

## 데이터스트림 처리 시스템에 기반한 연속적인 헬스케어 데이터 관리 시스템 설계

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## The Design and Implementation of Continuity Health Care Record Management System based on Data Stream System

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### Abstract

The development of the internet and information management has enabled new applications which include: Electronic medical record (EMR), intelligent transportation, environmental monitoring, etc. In this paper, we design and implement the Continuity Care Record(CCR) Data Stream management server that compiled with DSMS and DBMS in EMR system for processing, monitoring the incoming CCR data stream and storing the processed result with high-efficiency. The proposed system enables users not only to query stored CCR information from DBMS, but also enables to execute continue query for the real-time CCR Data Stream. By using of CCR Viewer Application users can view or update their personal health records even compare self health care records with standard health care records in order to monitor the healthy status, and the on line updating information would be minimized and medical error.

Keywords— Health Care Record; Data Stream Management System; Database Management System;

### 1. Introduction

The development of the internet and information management has enabled new applications which include: Electronic medical record (EMR), intelligent transportation, environmental monitoring, telecommunications services, supply chain management, industrial production, etc. [1]. In these applications, the data which we called data stream is multidimensional, continuous, rapid, and time-varying, which should not only meet the needs of traditional ad-hoc query, but also continuous one for special.

As the EMR system for example, in a country or area there is multiple of healthcare provider (HCPs), and due to the health insurance coverage, cost and quality of care, the patients often be cared from different HCP [2][3], and at a period time like daytime there would be generated a large of Continuity of Care Record (CCR) data from a lot of devices and many kinds of operation to the CCR information, for example view, update or monitor CCR information data, these would be form a data stream to the server centre. However the traditional Database Management System (DBMS) suffers

from processing the real time and complex application since it serious design bottlenecks [1]. As a result, researchers put forward to Data Stream Management System (DSMS) which focusing on supporting continuous queries over massive and busy data streams, also providing quality of service (QoS) guarantees. And some major research prototypes system (STREAM [4], Aurora [2], Telegraphcq[5]) and commercial systems (Streambase [6], Coral8 [7]) is developed with higher technology for the real-time requirements.

However, there are no result storage components in DSMS while in practical analytical applications, such as CCR information monitor and transfection, it is necessary to analyze the results for future. So we should compile the DSMS and DBMS in EMR system that DSMS process the stream data and DBMS store the results. For these reasons, we need to design a system to processing the CCR stream data and transfer between different HCPs with high-efficiency.

The rest of this paper is organized as follows. Section II describes the related work to the EMR system. In Section III, we will discuss the system architecture, stream data query management and workflow. In Section IV, we implement the system followed by the related work and conclusion.

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## 2. Related work

It has been reported that between 44,000 and 98,000 patients in the world die from medical errors annually and many errors and adverse incidents occur as a result of poor quality data and information [8]. For the importance of the correct and continuity of care record, the Healthcare Informatics committee of the American Standard for Testing and Materials (ASTM) standards development organization developed the Continuity of Care Record (CCR) standard (Figure 1) in order to improve continuity of patient care, to reduce medical errors, and to assure at least a minimum standard of health information transportability [9]. The CCR was designed to provide a snapshot of treatment and basic patient information and ease the transition of a patient from one HCP to the next cause the CCR is a core data set of the demographic, medication lists, clinical and insurance information, medication lists and recent medical procedures. And the Google Health (GH) and Microsoft Healthvault (HV) are two famous systems that use CCR standard [10][11]. In our CCR Data Stream System we combine the DSMS and DBMS for processing the CCR data information. According to the intergrade system, we can get the many benefits from the system like:

- the time to update the patient's information and ask symptom will be minimized cause all the information is stored in system and we can update these information on time;
- the next HCP will not need to search for or guess about the patient's allergies and can be informed about the patient's most recent healthcare and know who last treated the patient and what had done and cause of this the medical error will reduced;
- some health care costs will not be needed due to the basic information and adverse reaction can be queried from system.

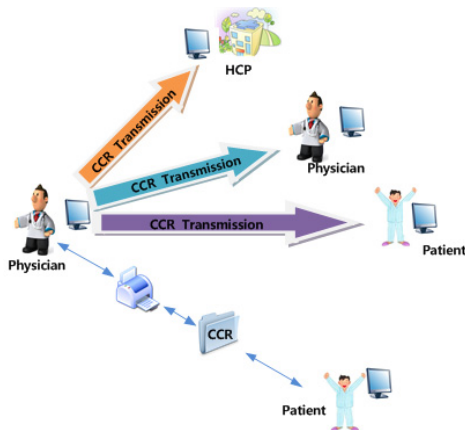


Figure 1: the transmission of the CCR Standard

## 3. System Design

A CCR Data Stream System is designed to manage the large CCR data stream from multiple clients with many kinds of operation, and can execute process translation query and continue query.

