

inside government

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.

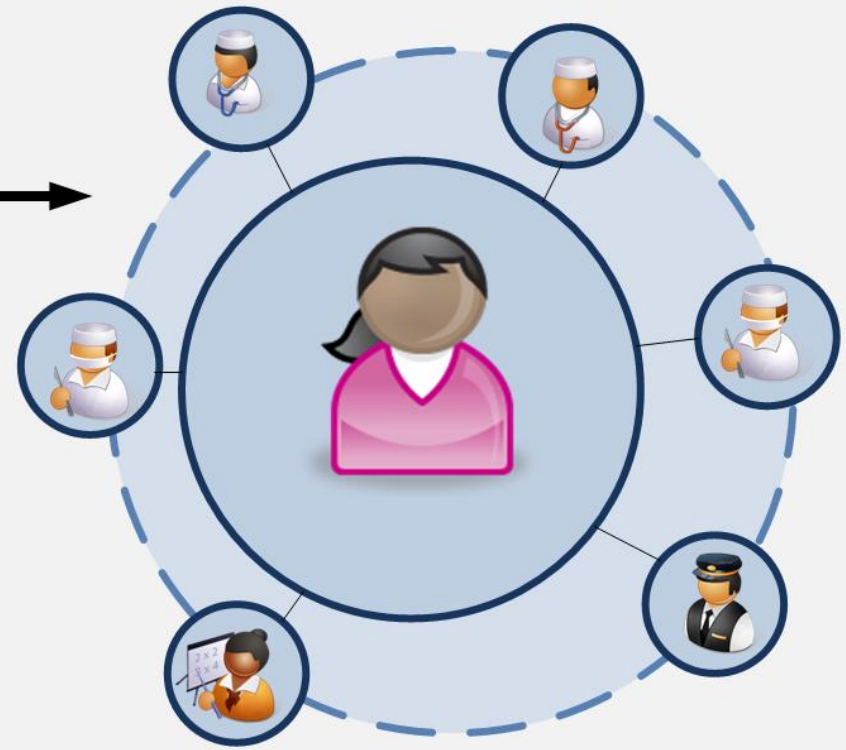
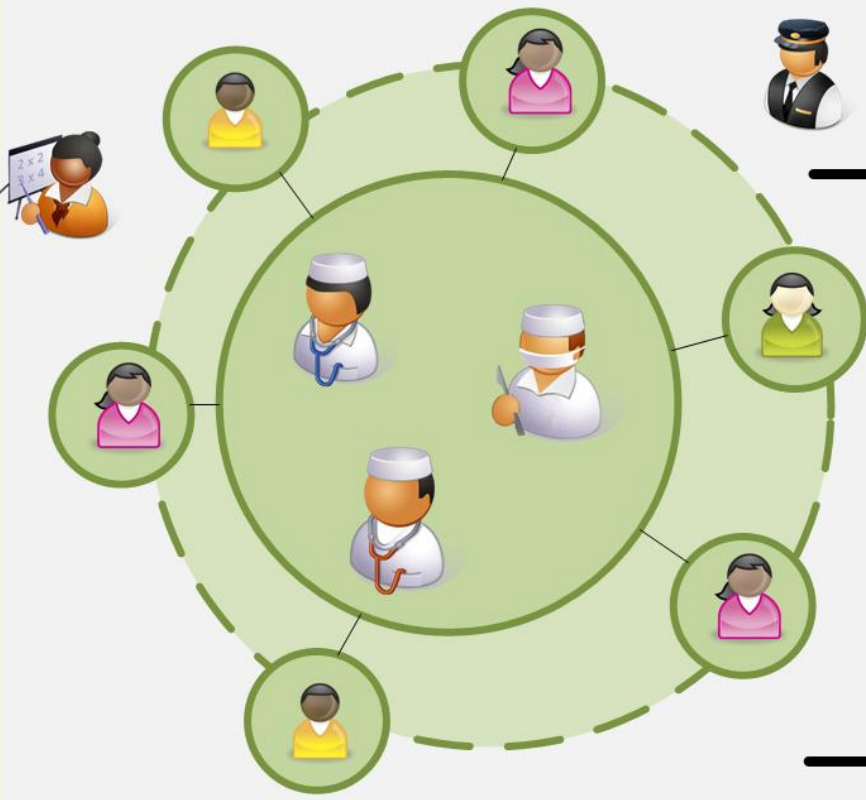
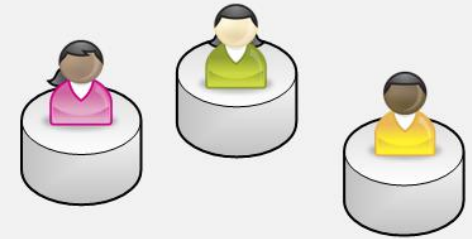
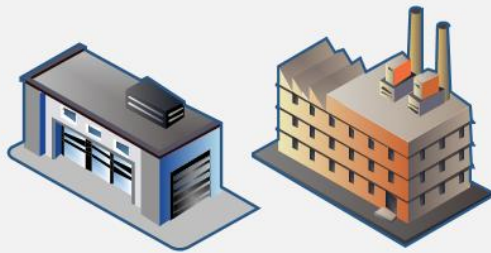
Contact: w.buchanan@napier.ac.uk

Web: cloud4health.com



Industry Age

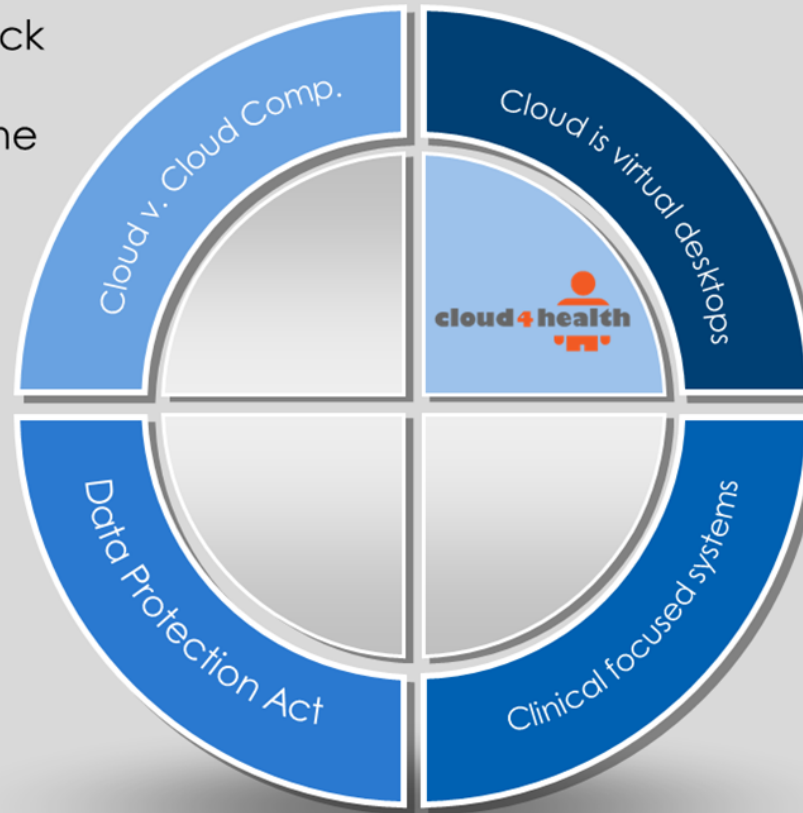
Information Age



**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.

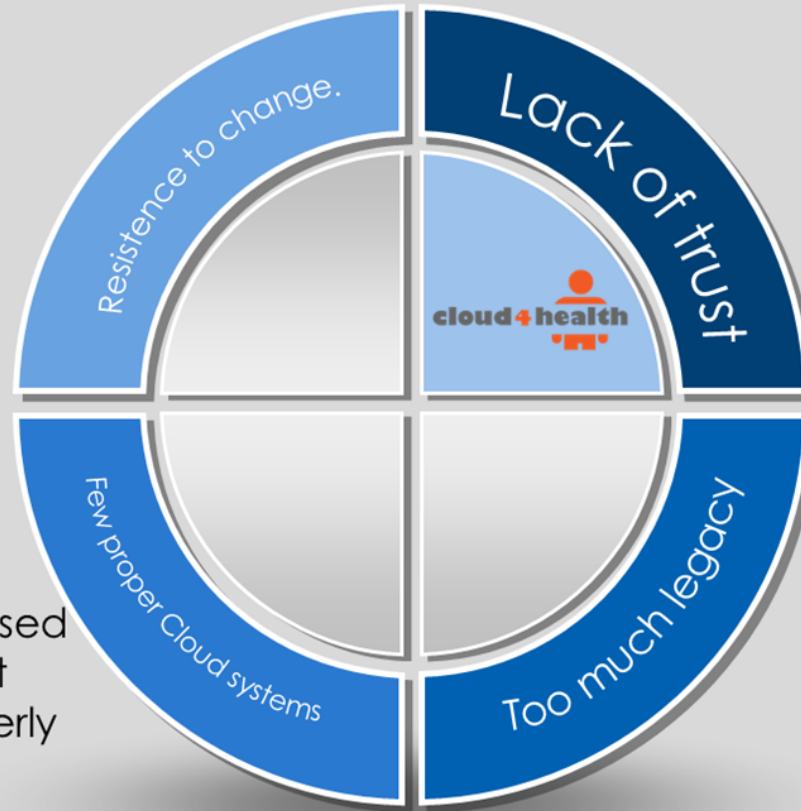
DPA often acts an inhibitor to reduced patient risk

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

Current barriers

Possible resistance of clinical staff in supporting more flexible 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

