Hype Cycle for Hybrid Infrastructure Services, 2020

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Hybrid infrastructure services are evolving rapidly into new technology-as-a-service offerings and user-centric support services. This Hype Cycle assesses the maturity of emerging and evolving services and solutions, enabling organizations to achieve business advantage through planned adoption.

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What You Need to Know

As cloud services begin to reach mainstream maturity over the next few years, the benefits they can deliver are materializing at pace. Cloud allows the flexibility and scaling of core systems while enabling greater connection of organizations to customers through IoT and edge-based technologies.[1] In turn, cloud, IoT and edge services will allow the development of new support and operational models, centered on asset-based services incorporating analytics and intelligent automation to drive differentiated, real-time client experiences.

In light of these changes, whether to use cloud has stopped being a question for most organizations. Instead, the question is how to effectively integrate new external service offerings with on-premises core systems that are not yet ready for migration to pure cloud services. This makes a hybrid strategy encompassing the workplace, data center, private cloud, public cloud, edge and IoT capabilities necessary for organizations. Such hybrid infrastructure services will create and support the digital platform needed to underpin the next generation of business operations.

However, with providers continuously promoting new services, with offerings maturing at different rates and with each producing a variety of impacts, the hybrid market is complex and confusing. To cut through the hype, IT leaders should use this research to guide their strategic planning for hybrid services.

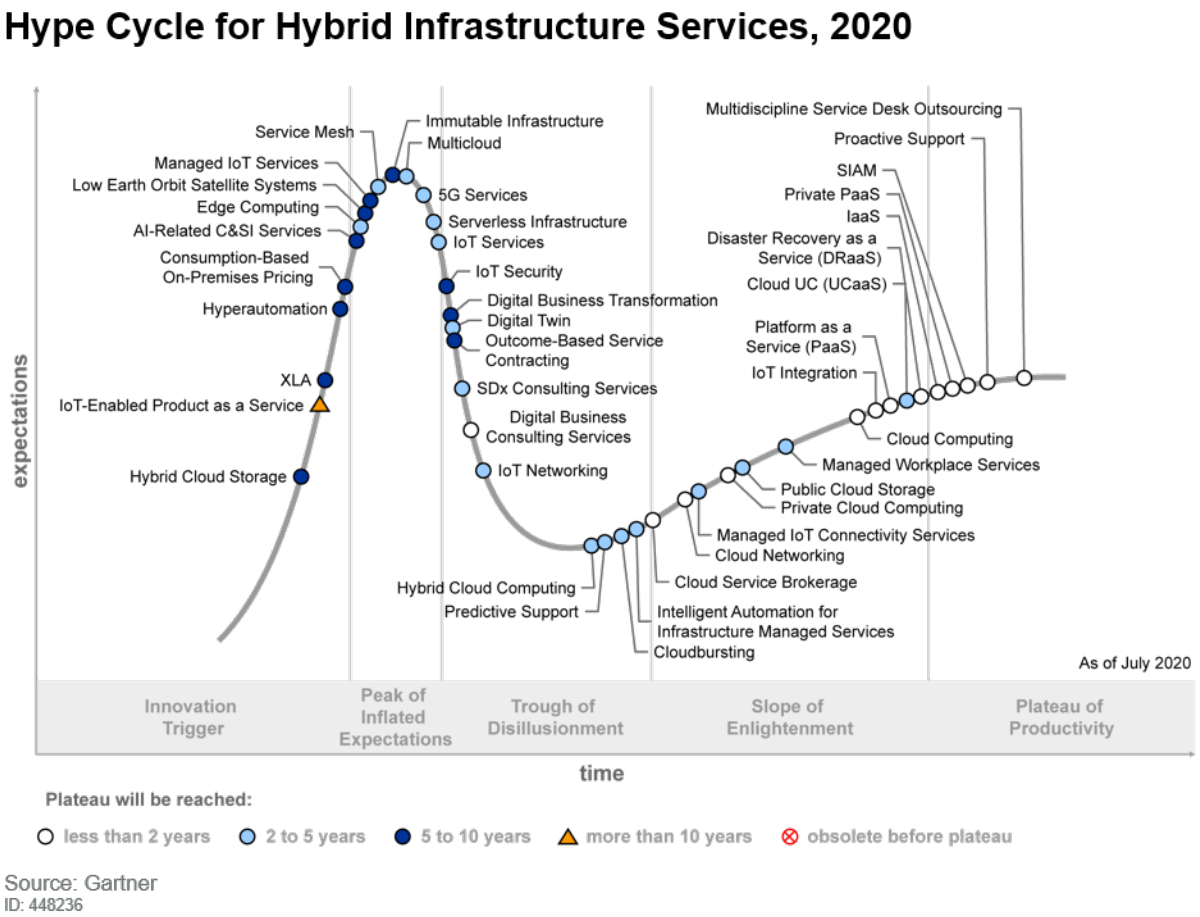
The Hype Cycle

The Hype Cycle for Hybrid Infrastructure Services analyzes innovative services and solutions that span local delivery, on-premises hosting, private cloud, public cloud and edge solutions. This year's Hype Cycle shows three significant trends for organizations to track:

- **Change is accelerating —** The pace of change of hybrid infrastructure offerings continues to increase. Nearly three-quarters of the services featured on the 2020 Hype Cycle will mature in the next five years. Key digital service capabilities such as intelligent automation for infrastructure managed services, predictive support and service mesh are moving particularly quickly. However, this rate of change creates a challenge for legacy organizations, which are already struggling to keep pace, and will require a strategic redesign to how change is driven in both IT functions and business capabilities. For many organizations, standardization and rationalization of existing capabilities will need to be a key first step.
- **Service-led revolution —** Both the Slope of Enlightenment and Plateau of Productivity of this year's Hype Cycle are populated by service-led infrastructure, where technology capabilities are delivered in the form of consumable service offerings. While the first wave of cloud-based technologies is beginning to mature, a second wave of expanded cloud, IoT and edge capabilities is entering maximum hype. As a result, services such as edge computing, immutable infrastructure and serverless infrastructure can be seen at the peak of the Hype Cycle. In the on-premises world, consumption-based on-premises pricing has emerged onto the Hype Cycle, as a hosted "cloudlike" infrastructure solution, in response to the flexibility and usage-based challenges posed by public cloud. This constant flow of new services will drive asset-based, service-led business strategies, with the capability to shift organizations into new product-as-a-service offerings. In the projected "new normal" following COVID-19, digital capabilities in customer experience and in operations will be crucial for all organizations,[2] and these capabilities may become critical to business relevance and survival. At the same time, though, the economic impacts of the pandemic have reduced investment in digital business. As a result, digital business transformation has moved backward in maturity, while IoT-enabled product as a service is now predicted to take over 10 years to mature.
- **Change in support models —** At the same time as business offerings are being disrupted, IT support models are being reinvented to create new forms of service offerings. With integral analytics and automation, these services aim to prevent issues before they occur, reduce manual mistakes in operations and drive an enhanced user support experience. In turn, this allows service delivery to be tied ever more closely to business KPIs, allowing businesses to contract their support models against the outcomes they need to achieve. This year sees new support service offerings enter the Hype Cycle for the first time, in the form of experience-level agreements (XLAs) and hyperautomation.

Across these trends, it is clear that IT leaders must constantly sift through innovations with a business lens, aiming for optimization and alignment of business value, rather than just traditional IT service efficiency.

Figure 1. Hype Cycle for Hybrid Infrastructure Services, 2020



Source: Gartner
ID: 448236

The Priority Matrix

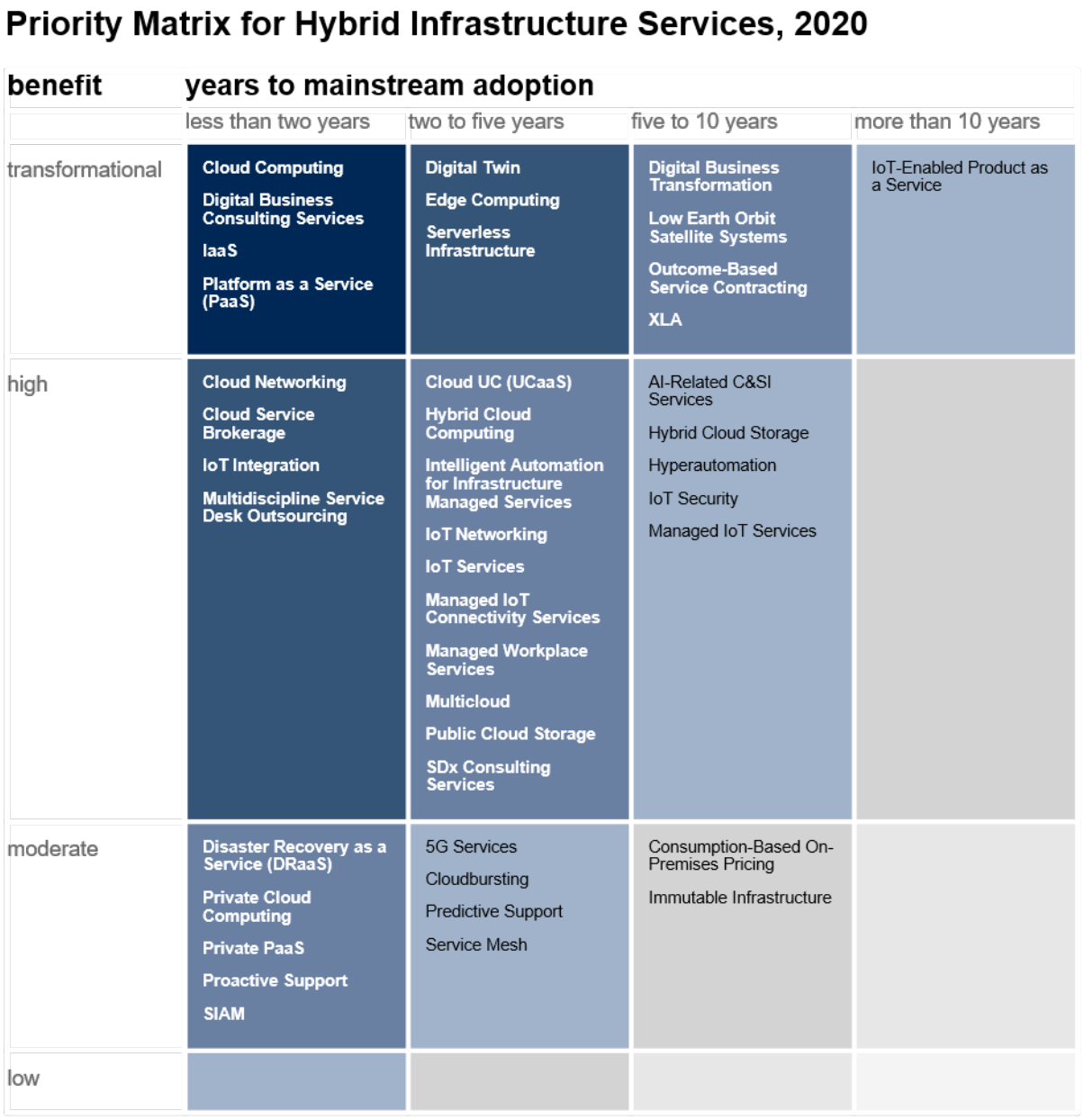
The on-demand, elastic nature of cloud-based services is driving them to move through the Hype Cycle rapidly, creating significant benefit for businesses in two distinct waves. The first wave of cloud hosting and service models is close to maturity, providing infrastructure modernization options and allowing rapid relief of technical debt, and allowing IT services to scale with business demand. In the next wave, starting two years from now, next-generation cloud capabilities such as serverless infrastructure and multicloud will begin to mature, expanding cloud potential even further.

Partly enabled by cloud, a suite of IoT- and edge-based innovations will break through into mainstream use within a five-year time frame. In particular, two of these — edge computing and digital twins — will deliver transformational change in the market. Edge computing will close the gap between organizations and their clients — both human and IoT devices — allowing real-time responses to events in the physical world. At the same time, modeling of assets, people or organizations through digital twins will allow new modes of operation, based on detailed understanding and simulation of responses to new situations. Together, these capabilities will

transform the digital engagement of businesses with their customers and users. Sourcing, procurement and vendor management leaders must engage digital business consulting services now to provide analysis of the impact and benefits of IoT solutions, and begin progressing to large-scale pilots in a controlled manner.

While cloud, IoT and edge are progressing rapidly with high benefit, hybrid capabilities are struggling to deliver in the same way. Services such as cloudbursting, hybrid cloud storage and consumption-based on-premises pricing are generally showing lesser benefits. With transformational cloud and edge experiences ready to break through, infrastructure leaders must reassess any requirement for remaining on-premises, which will prevent their organization from gaining the fullest benefits of native cloud and IoT capabilities.

Figure 2. Priority Matrix for Hybrid Infrastructure Services, 2020



Source: Gartner
ID: 448236

Off the Hype Cycle

The following innovations have reached maturity with widespread market penetration, and so moved off the 2020 Hype Cycle:

- IaaS+
- Managed WLAN

We also removed the profile for IoT business solutions. While the concept of an IoT business solution remains viable, the emergence of digital twins — which are effectively used to implement IoT business solutions — will be our focus moving forward.

We changed the name of the profile for "Multisourcing Service Integrator" to "SIAM," in line with current industry practice.

On the Rise

Hybrid Cloud Storage

Analysis By: Raj Bala; Julia Palmer

Definition: Hybrid cloud storage encompasses a number of deployment patterns with varying underlying technologies. It can take the form of purpose-built hybrid cloud storage appliances, software-defined storage, broader storage systems with hybrid cloud features or the use of storage technologies from within colocation facilities connected by private network link to cloud service providers. The common thread among the varying patterns is the notion of a seamless bridge between disparate data centers and public cloud storage services.

Position and Adoption Speed Justification: The term "hybrid cloud storage" was first used in 2009 by vendors in the cloud storage gateway segment to describe their nascent offerings. Those early hybrid cloud products treated public cloud storage as an archive tier for infrequently used, low-value data. But the current market for hybrid cloud storage has moved well-past the early products in the cloud storage gateway market. Hybrid cloud storage is now used for modern workloads that transform data using the elasticity that public cloud compute provides. These workloads typically start off as large, bulky datasets that require transformation to a smaller result. Examples include videos and a broad range of analytics-oriented data. In the case of videos, artifacts of a video are collected over time and then rendered into a final result using the compute capabilities of public cloud IaaS providers.

User Advice: Evaluate vendors of hybrid cloud storage across two imperatives: tactical and strategic uses. The tactical approach includes uses such as tiering data to the cloud. The strategic approach includes using public cloud compute services to transform data into usable results. Most vendors focused on tactical use cases are unable to provide the strategic, transformational capabilities that are emerging in the market.

Business Impact: Tactical uses of hybrid cloud storage have been available for nearly a decade. These solutions are often designed such that data is not easily readable in the public cloud due to the opaque storage formats used by vendors. As a result, these methods limit the full breadth of functionality that can be unlocked in the cloud.

The strategic uses of hybrid cloud storage are often developed with modern approaches in mind. As such, vendors have taken care to ensure that data can not only be read in the public cloud, but also

modified and synchronized back to its source. This end-to-end capability requires that providers of hybrid cloud storage solutions integrate deeply with the cloud service provider in a manner that far exceeds the functionality required to simply tier to the cloud.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Amazon Web Services (AWS); CTERA Networks; Hammerspace; Microsoft; Nasuni; NetApp; Peer Software; Qumulo; Vcinity

Recommended Reading: "Top Five Approaches to Hybrid Cloud Storage — An Analysis of Use Cases, Benefits and Limitations"

"Market Guide for Hybrid Cloud Storage"

IoT-Enabled Product as a Service

Analysis By: Eric Goodness

Definition: IoT-enabled product as a service is a commercial model where businesses acquire operational assets as recurring operating charges. Acquisition is based on agreements defining fitness for purpose and desired outcomes relating to performance, availability and quality of output. Embedded IoT technologies leveraging common IoT design patterns and industry frameworks provide users, manufacturers and financial intermediaries the data required to ensure asset effectiveness and availability, and to mediate concerns and remedies for nonperformance.

Position and Adoption Speed Justification: While examples of traditional leasing (such as for autos and industrial equipment) are well-established in select industries, the adoption of IoT-enabled product as a service, based on the true spirit of "as-a-service" where fee structures are utilization-based and not grounded in minimum contract terms and revenue commitments; is nascent but growing.

To implement IoT-enabled product as a service, manufacturers, certified distributors and resellers, and, service providers must apply IoT innovation to create connected products. Embedded technologies enable remote product state monitoring, control and optimization, and, software release and change management for feature updates and security patches. Connected products are integrated with back-end business applications of the asset owner (not the user) to optimize support. For example, connected products are integrated to automate the procurement of consumables and spare parts or with field service management systems so the products can schedule repair without intermediaries at the customer site or within the manufacturer.

A technical driver for IoT-enabled product as a service is that all the technologies needed to implement such a business model are readily available at reduced costs. A commercial driver for IoT-enabled product as a service is the strong overall business trend to shift business costs from

asset ownership and capital expenditure (capex) to asset subscription and operating expenditure (opex). Technical inhibitors to adoption of IoT-enabled product as a service include the complexity of end-to-end IoT business solutions and specific technical challenges, such as device management, security, integration and information management. Key commercial inhibitors include the relatively immature IoT-enabled product-as-a-service business model, challenging SLAs, outage penalties and access to managed assets.

User Advice: IoT-enabled product as a service has great potential for transforming how manufacturers offer their products and services, and how companies consume them. A good implementation of IoT-enabled product as a service means having a proven end-to-end IoT device to back-end application distributed architecture that supports a proven IoT-enabled product-as-a-service business model based on reliable outcomes with predictable SLAs for a reasonable cost. Such an implementation requires a provider's careful design, business acumen, good execution and sustained attention to detail.

Companies that are considering IoT-enabled product as a service should consider the following recommendations:

- Perform your own multiyear total cost of ownership analysis to validate the benefits of IoT-enabled product as a service.
- Update business processes to take advantage of IoT-enabled insights or benefits, such as personnel scheduling or supply chain for predictive maintenance.
- Reconcile whether aggressive time-to-deployment requirements are achievable with internal resources, and if not, whether help (such as via a system integrator) is required.
- Work to determine if the manufacturer engages with financial intermediaries to operationalize the "as-a-service" offerings. Determine if P&C coverage is available to mitigate the risks of engaging in such a model.
- Negotiate agreements that clearly establish mutually agreed SLAs and OLAs for IoT-enabled product-as-a-service performance and reliability.
- Factor in all nonrecurring and recurring charges, terms of agreement and penalties into your IoT-enabled product-as-a-service business model.
- Secure the rights to IoT-enabled product-as-a-service data, including mutual agreements on exactly which data and the methods are required for accessing it.
- Determine which other entities will have access to your data and how your data is monetized by the supporting ecosystem.
- Consider IoT-enabled product as a service for more standard, expected product outcomes and realize that offerings are still relatively immature.
- Ask for end-user IoT-enabled product-as-a-service references — then speak to them before engaging with external providers.

Business Impact: Potential benefits of IoT-enabled product as a service for customers (i.e., end users) include:

- Shift asset acquisition from capex- to opex-based subscriptions.
- Leverage of economies of scale innovation investments by the manufacturers/providers.
- Mitigate risks for asset selection and procurement by transferring responsibility for IoT-enabled product-as-a-service outcomes, innovation and upgrades to the manufacturer.
- Potential faster time to deployment and asset benefits (assuming your IoT-enabled product-as-a-service provider can deploy faster than you).

Potential challenges include:

- Reliance on a manufacturer's investments to modernize IoT-enabled product-as-a-service offerings.
- Potential commercial and technical challenges for accessing IoT-enabled product data.
- Integrating IoT-enabled product-as-a-service solutions with your back-end applications and data.
- Integrating heterogeneous IoT-enabled product-as-a-service offerings from multiple providers.
- Potential disruptions of IoT-enabled product-as-a-service offerings that become commercial failures.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Caterpillar; Danfoss; Hartford Steam Boiler; Michelin; Philips Healthcare; SAP; Xylem

Recommended Reading: "A Digital Business Technology Platform Is Fundamental to Scaling Digital Business"

"Digital Business Ambition: Transform or Optimize?"

"Digital Business Models Compendium"

"Show the Value of OT and IT Alignment, and Realize Digital Business Results"

XLA

Analysis By: Daniel Barros; David Groombridge

Definition: Experience-level agreements (XLAs) help drive better IT experiences by leveraging elements of digital experience monitoring (DEM), sentiment analysis and traditional service-level metrics that monitor the timeliness and effectiveness of supporting processes. The goal is to measure the end-to-end user experience within a given business process, and then be able to

optimize it so that employees are continuously improving their technology experience in a wide variety of workspaces, including home offices.

Position and Adoption Speed Justification: XLAs are still in the early stages of maturity and adoption, and have not been traditionally measured, but organizations have found that focusing on the overall user experience drives higher user satisfaction and engagement. XLAs are currently mainly used in managed workplace services (MWS) deals, where client organizations seek to transform the employee experience. In these scenarios, clients want the service provider to agree to outcome-based metrics that go beyond timeliness in resolving tickets with a focus on the employee experience. XLAs aim to measure the end-to-end experience of a user in consuming the IT services necessary to perform their daily activities. In order to accurately measure this, XLAs usually rely on the implementation of DEM tools that are capable of measuring each touchpoint in the overall user journey, though they can also incorporate traditional user experience surveys. XLAs allow the impact of IT systems and services to be mapped directly onto business KPIs, allowing the creation of outsourced service deals that contract for defined business outcomes.

