Structuring the Market for E-Collaboration Systems: A Study Based on Cluster Analysis

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ABSTRACT

Software systems for supporting communication, coordination and cooperation processes in groups have become the backbone infrastructure to support knowledge work in a globalized economy where virtual work has become the prevalent modus operandi. Fuelled by recent technology trends numerous new E-Collaboration systems have appeared in the marketplace. In this paper a study that aims to shed light on the market for E-Collaboration systems is presented. A sample of 66 E-Collaboration systems was characterized in terms of their feature sets using a classification approach. Cluster analysis was used to uncover patterns in the resulting data. Four systems classes and a range of sub classes were identified each of which is briefly described. The results, being a reflection of the existing market complexity, should be equally helpful for researchers who deal with E-Collaboration systems as their objects of interest, as well as for business executives, who need to gather information to support buying decisions.

INTRODUCTION

E-Collaboration systems are an increasingly important class of information systems. For many people work arrangements with colleagues from different companies in spatially distributed teams have become the new reality in contemporary organizations (Bélanger *et al.*, 2003). Increasingly, virtual teams are used to organize knowledge-intensive work in projects where the best experts are distributed across the globe (Lavin Colky *et al.*, 2002). Consequently, E-Collaboration systems have become a key technology and indispensable infrastructure for many enterprises. Fueled by recent trends such as the emergence of new communication media numerous new E-Collaboration systems have appeared in the marketplace. Hence today, an almost incomprehensible number of systems exists that often support a wide range of features.

In this paper a study is presented that aims to shed light on this market by structuring the range of available systems in meaningful classes. Such a classification is equally desirable from a management point-of-view having to deal with the selection of systems, as well as for researchers who focus on E-Collaboration systems as their objects of interest. Researching the application and the impact of E-Collaboration systems on individuals and organizations is only possible, if one has a good understanding for the typical features of these systems and available alternatives.

SYSTEMS CLASSIFICATION AND CLUSTER ANALYSIS

Previous attempts to the classification of E-Collaboration systems were mainly conceptual and based on single features; systems were divided in classes such as E-Mail, Conferencing, Calendars and the like (e.g. Munkvold, 2003). Today, most E-Collaboration systems would fall in two or more of these categories. With the diversification and the expansion of the available range of features such a classification seems no longer suitable. Rather, this study follows an empirical approach that explores systems classes in the marketplace by means of cluster analysis. Only those systems were included in the study that support direct inter-personal interactions in terms of group communication, coordination, and collaboration. According to this definition no systems were considered that only support human-computer or computer-to-computer interactions like electronic data interchange (EDI) applications.

An initial Internet search resulted in a list of 212 software systems that comply with this definition. Based on a catalogue of classification criteria a sample of 66 systems was classified[1]; the sample was made up of all systems about which enough information was available on the Internet to carry out the classification. The resulting sample turned out to be quite diverse so that it provides a good representation of the entire market.

Classification Criteria

Since the aim of our study was to distinguish systems from a user perspective and in regards to the support of E-Collaboration processes and not their technical background, characteristics like systems architecture were not considered.

Table 1. Catalogue of classification criteria

Group process	Communication			Coordination			Collaboration		
Types of communication	Text			Audio			Video		
	synch.	asynch.		synch.	asynch.		synch.	asynch.	
Shared resources and features	Discussion forum	Black board		Document spaces	Surveys		Online presentation	Application sharing	
	Address book	Group calender		Task list	Project plan		Resource management	Project controlling	
	Document distribution list		Workflow			Protocol			Whiteboard
System use	Continuous					Situational			
Role for group	Primary					Secondary			
Awareness	Informal Awareness		Group structural Awareness			Social Awareness			Workspace Awareness

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The following list gives a brief introduction of the classification criteria; table 1 provides a detailed summary[2]:

- *Group processes supported by the system*: Group processes can be distinguished according to their level of interdependency: Communication describes the process of inter-personal information exchange by means of various types of media. Coordination refers to aligning group activities in regards to joint activities, and collaboration describes the joint work on shared objects where people are jointly responsible for the outcome.
- *Types of communication*: Communication can take different forms and be distinguished by media type and temporal distribution. Depending on temporal distribution the three media types *text*, *audio,* and *video* can be differentiated in synchronous and asynchronous communication.
- *Shared resources and features*: Besides access to communication media most E-Collaboration systems provide a range of shared resources or features that support group processes such as electronic forums, blackboards, document spaces, application sharing facilities, group calendars, project plans etc.
- *Typical use of system*: E-Collaboration systems can further be distinguished by their typical use within the group, whether they are typically used continuously in a day-to-day fashion to support ongoing activities or whether the system is used only situational to support a specific activity.
- *Role for the group*: Systems that provide functions for the support of basic group processes are regarded as primary systems; they support the group members with all essential functions like for example e-mail communication or calendar functionality. Secondary systems provide additional functions that complement primary systems.
- *Awareness features supporting shared perceptions*: Compared with traditional workplaces distributed collaboration has several deficits in relation to the perception of shared activities (Jang *et al.*, 2000). To this end, E-Collaboration systems offer functionality to create what is called *group awareness* in order to bridge these deficits: „Awareness is an understanding of the activities of others, which provides a context for your own activities" (Dourish and Bellotti, 1992, 117). Four types of awareness can be distinguished (acc. to Greenberg *et al.*, 1996): 1) *Informal awareness* refers to the knowledge of the location and availability of group members. 2) *Group structural awareness* indicates the structural properties of the group. 3) *Social awareness* refers to the perception of others in a shared work environment. 4) *Workspace awareness* describes the knowledge of actions of others in relation to shared documents.

Cluster Analysis

Based on the criteria catalogue a sample of 66 E-Collaboration systems was classified. The resulting data was used to perform a cluster analysis using the statistical software package SPSS in order to uncover patterns of similarity between systems in the data set. A cluster analysis is an explorative analysis that typically involves an iterative process of applying different algorithms and interpreting the results in order to come to a result that is found meaningful with regards to the criteria. In doing so, the *Ward* method was used as the main algorithm with other procedures to corroborate the results. According to Everitt the *Ward* algorithm is a versatile method that in most cases promises interpretable results (1993). The method tends to the formation of clusters that are relatively homogeneous and in most cases signals the correct number of clusters (Everitt, 1993). Euclidean Squared Distance was used as the proximity measure, since it is suitable for binary data and also recommend in combination with the *Ward* algorithm.

A cluster analysis is deemed successful if the researcher, who is familiar with the data, can sensibly interpret the resulting clusters (Everitt, 1993). A good set of clusters shows homogeneous and clearly separable clusters. To identify the clusters dendrograms were used in combination with rearranging the classification matrix according to the set of clusters found in each of the analysis runs.[3] The first turn of applying Ward already delivered a well interpretable and almost satisfactory result. However, the resulting clusters contained some allocations that did not quite fit. It quickly became clear that all wrongly allocated systems where smaller tools that only provided a limited set of features. Hence, a total of 17 systems were separated from the rest of the sample to become the class of "specialized tools". Processing the remaining 49 systems using *Ward* then delivered a clear and unequivocal result. The dendrogram (see appendix A) shows three clearly separated clusters.[4]

RESULTING E-COLLABORATION SYSTEMS CLASSES

According to the cluster results the market for E-Collaboration systems can be divided into four systems classes. Since these classes are still quite large and contain a range of systems further sub classes were identified.[5] In the following, the classes are described using typical characteristics; for details and examples please refer to the resulting classification in appendix B.

Everyday Systems

Everyday systems are continuously used by the group as primary systems to support everyday activities. To this end, the systems provide basic features to support all three group processes - communication, coordination and collaboration. Everyday systems focus on asynchronous text-based communication; all systems offer e-mail as the primary type of communication; most systems also provide discussion forums. Other typical features are calendars, address books, task lists, and document spaces. The only supported form of awareness is workspace awareness in relation to documents in shared spaces. The class holds a total of 23 systems in five sub classes:

- *Client server groupware systems* have a long history in the market. Most systems descend from traditional e-mail systems offering typical functions such as calendars, address books, task lists. These systems are directed at middle sized to large enterprises because of considerable setup costs.
- *Web-based team rooms* follow a different philosophy. Access to the system is provided via an Internet browser. The core idea is to provide a shared online workspace. In addition to the typical features provided by Client server groupware they also provide discussion forums and black boards. The systems are suited for smaller enterprises; some providers offer ad hoc workspaces that can be rented by teams for the duration of a project.
- Although being similar to web-based team rooms in terms of features *Intranet systems* differ in their focus in that they are intended for enterprise-internal use. They supply typical Intranet features such as discussion forums and black boards. In addition, some systems support enterprise-internal processes by providing document distribution lists.
- *Document-oriented systems* have their origin in document management systems. Their main focus is on asynchronous collaboration on shared documents. To this end, the systems support document versioning as well as mechanisms for the structured storage and retrieval of knowledge objects.
- *Real-time systems* are a rather small sub class[6]. Beside the support of asynchronous group processes these systems also provide means of synchronous real time communication via Instant messenger as well as audio and video conferencing. A central feature is the presence information of the team members for the purposes of creating informal awareness.

