "best practices." To fully deliver the promise of outcome-driven applications, software providers do not just require accelerated product investments, they also need infrastructure deployment to enable fast processing at scale.

Enterprise product leaders should review tech profiles such as intelligent applications, IoT platforms, hyperautomation, digital twin, quad-level cell (QLC) NAND flash, service mesh, packaged business capabilities, process and task mining, collaborative ecosystem product development, graph technologies, multimodal user interface (UI) and cloud ERP suites for product-centric enterprises to shift from products to business solutions.

The Future of Composable Enterprise Software Applications Is to Deliver Generative-Style Solutions

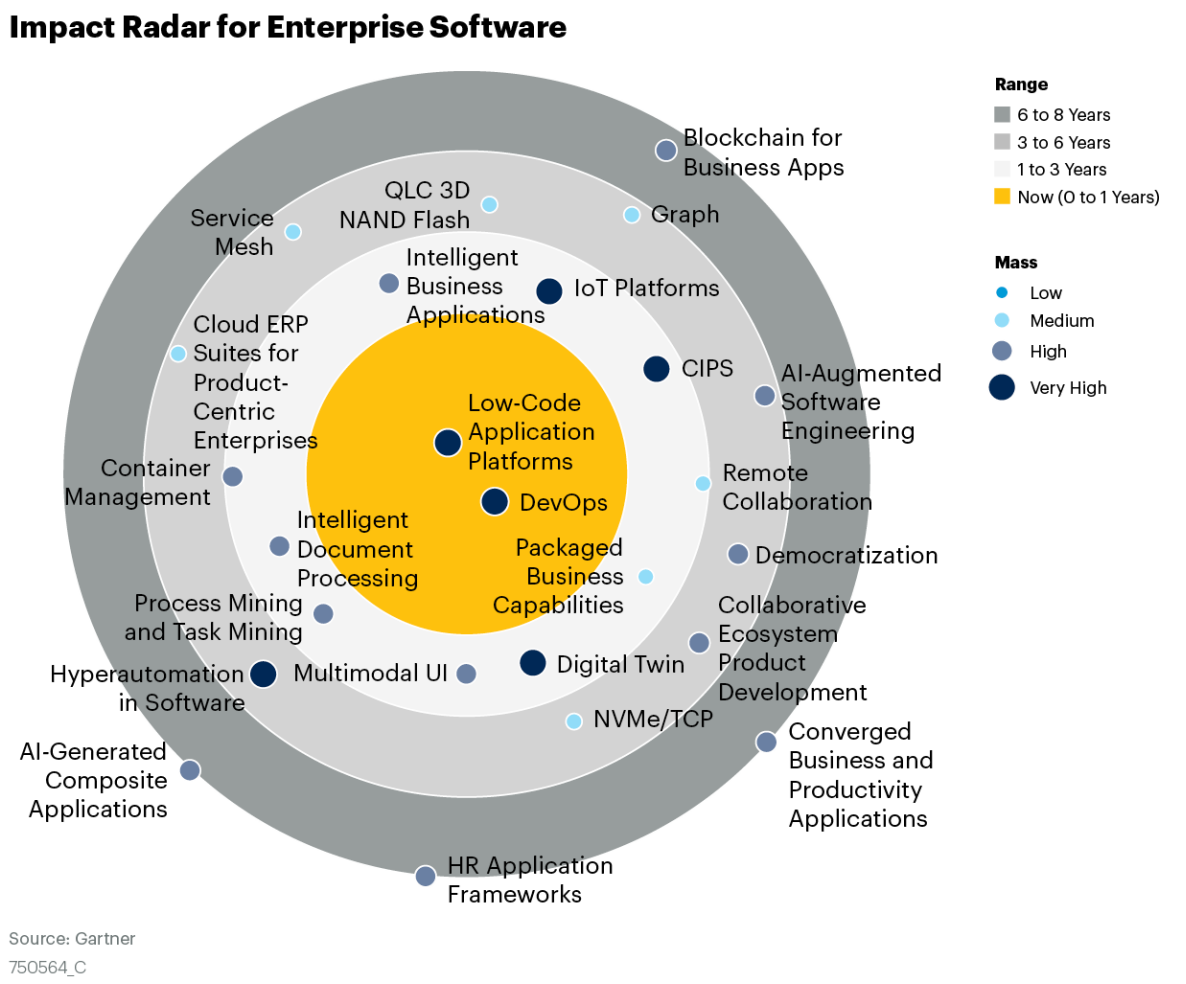
Traditional business models are no longer sufficient to fulfill changing expectations about enterprise software applications. As enterprises become more technology-intensive, enterprise leaders expect their software applications to generate competitive advantage. This pushes enterprise software product leaders to generate business solutions that can quickly impact specific and changing business strategies (see Tech Providers 2025: The Generative Future of High-Tech Providers). Generative solutions are linked to business strategies, not to lists of business requirements; this is a profound shift for software providers in terms of technology capabilities, but, most importantly, in terms of organizational and business models.

A combination of technologies, processes and tools begins to evolve to support these requirements at scale, from software conception to activation. This redefinition is already showing how entire application markets will evolve, such as human capital management (HCM), with an evolution from today's HCM cloud suite toward HR application frameworks to exploit greater customization capabilities and freedom to switch in and out capabilities from different vendors.

Enterprise software product leaders should start exploring tech profiles such as AI-powered composite applications, converged business and productivity applications and blockchain for business apps to prepare for the generative future.

The Impact Radar

Figure 1: Impact Radar for Enterprise Software



This Emerging Technologies and Trends Impact Radar content analyzes and illustrates two significant aspects of impact. We expect it to have a significant impact on the market (namely, the range) and a big impact on relevant markets (specifically, mass). Each emerging technology or trend profile analysis is composed of these two aspects. Profiles are organized by range, starting with the center and moving to the outer rings of the radar. See the How to Use the Impact Radar section for more information.

Emerging Technologies or Trend Profiles

Table 1: Emerging Technologies and Trends in Enterprise Software

Now	1 to 3 Years	3 to 6 Years	6 to 8 Years
DevOps	Cloud Infrastructure and Platform Services (CIPS)	Hyperautomation in Software	AI-Generated Composite Applications
Low-Code Application Platforms (LCAPs)	Digital Twin	AI-Augmented Software Engineering	Converged Business and Productivity Applications
	IoT Platforms	Collaborative Ecosystem Product Development	HR Application Frameworks
	Container Management	Democratization	Blockchain for Business Apps
	Intelligent Business Applications	Cloud ERP Suites for Product-Centric Enterprises	
	Intelligent Document Processing	Graph	
	Multimodal UI	Nonvolatile Memory Express Over Transmission Control Protocol (NVMe/TCP)	
	Process Mining and Task Mining	Quad-Level Cell (QLC) 3D NAND Flash	
	Packaged Business Capabilities	Service Mesh	
	Remote Collaboration		

Now Range

DevOps

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Analysis by Laurie Wurster, Michael Warrilow, Bill Holz

Description:

DevOps is a business-driven approach for delivering solutions using agile methods, collaboration and automation. DevOps improves business outcomes by applying agile values to operations — automating tasks like environment provisioning and configuration, builds, deployments, and monitoring. "DevOps," made up of "dev" from "development" and "ops" from "operations," addresses the schism that exists between these teams as well as with other IT stakeholders and the business. DevOps reorganizes roles and practices to encourage collaboration between disciplines and to streamline the release engineering, implementation and maintenance phases of the software development life cycle (SDLC).

Sample Providers: Atlassian, CloudBees, Digital.ai, GitLab, JFrog, Microsoft, SonarSource, Harness, Plutora, Tasktop

Range: Now (0 to 1 Years)

Buyer interest in DevOps adoption in response to the work-from-anywhere trend kicked-started by COVID-19 mandates is driven by increased demand to gain agility, move faster and improve the ability to innovate. We classify the range of impact as "now" because DevOps principles are generally understood in most enterprises. Adoption is significantly underway, although some organizations continue to struggle with the level of cultural change required for successful implementation (a move away from a "them and us" mentality to a collective "us" team). The primary reasons for adopting DevOps practices among respondents to the 2020 Gartner Achieving Business Agility With Automation, Continuous Quality and DevOps Survey were to increase IT and organizational agility and improve the delivery of customer value. In terms of velocity, forecast market growth is an estimated 15% year over year through 2025. There is still room for technology progression/innovation and process maturation (see Hype Cycle for Agile and DevOps, 2021). New and emerging trends include site reliability engineering, platform ops and value stream platforms.

DevOps is a mature discipline in software engineering teams but has only sporadic adoption within data and analytics teams. The bottlenecks for delivering data, AI and analytics solutions are typically the result of siloed working, lack of collaboration as well as constant duplication of effort across the multiple workflows (see Apply Foundational DevOps Principles to Accelerate Data, Analytics and AI Delivery). These are the very challenges DevOps was created to solve in order to deliver value. Success requires establishment of DevOps value streams that remove constraints, support pipeline activity and provide feedback. In addition, solutions must assist with culture change, waste elimination and removal of organizational barriers while improving productivity through automation. Through 2023, focus continues to expand toward improved/integrated security and compliance into value stream platforms providing opportunity for new entrants and expanded offerings.

Mass: Very High

We rate the mass as very high, in part due to increased interest in platform-centric approaches for supporting end-to-end continuous delivery and management. As adoption grows, integrated product teams see the potential benefit of an even greater need for unified visibility, orchestration, integration, governance and management. Adopters realize the benefit that improved flow and traceability deliver to the product value stream. This is occurring across a range of industry verticals hand-in-hand with investment in digital transformation.

With increasing interest in cloud-based services, platform capabilities will provide improved support for AI, ML, data and analytics commercial off-the-shelf and open-source software. To accelerate adoption, enterprises are looking to further reduce siloed processes in favor of a platform approach. This approach expands the requirements across an expanding variety of IT, security, and compliance teams (including operations, infrastructure, analytics, security, networking, environment and release management, deployment, and maintenance).

Recommended Actions:

- Develop and/or bundle products into platforms designed to assist engineering and operations as well as other stakeholders to work collaboratively.
- Design tool functionality that meet the demands for both highly skilled developers requiring sophistication as well as less-skilled business stakeholders needing simplicity.

- Use a platform-centric approach to support agile development processes that allow all teams to work effectively together.
- Institute a customer success strategy that uses marketing and support teams for continued nurturing to ensure prospects and clients understand features and the value to the business.

Recommended Reading:

- The Future of DevOps Toolchains Will Involve Maximizing Flow in IT Value Streams
- Bust Silos, Focus on Customers and Enhance Business Outcomes Through Value Streams
- Solution Path for Continuous Delivery With DevOps
- Infographic: Top 10 Technology Trends Impacting DevOps
- Solution Path for Agile Transformation

Low-Code Application Platforms (LCAPs)

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Analysis by Fabrizio Biscotti, Paul Vincent, Jason Wong, Laurie Wurster

Description:

An low-code application platform (LCAP) supports rapid application development, one-step deployment, execution and management using declarative high-level programming abstractions such as model-driven and graphical development approaches. They support the development of UIs, business logic and data services, and they improve productivity at the expense of runtime portability and openness, as compared with high control application platforms, and are typically delivered as cloud services.

Sample Providers: Appian, Creatio, Mendix, Microsoft, Oracle, OutSystems, Pegasystems, Quickbase, Salesforce, ServiceNow

Range: Now (0 to 1 Years)

The movement of LCAP to the early majority will happen within a year, as LCAP covers a large and increasing subset of enterprise application requirements, with some enterprises starting to choose them as their strategic application platform. Indeed, its application scope is evolving to cover more digital business scenarios and advanced use cases such as consumer-facing applications.