User Advice: Client organizations that need to enhance employee experience through digital workplace transformation should:

- Link technical service delivery to business KPIs by adopting XLAs with their service provider to measure and drive the desired user experience.
- Tie service revenue to improvement in XLA performance. Well-designed XLAs should also affect how the service is compensated. The overachievement of the target user experience should result in a premium, and the underachievement in a deduction. The premium and the reduction should be capped at an amount that is reasonable for both parties. However, having a financial incentive for overachieving the target is only effective for the client if the user experience metrics relate back to business performance.
- Ensure that XLAs measure end-to-end user experience by selecting providers with a strong track record in process mapping, analytics and digital experience monitoring. Down-select providers on the basis of their capability to demonstrate referenceable business improvement from ongoing XLA optimization. Seek providers who can align strong organizational change management to XLA-based deals.
- Organizations that run their own internal operations should identify the leading causes of employee dissatisfaction with IT services and improve them with a series of XLAs.

Business Impact: Any organization that is highly reliant on its workforce's engagement and digital dexterity to drive success should consider adopting XLAs with its service providers — or develop their own. The key purpose of an XLA is create meaningful user experience metrics that will be linked to business performance. The underlying metrics should measure individual factors that make up the user experience, such as:

- Network performance at the end-user device
- Performance of the applications that are relevant to the specific intended experience objectives
- Time to access needed applications

- User sentiment

The ability to measure these elements needs to be prebuilt by service providers. The decision of which specific metrics to use should be made through a professional services engagement to bridge the gap between the intended business performance improvements and the services that will be delivered and measured through the XLA metrics.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Atos; HCL Technologies; NTT DATA; TCS; Wipro

Recommended Reading: "Contract for User Experience When Outsourcing Managed Workplace Services"

"Getting Value From Employee Productivity Monitoring Technologies for Remote and Office-Based Workers"

"Market Guide for Digital Experience Monitoring"

Hyperautomation

Analysis By: Stephanie Stoudt-Hansen; Frances Karamouzis; David Groombridge

Definition: Hyperautomation involves the orchestrated use of multiple technologies, tools or platforms (inclusive of, but not limited to, AI, machine learning, event-driven software architecture, RPA, iPaaS, packaged software and other types of decision, and process and/or task automation tools). Hyperautomation-related services refer to the strategy, design, implementation and managed services offered by service providers to leverage one or more hyperautomation technologies.

Position and Adoption Speed Justification: Gartner estimates that over 70% of commercial enterprises have dozens of automation initiatives underway. However, these have met with varying degrees of success, as organizations' traditional build-up of debt and a patchwork of technologies have made the move to automated and hybrid environments challenging. Instead, organizations are now looking to service providers for hyperautomation solutions, which draw on the orchestration of interrelated automation technologies and processes to streamline their environments and achieve greater outcomes. This hyperautomation approach integrates and orchestrates automation using AI, machine learning, event-driven software architecture, RPA, iPaaS, packaged software and other automation tools. Leveraging multiple best-of-breed tools and processes allows providers to deliver more rapid, complex and successful automation, and allows clients to deliver outcomes that distinguish them from competitors. The reality of automation technologies are they are not a future concept. Organizations and service providers have been leveraging them for decades to gain efficiencies through a number of different initiatives and often in a disparate and siloed fashion. Hyperautomation is not about automation technologies products or services alone, it's the approach

of combining business process design, IT architecture deployment, governance and greater business agility to drive competitive advantage at a higher order of magnitude.

User Advice: As organizations continue to demand greater efficiencies and business outcomes from managed service providers, the providers are leveraging hyperautomation to achieve greater outcomes and distinguish themselves among their competitors. The level of efficiency that service providers have achieved through automation in areas such as service desk provision, management of hybrid infrastructures and reduction of incidents ranges from 30% to 80%. The efficiency achieved depends on the ability of the service provider to automate and the area of infrastructure. This was the first wave of leveraging individual automation technologies to drive efficiencies. The next wave is through the combination of automation and intelligent tools in a continuous process driven by strategy, architecture and planning to achieve further efficiencies — Hyperautomation.

Organizations preparing for increased use of hyperautomation now and in the future should:

- Drive hyperautomation decisions by identifying where a hyperautomation approach is required instead of a traditional automation approach by working with IT and business stakeholders to identify processes that change frequently, are heavily integrated across systems but which are highly repetitive in nature. Incorporate these requirements into your service provider agreements through contractually linked business outcomes. Look for continuous improvement and document the metrics supporting the end results.
- Determine a “litmus” test on what needs to be automated and work with your providers to determine where you will gain your greatest return on investment (ROI). Providers have the capabilities to help you benchmark and flag both short-term and long-term impact on your investments and drive greater impact. Also, discuss the value of their proprietary offerings versus vendor agnostic to avoid lock-in.
- Collaborate with your provider to create a blueprint or roadmap, and continuously work to update your environments based on the hyperautomation technologies and processes available or that will create the greatest leverage.

Business Impact: Competitive pressures for efficiencies and returns are forcing organizations to seek the best in breed and strategic relationships with their service providers. Gartner estimates that by 2024, organizations will lower IT and business operational costs by 30% by combining hyperautomation technologies with redesigned operational processes. The concept of hyperautomation is constantly in automation flux and does not neatly fit into one process or tool. Infrastructure service providers will therefore need to continually work with organizations on a business-driven approach. They need to rapidly identify, determine and automate in a defined and disciplined fashion. The providers that embrace these concepts and processes will gain competitive advantage and drive greater results for their customers and be seen as a strategic partner. Hyperautomation is the continuous build on the intelligent automation journey.

Benefit Rating: High

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Capgemini; Cognizant; HCL Technologies; IBM; Infosys; NTT DATA; T-Systems; TCS; Wipro

Recommended Reading: "Top 10 Strategic Technology Trends for 2020: Hyperautomation"

"Move Beyond RPA to Deliver Hyperautomation"

"Tech CEOs Must Use Hyperautomation to Enhance Offerings"

"Communicate the Value of Hyperautomation Using ROI"

"Predicts 2020: Sourcing and Procurement Application Technology Disruptions"

Consumption-Based On-Premises Pricing

Analysis By: Daniel Bowers

Definition: Consumption-based pricing for on-premises data center infrastructure is an acquisition model that includes a variable payment tied to measured usage.

Position and Adoption Speed Justification: Server and storage hardware vendors have launched or rebranded consumption-based pricing models in the last two years, positioning them as cloudlike or alternatives to public cloud. Examples include Dell Technologies' Flex on Demand, HPE's GreenLake Flex Capacity, and Pure Storage's Pure as-a-Service. These programs meet some users' desire to better align infrastructure costs with resource usage, and to shift infrastructure spending from capital expenditure to cloudlike operating expenditure. As early adopters learn financial and capacity planning lessons, vendors are evolving their offerings to offer a broader range of products and more flexible terms.

User Advice: While hardware-as-a-service offers appeal to organizations seeking to cut infrastructure costs, these programs are typically *not* cheaper than an outright purchase. Required minimum-usage commitment levels and three- to five-year contracts including mandatory services mean consumption-based options are not strictly pay per use. Pricing often ignores market changes during the contract period, such as the long-term industry trend toward lower storage cost per GB. However, these programs enable infrastructure without large upfront capital investment. Consumption-based pricing can also be part of IT's evolution from a cost center toward a service- or product-centric delivery model. IT leaders considering these programs must address any misalignment between variable hardware usage and perpetual- or subscription-based software licensing.

Business Impact: IT leaders — jointly between infrastructure and operations, vendor management and finance — should evaluate the total cost of ownership (TCO) of a range of potential consumption-based program scenarios. For centralized IT organizations with mature chargeback processes, consumption-based programs can improve the linking of costs to specific usage. Organizations must ensure that contract terms match company requirements for categorizing capital versus operating expenses, and that contracts include appropriate end-of-term options (for example, renewals or buyouts). Consumption-based programs change hardware life cycle

management, resulting in both high renewal rates and high barriers to exit because it can be difficult to resume traditional acquisition. By removing friction from new infrastructure deployment, these programs also risk allowing unchecked growth of storage resources.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Cisco; Dell Technologies; Hewlett Packard Enterprise (HPE); Hitachi Vantara; Lenovo; NetApp; Pure Storage

Recommended Reading: "How to Use Consumption-Based Procurement Models for On-Premises Infrastructure"

"Key Considerations for CSOs Moving to a Consumption-Based Subscription Model"

"Create Consumption-Based On-Premises Infrastructure Bundles for Midsize Enterprises"

At the Peak

AI-Related C&SI Services

Analysis By: Frances Karamouzis; Susan Tan

Definition: AI-related consulting and system integration (C&SI) services refer to strategy, design and implementation services offered by service providers to leverage artificial intelligence. Services include design thinking, ideation, reconfiguring or redesigning business or IT processes, evaluating technologies, architecting, and COE setup and management. They also include curating data, building and training algorithms and models, developing, testing and integrating solutions, assessing and mitigating risks, and defining new talent mixes of skills.

Position and Adoption Speed Justification: The moniker of "AI" related to an organizational initiative continues to garner high attention and even higher expectations for significant impact. It also brings high risk, uncertainty, and often lack of skills or approach to build and/or operationalize. Hence, the demand for the use of service providers continues unabated. Buyers are seeking guidance and recommendations as to best use cases as well as expertise to navigate the vast array of technologies and approaches that make use of artificial intelligence.

One of the most significant hurdles for AI initiatives has been trust — specifically, the trust factor for shifting to data-driven decision making guided by the results of AI solutions. Hence, our positioning of pre-peak is related to the continued lack of clear line of sight for managing the risk-reward factors of AI investments. Given the potential to infuse AI into a majority of processes and applications, the number of solutions in production is still small, and the quantified value is opaque or limited.

User Advice: AI initiatives never involve a single technology. The most difficult challenge for clients when selecting service providers for AI-related efforts is the difficulty for buyers to compare,

evaluate and differentiate. The technology solutions are so diverse, and AI itself is opaque with an extremely high level of ubiquity. As such, ubiquity is both the biggest strength and the biggest weakness due to the variety of business functions and processes where it can be applied (i.e., finance, HR, CRM, sales). Therefore, it's difficult to determine the scope of the required C&SI services and whether they can be delivered by a single provider or multiple providers.

Clients looking to engage AI-related C&SI service providers should:

- Recognize that they will likely have multiple concurrent AI initiatives within the organization. Therefore, it is imperative to have an overall AI strategy as well as a knowledge management approach to ensure ongoing risk management as well as efficiency and efficacy.
- Ensure that knowledge transfer and competency building is part of the C&SI scope of services. After consulting firms depart, organizations must have the skills and expertise for managing AI solutions and driving additional initiatives.
- Proactively evaluate and build profiles of service provider options in order to be able to speed up the process of securing service providers for various AI initiatives. Consider profiling complementary capabilities in IoT, analytics or blockchain.
- Build significant muscle in contracting for C&SI services and AI software and platforms. There are already examples in the market of budgets allocated for two years' cycles being expended in the first month of an AI application being in production.
- Plan for selected incremental starting points, gaining proof points and then accelerating for scale.
- Ensure that service providers bring the right mix of interdisciplinary consultants with relevant experience, including technical, domain and industry/process knowledge, while understanding that the newness of the technologies means few have direct AI solutioning experience.
- Get provider references and discuss with them how their implementation went, including issues they did not anticipate, to avoid repeating the same mistakes.

Business Impact: Enterprise buyers have different appetites for risk, business models, pain points and corporate cultures for embracing change. Therefore, the selection of initiatives for applying AI technologies varies significantly. Some choose a high volume of lower-risk AI initiatives to build their knowledge base and determine what is proven, reliable and can deliver measurable business impact. An alternative approach is a lower volume of AI initiatives with a much higher impact that seeks to define new products or services to disrupt an industry.

The biggest impact that AI-related C&SI services can deliver is the ability to sort out the options across the business and IT processes and functional areas of the enterprise within the appropriate security, risk and brand value guardrails.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Sample Vendors: Accenture; Capgemini; Deloitte; EPAM; Fractal Analytics; IBM; Mu Sigma; PwC; TCS; Wipro

Recommended Reading: "Top 10 Strategic Technology Trends for 2020: Hyperautomation"

"Staffing Data Science Teams: Mapping Capabilities to Key Roles"

"Tool: Banking and Insurance Use Cases to Drive Hyperautomation"

Edge Computing

Analysis By: Bob Gill; Philip Dawson

Definition: Edge computing describes a distributed computing topology in which data storage and processing are placed close to the things or people that produce and/or consume that information. Drawing from the concepts of mesh networking and distributed computing, edge computing strives to keep traffic and processing local and off the center of the network. Edge balances latency requirement and the bandwidth required for an application, allows for autonomous operation, enables the placement of workloads and data that satisfies regulatory/security demands.

Position and Adoption Speed Justification: Most of the technology for creating the physical infrastructure of edge data centers is readily available. However, widespread application of the topology and explicit application and networking architectures are not yet common outside of vertical applications, such as retail and manufacturing. As IoT demand and use cases proliferate, the acceptance of edge computing as the topological design pattern (namely, the "where" a "thing" is placed in an overall architecture) has dramatically increased interest in edge technologies and architectures. However, the still-nascent state of non-IoT edge applications has prevented more rapid movement along the Hype Cycle since 2018.

User Advice: We recommend the following:

- We urge enterprises to begin considering edge design patterns in their medium- to longer-term infrastructure architectures.
- Immediate actions include simple trials using colocation and edge-specific networking capabilities, or simply placing remote location or branch office compute functions in a standardized enclosure (for example, "data center in a box").
- Some applications, such as client-facing web properties and branch office solutions, will be simpler to integrate and deploy, while data thinning and cloud interconnection will take more planning and experimentation to get right.
- We are beginning to see viable offerings from hyperscale cloud providers in extending their programming models and management systems to on-premises and edge-located devices, complementing their mostly centralized computing model with a distributed analog.

- For distributed applications requiring a consistent, global infrastructure, with less emphasis on IoT or unique physical endpoints, consider an edge infrastructure as a service provider, such as Cloudflare or NetActuate.
- Enterprises must also become familiar with an emerging "Edge-IN" application model, in which edge gateways and hubs serve as the linchpins for deploying heterogeneous, multicloud and multiendpoint applications. These are often based on open-source frameworks and technologies, such as containers and orchestration systems like Kubernetes.

Business Impact: Edge computing has quickly become the decentralized complement to the largely centralized implementation of public cloud. Edge computing solves many pressing issues, such as unacceptable latency and bandwidth limitations, given a massive increase in edge-located data. The edge computing topology enables the specifics of IoT, digital business and distributed IT solutions, as a foundational element of next-generation applications of all kinds.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Akamai; Amazon; Cisco; Cloudflare; HPE; IBM; Microsoft; Vapor IO; Verizon; ZEDEDA

Recommended Reading: "The Edge Completes the Cloud: A Gartner Trend Insight Report"

"Top 10 Strategic Technology Trends for 2019: The Empowered Edge"

"The Future Shape of Edge Computing: Five Imperatives"

"How Edge Computing Redefines Infrastructure"

Low Earth Orbit Satellite Systems

Analysis By: Bill Menezes

Definition: Low earth orbit satellites currently provide global or regional narrowband voice and data network services, including to areas with little or no existing terrestrial network coverage. LEO systems operate at lower altitudes (1,200 miles or less) than predominant geostationary systems (about 22,000 miles). Planned LEO broadband systems of up to thousands of satellites could support significantly lower latency and, depending on system technology, broadband data speeds that are greater than throughput of current GEO and LEO systems.

Position and Adoption Speed Justification: Demand for low earth orbit (LEO) services is well-defined. A further growth driver is the lower cost of launching smaller LEO satellites, which can cost around $1 million compared with the $50 to $100 million cost of a geostationary (GEO) satellite, and can be clustered on a single launch rocket. But newer and planned systems will move slowly through the Hype Cycle given the lengthy time frames to plan and deploy them and to develop

inexpensive directional antennas. Only about 53% of households globally had internet access at YE19, according to the International Telecommunication Union. Lack of broadband access hinders economic growth, thereby limiting enterprise business potential in underserved regions. However, not all of the next-generation LEO systems planned for extending broadband to at least 60% of the world's population in the coming decade will come to fruition. One of the systems closest to commercial deployment — OneWeb's 648-satellite, LEO constellation — halted with OneWeb's March 27 bankruptcy filing.

User Advice: Enterprises with current or planned business interests in remote or underserved global regions should closely follow LEO system development to align narrowband and broadband connectivity requirements for IoT and general data networking with technology capabilities and service availability. Among planned systems:

- OneWeb had launched 74 of its satellites by the time it declared bankruptcy. During 2Q19 the company began the process of trying to sell its radio spectrum, potentially enabling a successor to take over its plan. The system targets downlink speeds of multiple Gbps at round-trip latency of 10 ms to 30 ms. Terminals for fixed and mobile applications would provide a broadband satellite connection plus 2G, 3G and 4G LTE device connections.
- SpaceX venture Starlink as of 2Q19 had launched about 350 of its satellites, with plans to operate a 4,425-satcom LEO constellation providing global broadband internet access. The company scheduled launches of 180 additional satellites in 2020, targeting possible initial commercial service to North America by year's end. Global commercial broadband coverage is targeted for 2024. The full constellation will require more than 100 successful launches.
- Telesat, which already operates a number of GEO satellites, plans a constellation of 300 LEO satellites to provide global broadband connectivity. The Canadian company launched a test satellite in January 2018, targeting full commercial service in 2023.
- Amazon's "Project Kuiper" is seeking regulatory permission for a LEO constellation of 3,236 satellites to provide broadband internet access to underserved areas as well as to Amazon data-dependent services such as AWS. As of 2Q20, there was no announced service date.

Other planned or existing LEO services include those supporting narrowband data for IoT and digital imaging, or satellite phone and messaging services.

Business Impact: Planned LEO satellites will enable broadband connectivity for all remote or underserved geographies for consumer or enterprise use cases. These services also will be able to provide low-latency backhaul for terrestrial technologies such as remote cellular towers and Wi-Fi hotspots. It will possibly spur new development of those networks in areas where high costs have prevented fiber or other wired WAN backhaul connections. These systems will require customer infrastructure such as directional or phased-array antennas at manufacturing volumes large enough to make them cost-effective.

Just as significant is the use case for narrowband IoT, which requires simpler, less expensive ground antennas and only intermittent connectivity to endpoints or gateways that may be served with a small number of satellites rather than global constellations. Enterprise also may benefit for LEO

backhaul for private networking in use cases such as manufacturing, healthcare or natural resources.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: Amazon; Iridium; ORBCOMM; SpaceX; Telesat

Recommended Reading: "Market Insight: New Satellite Constellations Enable Revenue Opportunity for CSPs to Complement IoT Connectivity Services"

"Satellite Communications Strengthen Resilience Planning"

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

Managed IoT Services

Analysis By: Eric Goodness

Definition: Managed IoT services are third-party services that support part or all of an end user's production IoT solution on an ongoing basis. Delivery of managed IoT services is enabled by cloud-based tools and skilled personnel observing structured processes in an operations center. These services may reside on the customer's premises, in a colocation facility, or within public and private clouds.

Position and Adoption Speed Justification: Managed IoT services integrate and aggregate a range of technologies included within the categories of IoT edge devices and IoT platforms as well as related IT and OT integration points and analytics to provide business outcomes. The goal for managed IoT services is the optimization of service delivery through automated operational and administration activities that may require integration with other digital platforms like ERP or CRM.

Enterprises recognize the need to offload the management of their IoT solutions for a number of reasons, including the following:

- Cost reductions;
- Access to skills which do not exist within the company;
- Improved user experience;
- Effective monitoring and management to guarantee a certain level of uptime;
- Security; and so on.

Managed IoT services moved further toward the Peak of Inflated Expectations on the Hype Cycle. The move is based on the increase in IT-centric and IoT service providers now offering managed IoT services and the use-case examples being shared with Gartner. For example, IT system integrators and communications service providers are offering managed IoT services, beyond the traditional machine-to-machine (M2M) providers.

User Advice: The use of managed IoT services can be complex in terms of service activities supported, pricing, the ecosystem involved and required expertise. IT leaders should apply the following before contracting managed IoT services.

First, gain an understanding of what both basic and complex managed IoT service deals might entail:

- A basic managed IoT service deal may be a per incident, at-will relationship to include passive threshold monitoring of IoT devices with event notification to a user's service desk. The event notifications may be accompanied by best-effort remediation, depending on service entitlements.
- A complex managed IoT service deal can be a multisourcing service integration agreement for the management of security, infrastructure, and instances across customer premises and cloud environments. Such deals may encompass the full ITIL "stack" of service operations management, including continual service improvement targets and agreements.

Next, align managed IoT service provider attributes and capabilities within your sourcing selection criteria, including foundational elements, such as:

- Expertise in creating and managing large, complex multisourcing agreements that span the management of technologies, service delivery, technology and business SLAs, and financial imperatives relating to IoT solutions.
- Consulting for integrating IoT edge devices, IoT platforms and IoT data into enterprise applications.

Alignment of your key performance indicators (KPIs) with the SLAs of the managed services proposed.

Business Impact: The primary value for adopting IoT is often made for internal cost reductions and operational efficiency. However, there is increasing demand for IoT-enabled "soft dollar" benefits, such as improved customer experience, new "connected" products and services, and value creation (for example, revenue and insights from data).

An enterprise deploys managed IoT services for the following key reasons:

- Substantially reduced time to value.
- A cost-optimized solution with little or no capital expense.
- Support for the IoT adoption strategies, as well as fulfillment of planned benefits and outcomes.
- Access to providers that have expertise in IoT technology and development.

- The ability to structure meaningful joint ventures across the continuum of value in the IoT stack.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Emerging

Sample Vendors: Accenture; Atos; Insight Enterprises; Orange Business Services; Tata Consultancy Services; Wipro; Zensar

Recommended Reading: "Emerging Technologies: Combinatorial Digital Innovation Delivers Product and Service Leadership"

"Deploy Leaner AI at the Edge: Comparing Three Architecture Patterns to Enable Edge AI"

"Architecting Machine Learning With IoT"

"Market Opportunity Map: Commercial IoT, Worldwide"

"Market Opportunity Map: Industrial IoT, Worldwide"

Service Mesh

Analysis By: Anne Thomas

Definition: Service mesh is a distributed computing middleware that optimizes communications between application services. It provides proxy and/or lightweight mediation for service-to-service communications, and supports functions such as authentication, authorization, encryption, service discovery, request routing, load balancing, self-healing recovery and service instrumentation.