Current barriers



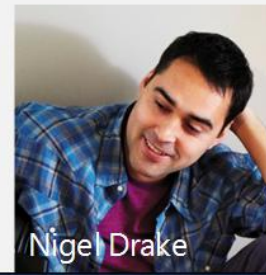
Nurse Kate

- Healthcare Professional.
- Invited user



Deirdre Drake

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



Nigel Drake

- Invited user

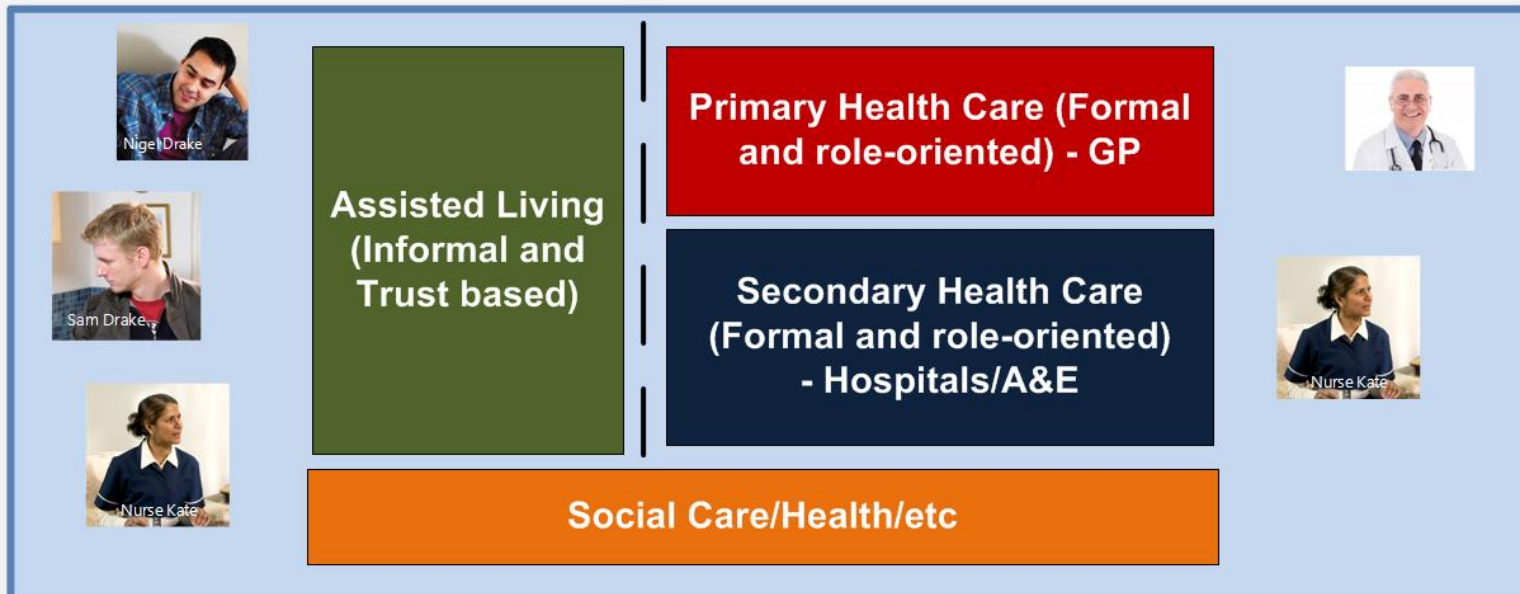


- GP.
- Invited user

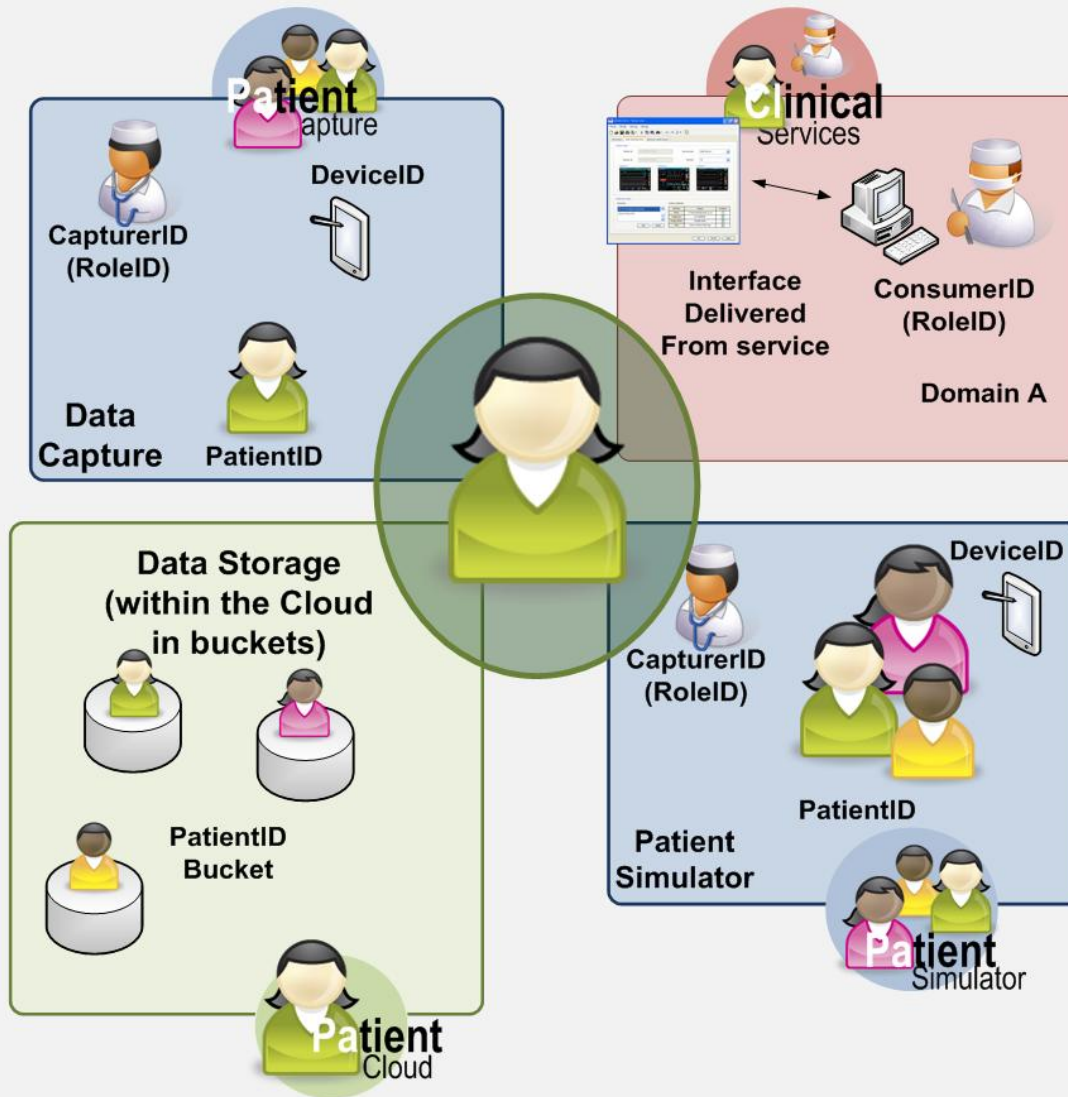


Sam Drake

- Site Creator
- Primary Carer



Introduction/ Context



Deirdre





DACAR e-Health Platform

Trusted Services 

Chelsea and Westminster Hospital 
NHS Foundation Trust

Edinburgh Napier 
UNIVERSITY



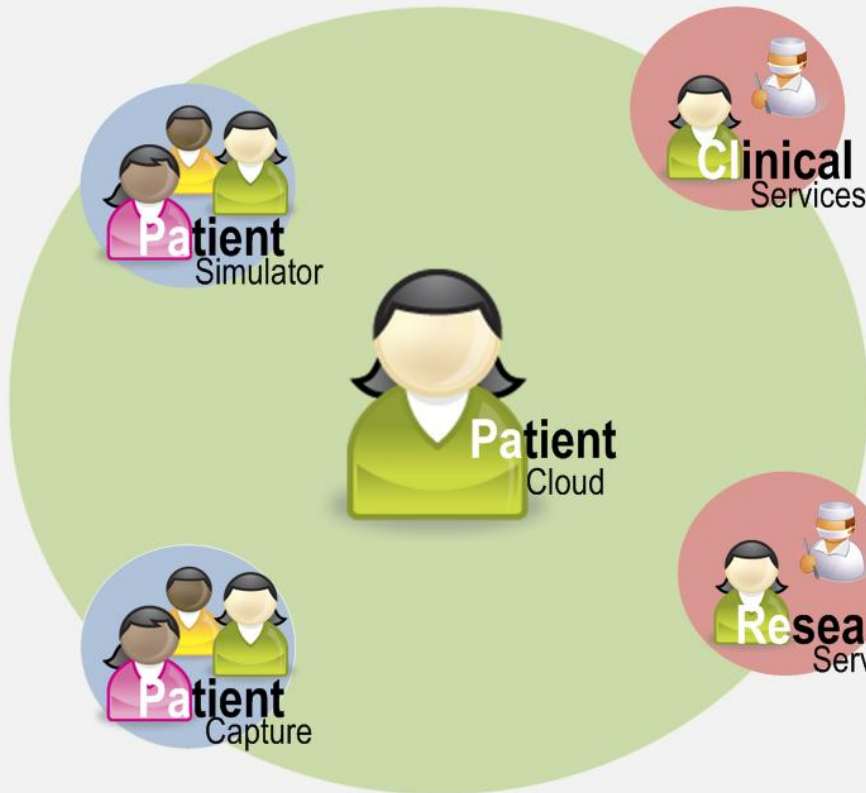
Imperial College
London





Technology Strategy Board
Driving Innovation


Pioneering research
and skills







Edinburgh Napier 
UNIVERSITY

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



Digital Trust

Rights

Clinical Services

Human Trust

Identity



Strong

Governance

Infinite

possibilities

Translation of rights
Translation of identities

Strong Governance
Policy



**Assisted Living
(Informal and Trust based)**

Primary Health Care (Formal and role-oriented)

**Secondary Health Care
(Formal and role-oriented)**

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?

PatientID



Static Patient Record

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



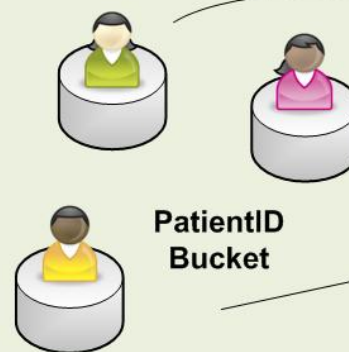
Clinical Services



ConsumerID (RoleID)

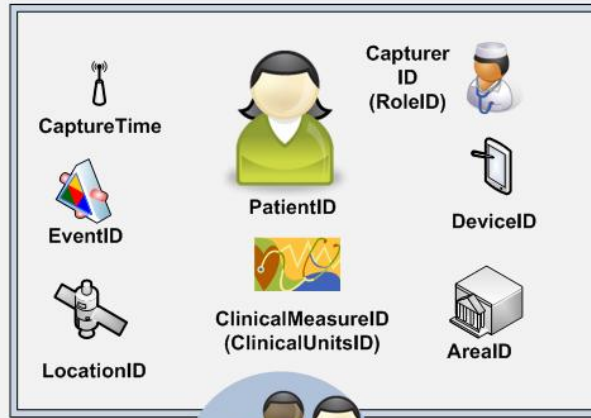
Domain A

Data Storage (within the Cloud in buckets)

