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A Multi-agent Solution for Advanced Call Centers

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Abstract. In the past few years, call centers have been introduced with great success by many service-oriented enterprises such as banks and insurance companies. It is expected that this growth will continue in the future and that call centers will be improved by adding new functionality and by embedding call centers better into the workflow of a company. In this paper we show how agent technology can help to realize these goals. Agent-based approaches are becoming more and more mature for applications distributed over networks, supporting (dynamic) workflow and integrating systems and services of different vendors. We show by a typical example of a call center, the call center of a car rental agency, what the deficiencies of current call centers are and how agents can help to improve this situation.

1 Introduction

Over the last years, many customer-oriented enterprises (e.g. insurance companies, banks, mail order shops,...) have introduced call centers. Call centers are currently applied to domains like hot lines, tele-marketing, helpdesks, information services, mail order centers and advice services. The huge annual growth rates in this market field can only be continued if today's call centers are extended from simple transaction-oriented call handling systems to interactive, multi-medial customer oriented communication systems, embedded tightly into the workflows of enterprises.

During the seventies, structured programming was the dominating paradigm. The eighties were the decade of object orientation with data encapsulation and inheritance of behavior. Agent oriented software development is the paradigm of today. Compared to objects, agents are active by executing one or more internal threads. The activeness of agents is based on their internal states which include goals and conditions implying the execution of defined tasks. While objects need control from outside to execute their methods, agents know the conditions and intended effects of their actions by themselves and hence take responsibility of their needs. Furthermore, agents do not only act on their own but in cooperation with other agents. Multi-agent systems are a kind of social community of which the members depend on each other though acting individually on behalf of their users.

In this paper, we show how agents can be used to build advanced solutions for call centers. We will show how agents can solve the challenges of today's call centers, which among others are the integration of new multi-media communication techniques, the support of business processes, customer-specific services and the integration of legacy systems.

The remainder of this paper is structured as follows: First, agent technology is presented. Second, the car rental agency "Happy Driver" is introduced, representing a typical scenario for the application of call centers. For "Happy Driver", we sketch the existing call center solution and discuss its deficiencies. We design an agent based solution and use a simple scenario which shows how agents can solve the above mentioned challenges. Finally, we conclude and point out future work.

2 Agent Technology

Software agents are an innovative technology for the efficient realization of complex, distributed and highly interactive heterogeneous application systems. Software agents are software components which are characterized by **autonomy** (to act on their own), **re-activity** (to process external events), **pro-activity** (to reach goals), **cooperation** (to efficiently and effectively solve tasks), **adaptation** (to learn by experience) and **mobility** (migration to new places). On the one side agents must be specialized for the individual demands of their users to be used with minimal effort, on the other side they must communicate with other agents and external components in order to use or modify global relationships, see e.g. [3; 8; 11; 12].

Messages between agents must satisfy standardized communicative (speech) acts which define the type and the content of the messages (agent communication language (ACL) [3]) The order of exchanging messages of a certain type is fixed in protocols according to the relation of agents or the intention of the communication. For example, a PROPOSE message opens a negotiation process and ACCEPT or REJECT terminates it. A negotiation process is useful in equal opportunity scenarios like meeting scheduling [3].

Each agent maintains a model of its world, representing its current view of its environment. The goal of an agent is represented as a formula over the states of the world model, which should hold at some time in the future. The goal can either be described by a user, by an event of the surrounding or by another agent. Activating a new goal the agent starts a planning phase in order to calculate a plan from the actual state to the goal state within the states of the world model. Such a planning can be performed either by an agent itself or in combination with other agents. The deduction algorithm use heuristics. A planning component can be implemented e.g. using constraints and constraint handling rules (CHR), see e.g. [5; 6; 7], on topics of planning see [13] and the referred links. Such planning strategies can be used to schedule the dynamic workflow within a call center and the connected infrastructure of the company.