Position and Adoption Speed Justification: A service mesh addresses the lightweight middleware requirements of service-to-service communications (east-west), especially among microservices running in managed container systems. These technologies are evolving rapidly. Many commercial and open-source solutions are now generally available.

Hype surrounding service mesh technology accelerated in early 2017 when Google, IBM and Lyft launched the Istio open-source project to produce a service mesh for Kubernetes. Numerous vendors now contribute to the project and provide commercial Istio-based products, and many people associate the service mesh market exclusively with Istio, even though it isn't the most mature product in the market.

Many clients have expressed confusion about the relationship between service meshes and other API mediation technologies, such as API gateways and application delivery controllers (ADCs.) A service mesh is lighter weight, and therefore doesn't replace traditional API mediators. (See "How a Service Mesh Fits Into Your API Mediation Strategy".) Unfortunately, management, federation and interoperability between the various API mediators and service meshes haven't been addressed by the vendor community, yet.

User Advice: Application leaders responsible for API management and microservices middleware should:

- Deliver secure and resilient miniservices and microservices operations by adopting a service mesh.
- Limit code dependence on any particular service mesh technology by favoring approaches that reduce vendor lock-in, such as sidecar proxies (over library-based implementations).
- Reduce cultural issues and turf wars by assigning service mesh ownership to a cross-functional PlatformOps team that solicits input and collaborates with networking, security and development teams.
- Accelerate knowledge transfer and consistent application of security policies by collaborating with I&O and security teams that manage existing API gateways and application delivery controllers.

Business Impact: A service mesh is a powerful piece of middleware that improves development and operations of microservice-based applications. It ensures reliable, resilient and secure service-to-service communications. It provides deep visibility into the services, enabling proactive operations and faster diagnostics. It automates complex communication concerns, thereby improving developer productivity and ensuring that certain standards and policies are enforced consistently across applications.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Adolescent

Sample Vendors: Amazon Web Services; Buoyant; F5; Google; HashiCorp; Istio; Kong; Microsoft; Netflix; VMware

Recommended Reading: “How a Service Mesh Fits Into Your API Mediation Strategy”

Immutable Infrastructure

Analysis By: Steve Riley

Definition: Immutable infrastructure is not a technology capability, rather it is a process pattern in which the system and application infrastructure, once instantiated, is never updated in place. Instead, when changes are required, the infrastructure is simply replaced. Immutable infrastructure could encompass the entire application stack, with in-versioned templates provisioned via APIs, which are most commonly available in cloud IaaS and PaaS.

Position and Adoption Speed Justification: Immutable infrastructure is typically used by organizations that take a DevOps approach to managing cloud IaaS or PaaS; however, it can be used in any environment that supports infrastructure as code. It represents a significant change in process for traditional infrastructure and operations groups. It may manifest as:

- Native cloud capabilities, such as Amazon Web Services (AWS) CloudFormation or Microsoft Azure Resource Manager templates
- Cloud management platforms, such as Flexera
- Software tools, such as HashiCorp's Terraform
- The customer's own automation scripts

Some or all of an application stack will be instantiated in the form of virtual machine images or containers, combined with continuous configuration automation tools that run after initial boot. Containers can be quickly replaced during runtime, while VM replacement is slower and requires greater coordination among other workload components. Containers improve the practicality of implementing immutable infrastructure and will drive greater adoption.

User Advice: Immutable infrastructure ensures that the system and application environment is accurately deployed and remains in a predictable, known-good-configuration state. It simplifies change management, supports faster and safer upgrades, reduces operational errors, improves security, and simplifies troubleshooting. It also enables rapid replication of environments for disaster recovery, geographic redundancy or testing. Cloud-native workloads are more suitable for immutable infrastructure architecture than traditional on-premises workloads. And, because redundancy may be required by CSP terms of service to receive service-level agreement relief, workloads designed with an immutable infrastructure approach lend themselves to easier replication.

The application stack for immutable infrastructure is typically composed of layered components, each of which should be independently versioned and replaceable. The base OS for the master image may be updated using traditional patching tools, or automatically or manually updated. Automation is then used to bundle components into artifacts suitable for atomic deployment, including VM images, container images, storage objects, network connections, and other necessary resources. The scripts, recipes, and other code used for this purpose should be treated similarly to the application source code itself, which mandates good software engineering discipline.

Some organizations that use immutable infrastructure reprovision only when a change is necessary. Others automatically refresh the infrastructure at frequent intervals (known as systematic workload reprovisioning) to eliminate configuration drift, to update components in which vulnerabilities were discovered, or to possibly eliminate advanced persistent threats. Frequent refresh is only practical in environments with fast and reliable provisioning; thus, it benefits strongly from containers. Integrate with a ticketing system so that refreshes can be initiated and tracked to completion.

The use of immutable infrastructure requires strict operational discipline. IT administrators should eliminate the habit of making one-off or ad hoc modifications to avoid configuration drift. Updates must be made to the individual components, versioned in a source-code-control repository, then redeployed so that everything is entirely consistent. No software, including the OS, is ever patched in production. Organizations that use immutable infrastructure may turn off all normal administrative access to instantiated compute resources — for example, not permitting SSH or RDP access. IT

leaders should set a hard date for when all new workloads will use immutable infrastructure if technically feasible; deadlines can be effective motivators of behavior change.

None of the vendors listed in this innovation profile sell a product called “immutable infrastructure.” Rather, they offer one or more elements that help to establish an immutable infrastructure style. Expect to purchase multiple tools.

Business Impact: Taking an immutable approach to server and compute instance management simplifies automated problem resolution by reducing the options for corrective action to, essentially, one. This is to destroy and recreate the compute instance from a source image containing updated software or configuration that addresses the problem. Although immutable infrastructure may appear simple, embracing it requires a mature automation framework, up-to-date blueprints and bills of materials, and confidence in your ability to arbitrarily recreate components without negative effects on user experience or loss of state. In other words, getting to that single corrective action is not without effort. Treating infrastructure immutably is an excellent test of the completeness of your automation framework and the confidence of your platform. The immutable approach is a management paradigm, not a technology capability. The long-term outcome is one in which the workload defines the infrastructure, which is the opposite of traditional scenarios.

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Amazon Web Services; Ansible; Chef; Fugue; Google; HashiCorp; Microsoft; Puppet; SaltStack; Turbot

Recommended Reading: “Top 10 Technologies That Will Drive the Future of Infrastructure and Operations”

“Programmable Infrastructure Is Foundational to Infrastructure-Led Disruption”

“Adapting Vulnerability Management to the Modern IT World of Containers and DevOps”

“Solution Path for Infrastructure Automation”

“How to Make Cloud More Secure Than Your Own Data Center”

Multicloud

Analysis By: David Smith

Definition: Multicloud computing refers to the deliberate use of cloud services from multiple public cloud providers.

Position and Adoption Speed Justification: Multicloud computing is a deliberate strategy for an organization’s use of multiple cloud services from different providers. An example of this is when multiple cloud providers are used as part of a high availability, redundancy or exit strategy in a

planned manner. Multicloud is much more common in IaaS (and converged IaaS/PaaS) scenarios than SaaS. While it is possible for multi-SaaS environments in an organization, these would typically be stovepiped types of situations. Multicloud can, in some cases, mean very common situations such as using Amazon Web Services (AWS) for IaaS and Microsoft Office 365 for cloud office SaaS, but these are for very different purposes and not the sweet spot of multicloud.

Multicloud computing has potential to lower the risk of cloud provider lock-in, can specify functional requirements that a business unit may have and can provide service resiliency and migration opportunities, in addition to the core cloud benefits of agility, scalability and elasticity.

As with many cloud-related concepts, there are many variations in real-world use and scope. In this case, they align with maturity. Many enterprises start with one provider and, as they use that solution, they become concerned about lock-in. So, the first use of a multicloud strategy is often procurement-based to encourage competition. Then as multicloud providers are in use, the need to manage and govern those services becomes important. And, eventually, some enterprises get to multicloud architectures, which rely on architectural principles and portability solutions and potentially even cloudbursting and other dynamic placement efforts.

User Advice: When using multiple cloud computing services, establish security, management, governance guidelines and standards to manage cloud service sprawl and increasing cost, and develop decision criteria to decide placement of services. Multicloud implementations will need coordination and strategy across the enterprise to identify the types of services needed and deliver the benefits of a cloud environment. IT organizations will also need training and skilled engineers and need to be prepared for the additional expense. Use of a cloud management platform (CMP) and/or a cloud service brokerage (CSB) in a multicloud environment can enable organizations to implement governance and optimizations, but care must be taken to not just shift vendor lock-in to a CMP or CSB vendor.

Business Impact: Multicloud provides an organization with agility and the potential of some target cost optimization opportunities. It also can provide a basis to lower cloud provider lock-in and increase workload migration opportunities.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Amazon; Google; IBM; Microsoft; Oracle

Recommended Reading: “The Cloud Strategy Cookbook, 2019”

“A Guidance Framework for Architecting Portable Cloud and Multicloud Applications”

“Define and Understand New Cloud Terms to Succeed in the New Cloud Era”

“Technology Insight for Multicloud Computing”

5G Services

Analysis By: Bill Menezes

Definition: 5G services comprise local or wide-area cellular data connectivity based on 3GPP Release 15 or later, providing the next generation of cellular communications networking to follow 4G LTE. Providers will base services, such as new or enhanced end-user or IoT applications, on key 5G performance requirements of up to multigigabit mobile data throughput. Services will also be based on low-latency data transmission and support for massive deployment of machine-to-machine communications that are supported by Release 16 and later.

Position and Adoption Speed Justification: 5G is the most-searched term among networking technologies considered for Gartner Hype Cycles, based on a composite metric comprising Gartner search, Gartner inquiry, and Google trends. As of 2Q20, more than 70 service providers globally had launched commercial fixed or mobile wireless services using 3GPP-compliant 5G technology, according to the Global mobile Suppliers Association (GSA). Expanding network availability will keep 5G services moving rapidly through the emerging state. However, coverage will grow slowly in some regions and service providers have identified few use cases requiring 5G performance capabilities instead of widespread alternatives such as Wi-Fi or 4G LTE. Ratification of the next two 5G technology specifications, Releases 16 and 17, expected in 2020 and 2022, respectively, will bring significant performance improvements beyond data throughput. These will support ultra-low latency, massive coverage density for low-powered IoT endpoints and network slicing. Gartner still expects that by 2025, less than 45% of communications service providers (CSPs) globally will have launched 5G.

Early 5G launches, such the U.S. service by AT&T and T-Mobile U.S., focused on wide-area 5G coverage for general use cases using low- or midband spectrum in “non-stand-alone” architectures complemented by 4G LTE. Verizon Wireless initially focused on clusters of higher performance 5G coverage using millimeter wave spectrum requiring significantly more transmitters. SK Telecom’s initial launch supported a 5G smartphone for mobile service. Other CSPs, such as NTT DOCOMO, KT, Telstra, China Mobile, EE and Swisscom were among carriers that began providing similar services.

User Advice: 5G continues to suffer from immaturity, substantial hype and unrealistic expectations about features and availability sets, caused by infrastructure and service provider marketing. Enterprises must incorporate realistic networking assumptions for business plans by working with business leaders and network service providers to identify the availability of 5G at specific locations. Optimal 5G performance will require use of low- and midband cellular spectrum plus millimeter wave spectrum. We do not expect 5G using millimeter wave spectrum to become readily available outside of dense urban areas. Further, identify locations where available millimeter wave signals may encounter signal propagation challenges from obstacles such as building walls, window glass and heavy foliage.

Identify opportunities to pilot 5G networks and services to deliver innovation, based on current 5G capabilities, such as high-speed data. At the same time, identify applications where currently available service provider technologies (such as LTE-A) will support usage scenarios requiring up to 1 Gbps data speeds and latency up to 30 milliseconds.

For specialized local area use cases, identify situations in which private networks and future 5G features can be combined with edge computing to enable new business capabilities and integrate with innovation plans.

Service provider "5G service" actually will be based on an ecosystem of licensed, unlicensed and shared spectrum bands. Technologies will include not only proprietary prestandard specifications (such as Verizon's V5GTF), but also standards-based 5G New Radio, legacy 2G, 3G, 4G LTE, LTE Advanced (LTE-A), and Wi-Fi, providing mobile and fixed access services to a common core WAN service.

Business Impact: Gartner expects 5G services to be a key enabler of fixed and mobile enterprise IoT strategies (such as in manufacturing) that will require very low latency connections for large numbers of endpoints. 5G services will move beyond throughput improvements to address various new technical requirements and market drivers/expectations that take advantage of capabilities the 5G standards will define. These eventually will include narrowband IoT and LTE Cat-M1 capabilities for ultra-low-powered devices. Service providers also plan to include 5G as an element of SD-WAN offerings. New service providers also may emerge to utilize 5G features such as network slicing or "network as a service" for edge computing. Specific performance and cost impacts will remain unclear until CSPs refine their plan structures and prices beyond the initial commercial launches.

Benefit Rating: Moderate

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: AT&T; BT; China Mobile; EE; NTT DOCOMO; SK Telecom; Telstra; Verizon

Recommended Reading: "Innovation Opportunities Will Be Enabled As 5G Evolves Through 2025"

"Don't Expect 5G to Replace Wired Access WANs Anytime Soon"

"Four Key Ways Enterprises Should Plan for 5G"

Serverless Infrastructure

Analysis By: Arun Chandrasekaran

Definition: Serverless infrastructure is a model of IT service delivery in which the underlying enabling resources are used as an opaque, virtually unlimited, shared pool that is continuously available without advance provisioning and priced in the units of the consumed IT service. The runtime environment consisting of all the necessary underlying resources (specifically, the compute, storage, networking and language execution environment) required to execute an application or service are automatically provisioned and operated.

Position and Adoption Speed Justification: The term "serverless" is a misnomer, but serverless computing does transform how compute and associated resources are provisioned, operated and

consumed. The most prominent manifestation of serverless computing is serverless functions or fPaaS. With fPaaS, application code is packaged into fine-grained units called "functions," with the execution of these functions delivered as a managed service. The key benefits of serverless fPaaS are:

- Operational simplicity — It obviates the need for infrastructure setup, configuration, provisioning and management.
- "Built-in" scalability — In serverless functions, infrastructure scaling is automated and elastic, which makes it very appealing for unpredictable, spiky workloads.
- Cost-efficiency — In public cloud-based serverless environments, you only pay for infrastructure resources when the application code is running, which exemplifies the "pay as you go" model of the cloud.
- Developer productivity and business agility — Serverless architectures allow developers to focus on what they should be doing — writing code and focusing on application design.

Serverless delivery of IT services has gained broad notice after Amazon popularized its Amazon Web Services (AWS) Lambda function platform as a service (fPaaS). Although some associate the notion of serverless exclusively with fPaaS, the significance of serverless, as demonstrated by the leading vendors (including Amazon, Google and Microsoft), extends beyond functions to an operational model where all provisioning, scaling, monitoring and configuration of the compute infrastructure are delegated to the platform. Examples of such services include AWS Fargate, Amazon Simple Queue Service (SQS), Amazon Athena, Microsoft Azure Container Instances (ACI) and Google Cloud Run, to name a few. Hence, fPaaS is no longer the only form of serverless platform services.

User Advice: Serverless infrastructure does not spell the end of traditional I&O roles. However, it will significantly change the way I&O roles operate. Although perhaps counterintuitive, serverless does require operations but, instead of managing physical infrastructures, I&O leaders increasingly will have to adapt to new serverless realities by:

- Including the cost implications of event-driven application architectures and the pricing models of different vendors to ensure cost governance and budget control when planning for serverless deployments by considering API gateway, network egress and other costs.
- Revising data classification policies and controls to account for the fact that objects in a content store can now also represent code, as well as data.
- Rethinking IT operations from infrastructure management to application governance, with an emphasis on ensuring that security, monitoring, debugging and ensuring application SLAs are being met. In those cases where an on-premises deployment is merited, I&O teams can support fPaaS in the role of service provider.

Business Impact: New application architectures, such as microservice patterns, are enabling unique competitive differentiation for companies that can rapidly scale their applications with the continuous deployment of software features, a high level of resiliency and more automation. Serverless infrastructure, implemented on-premises or off-premises, enables applications to be built

quickly and deployed at a large scale. As such, it is suitable for any customer or web-facing activity in which speed of response and dynamic scalability are concerns. For variable workloads, serverless can be economical, compared with alternatives, due to its ability to provision and consume infrastructure resources only when they're needed. On-premises implementations are uncommon today due to data integration and scalability challenges.

To reap the benefits of serverless, organizations must invest time upfront to build a proof of concept (POC) to validate assumptions about the application design, code, scalability, performance and total cost of ownership.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Alibaba Cloud; Amazon Web Services; Cloudflare; Google Cloud Platform; IBM; Iguazio; Microsoft Azure; Oracle; Red Hat; VMware

Recommended Reading: "A CIO's Guide to Serverless Computing"

"2019 Strategic Roadmap for Compute Infrastructure"

"Evolution of Virtualization: VMs, Containers, Serverless — Which to Use When?"

IoT Services

Analysis By: Eric Goodness

Definition: IoT services encompass support, maintenance and professional services to provide a range of business and technical expertise in support of IoT plan, build and run services. Various frameworks, methodologies, and assets are within scope for IoT services. IoT services must be viewed within the broader remit of "digital services." The core outcomes of IoT services lie in the enablement of data acquisition and data contribution to broader digital business strategies.

Position and Adoption Speed Justification: Years of Gartner surveys continually point to the enterprises' lack of internal resources skilled in IoT technologies and how to apply and how to operationalize the integration of IT, OT and IoT. Adoption of ESPs for IoT services remains high in the market. There is a broad mix of providers, industrial equipment OEMs, traditional IT ISVs, IT and OT system integrators, niche IoT providers (hardware and software), offering a catalog of IoT services that spans:

- Advisory and consulting services that address business and technology issues.
- IoT-specific development and integration of legacy IT and OT, or ensuring that legacy enterprise applications benefit from IoT data acquisition.
- Installation and product support services aimed at the Microsoft Azure IoT Edge.

User Advice: Determining the suitability of the mix of providers is challenging for buyers. The market is fragmented and expertise is distributed unevenly. The leaders in IoT strategy lies with larger system integrators and consultancies. However, users have chosen to use the IoT platform vendors (of which there are hundreds upon hundreds of ISVs), no matter how small, as the main pool of ESPs for development and integration services. Maintenance and support services tend to be awarded to the device OEMs as a robust third-party maintainer (TPM) market has not emerged. Users must take steps now for your IoT service prioritization and provider selection process:

- Based on the defined business outcomes for adopting IoT, define the necessary IoT service requirements across the projects to determine when to contract an IoT service provider.
- Identify success metrics early and clearly to get POCs into field trials and production.
- Allow alternate mechanisms to achieve outcomes. This may require the abandonment of legacy vendor management approaches (e.g., approved vendor lists, RFP cycles) which threaten value recognition. The IoT is fueled by nontraditional service models, such as revenue sharing and contingent-fee contracts.

Business Impact: IoT contributes to digital business value propositions of "optimization" and "transformation" across all industries. Buyers seek IoT services to:

- Improve the processes related to strategy development, vendor due diligence and technology independent verification and validation relating to IoT technologies and business design patterns.
- Accelerate the time to solution to recognize internal (operations, processes) and external (market, customers) benefits.
- Reduce noncore resources and mitigate the risks of deployment, integration and support.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Accenture; Atos; AT&T; Cognizant; Hitachi; Insight; KORE; Vodafone

Recommended Reading: "Emerging Technologies: Combinatorial Digital Innovation Delivers Product and Service Leadership"

"Deploy Leaner AI at the Edge: Comparing Three Architecture Patterns to Enable Edge AI"

"Architecting Machine Learning With IoT"

"Market Opportunity Map: Commercial IoT, Worldwide"

"Market Opportunity Map: Industrial IoT, Worldwide"

Sliding Into the Trough

IoT Security

Analysis By: Barika Pace

Definition: Internet of Things (IoT) security works addresses software, hardware, network and data protection for digital initiatives involving IoT. The term is most often used in the context of business or marketing efforts, as opposed to cyber-physical systems security, which is a more descriptive and pragmatic term for security and risk practitioners. IoT security shares many of the same technologies and processes as IT, operational technology (OT) and physical security. IoT security provides safety, privacy and resilient for digital systems.

Position and Adoption Speed Justification: IoT security technologies and services are progressing but through the lens of a converging security ecosystem with end user and vendors seeking higher levels of integration with IT, OT and CPS solutions. IoT security continues to move at a modest pace. Areas such as digital trust, tamper-resistant device hardening techniques in hardware and firmware, secure cloud integration, remote access, device discovery, event detection and response systems, and improved consulting and system integration are contributing to the progress. Larger security providers continue to enter the market space and offer slightly higher levels of security product integration with IoT solutions. New IoT security technologies continue to emerge primarily as part of existing IT, OT and physical security technology refreshes. Increasing regulations (for example, GDPR and California's new SB-327 cybersecurity law) will continue to spur demand for IoT security products and services over the years to come. Over the past year these regulations and compliance requirements have fueled adoption. While merges and acquisitions this past year left some end users slower to adopt, the past is expected to remain on track through this current period. Furthermore, as the threat landscape continues to evolve, IoT security is maturing rapidly to address and adapt to the new threats, thus leading it into the adolescent phase, as demonstrated by increasing maturity in areas of safety and reliability.

