Motivation

The use of collaboration technologies to support and coordinate distributed collaborative work is increasing in both scale and scope. This has been especially noticeable in the past two years as organisations have responded to the short-term challenges presented by the work from home mandates triggered by the COVID-19 pandemic (McKinsey Global Institute, 2021; World Economic Forum, 2020) as well as the longer-term trend for organisations to offer employees more flexible work options to support hybrid work (Gratton, 2021). This is resulting in a wider range of working arrangements and an increased requirement to provide collaboration technologies to support distributed work teams.

As a response to this increase in the scale of distributed collaborative working there has been a concomitant increase in the scope and functionality of technologies to support collaborative work (Gartner, 2021). As the degree of hybrid working increases, the complexity of supporting collaborative work has also increased, requiring IT departments to place greater attention on the selection and provision of "collaboration software" to provide a stable technology environment to support a wider range of collaborative work situations.

However, collaboration software designed to support *ad hoc collaborative work activities* is inherently different from software such as Enterprise Resource Planning (ERP) systems that, by design, support *repetitive and highly structured business processes.* Whilst the majority of today's ERP Systems have evolved into highly integrated systems with functional modules that store data in a central database, the commercial solutions for collaboration software are highly specialised, focusing on supporting selected areas of joint work. Only a small number of collaboration software products (e.g. HCL Connections, Atlassian Confluence, Jive) contain multiple functional modules and would qualify as *integrated* Enterprise Collaboration Systems.

The fact that collaboration software is highly specialised means that organisations often need to combine many different software products to support the diverse requirements for joint work. This has led to a (somewhat uncontrolled) growth of available products in use in organisations (Schubert & Williams, 2022) and as a consequence, many companies have implemented a heterogeneous range of tools (from different vendors) with overlapping (redundant) functionality. These portfolios of collaboration software include lightweight tools for specific tasks such as file sharing or simple message exchange to more complex Enterprise Collaboration Systems (ECS). Taken together the tools provide an "Enterprise Collaboration *Platform*" (ECP) that comprises the full range of collaboration software tools and applications available to the registered users of an organisation. Frequently, the selection of these products arises bottom-up in a piecemeal fashion as different tools are requested by single departments and is not conduct-

Literature review

For the development of our classification scheme, we examined existing approaches in the literature. We were particularly interested in meta classification schemes that provide a comprehensive classification of the entire field of collaborative work. Examples are the study of *categories of tools* by Bafoutsou and Mentzas (2002), Riemer's *catalogue of classification criteria* (Riemer, 2007), the *8C Framework* by Williams (Williams, 2010) and Schubert's *classification of software components* (Schubert, 2018). All of the identified classification approaches contain similar dimensions, the most prominent being *synchronicity* (synchronous/asynchronous) and *place* (Ellis et al., 1991), *permanency* of the information (ephemeral/long-term) (Schubert, 2018), type of *group process* (communication, cooperation, coordination) (Williams, 2010), *content type* (text, image, video, audio) and number of *communication partners* (1/many) (Ellis et al., 1991). The type of activity is often grouped into three (or four) "Cs": Communication, Cooperation, Coordination (and Content). In addition, studies have shown that collaboration software can be classified into categories, which are dependent on the *type of work* which they support. Riemer (2007) suggested the five categories *Integrated Systems*, *Everyday Systems*, *Meeting Systems*, *Coordination Systems* and *Specialised Tools* as a result of a cluster analysis on a sample of 94 collaboration software products using some of the attributes listed above. Bafoutsou and Mentzas (2002) found similar categories in their functional review of collaborative systems. Their main groups are *real-time conferencing*, *non-real time conferencing*, *file and document sharing*, *electronic workspace* and *electronic meetings systems*.

Software analysis

We used the *Collaborative Technologies Evaluation Tool* by Schubert and Williams (2011) for our analysis of leading commercial software products. The evaluation tool is based on the 8C Model (Williams, 2010) and contains a list of 42 functional criteria which are grouped by the four inner Cs (see Annex).

