TALLINN UNIVERSITY OF TECHNOLOGY
School of Information Technologies
Department of Software Science

Gleb Rimmel 154831IABB

# ADVANTAGES OF MIGRATION TO ADOBE EXPERIENCE MANAGER CONTENT MANAGEMENT SYSTEM ON THE EXAMPLE OF SWEDBANK AB

Bachelor's thesis

Supervisor: Inna Švartsman
MSc
Lecturer
Co-supervisor: Pavel Novitski
BSc
System architect

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TALLINNA TEHNIKAÜLIKOOL
Infotehnoloogia teaduskond
Tarkvarateaduse instituut

Gleb Rimmel 154831IABB

# ADOBE EXPERIENCE MANAGER SISUHALDUSSÜSTEEMILE MIGRATSIOONI EELISED SWEDBANK AB NÄITEL

Bakalaurusetöö

Juhendaja: Inna Švartsman
MSc
Lektor
Kaasjuhendaja: Pavel Novitski
BSc
Süsteemiarhitekt

Tallinn 2018

# Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

Author: Gleb Rimmel

20.05.2018

# Abstract

Following study's aim is to determine potential value for Swedbank AB, that is achieved by migrating to the new content management system.

Main objective is to compare and analyse two content management systems that are used by Swedbank AB.

This thesis describes existing platform, requirements, vendors study conducted by Swedbank, chosen platform and its capabilities. Final "Comparison" chapter describes the advantages and value that are achieved with the migration to the new platform comparing to the old one. All gathered data and analysis can be used during pre-studies conducted in the other Swedbank departmens, which are still utilizing Oracle WebCenter CMS.

This thesis is written in English and is 34 pages long, including 7 chapters, 16 figures and 1 table.

# Annotatsioon

## Adobe Experience Manager sisuhaldussüsteemile migratsiooni eelised Swedbank AB näitel

Käesoleva töö eemärk selgitada mis eelised on saavutatud migratsiooniga Adobe Experience Manager platvormile.

Selle eemärgi saavutamiseks analüüsitakse ja võrreldakse kaks sisuhaldusesüsteemi mis on kasutuses Swedbank AB organisatsioonis ning põhi probleem mida lahendatakse selle tööga on migratsiooni post-analüüsi ja äriväärtuste kirjelduse puudumine. Andmed saadud selle lõputöö käigus saab kasutada ka teiste panga osakondadel, kus on kasutuses jäänud Oracle WebCenter sisuhaldussüsteem.

Käesolevas töös on rõhutatud järgmised punktid: vana Oracle platvormi arhitektuur, funktsionaalsus ja sellega kaasa käevad probleemid ja raskused; põhjused uuele süsteemile migreerimiseks; nõuded uuele süsteemile ja nende põhjendus; uue süsteemi valimise protsessi kirjeldus ja resultaadid; valitud AEM platvormi kirjeldus, arhitektuur, funkstionaalsus ja kasutatud tehnoloogiad.

Viimases osas on tehtud võrdlemine, mis baseerub eelmistest osadest saadud informatisoonil. Selle võrdlemise resultaadiks oli välja selgitatud kõige tähtsama ja kasuliku funktsionaalsuse kirjeldused. Iga kirjeldatud protsessi ja funktsionaalsuse kohta on ka välja toodud väärtus Swedbank AB jaoks. Väärtus on vaadeldatud nii äri- kui ka arendajate poolt. Olid ka leitud tehnilised aspektid mis mõjuvad kogu süsteemi haldatavust ja stabiilsust ning seega toovad lisaväärtust pangale. Võrdlemise käigul on välja uuritud, et uus süsteem lahendab suurem osa probleemidest mis olid seotud Oracle süsteemiga.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 34 leheküljel, 7 peatükki, 16 joonist, 1 tabel.

# List of abbreviations and terms

| | |
|---|---|
| CMS | Content Management System |
| WCM | Web Content Management |
| WCMS | Web Content Management System |
| AEM | Adobe Experience Manager |
| OOTB | Out-of-the-box |
| UCM | Universal Content Management (old naming of Oracle WebCenter Content) |
| WCC | WebCenter Content |
| MSM | Multi-site management |
| SEO | Search Engine Optimization |
| SSO | Single-Sign-On |

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# 1 Introduction

Nowadays almost every enterprise is reliant on the web services, especially when it comes to marketing and own public content distribution through the Web. Ability to easily create content, reshape it without any need in additional development and extend existing content is in great demand. To fulfil these purposes it is reasonable to use content management systems.

Content Management System (CMS) – software application that allows creating and editing digital content. [1]

Web Content Management System (WCMS) – is a CMS that supports web-publishing, management of web pages and web-content, such as photo, video, audio and others. WCMS systems usually also provide OOTB solutions for user access rights, search engine optimizations, web-page templates creation, version control, workflows.

WCMS includes an engine, set of tools and configurations to fulfil most enterprises' requirements. That way CMS enables using the common way for content management and speeds up the process of managing digital assets. Web Content management systems also greatly reduce the amount of additional development needed by applying reusable solutions for the most often used features. Importance of utilizing WCMS by an enterprise increases accordingly to the amount of content that an enterprise already owns and plans to create and operate in the future.

Concerning Swedbank, the significance of using WCMS has been constantly growing in years. Swedbank has at least 11 external websites for the main branch and 60 of external websites for Savings banks operating on the current platform supplied by Oracle. Each of these sites have their own specific content as well as content shared in-between. To operate that high number of websites there is a need of quite customizable, performant content management system with a flexible multi-site management solution.

The main problem this bachelor thesis solves is absence of post-analysis and clear description of business- and technical advantages that were achieved with a complete migration to the new platform from Adobe Systems.

Main objective of the study is to compare both systems, analyse the functionality and technologies used, and describe the advantages of new platform, which bring additional value for Swedbank.

In this study I describe the current system's capabilities, architecture and existing challenges that lead to a necessity of an upgrade. Afterwards, I summarize and review the requirements for the new system and describe the vendor assessment process. Then I describe new system's functionality, technologies and architecture. Finally, I bring examples of new system's functionality and technologies that create additional value for Swedbank comparing to the old system.

# 2 Current production system

Oracle WebCenter **Content** (former Oracle UCM) – WCMS developed by Oracle, part of WebCenter platform.

Oracle UCM 10g was presented as highly secure, reliable, and scalable content management solution that meets the growing day-to-day needs of end users, while delivering sophisticated content management capabilities to professional users. System also provides capabilities for multi-site management, digital assets management, document management, content and usage tracking, content categorization and content conversion. [26]

Current system is running on WebCenter Content version 10g released in January 2007, which lifecycle has ended in December 2015. [24]

It is important to note that WCC has three main generations (10g, 11g, 12c), which are different in architecture and offered suite of available integrations with other WebCenter components.

In this thesis, comparison is made on the example of WebCenter Content 10g. In addition, reasons for abandoning WCC solution are investigated.

## 2.1 Features

- Oracle ecosystem – there is wide range of applications and products available from Oracle, starting from web-servers, frameworks, database management systems and ending with cloud services. Thus, most of the Oracle products are fully compatible and ready for integrations with other components from the ecosystem.

- Integrations – WCC platform has a number of integrations with other software manufacturer's products and services. To name, Microsoft Sharepoint Integration, Autonomy Enterprise Search or Microsoft Fast search engine support.

- Site Studio Designer – application for managing site hierarchy and creating the overall look-and-feel of the site. Through the application, an administrator is able to alter page layout, site navigation, and the use of fragments and contribution regions.[23]

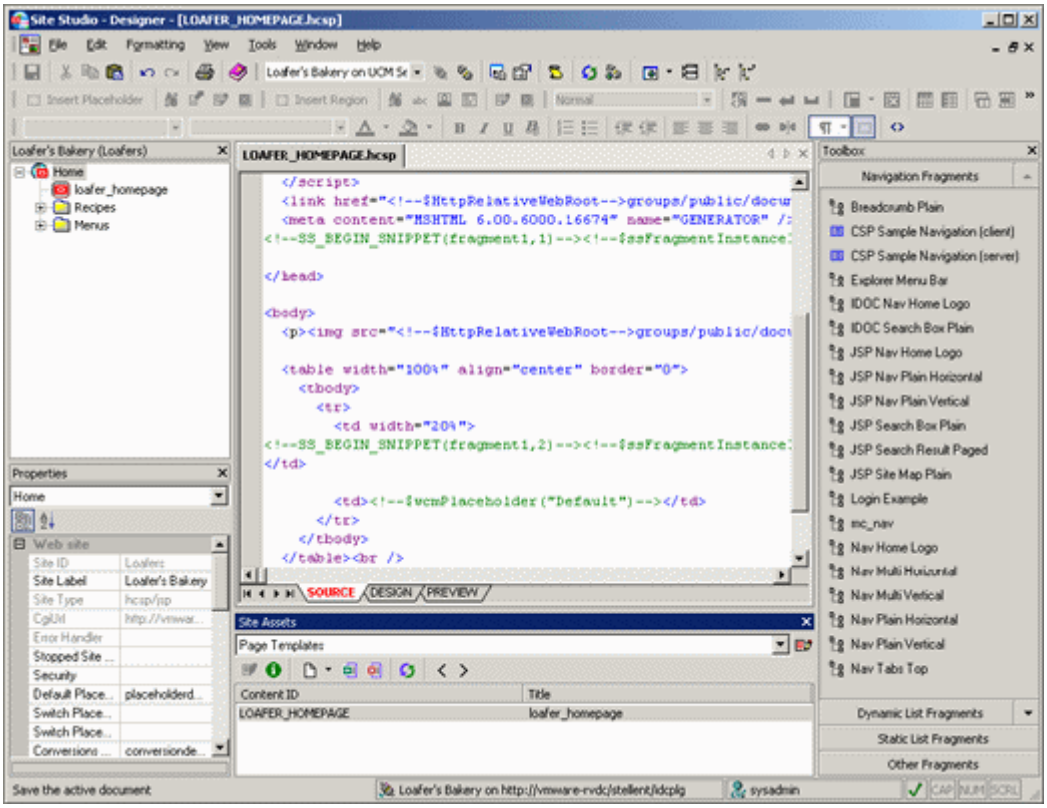


Figure 1. Screenshot of the Site Studio Designer application

This figure *"shows the main interface, with menus and toolbars at the top, the fragments toolbox on the right, the site hierarchy and asset properties on the left, and the workspace and site assets pane in the middle.*" [23]