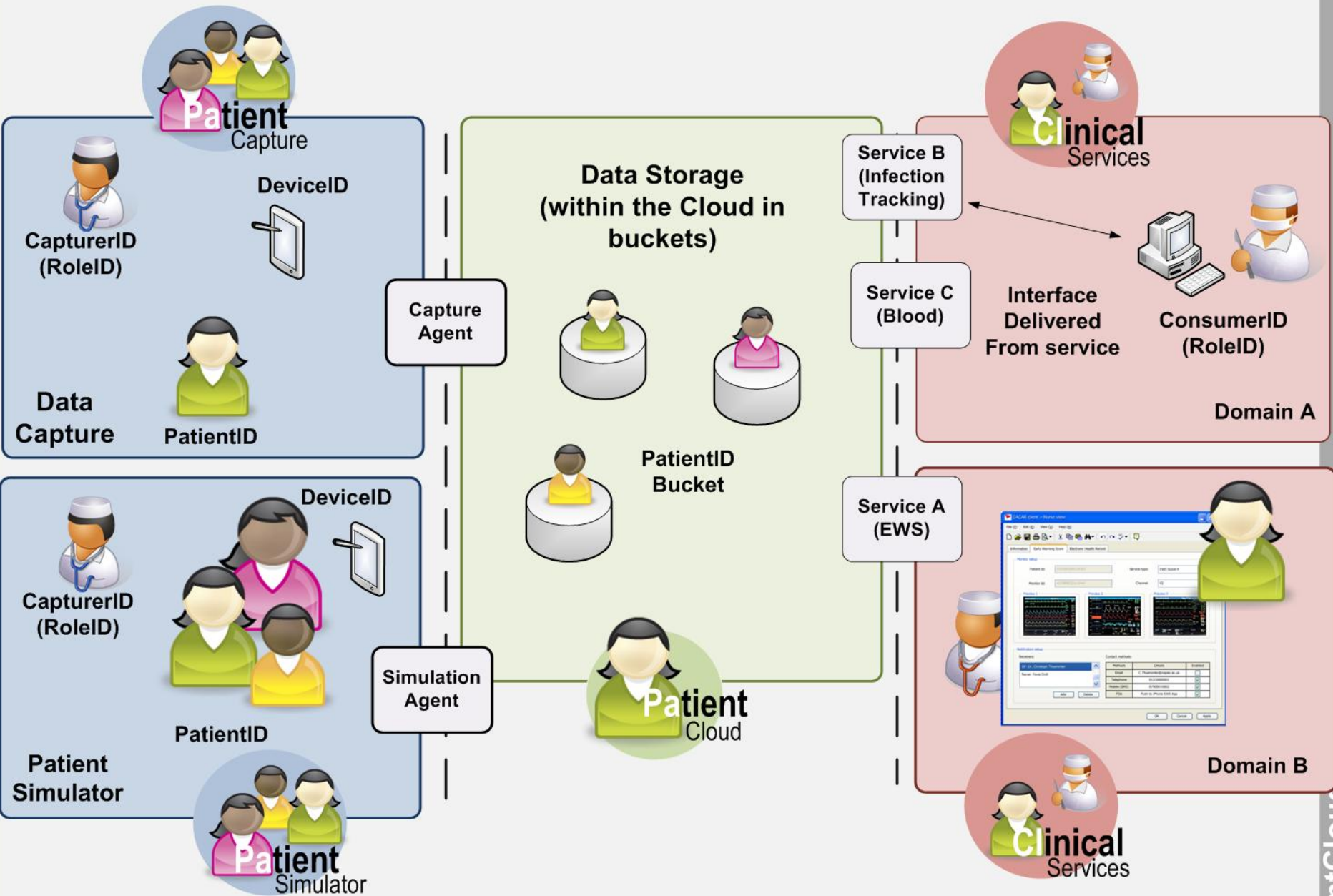


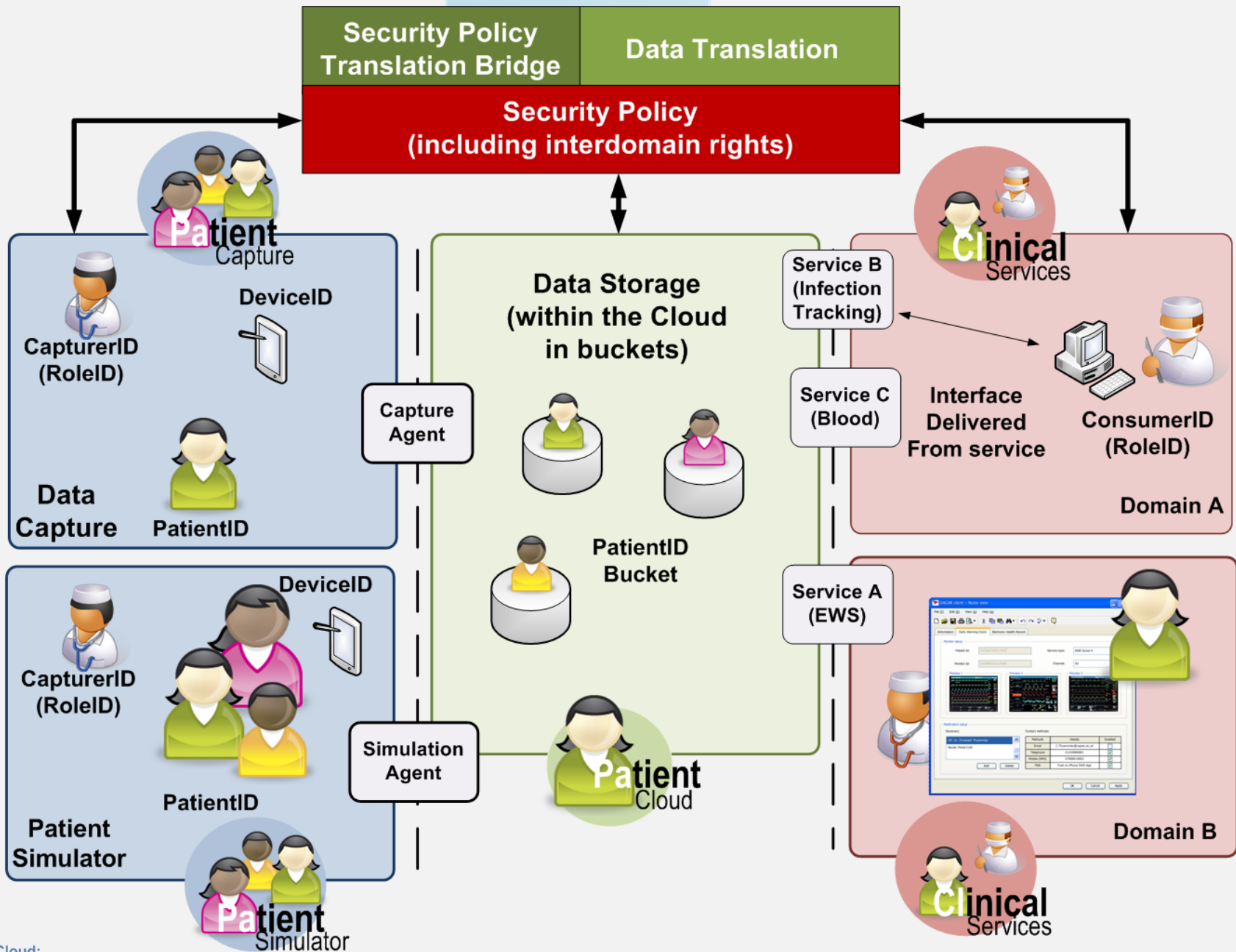
Dynamic Patient Records

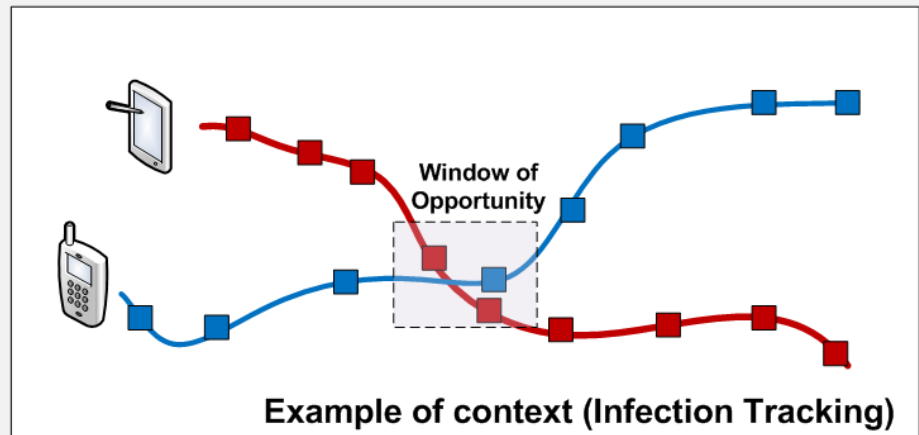
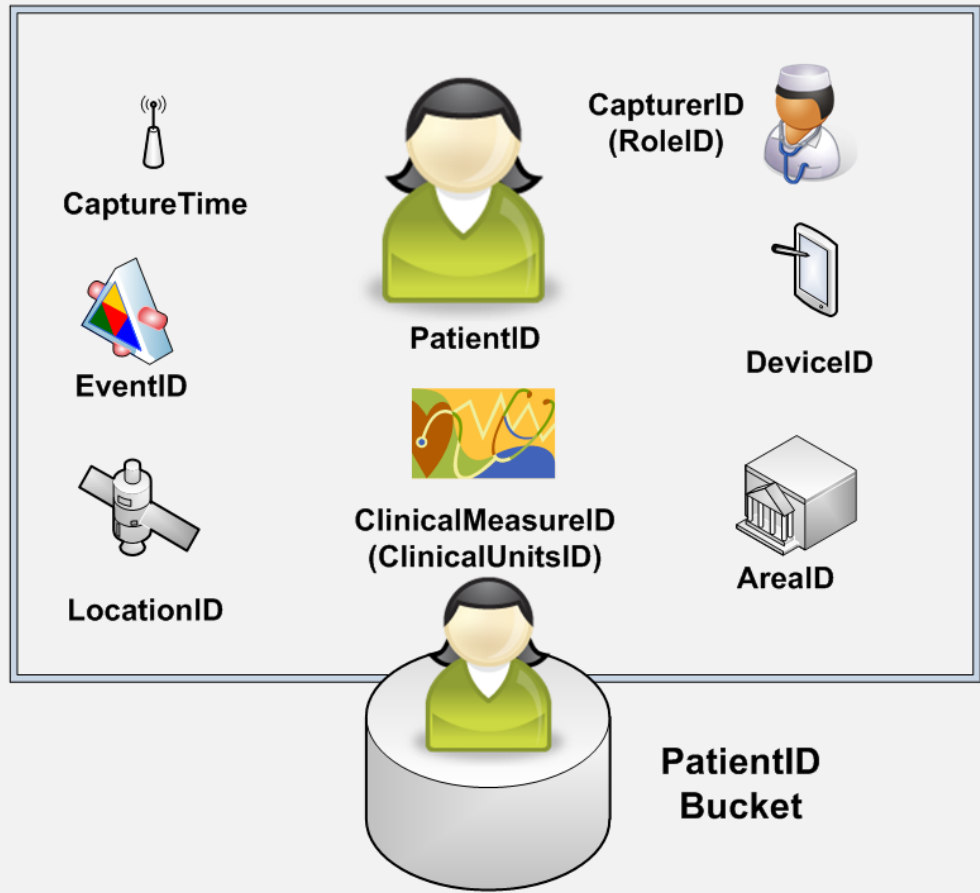
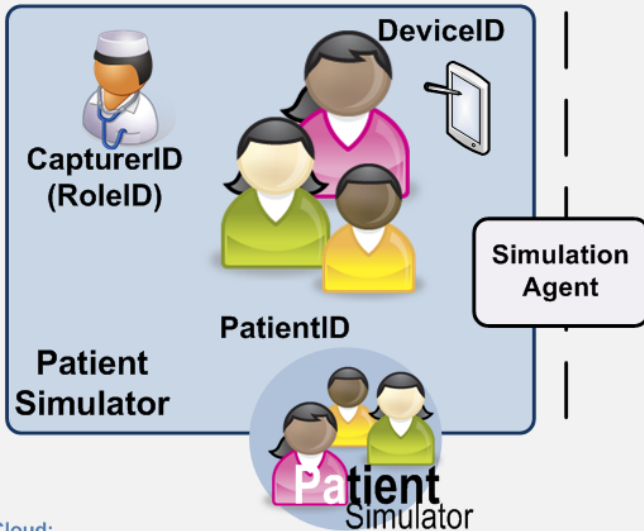
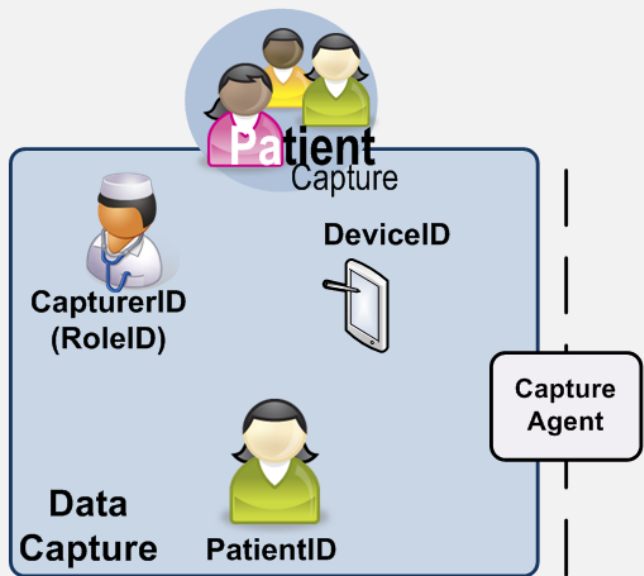
Security Policy (including interdomain rights)