User Advice: Security and risk management leaders, including business executives, chief digital officers, chief risk officers, chief information security officers (CISOs) and CIOs, should:

- Establish proofs of concept to discover, classify and manage all connected devices to ascertain risk landscape, raise organizational awareness and create business value by onboarding visibility tools that can have dual purpose for operational team
- Determine design gaps in capability, skills and infrastructure
- Elevate IOT security requirements into their enterprise risk management efforts by adopting an integrated security strategy across IT, IOT and CPS.
- Account for data privacy concerns brought about by the increasing regulations for IoT devices that process personal data
- Record all IoT assets, from sensors to large industrial equipment, and create visibility into their IoT networks and topologies

- Include IoT security into the expanding scope of responsibility now and into the future
- Prepare for increasing regulations by focusing on safety and privacy in IoT designs that safeguard data, people and the environment
- Analyze regulatory exposure to IoT security requirements
- Work on developing in-house IoT security expertise, including coordination with environmental, health and safety subject matter experts
- Invest in digital risk management to properly plan for IoT security in digital transformation projects
- Change governance and oversight of IT and OT projects to accommodate specific digital risk concerns that lead to IoT security decisions
- Restructure skill sets and support resources (that is, organizational accountability and responsibility) to accommodate differences in deployment and operation of digital initiatives requiring secure IoT systems
- Incorporate regulatory compliance requirements for IoT technologies within existing IT, OT, CPS and physical security regulation tracking and management.

Business Impact: High-profile cyberattacks can create compromises in verticals such as telecommunications, government, transportation, energy and utilities, and healthcare. Initiatives such as connected homes, smart cities, connected automobiles and medical devices are vulnerable as well. Cyberattacks have driven early IoT security spend in these verticals and initiatives. Growing attention and pressure from different layers of government may lead to potential regulations. The effects of cyberattacks also highlight the overlapping safety regulation and general safety management impacts of IoT security. In the short term, IoT security will continue to be the No. 1 barrier to entry to the IoT. In the longer term, these emerging security technologies will enable the IoT.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Adolescent

Sample Vendors: 802 Secure; Armis; Darktrace; Forescout Technologies; Infineon Technologies; IOActive; Microsoft Azure; Prove & Run

Recommended Reading: “How to Secure the Enterprise Against the Internet of Things Onslaught”

“IoT Solutions Can’t Be Trusted and Must Be Separated From the Enterprise Network to Reduce Risk”

“Market Trends: IoT Edge Device Security, 2020”

“Market Insight: Tech CEOs Must Act Before Convergence Kills Your Stand-Alone OT/IoT Product Solution”

"Focus More on the Realities of Cyber-Physical Systems Security Than on the Concepts of IoT"

Digital Business Transformation

Analysis By: Jorge Lopez; Kristin Moyer; Don Scheibenreif

Definition: Digital business transformation is the process of exploiting digital technologies and supporting capabilities to create a new, competitively robust digital business model.

Position and Adoption Speed Justification: Surveys of board directors and CEOs show that digital business remains a very high priority now. Digital business may include the adoption of new business and operating models and lead to business transformation (see "Four Definitions Make a Digital Business Strategy Process More Effective"). It stands in contrast to digital optimization, which is studied separately. The onset of a global pandemic in the first quarter of 2020 has, in a manner different from digital business and digital transformation, caused disruptions. These attacked expected revenue, excess costs and also narrowed the corporate mission in most cases. While in cases such as Amazon, the pandemic has actually driven revenue up. This has also been disruptive by causing major supply chain players like Amazon and Walmart to shift and grow resources and hiring to meet crisis needs.

As board directors turn to evaluate their own efforts on digital transformation, it is their conclusion that digital strategies are not yet well developed. They have also concluded that no major revisions to strategy instructions for the leadership team are in place, and they struggle seeing a return on investment on digital business (see "Toolkit: Presentation for Key Findings From the 2020 Board of Directors Survey").

As more regulations are changed in response to the global pandemic, it further accelerates the finding from the 2020 Gartner Board of Directors Survey that companies are planning to push regulatory boundaries to get to digital transformation. Expect aggressive thrusts to expand business boundaries even with the constraints introduced by the pandemic.

User Advice: CIOs leading innovation and strategic change can impact organization digital business transformation in the following ways:

- In the face of the global pandemic, as hard as it may be, start to think about, and plan for, the opportunity to capture new space as the situation goes from economic crisis to economic growth.
- Help your organization define its digital ambition at the executive level. Digital ambition is a clearly identified, desired digital outcome of a digital business strategy — shaped by a digital industry vision and an enterprise's response to that vision.
- Ensure that the organization understands the difference between digital optimization and digital business transformation, so a misunderstanding of these terms does not cause corporate executives to commit to a less ambitious strategy than the enterprise needs. Executives often believe they are pursuing digital business when they are really engaged in digital optimization.

- Recognize that digital business transformation requires business model change, and the value proposition is the foundation of a business model. Help the organization analyze dependencies across strategy, business models and operating models.
- Evaluate technology and service providers, in part, on the accurate use of the digital business transformation term. Misuse indicates a lack of understanding of digital business or an attempt to make conventional offerings sound more exciting. A common understanding of terms with vendors will help put initiatives and expectations in their proper context.

Business Impact: Digital business transformation is creating new industries and destroying old ones. This will happen if a competitor masters a significantly more efficient way of supplying a product and you are no longer competitive. It is changing the basis of competition in industry after industry. Not every organization needs to be the organization that is disrupting its industry. But every organization does need to have a strategy for how to deal with the realities of digital business transformation and how to create value in new ways.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Recommended Reading: "Four Definitions Make a Digital Business Strategy Process More Effective"

"4 Starting Points for Digital Business Transformation"

"How to Design Digital Business Transformation"

Digital Twin

Analysis By: Alfonso Velosa; Benoit Lheureux; Marc Halpern

Definition: A digital twin is a virtual representation of an entity such as an asset, person or process and is developed to support business objectives. The three types of digital twins are discrete, composite and organizational. Digital twin class elements include the model, rules, relations and data properties. Digital twin instance elements include the model, data, unique one-to-one association, and monitorability.

Position and Adoption Speed Justification: The idea of modelling people, physical assets, and processes continues to gain traction, especially as the architecture for the future of applications includes digital twins as features of an application, and as stand-alone supplements to portfolios of applications that address an entity.

- People: Digital twins are the evolution of trends including customer 360-degrees, patient electronic health records, and fitness monitors. Their near-term uses include health monitoring and employee safety, particularly in response to the pandemic.

- Physical assets: Digital twins adoption aligns to Internet of Things (IoT) trends. For owner/operators, near-term use includes lowering maintenance costs and increasing asset uptime for equipment users in factories, hospitals, utilities, etc. For product original equipment manufacturers (OEMs), near-term uses include product differentiation, business model differentiation through new product service models, and obtaining customer data.
- Processes: Digital twins are being developed to model IT organizations, financial exchanges, and processes such as purchase orders.

The digital twin profile has moved past the Peak of Inflated Expectations, based on enterprise confusion driven by conflicting vendor marketing and on challenges implementing digital twins. Gartner's CIO Survey 2020 shows that 6% of enterprises have implemented digital twins, although less than 1% of assets have digital twins. Another 41% of enterprises expect to deploy digital twins within three years. These trends lead us to shorten the time to plateau down to two to five years. In the next decade, digital twins will become the dominant design pattern for digital solutions.

User Advice: CIOs should work to guide and protect business adoption of digital twins:

- Business outcomes: Work with business leaders to establish clear business objectives for digital twins. In parallel, establish an IT vision for digital twins, to establish a coherent approach to support the business units.
- Technology: Start with models that are as simple as possible of the entities that are of interest for your business process, whether basic, such as the location of vehicles or a very high fidelity models of a human heart. Determine what data is necessary to "feed" the models and the types of analytics needed; a corollary here is the need to verify and drive data quality. Don't let the dearth of standards limit innovation. Assess how composite and organizational digital twins will require integration and custom development.
- Governance and accountability: Engage the business unit to identify champions, budget support, and to co-build the digital twin strategy and roadmap. Establish a joint business and IT governance process for digital twins, covering their alignment to business KPIs, short and long term value, and their updates and life cycle management.
- Digital ownership and ethics: Work with business and legal teams to establish a policy on ownership of the digital twin models and data, as well as who may participate. In parallel, establish a digital ethics policy to guide the organization to develop twins that positively support the enterprise while serving employees, customers or citizens. This policy will set guidelines to engage ecosystem stakeholders about what data may be shared and what monetization experiments to conduct.
- Vendors selection: Understand most technology providers are still developing their strategy and mostly offer enabling technology. A small number of technology providers have digital twin portfolios which align with specific vertical markets.

Business Impact: Digital twins are transformational as they enable business to drive new digital business models as well as update existing models. For example, they enable superior asset utilization, service optimization and improved customer experience. They create new ways to

operate, such as consumption of physical outcomes instead of the capital expenditure acquisition of industrial assets, or new ways to drive an ecosystem or supply chains. And they will open new ways to monetize data.

Digital twins will challenge most enterprises to change their thinking of master data from an IT practice to one that engages the business units and IT to get a more comprehensive situational awareness of assets, people, or processes. In addition, a digital twin can be expensive to maintain, and its value centers on remaining a live model, synchronized with the entity.

Benefit Rating: Transformational

Market Penetration: 1% to 5% of target audience

Maturity: Emerging

Sample Vendors: AVEVA; Bentley Systems; C3.ai; Cognite; GE Digital; Mavim; Microsoft; QPR Software; Schneider Electric; ThoughtWire

Recommended Reading: "Market Guide for Digital Twin Portfolios and Enabling Technologies"

"Survey Analysis: IoT Digital Twin Adoption Proliferates Across Many Sourcing Options"

"Toolkit: Enterprise Readiness for Digital Twin Deployment"

"Market Trends: Software Providers Ramp Up to Serve the Emerging Digital Twin Market"

"Software Product Managers Should Exploit the Full Revenue Potential of Digital Twins"

Outcome-Based Service Contracting

Analysis By: Eric Goodness

Definition: Outcome-based service contracting is the award of IT/OT support and professional services, associated with business processes, to an external provider. Commercial terms are tethered to user prescribed metrics and objectives, and vendor compensation is based primarily on contracted outcomes. The trigger for increasing adoption of outcome-based services, with more impactful remediation for nonperformance, lies in the adoption of asset and process-related data based on the deployment of remote data acquisition and control.

Position and Adoption Speed Justification: The greatest challenges to creating outcome-based service contracts include:

- Finding providers with the requisite business and sector acumen, processes and systems to guaranteed outcomes that span IT and OT requirements (assets and processes).
- Defining and negotiating substantive and actionable nonperformance criteria for a provider.
- Lack of alignment between users and external service providers on expected business outcomes due to inadequate statements of work, indefinite terms relating to disputes on contingent fees, and lack of equitable criteria to measure success.

- Vendor managers and procurement teams that create RFPs are risk-averse to new contracting styles and pricing methodologies. Additionally, outcome-based service contracts are more complex and there needs to be multiple stakeholders involved, such as finance and operations.

Most nonperformance agreements are based on benign enforcement mechanisms focused on vendor absolution rather than meaningful assessment of penalties. New outcome-based contracts require ESPs to augment their systems and processes to translate the impact of IT/OT/IoT services management based on business opportunity and real dollars to business units, personnel, the general ledger, and the top and bottom lines.

When the organizations represented by the CIO, CFO and COO are collectively represented in the development of services outcomes, the potential for business value, beyond cost reduction and containment, is transformational. In the near term, the pool of vendors investing in the processes and technologies to recognize such transformational value is modest. Investment of IoT (as a bridge between IT and OT) is most often executed in a fragmented or "stove-piped" manner among independent centers of excellence and business units within many companies. Therefore, Gartner believes that the time to plateau for "real" outcome-based services will take more time to reach the market. It is also increasingly clear that the success of outcome-based services, which includes IoT-enabled product as a service, is increasingly dependent on the emergence of a new class of financial intermediary to underwrite user investment and manufacturer risk.

User Advice: Outcome-based service contracting, often referred to as "outcome-based procurement," has existed in many forms as outsourcing preferences and delivery models have changed during the past 15 years. The reemergence of contracts based on definable and measurable outcomes has found the greatest traction in the managed service market. Providers blend IT- and IoT-technology-based services and personnel — such as real-time monitoring, service management, service and process automation, and full-time-equivalent-based root cause analysis — to achieve results. Typically, outcomes have taken the form of service-level guarantees by individual IT elements (such as per active port, per instance and per virtual machine). As users demanded more business value beyond IT performance and availability, continual service improvement within managed service agreements augmented standard SLAs to achieve targeted outcomes. Such challenges will only increase as enterprises build out digital business platforms that create dependencies for the business, and the platform is extended to third parties that comprise its digital ecosystem.

Sourcing leaders must connect with the leaders of, or change agents responsible for, business-focused innovation and digital initiatives within their organization to ensure that outcome-based service contracting is understood and considered by business unit teams, enterprise architects and IT leaders. Outcome-based services contracting is an achievable goal among providers that have invested in platform-centric capabilities to monitor and manage technology elements of IoT solutions. The general requirements include the capabilities to measure, rate and meter platform and systems utilization and health; and technology and business transactions.

Business Impact: The new form of outcome-based service contracting will require ESPs to augment their systems, processes and personnel to incorporate and recognize IT and IoT data,

events and incidents. They will also need to translate their impact — in terms of opportunity and real costs — on the business. KPIs for performance vs. nonperformance must be set.

The benefits of outcome-based service contracting will be transformational in terms of costs and impact to the enterprise. Early examples have confirmed improvements in customer satisfaction, alignment of pan-enterprise requirements and reduction in costs (capital and operational expenditures and ultimately profits), risk mitigation, and improvements in processes (elimination of time waste and improved process outcome). Gartner expects the market pressure to invest and innovate in the next generation of outcome-based service contracting will take two to five years. Many service contracts are currently based on SLAs, where true outcome-based service contract outcomes are directly tied to real business metrics, enabled by digital business/IoT.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Accenture; Beam Dental; BOGE; Cognizant; Genpact; Hartford Steam Boiler; Philips Healthcare; TenFour; Xylem

Recommended Reading: "Emerging Technologies: Combinatorial Digital Innovation Delivers Product and Service Leadership"

"Deploy Leaner AI at the Edge: Comparing Three Architecture Patterns to Enable Edge AI"

"Architecting Machine Learning With IoT"

"Market Opportunity Map: Commercial IoT, Worldwide"

"Market Opportunity Map: Industrial IoT, Worldwide"

SDx Consulting Services

Analysis By: Mark Ray

Definition: Software-defined anything consulting services provide expertise that enables the use of software-defined capabilities in the data center and in storage (infrastructure), networking and security and continues to expand into edge and cloud. SDx consulting provides architectural design, roadmap and implementation capabilities for IT organizations that seek to achieve infrastructure agility.

Position and Adoption Speed Justification: The fundamental principle of a software-defined anything (SDx) architecture is the migration of IT services from hardware into software. By extracting services that were previously bound to hardware from a specific vendor, IT organizations can leverage commodity hardware and software-only solutions. Software-defined services are key enabling technologies for automation, hybrid clouds and edge infrastructure, which continues to drive demand. SDx autoprovisioning and policy-based orchestration help deliver improved

standards for infrastructure programmability and data center interoperability. These are enabled by automation and support DevOps, and fast infrastructure provisioning.

Many vendor-offered SDx solutions are integrated, all-encompassing product offerings currently available with varying degrees of capabilities. However, some software-defined offerings lack cross-silo interoperability, automation and integration unless provided by a single provider. SDx products are highly complex and ever-changing, creating a need for well-versed professionals to continually optimize their use.

To create the interoperability required for SDx success, expertise of a consultancy is required. Most traditional data center outsourcing vendors and many specialty shops have SDx consulting services. Some can offer SDx as part of their data center modernization and cloud strategies and have initiatives of their own. SDx consulting has continued to evolve rapidly over the last year. This rapid growth will continue for the next two to five years as organizations seek to achieve the potential cost savings and efficiencies promised from SDx. The SDx consultancies that achieve substantial growth will have demonstrated the ability to deliver faster provisioning and integration with DevOps while circumventing the obstacles.

User Advice: We recommend the following:

- Engage with consultants or other types of solution providers to understand the state of the market and the potential benefits of employing SDx, as well as navigate the complexity of the products and interoperability.
- Focus on northbound and southbound APIs and interoperability orchestration to improve service levels, improve data protection and confidentiality, improve resiliency and reduce capital expenditure (capex) and operating expenditure (opex).
- Build an SDx strategy document. SDx deployments are a journey crossing multiple groups and technology silos such as IT operations, business application developers, procurement and cloud teams.
- Deploy SDx solutions for tactical gain and business advantage associated with speed and agility. Be cautious of implementing SDx initiatives driven solely by consultancies, system vendors and their go-to-market providers.
- Look for reuse of SDx skills between projects — initially for monitoring and high-level alerts — building up into more detailed recovery SLAs. Leverage SDx from on-premises data centers to edge and hybrid-cloud environments.
- Develop a documented cloud deployment and transition strategy to more effectively gauge the value of SDx for both predictability and safety (Mode 1), as well as, exploration and agility (Mode 2) applications.

Business Impact: The migration of services from hardware-based implementations to software can deliver greater business value and agility, and reduced complexity and increased automation. However, many of the software-defined product offerings still lack enterprise-class maturity, and more importantly, they lack interoperability. SDx has the potential to significantly reduce both capex

and opex. The use of a specialist consultancy to guide the design and implementation can reduce risk and ensure that any operational and technical changes allow future developments to be integrated. The growth of private and public cloud service providers as well as edge capabilities is accelerating the growth of SDx, as most providers are investing in SDx.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Sample Vendors: Accenture; Atos; Capgemini; Dimension Data; DXC Technology; HCL Technologies; IBM; PwC; Rackspace; Tata Consultancy Services (TCS)

Recommended Reading: "Magic Quadrant for Data Center Outsourcing and Hybrid Infrastructure Managed Services, North America"

"Solution Comparison for Four Hyperconverged and Software-Defined Infrastructure Solutions"

"A Guidance Framework for Implementing Software-Defined Infrastructures"

"Magic Quadrant for Public Cloud Infrastructure Professional and Managed Services, Worldwide"

"The Future of Software-Defined Storage in Data Center, Edge and Hybrid Cloud"

Digital Business Consulting Services

Analysis By: Chrissy Healey; Brendan Williams

Definition: Digital business consulting services (DBCS) are consulting services with the objective of generating increased business value by using digital technologies to optimize clients' operating models and/or transform business models. These services include digital strategy and design, digital operations improvement, digital employee experience, digital customer experience, digital product and service innovation, and digital business model transformation.

Position and Adoption Speed Justification: Eighty-two percent of those surveyed in Gartner's 2020 Gartner CEO and Senior Business Executive Survey indicated plans to increase investment in digital capabilities. Relatively few organizations have embarked upon comprehensive, top-to-bottom digital transformation. Focused projects are common, usually digital customer experience and digital strategy initiatives. Many organizations continue to struggle with execution of digital strategies, most often due to internal hurdles like talent, culture, and technical debt and external hurdles like regulatory and political uncertainty. Yet, pressures from board leaders, investors, competitors, vendors, and clients are a catalyst for businesses to transform. Even in an economic downturn, 52% of organizations said they would increase speed of digital business initiatives. While demand has slowed in some areas, these organizations are seeking help from digital business consultancies to scale their digital initiatives across lines of businesses and geographies and to extend activities across more of their business processes (each of which is reflected by the six key DBCS service lines).

User Advice: Organizations must factor digital into corporate strategy to meet business priorities to identify and capture cost efficiencies, alongside profitable growth. Across all industries and countries, these organizations seek to take advantage of the opportunities and mitigate the risks presented by the shift to digital business. Yet, those stating digital business investments have been better or exceeded expectations over the last three to five years were just 20% in Gartner's 2020 CEO and Senior Business Executive Survey. Forty-eight percent indicated results have been in-line with expectations. As organizations seek to transform to meet the challenges of the current economic environment, they are adjusting their business models. Fifty-nine percent of those surveyed indicated they are planning significant changes to their business models in one or more areas. Consulting providers have responded to this rising demand with increasingly sophisticated offerings aimed at helping these organizations achieve their digital business ambitions, while managing the change required.

Digital technologies such as predictive analytics, artificial intelligence, cloud service portfolios, and the IoT have incredible potential, but are not magic solutions. Many organizations are finding that implementing these technologies is harder in practice than they were led to believe. The hype surrounding the transformative technologies underpinning DBCS has served to obscure the reality. Organizations who are considering using DBCS should:

- Involve in the buying team visionary leaders of the business functions that will be impacted by changes envisioned in the DBCS project, to ensure successful buy-in post project.
- Demand that their providers also bring fundamental business consulting capabilities, such as business process improvement, organizational design, and above all, cultural change, alongside driving current and future technology vision.
- Select a provider that includes in its solution an approach for building skills which will enable and drive transformative change when the provider finishes the project.
- Seek providers that are investing in intellectual property and assets that can accelerate and bring a data-centric approach to DBCS opportunities.

Business Impact: In 2020, primarily those who are seeking DBCS are large enterprises and government agencies. Small and midsize organizations remain a challenge for many providers to broadly reach in terms of scaling sales effort and pricing accordingly.

Thus, current market penetration is primarily from:

- New business with large enterprise and government entities, first-time buyers of DBCS.
- New business in the same area with existing buyers (e.g., scaling up a digital CX pilot).
- New business in a new area with existing buyers (e.g., previously digital CX, but now have initiatives in other areas of business).

As enterprise organizations and government entities continue to see success, the full market for DBCS, which includes small and medium enterprise organizations and government entities, will further open. Additionally, the rise in the use of assets, digital platforms, and automation is starting to increase the ability of DBCS providers to serve the small and medium enterprise markets.