- Flexible templates and access rights – every template can have one or more placeholders for the content. It is possible to specifically set rules for the allowed content types and display options for any particular placeholder, also per-user. Moreover, access rights can be applied for certain element's properties to be shown to or hidden from the editor. [27]

- Components reusability – author is able to build pages by the Content ID of the existing documents or components. Reusable blocks of content can be saved in Fragments Gallery and afterwards utilized in any number of templates. [27]

- OOTB file converters – *"A core strength of Oracle Universal Content Management is the ability to transform native formats to PDF, TIF, HTML, and XML, as well as convert multiple image and video formats for quick viewing and Web publishing. The new content refinery in Oracle Universal Content Management 10g is built on a service-oriented architecture, enabling customers to create custom conversion options for their unique needs. Additionally, the conversion engine can be quickly called from any application across the enterprise as a Web service.*" [26]

## 2.2 Technology stack

Oracle WebCenter 10g has comprehensive technology stack that made it one of the leader CMS-s in the year 2007. [46]

**Java Runtime Environment 1.6** grants whole system multiplatform capabilities and space for improvement by using existing custom Java 1.6 libraries.

**Oracle Application Development Framework** (Oracle ADF) **–** Java EE based framework with MVC architecture that simplifies application development by providing OOTB design patters, infrastructure services and tools for creating visual. Its core properties are metadata-driven architecture and focus on the Oracle ecosystem. Oracle ADF is a foundation for all Oracle Middleware family products and others.

Model-View-Controller (MVC) – is a software architecture pattern, which is used for developing application concentrated on user interfaces. Pattern follows the principle of dividing application into three interconnected parts, with each part being responsible for either business logic, design or interaction.

**iDoc Script** - is a Oracle's proprietary server-side scripting language used primarily for the presentation of HTML templates and configuration settings. It has hundreds of built-in global functions for variables comparison, object's properties and other data manipulation. Developers can define new global functions, including custom classes, with Java code. [28]

**Web Services Definition Language (WSDL) Generator** – WCC 10g has native support of Simple Object Access Protocol (SOAP) based web services. To achieve full

capabilities a WSDL Generator adaptor should be installed on the Content Server (see 2.3). Afterwards, *"web services access the content server via the WSDL Generator component and use the exposed Content Server services to execute actions and provide data transaction between the user employing web services and the content server*". [25]

**Content Integration Suite (CIS) –** product that can be deployed on J2EE application servers to enable communication with Content Server and Image Server. CIS provides an interface to communicate with services through object-oriented Universal Content and Process Management API (UCPM API). [29]

## 2.3 Architecture

Figure below describes basic system infrastructure architecture of WebCenter Content implementation in Swedbank.

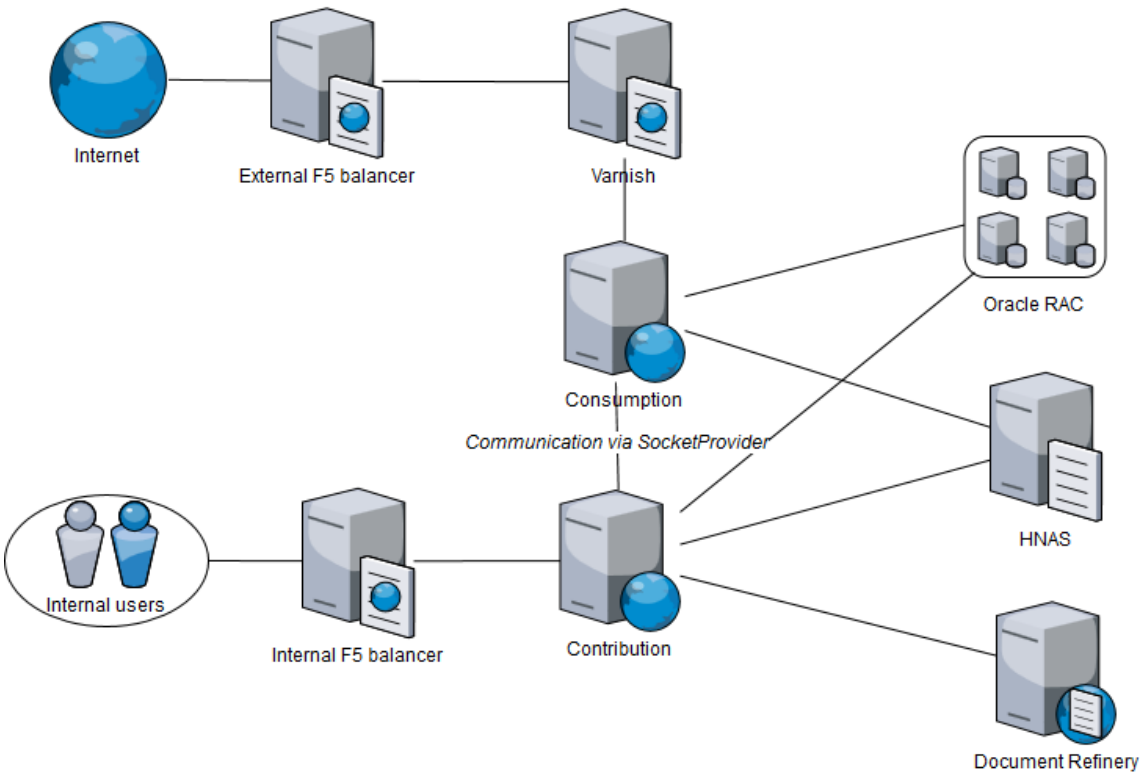


Figure 2. Basic WCC system infrastructure architecture diagram [38][39]

**Oracle Content Server** – Java application for web servers, core application of WebCenter Content CMS. It provides centralized web-based repository that manages all phases of the content life cycle: from creation and approval to publishing, searching, expiration, and archival or disposition.

*In addition, Content Server needs a database to store information: any supported and licensed database such as Oracle database, MS SQL Server or IBM DB2 will work.*

**Contribution server** – web server with installed Content Server application that is used by editors to create, edit and publish content. After content was queued for publishing and approved, it is transferred to Consumption servers.

**Consumption server** – web server with installed Content Server application which main purpose it to display content to consumers.

Depending on scope of WebCenter Content platform implementation and security considerations, there are four ways to handle published data described in Oracle documentation.

- *Content Publisher to File System - Oracle Content Publisher extracts content from Content Server and publishes the generated web content to a file system.*
- *Content Publisher to Content Server - Oracle Content Publisher extracts content from Content Server and transfers the generated web content to another content server, where the web content is subsequently checked in*
- *Content Server to Content Server - Content Server archives or replicates checked-in content to another content server.*
- *Content Server to File System - Content Server backs up checked-in content to a file system.* [30]

In Swedbank, system is built on *Content Server to File System* principle that uses built-in Archiver utility to transfer content from Contribution environment to the shared Network Attached Storage server, which is represented in Figure 2 as HNAS. [38]

**Hitachi Network Attached Storage (HNAS) -** data storage server implementation by Hitachi, connected to a computer network providing data access to the other network clients. HNAS has number of advantages such as: simplified backup and recovery; automated data migration to the number Cloud Services; improved monitoring; high scalability; disaster recovery capabilities.

Figure below displays publication principle used in Swedbank.

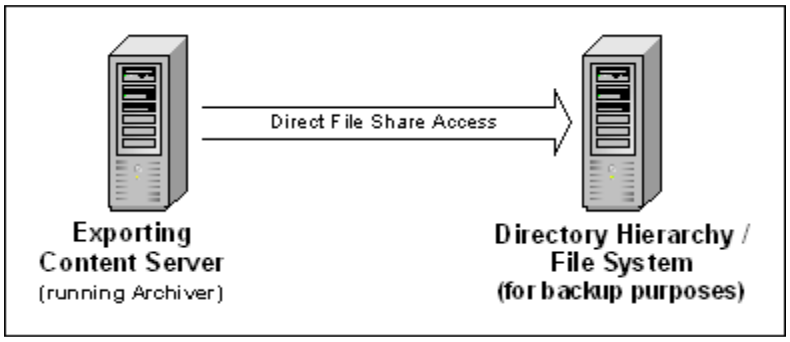


Figure 3. *Content Server to File System* publication principle [30]

Afterwards, Consumption servers read data from the NAS server. This approach can also be used to transfer checked-in content to a file system for backup purposes. [30]

**Oracle Real Application Clusters (Oracle RAC) –** an option for Oracle Database instances to be run on multiple computers providing access to a single database for higher performance. The instances are interconnected with each other, which enables all the instances to have synchronized data.