Multi-agent systems require an appropriate adaptation to changing environment and to dynamic demands of customers. Learning techniques are well suited for the adaptation of single agents and whole multi-agent systems, especially user profiles and preferences can be learned by an agent, see e.g. [4; 9; 10]. Learning the predilection of a customer leads to a content customer. The contentment of a customer is a main issue of call centers, since it is many times harder to acquire new customers than to hold existing customers.

3 Example: Car Rental Agency ”Happy Driver”

From the point of view of an enterprise, the main motivation for introducing a call center is to provide an organizational unit which supports communication intensive business processes. As such, a call center is the externally visible ”interface” to customers of modern service oriented companies, and hence has to be designed with great care.

The functions which are supported by today’s call centers are: **Automatic call distribution (ACD) -** Incoming calls are distributed to human agents. **Automatic call handling -** Components such as automatic voice generation devices or voice recognition devices make it possible to handle some calls automatically. **Computer-Telephony Integration (CTI) -** provides additional support for the human call center agents. For instance, it is possible to dial automatically a phone number by clicking with the mouse on a telephone number on the screen.

As a typical example for the use of call centers, we introduce the example of a car rental agency. This example is used in the sequel to sketch an agent based call center solution and to highlight its benefits. Although our example is focused on a special case – the car rental agency ”Happy Driver” – we believe that the presented scenario can easily be adapted to other applications of call centers.

3.1 Current Situation

The car rental agency ”Happy Driver” rents cars to private persons and to business travelers. It has branches in 50 locations in the nation. ”Happy Driver” currently operates a centralized call center, which is accessible via the nationwide 0800-HAPPY-DRIVER number. In this centralized call center, 24 hours/day, incoming calls are automatically distributed up to 30 human agents which handle requests for information and for the reservation of cars. After the car has been picked up by the customer, the local branches are responsible for communicating with the customer, e.g. in case of a car accident or the modification of a rental contract. For this reason, the telephone number of the branch office is handed out to the customer when the car is delivered.

The current solution has some severe disadvantages concerning the functionality. We highlight the following:

Integration of new media types: The integration with new multi-media communication techniques such as the WWW, FAX and SMS is very weak. The operation of the web server is currently outsourced to an internet service provider (ISP). A reservation originating in the WWW currently generates a FAX message, which is sent to the call center, where the reservation request is handled manually. In particular, online confirmations of reservations are not possible.

Workflow support: As an additional service, ”Happy Driver” delivers the rented cars directly to their customers home or office. Also, the cars can be returned this way. Field staff is used to drive the cars both between clients and branch offices as well as between branch offices and service centers (e.g. car wash, car maintenance, gas station etc.). The travel schedules and travel routes of the field staff are currently planned manually by a human dispatcher. As a result, it is not always possible to tell a calling customer immediately when and whether a car can be delivered to a certain place/time. Instead, the human call center agent has to call manually the dispatcher (who may be busy talking via mobile phone with the field staff) whether a certain delivery is possible. Conversely, in case the delivery is not possible due to some unforeseen condition (e.g. car accident), the customer is often neither informed about this problem nor are alternative solutions searched for pro-actively. In addition, field staff cannot always be reached by mobile phone due to a limited coverage of the mobile phone network.

Customer care: Customers calling the call center are treated the same way, independently whether they are first-time customers or whether they are regular business customers. However, the management of ”Happy Driver” decided to pursue a more customer-oriented and aggressive marketing model. For instance, depending on customer profile, car availability and available reservations, regular business customers are always upgraded to a higher-class car when possible. Moreover, for these customers a specialized and simplified reservation process is envisaged, which can only be made by specially trained human call center agents. On the other hand, available low-end cars should be rented to private persons at discount rates in order to increase the utilization of the fleet.

Integration of legacy systems: Information systems of business partners are currently not integrated into the existing infrastructure. For instance, it is desirable that fees for gas refill can automatically be billed to the respective customer or that bills for car repair are automatically be forwarded to the customer or the insurance company.

