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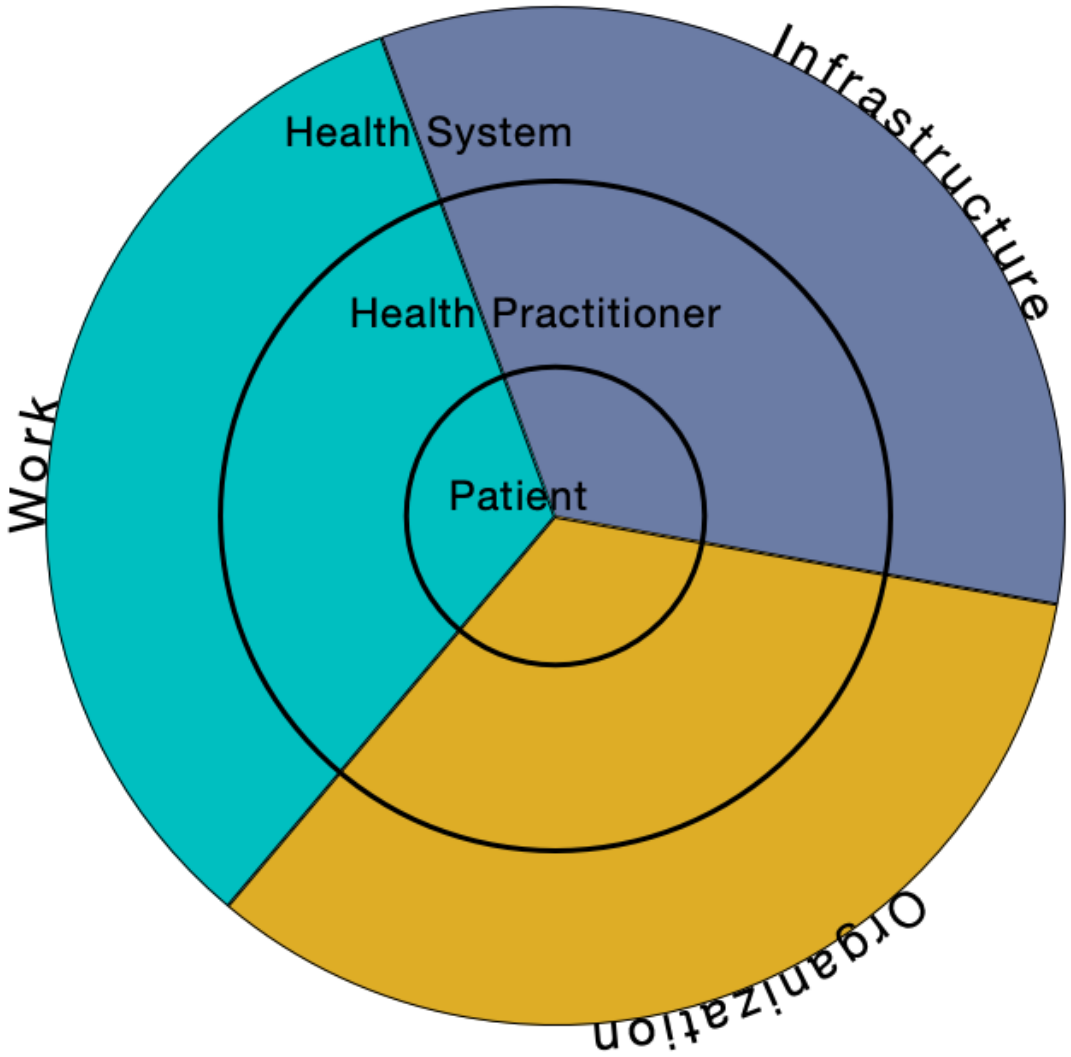
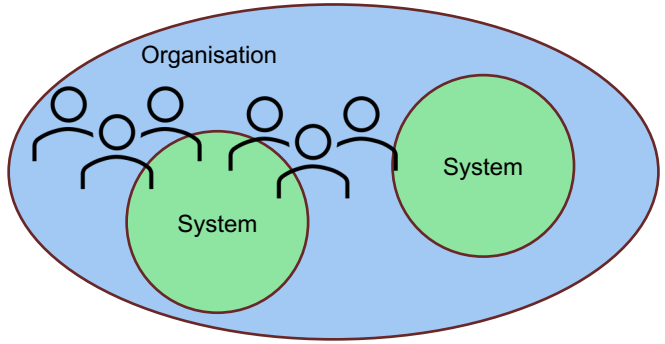
IN5090 Infrastructures

Alexander Kempton

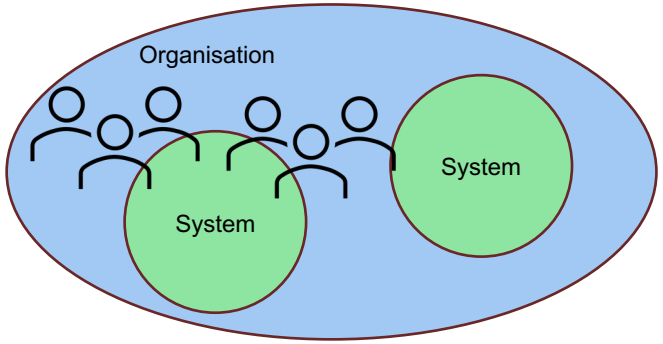
Agenda

- Infrastructures and interoperability
- Levels of interoperability
- Standardization and standards
- Architecture and governance