**Document Refinery** – separate web-server with Inbound Refinery module installed. Inbound Refinery is conversion server that manages file conversions and provides thumbnailing functionality. Module has PDF, XML and TIFF converter adapters available for setup. [29]

**Varnish** – is a web application accelerator also known as a caching HTTP reverse proxy. It is used in front of HTTP servers to cache the content. Varnish Cache typically speeds up delivery with a factor of 300 - 1000x, depending on an architecture. It relies on a rule-set when processing HTTP requests. Rules are written in proprietary VCL domain-specific language. [31]

**F5 balancer** – consolidating name for load balancing products from F5 Networks company that provide reverse proxy and distribute network or application traffic across a number of servers. [32]

Figure 2 describes basic system architecture, some of the details are not present for internal reasons. System consists of Contribution servers cluster and Consumption servers cluster. Both clusters are connected to Oracle RAC database, as well as shared file storage that is accessible on HNAS.

"*In Oracle-based content management, a clustered, multi-server configuration uses a common content server file system, database, and search index collection. A load balancer can be used to provide high availability for consumption.*" [30]

Every Contribution server communicates with Inbound Refinery via set-up Server Socket Port and outgoing connection provider to convert images or documents submitted by the editors. In addition, Consumption servers have configured Archiver process for backward replication, which is required for transferring data of customer-submitted forms back to the Contribution servers.

Oracle describes own content management solution as "fully scalable". It can grow and adapt to organization's needs. Scalability can be achieved by adding new instances in two possible ways – separate computer for each instance or multiple instances on one physical machine (mainframe).

Following Oracle's documentation, it is also advised to set up server redundancy for Consumption environments to raise system availability. Swedbank expands this vision even further by utilizing Varnish instances that are embedded in front of Consumption instances. Varnish servers take major part of the load by saving cached versions of the pages and delivering requested content to the customer. Additionally, F5 balancers are used from both - external and internal side, to spread incoming traffic equally between servers.

## 2.4 Existing problems

When it comes to making decision regarding system upgrade, it is important to have a full vision on existing system flaws, problems and possible obstacles. Making an analysis of "Request For Information" documents, as well as Oracle's documentation research brings up following technical and business points.

### 2.4.1 Technical perspective

- Current system is discontinued, which means that there will not be any patches for critical bugs.

- System is too “spread”, relies on other servers like Oracle RAC, HNAS and Inbound Refinery. Problem with one of these parts affects whole system’s stability.

- WCC 10g is built on Java 1.6, which means that there is no support for any modern frameworks or libraries.

- Updating WebCenter Content system from 10g to 12c is very complicated process that involves full system migration. It means that there is no direct system upgrade available. Moreover, Oracle is not providing migration as a service and cannot guarantee that existing components are going to work after migration.

- All Java components will require recompilation since 12c requires Java version 1.8. Most of the components will need additional development due to system architecture changes.

- Legacy code is harder to maintain and its refactoring will take more time.

- 10g to 12c upgrade requires updating all reliant external components, for example Autonomy IDOL search engine integration is not supported anymore.

- Since WCC 10g is tightly coupled with Oracle RAC, migration will also require Database Administration Department’s resource.

- Oracle representatives could not really clarify what are the advantages of the 12c version over 10g or other systems during “Request For Information”, moreover it seemed that platform has not really changed, but was made more complex.

### 2.4.2 Business perspective

- License policy of WebCenter Content (or UCM) has two options - per named user and per CPU. Both of them are source of additional expenses in case of need for system expansion. “Scalability costs”.

- Upgrading WCC 10g to 12c requires new license agreement to be signed. Prices have risen since implementing it in 2008. In year 2010 price for UCM Named user license ranges from US$ 1,200 to US$ 2,300. With the CPU model, the list pricing

varies from US$ 57,500 to US$ 115,000 per CPU. Currently, WebCenter Content named users license costs 3450 US$ and CPU license 172 500 US$. [27][33]

- Potential additional development and migration costs are hard to evaluate and predict. They might get comparable to the development a system from scratch.

- Business reports that look and feel of WCC 12c is not that much different from current system, but "functions that annoy the users are still there".

- During pre-study, WCC platform was described as "not editor-friendly" because of "editing interface that creates worry and fatigue". [34][37]

  While making my own study of Oracle documentation for WCC, I have formed an opinion that the WCC platform is too complex from development, administrative and content editing points of view. It is too granular, with many "optional" features, which appear in one version, but stop being supported in future versions of the platform. Oracle's documentation is too spread out, hard to navigate and often free for interpretation. Moreover, some important documentation files for WCC 10g are not available anymore.

# 3 Requirements for the new system

Before conducting study of the CMS market leaders, a set of requirements was composed. When requirements were being created, it was already known, that there is no option for any effortless upgrade of existing system to the newest version, since the system had not been updated to the version 11g, because of appeared technical difficulties. Consequently, whole project is considered as system migration project, therefore affecting the shape and specifics of the requirements.

## 3.1 High-level requirements

In the first place, high-level requirements of stockholders were presented and taken as foundation for composing the upcoming, more specific types of requirements. They can be sorted in four groups depending on perspective: editor, developer, customer and platform.

- Editor – "*easy to use, fast and reliable editing interface, as well as optimal access to and management of content of all types.*" [34]

- Developer – easy administered, flexible for proprietary development, integration friendly platform. Fit for continuous and agile development.

- Customer – significantly better content relevance, including personalized offerings and advices. Better customer engagement.

- Platform – high speed and top performance in load-times, security and integrity, compliance to international regulations. 24/7 availability and stability. Multi-site and multi-language management. Access rights management capability that enables flexible and easily administrated access rights model with monitoring and ability to integrate with Swedbank's internal identification methods.

## 3.2 Specific requirements

Specific requirements were described in a set of Swedbank's internal documents "Supplementary requirements", "Editor requirements" and a number of "Editor Use case" documents. Combined list of functional and non-functional requirements for the new system consists of over 150 items. The following list is a shortened version that keeps the most important and representative requirements, which fulfilment is possible to demonstrate in this study. [35][36]

### 3.2.1 Functionality

System shall have:

SEO capabilities – system includes OOTB functionality and mechanisms to semi- or automatically improve Search Engine ranking for every website that is founded on the platform;

Flexible access rights, user groups and roles management system – it must support following actions: set user access rights on site, page and content type level; create user groups and roles with common access rights;

Content versioning and rollback functionality – it must be possible to watch version history of a piece of content (i.e. page), view of the page in particular moment of time and rollback to chosen version;

Image cropping capabilities for different screen sizes;

Notifications on image or video usage license expiration;

Easy to navigate site structure overview;

Smart tracking of customer's experience and gathered data analysis capabilities;

System shall handle multiple websites – Swedbank Group includes over 70 websites working on current platform simultaneously, the new system must have same capabilities. In addition, Savings banks must be able to reuse parts of content from Swedbank website and change local- and bank-specific parts. Furthermore, it should be possible to have language versions of any website.

System shall provide content advanced publish and unpublish settings – system should enable particular date and time to be set.

System must allow easy and effective forms creation and management – forms are used for gathering information and data that is provided by customers.

System shall enable fast and easy campaign sites creation – small, interactive sites that are used to advertise Swedbank's products and services.

System must follow latest accessibility principles described in WCAG2.

### 3.2.2 Integrations

Integrations requirements are fairly spread and wide-scoped, since Swedbank's current WCMS utilizes a number of third-party web-services and has multiple integrations with other internal systems.

Main requirements for the new system is to support popular protocols and standards including JSON, XML, SOAP, LDAP, REST as well as APIs based on them. High number of OOTB seamless integrations with other systems or services is essential. As an example, support of third-party search engine is considered as an advantage.

### 3.2.3 Technical requirements

From technical perspective there are three main points that must be fulfilled by the platform:

- Support of SSO with the use of SAML2.0 – Swedbank is trying to optimize and unify the SSO approach;
- Support of Varnish;
- Strategic operating systems support – Microsoft Windows from editor-side and RedHat Linux from backend.

# 4 Vendors study

Based on described requirements a pre-study was conducted to identify and describe existing WCMS market leaders, as well as analyse their compliance.


Figure 4. Gartner Magic Quadrant for WCM, July 2015 [40]

Figure 4 shows WCMS market niche players, challengers, visionaries and leaders as of July 2015.

During this study, products of such leading vendors as: Acquia, Adobe, Episerver, HP, IBM, OpenText, Oracle, SDL, SiteCore and SiteVision, were assessed.

First round of assessment consisted of presentations made by every vendor's sales representative. During this part, vendor's interest as well as system's "look and feel" were rated.

Acquia with open source Drupal CMS was eliminated in the first round, since it is built with the use of PHP programming language, therefore its development requires PHP specialists. Swedbank's IT personnel does not include any experienced PHP developers. Another reason for the elimination was: slow answers from sales representatives. Vendor's official support is vastly important, so that unstable communication is not acceptable.

