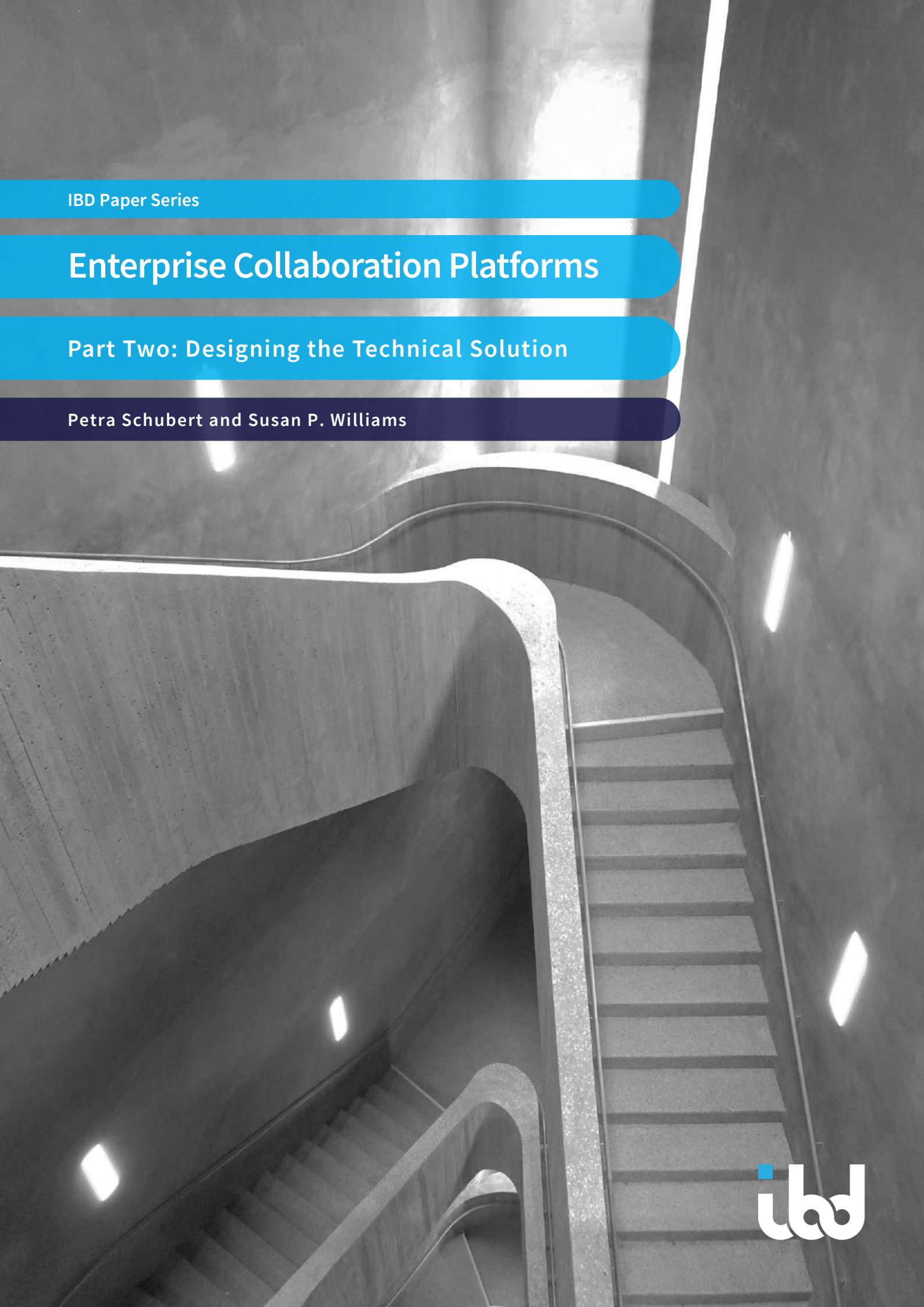

IBD Paper Series

Enterprise Collaboration Platforms

Part Two: Designing the Technical Solution

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Executive Summary

Driven by the COVID-19 pandemic, organisations worldwide were forced to quickly implement collaboration software to provide the necessary digital support to enable employees to work remotely. Many of the resulting 'quick-fix' solutions for Enterprise Collaboration are patchworks of tools that may not provide a viable solution in the long run and will need to be redesigned. In this paper, we provide a framework for the structured thinking about the technical design of future-oriented Enterprise Collaboration Platforms.

The market for collaboration software is not clearly structured and empirical studies show that the need to make collaboration tools available swiftly has resulted in heterogeneous software portfolios in organisations. As a consequence, employees are confronted with a proliferation of collaboration functionality, that is scattered among different software systems, often with high levels of redundancy. The end-user is frequently required to play the role of the 'integration point' by using their own best efforts to select appropriate tools from the growing portfolio of tools available. This means that organisations are not making the most of their digital information assets and that they miss out on the increased awareness about organisational activity that an integrated system could natively provide. Further, the burden of articulation work, the work that needs to be done to organise the digitally supported work, has significantly increased.

For more than 40 years, IT departments have focused on the implementation of operational information systems for Enterprise Resource Planning (ERP). Socially-enabled Enterprise Collaboration Systems (ECS) have only existed for a little over 10 years and are still evolving. Currently, no fully integrated solution exists that covers the whole range of Enterprise Collaboration requirements; this has led to the emergence of heterogeneous collaboration software portfolios in user organisations. The resulting challenge for IT Managers is to unite a plethora of different full stack applications to create a uniform user experience and to avoid information silos.

This paper is the second in a series of papers and reports based on our research and consulting experiences that examine the design of the digital workplace and the effective use of collaboration technologies to support collaborative work and workgroups in organisations.

The paper is published in two parts. In Part One (Understanding Collaborative Work) we provided a structure for thinking about an organisation's collaborative working and collaboration software requirements and presented insights about the provision of an enterprise collaboration platform. In this paper, Part Two (Designing the Technical Solution), we build on these insights based on our work with user organisations and provide a structured overview for building the technology solution for a performant Enterprise Collaboration Platform (ECP).

Target audience

The two papers address different target audiences. The first addresses primarily Senior and Middle Managers, the people who lead the teams that use the technology for their joint work and who need to ensure that their team members have the necessary tools, technologies and skills for work in the digital environment. The second is targeted at IT Managers, the people responsible for building the infrastructure that supports Enterprise Collaboration and delivering a performant enterprise-wide collaboration solution for their organisation.

Key Take-Aways

Enterprise Collaboration Platforms provide the necessary digital infrastructure to support collaborative working and provide organisational competitiveness.

Building an Enterprise Collaboration Platform is a task for both, IT managers and end-users. It requires provision of the right infrastructure to support work as well as strategies and actions to ensure user engagement and the effective use of the platform.

Long-term benefits will only arise from integrated platforms. Enterprise Collaboration Systems (ECS) are the ideal core component for the essential organisational and technical integration.

User-generated content is a big asset and its value grows over time. It must be carefully managed to ensure it is available and accessible over the long-term. ECS provide ideal containers to build valuable repositories of organisational information.

Awareness is a key aspect of collaboration. An integrated ECP provides the means to feel the pulse of a company, to reveal ideas and inspiration and to push information to the right recipients, often leading to serendipitous moments.

ECP need to provide mechanisms for efficient articulation work and support for coordinative activities around appointments, rooms, agendas, content structures, tasks and sequencing of work.

IT Operations determine software selection. The decision to select a software product has become inseparable from its operational model. Cloud services are the delivery model of the future.

