

Logica's eCareLogic: A Service Oriented Architecture for Connected Health

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Abstract. Providing a centralised, complete patient history across acute, primary and community healthcare is the aim of Logica healthcare system design. Achieving this complex system integration without major disruptions to normal work practice is a key factor in the acceptance of eHealth by medical practitioners. This paper will outline how a service-oriented architecture (SOA) can be successfully used to transform current paper based and, stand-alone computer based system data, into a web-based managed service with 0% failure rate and a secure centralised database. Logica's eCareLogic (eCL) has been shown to improve the performance of a health facility by saving money, increasing system use by clinicians, improving patient safety and being easily deployable alongside existing systems. This paper includes an overview of our experience integrating Logica eCL with legacy systems at University College London Hospitals NHS Foundation Trust (UCLH) in UK.

Keywords: Central and complete patient history, real-time access, web-based managed service, messaging and alerts.

1 Introduction

Motivation for change. Today information and technology play a critical role in the lives of people. In both developed and developing countries societies are increasingly turning to web based and mobile phone based approaches to delivering timely and targeted information to as many people as possible. Health transcends cultures and class and is at the heart of social development. So governments are turning to information and technology to improve care delivery as efficiently as possible.

In this scenario technology can be used to enable improved access to information, efficient health processes management, increased quality of care. This paper is concerned with an exemplar of efforts made in the UK to develop the future NHS based on integrated technology to aid delivery of care. In order to provide a high quality, efficient and informed service a reconfiguration of patient centred care was deemed necessary along with reforming working and clinical practices. In 2002 the NHS in England established the National Programme for Information Technology (NPfIT) to define and deliver high-quality IT systems for healthcare professionals. This programme was the first major policy step taken by the government to modernise and standardise the IT services of the NHS at national level [1].

This programme includes a secure national broadband network (N3), care records service (CRS), picture archiving communications system (PACS), secure email and directory service (NHSmail), choose and book for outpatient appointments, electronic prescription service (EPS) and support systems for GPs such as electronic patient record transfer (GP2GP), payment systems (QMAS), GP systems of choice (GPSoC) etc. Initially an ambitious 3 year plan was put in place to deliver these infrastructure components. At present as we approach the end of a decade since the programme initiation most of these central and primary care components are recognised to have been successful. There are many issues with the complexity and delivery of enterprise level hospital systems where many components have raised controversy in terms of localisation and implementation.

With the new government in UK there is now a paradigm shift in frontline healthcare [5]. Due to take effect from 2013 onwards the emphasis is on GP consortiums managing local services and scrapping many existing management structures based on 10 strategic health authorities and 151 primary care trusts. At this initial stage the emphasis remains on patient centric care with easy access to information for patients in order to aid more participation in decision making and control of their own care. This along with bottom-up approach to managing budgets and performance means the importance of a technology platform that serves the purpose of matching local delivery with national models. Both infrastructure and local operational systems investments are now subject to new business demands and change is required against a background of fixed or falling revenues.

Connecting for Health and reconfiguration of health services in England.

Connecting for Health (CfH) is a directorate of the Department of Health formed in 2005 with the primary role of supporting and reforming existing IT supporting services delivering the NPfIT and management of existing IT-related functions of the NHS at national level. Many of the NPfIT aims have been achieved, for example all GP practices have updated systems and there is a rich connectivity on a VPN for health providers. More than 8500 general practices (GPs) and many community health services are connected to almost 300 hospitals. All health provider organisations have some sort of operational electronic patient record and submit central statistical returns. There is an ongoing attempt to deliver a national summary patient record, which is much debated in terms of usefulness and proper consent and governance. Local programmes are delivered regionally by two commercial local service providers (LSP) who carry out local system integration with national systems.

One of the key lessons learnt from initiatives launched so far is the importance of strong standards and systems designed and supported by health pathways and clinical governance. Secondly this clinical and management structure needs a common information system with one patient record and shared information across disparate care delivery and decision making sections. Unfortunately, NHS CfH which originally had a wide agenda was concentrated on the challenge of generating better use of existing systems for management [3]. Hence providing a centralised information system with localised service delivery that integrates primary and secondary care along with social care, payment systems, management decision support and independent providers a significant challenge. As part of a national installation of IT solutions, the management of information is at least as great a

challenge as delivering the necessary IT. A way must be found in accelerating this agenda if the 21st-Century IT is to underpin the modernisation of the NHS as effectively as it could.