Coordination Systems

This class comprises 13 systems that focus on group coordination processes. The systems are typically used continuously by the group members albeit as secondary system to complement everyday systems; typically they do not support the most basic group processes such as E-Mail communication. Typical features are document archives, group calendars, task lists, project and resources plans, project controlling, as well as document distribution lists and workflows. Most systems support group structural awareness that gives team members an overview of group structures, roles and competences in order to further support coordination. Three sub classes were identified:

- *Process coordination systems* focus on the planning, modeling, execution, and coordination of processes in teams and organizations. The systems are mainly specialized workflow tools but systems like Actionworks also offer a broader range of resources to support team coordination besides workflow support.
- *Project coordination systems* focus on the project as the main entity. In addition to project planning features, project coordination is further supported by project controlling features (i.e. to capture times and project expenses) and shared calendars, document spaces, and sometimes document distribution lists.
- *Task coordination systems* are used for day-to-day coordination mainly within enterprises, e.g. with the focus on field service coordination. The systems feature shared calendars to coordinate meetings, appointments, or client visits. The systems also offer a rudimentary project support by means of task lists or documents distribution lists.

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Table 2. Characteristics of systems classes

Criteria	Everyday systems	Coordination systems	Meeting systems
Group processes	Communication Coordination Collaboration	Coordination Collaboration	Communication Collaboration
Type of communication	Text asynchronous and synchronous	Text asynchronous	Text, Audio, Video synchronous
Shared resources and features	Group calender Address book Task list Document spaces Discussion forum	Group calender, Task list Project plan Ressource management, Project controlling Workflow Dokument spaces	Whiteboard Application sharing Presentations Surveys Protocols Document spaces
Use of syste,	Continuous	Continuous	Situational
Role for the group	Primary	Secondary	Secondary
Awareness	Workspace	Group structural	Informal, social, workspace

Session and Meeting Systems

Meeting systems comprise 13 systems that support online sessions and video conferences; they are used situational and as secondary systems. Online meetings are typically used for decision making or simultaneous work on shared documents. The systems are based on extensive synchronous communication such as audio and video communication. Other typical features are application sharing and whiteboards. Surveys can be administered to support ad hoc decisions and online presentations can be held to conduct online seminars. Awareness is supported to a significant degree in the informal, social, and workspace dimensions. Three sub classes were identified:

- Two of the systems in this class can be described as *Ad hoc meeting systems*. These are smaller tools that allow for the quick and uncomplicated initiation of conferences.
- *Standard meeting systems* offer all functions described above and thus support shared meeting sessions. Sessions and meetings can be planned using a scheduler.
- In addition to the standard features of meeting systems *systems with seminar capabilities* offer services for the planning and realization of online seminars and entire e-learning curricula. These seminars can be given by tutors or be recorded and provided for asynchronous use.

Specialized Tools

This class summarizes the group of 17 systems that only implement limited features to support computer-aided group work. Since this group is quite heterogeneous no common characteristics can be identified that are shared by all systems. Nevertheless, the following sub classes can be described:

- *E-mail systems* provide server functionality that allows enterprises to setup their own e-mail infrastructure.
- *Forum servers* support the setup of discussion forums, text chat or voice conferences. Enterprises can use these systems to open up communication channels for teams in an intranet environment.
- *Social software* describes a novel type of Internet systems that provide new ways of text-based collaboration. Popular examples are Blogs or Wikis. These technologies can be used in teams to facilitate discussions or joint work on text documents.
- *Team calendars* are web-based tools that provide group calendars to coordinate and schedule team meetings and project work.
- *Instant Messaging and A/V chat systems* offer synchronous text, audio and sometimes video communication. These are small software tools that hold a list of contacts (the buddylist), provide presence information, and facilitate the ad hoc initiation of conference calls.
- *Group editors* support concurrent work on text documents. The spectrum reaches from simple text editors to server software that enables the synchronous use of modern office programs.

