Whitepaper

Digital Health Platforms

For a future of more connected
end-to-end patient experiences

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Summary

One result of the global digital transformation is that the life sciences sector (pharma, medical devices, healthtech) and healthcare sector (hospitals, clinics) are generating **unprecedented and ever-growing volumes of clinical trial and real world** health data. This data suffers from significant siloization. This growth in data is being further amplified by the fact that more and more devices are becoming connected ('smart'). Life sciences companies are also developing ever more medical-grade software applications (companion apps, digiceuticals, etc), blurring the line between the traditionally fairly distinct pharma and medical device sectors. As new innovation ecosystems are created, closer links are being forged between life sciences companies, healthcare institutions, and health-tech innovators.

This trove of data creates **huge opportunities for improving patient care, diagnosis, and treatment** (even in some cases for replacing traditional biochemical approaches), and for realizing significant healthcare efficiency gains. It is also essential for making precision medicine a reality. However, storing, processing, and accessing these data also throws up some significant challenges. These data necessitate a robust IT infrastructure able to handle large volumes of sensitive data while ensuring compliance with local privacy, security, and quality laws and regulations.

Cloud technologies provide solutions for managing virtually unlimited volumes of data, and offer scalability and, during peaks of activity, additional benefits such as vast computing power. But building a homegrown medical IoT development platform directly on this infrastructure layer is not easy. It requires high levels of capital investment, entails significant operating costs, requires sizeable teams of IT experts and data governance expertise, and, to ensure product compliance, an understanding of medical regulations. Because **life sciences companies and** (to an even greater extent) **healthcare institutions** are not tech companies, they will usually want to consider licensing a digital health technology platform (DHP) in the form of a platform as a service (PaaS). This enables them to sidestep some of the complexity of building their own platform and focus on their core business. For life sciences companies, the ultimate aim is the development of applications to support their drug or device sales. For healthcare institutions, the aim is to leverage patient data as efficiently and powerfully as possible.

In this white paper, we take an unbiased look at the reasons for the emergence of these specific, vertically-integrated, broad technology platforms for the life sciences and healthcare sectors. Our main focus is on the life sciences sector. We then look at different approaches and at the benefits and disadvantages of these platforms. We present three examples of custom-build regulated platforms for medical IoT applications and one cloud provider which has used its existing technology components to develop a platform aimed specifically at the healthcare sector. We hope this paper will help life sciences companies in particular in choosing the right IT infrastructure and technology provider. To ensure that this paper is relevant to both IT professionals and managers in the digital health space, we have tried to avoid going into too much technical detail.

1 What is a digital health platform?

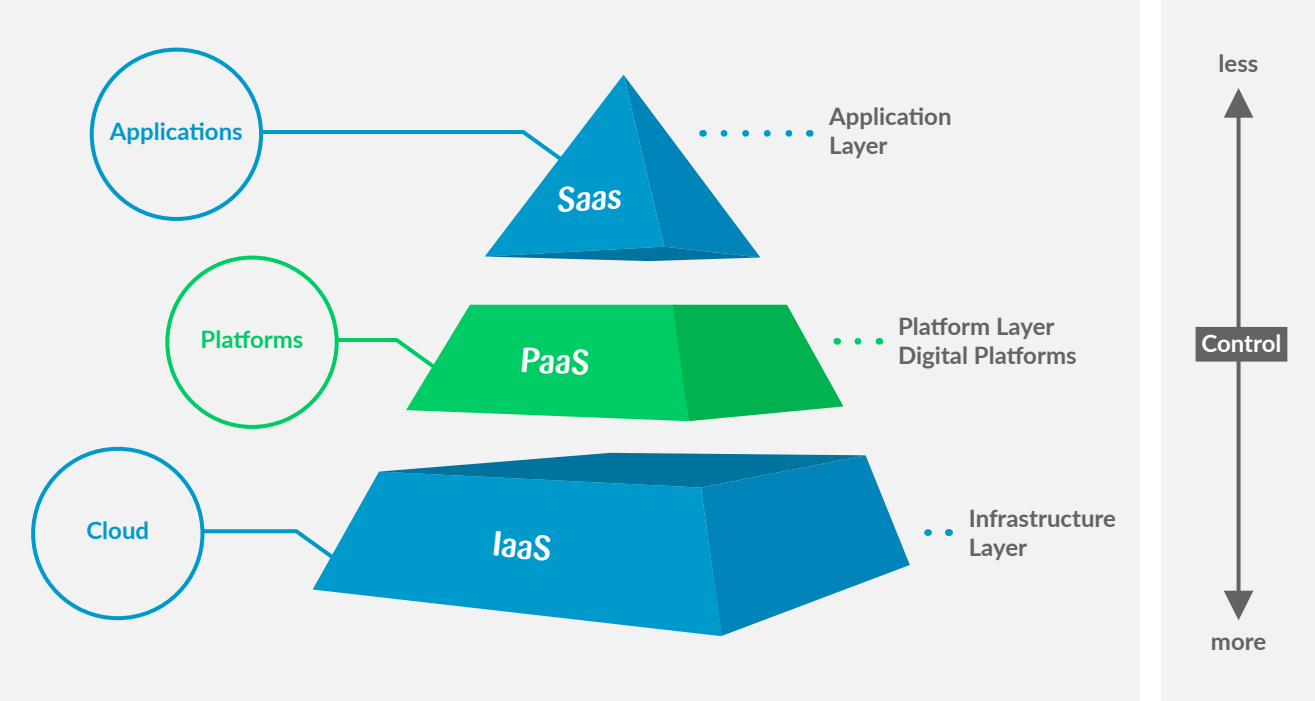
1.1 Definition and context

Platforms are omnipresent in today's digitalization business. The word is used to mean a number of different things, depending on the context. **A platform** is commonly understood as something that **connects different user-groups in a meaningful way** (e.g. in a marketplace).

In the context of medicine and healthcare, there are at least **six main types of platform**, with some overlap between them:

R&D platforms	aggregate specific types of health data	Flatiron, DNAnexus, IBM Watson Health, etc.
Telehealth platforms	connect healthcare service providers and patients, and provide virtual healthcare services	Amwell, Grandrounds, Teladoc, etc.
Clinical data management platforms	are used to manage clinical trials	Oracle ClinicalOne, Medidata, IQVIA, etc.
CRM systems	for customer relations management	SalesForce, Veeva, etc.
Software development platforms	are validated tech stacks used for developing SaMDs	Voluntis Theraxium, Smartpatient, S3 Connected Health Affinial, etc.
Vertically integrated 'horizontal' technology platforms	which allow companies to manage health data coming from any source and build applications, available in the form of a PaaS. It is this type of platform that forms the focus of this paper. They are 'horizontal' because they sit horizontally as a layer between the infrastructure and application layers (see below). They are vertically integrated in that they are built specifically for the regulated medical environment.	HSDP, Teamplay, Brightinsight etc.

Source: Zühlke



Source: Zühlke

Figure 1: Vertically integrated 'horizontal' technology platforms sit horizontally as a layer between the infrastructure and application layers.

These platforms emerged less than a decade ago, when the cloud revolution first started to gain traction. Philips was a pioneer in this space, launching their HealthSuite platform (in collaboration with SalesForce) in 2014. This was also the beginning of the Internet of Medical Things (IoMT), driven by the emergence of more and more connected devices generating a continuous flow of data. This in turn has thrown up new challenges.

These platforms are targeted not at end users (patients, healthcare practitioners, life sciences professionals, etc.), but at software engineers involved in developing applications for end users. Patients and doctors connect to different applications through different front ends; the platform runs in the backend. The platform is not directly visible to the end user.

The main goal of these platform providers is to facilitate and accelerate the development of regulated software applications (Software as a Medical Device, SaMD) and access to health data, while ensuring compliance with security, quality, and regulatory standards. In short, they allow stakeholders to **better manage patient health and outcomes through secure connectivity, data access, data management, and data analysis**. To borrow a metaphor from the automotive industry, they are the engine in the car that provides the traction to move forward.

By offering a common set of APIs, such platforms free the user from having to undertake API management, which, while removing a degree of freedom, reduces complexity and is generally perceived as offering life sciences companies the benefit of **shorter times to market**. They provide greater consistency in areas such as usage monitoring, security, etc. Using these platforms, some companies have succeeded in developing new smart connected solutions in less than 6 months – solutions which, without such a platform, could take several years to develop.