Finding the right human call center agent: The current call center solution are mainly designed to deal with simple tasks such as reservations and requests for information. For that reason, one kind of human call center agent, which has been trained in a one week seminar, was sufficient. However, in order for improved customer satisfaction a more advanced scheme might be desirable. For instance, premium customers should be identified by their calling number and connected directly and immediately to a dedicated human call center agent. Moreover, qualified

help in case of accidents should be available immediately, depending on the car type and the accident location.

Besides its limited functionality, the current call center solution also is not very economic:

Expensive centralized call center: The centralized call center requires a dedicated office. Moreover, in order to guarantee fast reaction time to incoming calls of customers, a sufficient amount of call center staff has to be available 24 hours/day. On the other hand, in the branch offices there is enough space for call center workplaces, and there is also available staff. Therefore a distributed call center is desirable.

Lack of automation: The increasing use of the WWW interface leads to a severe and unnecessary overload of the call center staff due to the manual handling of reservations from the WWW.

Insufficient support of business processes: The business process of one-way rents, where the car is returned at a different branch office, is not supported sufficiently. Since car reservation and car maintenance are made on a per-branch-office basis, cars have to be returned to their home branch office after a one-way rent by field staff. For this reason, one way rents can only be offered quite expensively to customers.

These disadvantages already indicate that software agents can be an ideal approach for an improved call center solution. In particular, we expect that an agent-based approach should be selected for developing a call center, since the following properties are satisfied by the call center scenario which can nicely be dealt with by a multi-agent system: distribution, co-ordination and communication, mobility, robustness and non-stop operation.

Viewing the above-mentioned general challenges of today's call centers and the particular disadvantages of the current solution of "Happy Driver", we expect that agent technology offers the following benefits:

Integration of new media types: As mentioned above future call centers have to support many new communication techniques (e.g. e-mail, FAX, SMS...) besides simple telephone calls. Nevertheless, independently of the used communication media, communicative acts may have the same meaning, and hence these communicative acts can be mapped to a internal SW agent language abstracting from the concrete syntax of the input. SW agent wrappers can be used for that purpose, mapping from the concrete input (e.g. an incoming e-mail message) to agent communication language and vice versa. In the case of "Happy Driver", a web interface can be an additional access mechanism to the call center.

Workflow support: Using the planning component of agents, dynamic workflow can easily be modeled by multi-agent system, see [1]. Distributed planning leads to a more sophisticated scheduling than the centralized approaches of today's workflow systems. Workflow can be optimized by negotiation between the SW agents about their capabilities and resources. Especially the data component can be taken into account. Moreover, learning techniques can be applied in order to derive estimations

about the necessary time to perform certain tasks. This knowledge can be used as a working hypothesis for planning future workflows.

Integration of legacy software: Again the notion of agent wrapper helps to integrate components from business partners (e.g. from car maintenance companies) and of existing parts (e.g. the existing CTI system, the existing ACD system). More examples are facilities for speech recognition, e-mail gateways, web servers etc. Having components with the same supported functionality those SW agent wrappers can use the same communication language while talking to other call center agents.

Customer care: "know your customer" - learning techniques can be applied to learn the behavior of individual customers and of the customer behavior as a whole. The learned knowledge can be used to achieve more satisfied customers and to optimize the utilization of the car fleet.

In the following subsections we describe first of all the physical architecture, second the logical architecture, i.e. the agent architecture, and we finish this chapter with some scenarios of our agent based call center example.