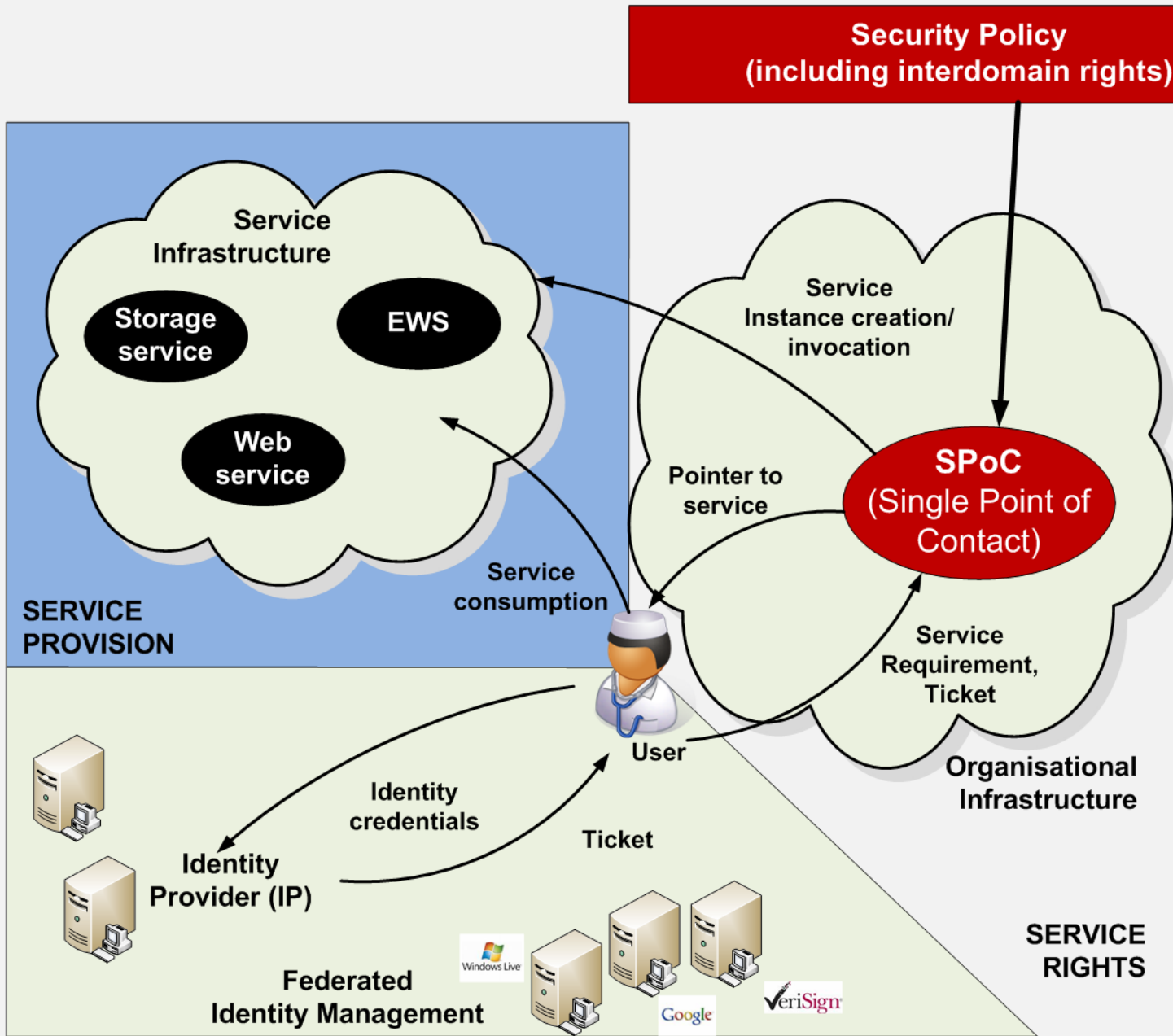


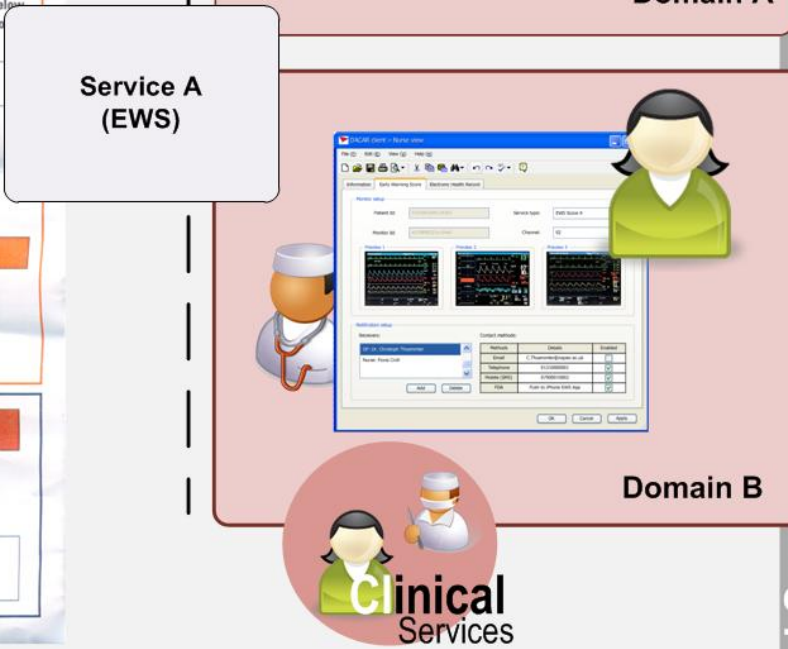
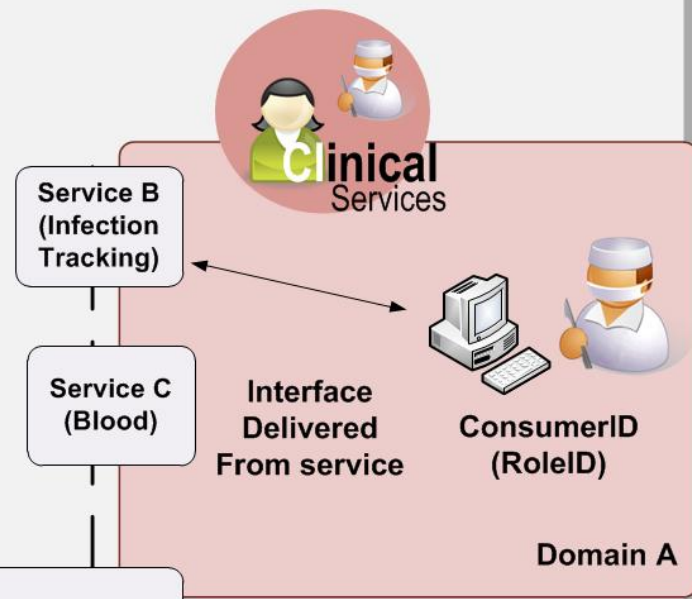
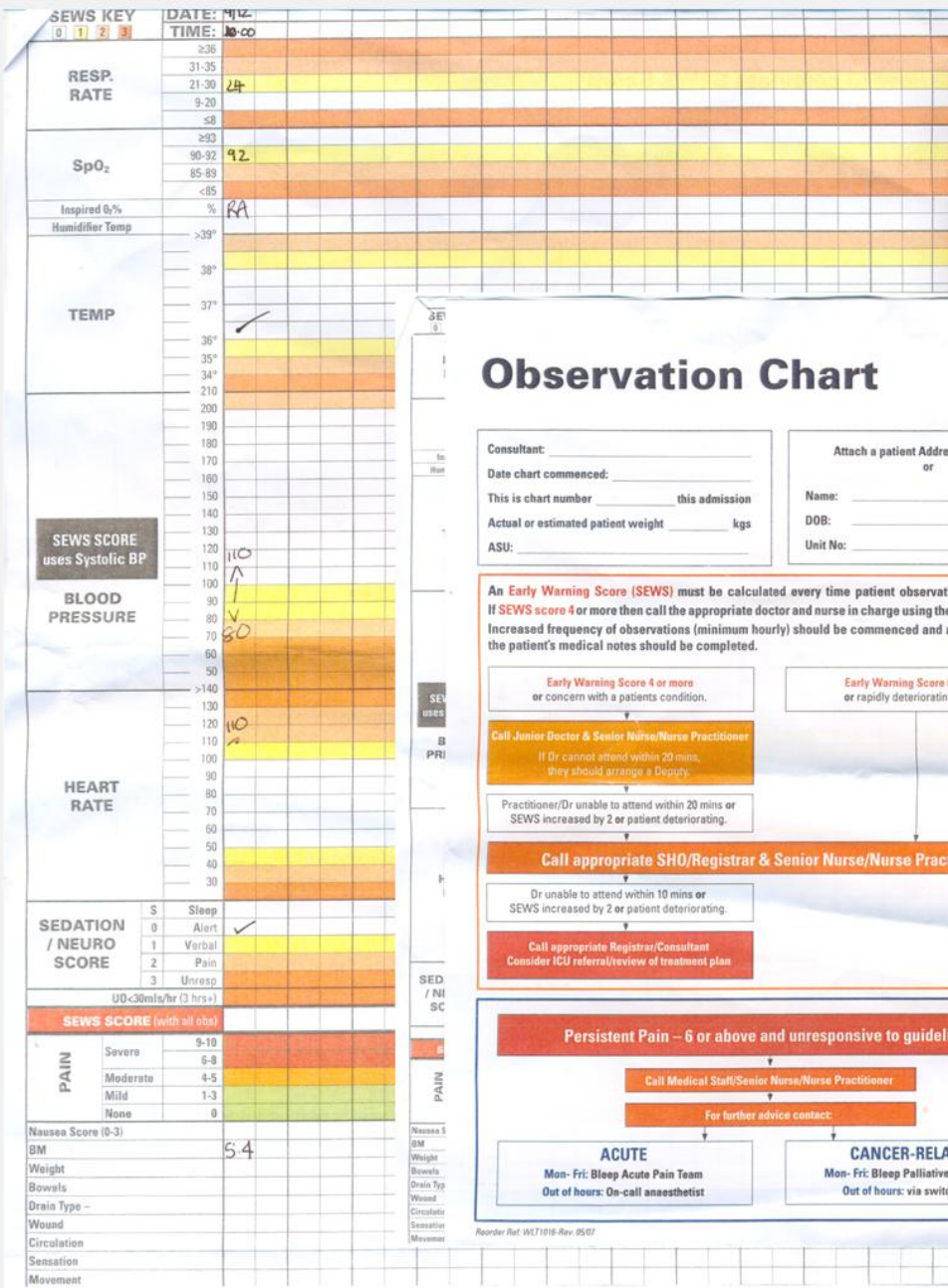
Why?

