
Dedalus
KUBERNETES
– THE NEED FOR SCALABLE SOLUTIONS IN THE HEALTHCARE SECTOR

The healthcare industry is undergoing a digital transformation driven by the need to securely handle large volumes of sensitive data, provide efficient communication channels, and ensure high availability of critical systems. In the healthcare sector, flexibility, security, and scalability are crucial factors for software applications. Therefore, the development of such applications must be based on a stable yet flexible infrastructure. Such an infrastructure can be created with the open-source platform Kubernetes, which is used for deploying, scaling, and managing containerized applications.

1. The evolution of application delivery

Before the introduction of Kubernetes and other container orchestration solutions, many companies relied on monolithic architectures. These were operated on physical servers or virtual machines (VMs), which provided some flexibility but also introduced significant complexity. Deploying and scaling applications was often cumbersome, as any change to the application required redeploying the entire infrastructure.

Monolithic architectures

In the early stages of IT, applications were often built in a monolithic architecture, meaning that all components of an application (such as the user interface, business logic, and database access) were tightly coupled. While this architecture was straightforward to develop and manage, it also led to issues with scaling and maintenance, as any change to one component required redeploying the entire application.

The rise of virtualization

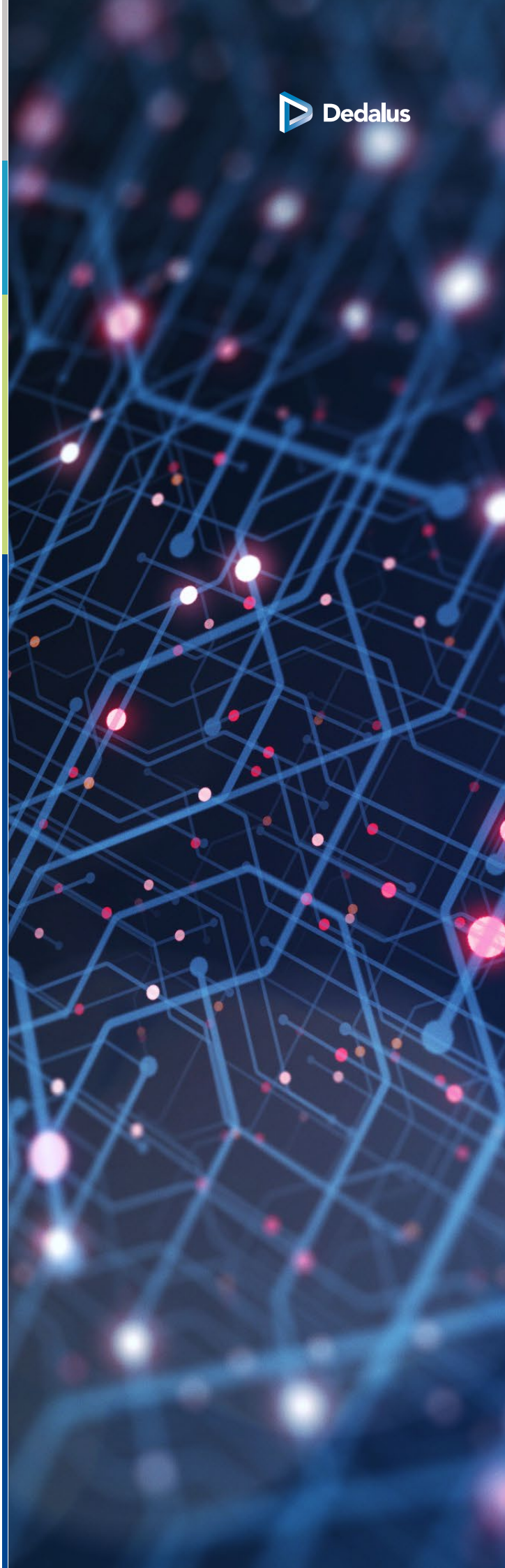
With the advent of virtualization, companies could run multiple virtual machines on a single physical server, improving resource utilization and increasing flexibility. Virtualization allowed for the isolation of applications, enabling different applications to run independently on the same physical server. However, challenges related to scaling and management remained.

The era of containerization

The next stage in the evolution was containerization, where applications and their dependencies were packaged into lightweight, isolated containers. Docker, one of the most well-known container technologies, revolutionized the way software was deployed and operated. Containers provide a consistent environment for applications, regardless of where they are run, whether on a developer's laptop or in a large data center.

The emergence of Kubernetes

Kubernetes was developed by Google and released as an open-source project in 2014. It emerged from Google's internal experiences with managing large, distributed systems and is based on the principles used in Google's internal system Borg. Kubernetes was designed to simplify the management of container clusters by providing features such as automatic scaling, load balancing, and self-healing. The open-source nature of Kubernetes and its strong community have led to it quickly becoming the standard for container orchestration.



