Adaptive Case Management: Overview and Research Challenges

Hamid R. Motahari-Nezhad

Service Computing Group
University of New South Wales
Sydney, Australia
hamid.motahari@ieee.org

Keith D Swenson

Advanced Software Design Center
Fujitsu North America
Sunnyvale, California, USA
kswenson@us.fujitsu.com

Abstract—Case management refers to the coordination of work that is not routine and predictable, and requires human judgment. Case management has applications in many domains such as healthcare, legal, police detective, social work, etc. The common aspect of such domains is that the work procedure cannot be prescribed into machine programs; instead the work is highly variable and must be figured out by knowledge workers each time. They might start with high-level guidelines and frameworks, but the sensitive dependence upon the details of the case mean that the work patterns emerge from the case as more information becomes available. Knowledge workers must make decisions on the course of action as the case proceeds. Traditionally case management has been supported by custom-built applications for each domain. There are approaches that attempt to standardize work practices without appreciating the full range of required responses. There is a push in industry from different vendors in areas such as enterprise content management, customer relationship management and business process management also to position their products as case management applications. In this article, we will review trends in industry and selected work in academia in the case management space, to identify challenges that the industry and the research community are facing in supporting knowledge workers in an adaptive and flexible manner, where systems need to support the work while should keep the knowledge workers in control.

Keywords— case management; knowledge work; best practice processes

I. Introduction

The landscape of work in the organizations has changed significantly. Over the last decade automation has been a major focus of organizations in IT and in other work segments. As the result, a lot of less skilled workers have given their place to machines and software [25]. Workers today spend less of their time on routine tasks, most of which are often automated, and more of their time on things that really require thinking, than was possible just ten years ago. The challenge today is how to support higher skilled modes of work: knowledge work. We can also call this kind of work "unpredictable work" because one cannot predict in advance the exact course of what will be done. It requires thinking in order to figure out what to do. The exact course of what needs to be done cannot be known in advance, and this is the central challenge to the traditional way of designing IT systems. The name "case management" is used to talk about an approach that supports the knowledge worker, without requiring that the work be constrained to a set of pre-defined actions.

Indeed, between 25% and 40% of the workforce can be classified as knowledge workers today [1]. Knowledge workers include managers, decision makers, executives, doctors, lawyers, campaign managers, emergency responders, strategist, and many others who think for a living. While extensive software and tooling support are provided for routine tasks, this has been less the case for knowledge workers and case management. The state of the art in technology support for case management can be described as systems of record, today. These approaches rely on people maintaining consistent information records, using disparate applications and manually tracking pieces of information related to a case across different systems. Substantial information related to cases lives outside the applications, often in the personal inboxes of knowledge workers without being linked to and shared with other relevant applications. This fragmentation makes it hard to reconcile case information.

As technologist, we are biased to see this change in the work landscape as a technology trend. However, what the current practice in case management needs to realize is that we are seeing a fundamental shift in our workforce, and in the ways they are managed. Not only are companies engaging their customers in new ways -- using social media, mobile computing devices, and social networks -- but managers are engaging workers in similarly transformed ways. The office is being transformed from an assembly line for the processing of forms, to far more agile and effective patterns for accomplishing organizational goals. While knowledge workers try to leverage recent technology developments in managing case work, there is a need for new approaches to support knowledge work in an integrated, flexible, worker-driven and holistic manner.

The term adaptive case management refers to managing the work needed to handle a case in a flexible manner by adhering to the principle of planning-by-doing, considering the work context, and the ability to accommodate changes in the environment and the work context [3]. Today, knowledge workers use a mix of applications (emails, communication, document and where applicable workflow management applications) and human work. Indeed, the majority of cases (74%) in Fortune 1000 companies are managed using multiple applications or are mostly done manually [3]. Some of the issues in this context include the fact that critical information to

the handling of cases live in disparate systems, information loss on workers' hand offs, workers who are not on sync, and the fact that communication and information exchange tools (such as email, chat and other tools used for sharing case information) are un-aware of the work context.

In this article, we provide a brief overview of case management historically and offer a framework for understanding the work spectrum in the enterprise (doing a comprehensive survey is beyond the goals of this paper). We highlight research challenges in supporting knowledge workers, and review few recent work and products that take initial steps in this supporting knowledge workers. We describe a grand vision for an architecture of software systems for supporting knowledge work. The rest of the paper is structured as follows. In Section II, we describe case management. Section III, we give a brief overview of the state of the art in case management. In section IV, we outline a high level vision on the evolution and the needs for supporting knowledge workers in different case management applications. We conclude in Section V.