Another key benefit of such a platform is **data unification**. Data is converted to a common format, normalized, and correlated for consistency. This often involves unit conversion and the elimination of empty, duplicate, or obviously wrong data.

“Data unification converts data imported from different systems into a common format without loss of information, with the aim of making data comparable and facilitating further analysis and processing.”

Jörg Keller,
Lead Software Architect Zühlke

In a world in which data volumes are growing exponentially, this is extremely important. Quality matters as much (if not more) than quantity, especially when it comes to training machine learning models.

The overwhelming majority of physicians say that access to the right data at the right time will help them improve care. In 2018, hospitals performed 3.6 billion imaging procedures and produced on average 50 petabytes of data each (90% of which was imaging data). 97% of that data goes unused or unanalyzed . Combing through these data is likely to yield a lot of value, as it may well contain hidden insights. AI could be used for tasks such as helping radiologists identify patterns in radiographic data, for example. In 2021, with the rise of IoMT, it is estimated that overall, hospitals generated several exabytes of data. One medical-grade connected device can generate up to 10 Gb of data per day per person!

[1] Source: 4 ways data is improving healthcare | World Economic Forum (weforum.org)

1.2 Difference between IaaS, PaaS and SaaS

Platform as a service (PaaS) allows users to leverage a subscription-based data and cloud computing service without the complexity of building and maintaining the underlying infrastructure. PaaS allows users to access, develop, and run applications via a single platform, and reduces the time, effort, and resources required to drive digital transformation of their product development lifecycle and offer holistic solutions spanning the care continuum.

Source: Zühlke

Figure 2: Differences between On Premises, IaaS, PaaS and SaaS. ● you manage ● others manage

2 Why do life sciences companies need a digital platform?

The medtech and pharma industries face a number of challenges, ranging from changing healthcare delivery models and declining revenue growth, to increased cost of bringing innovations to market, to growing competition from technology companies. To overcome this, medtech and pharma companies need to move beyond just supplying drugs and medical devices, and evolve to become solution providers right across the patient care continuum. They are expanding their offerings to offer holistic solutions from admission to follow-up, leveraging digital delivery and collaboration models to focus on the patient.

This transition is being enabled by **digital tools and technologies that complement core drug and device products**. By offering secure connectivity and data access, management, and analysis, these tools help stakeholders better manage patient health and outcomes. This has the potential to offer significant cost benefits, in keeping with the Quadruple Aim of healthcare: improved patient experience, better outcomes, lower costs, improved clinical experience.

Intended use determines the safety risk level and thus medical device class (I, IIa/b, or III) and software class (A, B, or C). To minimize development time, some platforms offer pre-defined templates and functions for high classification SaMDs, with associated support and automatic updates in response to regulatory changes (e.g., BrightInsight, which takes care of much of the 'heavy-lifting', enabling life sciences companies to concentrate on developing core product functionality).

Medtech and pharma companies need to evolve to become solution providers right across the patient care continuum.

More specifically, companies need to properly manage design history files (DHF). This set of standardized documents is extremely important for life sciences companies, as it must be submitted to the relevant regulatory authority (a notified body for CE marking or the FDA) during the approval process for an SaMD.

Some pharma companies are very much behind the curve in terms of having an enterprise-wide platform for developing in-house digital health projects. Others are investing heavily in IoMT with the aim of developing companion apps or smart connected devices for 'around the pill' solutions. Data silos and legacy systems that prevent data unification and, in the long term, digital innovation are still common. For many organizations, legacy infrastructure and the need to acquire and maintain essential hardware, software, and personnel (in the face of growing demand) create a bottleneck. As a result, many are considering **buying or partnering with a platform provider**.

A few pharma companies are taking a bolder approach and developing high-risk, medical grade products. This leaves them even more reliant on robust systems for ensuring regulatory compliance. Conscious that they are not IT or medtech companies, to minimize or partially outsource their risk, they are therefore tending to **use regulated digital health platforms**.

At the other end of the spectrum, some life sciences companies have decided to outsource development and operation of medical-grade applications (SaMD) completely, and in particular are outsourcing the role of legal manufacturer. These companies clearly do not need a DHP to build their applications. Where the only requirement is data access and storage, simpler alternatives are available.

Why do healthcare institutions need a digital platform?

Patient-centered care delivery models are a hot topic right now. These models focus on providing a seamless, integrated experience across the continuum of care, as patients move from being healthy, to pre-diagnosis (when risks factors are identified), to diagnosis, treatment, home care and aftercare. (Note that this is a simplified overview of the main stages of the care journey.)

Under pressure from governments, electronic health records have been developed to help realize this model. In most countries, however, these records are not yet in widespread use, and most patients rely on service providers to manage their clinical information.

Platforms are therefore a linchpin of the IT ecosystem

The challenge is to **integrate data from different sources** – from within the same hospital or from different hospitals – **and different IT systems**. Data from different sources may be in different formats. There are currently four main open standards: FHIR, HL7 v2.0, DICOM and IHE. Most platforms offer sufficient interoperability to enable aggregation of data from multiple vendors and sources. Platforms are therefore a linchpin of the IT ecosystem, since in the absence of interoperability it is impossible to aggregate data with different formats and therefore impossible to extract meaning from these data. In addition, most platforms allow information flow to be tailored to clinic workflow, so feature some 'intelligence by design'.

At present, the trend in the hospital sector is for hybrid DHP systems comprising a mixture of cloud and on-premise systems. Many hospitals still do not trust cloud providers, especially large US cloud providers, which are not subject to the GDPR and could in theory access patient data in a manner which is not GDPR compatible.

Does your company have a data governance & platform strategy?

Both pharma and medtech companies are looking at digital transformation to accelerate innovation, help them stay relevant in the marketplace, and develop their core competencies to enable them to become data-driven organizations.

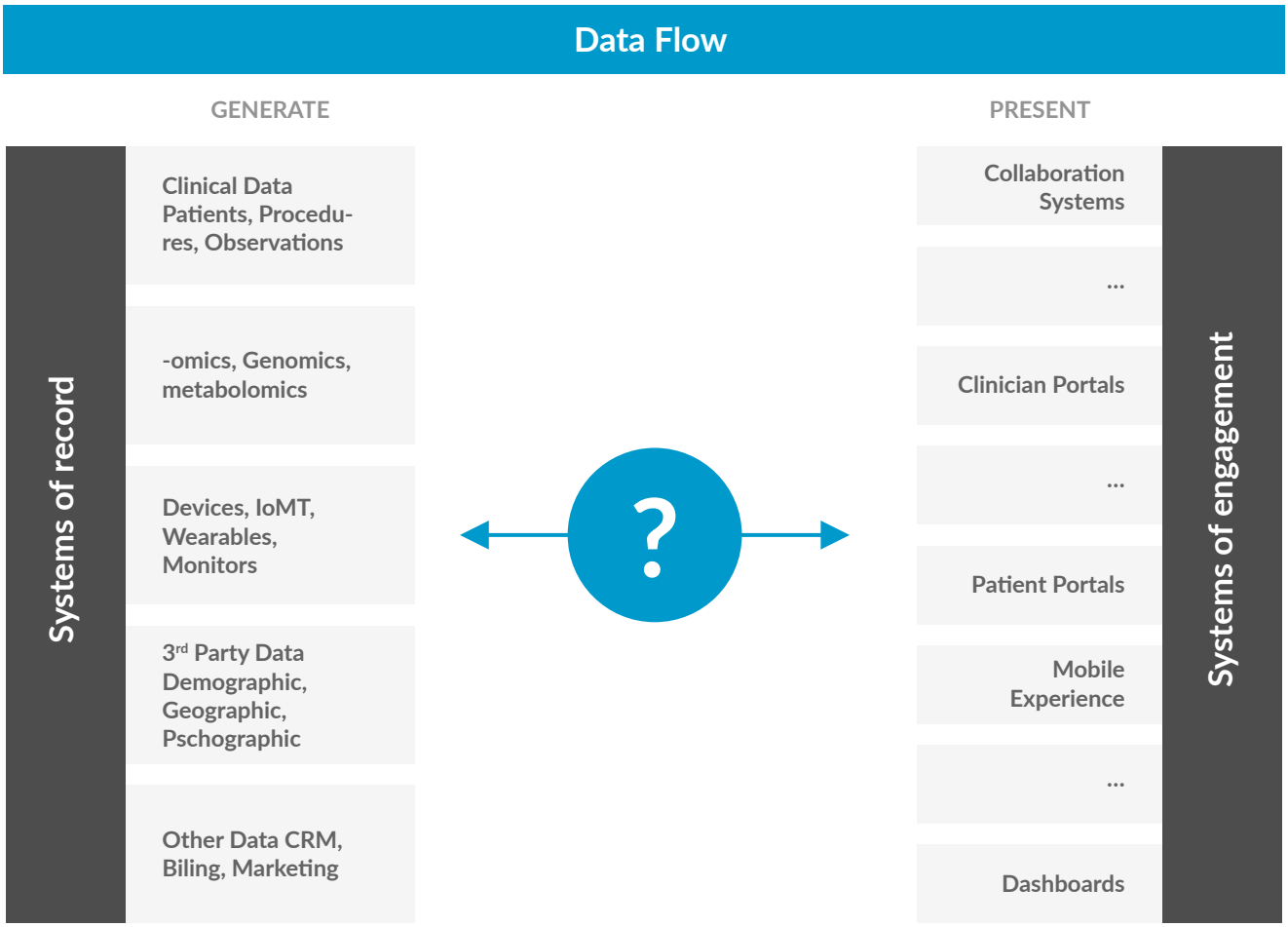
Data generated by the healthcare industry still suffers from **significant levels of siloization**, making it difficult to access and utilize for clinical decision support and performance management. Developing systems for accessing data which are secure and regulatory compliant requires a significant investment of time, money, and resources. There are also a number of challenges in terms of how data is collected, where it is stored, and how it is labeled for training or testing supervised machine leaning algorithms.

