A Next Generation Cloud-based Health Care Platform
Moving Towards an e-health Platform to Store NHS Patient Information in the Cloud

Prof Bill Buchanan, Dr Lu Fan, Prof Christoph Thuemmler, Dr Elias Ekonomou, Owen Lo, and Alistair Lawson, Edinburgh Napier University.

Contact: w.buchanan@napier.ac.uk
Web: cloud4health.com
Integrated and Secure Cloud-based eHealth for Holistic Care

Industry Age → Information Age

Centralised, Non-integrated, Ad-hoc, Clinician Focused, Reactive, Clinician Control of Records

Distributed Patient Care, Holistic, Patient Focused, Pre-emptive, More Patient Control of Health
Major problem with lack of understanding the difference between the “Cloud” and Cloud Computing

Virtualisation of desktops and servers is just the first small step.

DPA often acts an inhibitor to reduced patient risk

Systems are still focused around clinical staff rather than patient-centric

Current barriers
Current barriers

- Possible resistance of clinical staff in supporting more flexible access to patient records
- Lack of trust
- Too much legacy
- Few proper Cloud-based systems on the market which integrate properly with the formal healthcare system;
Integrated and Secure Cloud-based eHealth for Holistic Care

- Healthcare Professional
- Invited user

- GP
- Invited user

- Care Subject
- 82 years old
- House bound
- COPD (Chronic Obstructive Pulmonary Disease)

- Invited user

- Site Creator
- Primary Carer

Assisted Living (Informal and Trust based)

Primary Health Care (Formal and role-oriented) - GP

Secondary Health Care (Formal and role-oriented) - Hospitals/A&E

Social Care/Health/etc

PatientCloud: Funded by EPSRC and TSB, and is a collaboration between C&W, Imperial College, Edinburgh Napier University, Kodit, GS1 and Ciperlab
Introduction/Context

Integrated and Secure Cloud-based e-Health for Holistic Care

Data Capture
- CapturerID (RoleID)
- DeviceID
- PatientID

Clinical Services
- Interface Delivered From service
- ConsumerID (RoleID)
- Domain A

Data Storage (within the Cloud in buckets)
- PatientID Bucket

Patient Simulator
- Patient Simulator
- PatientID

Patient Cloud
Integrated and Secure Cloud-based e-Health for Holistic Care

DACAR e-Health Platform

Chelsea and Westminster Hospital NHS Foundation Trust

Edinburgh Napier University

Microsoft

kodit

Imperial College London

HoLP

Edinburgh Napier University

CipherLAB

GS1 UK

Technology Strategy Board
Driving Innovation

EPSRC
Pioneering research and skills
Societal

- Lack of integration between assisted living, primary and secondary care
- Aging population
- Lack of information sharing across the public sector
- Strong demand to consume health care data
- Lack of integration with careers and trusted people

Technical

- Patient records are often static
- Different systems/formatting used for data
- Limited/difficult access methods ... typically Government infrastructures ... lack of trust
- Poor access control to data
- Data often aggregated and context is often lost

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Rights

Clinical Services

Human Trust

Identity

Infinite possibilities

Digital Trust

Translation of rights
Translation of identities

Strong Governance Policy

Manager might ask: What’s difference in length-of-stay between different age categories for June?

Consultant might ask: How does the Early Warning Score affect the length-of-stay?

Family friend might ask: In which ward is Deirdre?

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- Often localised
- Different systems/formats
- Poor access control
- Poor identity verification
- Cannot be aggregated
- Etc.

Data Storage (within the Cloud in buckets)

Dynamic Patient Records

Security Policy (including interdomain rights)

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Security Policy Translation Bridge

Data Translation

Security Policy (including interdomain rights)

Data Storage (within the Cloud in buckets)

Service A (EWS)
Service B (Infection Tracking)
Service C (Blood)
Interface Delivered From service

Capture Agent

PatientID Bucket

Domain A

PatientID (RoleID)

Domain B

PatientID (RoleID)

DeviceID

CapturerID

PatientID

Patient Cloud

Clinical Services

Clinical Services

Simulation Agent

Patient Cloud

Patient Simulator

Patient Simulator

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Patient Capture
- CapturerID (RoleID)
- DeviceID
- CaptureTime
- EventID
- LocationID
- ClinicalMeasureID (ClinicalUnitsID)
- AreaID

PatientID

Data Capture
- PatientID

Simulation Agent
- CapturerID (RoleID)
- DeviceID

Patient Simulator
- PatientID

Patient Bucket

Example of context (Infection Tracking)

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SPoC (Single Point of Contact)

Security Policy (including interdomain rights)

Service Provision

Service Infrastructure

Storage service

EWS

Web service

Service consumption

Service Instance creation/invocation

Pointer to service

SPoC Concept

User

Organisational Infrastructure

Service Requirement, Ticket

Identity Provider (IP)

Identity credentials

Ticket

Federated Identity Management

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Observation Chart

Consultant: [Name]

Attach a patient Addressograph here or

Name: [Name]
DOB: [DOB]
Unit No: [Unit No]

An Early Warning Score (SEWS) must be calculated every time patient observations are recorded. If SEWS score is more then call the appropriate doctor and nurse in charge using the guidelines below:

- Increased frequency of observations (minimum hourly) should be commenced and a detailed report of the patient’s medical notes should be completed.
- Early Warning Score 6 or more or rapidly deteriorating patient.
- Call Junior Doctor & Senior Nurse/Nurse Practitioner if score remains within 24 hrs. they should arrange a Consult.
- Consultant should be notified within 24 hrs.
- Call appropriate SHO/Registrar & Senior Nurse/Nurse Practitioner.