EpiServer was excluded due to being Microsoft dependent platform, while Swedbank's vision does not include .NET and Microsoft servers as strategic platforms. In addition, all questions regarding implementation and support were redirected to a third-party "partner" instead of direct communication with the vendor.

Main reason for skipping OpenText platform was Swedbank's doubt in the platform's perspectives, since OpenText acquired similar product from HP, which seems to have better functionality. Furthermore, vendor was described as "anonymous on swedish market", thus raising another concern. Also, demonstrated system's interface was rated as "not very intuitive".

Oracle was eliminated for the reasons that were described in chapter 2.4 – overall dissatisfaction with the platform's user interface; absence of innovative features in newer version; high number of interconnected products that require licenses and additional competency. Apparently, Oracle's new product called WebCenter Sites was obtained together with "FatWire" company acquisition. It raises feel of uncertainty about the system upgrade and its future in general. [42]

SiteVision was excluded since the product was considered as not mature in comparison to the other vendors; although it has large community, its main language is Swedish, which might be a blocker for developers from other countries; unclear support program and architectural problems in case of high number of sites.

After first round there were only five vendors left: Adobe, HP, IBM, SDL, SiteCore. Second round was conducted with the use of "Request For Information matrix".

"RFI matrix", which was used for the assessment, included over 200 questions or criteria that were introduced to every vendor. All questions were based on the refined list of requirements that was described in chapter 3.2. Some of the requirements were excluded from the list during refinement. Vendor's answer to every question had to consist of written part, describing the feature or the approach for solving the problem, and numeric grade from 0-4, which was used to rate solution existence, flexibility and ease of use.

Although, HP's product TeamSite was excluded, it had positive ranking overall, but the fact that the product itself was sold to OpenText company, thus also having unclear future – it is unpredictable which platform is going to become a flagship and which one is going to be discontinued. It also rises a concern that even in a case of merging both platforms into one product there might be licensing, maintenance and upgrade problems that Swedbank would face.

IBM's platform was eliminated due to the absence of functionality important for Swedbank, which is provided by most of the other reviewed vendors – no content changes history (instead IBM handles this problem by backup routines); no automatic notifications on image license expiration. Consultance services and offered training courses were also rated as "mediocre".

Despite the fact that SiteCore has taken second place, it was eliminated for the reason similarly to the EpiServer - .NET platform, which does not comply the Swedbank's strategy. Forthcoming internet bank integrations will be less time and resource consuming if all involved platforms are Java-based.

SDL was highly rated and introduced wide set of functionalities, judging by the information provided in RFI matrix, it had slightly lower rank in fulfilment of "publishing to multiple outlets" requirement, as well as absence OOTB "validity time" option for automatic notifications, even though it can be created and configured via "event system API". Another reason for not taking the leadership in second round of assessment is that demo- or test- environment of the solution was not provided on time.

As a result of the study, Swedbank's team picked platform supplied by Adobe as its target migration platform, since it had all requested functionality, editor-friendly interface, best product presentation and full compliance with Swedbank's strategy for IT paltforms.

# 5 Currently developed system

Adobe Experience Manager (formerly known as CQ5) – web content management system, provided by Adobe since 2010. AEM is designed mainly for large enterprises, since it grants many additional features, such as digital asset management, social collaboration, workflows, management of multiple internal and external websites, storing and managing vast amounts of data. [2]

AEM itself is being a part of Adobe Marketing Cloud - a wide-coverage set of marketing tools for personalizing, analytics, creating and spreading social content. Therefore, Adobe Experience Manager's functionality can be extended with additional integrations from Adobe Marketing Cloud, if enterprise is able to take an advantage of them.

Adobe Experience Manager platform is also used by such companies as Audi, McDonald's, Volkswagen, Mastercard and Royal Bank of Scotland. [3][4][5][9]

According to Adobe – "*Adobe Experience Manager is a web-based client-server system for building, managing and deploying commercial websites and related services. It combines a number of infrastructure-level and application-level functions into a single integrated package."* [8]

## 5.1 Features

There is a long list of features described by Adobe, but the most important ones based on the requirements for the new system are these:

- Multisite management – in AEM there is a set of tools, which allows authors to create multilingual sites, with the use of built-in translating **i18n** solution, use master-templates to provide single solution for all the sites and reuse as many assets as possible, and create microsites, when it is required. Overall principle is described as "*Global consistency and local flexibility*". [11]

- Business-friendly authoring – authoring process with accent made on drag-and-drop, which was further improved in AEM 6.1 with introduction of modern-looking Granite UI. [10]
- Asset Management – a limited set of tools is available for authors, which includes image size editing, renditions creation, version control. In addition, digital assets repository (DAM) allows assets distribution among sites or teams, as well as access-rights management.
- Experience platform – it was already mentioned, that AEM is a part of Adobe Marketing Cloud, which allows seamless integrations with other tools from this package. [10]
- Community – one of the most influential points is the community that spreads ideas, information and experience. In case of Adobe, the community is substantial, with many enthusiastic projects, annual conferences, Adobe online trainings, which are available not only for developers, but also for editors, designers and system administrators.
- Continuous delivery support – a good set of community development tools is available for the popular IDEs, such as Intellij IDEA and Eclipse. Maven project architecture and plugins for organizing automated application builds that can be extended even more with the use of automation servers, such as Jenkins.
- License cost is fixed – there is no dependency on the number of instances or users, therefore scalability is unlimited in sense of license cost.

Other advantage, compared to the Oracle Content Management, is regular update-scheme, since AEM is in the active phase of software maintenance. In example, when the Swedbank's development project started in first quarter of 2017 Adobe Experience Manager was of version 6.2. At the moment of writing two service packs were released for AEM 6.3 and current up-to-date version is 6.4. [19]

## 5.2 Technology stack

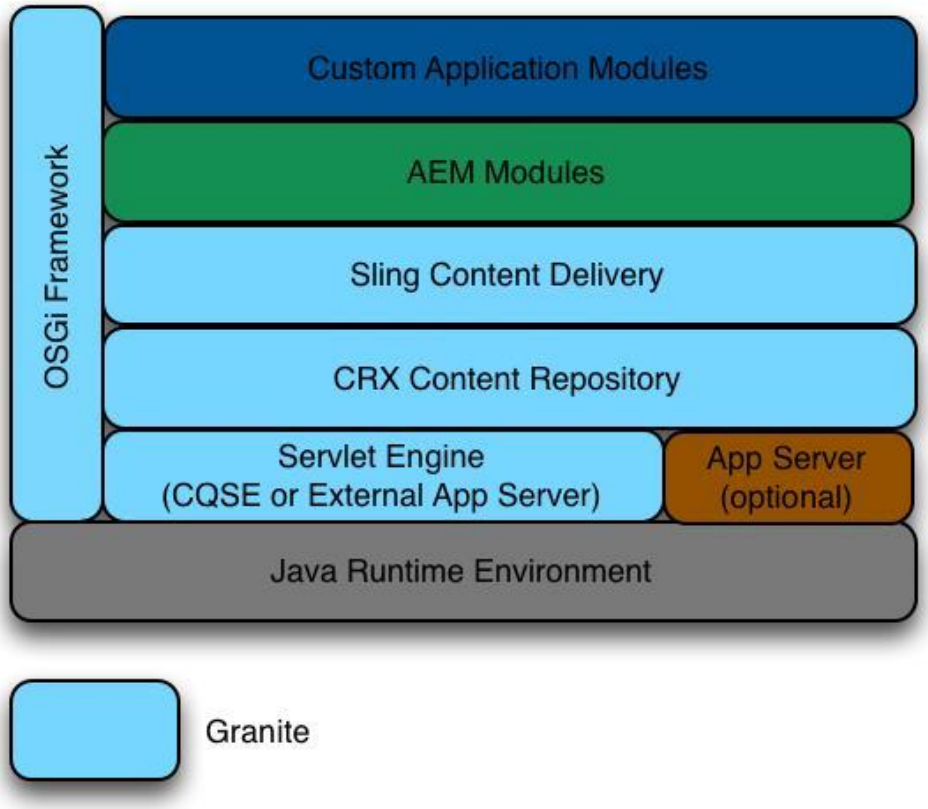


Figure 5. AEM technology stack [6]

As follows from diagram (Figure 5) Adobe Experience Manager consists of four main modules: Java Runtime Environment, Granite platform, AEM Modules and Custom Application Modules.

**Java Runtime Environment 1.8** – similarly to the WebCenter 10g, platform benefits from Java's multiplatform nature. System itself is built as a combination of Java Archives (JAR), servlets, plain java classes and java server pages (JSP). [6]

**Granite platform** is Adobe Experience Manager's core, which is built around two powerful Java frameworks - Open Service Gateway Initiative (OSGi) framework and and Sling Web application Framework, together with CRX Content Repository and CQ Servlet Engine. [6]

**OSGi framework** introduces a technology that enables the development approach where whole system is composed of many different reusable components. Components have no a-priori knowledge of each other.

