Project: Eastern Ontario Bed Chaser

Problem Statement

The shortage of beds in acute and long-term health care facilities has been a problem plaguing Eastern Ontario for many years. Recent contagion scares, such as SARS and H1N1, have highlighted the need for a sustainable number of available critical care beds in hospitals, however these are often occupied by patients requiring long term care who cannot find beds in nursing homes. In a recent newspaper article, officials at the Ottawa Hospital have proposed the development of a large-scale system to manage the number of acute care and long term care beds available in Eastern Ontario, so that administrators can view "traffic reports" of patients, admitted to a facility and/or on a waiting list for admission, and redirect patients to facilities with available capacity. The main benefit of such a system will be the optimal placement of patients in beds that suit their required level of care, preferably close to their home and family. A secondary benefit will be to allow administrators at the Champlain Local Health Integration Network (LHIN) to view the occupancy rates and waiting list sizes of all facilities across Eastern Ontario and determine where the need for additional facilities is greatest.

The Eastern Ontario Bed Chaser (EOBC) system proposes to address these issues by providing real-time, up-to-date tracking, updating and reporting of:

- the total number of beds, given each different type of care, at each facility;
- the occupancy rate of beds, given each different type of care, at each facility; and
- the number of patients on waiting lists for long term care in each area of Eastern Ontario.

In addition to visual tracking mechanisms enabling users to view current data and update it, EOBC will provide an extensive suite of on-demand reports of bed occupancy and waiting lists over user selected intervals of time and space.

For our purposes, health care *facilities* consist of hospitals and nursing homes, each containing a number of beds providing a specific level of care. Patients require *care* at three separate levels: acute care, complex continuing care, and long term care. Acute care is intensive and critical care that is required in case of severe injury, life-threatening illness, and post-surgery. Only hospitals offer acute care. Complex continuing care (CCC), also known as chronic care, is longer term care that requires very close monitoring in case complications arise. In Ontario, only hospitals offer CCC. Long term care (LTC) is available in nursing homes, where patients require regular monitoring under the care of medical staff, without hospitalization. Each facility provides a number of beds, available for a specific level of care.

Facilities staff will be the main users of the EOBC system, and they will have access to a number of different features. They will enter the raw data for tracking the total number of beds and the number of beds occupied for each type of care at their facility. They will also be responsible for adding patients to a waiting list associated with an area of Eastern Ontario, and assigning patients from a waiting list to an open bed. Patients can be added to a waiting list for LTC only, and not for the other types of care. Patients on waiting lists may be inpatients at an existing facility, waiting for a LTC bed to open up, or they can be outpatients under the care of a family doctor. For inpatients, the date of admission into a facility must be recorded. For both inpatients and outpatients, the date on which they are placed on a waiting list must also be stored, for use in EOBC's reporting capability. Each patient on a waiting list may specify an area of Eastern Ontario where they wish to be admitted for LTC. A map of the geographical region covered by the Champlain LHIN and the pre-defined areas in Eastern Ontario can be found on the Champlain LHIN web site. Facilities staff may also add new beds, of a selected type of care appropriate for that type of facility, in case additional rooms are opened up. However, these users cannot create new facilities. Users should be able to view a map of Eastern Ontario and see either the occupancy rate for selected facilities and/or the number of patients on waiting lists for selected areas. The occupancy rates and/or numbers of waiting patients should be represented not exclusively using numbers, but also visually, such that higher concentrations look different from smaller groupings. It should be possible to view the occupancy rate for different types of care (acute care, CCC or LTC) at the same time, as each type of care should be visually differentiated using unique icons or images.

LHIN staff members are users who have access to all the EOBC system options available to facilities staff. In addition, they can access a number of reporting features. LHIN staff can enter ranges of dates, specific facilities, and types of care (acute, CCC, LTC) or types of facilities (hospitals, nursing homes) for which they want to view the data. Examples of commonly

required reports over different time frames and geographical areas include bed occupancy rates, size of waiting lists, wait times and mismatch in levels of care (for example, patients requiring LTC who are occupying CCC beds). Report data should be organized in graphs or histograms (bar charts) in a way that is scientifically valid and easily readable.

System administrators are users who can create new user accounts, and add new facilities at specific geographical coordinates.

Technical Specifications

The SCS Linux network will be used as the test bed for evaluating the EOBC system, so all processes **must** work on this platform. All source code must be written in C++.

