OpenEyes Overview

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Version: 1.02:

Date issued: 9 March 2012

Target Audience

General Interest	✔
Healthcare managers	✔
Ophthalmologists	✔
Developers	✔

Amendment Record

Issue	Description	Authors	Date
0.9	Draft	G W Aylward	6 January 2010
0.95	Draft	G W Aylward	24 February 2010
1.00	Release	G W Aylward, M Andersson	23 March 2010
1.01	Release	G W Aylward, M Andersson	26 March 2010
1.02	Release	G W Aylward	9 March 2012

Executive Summary

OpenEyes is an open source project with the aim of producing a world class ophthalmology electronic patient record system. It consists of a series of designs, documents, and software which together make up a modular toolkit which can be used by an ophthalmic department or hospital to rapidly build a fully functional electronic patient record system.

OpenEyes is supported by a range of ophthalmic units including Moorfields Eye Hospital, St Thomas' Hospital, NHS fife, and Cardiff. It has developed links with the OpenEHR project from UCL, and the Royal College of Ophthalmologists.

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Background

Delivery of excellence in health care requires good quality information available in the right place, and at the right time. This is true for the clinical management of an individual patient, but it is also a pre-requisite for reliable audit, analysis of outcomes, research, revalidation, and resource management. These are problems crying out for information technology solutions, but despite this, the vast majority of healthcare continues to be delivered using paper based records. There reasons for this are legion, but include the challenge of data input in a busy clinical environment, cultural issues, and the lack of capable and affordable IT products to process the information. Among medical specialties, Ophthalmology has a particular problem in that the use of images collected by an increasing range of specialised devices is becoming vital for the diagnosis and management of many patients.

None of these problems are new, and in 1997, a pilot scheme using internally developed electronic records (EPRs) to gather routine clinical information was established on the vitreoretinal, and medical retinal services at Moorfields Eye Hospital. The system succeeded in collecting sufficient clinical data to allow the first ‘fully automatic’ clinical audit to be carried out.[1] The concept of a fully automatic audit is that a computer algorithm is used to extract and analyse data collected as a by-product of routine clinical practice, producing useful audits and outcome analysis without additional effort. The system formed a core component of the Hospital’s IT strategy in 2000, when it was handed over to a commercial software company, and the resulting product (ePatient) remains in use today. However, further development stalled due to a combination of commercial factors, and the promise that the National Programme for IT (now Connecting for Health) would deliver a comprehensive solution. However, recent research has indicated that local EPR systems are often more effective than larger scale projects.The same study also found evidence that if EPR systems are developed organically and in-house, they are more likely to be successful.[2]

Purpose

This document provides an outline of an open source project with the aim of producing a modern, highly capable, electronic patient record for ophthalmology. It assumes a basic level of knowledge of both ophthalmology and informatics on behalf of the reader. The goal is to create a collaborative framework which will allow the rapid, and continuous development of EPR technology, with contributions from a number of institutions, academic departments, companies, and individuals. Any ophthalmic unit, from single practitioner to a large eye hospital, can make use of the structure, design, and code to rapidly produce a functional, easy to use EPR at minimal cost. By sharing experience, pooling ideas, and distributing development effort, it is expected that the resulting EPR will evolve rapidly.

Design Principles

As a minimum, good software should carry out the functions it was designed to do reliably and efficiently. In the past, the importance of the user interface has often been underestimated. However, the time pressure of a busy clinical environment means that an efficient, fast, and user-friendly interface is not just desirable, but absolutely essential to the acceptability of the system to clinicians. Rapid turnover of clinical staff, particularly junior doctors, means that the ability to use the system efficiently must be acquired in a very short time.

The system should also be 'intelligent' and efficient in the sense that it should only be necessary to provide it with a piece of information once. A simple example would be entering personal details. If the title is given as 'Mrs', then it should not be necessary to also enter the sex of the patient!

Many pieces of software are over-complicated for the purpose at hand. This often arises for historical reasons, or because of erratic development, but a plethora of functions can confuse the user, and slow down the system, as well as increasing the risk of bugs or system failures. Simple software is easier to understand and to use, as well as easier to modify and maintain.

Modularity in construction of the software allows addition of new features without interfering with existing ones, permitting modification and updating of the system without major outages. If new or modified functions are required, these can be 'bolted on' rapidly. This is vitally important in current times, where frequent changes in treatments or the healthcare environment mean that the system should be both flexible and responsive to change.