Benefit Rating: Transformational

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Accenture; Boston Consulting Group; Capgemini; Cognizant; Deloitte; EY; KPMG; McKinsey & Co.; PwC; Tata Consultancy Services

Recommended Reading: "Forecast Analysis: Digital Business Consulting Services, Worldwide"

"In an Economic Slowdown, Consulting Product Managers Should Target CEOs With Prior Digital Business Success"

"Market Share Analysis: Consulting Services, Worldwide, 2019"

IoT Networking

Analysis By: Bill Menezes; Tim Zimmerman

Definition: Internet of Things networking is the communications infrastructure to support enterprise IoT initiatives, specifically how "things" and their related distributed, edge and cloud platforms connect through the enterprise network. Wireless is a strategic technology component of most IoT projects, although the IoT network may connect fixed or mobile endpoints over a wide-area, local or short-range network.

Position and Adoption Speed Justification: Gartner forecasts that the installed base of Internet of Things (IoT) endpoints in service will grow to about 16.6 billion by YE29. That would be an 11% CAGR for IoT devices attached to the enterprise network, moving IoT networking on the Hype Cycle into an Early Mainstream technology. Enterprise IoT architectures that are based on combinations of endpoints, gateways and cloud infrastructure require diverse network connectivity to achieve the IoT deployment's targeted business outcome. Increasingly prevalent are IoT edge architectures serving as a decentralized extension of an IoT platform and defining how data generated by sensors or other "things" gets aggregated and integrated at the edge of a cloud, data center or campus network. Connectivity among components of such an architecture — endpoint "things," gateways, controllers — is an essential element of such architectures. Planned enhancements to 5G cellular to support low-powered, narrowband endpoints as well as updates to Wi-Fi and non-Wi-Fi standards will further support diverse IoT implementations. However, the challenges of attaching billions of devices to the enterprise network, with differing provisioning, security, monitoring and management requirements, keep this moving quickly into the Trough of Disillusionment.

User Advice: Identifying the most appropriate network technology in terms of performance, cost and availability is a critical execution factor. IoT-enabled solutions are typically purpose-built with many variables that stress the functional limits of current enterprise IT infrastructures. Each vertical market ecosystem solution has a different set of hardware vendors, service providers, system integrators and skill sets that must coexist within the enterprise. A cohesive networking strategy is therefore essential, given the numerous options for connecting IoT devices, applications, storage and other components.

Effective implementations require organizations to:

- Understand the proper networking architecture that is needed to communicate the IoT data, recognizing that on-premises Wi-Fi and cellular solutions require different components.
- Calculate the varying performance, total investment and operating costs of options. These include Ethernet LAN; wireless LAN based on such technologies as 802.11ac/ax or Zigbee; 3G/4G/5G cellular, including low-power wide-area and LTE machine-type communications; broadband or narrowband satellite; and short-range PAN platforms such as Bluetooth, NFC and 802.1ad.
- Assess the impact of IoT usage on the enterprise network infrastructure for on-premises and cloud-based application requirements by modeling scenarios of complexity and growth projections.
- Modify network policies by analyzing how multiple projects will consume enterprise network resources and how they will be secured. By 2021, more than 60% of all IoT devices on enterprise infrastructure will be "virtually segmented" from traditional business applications, up from less than 5% in 2018.
- Plan for continued IoT evolution by developing a combined strategic networking roadmap for the integration of IoT components in conjunction with network advancements.

Business Impact: Successful IoT initiatives require well-planned network connectivity. IoT networking choices will impact the project's implementation and operating costs as well as its ability to achieve the initiative's targeted outcomes. Effective network choices also are dependent on the project's architecture domain: machine-to-machine, vertical market-specific or industrial IoT and building automation. The architecture's impact on the enterprise network is critical to realize the opportunities IoT presents for cost optimization, product refinement and new revenue models.

IoT projects, including headless devices (such as smart readers and sensors), will add many new endpoints to the enterprise network, requiring efficient methods for registering, onboarding and management. Further, not all devices will attach the same way or via the same architecture, creating the need to address differing provisioning, security, monitoring and management requirements.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Sample Vendors: AT&T; Cisco; Hewlett Packard Enterprise (HPE); Sigfox; Verizon; Vodafone

Recommended Reading: "IoT Solutions Can't Be Trusted and Must Be Separated From the Enterprise Network to Reduce Risk"

"Magic Quadrant for Managed IoT Connectivity Services, Worldwide"

"2019 Strategic Roadmap for IoT Network Technology"

"Market Definitions and Methodology: Internet of Things Forecast"

Hybrid Cloud Computing

Analysis By: David Smith; Milind Govekar

Definition: Hybrid cloud computing comprises public and private cloud services that operate as separate entities, but are integrated. A hybrid cloud computing service is automated, scalable and elastic. It has self-service interfaces and is delivered as a shared service using internet technologies. Hybrid cloud computing needs integration between the internal and external environments at the data, process, management or security layers.

Position and Adoption Speed Justification: Hybrid cloud theoretically offers enterprises the best of both worlds — the cost optimization, agility, flexibility, scalability and elasticity benefits of public cloud, in conjunction with the control, compliance, security and reliability of private cloud. As a result, virtually all enterprises have a desire to augment internal IT systems with external cloud services. The solutions that hybrid cloud provides include service integration, availability/disaster recovery, cross-service security, policy-based workload placement and runtime optimization, and cloud service composition and dynamic execution (for example, cloudbursting).

Hybrid cloud computing is different from multicloud computing, which is the deliberate use of cloud services from multiple public cloud providers.

A hybrid cloud computing architecture complements multicloud computing. Although most organizations are integrating applications and services across service boundaries, we estimate approximately 15% of large enterprises have implemented hybrid cloud computing beyond this basic approach — and for relatively few services. This decreases to fewer than 10% for midsize enterprises, which mostly are implementing the availability/disaster recovery use case. Most companies will use some form of hybrid cloud computing during the next two years, but more advanced approaches lack maturity and suffer from significant setup and operational complexity. Hybrid cloud is different from hybrid IT, which is where IT organizations act as service brokers as part of a broader IT strategy and may use hybrid cloud computing. Hybrid IT can also be enabled by service providers focused on delivering cloud service brokerage, multisourcing, service integration and management capabilities to customers building and managing an integrated hybrid IT operating model. These services are provided by vendors (such as Accenture, Wipro and TCS) and other service providers and system integrators.

Microsoft's Azure Stack Hub, Google's Anthos, VMware's hybrid cloud portfolio, and AWS's Direct Connect and Amazon Virtual Private Cloud (VPC) are all attempts to support hybrid cloud implementations. Red Hat's OpenShift and Pivotal Web Services are attempts to support hybrid PaaS implementations.

As more providers deliver hybrid cloud offerings, they are increasingly delivering a packaging of the concept. "Packaged hybrid" means you have a vendor-provided private cloud offering that is packaged and connected to a public cloud in a tethered way. Azure Stack from Microsoft is a good example of this packaging, but there is another approach as well. We call these two main

approaches “like-for-like” hybrid and “layered technology” hybrid (spanning different technology bases). Packaged hybrid cloud is a key component of the distributed cloud concept.

User Advice: When using hybrid cloud computing services, establish security, management, and governance guidelines and standards to coordinate the use of these services with public and private applications and services to form a hybrid environment. Approach sophisticated cloudbursting and dynamic execution cautiously, because these are the least mature and most problematic hybrid approaches. To encourage experimentation and cost savings, and to prevent inappropriately risky implementations, create guidelines/policies on the appropriate use of the different hybrid cloud models. Coordinate hybrid cloud services with noncloud applications and infrastructure to support a hybrid IT model. Consider cloud management platforms, which implement and enforce policies related to cloud services. If your organization is implementing hybrid IT, then consider using hybrid cloud computing as the foundation for implementing a multicloud broker role and leveraging hybrid IT services and service providers to complement your own capabilities.

Business Impact: Hybrid cloud computing enables an enterprise to scale beyond its data centers to take advantage of the elasticity of the public cloud. Therefore, it is transformational when implemented, because changing business requirements drive the optimum use of private and/or public cloud resources. This approach improves the economic model and agility. It also sets the stage for new ways for enterprises to work with suppliers and partners (B2B) as well as customers (B2C), as these constituencies are also moving toward a hybrid cloud computing model.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Alibaba Cloud; Amazon Web Services (AWS); Google; Hewlett Packard Enterprise (HPE); IBM; Microsoft; Oracle; Rackspace; Red Hat; VMware

Recommended Reading: “The State of Hybrid Cloud”

“Market Guide for Managed Hybrid Cloud Hosting, North America”

“Prepare for AWS Outposts to Disrupt Your Hybrid Cloud Strategy”

“Utilizing Hybrid Architectures for Cloud Computing”

“Top 10 Strategic Technology Trends for 2020: Distributed Cloud”

“I&O Leaders Must Plan for Hybrid Cloud Orchestration”

“Cloud Adoption Is Driving Hybrid WAN Architectures”

Predictive Support

Analysis By: Christine Tenneson; Rob Addy

Definition: Predictive support provides real-time incident prevention based on continuous remote monitoring and anomaly detection. Predictive support prevents service-impacting events and incidents, as well as guarantees performance and availability. Using automation, predictive services reach out to customer contacts before specific unknown or unpredictable issues manifest. Service providers proactively attempt to eliminate causes and mitigate contributory factors where feasible within the scope of the defined support or managed service contract.

Position and Adoption Speed Justification: Predictive support offers more than the enhanced incident management that proactive support provides on a per-element basis. Predictive support provides automated incident prevention. It leverages monitoring, event correlation and root cause analysis on a systemwide basis to predict future performance and eliminate future issues.

When unavoidable issues are identified, predictive services ensure customers are automatically notified ahead of time. Predictive support is a product-based support service aimed at increasing the level of return from the customer's specific technology investment under support while minimizing planned and unplanned operational costs. Real-time monitoring remains a cornerstone of predictive support offerings. Monitoring on its own is still not enough, and monitoring results need to be checked against historic data patterns using analytical techniques to find emerging issues. Predictive support may be included in a product support contract or may be an element of a managed service contract.

Organizations that want to derive the benefits of predictive services must participate in the process with the OEM or channel partner. Acceptance of this new operations model is beginning to be seen, as a growing percentage of organizations give their providers the visibility and access required.

We position this technology on the Hype Cycle in the Trough of Disillusionment based on the adolescent deployment of the technology and the minimal but growing penetration across the vendor landscape.

User Advice: Support customers:

- Conduct detailed reviews to determine if the vendor solution is operating in real time to detect yet-unknown problems and intervening to remove the defects.
- Challenge your support providers to quantify how predictive services improve system performance and availability. Service providers will have demos of dashboards and will also be able to show examples of reports used to articulate the value of the service.
- Balance the potential operational impacts of system failures against the higher costs of predictive services when deciding where to deploy predictive services.
- Request comparative customer performance and experience data from providers so you can see how the predictive support experience differs from other support options.

- Establish the foundation for a trust-based relationship with key support providers, which will be necessary to fully leverage predictive support services.
- Be prepared to open your corporate firewall to enable real-time monitoring of, and direct provider intervention to, mission-critical production systems.

Business Impact: Businesses looking to take advantage of prevention-based services must accept that they will have to spend more and work closely with their provider to realize the benefits. This requirement for greater involvement will deter many. However, the upside is significant. Those that are ready, willing and able to play their part in predictive support processes will benefit in many ways. Predictive support services help organizations avoid the pain, frustration and costs associated with system failures. They also help organizations realize a greater return from their technology investments. Total cost of operations reduction will be the primary driver for most adopters, but that is only the beginning.

Traditional total cost of ownership models often neglect to include the full life cycle costs associated with technology failures. The true costs of an IT system go far beyond those associated with purchasing, implementing and running it.

Predictive support services have the potential to dramatically reduce or eliminate these "hidden" costs, while increasing stability and driving higher returns from legacy technology investments.

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Cisco; Citrix; Cloudera; Dell Technologies; Hewlett Packard Enterprise; IBM; Juniper Networks; Pure Storage; Red Hat; SAP

Recommended Reading: "Market Share Analysis: Hardware Support Services, Worldwide, 2018"

"Toolkit: Buying the Right SAP Maintenance and Support Service Will Help Optimize Your Costs"

Cloudbursting

Analysis By: Ed Anderson

Definition: Cloudbursting is the use of an alternative set of public or private cloud services as a way to augment service capacity and respond to increases in IT system requirements. Cloudbursting can occur between on-premises IT environments and public or private cloud environments, across cloud providers or across resource pools of a single provider.

Position and Adoption Speed Justification: Cloudbursting is based on the concept of utilizing cloud services as a way to rapidly add resource capacity when applications or services experience spikes in demand. Cloudbursting is seeing a resurgence as applications are implemented using container-based models and microservices architectures. The growing preference for hybrid and

multicloud strategies increases the value of cloudbursting across systems. Cloudbursting is implemented as a type of autoscaling where applications scale across system boundaries. Although cloudbursting includes any scenario where cloud services are allocated in an on-demand fashion when additional capacity is required, cloudbursting also includes scenarios where less critical resources are moved to a cloud service in order to free up capacity for critical on-premises workloads.

Cloudbursting has historically been a manually-initiated process, however, with the development of more sophisticated cloud management and orchestration tools, cloudbursting can become automated through the use of triggers and service governor technology for the following roles:

- A provisioning time placement role
- A runtime movement role
- A runtime expansion role

The provisioning time placement role is the easiest to implement because services are placed based on available capacity and policy. The runtime movement role is harder, may require some downtime and will be less common because moving services between cloud environments and across different providers can be complex. The runtime expansion role requires applications to be specifically written or adapted to cloudbursting, such as scale-out web architectures or batch-computing jobs that can disperse workloads in parallel across distributed resource pools. If a microservices architecture is established on the target system, runtime expansion is much easier. Most legacy applications have storage and database architectures that cannot be easily adapted to geographically dispersed data centers. Likewise, networking challenges, including latency issues, can make cloudbursting unfeasible.

Barriers to cloudbursting usage include the lack of cross-platform cloud API standards, inadequacy of application instrumentation and management tools, networking latency between data centers, identity and security limitations, configuration management, technology license restrictions, and incompatible application architectures. Standardization of application models and the use of technologies that facilitate application migration, such as containers, can mitigate some of the cloudbursting challenges. While some organizations (mostly large organizations) report the use of cloudbursting, the actual number of applications and services that make use of cloudbursting is small.

The rising use of multicloud and distributed cloud architectures has renewed interest in cloudbursting as a means to leverage cloud capacity and capabilities across cloud environments. Distributed cloud offerings such as AWS Outposts, IBM Satellite, Microsoft Azure Stack and Oracle Cloud at Customer will drive cloudbursting scenarios. Additionally, platform abstraction technologies such as IBM/Red Hat OpenShift, Google Anthos, VMware Tanzu and others help establish a common set of capabilities across cloud and non-cloud environments and theoretically simplify cloudbursting across these systems.

User Advice: Cloudbursting is often cited as a key use case for hybrid cloud or multicloud environments. In practice, cloudbursting remains an aspirational notion for most organizations

because of the difficulties in implementing cloudbursting. Use cloudbursting in situations where there is notable benefit to offset implementation cost and complexity:

- Select workloads and applications that are conducive to scale out execution using parallel and distributed processing models and which experience periodic spikes in resource requirements.
- Do not assume that cloudbursting will become a broadly viable approach for cross-cloud workload portability and expansion, even when hyped technologies such as "containers" and multicloud management solutions are used.
- Determine which applications will get real value from cloudbursting and whether these applications meet the technical criteria and constraints for implementation.
- Leverage cross-platform abstractions to increase compatibility between systems.
- Implement cloudbursting as an automated, operational process that can dynamically identify cloudbursting opportunities and automatically initiate cloudbursting.
- Implement robust network connectivity between cloud environments where cloudbursting is expected to occur.
- Carefully evaluate the financial implications of cloudbursting; there may be significant costs associated cloud resource consumption as well as increased networking costs.

Business Impact: Cloudbursting has the potential to reduce the overall cost of supporting applications by dynamically provisioning computing resources on-demand using cloud resources. This is particularly true for workloads with variable resource demands. Cloudbursting makes use of cloud services to satisfy capacity overflow for on-premises and cloud-based workloads.

Benefit Rating: Moderate

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Sample Vendors: Amazon Web Services; Dell; Flexera (RightScale); Google; Hewlett Packard Enterprise; IBM; Microsoft; Nutanix; Red Hat; VMware

Recommended Reading: "Revisiting the Top 10 Cloud Myths for 2020"

"Define and Understand New Cloud Terms to Succeed in the New Cloud Era"

"'Distributed Cloud' Fixes What 'Hybrid Cloud' Breaks"

"Top 10 Technologies That Will Drive the Future of Infrastructure and Operations"

Intelligent Automation for Infrastructure Managed Services

Analysis By: David Groombridge; Stephanie Stoudt-Hansen

Definition: Gartner uses the umbrella term "intelligent automation" to cover a variety of strategies and technologies. These range from rapid-automation technologies (i.e., robotic process automation software or scripting) to AI approaches, such as deep learning, machine learning, cognitive techniques, NLP, speech recognition and synthesis, machine vision, and machine reasoning. Intelligent automation (IA) for infrastructure managed services is the application of these technologies to IT infrastructure operations, delivered through managed services.

Position and Adoption Speed Justification: Infrastructure service providers continue to enhance their automation capabilities and embed IA deeper in their existing infrastructure services. Where service delivery relies on knowledge workers, IA can be used instead for routine parts of that work, reducing human effort, potential errors and thus cost. Within service desk provision, leading providers can use analytics capabilities to reduce the occurrence of incidents by 30% to 80% for some clients, and then resolve 15% to 25% of the remaining tickets without human intervention. In addition, global outsourcers can automate 80% to 95% of the provisioning and management of hybrid infrastructure services using tools that learn and automate the required operational activities. This automation is now extending further into related services such as application administration and security services.

Penetration of these services into enterprises is increasingly common but not yet universal, with existing contracts often seeing little change until renewal. Most leading infrastructure services providers now have their own automation tools, which provide integration and orchestration of third-party automation tools. This has allowed providers to expand their capabilities from simple task automation, into process automation and orchestration, spanning complex operational processes. Some providers are also beginning to sell their automation tools as stand-alone solutions, and offer outcome-based "automation-as-a-service" offerings, which are only paid for on the basis of cost reductions achieved. As such service providers continue to make substantial investments in these services, they will evolve rapidly and become core parts of all infrastructure service offerings within a few years.

User Advice: Organizations buying infrastructure managed services have come to expect their service providers to offer year-over-year savings, with step-down pricing during multiyear contracts. In the past, providers delivered this through industrialization of services and use of low-cost labor in a global delivery model. Increasingly, though, buyers should expect that savings will now be achieved by "automation arbitrage," in which intelligent automation replaces a substantial part of the human labor in provider offerings. In comparing providers' offers, sourcing, procurement and vendor management leaders should evaluate the use of intelligent automation in infrastructure managed services by seeking concrete pricing and quality commitments from service providers in the form of outcome-based contracts. In particular, with lower labor usage, an added benefit of higher quality from reduced errors should be reflected in ongoing improvements in contractual SLAs.

The critical component needed to make intelligent automation work is a substantial and detailed data record. For infrastructure managed services, AI systems will learn by tracking the actions of engineers during incident resolution, and by reading and identifying patterns in logs of incident, change or other data from the recent past, and how each was addressed. Organizations preparing for increased use of AI now and in the future should:

- Ensure that all log data and any related metadata is contractually available to their organizations in the future, even if an external service provider currently maintains it. Furthermore, the contract must require such data to be comprehensive, clear and complete through defined quality criteria.
- Incorporate step-down forward pricing in contracts, coupled with regularly-increasing targets for SLAs, predicated on the use of additional automation.
- Track the percentage of automated processes in any managed service monthly, to avoid the provider trying to deliver annual cost reductions by cutting staffing levels without automating.

Business Impact: Intelligent automation in infrastructure managed services offers a number of potential benefits. Gartner expects contracts containing intelligent automation to show annual cost savings of 2% to 8% for commodity services, depending on the specific service and the extent of its use. Furthermore, it will become easier in the future for businesses to scale to new business demand by rapidly deploying new instances of intelligent automation rather than hiring new people. In addition, such intelligent automation will not require annual pay raises or additional hiring due to staff turnover. The intelligent nature of the automation also generates analytical insights that allow for proactive and preventative maintenance actions, to help reduce system downtime and impact to users. This combination of rapid scaling, multi-language, reduced business impact and repeatable quality that intelligent automation delivers, along with the ability to refocus remaining staff on more value-added business needs, in turn drives improved user satisfaction and SLA delivery.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Adolescent

Sample Vendors: Accenture; Atos; Cognizant; Fujitsu; HCL Technologies; Hexaware; IBM; Tata Consultancy Services; Tech Mahindra; Wipro

Recommended Reading: “Market Guide for Intelligent Automation Leveraged for IT Managed Services”

“Scale Infrastructure Operations With Intelligent Automation and a Central Knowledge Unit”

Cloud Service Brokerage

Analysis By: Sid Nag

Definition: Cloud service brokerage combines technology, people and methodologies to help organizations consume cloud services. Cloud service brokerage is defined as an IT role and business activity in which a company or internal entity adds value to one or more (public or private) cloud services. This is done on behalf of one or more consumers of that service by providing an aggregation, integration, customization and/or governance role. CSB enablers provide technology to support cloud service brokering activities.

Position and Adoption Speed Justification: With cloud computing already being mainstream, especially the adoption of multicloud models, the adoption of cloud service brokerage (either taken on internally or outsourced to a service provider) continues to increase. This has cloud service brokerage (CSB) moving steadily toward the Plateau of Productivity. As companies continue to formulate their cloud strategies, the role of IT as a cloud service broker has become a role model for many IT organizations especially those that are adopting multiclouds. According to Gartner's cloud survey, more than 80% of organizations have adopted or plan to adopt multiclouds by the end of 2020.

