MENDIX FOR PRIVATE CLOUD DEPLOYMENT

WHITE PAPER
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Introduction

This paper addresses considerations and options to deploy the Mendix Platform in a private or hybrid cloud. Mendix has strategically adopted Cloud Foundry as an open source foundational platform. Both for Mendix Cloud, the public cloud service, as well as for its capabilities to be implemented as a private cloud.

This paper describes what services Mendix offers on Cloud Foundry for private cloud deployments, and highlights the services of our technology partners HP Enterprise (HPE) and Pivotal who offer Cloud Foundry distributions for which Mendix Platform deployment is validated.

Why use a private cloud?

As businesses rapidly digitize, there is a manifest need for IT to become more agile and responsive to business demand while delivering solid reliability at the same time.

Research firm Gartner recommends implementing a bimodal IT strategy “that combines the rock-solid conventional capabilities of IT alongside a capability to respond to the level of uncertainty and the need for agility required for a digital transformation.”

Using the analogy of runners and sprinters, Gartner explains that key capabilities for Mode 2 “include a differentiated approach to investment management, governance, software development, sourcing, innovation management, intermodal collaboration, DevOps, automation and others.”

Many organizations that adopt a bimodal IT strategy take advantage of cloud computing, leveraging scalable and elastic services, to support digital initiatives.

Based on extensive experience helping industry leaders with Digital Transformation, Mendix has identified five key cloud capabilities that are required to establish a Mode 2 practice in your organization:

- **Rapid / instant provisioning**
  If minimizing time to market is of the essence (e.g. to gain competitive advantage or provide a new service substantially faster), IT should be able to instantly provision the environments and full set of computing services to support the initiatives.

- **DevOps support**
  A key attribute of IT agility is the level of integration between development and operations. Integrated DevOps services facilitate an iterative application delivery cycle.

- **Automated / self-service provisioning**
  Flexibly spinning up and down of compute services based on success of the digital initiatives removes the cost barrier for a test and learn / fail-fast approach. Testing out a new idea or application initiative should go at a fraction of the cost of the traditional Mode 1 approach.

*Figure 1. Bimodal IT Strategy*
- API level integration
  Since digital initiatives typically involve multiple technologies, support for Test Automation and Continuous Delivery based on API level integration is key.

- (Auto) scaling features
  Digital initiatives may start small, but should be rapidly scalable upon success. Not just for plain compute power. From an architectural viewpoint, designing micro-services with versioned APIs that are deployed independently are a proven pattern to build web scale applications. This shouldn’t come as an afterthought and cause major refactoring late on.

These key capabilities are typically offered as public cloud services, a style of computing where scalable and elastic IT-enabled capabilities are provided as a service to external customers using Internet technologies. Using public cloud services generates the types of economies of scale and sharing of resources that can reduce costs and increase choices of technologies.

Some organizations however, due to company policies or government regulation with respect to security, data privacy and data residency do not allow to leverage public cloud services for (part of) their workloads. In that case, in order to take advantage of cloud computing characteristics, implementing a private cloud is a viable alternative.

A private cloud is a form of cloud computing that is used by only one organization, or that ensures that an organization is completely isolated from others. Such private cloud could be implemented at an on premise data center or at a provider of cloud services that meets the requirements for offering the service.

The Mendix Platform supports the key capabilities mentioned above for driving digital innovation and establishing a bimodal IT strategy.

Mendix offers customers freedom of choice to consume the platform as a public cloud service or run Mendix on a private cloud.

Mendix Platform Services

The Mendix Platform provides a set of core services to build, deploy, run and manage multi-channel applications. These services are loosely coupled, yet logically grouped in platform modules:

- **Dev Center** for project management, design and visual application development.
- **App Store** that is integrated with the Dev Center.
- **Cloud Portal** for application deployment and management.
- **MxID** for user management.
- **Launchpad** a central place for users to access Mendix apps integrated with MxID.
- **Mendix Business Server** that handles runtime services.