In addition, access to these data sets can be complicated, especially in large organizations. The situation becomes even more complicated when it comes to sharing data between multiple organizations of different types (e.g., pharmaceutical companies working with hospitals in different countries, a medical device manufacturer, and perhaps also healthtech startups).

Most governance policies have been written by lawyers with the aim of minimizing the risk of data getting into the wrong hands. As a result, they generally also place constraints on how data can be leveraged. Many companies (rightly) exercise extreme caution, even declining to set up a shared digital platform for the whole company – R&D and commercial departments of the business are deliberately kept separate.

A fundamental question in the healthcare sector is:

How do you connect data sources with users?



Source: Zühlke

Figure 3: Connection between data sources and users

There needs to be an IT infrastructure which allows 'systems of record', where data are generated and stored, to connect to 'systems of engagement', which present information to the right user at the right time.

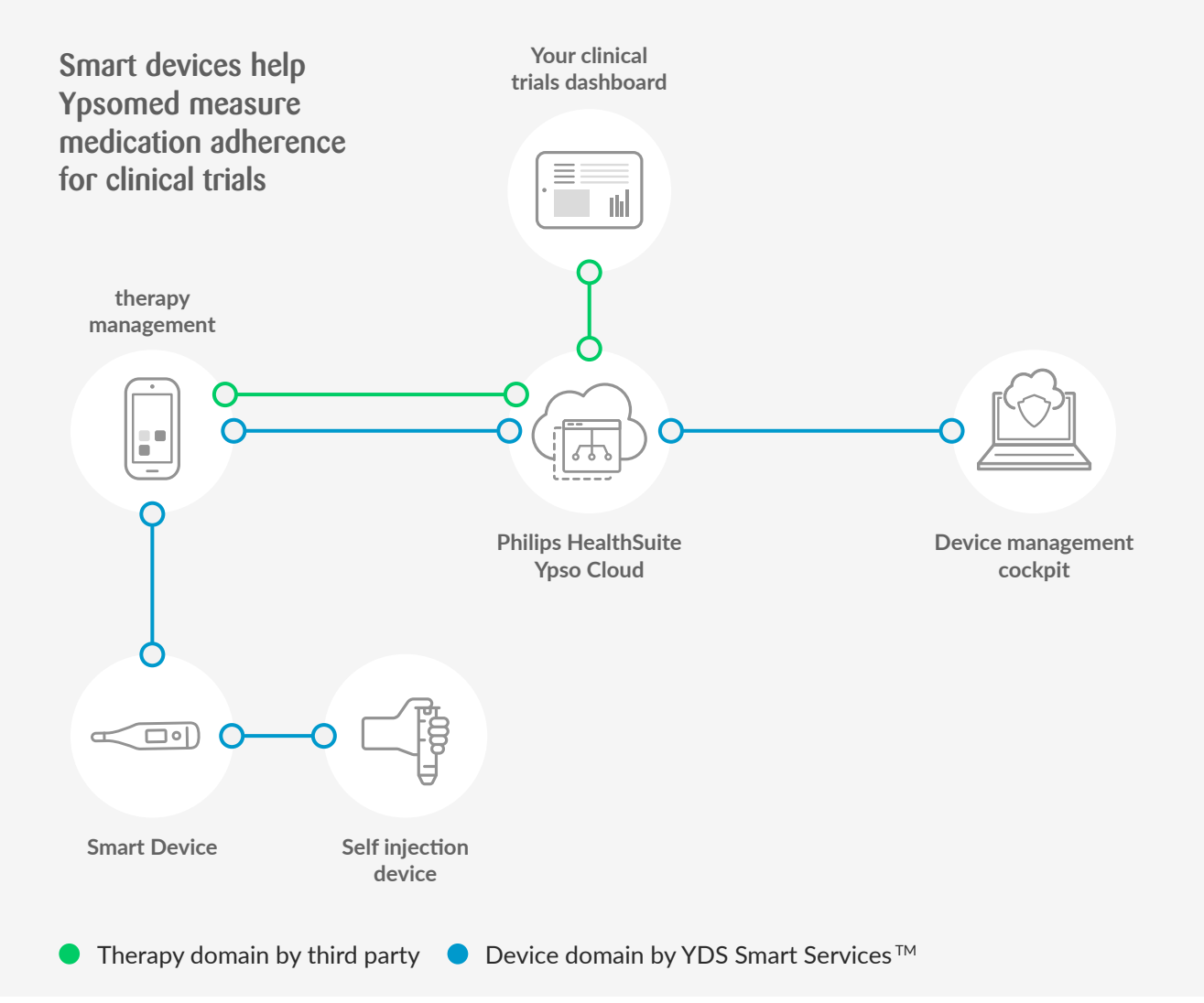
Some platforms are **highly modular**, but require advanced IT expertise to tailor pre-assembled components to use cases. Some are more **'vertically integrated'**. These require less advanced IT skills but are more limited in their range of use cases or less flexible in terms of architecture.

Nowadays all life sciences corporations have a **data governance policy**, but these policies often fail to cover data from external sources. Sooner or later, these policies will need to start to cover such data, as the **winners in tomorrow's digital world will be those companies which are most interconnected**.

2.1 Example of a use case with a medical device manufacturer

There are many use cases for DHPs. **DHPs in theory enable you to build any application you wish and to manage any data coming from any source.** The common feature is that there is always either a connected device involved, and/or a smartphone with a medical grade app (i.e., CE marked in Europe, with FDA clearance in the US).

Below we discuss a typical example. In this example data is collected from a connected device and information is then displayed to the right user at the right time, with the aim of improving patient adherence to a treatment plan.



Source: aws

Figure 4: Choosing the right DHP enabled Ypsomed to deliver a minimum viable product in less than six months.

Ypsomed is a medical device manufacturer which both directly commercializes devices and solutions, and builds custom products for pharmaceutical and medical device companies. A few years ago, they developed a smart insulin injector device (along with a self-injection device) for which, for the purpose of clinical trials, they needed to build a complete cloud-based backend infrastructure to connect patients, clinicians, and the manufacturer (see figure above). They partnered with Philips, who provided a turnkey digital solution for remote medication adherence monitoring and device management through their HealthSuite platform. This choice enabled them to deliver a minimum viable product in less than six months.

The smart injection device uses Bluetooth to pair with a mobile app on the patient's smartphone. The app explains how to use the device, reminds the patient of the prescribed injection frequency, connects the device to the cloud, offers a visual representation of injection data, and offers the ability to set up reminders.

The clinical dashboard enables clinicians to precisely monitor the dosage and timing of each injection.

