# Department of Computing
## BACPT Final Year Project Proposal Form (2003/2004)

<table>
<thead>
<tr>
<th><strong>Student Name</strong></th>
<th>Wan Tsz Wan, Kathy (Student ID: 01531748T)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supervisor</strong></td>
<td>Dr. Ng To Yee, Vincent</td>
</tr>
<tr>
<td><strong>Project Title</strong></td>
<td>M-Care: Patient Information System on the road / interactions and accesses at the client-side</td>
</tr>
<tr>
<td><strong>Project Area Code</strong></td>
<td>12, 13, 15, 32</td>
</tr>
</tbody>
</table>

**Brief Description** (for quick reference):
The project mainly focuses on the Clinical Patient Management and adopts XML, HL7 and wireless technology to design and develop a patient information system on the road.

**Problem Statement:**
1. How can the clinicians retrieve the update profiles and medical history of referral patients from healthcare information systems of other healthcare institutions?
2. During visiting, how can the visiting clinicians retrieve the patients’ medical information on the road?
3. It is inconvenient and wasteful to print out the patients’ profile and medical history on every diagnoses / visiting.
4. After diagnoses / visiting, it is time-consuming and waste of manpower to input back the patients’ medical record from the papers to the information system.

**Suggesting Approach or Working Steps to the Problem**
1. Problem Identification and Literature Review
2. Identify the objectives
3. Data Analysis – Data collection and integration
4. System Design – Design the system, database and user interfaces with XML and HL7 technology
5. Implementation of the system according to the system design
6. Testing and refining the system to achieve the objectives
7. Documentation of the system report

**Expected Outcome**:
Establish a realistic patient information system with workable functions and to optimize for the information retrieval with communication ability to other healthcare information systems on the road.

**Resources Required**
Hardware: Personal Computer, PDA (Pocket PC / Palm)
Software: Windows 98/2000/NT, Oracle 8i, Java Development Kits, XML/XSLT Processor
BA (Hons) Degree in Computing
Final Year Project Proposal

M-Care: Patient Information System on the road / interactions and accesses at the client-side

Supervisor : Dr. Ng To Yee, Vincent
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Student ID : 01531748T
Date : 3 October 2003
Table of Content

A. INTRODUCTION .............................................................................................................1

B. PROBLEM STATEMENT ...............................................................................................2

C. OBJECTIVES AND OUTCOMES ..................................................................................4

D. PROJECT METHODOLOGY ........................................................................................ 6

   Phase 1 – Problem Identification and Literature Review .....................................................7
   Phase 2 – Identify the objectives ....................................................................................10
   Phase 3 – Data Analysis ...............................................................................................10
   Phase 4 – System Design ............................................................................................10
   Phase 5 – Implementation ..........................................................................................12
   Phase 6 – Testing and refining the system ..................................................................13
   Phase 7 – Documentation ...........................................................................................13

E. PROJECT SCHEDULE ................................................................................................. 14

F. RESOURCES ESTIMATION ........................................................................................16

G. REFERENCES/BIBLIOGRAPHY ................................................................................17
A. INTRODUCTION

Today, the number of computers and health care institutions (hospitals, medical/dental clinics, nursing and retirement homes, rehabilitation centers, etc.) has grown dramatically over the past decade. The low-priced personal computer (PC) is rapidly gaining a place and plays a part in every aspect of health care.

Computers indeed have made a major and positive contribution to the healthcare industry. For instance, physicians and nurses can retrieve detailed and accurate patients’ medical record from the information systems of the health care institutions.

On the other hand, the demand for network communication is growing. Through network communication, a PC can access data from the hospital/clinic information systems and process them locally by user-friendly software available for PCs and workstations. In the respect, communication is required between PCs and health care institutions information systems, and other healthcare information systems inside or outside the institutions. In order to communicate with ease and convenience, the portable devices (handheld PC, PDA devices, WAP phones) therefore become one of the popular commodities and choices for everyone to interact with the system.
B. PROBLEM STATEMENT

Nowadays, in Hong Kong, most of the clinics mainly provide (1) *Out-patient Clinic Services* and (2) *Visiting Services*. The typical workflows of physicians and nurses are illustrates as follows:

(1) **Out-patient Clinic Services**

When a patient comes to the clinic, the nurse makes an appointment and registration by hand if necessary. Then she is responsible to retrieve and print out the profile and medical history of patient and to pass them to doctor for diagnoses. If the patient is a newcomer or referral by another healthcare institutions, no profile and medical history can be found and retrieved from its information system of the clinic for diagnoses. In this case, the clinicians have to request the referral healthcare institutions to send the patient’s profile and medical history from their healthcare information systems to them by fax / email.

