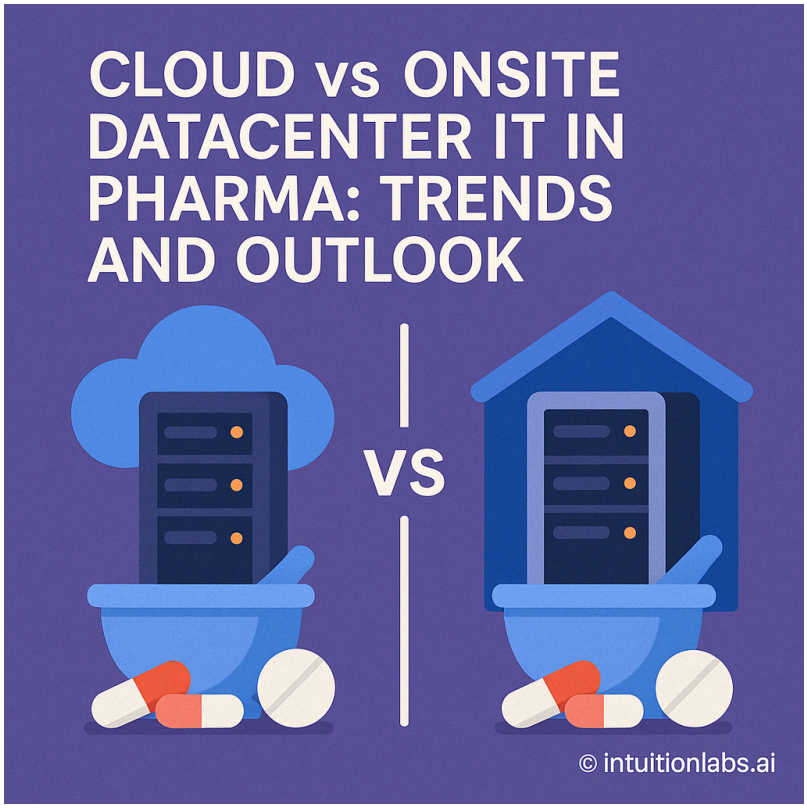
Cloud vs On-Premises IT in Pharma: Trends and Outlook

By IntuitionLabs • 4/10/2025 • 35 min read

cloud-computing | on-premises | pharmaceutical | it-infrastructure | hybrid-cloud | public-cloud | private-cloud | digital-transformation | regulatory-compliance | data-security | cost-analysis



Cloud vs On-Premises IT in Pharma: Trends and Outlook

The pharmaceutical industry has traditionally relied on on-premises data centers and in-house IT systems, but this is rapidly changing with the rise of cloud computing. Pharma companies in the U.S. are increasingly moving workloads to the cloud, although many still maintain hybrid environments. This article provides an in-depth look at cloud computing usage versus onsite infrastructure in pharma, including current adoption statistics, historical trends, future forecasts, functional area breakdowns, private vs. public cloud usage, key drivers of cloud migration, and the barriers that keep some systems on-premises. The goal is to give IT professionals in the pharma sector a comprehensive, data-driven view of where the industry stands and where it's headed.

Current State of Cloud Adoption in Pharma

Today, the vast majority of pharmaceutical companies have embraced cloud computing in some form, although few are *completely* cloud-based. Surveys indicate that about 83% of pharma companies are leveraging cloud solutions to at least some extent, meaning only roughly 17% remain purely on-premises with no cloud usage (Cloud vs. On-Premises in the Pharmaceutical Industry - Sikich). However, full cloud adoption (where *all* operations run on cloud) is still the exception rather than the rule. A 2023 PwC survey of pharma and life sciences executives found that only 40% have all of their operations already in the cloud, while the rest still rely on a mix of cloud and onsite infrastructure (How cloud is transforming pharma survey: PwC). In other words, most companies are operating in a **hybrid** IT mode – blending cloud services with traditional on-premises systems.

(image) *Breakdown of cloud vs on-premises IT adoption among pharmaceutical companies.* As of 2023, about four out of five pharma firms use some cloud computing (fully or partially), while roughly one out of five remains exclusively on-premises (Cloud vs. On-Premises in the Pharmaceutical Industry - Sikich). Only ~40% of companies have moved **all** IT operations to the cloud, with the majority instead running a **hybrid** mix of cloud and on-prem environments (How cloud is transforming pharma survey: PwC). This indicates that onsite data centers are still in play for many organizations, even as cloud services become ubiquitous.

It's worth noting that pharma's cloud uptake, while high, still lags behind some other industries. For context, across industries in 2023 an estimated 95% of businesses are using cloud in some form (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). Many organizations in sectors like finance, tech, or retail have already adopted "cloud-first" strategies, with 42% reporting a cloud-first approach and over half operating hybrid clouds in one cross-

industry survey (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). The pharmaceutical sector's ~83% cloud adoption rate signals that it has become mainstream, but pharma has been somewhat more cautious compared to the most aggressive cloud adopters. In fact, one industry analysis valued the **global pharma cloud computing market at only about $4.8 billion in 2022**, highlighting that pharma was behind in cloud spending relative to other major industries (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). (By contrast, the overall global cloud market across all sectors was estimated around $569 billion in 2022 (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?).) The good news is that *virtually all* pharma companies have plans to expand cloud use – the PwC survey found an additional 55% of pharma and life sciences companies expect to be fully cloud-operational within two years (How cloud is transforming pharma survey: PwC). This means that on-premises footprints will continue to shrink as companies transition remaining systems to the cloud.

From an IT infrastructure perspective, current pharma environments are largely **hybrid**. Critical applications might still run on-premises (due to regulatory or legacy reasons), while new projects and less sensitive workloads are deployed to public or private clouds. This is reflected in the fact that 55% of organizations (across sectors) report using a hybrid cloud approach, combining on-prem and cloud resources (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). Pharma companies are leveraging cloud for many functions already – from research data analysis to CRM systems – but in most cases the cloud supplements or integrates with existing on-prem systems rather than replacing everything. As we'll explore, the industry is steadily moving along the spectrum from on-prem to cloud, but the pace varies by company and function.

Historical Adoption Trends in Pharma IT

Over the past decade, cloud adoption in pharma has evolved from tentative early experiments to a near-universal strategic imperative. In the early 2010s, pharmaceutical IT leaders were notably cautious about the cloud. Concerns about data security, regulatory compliance (e.g. FDA 21 CFR Part 11 requirements), and cultural resistance to off-premises data held back adoption. For example, a survey of R&D IT professionals in 2010 found that more than half expected to devote *only* about 11% of their IT budget to cloud computing over the following three years. Fewer than 10% of those respondents anticipated allocating the majority of their IT budget (>50%) to cloud by 2013 (Cloud Computing Efficiency). At that time, many pharma companies were just beginning to test cloud solutions in isolated areas (such as basic research), and most critical systems remained on in-house servers.