Key challenges for successful Enterprise Collaboration

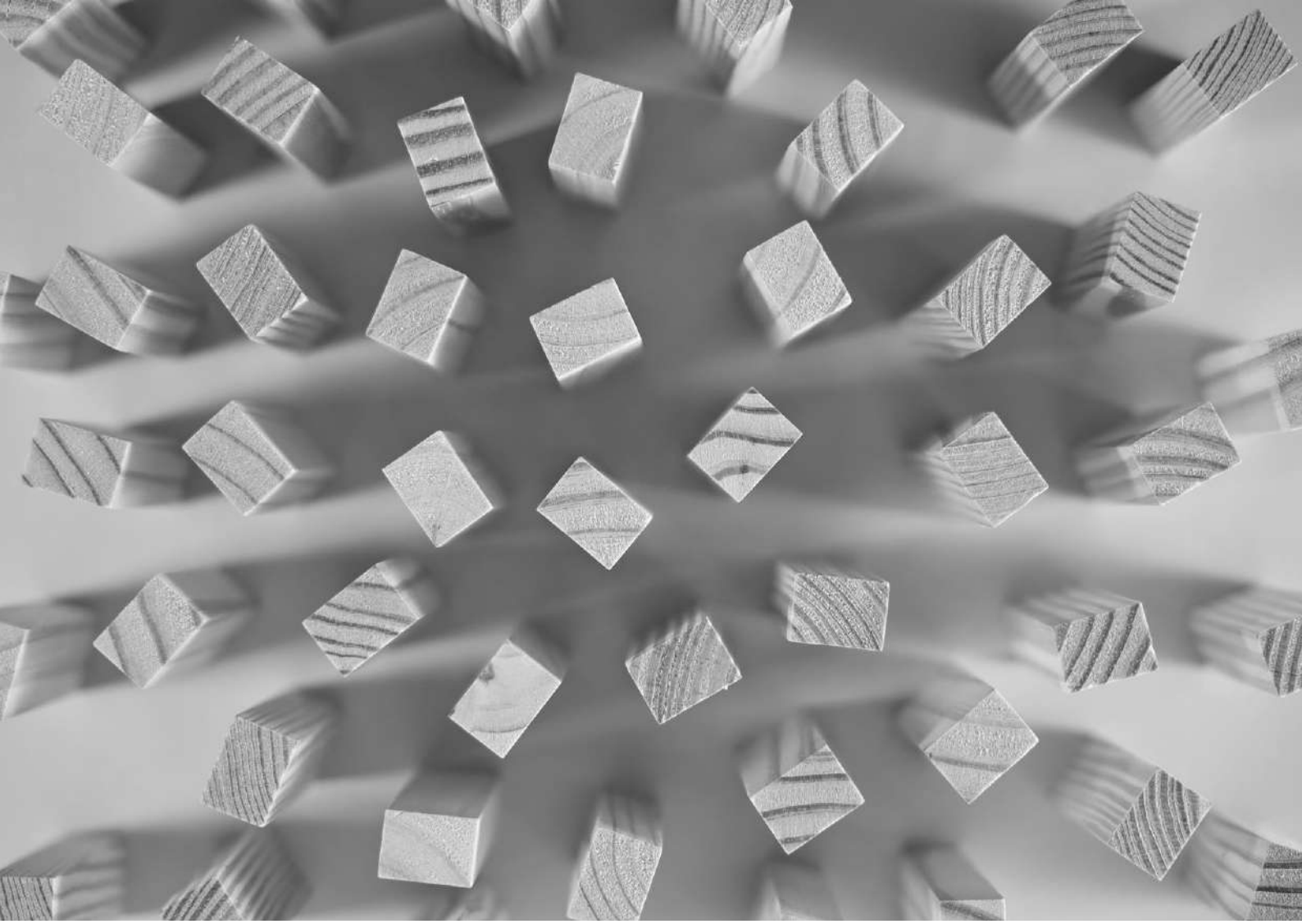
A portfolio of scattered and heterogeneous collaboration software leads to the following problems:

Tool fragmentation

Providing a multitude of full-stack applications leads to tool fragmentation and resulting inefficiencies in the use of multiple user accounts. Each independent tool comes with its own user registry and, if no technical solution for organisation-wide central user management exists, it requires users to manage a multitude of different usernames and passwords. There is also additional effort required to understand the functionality of each tool, how to use it most effectively and to coordinate and make choices between tools due to redundant functionality.

Content fragementation

The second challenge relates to content fragmentation. The content being generated and stored in collaboration tools has important business value and is a source of organisational knowledge. Having a wide variety of collaboration tools can result in silos of information, each locked away in the databases of a different software product; requiring additional effort to combine or connect information and make it available in a consistent and usable form.



Enterprise Software Landscape

The digital support for the new way of distributed work requires a performant Enterprise Software Landscape. In most organisations this landscape contains hundreds of different software products.

The most prominent larger systems can be categorised into process-oriented systems (operational systems for ERP and PPS), document-oriented systems (CMS, WCMS, DXS, DRMS) and collaboration-oriented systems (ECS). Business Process Management Software is used to orchestrate these systems along the main business processes (see Figure 1).

Process-oriented ERP Systems have been developed and optimised as integrated solutions for more than 30 years. Socially-enabled Enterprise Collaboration Systems, however, have only been around for a little over 10 years and are still in their forming phase. As of today, there is no fully-comprehensive, integrated system for Enterprise Collaboration that supports the complete array of collaborative work.

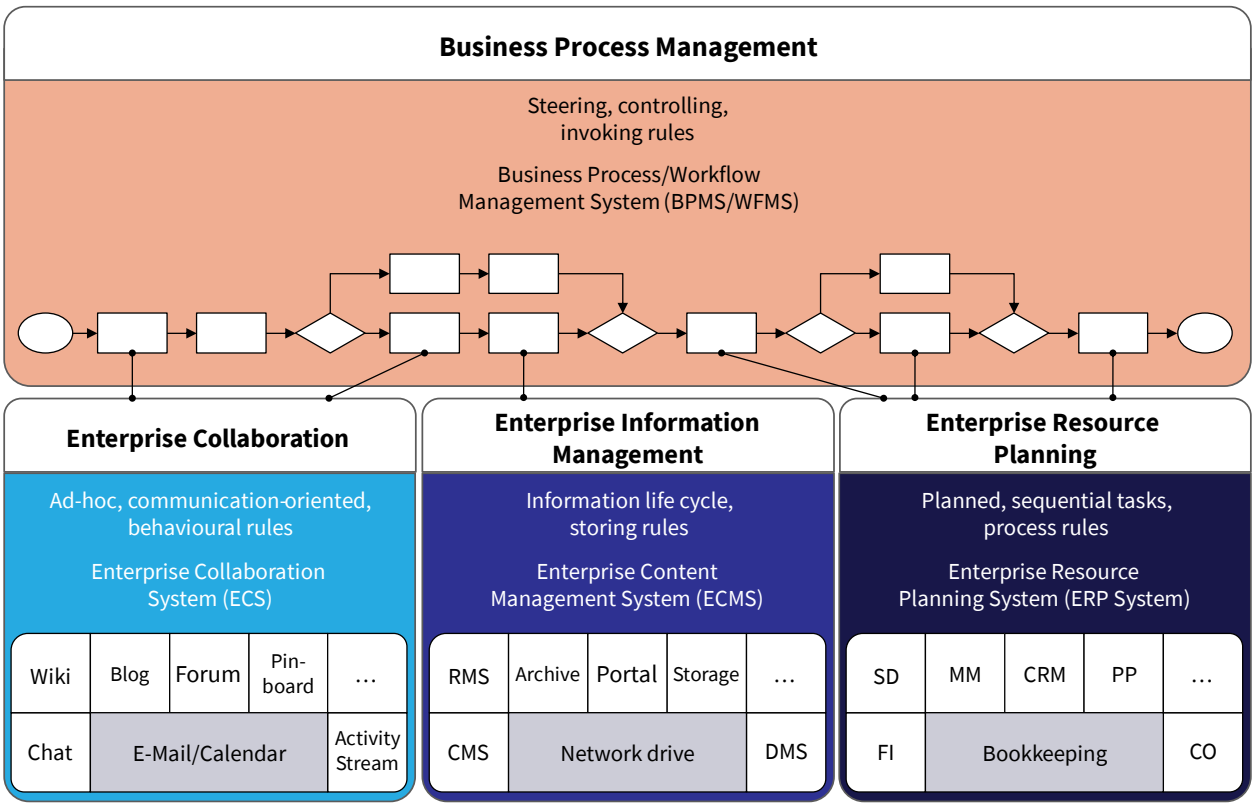


Figure 1: Different types of Enterprise Software

This has forced organisations to work with heterogeneous portfolios comprising a multitude of different software products from different vendors.