Security is an ever-present concern, particularly in the light of recent high profile data losses. Protecting patient data, and ensuring confidentiality are essential.

Changes in healthcare delivery will require the ability to access records in multiple locations, so location independency, and the use of agreed standards for software and protocols will help to make OpenEyes as future proof as possible.

These principles are summarised in the following table

Number	Principle	Description
1	User-friendly	Fast, efficient, intuitive interface
2	Intelligence	Built in knowledge of ophthalmology, no duplication of data entry
3	Simplicity	Easy to understand, easy to use, and easy to maintain
4	Modularity	Ability to ad or modify modules quickly and easily
5	Security	Security of data, protection of confidentiality
6	Standards	Use of agreed and open standards wherever possible

Structure

An outline of the overall system structure is shown in figure 1. The data is stored on a central server, or servers using a Relational Database Management System (RDMS). Data is entered into the data base in a variety of different ways, and there are links with other sources of data, particularly the Patient Administration System (PAS) or similar which most organisations already have to store patient demographic data. The user communicates with the system using a familiar web browser on a PC, laptop, or a handheld device. Data can be extracted for analysis for audit, research, or management information.

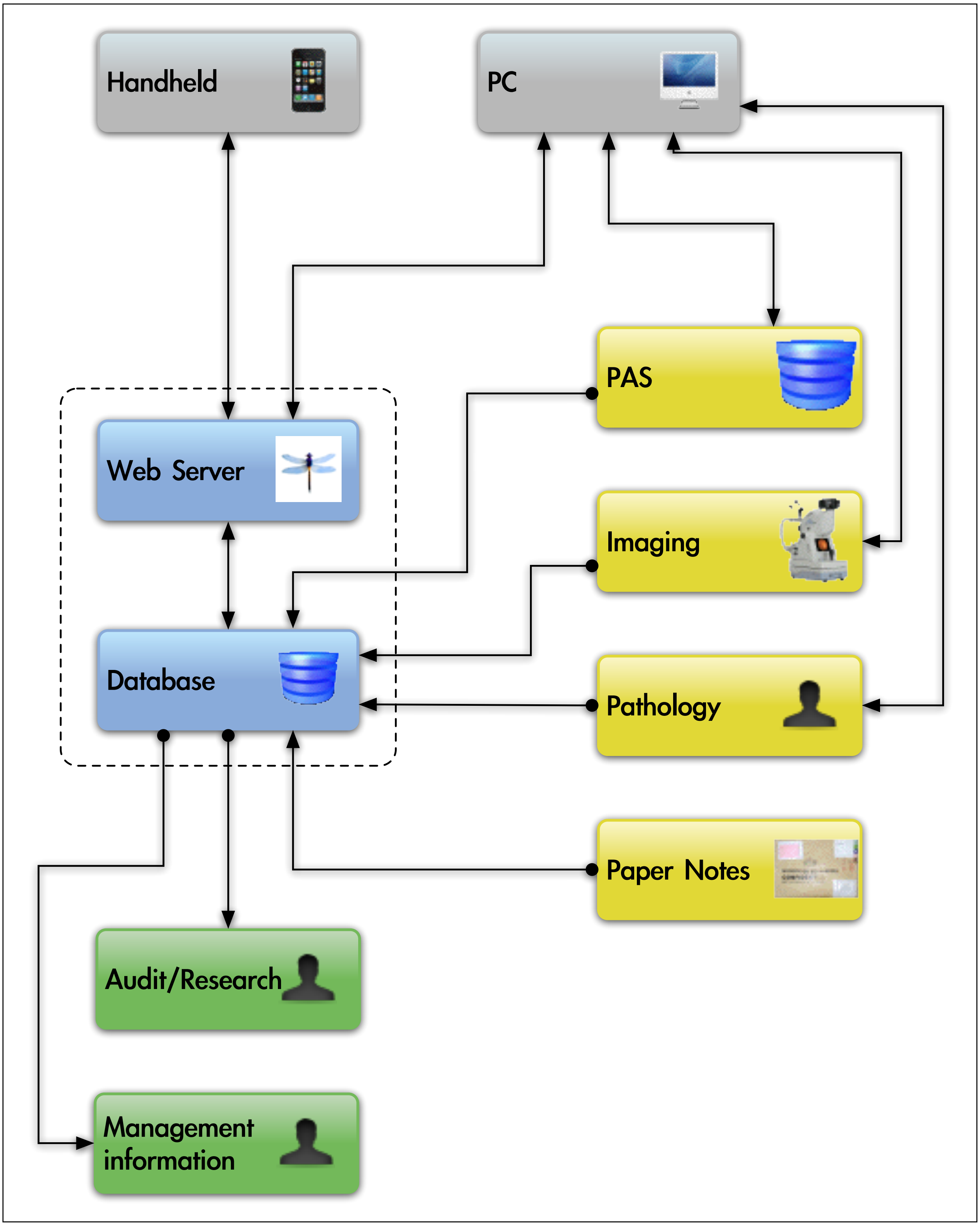


Figure 1. Overall System design. In smaller departments the web server and database (enclosed with dotted line) will be running on the same computer. Clinicians entering data are shown in the gray boxes, Other inputs are shown in yellow, and the green boxes are outputs

Software

For most purposes, the user will communicate with the EPR using a standard web browser. A browser interface has been chosen for several reasons. The conventional model of running specialised applications on a PC has a number of disadvantages, which are particularly troublesome in a multi-user environment. Applications need to be installed, updated, and maintained on each machine, which even using remote management tools, represents a significant