cloud4health

Our Vision? … **to Provide a new Information Architecture for Health and Social Care … and thus to change the World we live in**

Prof Bill Buchanan, Dr Lu Fan, Prof Christoph Thuemmler, Dr Elias Ekonomou, Owen Lo, Omair Uthmani, Richard Lewis, and Alistair Lawson, Edinburgh Napier University

Cloud4Health

Why?

cloud4health

Deirdre Drake

Why?
What is it?
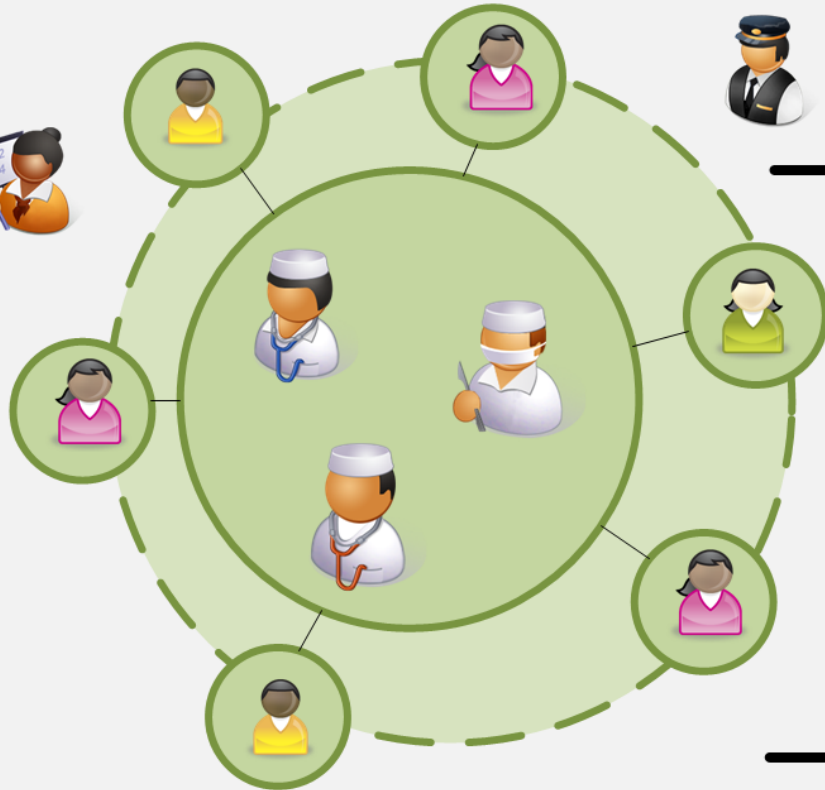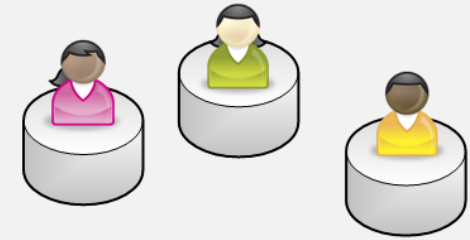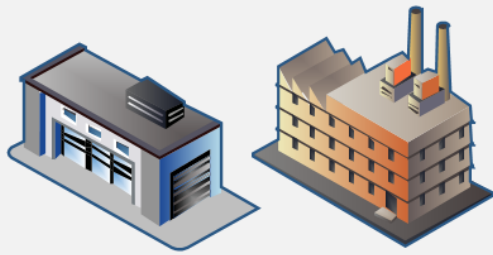What benefits does it have?
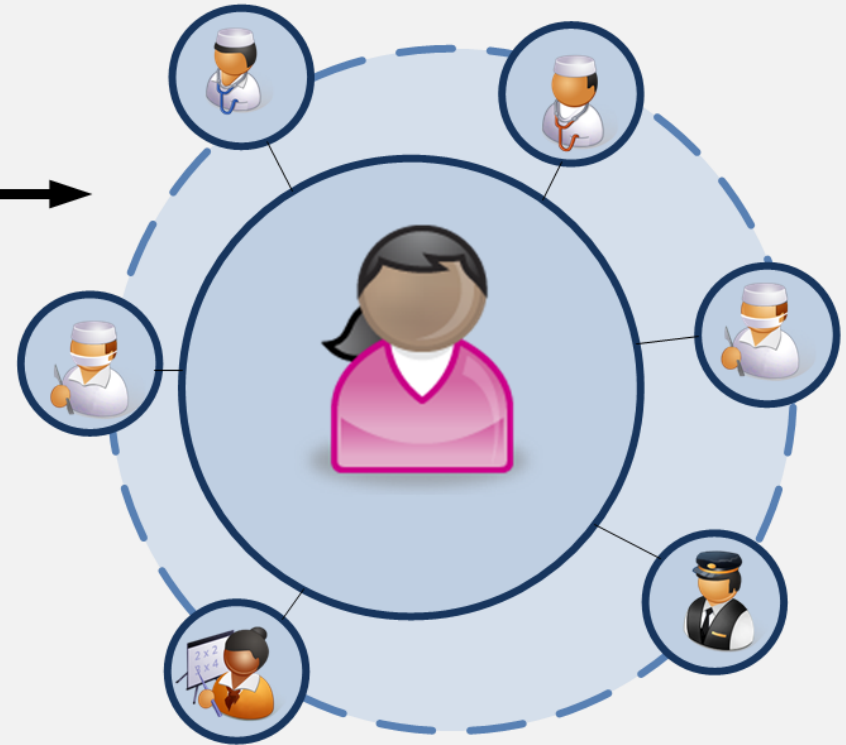Will it scale?
The architecture?
Patient Simulator?
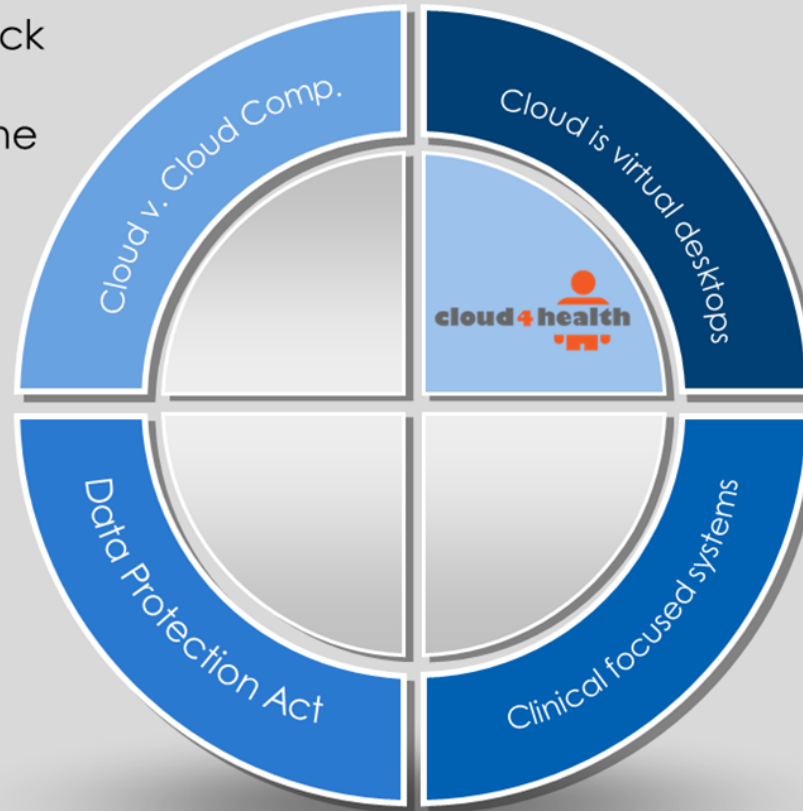What's the future?

