Smart Call Routing Utilizing a Multi-Agent Architecture

Ahmed Kamel
Concordia College
Offutt School of Business
Moorhead, Minnesota, USA
Email: kamel@cord.edu

***Abstract*— We present an agent-based architecture for routing incoming calls based on user needs and provider skill levels. We illustrate the use of the architecture in the context of routing Information Technology (IT) help desk incoming calls. The presented architecture reduces the need for involving clients in multiple iterations of assessment of their reported issues before a resolution is reached.**

Keywords - agents; decision-support; human-computer collaboration.

I. INTRODUCTION

Traditionally, corporate computing systems consisted of hardware and software systems purchased from one or more vendors and maintained on site typically by local information technology staff. In recent years, a gradual shift occurred to a managed system model where corporations contract a vendor to install and support integrated IT systems [1]. This shift was accompanied by a shift of the help desk support from the corporate IT department to the vendor's own staff. As a result, vendors set up large help desk installations where staff accept calls from personnel at a large number of corporate clients and attempt to troubleshoot a variety of issues [2]. Because of the diverse needs of the different clients and even the diverse issues that face each client, help desk personnel are trained to quickly attempt to identify the type of problem and route it to the appropriate staff for further evaluation. This process is often plagued with inefficiency with the same call often rerouted to multiple human agents, resulting in a high level of user frustration. In this paper, we present a multi-agent approach to automate the process of routing the call to the most appropriate human agent for the problem presented. Each computerized agent specializes in one type of problems corresponding to the expertise of a human staff technician and is tasked with identifying whether the problem presented falls within the scope of its area of specialty and thus routing the call to the associated staff technician. The goal of this process is to minimize the number of technicians a caller would interact with before their problem is solved. Given the large number of possible issues, a large number of agents is necessary. This paper presents a partial solution involving a subset of the needed agents. Section II of this paper describes the nature of the problem in detail, Section III describes the proposed solution, and Section IV presents the results of our research and outlines our future efforts.

II. NATURE OF HELP DESK PROBLEMS

As described above, the issues which have to be handled by help desk personnel span a very large range of problems, from hardware issues with diverse hardware architectures to software issues with a large number of software applications. This problem is often complicated by the fact that most corporate users who often call for help are non-technical staff without the necessary background to determine the nature of any issues they might be encountering. As a result, symptoms communicated to help desk staff are often vague and incomplete [2]. Due to the typically large number of calls at a typical call center, help desk personnel are often under pressure to handle the call by routing it to the appropriate troubleshooting personnel as fast as possible. Combined with the fact that the first line of help desk personnel is often the technicians with the least experience, this frequently results in calls routed to the wrong troubleshooting technicians who would then return the call to the intake staff for re-assessment. Clients report (in the post-service surveys collected by our corporate client) that this process is often repeated multiple times resulting in high levels of dissatisfaction. Figure 1 shows the flow of a typical client call. From this diagram, we can see that there are multiple paths for reevaluation that can result in the same problem being evaluated many times, resulting in high levels of client dissatisfaction. This process is further complicated by having the entire help desk often located in a foreign country with help desk staff for whom English is not the first language, resulting in even higher levels of dissatisfaction among clients. Frequently, help desks in different countries are utilized to allow for round the clock staffing, which often results in inconsistent response based on the level of skill and training at the different centers.

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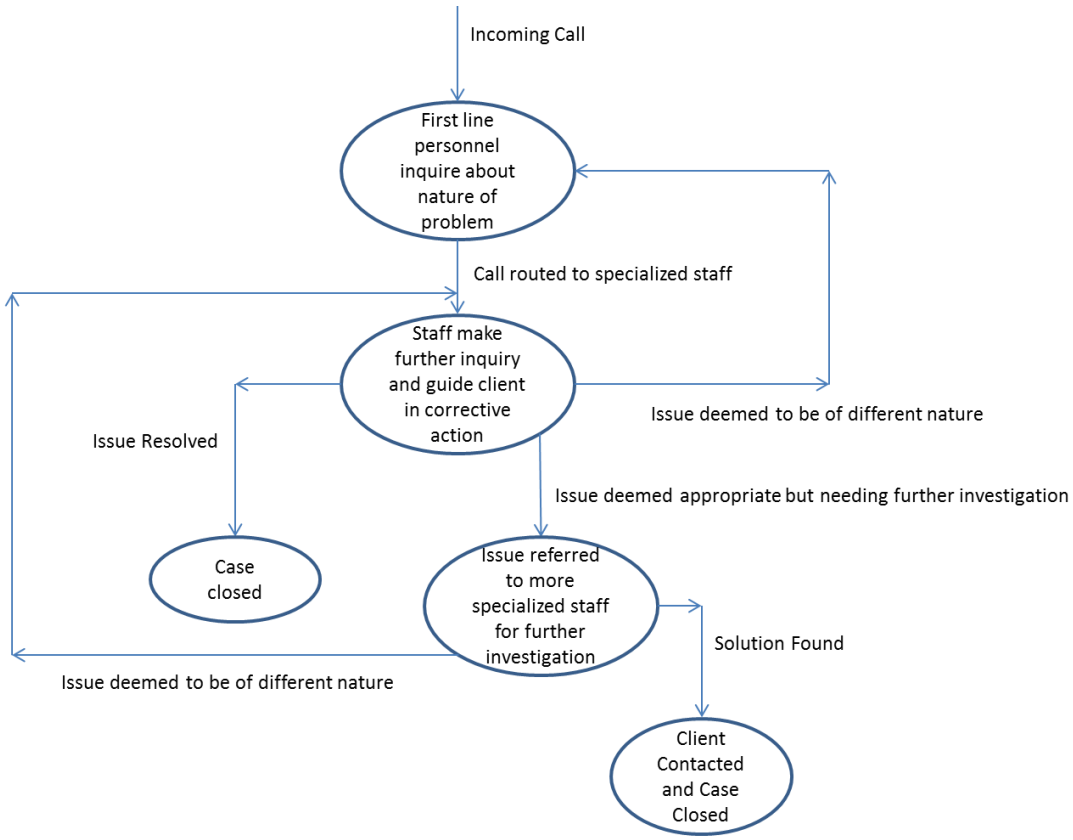

