A Next Generation Cloud-based Health Care Platform

Prof Bill Buchanan, Dr Lu Fan, Prof Christoph Thuemmler, Dr Elias Ekonomou, Owen Lo, and Alistair Lawson, Edinburgh Napier University.
Integrated and Secure Cloud-based e-Health for Holistic Care

- Nurse Kate
  - Healthcare Professional
  - Invited user

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

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- Sam Drake
  - Site Creator
  - Primary Carer

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

Assisted Living (Informal and Trust based)

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
Integrated and Secure Cloud-based eHealth for Holistic Care

Introduction/Context

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

DACAR e-Health Platform

Trusted Services

Chelsea and Westminster Hospital NHS Foundation Trust

Microsoft

Edinburgh Napier University

kodit

Imperial College London

CipherLAB

GS1 UK

Technology Strategy Board
Driving Innovation

EPSRC
Pioneering research and skills

Patient Simulator

Clinical Services

Research Services

Patient Capture

Patient Cloud
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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Manager might ask: What’s the 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?
Often localised
Different systems/formats
Poor access control
Poor identity verification
Cannot be aggregated
Etc.
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Data Storage (within the Cloud in buckets)

Service B (Infection Tracking)
Service C (Blood)
Service A (EWS)

Patient ID

Capture Agent

Patient Cloud

Domain A

Domain B

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Patient Capture
- CaptureAgent
  - CaptureTime
  - EventID
  - ClinicalMeasureID
  - LocationID
  - ClinicalUnitsID
  - AreaID

Data Capture
- PatientID
- DeviceID
- CapturerID

Patient Simulator
- PatientID
- DeviceID
- CapturerID

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Service Infrastructure
- Storage service
- EWS
- Web service

Service Provision

Service Consumption

Security Policy (including interdomain rights)

Service Instance creation/invocation

Pointer to service

SPoC (Single Point of Contact)

Service Requirement, Ticket

Organisational Infrastructure

User

Identity credentials

Ticket

Identity Provider (IP)

Federated Identity Management

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Service B (Infection Tracking)
Service C (Blood)

ConsumerID (RoleID)

Domain A

Service A (EWS)

Domain B

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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SPoC Architecture

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Single Point of Contact (SPoC)

- A security authority with the following functions
  - Authentication
  - Authorisation
  - Federation
- Claim-based identity management & access control
  - User & Client
  - Claim
  - Security Token Service (STS)
  - Resource Security Token Service (R-STS)
  - Relying Party (RP)
• **Authentication**
  – Internal users
    • A SPoC may serve as a **STS**
    • A SPoC may be a **RP** of Federated ID Providers
  – External users
    • Each SPoC serves as a **R-STS** in a **SPoCs Federation**

• **Authorisation**
  – Service authorisation
    • Role- or individual-based access to e-Health services
    • A SPoC issues a *Service Ticket* to an authorised client
  – Data authorisation
    • Role- or individual-based **CRUD** over medical attributes
    • A SPoC issues a *Data Ticket* to an authorised client
SPoC Architecture

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

Policy Engine
- Policy Repository
- Pseudonym Repository

Domain Ontology
Single Point of Contact (SPoC)

Service Instances & Clients

Users
Services

Personal Information Management Console
Patient

Administrator Interface
Administrator

SPoC Configuration Console
[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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Service Description & End-user's Licence Agreement (EULA):
The Early Warning Score (EWS) service constantly monitors a patient's 6 vital sign parameters in real-time, and notifies medical staff when the patient is evaluated to be at risk.

Dependent Attributes:

Subscription Status:

Policy Selector
- Policies set up by myself
- Policies set up by the SPoC Administrator

Policy Editor
- Purpose: Permit, Denial
- Class: Role-based, Individual-based

Managed Attributes:
- Hospital. VITAL SIGN.Pain
- Hospital. VITAL SIGN. Temp
- Hospital. VITAL SIGN. Heart Rate
- Hospital. VITAL SIGN. Blood Pressure
- Hospital. VITAL SIGN. Respiration
- Hospital. MEDICAL INFO

Available Grantees:
- Westminster Hospital. ROLE.GP
- Westminster Hospital. ROLE.Critical Care Nurse
- Westminster Hospital. ROLE.Nurse
- Westminster Hospital. ROLE.Service

Valid from: 23/03/2012 to: 23/02/2012

Add  Update  Delete
Policy Categories

- Service Authorisation
  - To allow or deny certain roles or individuals to consume an e-Health service

- Service Subscription
  - To allow a service to access or modify a set of a patient’s medical data in order to perform its functionalities

- Specific Consent
  - To allow or deny certain roles or individuals to access or modify a patient’s data in a fine-grained manner

- General Consent
  - To express a patient’s willingness to share anonymised medical data in a certain application context
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