Workflow tasks on disconnected environments with mobile devices

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Introduction

Today and increasingly more in the future are arising new paradigms from the permanent change in the market of information technologies and communication. Daily we are confronted with new products and services to mobilize the business, which change the very way of working and living, something as well important are the constant evolution of mobile devices like PDA, the scope and speed of connections including 3G offered by mobile operators, and mobile data-bases. Another motivating factor is the growing number of mobile users around the world, as shown in the five-year study conducted by IDC (1). In these devices companies can find competitive advantage for business, particularly on cost reduction, quality and efficiency of the services and streamline their business processes.

To introduce the context where the problem lives we may relate several instances in which employees of various companies need updated information on the field, out from company boundaries, information like customer data required for a seller, tasks to be performed by a worker, data collected on site by a responsible supervisory and the junction of the three in more complex cases. This type of connection is usually done by low efficiency traditional tools like the telephone and the paper reports. In addition to this the fact the tasks of gathering information and the subsequent insertion of the same in the back office system, are made by different persons making it a greater likelihood of transcription errors.

One example is the case in which I will focus the attention of my research, it is the operations carried out in the forest industry, where only traditional tools are used without any automation or technology, in this example is especially evident the absence of network connection, which is the fundamental problem encountered.

This study was conducted at Link Consulting SA Company under coordination of Professor Pedro Manuel Moreira Vaz Antunes de Sousa, from Department of Computer Engineering of IST, and co-ordination of Engineer José Manuel Fonseca Roll.

Problem

The problem discussed in this dissertation is:
Lack of support to perform tasks of a workflow on disconnected environments with mobile devices

This problem is facing particularly in forestry, where the network coverage in the middle of the forest is scarce and often nonexistent. Depriving the use of automated tools for data collection and to control operations, in conclusion, everything is done with traditional tools of low efficiency and high number of errors.

To have a system where the mobility is not a constraint, allowing the assignment of tasks and distribution of data on disconnected environments or partially disconnected, are found several problems with the hardware as well as with the existing software. The factors presented below are the main constraints and that in turn generate other problems around the main problem.

Small screens for complex applications, as well as the mechanisms for inserting data tend to be smaller and less ease of use comparing to a desktop or laptop computer.

Normally all the mobile devices have a processing power and storage noticeably weaker than a server or desktop computer, preventing the installation of heavier applications, including a workflow management engine to support all the business logic of an workflow. And in the case of forest exploration it’s even worst because there are important factors like robustness of the equipment and autonomy that penalty a lot of processing power and storage.

There are a big variety of PDAs devices, resulting in heterogeneity in operating systems, support for programming languages, and their mechanisms for entering and viewing information.

Workflow management systems and other information systems restrict, by rule, access to resources that lie outside the premises of the organization. When there is support, the workflow management system demands that mobile devices are connected all the time in which they are doing the tasks, making it impossible from the standpoint of software to interact with resources in disconnected environments or continue tasks on breaks of connection.

Objectives

In this sense I propose to find a solution that will integrate the workforce with their work in environments without network, depriving the connection with the back office systems, mainly workflow management systems. I will focus my solution in the case of the forest, and focus on the tasks to support data collection and monitoring of operations. The focus in this work aims at finding a solution for this niche market.

Having regard to the problem and the needs desired by users disconnected from a workflow management system in the forest, summed it up and wrote up the most important requirements in order to serve as a guide. I identified the following functional requirements:

- Automate the distribution of tasks to the different resources in the field;
• Provide an indication of the location and description for each job;
• Allow record of data locally at the time of completion of tasks;
• Provide services to update the system back office;
• Interface suitable for PDAs;
• Ability to work in disconnected mode;
• Provide locally persistent storage;
• Provide autonomy to avoid conflicts between all workforce at the time of synchronization with the back office;
• Appropriate mechanisms for sending and receiving data in order to maintain the integrity of information.

State of the Art

All work found that include support for users outside the organization's facilities are divided into two different methods of operation: online solutions and some solutions that allow some work in disconnection mode with some mechanisms of synchronization. The online solutions are those that are normally accessible on mobile devices through a simple browser, such solutions do not have any logic on the client side, preventing it from carrying out any operation in the absence of network. Since the online solutions do not solve the problem inherent to this research, they will be discarded and will not be made any reference to them in this document. The solutions of interest are those that have some simple logic on the client side and allow to perform the same work regardless of network conditions, work that is later synchronized with the back-office applications like workflow management systems.

Next I will do a brief critique on the state of art and found the nuances aside for the implementation of the solution.