Organisation
System
System

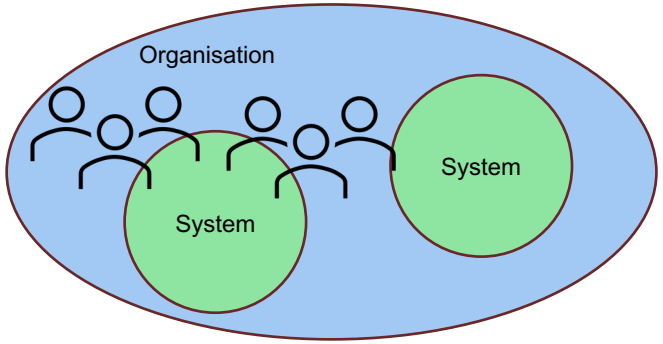
- Health data is produced and used differently in different (work) practices
- Different goals, information needs, workflows
- Effectivity and pragmatic concerns

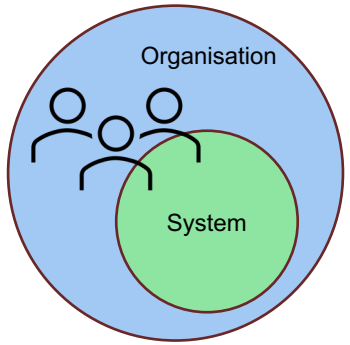


Findings (III)

- Four coexisting logics of information use

1. Patient centered ordering
   - Chronological order, medical history
   - storyline
2. Treatment centered ordering
   - Heart transplantation as specific treatment
   - Specific category of patients
   - Research oriented
3. Procedural ordering
   - Concurrent tasks and patient trajectories
4. Planning ordering
   - Specific event
   - Minimize uncertainties