Figure 1. Original Flow of Client Incoming Call.

III. AGENT BASED SOLUTION

We were presented with this problem by the manager of a call system for a major solution provider (A confidentiality agreement prevents the disclosure of the provider). We ran an analysis on the performance of the first line personnel in routing the calls and determined that the average call is routed back to the first line personnel an average of 5.6 iterations per call. Once the call is routed to even more specialized personnel, they are routed back to the first specialist an average of 1.7 iterations per call. By examining the data of a large number of historic calls, it was determined that the large number of repeated referrals is in many cases caused by the vague nature of the symptoms provided by the client. These vague symptoms make it possible for the cause of the issue to be one of many possibilities. Because of the large number of combinations of possibilities, a fully automated diagnostic system like these presented in [3] or [4] was deemed inappropriate. Additionally, a routing system based on fixed rules (similar to the manual referral system being replaced) was deemed too rigid. The manual system relied on over-simplified rules of the form “If the client is complaining about a slow response rate, refer the call to a hardware technician.” Instead, we focused on developing a decision support system for the first line personnel to aid in the diagnostic process. The proposed solution is based on an agent architecture consisting of a large number of agents with each agent specializing in a narrowly focused problem. Each of these agents is based on diagnostic information obtained from past cases. This design is based on a similar architecture we have previously used in managing agricultural systems [5], [6] and in controlling unmanned air vehicles [7], [8]. Once the first-line technician obtains the symptoms of the impending issue from the client, the technician enters the data into the agent intake system. The agent intake system passes the data to all the agent systems. Each agent system runs its independent assessment of the data to determine whether its area of specialty might be the culprit. Each agent is based on a simple set of rules to determine a confidence factor in the problem area falling within its area of specialty. The rules are designed to first examine rules that would eliminate the possibility of the problem falling within the area of expertise of the particular