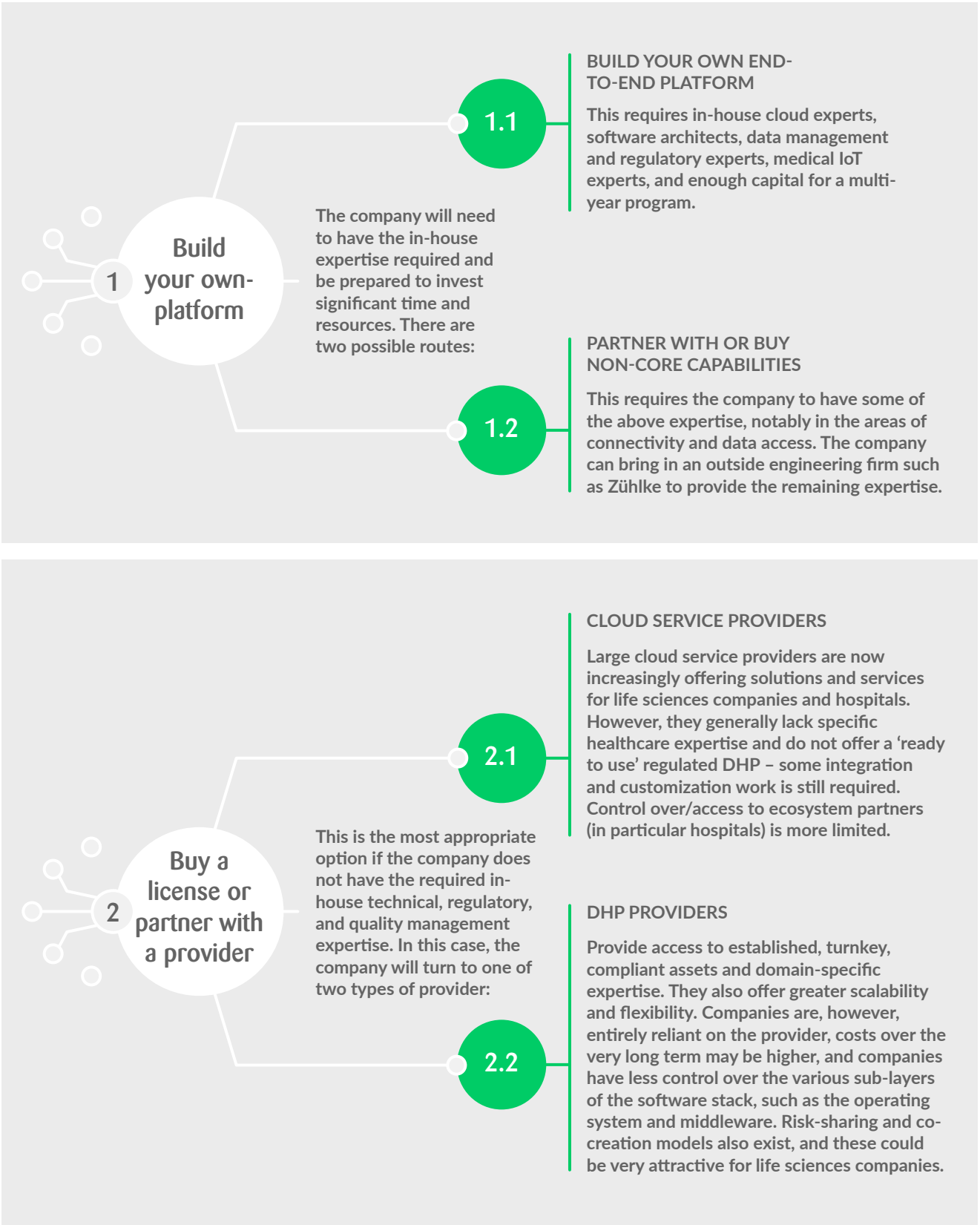
The device manufacturer can monitor technical data such as battery and device telemetry parameters.

Using this approach enabled Ypsomed to have a private cloud (Ypsocloud) up and running within a very short timescale, and **considerably reduced implementation time and costs**. Many medical device manufacturers aiming to implement device connectivity (i.e., make their devices 'smart') prefer to buy in a regulated digital platform in the form of a PaaS rather than build it themselves. There are also other options that we will explore below.

2.2 Make or buy?

For many IT departments at both life sciences and healthcare organizations, building, buying, and managing systems for supporting digital health products is a new departure – it is a long way from being part of their core business. They are also quite expensive to build. According to BrightInsight, building such a system can cost up to $20m and maintaining the backend infrastructure around $10m per year. And note that these figures are for a custom platform that barely meets requirements for one country.

For companies looking to pursue a platform approach, there are four basic options:



Source: Zühlke

Figure 5: Options for lifescience companies to pursue a platform approach.

There are pros and cons to all of these options. The important thing is to **properly assess the organization's in-house capabilities, strategic objectives, and 'digital maturity'** (i.e., can the company handle large, complex digital transformation projects?).

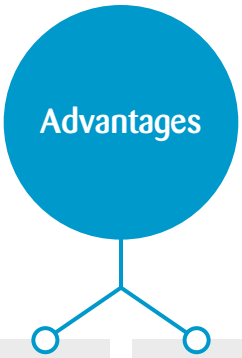
If you want to buy a DHP/partner with a DHP provider, you also need to ask yourself the following questions:

- Are there pre-defined interfaces with the clinician workflow, with EHRs, medical devices, etc.?
- Are there pre-defined templates and functions?
- Is technical and regulatory support available?
- Is there a marketplace of curated applications?

The latter is an important point to consider. Some digital health platforms use an open-innovation ecosystem approach and provide access to a large set of curated applications developed either directly by the platform provider or by third parties. Almost all of the leading providers offer such a marketplace, which enables clients to buy software for tasks such as X-ray analysis, surgical planning, interpreting MRI scans of the brain, etc.

2.3 Advantages and disadvantages of regulated health platforms

Getting started with a DHP is far from trivial. These platforms offer a lot of advantages, but they also entail some disadvantages.



Technical

Data unification – managing health data is a complex task, as it is often intermittent and requires careful interpretation

Platform-level certification and regulatory conformity:

Security, privacy, compliance (regulatory and quality), with pseudonymization and anonymization capabilities

Aggregation of clinical and consumer data

Curated components and services for life science companies

Orchestration capabilities designed to integrate dependent services with identity and access management

APIs that enable developers to use underlying orchestrated services

Some platforms have an abstraction layer on top of the cloud infrastructure and foundation cloud services that allows developers to consume the underlying services

Business

Allows a life sciences company to focus on its core capabilities. Essential application development, testing, and management tools are provided.

Simplicity – outsources the complex task of building and managing your own healthcare compliant, orchestrated, secure cloud infrastructure and platform, leaving you to focus on building applications.

Speed – reduces time to market. DHPs offer ready-to-use cloud services, tools, and resources to accelerate development of connected consumer and healthcare solutions.

Savings – lowers your overall expenditure. A DHP reduces your expenditure on hardware and software, compliance, and staff by providing a shared, fully-managed cloud infrastructure and platform.

Disadvantages

Vendor lock-in. You are dependent on the platform provider. Once you have selected a DHP, it is difficult to change. Full scale implementation of a DHP across a large corporation takes years and moving away from your existing DHP is also likely to take a long time.

Reliance on cloud providers to which you have no direct access.

Potential security risk. Storing application data on cloud servers controlled by third-party vendors can compromise the confidentiality and integrity of data.

Limited capabilities. Some PaaS services may limit application development capabilities

As usage grows exponentially, operating costs may become very high.

2.4 What a (good) regulated health platform, designed for companies developing medical-grade applications, needs to have

If you are a life sciences company willing to leverage the potential of the IoMT and build products which will be rolled out globally, you need a platform that has been developed and is maintained by a provider with a certified quality management system, and which meets all of the standards listed below:

If you want to buy a platform (or more precisely buy a license to use a platform), there are a number of other important parameters (to which we will return later) to consider when choosing a platform, depending on your use case.

Data	Security	Regulatory	Quality
HIPAA compliance?	HITRUST CSF® v9.1 certified?	Master File accepted by the FDA?	QMS is ISO 13485 certified?
GDPR compliance?	ISO/IEC 27001?	CE certification allowing to run SaMD modules on the platform?	SW development lifecycle conforms to IEC62304
Certified under both the EU-US and Swiss-US Privacy Shield frameworks?	HITRUST certification from NIST cybersecurity framework?	Other local regulations met?	Is QMS built to support up to Class III and Combination Products Intended Use?

Source: Zühlke

Figure 6: Standards that your DHP provider needs to meet.

2.5 Why not partner directly with a cloud provider?

Healthcare and life sciences organizations **can't afford to suffer a data breach**. To ensure operational security, competent healthcare cloud providers will conduct external audits and penetration testing, and offer privacy, security, and regulatory controls. They will also maintain an extensive set of external compliance certifications and attestations to provide objective evidence of compliance with security and privacy regulations.