Figure 2. For more detailed description of the platform, see the Mendix Platform White Paper
Mendix private cloud deployment

The deployment architecture of Mendix in a private cloud is as follows:

- The Mendix Business Server will be deployed on the private cloud infrastructure.
- The Dev Center and App Store will be used as public cloud services from Mendix. Since these are ‘design time’ services there is generally no issue of consuming these from a public cloud. If required the repositories for storing design artifacts could be implemented on the private cloud as well.
- Since The Cloud Portal, MxID and Launchpad that interact with or control runtime services are exclusively offered as public cloud services, they cannot be used for private cloud deployments. Hence equivalent services need to be leveraged from the private cloud infrastructure.

Mendix expects the following services to be provided by the private cloud infrastructure:

- Database management services
- File / object storage services
- Container Management Services
- Application Lifecycle Management & Monitoring services

Mendix has standardized its private cloud deployment on Cloud Foundry, an open source foundational PaaS. This ensures quality of service and supportability as well as interoperability across providers of Cloud Foundry.

Cloud Foundry

Cloud Foundry is an open standard for cloud applications. It is open source, multi-cloud, and multi-vendor. It provides hardened production infrastructure for global enterprises, designed to make DevOps the normal state of computing. It is built for fast-cycle innovation of cloud applications.

The Cloud Foundry Foundation

The Cloud Foundry project is governed by the Cloud Foundry Foundation, an independent not-for-profit 501(c)6 Linux Foundation Collaborative Project. Industry leaders such as Pivotal, HPE and IBM are driving the initiative together with a fast growing community of members. Mendix is a Cloud Foundry Foundation member and actively contributes to the project.

Why we chose Cloud Foundry

Standardizing private cloud deployment on Cloud Foundry brings Mendix and Mendix customers the following benefits:

- Cloud Foundry is a framework for both Container technology and service management supporting:
  - Automated provisioning (including binding of services)
    - Load balancing
    - Auto scaling
    - API
    - Portal
    - Health Manager

- Cloud Foundry is adopted by major technology vendors who have deep relations with the enterprises that trust them to provide private cloud services.
Cloud Foundry is open source which prevents vendor lock-in for customers.

Cloud Foundry has a vibrant ecosystem of technology vendors providing value-added services and technologies for customers.

Mendix Cloud Foundry Strategy
Mendix has strategically adopted Cloud Foundry as foundational PaaS layer underneath the Mendix Platform for both private cloud and public cloud. Mendix on Cloud Foundry is a General Available (GA) offering and can be deployed as build pack on Pivotal CF, HPE Helion and IBM Bluemix.

Mendix Cloud, the public cloud service of Mendix will be released on Cloud Foundry at AWS early 2016. This enables seamless operation of hybrid cloud environments where workloads may shift from private cloud to public cloud and vice versa.

Deploying Mendix on Cloud Foundry
Technology vendors such as Pivotal, HPE and IBM provide Cloud Foundry distributions containing the core platform augmented with their value-added services and support SLA.

Cloud Foundry distributions are implemented on an infrastructure layer such as Openstack or VMWare VSphere / ESX. Per vendor the level and richness of the out-of-the-box integrations differs.

Mendix can be deployed on a Cloud Foundry distribution using the Mendix Cloud Foundry Buildpack that is published on Github. Mendix supports this buildpack and has validated the buildpack to work on distributions from HPE and Pivotal. The buildpack should work however for any provider offering Cloud Foundry, including the open source download.

Note: Mendix does not provide support for the Cloud Foundry distribution itself. Customers running Cloud Foundry as private cloud should arrange support with the vendor providing the distribution.

Cloud Foundry Architecture
Cloud Foundry components include a self-service application execution engine, an automation engine for application deployment and lifecycle management, and a scriptable command line interface (CLI), as well as integration with development tools to ease deployment processes.

Cloud Foundry has an open architecture that includes a buildpack mechanism for adding frameworks (e.g. the Mendix Buildpack), an application services interface, and a cloud provider interface.

![Cloud Foundry Architecture](image)

Figure 3. Cloud Foundry Architecture

Router
The router routes incoming traffic to the appropriate component, usually the Cloud Controller or a running application on a DEA node.

Authentication
The OAuth2 server and Login Server work together to provide identity management.
Cloud Controller
The Cloud Controller is responsible for managing the lifecycle of applications. When a developer pushes an application to Cloud Foundry, he or she is targeting the Cloud Controller. The Cloud Controller then stores the raw application bits, creates a record to track the application metadata, and directs a DEA node to stage and run the application. The Cloud Controller also maintains records of orgs, spaces, services, service instances, user roles, and more.