The area related to cloud service brokerage that has, however, grown the fastest over the last few years is the segment of third-party managed service providers (MSPs). These MSPs offer value-added services for cloud migration and managed services on top of cloud infrastructure (for details, see "Market Guide for Cloud Service Brokerage"). Providers come from a wide variety of backgrounds, including system integration, managed hosting and full-service outsourcing, which compete with pure-play startups.

Providers of CSB-enabling technologies include dedicated cloud brokerage platforms, cloud management platforms (see "Magic Quadrant for Cloud Management Platforms") with embedded brokering capabilities, and a wide variety of cloud management point solutions.

User Advice: We recommend the following:

- Have a unified layer of consumption that is predicated on four pillars — aggregation, integration, customization and governance. These drive the need for cloud service brokerage in multicloud adoption (see "Market Insight: Cloud Imperative — Embrace Hybrid Cloud and Multicloud Architecture and Services"). In some cases, your organization can take on the role of an internal service broker to provide multiple cloud services to both internal and external customers via a brokerage enablement platform/app store. And for some other cases, your organization can turn to an external cloud services broker (see "Competitive Landscape: Cloud Service Brokerage").
- Engage an external cloud managed service provider to perform the CSB function, if you lack the requisite CSB skills and capabilities, or when an external provider can best meet your time-to-deployment or risk management requirements. Make sure to assess potential CSB provider maturity at the commercial and technical level (see "6 Best Practices to Create a Cloud Service Brokerage Offering in the World of Multicloud and Hybrid Cloud").
- Institute an internal CSB role when brokering is perceived as a required internal core competency. Examples are when you want full unilateral control over cloud consumption, or you are responsible for delivering IT services across a hybrid and multiple combination of public and private clouds. Consider colocating your CSB function with your cloud center of excellence (see "How to Build a Cloud Center of Excellence"). Give preference to CSB technology enablers that have a roadmap indicating the broad understanding of the emerging role of the CSB as the enterprise strategic intermediary for cloud consumption.

Business Impact: Internal IT, on the back of increased adoption of multicloud, has now widely embraced the "cloud service brokerage" term. However, external providers by and large have used the "brokerage" label intermittently from a marketing perspective while offering the same functionality. Instead, they prefer terms such as "multicloud management" or "cloud managed

service provider." Meanwhile distributors, value-added resellers, independent service providers and OEMs are continuing to look how to redefine their business models in context of the new cloud reality but struggle to find the right business model for monetizing their value-added brokering activities.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Accenture; Cognizant; DXC Technology; Flexera (RightScale); Fujitsu; IBM Global Technology Services; NTT DATA

Recommended Reading: "Adapting IT to Become the Broker of Cloud Services"

"Market Guide for Cloud Service Brokerage"

"Competitive Landscape: Cloud Service Brokerage"

"6 Best Practices to Create a Cloud Service Brokerage Offering in the World of Multicloud and Hybrid Cloud"

"Magic Quadrant for Public Cloud Infrastructure Professional and Managed Services, Worldwide"

"Critical Capabilities for Public Cloud Infrastructure Professional and Managed Services, Worldwide"

"Forecast Analysis: Cloud Consulting and Implementation Services, Worldwide"

"Market Insight: Top 10 Things 'To Do' to Seize the Cloud Service Brokerage Opportunity"

Climbing the Slope

Cloud Networking

Analysis By: Sid Nag

Definition: Cloud networking is a cloud provider service to connect hybrid IT, hybrid cloud and multicloud environments and IaaS networking. Such services provide robust interconnectivity within a cloud provider's network and between external cloud data centers; a customer's on-premises, hosted data centers; and colocation facilities. It includes capabilities such as virtual private cloud, QoS and latency, content distribution; network availability for applications, hosted or colocated environments, private clouds and external public cloud services.

Position and Adoption Speed Justification: Cloud networking which includes cloud interconnect, VPC networking, zero trust networking and network services, is a major decision criterion for selection of cloud providers by 75% of enterprises. Organizations must select providers that include cloud networking as a cornerstone of their cloud provider's capabilities, as issues with network

connectivity across the hybrid IT environment and multiple cloud providers' data centers increase in complexity. Cloud networking is therefore a critical component of an organization's multicloud adoption model. Over 80% of organizations have adopted or plan to adopt multicloud environments by the end of 2020, making cloud networking an important technology. Cloud networking is also the technology that provides for building and managing secure private networks over the public internet by utilizing global cloud computing infrastructure. In cloud networking, the traditional network functions and services, including connectivity, security, management and control, are delivered as a service in the cloud.

User Advice: As users move applications into the cloud, new cloud networking requirements may emerge:

- There will often be a requirement for the application and (users of such applications) running in a cloud provider's data center to interact and interoperate with other applications that still reside in the customer's data centers.
- Cloud applications may need to interact with other applications running in a different cloud provider's cloud data center.
- As multicloud adoption increases, organizations need to be familiar with multiple CSP stacks, and may look at third-party solutions for help.
- Due to governance and compliance reasons, the data associated with an application running in the cloud may still have to reside in the customer's data centers.

All of these scenarios create a need for a robust connectivity model to achieve optimal application performance. Organizations must:

- Select cloud networking offerings that include capabilities to select the right connectivity provider whether it is a cloud provider, a cloud networking exchange provider (such as a data center hosting or colocation provider) or a traditional ISP. Furthermore, cloud networking offerings should provide cost comparisons of selecting one connectivity provider over the other.
- Institute a requirement that critical quality of service (QoS) and latency and availability issues are addressed by their cloud provider, especially for mission-critical applications that are running in the cloud. Provider offerings should address requirements for dual homing, peering point selection, route advertising, elastic load balancing, content distribution, virtual private cloud, and other networking issues.
- Mandate other capabilities which include rapid provisioning of MPLS, VPN and SD-WAN support for complex overlays for connecting their on-premises locations into the cloud provider's data center.

Business Impact: Cloud networking challenges, which continue to be a top challenge to the adoption of cloud, have gained attention in the industry as a critical element that many organizations are using as selection criteria for cloud services. It is clear that cloud interconnect architectures (see "Market Insight: How to Seize the Cloud Networking Service Opportunity") are important for all applications across the disaggregated multiclouds, hybrid cloud and hybrid IT environments. Moving forward, as organizations increasingly adopt multiclouds and move their

vertical-specific mission-critical applications to the cloud, cloud interconnect architectures will become even more critical.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Amazon Web Services (AWS); AT&T; Aviatrix; Cisco; Digital Realty; Equinix; Google Cloud Platform; Microsoft Azure; Verizon; VMware

Recommended Reading: "Market Insight: How to Seize the Cloud Networking Service Opportunity"

"A Tour of Gartner's Cloud Networking Research"

"Utilizing Network Service Provider Direct WAN Connectivity for the Cloud"

"Five Key Factors to Prepare Your WAN for Multicloud Connectivity"

"How to Interconnect With Azure, AWS and Google Backbones"

"How to Architect Your WAN for Hybrid Cloud and Multicloud"

Managed IoT Connectivity Services

Analysis By: Pablo Arriandiaga

Definition: Managed IoT connectivity services, also known as managed machine-to-machine (M2M) services, encompass connectivity hardware, software, and network and IT services that are generally bundled and managed by a third-party provider. These services enable enterprises to connect, monitor and control business assets and processes over a fixed or wireless connection. These services are key to informing and integrating purpose-built and stand-alone telematics systems, IoT platforms or legacy back-end IT (e.g., ERP, CRM) and OT systems (e.g., SIS, DCS).

Position and Adoption Speed Justification: The market for cellular-based-managed IoT connectivity services is mature for traditional 2G, 3G and 4G LTE networks, field-area networks (FANs) and satellite. Cellular, LPWAN, FAN and satellite are the connectivity technologies upon what providers in this market mainly have based their managed IoT connectivity services.

Market for 3GPP LPWAN is starting to accelerate due to national deployments in big countries such as China with NB-IoT or the U.S. with both networks. This acceleration will bring the price of the modules down in a position to compete with non-3GPP LPWAN technologies such as LoRa WAN or Sigfox, adding the value of being a standard, which guarantees its future evolution including seamless integration into 5G. Main challenge with 3GPP LPWAN are global deployments, needing roaming and interoperability that will need at least two years to mature. The new technologies that will accelerate growth in this market will be 5G and edge computing.

User Advice: Managed IoT connectivity services are a small component of an IoT solution but have a critical role due to the complexity of endpoints and connectivity types to manage. So, it is important that the managed IoT connectivity services solution components are appropriate and rightsized for broader IoT initiatives. The way of how connectivity is integrated in a broader proposition including edge devices and gateways, connectivity to the cloud, flexibility to include a variety of connectivity providers in a seamless way through technologies such as eSIM is very important.

Companies that are considering managed IoT connectivity services should consider the following recommendations:

- Invest time and resources to integrate multiple vendors' offerings that span the value continuum of IoT solutions. End-to-end IoT platforms are rare within these providers, leaving customers to source device engineering and resale, device management software, and other IoT platform elements.
- Look for vendors that could add more value on top of connectivity. Bundled solutions can be more cost-effective when including point solutions. Verticals that are well-served in this market are automotive, transportation and logistics, utilities or smart cities but increasingly manufacturing, retail and healthcare as well.
- Evaluate cellular and 3GPP LPWAN capabilities by requesting specific agreements with local providers, global points of presence to avoid latency and flexibility through multi-IMSI, eSIM and iSIM to add third-party connectivity into vendors' managed IoT connectivity platforms.
- Assess the evolution of the vendors' roadmaps and ecosystem by ensuring they include edge and cloud integration, APIs availability natively integrated with hyperscalers and roadmap for 5G and mobile private networks.
- Ensure that contract service-level agreements, delivery times and governance models avoid hidden costs and unclear responsibilities between the client and the vendor.

Business Impact: Managed IoT connectivity services have many benefits for enterprise users and governments. These services are part of broader telematics and IoT solutions to improve the efficiency of assets, provide data-driven decisions for asset utilization and offer incident management for enterprise asset.

Managed IoT connectivity services are an important set of facilitating technologies and services for use in operational technology (OT) and consumer environments. The architecture of these services is important if selected to ensure they support the secure integration of IT and OT.

When the portfolios and ecosystem integration of CSPs and IoT MVNOs broaden to consistently offer more value than connectivity, the number of solutions aimed at specific industry verticals will grow at a fast rate. Some traditional HW-related players are adding IoT MVNO capabilities, so they can provide a stronger and more secure proposition bundling device and connectivity management for commercial and industrial environments connecting the edge and the cloud.

Benefit Rating: High

Market Penetration: 5% to 20% of target audience

Maturity: Early mainstream

Sample Vendors: Aeris; Arm; AT&T; Eseye; KORE Wireless; Orange Business Services; Telefónica; Telenor Group; Verizon; Vodafone

Recommended Reading: "Magic Quadrant for Managed IoT Connectivity Services, Worldwide"

"Critical Capabilities for Managed IoT Connectivity Services, Worldwide"

"Competitive Landscape: IoT Mobile Virtual Network Operators"

"Market Guide for Internet of Things Mobile Virtual Network Enablers"

Private Cloud Computing

Analysis By: Thomas Bittman

Definition: Private cloud computing is a form of cloud computing used by only one organization, or one that ensures an organization is completely isolated from others. As a form of cloud computing, it has full self-service, full automation behind self-service and usage metering. It does not have to be on-premises or owned or managed by the enterprise.

Position and Adoption Speed Justification: Private and public cloud computing are at opposite ends of the "isolation" spectrum. As public cloud providers have offered virtual private cloud, dedicated instances and dedicated hosts, the gap between private and public has become a spectrum of isolation choices. Recent offerings from the major cloud providers for on-premises cloud footprints (tethered cloud) have created another, newer form of private cloud computing — and these immature alternatives are keeping private cloud from the Hype Cycle plateau.

Organizations that build a private cloud service are emulating public cloud computing providers to acquire similar benefits — mainly agility, mainly for new cloud-native applications, and mainly for business value and growth. This can be for infrastructure as a service (virtual machines or containers), platform as a service, or, in some situations, software as a service.

Due to cost and complexity, most successful private clouds are built and delivered by third parties.

This term is also used to describe a very different trend, where traditional infrastructures are being modernized with virtualization, some automation and some self-service. In this manner, they are leveraging only some valuable attributes of cloud computing, but are applying them to existing applications with traditional infrastructure requirements. However, because these are different trends, Gartner does not include this form of modernization in our definition of private cloud. But when the goal is IT efficiency or modernization for existing applications, these "just enough cloud" architectures can be beneficial.

User Advice:

- Evaluate third-party options first. These include hosted private cloud, managed services, virtual private cloud alternatives, tethered cloud or public cloud.
- Choose your private cloud strategy based on the necessary return on investment or business goals. If business growth or business value for new applications is the goal, consider a true cloud architecture. If IT efficiency or IT modernization for existing applications is the goal, choose cloud-inspired technologies and methods to implement. Just-enough cloud is often enough.
- Focus on business and application needs first; don't start with the technology. One technology architecture and operational model cannot support all of the application needs of a typical enterprise. Either build multiple architectures and operational models, or leverage third parties.
- Focus on services that fit the cloud model: standard, high volume and self-service; those that require agility and horizontal scalability; and usages that might be short-lived.
- Consider the long-term roadmap for your private cloud services. Build with the potential to integrate, interoperate or migrate to public cloud alternatives at the appropriate time.
- Manage the scope of work — start small and expand based on the business case.
- Build expertise in managing multiple architectural and operational models, and multicloud — this is more valuable to an enterprise than expertise in building a single cloud architecture.

Business Impact: Cloud computing enables agility that an enterprise can use to react quickly to business requirements in functionality or scale. Due to economies of scale, cloud computing can also improve efficiency and lower costs. However, because leveraging a true cloud computing architecture requires applications and operational models designed for cloud computing, the cost of transformation for existing applications does not always justify the investment.

True private cloud computing is used when enterprises aren't able to find cloud services that meet their needs in terms of regulatory requirements, functionality or intellectual property protection. True private cloud computing is almost always purpose-built for a specific set of new applications, and its success can be measured in revenue or market share.

When the primary goal of a private cloud is IT efficiency, businesses can reduce costs and improve overall operational efficiency for their existing application portfolios by leveraging cloud technologies where appropriate. They can then add manual or custom intervention, or customized changes as needed, to support those applications.

However, enterprises need to recognize that these are two different goals with different architectures, and trying to accomplish them in a single architecture usually achieves none of the goals well. Being bimodal based on business and application needs makes the most business sense.

Benefit Rating: Moderate

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Sample Vendors: Hewlett Packard Enterprise (HPE); IBM; Microsoft; Red Hat; VMware

Recommended Reading: "Rethink Your Internal Private Cloud"

"Building 'Just Enough' Private Cloud With Virtualization Automation"

Public Cloud Storage

Analysis By: Raj Bala

Definition: Public cloud storage is infrastructure as a service (IaaS) that provides block, file and/or object storage services delivered through protocols. The services are stand-alone, but are often used with compute and other IaaS products. They are priced based on capacity, data transfer and/or the number of requests. The services provide on-demand storage and are self-provisioned. Stored data exists in a multitenant environment, and users access that data through block, network and Representational State Transfer (REST) protocols.

Position and Adoption Speed Justification: Public cloud storage is a critical part of most workloads that use public cloud IaaS, even if it's often invisible to end users. In fact, the default volume type used for virtual machines (VMs) on some providers is solid-state drive (SSD)-based block storage. Unstructured data is frequently stored in object storage services for high-scale, low-cost requirements; however, end users are often unaware of the underlying storage type being used. The market for public cloud storage is becoming more visible to end users, as cloud providers are beginning to offer more-traditional enterprise brands with data management capabilities of storage systems found on-premises.

User Advice: Do not choose a public cloud storage provider based simply on cost or on your enterprise's relationship with the provider. The lowest-cost providers may not have the scale and operational capabilities required to become viable businesses that are sustainable over the long term. Moreover, these providers are also unlikely to have the engineering capabilities to innovate at the rapid pace set by the leaders in this market. Upheaval in this market warrants significant consideration of the risks if organizations choose a provider that is not one of the hyperscale vendors, such as Alibaba Cloud, Amazon Web Services (AWS), Google and Microsoft. Many of today's Tier 2 public cloud storage offerings may not exist in the same form tomorrow, if they exist at all.

Use public cloud storage services when deploying applications in public cloud IaaS environments, particularly those workloads focused on analytics. Match workload characteristics and cost requirements to a provider with equally suitable services.

Business Impact: Public cloud storage services are part of the bedrock that underpins public cloud IaaS. Recent advances in performance, as they relate to these storage services, have enabled enterprises to use cloud IaaS for mission-critical workloads, in addition to new, Mode-2-style applications. The security advances enable enterprises to use public cloud storage services and experience the agility aspects of a utility model, yet retain complete control from an encryption perspective.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Mature mainstream

Sample Vendors: Alibaba Cloud; Amazon Web Services (AWS); Backblaze; Google; IBM; Microsoft; Oracle; Tencent Cloud; Virtustream; Wasabi

Recommended Reading: "Magic Quadrant for Cloud Infrastructure as a Service, Worldwide"

Managed Workplace Services

Analysis By: Daniel Barros; David Groombridge

Definition: Gartner defines managed workplace services (MWS) as a subset of the IT outsourcing (ITO) market. MWS includes traditional end-user outsourcing (EUO) as well as new digital workplace services to provide cloud-first, automated and integrated support to end users.

Position and Adoption Speed Justification: Holistic and integrated MWS are in early mainstream in terms of boosting employee engagement to support the organization's digital business initiatives. The objective of MWS is to provide a flexible end-user environment that supports the organization's digital workplace initiative to improve end-user experience, increase employee engagement and ultimately increase productivity. MWS often includes digital workplace transformation delivered as professional services to transform the user experience while using technology to perform their duties. Examples of transformative MWS include intelligent automation, virtual assistance, ubiquitous access to a digital workplace environment and flexible device support (walk-up support, self-service kiosks, smart lockers and IT vending machines).

Most providers in this market have embedded, to some extent, intelligent automation, robotic process automation (RPA), computer vision, machine learning/AI, self-service, peer-to-peer support, persona-based support and workplace analytics to improve support effectiveness and resource efficiency. A more consumerized work environment is core to the digital workplace program, boosting employee engagement and agility. Such services are increasingly focused away from the provider's internal efficiencies and toward delivering an engaging user experience.

User Advice: Client organizations sourcing MWS must be diligent in understanding what is hype and what is real in this market. It is important to reach out to references that have previously implemented such services to inquire about which results were effectively achieved. Gartner clients can use the managed workplace services Magic Quadrants and Critical Capabilities (North America, Europe and Asia/Pacific), Peer Connect and Peer Insights to get other clients' feedback on service providers' MWS. If no such references exist, and the client decides to pioneer a service, then conduct a proof-of-concept project to assess what is possible. Consider a shorter-term deal with balanced risk-and-reward price models based on outcomes achieved over time.

Even for more mature MWS (i.e., service desk and self-service portals), it is important to include expected outcomes from implementing new service models to support the organization's digital workplace strategy. Traditional end-user service-level metrics, such as speed to answer and

average handle time, are not as effective for MWS, because automation, peer-to-peer support and self-service seek to eliminate the number of contacts with human agents. Clients contracting for MWS must challenge the vendor on end-user experience monitoring techniques that more accurately represent the actual digital workplace experience. Service agreements based on the end-user experience for MWS are often referred to as experience-level agreements (XLAs). The pricing throughout the contract's life cycle must reflect the results of efficiencies gained with self-service, peer-to-peer support and automation. The SLAs and XLAs should measure efficiencies, user satisfaction and increased productivity that generally result in 2% to 5% YoY price reductions.

There are many obstacles to effective implementation of MWS. The biggest from a buyer perspective is the excessive hype about "artificial intelligence" or "cognitive computing" that makes it difficult for client organizations to differentiate what results can be realistically achieved in their environment during the contractual term. From the provider perspective, it is the continuous investment in research, the competitive environment to reduce costs, and development to make analytics and machine learning services more effective.

Business Impact: Most non-IT organizations today are challenged to expand their digital services and products, to increase their workforce discretionary effort, and to attract and retain the skills necessary for digital business transformation. To succeed in digital business, organizations must transform their workplace experience to make it more digital, flexible and consumerized. MWS should take a user- and business-centric approach to the end-user workplace experience to increase employee engagement and discretionary effort to support the development of digital business.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Atos; Cognizant; CompuCom; Genpact; HCL Technologies; NTT DATA; TCS; Unisys; Wipro

Recommended Reading: "Magic Quadrant for Managed Workplace Services, North America"

"Magic Quadrant for Managed Workplace Services, Europe"

"Magic Quadrant for Managed Workplace Services, Asia/Pacific"

"Managed Workplace Services Will Transform End-User Outsourcing to Enable Digital Business Transformation"

"Leveraging Managed Workplace Service Relationships Can Create AR/VR Solutions and Improve Business Productivity"

"Contract for User Experience When Outsourcing Managed Workplace Services"

Cloud Computing

Analysis By: David Smith

Definition: Cloud computing is a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service using internet technologies.

Position and Adoption Speed Justification: Cloud computing is a very visible and hyped technology, and has passed the Trough of Disillusionment. Cloud computing remains a major force in IT. Every IT vendor has a cloud strategy — although some strategies are better described as "cloud inspired." Users are unlikely to completely abandon on-premises models, but there is continued movement toward consuming more services from the cloud and enabling capabilities not easily accessible elsewhere. Much of the cloud focus is on agility, speed and other benefits beyond cost savings.

"Cloud computing" continues to be one of the most hyped terms in the history of IT. Its hype transcends the IT industry and has entered popular culture, which has had the effect of increasing hype and confusion around the term. In fact, cloud computing hype is literally "off the charts," as Gartner's Hype Cycle does not measure amplitude of hype (meaning that a heavily hyped term such as "cloud computing" rises no higher on the Hype Cycle than anything else).