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

Cloud4health

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.

Cloud v. Cloud Comp.

Cloud is virtual desktops

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Data Protection Act

Clinical focused systems

DPA often acts an inhibitor to reduced patient risk

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

Current barriers

Possible resistence of clinical staff in supporting more flexiable access to patient records

Lack of trust.
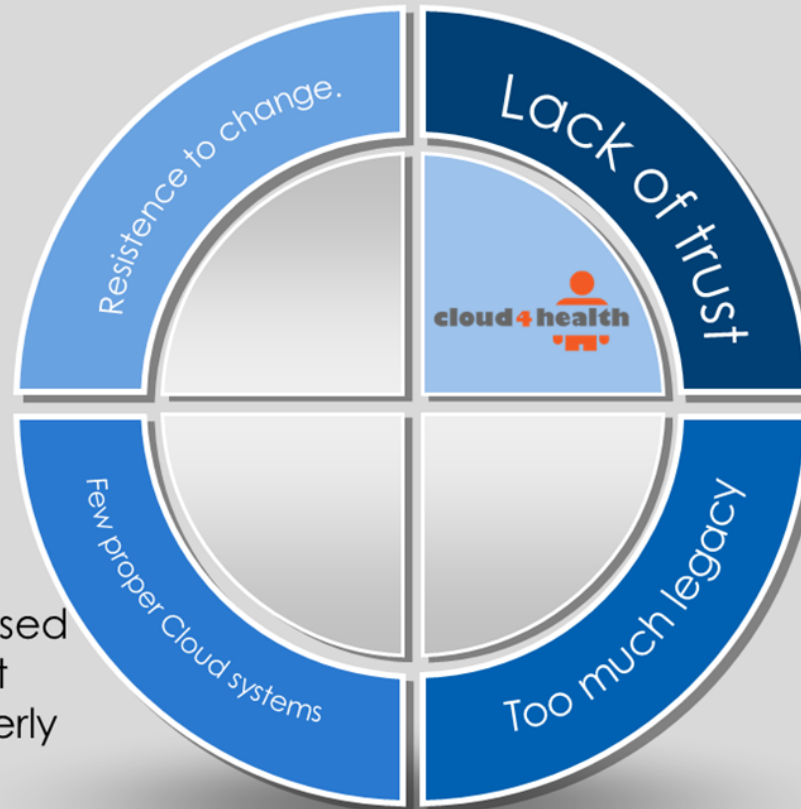
Few proper Cloud-based systems on the market which integrate properly with the formal health care system;

Too many legacy systems

Resistence to change.

Lack of trust

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Few proper Cloud systems

Too much legacy

Current barriers

Nurse Kate
- Healthcare Professional.
- Invited user

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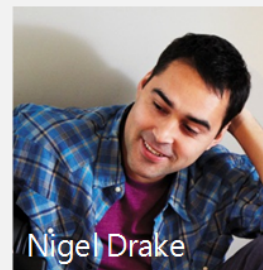
Nigel Drake
- Invited user

- GP.
- Invited user

Sam Drake
- Site Creator
- Primary Carer
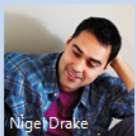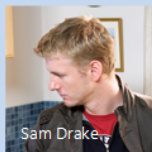
Assisted Living (Informal and Trust based)

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

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

Social Care/Health/etc

Cloud4Health

What is it?

cloud**4**health

Deirdre Drake

Why?
What is it?
What benefits does it have?
Will it scale?
The architecture?
Patient Simulator?
What's the future?

DACAR e-Health Platform

Trusted Services

Cloud4Health
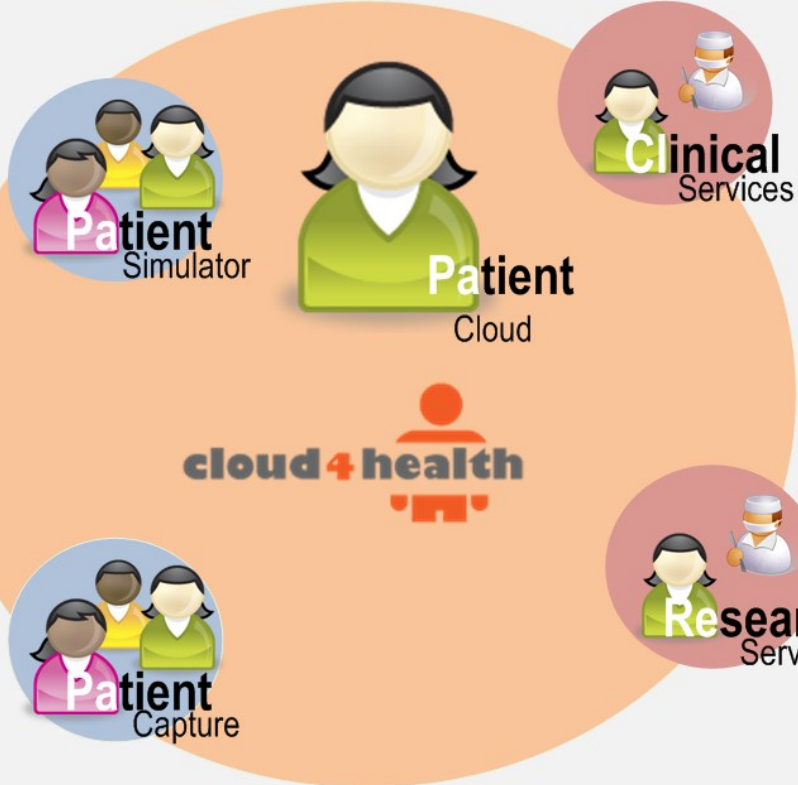
Societal

Technical

Lack of integration between assisted living, primary and secondary care

Patient records are often static

Aging population

Different systems/formatting used for data

Lack of information sharing across the public sector

Limited/difficult access methods … typically Government infrastructures … lack of trust