workload for an IT department. When the World Wide Web was invented, browsers could do little more than display text and images, but the exponential increase in usage has resulted in a rapid and continuing development of technologies in recent years. As a result, the capability of web browsers has now reached the stage where programs running within them can match stand-alone applications in both functionality and speed. Since the changeable part of the software is running on a central server, installation and updating becomes much easier, as does user access, particularly from remote locations.

Security and Confidentiality

Principles

The importance of security and confidentiality cannot be over-emphasised when it comes to personal health records. Thankfully, partly because of the use of the internet for security-sensitive applications such as online shopping and banking, sophisticated security protocols and procedures have been developed in recent years.

Access Control

In a multidisciplinary healthcare environment, graded access to healthcare records is required. For example, a medical secretary should be able to access details of patient appointment dates and times, but should not be able to access sensitive details such as diagnosis or HIV results. Medical staff need to be able to enter and retrieve information on their patients, but not necessarily those under the care of other doctors. This scenario calls for a sophisticated level of access control, such as Role Based Access Control (RBAC) which has been developed in OpenEyes.[3]

Data Transfer

Data transferred to and from the browser is encrypted by the standard means (https). This is to prevent unauthorised access to data while it is in transit.

Additional Measures

OpenEyes will include further security measures as necessary. It also allows separate security measures. For example, particularly for remote access, authentication using dongles or tokens is an option.

Three Tier Design

Outline

The design of the clinical component of OpenEyes is based on a three level structure which is summarised in Figure 2. The user interacts with the database through a web browser, which communicates with a relational database management system (RDBMS) through an intermediate web server layer.