GUI

Users will be able to view all up-to-date information graphically, superimposed on a map of Eastern Ontario. Different types of data (bed occupancy rates and size of waiting lists) can be viewed separately or together, depending on the user selection. Reports should be generated based on different criteria and combinations of criteria (range of dates, selected facilities, types of care and types of facilities). Information contained in reports should be displayed using the type of graphing tool that is most natural for the type of information.

In general, the different features should be available as menu items. The look-and-feel of the EOBC system should be professional and consistent with typical GUIs, including the use of popup menus where appropriate.

Data Storage

Each facility in the Champlain LHIN will have one host machine running one EOBC user process. All information pertaining to that facility will be stored permanently on its local host. The EOBC user process will be running a graphical user interface (GUI) that synchronizes with every other host in the network, in order to display and report current and up-to-date information. The only data stored on a host between sessions is the data for the facility associated with that host. When the EOBC user process starts up, it will supplement its own local data with the data from all the other hosts in the network. Area-specific waiting list data will be stored at the largest facility in that area.

Data may be stored in flat files, or any other mechanism available on the SCS Linux servers.

When a user changes the information on his/her GUI, this data must be updated not only on the user's local host, but also *propagated* to every other EOBC host that is currently active, in a peer-to-peer fashion, so that every other EOBC user receives and displays, in real-time, the most up-to-date information. The EOBC system must be able to support a minimum of six concurrent user processes, each executing on a different host.

Peer-to-Peer Communications

Each user process will be executing on a **different** machine. The EOBC processes will communicate with each other through a socket interface, using UDP/IP. Upon start-up, each user process will query all the hosts contained in a preconfigured host list, to see if they are running an active EOBC process and to obtain their most up-to-date information. If a host responds, the user process will request the data on that host, in order to populate its own GUI. Every time a user updates the data on his/her GUI, the new information **must** be sent, asynchronously, to every other active EOBC host, so that the other host can update its GUI.

All team projects will implement the same inter-process message protocol. That way, team projects can be tested in a plug-and-play fashion, where copies of one team's user process will be tested with other teams' processes. While every team will specify its own message protocol as part of Deliverable #2, an official design review will be held during class, immediately after Deliverable #2 is due, to determine the best design. The selected message protocol will be implemented by **all** teams for their final deliverable.

Deliverables

Deliverable #1

This deliverable will consist of a hard copy of:

- Requirements Analysis Document

and a soft copy of the following, e-mailed to comp3004@scs.carleton.ca

- GUI prototype (proof-of-concept of user interface screens)

The format and contents of this deliverable will be discussed in class. A hard copy of the document must be submitted on or before Thursday, February 3 at 9:00 AM, in the boxes in 3115 HP. The submitted copy must be typed, legible and suitably bound (stapled is fine). A `tar` file of the prototype source code must be submitted to the email address given in class.

Deliverable #2

This deliverable will consist of a hard copy of:

- System and Object Design Document

and a soft copy of the following, e-mailed to comp3004@scs.carleton.ca

- revised Requirements Analysis Document from Deliverable #1
- communications prototype (proof-of-concept of UDP/IP socket communications)

and an in-class presentation of:

- the user process message protocol

The format and contents of this deliverable will be discussed in class. A hard copy of the documents must be submitted on or before Thursday, March 3 at 9:00 AM, in the boxes in 3115 HP. The submitted copy must be typed, legible and suitably bound (stapled is fine). A `tar` file of the prototype source code must be submitted to the email address given in class.

An official design review will be held during class on March 3 and March 8. Each team will be given *five minutes* to present their user process message protocol. We will choose the best design together in class, and every team will be required to implement this selected protocol for Deliverable #3.

Deliverable #3

This deliverable will consist of a hard copy of:

- Test Plan
- Project book

and a soft copy of the following, e-mailed to comp3004@scs.carleton.ca

- revised Requirements Analysis Document from Deliverable #1
- revised System and Object Design Document from Deliverable #2

and a CD containing a soft copy of:

- all documents
- all project source code

and:

- a project demo to take place by appointment on Wednesday, April 6

The format and contents of this deliverable will be discussed in class. A hard copy of the documents, with a soft copy of the source code and all documents, must be submitted on or before Tuesday, April 5 at 9:00 AM, in the boxes in 3115 HP. The submitted copy must be typed, legible and suitably bound (stapled is fine).