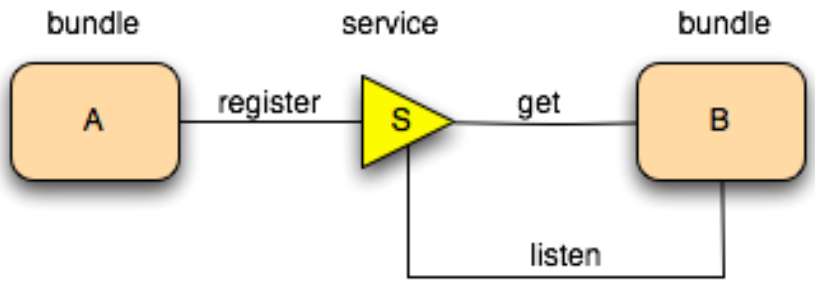


Figure 6. "Broker pattern" or bundle-service connection diagram [12]

Components of the system are held in bundles. Bundles are capable of registering, getting or listening to a service. Service is an object that is shared between components, that way hiding component's implementation and sharing only common interface to operate that component.

OSGi framework's API allows bundles to install, start, stop, and update other bundles. In this case, if the bundle is uninstalled, other bundles can instantly adapt to the change. Bundles running in the same environment can also use explicit imports and exports to share and reuse the code.

All these principles simplify development and deployment processes, potentially raise system up-time. Code becomes more manageable, API allows detecting bugs earlier and monitoring running components. [12]

**Sling –** Web framework designed to create applications on top of Java Content Repository (JCR). It utilizes OSGi framework's component model, fosters RESTful application design by allowing exposure of any content of the repository as HTTP resource. Sling introduces different URL decomposition approach, where every URL consists of resource path, selectors, extension, suffix and parameters. Thus, allowing Sling to decide how to render requested resource from the URL structure, and calling respective script. [14][15][16]

**Java Content Repository –** is an API, which standardize a way for accessing a content repository. JCR standard describes the object database type with hierarchical principle. [18]

Object database – is a database management system, which represents information as objects, instead of tables, which are used in relational database management systems (RDBMS).

JCR has number of advantages over RDBMS, such as: [21]

- Version control
- Inheritance
- Free structure
- Navigation
- Changeability

One of the JCR 2.0 API implementations is **Apache Jackrabbit –** an open source project developed by Apache Software Foundation.

**CRX (Content Repository Xtreme) –** commercial content repository developed by Day Software (acquired by Adobe in 2010) and used in the AEM, which is based on Apache Jackrabbit solution, but extends it and has different implementation of storage and persistence mechanisms. It has built-in user web-interface CRXde, which partly eliminates the need of additional development and works as administrator's tool, similarly to Oracle Site Studio Designer, that way saving on development and authoring costs. [17][20]

**CQ Servlet Engine –** AEM is delivered together with built-in standalone Jetty server and full support of Java Servlets API. Thus, it provides simplified "just run" approach, speeding up the development process, but at the same time keeps flexibility to be deployed in any third party server application. [6]

Additionally, in AEM 6.0 Adobe introduced new server-side language, that was called "Sightly" and then renamed to HTL in upcoming versions –

**HTML Template Language (HTL) –** server-side programming technology made by Adobe that takes place of JSP. Main advantages of HTL: simple syntax, support of JavaScript-Use and Java-Use APIs, ability to reuse JSP code. [13][22]

## 5.3 Architecture

In context of architectural solutions, Adobe has chosen prevalent approach of having separate servers for content creation and content distribution, but with some modifications.

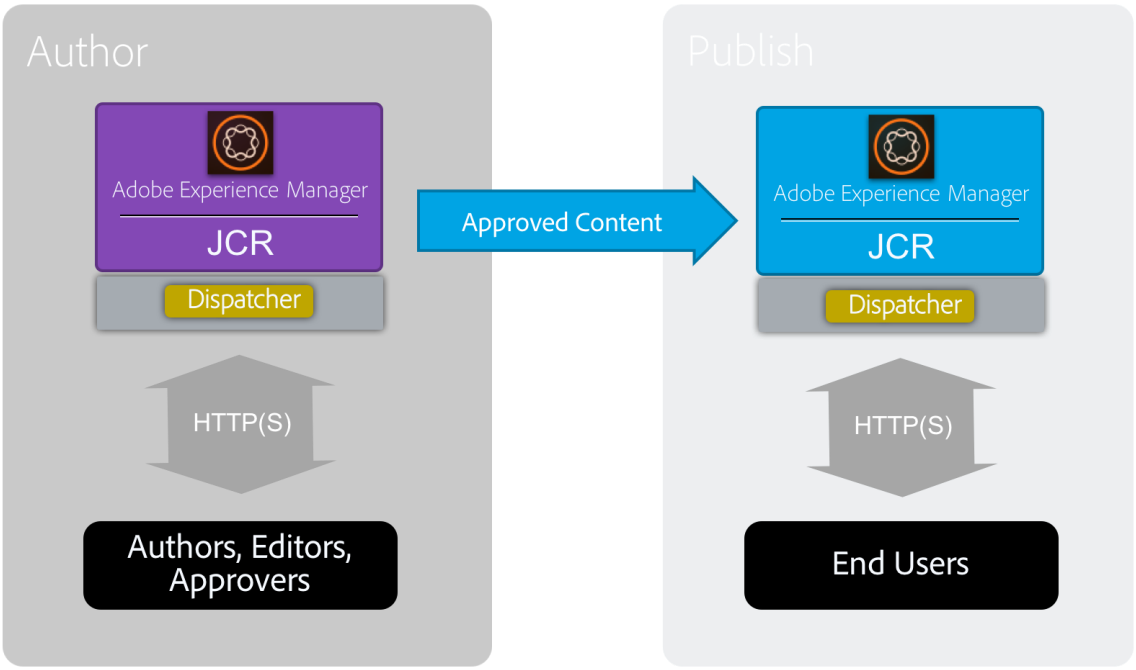


Figure 7. The AEM Architecture [7]

From Figure 7 it can be concluded that every system running on Adobe Experience Manager solution consists of three main parts:

**Author instance** – server with running copy of AEM configured to be used by authors, editors and approvers to create, update and publish content. Content publication is a process of replicating data to the linked publish instance(s). [8]

**Publish instance** – server with running copy of AEM configured to serve the published content to the end users.

Consequently, Author and Publish instances have the same AEM application running on both of them, but differ in configuration. [8]

**Dispatcher** – a static web server with the AEM dispatcher module installed on top of it. It caches web pages produced by single author or publish instance to improve performance by reducing the number of direct requests instance has to process.

Simplified AEM system architecture used in Swedbank is shown in figure below.

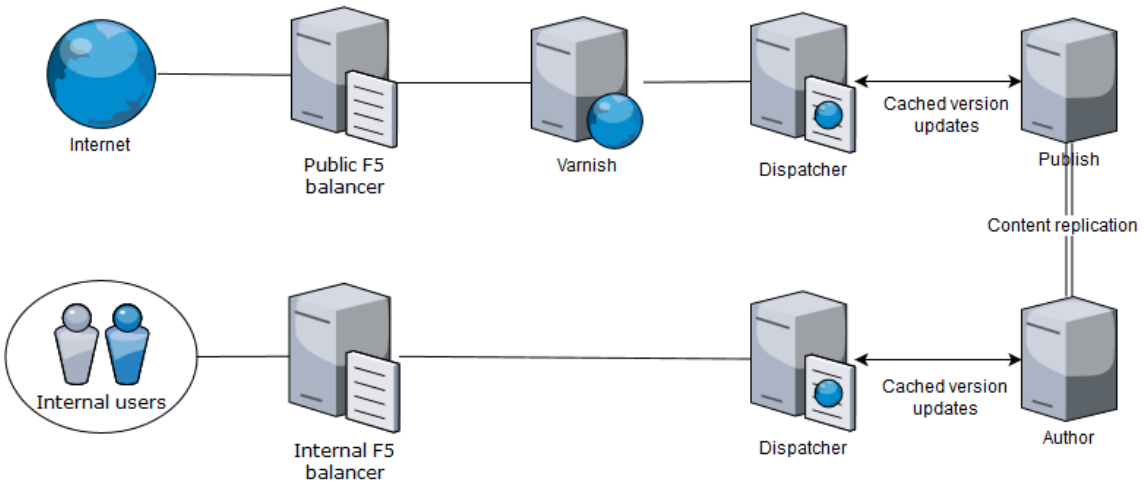


Figure 8. New system's basic infrastructure architecture diagram

As follows from diagram (Figure 8), architecture used in Swedbank follows best practices suggested by Adobe – dispatchers are used on both author and publish sites to reduce the load.

Moreover, Varnish accelerator is used in combination with dispatcher on publish side to increase system robustness. In addition, F5 load balancers are present on both author and publish sides to rise the capacity of concurrent users by spreading the traffic equally between multiple servers. Load balancers include health-checking scripts to support availability and switch over to another instance if one of the servers becomes unavailable.

When it comes to scalability and persistence strategies, there are two options supported by Adobe – Tar Microkernel and Mongo Mikrokernel (TarMK and MongoMK respectively).

TarMK is designed for performance, while MongoMK is used for scalability. It is important to notice that publish instances are scalable “de-facto”, although they are using TarMK. It is achieved by the fact that Author instance sends an updated content to every publish instance separately. Therefore, the choice of microkernel is valid only for author instances.

TarMK introduces three strategies:

- Single TarMK instance – default strategy that is easy to maintain. Disadvantages are evident: absence failover capacity and no scalability options beyond the limits of server capacity.