II.   CASE MANAGEMENT

Knowledge work is work that requires thinking, skills and expertise. Knowledge work involves putting facts together like a detective. Knowledge workers make decisions like executives or managers. Knowledge work requires experience with the details of the situation in order to make the right plans. Knowledge workers include all levels of management; the lawyers taking a case to court; the judges that preside over those cases; elected representatives crafting new legislation; detectives following up on a crime; business people drawing up a new plan; IT professionals handling IT incidents, stock traders trying to corner the market; product designers determining the feature set for a new product; marketing staff deciding a media campaign. All of these require specific insight into a situation in order to make the right decisions for success.

Peter F Drucker made the first reference to knowledge work in his 1959 article [4]. He calls attention to the uniqueness of each knowledge worker's job when he describes a knowledge worker loosely as "*someone who knows more about his or her job than anyone else in the organization.*" Each knowledge worker may need to do things different ways, depending upon the specifics of the situation. Ironically, information systems have focused in past on making everyone work in exactly the same way.

In this context, case management refers to the practice of coordinating work in response to a request by organizing all of the relevant information into one place -- called a case folder, and acting upon the information to fulfill the request. The case becomes the focal point for assessing the situation, initiating activities and processes, as well as keeping a history record of what has transpired. Case management as a practice is not new; references to the term go back to the 1980s or earlier. The Case Management Society of America was founded in 1990. The term case management has been traditionally used in four predominant fields: health care, legal cases, police/detective cases, and social cases.

The increased interest in case management today results from two factors. First is the rise in the awareness that case management techniques could be used to support knowledge workers across a large variety of industries and domains. The rise of social networking has opened knowledge workers to modes of interaction beyond email, the possibility to associate various pieces of information to particular concepts or entities (here a case – as an example think of hash-tagging information with the name of a case). This brings about the second factor, vendor interest in providing generalized case management system products, which are designed specifically to support case management.

The term adaptive case management has been used to mean an extension in capability of such a system to support a learning organization, (Peter Senge www.infed.org/thinkers/ senge.htm). The term 'adaptive' has been dismissed by some researchers as being nothing more than a marketing term to hype products, which is why we need to carefully consider the precise meaning of this term. Case management focuses on a case folder, and as such even a primitive document management system can be considered a case management system. In the past two decades years, case management systems have been constructed using traditional programming techniques [5] which offer beyond folder capability a set of rigid, predefined actions that case managers use to process information or to communicate the specific state of the case to others.   A static set of actions can actually prevent organizational learning. Nassim Taleb argues that enforcing uniformity can actually make such organizations fragile [6]. Knowledge changes quickly [4], and a knowledge worker organization with fewer constraints can more quickly adapt to new situations. The term adaptive case management is used here specifically to refer to case management systems that have a specific set of features that allow them to be adapted at run time by the knowledge workers [7].

This is contrasted with production case management (PCM) which refers to highly specialized case management systems which knowledge workers cannot modify in significant ways. While ACM is a "do-it-yourself" system for knowledge workers, PCM is customized by professional solution developers into domain specific applications. PCM offers considerably more power in the ability to express precise actions that a user might take, possibly through use of a graphical language. There is even an effort within the Object Management Group to create an industry wide standard for this named Case Management Model and Notation (CMMN) [32].

The opposite kind of work to knowledge work, routine work, is predictable and repeatable and amenable to automation. Routine work is something that is done a particular way, over and over. A workflow management system [26] is an example of a system that facilitates managing routine processes. It is just a matter of time until all routine work becomes automated. Because knowledge work is not predictable, and therefore difficult to automate, we find that the work force has to shift to do more knowledge work. Across all industries, the percentage of routine work done by workers is diminishing and the percentage of knowledge work is growing. The working population is spending more time thinking, and needs more support for this.

A Business Process Management System (BPMS), which includes management components around a workflow management system, is a related technology which is often conflated with an ACMS. A BPMS is designed to support highly repeatable, medium to high volume business processes. BPM is focused on the exact sequence of activities, and generally aims to enforce a particular sequence. The goal of the sequence is built implicitly into the definition of the process. Case management focuses instead on the goal to be achieved, and leaves the determination of how to achieve that goal to the knowledge worker. While an ACMS may include guidance on how to handle cases (see [27, 28] for examples of intelligent assistance and recommendations that an ACMS may provide to its user to guide them), in contrast BPM routine tasks, the how-to specification cannot be devised in advance. Only an ACMS can support an emergent process which is designed while being performed.
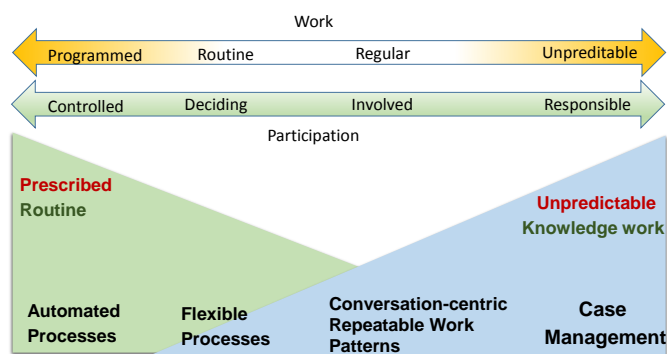