2. What is Kubernetes?

Basics of Kubernetes

Kubernetes, often abbreviated as 'K8s,' is a platform for automating the deployment, scaling, and management of containerized applications. It allows developers and operators to manage complex applications efficiently and securely.

Core components of Kubernetes

- **Pods**

The smallest deployable unit in Kubernetes, which includes one or more containers. Pods are ephemeral and can be restarted as needed.

- **Nodes**

Physical or virtual machines on which Pods run. Each Node is monitored by the Control Plane.

- **Cluster**

A group of Nodes managed by a common Control Plane.

- **Control Plane**

Composed of components such as the API server, Scheduler, and Controller Manager, which together handle the overall management of the Cluster.

Functions of Kubernetes

- **Automatic Scaling**

Kubernetes can automatically adjust the number of running Pods based on current load.

- **Self-Healing**

Kubernetes restarts failed Pods and replaces or terminates Pods that are not responding.

- **Service Discovery and Load Balancing**

Kubernetes can automatically discover services within the cluster and evenly distribute traffic between Pods.

- **Rollouts and Rollbacks**

Kubernetes supports continuous rollouts of updates and allows reverting to a previous version if needed.

Comparison with precursor technologies

Before Kubernetes, several technologies and concepts were used for managing applications, including:

- **Ansible / Chef / Puppet**

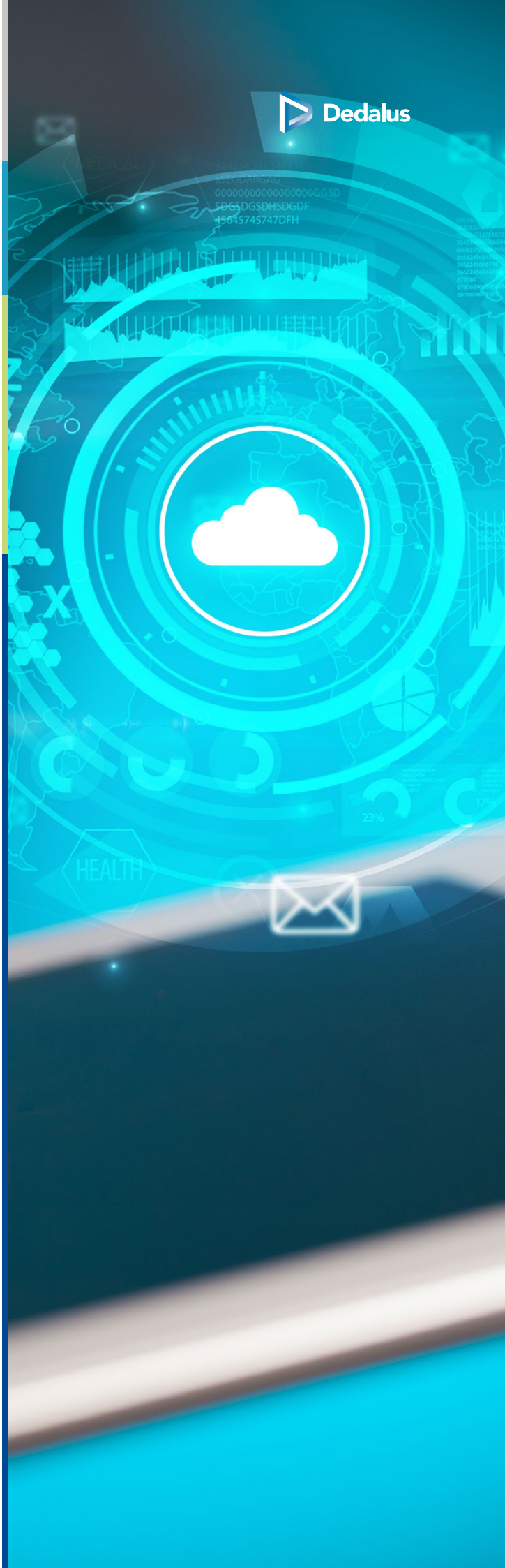
These configuration management tools were often used for automating application deployment and managing VMs, but they did not offer the same level of flexibility and scalability as Kubernetes.

- **Docker Swarm**

A container orchestration tool developed by Docker, but with fewer features and flexibility compared to Kubernetes.

- **OpenStack**

A cloud computing platform that manages virtual machines but is not specifically designed for container management.



3. Why Kubernetes in Healthcare?

Requirements in B2B healthcare

In the B2B healthcare sector, reliability, data protection, and scalability are crucial. Applications in this field must not only be reliable and high-performing but also comply with strict data protection requirements such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA).