Providing the Infrastructure for Enterprise Collaboration

The market for commercial collaboration software is extensive, ranging from small tools with highly specialised functionality to complex Enterprise Collaboration Systems (ECS), which provide functionality in multiple collaboration areas (e. g. spaces with a forum, blog, microblog, wiki and tasks). Most organisations provide a variety of software products from different software vendors to their employees. These software solutions are mostly full-stack applications that come with their own user frontend, user directory and database(s). As a consequence, the people responsible for setting up a digital environment for the support of a group (e. g. the manager of a project team or an organisational entity) need to manually create (and update) identical member lists for every independent tool used by this group. As an example, a project team could decide to use (1) Slack for chatting, (2) WhatsApp (=shadow IT) for short messages, (3) a Confluence Wiki, (4) SharePoint as their file container and (5) GitLab to manage their tasks. This would mean that the workspace manager, the person in charge of organising the digital support for this group, would need to create the same member list in five different software products. Additionally, every group member would have to use a separate account for all five products with potentially five different passwords and would have to login five times if they use all products in a day. To make the scenario worse, some of the content produced by this group (i. e. in Slack and WhatsApp) would be stored on servers outside the organisation that are operated and owned by Social Media companies. Confluence, SharePoint and GitLab have their own user registries but these products have the potential to be integrated with a central directory server.

Imperative: This scenario shows that user organisations need to purposefully design their collaboration infrastructure to prevent time wasted on tedious management of user accounts, edits of passwords and member lists, repeated logins and potential loss of valuable content. A performant solution must integrate the portfolio of collaboration software in an Enterprise Collaboration Platform (ECP) that addresses the challenges identified above. We describe the components and the architecture of such an ECP in the following sections.

Enterprise Collaboration Platform

In this section, we turn our attention to the design of the infrastructure for the digital support of joint work: The Enterprise Collaboration Platform.

To facilitate the classification of collaboration software, we have developed a software typology ranging from lightweight tools to large-scale integrated Enterprise Collaboration Systems (**Table 1**).

A recent study[1,2] of 23 leading user organisations showed more than 50 different software products in use, which points to high redundancy in tools supporting the same kind of functionality.

Type	Symbol	Description
Enterprise Collaboration Systems (ECS)		A purposefully developed selection of applications/tools that are fully integrated and are provided to the user in a workspace under a uniform interface (e. g. HCL Connections).
Collaboration Suite		Bundle of applications/tools (often under a joint license) that can be used independently. They provide a certain degree of technical integration because they have been designed to work together (e. g. the collaboration suites by Google, Atlassian and Microsoft).
Application		Standalone software product with a range of collaboration features (e. g. TeamViewer with screen sharing, video conference and file transfer).
Tool		Lightweight desktop or mobile software/plug-in/functionality with a central focus on one feature (e. g. chat in WhatsApp). High focus on one/few features.

Table 1: Typology of collaboration software

The building blocks of an Enterprise Collaboration Platform

Enterprise Collaboration Platform (ECP) is the term used for the integrated technology portfolio that user organisations build to provide their employees with the necessary digital support for joint work. An ECP provides the functionality for communication, the creation and exchange of information, cooperative work as well as the coordination of work activities.

The idea behind a software platform is that it provides an environment with basic functionality that can be flexibly extended with plug-and-play components that are deployable on the platform. However, this concept does not work with collaboration software that comes with its own (redundant and inseparable) user management.

As a consequence, many of the integration issues in collaboration environments must be solved manually by the users which leads to acceptance problems and prevents smooth user adoption. Signs of this situation are multiple user accounts for different systems and the need to manually copy content from one system to another not to mention dealing with heterogenous user interfaces and redundant functionality.

A typical example is an organisational group (e. g. a project team) that is using a workspace to asynchronously discuss and work on documents and, in addition, is using an independent chat tool that comes with its own (and thus different) user registry. This requires the group members to login twice and to copy important information from the chat into the wiki or task component of the basic workspace in order to preserve it.

Enterprise Collaboration Platforms are built to address the problems of technical integration and they provide an environment with known APIs and a central user directory.

A well-designed Enterprise Collaboration Platform provides user and content integration

The ECP can be used for the integration of software products from different providers as long as they abide by the platform's integration mechanisms. The concept of a platform addresses the two challenges introduced above: tool and content fragmentation, by providing a central user directory (thus achieving user integration) and preventing distributed information silos (thus ensuring content integration). We discuss the building blocks of an ECP in more detail in the next sections.

Components for Integation: Identity and Access Management (IAM)

There are two important components for successful user integration: the Enterprise-Wide User Directory and the Enterprise Social Network (ESN).

1 The Enterprise-Wide User Directory is a technical component and concerns the unique user account that makes single-sign-on to all the software on the platform possible. The management of the central user directory is a key responsibility of the IT department of a user organisation. The central user directory is maintained in the Enterprise-Wide Directory Service, the functional component in which all users that are eligible to use the IT resources of the user organisation are registered. These include staff members as well as external partners who need access to selected resources.

The integration of applications into a platform needs to be explicitly managed as it is seldom a plug-and-play process. In order to work as a stand-alone application, every collaboration software is equipped with its own functionality of user management. The information about users and groups that are authorised to access user-specific functionality and data in this software resides in the user registry of that application (internal directory). The problem with multiple heterogenous applications is that they require Federated Identity Management so that the user does not have to login to all the different applications separately. In order to allow Single-Sign-On (SSO), each involved software product requires the capability to connect to an external user directory (e.g. an LDAP directory). A common solution for this is SAML (Security Assertion Markup Language), an open-source XML Framework (developed by OASIS), that enables the exchange of authentication and authorisation information. In this setup, the central user directory (e.g. Active Directory, Domino LDAP or any other LDAP directory) acts as the identity provider.

The software to build Enterprise-Wide Directory Services is called Identity Management Software. Such software solutions can be operated on premises or procured as a cloud service. Identity Management is a feasible solution for most of the applications officially provided by the IT department of the user organisation but it has its limitations when it comes to shadow IT that is provided by Social Media providers (e.g. Slack, LinkedIn, WhatsApp).

Heterogeneous collaboration tools need Identity and Access Management

The design of an Enterprise Collaboration Platform and the resulting user experience is substantially influenced by the degree of integration that the IT department provides. A purposefully built platform should offer a high degree of integration and a platform-wide SSO. Enterprise Collaboration Platforms are designed for and shaped by people. There are two important functional blocks that form the basis of the platform. The first is the technical aspect of the

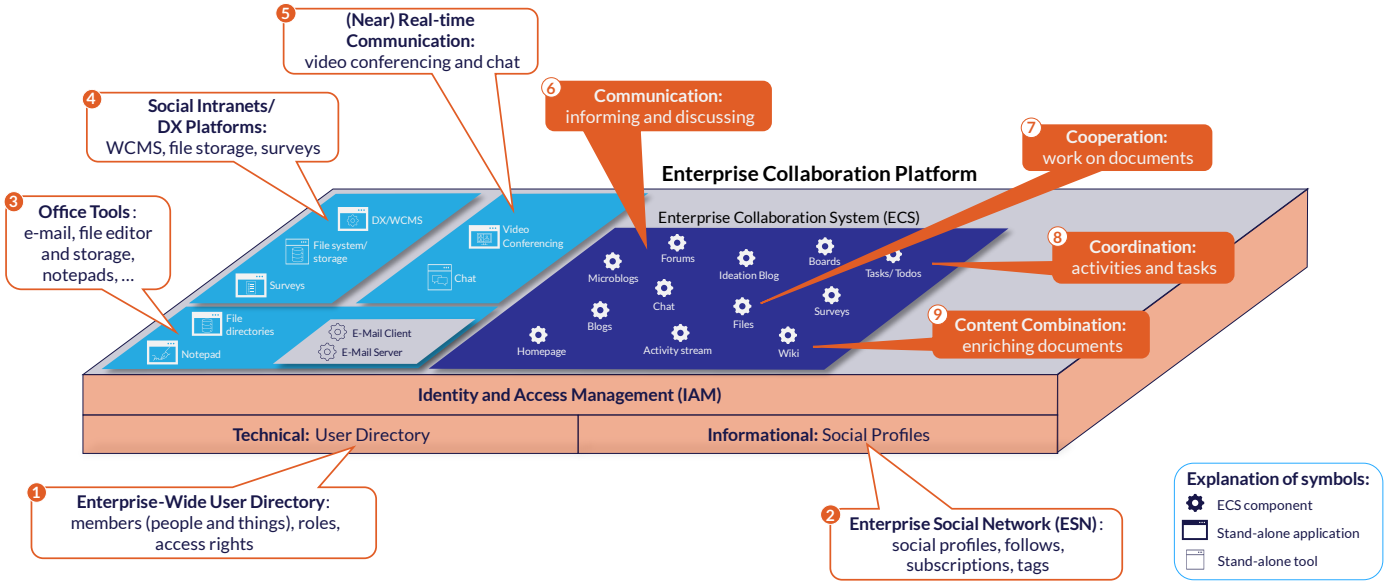


Figure 2: Architecture of an Enterprise Collaboration Platform (ECP)

Central User Directory containing the people who can access the platform as described above.