During the mid-2010s, pharma began slowly opening up to cloud services, initially for less regulated domains. Early adopters leveraged software-as-a-service for functions like HR or sales, and infrastructure-as-a-service for extra data storage or burst compute power. A notable turning point came as leading technology providers demonstrated that cloud platforms could

meet stringent security and compliance standards. By the late 2010s, cloud computing "came of age" in life sciences (The case for cloud in life sciences - McKinsey). Many top pharma companies started announcing cloud initiatives and partnerships. In fact, by 2019–2020, 16 of the top 20 pharmaceutical companies (by revenue) were publicly referencing cloud technology in their annual reports, press releases, or investor calls (The case for cloud in life sciences - McKinsey). These companies reported deploying cloud across a wide range of use cases – with **research & early development, clinical trials, commercial operations, and medical affairs** being among the most commonly cited areas leveraging cloud solutions (The case for cloud in life sciences - McKinsey). This marked a significant shift in mindset: cloud was no longer seen purely as a cost-saving IT outsourcing, but as an enabler of innovation across the pharma value chain.

The **COVID-19 pandemic (2020)** dramatically accelerated cloud adoption in pharma, as it did in many industries. With global lockdowns, remote work, and urgent demands for vaccine and therapeutic development, pharma companies had to rapidly scale up digital capabilities. Cloud-based collaboration and data analysis tools became essential for researchers spread across locations. Virtual clinical trials and remote monitoring, supported by cloud infrastructure, gained traction when in-person site visits were limited. A survey of industry professionals found that roughly 27% believed COVID-19 accelerated digital transformation in pharma by at least one year or more (and many felt it sped things up by several years) (COVID-19 accelerated digital transformation of the pharma industry). During the pandemic, **cloud proved its value** by enabling resilience and speed. A famous example is Moderna's COVID-19 vaccine development: Moderna credited its cloud-native approach (partnering with AWS) for allowing it to deliver a first clinical batch of the vaccine just 42 days after the virus's genetic sequencing was published (The case for cloud in life sciences - McKinsey). As CEO Stéphane Bancel put it, using the cloud meant "you don't have to reinvent anything. You just fly." (The case for cloud in life sciences - McKinsey) This success story resonated across the industry and showcased how cloud computing can shrink timelines in drug R&D.

By 2023, cloud adoption in pharma had firmly shifted from *if* to *how*. Nearly every pharma company was using cloud in some capacity, and attention turned to maximizing value from the cloud. Many organizations that initially "lifted and shifted" some applications to cloud began focusing on true cloud modernization – rearchitecting applications to be cloud-native and take full advantage of scalability and analytics. (According to Deloitte, only about 65% of life sciences companies had made significant investments in **cloud-native modernization** as of 2023, meaning a substantial portion still needed to refactor legacy systems to fully leverage cloud benefits (EngineeringBeat: Cloud Modernization for Life Sciences - Deloitte US).) Overall, the last few years have seen an inflection point: cloud computing is now regarded as a *strategic necessity* for pharma rather than a niche experiment. On-premises systems, while still part of the landscape, are generally legacy holdovers or reserved for special cases, as the industry's center of gravity decisively shifts to the cloud.

Future Outlook: 5–10 Year Cloud Adoption Forecast

All signs indicate that cloud adoption in pharma will continue to surge over the next decade, eventually far outpacing on-premises usage. Analysts predict that **by the late 2020s, the majority of pharma IT workloads will be running in cloud environments**. Gartner, for instance, forecasts that by 2028 roughly 70% of all tech workloads across enterprises will be in the cloud – up from only about 25% in 2023 (Gartner: By 2028, 70% of Workloads Will Run in a Cloud Computing Environment). In other words, on-premises processing will shrink to around 30% or less of workloads. We can expect the pharma sector to follow this general trajectory, albeit with some remaining conservative pockets. It's quite feasible that by 2030, only highly specialized or ultra-sensitive systems (where regulatory constraints demand local control) will remain on-prem, with everything else having migrated to cloud or hybrid cloud setups.

In terms of market growth, the spending on cloud computing by pharma companies is projected to expand robustly. One market research report (Straits Research) estimates that the **global cloud computing market in the pharmaceutical industry** will grow from about **$17.2 billion in 2021 to roughly $59–62 billion by 2030** (Understanding the Impact of Cloud Computing in Pharma - Symphony Solutions) (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033). This represents more than a three-fold increase in market size, equating to a compound annual growth rate (CAGR) on the order of 14–15%. Another analysis by IDC found that enterprise cloud infrastructure spending in 2024 was already surging – increasing 62% year-over-year in Q2 2024, far outpacing growth in traditional IT spending – due in part to accelerated investments in AI and data analytics workloads in the cloud (Cloud vs. On-Premises in the Pharmaceutical Industry - Sikich). As pharma companies invest in capabilities like artificial intelligence (which thrive on cloud scalability), their cloud expenditures are expected to climb significantly.

(image) *Growth of cloud computing usage in the pharmaceutical sector (global market size in USD billions)*. Industry forecasts anticipate a rapid rise in pharma's cloud investments, from an estimated ~$17 billion in 2021 to nearly $60 billion by 2030 (Understanding the Impact of Cloud Computing in Pharma - Symphony Solutions). This ~3x growth in a decade highlights a **strong upward adoption trend**, with cloud spending in pharma growing at roughly 15% CAGR – significantly faster than overall pharma IT budgets. By the early 2030s, cloud is expected to be the default platform for most pharma IT needs, while traditional on-premise spending stagnates or declines.

Not only is cloud spending increasing, but the *nature* of cloud adoption is also maturing. We will likely see more pharma firms moving from a tentative hybrid approach to a **cloud-first or cloud-only posture** for new projects. According to PwC's 2024 Cloud Business Survey (across industries), 47% of companies were already pursuing a cloud-first strategy, and 30% described themselves as fully cloud-native, with another 37% aiming to be cloud-native within three years (101 Shocking Cloud Computing Statistics (UPDATED 2024)). We can expect similar or slightly slower timelines in pharma – meaning that by around 2025–2028, most large pharmaceutical

organizations will have completed the bulk of their cloud migrations and be focused on optimization and innovation in the cloud. In fact, in the PwC pharma/life sciences survey, an overwhelming 95% of respondents projected that they would be operating fully in the cloud within a couple of years (How cloud is transforming pharma survey: PwC), indicating that virtually every pharma company either has or is developing a roadmap to retire remaining on-prem systems.