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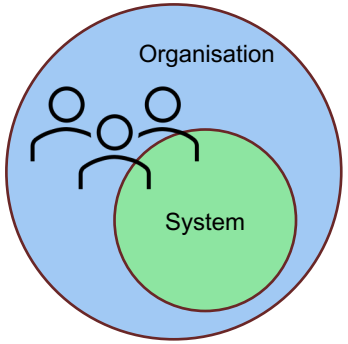
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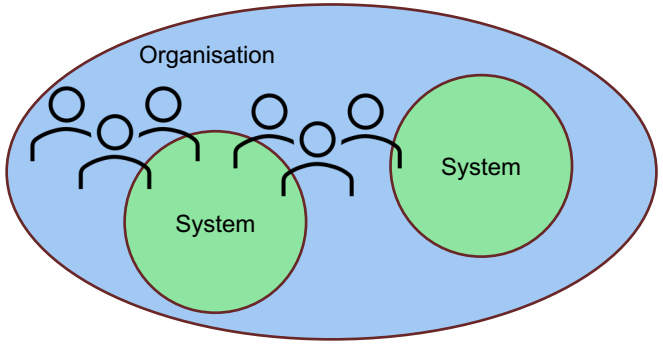
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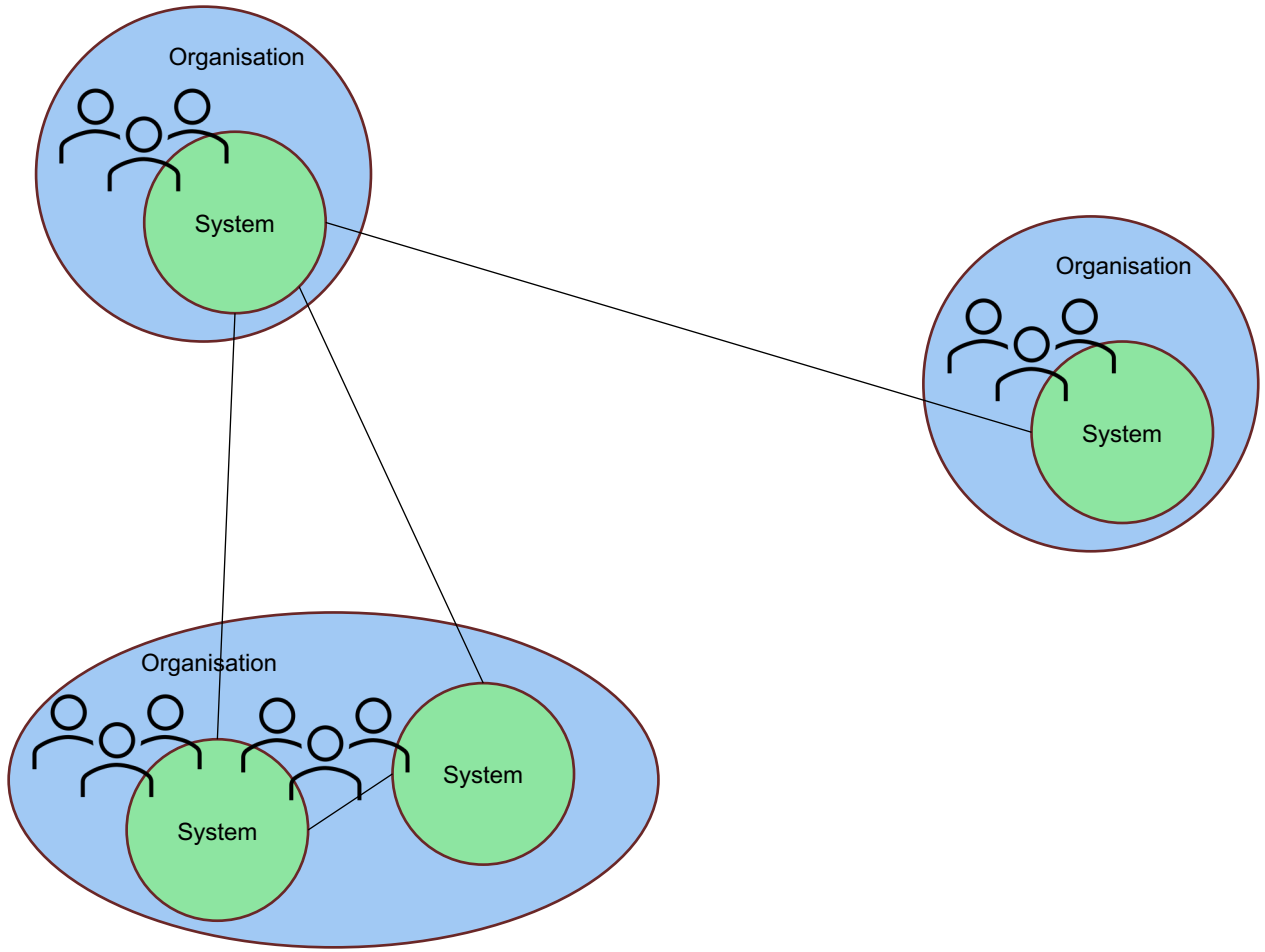
Organisation
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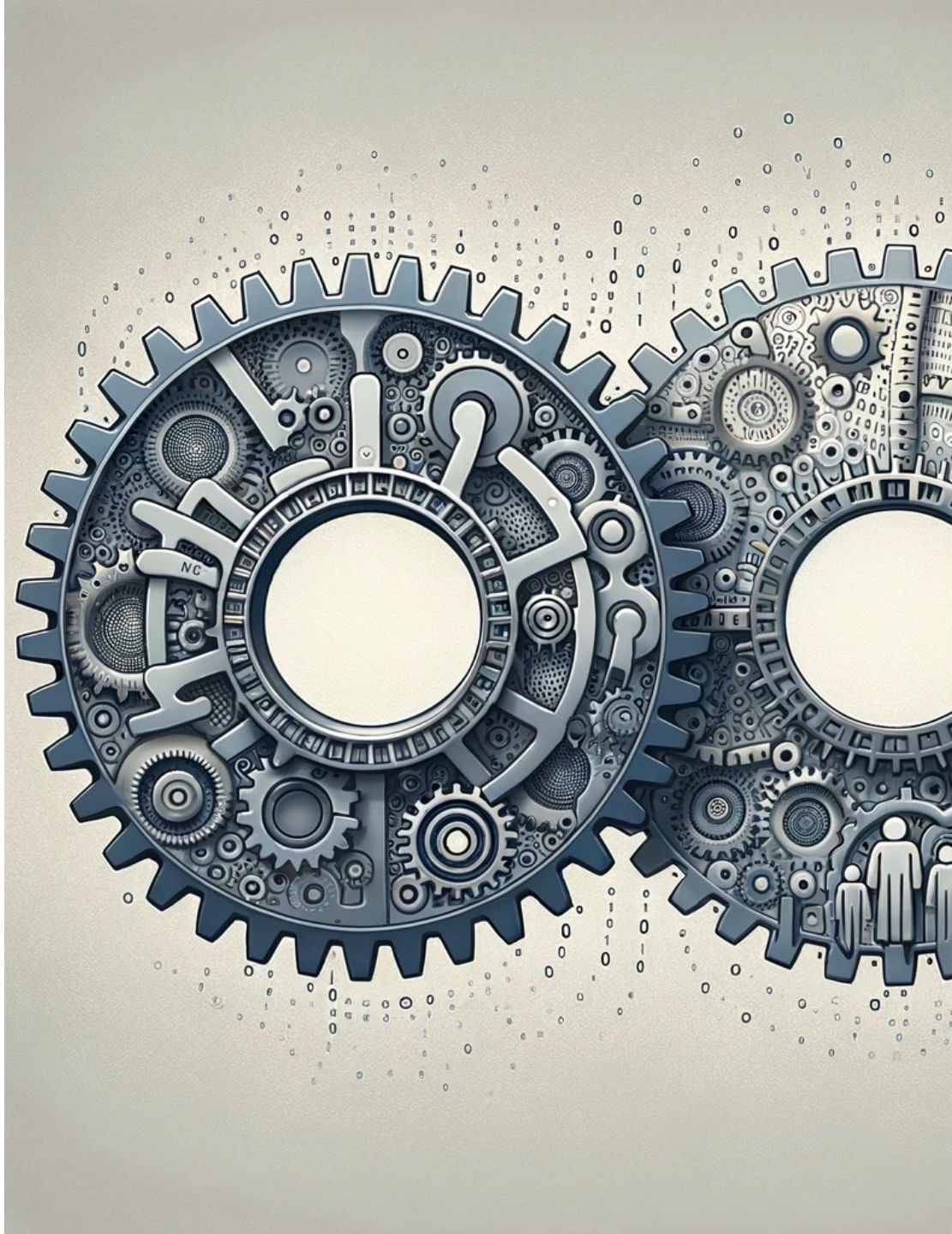
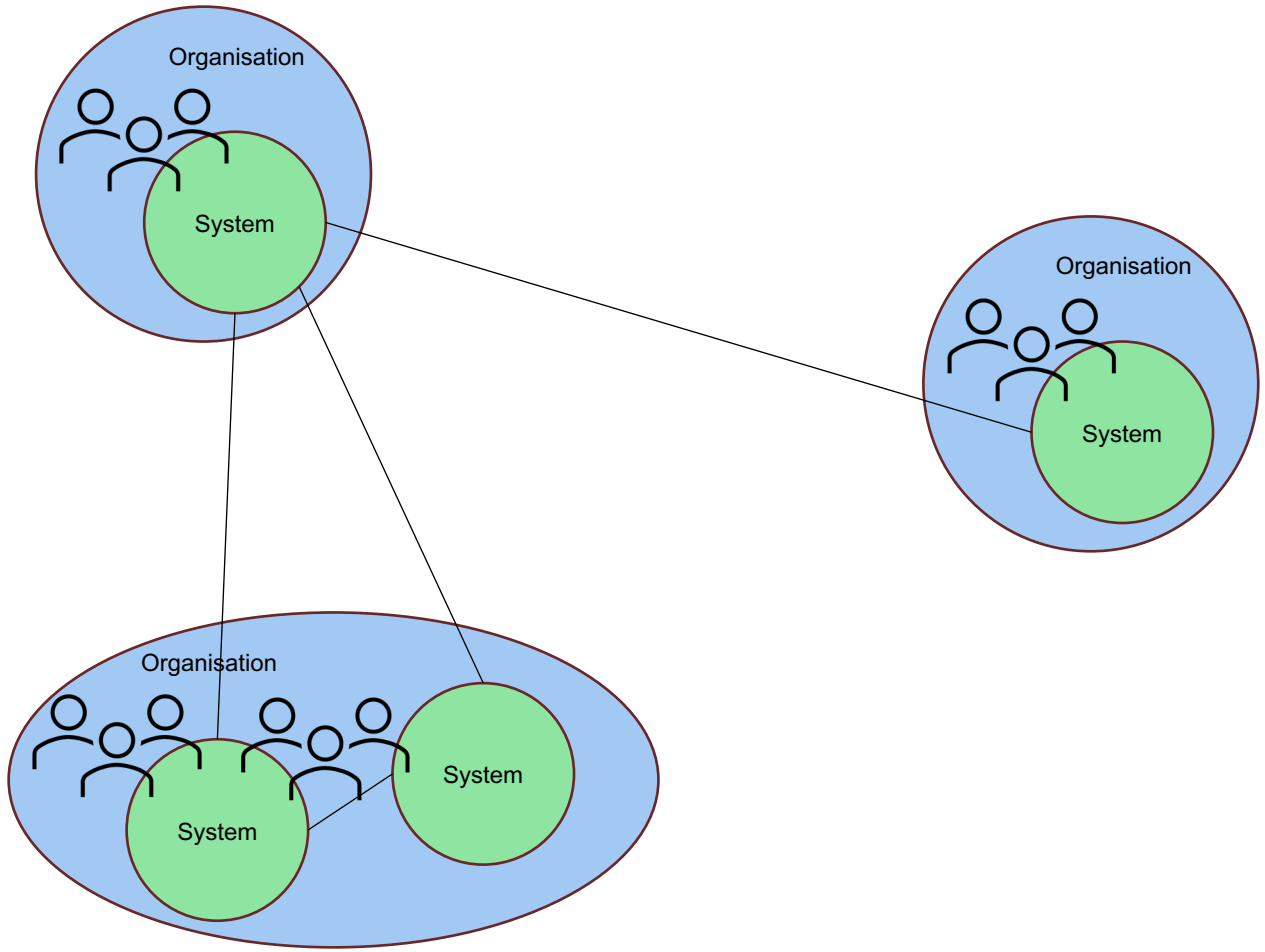
Infrastructure and interoperability