Benefits of Kubernetes in the Healthcare Sector

Kubernetes offers numerous advantages that make it particularly well-suited for use in the healthcare sector:

- **Automatic Scaling**

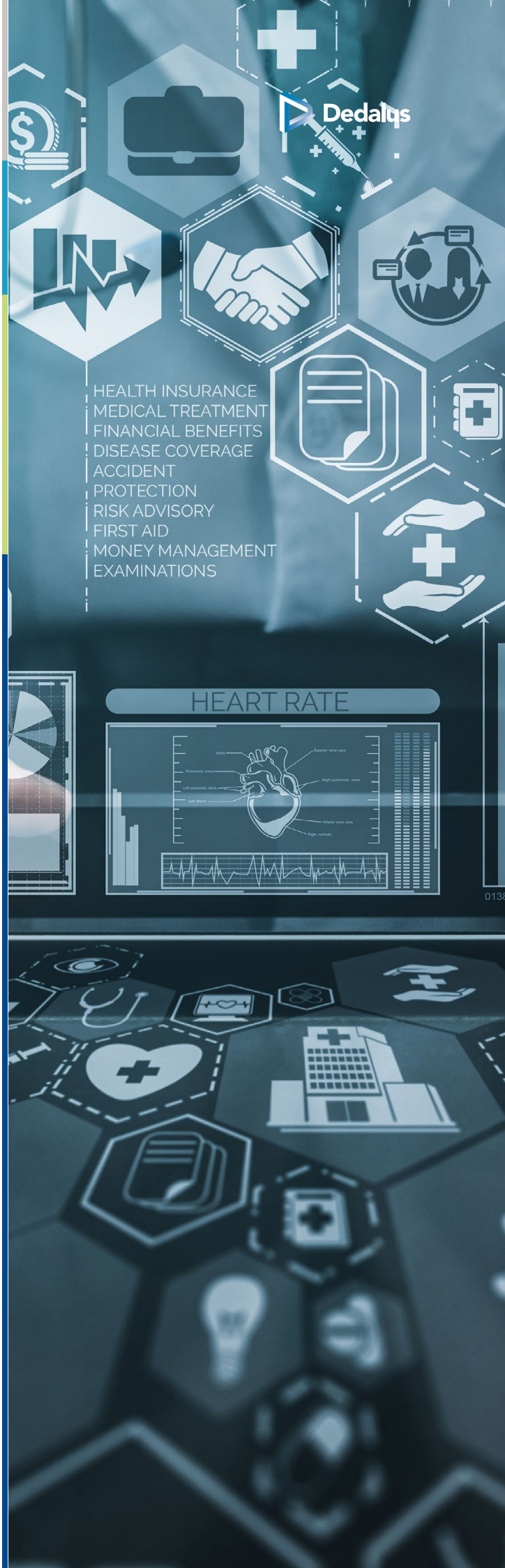
Healthcare applications often need to handle sudden spikes in load, such as when processing patient requests. Kubernetes automatically scales applications to efficiently manage such loads.

- **High Availability and Fault Tolerance**

Kubernetes ensures high availability of applications by automatically restarting Pods and distributing workloads across different Nodes.

- **Security Features**

Kubernetes provides integrated security features such as secrets management and network policies, which help protect sensitive data.

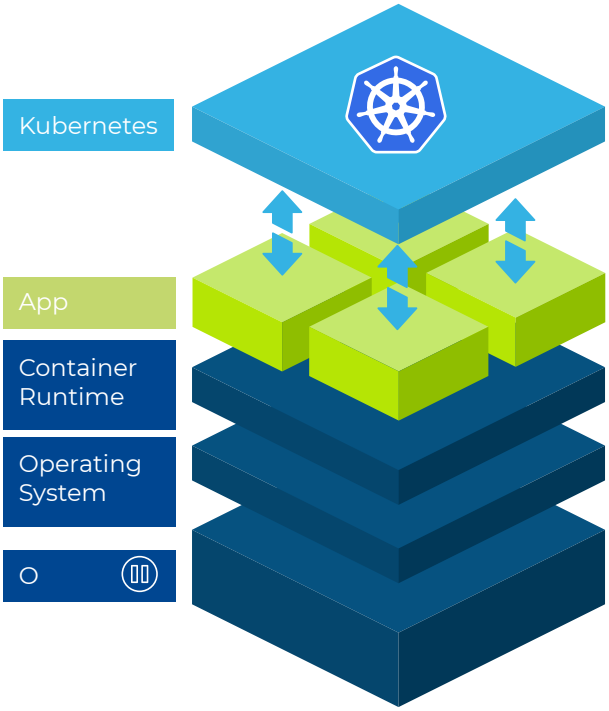


Kubernetes for DeepUnity Applications

All DeepUnity applications use a unified, modern technology stack, with Kubernetes serving as the container orchestration service. This technology stack is referred to as the DeepUnity Platform.