One of the most referenced documents in all scientific papers involving customer support in disconnected environments is Exótica, and I realized this, because it is a simple solution with good theoretical ideas, with three details that make it bad practice and scarcely used. These details are expensive and old IBM technology, lack of support for mobile devices and finally the need of an preparation phase before disconnecting, making the solution useless on a unexpectedly disconnect, but good ideas are there. The simple changes made only to the existing workflow client to support disconnections, to add persistency to this, as well as the mechanisms to start the process of disconnection and mechanisms to synchronize data later (1).

Regarding the INCA I think it's too complex for a solution to apply in the forest exploration, and the fact that a P2P architecture raises the issue of control, and contrary to what I might think does not increase the collaboration between users, since they cannot be making two tasks the same workflow in parallel, and finally as a key point supports mobile devices is quickly discarded, leaving only the vision to make one possible link between P2P client for collaboration of users that works (2).

In order to create one solution using the Magi, we have another complex system with a thorough use of Apache, I found it very difficult
to apply. The use of bookmarks (bookmarks) with cache pointer beyond simply is not intuitive, and this is the way used to support the disconnection. Designed for tasks that will evolve only exchange of documents, all other functions more related to task management and workflows are not implicitly supported, just with some development work (3).

The CosmoBiz is another scientific paper with a solution similar to the Inca's presenting the same problems, there is no centralized control makes it impossible to perform tasks in parallel in the same workflow, and does not support mobile devices, which also leads to discard its use (4).

Described next is a document that presents an interesting solution, controlled by state machines. The whole process of doing a task goes through several states. In case of disconnection all the tasks in progress and those that take place in disconnected mode have a state machine that needs to be kept pending until a new connection is on. With the conduct of many task this will increase memory consumption linearly, making the device slow, specially mobile devices, long periods in the absence of network. This solution is also based on IBM products, that fact makes its price high and difficult to access for testing and future application (5).

Another ancient reference like Exótica, whose use is not feasible it is an outdated UNIX solution. The only point of interest is the nuances that you could make the system caches this in Coda, type of client server, and a centralized data manager caches on each client.

The solution called WHAM reported, says that support disconnection in the document, but is not explained how this support is accomplished, I suppose it is some persistence on the client side somehow managed by proxies in the paper. It's another of the developments at IBM, which I had no access to test or get more information (6).

**Solution**

The following Chapter is to explain to the reader the solution I found to address the problem and the architecture and operation of developed framework for the interests of forest exploration.

None of these state of art solution seems to be ideal, at the end of the search for the state of the art, taking into account the problems of the solutions previously criticized, I concluded that creating a versatile and extensible framework, using latest technologies, with a simple operation, that allows easy integration with information systems, including workflow management system, would be the step to take.

![Figure 1](image.jpg)

The solution is simple, make a persistent worklist available in the PDA, and synchronizations are done through data base, as well as integration with back office system, Illustration figure above. It consisted in
designing and implementing a mobile system consisting of a fixed station and several mobile stations. The fixed station serves as middleware between the workflow management system, located in the back office, and the mobile station. In addition to implementing a mobile system that connects with the workflow management system, I also have some restructuring on the part of business processes in this document in order to support a wider range of tasks.

This system developed possess a fixed station where is all the middleware connection between the workflow management system, and the mobile station. It also observed the presence of several mobile stations that have the application to perform tasks and their worklist viewer. The communications are made, usually between the fixed station and mobile station through WCF services, communications between the management system and workflows middleware is done through a specific adapter.

The need for some manipulation of business processes exists in order to promote greater support in case of disconnection. Also, here are also identified some instances of business processes to avoid. In the first instance this is possible since there isn’t great complexity in activities that are carried out in forestry. The activities are mainly collection of data on the forest for forest inventory and the values recorded during the inspection of cargo operations, these tasks can be viewed as dynamic questionnaires, different for each task.

![Figure 2](image)

Figure 2

All activities sequences that are the responsibility of the same resource, should be merged into a macro activity due to the fact that the second task of the sequence becomes available in the worklist of the user after the execution of the first one and the synchronization with the same system management workflows. An example is the activities A and B in the diagram below, which are the responsibility of the same resource must be merged into one more complex.

Referring now to avoid cases, it is important to highlight those where there are several tasks of the user’s responsibility scattered in a workflow, interspersed with those from other users, due to the increase of waiting for synchronization. An example is the existence of a mobile user assigned to tasks A and C. Thus, user B will have to wait a synchronization of A that can only happen at the end of the day. The tasks should only be mixed if there is need for data, otherwise it should be in different branches.

**Architecture**

The architecture implemented in this framework it is a client-server architecture, between the mobile station and fixed station. The server (fixed station) communicates with
the workflow management system via an adapter.

![Diagram](image)

**Figure 3**

In the case of application in which this document focuses, both providers, the fixed station and mobile stations are of type Data Base, being a case of common type was used a predefined type from the Microsoft sync framework.