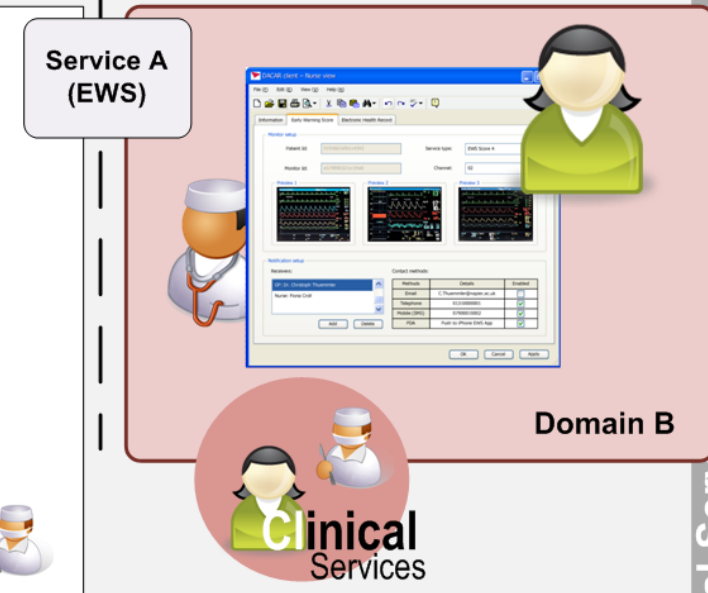
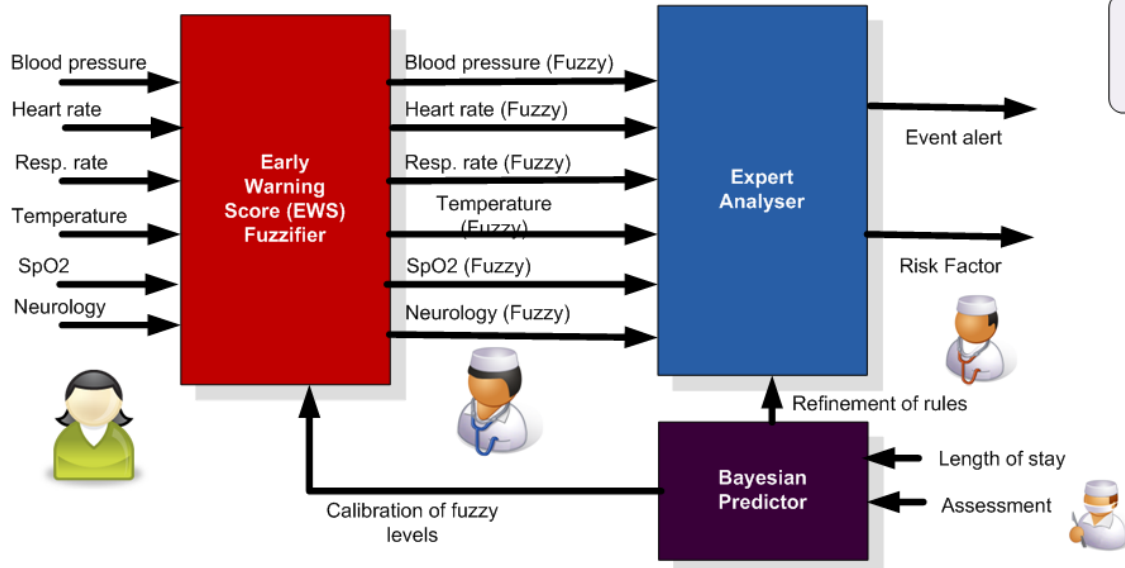
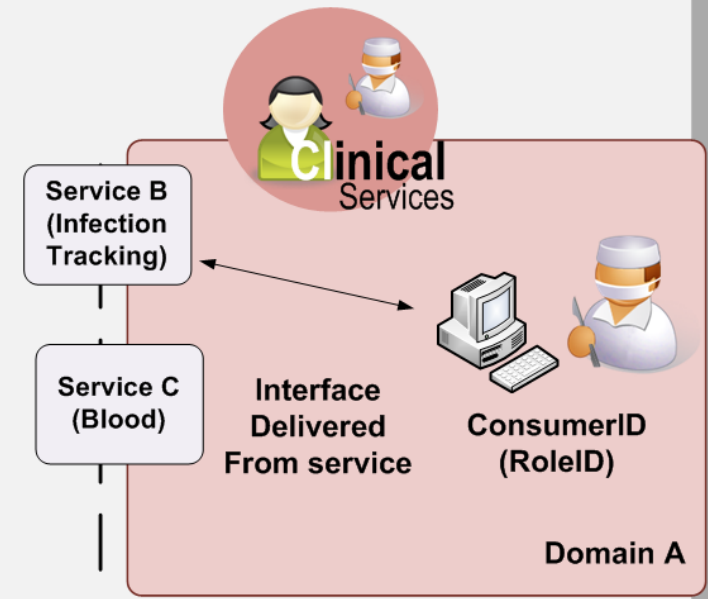
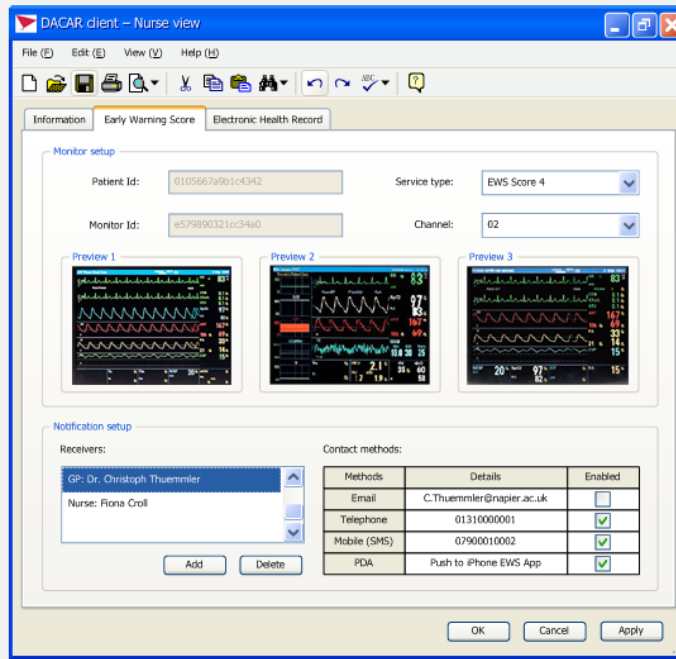
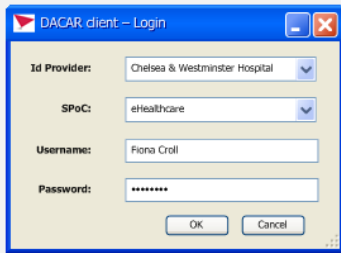


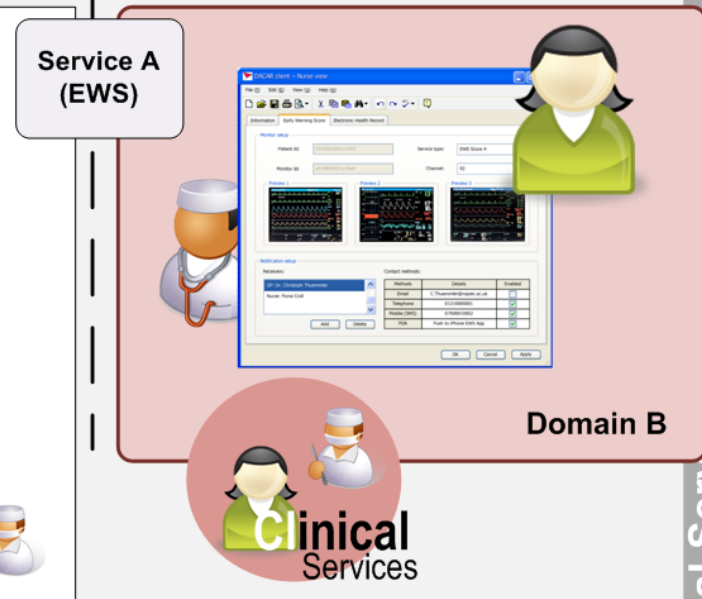
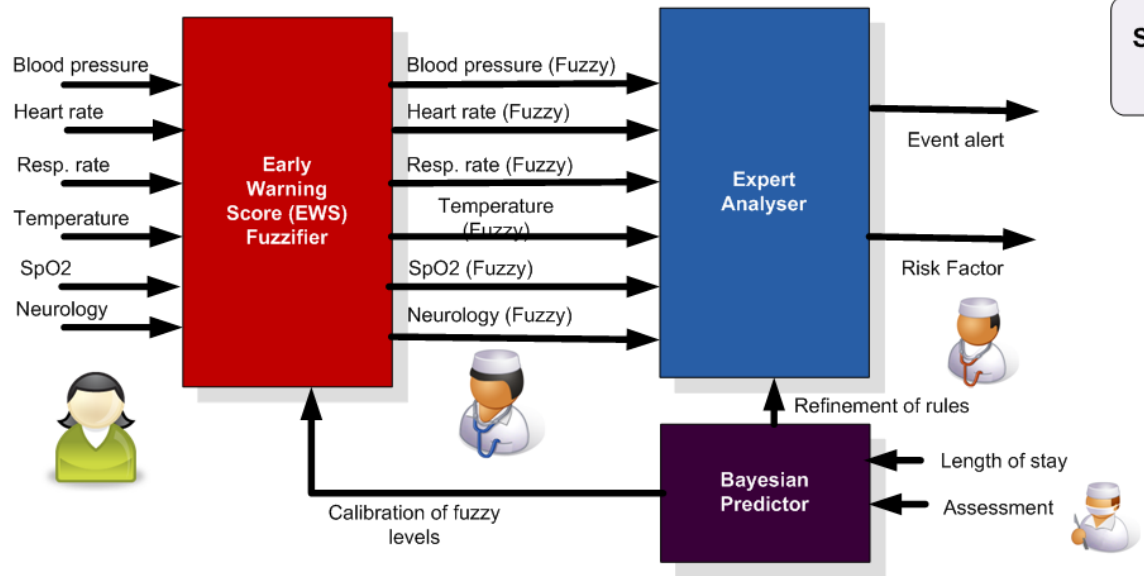
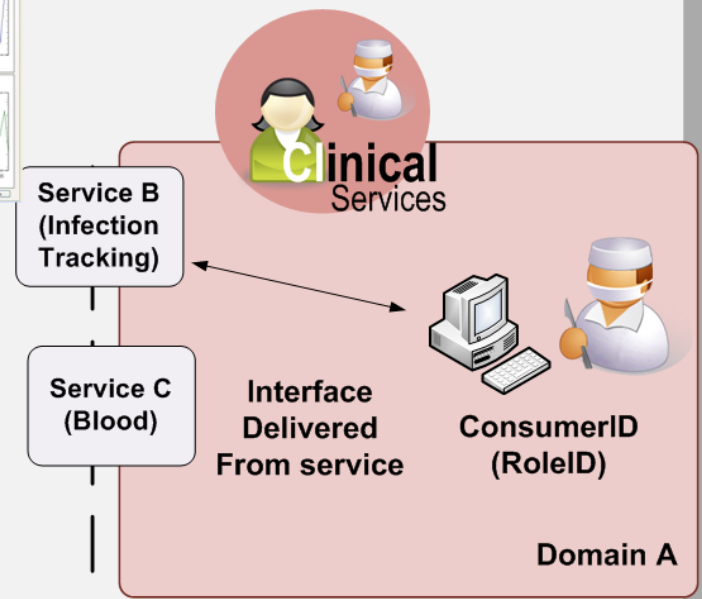