3.2 Physical Architecture

The physical architecture (Fig.1) consists of the following components:

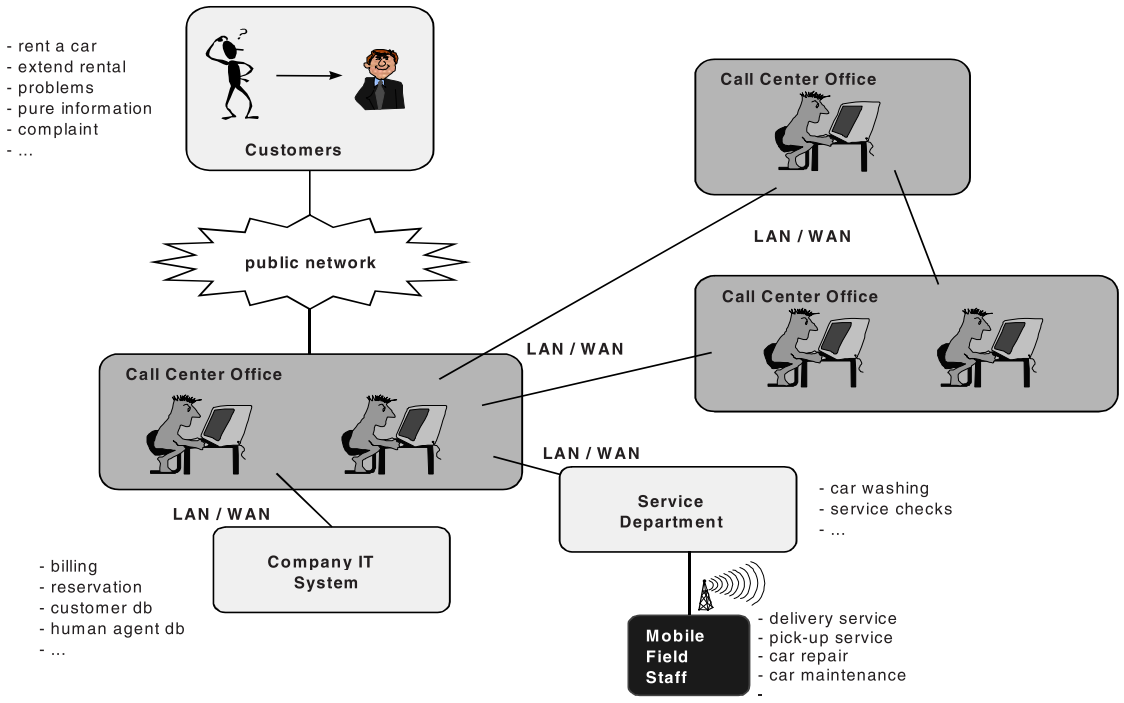

Fig. 1. Physical architecture of "Happy Driver"

- The customers of "Happy Driver";
- The field staff of "Happy Driver" and the associated human agents.
- Several physically distributed call center sites, involving both branch offices as well as teleworking sites;

- Additional sites, such as the field staff center, the car wash- and maintenance facilities etc.;
- Existing systems, such as the reservation & billing system as well as a web server.

The components belonging to ”Happy Driver” are connected by LAN/WAN technology for data communication as well as by a fixed and wireless telephone network for voice communication. The data communication system and the telephone system are integrated with usual CTI technology, e.g. telephone calls can be initiated and terminated under control of the data system.

3.3 Logical Architecture

On top of the physical architecture of the previous section we can now define the logical architecture, i.e. the agent architecture, for the call center of ”Happy Driver” (Fig. 2.)