The preceding analysis of the literature showed that there is no accepted "standard" classification scheme for all areas of collaborative activity. The following analysis of the software identified that there is no *single integrated* Enterprise Collaboration System that covers all aspects of collaboration. Instead, the market for collaboration software is heterogeneous, comprising a multitude of commercial collaboration tools with both overlapping and disjoint functionality.

Based on this analysis, we developed and used a classification scheme that is relatively straightforward in its reflection of daily work practices and allows organisations to clearly define requirements according to user activity. To map the software functionality to this scheme, we decomposed software products on a modular level, assigning (some of) them to multiple areas. This turned out to be a feasible approach and it also helped to clearly identify overlapping and redundant

functionality. The resulting classification contains *8 functional categories* (Figure 2) which represent the areas of collaborative work (ArCoW).

On the highest level, we distinguish between synchronous and asynchronous activity. *Synchronous* activity is further sub-divided into communication-oriented *meetings* and cooperation-oriented work on *documents/files*. *Asynchronous* activity has two additional sub-areas according to the *permanency* of the information: ephemeral (of short-term interest) and persistent (of long-term interest). The *ephemeral* section contains communication-oriented short messages (microblogging) as well as the coordinative features *ideation, polls and voting*, content which is normally only relevant for a short amount of time. The *persistent* section has four sub-areas: the coordination-oriented *task management* and the three content-oriented *file sharing*, *information collection* (documentation) and *information exchange* (question-response).

Asynchronous Work	
Persistent information of longitudinal interest	
Task Management	File Sharing
Information Collection	Information Exchange
Ephemeral information of short-term interest	
Short messages (Microblogging)	Ideation, Polls, Voting
Synchronous (simultaneous) Work	
Meetings	Joint work on documents/files

Figure 2. ArCoW Framework (Areas of Collaborative Work)

All dimensions that were identified in the literature review are contained in this classification but they are not all equally important/visible. Our main dimensions are *synchronicity* and *permanency* of the information. The sub-areas reflect different types of *group processes* (communication, cooperation, coordination, content creation). *Content type* (text, image, video, audio) and number of *communication partners* are implicitly embedded in the functionality provided by the software. We excluded the dimension of *place* (Ellis et al., 1991) in our preliminary analysis of distributed remote and hybrid work, where nothing is (solely) co-located. This is not to say that place is not important, however, for the purposes of this preliminary study where the objective is to analyse the constellations of software tools in use and emerging technology platforms being formed, the analysis of the place where someone is working from is less important than the mode of working, i.e. synchronous/asynchronous and the requirements (or not) for persistence of information. Place (and physical distribution of actors), as well as other dimensions such as those identified by Lee and Paine (2015) such as scale, scope and nature of work play an important part in our subsequent analysis of the collaborative work and work practices.

Introducing the platform view

The aim of our study was to investigate how organisations build their Enterprise Collaboration Platform – the collective portfolio of collaboration software to provide the technology environment to support enterprise-wide collaborative work. As demonstrated in our software analysis, commercial collaboration software can be assigned to specific areas of collaborative work (discussed above). When examining the infrastructure of a whole organisation (*the platform level*), we need to also consider the *basic technology stack* that is used to form the foundation of the platform. The foundation includes the *user management*, *personal information management* as well as the *organisational "homepage"* (usually a *portal or intranet*) that provides a structured and uniform access to the information resources of the organisation.

The *technical* aspect of the *Central User Directory* is covered by solutions for identity and access management (IAM) that comprise services for authentication, authorisation, user management as well as a central user repository. IAM provides the possibility for single sign-on for multiple software applications from desktops as well as mobile devices (Gartner, 2022b). The *informational employee directory* addresses the need to know the background of a person (area of expertise) in order to identify experts or appraise their contributions (name of person, room, contact info, expertise, role, …). In recent years, this functionality has been added in the form of "Enterprise Social Networks" (ESN) (Wehner et al., 2016) or "Social Intranets" (Williams & Schubert, 2018). These terms were coined when "Enterprise Social Software" was introduced into organisations as a direct result of the success of the public Social Media (Leonardi et al., 2013). These two software types have similar functionality but differ in their primary objective. Both provide "social features" (social profile, link, follow, like, tag, post, comment, …) where the *ESN* has a focus on people with the aim of establishing links between them to build an organisational network structure and the *Social Intranet* has a focus on content to share and increase awareness about information.