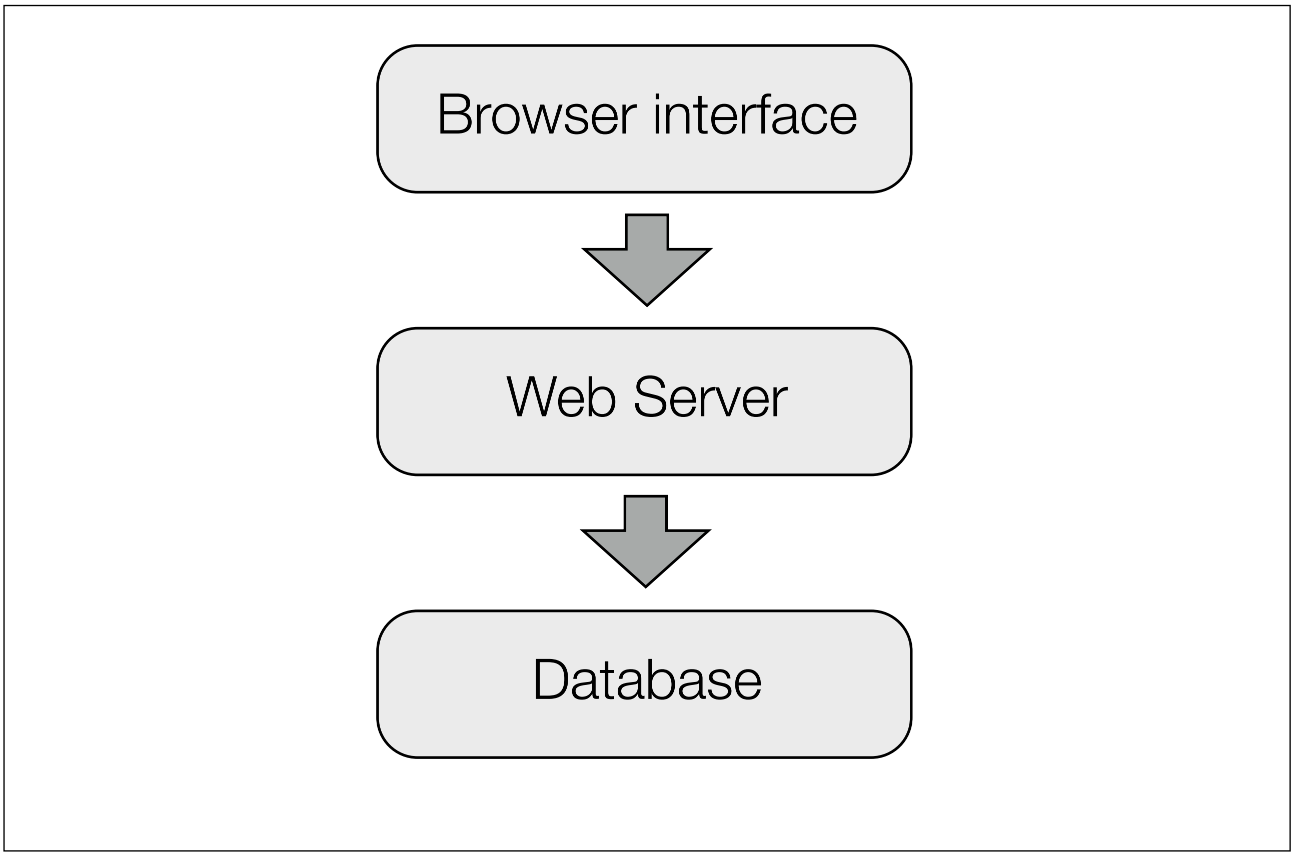


Figure 2. Three level structure of the clinical component

Database Tier

Detailed descriptions of the internal structure of the database are included in Appendix 1. Communication between the middle layer and the database layer is done by means of standard SQL statements called by scripts written in PHP. PHP is able to communicate with most RDBMS packages, but the syntax and coding varies significantly between them. For this reason a Database Abstraction Layer (DAL) has been designed to handle communication with the underlying RDMS, so that none of the PHP scripts need to be re-written for different database software, such as MySQL, Oracle, Microsoft SQL server.

Middle Tier

PHP (PHP) has been chosen as the language in which the middle tier is written. The reasons for choosing PHP include its wide user and developer base, its large development team, and frequent updates.

Interface Tier

The user will interact with OpenEyes through a web browser running on a PC or other device (e.g. a mobile phone). Standard HTML, CSS and Javascript will be used to provide a rich and efficient user interface for adding, and analysing data. Java Applets will be utilised to provide any additional functionality that cannot be derived by the use of other tools.

Connectivity

Existing systems

In most environments, there will be an existing Patient Administration System (PAS), or similar, which will be used to house and update demographic information on the patients in the organisation. It is therefore essential to provide a means of exchanging such data with OpenEyes.

Imaging

The use of images for diagnosis and monitoring of treatment is becoming increasingly important in ophthalmology, and the rapid and relevant presentation of such images to the user is a vital component of an EPR. Most suppliers provide proprietary systems for both image acquisition and display, and although there is a move towards the use of standards for interchange (eg DICOM) there is not yet agreement on whether or when this will happen.

Therefore, in the short term, It is proposed to take a pragmatic approach to images with OpenEye. All devices that acquire images have either an accessible database, some sort of facility to output images (eg a printer port), or both. Summary images, obtained by whatever means is appropriate, will be stored directly on the OpenEyes database for inclusion in the clinical record.

Coding

Introduction

There are several advantages of storing clinical information in coded form, particularly when it comes to the analysis of stored data. A number of terminology and coding systems are available, and SNOMED CT ® is being developed to provide a comprehensive terminology to allow coding and storage of almost any clinical event or encounter. However, the selection of codes ('browsing') can be a time consuming process which is not always justified. OpenEyes uses a range of methods of data capture and storage, including free text where appropriate, drawings, and coding and terminology systems. These are summarised in the following table. Although SNOMED CT ® also provides procedure codes, the use of OPCS codes is recommended for National Health Service applications because of the direct link to NHS funding.