Health Manager
The Health Manager (HM) is essential to ensuring that apps running on Cloud Foundry remain available. HM restarts applications whenever the DEA running an app shuts down for any reason, when Warden kills the app because it violated a quota, or when the application process exits with a non-zero exit code.

Application Execution (DEA)
The Droplet Execution Agent manages application instances, tracks started instances, and broadcasts state messages. Application instances, running on the Mendix Business Server, live inside Warden containers. Containerization ensures that application instances run in isolation, get their fair share of resources, and are protected from noisy neighbors.

Blob Store
The blob store holds:
- Application code
- Buildpacks
- Droplets

Service Brokers
Applications typically depend on services such as databases or third-party SaaS providers. When a developer provisions and binds a service to an application, the service broker for that service is responsible for providing the service instance.

Message Bus
Cloud Foundry uses NATS, a lightweight publish-subscribe and distributed queuing messaging system, for internal communication between components.

Logging & Statistics
The metrics collector gather metrics from the components. Operators can use this information to monitor an instance of Cloud Foundry. The application log aggregator streams application logs to developers.

For more details, see the Cloud Foundry documentation.

Deploying Mendix applications on Cloud Foundry
From a deployment perspective a Mendix application is defined as a versioned Deployment Package that contains all the artifacts needed to run the application.

The flow starts at the Business Modeler where the application is developed and composed. The modeler is a desktop application that connects to the Dev Center where application projects are defined and their repositories are managed.

All the artifacts are stored in the application project repository on the Team Server. The Build Server creates the deployment packages from a revision of artifacts in the app project repository. The package is placed in the Deployment Package Repository.
To deploy the package on Cloud Foundry the following options are available:

- Using a Command Line Interface (CLI) to manually trigger the creation of an application on Cloud Foundry. A detailed guide is available on Github.
- Configure the Mendix Business Modeler for one-click deployment of applications on HPE Helion or Pivotal CF. See the how-to guide for details.

Support for DTAP Environments
Cloud Foundry supports the concept of staged deployment of applications through Test and Production environments into Production by making use of Spaces that are defined for an organization (Org).

It is common practice to define a dedicated space for Test, for Acceptance and for Production and deploy applications in their respective stages in those spaces.

The figure below shows the deployment architecture of Mendix on Cloud Foundry. Note that the database services and file services are just two examples of services that can be bound to an instance of Mendix Business Server.

Figure 4. DTAP Environment
**Cloud Foundry Services provided by Mendix partners**

Mendix has validated and supports the Mendix Cloud Foundry Buildpack for the following Cloud Foundry distributions: HPE Helion and Pivotal CF. As the private cloud services offered by the respective vendors do vary the table below highlights the specific service offerings. The Services listed are limited to those required to run Mendix on Cloud Foundry and are supported in Production. Note that our partners offer a more extensive range of services that may be relevant in broader context of implementing a private cloud within your organization.

<table>
<thead>
<tr>
<th>Cloud Foundry Services</th>
<th>HPE Helion</th>
<th>Pivotal CF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong></td>
<td>HPE Helion Development Platform is an application platform as a service that enables developers to rapidly develop, deploy &amp; scale cloud applications across a mix of public &amp; private clouds. The platform supports a wide &amp; growing list of programming languages &amp; technologies.</td>
<td>Pivotal Cloud Foundry helps you make the transition to a cloud native enterprise with a complete platform for delivering software rapidly, consistently and reliably at scale, in an IaaS agnostic fashion. It's the comprehensive cloud native platform for building your future.</td>
</tr>
<tr>
<td><strong>Cluster Management</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDP CF-MGMT</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Database Services managed by Cloud Foundry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MySQL</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>MySQL - HA</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Mendix State Storage Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redis</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>File / Object Storage Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3 Compliant Object Storage</td>
<td>Shared File System in HDP, Swift, Cinder</td>
<td>Basho, EMC ECS</td>
</tr>
<tr>
<td><strong>Monitoring Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP Application Monitor</td>
<td></td>
<td>Pivotal APM, Pivotal Ops Metrics</td>
</tr>
<tr>
<td><strong>3rd Party Monitoring Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Relic, Splunk</td>
<td></td>
<td>New Relic, ELK, JMX</td>
</tr>
<tr>
<td><strong>Other Services</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto scaling</td>
<td>Automatic</td>
<td>Slider-based</td>
</tr>
<tr>
<td>SSL Termination / Load Balancing</td>
<td>Stackato / 3rd party solution</td>
<td>HAPProxy / 3rd party solution</td>
</tr>
</tbody>
</table>