That said, **on-premises infrastructure will not disappear overnight.** Pharma firms will likely maintain some on-site data centers for specialty needs (for example, certain manufacturing control systems or highly sensitive data that they choose to keep in-house for sovereignty reasons). Edge computing on-premises may also complement cloud – e.g. processing data locally at a manufacturing site for low latency, then aggregating to cloud. But in terms of *proportion of IT workloads and spend*, the tilt will be heavily toward cloud services. By 2030, it's reasonable to say that on-premises IT in pharma will play a **supporting role**, with the cloud being the primary engine for computing, storage, and application deployment.

Cloud Adoption by Functional Area in Pharma

Cloud penetration in pharma isn't uniform across all business functions – some areas have embraced cloud much more readily than others. Below is a breakdown of how different functional areas in a pharmaceutical company are using cloud computing, and the relative adoption levels on cloud vs. on-premises in each:

- **Research & Development (R&D):** R&D was one of the earliest adopters of cloud in pharma and continues to be a **cloud-heavy domain**. Drug discovery and development generate enormous volumes of data (e.g. genomic data, high-throughput screening results, clinical trial data) that benefit from scalable cloud storage and computing power. Cloud platforms enable secure collaboration between research teams globally and provide the elasticity needed for computational chemistry simulations or bioinformatics pipelines. For example, companies like Eli Lilly started using cloud-based research environments in the early 2010s to extend their computing capacity for drug discovery (Cloud Computing Efficiency) (Cloud Computing Efficiency). Today, it's common for R&D units to use cloud-based data lakes and analytics: in a 2023 PwC survey, pharma execs said **analytics** is the #1 area with potential for cloud-native solutions (87% of respondents), and specifically cited the value of better data interoperability for research data exchange (53%) (How cloud is transforming pharma survey: PwC). Cloud-based **AI and machine learning** are also driving R&D – for instance, Pfizer partnered with AWS to utilize machine learning on cloud for drug discovery efforts (The impact of cloud computing on the pharmaceutical industry - Pharma Technology Focus - Issue 129 - April 2023). Overall, R&D has largely moved away from on-premises-only computing; while certain lab instruments or secure research environments may still be local, the **trend is toward cloud-enabled labs** (even remote "virtual labs"). The COVID vaccine development by Moderna, leveraging AWS cloud, is a case in point of R&D acceleration via cloud (The case for cloud in life sciences - McKinsey). We can say R&D functions in pharma are now predominantly hybrid or cloud-based, using on-premises mainly for legacy systems or extremely sensitive projects, and using cloud for everything from data storage to simulations.

- **Clinical Trials & Medical Affairs:** Closely related to R&D, the clinical development and medical affairs areas are increasingly cloud-supported. Clinical trial management systems, electronic data capture (EDC) for trials, and pharmacovigilance databases have traditionally been on-prem or vendor-hosted, but now many are offered as **cloud-based solutions** (often via SaaS). Cloud computing supports decentralized clinical trials – e.g. patients input data through cloud-hosted apps, and investigators access trial data via web portals. This improves trial efficiency and data sharing. During COVID-19, many companies used cloud platforms to monitor trials remotely when physical monitoring was impossible. Additionally, medical information systems and real-world evidence platforms are moving to cloud to enable integration of data from hospitals, patients, and researchers. While some critical GxP systems in this domain might still be on-prem for validation reasons, the **direction is toward cloud** as vendors obtain regulatory compliance certifications for their cloud offerings. In fact, regulators themselves are encouraging modernization – the FDA has been developing guidelines on the use of cloud computing and even leveraging cloud for some of its own analytics, which gives pharma more confidence to do the same (Cloud Computing Efficiency).

- **Manufacturing & Supply Chain:** Manufacturing IT in pharma (manufacturing execution systems, process control, supply chain management) has traditionally been very **on-premises-centric** due to strict validation (every change in a production system must be validated) and real-time control requirements. However, even in manufacturing, cloud is making inroads in specific ways. **Hybrid cloud** is a common model here: the most sensitive production controls may remain on-prem or in a private cloud, but production data and planning systems are increasingly connected to the cloud. For example, cloud-based **production management systems (PMS)** are being adopted to optimize manufacturing processes and quality control. According to industry reports, production management applications currently *dominate* the pharma cloud market by helping monitor and streamline production with real-time data, reducing errors and enhancing decision-making (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033). These cloud-based PMS can collect data from plant equipment (IoT sensors, etc.) and upload it to cloud analytics dashboards for analysis of trends, predictive maintenance, and efficiency improvements. Similarly, **supply chain** and logistics in pharma benefit from cloud for improved visibility – companies use cloud platforms to track product distribution, manage inventory across sites, and ensure supply continuity (a lesson reinforced by the pandemic's supply disruptions (Cloud vs. On-Premises in the Pharmaceutical Industry - Sikich)). While core manufacturing control systems might still run on local servers for now, the **peripheral systems (data analysis, scheduling, supply chain tracking)** are moving to cloud. This hybrid approach balances the **security and low-latency needs on the factory floor with the scalability of cloud** (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033). Over the next 5–10 years, we expect more validated manufacturing solutions to become cloud-certified, gradually shifting even production and quality management software to cloud deployments (likely private or hybrid cloud for compliance). Already, companies are piloting cloud-based batch release and electronic logbooks, showing that even regulated manufacturing IT can transition with proper controls.

- **Quality Assurance & Regulatory Compliance:** QA/QC and regulatory functions have been **slower to move to cloud** due to compliance concerns, but they are now catching up. Quality assurance systems (like Quality Management Systems for deviations, CAPA, document management for SOPs) have traditionally been behind the firewall. In recent years, **cloud-based quality systems** (often provided by industry-specific SaaS vendors) have gained trust. These systems come with strict security, audit trails, and validation packages to meet FDA and EMA requirements. Regulatory compliance departments, which handle submissions, correspondence with regulators, and compliance documentation, are also starting to use cloud-based solutions. For instance, many pharma companies now use cloud-based **Regulatory Information Management (RIM)** systems to manage drug submission documents and product registrations globally. Cloud providers have addressed regulatory requirements by implementing strong security controls like encryption, granular access controls, and robust audit logging (Understanding the Impact of Cloud Computing in Pharma - Symphony Solutions). This helps assure that using the cloud can comply with regulations such as 21 CFR Part 11 (which governs electronic records and signatures in pharma) (Understanding the Impact of Cloud Computing in Pharma - Symphony Solutions). Still, **barriers remain** – some QA/QC labs keep data on-prem for fear of compliance issues or because instruments aren't yet cloud-connected, and regulatory teams may be wary of storing draft submission data in the cloud. But the trajectory is shifting – as cloud vendors achieve compliance certification and pharma IT validates cloud systems, the comfort level is rising. For example, firms are using validated cloud document management for regulatory filings and employing cloud analytics to ensure data integrity across quality processes. We can characterize QA/regulatory cloud adoption as **emerging but growing**: on-premises systems are still common, but most companies have plans to migrate or are actively migrating these functions to cloud-based platforms designed for GxP compliance.