CONCLUSION AND OUTLOOK

The market study has produced four systems classes and a range of sub classes that provide an overview of the fast growing E-Collaboration market. The systems were characterized using typical features and characteristics. The study provides practitioners with an overview of available systems classes and their respective focus in order to support investment decisions. Researchers who are interested in the development, use, and adoption of E-Collaboration systems can use the typology as guidance to structure their domain and as support in selecting suitable systems as research objects.

While the study illustrates the status quo of the market, two interesting trends emerged from our inquiries that are likely to shape future market developments. First, drawing from recent media reports, it becomes clear that there is a tendency towards integrating richer sets of communication media. This trend is fueled both by the popularity of Instant Messaging as well as voice-over-IP telephony. Today, with *real-time systems* already showing up as a sub class in this study it can be assumed that the trend towards real-time communication (RTC) systems will gain momentum. RTC systems are based on instant synchronous communication and presence awareness information and aim at improving availability and coordination in distributed work processes (Riemer and Frößler, 2006). Second, there is a tendency towards systems integration and convergence. On the one hand, a convergence of different market segments can be observed. A good example is the fusion of the markets for document management systems with traditional groupware; the *document-oriented systems* are a result of this trend. On the other hand, software enterprises like IBM, Microsoft or Oracle pursue strategies of systems integration which creates comprehensive E-Collaboration Suites. IBM for example is at the moment integrating its Workplace suite with its Lotus Domino products in order to create an integrated collaboration infrastructure that features characteristics of more than one of the systems classes described in this study.

Hence, a replication of this study in a few years time is likely to paint a slightly different picture with more synchronous media support and a range of integrated systems likely to show up in the cluster analysis. The proliferation of new types of integrated systems will create new research opportunities for researchers in the E-Collaboration domain.

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ENDNOTES

[1] The systems classification was carried out by three experts independently. A few deviations arose during the process of classifying; these were discussed and led to a more precise specification of the criteria.

[2] For detailed information on the classification criteria, background information on the study and additional material such as classification tables and dendrograms please visit our web site online at http://collaborate.uni-muenster.de/market-study.

[3] See appendix A for the final dendrogram and appendix B for a rearranged matrix for the final result.

[4] Two more procedures (average linkage and complete linkage) successfully corroborated these results. The resulting dendrograms were omitted due to space restrictions.

[5] Please note that the sub classes are not based on the cluster analysis and do not correspond with the dendrogram shown in appendix A; internally, the three clusters are too homogenous for the algorithms to come up with sensible sub classes. Rather, they were identified by the researchers using the classification criteria as well as other information such as the history and market positioning of the systems.

[6] Oracle Collaboration Suite qualifies both as documents-oriented and a real-time system (see classification in appendix B).