Logica's eCareLogic (eCL). Logica's eCL was conceived to create a central information source that communicates with independent IT systems from different providers. Inter-operability features of the solution is aimed at enabling hospitals to free up data trapped in legacy systems and use this data and newly captured data as the basis for a scalable and incremental electronic patient record. The development is based on a service oriented architecture where modular components are 'wrapped around' a kernel to support the management of patient pathways from referral to treatment and subsequent discharge and follow-up in the community. Logica eCL is designed to work across a health economy, in Acute and Community hospitals, GP practices and polyclinics.

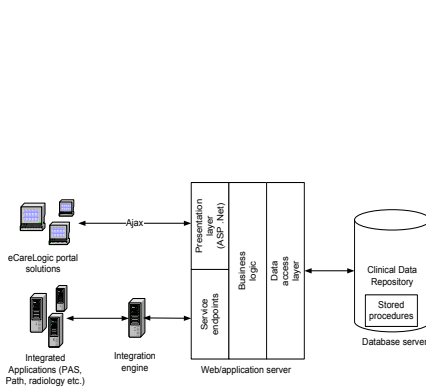


Fig. 1. System overview: the core

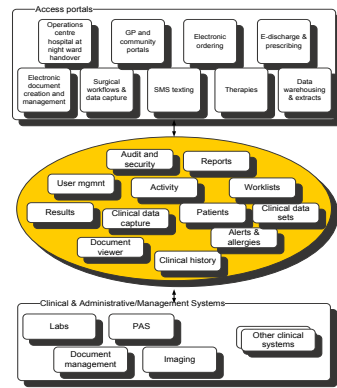


Fig. 2. Functional overview: sources, access and portals

The various modules of eCL can be combined according to the needs of the healthcare practice; the kernel consists of a *data repository*, *data access layer* and *basic portal* which are common to all installations. The *integration engine* is a key component which acts as an 'innovation wrapper' around the kernel and its core elements. This engine enable service oriented modular elements to be implemented on demand and integrated with existing systems following the principles of CfH interoperability toolkit. If an integration engine already exists within a legacy healthcare IT system then the kernel can still be implemented since it is agnostic of the integration software. Fig. 1 illustrates this core architecture.

The various modules of Logica's eCareLogic are made available via web browser based portals and provide solutions such as Reporting, Allergies and Alerts, GP and Community, Audits, Clinical history, Clinical data capture and so on. The user interface also supports integration of desktops from different systems. For example, results reporting portal can display information from the Patient Admin System (PAS) application or other existing clinical systems.

The web/application server handles user accounts, access security, auditing and business logic. The data access layer provides role-based access to data in the system and audits individual transactions and user activity so that viewing and updating a record can be controlled and monitored. The database is an inherent part of eCL for a number of reasons including supporting ad-hoc queries, not impacting the performance of existing systems, storing additional information not captured by legacy systems and most importantly transforming data gathered from variety of sources in to a coherent record for ease of access by end users. This innovative solution performs in real-time data collection/storage, information mapping and management and pathway and workflow modelling.

Deployment of eCL is managed by a governance structure which includes assessing clinical requirements, business requirements and user acceptance. The final stage includes a change management process and follow-on technical support for users. This capability contributes to the local NHS hospital aims of, 1) Saving NHS money 2) Speeding system deployment 3) Simplifying change management.

2 System Design

The healthcare environment has gradually developed over time with numerous systems to support medical care delivery based on a number of hardware and software infrastructures such as mainframe, mini computers, client-server etc. These disparate information systems together with the prevalent use of paper based systems, lent towards silo working by individuals, departments and laboratories. At initial glance, the individuals who work within a specialisation and are well versed in the processes might appear to benefit from this structure. However this leads to less efficient delivery of care which is detrimental to the patient and in the end affect the medical staff's ability to work cohesively together.

It is now widely accepted by governments, policy makers, healthcare managers and medical staff that a one-to-many communication network with the patient as the key information index will lead to improved information flow and efficient decision making. eCL is based on this hypothesis and is designed to connect existing health systems, re-use these systems and provide a seamless view and aid decision making by hospital clinicians and managers at national and local level.

The system is structured around the patient record and provides a complete medical history of individual patients, a GP portal, intelligent analysis and real-time activity reports, pathway & workflow modelling and better resource management aides. All this is achieved while keeping the initial investment on the part of the health centre at a minimum by building upon existing hardware and software as illustrated in Fig. 2.

Functionality of eCL encompasses some or all of the user access portals, the complete data repository and some of the existing IT systems. The rest are existing systems of the healthcare facility from which relevant information will be extracted in order to construct a complete historical and real-time data repository. This repository is the central information source for patient centric data that can be accessed via an integrated desktop by the users of the system. Users will range from doctors and nurses to lab technicians and radiologists to management and administrative staff. The browser based portals will provide authorised user access to information as well as capture new data and actions to be transferred to backend systems.