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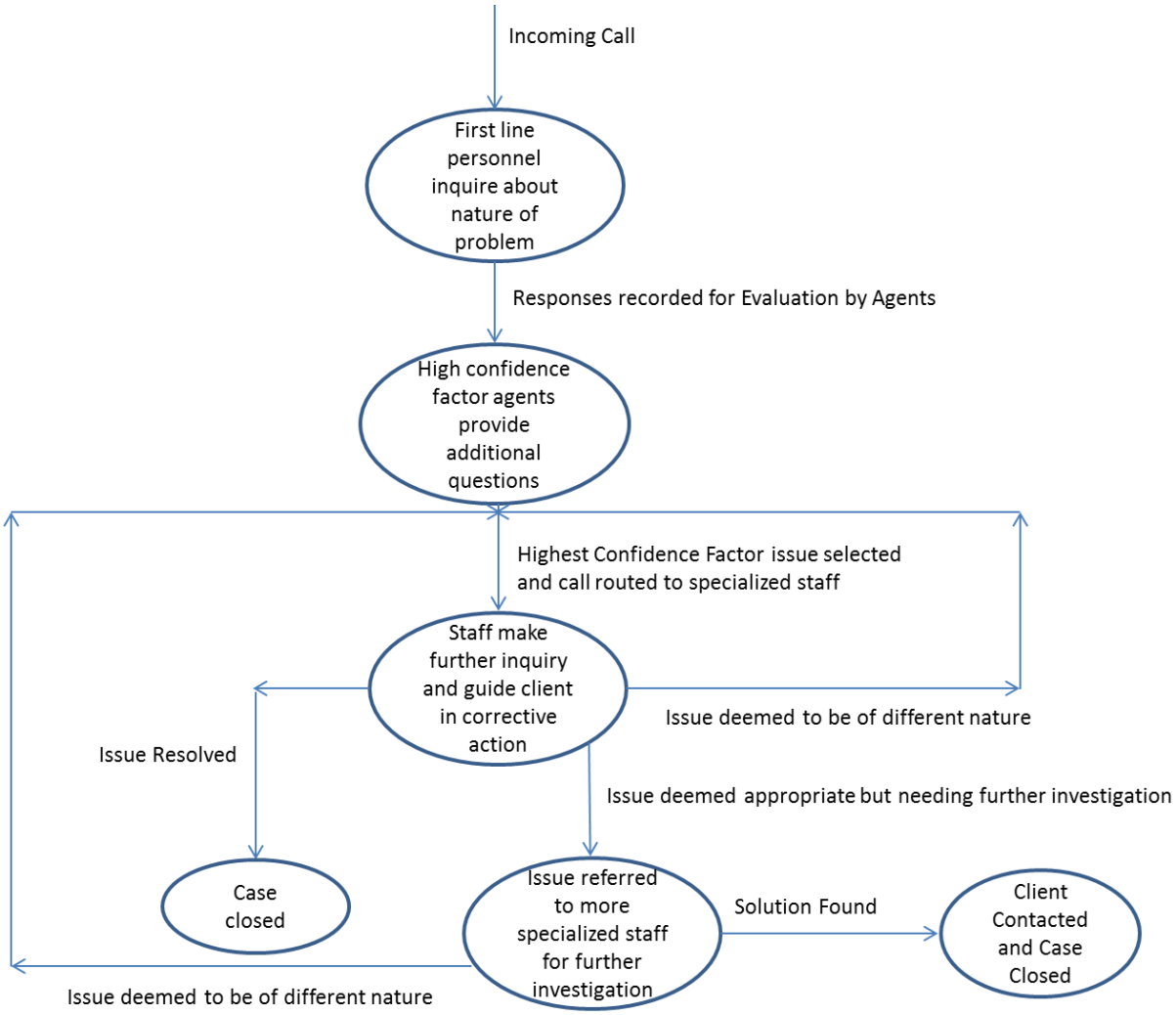

Figure 2. Agent-Based flow of Client Incoming Call.

agent in order to minimize the probability of needing to collect more data from the user. Agents returning confidence factors of 50% or higher are considered for further evaluation. Every agent within that group provides an additional set of questions (if needed) to the intake technician to ask the user. This step ensures that as much data as possible is collected from the client up-front, reducing the need for involving the client in multiple iterations of re-evaluation. Responses to these questions assist the agent in refining its confidence factors. After this assessment, any agent whose confidence factor drops below the 50% threshold is eliminated from further consideration. The specialty areas of the remaining agents are then sorted in descending order of confidence factors. The top area of specialty is then referred to the specialty team of technicians for further assessment. Only if the team of specialists deems the problem not to be of their specialty, is the problem referred to the next team of specialists. Figure 2 shows the flow of information under this solution. If no agents exceed the 50% threshold, the case is handled by the intake technician agents using the traditional methods used prior to the implementation of the agent system.

We implemented a prototype of this system using a limited number of agents. The initial prototype included 6 agents. Based on the encouraging initial results, we have been steadily expanding the number of agents, the system currently encompasses over 50 agents. In situations where the incoming calls fell within the area of specialty of the incoming agents, the number of iterations where additional data was needed from the client was significantly reduced and, in most cases, eliminated. The average number of referrals of each call back to in-take specialists dropped

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from an average of 5.6 iterations per call to 2.4 iterations per call. As a result, clients reported a much higher level of satisfaction as indicated by a voluntary client satisfaction survey that is administered to clients after completion of their calls. The same survey has always been used even before introducing the agent-system solution. These results are based on qualitative data. We are considering redesigning the survey to include numeric measures in the future.

IV. CONCLUSIONS

The limited prototype of the proposed architecture resulted in a higher level of satisfaction among clients whose problems fell within the scope of the implemented agents. Once the developed agents cover all existing systems, we expect the overall client's level of satisfaction to increase substantially. This type of system is never completed since new software and hardware systems are constantly being introduced, needing additional agents. We expect a delay between the introduction of any new system and the development of appropriate agents for that system. This delay is necessary for the accumulation of a sufficient number of cases to be used as the basis for the knowledge of the necessary agents.

Many solution providers utilize call centers in different countries to allow for call centers to be staffed around the clock. The availability of this agent system to the first-line technicians in all locations allows for a consistent performance among the different centers.

The developed architecture is flexible enough to support other areas of needed technical support through the customization of the knowledgebases for the different agents. We plan to test this architecture on other application areas in the future.

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