- TarMK Cold Standby – strategy involves two or more instances, that can be spread across multiple datacenters, with only one being active at a time (primary instance). Repository from primary instance is replicated to the standby failover instances. Drawbacks are: system scalability is still limited by server's own capacity, standby servers idle most of the time, absence of automatic failover, thus additional tools are required to detect failover scenario.

  Following diagram (Figure 9) represents TarMK Cold Standby principle.

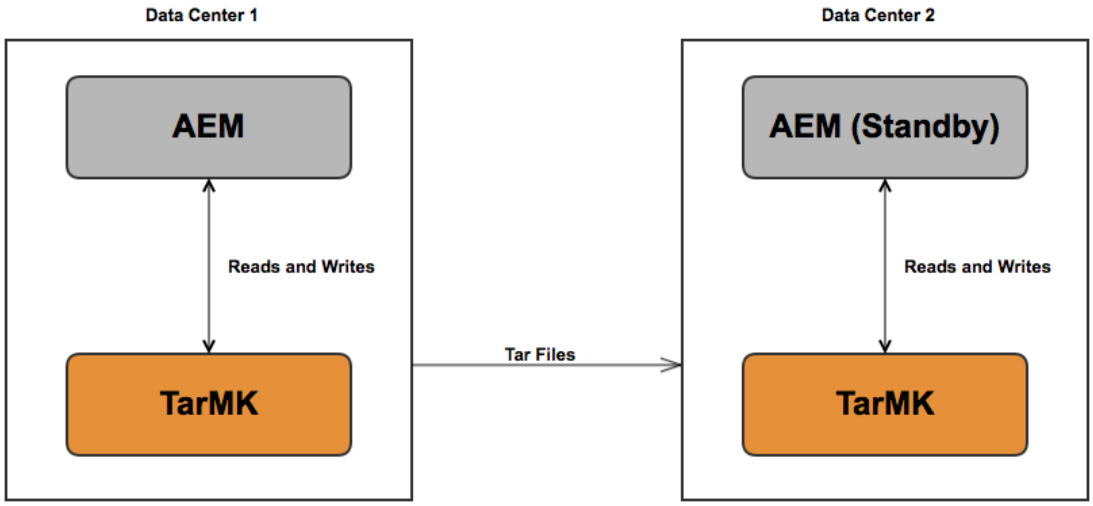


Figure 9. TarMK Cold Standby principle [41]

- TarMK Farm – default strategy for publish instances, multiple independent AEM instances with their own repositories, which have to be kept in sync. Not applicable to author instances.

MongoMK strategies include:

- MongoMK Failover for High Availability in a Single Datacenter – "This approach implies multiple Oak instances accessing a MongoDB replica set within a single

data center. Replica sets in MongoDB are used to provide high availability and redundancy in the event of a hardware or network failure.” [41]

Scheme below (Figure 10) displays MongoMK Failover for High Availability in a Single Datacenter strategy.

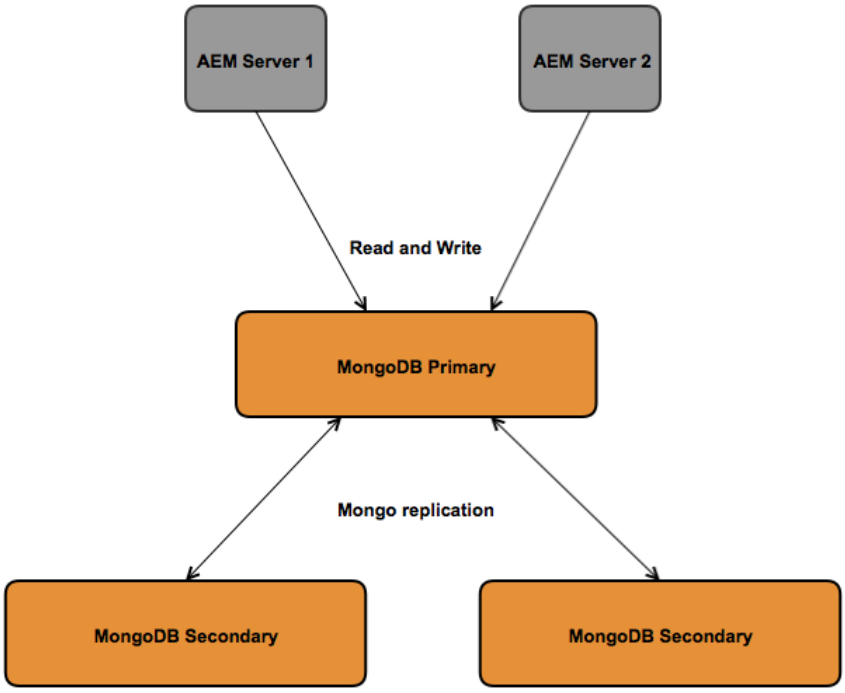


Figure 10. Oak Cluster with MongoMK Failover for High Availability in a Single Datacenter

- MongoMK Failover Across Multiple Datacenters – similar to the first option, except MongoDB replicas are located in multiple datacenters. Additionally to the features set provided by the first option, it also brings extra failover capacity on datacenter level.

In Swedbank it was decided to follow “TarMK Cold Standby“ strategy, since it is easier to maintain and does not require additional resources to implement Mongo Database. However, regular performance tests are conducted to find out if this solution is enough in regards to the number of concurrent editors working on the author instance. In case the performance is not satisfactory, first step will be to upgrade the hardware of the author server. If afterwards the productivity does not reach the sufficient levels, then “MongoMK Failover Across Multiple Datacenters” option is going to be evaluated.

# 6 Comparison

This part describes the benefits that are achieved with the migration to the new platform from business and developers points of view.

Adobe Experience Manager is a modern WCM platform that takes the advantage of open standards and technologies. It utilizes shared, open-source knowledge from Apache Software Foundation and combines it with Adobe's own vision of user experience and content management. Even though it has some drawbacks comparing to the Oracle's WCC platform, such as: not that flexible access rights management and absence of built-in file conversion functionality, AEM delivers considerable additional value for the business.

The most important aspect of new platform is the multi-site management capability. It allows dozens of websites to work simultaneously on the same platform, share components and reuse content one the sites. Principle of content inheritance via Live copies is used to deliver content for Savings banks. This allows Swedbank to maintain high governance, yet allow local flexibility. The process can be seen on the figure below (Figure 11).

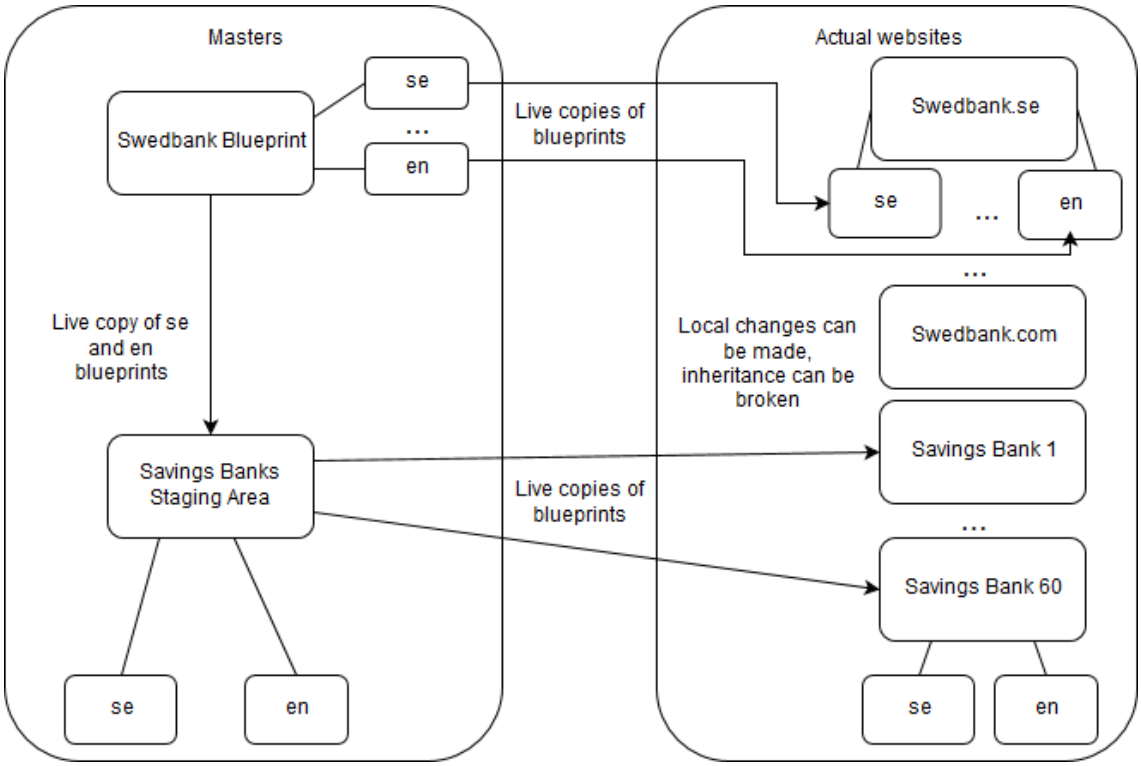


Figure 11. Multi-site management and content inheritance basic process diagram

Second major advantage of Adobe's platform is SEO capabilities that are achieved with multiple built-in tools and development approaches. In example, instead of using J2EE approach with Bin servlets, AEM brings Sling servlets with the idea of "selectors".

https://your-site.com/bin/my-app/product-servlet.xml?id=52

Can't be cached due to parameter's presence
Long
Less readable for user
Search Engine rating is very low

https://your-site.com/content/products.52.xml

Can be cached by Dispatcher
Shorter
Semantic value is higher
No additional link-shortening configurations required
Search Engine rating is higher

Figure 12. Advantages of Sling servlets over Bin servlets

As follows from diagram (Figure 12) Sling selectors save the SEO value of the link, readability and enable page caching on Dispatcher level.