- **Infrastructure**: Sociotechnical networks that support the production, use, storage, processing, and sharing of data across contexts
- **Interoperability**: The ability to communicate and exchange information across contexts and organizational boundaries.
- When we say that a system is interoperable with another, we mean that the two systems can operate and 'talk' together in an efficient manner




Organisation
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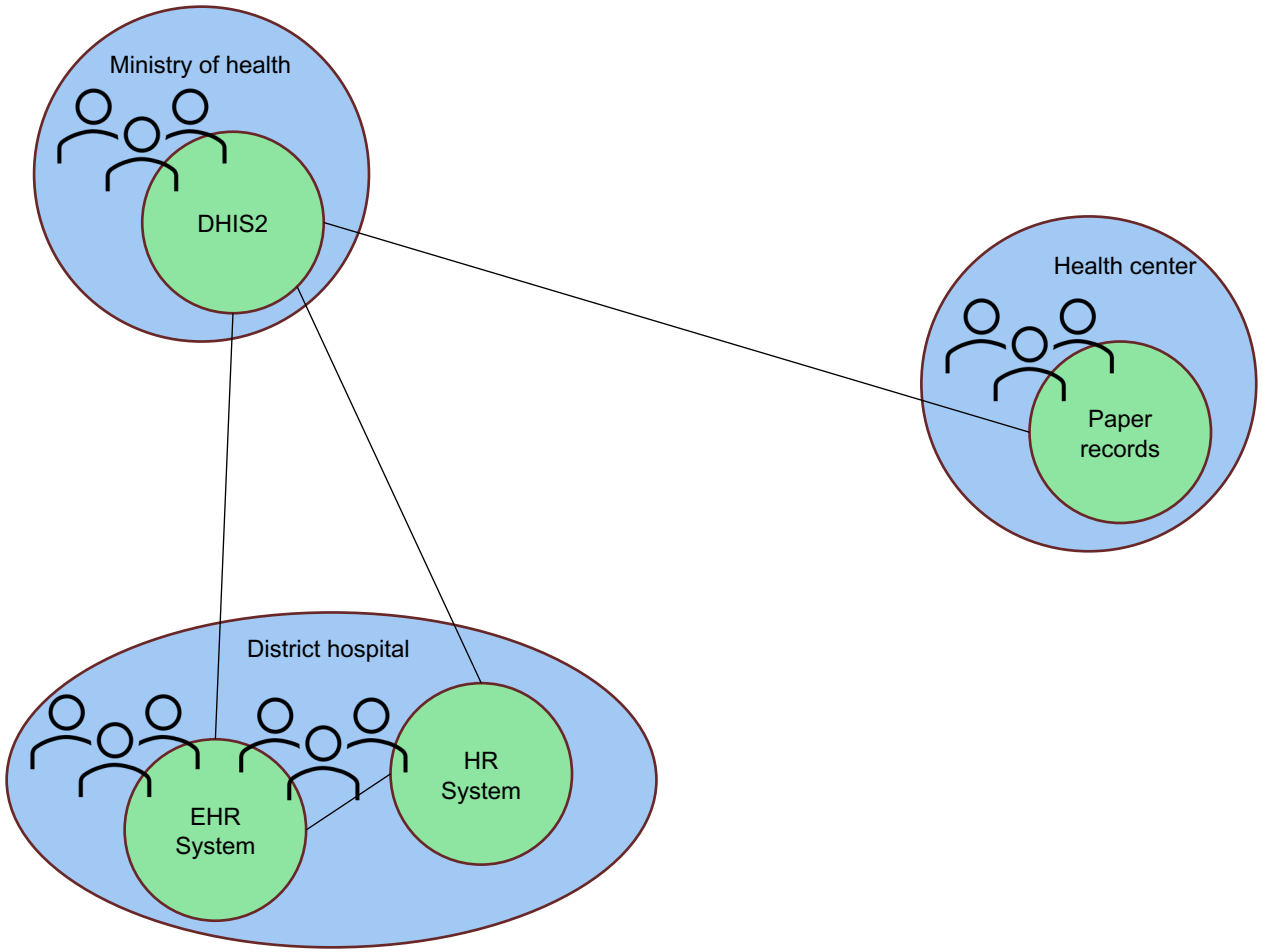
Ministry of health
DHIS2
Health center
Paper
records
District hospital
EHR
System
HR
System