During diagnoses and treatment, the doctor is responsible to record the medical treatments and prescribed medicines of the patient on papers. Then, the nurse is required to collect and input the information to document the patient’s progress and responses of treatment to the information system if necessary. After that, the nurse will distribute the prescribed medicine and issue a receipt to patient upon request.

(2) **Visiting Services**

Once the patients’ data have been collected in the information systems of the clinics / hospitals, the visiting clinicians have to photocopy / print out all the relevant profile and medical record of patients on every visit in advance. The visiting clinicians have to jot down and record the diagnoses and treatments of patients on papers and request the nurses to input back to the information system at the later time. Once the profile and medical record are omitted during diagnoses, they have to go / call back to the clinic to enquiry.

After overview of the workflows of the clinicians in Hong Kong, the clinics probably keep their patients’ profile and medical records on papers / single patient information systems. As we know that the purpose of data collection from patients is to provide the clinicians with accurate and complete information, therefore some problems are encountered and raised by the clinics.

The encountered problems are:

1. How can the clinicians retrieve the update profiles and medical history of referral patients from healthcare information systems of other healthcare institutions?

2. During visiting, how can the visiting clinicians retrieve the patients’ medical information on
the road?

3. It is inconvenient and wasteful to print out the patients’ profile and medical history on every diagnoses / visiting.

4. After diagnoses / visiting, it is time-consuming and waste of manpower to input back the patients’ medical record from the papers to the information system.

Therefore, in my proposed project, it is suggested to design and develop a realistic patient information system for clinic, which provides a media for the users (physicians, nurses and patients) to interact and access to the system (even on the road) at the client side and provides standards for the exchange, management and integration of data.
C. OBJECTIVES AND OUTCOMES

Since 1990, the Health Level Seven technology has been widely used in the healthcare information systems of the healthcare institutions around the world.

In Hong Kong, the government is currently working on XML/HL7 technology to provide a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services. Specifically, to create flexible, cost effective standards, guidelines, and methodologies to enable healthcare information system interoperability and sharing of electronic health records

1. Objectives

This project involves the design and development of a realistic patient information system (It is called ‘M-Care’). It aims to provide a universal healthcare information system optimized for the information retrieval with communication ability to other healthcare information systems and provide standards for the exchange, management and integration of data.

Furthermore, the users can interact and access the patient information system at anytime and anywhere (at clinic, at home and even use of portable computing devices to interact and access on the road.). The users can retrieve the patients’ medical records with the aid of portable computing devices. Therefore, they are no need to re-entry / re-print all the healthcare information during every diagnoses / visiting. It helps to minimize the time, the manpower and resources on the paper-works routine.

As the areas of healthcare industry are quite extensive, this project mainly focuses on Clinical Patient Management only. It includes

1. Patient Administration
2. Medical Records Management
3. Scheduling
4. Patient Referral

Within the limitation of time and resources, I will concern on the design and development of the system at the client side. It includes the patients information querying, user interface handling and security issue for the patient information system by using XML/HL7 technology. Using XML and HL7, the system will be able to exchange data with other healthcare information system with standardization.
2. Outcomes

The aim of this proposed project is to benefit to the clinical daily operations. Therefore, the possible outcomes are:

- Create a central relational database of the universal healthcare records for all users to access
- Query and retrieve patients’ medical information (e.g. profiles and medical history) from database
- Update / Store the patients’ medical record into database
- Transform a database table into an XML document with a DTD to validate the HL7
- Display / Output XML documents to the users
- By use of XSLT technology, transform and generate different outputs / displays (user interfaces of system) to different end-users (PC / PDA users).
- Handling validation checking on the user interfaces.
D. PROJECT METHODOLOGY

The development of the proposed M-Care Patient Information System can be divided into several phases:

**Problem Identification and Literature Review**
- Study related materials and identify the problems

**Identify the objectives**
- Estimate the project scope and identify project objectives

**Data Analysis**
- Collect and integrate data (e.g. Clinical daily operations and workflows of users)
- Is the data satisfied for system design?
  - No
  - Yes

**System Design**
- Design the system, database and user interfaces with XML and HL7 technology

**Implementation**
- Implement the system according to the system design

**Testing and refining the system**
- Test and refine the system to achieve the objectives

**Documentation**
- Prepare the documentation of the system
PHASE 1 - PROBLEM IDENTIFICATION AND LITERATURE REVIEW

In this stage, research must be done on the background of the healthcare industry. We can get an overview about the fields of project topic by studying the related healthcare information from books, papers, articles and references. After that, we should identify the problems and what we want to do to solve the problems and improve the current situation.

