TASK MANAGEMENT AND ITINERARY PLANNING
An Integrated View based on Multi-Agent Systems

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Abstract: The main objective of this paper is to describe the framework of an agent-based agenda manager. The technology herein presented is intended to be able to assist a user in his/hers every day's life, supporting all aspects of activities to be carried out in different places and times. Differently from other tools with the same ability, our agenda agent goes beyond the simple task of managing activities and their common attributes, such as date, time and place at which an activity is to be performed. Profiting from all potentials offered by mobile communication and portable devices, activities must now be assisted throughout their whole lifecycle, meaning the user will be able to optimize his/hers daily agenda including journeys he/she must make between places of two consecutive activities. This paper reports on the first steps towards the specification of the whole multi-agent architecture for an agenda management system, accounting for real-time and geographical distribution constraints that are inherent in this kind of systems.

1 INTRODUCTION

In today's hectic world, professionals in various areas of activity have to multiply themselves into many individuals (as if that was possible) in order to manage their professional and personal lives. Indeed, life today is extremely demanding and professional, as well as personal activities are usually meshed up and overlapped, which increases conflicts of interests that must be minimized when tasks and activities are being planned. Our goal is to conceive a system offering the adequate means to blend their personal and professional agendas, accounting for their geographical distribution and allowing fast and dynamic adaptation as the day evolves.

Thinking of different potentials of such a system, it is easy to identify ways in which it could contribute to the alleviation of the stress associated to dealing with several compromises simultaneously. For instance, many companies depend on delivering or receiving products and this depends on one's ability to transport something somewhere as quickly and efficiently as possible. Current technology already offer us devices that make everyone's tasks easier by calculating the best routes according to traffic information, thus saving time that can be used in the accomplishment of other tasks.

Companies also have a huge to-do list which has to be performed throughout the day, week or month, accounting for the various constraints each activity will impose. Managing such individual characteristics of every single task on an integrated and optimal basis represents a time-consuming task anyone would like to avoid.

Some tools, however, are frequently applied as an attempt to better manage activities and their constraints. Not surprisingly, many people still find great use in old-fashion agendas, where tasks are listed and contacts are maintained. Certainly new technology has already proven to be a fascinating way to turn these agendas into a more productive and efficient way to manage duties. They have been incorporated into our desktop environments, electronic mail applications and more recently have they proliferated among portable devices such as PDA and mobile phones. These applications have the ability to organize one's day, week or month, to set up an alarm on/off to warn us of a certain event, to set tasks' relative importance, or even to integrate information among different thematic agendas into an integrated environment.

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However, all afore mentioned gadgets require a frequent interaction with the user that needs to explicitly set up all attributes and task information so as to make them work properly on his/hers own benefit. Another factor that increases even more the complexity of such a scenario is the fact that many tasks are generally geographically distributed. This implies the user needs to plan journeys between activities that are to be performed in different places. In tricky situations when no time is left for the user to plan an itinerary in advance, he/she is at risk of arriving late at a certain activity. Thus, managing activities is much more than just avoiding time conflicts or ordering them in an optimized way. It will involve planning itineraries between tasks as well.

Our goal in this work is to devise a system capable of integrating all aspects related to task management and itinerary planning as a way to improve daily agendas, taking into account user's preferences and performance measures. We will rely on the concept of autonomous agents and multi-agent systems to provide us with the necessary architecture to implement such a system. Technologies such as GPS and route guidance systems, as well as contacts and calendar tools will be used in the conceptualization of our framework, which is expected to contribute for a reduced stress and better quality of life.

2 RELATED TECHNOLOGIES

Let us take a look at the most common structure of an agenda management application nowadays. The user has to input the task's or the event's characteristics and has to manually format them. For example, if we use applications such as Microsoft Outlook or Mozilla Sunbird, we have to introduce the duration of tasks, their frequency (if it is a daily, a weekly or monthly task), the location, if we want a reminder or not, when this reminder should be set on/off and so forth. Also, once the task or event is completed it is up to the user to check the calendar entry as completed or if one was not able to complete a certain task, again, it is up to the user to postpone the calendar entry.

These applications have the possibility to be synchronized with a cell phone and/or PDA which give the user a certain mobility freedom. However, they are not clever enough so as to self adjust according to the user's needs.