- **Commercial Operations (Sales & Marketing):** Commercial and customer-facing functions in pharma have been **among the earliest and most fully in the cloud**. This includes systems for sales force automation, customer relationship management (CRM), marketing automation, and analytics on sales data. For instance, many pharma sales teams use cloud-based CRM platforms (like Veeva CRM, which is built on Salesforce) to manage interactions with healthcare providers – these have been industry standard for years, replacing older on-prem CRM tools. Marketing organizations rely on cloud services for digital marketing campaigns, omnichannel customer engagement, and managing content for physicians and patients. The reason commercial functions moved quickly to cloud is that they are less encumbered by regulatory compliance compared to R&D or manufacturing, and they benefit greatly from the agility and scalability of cloud (e.g., launching a new drug's digital marketing campaign across many markets). Additionally, commercial operations often require integration of data from multiple sources (sales data, market data, patient insights), which cloud data warehouses and analytics platforms handle well. According to McKinsey, "market access and commercial applications" are among the most frequently mentioned cloud use cases by top pharma companies (The case for cloud in life sciences - McKinsey), indicating heavy adoption in these areas. Today, it's commonplace for a pharma company's entire CRM, analytics dashboards, and even training platforms for sales reps to reside in the cloud (often provided by third-party SaaS vendors). Only legacy commercial IT systems (like old on-prem data marts) remain in-house, and those are steadily being retired. Thus, in the commercial realm, cloud has essentially **supplanted on-premises infrastructure** for most purposes.

- **Corporate Functions (Finance, HR, IT):** Although not unique to pharma, it's worth noting that internal corporate functions have also moved to cloud. ERP systems in pharma are sometimes still on-premises (e.g., a heavily customized SAP system managing manufacturing and finance), but many companies are evaluating or implementing cloud-based ERP or financial systems. HR systems (Workday, SuccessFactors, etc.) are often SaaS in the cloud. The IT department itself uses cloud for dev/test environments, data backups, and productivity tools. Pharma companies have been adopting industry-specific **"validated cloud"** offerings for things like electronic document management, training records, etc., which support corporate compliance needs. Over time, even core ERP and financial processes are expected to transition to cloud-hosted versions as those solutions mature and prove compliance-ready.

In summary, **every segment of the pharma value chain is now touched by cloud computing, but at varying levels of maturity**. R&D and Commercial leads the pack in cloud utilization, Manufacturing and Quality/Regulatory are in transition but making notable strides, and corporate/back-office functions are steadily moving to cloud-based solutions as well. Where on-premises infrastructure remains, it is often due to either historical inertia (legacy systems not yet replaced) or specific regulatory/technical constraints that are gradually being addressed. The overall direction across functions is clear: increasing reliance on cloud to enhance collaboration, data analysis, and agility in each area of the business.

Private vs. Public Cloud Adoption in Pharma

When pharma companies move to the cloud, they face choices between using **public cloud** services (shared infrastructure provided by vendors like AWS, Microsoft Azure, Google Cloud), **private cloud** deployments (dedicated infrastructure for one company, which could be on-prem or hosted), or a combination thereof. In practice, most pharma firms have gravitated toward a **hybrid multi-cloud** strategy that blends the strengths of both public and private environments.

Hybrid cloud dominates in pharma because it balances the industry's needs for security and compliance with the benefits of scalability and innovation. A pharma company typically handles highly sensitive data (e.g., patient records from clinical trials, confidential formulas, etc.) that they may prefer to keep in a private cloud or within a controlled environment, *while* leveraging public cloud for less sensitive workloads or for burst computing needs (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033). For example, a company might store patient-identifiable data or regulated production data in a private cloud environment (or virtual private cloud) to ensure strict data residency and dedicated security, but use public cloud resources to run large-scale analytics on de-identified data or to host its corporate website and collaboration tools. This **hybrid approach** allows firms to comply with regulations and internal policies on certain data, and at the same time not miss out on the virtually unlimited compute power and advanced services (AI/ML, big data processing, etc.) that public clouds offer.

Surveys of IT trends show that *most enterprises are not single-cloud*. In fact, about 80% of organizations use multiple cloud providers (mixing public and/or private clouds) rather than

relying on just one (101 Shocking Cloud Computing Statistics (UPDATED 2024)). Pharma is no exception – many large pharmaceutical companies use a **multi-cloud** strategy, partnering with multiple public cloud vendors to diversify capabilities and avoid lock-in. They might use AWS for R&D and data lakes, Azure for office productivity and some enterprise applications, and a private cloud or hosted data center for particular legacy systems. One O'Reilly survey noted that roughly two-thirds of companies operate in a public cloud, 45% use private clouds, and 55% still use traditional on-premises – these categories overlap since hybrid setups are common (101 Shocking Cloud Computing Statistics (UPDATED 2024)). The takeaway is that **public vs. private is not an either/or choice** for pharma; it's usually a mix.

That said, we can examine **trends in public vs. private cloud adoption** in pharma:

- **Public Cloud** – Usage of public cloud services in pharma has been rising steeply, especially for data-intensive and collaborative tasks. The big three public cloud providers (Amazon Web Services, Microsoft Azure, Google Cloud) all have dedicated life sciences teams and are offering industry-specific solutions to attract pharma clients. Pharma companies have formed high-profile partnerships with public cloud providers: for instance, Johnson & Johnson, Novartis, and Merck have strategic collaborations with AWS or Azure to modernize their infrastructure. Takeda announced a strategic partnership with AWS to accelerate its digital transformation (The case for cloud in life sciences - McKinsey), and Sanofi has partnered with Google Cloud for AI-driven innovation. Public clouds provide ready access to advanced tools like AI platforms, IoT integrations for smart factories, and global content delivery – capabilities hard to replicate on-prem. Initially, some pharma CIOs were hesitant to put critical data on a public shared infrastructure, but over time the major cloud providers have proven they can meet pharma's requirements (offering virtual private clouds, encryption, compliance attestations, etc.). **Public cloud adoption is now mainstream in pharma** for many applications, particularly R&D analytics, cloud data warehouses, CRM systems, and even high-performance computing for simulations. By 2025, a large portion of new IT initiatives in pharma are expected to launch in public cloud environments by default, unless there's a compelling reason to do otherwise.