LITERATURE REVIEW

1. XML

WHAT IS XML?

Extensible Markup Language (XML) is a markup language for documents containing structured information.

Structured information contains both content (words, pictures, etc.) and some indication of what role that content plays (for example, content in a section heading has a different meaning from content in a footnote, which means something different than content in a figure caption or content in a database table, etc.). Almost all documents have some structure.

A markup language is a mechanism to identify structures in a document. The XML specification defines a standard way to add markup to documents

WHAT IS XSL?

Extensible Style Language (XSL) is a language for expressing style sheets. An XSL style sheet is, like with CSS, a file that describes how to display an XML document of a given type. XSL shares the functionality and is compatible with CSS2.

- A transformation language for XML documents: XSLT. Originally intended to perform complex styling operations, like the generation of tables of contents and indexes, it is now used as a general purpose XML processing language. XSLT is thus widely used for purposes other than XSL, like generating HTML web pages from XML data.

2. HEALTH LEVEL SEVER (HL7)

WHAT IS HL7?

Health Level Seven (HL7) is one of several ANSI-accredited Standards Developing Organizations (SDOs) operating in the healthcare arena. Most SDOs produce standards
(sometimes called specifications or protocols) for a particular healthcare domain such as pharmacy, medical devices, imaging or insurance (claims processing) transactions. Health Level Seven’s domain is clinical and administrative data. The mission of HL7 is to: "To provide standards for the exchange, management and integration of data that support clinical patient care and the management, delivery and evaluation of healthcare services. Specifically, to create flexible, cost effective approaches, standards, guidelines, methodologies, and related services for interoperability between healthcare information systems."

WHY HL7?

HL7 is singular as it focuses on the interface requirements of the entire health care organization, while most other efforts focus on the requirements of a particular department. Moreover, on an ongoing basis, HL7 develops a set of protocols on the fastest possible track that is both responsive and responsible to its members. The group addresses the unique requirements of already installed hospital and departmental systems, some of which use mature technologies.

HL7 strives to identify and support the diverse requirements of each of its membership constituencies: Users, Vendors, and Consultants. Cognizant of their needs, requirements, priorities and interests, HL7 supports all groups as they make important contributions to the quality of the organization. The committee structure, balanced balloting procedures and open membership policies ensure that all requirements are addressed uniformly and equitably with quality and consistency.

3. PORTABLE COMPUTING DEVICES

HOW CAN PORTABLE COMPUTING DEVICES HELP IN HEALTHCARE INDUSTRY?

Physicians are expected retain and accurately process an unbelievable amount of information. While portable computing will not eliminate these expectations, available technology can make them easier to meet. Clinicians, frequently on the run, gather many scrape of information and face the challenge of effectively saving, organizing, and retrieving them. Portable computing offers numerous advantages over conventional methods of managing the daily onslaught of miscellaneous data.

ADVANTAGES OF PORTABLE COMPUTING

1) Flexible Entering and Organizing of New Information

The most obvious use of portable computing is for managing scraps of information such as
appointments, telephone numbers, meeting reminders, and so forth.

2) Immediate Availability of Reference Information

Currently, you can carry up to 80Mb (80 million characters), or about 46000 typed pages, of information in electronic format in your pocket.

Using portable modem and a telephone, information can be obtained immediately from database by the hand-held device. Hospital and office database can be configured to permit the same kind of data exchange.

3) Faster and More Complete Data Entry than by Hand

A good set of checklists and input forms reduces the time required to collect information to document your patients’ progress and responses to treatment.

4) Prompt Communication of Data to Others

Combine a portable computer with a fax/modem, and you can send correspondence, clinical data, or other information almost anywhere, almost instantly, from wherever you are, as long as there is a telephone hookup.

4. PALM VS POCKET PC

**REASONS TO CHOOSE A PALM**

*Lower prices* - By comparison, the least expensive new Pocket PC models is two times more expensive than Palm OS device.

*Easier to use* - The Palm OS and the applications that run on it are more straightforward and simply designed than their equivalents on Pocket PCs.

*Smaller size* - In general, Palm devices tend to be more compact and smaller than Pocket PCs.