Strong demand to consume health care data

Poor access control to data

Lack of integration with careers and trusted people

Data often aggregated and context is often lost
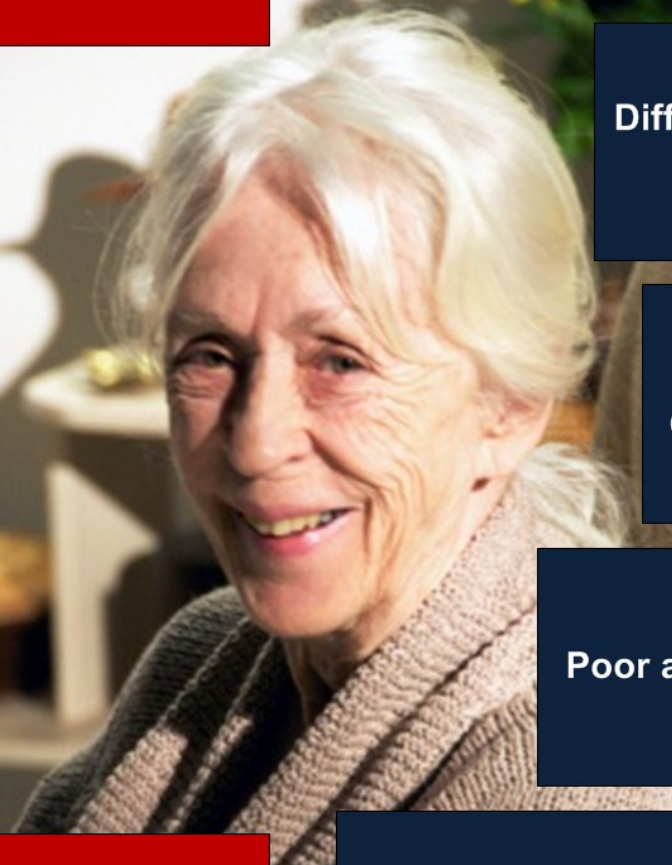
Rights

Clinical Services

Digital **Trust**

Human **Trust**

Identity

Strong Governance

Infinite possiblities

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?

Assisted Living (Informal and Trust based)

Primary Health Care (Formal and role-oriented)

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

Family friend might ask: In which ward is Deirdre?

Secondary Health Care (Formal and role-oriented)

Trust ... and integration

PatientID

Static Patient Record

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

Clinical Services

ConsumerID (RoleID)

Domain A

Data Storage (within the Cloud in buckets)

PatientID Bucket

Dynamic Patient Records

CaptureTime

CapturerID (RoleID)

EventID

PatientID

DeviceID

LocationID

ClinicalMeasureID (ClinicalUnitsID)

AreaID

Patient Capture

Patient Cloud

Security Policy (including interdomain rights)

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What benefits does it have?

cloud **4** health

Deirdre Drake

Why?
What is it?
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Patient Simulator?
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SEWS KEY 0 1 2 3
DATE: 4/12 TIME: 10:00

RESP. RATE: ≥36, 31-35, 21-30 (24), 9-20, ≤8

SpO₂: ≥93, 90-92 (92), 85-89, <85

Inspired O₂% : RA
Humidifier Temp

TEMP: >39°, 38°, 37°, 36°, 35°, 34°

SEWS SCORE uses Systolic BP

BLOOD PRESSURE: 210, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110 (110), 100, 90, 80 (80), 70, 60, 50

HEART RATE: >140, 130, 120 (110), 110, 100, 90, 80, 70, 60, 50, 40, 30

SEDATION / NEURO SCORE:
S — Sleep
0 — Alert ✓
1 — Verbal
2 — Pain
3 — Unresp

UO<30mls/hr (3 hrs+)

SEWS SCORE (with all obs)

PAIN:
Severe — 9-10
Severe — 6-8
Moderate — 4-5
Mild — 1-3
None — 0

Nausea Score (0-3)
BM — 5.4
Weight
Bowels
Drain Type –
Wound
Circulation
Sensation
Movement

Observation Chart — NHS Lothian

Consultant: _____
Date chart commenced: _____
This is chart number _____ this admission
Actual or estimated patient weight _____ kgs
ASU: _____

Attach a patient Addressograph here
or
Name: _____
DOB: _____
Unit No: _____

An Early Warning Score (SEWS) must be calculated every time patient observations are recorded.
If SEWS score 4 or 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 4 or more or concern with a patients condition.

Early Warning Score 6 or more or rapidly deteriorating patient.

Call Junior Doctor & Senior Nurse/Nurse Practitioner
If Dr cannot attend within 20 mins, they should arrange a Deputy.

Practitioner/Dr unable to attend within 20 mins or SEWS increased by 2 or patient deteriorating.

Call appropriate SHO/Registrar & Senior Nurse/Nurse Practitioner

Dr unable to attend within 10 mins or SEWS increased by 2 or patient deteriorating.

Call appropriate Registrar/Consultant
Consider ICU referral/review of treatment plan

Persistent Pain – 6 or above and unresponsive to guidelines

Call Medical Staff/Senior Nurse/Nurse Practitioner

For further advice contact:

ACUTE
Mon- Fri: Bleep Acute Pain Team
Out of hours: On-call anaesthetist

CANCER-RELATED
Mon- Fri: Bleep Palliative Care Team
Out of hours: via switchboard