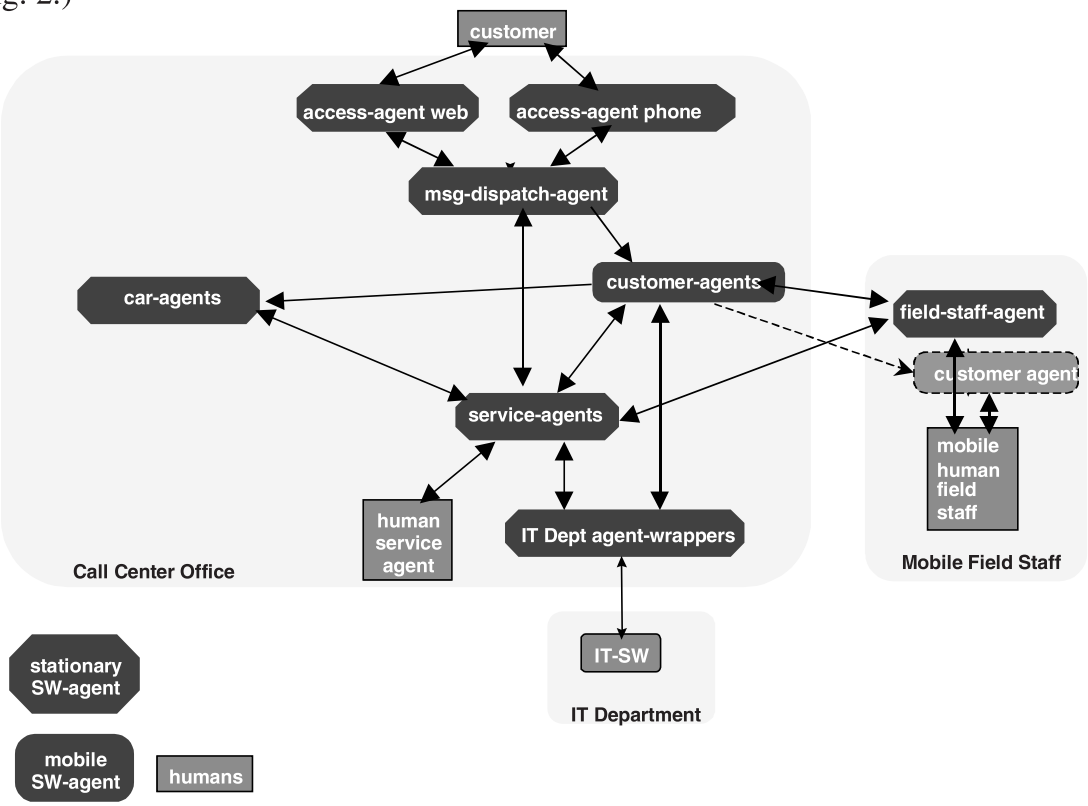

Fig. 2. Logical architecture of the call center of “Happy Driver”

The different kinds of software agents in this architecture have been introduced in order to solve the following tasks:

- A customer may contact the call center via different communication media. One example is a simple telephone call, where voice-announcements are used for output to the customer and touch tones or speech-recognition is used for customer input. Another example is world-wide web access. Access agents such as *access-agent-web* and *access-agent-phone* convert the incoming messages into a standardized internal format for inter-agent communication. This allows it to

easily accommodate new communication media in the future. The other way round, these access agents provide facilities to send messages to customers. For instance, they may interface with an SMS gateway, an e-mail gateway or a FAX modem. Moreover, they may also establish telephone calls to customers.

- The *message-dispatch-agent* is responsible for dispatching incoming calls and web requests to dedicated service agents. For that reason, it first tries to identify the requested service and/or to identify the calling customer. After this, it forwards all incoming messages to the respective service agent. Moreover, it also creates a customer agent, based on the customer profile in the customer database. In the opposite direction, the *message-dispatch-agent* knows the communication channel which can be used to reach a particular customer, e.g. via telephone, wire-less communication or WWW.
- Depending on the incoming requests the best fitting *service agent* available at the moment for the problem is chosen. This is performed by negotiation of the SW agents depending on the service descriptions of the service agents, the capabilities of software agents, the availability of human service agents and the customers preferences. The service agents may be distributed over several call center offices and also include tele-workers at home, thus making a fully distributed call center possible. The goal of service agents is to make customers happy while at the same time maximizing the profit of the company.
- For each customer a *customer agent* exists knowing the data of a customer and especially his/her preferences to optimally process the belongings of him/her. Moreover, he maintains also data which is relevant for identifying customers, e.g. their telephone number or email address. Customer agents are responsible for pursuing the interest of customers. For instance, they proactively interact with field-staff agents in order to plan for a timely delivery of cars. Moreover, the customer agent maintains all states belonging to a particular communication session, e.g. during a telephone call. This allows to pass information already communicated by the customer to the call center between the different service agents. Note that customer agents are mobile. They are sent to hand-held mobile devices of field staff in order to support their work in order to allow field staff to work even if no online connection to the agent system is available.
- For each car a *car agent* exists, maintaining all knowledge about the car and pursuing the interests of the car. These include reservations for the car and other constraints (e.g. necessary maintenance times etc.).
- Several *agent-wrappers* are used to interface with legacy IT systems and to support the call center application, e.g. by providing persistent storage.