**REASONS TO CHOOSE A POCKET PC**

*Better screens* - Most of the Pocket PC color displays were crisper and offered more resolution than most Palm OS displays.

*Better Web browser* - It has a better Web browser “Pocket Internet Explorer”.

*Easier multitasking* - Pocket PC can open more than one application at a time. This makes it a bit easier and faster to jump between applications.
As the M-Care patient information system is going to develop as a web application. In order to provide a better environment to users, Pocket PC is a better choice and it is advised to be the portable wireless device in this project.

**PHASE 2 - IDENTIFY THE OBJECTIVES**

After understanding the identified problems of the project, we should identify the objectives of the system and set up the main concern of the project. For this project, we should fully understand and learn the workflows of clinic, the concept of XML and HL7 and the programming techniques to develop the patient information system.

**PHASE 3 - DATA ANALYSIS**

In this stage, it involves the finding about the existing healthcare information systems, the current security concerns and the solution plans for the identified problems.

In order to build up a realistic patient information system, data collection and research must be done in order to thoroughly understand the existing workflows of healthcare industry in Hong Kong. Moreover, it helps to determine how to apply the XML, HL7 and wireless technology to improve the performance and quality of healthcare information systems.

Also, defining who are the users and the roles of the patient information system are necessary in this stage. Find out what methodologies can be applied and study their feasibility and understand the requirement of the system. Study and understand all the feasible methodologies and ready for system design and programming.

**PHASE 4 - SYSTEM DESIGN**

**SYSTEM OVERVIEW**

For the M-Care patient information system, it can communicate with the external and outside healthcare institutions by use of XML/HL7 technology. In this project, we mainly focus on the design and development of the *Clinical Patient Information System*. 
SYSTEM FUNCTIONAL REQUIREMENTS

The M-care patient information system provides several main functions to the users, they are:

- User Registration
- User Login

For Patient
- Patient Profile
- Make Appointments
- View Medical History
- Doctors Searching

For Clinical Staff (Physician and Nurse)
- Today Schedule
- Staff Profile
- Patients Searching
- Diagnoses / Treatment
- View Patient Medical History
- Retrieve Patient Medical Record from other healthcare institutions.

Figure 1: System Overview - The simple relationship of the healthcare institutions in HK.
For System Administration

- User Accounts Maintenance

### SYSTEM ARCHITECTURE DESIGN

The system architecture of M-Care Patient Information System is showed as below:

![Three-tier System Architecture of M-Care Patient Information System](image)

**Figure 2: The three-tier System Architecture of M-Care Patient Information System**

The Personal Computer, Laptop and PDA provide the main user-interface for end-users. The client browsers send the HTTP requests to the web application server and then it will send the SQL statement to query the database. Once the server receives the ResultSet, the program will convert it into a XML document and pass it to the XSL processor. It will combine the XSL stylesheet to generate the HTML pages to display on the client browsers.

### PHASE 5 - IMPLEMENTATION

In this phase, it focuses on the implementation of system and system programming. The system is intended to run on the Internet and support large number of users. Therefore, the system is proposed to develop by Java technology.

**Java Implementation**

Java from Sun Microsystems is an ideal language for development of the patient information
system with XML/HL7. It is because:

- Java is small, robust and architecture independent language that can be executed on any platform.
- Java interacts well with today’s popular WWW browser and therefore provides a convenient means for accessing the agents.
- Related technologies such as Java servlets and Java Scripts make this language ideal for building system on the Internet.

After the implementation, the patient information system should have several workable functions mentioned in phase 4.

**PHASE 6 - TESTING AND REFINING THE SYSTEM**

After establishment of the patient information system, it will be tested and analyzed its performance and capabilities. Some enhancement will be applied to the system and the system should be bug-free proved.

**PHASE 7 - DOCUMENTATION**

After testing and refining the system, the M-Care patient information system will then complete and ready for demonstration.