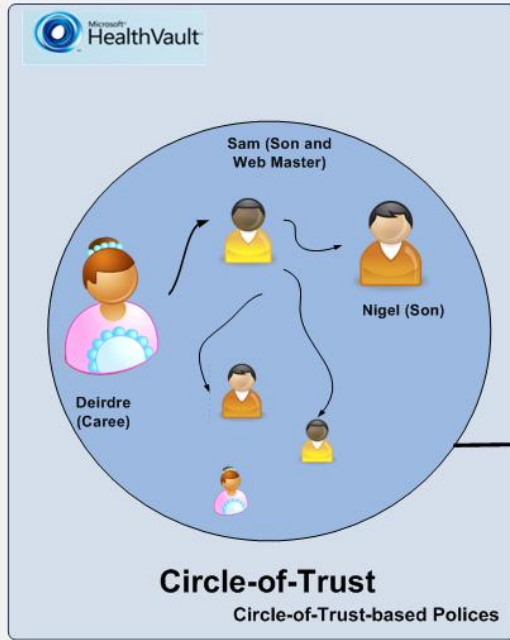






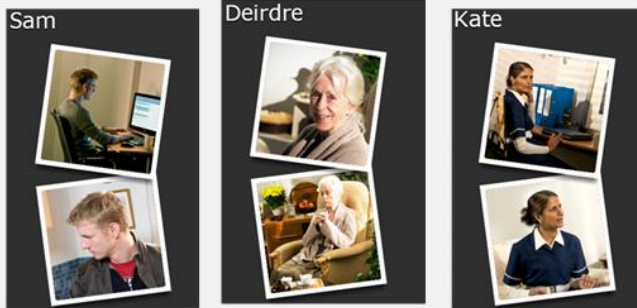
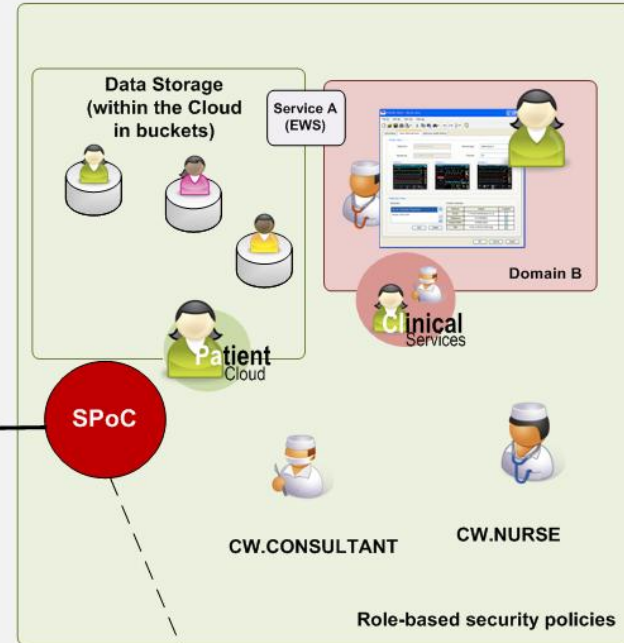