Additionally, it is possible to apply URL rewriting with built-in service called Resource Resolver, thus shortening any link that follows specified pattern that way increasing its Search Engine Rating. [43] Following diagram (Figure 13) provides an overview of the result of applied Resource Resolver link rewriting.

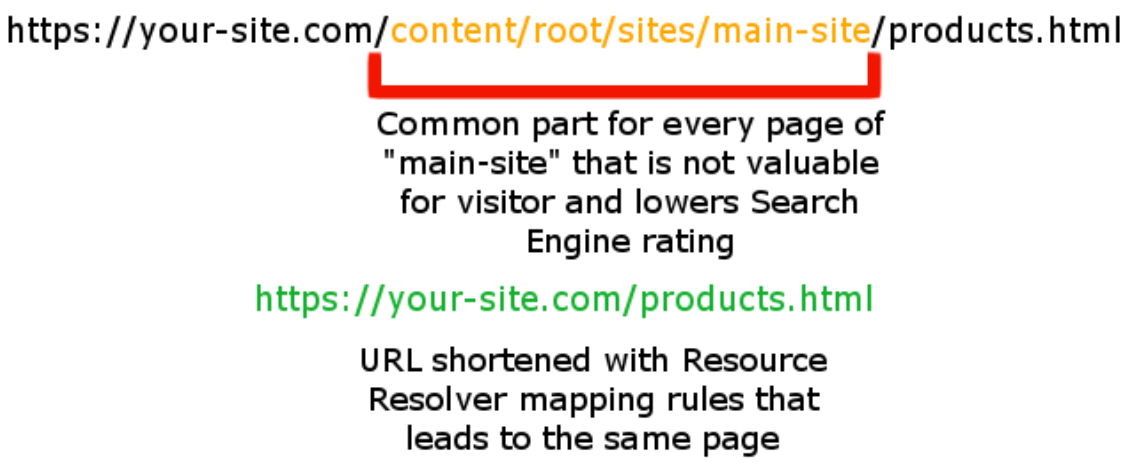


Figure 13. Appliance of resource resolver link mapping

Another way of shortening the link is to use “Vanity URL” - page parameter that can be set by editor and does not require IT interference. SEO is an essential topic for the modern web-commerce and marketing. AEM improves and unifies the approach for all the websites on the platform, thus raising competitiveness of Swedbank Group and providing clients with the more relevant information.

Although it was mentioned that access rights management is not that variable in AEM comparing to WCC, it is still flexible enough to fulfil the requirements. It allows creating user groups or “roles” with common access rights, as well as setting access rights on site, page or content type level. Figure 14 represents the process of repository request resolving, which takes in consideration privileges of the user from access control list. [44]

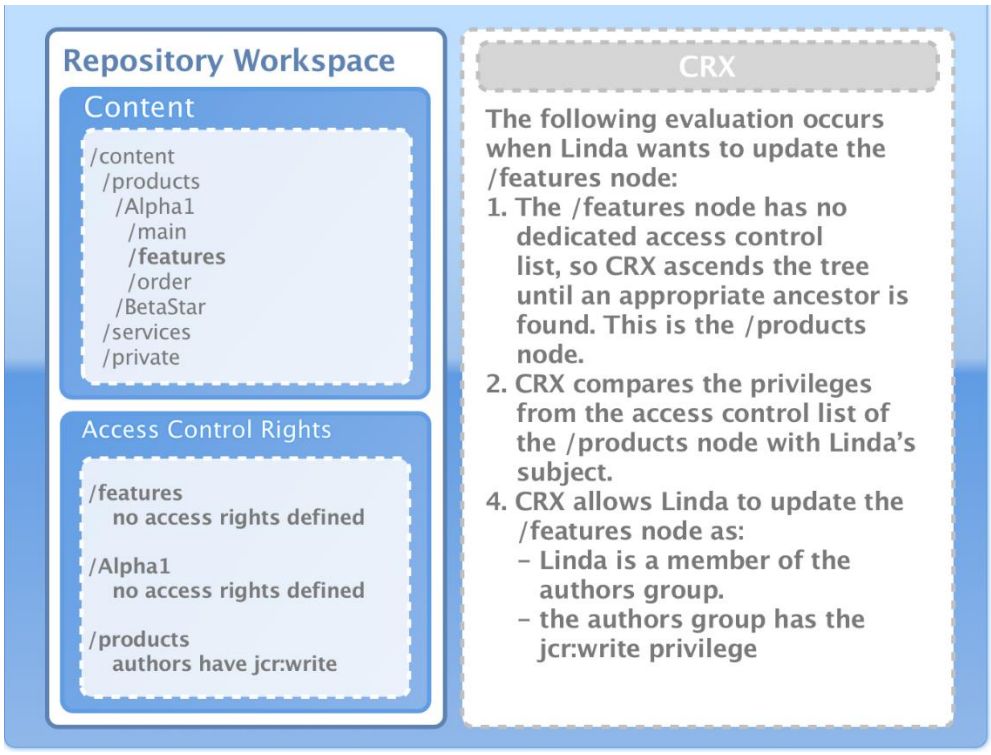


Figure 14. CRX repository "Resolving Request and Access Rights " principle [44]

In theory, access rights can be applied to any node in CRX repository, however it is not supported with existing access rights management interface – for instance, access rights cannot be set for certain dialog fields and components. Yet, it is achievable by manually adding and setting "jcr:read" property through CRX interface. However, in case existing access rights management will be considered as not providing the desired level of flexibility, it can also be tuned and customized with moderate amount of development.

One more serious problem that was mitigated by migration to AEM platform is the user interface. As it was mentioned in chapter 2.4, WCC "back-end interface" was causing worry and fatigue for the editors. AEM's interface is responsive, modern-looking and concentrates on drag-and-drop. During pre-study it was described as "likeable for a web editor".

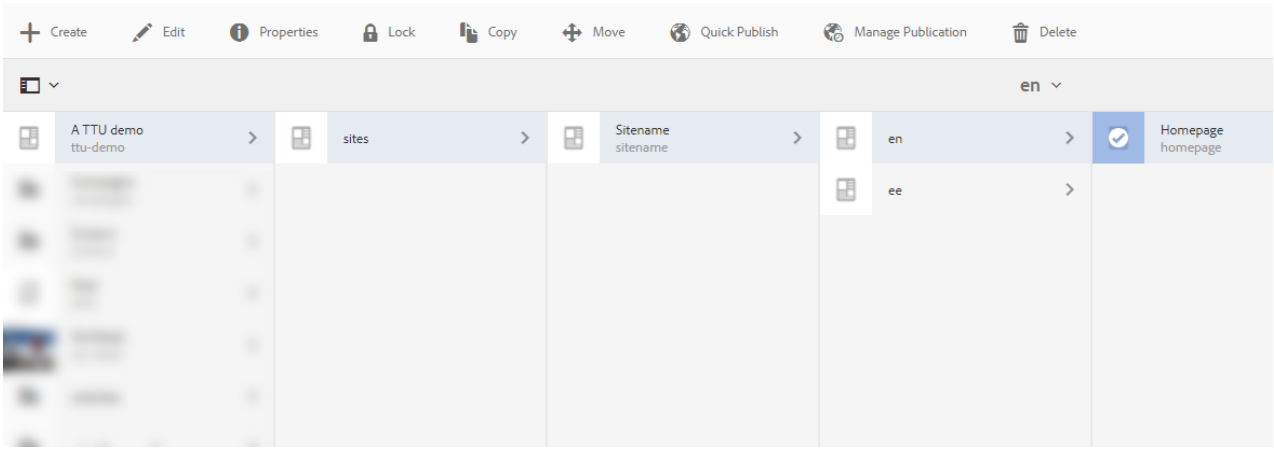


Figure 15. AEM user interface for site structure overview

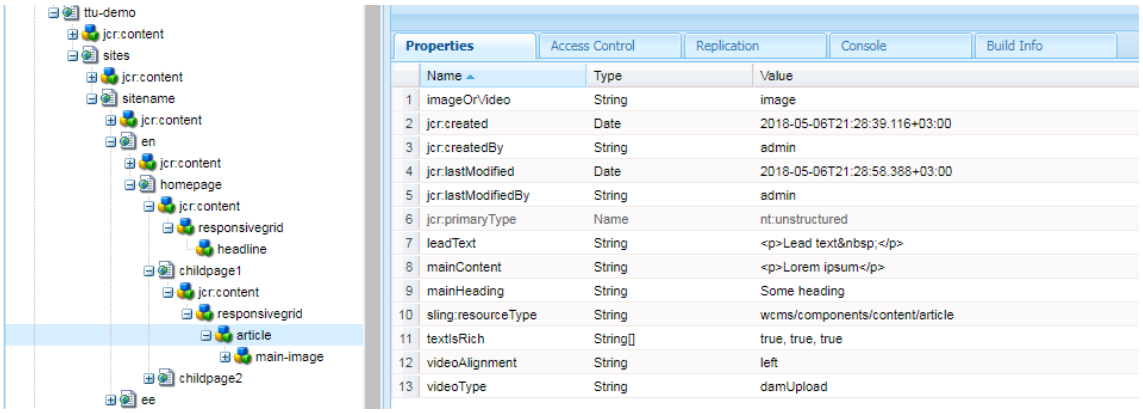


Figure 16. CRX user interface for detailed site structure and content structure overview

Part of the user interface is also demonstrated by these two figures (Figure 15, Figure 16) showing Site structure overview functionality. Site structure can be viewed in two ways – from standard UI that is easily navigable and from CRX repository, in case editor or administrator needs more detailed information and control. User interface is important part of every CMS, it is a tool of everyday use for an editor, therefore it has to be easy to use and navigate to avoid the same situation that happened in current WCC system. Editor-friendly interface lowers the number of mistakes, increases the speed of content management and raises the quality of delivered content, thus reducing costs and keeping the prestige of Swedbank.