Currently, cloud providers are not sufficiently vertically integrated to be able to offer platform-level compliance with health data standards (they lack domain knowledge and take a more technology-oriented approach). Microsoft has developed a platform that appears to meet the kind of regulatory compliance specifications required by the healthcare sector (see below), but integration represents a significant workload, as their solution has not been developed specifically for the life sciences sector.

In addition, most healthcare data/security breaches are the result of human error, often something as simple as selecting the wrong checkbox in a public Amazon S3 bucket, for example, resulting in data that should have been private being made public. An experienced healthcare cloud provider understands the critical nature of the data stored on its cloud and the sensitivity, privacy, and security requirements for healthcare data, and removes opportunities for human error by using layered authentication and role-based profiles. By design they make it almost impossible for mistakes to be made.

To enable safe integration of data from a diverse set of third party systems and IoMT devices (patient monitors, drug delivery systems, RFID readers, vital signs monitoring devices, etc.), providers need three things. They need to be familiar with each individual protocol. They need to know how to deal with the relevant data. They need to have the ability to trace the provenance of data in order to be certain it is used only for those purposes for which its use has been authorized.

In addition, because cloud providers lack access to an extensive network of healthcare institutions and are rarely as fluent in the language of medicine as companies with medicine in their DNA, much more work is required on the client side.

Having said that, cloud providers are increasingly designing services specifically for the life sciences and healthcare sectors, and are building domain-specific capabilities. It is possible that partnering directly with a cloud provider may become a more attractive choice in future, with lower costs, as long as the client has sufficient in-house IT resources to directly manage the cloud infrastructure and properly integrate their services.

3

An overview of design differences between popular DHPs

Over the last few years, three companies have emerged as leading DHP providers:

1. Siemens Healthineers teamplay
2. Philips HealthSuite
3. BrightInsight

The first two are among the largest medical device manufacturers in the world, best known for large, sophisticated pieces of equipment such as MRI, CT and PET scanners. They therefore have a long history of engineering medical technology products and have a very good understanding of the hospital environment and hospital processes. In addition, when the digitalization revolution was still in its infancy, they were quick to latch onto the huge potential that being able to connect devices to hospital IT systems offered, albeit initially for maintenance purposes.

Siemens Healthineers and Philips also understand that this trove of data has huge unrealized value. They have shifted their business models away from product sales and towards **services, solutions, and integration into a broader ecosystem**. Once a hospital decides to use one of their ecosystems it becomes very difficult to move to a different provider, thus creating vendor lock-in.

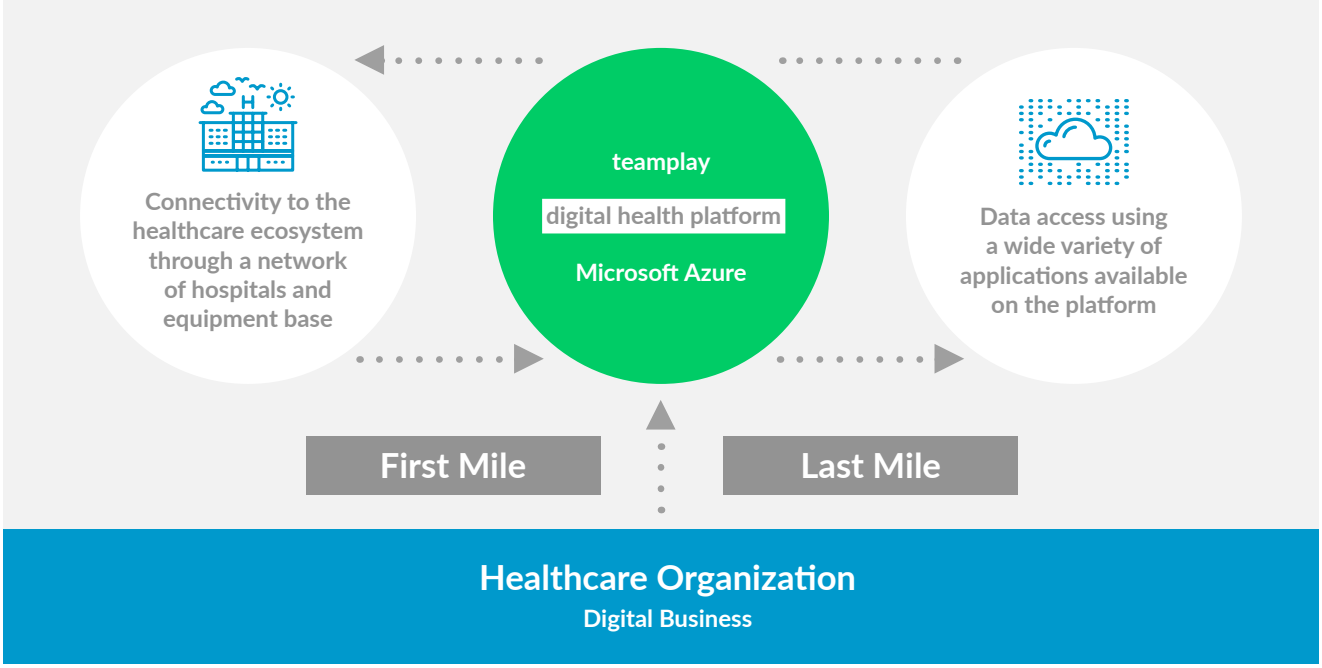
BrightInsight comes from a different background, having been spun off from Flex, a company with 200,000 global employees which designs, engineers, and delivers logistical and manufacturing solutions. The BrightInsight platform launched in 2018 and in March 2021, they raised $101m in Series C funding from top healthcare and tech VCs.

Each of the three has built its platform on a different cloud, **Philips on AWS, BrightInsight on Google Cloud**, and **Siemens Healthineers on Microsoft Azure.**

Siemens Healthineers 'teamplay'

In 2012, Siemens Healthineers utilized its expertise in the healthcare field to start building a digital asset to enable it to stay ahead of the innovation curve. It was primarily designed for hospitals, but over the last few years it has been modified to additionally **cater to the needs of life sciences companies.**

One of the main unique selling points of the teamplay digital health platform is that it offers **first mile connectivity to hospital ecosystems** and **last mile access to data**, thereby enabling partners to focus on their core competencies and to co-create applications. They claim to have a network of more than 6,500 connected institutions and 32,000 connected systems in more than 60 countries with more than 10 million patient records. It is clear that they have achieved significant scale.



Source: Siemens

Figure 7: Teamplay from Siemens Healthineers is designed to enable partners to focus on their core competencies and to co-create applications.

The first mile provides the ability to aggregate a specific data type (e.g. electrophysiological data) from a network of hospitals willing to share this type of data. The last mile provides access to the right data through a dedicated application designed to present it to the relevant audience in a comprehensible form.

Their platform uses the same eHealth platform technology used by a number of institutions (e.g. Swiss Post) involved in building critical infrastructure required to realize the Swiss Electronic Patient Record.

BrightInsight

Some solutions have strong vendor lock-in and are closed ecosystems, others are open. BrightInsight falls into the former category, as it does not offer a marketplace. This is because the focus is heavily on **IoMT for pharmaceutical companies** with a relatively bold approach involving **developing SaMDs with ambitious intended uses** and which are therefore higher risk (usually, but not always, a higher medical device class).

One of their core value propositions is that their platform **eliminates regulatory bottlenecks** that can lead to costly delays. It does so by offering turnkey regulatory design control and file management of master files with the FDA.

AstraZeneca selected the BrightInsight platform for their Amaze platform, an end-to-end digital solution aimed at driving improved healthcare delivery for patients with chronic diseases by bridging the gap between patients and providers. BrightInsight is designed to be device agnostic, includes EHR integration, and is designed to deliver valuable clinical insights at the point of care to enable improved clinical outcomes. AstraZeneca went **from project launch to commercialization in less than a year**, half the time a project of this kind would normally take.