3.3 Example Scenario

We now demonstrate the benefits of our solution by means of a simple scenario:

- Customer Joe calls the 0800-HAPPY-DRIVER number. The call setup message is forwarded via a legacy wrapper from the existing CTI system to *access-agent-phone,* which passes it to a *message-dispatch-agent*. Based on the phone number

of the calling party, it is determined that Joe is a premium business customer. *Message-dispatch-agent* generates a new customer agent with the information stored in the database being accessible via IT-system-wrapper and searches for a suitable service-agent for premium customers. The appropriate human agent "Jacky" is found and the message-dispatch-agent requests the CTI system to forward the call to Jacky.

- Joe tells Jacky that he wants to make a one-way rent over the weekend from (A-City, December 1st) to (B-City, December 3th) with a low-budget car. Jacky enters the data into the according *service-agent*, which in turn sends the reservation to the appropriate *customer-agent.*
- The *customer-agent* is responsible for pursuing the goals of the customer. As such, it immediately makes a reservation at the *car-agent* of Car A. After the reservation has been confirmed, the information is propagated to the corresponding *service-agent*, which passes it to Joe. The telephone call ends.
- Another customer, Paul, wants to make a reservation from (B-City, December 4th) to (C-City, December 24th). Since it is planned that Car A is at B-City on December 4th, Car A is reserved.
- Since Joe is a premium business customer, some *service-agent* proactively checks whether a higher-class car can be delivered to Joe as well. Because there are sufficient higher-class cars in A-City for the weekend, it seems to be possible to give Joe SportsCar B. However, the re-negotiation with Car A fails, because this way Car A would not be available in B-City on December 4th.
- For that reason, *customer-agent* Paul is asked to take another car or to take SportsCar B. *Customer-agent* Paul negotiates with service agents and other car-agents. Finally, some other car is found which suites Paul's needs. Paul is not allowed to take SportsCar B, because the business policy does only allow premium customers to get such cars for three weeks.
- The pro-active planning of the field staff activities allows to deliver SportsCar B to Joe's office on the evening of November 30th, directly from the maintenance center. Joe is happy, because he gets a better car as he had paid for.

4 Conclusions and Prospective

We have shown that agents are a promising technology for the implementation of advanced call center solutions. It will be applied to the software within a call center, to connect existing SW of the IT department, to schedule the dynamic workflow of the call center and its surrounding, to adapt the customers predilections and to coordinate the mobile service staff. This guarantees customers to receive high quality support for their requests. The call centers provides all customers, human agents and mobile staff with sufficient information at any place and any time. This call center scenario will be able to reduce the waiting times and wrong processing of customer requests by optimal scheduling and consideration of customers' preferences and staffs' behavior.

Call center providers get new means to advertise their services and to catch customers.

We are well aware that we have presented a high-level view of an advanced call center. For a concrete implementation, the given model has to be refined. An example where certain aspects of an agent-based call center are described in more detail can be found in [2]. It is planned to prototypically implement such a call center with different access-media and mobile devices. Especially with learning customer preferences and with dynamic workflow scheduling the tasks of the (human) service agents can be efficiently supported.

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