C³TO: An Architecture for Implementing a Chat Based Call Centre and Tutoring Online

Laurie BUTGEREIT [1,2] and Reinhardt A BOTHA**²**

¹Meraka Institute, CSIR, PO Box 395, Pretoria, 0001, South Africa
Tel: +27-12-841-3200, Fax: + 27-12-841-4720, Email: lbutgereit@meraka.org.za
²Nelson Mandela Metropolitan University
PO Box 77000, Port Elizabeth 6031, South Africa
Tel: +27-41-504-1111, Fax: +27-41-504-2574, Email: ReinhardtA.Botha@nmmu.ac.za

Abstract: The mobile phone is quickly becoming the personal computer of Africa. In Africa the cell phone is widely used, for example, in banking, crime prevention, tracking applications for identification documents, and education. C³TO is an architecture for implementing a call centre over various chat protocols such as Mxit, Jabber, and Google Talk. It is a J2EE based application running with Mobicents and provides the functionality to enable a number of tutors (or counsellors or information officers) to answer questions or provide information to thousands of people using inexpensive chat protocols on their cell phones. The first practical implementation of C³TO was the re-design and re-implementation of the Dr Math project in South Africa where thousands of primary and secondary school pupils get help with their mathematics homework from a handful of university students using Mxit on their cell phones.

Keywords: C³TO, Dr Math, Mxit, chat, mobicents, jabber

1. Introduction

A recent draft report by Higher Education South Africa shows that less than seven percent of South Africa's first year university students have sufficient mathematics background in order to cope with university work [1]. Prior international research which measured the mathematics and science knowledge and skills of eighth graders placed South Africa last among the fifty participating nations [2].

It was shocking statistics such as these which prompted the original Dr Math research project in January, 2007. The original project was to investigate whether secondary school pupils would use their personal cell phone and their personal airtime in order to obtain assistance with their mathematics school homework. That original project has grown far beyond any expectations with over 6000 pupils having received assistance with homework over the past 3 years [3-5].

The original Dr Math implementation needed a complete re-design and re-write to handle the increased volumes. In mid-2009, a new research project was initiated to determine whether or not open source products could be used to create a call centre type application to provide information to people using various chat protocols over cell phones and could such an implementation handle the increased volumes of participants. This paper describes the design and implementation of C³TO, Chatter Call Centre/Tutoring Online.

2.   Cell Phones, Mxit and Teenagers in South Africa

Although there are no official statistics on teenage cell phone usage in South Africa, recent research among low-income South African youth estimates teenage cell phone use to be as high as 97% taking into account that people often share cell phones [6, 7].

One of the extremely popular cell phone applications available is Mxit. The term "Mxit" is often confusing. The term can refer to the application which runs on the cell phone, or it could refer to the entire service, or it could refer to the company which hosts the service.

Mxit is an instant messaging system ideally suited to run over cell phones. The instant messages are carried over GPRS (or 3G as the case may be) and cost a fraction of what a standard SMS would cost. According to press releases on the Mxit corporate website, Mxit boasts more than fourteen million users.

Because of the wide use of cell phones by teenagers and the low cost of instant messaging using Mxit, Mxit has become a virtual meeting place for South African youth. In fact, using Mxit as a medium for reaching children and teenagers with good content is not unique to Dr Math. Similar projects exist which provide youth with important information about drugs [8] and information about HIV/AIDS [9].

3.   Dr Math Prior to C³TO

Prior to the implementation of C³TO, Dr Math was in danger of being overwhelmed by its own success. There were three problems which needed to be overcome:
  1. Security restrictions with the original Dr Math implementation made it necessary for tutors to physically visit our offices in order to assist pupils with mathematics. If additional tutors could work from their home, their university labs, or from internet cafes (as long as security was not compromised), then it would be easier to handle the increased number of participants.
  2. Addition protocols (besides just Mxit) needed to be implemented. Other protocols such as Jabber or Google Talk and other channels such as SMS or Bluetooth needed to be supported. Although Mxit is extremely popular in South Africa and is growing outside the borders of South Africa, C³TO needed to be able to handle additional protocols for areas where Mxit did not have a huge user base.
  3. The platform needed to be easily configurable so that it could quickly be re-implemented as a counselling site, a general information site, or a science site, etc.

In addition, if these three problems could be solved using open source technologies, then a multitude of various social problems could be solved in an inexpensive manner.