❷ The second founding block is informational and is about knowing who these people are and how they are socially connected. This informational aspect is nowadays implemented with the help of software that can be used to build an Enterprise Social Network (ESN). The ESN addresses the need to know the background of a person (area of expertise) in order to identify experts (name of person, room, contact info, experience, expertise, role, links, etc.) and view their contributions. An Enterprise Social Network is a concept describing the relationships between the users of an Enterprise Collaboration Platform that emerges through user activity and content creation. Customers, suppliers and other business partners can be included in this network. Technically speaking, the ESN is a graph structure that consists of 'social profiles' (nodes) and their relationships (links between the nodes) that are created through the social interactions of people (e.g. follow, subscribe, link, like, @mention, tag). The social profiles contain information about the members of the ESN and provide important background information about the authors of content and their levels of expertise.

Areas of work supported by the Enterprise Collaboration Platform

The wide range of functionality for collaboration can be classified into different areas described in the following paragraphs.

❸ Office tools help individuals create digital content (texts, slides, worksheets, graphics, databases, charts, videos, music, …). The majority of this content is first created within individual desktop environments and only later 'becomes social' when it is uploaded or copied into collaboration software. E-Mail messages are also contained in this area as they are created and stored in the personal space of a user and not in a shared space. Content that is natively created in Social Software, on the other hand, is 'born social'[3].

❹ Social Intranet and Digital eXperience Platform (DXP) are terms used for software that has a focus on building the organisational homepage and the joint information space. This software type is used to build 'Portals' or '(Social) Intranets' that contain an overview of relevant information and tools for the employees. According to Gartner, a Digital eXperience Platform (DXP) is 'an integrated set of technologies, based on a common platform, that provides a broad range of audiences with consistent, secure and personalized access to information and applications across many digital touchpoints.' Further, 'DXP are used to combine the applications that contain content and to provide search and navigation, personalization, integration and aggregation, collaboration, workflow, analytics, mobile and multichannel support'[5].

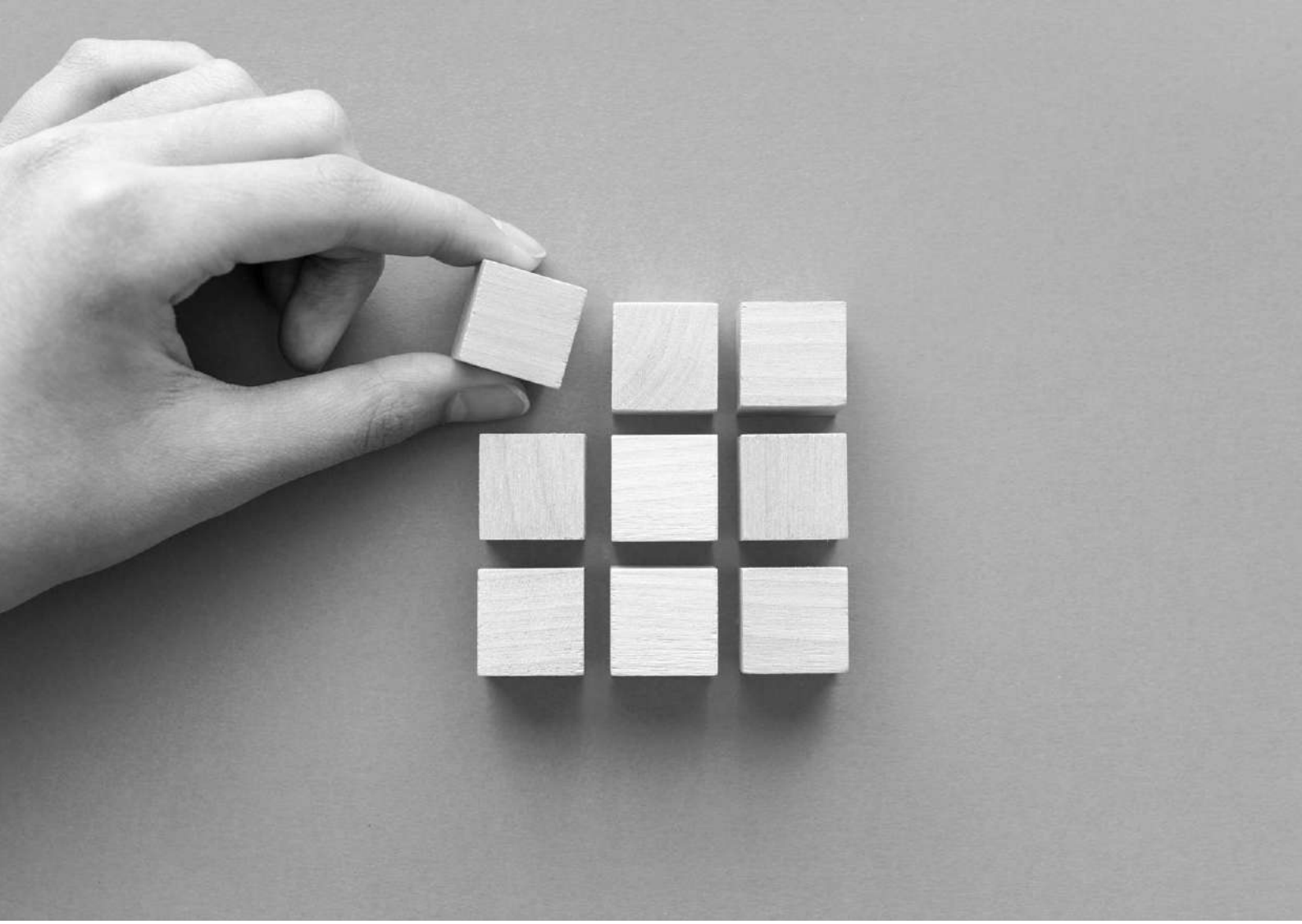
A Social Intranet is an Intranet with social features. The names Enterprise Social Network and Social Intranet were coined in close connection with Social Business[4], in the time when Enterprise Social Software was first introduced into organisations as a direct result of the success of social functionality in Social Media. These two software types have similar functionality but differ in their primary objective. Both provide 'social features' (e.g. social profile, link, follow, like, tag, post, comment) but the ESN has a focus on people with the aim of establishing links between people to build an organisational network structure whilst the Social Intranet has a focus on content to jointly create and increase awareness about information. In practice, initiatives to build an ESN or a Social Intranet can have very similar outcomes and they both require the introduction of an Enterprise Collaboration System.

❺ The area of (near) real-time communication includes software for video conferencing and chat and is often supported with specialised tools by third-party providers that can be easily made available to external participants (e.g. Zoom and Slack).

⑥–⑨ An Enterprise Collaboration System (ECS) contains a selection of applications and tools for the core areas of collaboration that are fully integrated and provided to the user to create workspaces under a uniform interface.

Enterprise Collaboration Systems (ECS) support the core areas of collaborative work

An ECS provides a certain degree of content integration for the functional components that share its underlying database system.



Configurations of Enterprise Collaboration Platforms

Enterprise Collaboration Platforms contain compositions of multiple software products from different software vendors. In order to investigate if there are typical combinations of products in practice (which we refer to as 'configurations'), we investigated the current portfolios that user companies have implemented to build their ECP. The sample is based on responses from 23 user companies with a total of more than 730'000 employees. The organisations are all members of IndustryConnect[6] and are mostly large organisations from different industry sectors (e.g. manufacturing, engineering, services) in the DACH area. They are early adopters of Enterprise Social Software and leaders in the development of their Digital Workplace.