1) Customers may want to use database services that are not included in- and managed by the Cloud Foundry distribution, e.g. Microsoft SQL Server or Oracle. It is possible to connect the Mendix Business Server to such 'external' services. This needs to be configured and managed by the customer.
High Availability on Cloud Foundry

The Mendix architecture is optimized for high availability (HA) scenarios on Cloud Foundry and leverages components and services that Cloud Foundry provides.

Health Manager Responsibilities

The Cloud Foundry Health Manager ensures that apps running on Cloud Foundry remain available. The Health Manager:

- Monitors applications to determine their state (e.g. running, stopped, crashed, etc.), version, and number of instances.
- Determines applications’ expected state, version, and number of instances.
- Reconciles the actual state of applications with their expected state.
- Directs the Cloud Controller to take action to correct any discrepancies in the state of applications.

HA Scenarios

The following HA scenarios are supported:

- If the application runs on a single instance of the Mendix Business Server, the Health Manager will automatically trigger a reboot if this instance goes down.

- If the application runs on multiple instances of the Mendix Business Server and one of the instances goes down, traffic will automatically be routed to the available instance(s) while the Health Manager triggers rebooting the instance that is unavailable.

For applications running on the Mendix 5 release, enabling sticky sessions is required to run multiple instances of the Mendix Business Server. Mendix 6 supports external session storage, which makes it easier to run multiple instances of the Mendix Business Server to configure an “active – active” HA configuration. This requires an additional DBMS service to store the state cache.

Scaling on Cloud Foundry

Mendix supports both vertical and horizontal scaling of applications running on Cloud Foundry.

Vertical scaling

Vertical scaling is achieved by adding additional compute resources to the application. Mendix has standardized resource configurations of various sizes for Mendix Cloud, called App Containers. We recommend applying the same practice for vertical scaling of applications on Cloud Foundry. The specification of Mendix App containers is included in the paragraph Hardware Requirements & Sizing Recommendations.

Horizontal scaling

Horizontal scaling is achieved by creating a cluster of Mendix Business Server (MBS) instances to handle the load of the application. This configuration is identical to the “active-active” HA configuration described above.

Note that the database will become the bottleneck and single point of failure if only MBS instances are clustered. For true horizontal scalability the database needs to be configured as such as well.
The Mendix App Platform meets enterprise-level requirements for security and addresses security measures on multiple levels of granularity. In the context of private cloud deployment the following aspects are relevant:

**Runtime & Design time security**
- The Mendix Business Server handles known security threats in the runtime

**Application lifecycle logging**
The Mendix App Platform logs relevant activities during the app delivery cycle, from requirements management, to development, deployment and application monitoring to ensure compliance with customers’ requirements for auditability.

**Organization level security measures**
Mendix, as an organization, embeds security in company processes and standard operating procedures by adopting a representative subset of the ISO 27001 / 27002 Information Security Framework. Mendix achieved ISAE 3402 Type II assertion. An independent auditing firm periodically performs security audits. Furthermore, a leading IT security firm performs regular penetration tests on the Mendix App Platform.

For a detailed description of security measures in the Mendix Platform, see the security white paper.

**Note on Encryption at transport.**
Similar to the setup in Mendix Cloud, SSL is terminated at the load balancer in Cloud Foundry. An SSL Termination service should be provided by the vendor distributing Cloud Foundry or could be configured in 3rd party load balancer at OSI level 4 (TCP) or 7 (HTTP/S). For traffic in Cloud Foundry, full network isolation is implemented through containerization with Warden.

**Note on Encryption for data at rest**
Encryption for data at rest needs to be configured by the provider of DBMS and File Storage service.
# Hardware Requirements & Sizing Recommendations

Mendix recommends the following specification regarding hardware for running Mendix on Cloud Foundry and for running applications on Mendix. The recommendations for hardware and sizing are a rule of thumb and depend on the complexity of the application logic.