- **Private Cloud / On-Premises Clouds** – Private clouds (which could be on-premises or hosted in a specialized provider) remain important for pharma's most sensitive or performance-critical workloads. Some pharma companies have invested in building their own private cloud infrastructures – essentially modernizing their data centers with virtualization and automation to get cloud-like flexibility but under their own control. These private clouds are used for hosting sensitive data, legacy enterprise applications that aren't easily moved, or workloads where companies want fixed cost infrastructure. Private clouds in pharma often serve as an intermediate step: for example, a firm might first virtualize its internal servers into a private cloud as it retires old hardware, then later evaluate migrating those virtual machines into a public cloud. There are also **community clouds** or industry clouds emerging, where infrastructure is tailored for pharmaceutical industry needs (with compliance pre-built). For instance, some regulatory submission platforms operate on a cloud built specifically for life sciences companies. In general, private cloud use in pharma is about control and compliance. But one challenge is that private clouds typically can't match the scale economics of public clouds, so they might be more expensive or less agile in the long run. We see many companies keeping a core private environment but steadily shrinking it as confidence in public cloud grows.

- **Hybrid Integration:** The dominant model is hybrid – e.g., using public cloud for front-end applications and private cloud for the database, or vice versa. A typical scenario: a pharma company uses a cloud vendor's regional data center to store clinical data to satisfy local privacy laws (effectively a private isolated instance), but then uses the public cloud's global network to share insights derived from that data. Hybrid setups require robust integration and security strategies (e.g., VPNs or dedicated connections between on-prem and cloud). Many pharma IT departments have had to develop new **cloud governance** models to manage this complexity – ensuring that data moving between private and public clouds remains secure and compliant. Over time, as confidence in public clouds increases, some companies are shifting more of the workload onto public infrastructure and using techniques like encryption and anonymization to alleviate compliance concerns.

In summary, **pharma IT is operating in a multi-cloud world**. Hybrid cloud is currently the prevalent strategy (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033), but the balance may tilt increasingly toward public cloud usage as those platforms continue to mature and address regulatory requirements. Private clouds and on-prem systems will serve niche needs – such as ultra-sensitive data, ultra-low latency processing, or proprietary systems – whereas the heavy lifting of data processing and enterprise applications will run on public clouds. Importantly, pharma companies are learning to treat cloud providers as extensions of their own IT. As one Gartner analyst put it, by 2028 cloud will be seen not just as tech augmentation but as *essential for business survival*, even for traditionally conservative industries (Gartner: By 2028, 70% of Workloads Will Run in a Cloud Computing Environment) (Gartner: By 2028, 70% of Workloads Will Run in a Cloud Computing Environment). Pharma organizations are moving in that direction, treating cloud and on-prem not as two separate worlds, but as parts of one cohesive infrastructure strategy with cloud services playing an ever larger role.

Drivers Behind Cloud Adoption in Pharma

Multiple factors are propelling pharmaceutical companies to embrace cloud computing. These drivers range from technological needs (managing big data, leveraging AI) to business imperatives (cutting costs, speeding up innovation) and even strategic considerations (improving collaboration and resilience). Below are some of the key drivers behind the cloud migration trend in pharma:

- **Exploding Data Volumes and Advanced Analytics Needs:** The modern pharma enterprise deals with unprecedented amounts of data – *omics data from research, high-resolution imaging, electronic health records, real-world evidence, IoT sensor data from manufacturing equipment, etc.* Traditional on-premises setups struggle to store and analyze such **big data** efficiently. Cloud platforms offer virtually unlimited storage and scalable computing clusters for analytics. This is crucial for activities like genomics (which can generate terabytes of data per experiment) and pharmacovigilance (mining large databases for safety signals). Moreover, the rise of **artificial intelligence (AI) and machine learning** in drug discovery and personalized medicine is a huge driver for cloud: training machine learning models requires significant computational power that cloud GPU/TPU instances can provide on-demand. As one report highlighted, global data generation is expected to soar to 180 zettabytes by 2025 (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033) – pharma contributes its share to this data deluge, and cloud-based data lakes and analytics tools are increasingly the only practical way to derive insights from these massive datasets. In a survey, 87% of pharma execs pointed to analytics as the top area where cloud-native solutions add value (How cloud is transforming pharma survey: PwC). The ability to run complex analytics and AI workloads in the cloud – and quickly scale them up when needed – is arguably the **single biggest technical driver** for cloud adoption in pharma.

- **Speed, Agility, and Time-to-Market:** In the pharmaceutical business, timelines for R&D and product launches are critical. Cloud computing can dramatically increase the speed of IT operations and, by extension, the speed of research and decision-making. For example, setting up a new on-premises server for a project might take weeks for procurement and installation, whereas in the cloud it takes minutes to provision a new environment. This agility means researchers and project teams don't have to wait on IT infrastructure – they can prototype and iterate faster. The case of Moderna's rapid COVID-19 vaccine development with cloud support (achieving in weeks what used to take months) illustrates how cloud can cut down **time-to-market** for critical programs (The case for cloud in life sciences - McKinsey). Cloud also enables faster **software deployment cycles** through DevOps practices – teams can push updates to cloud-hosted applications continuously (helpful for things like clinical trial portal updates or internal analytics dashboards). In an industry where being first to market can be worth billions, the acceleration that cloud offers is a compelling driver. Executives see cloud as a way to gain a competitive edge by bringing therapies to market faster through improved collaboration and streamlined processes (How cloud is transforming pharma survey: PwC). In surveys, however, some pharma companies noted they have not *fully* realized these agility benefits yet (less than half said they achieved faster time-to-market from cloud so far) (How cloud is transforming pharma survey: PwC) (How cloud is transforming pharma survey: PwC), suggesting that as they mature in cloud usage, even greater speed gains will materialize.

- **Cost Efficiency and Scalability: Cost** is a nuanced driver in pharma's cloud decisions. On one hand, pharma companies have large capital budgets and existing data centers, so cost was not the sole initial motivation to move to cloud (especially given the high profit margins in pharma). However, cloud computing shifts IT spending from capital expenditure (buying hardware) to operational expenditure (pay-as-you-go usage), which can be attractive for managing budgets and scaling costs with actual needs. Many companies have found that for variable workloads, cloud is cheaper – you don't pay for idle servers, and you can downsize environments after peak usage. Accenture has estimated that migrating to public cloud can reduce total cost of ownership by up to 40% in some cases (101 Shocking Cloud Computing Statistics (UPDATED 2024)). Additionally, cloud providers benefit from economies of scale, often making commodity computing and storage cheaper than on-prem solutions. Pharma CIOs are also considering **opportunity cost** – the value of things you can do in cloud (like advanced analytics) that you might not easily do on-prem. It should be noted that cost isn't always lower – if cloud is poorly managed, costs can spike – but overall the promise of **scaling efficiently** (scale-out when demand increases, scale-in to avoid waste) is a big driver. Cloud also reduces the need for maintaining excess capacity "just in case" – freeing IT teams from constantly upgrading hardware. Given that pharma companies must allocate significant funds to IT to support R&D, anything that makes IT spending more efficient can indirectly free funds for other investments (or reduce SG&A expenses). In practice, many pharma firms are reinvesting cloud-related savings into new digital initiatives, creating a virtuous cycle driving further cloud use.