Reorder Ref: WLT1016-Rev. 05/07
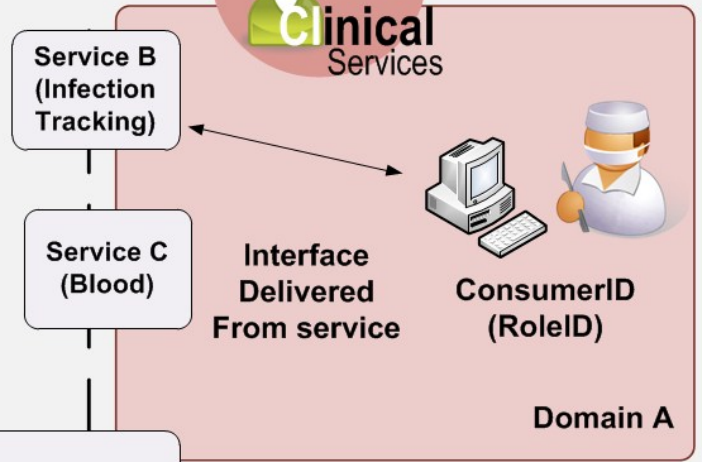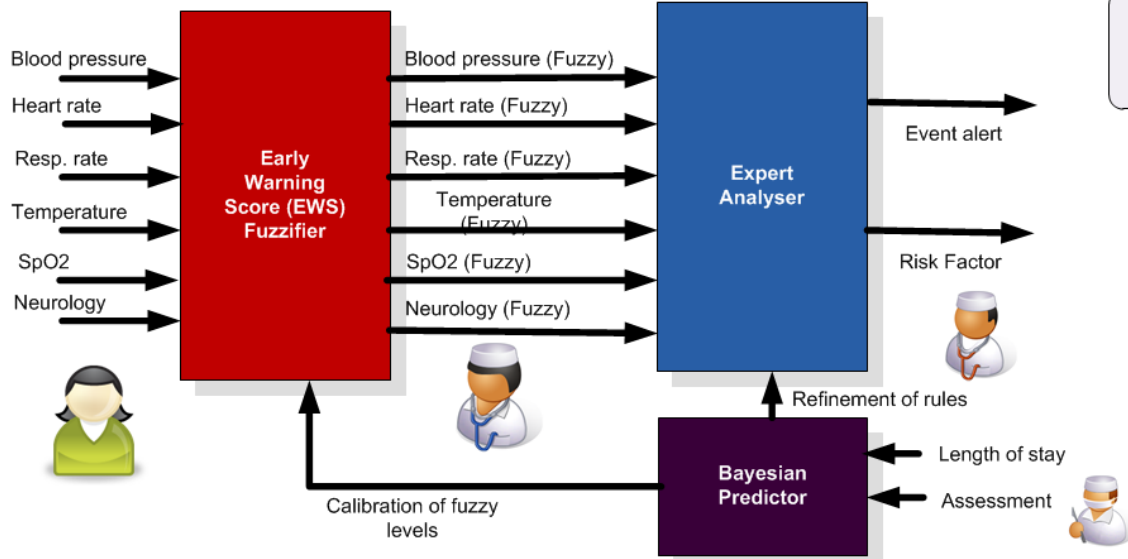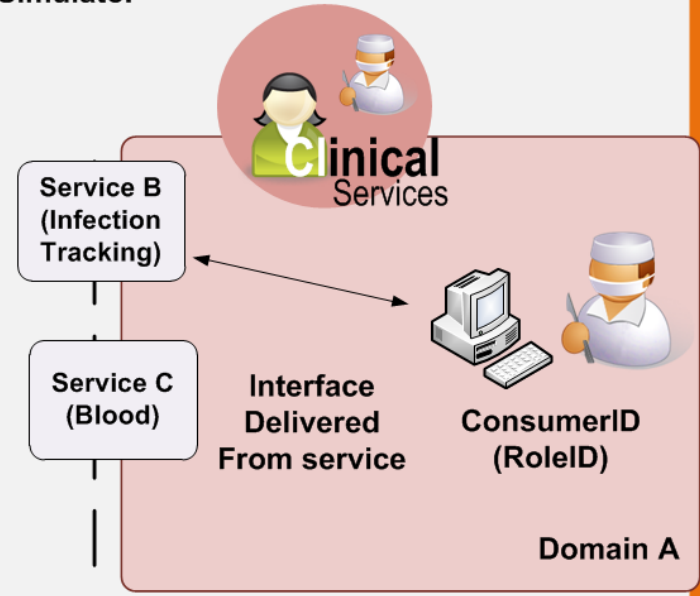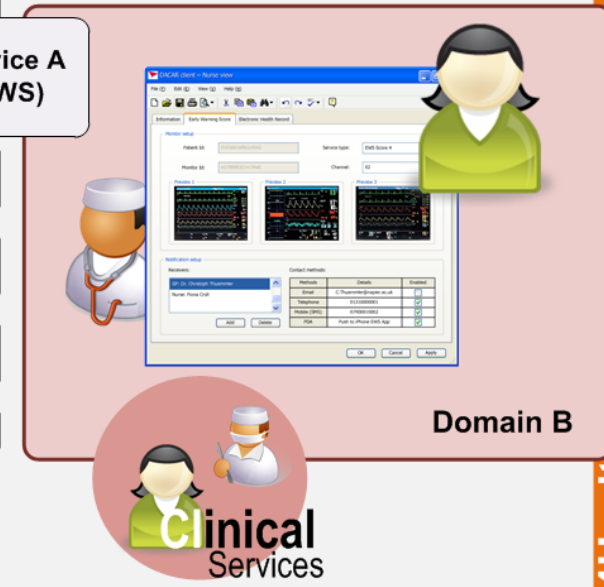
Diagram

Clinical Services

Service B (Infection Tracking)

Service C (Blood)

Service A (EWS)

Interface Delivered From service

ConsumerID (RoleID)

Domain A

Domain B

Clinical Services

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Will it scale?

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Deirdre Drake

Assisted Living

Circle-of-Trust

Sam (Son and Web Master)

Nigel (Son)

Deirdre (Caree)

Circle-of-Trust

Circle-of-Trust-based Polices

Translation Gateway (Security Policy/ ID Mapping)

Primary/Secondary Care

Data Storage (within the Cloud in buckets)

Service A (EWS)

Domain B

Clinical Services

Patient Cloud

SPoC

CW.CONSULTANT

CW.NURSE

Role-based security policies

Sam

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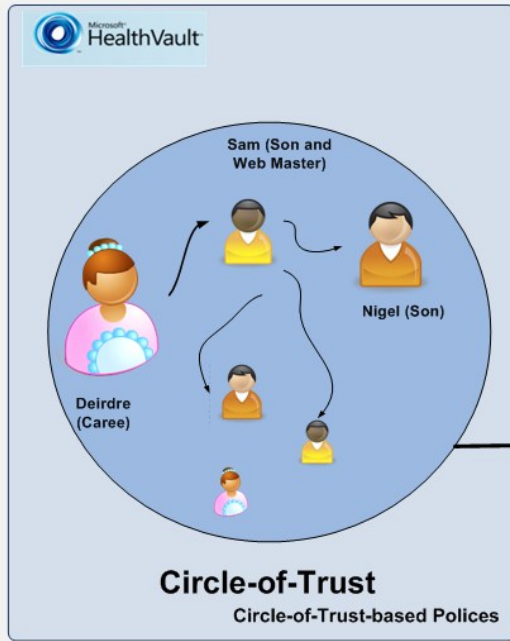
Kate
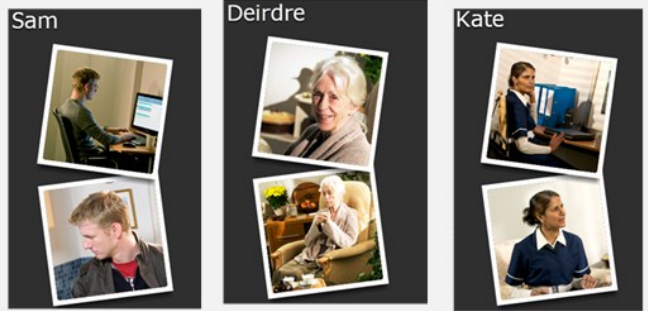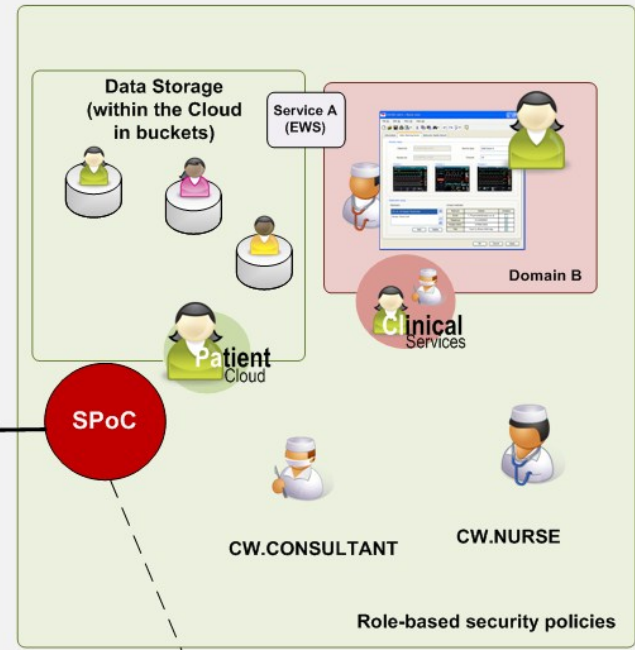
[permit] [C&W.NURSE] [C | R] [Temp | SpO2 | HR | BP | RR | Pain] of [Patient26078] with [EWS] from [Chelsea & Westminster Hospital] for [*] records in [P2010-12-30T00:00:00] using [Data Protection Act]