Adobe also provides User support and special training courses to educate and raise competence of editors, administrators and developers.

WCC system provided decent content revisions tracking functionality hence new system has to keep the same level. In AEM content versioning and rollbacks is achieved with Timewarp function. It allows to preview, compare and revert to any existing page versions. Whereas page versions can be created either manually or automatically, for example, during page publishing workflow.

Swedbank is international enterprise with wide client-base, so it is crucial to follow latest accessibility standards, such as WCAG 2.0. *"AEM has been developed to maximize compliance with the WCAG"*. In addition, Adobe provides best practices and guidelines for developers that are working with AEM to keep the custom-developed components WCAG compliant. [45]

Another functionality that was requested is built-in cropping of images for the editors. AEM is delivered with basic images cropping available. Moreover, it can be seamlessly extended with the use of Dynamic Media integration. Although all sorts of official extensions increase the license costs, they get official support and updates, save development time and increase efficiency of editor's work. All these pluses also apply for the others other products from Adobe Marketing Cloud, which can be seamlessly integrated into AEM notably increasing its capabilities. For instance, Adobe Analytics integration allows advanced analytics and A/B testing to be conducted; Adobe Campaign provides dynamic, cross-channel and personalized campaigns ready for set up.

It is also worth noticing, that in comparison to WCC platform, AEM has better licensing strategy. In case of Oracle's platform, license cost bases on the number of CPUs used in every cluster of instances, therefore scalability costs sufficiently more. When it comes to AEM, license price is fixed and depends only on the number of additional products bought from Adobe Marketing Cloud. Benefits for Swedbank are obvious – unlimited scalability without a need in license updates.

From technical perspective, support of Swedbank's strategic platforms and standards is fundamental. AEM is completely compliant from operating systems point of view, since it runs on RedHat Linux and is accessible from Microsoft Windows based systems. SSO with SAML2.0 is also supported, therefore it is already set up and running in Swedbank. OOTB compatibility with Varnish, while having its own caching solution is another advantage of AEM. Overall compliance with Swedbank's strategy for IT platforms

development summarizes in lower maintenance costs, due to the lower number of software licenses and unrequired additional competence.

From developer's point of view, AEM has many positive traits. The amount of time needed to set up local environment is relatively small and mostly automatic. Support of Maven archetypes and Jenkins automation server plugin enables continuous delivery from the beginning of the project. There are extensions available for the popular IDE's such as IntelliJ IDEA and Eclipse, which speed up development drastically. AEM's and Apache Sling's communities are large enough to get answers for the most questions and share best practices. All of that combined allows increasing the development process speed and effectiveness, therefore having less bugs, faster fixes and organized continuous delivery.

Finally, system maintenance and administration has become less complicated, because of AEM platform's relatively high independence from the other departments of Swedbank and appliance of OSGi architecture, which enables high modularity and dynamic service upgrades without need in system reboots. For Swedbank it means reduced time to the market; higher stability, availability and control.

Summed up comparison results can be seen in Table 1.

# 7 Summary

Main objective of this study was to compare and analyse both systems, their functionality and technologies to find out the advantages of migration to AEM platform.

To achieve that, existing production system's documentation was studied and analysed. Oracle WCC based system was described in Chapter 2, together with its features, technology stack and architecture. Additionally, existing problems were clarified from analysis and internal documents, therefore justifying the necessity of the full migration.

Afterwards, requirements for the new system were gathered from internal documents and summed up to explain the criterias used for the Vendor's study described in Chapter 4. From the vendor's study documents, it was clarified that AEM platform was chosen due to presence of all required functionality, user-friendly interface, support of Swedbank's strategic platforms and best vendor's presentation.

In Chapter 5, Adobe Experience Manager platform and its features, technology stack and architecture was described in order to have a basement for comparison.

The most important part – Comparison, combines information provided in previous parts, describes the advantages of AEM platform in comparison to the Oracle's WCC, brings the examples of functionality, which delivers the additional value for Swedbank. In this part, it can be seen that AEM has noticeably wider capabilities, higher maintainability and lower costs. It is clear that AEM mitigates most of the problems that existed on the old platform. Results of this comparison and the platform analysis can be used in the other Swedbank departments that utilize CMS that bases on Oracle WebCenter solutions.

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# Appendix 1 – Side-by-side system comparison table

| Aspect | Oracle WebCenter Content 10g | Adobe Experience Manager 6.3 | Benefits from migration to AEM |
|---|---|---|---|
| Software lifecycle status | Discontinued in December 2015 | Version 6.3 is supported until 2022.<br>Update to 6.4 is available. | Official support, updates trainings are available. |
| Back-end language | Java 1.6 | Java 1.8 | More libraries, up-to-date codebase, raises system stability and support |
| Additional domain-specific / script languages | iDoc script | HTL | HTL is easier to read, maintain and use. Although it does not have that wide functionality as iDoc, its purpose is to dynamically provide access to Java objects in HTML. |
| Base frameworks | Oracle Application Development Framework | OSGi framework,<br>Sling framework | OSGi: Modularity, updates without reboot, reusable parts.<br><br>Sling: easy creation of different views of the same content, utilization of content in the code, Sling Servlets, selectors. |

| | | | |
|---|---|---|---|
| | | | Overall: system flexibility, faster updates, higher system stability |
| Product suite | WebCenter 10g, MiddleWare Fusion 10g | Adobe Marketing Cloud | Wide range of modern marketing and analysis tools. Official support. Higher content relevance for customers. |
| Content storage | Network Attached Storage + metadata stored in Oracle RAC | All data stored in native CRX content repository | Content and metadata is viewed as an organic whole. Faster development. |
| Authors scalability | Unlimited | Requires MongoDB integration | None |
| Publish scalability | Unlimited | Unlimited | None |
| Caching | No OOTB solution | Dispatcher module | Less competence required, easier to configure than Varnish. Potentially less dependencies from other departments. |
| Development Tooling | Oracle JDeveloper | Extensions for IDEs and continuous integration tools | No additional tools required, common IDEs can be used, faster continuous integration process setup. Faster development, faster updates, reduced time to market. |
| License costs | 100 000 $ per CPU used by system clusters, annually | Fixed price.<br>250 000$ - 1 000 000$ | System scalability is not limited by license budget. No need to renew the |

| | | | |
|---|---|---|---|
| | | depending on required features, annually | contract in case more hardware was added. |
| System dependencies | Database, network attached storage, Inbound Refinery | None (in case authors scalability is not needed) | Lower system maintenance costs, less dependencies on other departments, faster incidents resolution. |
| Additional software for administrative and editing purposes | Site Studio Designer | Not required, everything is accessible through Web-interface | Fewer dependencies on operating system. |
| Built-in file conversion tools | Inbound Refinery with plugins is able to convert:<br><br>Files to PDF (PDF Converter needs the native applications to perform the conversion)<br><br>XML and HTML converters. | Built-in PS-to-PDF, EPS-to-PDF, PRN-to-PDF, Image-to-PDF converter.<br><br>AEM Forms product adds documents conversion functionality, but also requires native application to perform the conversion. | None |
| Image renditions and cropping | Image thumbnails and renditions in PNG, GIF, JPEG formats.<br><br>Automatic rendition sets generation that can be used by editors. | Automatic image renditions creation for system-use only (mobile view, icons).<br><br>Built-in cropping tool for manual cropping.<br><br>Advanced automatic cropping with Dynamic Content paid integration. | Built-in cropping tool for editors and potentially extendable automatic cropping functionality. |

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|---|---|---|---|
| User interface | WYSIWYG principle in editor interface. | WYSIWYG principle in editor interface. Concentrates on drag and drop. Responsive. Modern looking. | Lower interface complexity. Editor-friendly. Therefore, reduces the number of mistakes. |
| Multi-site management functionality | None | Live copies, content inheritance. | Capability to setup high number of websites. Swedbank is able to share content with Savings banks. Easier to maintain and govern. |
| SEO enhancing functionality | None | Link rewriting, Vanity URLs, Sling servlets, selectors | Higher information relevance for customer. Improved competitiveness. |

Table 1. Systems side-by-side comparison table