- **Collaboration and Global Access:** Pharma R&D and business operations are global, involving cross-border collaboration among research sites, clinical investigators, manufacturing sites, and commercial teams. Cloud computing enables a **unified platform accessible from anywhere**, which greatly enhances collaboration. Researchers from different countries can work together in a shared cloud workspace, accessing the same data and tools without needing to be on the same corporate network. During regulatory submissions, global teams can concurrently work on documents in cloud-based systems. With the industry's increasing focus on external collaborations (with biotech startups, academic labs, contract research organizations, etc.), cloud has become an **integration layer** that allows secure data sharing with external partners without opening up internal firewalls. For example, a pharma company can share a subset of clinical trial data in a cloud repository with an academic research partner, facilitating open innovation while keeping the master data secure. This level of flexibility and connectivity was hard to achieve with on-prem systems alone. The cloud's ubiquitous access also supported remote work – an important factor during COVID-19 when most knowledge workers had to work from home. Pharma companies with robust cloud infrastructure experienced relatively smoother transitions to remote operations (with employees accessing cloud-based apps and data securely from home) compared to those reliant on VPNs into on-prem systems. Enhanced **collaboration, remote access, and data sharing** are thus key drivers – they improve productivity and enable new ways of working across the pharma value chain.

- **Innovation and New Technologies (AI/ML, IoT, GenAI):** Cloud environments are fertile ground for rapid innovation because they provide quick access to new technologies. Major cloud providers continuously roll out cutting-edge services (for instance, managed machine learning platforms, Internet of Things frameworks, blockchain-as-a-service, and most recently, **generative AI** services). Pharma companies are adopting cloud in order to tap into these innovations without having to build them from scratch. For example, if a company wants to experiment with **generative AI** for molecule design or medical writing, they can leverage a cloud provider's GPU clusters and large language model APIs rather than procuring expensive hardware and building models internally. In fact, surveys show that the ability to leverage AI is now one of the top reasons organizations are increasing cloud investments (2024 Cloud and AI Business Survey: PwC) (2024 Cloud and AI Business Survey: PwC). In pharma, this translates to things like using AI for drug discovery (as mentioned earlier), or using advanced analytics to personalize marketing – all enabled by cloud-hosted AI services. IoT in manufacturing (smart factories) is another area: connecting manufacturing equipment to cloud systems for monitoring and predictive maintenance can drive efficiency and is much easier with cloud IoT suites. In short, **cloud is a gateway to rapid innovation** – pharma companies see it as the platform that will allow them to deploy next-generation solutions (AI, data science, digital health apps) faster and keep pace with technological change.

- **Improved Reliability, Disaster Recovery, and Security Posture:** Although security was once seen as a barrier to cloud, many companies now recognize that leading cloud providers invest heavily in security and reliability – often more than a single company could on its own. Downtime in pharmaceutical operations (whether an R&D system or a manufacturing site's IT) can be very costly. Cloud infrastructure, spread across multiple data centers and built with redundancy, can provide higher uptime and faster disaster recovery than a single on-prem data center. For instance, if a company's primary data center experiences an outage, a cloud-based disaster recovery setup can fail over workloads to a different region, minimizing disruption. The **resilience** of cloud is a driver – in PwC's survey, 57% of pharma executives said cloud had improved their cybersecurity posture, and 53% said it improved stakeholder trust via robust security and privacy measures (How cloud is transforming pharma survey: PwC). Cloud providers offer built-in backup, replication, and multi-site high availability that can be complex to achieve in-house. Additionally, from a security standpoint, top cloud providers have armies of security experts, advanced threat detection, and compliance certifications (HIPAA, GxP, etc.) that can help pharma meet regulatory security requirements. Many companies find that by moving to the cloud, they can modernize their security (zero-trust architectures, better identity management, encryption at rest and in transit) more effectively than updating older on-prem systems. Thus, while paradoxical at first glance, **improving IT reliability and security is actually a driver** for cloud adoption now that the technology has matured. Executives are increasingly trusting cloud for mission-critical systems as they see evidence that it can reduce downtime and security incidents.

- **Regulatory Flexibility and Scalability:** Pharma is a highly regulated industry, which historically made companies reluctant to change IT systems frequently. However, regulations themselves are evolving (e.g., new data privacy laws, electronic records requirements, pharmacovigilance data standards), and cloud offers a degree of flexibility to adapt. For example, if a new regulation requires storing certain data in the EU only, a cloud provider can enable data residency in specific regions more easily than an on-prem solution that might require building a new data center. Cloud vendors also frequently certify their platforms against relevant standards (such as ISO, SOC, and even specific FDA/EMA guidelines), which can simplify compliance for pharma companies. In addition, cloud-based solutions designed for pharma often come with **validation packages** to ease the burden of computer system validation – updates in the cloud can be validated in a continuous manner by the vendor. This means pharma companies can stay in compliance without huge internal efforts every time software updates (since the cloud vendor helps handle it). Such factors drive adoption because they turn regulatory compliance into less of an obstacle. Also, when regulations change or unexpected demands arise (like new reporting requirements to health authorities), a cloud system can scale and adjust configurations faster than an on-prem one. Essentially, cloud can be an **enabler of regulatory agility**, despite the irony that regulatory concerns initially kept companies away from cloud. This driver is subtle but increasingly appreciated as firms realize that compliance *can* be maintained in cloud and that cloud infrastructure can respond swiftly to new compliance needs.

In summary, pharma companies are moving to the cloud to harness data and AI, accelerate processes, control costs, foster collaboration, tap into continuous innovation, and bolster resilience. These drivers align with broader digital transformation goals in the industry – cloud is a foundational piece of pharma's strategy to become more data-driven and patient-centric. As Deloitte noted, the greatest value from cloud comes not just from IT cost optimization but from **enabling business innovation and agility** (The case for cloud in life sciences - McKinsey). The companies that effectively leverage these drivers – going beyond simply migrating servers, to reinventing workflows in the cloud – are seeing outsized benefits in terms of R&D productivity, time saved, and new capabilities unlocked (How cloud is transforming pharma survey: PwC) (How cloud is transforming pharma survey: PwC).