Item	Coding	Comments
Diagnosis	SNOMED CT	Conversion to ICD10 for PbR
Procedures	OPCS 4.5	Direct input into coding for PbR
Drugs	SNOMED CT	Monthly update provided

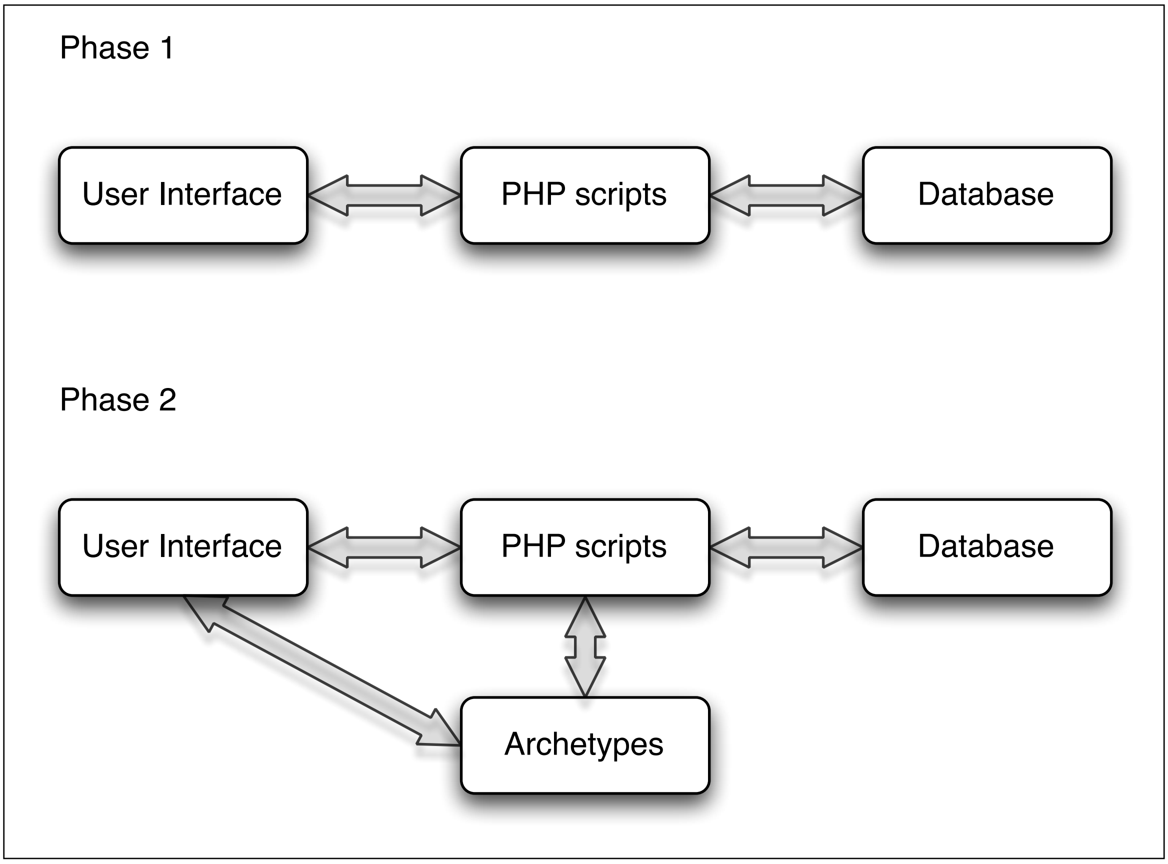
Standards

OpenEyes is committed to using open, preferably internationally but otherwise more locally agreed standards wherever possible. These include the clinical data sets approved in England for cataract, glaucoma, and ARMD, as well as others that are currently in development. As mentioned earlier, other official or *de-facto* standards adopted by OpenEyes include SNOMED CT, ICD-10, and OPCS-4. HL7 is supported for communication with other health care systems, such as Patient Administration Systems.

OpenEHR

OpenEHR is an international not-for-profit Foundation, based in UCL the aim of which is to assist the production of life-long electronic health records.[4] OpenEHR is about creates specifications, open source software and tools to achieve that goal. It creates high-quality, re-usable clinical models which are known as archetypes, which are flexible and aid storage and interchange of data.

OpenEyes will be working closely with OpenEHR during development, and to assist in the creation of archetypes for ophthalmology. Initially these will be parallel work-streams, but it is intended that archetypes, as well as other aspects of the OpenEHR architecture become fully integrated in the future. The two phases are illustrated in the following diagram.



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