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

Governance Policy

Integration with Assisted Living and Formal Health Care

Identity Providers

- Facebook
- PayPal
- NHS

(3) Return Identity
(2) Present Credential

Attribute Providers

- NHS
- Assisted Living

(4) Present Identity
(5) Return Attributes

U-Prove Agent

(1) Request Claim
(6) Present Claim

Service Providers

- Assisted Living
- HealthVault

M2M

VitalLink
Enabling Healthcare Everywhere

HealthVault

E-Health Platform

Deirdre Drake

Sam Drake

Nurse Kate

CW.CONSULTANT

CW.NURSE

Application services and data

SaaS

Evidence-based Medicine

Early Warning Score (EWS)

Personal Health Records

Identity Mgmt

Audit Trail

Access Control

Data Buckets

SDKs, APIs and Middleware

PaaS

Secure Web Services

Single Point of Contact (SPoC)

Virtualised operating systems and resources

Virtual Machine

Virtual Machine

Virtual Machine

debian

fedora

Xen

KVM

CentOS

Ubuntu

IaaS

Physical servers, storages and networks

HaaS

E-Health Platform Architecture

SPoC Architecture

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]

[permit | deny] [Requester] [C | R | U | D] [Attribute] of [Object] with
[Context] from [Owner] for [N] records in [Time Window] using [Compliance].
```
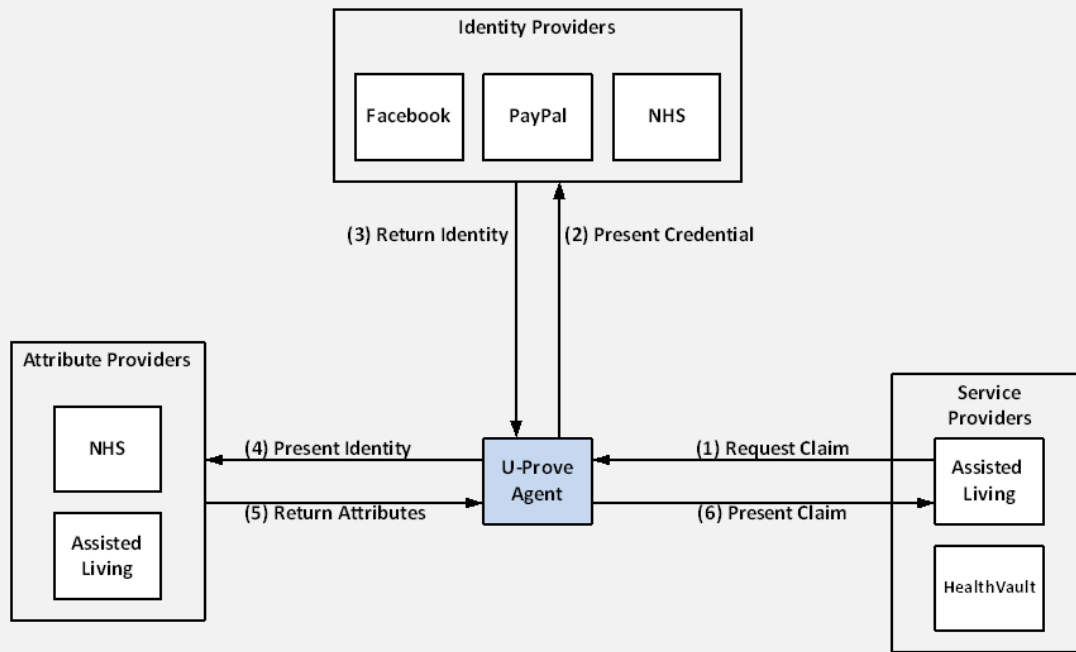
A similar syntax is also applied to the request messages:

```
[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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SPoC User Console v0.1.10102011

My Registration | My Services | My Policies | My Circle of Trust | More...

Available Services

Service Provider:
Chelsea & Westminster Hospital

Service Category:

Service Name:
Early Warning S

Service Details

Service Description & End-user's Lisence Agreement (EULA):

The Early Warning Score (EWS) service constantly monitors a patient's 6 vital sign parameters in real-time, ar and notifies medical staff when the patient is evaluated to be at risk.

Dependent Attributes:

Subscription Status:

SPoC User Console v0.1.10102011

My Registration | My Services | My Policies | My Circle of Trust | More...

Policy Selector

○ Policies set up by myself   ○ Policies set up by the SPoC Administrator   Refresh   New

Policy Editor

Purpose: ● Permit   ○ Denial   Class: ● Role-based   ○ Individual-based

Managed Attributes: Available Grantees: Managed Grantees:

.Pain   Hospital.VITAL SIGN.SpO2   estminster Hospital.ROLE.Critical   stminster Hospital.ROLE.GP
.Hea   estminster Hospital.ROLE.Nurse
.Bloc   →   estminster Hospital.ROLE.Service   →
.Tem
.RES   ←   ←
NFO.I

/2012   to: 23/02/2012   Add   Update   Delete

SPoC User Console v0.1.10102011

My Registration | My Services | My Policies | My Circle of Trust | More...