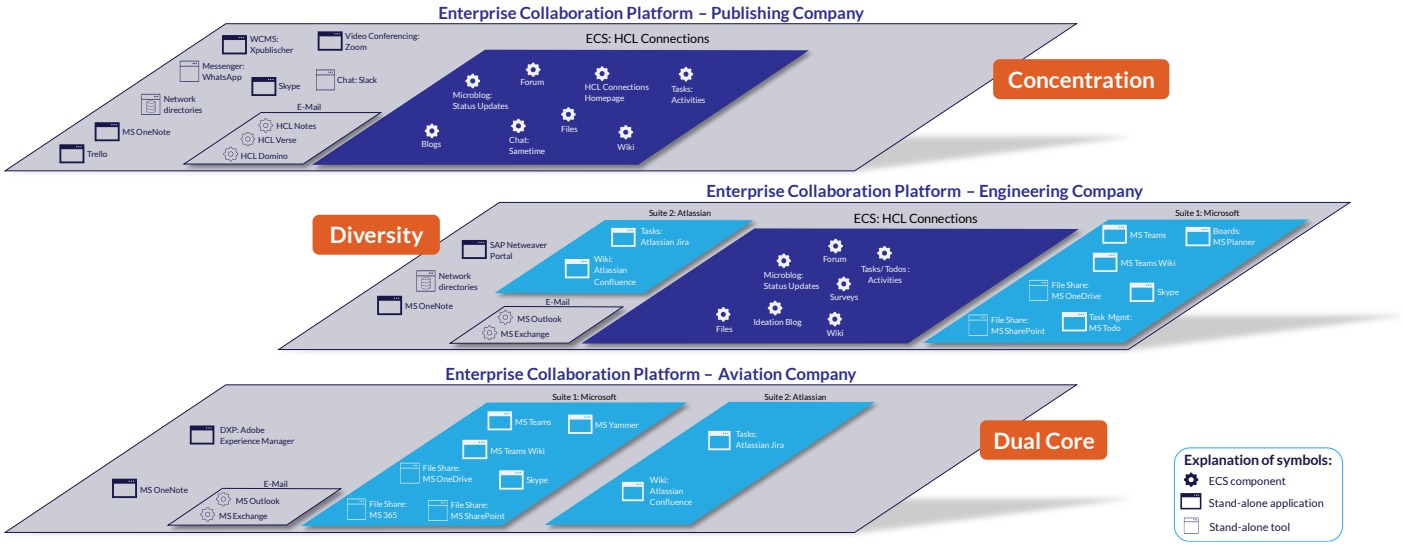


Figure 3: Examples of platform configurations for 3 selected case companies

In the questionnaire the respondents were asked to select the products that are contained in their collaboration tool portfolio from a list of software products for the different areas of Enterprise Collaboration. It was possible for respondents to also add other software products that were not on the original list.

The analysis of the responses revealed three dominant ECP configurations, which we named Concentration, Diversity and Dual Core. A few companies were still in the early stages of defining their collaboration portfolio and were classified into a miscellaneous group named 'Forming'.

There are some commonalities to all companies in the sample regarding general platform functionality, which means that these tools had no influence on the identification of the platform configurations: all companies have multiple (independent and redundant) communication tools such as chat and video conferencing. The software category of Intranet/DX mostly contains complementary stand-alone products. All companies provide office tools in the form of word-processing and spreadsheet editors, E-Mail, network directories and shared notebooks. Additionally, most (but not all) organisations provide software to build their Enterprise Social Network.

The differences in the configurations, however, were clearly visible in the core areas of multilateral joint work: the direct communication among employees, the cooperative work on documents, the coordination of work and the joint combination and enriching of documents.

Figure 3 shows three concrete cases that visualise the characteristics of the three ECP configurations that emerged from the study. User companies that choose the Concentration approach form their collaboration platform around a core Enterprise Collaboration System (in this example HCL Connections). Platforms following the Diversity approach have more than two cores (usually an ECS + 2 Suites) and a range of other modules for collaboration support which typically creates a lot of functional redundancy. In the example we can see that there are, for example, three different products that support Wikis. The third approach was named Dual Core because the platform is built around two software collections (either ECS + Suite or 2 Suites).

The findings show that there are multiple emerging platform strategies and designs and that every single ECP has a unique combination of tools. The three selected case examples in Figure 3 are representative for the distinct approaches: (1) The Publishing Company following the Concentration approach maintains a rather strict control over the number of tools in use by focusing on the functionality of the core ECS, (2) The Diversity approach chosen by the Engineering Company, is more open, offering multiple tools to support the same functionality and thus giving the employees more options but also the burden of choice. (3) The Dual Core approach of the Aviation Company combines two collections to provide the necessary range of tools which, as a side effect, also creates a certain degree of functional redundancy (but lower than in the Diversity example).

Modules	#	Concentration	#	Diversity	#	Dual Core
Files	2	ECS (files), network directories	4	All 3 collections, network directories	3	Suite 1 (OneDrive, SharePoint, Office 365)
Microblogs/Chat	5	ECS (Status Update), Slack, Skype, WhatsApp, Sametime	3	ECS (Status Update), Suite 1 (Teams, Skype)	3	Suite 1 (Yammer, Skype, Teams)
Video Conf.	2	Zoom, Skype	2	Suite 1 (Teams, Skype)	2	Suite 1 (Teams, Skype)
Surveys	0	-	1	ECS (Surveys)	0	-
Tasks	2	ECS (Activities), Trello	4	ECS (Activities), Suite 1 (Planner, Todo), Suite 2 (Jira)	1	Suite 2 (Jira)
Wiki	1	ECS (Wiki)	3	All 3 collections	2	Suite 1 (Teams Wiki), Suite 2 (Confluence)
Forum	2	ECS (Forum), Notes Forums	1	ECS (Forum)	0	-
ESN	1	ECS	1	ECS	1	MS Suite (Yammer)

Table 2: Number of functional modules and their location in the ECPs of the three case companies

Comparison of the configurations

Table 2 contains an analysis of the locations of the functional modules in the three selected case companies. Numbers greater than 1 indicate redundant functionality. As is typical for the Concentration approach, the example case company has built its ECP almost entirely on the core ECS. They provide their employees with only a few additional software components specialised on communication and task management. In the example of the Diversity approach, redundant functionality for files, tasks and wikis is provided by all 3 implemented vendor portfolios. The case example for the Dual Core approach has two Suites with some overlapping functionality and some functional areas that are not supported at all (surveys and forums).

Discussion of the solutions

Figure 4 shows an appraisal of the three configurations along the four assessment criteria: user integration, content integration, functional redundancy and IT maintenance. The Concentration approach is characterised by a high degree of user and content integration because the ECS consists of natively integrated components (joint user directory and database). The Diversity approach has multiple cores which leads to a scattered user and content management, functional redundancy and comparatively high IT maintenance. Companies who implement this approach, must have a particular reason for choosing this solution. Finally, the Dual Core approach is characterised by two cores containing multiple full-stack applications, which also leads to distributed user and content integration with a medium IT maintenance.

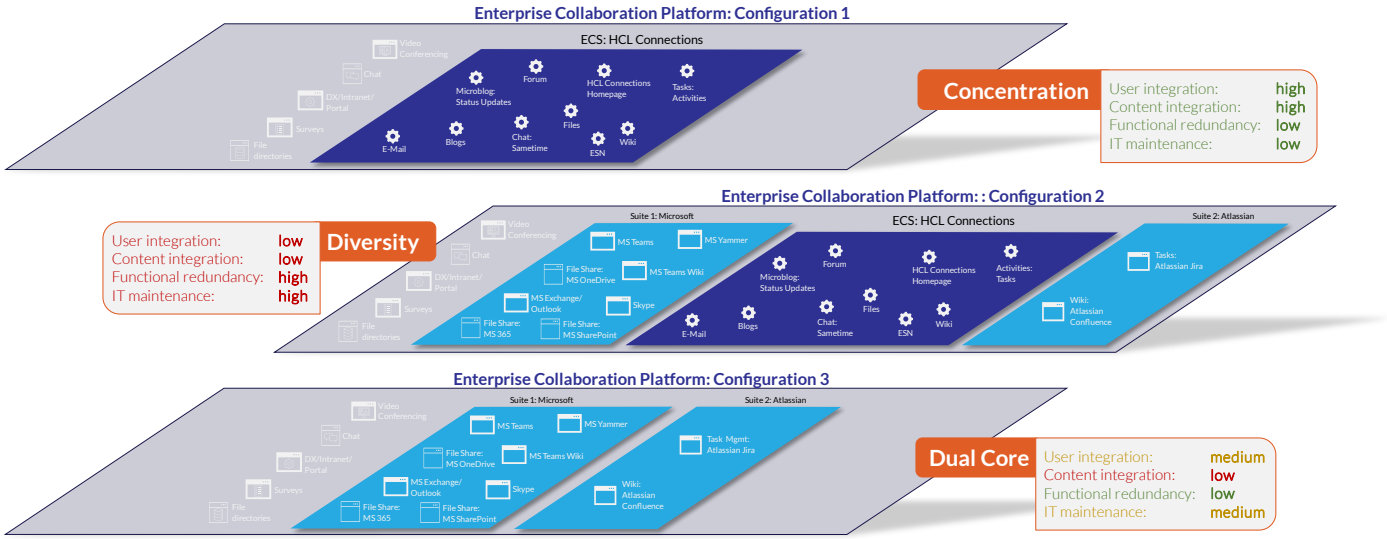


Figure 4: Appraisal of the three platform configurations

Software Operations: Transition to Cloud (Native)

Purposefully designing a performant Enterprise Collaboration Platform (ECP) requires knowledge of recent trends in software operations.