Figure 1. The spectrum of work

Figure 1 shows the classification of work in a spectrum of programmed, routine work to unpredictable (described as opposed to prescribed) that is commonplace in knowledge work (A similar classification is also reported in [29]). The characteristics of the work in the left is that the work and the process of handling it can be defined in apriori, the process can be expressed in process models, and it is automatable with controlled and apriori-determined participation of workers. While the work on the right cannot be fully defined apriori, the process is available in form of documentation in best practices, guidelines and framework, and the participation is in form of on-demand solicitation and collaboration. The automation of the work on the left leads to achieving efficiency, accuracy and transparency in how the work gets done. For the right hand side, technology is needed to support human workers to get their work done more efficiently and effectively rather than automating and removing the work from the workers.

In between, there is a gray area where from the left to the right, we face processes with a lot of exceptions and the need for changing or adapting the process in the course of the actions. A lot of work in the business process management space (BPM) is done to support flexibility and adaptively in the process definition and execution (e.g., [12, 13, 14]). Nevertheless, in its core, there is an assumption that there is a process to begin with. On the other hand, moving away from the right hand side of the spectrum, there is work that is not completely unique and un-predictable every time, and there are

work patterns that can be identified for a good part of the case management. A number of tools and efforts in the computer support cooperative work (CSCW) can be attributed to brining structure in collaboration tools to support repeatable work patterns such as turning emails into productivity tools [21, 22, 23, 24], PCM (production case management explained earlier) and tools supporting the software development practices for developers, designers, testers, product managers and in some cases involves customers.

An orthogonal aspect in characterizing case work (that is not captured in Figure 1) is data aspect, whether we work with structured or unstructured data [15]. The work with a combination of structured processes and structured data is a prime candidate for automation. Work with structured processes but unstructured data require effective content management with respect to the process stage. Supporting knowledge work with structured or unstructured data is challenging, today.

III. STATE OF THE ART IN CASE MANAGEMENT

We can look at the space of approaches and technologies that aim or are marketted for case management in few categories: work that advocates making business process management solutions and approaches more flexible, content management solutions that push for bringing more work structure into the solution for case management purposes; customer relationship management solutions that aim to upgrade their customer point of contact solutions into handling customer requests by integrating with other tools such as document management and communications tools; and collaboration and office productivity tools that support coordination and collaborations among workers in the enterprise and push to capture more information about cases. We will briefly give an overview of each category in the following.

A. Business Process Management Hybrid

It is not within the scope of this document to discuss BPM systems in depth, and there are other good surveys in this space w.r.t. case management practices [1, 2]. In the products space, there are a number of vendors that claim to cover both the BPM and case management realm. Pegasystems (*www.pega.com*) offers a BPM suite which also gets high marks from industry analysts in the case management space [16]. Appian (*www.appian.com*) offers a suit of BPM solutions that have accommodated a great degree of flexibility for case management applications, where there is some work practices that can be captured in terms of processes. Cordys offers the Business Operations Platform (www.cordys.com), also available from Fujitsu. Kofax (originally Singularity) is another leader in offering BPM-focused case management solution provider, which includes both BPM and case management modules. (http://www.kofax.com/).

Case management has received attention in the academic BPM community. As one of the early works in this space, van der Aalst, et al., [8] introduced *case handling* as a paradigm shift in office work management and recognized both data and process as first class citizens as opposed to workflow

management which focuses on the control flow perspective. Approaches and tools such as FLOWer [9], ECHO, the Staffware Case Handler [10], COSA Activity Manager [11] are other pioneer work in this space, each of which focus on a specific domain or product for case management. However, these are focused on offering flexible BPM solutions at the product levels. Related to these efforts [12, 13, 14] are literature on adaptive business processes. They focus on supporting knowledge workers in environments in which there is a process definition at some level of abstraction that is detailed or can change on the fly after definition, and possibly during execution.