The data repository plays a key role in providing integrated care. It is the central information source to which the integration engine maps data from different systems and user activities. This data model enables the creation of a comprehensive patient record which tracks the complete clinical history of patient. This does not mean data will be replicated across different systems. This store is to capture new data, and map data between different systems so that a user desktop workstation irrespective of physical location can provide all necessary and authorised information.

The system deployment is based on modular components each of which provide a service which can be clinical, administrative or management such as electronic ordering and results reporting of medical tests, bed states and clinic lists and operations management respectively. The advantage of this structure is that more functionality can be added as required thus speeding up deployment by eliminating downtime to existing systems.

Service oriented architecture. The system is an N-tier architecture separating data, logic and presentation enabling health centres to integrate functionality seamlessly with other applications and develop portal services for end users who range from front-line health staff to hospital managers.

The architecture is based around industry standard products that are easily supportable and scalable e.g. Visual Studio.NET, MS SQL Server and HL7. Logica's eCareLogic is already integrated with 120 other systems including PAS, Pathology, Theatres, ICU, Oncology, Cardiology, PACS, Radiology, Endoscopy Nursing Assessments and Choose and Book. These system integrations were based on a mixture of eCL's own integration engine plus capacity for messages from Trust Integration Engines (TIE) such as those from Microsoft, Oracle, Sun, IBM, Intersystems and Orion. The data mapping between disparate systems and eCL database is achieved via a Health Data Dictionary. However eCL can also setup integration on the basis of Extract Transform and Load (ETL) technologies such as Business Objects Data Integrator and Microsoft Integration Services. These techniques expose and link data previously stored and hidden within legacy systems. Most importantly the exact architecture can be tailored to meet the needs of individual healthcare organisations as illustrated in Fig. 3.

Security and business continuity. The software system is hosted at two separate sites 7km apart and connected via a Gigabit fibre link. Web access is provided via Hyper Text Transfer Protocol Secure (HTTPS) which provides encryption and secure identification of the server. This protocol is used for sensitive transactions in corporate/public information systems with RLI wide area network connection which provides high security access to application and database servers. Active servers are at both hosting sites and the Storage Area Network (SAN) at primary site is the master with synchronous replication to the secondary site.

This provides the most effective storage solution with flexibility to ensure high performance and availability at all times. The physical design is shown in fig. 4.

As described the physical architecture is centred on security and business recovery vital when managing health data. From Logica's experience implementing this solution since 2005, the overall benefit to the patient ranges from more access to

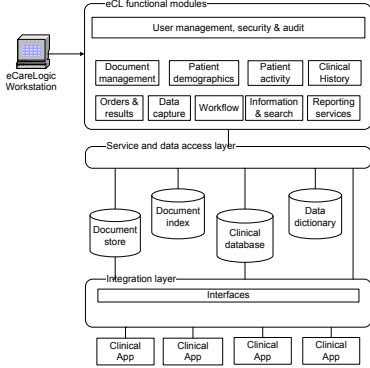


Fig. 3. Service oriented architecture

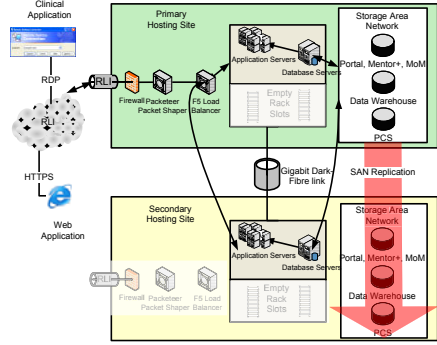


Fig. 4. Physical design

information to increase in safety and quality of care received. Professionals experience improved timeliness in delivery of care, due to instant online access to medical information and reports, and better management of hospital resources.

3 Patient Workflow Modelling

Fig. 5 describes how the various modules assist in providing a clinical and management view for inpatient care. The document management system allows users to view the EPR, upload documents by scanning or as attachments and produce discharge letters. Clinicians can admit patients by browsing online for clinical histories and patient documents before completing e-forms to record new data and planned admission details. eCL also allows electronic ordering of lab and imaging tests, endoscopy etc. and avoiding redundant tests.

Clinical pathways can be determined by tracking events along a patient’s treatment process over time. This facility is extremely useful in drug discovery and supporting specialty pathways such as cancer and heart disease. Management related pathway models include support for meeting 18 week referral to treatment targets, ward management, operation theatre management, e-discharge which include takeaway prescription and follow-up care and overview of inpatient activity. Fig. 5 describes how the various modules assist in providing inpatient care management.