There is an observable trend towards procuring hardware and software from cloud providers. The selection of a software product can, today, no longer be done just by considering its functionality and possible license models. The way that software is developed is following agile principles (e.g. DevOps) and its procurement is highly dependent on its operational model. Some software products are available as either on-premises solution or cloud service; others are available in both delivery models.

As described above, the approach to user management plays a decisive role. It is a challenge for IT departments to unite a zoo of different full-stack applications (with individual user registries) in a seamless way so that it creates a uniform user experience.

There are different forms of cloud services that can be used to procure the necessary components (hardware, operating system, virtualisation environment, database, application server) for an Enterprise Collaboration Platform.

Infrastructure-as-a-Service (IaaS)

IaaS is the provision of compute, storage and networking resources on demand to a user company by a cloud service provider. It frees the user company from having to buy and manage physical servers and other infrastructure. In this service model, hardware is shared among multiple tenants. A recent trend in this area is the so-called 'serverless computing', in which computing resources are only billed on a utility computing basis (pay-as-you-go) without having to pay for idle cloud infrastructure. Examples for IaaS products are Microsoft's Azure or Google's Cloud Services.

Platform-as-a-Service (PaaS)

PaaS is the provision of resources required to build and run applications and services to (the IT department of) a user company by a cloud service provider. PaaS includes IaaS plus a ready-to-use software development and deployment environment (a technology stack with programming languages, frameworks and development tools). It allows the user company to focus on the actual development of their tailored software and frees them from having to buy and manage software licenses and management software for server virtualisation and/or container orchestration. The software services and pre-coded components that are available on the platform can be used by the software developers in their own applications. In some cases, such platforms attract their own developer community (e.g. Domino Developer Community) who share code and support each other.

SaaS also includes Identity and Access Management (IAM) solutions that comprise services for authentication, authorisation, user management as well as a central user repository. They are available as cloud-based solutions and are essential for hybrid multi-cloud platforms. IAM provides the possibility for single sign-on to multiple software applications from desktops as well as mobile devices – not only for software on this platform but for any application that can be connected to the central user directory.

Software-as-a-Service (SaaS)

SaaS is the provision of an application (that is operated in a cloud service centre) to a user company over an Internet connection. It is based on a multi-tenant model where many user companies are sharing the same hardware and software instance but have their own private data spaces. In many cases, SaaS is only suited for software 'out of the box' that does not require a lot of customisation or integration with other (company-internal) applications. As with the other two cloud services, SaaS frees the user company from buying and operating the necessary hardware and software. All infrastructure is located in the data centre of the cloud service provider. The availability of the service and response times of the support staff are defined in Service Level Agreements (SLA).

These three basic cloud options can be used to provide the necessary components to build Enterprise Collaboration Platforms. But the platform metaphor is not only useful within the boundaries of *one* organisation. In order to secure long-term continuance and to be prepared for the future, it is important to look beyond the platform of a single company (Enterprise Platform) and to extend the due diligence to the whole ecosystem that is surrounding a particular cloud offering (Provider Platform).

Enterprise-Platform-as-a-Service

IT managers have to make sure that the selected software is sourced from a healthy ecosystem that is active and will be available in the future. Migrating from one cloud provider to another comes with a switching cost. Even more importantly, the user-generated content of the ECP is a costly and valuable investment and the content is 'locked-in' and cannot easily be migrated out of a chosen technology. Platforms, in which software developers gather to provide software for the platform's core technology are ideal environments for sustainable ecosystems. The mobile app stores by Apple and Google are impressive examples for this platform model.

Also, the development of an Enterprise Collaboration Platform is never 'finished'. Internal user requirements are in a constant flux and newly available software features need to be explored, which means that the design of the platform is a constant work in progress.

This is why user companies are well advised to purposefully evaluate and choose both, the technology for their own Enterprise Platform and the software ecosystem (Provider Platform) behind it (Figure 5).

The role of platforms

Platforms are ideal touchpoints between software providers and user organisations. From the point of view of a user organisation, they receive ready-to-use software for their users in the form of their customised Enterprise Platform. On the level below, this service can be based on a specific technology platform offered by a specialised provider (Provider Platform), which can additionally provide a PaaS that is geared at software developers for both, IT departments in user organisations and specialised software development companies alike.

Brought together on this platform, the programmers become part of a specific software ecosystem around the core Enterprise Collaboration System.

***Provider Platforms** are incubators for a Community of Software Developers*

The role of the Enterprise Collaboration System

Enterprise Collaboration Systems are natural candidates to provide the core not only for Enterprise Platforms but also for the Provider Platform. ECS provide a basic set of functional components that are already 'natively' integrated. Third-party components can be seamlessly integrated into the ECS and thus provide the uniform access to its functionality. Programmers can use the basic functionality that is already in place and do not have to reinvent the wheel. They can concentrate on the key functionality of their apps.

The paradigm for this way of software development is cloud native. The new functionality can be deployed into the platform and is immediately available for all platform users. This way, the members of the platform ecosystem provide a growing collection of functionalities that become natively available to user organisations to choose from.

***Cloud-native add-ons** ensure the necessary agility for changing functional requirements*

By selecting the portfolio of collaboration software for their employees, a user organisation defines its own Enterprise Platform. Their IT staff controls the central user directory and the software that is deployed on the platform.

This will lead to Enterprise Platforms that are built using the functionality of a Provider Platform (Figure 5). The foundations (e.g. Identity Management) of the ECP are embedded in the provider platform but the

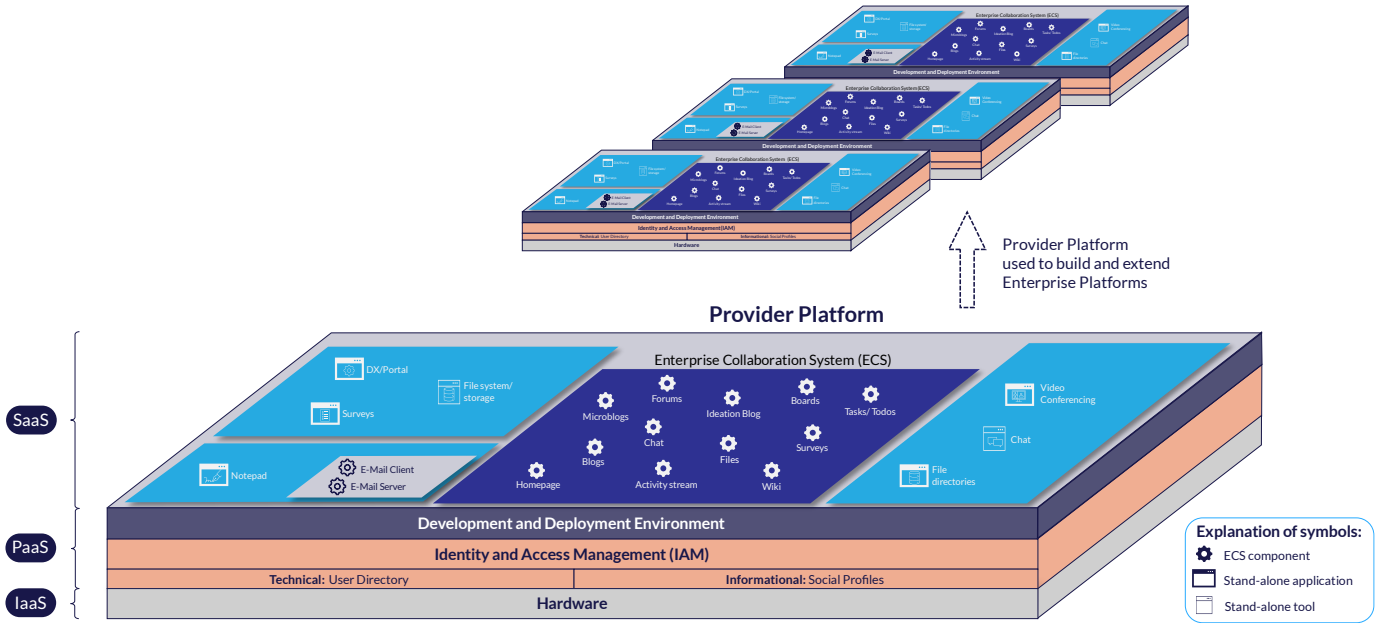


Figure 5: Provider Platform is used to build Enterprise Platforms as instances (tenants)

user consumes the software as a Service (SaaS). At the same time, the PaaS can be the host to a healthy ecosystem (development & deployment environment) for software developers that develop and 'sell' their applications through this platform. Such Provider Platforms can be run by (independent) Cloud Service Providers. The SaaS or PaaS provided by the cloud service provider can be used to build the core of the Enterprise Platform of many user platforms. It is thus possible to build multiple 'platforms in a platform'.