Assisted Living



Primary/Secondary Care

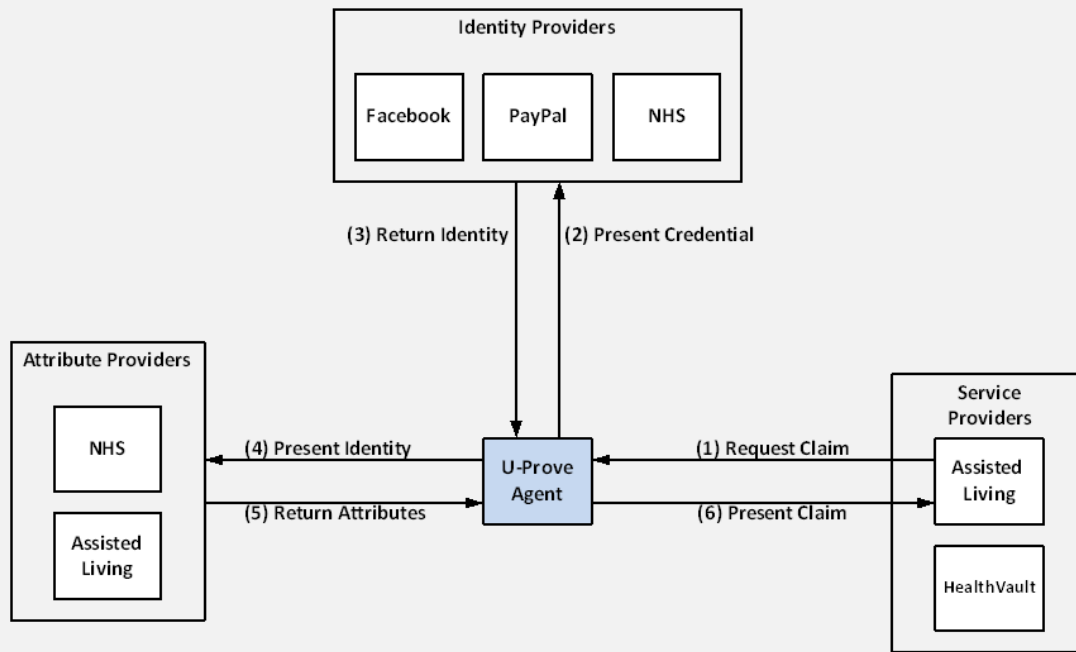
Translation Gateway (Security Policy/ ID Mapping)



```
[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



Deirdre Drake



Sam Drake



Nurse Kate

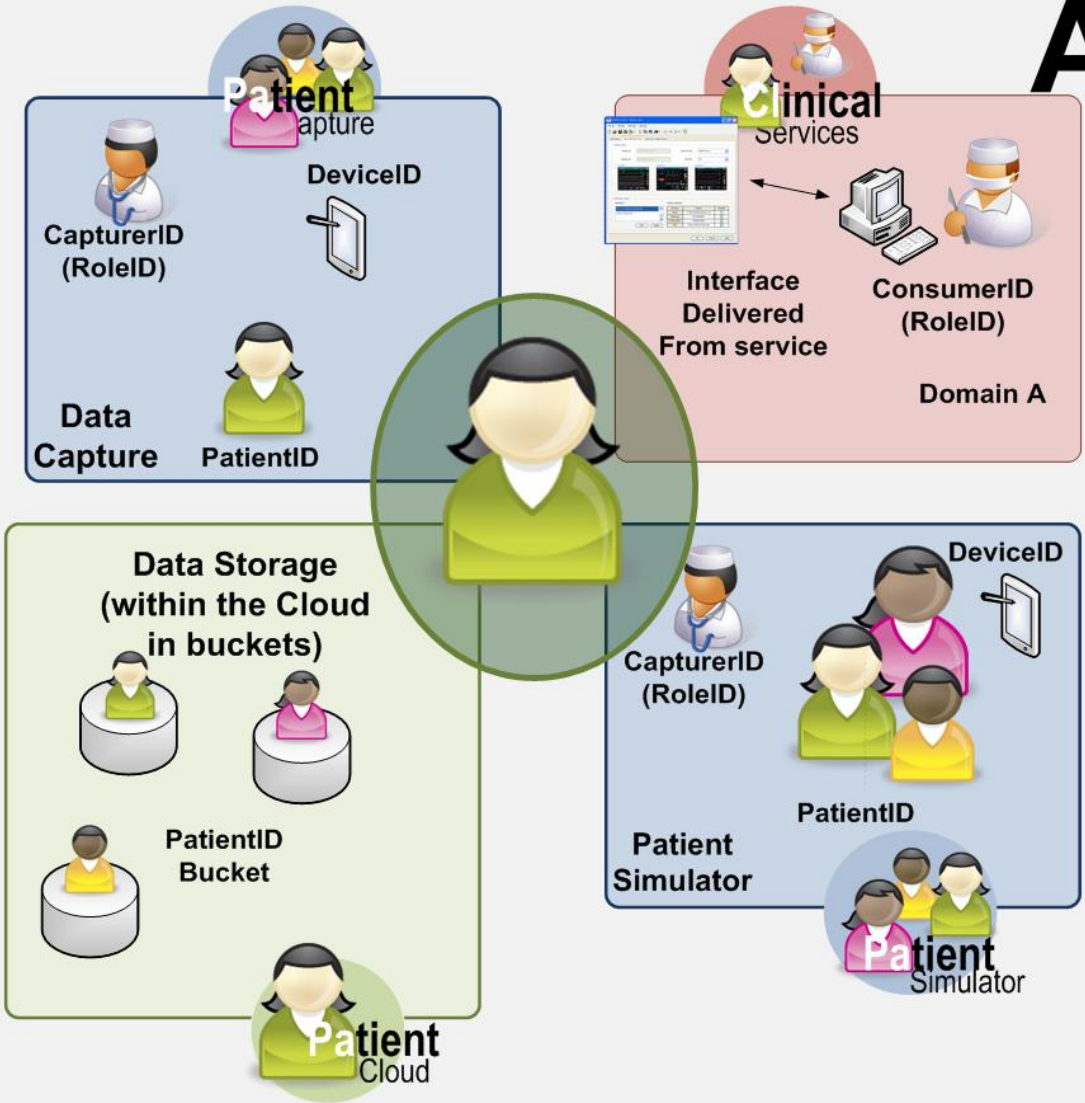


CW.CONSULTANT



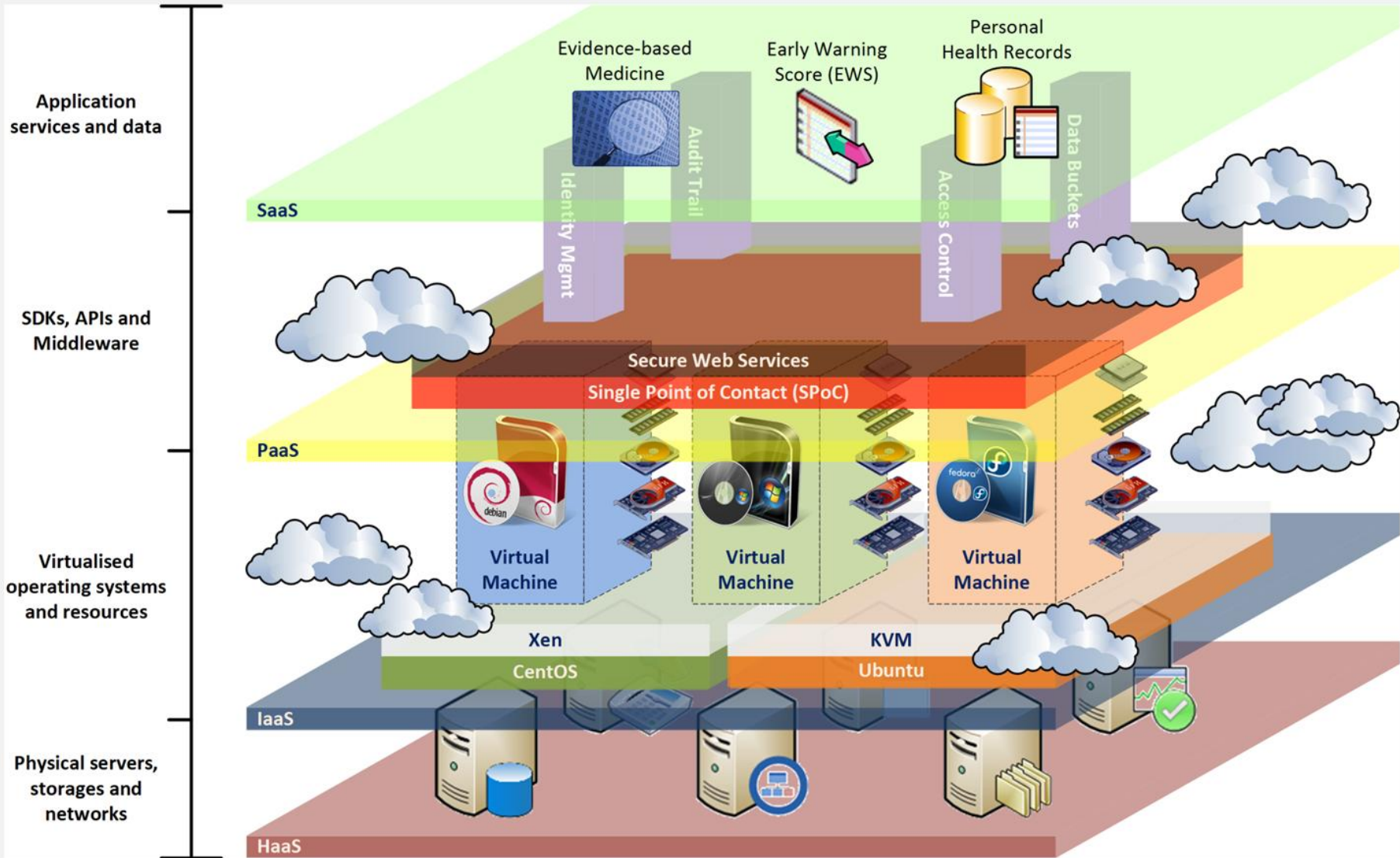
CW.NURSE

SPoC Architecture

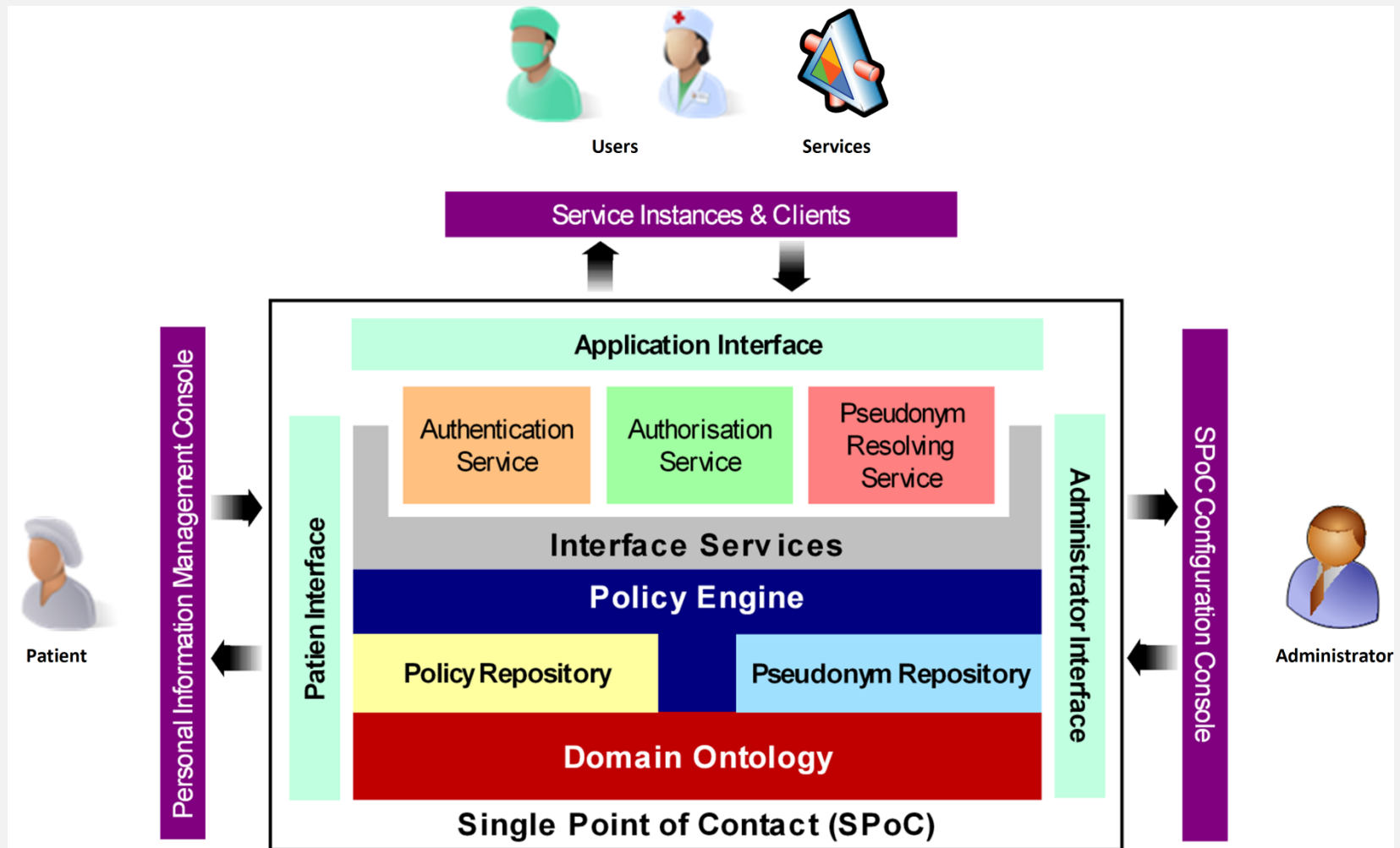


Deirdre





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.

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: [Empty]

Service Name: Early Warning S

Service Details

Service Description & End-user's Liscence 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: [Empty]

Subscription Status: [Empty]

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: Hospital.VITAL SIGN.SpO2

Available Grantees: Westminster Hospital.ROLE.Critical, Westminster Hospital.ROLE.Nurse, Westminster Hospital.ROLE.Service

Managed Grantees: Westminster Hospital.ROLE.GP

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
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[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: Westminster Hospital.VITAL SIGN.Pain, Westminster Hospital.VITAL SIGN.Hea, Westminster Hospital.VITAL SIGN.Bloc, Westminster Hospital.VITAL SIGN.Tem, Westminster Hospital.VITAL SIGN.RES, Westminster Hospital.MEDICAL INFO.I

Managed Attributes: Hospital.VITAL SIGN.SpO2

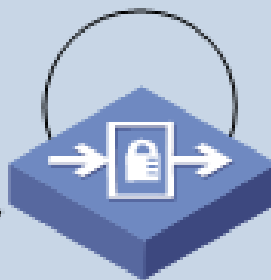
Available Grantees: Westminster Hospital.ROLE.Critical, Westminster Hospital.ROLE.Nurse, Westminster Hospital.ROLE.Service

Managed Grantees: Westminster Hospital.ROLE.GP

Valid from: 23/01/2012 to: 23/02/2012

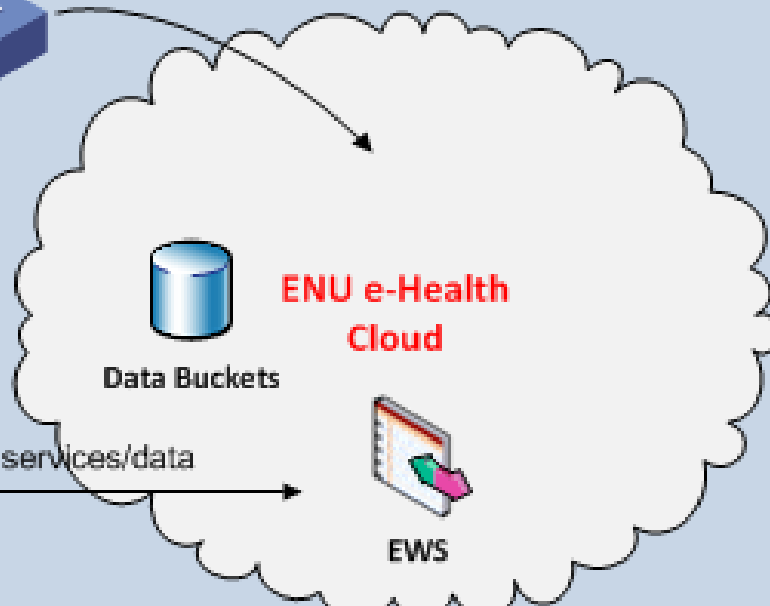
Add Update Delete

Step4: Analyse policies



SPoC

Step5: Locate/initialise service instances



ENU e-Health Cloud

Data Buckets

EWS

Step3: Present claims & request for service/data

Step6: Issue service/data ticket

Step7: Establish secure sessions to consume services/data

Step2: Issue claims

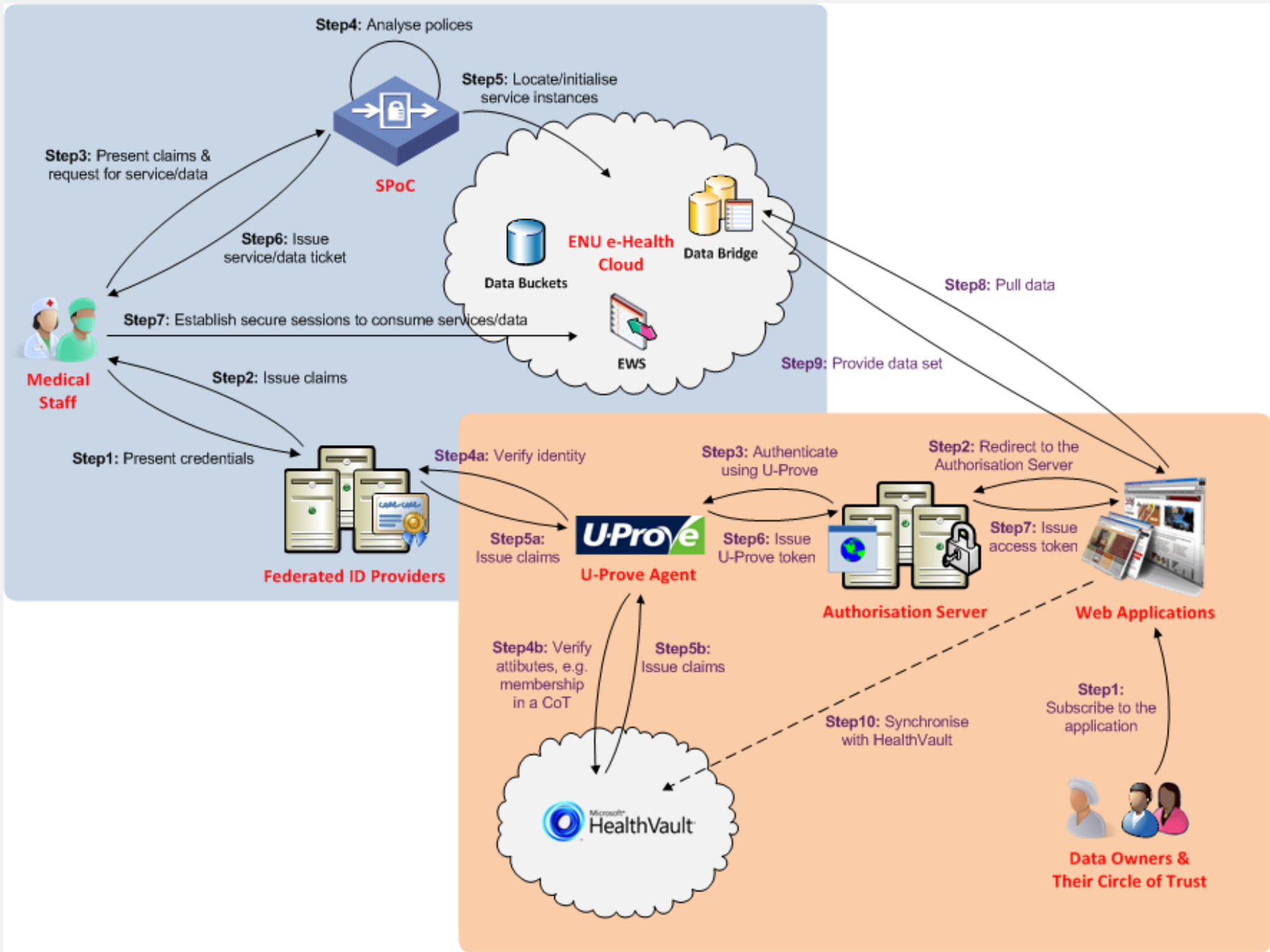
Step1: Present credentials



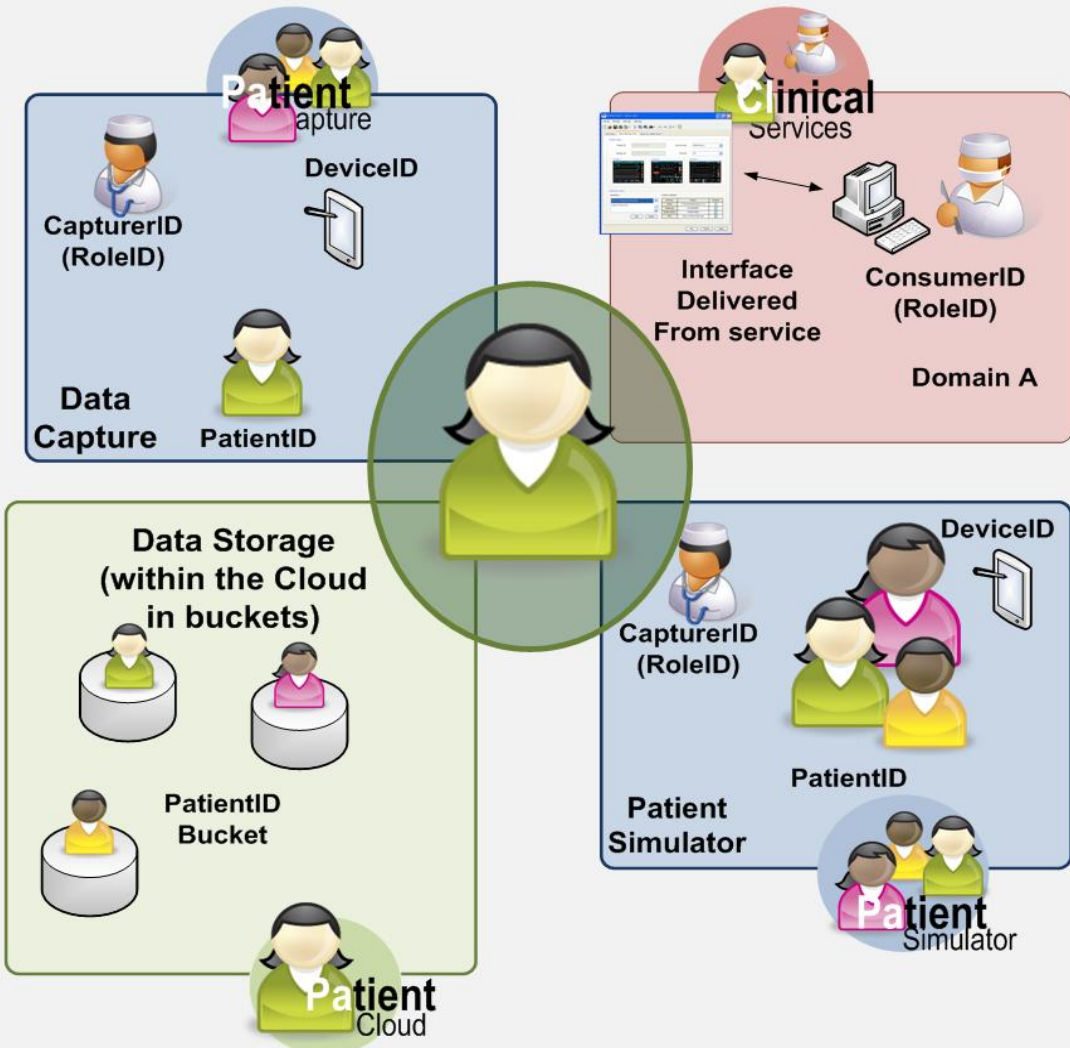
Medical Staff



Federated ID Providers



Patient Simulator



Deirdre



Patient Simulator

Edinburgh Napier UNIVERSITY

Patient List

- Daniel Smith (61980f5d-e9cc-4a9f-b7b6-7fb8fc17140)
- James Mondella (12616ff5-fbe4-4665-bca6-dcf0f0defef3)