Persistent Pain – 6 or above and unresponsive to guidelines:

ACUTE

- Call Medical Staff/Senior Nurse/Nurse Practitioner

CANCER-RELATED

- Call appropriate Registrar/Consultant

For further advice contact:

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Service B (Infection Tracking)
Service C (Blood)
Interface Delivered From service
ConsumerID (RoleID)

Domain A

Service A (EWS)

Blood pressure
Heart rate
Resp. rate
Temperature
SpO2
Neurology

Early Warning Score (EWS) Fuzzifier

Blood pressure (Fuzzy)
Heart rate (Fuzzy)
Resp. rate (Fuzzy)
Temperature (Fuzzy)
SpO2 (Fuzzy)
Neurology (Fuzzy)

Expert Analyser

Event alert
Risk Factor
Refinement of rules
Length of stay
Assessment

Bayesian Predictor

Calibration of fuzzy levels

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Domain B

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Assisted Living

Circle-of-Trust
Circle-of-Trust-based Policies

Primary/Secondary Care

Translation Gateway (Security Policy/ID Mapping)

Data Storage (within the Cloud In buckets)

Role-based security policies

SPoC

CW.CONSULTANT
CW.NURSE

[permit] [C&W.NURSE] [C | R] [Temp | SpO2 | HR | BP | RR | Pain] of [Patient26078] with [EWS] from [Chelsea & Westminster Hospital] for [*] records in [P2010-12-30T00:00:00] using [Data Protection Act]

[permit | deny] [Requester] [C | R | U | D] [Attribute] of [Object] with [Context] from [Owner] for [N] records in [Time Window] using [Compliance]

Governance Policy

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SPoC Architecture

Service Instances & Clients

Application Interface
- Authentication Service
- Authorisation Service
- Pseudonym Resolving Service

Interface Services
- Policy Engine
- Policy Repository
- Pseudonym Repository

Domain Ontology

Single Point of Contact (SPoC)

Users

Services

SPoC Configuration Console

Patient

Administrator Interface

Personal Information Management Console

Administrator
Policy Syntax

[permit] [Medical Staff] [C | R] [Temp | SpO2 | HR | BP | RR | Pain] of [Patient26078] with [EWS] from [Chelsea & Westminster Hospital] for [*] records in [P2010-12-30T00:00:00] using [Data Protection Act]


A similar syntax is also applied to the request messages:

[Requester] [C | R | U | D] [Attribute] of [Object] with [Context] from [Owner] within [Start] to [End]

- { [permit | deny] This is part of the rule syntax which indicates the action of the rule. This defines whether a request meeting the rule criteria will be permitted or denied access.
- { [Requester] This identifies a request sender's role, e.g. GP, or pseudonym, e.g. 10420, or a combination of the two, e.g. GP10420.
- { [C | R | U | D] This defines detailed permissions for a requester to create, read, update and delete certain information.
- { [Attribute] This is a unit of information describing an object. An attribute may be a primitive data type, e.g. the pseudonym of an object as a string, or a complex data type, e.g. a person's ECG record for 45 seconds.
- { [Object] This is part of DACAR's system model. It refers to any entities in a healthcare scenario, about which information is held.
- { [Context] This identifies the reason why the information is being shared. The context governs the level of access and permissions associated with information exchange, and hence defines the priority accorded to information requests.
- { [Owner] This species a role with sufficient privileges to manage all aspects of an information source. The owner has the authority to allow or deny access to an information element, as required by legislation and defines responsibilities.
- { [N] records in [Time Window] This defines the number of records permitted over a period of time, where N can be any positive integer.
- { [Compliance] This refers to legislative requirements that support the exchange of information, such as the Data Protection Act, the Human Rights Act, the Freedom of Information Act and so on.
- { [Start] and [End] These identify the start and end of the date/time period over which information shown.
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Step 1: Present credentials

Step 2: Issue claims

Step 3: Present claims & request for service/data

Step 4: Analyse polices

Step 5: Locate/initilise service instances

Step 6: Issue service/data ticket

Step 7: Establish secure sessions to consume services/data

Medical Staff

Federated ID Providers

ENU e-Health Cloud

Data Buckets

EWS

Cloud4health.com
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**Step 1:** Present credentials

**Step 2:** Issue claims

**Step 3:** Present claims & request for service/data

**Step 4a:** Verify identity

**Step 4b:** Verify attributes, e.g., membership in a CoT

**Step 4:** Analyse policies

**Step 5:** Locate/initialise service instances

**Step 6:** Issue service/data ticket

**Step 7:** Establish secure sessions to consume services/data

**Step 8:** Pull data

**Step 9:** Provide data set

**Step 10:** Synchronise with HealthVault

**Authorisation Server**

**Web Applications**

**Data Owners & Their Circle of Trust**

**U-Prove Agent**

**Federated ID Providers**

**Medical Staff**

**SPoC**

**ENU e-Health Cloud**

**Data Buckets**

**Data Bridge**

**Microsoft HealthVault**
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Patient Simulator

Deirdre
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