Enterprise Platforms are instances of the Provider Platform

The increasing modularisation of software makes it even possible to combine software services from different providers in an Enterprise Platform. The user company has their own private instance of the ECS (the 'tenant') and as a side effect also has access to the platform ecosystem of the provider (e. g. the software modules developed by the development community). The ideas behind this 'select-and-deploy' approach is further stimulated by latest trends in containerisation and serverless computing.

Containerisation is the idea of building independent modules of software code (microservices) that include operating system libraries to create a lightweight executable (the container) that runs on different infrastructures. Its independence of a particular technology stack makes it ideal for deployment into Enterprise Platforms that combine heterogeneous software products from different providers. However, microservices still need a platform to run.

Group Workspaces: the actual places of joint work

Group Workspaces are the instantiations of virtual environments for joint work. They provide the digital equivalent to office spaces with their desks, cupboards, containers, archives, whiteboards and coffee corners and create awareness of what the other members of the group are doing. The Enterprise Collaboration Platform (ECP) has to provide workgroups with the necessary functionality to create performant workspaces that fit their needs.

ECP can only provide the necessary modules for the functionality needed by the users – the actual user and content integration happens at the workspace level. The creation of self-managed workspaces is a central functionality provided by collaboration software. From a technical point of view, a workspace is defined by a list of members (user registry) and the functionality it provides (e.g. activity stream, chat, files, whiteboard). Digital workspaces are virtual environments for workgroups, for example the members of a department or a project group (internal work-

space). They are usually self-managed, meaning that they are created by the initiating member (the workspace owner) who can add (or invite) user accounts from the user directory into the space. Workspaces can be public (visible and accessible for all users in the central directory of the platform) or private (on invitation only). Workspace awareness (the up-to-date information about what has happened) is provided by the activity stream (which displays events that occurred in the workspace) and other awareness markers (e.g. colours or asterisks).

Enterprise Collaboration Platforms provide the components for self-managed workspaces

Joint work is contextual and situational and there are many conceivable purposes and types of workspaces (as indicated in Figure 6). Employees have their own personal workspace (the office tools for content creation). Most employees are members of multiple organisational groups which means that they are also members of multiple digital workspaces. For example, the members of a business department are typically members of a joint departmental workspace (e.g. the digital workspace of the Sales Department). A large part of knowledge work is organised in internal (employees only) and external (including partners) project workspaces. The public website or portal of a company is also a workspace and addresses people outside the company (external workspace).

There are also enterprise-wide workspaces which are accessible for all registered users. With the ongoing trend towards work from anywhere, it is becoming increasingly difficult for organisations to provide their staff members with a sense of what it means to be an employee in their company and to communicate the corporate culture to new staff members. Whereas in previous times an employee would get a sense of an organisation by experiencing the activity in the physical office building, today's remote work is limited to what is happening on a computer screen. However, companies cannot 'lose touch' with their employees, which means that they are required to build a performant digital work environment with the necessary awareness mechanisms that can complement the physical environment and convey the feeling of being part of the organisation. Organisations need a new workplace metaphor that replaces or complements the physical workplace: the Digital Workspace.

Workspaces are the instantiations of virtual environments for workgroups

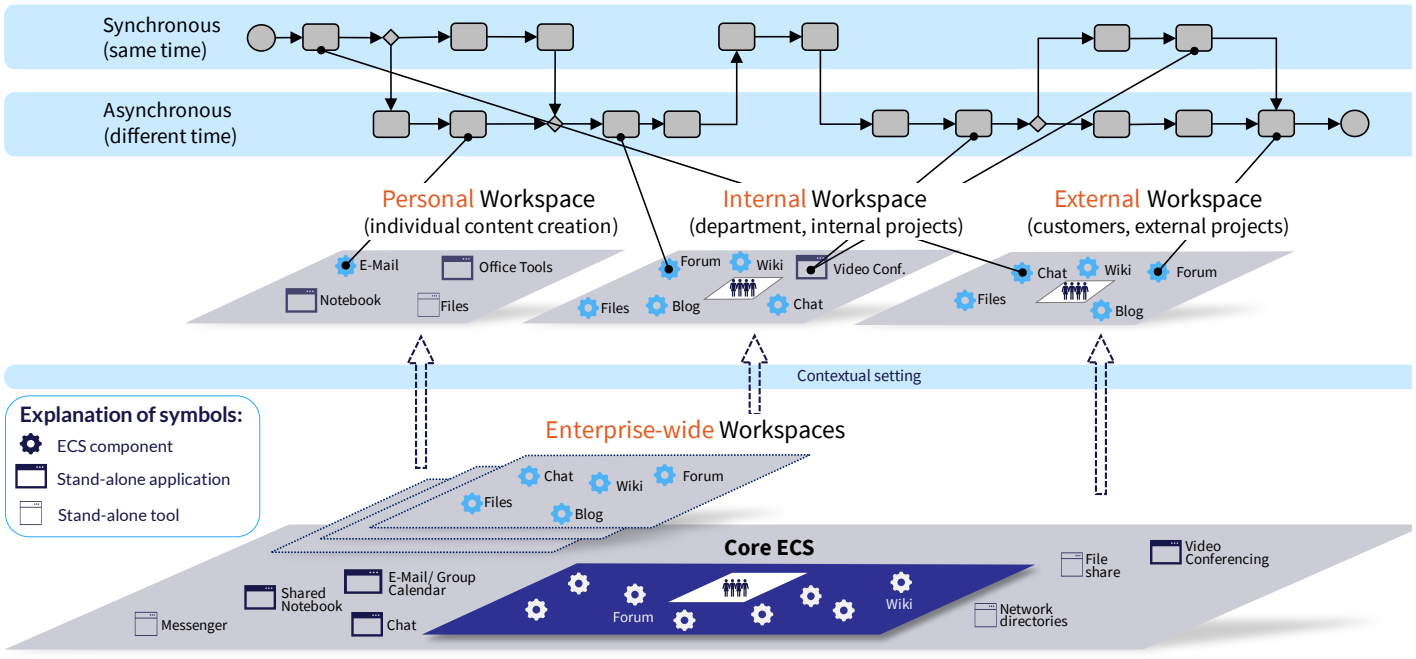


Figure 6: Workspaces are the virtual environments for work

The Core is Key: The Decisive Role of Integrated Systems

Our studies of leading user organisations show that the core space is the essential ingredient for these workspaces and that an integrated system is an ideal technical solution. A recommended way of ensuring technical as well as informational user integration is to choose an Enterprise Collaboration System (ECS) as the core of the ECP.

The ECS provides a basic set of functional modules that are natively integrated and it comes with a common user directory. This user directory is an ideal candidate for persistent identity management (see section on AIM above) across the entire Enterprise Collaboration Platform. Additional software modules can be added to work with the central user directory or compatible components can be deployed directly into the core ECS.

The central user directory is also the prerequisite for the informational directory, in its simplest form a 'staff directory' (that contains background information on people) or, ideally, the user accounts are complemented with corresponding social profiles that represent the nodes in the Enterprise Social Network.

Building an integrated Enterprise Collaboration Platform is also a way of successfully addressing the issue of content integration. The introduction of Enterprise Social Software (ESS) has changed the way we create and think about information. Social documents (the content in ESS) are no longer written by a single author. Social features allow other users to respond or add comments and to quickly add simple components (likes, tags, follows) that enrich documents and turn them into multi-author documents. Every member of a workspace can engage in the conversation and the 'wisdom of the crowd' can lead to valuable and serendipitous insights. The social network that drives awareness has its origin in the possibility to follow content (workspaces, containers, or single documents) and people (the connections defined in the Social Profiles of the ESN).