4.   Technology Description

After initial investigation, it was decided to re-design and re-write Dr Math as C³TO using a scalable enterprise architecture. The architecture is divided into two major sections. One section primarily handles the cell phone communication. The other section primarily handles the web communication. Both sections are implemented using Jboss, an open source implementation of J2EE, the Java 2, Enterprise Edition [10]. J2EE is a model for writing distributed systems taking into account the importance of reliability and scalability [11].

Mobicents was used with Jboss to implement the actual cell phone communication [12]. Jboss with Mobicents provides the first open source platform which is JAIN SLEE compliant [13]. JAIN (Java APIs for Integerated Networks) was an initiative to provide a standardised set of Java APIs for network applications and JAIN SLEE (Service Logic Execution Environment) is specifically designed for telecommunications applications [14].

Mobicents provides a framework where various resource adaptors (RAs) can be written and used to provide communication at a low level. For example, there could be a resource adaptor for communicating via XMPP, another resource adaptor for communicating using MXit, another resource adaptor for communication via SMS, and another resource adaptor for communication via Bluetooth.

In addition, Mobicents provides for service building blocks (SBBs) which provide the business logic for the application. For example, it would be possible to write a service building block to handle a banking application and then configure it to use a resource adaptor for SMSs and a resource adaptor for XMPP. Another example could be to write a service building block to handle a crime reporting system and then configure it to use an SMS resource adaptor and a Mxit resource adaptor. In the case of C³TO, the logic to support a call centre was implemented as a service building block while the communication with the various protocols was implemented in the resource adaptors.

For the web portion of C³TO, Jboss Seam was used to tie together all the various components typical of a three-tiered web application including the database (Postgresql along with Hibernate), the GUI (Myfaces implementation of Java Server Faces), and the business login (implemented as EJBs).

5. Development Environment

C³TO was completely developed on an Ubuntu Linux system. A brief comment about the development environment is warranted.

Mobicents is released as a Maven project. Maven is a build and deployment tool ideally suited for Java projects. Maven is built on the Ant build and deployment tool with the added functionality that Maven checks to ensure that the latest versions of libraries and tools which a project uses are downloaded when necessary. This is suitable for organisations which have fast internet. However, for organisations which do not have fast internet or for people who are also developing from home with limited data bundles, Maven is not suitable. For this reason, we continued to use Maven for the development of resource adaptors and service building blocks, but we did not use Maven for the development of the web portion of C³TO. For the web portion, Ant was used as the build and deployment tool.

6. New Functionality beyond Dr Math

Besides the basic question-answer functionality required of a tutoring or counselling system, additional function was added to C³TO including:

1. Remote tutoring – depending on permissions and authorisation, the people answering the questions (the tutors or counsellors) can work from remote sites
2. Web administration – administrators can administer the tutors from a web interface
3. Web configurable competitions – competitions in various mathematical skills can be administered via the web.
4. Web configurable quizes – multiple choice quizes and questionnaires can be configured and administered via the web.
5. Web configurable definitions and static data – static lookups such as definitions and formulae (in the case of mathematics) can be easily configured and administered via the web.
6. Web configurable links to other websites – links to other websites (such as Wikipedia) can be configured and administered via the web.
7. Log files and time sheets – extraction of tutor log files and time sheets can be obtained via a web interface.
8. In addition C³TO is written in such a manner that one instance of C³TO can monitor numerous communication channels and run numerous different services (such as

math information and HIV/AIDS information and crime prevention information) all on the same server.

7. Scalability

Scalability was a crucial feature in the design and development of C³TO. The features implemented in C³TO which specifically talk to the scalability issue can be broadly grouped into three different types:
1. Technical features
2. Tactical features
3. Strategic features

Some of the technical features implemented in C³TO which directly affect scalability include:
1. C³TO is implemented as a J2EE application. One of the attractive features of J2EE applications is the scalability of the application.
2. C³TO supports multiple XMPP connections and is designed so that it will support multiple connections of other protocols.
3. Web based tutoring. Allowing tutors to login over the internet in order to assist pupils ensures that more tutors can be made available.