Barriers and Challenges: Why On-Premises Persists

Despite the strong momentum toward cloud computing, several barriers and challenges continue to **anchor certain systems on-premises** in the pharma industry. These are the factors that make some executives hesitant to fully "lift and shift" everything to the cloud or that slow down the pace of migration. Understanding these barriers is important, as they explain why onsite infrastructure hasn't disappeared and why some pharma workloads remain in local data centers or private clouds. Key challenges include:

- **Regulatory Compliance Concerns:** By far one of the biggest barriers is ensuring compliance with stringent regulatory requirements when using cloud systems. Pharma companies operate under regulations like FDA's 21 CFR Part 11 (for electronic records/signatures), Good Clinical Practice (GCP) guidelines for clinical trial data, Good Manufacturing Practice (GMP) for production systems, and various data privacy laws (HIPAA, GDPR, etc.). In the past, there was a fear that cloud providers might not meet these requirements or that regulators would not accept data stored off-premises. Companies worried about being able to validate cloud software updates, maintain audit trails, and demonstrate control over data in a multi-tenant environment. **Validation of cloud systems** is a specific hurdle – traditionally, pharma validates (tests and documents) its computer systems to ensure they function as intended. Doing this in a cloud, where updates are frequent and infrastructure is abstracted, required new approaches. Although guidance now exists and many cloud offerings are compliant, this remains a conservative point: some QA/Compliance departments prefer to keep systems in-house where they feel they have direct oversight. Until they gain confidence with cloud compliance (which is happening gradually), they will resist moving certain regulated applications. We see this for things like laboratory information management systems (LIMS) or manufacturing execution systems – highly regulated and historically on-prem. The **compliance barrier** is gradually lowering (with vendors providing compliance assurances), but it's still cited as a top reason for reluctance (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?).

- **Data Security and Privacy:** Pharmaceutical companies are custodians of extremely sensitive data – from patient health information in trials to trade secrets like drug formulas and manufacturing processes. The thought of these crown jewels residing outside the company's own walls raises understandable anxiety. **Cybersecurity threats** such as hacking, data breaches, and intellectual property theft loom large. Some executives feel more secure having data on servers they control physically. There's also concern about **insider threats or multi-tenancy risks** in public cloud (sharing hardware logically with other cloud customers, even if isolated, is a mental hurdle). Additionally, **patient privacy** is a major consideration: trials and patient support programs generate personal health data that companies must protect per regulations like HIPAA. While cloud providers offer robust security, the challenge is partly perception and partly ensuring that all security configurations are done correctly by the user. High-profile cloud data breaches (often due to customer misconfiguration rather than cloud failure) have made companies cautious. In practice, when due diligence is done, cloud security can be very strong, but achieving internal buy-in requires education and trust. A 2024 CDW survey of healthcare IT leaders found reliability and recovery advantages in public cloud, yet security is always a top-of-mind issue (Cloud vs. On-Prem: Healthcare Organizations Can Find Key ...). For pharma, **data breaches could be devastating** (financially and reputationally), so some prefer the devil they know (on-prem security) over the devil they don't (cloud). That said, this barrier is easing as well – pharma companies now routinely encrypt data and use virtual private clouds to mitigate security concerns, and many acknowledge that cloud providers can deploy security measures beyond what the company might manage on its own.

- **Data Sovereignty and Residency Requirements:** Pharmaceutical companies operate globally, but data cannot always freely move globally due to legal restrictions. Certain countries require that personal data (like patient data) remains within their borders. This can complicate cloud adoption if the cloud provider doesn't have a local data center or if moving data to a cloud would mean exporting it. For example, a European patient data set might not be allowed to be stored on U.S. servers. In on-premises setups, companies could simply keep that data in a local facility in the required country. In cloud, they need assurances that the data will reside in specific regions. While major cloud providers have data centers in many regions, ensuring compliance with each country's data laws can be challenging. **Data sovereignty** concerns thus make some companies hesitant to move globally sensitive datasets to a public cloud. They fear inadvertently violating laws or losing direct control needed to demonstrate compliance to regulators. Many pharma firms address this by using the cloud provider's region-specific services or by adopting hybrid models (keeping data in-country on a private cloud, but processing it in public cloud under certain controls). Nevertheless, navigating the patchwork of global data regulations is a barrier that complicates a simple "all-in" cloud approach.

- **Legacy Systems and Technical Debt:** Pharma companies that are decades old have significant **legacy IT systems** – old applications, custom-developed software, instruments connected to local PCs, etc. Many of these systems were not designed for cloud and cannot be easily migrated without re-engineering. Some may run on outdated operating systems or have hardcoded dependencies on local networks. Replacing or upgrading them entails risk (e.g., a legacy system might be tied to a currently marketed product's manufacturing; changing it could require regulatory re-approval). This **technical debt** means that even if leadership wants to go cloud-first, the reality of modernization is complex and time-consuming. For instance, an older laboratory system might not have a cloud-ready alternative yet, or migrating a huge on-prem Oracle database might require significant downtime and testing. The Deloitte finding that 35% of life sciences firms had not invested in cloud-native modernization suggests many still operate cloud in a "data center in the cloud" mode (EngineeringBeat: Cloud Modernization for Life Sciences - Deloitte US) – essentially lifting VMs to cloud without rearchitecting. If not done carefully, such moves can even *increase* cost and complexity. Thus, some IT departments opt to keep certain legacy systems on-prem until there's a clearer, low-risk path to replace them with cloud solutions. In short, the **inertia of legacy IT** is a barrier: "if it ain't broke (and is validated), don't fix it" is a common refrain, given the effort and risk of re-platforming some entrenched systems.

- **Culture and Risk Aversion:** The pharma industry is inherently risk-averse because product quality and patient safety are on the line with any change. This cautious culture can extend to IT changes. Some organizations have internal resistance from stakeholders who are used to the old ways. For example, a manufacturing IT manager might be uncomfortable not having direct hands-on control of the servers that run his plant's operations. Or an R&D scientist might have concerns about putting her research data on an external cloud. These cultural barriers often manifest as "what if" scenarios (What if the cloud goes down? What if the internet link fails? What if the vendor snoops on our data?). Convincing all stakeholders – especially those in senior roles who built their careers with on-prem systems – to trust the cloud can take time. As one commentary put it, **risk aversion and organizational inertia** are significant reasons some pharma companies don't adopt cloud faster (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). There's also a skills aspect: company IT staff may need training to manage cloud infrastructure, and without those skills in-house, leadership might delay cloud projects. Additionally, the perceived loss of control when moving to cloud can be unsettling – IT teams go from managing every detail of hardware to managing vendor relationships and abstract configurations. Overcoming this requires change management and demonstrating early wins so that confidence in cloud grows within the organization.