The outpatient access to the system starts at the GP portal which gives access to hospital data of registered patients (Fig. 6). The clinical portal allows access to a comprehensive EPR which includes lab tests such as PACS images, to support outpatient consultations. All the pathways available to inpatient are also available to outpatients who are referred to the hospital as well as specialist systems to manage information, reports and messaging systems. For instance, SMS text messages and reminder letters are sent to patient’s mobile phones as well as producing batch reminder letters. These have been proven to significantly reduce the number of unattended appointments in clinic.

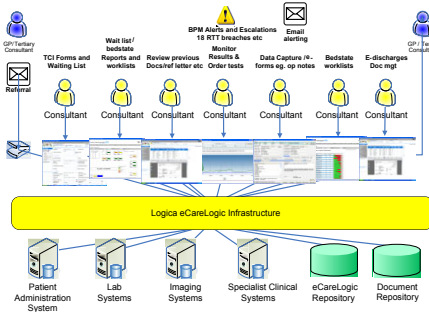


Fig. 5. Inpatient care

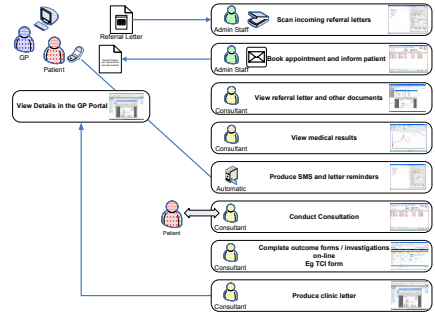


Fig. 6. Outpatient care

4 Case Study- University College London Hospitals, UK

Information at the point of care and decision-making is crucial to the University College London Hospitals NHS Foundation Trust (UCLH) along with trust and dependability. Logica engagement with UCLH started in 2003 with the start of a project to deploy a new clinical workstation and managed service which meets NHS NPfIT objectives and includes electronic document management, order communications and additional services outside the seven hospitals to a wider health community, including PCTs and GPs. The managed service has 100% availability of the Trust’s systems on a 24x7 basis as well as contracting to provide a converged network within the new £420 million state-of-the-art UCL Hospital. eCL is part of this technical solution being implemented at UCLH and the design stage ensured that:

- it was a clinician-led programme, one where clinicians and other users were actively consulted to ensure that the system satisfied their needs and more closely fitted the prevailing working methods;
- communications programmes were established to keep users aware of progress, to respond to questions and to reduce anxieties;
- training and support was available for all users prior to and during roll-out and beyond;
- existing records were properly “cleansed” before being aggregated and migrated to the new system prior to cutover. (All of which was undertaken while existing systems were still being actively used and maintained);
- the roll-out was undertaken in an incremental and controlled manner to minimise disruption and ensure “quick win” benefits were realised early and on a continuous basis.

The Benefits. Logica’s eCareLogic has been running successfully at UCLH since 2005 and since then has been extended to introduce more clinical facilities, real-time management and clinical dashboards, and comprehensive ‘exception based’ control over waiting times. The benefits that UCL Hospitals sought were to ensure that they remain a leading NHS hospital, ready to face the demands of the future:

- improved attendance through the use of automated reminder notices and text messaging
- reliance on clinical notes as scanning and electronic document management systems have enabled clinicians and carers to access all previous correspondence and notes in clinic and across any of the hospital's 4000 PCs
- in partnership with UCL Hospitals pharmacy Logica has introduced electronic discharge prescribing that has speeded and improved the prescribing and dispensing process
- mobile working desktop integration which enables users to move between systems without logging in to each system or having to re-select patients. Not only is this more efficient but reduces the need for multiple passwords and reduces password sharing

The systems and methods introduced by UCL Hospitals in partnership with Logica have helped to make it a more flexible and agile organisation, more capable of embracing new NHS initiatives.

5 Conclusion

This paper presents the current challenges faced by the NHS in England in introducing IT systems for improving care delivery. The NHS success in primary care can be contrasted to problems in the challenge of new hospital systems. As an alternative to new hospital systems a successful implementation of an integrated and secure electronic healthcare solution has been achieved. This innovative system is one of the foremost in building upon existing legacy systems and is supported by an expert change management process and a reliable hardware deployment that guarantees 0% downtime and remote connection via one of the biggest metropolitan networks in Europe. Live implementation of Logica's eCareLogic into a working hospital environment is seamless and risk is neutralised due to no downtime of existing systems. In essence eCL is a solution that combines the information in the multitude of existing 3-rd party IT applications to build a complex but easy to deploy implementation that provides a connected eHealth infrastructure.

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