Some of the tactical features implemented in C³TO which directly affect scalability include:
1. Configurable over the web. There is a complete web interface for administration of C³TO. This makes it easy to install complete new instances of C³TO with the administrator being in a centralized or different location.
2. The tutoring facilities is handled primarily with an AJAX web interface. AJAX is a polling mechanism for web pages which simulates a web "push". The polling rate of the AJAX components is configurable as per the tutors requirements.
3. A "busy-ness" model to ensure that tutors worked to their personal maximum capacity. Some tutors can type faster than others. Some tutors have a better background in mathematics than others. A model was developed where tutors could help describe their abilities and this could assist C³TO in assigning pupils to tutors.

Some of the strategic features implemented in C³TO which directly affect scalability include a number of automated "bots" to attempt to offload some of the load on the tutors. These include:
1. A full scientific calculator. Many pupils used to ask Dr Math for simple calculation results because the pupils said they did not have access to a scientific calculator. By giving pupils access to a full scientific calculator over Mxit, this reduced the load on the tutors.
2. Full access to Wikipedia. Most pupils who contact Dr Math do not realize that if they can use Mxit on their phones, then they have access to the internet on their phones. We implemented a full scrape of Wikipedia to give pupils access to textual information which they often need for research and resports. A number of additional informative web sites will also be scraped in the near future.
3. Arithmetic and algebra competitions. Many pupils repeatedly asked Dr Math to test them on arithmetic and algebra prior to a test or an exam. We have automated this and turned it into a competition in order to free up the tutors to handle in depth questions.

8. Twitter

As a marketing technique, C³TO is easily configurable to enable it to also communicate with Twitter. Although Twitter is not a common mode of communication for South African teenagers, it is becoming commonly used by South African adults.

C³TO can login to Twitter and regularly posts the results of the various mathematics competitions with leaderboards and statistics. This is done primarily to encouarge adults such as teachers (who probably do not use Mxit or chat) to easily follow the competitive action on C³TO. The Twitter link is completely optional and can be configured at run time.

9. Pilots

Before attempting to move the thousands of existing Dr Math users to the new C³TO implementation, a number of smaller pilots were done to ensure that C³TO functioned as expected.

The first pilot was at a private school in Gauteng, South Africa. This first pilot was to encourage pupils to increase their knowledge about their school. Quizes were set up to encourage pupils to learn the history of their school by asking questions about famous pupils, school functions in the past, teachers, etc. Tables of definitions and telephone numbers were accessible via C³TO to make it easy for pupils to find information about their school.

The second pilot was done as a support facility for a conference. The static lookup facility was used to provide biographies of the speakers, lists of commonly used industry definitions, lists of exhibitors and stand numbers, etc. The quiz facility was used to run a conference wide competition which encouraged attendees to visit all the stands in the exhibition area.

Because of date restrictions, the migration of the existing Dr Math user base to the new C³TO implementation will only begin November, 2009. We hope to report positively about this migration at the presentation of this paper.

10. Creative Commons License

The sources to C³TO are freely available under a Creative Commons License.

11. Business Benefits

C³TO supplies a mechanism to reach large numbers of people using a medium which is widely available (the cell phone) and low cost (chat protocols over GPRS). The tutoring or counselling facility provides for a few domain experts (such as math teachers or social counsellors) to chat with large number of people concurrently. From our experience with the Dr Math project, we have found that one tutor can chat with approximately 50 pupils per hour making this an extremely low cost mechanism.   These conversations are overlapped. In other words, the tutors do not chat with one pupil for a minute and then swap to another pupil, etc. The tutors are chatting typically with ten pupils concurrently for ten to fifteen minutes and then additional pupils ask questions and the original pupils stop asking questions.

C³TO provides for all administration to be done via the web making it easy to reconfigure C³TO when required. In addition, care was taken to ensure that one instance of C³TO would be able to support multiple connection types and multiple service types.

12. Conclusions

C³TO is an architecture ideally suited to providing call centre functionality over chat protocols. In an developing world context, this is also ideal for use with internet enabled cell phones. Education is so important in a developing country. C³TO provides an open source product to easily support pupils in their education.

C³TO has been running since November, 2009. Volunteer tutors from around South Africa have been providing help to pupils who are also spread throughout South Africa. A handful of comments from tutors and pupils have resulted in some slight modifications to

the software. As more tutors volunteer from different organisations, we plan to augment the tutor management facilities of C³TO so that it can provide institutions with summary reports about the number of tutors volunteering, hours spent volunteering, and number of pupils assisted. At the time of writing this paper, the academic year has only just started in South Africa. We hope to report more fully on the success of this project at the presentation of this paper.

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