Personal Information Management (PIM) is the term used for the realm of information creation and organisation of each employee. PIM software enables individuals to create digital content (texts, slides, worksheets, graphics, databases, charts, videos, music, …). The majority of documents are first created within individual desktop environments and only later "become social" when they are uploaded or copied into collaboration software. Content that is natively created in a collaboration software is "born social" (Hausmann & Williams, 2016).

Information Portals are typically implemented by means of *Digital eXperience Platforms (DXP)* (Gartner, 2022a) or *Content Service Platforms (CSP)* (Gartner, 2022c).

These basic platform components are the necessary foundation for the building of an Enterprise Collaboration Platform. Collaboration software for the different areas of collaborative work (ArCoW) is then added to the ECP according to the

requirements of the user organisation. Figure 3 shows an example of an ECP with its portfolio of software products. As mentioned earlier, software products containing multiple functional components can appear in multiple areas. For example, NextCloud is a tool for (asynchronous) *file sharing* but also allows users to *synchronously work on files*. HCL Connections is an integrated Enterprise Collaboration System with multiple functional modules (wiki, blog, forum, etc.) that supports almost all areas of asynchronous work. For our analysis, we decomposed such systems and suites into their separate modules. This explains why the same symbol can occur multiple times with different labels.

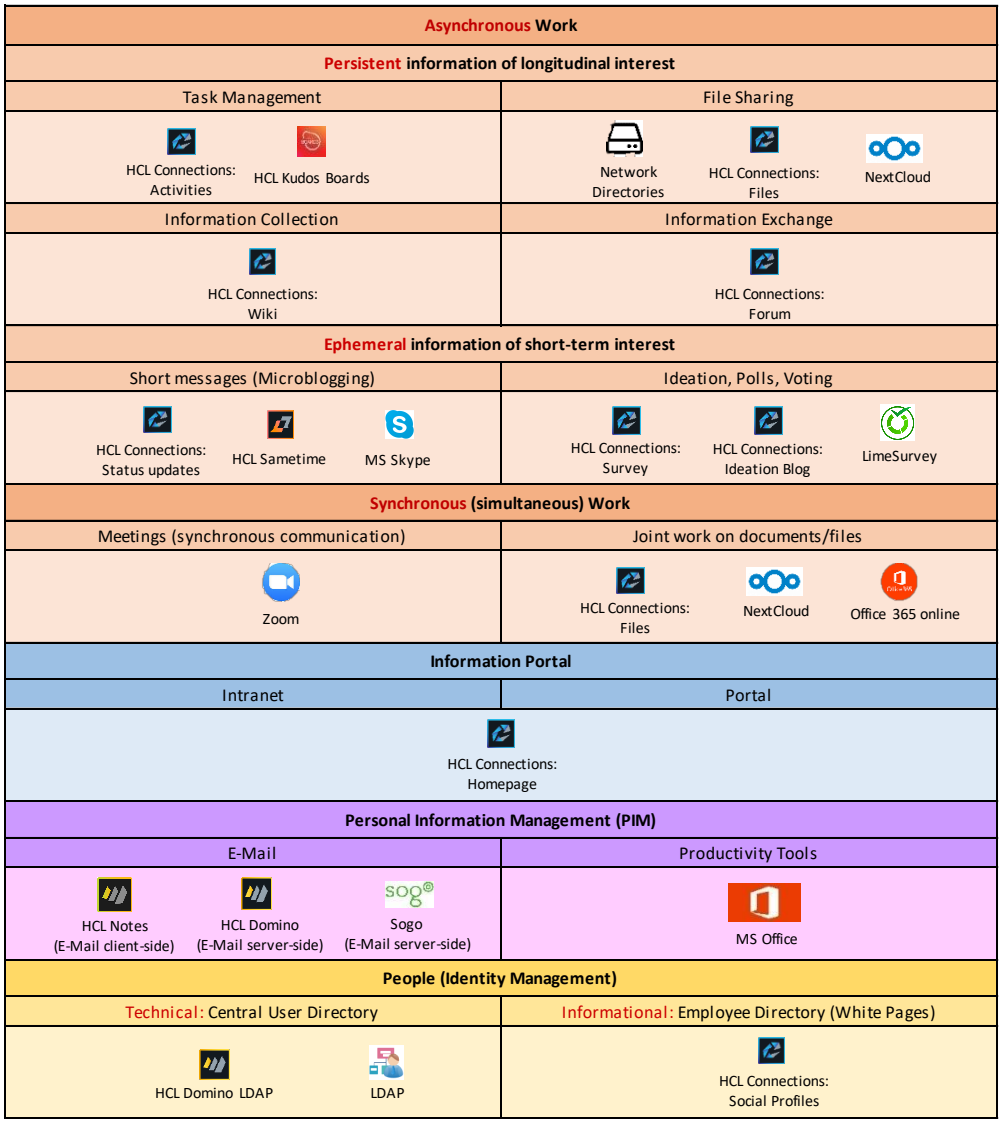

Figure 3. Case example for a platform configuration (ArCoW and basic platform components)

The visualisations show the different enterprise collaboration platform design strategies that the organisations are following.

Case Company 3 is following the ***Concentration approach***. The company is using all functional modules of the integrated ECS. Only where functionality is missing or insufficiently provided, are they making use of complementary tools (e.g. in this case the company is doing this to support synchronous communication through video conferencing and specialised task management through Trello).

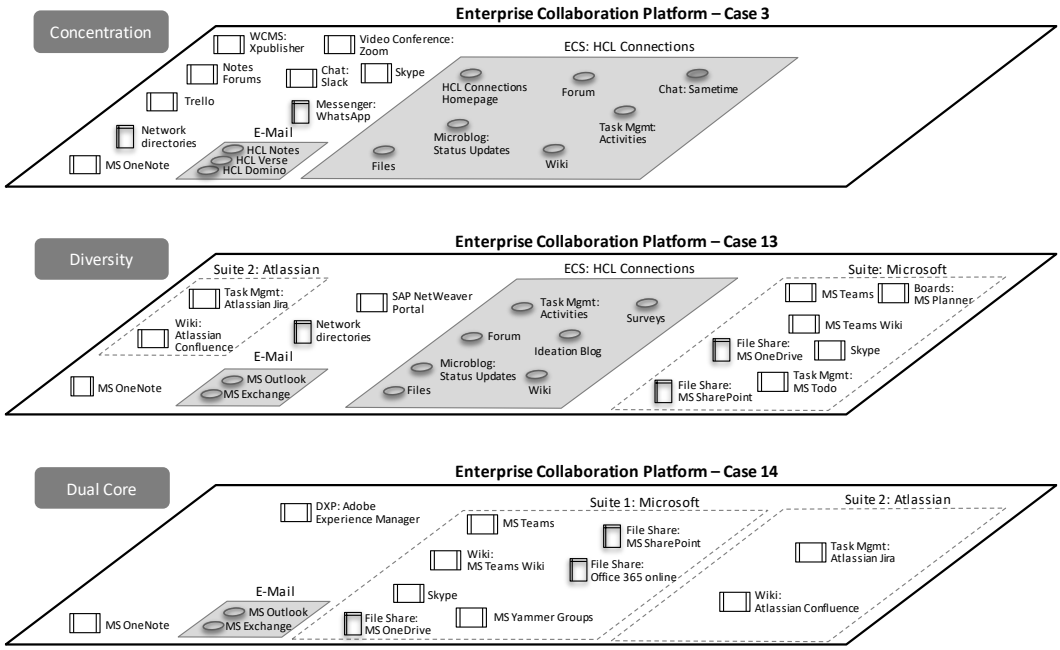

Figure 6. Three dominant ECP configurations: Concentration, Diversity and Dual Core

Case Company 13 is following the ***Diversity approach***. The company is only using selected modules in the core ECS and is complementing the functionality of the platform with applications from two other collaboration suites. Whilst this configuration provides the users with a broad range of options for collaboration support it also creates the problem of redundancy (e.g. in this case there are three different software products supporting wikis).