Policy Selector

● Policies set up by myself   ○ Policies set up by the SPoC Administrator   Refresh   New

[class="RULE";type="PROTECTED";object="b8f2544b-9696-4ee9-928e-cf1d54cb8928";role={"320a9658-7cbc-4a50-8470-2cbf9dbf7d2f","1c
[class="RULE";type="PROTECTED";object="b8f2544b-9696-4ee9-928e-cf1d54cb8928";role={"320a9658-7cbc-4a50-8470-2cbf9dbf7d2f","1c
[class="RULE";type="PROTECTED";object="b8f2544b-9696-4ee9-928e-cf1d54cb8928";role={"320a9658-7cbc-4a50-8470-2cbf9dbf7d2f"};ps
[class="RULE";type="PROTECTED";object="b8f2544b-9696-4ee9-928e-cf1d54cb8928";role={"320a9658-7cbc-4a50-8470-2cbf9dbf7d2f"};ps

Policy Editor

Purpose: ● Permit   ○ Denial   Class: ● Role-based   ○ Individual-based

Available Attributes: Managed Attributes: Available Grantees: Managed Grantees:

ter Hospital.VITAL SIGN.Pain   r Hospital.VITAL SIGN.SpO2   estminster Hospital.ROLE.Critical   stminster Hospital.ROLE.GP
ter Hospital.VITAL SIGN.Hea   estminster Hospital.ROLE.Nurse
ter Hospital.VITAL SIGN.Bloc   →   estminster Hospital.ROLE.Service   →
ter Hospital.VITAL SIGN.Tem
ter Hospital.VITAL SIGN.RES   ←   ←
ter Hospital.MEDICAL INFO.I

Valid from: 23/01/2012   to: 23/02/2012   Add   Update   Delete

Step4: Analyse polices
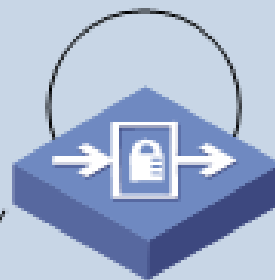
Step5: Locate/initialise service instances

SPoC

Step3: Present claims & request for service/data

Step6: Issue service/data ticket
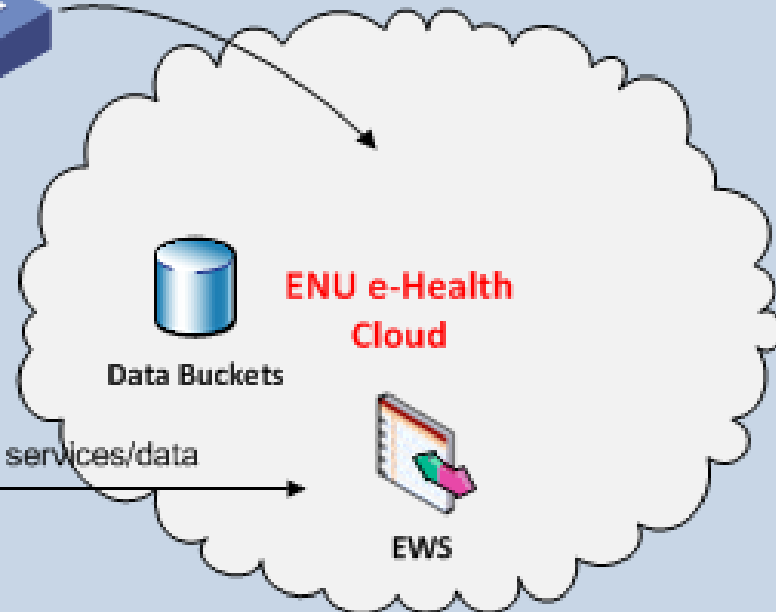
ENU e-Health Cloud

Data Buckets

Step7: Establish secure sessions to consume services/data

EWS

Medical Staff

Step2: Issue claims

Step1: Present credentials

Federated ID Providers
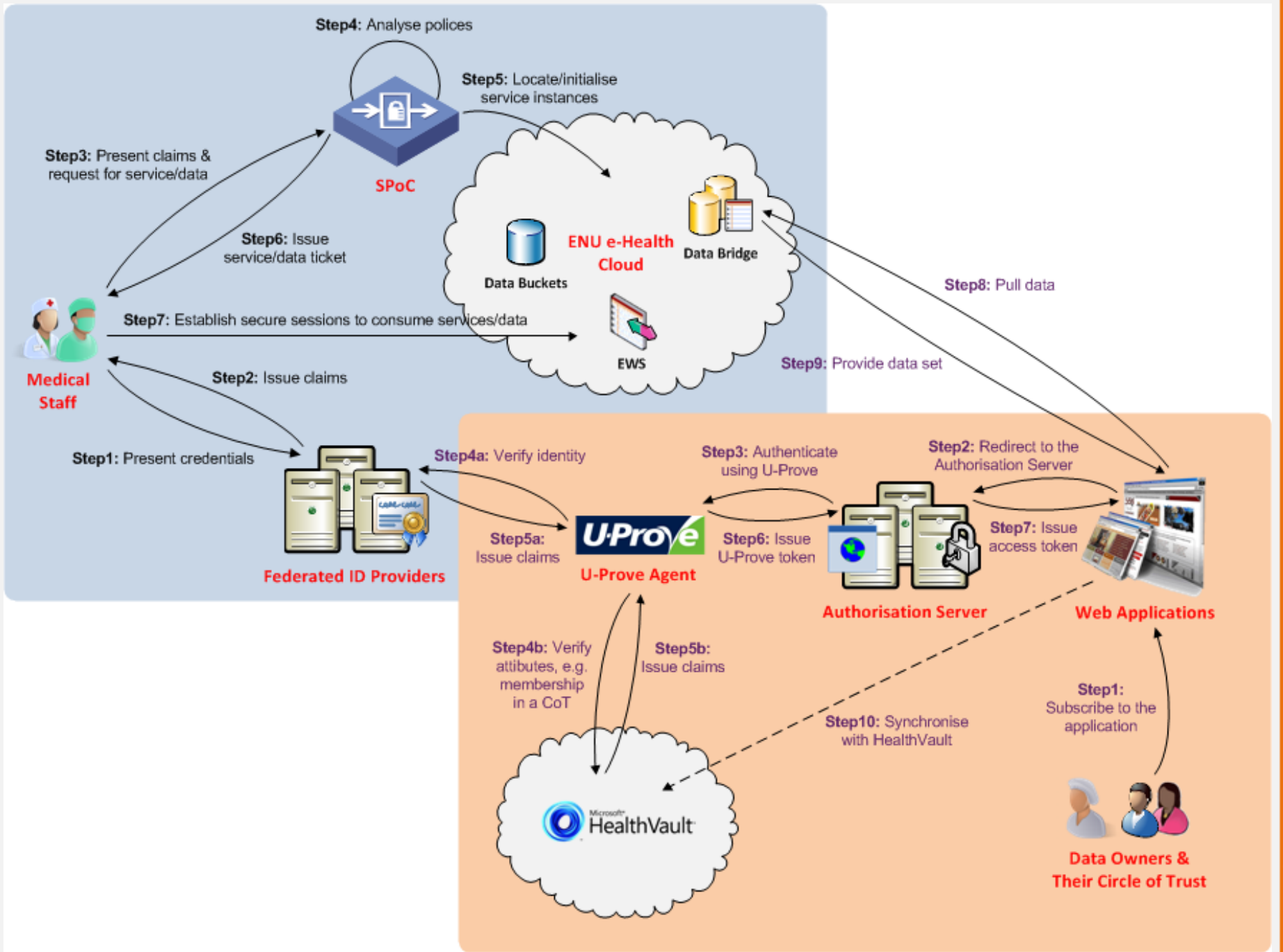
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Patient Simulator

cloud 4 health

Deirdre Drake

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Patient Simulator?
What's the future?