The scenario given above has been addressed in several research works. For instance, Berry et al. (2006) devised the PTIME agent that is able to learn from its interaction with the user in order to improve its agenda. The multi-agent approach has also been applied to this kind of domain with relative success, as in (Modi et al., 2005). In most of these works, however, authors are focused on scheduling rather than on managing the whole life-cycle of tasks, including their geospatial constraints as well. Our approach then differs from the others as we focus precisely on the integration of tasks scheduling and their in-between route planning.

Imagine someone who has a family with children and works somewhere. This person wakes up early in the morning and has to plan the day. He/she has to leave his/hers children at school, go to work, visit some clients, meet other companies' representatives, pick up his/hers children at school and fetch some house supplies on the way home. Some of these tasks are performed on a daily basis, like taking the children to school and picking them up, for instance. But others are sporadic, such as stopping to buy some groceries on the way home. Some are predicable, such as having to meet some clients but others are not, as having an urgent meeting at the company.

Bearing this picture in mind, consider that this person has his/hers calendar with everything he/she has to do during the day, week and month ordered in a certain preferable way. While arriving at the office, he/she finds out that a meeting has been postponed but he/she has to go somewhere to meet another client. By introducing something like "meet client X at certain place A," an intelligent calendar manager could connect to the Internet. Using an application such as Google Maps and receiving his/hers GPS coordinates, the system computes a route from his/hers current workplace to the exact location where the meeting is going to take place. Arriving at the destination, the calendar manager knows the user is a bit early and recognizes some grocery shop in the surrounding area and suggests he/she might fetch the groceries as an attempt at anticipating a task which is planned for later on.

Nowadays, we have almost every single technological aspect required to have such a service, meaning we have GPS devices through which one can see points-of-interest (POI), tools that can re-plan routes according to real-time traffic information, such as TomTom (www.tomtom.com), NDrive (www.ndriveweb.com) and Pioneer's (www.pioneer.eu/eur/page/products/NavGate/landing.html) navigation systems, to mention few.

Unfortunately, none of the systems mentioned above provides a really reliable managing service

which is able to establish a bridge between the geographical planning (itinerary selection) and the time scheduling (calendar management) with such intelligence and awareness.

The objective of the work herein described is to incorporate in an interactive service all these aspects. It is our intention to promote the task management from a static view to a dynamic perspective where a lot of environment variables would play an important role. A service capable of rearranging one's tasks efficiently, taking into consideration not only the task's time constraints but also the user's relative position, the commuting times between tasks' places, the user's shop preferences and so on. Considering these aspects the tool we are describing would optimize the user's time and geographical management, consequently, maximizing his/hers efficiency.

Taking this dynamic view at task management, we are going to be able to create a new service which will provide the professionals of the future with a time management aid which will be crucial in today's demandingly growing world.

3 THE AGENT-BASED ARQUITECTURE

We based our approach on the autonomous agents and multi-agent systems (MAS) metaphor, which represents a natural way to model our application domain. This approach is not actually new, as other authors have also investigated the potentials of MAS applied to this field (Modi et al., 2005). The novelty in our approach, nonetheless, lies on the integration of tasks management and itinerary planning as part of the activities handled by the same multi-agent systems that, to the best of our knowledge, has not been considered in other approaches. The multi-agent concept fits our idealized service because we would have three subsystems which would separately play an important role but still communicate with each other on a cooperative basis. The three multi-agent subsystems identified are i) a server oriented system, ii) a pc-client system, and iii) a mobile client system (see Figure 1).

The server oriented system encompasses an agent to manage tasks such as establishing the connection between the mobile-client and the pc-client whenever the mobile-client is out of the normal short wireless communications range. It also includes a synchronization agent in order to synchronize possible changes between the mobile and the pc calendars accordingly.

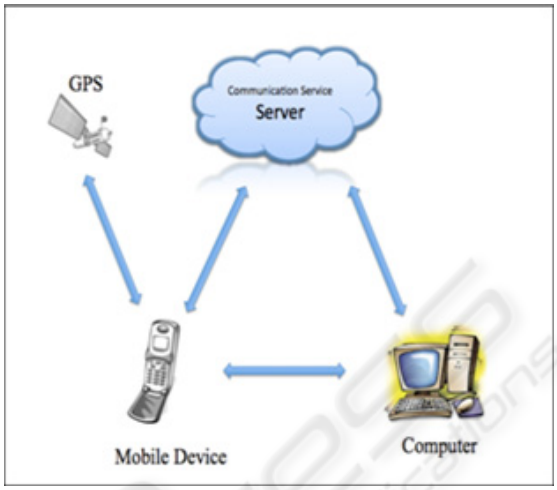

Figure 1: Multi-agent subsystems overview.