The artifact centric approach for business processes represents a class of approaches [17, 18] in which the state changes and evolution of business artifacts are considered as the main driver of the business process. This approach is related to case management as it recognizes the data as the main driver of the work. However, there is an assumption on the existence of a predefined process on artifacts. In this approach, the process model is defined on the lifecycle of artifacts and the interactions among the lifecycles of objects. While the data is considered a first class citizen in case management applications, the process aspect is at the same level of the data and may not be defined for each different artifact. In addition, the process may not be defined apriori.

B. Social BPM

Recently the topic of social BPM has received a lot of interest in academia and practice with the rise of social media. Most approaches by BPM vendors or research offer extensions for business process models to represent tasks that can be exposed in social networks, or special types of social tasks for increasing participant engagement in applications such as voting, ranking, etc. [19] offers a model driven approach for generating code for tasks in popular social networks such as Facebook and LinkedIn. They also offer an extended business process management engine to support such tasks. One point to note is that the current effort has focused on supporting traditional workflow applications in the social network environment [31].

In [20], authors present an approach for supporting case management in the social network environment, which represents case, process, task as first class citizens in the social network (having their own profile and adopting a publish-subscribe model so that they can emit update events for network users), and includes provision for collecting and analyzing feedback about the usage of process, task and artifact entities, offering intelligent assistant to support case workers in finding similar cases and making recommendation on the next steps to take based on the steps taken in similar cases. This approach and tooling present a unified tooling for collaboration and communication of knowledge workers and management of tasks which their output can evolve as new information become available during the course of handling a case.

C. Content Management and Customer Relations Management Solutions

Content management solutions such as EMC Documentum (http://www.emc.com/domains/documentum/) have recently extended their functionalities to introduce more structured management of content towards supporting case management. IBM Case Manager (http://www-01.ibm.com/software/advanced-case-management/case-manager/) is another case management system that evolved from a content management system (in this case FileNet, acquired by IBM), which also integrates people, process and rules. A number of customer relationship managements such as Microsoft CRM have created integrated offerings with other solutions such as Outlook, chat client, windows workflow foundations and MS Sharepoint to support case management. The report in [30] describes a case study in a customer pilot where Microsoft CRM has been used for case coordination and management.

D. Task Management integrated with Communication and Collaboration Solutions

Apart from usual to-do list that is used in case management by knowledge workers, there are websites such as do.com, and asana.com that offer group-based task and document management in a more flexible and collaborative manner, compared to a workflow management system. There have been several efforts in capturing the work that people do over emails (for example [21, 22, 23, 24]). Some of them such as TaskMaster [21] and ActiveInbox [24] suggest turning the user email inbox into an active task management application. There are also email clients such as Outlook that allow defining a task based on an email in the inbox. However, these approaches are limited to task management, and the user needs to actively manage their inbox as a limited-version workflow application.

E. Social Business Technology, Enterprise Social Technology

Coming purely from the social space, there are a number of entrants on the market that allow people to make a space for collaborations. Salesforce Chatter (www.salesforce.com/chatter/overview), CISCO Quad (www.cisco.com/web/products/quad/index.html), Yammer (yammer.com), Jive (www.jivesoftware.com) and TIBCO Tibbr (www.tibbr.com) are example of microblogging capability like Twitter except designed for use inside the enterprise to share status and content. These systems become useful for case management when they include ability to express and track goals/tasks and cases. Modeled on a simple to-do list model deployed in the cloud, these tasks can be assigned to others, have due dates, and can automatically notify people about changes in status. Good examples include Trello (trello.com) and Box.net, and DropTask (droptask.com).

F. Adaptive Case Management Pure Play

Because most of the IT industry is focused on automation of the office, and because the traditional IT customer is looking for development and automation technology, to get to a real adaptive case management product, you have to look outside the main stream systems vendors. What you find is a great variety of approaches, no two exactly the same. Isis Papyrus (www.isis-papyrus.com) starts from a complete document

management capability, but added rules, event, and triggers. Consilience International (www.ideate.com) offers Ideate, a software framework to develop collaborative applications through direct manipulation of artifacts and a focus on being context aware.

IV. NEXT GENERATION CASE MANAGEMENT SOLUTIONS

Already there are many flavors of case management applications such as simple of task and to-do-list management, and more advanced case management with tasks, processes, rules and events. We expect this trend to continue and more case management solutions may become available, and the existing ones to evolve to offer case management for specific application domains. This is due to the wide spectrum of work that can be considered case management by different people (see Figure 1). Thinking forward, we can envision a world where people in all industries are using various case management technologies. Even if the case management that they use is deployed in the cloud, because of the way that all business processes are ultimately cross connected, it is unreasonable to assume that all people will be using a single case management provider. These systems need to be able to exchange information about cases because case participants are increasingly brought together from multiple organizations.