The DeepUnity Platform forms the central technical foundation for all DeepUnity applications within Dedalus, including ECM, DICOM, and RIS. This platform has been designed to ensure the future-proofing of applications, focusing on state-of-the-art security technology, support for various deployment options beyond on-premises, and providing a consistent user experience (UX) across all applications.

Another crucial aspect of the DeepUnity Platform is its integrative approach. By operating all applications on the same technical foundation, it enables a tighter integration of the applications. This creates seamless integration and enhances collaboration between the various components, ultimately leading to a more efficient and coherent use of the entire Dedalus software landscape.



Kubernetes serves as the central foundation for container management, providing essential core components such as networking, load balancing, and other necessary infrastructure services. These components enable efficient operation and scaling of containerized applications by dynamically provisioning and managing the required resources.

One of Kubernetes' primary functions is the orchestration of containers and the management of applications running on them. Kubernetes ensures that containers are automatically started, scaled, and redeployed in the event of failures. This orchestration guarantees that applications always run optimally and reliably.

Kubernetes acts as a layer between applications and the operating system. This intermediary layer abstracts the complexity of the underlying infrastructure, allowing applications to run independently of the specific hardware or cloud environment. This abstraction makes Kubernetes the foundation for scalability and high availability in modern application landscapes. Organizations can horizontally scale their applications as needed, responding to changes in demand without compromising stability or performance.

Moreover, Kubernetes provides a robust platform for the development and operation of distributed systems through its self-healing mechanisms and support for continuous integration and deployment (CI/CD). In an era where flexibility and agility in IT are crucial, Kubernetes represents an essential technology for meeting the demands of modern software development.

It enables organizations to manage their applications more efficiently while maximizing their reliability and performance, which is particularly valuable in dynamic and critical sectors such as healthcare.

4. Added Value of DeepUnity Platform

The use of a unified technology stack for all DeepUnity products offers significant advantages in terms of consistency and integration, greatly simplifying the management and operation of applications. A key component of this architecture is a state-of-the-art security concept, ensuring that applications meet the highest security standards and that sensitive data is comprehensively protected.

Regular releases continuously ensure that systems remain up-to-date with the latest technology by implementing new features and security updates. This contributes to the stability and security of the entire infrastructure.

The modern user interface (UI) for centralized cluster management is designed to provide an intuitive and user-friendly interface, enabling efficient management of Kubernetes environments. In addition, modern IT admin dashboards based on tools such as Prometheus and Grafana offer comprehensive insights into system performance, allowing for the early identification and resolution of potential issues.

Moreover, PostgreSQL is used as a cost-effective alternative to Oracle, providing a robust and high-performance database solution that enables significant cost savings without compromising performance or reliability.

The technological foundation is designed to ensure future-proofing. The architecture is expandable, highly scalable, and cloud-capable, allowing it to adapt flexibly to the evolving demands of the IT landscape. This ensures that the infrastructure can meet growing requirements and support sustainable growth in the long term.

In summary, this technology stack results in a modern, secure, and future-proof platform that excels in both flexibility and performance, enabling efficient management and development of IT environments.

5. FAQ

1. Which hypervisor solutions are supported, and is support for others planned?

- Currently supported: ESX and Hyper-V (as of 06/2024).
- Proxmox is planned.
- Hyperscalers (Cloud) like AWS are planned for the near future.

2. Is Dedalus planning to introduce a consolidated Kubernetes platform for all solutions (ORBIS, PXCS, DeepUnity)?

- Consolidation is targeted, planned for supporting public cloud deployment.
- In parallel, discussions are ongoing between teams to unify general aspects of the Kubernetes platforms today.

3. As a customer, do I have access to the DeepUnity Platform cluster, and can I operate it?

- Yes, for example, via Kubernetes management tool, SSH on Kubernetes nodes.
- Read-only access to important system dashboards is possible.
- Consultation on project-specific details is available.

4. Is it planned to make the metrics of the DeepUnity Platform components and applications accessible to third-party monitoring solutions like Zabbix, PTRG, checkMK?

- In addition to the existing possibility to display metrics via Grafana dashboards, it is planned to make Prometheus data accessible via promQL. This allows integration into an existing monitoring solution, provided that querying Prometheus is supported.

5. How far along is the transition of the PACS backend (DeepUnity Server/IMPAX EE) to DICOM services in the XL segment (university hospitals)?

- A few years ago, we started piloting DICOM services at small sites and gradually expanded the pilots in terms of volume.
- Currently, we are preparing the transition of university hospitals/large customers in 2024 (as of 06/2024).
- Currently, two sites with a volume of more than 250k studies per year are in operation.

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