Patient Simulator

Edinburgh Napier UNIVERSITY

Patient List

1 :Daniel Smith (61980f5d-e9cc-4a9f-b7b6-7fb8ffc17140)
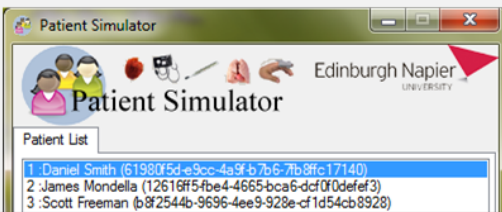2 :James Mondella (12616ff5-fbe4-4665-bca6-dcf0f0defef3)
3 :Scott Freeman (b8f2544b-9696-4ee9-928e-cf1d54cb8928)

Early Warning Score Service

Edinburgh Napier UNIVERSITY

Patient List

1 :Daniel Smith (61980f5d-e9cc-4a9f-b7b6-7fb8ffc17140)
2 :James Mondella (12616ff5-fbe4-4665-bca6-dcf0f0defef3)
3 :Scott Freeman (b8f2544b-9696-4ee9-928e-cf1d54cb8928)

61980f5d-e9cc-4a9f-b7b6-7fb8ffc17140

Patient Details

☐ Update Details

Date of Birth: 23/06/1978
Gender: Female
Title: Miss
Blood Type: AB
Forname(s): Daniel
Address: Edinburgh
Surname: Smith

Simulation Visualisation

ECG | BP (Plot) | TEMP (Plot) | RR (Plot) | SpO2 (Plot)

Vital Sign Parameters

HR: 80
Temp: 36.8
BP (Systolic): 120
Respiration: 12

Simulation Output

HR	BP	TEMP	RR	SpO2
79 BPM	120 mmHG	36.8 °C	11.9 BF	98

Time	HR	BP	Temp	RR	SPo2
23/01/2012 08:36:43	79	122	36.8	12	98
23/01/2012 08:36:44	79	119	36.8	12	98
23/01/2012 08:36:45	81	116	36.8	12	98
23/01/2012 08:36:46	79		36.8	12	98

Simulation Control

Start: 23/01/2012 08:36:42
Stop: 24/01/2012 08:36:42

61980f5d-e9cc-4a9f-b7b6-7fb8ffc17140

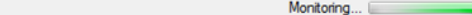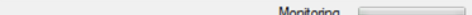**Patient Details**

Title: Miss
Forname(s): Daniel
Surname: Smith

Normal

Patient Status:

DATE	TIME	STATUS
23/01/2012	08:37:36	No Risk Detected
23/01/2012	08:37:42	No Risk Detected

Controls

Monitoring...
Stop Monitoring

Early Warning Score

	HR	BP	TEMP	RR	SPO2
Value:	79	118	36.8	11.7	98
EWS:	0	0	0	0	0

RISK SCORE: 0

Monitoring...

61980f5d-e9cc-4a9f-b7b6-7fb8ffc17140

Patient Details

☐ Update Details

Date of Birth: 23/06/1978
Gender: Female
Title: Miss
Blood Type: AB
Forname(s): Daniel
Address: Edinburgh
Surname: Smith

Simulation Visualisation

ECG | BP (Plot) | TEMP (Plot) | RR (Plot) | SpO2 (Plot)

Vital Sign Parameters

HR: 80
Temp: 36.8
BP (Systolic): 120
Respiration: 12
SpO2: 98
Scenario: Stroke

Simulation Output

HR	BP	TEMP	RR	SpO2
60 BPM	219 mmHG	37.0 °C	11.8 BF	97

Time	HR	BP	Temp	RR	SPo2
23/01/2012 08:36:43	79	122	36.8	12	98
23/01/2012 08:36:44	79	119	36.8	12	98
23/01/2012 08:36:45	81	116	36.8	12	98
23/01/2012 08:36:47	79	121	36.8	12	98
23/01/2012 08:36:48	81	122	36.8	12	98
23/01/2012 08:36:49	80		36.8	12	98

Simulation Control

Start: 23/01/2012 08:36:42
Stop: 24/01/2012 08:36:42

Simulating...
Stop Simulation

Simulating...

61980f5d-e9cc-4a9f-b7b6-7fb8ffc17140

Patient Details

Title: Miss
Forname(s): Daniel
Surname: Smith

Observe

Patient Status:

DATE	TIME	STATUS
23/01/2012 08:37:57		Low Risk Detected
23/01/2012 08:38:02		Low Risk Detected
23/01/2012 08:38:04		Low Risk Detected
23/01/2012 08:38:06		Low Risk Detected
23/01/2012 08:38:09		Low Risk Detected
23/01/2012 08:38:11		Low Risk Detected
23/01/2012 08:38:15		Low Risk Detected