### A. System overview

The following figure shows the overview of the system. As shows in figure the clinical and CCR data management is the

main job of the system. The patients and HCPs can query, update the data form system for the next diagnosis, and export the CCR information between different HCPs with international standard.

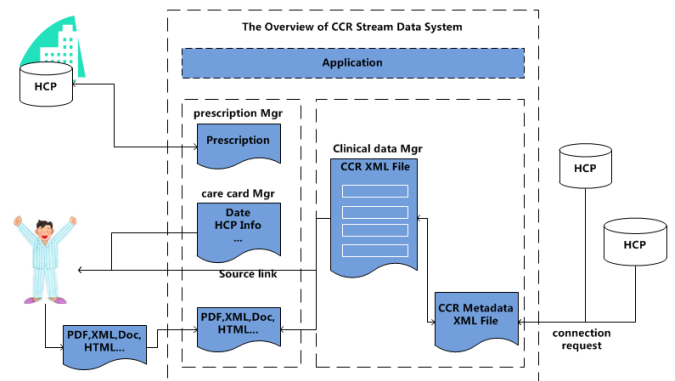


Figure 2: the main function of CCR Data Stream System

### B. System architecture

The figure 3 shows the detail architecture of the CCR Data Stream System. As shown in the figure, the system is divided to three layers: the data presentation layer, the business layer and the data access layer.

#### 1) Listener Part

In the presentation layer, the Listener part provide the GUI user interface for the patients, doctor, HCPs that include Receive Query and Return Result two parts module.

- Receive Query Module is designed to accept two types query, one type query is the from UI menu operation that include filter condition, another is one-time query that user self-defined. When the system received the query request, this module will change the request context, request time, user information to the system executable query and then send to Query Manager.
- Return Module is designed to return data process result from DSMS and DBMS.

#### 2) Query Manager

This component contains three function module (Filter Configure, Query Modify, and Dispatch Unit) and Query Execute Information (QEI).

- Filter Configure will receive the filter condition from Listener component and then send to DSMS in order to filter data stream;
- Query Modify is used to modify query information that in QEI;
- Dispatch Unit is a query schedule unit, it will decide the query information for DSMS and DBMS by schedule the query request ;
- QEI is used to store the query information, and the data structure is called Query Data Structure;

#### 3) Data Access

This layer contains three modules for processing the coming CCR Data Stream: Data Adapter, DSMS and DBMS.

- Adapter is used to get CCR Data Stream;
- The DSMS will process CCR Data Stream with high-effect and provide Continue Query;
- The DBMS will store the result from DSMS for the next time query or export.

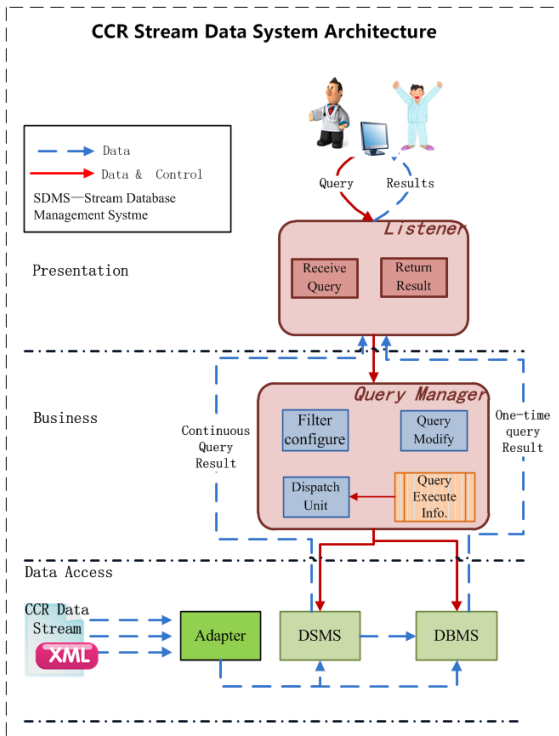


Figure 3: CCR Data Stream System Architecture

C. CCR Data Stream Query

According to data stream characteristics, we use the Continuous Query Language (CQL) for data stream query in DSMS [12], CQL uses the similar SQL syntax to describe the events and events reflected processing rules. For a lot of external events and internal objects are in the memory, the DSMS process the CCR Data Stream in memory, and after get results, we just store the interested data to DBMS for future query or display. Our system's CQL provides two inquire ways, Snapshot way and Continuous way. The Snapshot inquire just do once time, but Continuous way adapts the similar rules of the SQL engine, as long as the events or objects had been changed, it will execute inquires and the object is invoked to the corresponding call-back functions. The CCR Data Stream System is also designed to monitor the status of CCR data, when the data updated, we process it, and else the system waits.