- Scott Freeman (b8f2544b-9696-4ee9-928e-cf1d54cb8928)

Early Warning Score Service

Edinburgh Napier UNIVERSITY

Patient List

- Daniel Smith (61980f5d-e9cc-4a9f-b7b6-7fb8fc17140)
- James Mondella (12616ff5-fbe4-4665-bca6-dcf0f0defef3)
- Scott Freeman (b8f2544b-9696-4ee9-928e-cf1d54cb8928)

61980f5d-e9cc-4a9f-b7b6-7fb8fc17140

Patient Details

Update Details

Date of Birth: 23/06/1978
 Gender: Female
 Blood Type: AB
 Address: Edinburgh

Vital Sign Parameters

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

Simulation Visualisation

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

Simulation Output

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

Simulation Control

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

61980f5d-e9cc-4a9f-b7b6-7fb8fc17140

Patient Details

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

Patient Status:

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

Early Warning Score:

Value	HR	BP	TEMP	RR	SPO2
79	118	36.8	11.7	98	

EWS: 0 0 0 0 0

RISK SCORE: 0

Monitoring...

61980f5d-e9cc-4a9f-b7b6-7fb8fc17140

Patient Details

Update Details

Date of Birth: 23/06/1978
 Gender: Female
 Blood Type: AB
 Address: Edinburgh

Vital Sign Parameters

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

Simulation Visualisation

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

Simulation Output

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

Simulation Control

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

Buttons: Simulating... Stop Simulation

Simulating...

61980f5d-e9cc-4a9f-b7b6-7fb8fc17140

Patient Details

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

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

Early Warning Score:

Value	HR	BP	TEMP	RR	SPO2
118	157	37.0	11.6	96	

EWS: 2 0 0 0 0

RISK SCORE: 2

Monitoring...

inside government

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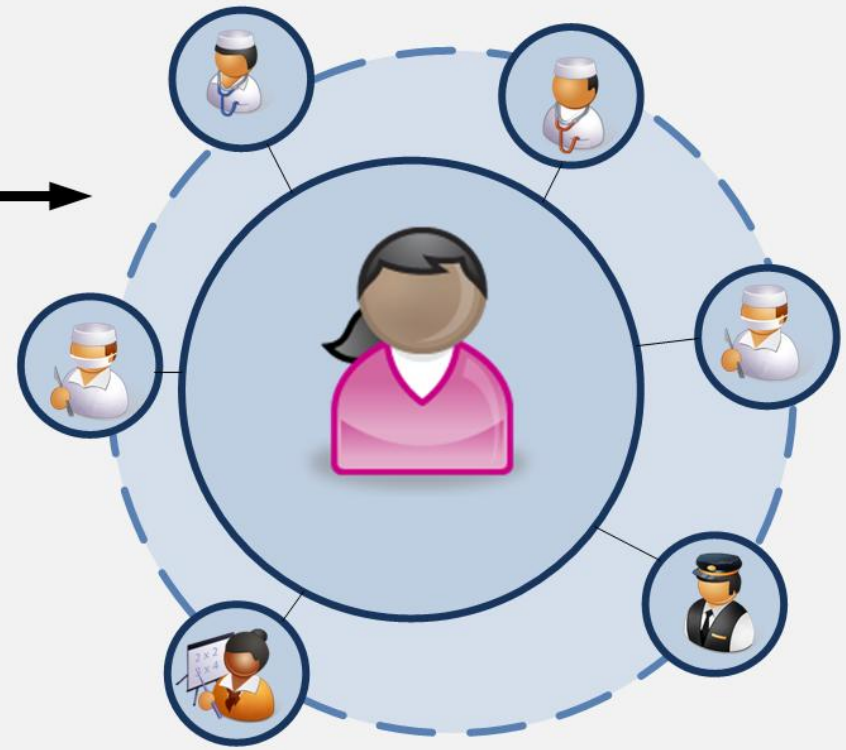
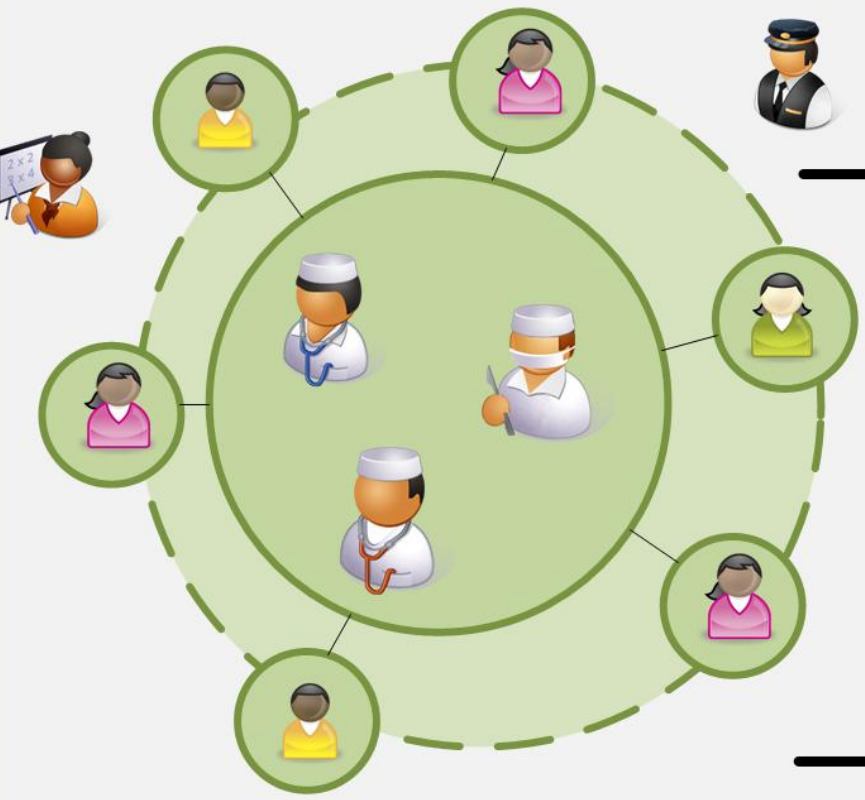
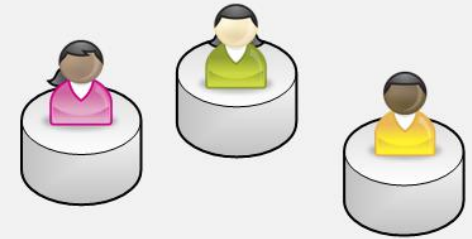
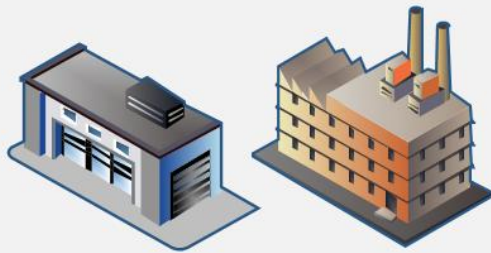
Contact: w.buchanan@napier.ac.uk

Web: cloud4health.com



Industry Age

Information Age



**Centralised, Non-integrated,
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Clinician Control of Records**

**Distributed Patient Care, Holistic,
Patient Focused, Pre-emptive,
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