Case Company 14 is following the ***Dual Core approach***. The company is using two suites (Microsoft and Atlassian) to provide the necessary ArCoW functionality.

There are many commonalities in our sample in the first three areas (1-3) of Figure 5, which means that these tools had no influence on the identification of the platform configurations. All companies provide (1) PIM software in the form of E-Mail, network directories and shared notebooks. The software category of (2) Intranets (DXP/CSP) mostly contains complementary stand-alone tools. All companies have multiple (independent and redundant) (3) communication tools

such as chat and video conferencing. Looking back at Figure 2 (Areas of Collaborative Work), it is noticeable that the commonalities on the left side of the figure are for 1:n activities such as "top-down informing" and "content provision and preservation".

The differences in the configurations, however, can be identified mostly in the core areas (5-8) of multilateral joint work, the *(5) communication* among employees, the *(6) cooperative work* on documents, the *(7) coordination* of work and the joint *(8) combination and enriching of documents*.

Table 1 contains an analysis of the locations of the functional modules in the three case companies. Numbers larger than 1 indicate redundant functionality. Characteristically for the *Concentration Approach*, the 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*, identical functionality is provided by all 3 systems/suites (files, tasks and wikis). The case company in the example for the *Dual Core Approach* provides two suites with some overlapping functionality and some functional areas that are not supported (surveys and forums).

Table 1. Location of functional modules in the ECPs of the three case companies

Module	*Concentration*	*Diversity*	*Dual Core*
Files	(2) ECS (files), network directories	(4) all 3 ECS/suites, 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)

The findings reveal that there are multiple emerging platform strategies and designs. The three case examples presented above show distinct approaches, one of more strict control over the number of tools in use by focusing on the functionality of the core ECS *(Concentration)*, a second more open, offering multiple tools to support the same functionality and thus giving the employees more flexibility but also the burden of choice *(Diversity)*. The third approach *(Dual Core)* combines two collections for the necessary range of tools to create the Enterprise Collaboration platform which also creates some redundancy.

Schubert, P. (2018): 'Joint Work and Information Sharing in the Modern Digital Workplace: How the Introduction of "Social" Features Shaped Enterprise Collaboration Systems', in K. Riemer, S. Schellhammer and M. Meinert (eds.): *Collaboration in the Digital Age: How Technology Enables Individuals, Teams and Businesses*, pp. 45–59, Springer, Berlin, Heidelberg.

Schubert, P. and Williams, S. P. (2022): 'Enterprise Collaboration Platforms: An Empirical Study of Technology Support for Collaborative Work', *Procedia Computer Science*, vol. 196, pp. 305–313.

Wehner, B., Ritter, C. and Leist, S. (2016): 'Enterprise social networks: A literature review and research agenda', *Computer Networks*, vol. 114, pp. 125–142.

Williams, S. P. (2010): *Enterprise 2.0 and Collaborative Technologies,* (Issue May 2010) Working Report of the Research Group Business Software, May 2010, University of Koblenz-Landau, Koblenz, Germany.

Williams, S. P. and Schubert, P. (2011, June): 'An Empirical Study of Enterprise 2.0 in Context', *24th International Bled Conference*.

Williams, S. P. and Schubert, P. (2017): 'Connecting Industry: Building and Sustaining a Practice-based Research Community', *50th Hawaii International Conference on System Sciences*, pp. 5400–5409.

Williams, S. P. and Schubert, P. (2018): 'Designs for the Digital Workplace', *Procedia Computer Science*, vol. 138, pp. 478–485.

World Economic Forum (2020): *Resetting the Future of Work Agenda: Disruption and Renewal in a Post-COVID World,* (Issue October) Cologny/Geneva, Switzerland.