LCAP offerings are all multifunction and combine development tools, runtime platforms for test and production, embedded databases, and integration/composition capabilities. The short development time for applications built on LCAP facilitates agile practices in conjunction with business users and encourages collaboration and innovation. Furthermore, LCAPs' raised abstraction levels for application development and process automation reduce the skill sets required for building basic business applications, and they support generic application functions such as data collection, workflow and reporting.

Mass: Very High

With many enterprises adopting multiple LCAP solutions with success, growing vendor numbers, continued advancement on innovation, and few issues beyond vendor lock-in and pricing model transparency, this technology is approaching mainstream adoption. Such adoption is prevalent across multiple industries and impacts most business functions, and markets replacing existing capabilities. So much so that we predict that by 2024, well over half of midsize to large enterprises will have adopted LCAP as a strategic application platform. LCAP supports both democratization of application development beyond central IT and enables increased automation of business services. Their multifunction support for data, user experience (some extending to multiexperience touchpoints), intuitive developer experience, and integration make them a potent best-of-breed application delivery tool for mainstream business use cases. They can entirely remove the need for high-control frameworks and platforms in some organizations.

Recommended Actions:

- Emphasize that LCAP will be lower-risk, require less coding skills and training, and be faster to deploy for many use cases over the traditional third-generation language alternative styles of application development while providing more flexibility and customization than SaaS alternatives. Develop a product strategy directed to citizen development, departmental application or enterprise application modernization use cases.

- Mitigate architecture constraints by giving preference to LCAPs that provide for composition of external services, SaaS APIs or other packaged business capabilities, or that fit well with your existing integration strategy and technologies.
- Help customers navigate the trade-offs of low-code application development and their fears of vendor lock-in (language, metadata and models are generally proprietary). The models supported in model-driven design usually focus on classic application components (database, form or page, and process). Also aim to support multicloud and hybrid cloud deployments with LCAPs that run on container architectures.

Recommended Reading:

- Forecast Analysis: Low-Code Development Technologies
- Magic Quadrant for Enterprise Low-Code Application Platforms
- Quick Answer: What Is the Difference Between No-Code and Low-Code Development Tools?
- Market Share Analysis: Application Infrastructure and Middleware Software, Worldwide, 2020
- Emerging Technologies: High-Velocity Demands Accelerate Low-Code Application Platforms

1 to 3 Years

Cloud Infrastructure and Platform Services (CIPS)

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Analysis by Sid Nag

Description:

Cloud infrastructure and platform services (CIPS) are the business and technology arrangement where infrastructure as a service (IaaS) and/or platform as a service (PaaS) capabilities are offered as cloud services. Integrated CIPS implies integration of IaaS and PaaS. The degree of integration may vary, but it includes the use of a single self-service portal and catalog, shared identity and access management, a single integrated low-latency network context, unified security, unified monitoring, and unified billing.

Sample Providers: Alibaba Cloud; Amazon web Services (AWS); Google Cloud Platform (GCP); IBM; Microsoft Azure; Oracle; Tencent

Range: 1 to 3 Years

We estimate the range to be one to three years because IaaS and PaaS are naturally complementary, causing IaaS providers to expand into PaaS as a natural extension of their offering portfolio. The more ambitious providers rooted in PaaS are expanding into IaaS, typically through partnerships. Hyperscale cloud providers such as AWS, Azure and GCP offer these integrated capabilities themselves. Integrated approaches allow users to combine different cloud delivery models of system and application infrastructure in a unified environment.

CIPS represent a continuum, and some offerings in the market have characteristics of both.

A well-functioning CIPS will offer enterprises a more natural, flexible, and comprehensive ramp-up path to cloud computing and, consequently, will increase the rate and scope of adoption of cloud by mainstream IT. CIPS allows customers greater flexibility to come into a cloud environment with the balance of control and ease of use that suits their needs at the time, and to shift that balance in either direction as their needs evolve.

Vendors also benefit from CIPS — those coming from IaaS and those specialized in PaaS increase their customer value proposition and ability to compete when covering the broader set of capabilities. Because only the largest vendors are able to offer their own implementations of IaaS and PaaS, the increasing popularity of CIPS will contribute to the trend of PaaS market consolidation.

Mass: Very High

We estimate the mass to be very high because the appeal for CIPS is not in best-of-breed offerings but in the unification and integration of platform capabilities across these services enabling a scalable user experience for enterprise governance and operations. Most customers that use a hyperscale CIPS provider, such as AWS or Microsoft Azure, have adopted a blend of the provider's IaaS and PaaS capabilities. IaaS resources are typically supplemented with cloud software infrastructure services such as database platform as a service (dbPaaS), application platform as a service (aPaaS) and integration platform as a service (iPaaS). Indeed, the availability of this broad portfolio of services is a key aspect of choosing a strategic cloud platform provider. Hyperscalers deliver PaaS services with a direct dependency on their IaaS services.

The complexity and level of investment required to offer a full, integrated portfolio of multifunctional PaaS and IaaS will likely limit the vendor options in this market to a handful of hyperscalers. Some of the hyperscalers will form ecosystems, enabling smaller PaaS specialists to be included in this market. However, the maturity of this technology will be primarily dependent on the capabilities of the hyperscalers.

Recommended Actions:

- Build CIPS offerings for both cloud-native and legacy migration projects to help organizations in their application design and deployment options. Keep in mind the DevOps and platform software elements while creating such offerings.
- Develop hyperscale CIPS offerings for organizations' consolidating systems that are operating and governing fleets of applications at enterprise scale. Improve organizations' abilities to drive application software development efficiencies using technologies such as serverless and functions. Offerings must be designed to be long-term application platforms. They should be managed as such, with appropriate attention to the software components related to potential application portability issues including orchestration and migration software.

Recommended Reading:

- Risk and Opportunity Index: Cloud Infrastructure and Platform Services
- Why Product Managers Must Enable a CIPS Adoption Model
- Technology Insight for Integrated IaaS and PaaS
- Not Just PaaS: Know and Use the Cloud Platform Continuum
- Platform as a Service: Definition, Taxonomy and Vendor Landscape, 2019

Digital Twin

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Analysis by Al Velosa

Description:

A digital twin is a virtual representation of an entity such as an asset, person or process. It is developed to support business objectives. Digital twin elements include the model, data, unique one-to-one association, and monitorability. The three taxonomy levels of digital twins are discrete, composite and organizational. These digital twin elements are built, used, and shared in enabling technologies such as analytics software, IoT platforms or simulation tools.

Sample Providers: Arrayworks, AVEVA, Cognite, Covacsis, Flutura, NTT, Quidgest, ScaleOut Software, Slingshot Simulations, Tuya Smart

Range: 1 to 3 Years

We assess the range to be one to three years because we see increasingly compelling offers from technology providers as well as increased adoption from a range of end user enterprises. However, keep in mind that enterprises' understanding of digital twin potential remains emerging. This is due to the lack of standards, deceptively challenging integration requirements that increase project cost, and a lack of governance processes and budget sponsors at most enterprises. Thus, digital twins are two-thirds of the way down to the Trough of Disillusionment (see Hype Cycle for the Internet of Things, 2021).

This challenges product leaders to have good marketing efforts in addition to clear sales strategies. Some technology and service providers (TSPs) are beginning to effectively link their digital twin enabling technologies to well-defined business outcomes, but most still overemphasize technology while lacking industry-specific solutions. Software product leaders are starting to build business solutions and portfolios of digital twin templates with a focus on revenue.

Digital twin revenue comes in two forms. The first is the revenue element, the initial, short-term enabling platform — for example, for the IoT or BPM or analytics platform — combined with design and implementation services. Second, the long-term revenue opportunity for digital twins includes marketplace, managed services, contract renewal, and digital twin refurbishment opportunities. Most enterprise digital twins are custom business engagements that can last a decade or two if the vendor shows clear value.

Mass: Very High

We assess mass to be very high because the number and type of customers planning investments reflects they expect to receive significant business benefits. Interest in digital twins remains high. Data from the 2021 Gartner Application Innovation Implementation Survey shows 11% of the participating enterprises have currently deployed digital twins at large or full scale, and in three years, 39% of enterprises plan to deploy them at large or full scale. [1]

Digital twins are being deployed in asset-intensive industries, such as oil and gas, and manufacturing. And interest is increasing in other sectors. Airports, real estate management, and other organizations that need to monitor people for health and safety purposes and conduct COVID-19-related compliance reporting, are increasingly using digital twins. Medical institutions are going beyond patient health records to develop digital twins of patients. OEMs are developing digital transformation and monetization strategies. Standards organizations and consortia are emerging, such as the Digital Twin Consortium and the National Digital Twin Programme at the Center for Digital Built Britain.

Recommended Actions:

- Incorporate digital twins into your product roadmap by reviewing your product's intellectual property for prebuilt models, and turn it into a digital twin product library, especially for asset-intensive industries.

- Build a digital twin revenue strategy by mapping short and long-term revenue opportunities for software licenses, cloud services, services, and digital twin libraries.
- Develop a digital twin go-to-market ecosystem map by identifying and aligning to key partners that complement your strengths, including partnering with horizontal digital twin TSPs to fill offering gaps.

Recommended Reading:

- Tool: 50-Plus Digital Twin and IoT Cost Optimization Examples
- Strengthen 4 Elements for Successful Management and Governance of Digital Twins
- Survey Analysis: Companies Heavily Use Digital Twins to Optimize Operations
- What Should I Do To Ensure Digital Twin Success?

IoT Platforms

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Analysis by Eric Goodness

Description: An Internet of Things (IoT) platform is a software middleware product that enables the development, deployment, and management of solutions connecting to, and capturing data from, IoT endpoints to drive improved business decisions. Functional capabilities include IoT edge device management, integration tools and management, data management, analytics, application enablement and management, and security.

IoT platforms may be deployed on-premises, as a cloud-based IoT platform as a service (PaaS), or as a hybrid architecture consisting of a distributed IoT software that is cloud-based — as well as on-premises and near-premises — across non-core edge hardware and software.

Internet of Things design patterns are built upon distributed computing edges that are resource constrained making IoT solutions the largest standing opportunity for leveraging edge AI embedded within assets, on gateways, and on local compute servers.

Sample Providers: Advantech, AWS, Envision Group, Microsoft, myDevices, Tuya, and Software AG

Range: 1 to 3 Years

Enterprise adoption of IoT platforms remains relatively strong as businesses add IoT capabilities to their physical plant and assets and as they have IoT-enabled their finished goods and services. However, continued vendor hype, culture, schedule, and security concerns likely push mainstream adoption out at least one to three years. Additionally, speed of adoption will vary across commercial and industrial verticals, with commercial (nonindustrial) adoptions reaching early mainstream adoption in the next year or so. Industrial adoption is hindered by culture and legacy investments in operational technologies (OT) and will reach early mainstream within the next three years as more OT providers develop IoT platforms as overlay solutions to their legacy industrial applications and OT systems.

The crowded marketplace of vendors restricts the overall success of IoT growth. Gartner estimates that there are more than 1,000 companies marketing and selling IoT platforms that are aligned with sector-specific needs or with targeted use cases ranging from asset monitoring to manufacturing intelligence. Vendors in this market have not convinced their customers to expand the use of IoT platforms as corporate standards. The bona fides relating to cost optimization and process transformation exist. However, the market lacks blue ribbon customers that have adopted IoT solutions across all relevant business units. Additionally, the lack of investment by IT service providers to create robust and competitive service practices to plan and build a broad continuum of platforms also restricts the market growth. To date, platform integration usually falls in the hands of the platform developers.

Mass: Very High

The size of impact of IoT platforms on products and markets is very high as the IoT is an expressed core component of all digital business. The IoT has broad appeal across all sectors regarding value derived from connecting and analyzing assets and processes. Initial estimations of market opportunity point to a more extensive installed base commercial IoT where the use of the cloud predominates technology decisions and where security is a lower concern than industrial IoT. However, the total economic impact of IoT within industrial enterprises will prove to be a larger market in the long term as IoT begins to augment and replace the functions of OT systems.