Levels of interoperability

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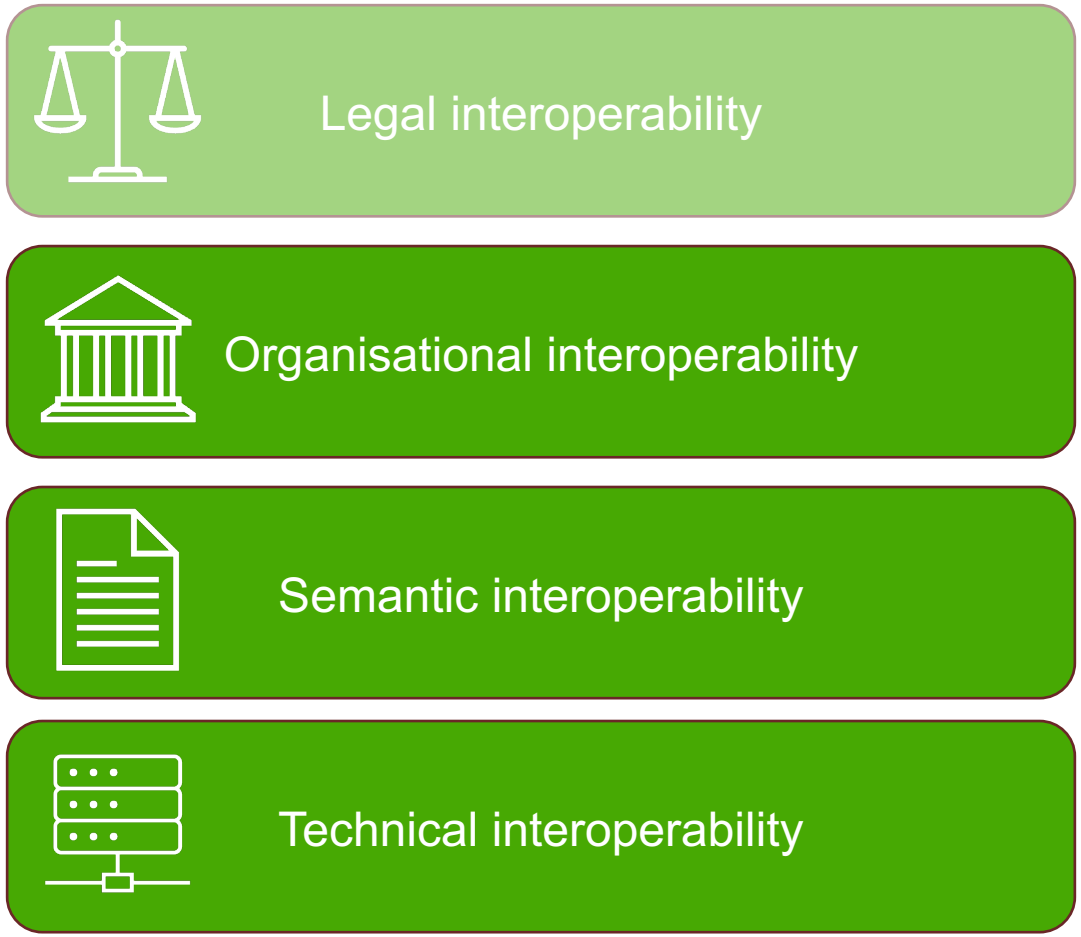
Carlile's knowledge boundaries

- Syntactic boundaries: Differences in format, terminology, and language used by different groups.
- Semantic boundaries: Differences in concepts and their meaning between groups.
- Pragmatic boundaries: Differences in goals or approaches to a problem between groups.