Controls

Monitoring...
Stop Monitoring

Early Warning Score

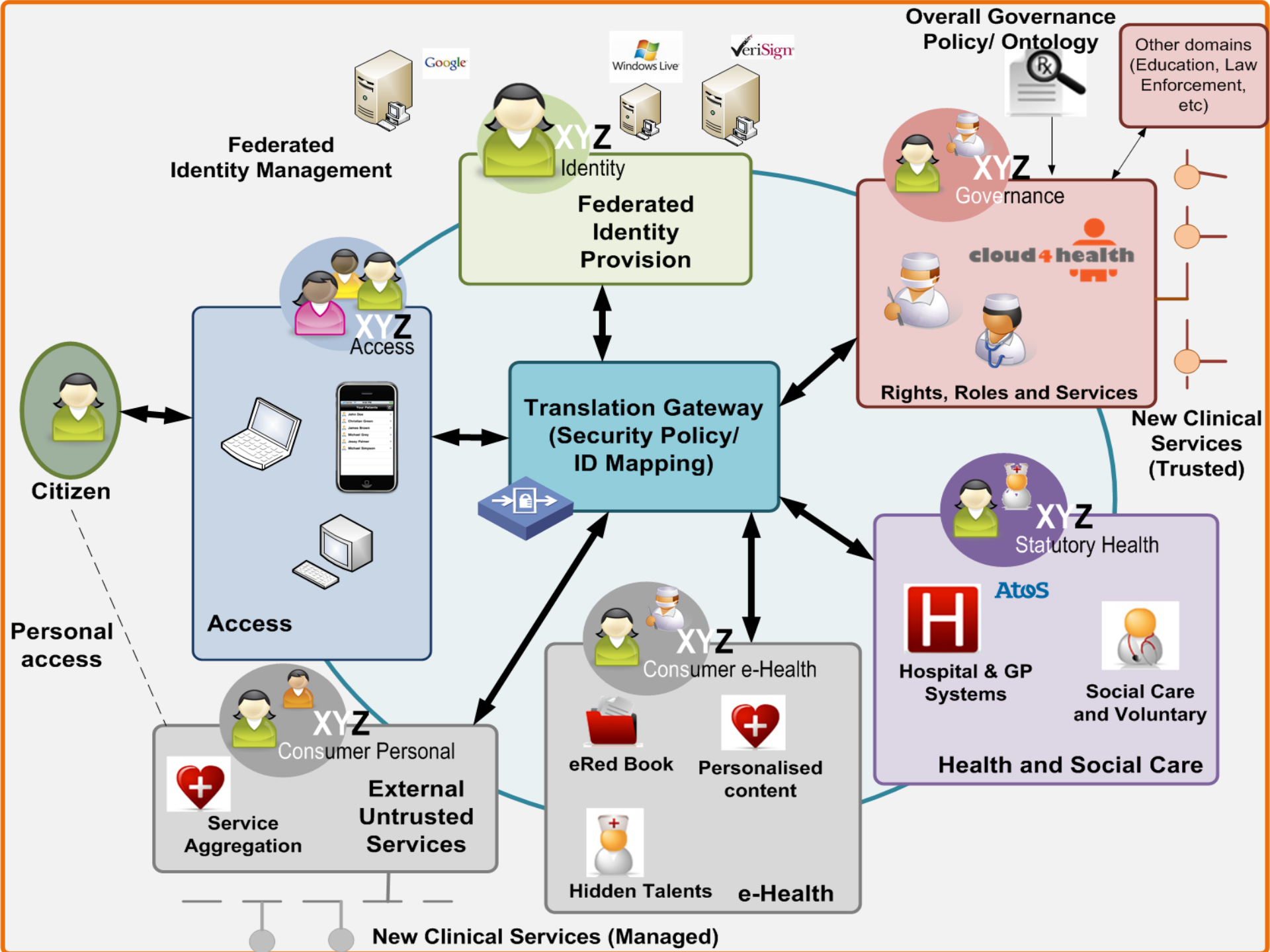|	HR	BP	TEMP	RR	SPO2
Value:	118	157	37.0	11.6	96
EWS:	2	0	0	0	0

RISK SCORE: 2
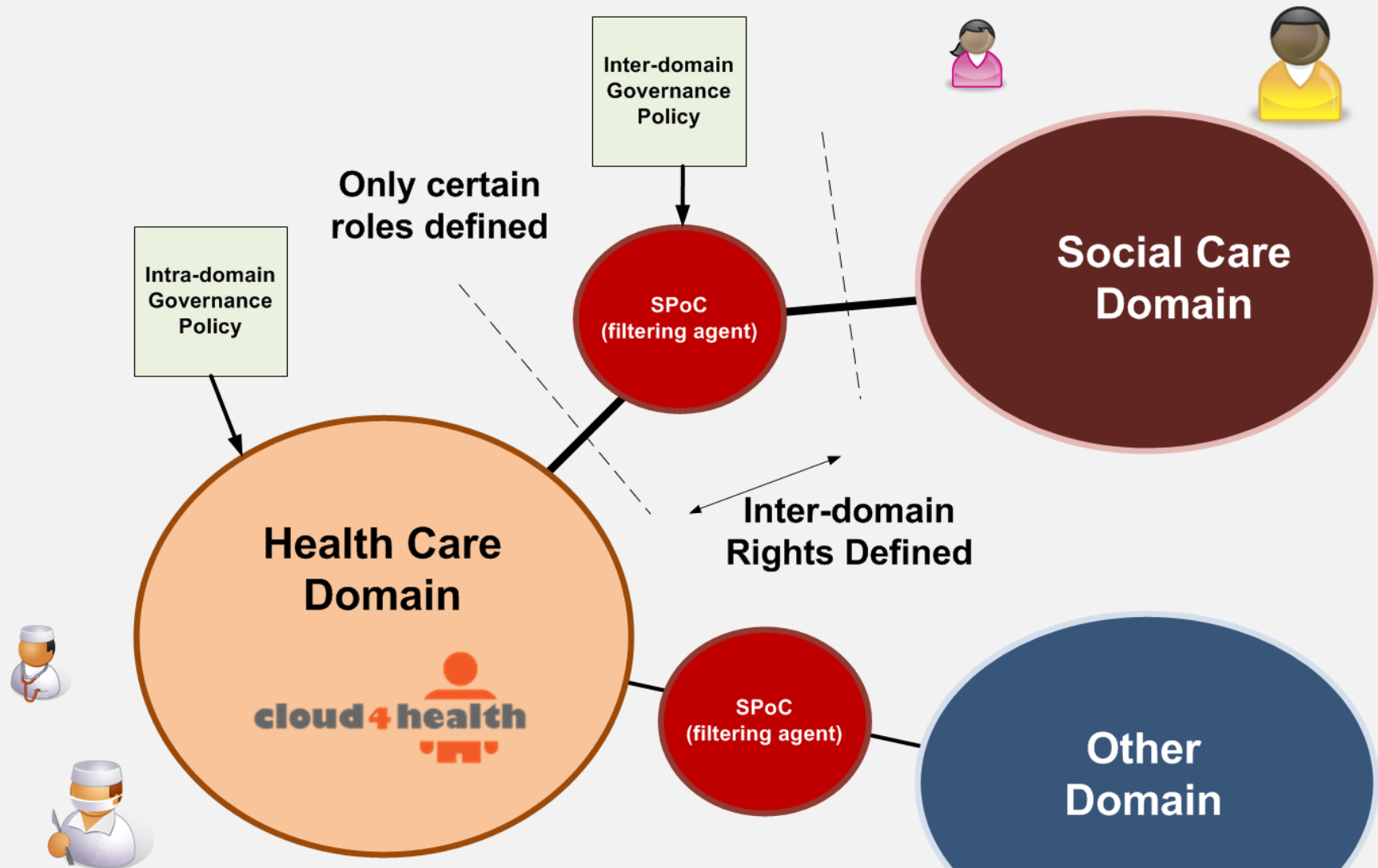
Monitoring...

What's the future?

cloud4health

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Our Vision? … **to Provide a new Information Architecture for Health and Social Care … and thus to change the World we live in**

Prof Bill Buchanan, Dr Lu Fan, Prof Christoph Thuemmler, Dr Elias Ekonomou, Owen Lo, Omair Uthmani, Richard Lewis, and Alistair Lawson, Edinburgh Napier University

Cloud4Health