What has distinguished the IoT platform market over the past few years is the impact of non-IT, nontraditional buying centers that drive increasing demand for IoT solutions. This trend will increase as IoT becomes more entwined with digital business. Through cloud and traditional analytics and innovative AI/machine learning (ML) techniques, the investments required to be competitive are rising.

Recommended Actions:

- Establish decision qualifiers for a build-buy-borrow approach to market entry if you are a product leader that is just investigating the IoT market. Given there are more than 1,000 providers in the market, investment in the development of an organic technology platform, rather than partnering or acquiring, offers diminishing returns.
- Focus on purpose-built IoT applications that are transportable across diverse platform containers, as this is likely the first, best step toward offering customers packaged and composable solutions benefiting from IoT sensor data. The growth in IoT applications that sit on top of IoT platforms is a growing focus of investment across all provider types that serve the market for IoT solutions.

Recommended Reading:

- The Typical IoT Buyer Team: IoT Product Managers Must Deliver Role Specific Value
- Top Opportunities for Sustained Differentiation in the Commercial IoT Market
- Competitive Landscape: IoT Platform Vendors

Container Management

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Analysis by Wataru Katsurashima

Description:

To manage containers at scale, container management provides capabilities such as container runtimes, container orchestration and scheduling, and resource management. Container management software brokers the communication between the continuous integration/continuous deployment (CI/CD) pipeline and the infrastructure via APIs, and aids in the life cycle management of containers.

Sample Providers: Alibaba Cloud, AWS, D2iQ, Google, IBM, Microsoft, Mirantis, Red Hat, SUSE-Rancher, VMware

Range: 1 to 3 Years

The market adoption of containers has crossed the chasm into mainstream enterprises for new custom application development use cases. A poll at the Gartner IT Infrastructure, Operations and Cloud Strategies Conference in Las Vegas in December 2019 showed that 36% of respondents were using containers in production and another 31% were testing or evaluating containers. Common use cases for containers are microservices, legacy app migration (without massive refactoring) and application portability.

We assess the range to be one to three years because all major container management vendors adopted Kubernetes in their core products. The emergence of the key open-source technology is accelerating vendors' product development and facilitating the growth of technology ecosystems for container management. Market interest in Kubernetes is growing rapidly, which is a precursor to investment in container management. The number of Gartner inquiries regarding Kubernetes in the second half of 2020 increased 65.7%, compared with that of 2019.

Mass: High

Gartner assumes container management to be widely adopted as a standard infrastructure for cloud-native applications in the near future. Gartner predicts that 85% of organizations will use containers by 2025 due to growing adoption of cloud-native applications and infrastructure (see Predicts 2021: Building on Cloud Computing as the New Normal).

To take leadership in this new technology area, hyperscale cloud providers and large software incumbents started to invest heavily in container management, with IBM acquiring Red Hat, SUSE acquiring Rancher, and VMware acquiring Heptio and Pivotal. With the entry of these major players, this technology will be potentially changing the competitive landscape in computing infrastructure.

Recommended Actions:

- Address business opportunities driven by the growing container adoption by providing certified container application images and life cycle management automation tools like Kubernetes Operator at container marketplaces.

- Support container management, as well as application platform as a service (aPaaS) features and other complementing management across various cloud deployment scenarios (hybrid cloud, multicloud and distributed cloud).

Recommended Reading:

- Competitive Landscape: Container Management (Software and Cloud Services)
- Grow Your Cloud Container Services Business With Distributed Cloud and Serverless

Intelligent Business Applications

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Analysis by Alys Woodward

Description: Intelligent business applications are enterprise business applications with embedded or integrated AI technologies, such as intelligent automation, data-driven insights, and guided recommendations in order to deliver a more personalized interface, improve productivity and support decision making. Injecting optimization, advisory, and decision support capabilities into process-centric workflows delivers significant enhancements to traditionally highly procedural enterprise business applications. Intelligent business applications will be enabled by the principles of composability, allowing for components to be added and recombined as required.

Sample Providers and/or Products: ConverSight.ai; Google Docs; Microsoft 365; Oracle Applications; People.ai; Salesforce Einstein; ServiceNow; Sievo; Twilio

Range: 1 to 3 Years

Intelligent business applications will cross the chasm in the next one to three years due to widespread embedding of AI technologies within their offerings by enterprise application vendors. These applications range from ERP to CRM to human capital management to workforce productivity applications. These offerings drive customer loyalty and application dependence, rather than specific revenue lines for vendors, with AI enhancing the usefulness of the whole application. Adding “intelligence” into applications, versus yet another procedural feature, will increasingly establish competitive differentiation and accelerate technology provider uptake. This is transformational where the intelligence can make the difference between a compelling business application and something that is nice-to-have but could be supported by manual processes or handcrafted in productivity tools like spreadsheets and documents. For example, insights into deal scoring and prioritizing tasks could be compelling in a sales application.

Mass: High

The vast majority of applications will ultimately become intelligent in some way via the use of AI technologies listed in the bullet points below, making the mass for intelligent applications high. Intelligent business applications that deliver better performance (i.e., accuracy), user productivity and faster inferencing will provide a strong business case for users across industries.

Common use cases for intelligent business applications include sales force productivity, human capital management, sales and marketing applications, manufacturing, distribution, and physical space management via image and video recognition.

Intelligent business applications use AI in the following ways:

- Data capture and response: AI technologies such as natural language processing (NLP), text analytics, deep neural networks and image recognition can be used for intelligent invoice matching, extraction of terms and conditions or clauses from contracts, or analysis of images for photographic recognition.
- Process augmentation: AI technologies like machine learning, decision intelligence, knowledge graphs and explainable AI can provide more intelligent actions for an application. In the future, process augmentation can be extended further to identify patterns of work, from which process models can be built and executed. When processes or recommendations change due to AI, the business user responsible for the process and decision being taken must understand the reason for the changes — hence, the use of explainable AI.

- User experience: Conversational UI platforms and NLP, facial recognition, and other AI applications can be used for understanding user emotions, context or intent, and predicting user needs.
- Analytics: AI technologies like augmented analytics can be used to create more predictive and prescriptive analytics that can then be presented to users in the form of insights, or as guided recommendations, for further evaluation, or plugged into a process to drive autonomous action.

Recommended Actions:

- Start addressing the intelligent business application trend and avoid "AI for AI's sake" by adding AI capabilities that add additional value over the current way the application delivers value.
- Gain quicker wins by leveraging data already captured by the business application.

Recommended Reading:

- Artificial Intelligence Maturity Model
- Hype Cycle for Artificial Intelligence, 2021

Intelligent Document Processing

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Analysis by Varsha Mehta, Cathy Tornbohm and Fabrizio Biscotti

Description:

Intelligent document processing (IDP) helps transform structured, semistructured, somewhat unstructured data from a variety of document formats into digitized and actionable information. It uses a combination of technologies such as optical character recognition (OCR), natural language processing (NLP), computer vision, deep learning, ML and AI capabilities to scan, classify, categorize and extract data. IDP overcomes the limitations of simple template-based document ingestions tools and streamlines the document processing activities using AI human-in-the-loop machine learning (HITL-ML)-based training to improve its capabilities over time — that is, understanding a wide variety of document formats, what the document is about, content/data type it contains, extracting the data, validating the data, and integrating the data into appropriate business processes/functions.

Sample Providers: ABBYY, Appian, AntWorks, Automation Anywhere, Kofax, Neutrinos, OpenText, Rossum, UiPath, WorkFusion

Range: 1 to 3 Years

We classify the range of impact as short because IDP will gain momentum in the coming one to three years by acting as a catalyst of transformation for modern enterprises by automating data extraction and document processing projects. Having exhausted low-value, text-based automation capabilities, organizations will eventually move to implement high-value, efficiency driving and cost saving next generation, end-to-end document processing solutions. With diverse use cases of IDP, insurance, banking, financial services, retail and telecom industries will broaden the applicability and integration of IDP solutions into their different business processes and functions.

According to Emerging Technologies Venture Capital Growth Insights: Robotic Process Automation, venture capital (VC) investment focus is shifting to companies offering technologies complementary to RPA. One of these complementary technologies/segments is — content ingestion, which includes OCR- and IDP-based capabilities. Over the next few years, the total VC investment into these segments is expected to accelerate as the companies operating in this space strive toward maturity and scalability. VC investments coupled with the growing sophistication of intelligent automation technologies (AI, ML, deep learning) and their convergence with RPA, computer vision, process mining and NLP capabilities, will drive the innovation, precision, and scale of the IDP solutions.

Mass: High

We estimate the mass to be high because major forward-looking enterprises, driven by the expectations of cost reduction, increased productivity, higher accuracy, and enhanced customer experience, plan to allocate more financial and human resources to implement intelligent document processing capabilities over the next few years. This is consistent across a range of industry verticals with heavy investments in the digital transformation driving projects, tools, and capabilities. Currently, the key adopting industries with targeted use cases, to name a few, include — insurance for claims processing, banking and financial services industry for customer know your customer (KYC), retail for invoice processing, sales order management and accounts receivable, telecom for maintenance logs, and software for contract management, among others.

Recommended Actions:

- Help customers understand that IDP will lower operational costs and enhance overall productivity by automating document processing tasks, which will help accelerate enterprise wide automation and digital transformation efforts.
- Develop or build IDP solutions on top of a legacy OCR platform or as an extension on the RPA platform to expedite the market entry process and quicken the integration and adoption process for customers.
- Tap into the market of focused/niche IDP solutions, which are targeted to address specific industry needs, functions, or particular document types, such as IDP solutions specific to invoices, financial documents or contracts or healthcare-, retail-, insurance industry-specific solutions.
- Work on improving and scaling data extraction capability from structured or semistructured documents to various unstructured document formats as well (handwritten bills/forms, memos, contracts) while aiming for precision to expedite the mainstream adoption of IDP solutions.

Recommended Reading:

- Forecast Analysis: Hyperautomation Enablement Software, Worldwide
- Magic Quadrant for Robotic Process Automation
- Product Roadmap Priorities: Content Services Platform Customer Satisfaction Drivers
- Forecast Analysis: Robotic Process Automation, Worldwide

- Emerging Technologies Venture Capital Growth Insights: Robotic Process Automation
- Product Manager Insight: Drive Growth From Hyperautomation With 5 Natural Language Technology Areas
- Market Share Analysis: Robotic Process Automation, Worldwide, 2020

Multimodal UI

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Analysis by Annette Jump

Description:

Multimodal user interface (UI) is a high-level design model in which user and machine interactions can occur simultaneously via a combination of various spoken or written natural language processing, as well as via touch (on a screen), with the ability to process data from various data sources beyond just text. These sources include images, video, tables, maps, audio, gesture, motion, myoelectric, brain-computer interface, and eye movement. Multimodal UI is enabling multiexperience in application development for users interactions on their digital journey across various touchpoints.

Sample Providers: Google Multitask Unified Model (MUM), NVIDIA Jarvis framework, Amelia, Kore.ai

Range: 1 to 3 Years

The range of one to three years for multimodal UI is driven by the rapid technology evolving from a niche emerging field to enabling multiexperience for users' interactions across various touchpoints on their digital journey. Multimodal UI is a next evolution stage of conversational UI (CUI) and can happen across enterprise applications, VAs, devices and IoT. Fusing vision, audio, voice and other inputs can support multiuser, multicontext conversations in various applications and dramatically change how humans do various complex tasks. The individual modalities enabling multimodal UI are quickly maturing, thus multimodal UI adoption is expected to accelerate very quickly in the next 12 to 18 months. By 2025, multimodal interactions will be a standard feature for virtual assistants (VAs), up from less than 2% in 2021. This technology would be enabled by amalgamation of various language technologies, computer vision, video, emotional AI, and gesture recognition.