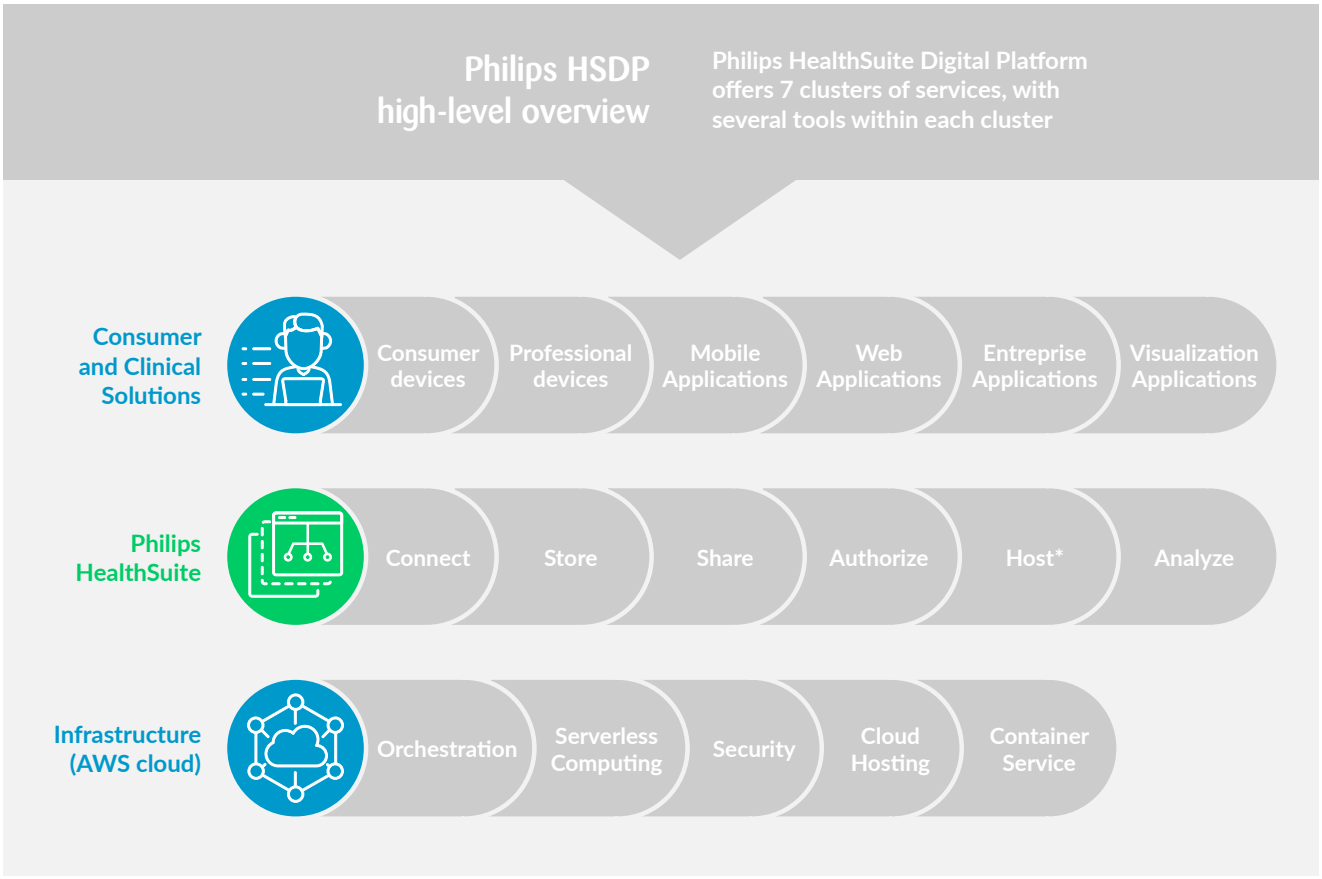
Comprising a patient mobile application and a care team portal, the AstraZeneca AMAZE Disease Management Platform enables patients, healthcare providers, and care teams to **monitor and manage chronic conditions across multiple indications**, including asthma, heart failure, chronic kidney disease, diabetes, and COPD. The solution bridges the gap between patient and provider outside the clinical setting by capturing pertinent clinical information through connected devices, quality of life measures, and patient-reported outcomes (PROs), while providing a direct communication channel between patients and their care teams.

Philips HealthSuite

Philips is definitely one of the frontrunners in the DHP field. Its HSDP **caters to the needs of both life sciences companies and healthcare institutions**. In addition to their new native cloud development services, they are also able to migrate customer on-premise legacy applications to and host these applications on their cloud infrastructure.

Their platform provides an abstraction layer on top of the cloud infrastructure and foundational cloud services that allows developers to consume underlying services. HSDP uses APIs, industry standards, such as OAuth2, and healthcare standards, such as HL7 and FHIR, to reduce software development workload.

In common with other platforms, their business model is **based on an 'à la carte' model** where the client can pick and choose the services they require, and is pay-per-use (i.e., costs are dependent on consumption). The platform is built around 6 key services: Connect, Share, Store, Authorize, Host, and Analyze (see below).



Source: Philips | Zühlke

*Philips also offers access to third-party services as part of its Host package.

Figure 8: Overview of Philips HealthSuite digitial platform modules.

Technical differences between the three platforms:

The major platforms differ signficantly in terms of the details of the underlying software architecture, though these **differences are not visible to users**. As the software architecture is considered core IP, it is not generally possible to access it.

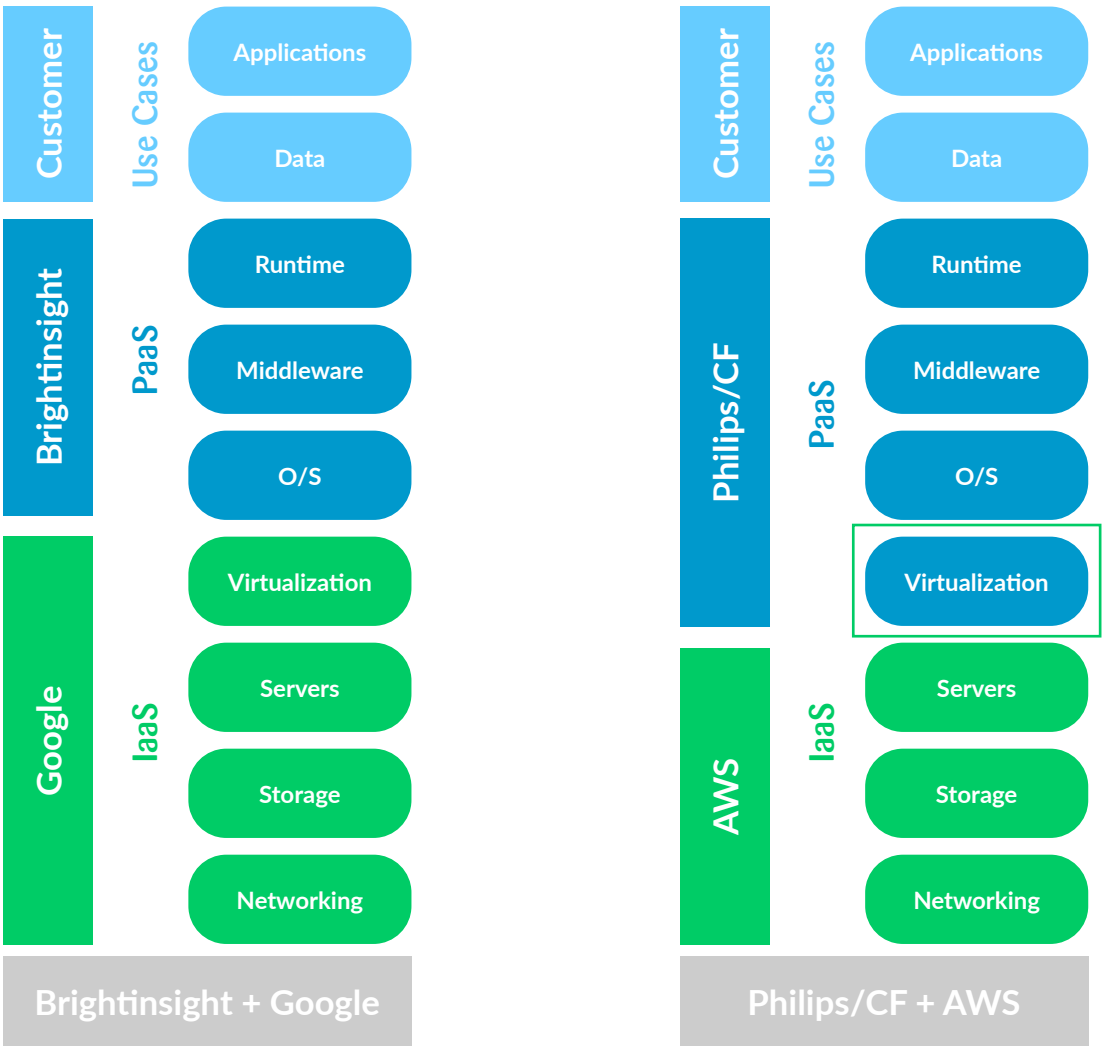
There are a number of other important factors to consider (some related to the software architecture), including:

- segregation
- shielding DHF (Design History File) (when there are multiple projects)
- availability rate
- interoperability (FHIR is increasingly becoming the gold standard)
- multi-tenancy
- scalability
- cloud neutrality

All platforms differ with respect to the above points. We will not analyze these points here; they should be evaluated on a case-by-case basis.