<table>
<thead>
<tr>
<th>Hardware</th>
<th>HPE Helion</th>
<th>Pivotal CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Foundry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual Machine Services</td>
<td>15 - 20 (Spread across three physical hosts)</td>
<td>15</td>
</tr>
<tr>
<td>HA</td>
<td>30-40</td>
<td>30</td>
</tr>
<tr>
<td>RAM</td>
<td>120 GB</td>
<td>120 GB</td>
</tr>
<tr>
<td>Infrastructure Options</td>
<td>Helion OpenStack</td>
<td>OpenStack, vSphere, AWS</td>
</tr>
<tr>
<td>DEA OS</td>
<td>Ubuntu</td>
<td>Ubuntu</td>
</tr>
<tr>
<td>Network Bandwidth</td>
<td>10 GB (recommended)</td>
<td>10 GB (recommended)</td>
</tr>
</tbody>
</table>

## Mendix Applications

### Start up footprint RAM

- **RAM**: 80 MB

### Sizing for Users

- **RAM**: Number of concurrent users * average amount of objects in cache -> 2 MB per (heavy) concurrent user
- **CPU**: Number of concurrent users * average amount of requests per user * Average processing time -> +/- 1 CPU core per 500 (heavy) concurrent users

### Sizing for Batch Processing

- **CPU**: Number of concurrent batch processes * Batch sizes -> 1 CPU core per concurrent batch
- **RAM**: Amount of objects processed -> 200 MB per batch of 100K objects
The outcome of the sizing calculation can be used to select the appropriate App Container(s).

<table>
<thead>
<tr>
<th>App Containers</th>
<th>S</th>
<th>M</th>
<th>L</th>
<th>XL</th>
<th>XXL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MX CPU</td>
<td>Shared</td>
<td>Shared</td>
<td>Shared</td>
<td>Shared</td>
<td>Shared</td>
</tr>
<tr>
<td>MX RAM</td>
<td>1 GB</td>
<td>2 GB</td>
<td>4 GB</td>
<td>8 GB</td>
<td>16 GB</td>
</tr>
<tr>
<td>DB CPU</td>
<td>0.5 Cores</td>
<td>1 Core</td>
<td>1 Core</td>
<td>2 Cores</td>
<td>4 Cores</td>
</tr>
<tr>
<td>DB RAM</td>
<td>1 GB</td>
<td>2 GB</td>
<td>4 GB</td>
<td>8 GB(^1)</td>
<td>16 GB(^1)</td>
</tr>
<tr>
<td>DB Storage</td>
<td>5 GB</td>
<td>10 GB</td>
<td>20 GB</td>
<td>40 GB</td>
<td>80 GB</td>
</tr>
<tr>
<td>File Storage</td>
<td>5 GB</td>
<td>10 GB</td>
<td>20 GB</td>
<td>40 GB</td>
<td>80 GB</td>
</tr>
<tr>
<td>Backup</td>
<td>10 GB</td>
<td>20 GB</td>
<td>40 GB</td>
<td>80 GB</td>
<td>160 GB</td>
</tr>
<tr>
<td>Network</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
</tbody>
</table>

\(^1\) For XL and XXL App containers additional DB Ram and DB Storage can be purchased.

**References**

Below is a list of references to documentation of our partners. In case of inconsistency between the services listed in this white paper and services described at the partner’s site, the latter prevail.

**HPE Helion Development Platform**

  [http://docs.hpcloud.com/](http://docs.hpcloud.com/)

**Pivotal Cloud Foundry**

  [http://docs.pivotal.io/elk/index.html](http://docs.pivotal.io/elk/index.html)  
  [http://docs.pivotal.io/pivotalcf/customizing/use-metrics.html](http://docs.pivotal.io/pivotalcf/customizing/use-metrics.html)
- MySQL Database Services: [http://docs.pivotal.io/p-mysql/index.html](http://docs.pivotal.io/p-mysql/index.html)  
  [http://docs.pivotal.io/p-mysql/backup.html](http://docs.pivotal.io/p-mysql/backup.html)
- Hardware Requirements: [http://docs.pivotal.io/pivotalcf/customizing/requirements.html](http://docs.pivotal.io/pivotalcf/customizing/requirements.html)
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