Overview

- Use Case
- Decentralized Provenance Management Architecture
- UMA + Provenance Management
Use Case

Transparent Health
http://www.transparent-health.us
‘Accounting of Disclosures’ in EHR systems
Motivations for Transparent Health

- No reliable means of transparency and accountability in health care systems
  - How was my health data transferred between one clinic to another?
  - Who looked at my health data? And for what purposes?
  - Can I report misuses or seek clarifications on my medical data?

Empower patients through Transparent Medical Record Systems!
**Peter Patient’s Medical Details**

<table>
<thead>
<tr>
<th>URI:</th>
<th><a href="http://transparent-health.herokuapp.com/patient/524bc6b9f6d9380200000001524bc6b9f6d9380200000001">http://transparent-health.herokuapp.com/patient/524bc6b9f6d9380200000001524bc6b9f6d9380200000001</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Country:</td>
<td>United States</td>
</tr>
<tr>
<td>Date Joined:</td>
<td>October 2nd, 2013, 7:09:45 am</td>
</tr>
<tr>
<td>Birthdate:</td>
<td>1950-01-01</td>
</tr>
<tr>
<td>Blood Type:</td>
<td>B+</td>
</tr>
<tr>
<td>Emergency Contact:</td>
<td>123-456-7890</td>
</tr>
<tr>
<td>Primary Care Provider:</td>
<td>Doctor Dee</td>
</tr>
</tbody>
</table>

**Medical Conditions**

- Medical Condition: HIV AIDS
- Medical Condition: Hypertension
- Medical Condition: Panic Attacks
Auditing Health Info

Audit Logs for conditions

Date: 12 Sep 2013
Agent: Doctor Dee
Role: Physician
Purpose: Preparation for a follow up visit
Questions?

Date: 23 Sep 2013
Agent: Steven Special
Role: Physician
Purpose: Referral Visit
Questions?

Date: 23 Sep 2013
Agent: Precilla Philip
Role: Pharmacist
Purpose: Check Prescription History
Questions?

OK
The type of information desired after a privacy breach

![Bar chart showing the number of participants ranking different types of information desired in a privacy breach.](chart)

- **Who:** Rank 1 (14 participants), Rank 2 (2 participants), Rank 3 (2 participants)
- **When:** Rank 1 (2 participants), Rank 2 (2 participants), Rank 3 (6 participants)
- **How:** Rank 1 (16 participants), Rank 2 (0 participants), Rank 3 (0 participants)
- **Where:** Rank 1 (2 participants), Rank 2 (8 participants), Rank 3 (2 participants)
- **Why:** Rank 1 (0 participants), Rank 2 (6 participants), Rank 3 (6 participants)
- **What:** Rank 1 (2 participants), Rank 2 (2 participants), Rank 3 (6 participants)
Provenance Management
Enabling a Transparent Infrastructure

Provenance Tracker Network

Provenance Enabled Client

Verification Service

Web Server

Data Transfer

Identity

Verified Identity

Identity

Verified Identity

Provenance Logs

Provenance Logs

Provenance Tracker Network
PTN Architecture

Instructions on joining the PTN is available at http://httpa.csail.mit.edu
### PTN Node Architecture

<table>
<thead>
<tr>
<th>Authentication Processor</th>
<th>Update Processor</th>
<th>Audit Processor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Log Store</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distributed Hash Table Overlay</td>
<td></td>
</tr>
</tbody>
</table>

- **PTN Node**
PTN Wrapper Interface

Authentication Processor
Update Processor
Audit Processor
Log Store
Distributed Hash Table Overlay
PTN Node

Identity and Role
Agents
Usage Restrictions
Sensitive Data
Intents
Processes
Web Application

PTN Wrapper Interface
Why DHTs?

- Incremental scalability
- High availability
- Low latency
Provenance Data Flow

http://genhospital/patient/peter/medicalrecord

sameAs

:MedicalRecord

:usage_restriction

:Treatment_Purposes

Legend

prov:Entity

prov:Activity

prov:Agent

Data Store
Provenance Data Flow

http://genhospital/patient/peter/medicalrecord

General Hospital Data

:MedicalRecord

prov:used

:usage_restriction

:Treatment_Purposes

prov:atTime

2013-09-17:T09:00:00

:Referral

prov:wasAssociatedWith

:http://genhospital/patient/peter/medicalrecord

sameAs

:General_Hospital

prov:actedOnBehalfOf

:Dee

:role

"Doctor"

prov:Entity

prov:Activity

prov:Agent

Data Store

Legend
Provenance Data Flow

Legend
- prov:Entity
- prov:Activity
- prov:Agent
- Data Store

http://starhospital/patient/peter/medicalrecord ➔ sameAs ➔ http://genhospital/patient/peter/medicalrecord

:DerivedMedicalRecord ➔ prov:wasDerivedFrom ➔ :MedicalRecord

:Agent prov:actedOnBehalfOf :Star_Hospital

"Specialist" :role :Steven

prov:atTime 2013-09-19:T10:00:00

:SpecialistCare ➔ prov:wasInfluencedBy ➔ :Referral

:Agent prov:actedOnBehalfOf :Star_Hospital

:Doctor :role :Dee

prov:atTime 2013-09-17:T09:00:00

prov:Entity ➔ prov:wasAssociatedWith ➔ prov:Agent

prov:used ➔ :usage_restriction ➔ prov:wasAssociatedWith

http://genhospital/patient/peter/medicalrecord ➔ sameAs ➔ http://starhospital/patient/peter/medicalrecord

:MedicalRecord ➔ prov:generated ➔ :MedicalRecord

"Treatment_Purposes" :usage_restriction :

:DerivedMedicalRecord ➔ :usage_restriction ➔ :MedicalRecord

:General_Hospital ➔ sameAs ➔ :General_Hospital

"Doctor" :role :Dee

prov:actedOnBehalfOf ➔ :General_Hospital

prov:AtTime 2013-09-17:T09:00:00
Provenance Creation Sequence

Data Consumer ➔ Data Provider

1. **Data Request**
2. **Authentication Request**
   - **Auth Protocol**: WebID, OAuth2.0.
3. **Credential Check**
4. **Usage Restrictions Options**
5. **Usage Intentions**
6. **Usage Aware Log**

Verification Agent

Provenance Tracker Network

Verified Credentials ➔ Verification Agent

Verified Credentials ➔ Provenance Tracker Network

Provenance Log ➔ Data Consumer

Provenance Log ➔ Data Provider
Provenance Retrieval Sequence

- Data Owner
- Data Provider
- Verification Agent
- Data Consumer
- Provenance Tracker Network

1. **Audit Request for D**
2. **Authentication Request**
3. **Credential Check**
4. **Verified Credentials**
5. **get D**
6. **Provenance Log for D**
7. **Visualization of Provenance Log**
8. **Questions**
9. **Clarifications**
10. **Provenance Log**
11. **Provenance Log**
12. **Provenance Log**

PTNs won’t solve all your problems...

- **Data Owner**
  - Mis-reporting of usage resulting in denial of service attacks

- **Data Consumer**
  - In fraudulent or illegal use of data, the data consumers won’t label the use as such
UMA + Provenance Management