In addition, there may be **differences in design at the sub-layer level.** To illustrate this, we will look at the example of Philips HealthSuite and BrightInsight.

These differences at the sub-layer level can have a significant impact on platform functionality, and in particular on the DevOps lifecycle. In the example below, the virtualization layer is managed by Google in the BrightInsight solution, but is included in Philips HealthSuite:

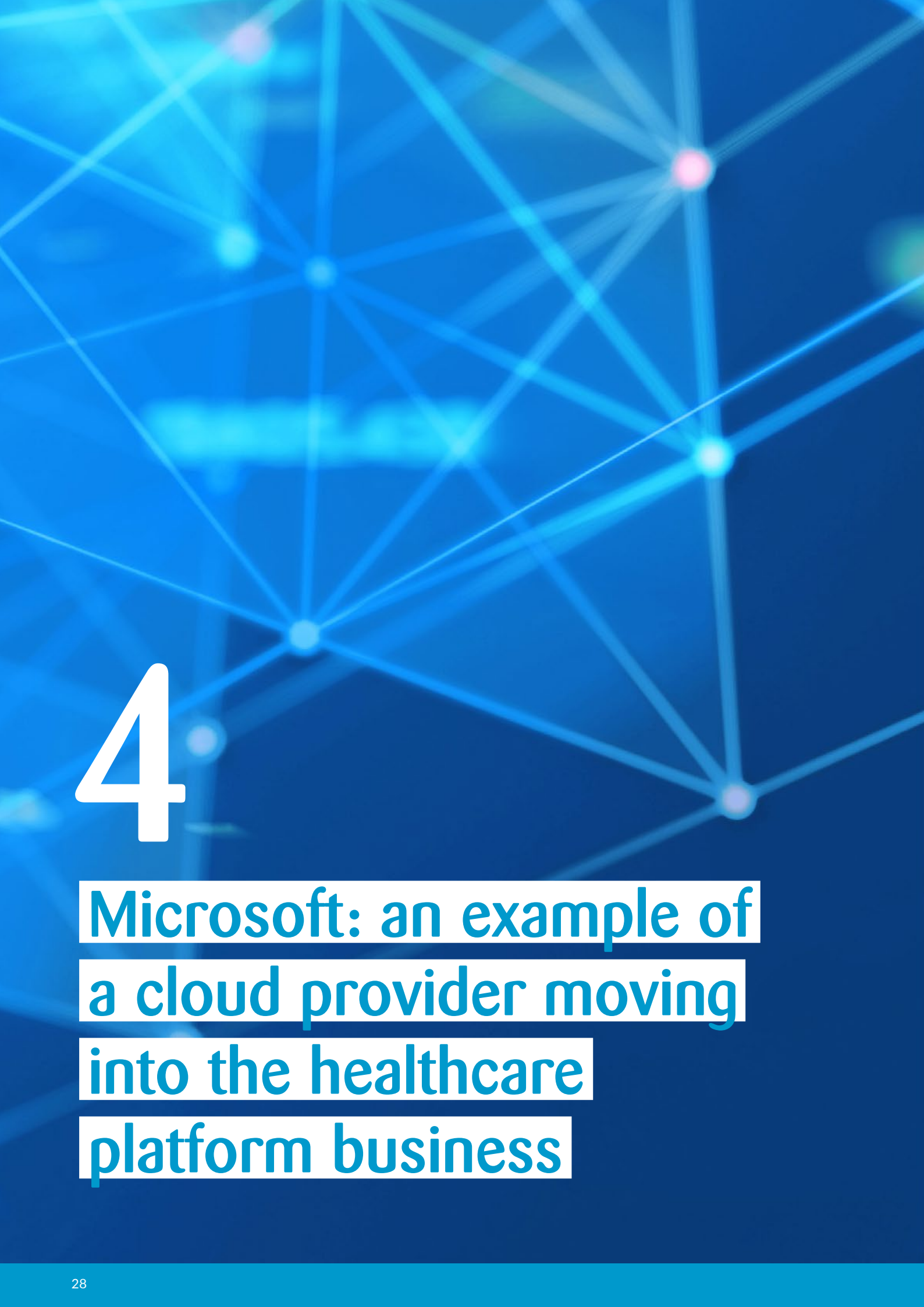


Source: Zühlke

Figure 9: Differences between BrightInsight and Philips at the sub-layer level.

CF = Cloud Foundry, an open source, multi-cloud application platform as a service (PaaS), on which Philips HealthSuite is based.

Having the virtualization layer controlled by the CF layer is a useful feature, as it allows the client development team and the client platform operations team to take a self-service approach to creating containers and virtual machines in the cloud. Generally, these resources are created and controlled within the IaaS layer by the platform vendor (e.g., AWS Elastic Container Service, Google Kubernetes Engine). Enabling DevOps teams to create containers and virtual machines in the cloud (e.g., Dockers, Linux Containers or Kubernetes containers) without needing to interact with the platform vendor removes a critical path step in the DevOps lifecycle. In some cases, however, having the cloud provider control this sub-layer could be considered an advantage (here, if, for example, the client is already familiar with Google Cloud).



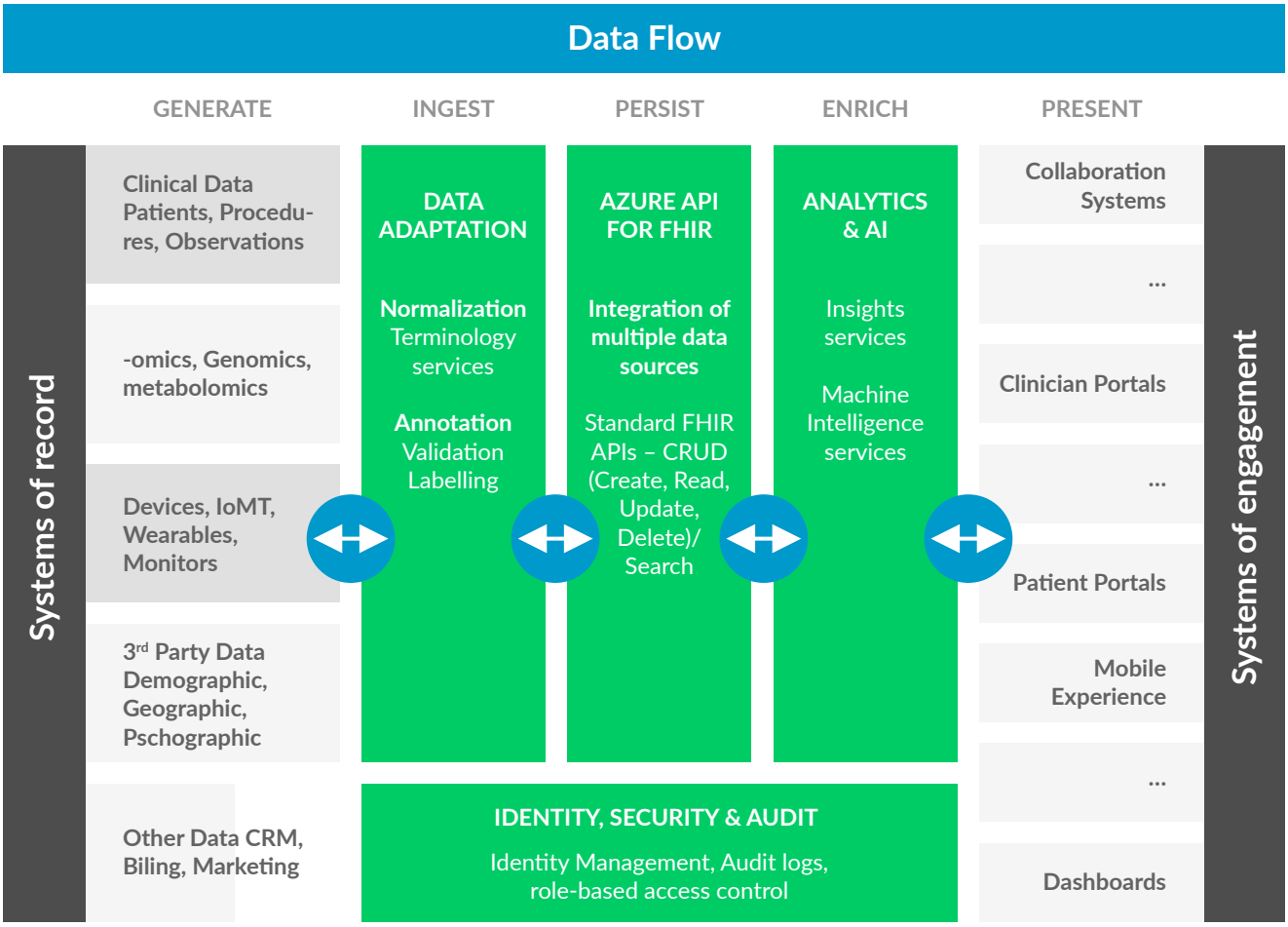
4

Microsoft: an example of a cloud provider moving into the healthcare platform business