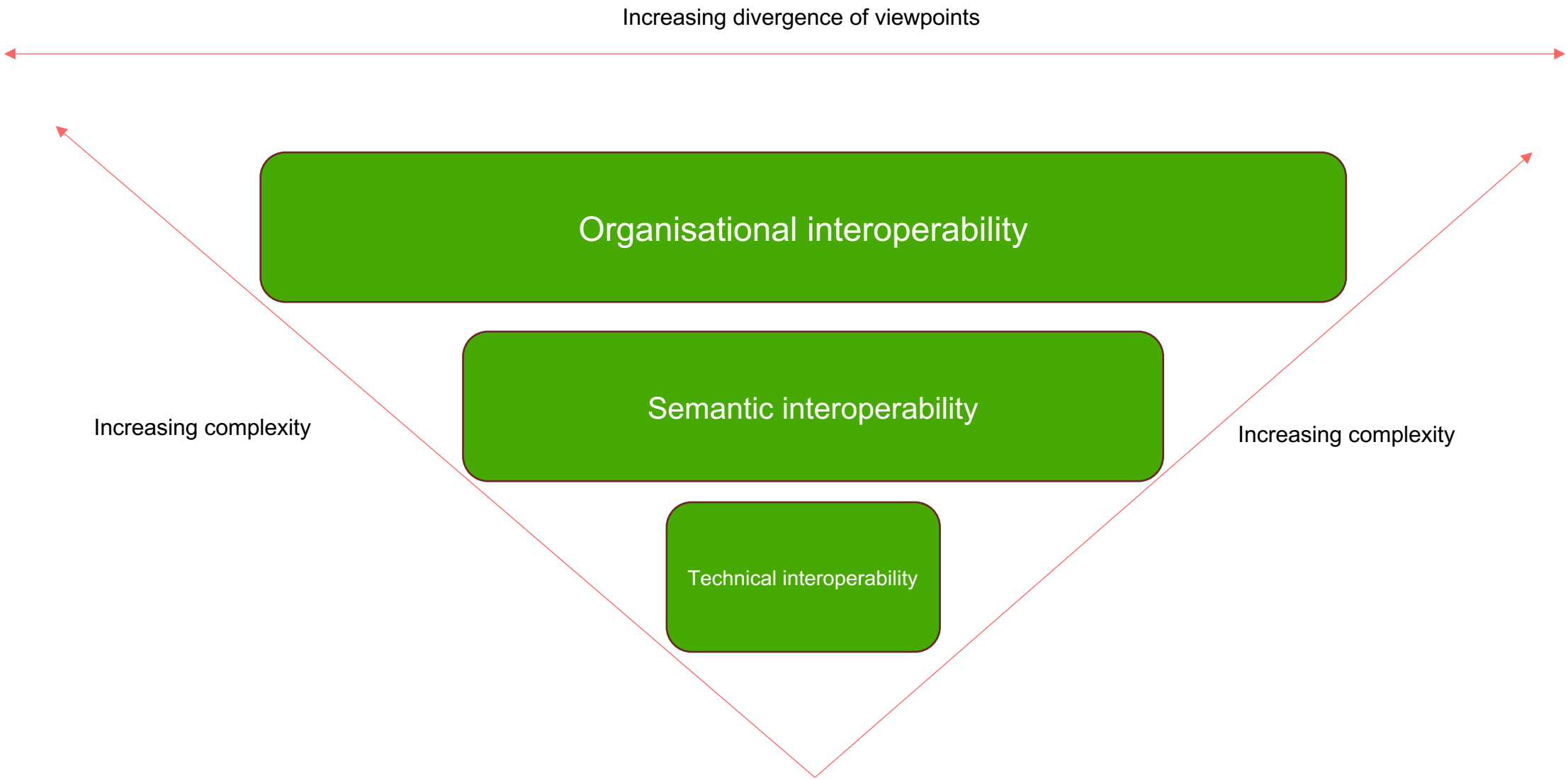
Discuss

- What does the syntactic, semantic and pragmatic boundaries entail for interoperability?

•Syntactic boundaries: Differences in format, terminology, and language used by different groups.
•Semantic boundaries: Differences in concepts and their meaning between groups.
•Pragmatic boundaries: Differences in goals or approaches to a problem between groups.