Although the peak of hype has long since passed, cloud still has more hype than many other technologies that are at or near the Peak of Inflated Expectations. Variations, such as private cloud computing and hybrid approaches, compound the hype and reinforce the conclusion that one profile on a Hype Cycle cannot adequately represent all that is cloud computing. Some cloud variations (such as hybrid IT and now multicloud environments) are now at the center of where the cloud hype currently is. And, of course, there are different types of cloud services such as IaaS, PaaS and SaaS, each at various stages of industry hype.

New and advanced use cases for cloud introduce even more terms such as distributed cloud, multicloud and cloud-native. These add to the overall cloud hype as well as the applicability of cloud to more and more scenarios, including enabling next generation disruptions.

User Advice: User organizations must demand clarity from their vendors around cloud. Gartner's definitions and descriptions (which align with other useful ones such as NIST) of the attributes of cloud services can help with this. Users should look at specific usage scenarios and workloads, map their view of the cloud to that of potential providers, and focus more on specifics than on general cloud ideas. Understanding the service models involved is key — especially the need to understand the shared responsibility model for security.

Vendor organizations should focus their cloud strategies on more specific scenarios and unify them into high-level messages that encompass the breadth of their offerings. Differentiation in hybrid cloud strategies must be articulated. This will be challenging, as all are "talking the talk," but many are taking advantage of the even broader leeway afforded by the term. "Cloudwashing" should be minimized. Gartner's Cloud Spectrum can be helpful.

Adopting cloud for the wrong reasons can lead to disastrous results. There are many myths surrounding cloud computing as a result of the hype (see “Revisiting the Top 10 Cloud Myths for 2020” for details and advice).

Business Impact: The cloud computing model is changing the way the IT industry looks at user and vendor relationships. Vendors must become providers, or partner with service providers, to deliver technologies indirectly to users. User organizations will watch portfolios of owned technologies decline as their service portfolios grow.

Potential benefits of cloud include cost savings and capabilities related to the flexible and dynamic usage models of cloud (including concepts that go by names such as “agility,” “time to market” and “innovation”). Organizations should formulate cloud strategies that align business needs with those potential benefits. Agility is the driving factor for organizations embracing cloud most of the time.

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Amazon; Google; IBM; Microsoft; Oracle; Red Hat; Salesforce; SAP

Recommended Reading: “Cloud Computing Primer for 2020”

“The Cloud Strategy Cookbook, 2019”

“Revisiting the Top 10 Cloud Myths for 2020”

“Four Types of Cloud Computing Define a Spectrum of Cloud Value”

IoT Integration

Analysis By: Benoit Lheureux

Definition: IoT integration refers to integration requirements and technologies needed to assemble end-to-end IoT-enabled business solutions that include IoT-specific integration challenges, such as integrating IoT devices, IoT data, digital twins and multiple IoT platforms. Other more traditional integration challenges include enterprise application and data integration, business process integration, SaaS integration, and B2B/ecosystem integration, as well as mobile app and legacy system integration.

Position and Adoption Speed Justification: IoT projects involve the integration of business application data and processes — competencies that are widely available. But such projects also introduced new integration requirements, such for as IoT devices, mobile apps, digital twins, hybrid edge-to-cloud infrastructure, large data volumes, and IoT time series event streaming and analysis. Most mid-to -large-sized companies can address some but not all these needs, so they are expanding their integration skills to compensate. Most IoT platforms offer some basic integration capabilities, including device communications (for example, MQTT) and API gateways management

(for example, to govern API access), and a limited number of adapters to facilitate integration with a few applications. While many IoT platforms still do not support all IoT device protocols (e.g., OPC-UA), strong translation, complex application workflow, and a complete portfolio of adapters for business applications and SaaS to be integrated, we have moved this IP further toward the Plateau of Productivity because iPaaS (needed to address these needs) is widely available from third-party TSPs, and many of the larger TSPs that offer IoT platforms (e.g., GE Digital, Hitachi, IBM, Microsoft, SAP) do offer an iPaaS in addition to their IoT platform (see "Technology Insight for Enterprise Integration PaaS").

User Advice: Comprehensive integration skills and technologies will help IT leaders more successfully implement IoT projects. Nearly every IoT implementer has adopted an "API-first" approach for integration, using APIs provided by IoT platforms for IoT device connectivity, data synchronization and process integration. Typically, features include event-stream processing, RESTful APIs and, sometimes, message-oriented middleware (MOM), such as MQTT. However, these approaches, alone, do not address crucial integration needs such as semantic integration (to translate data from one format to another) or workflow (to orchestrate the linking of data, events and processes across many systems). IoT implementers must also at times integrate multiple IoT platforms, e.g., to get data from IoT-connected products from an OEM's IoT platform. Thus, IoT implementers often discover that they must also leverage stand-alone integration technology, such as iPaaS, API management, ESB suites and ETL tools in order to fully meet their IoT project integration requirements. Sometimes IoT implementers will also benefit from data exchanges, to help propagate IoT data to external business partners (see "Use APIs to Modernize EDI for B2B Ecosystem Integration"). For IoT project implementers, the goal is to more broadly adopt a pervasive integration approach using a holistic set of integration skills and technologies to address all forms of integration required in their projects. For example, IoT integration needs should be addressed in your hybrid integration platform (see "How to Deliver a Truly Hybrid Integration Platform in Steps").

Business Impact: All end-to-end IoT business solutions require device, application, data and process integration (see "Use the IoT Platform Solution Reference Model to Help Design Your End-to-End IoT Business Solutions"). The challenges are nontrivial, often involving extraordinary:

- Heterogeneity (that is, multiple types of IoT devices, products and equipment, data, vendors, and systems to integrate)
- Distribution (that is, IoT devices, products and equipment are often remotely located across long distances and multiple geographies)
- Performance and scalability (that is, large numbers of IoT devices, products and equipment with high API throughputs and large volumes of time series data)

The cost of such integration includes:

- Integration skills development and integration development time
- Integration middleware or services (ESB software, iPaaS, data integration tools and API management, data exchanges or brokers)

- Integration products focused on operational technology (OT) integration (such as from OSIsoft and Skkynet) may be needed and must be licensed separately
- IT services fees when outsourcing integration to a system integrator

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Alleantia; Dell Boomi; Informatica; Microsoft; Reekoh; Salesforce (MuleSoft); Skkynet; Sky Republic; SnapLogic; Software AG

Recommended Reading: "Market Guide for Digital Twin Portfolios and Enabling Technologies"

"Choose the Best Integration Tool for Your Needs Based on the Three Basic Patterns of Integration"

"What to Expect When You're Expecting Digital Twins"

"Survey Analysis: Digital Twins Are Poised for Proliferation"

"Use the IoT Platform Solution Reference Model to Help Design Your End-to-End IoT Business Solutions"

Platform as a Service (PaaS)

Analysis By: Yefim Natis; Paul Vincent; Fabrizio Biscotti

Definition: Platform as a service (PaaS) is a type of a cloud offering that delivers application infrastructure capabilities as a service. Gartner tracks multiple types of PaaS (xPaaS), including, among many more, application platform as a service (aPaaS), integration PaaS (iPaaS), API management services (apiPaaS), function PaaS (fPaaS), business analytics PaaS (baPaaS), IoT PaaS and database PaaS (dbPaaS). PaaS capability can be delivered as a provider-managed or self-managed, multitenant or dedicated.

Position and Adoption Speed Justification: The time of rampant hype and confusion about the promise and nature of PaaS is behind us. Although some confusion remains and is even accelerating, brought about by the blurring boundaries between PaaS on one hand and IaaS or SaaS on the other. Mainstream users have been gaining real value from PaaS deployments and a growing number of organizations are making long-term strategic plans for PaaS projects, replacing their reliance on on-premises or IaaS+ (deploying platform software on IaaS) initiatives. Increasing number of mainstream organizations are seeking new relationships with the hyperscale vendors that offer integrated collections of IaaS and xPaaS capabilities often in the form of cloud integrated platform service (CIPS).

The increasing maturity of the overall PaaS offerings is due to:

- Fast-improving execution by IT megavendors (including Microsoft, Amazon Web Services [AWS], Google, SAP, Salesforce, IBM and Oracle)
- Growing market acceptance of the smaller xPaaS innovators.
- Momentum of SaaS and IaaS offerings that are introducing PaaS to more organizations.
- Emerging born-on-the-cloud xPaaS capabilities (such as serverless fPaaS) that are inherently cloud-only.

All these trends are increasing customers' confidence. And are also advancing adoption of PaaS overall toward the Plateau of Productivity. Some widely used xPaaS categories have already reached the maturity of mainstream adoption, including aPaaS, iPaaS, dbPaaS and others.

User Advice: Application leaders, CIOs, CTOs, and IT leaders and planners:

- Build new business software utilizing PaaS offerings to gain expertise in cloud-native experience, to take advantage of the continuous innovation common to cloud environment. Also, to gain high quality of service, including high availability, disaster recovery and security, and to be prepared for the next wave of business and technology innovation that will mostly be cloud-native and often cloud-only.
- Utilize PaaS offerings for a full scale of their capabilities, well beyond the most popular application PaaS, including integration, event processing and stream analytics, IoT, business process management, database management and business analytics.
- When public cloud is not an acceptable option, consider the provider-managed (remote or local) virtual private PaaS ahead of the self-managed private option. Self-managed private PaaS is often too hard to carry out, for organizational and cultural reasons.
- Choose the hyperscale IaaS+PaaS or SaaS+PaaS providers when looking to consolidate cloud business relationships but avoid exclusive commitments to retain the technical and business ability to incorporate PaaS capabilities of multiple providers.

Business Impact: The relationship between the vendors and their customers changes dramatically with transition to the cloud, where the vendors shift from just the role of the manufacturers of software to that of active facilitators of their customer's platform operations. Responsibilities, costs, skills, organization and culture of enterprise IT (and business operations) undergo a transformation. IT vendors and users that delay strategic adoption of cloud platform technology, architecture and organization, are at risk of losing loyalty of their customers. Customers that delay adoption of cloud platform services (PaaS), will find themselves with expensive vendor lock-in and chaotic handling of their hybrid technology environment.

Benefit Rating: Transformational

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Amazon Web Services (AWS); Dell Technologies (Boomi); Google Cloud Platform; IBM Cloud; Microsoft Azure; Oracle Cloud Platform; OutSystems; Salesforce Platform; SAP Cloud Platform

Recommended Reading: "Top 10 Trends in PaaS and Platform Innovation, 2020"

"Market Opportunity Map: PaaS, Worldwide"

"Platform as a Service: Definition, Taxonomy and Vendor Landscape, 2019"

"How to Manage and Optimize Costs of Public Cloud IaaS and PaaS"

"Application Architecture and Platforms for Technical Professionals Primer for 2020"

"Solution Criteria for Cloud Integrated IaaS and PaaS"

Cloud UC (UCaaS)

Analysis By: Rafael Benitez

Definition: Unified communications as a service (UCaaS) is a cloud-delivered approach to UC that integrates the following communication services: enterprise telephony, personal and team messaging, unified messaging (fax, voicemail, and SMS delivered to and stored in email systems), meeting solutions (audio/web/video conferencing, whiteboarding and content sharing), and mobility. Organizations buy per-user monthly subscriptions from UCaaS providers, typically delivered from multitenant "cloud" platforms.

Position and Adoption Speed Justification: The functionality offered by UCaaS application specialists (for example, Microsoft, RingCentral, 8x8 and Fuze) increasingly completely satisfies most organizations with basic telephony requirements, and exceeds them in mobility, meetings, messaging and collaboration services. Over the past year, UCaaS providers have focused R&D investment in many areas. These include further enriching the meeting and messaging capabilities, incorporating AI and analytics into management and end-user experiences, taking the mobile experience to the next level by taking cues from consumer apps, and expanding their API capabilities and marketplaces. During the past year, organizations of all segments, including the very large (above 20,000 seats) are routinely adopting UCaaS because:

- Providers have expanded their capabilities to address the requirements of large organizations (e.g., meetings, third-party integrations, management and global footprint).
- The required set of enterprise telephony features has diminished.
- Most organizations have a strong desire to no longer manage premises-based UC, which requires engineering-level resources.
- The time, skill and effort required to support and maintain premises-based UC platforms is much higher compared to UCaaS.

- UC technology providers are no longer significantly investing on innovation for premises-based UC platforms.

Larger organizations often prefer UCaaS (SaaS in general) from megavendors, such as Microsoft, and Cisco. RingCentral's and Zoom's profile has quickly risen among large and multinational organizations. Microsoft significantly disrupted the market throughout 2019 and continuing into 2020, as the market continues to adopt Microsoft Teams as a complete UC platform.

User Advice: SMBs (or organizations with fewer than 1,000 employees) should look at UCaaS as their first option. The business case for SMBs can be compelling, given their limited IT resources and skill set, the complexity of supporting remote sites, and the benefits of the high pace of innovation that UCaaS vendors provide. Many SMBs value the integrated contact center offered by many cloud UC providers. SMBs are largely located in a single geographical region, making the deployments simpler, faster, and giving them a wider choice of providers from which to select.

UCaaS is now a similarly common option for organizations with 1,000 to 5,000 employees, especially when their locations are concentrated in a single region (e.g., U.S., Canada, Europe). Many public-sector organizations fall into this category and are adopting UCaaS frequently.

Organizations with more than 5,000 employees, and especially multinationals, represent the final frontier for cloud UC. Outside the public sector, large organizations have personnel distributed across multiple global regions. They often have cultural biases, and/or security, compliance, or country and language requirements that often act as barriers to a migration to UCaaS. Nonetheless, these large organizations now often find that UCaaS meets their telephony requirements and exceeds their messaging and meeting requirements. Some organizations of this size and scope select hybrid UCaaS deployments, with a mix of cloud and on-premises delivery — but this hybrid deployment model is quickly declining in popularity. When UCaaS is not well-aligned for large organizations, some will use dedicated hosted solutions, or remain on-premises — both of these deployment models are also in decline.

Business Impact: UCaaS enables organizations to outsource the delivery of telephony, mobility, personal messaging, team messaging and meeting solutions (which include audio, web and video conferencing).

CFOs are attracted to UCaaS because it:

- Transforms capital expenditure (capex) every two to three years for upgrade into regular and more predictable operating expenditure (opex)
- Helps organizations become more agile as they grow, retrench or acquire or merge with other organizations
- Supports, out of the box, disaster recovery with data replication across various network operations centers
- Supports mobility and remote work much more easily

Businesses opting for UCaaS believe that UC functions are becoming commoditized and, therefore, suitable for cloud delivery. This enables them to reduce costs, focus on core competencies, and

reallocate IT staff to focus on strategic and competitive differentiation. The long-term view of UCaaS is positive, evidenced by how aggressively premises-based UC vendors are pivoting their R&D investment to the cloud.

The infrastructure licensing policies of major vendors such as Cisco, Microsoft and Google favor single-vendor, or at least dominant-vendor, solutions. Hence, UCaaS is well-suited to organizations that are open to dominant-vendor solutions and have highly distributed workforces. Organizations using UCaaS will need to undertake a process of vendor rationalization to streamline suppliers and to reduce the number of overlapping tools in their environments.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Mature mainstream

Sample Vendors: 8x8; Cisco; Dialpad; Fuze; Google; Microsoft; RingCentral; Verizon; Zoom

Recommended Reading: "Magic Quadrant for Unified Communications as a Service, Worldwide"

"Magic Quadrant for Unified Communications"

"Market Guide for Midmarket Unified Communications as a Service, North America"

"Selecting the Best External Calling Option for Microsoft Teams"

"Toolkit: Is UCaaS a Good Fit for Your Enterprise?"

"Assess Whether Microsoft Teams Meets Your Telephony Needs"

Disaster Recovery as a Service (DRaaS)

Analysis By: Ron Blair

Definition: The disaster recovery as a service (DRaaS) market provides application recovery at another location in the event of a disaster. It can be delivered as a fully managed offering, an assisted recovery offering, or via a software-as-a-service model. The service can be bought as a stand-alone offering. Minimally, it includes on-demand recovery cloud for planned exercises and declarations; server image and production data replication to cloud; automated failover/failback between on-premises and cloud; and recovery time SLAs.

Position and Adoption Speed Justification: Overall, Gartner clients' interest in DRaaS took a slight dip in 2019 in terms of volume, with client inquiry down 13% for all of 2019 compared to 2018. But because DRaaS offerings have become more industrialized, the size of DRaaS engagements have increased — from a couple years ago when engagements greater than 200 VMs were a rarity to some now in the thousands. Broad appeal remains across all industries, but over the last year, Gartner has observed a marginal uptick in interest from areas such as the public sector and manufacturing — another potential market maturity signal.

In terms of potential obstacles, “larger engagements” typically translates into more complex requirements — such as multinational, non-x86 workloads and multicloud support. If these needs are not adequately met, organizations will further examine internal options, including DIY enablers such as IT resiliency orchestration (ITRO) products. In addition, cloud providers themselves are baking more resiliency options into their services.

Leading DRaaS providers are responding in several ways in terms of strategy:

- More automation of front-end onboarding and change management
- Additional support for multiple platforms and more global reach
- Higher-order services such as hybrid cloud recovery, application recovery assurance and cyber-resiliency

User Advice: Consider DRaaS when:

- There is a mandate to improve disaster recovery capabilities quickly — whether internally charged, as a result of an audit or due to a business partner requirement.
- Your organization is bereft of DR skill sets, or you would prefer to focus on other strategic initiatives.
- Colocation agreements used for DR are nearing end of term.
- Significant investment will be needed in the next year for the existing DR infrastructure or the DR data center itself.

However, there are some DR use cases for which the use of DRaaS may not be the most optimal solution. Examples may include situations when organizations need computing-platform-specific recovery, stringent data privacy, geographical data sovereignty regulations, active/active operations or extensive commercially flexibility associated with large-scale public cloud migrations. Some non-DRaaS options include direct purchase of ITRO software for self-orchestration, a mix of colocation and DRaaS, additional standardization via hyperconverged and/or cloud, or full outsourcing. Therefore, it is important to look at DRaaS as just one possible alternative for addressing recovery and continuity requirements.

Business Impact: The business impact of DRaaS is moderate today. The actual benefits will vary, depending on the diversity of computing platforms that require recovery support and the extent to which service customers can orchestrate recurring recovery exercises that need to be performed. An additional consideration is the extent to which the customer can transparently and efficiently use the same provider’s cloud storage for ongoing data backup, replication and archival. The key challenge is ensuring that these services can be securely, reliably and economically used to complement or supplant the use of more traditional equipment subscription-based services or the use of dedicated facilities. In addition, given that no service, including DRaaS, is immune to scope creep, it is incumbent on service users to ensure that providers consistently deliver on committed recovery time and availability service levels. This is especially important as the size of the in-scope configuration increases and the in-scope data center configuration becomes more heterogeneous.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: C&W Business; iland; IBM; InterVision; Microsoft; Recovery Point; Sungard Availability Services; TierPoint; Webair

Recommended Reading: "Reduce Costs and Piggyback DR Investments"

"Magic Quadrant for Disaster Recovery as a Service"

"Market Guide for IT Resilience Orchestration"

"Critical Capabilities for Disaster Recovery as a Service"

IaaS

Analysis By: Raj Bala

Definition: Infrastructure as a service (IaaS) is a standardized, highly automated offering in which computing resources owned by a service provider, complemented by storage and networking capabilities, are offered to customers on demand. Resources are scalable and elastic in near real time and metered by use. Self-service interfaces, including an API and a graphical user interface (GUI), are exposed directly to customers. Resources may be single tenant or multitenant, and are hosted by the service provider or on-premises in a customer's data center.

Position and Adoption Speed Justification: Cloud IaaS is a mainstream technology that can be used to host most workloads, including mission-critical enterprise applications. Customers must still pay careful attention to selecting an appropriate provider, architecture and security controls, and are responsible for proper governance.

The best use of IaaS is transformational, where it can offer significant benefits in business agility, operations quality and cost. IaaS is frequently used to improve developer productivity and agility, and can facilitate continuous integration/continuous deployment (CI/CD), and the use of "infrastructure as code," including immutable infrastructure. IaaS is increasingly used as a general substitute for data center infrastructure, and may drive improved operations, efficiency and cost savings. In this context, it is typically used to host traditional business applications, and may even host complex enterprise applications such as ERP.

User Advice: The cloud IaaS provider market has bifurcated. Hyperscale integrated IaaS and PaaS providers dominate the market while the nonhyperscale providers have largely been relegated to specialized scenarios that require deep support for legacy technologies or that have specific location requirements that cannot be met by a hyperscale cloud provider. In general, the hyperscale providers offer a broad range of capabilities, and can meet enterprise requirements for availability, performance, security, regulatory compliance, service and support. The other providers also generally offer high-quality services, although these services are more limited in scope.

Most enterprises have begun to adopt IaaS strategically, and have a broad range of workloads on IaaS, including production applications. Midmarket businesses are the most likely to believe that IaaS will replace nearly all their data center infrastructures during the next five years. Most businesses have at least piloted IaaS, but those that have not done so should begin with new, greenfield applications.

Both public multitenant and private single-tenant offerings are available; however, the distinction between public and private cloud IaaS is blurring. The most cost-effective clouds are highly standardized and use a shared capacity pool. There are hybrid public/private cloud offerings — enabling "cloud bursting" for on-demand capacity and business continuity — but this technology is likely to remain confined to narrow niches.

In most cases, there are no technical barriers, and few contractual or business barriers, to using cloud IaaS for a virtualizable x86-based application. Instead, IT leaders should ask themselves whether cloud IaaS is the best possible solution for an application. In many cases, organizations should consider using both IaaS and PaaS — preferably from a cloud provider that offers integrated IaaS and PaaS, rather than IaaS alone.

Business Impact: Cloud computing infrastructure services are broadly advantageous for IT organizations. The cost benefits, driven primarily by automation, are particularly significant for small and midsize businesses (SMBs). Larger enterprises benefit primarily from greater flexibility and agility, although they can potentially also achieve cost reductions.