D. Workflow

There are various steps are performed between CCR Data Stream System and User Client as shown in figure3. Step 1: the patient turns on the CCR Application when he/she gets disease or needs some test; Step 2: the doctor or HCP will select the patient from patient list that from CCR Data Stream System; Step 3: for example in the scenario the patient 1 is selected; Step 4: the system will send a permission request to the patient 1 for the next action; Step 5: if the patient accept the accessing permission, client application will create a connection session with the Server and the doctor's CCR application, else ignore the requirement; Step 6: when the session is created the doctor can view the patient's detail CCR information as a reference to next diagnosis in order to reduce medical

error; Step 7.1: when the diagnosis is completed, the patient's CCR information is updated in the CCR Data Stream System; Step 7.2: it also will update the EMR (Electronic Medical Record); Step 7.3: finally this update will show in the patient's CCR application. So according the above steps, all of the participant can update the CCR information that contributes to avoid discontinuous records information.

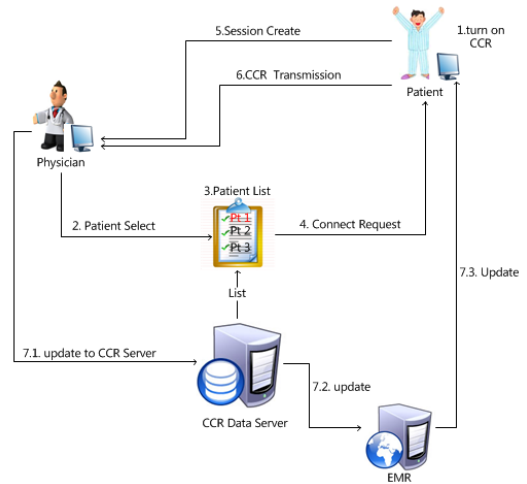


Figure 4: an example workflow of the CCR Data Stream System

4. Implementation

An application complaint with CCR standard requirement was designed and developed to connect with the CCR Data Stream System for viewing and updating CCR information in mobile devices.

A. Database Design

After server times discussion finally we design all the CCR information tables have same fields, but connect to different data element and different value, so we can use the same table structure but present different information. As the advance directives CCR information for example, the relationship between other tables is shown in the figure 5.

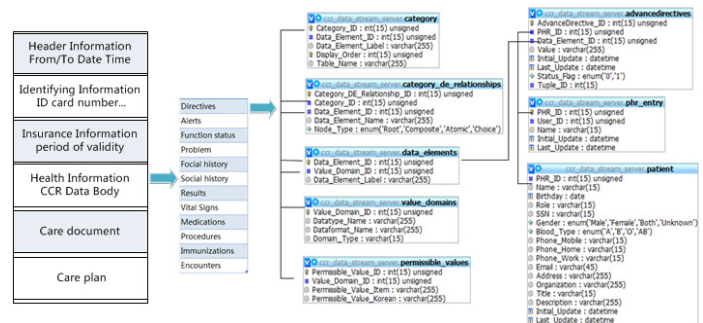


Figure 5 : an example of the relationship between tables

B. User Interface

The CCR Viewer application provides an easy but convince user interface for displaying, adding, modifying, deleting the CCR information. The main menu (figure 6a) contains the CCR standard body information like advance directives,

alerts, function status, problem, family and social history, results, vital signs, medications, procedures, immunizations, encounters, and all the body section is designed like the medications part (figure 6b) which allow patients to update their CCR information by convince navigation and easy operation.

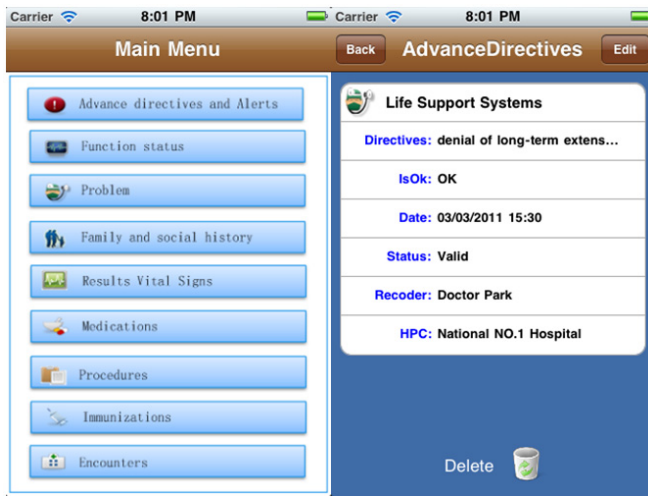


Figure 6: (a) the main menu; (b) an example of the CCR Data Display

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## 5. Conclusions

This paper discusses the CCR Data Stream System's design and implementation that compiled with DSMS and DBMS in EMR system for processing, monitoring the coming CCR data stream and storing the processed result with high-efficiency. With the help of CCR Viewer Application patients can view or update their personal health records at real time. Finally it helps to minimize the time of updating information and asking symptom since the centralization of management.

Although it can bring a lot of benefits from using the system, it just allows the user who registered in the system to use the CCR application. The system design has no mechanism to ensure that patients and/or HCPs do not conceal information during data acquisition process. Nowadays, we just support mobile device accessing to system to update their information, future study and design will need to overcome the shortcoming.

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