The final year project report can be generated and we can draw the conclusion on whether the system can meet the objectives (which we defined in the phase 2) and advice any future improvements in the report.
E. PROJECT SCHEDULE

The project schedule will be divided into several phases, which was shown as following Gantt chart:

Gantt Chart of Final Year Project - M-Care: Patient Information System

<table>
<thead>
<tr>
<th>ID</th>
<th>Task Name</th>
<th>Start</th>
<th>End</th>
<th>Duration</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Background Research Study</td>
<td>2003/9/1</td>
<td>2003/9/5</td>
<td>5d</td>
<td>Sep</td>
<td>Oct</td>
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<tr>
<td>2</td>
<td>Data Analysis (Data collection and data processing)</td>
<td>2003/9/6</td>
<td>2003/9/20</td>
<td>15d</td>
<td>Nov</td>
<td>Dec</td>
</tr>
<tr>
<td>3</td>
<td>Prepare proposal</td>
<td>2003/10/2</td>
<td>2003/10/2</td>
<td>12d</td>
<td>Jan</td>
<td>Feb</td>
</tr>
<tr>
<td>4</td>
<td>Submit proposal</td>
<td>2003/10/3</td>
<td>2003/10/3</td>
<td>0d</td>
<td>Mar</td>
<td>Apr</td>
</tr>
<tr>
<td>5</td>
<td>Design the system (DBMS, User Interface)</td>
<td>2003/10/4</td>
<td>2003/10/4</td>
<td>30d</td>
<td>May</td>
<td></td>
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<tr>
<td>6</td>
<td>Implementation</td>
<td>2003/11/3</td>
<td>2004/1/31</td>
<td>90d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Prepare mid-term check point progress</td>
<td>2004/1/2</td>
<td>2004/1/18</td>
<td>7d</td>
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<td></td>
</tr>
<tr>
<td>8</td>
<td>Submit mid-term check point progress</td>
<td>2004/1/19</td>
<td>2004/1/19</td>
<td>0d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Testing</td>
<td>2004/2/1</td>
<td>2004/2/2</td>
<td>31d</td>
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<td></td>
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<tr>
<td>10</td>
<td>Debugging and Refining the system</td>
<td>2004/3/3</td>
<td>2004/3/25</td>
<td>22d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Prepare final report</td>
<td>2004/3/23</td>
<td>2004/3/26</td>
<td>33d</td>
<td></td>
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</tr>
<tr>
<td>12</td>
<td>Submit final report</td>
<td>2004/4/27</td>
<td>2004/4/27</td>
<td>0d</td>
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<tr>
<td>13</td>
<td>Prepare presentation and Demonstration</td>
<td>2004/4/28</td>
<td>2004/5/7</td>
<td>10d</td>
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<td>14</td>
<td>Presentation and Demonstration</td>
<td>2004/5/8</td>
<td>2004/5/8</td>
<td>0d</td>
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In this project, there are four main deliverables. They are:

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Due Date</th>
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<tbody>
<tr>
<td>Project Proposal</td>
<td>3 Oct 2003</td>
</tr>
<tr>
<td>Mid-term check point progress</td>
<td>9 Jan 2004</td>
</tr>
<tr>
<td>Final Report</td>
<td>27 Apr 2004</td>
</tr>
<tr>
<td>Presentation and Demonstration</td>
<td>8 May 2004</td>
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F. RESOURCES ESTIMATION

The minimum hardware and software requirements of the proposed system are estimated as follows:

1. Hardware Resources

For Desktop / Laptop computer.

<table>
<thead>
<tr>
<th>Processor</th>
<th>Pentium III 733 MHz or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>128MB Ram or above</td>
</tr>
<tr>
<td>Disk Space</td>
<td>Around 500MB</td>
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</tbody>
</table>

For PDA (Pocket PC / Palm):

<table>
<thead>
<tr>
<th>Processor</th>
<th>206 MHx or above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory</td>
<td>32MB Ram or above</td>
</tr>
<tr>
<td>Other relevant tools</td>
<td>Mobile phone, modem, Compact Flash type 1 LAN card</td>
</tr>
</tbody>
</table>

2. Software Resources

<table>
<thead>
<tr>
<th>Operating Systems</th>
<th>Window CE / 98 / ME / 2000 / XP / NT 4.0 or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Tools</td>
<td>Server Side</td>
</tr>
<tr>
<td></td>
<td>Apache 1.3.12 Server / Microsoft Internet Information Server, J2EE, J2RE, J2ME, Xalan XSLT Processor for Java, Internet Explorer 5.5 or above</td>
</tr>
<tr>
<td></td>
<td>Client Side:</td>
</tr>
<tr>
<td></td>
<td>Browser which support Java/XML and J2RE</td>
</tr>
<tr>
<td></td>
<td>Others:</td>
</tr>
<tr>
<td></td>
<td>Java wireless toolkits</td>
</tr>
<tr>
<td>Database Tools</td>
<td>Oracle 8i or greater / MS SQL Server 2000</td>
</tr>
</tbody>
</table>
G. REFERENCES/BIBLIOGRAPHY

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REFERENCES