Similar to email protocol, which is a universally adopted protocol for exchanging messages, there is a need for a case-to-case protocol that allows for synchronization from one case provider to another case provider. This protocol may follow the same goals and principles of WfXML protocol (www.wfmc.org/wfmc-wf-xml.html) proposed by the WfMC as an interchange protocol for BPM engines. WfXML works by offering a web address for every process instance which can be accessed in a REST oriented way.

We expect that next generation case management solutions to support more personalization, context identification and using it to offer intelligent assistance and guidance to knowledge workers. Offering solutions with these two features are very challenging. In particular, the current workflow and process management solutions are focused on the business and the work at hand. However, handling cases is more about individual workers who drive the work, and the tools should provide facilities to the knowledge worker to organize their work and drive it. In terms of context identification, the next generation tools should be intelligent enough to bring the right and needed information to the knowledge worker in the right time in a proactive manner (e.g., recommend course of action, identify new relevant sources of information that may impact the decisions made in the course of a case, etc).

For cases, we envision any case management solution to support a basic architecture that enables supporting defining cases case consisting of three types of resources: documents, notes, and goals, and a framework for flexible task management supporting the fulfillment of the goals by knowledge workers. "Documents" (or artifacts) are simply documents categorized by MIME types, and read by independently installed application software. New document types can be included at any time, and participants get access to documents based on their role in the case. "Notes" are like

small documents, but their schema is either very simple (purely text) or exposed as an XML schema or an XBRL (www.xbrl.org) Taxonomy, which is a language for exchanging business information. Case management systems would thereby exchange structured and semi structured information. The notes can include comments that participants leave on the documents or goals, as well, or information in chat sessions or emails that are exchanged related to the case. Goals are fixed structure expressions about what needs to be done, and the status of those activities. These elements may follow a structure similar to the one specified in BPAF (www.wfmc.org/business-process-analytics-format.html) which is itself an extension of RSS with attributes to talk specifically about activity state in standard ways. Task management framework in support of case management application may get a variety of flavors depending on the domain and the industry, ranging from those, more informal approaches, defined on top of communication tools or dedicated tools that manage and track the commitments and task exchange among people and their relations to case goals.

Each user should have access to a view of a case instance. That view may include access to all parts of the case, or to a subset of that. The view becomes the basis for bidirectional synchronization between two case instances. Synchronization does not automatically assume that the synchronizing software has complete access to both parties. Because this is implemented as a protocol, a clone of a case may contain only a subset of the original case, and the original case can enforce that. Similarly, the cloned case may have additional roles and documents that the original case does not have. This will allow systems controlled by different parties to cooperate on the completion of the goals of a case, without having to use the same system, and without having to trust the other completely.
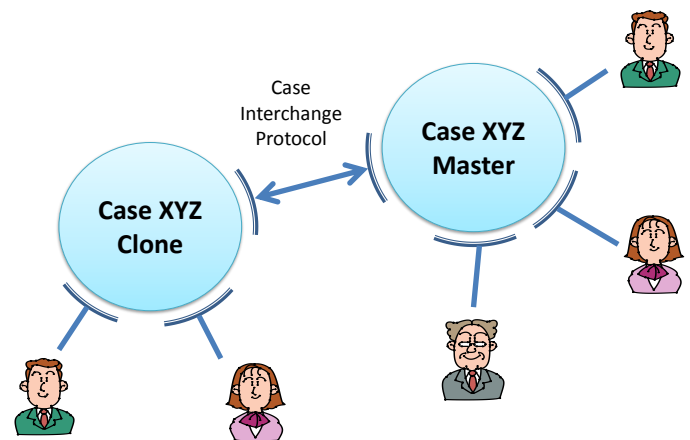
Figure 2. A schematic representation of case interchange protocol

Such a protocol speaks only about the current state of the case and artifacts, but not about the support for automated process hidden within the case. An external viewer can find out the current status, but not about what is necessarily to come next. There is no need to communicate the process diagram that describes the relationships among tasks. This allows ACM with an emergent process to communicate with the more

structured PCM and BPM. The documents, notes, and goals are common artifacts across these three domains. It seems likely that such an exchange format will become very useful.

V. CONCLUSIONS

Today, around 40% of the workforce can be called knowledge workers, and that number is growing. Never before has there been a systematic approach to making managers, executives, and other thinkers more effective at getting things done. The current knowledge workers will need to adopt this, or risk being replaced by the new people entering the workforce. As Drucker says, knowledge worker productivity is the biggest of the 21st century management challenges, and it is likely that case management will be a part of addressing that challenge in the next decade.

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