- **Cost and Vendor Lock-in Concerns:** While cost can be a driver, it can also be a **concern**. If cloud usage is not optimized, companies can face unexpectedly high bills (so-called "sticker shock"). Pharma projects often ramp up and down, and without proper governance, a team might spin up large cloud instances and forget to shut them off, incurring costs that wouldn't occur on fixed-cost owned hardware. There is also concern over long-term **vendor lock-in** – once a pharma migrates massive amounts of data and processes to a particular cloud vendor's ecosystem, it may be difficult or expensive to switch. This raises strategic worries about future pricing power of vendors or dependency on a third party for critical operations. Some companies mitigate this by multi-cloud strategies, but the complexity of supporting multiple platforms can itself be a barrier. Thus, CFOs and CIOs sometimes push back on "cloud everything" until they have clear cost control mechanisms (FinOps) and exit strategies if needed. A Bain & Company report noted that a poorly planned migration can end up costing 10–15% more than staying on-prem if inefficiencies aren't addressed (Rightsizing Your Way to the Cloud - Bain & Company) – so prudent managers avoid rushing to cloud without a solid plan. These economic and strategic considerations can slow cloud adoption: companies want to be sure the **business case** is truly beneficial and that they won't be stuck in a few years with higher costs or limited flexibility.

In the PwC pharma survey and other industry reports, the common reasons given for lingering reluctance to adopt cloud closely mirror the above points: *"regulatory compliance, data security, data privacy, costs, risk aversion, and data sovereignty"* are repeatedly cited (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). These factors are the anchor dragging behind the cloud rocket, so to speak.

However, the landscape is gradually shifting – **barriers are being addressed one by one**. Regulatory bodies have become more accepting of cloud (some even use cloud themselves, as noted). Cloud security capabilities have matured, and many pharma companies now report improved security after moving to cloud (How cloud is transforming pharma survey: PwC). Data residency can often be solved by choosing the right provider regions or hybrid solutions. Legacy

systems are being incrementally modernized, especially as workforce turnover brings in staff familiar with cloud. And crucially, success stories and competitive pressure are eroding cultural resistance – if Company A is gaining a market edge by leveraging cloud and AI, Company B won't want to fall behind due to sticking with old systems.

Therefore, while onsite infrastructure still exists in pharma due to these challenges, its role is diminishing. Companies are finding ways to overcome the barriers: e.g., conducting thorough GxP validation of cloud systems to satisfy compliance, using encryption and dedicated tenancy for security, implementing strict cloud cost governance, and training staff on cloud skills. In essence, the **perceived risks of cloud are slowly being outweighed by the risks of *not* moving to cloud** (such as losing competitiveness or failing to manage data growth). The remaining on-premises strongholds in pharma IT are likely to be either integrated into cloud setups (via hybrid architectures) or eventually phased out as solutions emerge that resolve today's obstacles.

Conclusion

The comparison between cloud and on-premises infrastructure in the U.S. pharmaceutical industry reveals a sector in transition. **Cloud computing has gone from a nascent idea to the centerpiece of pharma IT strategy within roughly a decade.** Current statistics show that the majority of pharma companies are embracing cloud in some capacity (over 80%), yet many still operate with a hybrid mix of cloud and on-site systems as they navigate regulatory and legacy constraints. Historical trends underscore how far the industry has come – from heavy skepticism and minimal cloud usage in the early 2010s, to widespread adoption accelerated by the COVID-19 pandemic in the 2020s, to an expected near-ubiquitous cloud presence by the end of this decade.

Forecasts for the next 5–10 years anticipate that cloud adoption will only grow, with on-premises footprints shrinking correspondingly. By 2030, cloud is projected to handle the vast majority of pharma computing workloads, propelled by big data and AI needs, and the global pharma cloud market is set to triple in size (Understanding the Impact of Cloud Computing in Pharma - Symphony Solutions). Functional analysis shows that **every department – R&D, clinical, manufacturing, quality, regulatory, commercial – stands to benefit from cloud technologies**, albeit at different paces. Pharma companies are leveraging private and public clouds in tandem, usually choosing a hybrid approach that gives them both security and scalability (Cloud Computing in Pharmaceutical Market Size, Trends & Demand by 2033).

Crucially, the **drivers behind cloud adoption align closely with pharma's overarching goals**: accelerating drug discovery and development, improving efficiency and collaboration, reducing costs, and enabling innovation (e.g., advanced analytics for personalized medicine). Cloud computing offers the infrastructure to meet these goals by providing agility, computational power, and connectivity that far exceed what traditional on-premises setups can deliver. The

experiences of top pharma companies – from faster vaccine development to streamlined global operations – are demonstrating the competitive advantages of being "cloud-powered" (How cloud is transforming pharma survey: PwC).

Yet, the journey is not without challenges. Pharma IT leaders must continue to address the legitimate concerns around compliance, security, and legacy system integration that still **justify maintaining some on-premises systems** today. The article highlighted that reasons like regulatory risk, data security, and cultural inertia have slowed full cloud migration (Why Are Pharmaceutical Companies Reluctant to Adopt Cloud Technologies?). However, the trajectory is clear: solutions are emerging for each of these barriers, and industry confidence in cloud is growing year by year. For example, the development of compliant cloud validation approaches and the strong security track records of major cloud providers are gradually easing worries that once kept systems on-premises.

For IT professionals in the pharmaceutical field, the implication is that **now is the time to plan and execute a thoughtful cloud strategy**. This includes deciding what mix of private vs. public cloud makes sense for their organization's risk profile, which legacy applications to modernize or replace, and how to build governance for cost and compliance in the cloud. It's equally important to invest in skills and change management – ensuring that IT teams and business users are cloud-savvy and that stakeholders understand the value cloud brings.

In conclusion, **cloud computing is poised to largely supersede on-premises infrastructure in pharma** over the coming years, marking one of the most significant technology shifts the industry has seen. Companies that successfully harness the cloud will gain greater ability to manage data, derive insights, collaborate globally, and respond with agility to new challenges – whether that's developing a breakthrough therapy faster or adapting to new regulatory demands. On-premises systems, while still part of the current landscape, are gradually becoming the exception rather than the rule, reserved for niche purposes or phased out entirely. The pharma industry's cloud journey reflects a broader digital transformation: one where leveraging the collective power of cloud technologies leads to better research, smarter development, and ultimately improved patient outcomes. By staying informed of the trends and carefully navigating the trade-offs, pharma IT leaders can ensure they reap the full benefits of the cloud era while maintaining the trust, quality, and compliance that the industry mandates.

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