Common use cases for multimodal UI include multiperson interaction environments, like in a meeting room or in a car (when you need to recognize different speakers), remote support/assistance use cases in noisy environments (such as on an oil rig or a busy train station), VAs for autonomous vehicles, and support human-machine interactions for people with disabilities via gaze detection and other methods.

Common challenges faced when using multimodal UI include conversational accuracy, and the ability to converge and process all or specific modalities data (like speech and voice, but not audio) and making them work together with open ecosystem solutions (while avoiding individual vendor lock-in solutions). Other challenges include multiturn and multi-intent recognition, the availability of context relevant training data, the need for specific hardware sensors, and cultural inertia.

Mass: High

The long-term impact of multimodal UI will be high, as it will transform all types of interactions between humans and machines, as well as enable more natural search and assist capabilities. The flexibility of combining various interaction modes within multimodal UI will enable them to be integrated into a wide range of enterprise applications, advanced VAs, mobile apps and human-machine interfaces for multitude of devices, consumer electronics, IoT and experiences. This will enable the ultimate potential for multimodal UIs to be vast and transformative and broadly impactful. The availability of frameworks from NVIDIA and Google will help accelerate and democratize the development of multimodal UI-enable experiences and applications across a broad spectrum of developers. The examples will include multiperson interactions in social venues or autonomous cars, or providing guidance based on voice authentication and visual feedback on the remote location.

Advancements in multimodal UI will result in new capabilities enhancing many existing capabilities (like sole reliance on text or voice), supporting the emergence of new technology providers and driving market consolidation among VA and natural language technologies (NLT)-solution providers in the next two to three years. Multimodal UI will coexist with other UI modes, like text or voice, for many applications in the next three to five years.

Recommended Actions:

- Enable more natural communications with your software, devices and IoT-enabled solutions by incorporating into your solutions selected adjacent technologies, such as computer vision, video support, emotion AI, and computer-generated imagery.

- Improve product differentiation and stickiness for your software products by identifying where multimodal UI can provide better guidance and experience, aggregating information from various data sources, and improving the intelligence of your VAs — or risk losing competitiveness in the next 18 months.

Recommended Reading:

- Emerging Technologies: Current and Future Capabilities of Advanced Virtual Assistants
- Emerging Technology Analysis: Differentiate Your User Experience With Human-Machine Interfaces
- Magic Quadrant for Multiexperience Development Platforms

Process Mining and Task Mining

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Analysis by Varsha Mehta, Cathy Tornbohm and Fabrizio Biscotti

Description:

Process mining is an analytical technique for discovering, monitoring, and improving end-to-end processes (and their subprocesses) by extracting knowledge from event logs readily available in information systems. Process mining is purpose-built to handle the dynamism and inherent complexity of the modern process environment. It offers objective, data-derived, fact-based visibility, and insights into the minutiae of existing individual business processes, which help audit, analyze, and improve these processes. Task mining, a subset of process mining, focuses on tasks which are smaller components of process or subprocess containing a number of steps. It involves inferring useful information from low-level event data available in UI logs to create insights into the process at task level. These UI logs describe the single steps within a task done by a user, for example, in using a workstation or based on keystrokes, mouse clicks and data entries. For more detailed definitions, see Market Guide for Process Mining.

Sample Providers*: ABBYY, Celonis, EdgeVerve Systems, FortressIQ, Lana Labs, IBM (myInvenio Process Mining), QPR Software, SAP-Signavio, Software AG (ARIS Process Mining), UiPath (UiPath Process Mining, UiPath Task Mining)

**Listing the offerings of a few vendors in the bracket to distinguish between process mining and task mining offerings. Vendors listed above may offer both these capabilities in one solution or as separate solutions.*

Range: 1 to 3 Years

We estimate the range to be one to three years because process mining and task mining are growing to be an essential part of organizationwide digital transformation initiatives. The core drivers for this growing essentialism include fast-paced evolution of intelligent automation technologies (AI, ML, deep learning) and their convergence with RPA and computer vision, increasing adoption of the hyperautomation driving solutions, COVID-19-induced increasing demands for operational resilience and the underlying application of these technologies in the bigger business mining scenario. Currently, the most predominant use case of process and task mining is targeted business improvements. However, their application is projected to increase in the areas of process automation (business process automation [BPA], RPA) and targeted digital transformation initiatives. Retail, telecom, and finance have been the early adopters, while other sectors — logistics, manufacturing, pharmaceuticals, and government — have just begun to step into the world of process mining and task mining-derived cost-saving automation.

According to Emerging Technologies: Venture Capital Growth Insights for Process Mining and Task Mining, VC investment in process and task mining technologies reached $431 million from January 2017 through December 2020, exhibiting a whopping three-digit CAGR of 117%. Considering that 46% of this investment is seed round or accelerator/incubator-based, the process and task mining market is still in a nascent stage. Even so, this push from rapid seed investments has propelled the global process and task mining market to grow by 37% in 2021, and this market is projected to grow at a CAGR of 19% from 2020 through 2025. In the near term, process mining adoption assisted by partnerships with system integrators and business process outsourcers that are looking to integrate process discovery and task mining capabilities into mainstream solutions will continue to accelerate the offering maturity and technology penetration.

Mass: High

Process mining is high impact because it can be applied in different areas of an organization, with five most common uses cases being — improving processes by algorithmic process discovery and analysis, improving audit and compliance by algorithmic process comparison, improving process automation by discovering and validating automation opportunities (using task mining), supporting digital transformation strategy by identifying correlation between operation and performances, and improving IT operations resource optimization (improvement of development and testing processes, preparation of migration processes, etc.).

Apart from process discovery, process mining is also quickly moving into the areas of conformance checking, process enhancement, productivity improvement and social media or organization mining. Its application has even spread into manufacturing, logistics distribution networks and IoT, which have clearly demonstrated the value-creating capabilities of process mining in terms of enterprise business process analysis, creation of the digital twin of the organization or processes, and so forth. Compared to the extended usability of process mining, the scope of task mining is fairly limited since it does not solve problems related to the end-to-end processes. Its goal is only to understand one activity in more detail, optimize, improve or automate these tasks or parts of it.

Development of massively scalable, easily deployable process mining solutions embedded with task mining capabilities and extended feature offerings, in combination with intelligent business process management suite (iBPMS), content ingestion and RPA solutions, can expedite the adoption of process mining solutions in large enterprises with complex and difficult business processes, as well as scale the adoption across midsize and small enterprises.

Recommended Actions:

- Focus on the integration of related process automation technologies, such as RPA and iBPMs, to enable end-to-end hyperautomation if you are an expanding process mining company.
- Explore niche markets and early-stage partnerships, particularly with system integrators and consultancies, to improve market competitiveness if you are an emerging process mining and task mining startup.
- Combine process and task mining techniques as complementary approaches to create better visibility, which will help drive the success of mining at both process and task level.

Recommended Reading:

- Emerging Technologies: Venture Capital Growth Insights for Process Mining and Task Mining
- Market Guide for Process Mining
- Discover the Differences and Use Cases of Process Mining Versus Task Mining
- Tech CEOs: Differentiate RPA Products via Process Mining and Robotic Process Discovery
- Emerging Technologies Venture Capital Growth Insights: Robotic Process Automation

Packaged Business Capabilities

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Analysis by John Santoro, Yefim Natis

Description: Packaged business capabilities (PBCs) are encapsulated software components that represent a well-defined set of business features that are recognizable as such by a business user. By delivering product functionality as PBCs, providers can enable their customers to implement the composable enterprise, in which customers buy the individual capabilities they need from providers, then create custom application experiences, perhaps by using low-code tools.

Sample Providers: commercetools, Contentful, Elastic Path, Mambu, SAP

Range: 1 to 3 Years

We estimate a range of one to three years because the promise of the composable enterprise will drive customers to demand that technology providers offer their solutions as PBCs. Many vendors have modularized their offerings — for example, vendors providing e-commerce tooling and digital experience platforms — but they do not provide a simple means to do assembly, composition or orchestration. Currently, most have APIs, and many have exposed APIs to customers and partners.

Although smaller providers and providers transitioning from older technologies still find themselves in the earliest stages of API adoption, customer demand is propelling PBC creation among providers. Even among providers that do offer APIs, few offer them as PBC UIs, event-based APIs or policy-based access via API management. Moreover, providers that offer a traditional end-user-oriented solution along with APIs need to license APIs so that they can be used without first licensing the UI. The need to license PBCs differently — and the need to deliver APIs as a product in terms of documented interfaces, support and product roadmaps — will slow the adoption of PBCs.

Mass: Medium

We assess the mass as medium because for enterprise software providers, PBCs typically represent a repackaging of existing capabilities. As a result, the incremental effect on product implementation will be small. However, the widespread implementation of the composable enterprise will transform the way that traditional providers market, sell and deliver their solutions.

Recommended Actions:

- Enable enterprise application customers, such as those using CRM, ERP, human capital management (HCM), and supply chain management (SCM), to better meet their custom application needs by providing applications as collections of PBCs. As part of delivering PBCs, ensure modularity, APIs, and simple means to do assembly, composition, and orchestration.
- Ensure consistency among applications sold to end users and applications sold as PBCs by reconciling packing, pricing, and positioning so that customers can use product capabilities without purchasing end-user (“seat”) licenses.

Recommended Reading:

- Future of Applications: Delivering the Composable Enterprise
- Innovation Insight for Packaged Business Capabilities and Their Role in the Future Composable Enterprise
- Emerging Technology Analysis: Productize APIs to Increase Product Value, Adoption and Innovation

Remote Collaboration

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Analysis by Craig Roth

Description:

Remote collaboration is the practice of working on joint, purposeful and often goal-oriented activities with others while not colocated. While workers have always had to collaborate with distantly located peers, each successive driver (virtual collaboration tools, cloud-based collaboration and the COVID-19 pandemic) has amplified interest. The remote collaboration trend results in changes in hiring practices, key business processes and technologies. These allow people to work together through shared online workspaces to coalesce tools, applications, artifacts and communication channels.

Sample Providers: Bluescape, Box, Dropbox, Dynamic Signal, Google Workplace, Microsoft Teams, Slack, Workplace from Facebook, Zoom

Range: 1 to 3 Years

The desire for virtual remote collaboration predates the SaaS-based options available today. Early usage was normally limited to applications usable via dial-up connections for road warriors or remote support. Remote collaboration has been made possible for many types of workers through advances in cloud office and productivity technologies that are accessible from phones, tablets and smart speakers instead of being tethered to a laptop.

However, changes in business processes and user behavior have lagged the capabilities of the software. We now assess the range for remote collaboration to be one to three years due to an immediate recognition of the value (although with an eye to the new challenges) of remote collaboration when workers were sent home due to COVID-19. There was a significant spike in adoption of remote collaboration, particularly video which is being sustained in the shift to a hybrid work model. Buyers seem primed, but historically, the goalposts for remote collaboration have gotten pushed back whenever it seemed like majority adoption was imminent.

Mass: Medium

The trend toward increasing amounts of remote collaboration impacts a wide array of markets. Direct impacts are felt across productivity markets such as workstream collaboration, employee communications applications, collaborative authoring and content collaboration tools. And indirect impacts hit any application or infrastructure software that may need modification to properly support a remote workforce. These indirect impacts include anything from customer relationship management to employee monitoring tools to mobile device management. While not explicitly created for remote collaboration, these products will ride the increasing wave of interest.

For the most part, supporting remote collaboration is only an incremental addition to existing product capabilities. Intranet platforms and office suites need to keep up with the state of the art in new desired forms of remote collaboration such as workstream collaboration and accessibility through natural language, personal assistants. For enterprise applications, it may mean adding functionality to orchestrate collaborative activities around key business processes such as capturing discussion and feedback around data or content entered into a system. It could also include making applications more device friendly so that they can be accessed at home or while traveling.