The benefits of IaaS have been driven primarily by the developer empowerment that comes from self-service, the flexibility offered by on-demand infrastructure, and the quality and efficiency of automation. Over time, system management tasks have become increasingly automated, leading to more-efficient infrastructure management. Organizations that simply "lift and shift" workloads to the cloud will reap limited cost and efficiency benefits, compared with those that use IaaS to drive IT transformation.

The metered-by-use attribute of these services results in more efficient use of capacity, and their self-service nature will empower employees outside of IT operations. This will improve developer productivity and make it easier for business buyers to obtain infrastructure.

Benefit Rating: Transformational

Market Penetration: More than 50% of target audience

Maturity: Early mainstream

Sample Vendors: Alibaba Cloud; Amazon Web Services (AWS); Google; IBM; Microsoft; Oracle; Tencent Cloud; Virtustream

Recommended Reading: "The Cloud Strategy Cookbook, 2019"

"Cloud and Edge Infrastructure Primer for 2019"

Private PaaS

Analysis By: Yefim Natis; Paul Vincent

Definition: A private platform as a service (PaaS) is a type of PaaS that offers exclusive access to a customer organization. Private PaaS may be established on-premises or hosted in a public cloud by the customer organization (self-managed). It can be managed by a service provider (provider-managed), typically as an isolated-tenancy (dedicated) rendition of a public PaaS available from the same provider.

Position and Adoption Speed Justification: "Private PaaS" is a name that has been often attributed — incorrectly — to simply a deployment of a PaaS framework software, like Red Hat OpenShift Container Platform, or a less-opinionated container management software, like Google Anthos GKE. Container management on-premises is a progressive development for most organizations, as it delivers greater agility and efficiency to the organization's IT. But it does not automatically deliver the cloud benefits associated with PaaS — standardization, separation of concerns, elastic scalability and self-service. Private PaaS, to be a service, must deliver the separation of providers and subscribers of the services. There must exist a platform operations team that is independent of the development team that subscribes to the platform services. In a self-managed environment, both the operations and the development teams belong to the same organization. In the provider-managed scenario the operations and the development teams are different companies (the provider and the customer). In both scenarios, a portal must isolate the two sides (the operations and development teams) and the provider does not offer any customer-specific services, only a standard list, available equally to all qualified subscribers. Such organizational discipline is hard to enforce in most self-managed deployments; the provider-managed option is more likely to deliver true cloud PaaS experience in a private context.

Growing popularity and production experience of organizations with PaaS framework and container management software have led most organizations to a more realistic understanding of what outcomes and experiences are available with that technology and the associated necessary investments. Some organizations have succeeded in establishing the firm separation of the providers and subscribers of the PaaS capabilities. Others have simply settled on the better operation of IT environment. The greater sense of reality for self-managed private PaaS and the increasing successful use of the provider-managed remote or local private PaaS — both lead to overall increasing maturity of private PaaS deployments, advancing it toward the Plateau of Productivity.

User Advice: Application leaders, CIOs, CTOs, IT leaders and planners should:

- Plan private PaaS initiatives in the knowledge that true cloud outcomes are not achieved through technology alone, but require changes to the IT organization, its culture, processes, policies and operations.
- Where feasible, choose public cloud services; recognize that establishing a private PaaS is not a trivial exercise — it will require a lot more effort, skill and experience than subscribing to a public PaaS service.

- When determined to establish a private PaaS environment, understand that taking the provider-managed (remote or local) private PaaS approach is more likely to deliver the desired cloud outcomes.

Business Impact: Private PaaS offers access to some of the benefits of cloud computing for organizations that are concerned about public cloud maturity, security and quality of service, vendor lock-in or data privacy. It positions these organizations for gradual transition to hybrid and public application platform options. Thus, private PaaS accelerates cloud adoption by the more-conservative mainstream enterprises. It also opens the customer organizations to potential multicloud presence to reduce vendor lock-in.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Mature mainstream

Sample Vendors: HPE; IBM; Microsoft; Oracle; Red Hat

Recommended Reading: "Rethink Your Internal Private Cloud"

"The Many Faces of Private Cloud"

"Peer Connect Perspectives: Public Versus Private Cloud"

"How Private PaaS Can Begin to Transform Your IT"

"Top 10 Trends in PaaS and Platform Innovation, 2020"

"Platform as a Service: Definition, Taxonomy and Vendor Landscape, 2019"

SIAM

Analysis By: Jim Longwood; Pablo Arriandiaga; Andrew Miljanovski

Definition: Service integration and management (SIAM) is a role that coordinates and integrates service delivery of multiple internal and external IT and business process service providers in a hybrid IT services ecosystem. It can be undertaken by the client, or by a third-party service provider appointed by the client. The SIAM role is different from the prime contractor role; if outsourced, the client organization has a direct contract with not only the SIAM role, but also each of the service providers managed by the SIAM on the client's behalf.

Position and Adoption Speed Justification: As digital, cloud and Internet of Things (IoT) adoption grows, multivendor management of hybrid IT services' ecosystems becomes more complex. The SIAM role continues to move up the Slope of Enlightenment as client adoption increases, and as offerings mature and start to address digital drivers. The role is called "multisourcing service integrator" (MSI) in some geographies. "SIAM V2" or "digital SIAM" terminology is emerging, reflecting market movement from first-generation operational-based into second-generation ecosystem-based SIAM offerings.

Other trends accelerating SIAM adoption:

- Midsize enterprises tend to insource the role or use a lead service integrator. Larger enterprises tend to outsource the role. Some use a build-operate-transfer (BOT) approach.
- Mature SIAM offerings in the market focus on consulting, BOT or managed SIAM services using standardized solution architectures.
- "Clustered"-based solutions to manage related providers, e.g., in IoT and CSP offerings.
- Further integration of CSB aggregation function into role.
- Leading solutions cover agile and DevOps, with providers introducing IA, RPA and digital capabilities.
- Clients increasingly want to know how to make the business case for SIAM.
- SIAM accreditation services are growing.
- SIAM-related toolset offerings are emerging (e.g., from 4me, ONEiO and SirionLabs)

User Advice: The SIAM role helps IT sourcing leaders achieve integrated, end-to-end service delivery outcomes across an expanding range of services — from traditional to cloud, IoT and communications — and increasing numbers of providers. The role's use in infrastructure services is higher than in application services, with limited uptake in BPO and growing uptake in emerging digital service offerings.

Before starting this journey, ensure that internal and external service providers are ready for the SIAM role and that individual providers are well-managed. Decide whether to insource or outsource the SIAM role via a managed service or clustered offering. If taking a DIY approach, consider the BOT model and ensure that you have the budget to buy and integrate the required ITSM toolsets and dashboards.

As you increase adoption of disruptive digital services, use the role to improve management of all service providers, reducing gray areas in handoff points.

Integrate the SIAM and CSB roles into your adoption of an IT solution broker role for your hybrid IT service ecosystem. As part of this:

- Review your existing SIAM arrangement to ensure integration of evolving offerings in intelligent automation, agile, DevOps and digital.
- Ensure that you have senior staff delivering and managing the SIAM role and service providers involved.
- Prepare an extensive business case ensuring allocation of a suitable budget for building and undertaking the role.
- Ensure that operational-level agreements (OLAs), KPIs and service provider interfaces are set up between all parties.

- Foster a collaborative working environment built on trust among all parties.
- Evaluate use of emerging offerings, e.g., for SLA/OLA auditing and solution brokering as well as SIAM-focused toolsets.
- Evaluate use of best-of-breed SIAM providers for bundled communication services.

Business Impact: The SIAM role is key to achieving end-to-end business and service outcomes in multisourced services ecosystems. Executed properly, the SIAM role, using OLAs and KPIs, break down intra-/interprovider service silos, delivering a seamless, integrated customer/end user service experience. The solution broker function has emerged to enable rapid delivery and management of new as-a-service solutions to the business. A CSP survey showed 13% reduction in total cost of ownership (TCO) of managed communication services in a multisourced ecosystem.

Done well, the role reduces interprovider incident, problem and change management issues, streamlines process handoffs, and fosters interprovider collaboration. It improves service excellence via standardization and reduces the complexity of managing a service ecosystem. This further optimizes operating costs and business agility, and improves operational efficiency and business effectiveness over time, justifying the business case for implementing the role. As cloud and digital adoption grow, the SIAM and CSB aggregation roles are coalescing, improving end-to-end ecosystem performance.

Benefit Rating: Moderate

Market Penetration: 20% to 50% of target audience

Maturity: Early mainstream

Sample Vendors: Atos; Capgemini; CGI; DXC Technology; Fujitsu; HCL Technologies; Kinetic IT; Leidos; Orange Business Services; Wipro

Recommended Reading: “The SIAM Role Is Critical in Managing Multiple Outsourced Service Providers”

“Market Trends: MSI-SIAM Buyer Behavior in Managed Communications Services”

“Build on Your Vendor Management Capabilities When Insourcing the MSI-SIAM Role”

“Optimize Multisourcing Service Integration Using the Right Toolsets to Drive Delivery Excellence”

Entering the Plateau

Proactive Support

Analysis By: Christine Tenneson; Rob Addy

Definition: Proactive support is a product support activity aimed at addressing support issues before they occur. In addition, proactive support improves system resilience and performance. This product support service provides enhanced incident management based on analytics. Proactive

services use customer environmental data and known problem profiles to notify customers of contingent and preventive action that should be taken to minimize the chances of problems developing and/or to mitigate the impact when they do occur.

Position and Adoption Speed Justification: Many hardware and software vendors have launched proactive support service offerings or include proactive support as an entitlement of all support offerings. Proactive support is designed to have enhanced incident management, but the specific entitlements of the offering vary from vendor to vendor and may not be fully automated. In addition, specific services offered may include an assigned account support manager, issuance of specific technical guidance on a regular basis, and monitoring of devices. The collection of customer data can be used to proactively alert customers of potential maintenance issues that may affect them before those potential problems arise in their environments.

Independent hardware and software vendors and OEMs and channel partners are promoting proactive support services for sound business reasons. Proactive support services are less expensive to deliver than reactive services. Reducing the unpredictable inbound call flow and pushing out fixes and workarounds before known technical issues become real-life incidents can reduce needed support resources. Providers can reduce their need to staff first-line and second-line support functions as densely as they would have for a purely reactive support service. Proactive services reduce the level of unplanned site attendance, enable engineer utilization rates to improve, and deliver increased customer value. Support providers that deploy proactive support see the benefits as improved margins and minimized fluctuation in their cost bases. Proactive support is truly a scenario that benefits both the support industry and its customers.

We position this technology on the Hype Cycle on the Plateau of Productivity based on the maturity of the technology and the continued customer adoption.

User Advice: We advise:

- Ask service providers to describe their proactive service offerings. Find out whether the proactive services are included with a standard support contract or with a premium support contract. If the vendor has an additional fee or premium for proactive as an uplift, oftentimes a trial of the proactive service can be negotiated to demonstrate the value.
- To achieve the best value, understand how the service is activated. Some customers receive proactive services as part of maintenance purchases but are not utilizing the services.
- Ask your provider to present an analysis and breakdown of how a proactive support offering can help you from a total cost of ownership perspective.
- Learn how to optimize the proactive service. Some vendors will offer an assessment to make sure that any proactive service that includes a hardware or software appliance is properly set up to achieve maximum results.
- Understand benefits of analytics from proactive support.

Business Impact: IT managers can either let incidents happen and simply react, or they can allow their support providers to proactively intervene on their behalf and direct change to happen on their

own terms. End users do not want their support providers to be good at putting the fires out after they have started. They would much rather have providers that can help them avoid the fires in the first place. The costs associated with system failures (which include disruption to operations and sales generation opportunities) are likely to far exceed the costs of putting in place processes and controls to decrease the likelihood of such failures. Beyond the obvious elimination of system outages and downtime to your IT infrastructure, other possible benefits from proactive support include savings from:

- Elimination of disruption to your staff, operations, clients, customer goodwill and branding
- Elimination of potential lawsuit liabilities caused by disruption to customer operations (especially mission-critical and high-availability)

Quantification of the basic economics (reduction of expenses and improved performance) and a desire to mitigate risk and uncertainty will be key drivers for the widespread adoption of proactive support services.

Benefit Rating: Moderate

Market Penetration: More than 50% of target audience

Maturity: Mature mainstream

Sample Vendors: Avaya; Cisco; Dell Technologies; Hewlett Packard Enterprise; HP; Juniper Networks; Microsoft; NetApp; Oracle; SAP

Recommended Reading: "Market Share Analysis: Hardware Support Services, Worldwide, 2018"

"Toolkit: Buying the Right SAP Maintenance and Support Service Will Help Optimize Your Costs"

Multidiscipline Service Desk Outsourcing

Analysis By: Daniel Barros; David Groombridge

Definition: Multidiscipline service desk (MDSD) outsourcing refers to a multiyear outsourcing relationship involving the transfer of the service desk support services to a service provider. It differs from the traditional help desk by also providing support to Level 2 — and for some applications, even Level 3 — for a wide range of offerings in multiple areas. These may include IT, business and collaboration applications (both cloud and traditional), as well as more traditional Level 1 help desk support.

Position and Adoption Speed Justification: While traditional IT help desk outsourcing is a mature discipline, MDSD outsourcing was introduced in 2011. It is currently entering the Plateau of Productivity because of new-generation service desk solutions that are based on intelligent automation and analytics, and services that have been increasingly adopted to replace traditional labor-based service desk services. Such service platforms offered by vendors in the managed workplace services (MWS) market focus on delivering end-user support through automation and a machine-first approach. They also seek to improve service desk agent effectiveness for the remaining contacts by using technology to expedite the process of diagnosing the user need. This

is then correlated with the most probable solution, without having to rely entirely on the agent's personal knowledge and experience.

This service offering is currently very standard, as end-user clients seek greater value for service desk services. Several service providers have invested in full-stack platforms that provide an integrated self-service portal to provide AI-based virtual assistance services that complement service desk services. Examples include HCL Technologies' DRYiCE OptiBOT, Wipro's HOLMES, TCS's ignio, IBM's Watson and Stefanini's Sophie, among others.

MDSD has evolved to offer support beyond basic Level 1 support, such as simply registering and directing an incident or service request. In fact, such simple tasks can be completely automated either through robotic process automation or intelligent automation. Many providers today can resolve more complex issues during the first user contact by leveraging machine learning-based platforms to assist the MDSD agents — or even the end user — when using self-service portals, chatbots and virtual assistants.

User Advice: Clients looking to outsource their service desk must understand the new trends driving the market, and consider expanding the initial scope of their initiative to leverage existing technology offered by service providers today to improve the end-user experience. The main characteristics of an MDSD are:

- Support for cloud-based business and collaboration applications
- Intelligent automation (machine learning, AI-powered knowledge management, automated password resetting, user-invoked scripts)
- Multiple-channel contact and support methods (chat, email, social media)
- AI-based virtual assistance (avatar and chatbot)
- Predictive and prescriptive analytics that help to identify potential failures before they affect the end user
- Enhanced self-service features to improve end-user productivity and satisfaction (self-service portals and peer-to-peer support)
- Persona-based services (personalized service desk services based on specific personas' needs)
- Digital experience monitoring tools to monitor end to end user experience

The MDSD model has shifted away from a highly commoditized and low-value service to a more industry-specific and high-value service. Thus, the scope of what is delivered by an MDSD service can have great variance from provider to provider. Clients must:

- Evaluate whether and how the potential provider can deliver MDSD outsourcing with the characteristics above.
- Establish how the MDSD service relates back to the organization's need to support digital business expansion, improve user experience and increase employee engagement.

Business Impact: Digital business transformation is driving traditional organizations to expand their digital services, reaching new consumers. However, the corporate end-user IT environment remains unchanged in most cases, creating a gap between the digital experience available in our personal and corporate lives. The wider the gap in the personal-corporate digital experience, the harder it is to attract the digital talent needed to succeed in digital business. Organizations' MDSD services, along with other managed workplace services, take a user-centric approach to workplace services and support in order to leverage the digital dexterity necessary for the development of digital business.

Benefit Rating: High

Market Penetration: 20% to 50% of target audience

Maturity: Mature mainstream

Sample Vendors: Atos; Cognizant; DXC Technology; HCL Technologies; IBM; NTT DATA; TCS; Unisys; Wipro

Recommended Reading: "Magic Quadrant for Managed Workplace Services, North America"

"Magic Quadrant for Managed Workplace Services, Europe"

"Magic Quadrant for Managed Workplace Services, Asia/Pacific"

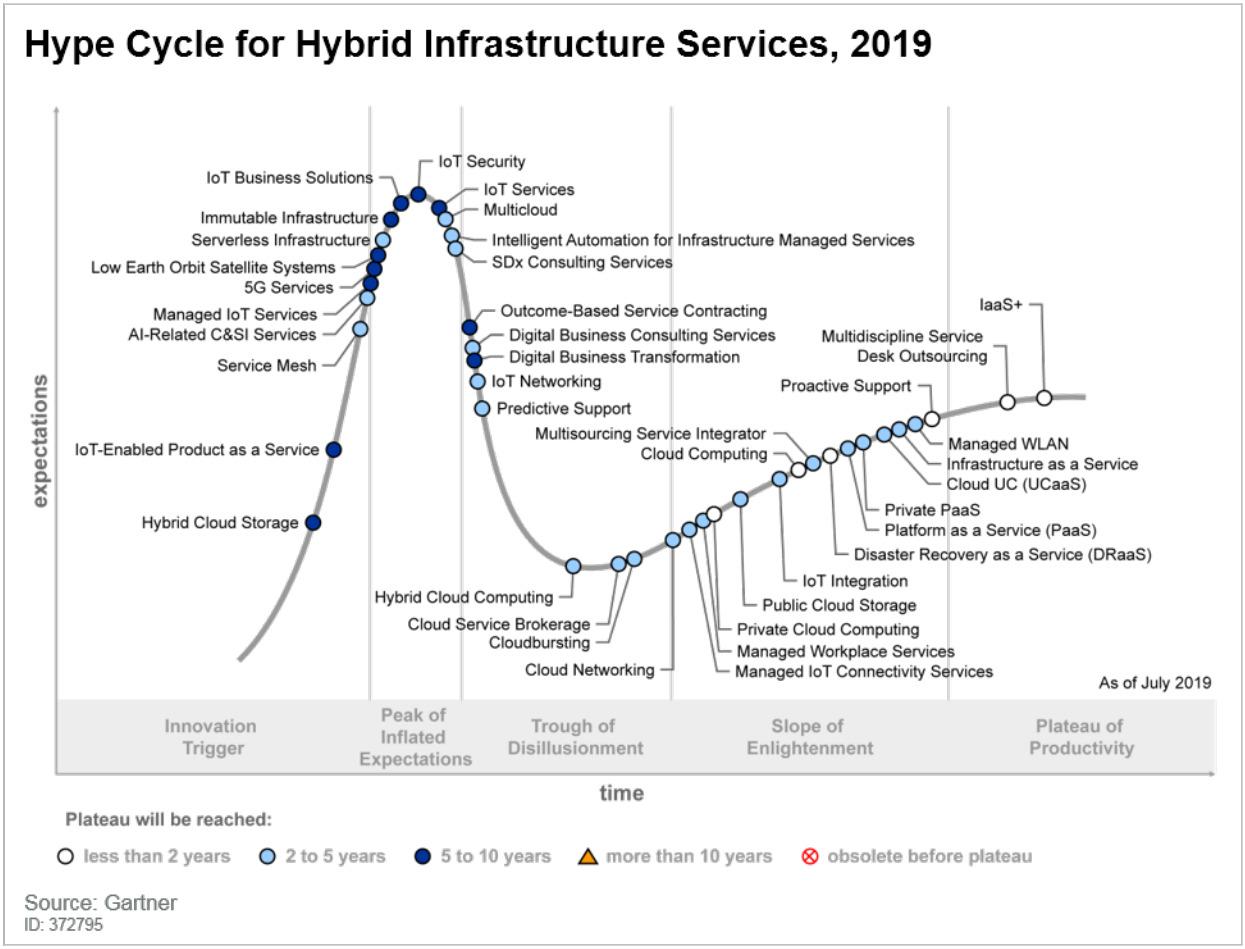
"Managed Workplace Services Will Transform End-User Outsourcing to Enable Digital Business Transformation"

"Leveraging Managed Workplace Service Relationships Can Create AR/VR Solutions and Improve Business Productivity"

"Contract for User Experience When Outsourcing Managed Workplace Services"

Appendixes

Figure 3. Hype Cycle for Hybrid Infrastructure Services, 2019



Source: Gartner
ID: 372795

Hype Cycle Phases, Benefit Ratings and Maturity Levels

Table 1. Hype Cycle Phases

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

Source: Gartner (July 2020)

Table 2. Benefit Ratings

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

Source: Gartner (July 2020)

Table 3. Maturity Levels

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

Source: Gartner (July 2020)

Gartner Recommended Reading

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

Understanding Gartner's Hype Cycles

Magic Quadrant for Cloud Infrastructure as a Service, Worldwide

Magic Quadrant for Managed IoT Connectivity Services, Worldwide

Competitive Landscape: IoT Platform Vendors

Market Guide for Digital Business Consulting and Implementation Services

Infrastructure Services Sourcing Strategy: Key Reasons to Outsource

Evidence

1. The Internet of Things (IoT) is the network of dedicated physical objects that contains embedded technology to communicate and sense or interact with the objects' internal states and/or the external environment. The IoT ecosystem comprises assets and products, communication protocols, applications, and data and analytics. Edge computing describes a distributed computing topology in which information processing is placed close to the things or people that produce and/or consume that information. Drawing from the concepts of mesh networking and distributed data centers, edge computing looks to keep traffic and processing local and off the center of the network. The goals are to reduce latency and unnecessary traffic, and to establish a hub for interconnection between interested peers and for the data thinning of complex media types or computational loads.

2. See, for example, the rise in post-COVID demand in cloud infrastructure skills reported in "U.S. Top Skills With Sustained Demand Amid COVID-19 (April 2020)."

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