In the pc-client system, a calendar management agent, a synchronization agent, and a route planner will share their knowledge on user's preferences in a common database. This database stores information such as the commuting times, in order to provide the route planner with some information on user trip performances, for instance. The calendar management agent supports most user tasks and is able to advise the user on how to plan his/hers day, week or month. This system also incorporates a traffic-monitoring agent to take advantage of most up-to-date and real-time information on traffic conditions. The synchronization agent is able to send information to the server, which would then be read and used by the mobile-client whenever the user is out of the office and dynamically needs on-route information about his/hers agenda.

The mobile-client system also includes a communication agent, capable of autonomously deciding whether a connection to the server or pc-client is needed and will manage the necessary resources to accomplish so, including WiFi, GPRS, 3G, Bluetooth or wired communication capabilities whenever they are available for use. This agent should know then when to use the server and what task should not be locally processed, thus minimizing performance loss if avoiding it is not at all possible. Also, the mobile client system encompasses a GPS agent in order to monitor user's position. This agent interacts with calendar management agent, whenever possible (this communication is managed by the communication agent), to define the next destination for the user.

The system also includes a calendar agent, similar to the one included in the pc-client, where the user is able to introduce sudden and/or unexpected tasks making the necessary adjustments autonomously. An intelligent SMS agent is also present, meaning one might receive a SMS informing about a meeting or a client visit being automatically introduced in the calendar and making any necessary adjustments. Accounting for agents' ability to interpret natural language, such as the one proposed in (Modi et al., 2005), the system could autonomously create a new calendar entry simply by recognizing it within the body of an email received by the user.

The portable device should do as few processing jobs as possible in order to maximize efficiency and autonomy. In order to do so, some tasks are only performed by agents when deemed really necessary. For example, when an email arrives with a new task, the pc-client system computes the necessary adjustments and then sends a message to the mobile device letting it know it should connect to the server so as to receive some new important information. If the new task is considered to be secondary, the pc-system will await a wired or Bluetooth connection next time the user is in the office. This could happen with a lot of new entries, meaning that whenever a new task is assigned to the mobile calendar, it should be clever enough to know if there would be major rearrangements letting the pc-client handle it.

All of the above mentioned subsystems are to interact and cooperate with each other in a certain way so that the user can have, in a single system, the functionalities of a full calendar manager, a full GPS navigation system, and the ability to combine both to maximize their potentials.

4 CONCLUSIONS

Mobile communication and computing give rise to a wide range of new applications. Coupling traditional calendar and task management features encountered in most desktop applications with the ability to wisely plan journeys between tasks to be performed in different locations seems to be a very promising application of such technologies. This is certainly one step forward towards a world where frontiers between human users and technology would no longer be evident.

We have conceived a multi-agent based task management system formed by three smaller multi-agent subsystems. These subsystems are intended to wisely cooperate with each other profiting from today's abundant information resources. The system provides user with a device functioning as his/hers own personal assistant, aware of where he/she is, communicating autonomously with his/hers calendar and computing the best way to go through the day wasting as less time as possible.

The implementation of this system is in its early stages and is based on the integration of many different technologies, from distributed systems, to autonomous agents and geospatial analysis. Nonetheless, all applications expected to interact with the user should be user-friendly as suggested by Wei and Rudnicky (2000).

Many issues arise from this complex scenario, which are related to the autonomy of mobile agents, communication protocols and implementation viability, as identified in (Zhang et al., 2007). Also, nowadays users are quite tied to service fees in order to send and receive emails and SMS, as well as to keep long lasting Intenet connections in their handset devices. So, addressing cost issues is another concern in this development too.

The very next steps in this research will include the definition, adaptation and/or implementation of a middleware to allow the above mentioned agents to interact with each other and with the user. The user would not have to worry about setting his/hers GPS device or rearranging his/hers week on separate applications, but every related task could be carried out on one single application.

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