Recommended Actions:

- Enhance transactional capabilities with features that support the human collaboration required to complete them. Observe users and the content and communication that takes place around the data entered into your systems. Then consider how the content and communication can be provided in context of the business process they support.
- Increase the priority of roadmap features that enable remote collaboration. Recognize that when users provide prioritization input, they often underestimate the value that collaboration can provide (due to overestimating the effectiveness of workarounds such as email).

Recommended Reading:

- Forecast Analysis: Remote and Hybrid Workers, Worldwide
- Forecast Analysis: Social and Collaboration Software in the Workplace, Worldwide
- The State of Team Collaboration: Remote vs. Hybrid vs. On-site
- Forecast Analysis: Remote Work IT Spending, Worldwide

3 to 6 Years

Hyperautomation in Software

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Analysis by Cathy Tornbohm

Description:

Hyperautomation refers to a combination of tools that can integrate functional and process silos to automate and augment business processes. Gartner has named hyperautomation among the top 10 strategic trends for 2021 (see Top 10 Strategic Technology Trends for 2021) and sized the software market that will support this trend (see Forecast Analysis: Hyperautomation Enablement Software, Worldwide).

Hyperautomation toolbox includes a wide array of technologies for structured and unstructured content ingestion, process mining and task mining to integration support like iPaaS, RPA, and business process management (BPM), workflow engines, decision management suites, process mining, LCAPs and others. This big picture is explained in see Market Trends: RPA Morphing Into Hyperautomation.

Sample Providers: No one provider has all the elements needed to perform all of hyperautomation, so vendors include a very broad array of process capture, integration and content ingestion software. Many well-known large providers and building up software portfolios to support this wide collection of needs, see The Future of RPA in 2025. In addition there are new entrants of smaller providers in hyperautomation enabling software, such as AltViz, SKAEL, Indico, Stereologic, FortressIQ, Datamatics, Enate.

Range: 3 to 6 Years

The philosophy of hyperautomation is that everything that can and should be automated will be automated. This means that the range of software that providers can offer in this topic will ramp up over the next three to six years until the full offerings combining at components of hyperautomation technological capabilities improve. We assess the range to be three to six years because the full suite of hyperautomation technologies are not yet mature. There are three main types of hyperautomation: content ingestion, integration and process visibility. Multiple technologies are needed to support ingestion of structured and unstructured data and technology to move this data effectively around organizations. On the ingestion side, structured and unstructured documents need to be converted from paper and relevant data that has been reliably extracted. For moving data components of hyperautomation, it is notably intelligent business process management suites (iBPMS), iPaaS, low code application platforms and RPA. RPA and iPaaS are experiencing notable adoption over the past few years, notably in banking and insurance, manufacturing and from services industries, such as consulting, IT outsourcing (ITO), and business process outsourcing (BPO).

Common challenges when using hyperautomation include misconceptions relating to the functionality of tools and where organizations should look to source that activity. That is when the functionality comes as part of their existing suite of enterprise applications that add new documents ingestion, process visibility and business process management capabilities or specialist tools for each topic will continue to be used.

Mass: Very High

We assess mass to be very high because every large and medium organization in the world has to have a hyperautomation strategy to ingest data and build integration strategies. Hyperautomation capabilities to address multiple business processes across all organizations means that there are still several years before all tooling elements of hyperautomation are considered a mature majority technology. Common use cases for hyperautomation are found in most front-, middle and back-office processes, predominantly customer onboarding, order taking, payments and customer data updates, which are typically highly manual. In addition, regulatory compliance, employee onboarding, and product tracking across supply chain systems for retail and manufacturing, as well as tracking for transportation and logistics.

Recommended Actions:

- Calculate how hyperautomation trends will enhance your offering as it will impact every type of enterprise software.

- Focus on clear messaging to explain what your tool's functionality is in business terms. Focus on articulating value in business terms like speed to ROI, improved process speed, and reduced costs — and try to avoid talking too much about AI as no one knows what it is. Competition for how to solve similar problems will be rife, and your story needs to stand out in business benefit terms.
- Establish partnerships for where your tool complements other hyperautomation solutions as your marketing budget and your functionality alone are not likely to meet all the needs of the hyperautomation market and reach all the potential buyers. Being part of an ecosystem is a great scheme to build traction.

Recommended Reading:

- Communicate Hyperautomation Product and Service Value Using a Maturity Diagnostic Model
- Communicate the Value of Hyperautomation Using ROI
- Forecast Analysis: Hyperautomation Enablement Software, Worldwide
- Product Manager Insight: Drive Growth From Hyperautomation With 5 Natural Language Technology Areas
- Emerging Technologies and Trends Impact Radar: Hyperautomation

AI-Augmented Software Engineering

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Analysis by Mark Driver, Arun Batchu

Description:

AI-augmented software engineering is the use of AI technologies such as ML, NLP and similar technologies to aid software engineering teams in creating and delivering applications faster, at lower effort and cost, and with higher quality. AI-augmented software engineering (AIASE) commonly integrates with an engineer's existing tools to provide them with real-time intelligent feedback and suggestions.

Unlike previous AI technologies that were brittle and static, today's AI technologies are general-purpose technologies and adaptive. They are transformative, just like steam and electric technologies were in their era. However, unlike steam and electric technologies, today's AI technologies increase in their capabilities proportional to the amount of data and computing capacity available to them.

Sample Providers: Amazon, Microsoft, OutSystems, Diffblue, Functionize, IBM, Kite, Mendix, Scopemaster

Range: 3 to 6 Years

While they have emerged among early adopters today, AIASE technologies are expected to reach mainstream adoption within three to six years. Propelled by the rapid growth of software code, the data generated by digital applications and cloud computing, these AI machines will gain capabilities that will transform the software development life cycle. We expect the technology to pass through three stages. The first and current stage is where AI is able to help as an apprentice, suggesting code fragments. The next stage is where the AI becomes smarter to act like a peer to the developer. The third stage is the lead expert stage where the AI generates entire applications, with the designer, developer, and tester tweaking as necessary.

Mass: HighWe assess the mass impact of AIASE to be high in coming years because various AIASE innovations will emerge across the *entirety* of the software development life cycle, in some areas this will be faster and in more depth than in others. For example, today, several AIASE innovations are emerging that show strong potential to disrupt modern application development. AIASE is enabling creative business problem-solving by automating boilerplate software engineering tasks. It is increasing developer velocity by recommending highly relevant code and library recommendations in a fraction of the time it would take otherwise. It is augmenting quality and testing engineers by allowing tests to self-heal and by automatically creating tests. In addition, market leading and innovative intelligent process management platforms (such as iBPMSs), business rule management systems, and decision management suites incorporate AI capabilities to support decision management and integrate with predictive analytics technologies.

In particular, the use of AI to build other AI models is increasing the ability of enterprise employees to create models that add value to applications and data in the business. We see this in the popularity of low-code tools that aim to increase productivity by reducing or avoiding the need for specialist "code" by scarce data scientists and developers. For example, In Microsoft's announcement of the integration of the AI model GPT-3 into its Power Apps low-code development tools, we see the convergence of AIASE with other developer productivity improvements. Finally, development and quality assurance in organizations are leveraging ML combined with NLP to provide a set of services based on large-scale source code analysis. "ML on source code" innovations have applications in several areas, including intelligent code completion, automated peer review, automated coding convention compliance, source code conversions and others.

Recommended Actions:

- Explore the AI-augmented software engineering features applicable to your products/services available today by focusing first on developer "quality of life" enhancements as a starting point.
- Account for significant changes and advances to the breadth and depth of AIASE capabilities over the next three to six years and proactively plan to make product/service "course corrections" to align with customer expectations.
- Incorporate AI-augmented software engineering into a broader software hyper-automation development strategy to fully exploit the potential of the technology with most long term industry impact.
- Build a roadmap for advancing AI-augmented product development strategies over time, leveraging both team practices (such as test-driven development and behavior-driven development techniques) and cloud services (AutoML).

Recommended Reading:

- Innovation Insight for AI-Augmented Development
- Hype Cycle for Software Engineering, 2021
- Infographic: Artificial Intelligence Use-Case Prism for Software Development and Testing
- Emerging Technologies: Critical Insights Into AI-Augmented Software Development

Collaborative Ecosystem Product Development

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Analysis by Balaji Abbabatulla

Description:

Collaborative ecosystem product development involves partnering with several, sometimes competing, vendors to develop new solutions. Such collaboration is strategic and aims to impact business outcomes over a period of time by delivering a series of solutions. Collaborative ecosystem product development (CEPD) enables product managers to both develop and deliver innovative solutions cost-effectively and frequently.

Sample Providers: Microsoft, Oracle, IBM, SAP, Salesforce, Blue Yonder, Adobe, Genesys

Range: 3 to 6 Years

We estimate that the early majority will use CEPD within a three to six year period because of the widespread support by application software vendors.

The top five software application vendors — Microsoft, Oracle, SAP, IBM, and Salesforce — worldwide support product partnerships. Leading vendors in fast-growing application markets have also been using product development ecosystems to develop and deliver innovative solutions. However, current product ecosystem partnerships are largely opportunistic, tactical relationships. A lack of robust governance models and transparent commercial frameworks discourages vendors from using CEPD to develop strategic solutions.

Changing buyer expectations about rapid impact on business outcomes will require vendors to develop solutions using capabilities beyond their internal resources. This will lead to an increase in the strategic solutions developed using CEPD, resulting in adoption by the early majority within three to six years.

Mass: High

We estimate that a number of industries, markets, and business functions will be impacted by CEPD solutions replacing existing product development methodologies over time.

The underlying architecture of a CEPD solution enables easy replacement of a set of modules delivered by one combination of vendors to another combination. This improves extensibility of solutions across multiple industries by replacing the vendor combination with a combination that is more appropriate for the new industry.

Enterprise software product leaders can improve business agility by quickly packaging the most appropriate product capabilities that are required to support a customer's new business strategy. The solution architecture includes several product capabilities required to fulfill a specific business outcome. The solution is designed to create a higher impact than the sum of the modules contributed by the ecosystem participants. The pace and the impact of CEPD solutions will replace and transform existing product development methodologies.

Recommended Actions:

- Use CEPD to develop strategic solutions as an alternative to traditional product development methodologies to deliver innovative solutions frequently.
- Improve trust among partners by defining a robust governance model, and align distribution of customer revenue to participants based on their roles and responsibilities.

Recommended Reading:

- Rebound Quickly From the Current Downturn by Using Collaborative Ecosystem Product Development
- Market Insight: How Product Managers Can Leverage Application Software Provider Ecosystems to Deliver Rapid Innovation
- Emerging Technology Analysis: Application Ecosystems Accelerate Software Product Innovation and Value
- Market Insight: How to Prioritize Your Product Roadmap Features by Using a Value Map to Gain Competitive Advantage

Democratization

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Analysis by Fabrizio Biscotti, Bindi Bhullar

Description:

The democratization trend is about providing universal access to technical capabilities and business domain knowledge to improve people's skills and to leverage, for instance low-code technologies. Democratization is not categorized as a technology — it is "driven by" or "supported by" technology, and it should be categorized as a behavioral trend. Democratization provides all people (who might be able to use the capability or data) with access to technical capability (e.g., ML and application development) or business domain knowledge (e.g., sales process and economic analysis). Democratization relies upon technology that offers a radically simplified experience and does not require extensive and costly training. In fact, economics is also part of democratization — if the cost is prohibitive, then the technology cannot be used for simple problems. Raspberry Pi, cloud services, and open-source software are all examples of democratization too. The notion of "citizen technologists" (e.g., citizen data scientists and citizen integrators) as well as the evolution of the Citizen Developer and no-code models are examples of democratization. Expert systems and VA are important aspects of enabling democratization by making technology easier to use through automated and integrated advice, action, and analysis. These systems provide advice, action and analysis for people to extend their knowledge or expertise beyond their experience or training.