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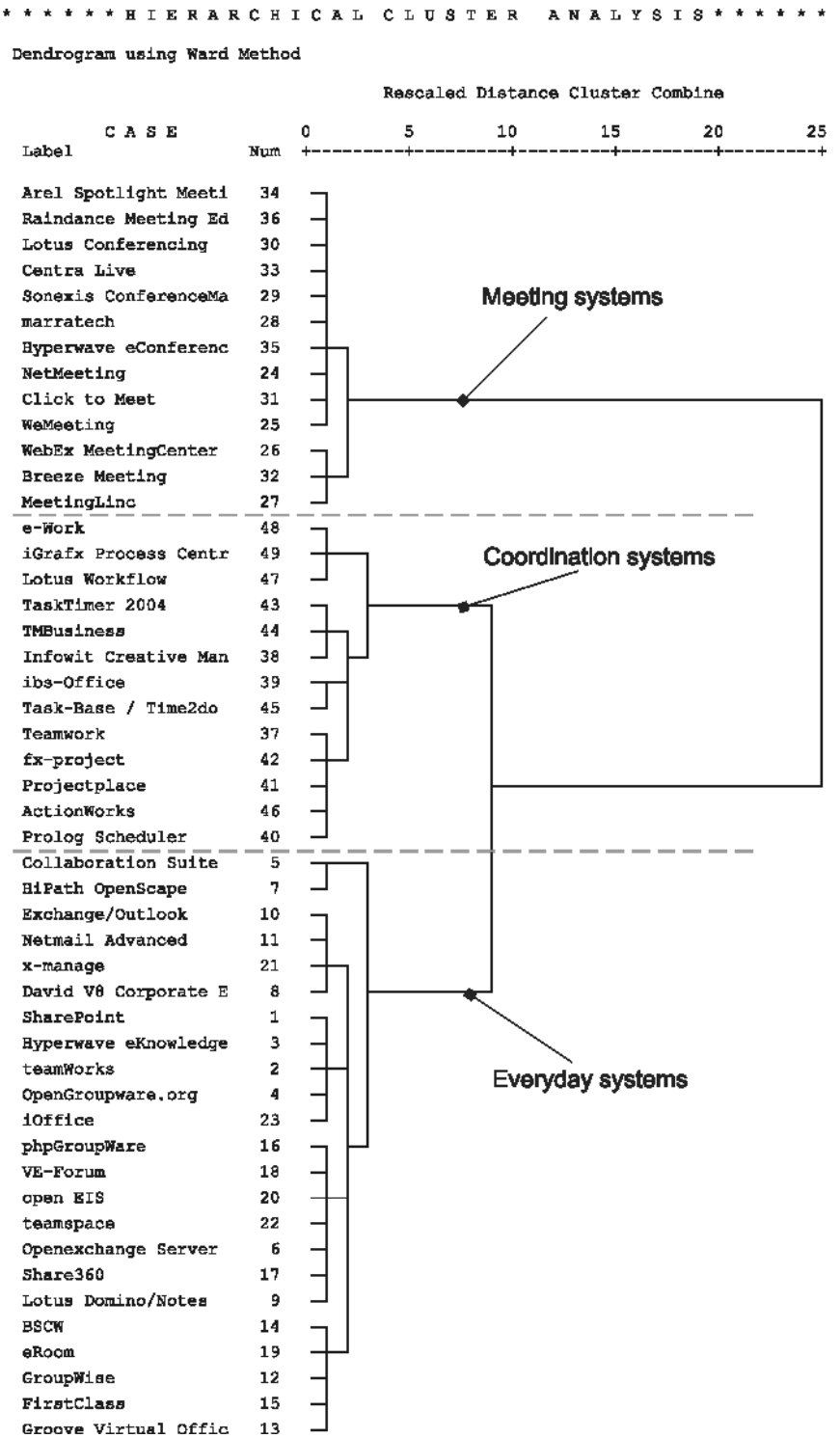
APPENDIX A: DENDROGRAM OF WARD CLUSTERING