The last few years have seen a trend in the further modularisation of software. In accordance with this trend, a large part of collaboration software is available as modules (tools, applications or components) that encapsulate functionality (read, write, copy, …) performed on different types of digital content (documents). Typical content types are, for example, e-mail and chat messages, blog and microblog posts or files. Modular tools or applications provide their own 'containers', in which content is stored and its actual physical location is often hidden or at least not (directly) visible for the user.

Content integration is paramount to a positive user experience and the long-term management of information assets. This means that the selection of a software module to be added to the ECP hinges on its 'openness' (by means of APIs) and its readiness for a seamless integration into the existing environment.

Integration needs to be done on the platform level and not on the user level!

Enterprise Collaboration Systems are the ideal solution for these requirements. They ensure user integration by means of a central user directory and provide the possibility for content integration among components that are specifically designed for this particular ECS and with third-party tools that have the necessary interfaces to this ECS.

Workspace Assemblage

Workspaces are assemblages of functional components provided by the ECP. The creation of a new workspace is triggered when a work group is newly formed. One person takes the role of workspace manager who is in charge of creating the core space and assembling the required functional modules. Due to the redundancy of functionality offered by current ECPs, the choice of the software components is frequently the outcome of a negotiation and agreement between the group members. In cases where the group includes externals (e. g. customers) the definition of software products can even be an explicit part of the project contract.

The decisive step of creating the virtual environment for a work group is the choice of the functional core element that contains the member list (user registry). The basic functionality of a space (that has been given many different names by different software providers, e. g.: community, space, channel or room) is a requirement for all collaboration software, which means that the core could come from any of the

products provided by the ECP. However, integrated systems (ECS) are an ideal provider of the core because they already contain multiple functional components that work with the core, which creates an easy-to-set-up and easy-to-maintain multi-functional workspace. Each tool that is added to the workspace that is not connected (integrated) with the central user directory of the organisation requires each member to create an account (and manage its login information) and additionally, it requires the workspace manager to manually edit the member lists for each of these tools.

The tools that are assembled for a workspace are not always components that are included in the Enterprise Collaboration Platform. The ECP only contains Enterprise IT, software purposefully provided and supported by the user organisation. In reality, users also often agree to use shadow IT because they are familiar with it and it seems to be the easier choice. Shadow IT is the term used for private (mobile) devices and third-party software that are used by employees for work-relevant activities. User organisations are well advised not to ignore shadow IT but to actively deal with it. Business-relevant content stored on private machines and third-party software services (that have no contract with the user organisation) brings about risks of security, privacy, confidentiality and loss of information assets. There need to be rules and policies about the use of unsupported third-party IT.

Figure 7 shows an example of an assemblage of functional modules for a group workspace. The modules are grouped by the type of work they support.

The core space defines the members of the group and their roles and access rights. In this example, the core element is a functional component of an integrated Enterprise Collaboration System. Files, Wikis, Forum and Blog are integrated components that natively work with the user directory of the core. Tasks and Boards are third-party components that have been technically embedded into this ECS and thus also work seamlessly with the core. In addition to these basic components provided by the ECS, the project team uses three additional applications for their (near) synchronous communication: Video Conferencing, Whiteboard and Chat. In the example, these applications are stand-alone applications and their access management is not integrated with the Enterprise Collaboration Platform. This means that the workspace owner has to setup three additional, independent member lists in these applications, which have to be manually updated every time a group member enters or leaves the group.

Although this is not an ideal situation, it represents the current practice in many organisations. This is not due to the negligence of IT departments but a result of a fragmented software market where no comprehensive integrated system exists that offers the full range of functional support for synchronous and asynchronous work activities. It can be assumed that socially-enabled collaboration software will further mature in the coming years and that building an integrated ECP will become easier. Currently, it is a difficult and time-consuming endeavour that requires a lot of combined knowledge about the nature of joint work and existing technical solutions and cloud services.

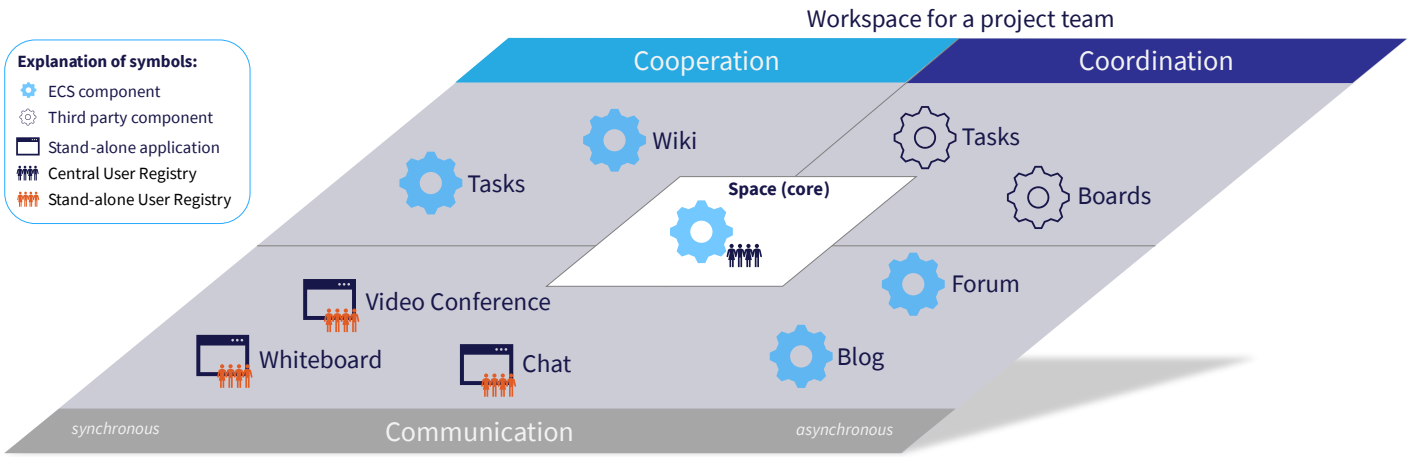


Figure 7: Workspace assemblage: core space and components of an *integrated* ECS plus complementary third-party products

Summary and next steps

This paper is the second part of a two-part report on the topic of technology support for collaborative work. In Part One, we focussed on the imperative for a carefully planned digital workplace and set the scene for understanding the types of collaborative work and the types of software required to support it. Here in Part Two, we describe the technical solution in the form of the Enterprise Collaboration Platform.

The future digital workplace for hybrid and remote working requires an integrated Enterprise Collaboration Platform. There is currently no software solution on the market that supports the full range of collaboration activities. As a consequence, ECPs need to be individually designed by user companies and are usually composed of multiple applications from different software vendors.

Loosely integrated portfolios of collaboration tools carry the risk of user and content fragmentation. These challenges can be overcome with an enterprise-wide collaboration platform that integrates heterogeneous components.

The choice of a specific technology should not be taken lightly. The user-generated content on the collaboration platform represents a valuable business asset and there are high switching costs associated with a technology change.

Designers and managers of collaboration platforms need to provide the necessary components for workgroups to assemble functional components to build performant workspaces. It is these virtual environments that are decisive for the effectiveness of successful teams. This is where user organisations can create competitive advantages.

Enterprise Collaboration Systems represent the ideal core of an Enterprise Platform as they provide the necessary functionality for the integration of third-party components (joint user registry, databases and a common user interface) and address the challenges of content and user fragmentation.

There are observable recent changes in the development and provision of enterprise software (DevOps). Technology is increasingly procured as cloud-services. Software development has adjusted to the cloud paradigm and is shifting towards cloud native. The increasing modularisation makes multi-vendor strategies feasible.

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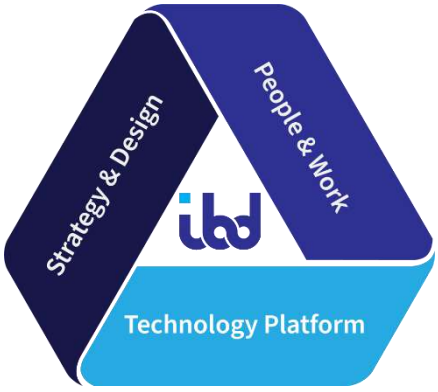

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