Sample Providers: Apple, Arduino, Google, Kintone, Microsoft, Raspberry Pi Foundation, Smartsheet, Slack, Workato, Zoho

Range: 3 to 6 Years

Business technologists want to create and execute their own ideas to drive more automation across their business applications and workflows. Low-code development technologies, and particularly ones targeting citizen automation and development use cases, will play an important role in supporting hyperautomation (see Infographic: Boost the Value and Success of Business-Driven Hyperautomation Initiatives). A Gartner hyperautomation survey found that 55% of business technologists work on more than four distinct automation initiatives in the past year using a variety of tools, including low-code and no-code development tools

The target for the democratization trend could be any person inside or outside the enterprise. This could include customers, business partners, corporate executives, salespeople, assembly line workers, professional application developers, and IT operations professionals. For example, democratization can be a marketing tool packed with AI capabilities allowing a nonmarketing employee to quickly set up a campaign to discover potential customers (a good self-service SaaS tool is also democratization).

Mass: High

We assess mass to be high because the growing level of technology competence in the workforce consumerization of technology is leading to higher capability and higher expectations for self-service within the workplace.

TSPs have responded to this market dynamic by providing technology and tools that enable and support the democratization of traditional IT capabilities. For example, these include the expansion of integration and development delivery to less technical employees through iPaaS and low-code application platform offerings that drive productivity and time-to-value gains. Gartner predicts that by 2025, 75% of large enterprises will be using at least four low-code development tools for both IT application development and citizen development initiatives. Common democratized roles include citizen integrators and citizen developers.

Recommended Actions:

- Invest in tools that better support ease of use for nontechnical users through AI-driven wizards, processes, recipes, and templates.
- Embed democratization thinking and design across products, starting by soliciting and collecting insights from a broad range of citizen technologists.

Recommended Reading:

- Forecast Analysis: Low-Code Development Technologies
- Manufacturing CIOs Should Accelerate Digitalization With Democratization of Development
- Presentation: Democratized Technology Delivery: The CIO's New Opportunity to Boost the Value of IT
- Risk and Opportunity Index: Low-Code Application Platforms

Cloud ERP Suites for Product-Centric Enterprises

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Analysis by Chris Pang, Tim Faith

Description:

Cloud ERP suites for product-centric enterprises provide operational (manufacturing and operations plus enterprise asset management) functionality and administrative ERP functionality (financial management plus HCM) in a unified solution. These can be delivered via public or private cloud infrastructure.

Sample Providers: SAP, Oracle, Microsoft, Infor, Sage

Range: 3 to 6 Years

We estimate a three to six year time horizon due to the emerging nature of operational ERP workloads in the cloud. For some vendors functional parity of manufacturing, operations and enterprise asset management in the cloud still lags or has only recently reached functional parity with on-premises equivalents. To gain mainstream adoption, functionality needs to be more than equivalent; it must be enhanced and differentiated to encourage buyers to migrate.

Another technical barrier still needing resolution is the ability to patch and upgrade systems with zero downtime for customers. This is important for product-centric industries that often have enhanced compliance needs and/or 24/7 operations. So they cannot be offline (even temporarily) for system patching and upgrades without significant planning in advance. Advances in cloud technology and the use of hyperscalers is lowering downtime, but it is not yet at zero.

Mass: Medium

This is a medium mass due to project centric industries (companies which make and distribute products) being a sizable customer catchment, but one which isn't applicable to all businesses.

The global COVID-19 pandemic in 2020 accentuated already known issues with legacy on-premises ERP (e.g., difficulty to change configurations, add new functionality and scale performance). This has accelerated interest in new cloud ERP systems, as organizations realize the cost benefit of deferring agility and ERP investment no longer holds. Indeed, as the pandemic has shown, business and systems agility can make a substantial difference in how well businesses can cope. In parallel, providers have improved functionality, maturity, and can offer greater flexibility for customers to take upgrades at a more appropriate time for the business.

Recommended Actions:

- Accelerate market appeal and adoption by adding extension and hyper automation capabilities. These are low-code/no-code toolkits and extensions that allow customers and partners to create last-mile functionality and customizations (also known as PaaS).
- Create packaged integration with commonly used complementary applications to reduce implementation cost and ongoing maintenance overhead for customers
- Improve the appeal and practicality of cloud ERP suites for product-centric enterprises by working toward zero downtime for upgrades and patching.

Recommended Reading:

- Hype Cycle for ERP, 2021
- Magic Quadrant for Cloud ERP for Product-Centric Enterprises
- Coordinate Agile Application Delivery With Traditional Release Management for ERP
- Two-Tier ERP: A Useful, Composable ERP Strategy for Complex Organizations

Graph

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Analysis by John Kostoulas, Alys Woodward and Robin Schumacher

Description:

Graph technologies encompass a wide variety of solutions that work with data represented as a set of nodes and edges instead of tables, rows and columns. It allows us to find relationships between people, places, things, events, locations and so forth across diverse data. Graph technology is forming the foundation of many modern data and analytics (D&A) capabilities. Increased understanding and collaboration with business users, organizing and preparing data for downstream processes, uncovering hidden insights, governance, security, improving ML model creation, and providing explainable AI are just some of the use cases driven by different graph technologies and techniques.

Sample Providers and/or Products: Amazon, ArangoDB, Cambridge Semantics, Datastax, MarkLogic, Neo4j, Redis RedisGraph, Stardog, TIBCO Graph Database, TigerGraph

Range: 3 to 6 Years

We have moved the range to be three to six years due to the increased buyer and vendor interest in this technology. Gartner inquiry volume and interest in graphs has risen by 280% from October 2018 through October 2020. Graph is becoming an integral part of data management technologies including data integration, metadata management, master data management, data catalogs, data analysis, and data stewardship.

New vendors continue to enter the market as cloud providers offer solutions, and both highly mature and more recent DBMS, data management and analytics products often embed either complete graph databases or graph functions to augment traditional database functionality. A number of vendors in the advanced analytics platforms, metadata management, and master data management space have introduced graph DBMSs as back ends. Vendors have begun offering packaged analytic applications for specific use cases (e.g., matchup of people and skills, and recommendation of relevant media content). More than 30 market solutions based on graph databases are now available.

Mass: Medium

We have assessed mass to be Medium because of a wide range of use cases that start to get supported. COVID-19 spiked the interest in graph analytics to more than 90% in healthcare management, clinical research and healthcare supply chains. Specific use cases that require analysis across an exponentially larger amount of heterogeneous data drive interest in graph analytics. Such highly complex models are developed and used in ML with the output stored in graph databases. Other areas for graph analytics include fraud detection, cybersecurity, supply chain optimization, customer 360, social network analysis and workforce analytics.

Graph technologies augment the DataOps process, enabling an enhanced view of data interconnectivity across disparate data management technologies. Graph analytics may include SQL interfaces to graphs that limit the need for specialized skills. Open-source projects continue to gain traction and compete with proprietary offerings for first projects as open-source options and standards may reduce the need for multiple proprietary skill sets. Improved, scalable and lower-cost processing options, including cloud-based services and dedicated hardware, are making graph analytics and databases prime candidates for accelerated adoption

Recommended Actions:

- Leverage graph technology to optimize solutions for high-value analytics use cases where traditional SQL-based queries and visualizations are too time-consuming or compute-intensive.
- Integrate graph capabilities with your data management and analytics offerings to support additional types of data and exploration use cases and improve adoption and loyalty with your customers, including a growing number of business users.
- Integrate knowledge graphs in enterprise applications to add value and support decision making for the users. Because the data modeling and API learning curve for graph can be lengthy in some cases, choose small, less visible projects when introducing graph technology to the enterprise.
- Embed graph analytics capabilities from other providers rather than building the capability yourself if you are not expert in this technology. Consider pure players along with established database providers with graph capabilities.

Recommended Reading:

- Top Trends in Data and Analytics for 2021: Graph Relates Everything
- Graph Technology Applications and Use Cases
- Graph Steps Onto the Main Stage of Data and Analytics: A Gartner Trend Insight Report
- Market Guide for Graph Databases

NVMe/TCP

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Analysis by Roger W. Cox

Description:

Nonvolatile memory express over TCP (NVMe/TCP) is an innovative networking protocol that incorporates a parallel architecture to accelerate input/output operations per second (IOPS) and to optimize latency among computing and shared ECB enterprise storage arrays. NVMe/TCP is a high performance replacement for legacy Small Computer System Interface (SCSI)-based Fibre Channel (FC), Serial Attached SCSI (SAS), and Internet SCSI (iSCSI) networking protocols that are now widely deployed to support storage area networks (SANs). Full compatibility with standard Ethernet protocol enables users to deploy NVMe/TCP across an Ethernet network made up of commodity adapter cards and network switches.

Sample Providers: Excelero, Infinidat, Intel, Lightbits Labs, Marvell, NVIDIA, Pavilion Data Systems, Xilinx

Range: 3 to 6 Years

We assess the range to be three to six years because NVMe/TCP is just now becoming available as a deployable networking protocol to support SAN infrastructures. It must compete with other, more established, NVMe over fabrics (NVMe-oF) protocols including NVMe over Fibre Channel (NVMe/FC), NVMe over remote direct memory access over converged Ethernet (NVMe/RoCE), and NVMe over Internet Wide Area Remote Direct Memory Access Protocol (NVMe/iWARP). The NVMe/TCP cost-performance advantages over the other more widely TSP-supported NVMe-oF offerings are yet to be fully validated.

Noting that an increasing number of next-generation data centers and edge deployments are based on Ethernet network technology, the pace of mainstream adoption will depend on how quickly across-the-stack development in the NVMe/TCP ecosystem occurs. The ECB enterprise storage vendors with the largest SAN-based installations have yet to incorporate NVMe/TCP in their software stack. However, VMware, along with leading ECB enterprise storage vendors have signaled that they will announce support for NVMe/TCP in the coming months.

Mass: Medium

SAN infrastructures based on the iSCSI protocol are preferred early targets for NVMe/TCP. Compared with the iSCSI protocol, NVMe/TCP not only provides an order of magnitude improvement in latency performance but can be deployed on existing Ethernet technology.

As a networking protocol for SAN-based infrastructures, NVMe/TCP reflects solid technology. Advances will be made in deployment use cases. Compared with iSCSI, NVMe/TCP enables more virtual machines (VMs) to be deployed on a physical server, leading to additional infrastructure cost reduction. NVMe/TCP presents a more favorable cost structure compared with Fibre Channel-based storage area networks (SANs) without sacrificing IOPS and latency performance.

Recommended Actions:

- Broaden the cost/performance appeal of your ECB enterprise storage array for primary storage workloads by qualifying its operating system to support the NVMe-TCP/IP networking protocol.
- Enable your integrated compute/storage solutions to optimally serve the low-latency needs of an edge infrastructure by incorporating the cost-effective NVMe-TCP/IP networking protocol in your operating software.

Recommended Reading:

- Meeting the Storage Needs of Midsize Enterprises
- Competitive Landscape: Innovative All-Flash Array Offerings Architected for the Data-Centric Era
- Positioning Your External Enterprise Storage Offerings for Growth
- The Critical Attributes an External Primary Storage Product Must Include
- Hype Cycle for Storage and Data Protection Technologies, 2021

Quad-Level Cell (QLC) 3D NAND Flash

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Analysis by Roger W. Cox

Description:

Storing four bits per cell, quad-level cell (QLC) 3D NAND flash is the most cost-effective shipping incarnation of 3D NAND flash memory technology. Relative to its most recent predecessor, triple-level cell (TLC) 3D NAND flash, QLC increases the density of a single NAND chip by 33% while further reducing the price per gigabyte by roughly 20%, depending on yields. However, QLC has roughly one-third the write endurance of TLC and is, therefore, more suitable for read-intensive and low frequency write workloads such as AI, ML and data streaming. Also, QLC flash has considerably higher write latency and — to a lesser extent — has higher read latency compared with TLC.