The application made to the mobile device will be the same that will be used in the field. It was developed to run on PDAs and have the essential role of providing to resources his worklist and a report editor in the field for dynamic data collection. With persistence storage this allows the independent operation in the absence of network and performs synchronization in the presence of the same, some screens can be seen on the next figure.

![Screenshots](image)

**Figure 4**

The software in fixed station exists essentially to bridge the gap between the client application, present in the mobile station, and management workflows system. This application exists to minimize the complexity of implementing the software in the mobile station and to create an independent relationship between the workflow management system and client application. Also is responsible for providing services to enable the synchronization of mobile devices to operate in the field. Accordingly, new tasks are transferred to the mobile station and complete tasks for the fixed station, as well as all logs associated with these operations.

Communication between these applications will be made primarily by the 3G and Wi-Fi networks using Web services available on the middleware. In a local application, a 2-tier architecture (Client-Server) would be ideal to sync, but since these are mobile devices, it is necessary to create a 3-tier architecture with a WCF Service Library middleware used.

All synchronization is done via the Sync Framework, available from Microsoft.

**Conclusion**

For those objectives, it can be argued that in part have been met, others work out short from expectations, probably due to lack of resources or time. Then the fulfillment of these objectives or not, will be explained in more detail.

- Automate the distribution of tasks between the different resources in the field;

The distribution automation task was not made, being therefore dependent on the
workflow management system. There is no optimization of the context of mobility interconnected locations.

• Provide an indication of the location and description for each job;
The indication and description of the location and description appears as a parameter of a task and it’s possible to use for geocoding and route optimization and tasks in future work.

• Data collection at the time of completion of tasks;
You can make a collection of data at the time of execution of tasks through the client application, it generates dynamic questionnaires, information is stored when these are populated, regardless of the state of the network.

• Provide services to update the system back office;
The Synchronization is made by Microsoft the Sync Framework, which synchronizes data between the base of mobile middleware and database.

• Interface suitable for PDAs;
All was developed specifically for Windows Mobile with regard to the resolution of the equipment that will be used later in the project CAM Tec.

• Ability to work in disconnected mode;
As already mentioned, performing tasks available on the worklist can be made in the presence or absence of network, thanks to persistent storage.

• Provide locally persistent storage;
Persistent storage was handled by a Microsoft SQL database compact.

• Provide autonomy to avoid conflicts between all workforce at the time of synchronization with the back office;
Each task is made available to one user only. When someone syncs it becomes responsible for it, with no conflict from this point on.

• Mechanisms for sending and receiving appropriate to maintain the integrity of information.
Sync Framework ensures data integrity. In addition, the completed tasks are erased from the mobile device only after a successful synchronization.

Finally, it can be concluded that the solution is well suited to the problem found in forest exploration. If you need more business logic on the client side, the most appropriate procedure would necessarily be different, implying a more complex solution, with associated rules, or decomposition of tasks into mini workflows within the mobile device, with a view to achieving immediate feedback from the user about the steps taken and an indication of the steps to be taken.

**Future Work**

As future work and continuation of this work there are some directions that can be followed in order to give more value to the developed framework.

One step would be to increase the potential for synchronization allowing the sharing of data between multiple mobile devices to maximize the use of the framework in disconnected
environments and minimize the load on the server. Enabling the sharing of data between new users as well as synchronization of data from the server, could thus perform sequential tasks in the absence of network case users have connection between them. Taking advantage of the potential from short distance connections such as Bluetooth and Wi-Fi LANs.

A more complex direction would be to export business logic to the mobile device, making client application able for completing one task and start a new one sequential in the same workflow.

Another way forward would be one of the solutions described in the project report, when the synchronization is made are discharged the tasks assigned to the resource and the difference is what the client application does on receive. When the task is received in the solution created in this work is visible in a workflow task of the client application, the other direction and possible future work would be to have one sub-workflow in the client application associated to the task received. Automatically on the arrive of an incoming task its fires an event that starts an instance of a sub-workflow. Upon completion of the sub-workflow results the data stored during the process is used to complete the task data to be sent back to the BackOffice application.

Above figure is a schematic illustration where it is represented an overview of both solutions. Task B is passed to the PDA via the Integration Module. In solution with workflow, the task originates an workflow with tasks B1, B2 and B3 for example, while the simple solution is presented the same task B in the worklist. After you run the workflow or task in the PDA, information is stored and passed to the integration module on the next synchronization.

Finally, with a vision to integrating more technology would be of great interest to enable the client application through the geo-referencing of a GPS receiver in the mobile device. Therefore making it possible to indicate the venue of tasks as well as integrate with a
navigation system to indicate the route to take to these.

References