As previously mentioned, most cloud providers are eyeing up the lucrative medical IoT business and are taking steps to enter this field. Google/Alphabet is already heavily invested in the healthcare business on both the consumer (e.g., Fitbit) and medical sides, where it is developing new analytics tools and SaMDs. We can therefore expect them to compete more directly with existing DHP providers in future.

The first hyperscaler to move into the DHP field was Microsoft with its Cloud for Healthcare platform.

The figure below illustrates the structure of Microsoft's offering between the systems of record ('Generate') and the systems of engagement ('Present'). The offering includes steps to ingest, ensure persistence of, and enrich data. The platform is based on an Azure API for FHIR core. This connects on the right to its analytics and AI offering and on the left to an Azure IoT Connector for FHIR. Smart devices connect to this connector via Bluetooth or a device gateway, and the connector feeds data into the Azure API for FHIR.



Source: Zühlke

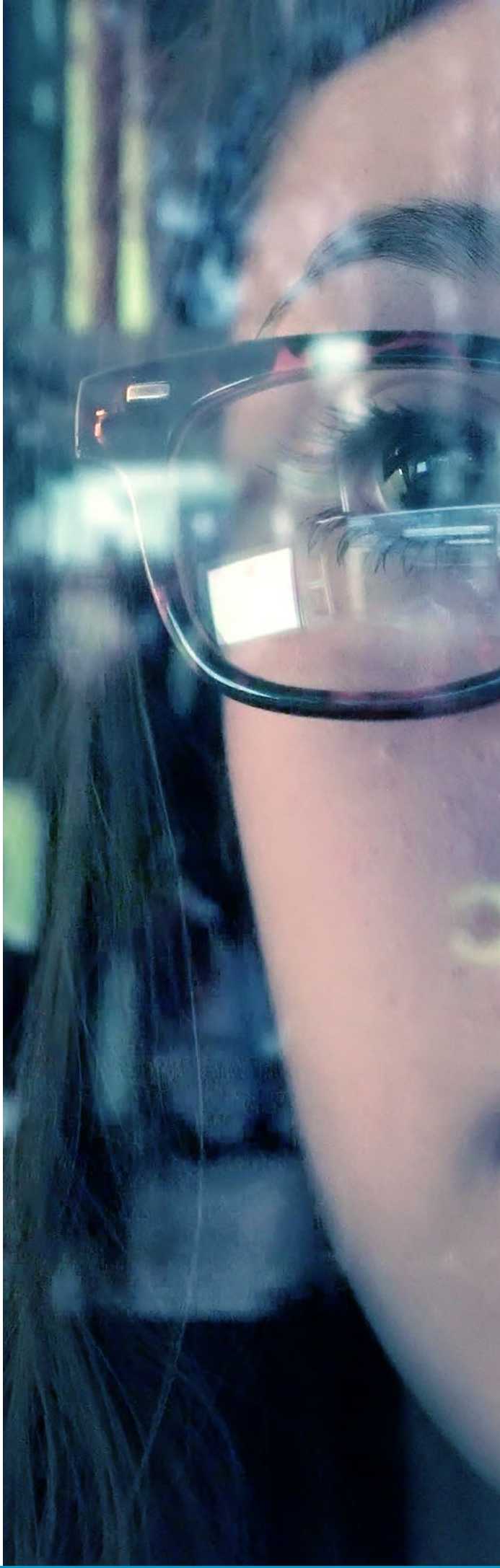
Figure 9: Microsoft's offering between the systems of record ('Generate') and the systems of engagement ('Present').

One competitive advantage enjoyed by Microsoft is that their solution connects to their vast office software ecosystem used by millions of people every day and featuring products such as Teams and SharePoint. Their platform requires considerable configuration, integration, and deployment work, and companies will therefore require support from an engineering service provider such as Zühlke.

According to our expert in this field, Albert Froemel, Microsoft currently offers the most open platform for healthcare specific solutions. “Microsoft offers many different building blocks which can be assembled to build virtually any type of system,” explains Froemel, “Is it the best solution? That depends on your use case. If you’re looking for a pure hospital infrastructure solution, with the focus primarily on internal processes, Microsoft’s approach will work, but may not be the best option. If you’re looking for a platform that can dynamically connect your hospital systems to new innovative solutions, then they are certainly in the top three in terms of platform providers.”

Microsoft operates Azure Marketplace, which features many healthcare specific applications. A further source for healthcare applications for the Microsoft ecosystem is AppSource. As of May 2021, there were **764 health/life science applications**.

The Microsoft platform is a pure cloud platform, but offers hybrid models. Existing on-premise hospital information systems can connect to the Microsoft cloud platform through APIs.



5 Conclusions

1

For IT executives, DHPs are becoming harder and harder to ignore, and we believe that everyone in the healthcare field needs to be aware of them and of why there is a need for them. The **exponential growth in health data** generated by connected devices and other systems of record requires a data governance approach which means consideration needs to be given to **buying or building a DHP**. This is especially true if the company intends to develop medical-grade applications, particularly SaMDs. Artificial intelligence models need large volumes of high quality data for training. Storing and handling large volumes of data securely and in compliance with relevant regulations is therefore of crucial importance for any company wishing to develop AI-based solutions or use AI-based systems.

2

For both life sciences companies and healthcare institutions, buying or building a digital health platform represents a **strategic decision with implications far beyond the IT department**. Consequently, any decision to do so needs to be driven by overall corporate strategy.

3

There is no universal, one-size-fits-all platform, although some platforms, with correct configuration, are suitable for use by both life sciences companies and hospitals. The trend today is for life sciences companies (both pharma and medical device companies) to build closer relationships with healthcare providers and patients, and these platforms can act as a **bridge for connecting different organizations from across the health ecosystem**. This has the potential to generate significant innovation, to the ultimate benefit of patients.

4

In choosing a DHP, there are **numerous points that need to be considered:** System design and software architecture in particular have significant long-term implications, and there are also other technical considerations. No platform is plug and play. They all require extensive IT expertise, particularly in the areas of IT infrastructure and architecture, and it is essential that the business context and use case are clearly understood. Zühlke can help you make the right choice.

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Blaise holds a Master's in Microtechnology Engineering with Biomedical specialization from the EPFL as well as an Executive MBA in General Management and Finance. He joined Zühlke at the end of 2020 as Principal Business Consultant and combines 15+ years of experience in Life Sciences (Pharmaceuticals, Medtech & Healthtech) in consulting, professional services and as an entrepreneur. He managed multiple projects in the context of digital, cultural & workforce transformation, and has taken part in various startup acceleration programs as a jury member in the selection committee or as a mentor.

Zühlke – empowering ideas

We believe that innovation and technology are a positive force of change for business and society. We support our clients to envision and create a sustainable future.

Zühlke is a global innovation service provider. We envisage ideas and create new business models for our clients by developing services and products based on new technologies – from the initial vision through development to deployment, production and operation.

Our Expertise

We specialise in strategy and business innovation, digital solutions and application services – in addition to device and systems engineering. Our outstanding solutions provide unique business value and a reliable foundation for sustained success

Our basis

Zühlke was founded in Switzerland in 1968 and is owned by its partners. Our 1,200 employees are based in Austria, Bulgaria, Germany, Hong Kong, Portugal, Serbia, Singapore, Switzerland, the United Kingdom and Vietnam, serving clients from a wide range of industries. In addition, our venture capital arm Zühlke Ventures provides start-up financing in the high-tech sector.

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