Sample Providers: Intel, Kioxia, Micron Technology, Samsung, SK Hynix, Western Digital

Range: 3 to 6 Years

We assess the range to be three to six years because the rate of QLC 3D NAND flash adoption will be influenced by two related events. As NAND flash pricing fluctuates, QLC must sustain, if not improve, its pricing distance to TLC 3D NAND flash. The development of QLC to enable capacities beyond 32 terabytes (TB) will enhance QLC as an alternative media to hard-disk drive (HDD) technology in the secondary storage market supporting performant-oriented workloads associated with unstructured data.

QLC 3D NAND flash technology traction is progressively broadening adoption with leading solid-state array (SSA) providers. Using innovative and advanced controller design and system management to overcome the QLC inherent write endurance issue, IBM integrates QLC 3D NAND flash technology in its performant FlashSystem SSA offerings. VAST Data incorporates QLC 3D NAND flash technology with Intel Optane storage class memory (SCM) to provide a cost-effective, high-capacity, performant SSA. Pure Storage deploys QLC 3D NAND flash technology in FlashArray//C SSA model. NetApp's FAS500f offering incorporates QLC 3D NAND flash technology to support high-capacity performant opportunities. While other leading SSA providers have QLC 3D NAND flash technology in their roadmaps, several other SSA providers including, Excelero, Lightbits Lab, Pavilion Data Systems, and StorONE, support QLC 3D NAND flash drives with their offerings.

Mass: Medium

The enterprise SSA market is expected to be a key driver for quad-level cell adoption, with high capacities and innovation keeping it a focal point for all NAND vendors. Releasing QLC 3D NAND models with a capacity of more than 32 TB per drive will have three positive effects on existing capabilities. First, higher capacity models enhance the competitiveness of QLC compared with HDD technology in read-heavy workloads requiring IOPS and latency performance beyond the capability of HDD technology. Second, higher capacity models elevate the attractiveness of QLC, in partnership with storage class memory (SCM), to cost-effectively support primary storage workloads relative to competing platforms based on higher cost TLC 3D NAND technology. Third, QLC 3D NAND flash represents an increasingly cost-effective alternative to legacy HDDs for secondary workloads where IOPS and latency are not key evaluation attributes.

Recommended Actions:

- Optimize the read performance of your AI and ML applications by specifying QLC 3D NAND flash media to cost-effectively support the latency requirements associated with randomly scanning millions of small files during the training phase.
- Elevate the performance attributes of your block, scale-out distributed file and object storage software offerings by qualifying them for deployment on storage platforms that incorporate QLC 3D NAND flash media technology.

Recommended Reading:

- Forecast Analysis: NAND Flash, Worldwide
- Forecast: NAND Flash Market Statistics, Supply and Demand, Worldwide, 2018-2025, 2Q21 Update
- Market Share: Solid-State Drives, Worldwide, 2020
- Leverage Storage Drive Media Technology to Create a Flexible Secondary Storage Portfolio

Service Mesh

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Analysis by Wataru Katsurashima

Description:

Service mesh is a distributed computing middleware that optimizes communications among application services, especially microservices. With microservices architecture, applications are composed of independent components that are deployed as distributed services that are typically ephemeral and dynamically scalable. These microservices require a distributed middleware that optimizes service-to-service communications (e.g., dynamic discovery and self-healing connections) and service instrumentation in a secure, dynamic and reliable fashion — and this is what service mesh enables.

Sample Providers: AWS, Buoyant, Google, HashiCorp, Kong, Microsoft, Red Hat, Solo.io, Tetrate, VMware

Range: 3 to 6 Years

Service mesh is not mature enough to be widely used by mainstream enterprise customers yet. Gartner estimated that market penetration was only 1% to 5% of the target audience as of July 2021 (see Hype Cycle for Cloud Computing, 2021). This means most users of service mesh are early adopters at the moment.

Gartner observes early adopters sometimes complain about operational and administrative complexity of service mesh, which is why we assess the range to be three to six years. For mainstream enterprises, its user experience needs to evolve to be simpler. In that sense, the integration of service mesh with container management offerings can be a major driver of service mesh adoption. Most major container management offerings have already integrated service mesh. Many enterprise organizations are expected to start using service mesh through and with container management offerings rather than deploying it separately.

Mass: Medium

Although service mesh is at an early stage of the technology life cycle, some open-source technologies are quickly gaining popularity among vendors. As for the data plane, Envoy has been broadly adopted by various service mesh offerings. Gartner believes Envoy is a de facto standard data plane, at least for Kubernetes environments. As for the control plane, it is too early to say which technology will be a common option. However, Istio has been adopted by more than half of the major container management software vendors. Linkerd from Buoyant and Consul from HashiCorp are other control plane technologies with a high adoption rate.

Service mesh complements, rather than replaces, traditional technologies. Service mesh is typically used for service-to-service traffic (east-west traffic) rather than for traffic between API consumers or back-end services (north-south traffic). That is because traditional gateway technologies (e.g., enterprise gateways and microgateways) do not fully address the needs of east-west communications between miniservices and microservices (see How a Service Mesh Fits Into Your API Mediation Strategy). Service mesh is not necessary if there is little east-west traffic, for example, when services are deployed on application servers.

Recommended Actions:

- Differentiate from other service mesh offerings that use the same open-source technology by delivering the service mesh technologies as DevOps and security-engineer-friendly solutions. Examples include integrating observability and security tools and enabling integrated policy management with other API mediation technologies.
- Mitigate the customer's concern about interoperability of vendor offerings by supporting federated clusters in hybrid cloud and multicloud environments, and driving conformance and standardization with other vendors.

Recommended Reading:

- Emerging Technologies: Service Mesh Is Being Pushed by Containers and Key Open-Source Projects
- Competitive Landscape: Container Management (Software and Cloud Services)

6 to 8 Years

AI-Generated Composite Applications

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Analysis by Jim Hare

Description:

AI-generated composite applications reflect the future generation of the composable business. A composable business is an organization that delivers business outcomes and adapts to the pace of business change. AI-generated composite applications are built using AI without a human application developer enabling more dynamic personalized experiences seamlessly across channels. The AI is context-aware and can determine a specific need based on a user action or a business situation and automatically build and orchestrate the application using PBCs as the building blocks. The application may exist permanently or until no longer needed.

Sample Providers: No vendors so far.

Range: 6 to 8 Years

We assess the range to be six to eight years. The technology to enable applications to be composed from building blocks exists today in the form of APIs. But most business applications today are static and monolithic and need to be decomposed into PBCs to achieve real reusability — both from inside and outside organizations. The ability to self-integrate is beginning to emerge from some integration vendors for specific vendor application suites, but none has yet combined all the elements successfully. The lack of standards and PBC cataloging capabilities are additional inhibitors. Until these challenges are addressed, AI-generated applications that can be automatically created and deployed are still some way off.

Mass: High

We assess mass to be rated high because composite applications will have an impact on nearly every industry and business function, especially in consumer-focused industry verticals. Organizations need to deliver innovation and adapt more quickly to respond to the accelerating pace of business change and market dynamics. Customers and employees increasingly expect more contextualized and personalized application experiences. To deliver on digital transformation, organizations will need applications that can be assembled, reassembled and extended. This will require a seismic shift in organizations deploying applications to building business capabilities and application experiences. AI-generated composite applications will help address this shift by making the composable experience more scalable and dynamic than manually composing applications using humans. Gartner is not aware of any vendor AI-generated composite application offerings in the market. Vendors that start planning offerings that move from static, monolithic applications to PBC that use AI to dynamically compose applications will have the first-mover advantage.

Recommended Actions:

- Refactor your software into discrete packaged business components and APIs that make it faster to create new applications and user experiences.
- Study and evaluate the multiple ways AI can be used by understanding the application user needs and what packaged capabilities are required, and by building and orchestrating the application services.
- Search for use cases where significant time savings or contextualized experiences can be delivered to users by automatically generating applications on-demand.
- Incorporate AI capabilities that can determine user needs and context to automatically build and deploy a custom application. Use AI to determine when the user no longer needs the application and spin down.

Recommended Reading:

- Future of Applications: Delivering the Composable Enterprise
- Innovation Insight for Composable Modularity Of Packaged Business Capabilities
- How to Design Enterprise Applications That Are Composable by Default

Converged Business and Productivity Applications

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Analysis by Craig Roth, Dennis Gaughan

Description:

Converged business and productivity applications are single, process-based or task-based solutions that combine business applications (process-aware applications such as ERP and CRM) and productivity applications (general-purpose applications such as email, persistent chat, content creation, and content management). Historically, there has been a clear line between these two areas for the same process, as they have separate origins, sponsors, owners, and often vendors. The COVID-19 pandemic and the shift to remote work shone a bright light on the need for new ways of expected user experience. Each user would stay "in the flow" of their work and would not notice or care where one application ends and another begins. Initial efforts may not go much deeper than "on the glass" (from the user's point of view) integration, but can extend over time to the back end as well.

Sample Providers: Headless business apps (Unit4, Elastic Path, commercetools), WorkJam Everywhere and business-collaboration partnerships such as Salesforce/Slack and Microsoft Teams and SAP.

Range: 6 to 8 Years

Technical barriers around integration are decreasing as SaaS becomes a common delivery model. But we assess that it will take more than six years to become moderately commonplace since buyers will be slow to envision converged business and productivity applications as a solution to be demanded. But there is hope as composable business has entered their radar and vendors such as Google and Microsoft are normalizing the idea of decreasing task switching between applications with a common canvas. Business buyers and owners, who have often been focused on business application functionality, are becoming more aware of the importance of total experience, which focuses on the impact of technology on employee engagement and productivity leading to better customer outcomes.

Three trends are acting as a catalyst for this change:

- **Attention hubs:** Attention hubs are centers of activity, interest and attention for a given business purpose. Ideally, these hubs could be assembled using composable application technology into a seamless interface, with integrated process-centric and collaboration-centric functionality.
- **Composable enterprise/business:** The accelerating pace of business change is driving organizations to adapt their technologies, organizations, and operating models to be more adaptive and resilient. The ability to assemble and orchestrate capabilities more quickly has become a central element of an organizations' ability to create competitive advantage.
- **Total experience:** Exploiting the links between customer experience and employee experience increases the value that front-office and back-office systems can provide. Workers involved in customer-facing efforts traditionally need to task switch to collaborate or share content with peers. This leads to ineffective use of technologies to deliver total experience value, as unstructured, ad hoc content becomes decoupled from the systems of record they relate to.

Mass: High

The applicability of converged business and productivity applications is widespread across industries and functions. But industries with more ad hoc customer interaction and roles that involve business applications are more likely to benefit from this convergence. For example, a service coordinator for an equipment reseller resolving a service issue for a customer will leverage both CRM systems (to check warranties, track the ticket, and price the repair) and collaborative systems (to find internal employees that are experts in the particular issue, discuss how to approach the problem, and finding relevant documents).

The converged business and productivity applications are less a change in the features of either type of application than a set of synergies that arise when they are combined. It does require software to be more modular and API-centric (see Packaged Business Capabilities) to allow for the integration necessary to enable new ways of working. Employee user experience (UX) improves since training is easier and ease of use improves as workflows are more intuitive. Reducing task switching will increase productivity and reduce workplace stress (see Constant, Constant, Multi-tasking Craziness: Managing Multiple Working Spheres). Customer experience will improve since employees can be more responsive and more likely to have a full view of the relevant structured and unstructured information.