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APPENDIX B: RESULTING CLASSIFICATION WITH SYSTEMS CLASSES

			Process			Use		Role		Type of comm.						Shared resources and features															Awareness			
			Communication	Coordination	Collaboration	continuous	situational	primary	secondary	Text/synchronuous	Text/asynchronuous	Audio/synchronuous	Audio/asynchronuous	Video/synchronuous	Video/asynchronuous	Discussion forum	Black board	Documnt spaces	Survey	Online presentation	Application sharing	Address book	Group calender	Task list	Project plan	Ressource management	Project controlling	Document distribution	Workflow	Protocol	Whiteboard	Informal Awareness	Group-Structural Aw.	Social Awareness	Workspace Awareness
Everyday systems	Client-Server groupware	Lotus Domino/Notes	x	x	x	x		x		x	x							x				x	x	x									x
		Exchange/Outlook	x	x	x	x		x			x							x				x	x	x									x
		Netmail Advanced	x	x	x	x		x			x							x				x	x	x									x
		Novell GroupWise	x	x	x	x		x		x	x							x				x	x	x							x			x
		Openexchange Server	x	x	x	x		x		x	x					x	x	x				x	x	x										x
		FirstClass	x	x	x	x		x		x	x		x			x		x				x	x	x							x			x
		David V8 Corporate Edition	x	x	x	x		x			x		x					x				x	x	x										
	Doc.-oriented	SharePoint	x	x	x	x		x			x					x		x				x	x	x										x
		Hyperwave eKnowledge Suite	x	x	x	x		x		x	x					x		x				x	x	x										x
		Collaboration Suite (Oracle)	x	x	x	x		x		x	x	x	x	x	x			x			x	x	x	x				x			x	x		x
	Real time	HiPath OpenScape	x	x	x	x		x		x	x	x	x	x	x			x			x	x	x								x	x		x	x
		Groove Virtual Office	x	x	x	x		x		x	x	x				x		x				x	x	x							x	x	x		x
	Web-based teamrooms	OpenGroupware.org	x	x	x	x		x			x						x	x				x	x	x									x		
		BSCW	x	x	x	x		x			x					x		x	x			x	x											x
		phpGroupWare	x	x	x	x		x		x	x					x	x	x	x			x	x	x											
		VE-Forum	x	x	x	x		x		x	x					x	x	x	x			x	x	x							x				
		eRoom	x	x	x	x		x		x	x					x		x	x			x	x	x	x					x					
		x-manage	x	x	x	x		x			x							x				x	x	x											
		teamspace	x	x	x	x		x		x	x					x	x	x	x			x	x	x	x										x
	Intranet systems	teamWorks	x	x	x	x		x			x					x	x	x				x	x	x				x							
		Share360	x	x	x	x		x			x					x	x	x				x	x	x											x
		open EIS	x	x	x	x		x		x	x					x	x	x				x	x	x											x
		iOffice	x	x	x	x		x			x					x	x	x				x	x	x			x	x							x
Meeting systems	Ad hoc	NetMeeting	x		x		x		x	x		x		x							x									x				x
		WeMeeting	x		x		x		x	x	x	x								x	x									x				x
	Standard meeting systems	Sonexis ConferenceManager	x		x		x		x	x		x						x	x	x	x								x	x				x
		WebEx MeetingCenter	x		x		x		x	x	x	x	x	x					x	x	x								x	x				x
		Raindance Meeting Edition	x		x		x		x	x		x		x				x	x	x	x								x	x				x
		Click to Meet	x		x		x		x	x		x		x				x		x	x								x	x				x
		Lotus Conferencing	x		x		x		x	x		x		x				x	x	x	x								x	x				x
		Hyperwave eConferencing Suite	x		x		x		x	x		x		x					x		x								x	x				x
	Systems w/ seminars	MeetingLinc	x		x		x		x	x	x	x	x	x	x				x	x	x									x				x
		marratech	x		x		x		x	x		x		x						x	x								x	x				x
		Breeze Meeting	x		x		x		x	x	x	x	x	x	x			x	x	x	x								x	x				x
		Centra Live	x		x		x		x	x		x		x				x	x	x	x								x	x				x
		Arel Spotlight Meeting	x		x		x		x	x		x		x				x	x	x	x								x	x				x
Coordination systems	Project coordination	Prolog Scheduler		x	x	x			x	x	x					x		x						x	x	x	x	x		x		x		
		Projectplace	x	x	x	x			x		x					x		x				x	x	x	x		x	x				x			
		fx-project		x	x	x			x									x	x			x	x	x	x	x	x					x			
		Teamwork		x	x	x			x		x							x					x	x	x	x	x					x			x
		Infowit Creative Manager		x		x			x		x					x							x	x	x	x	x					x			
	Task coordination	TaskTimer 2004		x		x			x		x											x	x	x		x	x					x			
		TMBusiness		x		x			x		x											x	x	x		x						x			
		Task-Base / Time2do		x		x			x		x							x						x		x		x		x		x			
		ibs-Office		x		x			x		x							x						x			x	x		x		x			
	Process coordination	ActionWorks		x	x	x			x		x					x		x						x	x			x	x			x			x
		Lotus Workflow		x	x	x			x									x										x	x			x			
		e-Work		x		x			x															x					x			x			x
		iGrafx Process Central		x	x	x			x		x							x						x					x			x			x
Dedicated, specialized tools	E-mail	IMail Server	x			x			x		x					x																			
		Sendmail	x			x			x		x																								
	Forum servers	phpBB	x			x			x		x					x			x																
		WebBoard	x			x			x	x	x					x	x	x												x					x
		SiteSticky	x				x		x	x		x																		x	x				
	Social Software	bBlog	x			x			x		x					x																			
		Blogger.com	x			x			x		x					x																			
		MediaWiki			x	x			x		x					x		x																	
	Cals	Wcal		x		x			x		x												x	x											
		Web Calendar		x		x			x		x											x	x	x											
	Instant Messaging & AV chat	Trillian	x			x			x	x	x																				x				
		Skype	x			x			x	x		x	x																	x		x	x		
		Teamspeask	x				x		x	x		x																			x				
		Eyeball Chat	x				x		x	x		x		x	x																x		x		
		Spontania4IM	x				x		x			x		x																	x		x		
	Joint edit	PabloDraw			x		x		x											x															x
		CoOffice			x		x		x											x															x

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