Recommended Actions:

- Form partnerships with technology providers on the other side of the fence (business applications providers for collaboration vendors and vice versa). Explore how you currently and could with future development support users with processes that combine business processes and collaborative systems.
- Refactor your software into discrete packaged components and APIs that could be used in a headless fashion to enable end user organizations to create new applications and end-to-end experiences.
- Explore the possibility of exposing your packaged capabilities through other vendor marketplaces to increase the number of potential channels and routes to market.

Recommended Reading:

- Future of Applications: Delivering the Composable Enterprise
- Salesforce Announces Intent to Acquire Slack to Broaden New Ways of Work Platform Play
- Top Strategic Technology Trends for 2021: Total Experience

HR Application Frameworks

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Analysis by Chris Pang, Sam Grinter

Description:

HR application frameworks is a new architectural style for HCM cloud suites which involves a decoupling of “one linear stack” into distinct components for data management, functionality and user experience which allows a more “composable” implementation for customers.

Refactoring the architecture promises to offer better data consolidation capabilities, improved integration to third parties, advanced user experience toolsets, more flexible customization capabilities, and greater technical freedom for end users to switch in and out capabilities from vendors. This enables end-user customers to more easily pair capabilities and products from multiple vendors.

Sample Providers: ADP, BizMerlinHR, Infor, PeopleSpheres.

Range: 6 to 8 Years

The range is long due to the early stage nature of HR application frameworks, which was introduced in The Future of Cloud HCM Suites in early 2020. Many vendors are adding some attributes of the concept in near-term product and architectural designs. But as with all generational shifts it takes time to materialize. Moreover, for many established vendors, it is not the No. 1 priority due to the needs of maintaining and evolving products. Another factor at play is the tension among HR application frameworks and the traditional cloud HCM suite approach. Vendors publicly speak about choice and openness, but they ultimately want to sell as much of their own product as possible. Therefore, general availability and customer adoption will be midterm to long term.

Mass: High

HR application frameworks have a high mass due to it being the next generation of HCM application which by HCM's nature has near universal applicability across midsize, large and global enterprise customers across industries and geographies. In addition, due to the "sticky" nature of HCM, once in place, they will sustain and generate additional business opportunities for HCM providers for at least a decade.

Market availability and customer adoption will occur in the midterm to the long term and at two speeds. More recently established providers (especially those targeting midsize organizations) will have faster success. This is due to the ability to leapfrog architectural styles with less disruption and customer migration issues. But for more established providers and those operating a portfolio of HCM products, the convergence from heritage products to new products built on HR application frameworks will be longer and slower. This is due to the care and attention needed to migrate customers.

Recommended Actions:

- Accelerate efforts in HCM application frameworks by taking a top-down CTO-led initiative. Product leaders at providers need to lay out a "north star" for the concept with agile development teams and streams beneath. Taking a top-down approach versus an organic bottom-up approach is key so the end result aligns to the vision.
- Improve the chances of success by making your HCM platform compatible and ready (remove technical debt and add new services/capabilities) for the HCM application frameworks vision. Vendors with aged application architectures may find it easier to develop from scratch rather than upgrade existing products.

Recommended Reading:

- Tech Providers 2025: How Product Managers Can Prepare for the Future of HCM Software
- The Future of Cloud HCM Suites
- Innovation Insight for Packaged Business Capabilities and Their Role in the Future Composable Enterprise

Blockchain for Business Apps

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Analysis by Balaji Abbabatulla, Ranadip Chandra

Description: Blockchain for business apps describes the trend of using blockchain technologies to develop enterprise software applications. A blockchain is an expanding list of cryptographically signed, irrevocable transactional records shared by all participants in a network. Enterprise software product leaders use one or more blockchain technologies such as immutability, encryption, peer-to-peer distribution, decentralization, and tokenization to develop business applications.

Sample Providers: param network, Ethereum Foundation, Hyperledger, Corda

Range: 6 to 8 Years

We estimate that blockchain for business apps will be used by early adopters for the next six years. Enterprise leaders are beginning to realize the limited business benefit and the extent of changes required to traditional centralized governance and control mechanisms to use these solutions. The prospect of decentralization, especially autonomous decentralization, disrupts established ways of doing business, and requires enterprise leaders to change foundational processes. Concerns about loss of control, security, unclear regulations, and technology immaturity will continue to inhibit blockchain adoption in the enterprise. The economics of some of the blockchain platforms are not transparent and could be confusing, as a result the immediate benefits for the participants are not clearly visible. These factors inhibit wider adoption of blockchain solutions despite the reasonable success of proofs of concept (POCs). Adoption of complete, and enhanced blockchain for business apps by an early majority of business customers is at least six years away.

Mass: High

Blockchain for business can replace traditional centralized business processes with decentralized, tokenized business workflows in a trusted environment. This has the potential to impact several industries, business functions and disrupt established market structure. Blockchain can become the foundation for such ecosystems thereby changing traditional views of products and markets.

Recommended Actions:

- Develop new blockchain for business apps POCs using technologies such as tokenization to replace existing collaboration processes and deliver generative solutions.
- Investigate specific use cases for particular industry verticals where the immediate benefit is tangible (e.g., tamper-proof employee career credentials for a skilled healthcare workforce).
- Define an architecture that enables easy migration to a new blockchain platform or a new set of enabling technologies to ensure longevity of the blockchain business application.

Recommended Reading:

- Blockchain Unraveled: Determining Its Suitability for Your Organization
- Common Mistakes to Avoid in Enterprise Blockchain Projects
- Emerging Technology Analysis: Blockchain Strategy for Enterprise Application Software Product Managers

Technologies or Trends Added or Dropped

In the latest update, we have included four new profiles that support the themes of product delivery agility, data-driven technology productization and transition into generative solutions. We have also renamed a number of existing profiles to better articulate their scope.

New:

- Intelligent Document Processing

- Process Mining and Task Mining
- Converged Business and Productivity Applications
- Blockchain for Business Applications

Modified:

- Intelligent Applications was renamed Intelligent Business Applications
- Conversational UI was renamed Multimodal UI
- Multicloud Container Management Platform was renamed Container Management
- AI-Augmented Software Development was renamed AI-Augmented Software Engineering
- IoT Platforms in Enterprise Software was renamed IoT Platforms

Dropped:

- None

Emerging Technologies or Trends Watchlist

The items listed here include technologies and trends that were considered but are not yet included because, in our judgment, it's too early to evaluate them or they have not yet demonstrated the potential for significant impact on the future of the area. This is not intended to be an exhaustive list; it serves as a view into some of the additional technologies or trends we have identified.

- Autonomous servware

How to Use the Impact Radar

This Emerging Technologies and Trends Impact Radar content analyzes and illustrates two significant aspects of impact — when we expect it to have a significant impact on the market (namely, the range); and how big of an impact it has on relevant markets (specifically, mass). Each emerging technology or trend profile analysis is composed of these two aspects. See Note 1 for a complete description of our approach to this research.

In this document, profiles are organized by range and mass. Impact Radar range starts with the center and moves to the outer rings of the radar. The center of the impact radar represents when the emerging technology will cross the chasm from early adopter to early majority. The rings represent one to three years, three to six years and six to eight years from crossing the chasm.

Mass is rated from very high to very low, represented by the size of the bubble on the Impact Radar Graphic. The higher the mass score, the more broadly the Emerging Technology or Trend is predicted to be adopted, and the more revolutionary the innovation is expected to be.

The objective of this research is to guide product leaders on how emerging technologies and trends are evolving and impacting areas of interest. Providers can leverage this knowledge to determine which technologies or trends are most important to the success of their business and when it makes sense to advance their products and services by investing in them. Technology vendors should use this Emerging Technologies and Trends Impact Radar to:

1. Identify emerging technologies and trends that are important to the success of their business

2. Determine when to act upon those trends and technologies based on business strategy

3. Begin formulating a response to the technology or trend's evolution

Evidence

[1] The Gartner 2021 Application Innovation Implementation Survey was conducted online from 20 July through 12 August to understand adoption of application innovations in support of newly acquired or custom-built applications and software; deployment of digital twins, and what role SWELs have in digital twin software engineering; and use of AI in application development. In total, 111 IT and Business Leaders Research Circle members participated; 75 were from Gartner's ITL Research Circle — a Gartner-managed panel — and 36 were from an external sample. Members from North America (41%), EMEA Region (41%) Asia/Pacific (10%) and Latin America (9%) responded to the survey.

The survey was developed collaboratively by a team of Gartner analysts, and was reviewed, tested, and administered by Gartner's Research and Data Analytics team.

Note 1: Research and Methodology for the Emerging Technologies and Trends Impact Radar

The Emerging Technologies and Trends Impact Radar content analyzes and illustrates two significant aspects of impact:

1. When we expect it to have a significant impact on the market (specifically, range)

2. How big an impact it will have on relevant markets (namely, mass)

Analysts evaluate range and mass independently and score them each on a 1 to 5 Likert-type scale:

- For range, this scoring determines in which radar ring the Emerging Technologies and Trends will appear.
- For mass, the score determines the size of the radar point.

In the Emerging Technologies and Trends Impact Radar, the range estimates the distance (in years) that the technology, technique or trend is from crossing over from early adopter status to early majority adoption. This indicates that the technology is prepared for and progressing toward mass adoption. So at its core, range is an estimation of the rate at which successful customer implementations will accelerate. That acceleration is scored on a five-point scale with one being very distant (beyond eight years) and five being very near (within a year). Each of the five scoring points corresponds to a ring of the Emerging Technologies and Trends Impact Radar graphic (see Figure 1). Those Emerging Technologies and Trends with a score of one (beyond eight years) do not qualify for inclusion on the radar. When formulating scores for range, Gartner analysts consider many factors, including:

- The volume of current successful implementations
- The rate of new successful implementations
- The number of implementations required to move from early adopter to early majority
- The growth of the vendor community
- The growth in venture investment

Mass in the Emerging Technologies and Trends Impact Radar estimates how substantial an impact the technology or trend will have on existing products and markets. Mass is also scored on a five-point scale — with one being very low impact and five being very high impact. Emerging Technologies and Trends with a score of one are not included in the radar. When evaluating mass, Gartner analysts examine the breadth of impact across existing products (specifically, sectors affected) and the extent of the disruption to existing product capabilities. It should be noted that an emerging technology or trend may be expressed in different positions on different Emerging Technologies and Trends Impact Radars. This occurs when the maturity of Emerging Technologies and Trends varies based on the scope of radar coverage.

Document Revision History

Emerging Technologies and Trends Impact Radar: Enterprise Software - 16 October 2020

Recommended by the Authors

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

Market Share Analysis: Enterprise Software, Worldwide, 2019

4 Phases for Technology and Service Providers to Lead in the COVID-19 Environment

Future of Applications: Delivering the Composable Enterprise

Disruptive Program Design for TSP Partner Ecosystems

Now	1 to 3 Years	3 to 6 Years	6 to 8 Years
DevOps	Cloud Infrastructure and Platform Services (CIPS)	Hyperautomation in Software	AI-Generated Composite Applications
Low-Code Application Platforms (LCAPs)	Digital Twin	AI-Augmented Software Engineering	Converged Business and Productivity Applications
	IoT Platforms	Collaborative Ecosystem Product Development	HR Application Frameworks
	Container Management	Democratization	Blockchain for Business Apps
	Intelligent Business Applications	Cloud ERP Suites for Product-Centric Enterprises	
	Intelligent Document Processing	Graph	
	Multimodal UI	Nonvolatile Memory Express Over Transmission Control Protocol (NVMe/TCP)	
	Process Mining and Task Mining	Quad-Level Cell (QLC) 3D NAND Flash	
	Packaged Business Capabilities	Service Mesh	
	Remote Collaboration		