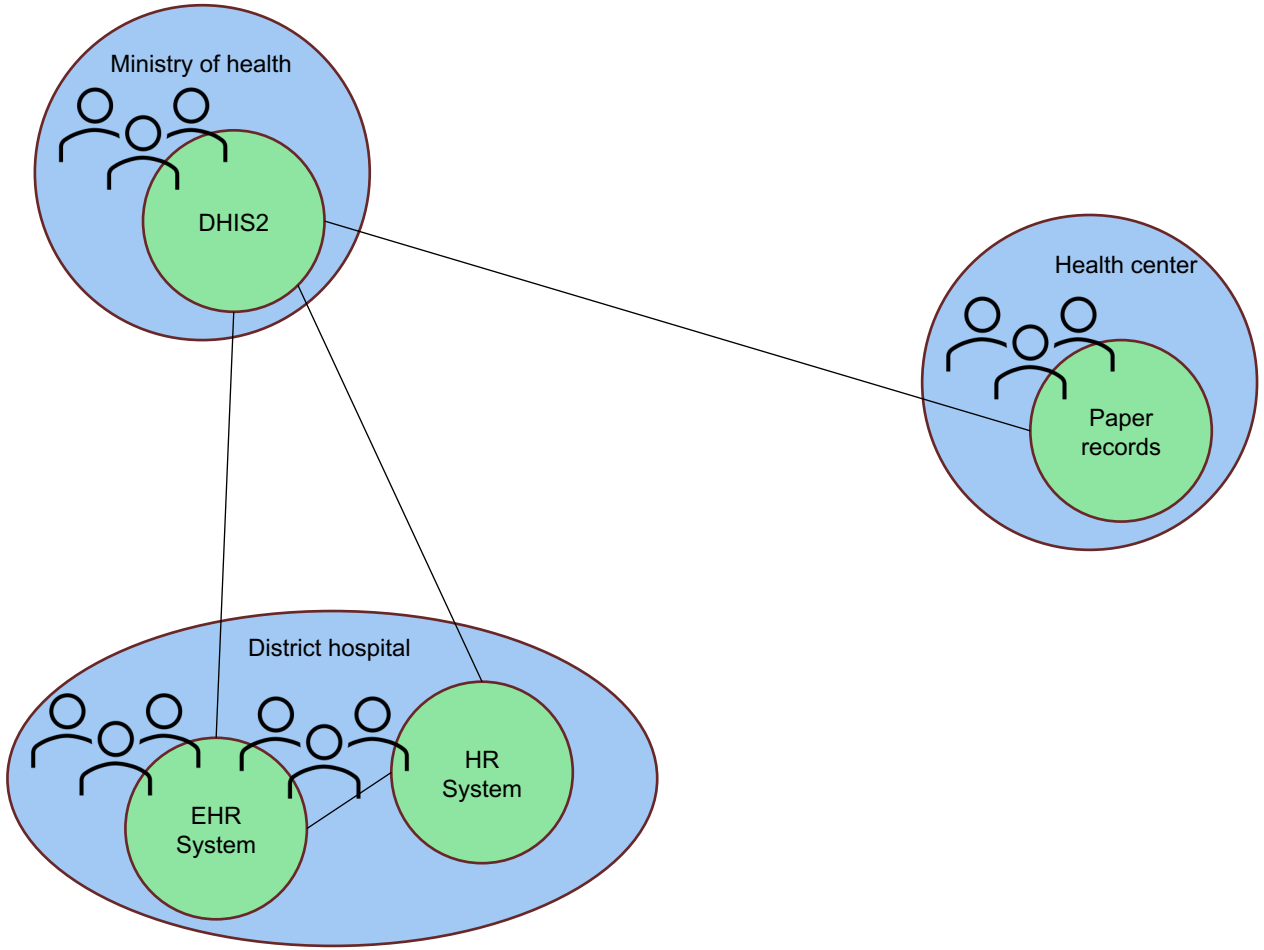
EUs Interoperability Framework



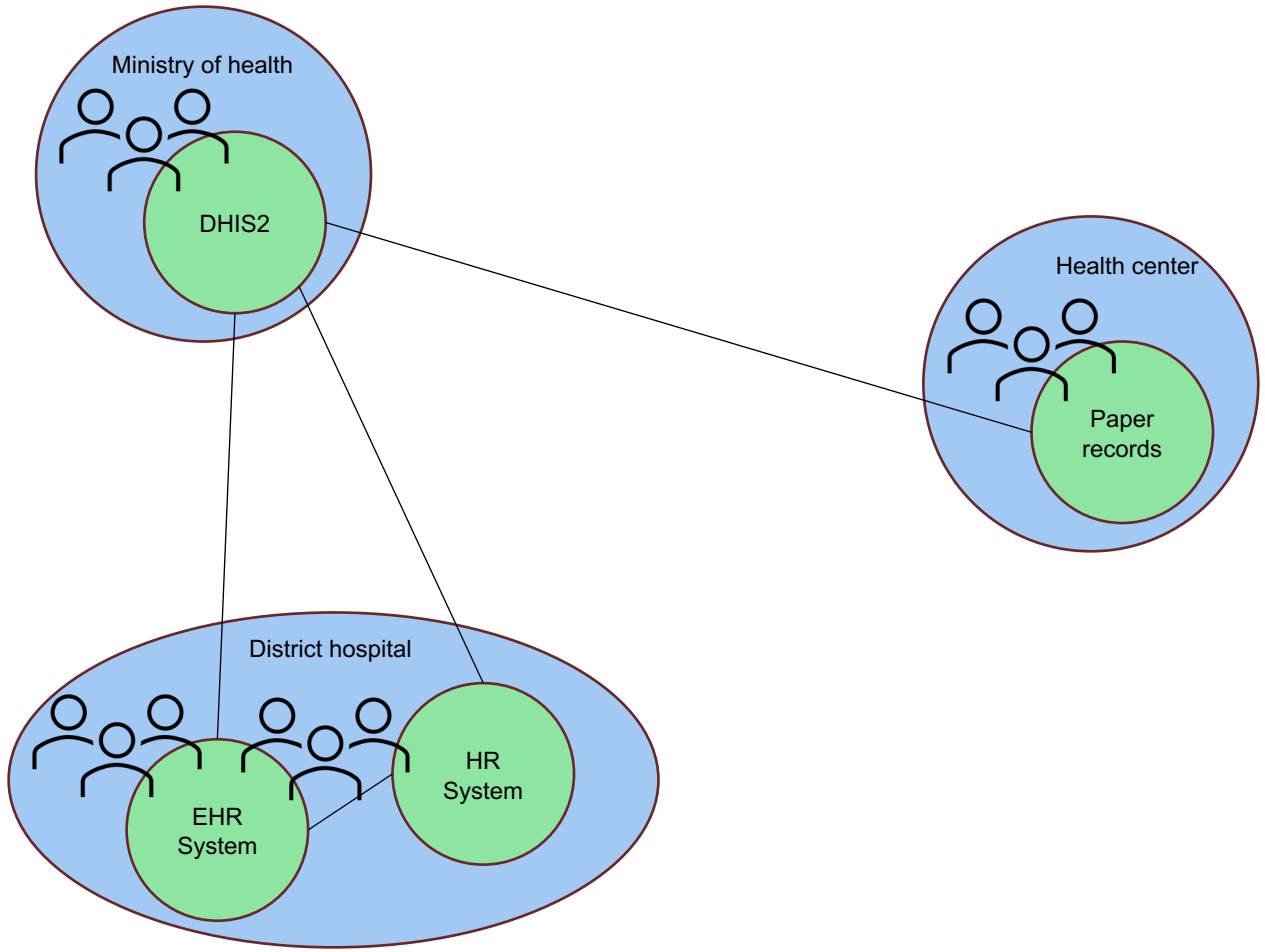
Based on Braa and Sahay 2012

Discuss

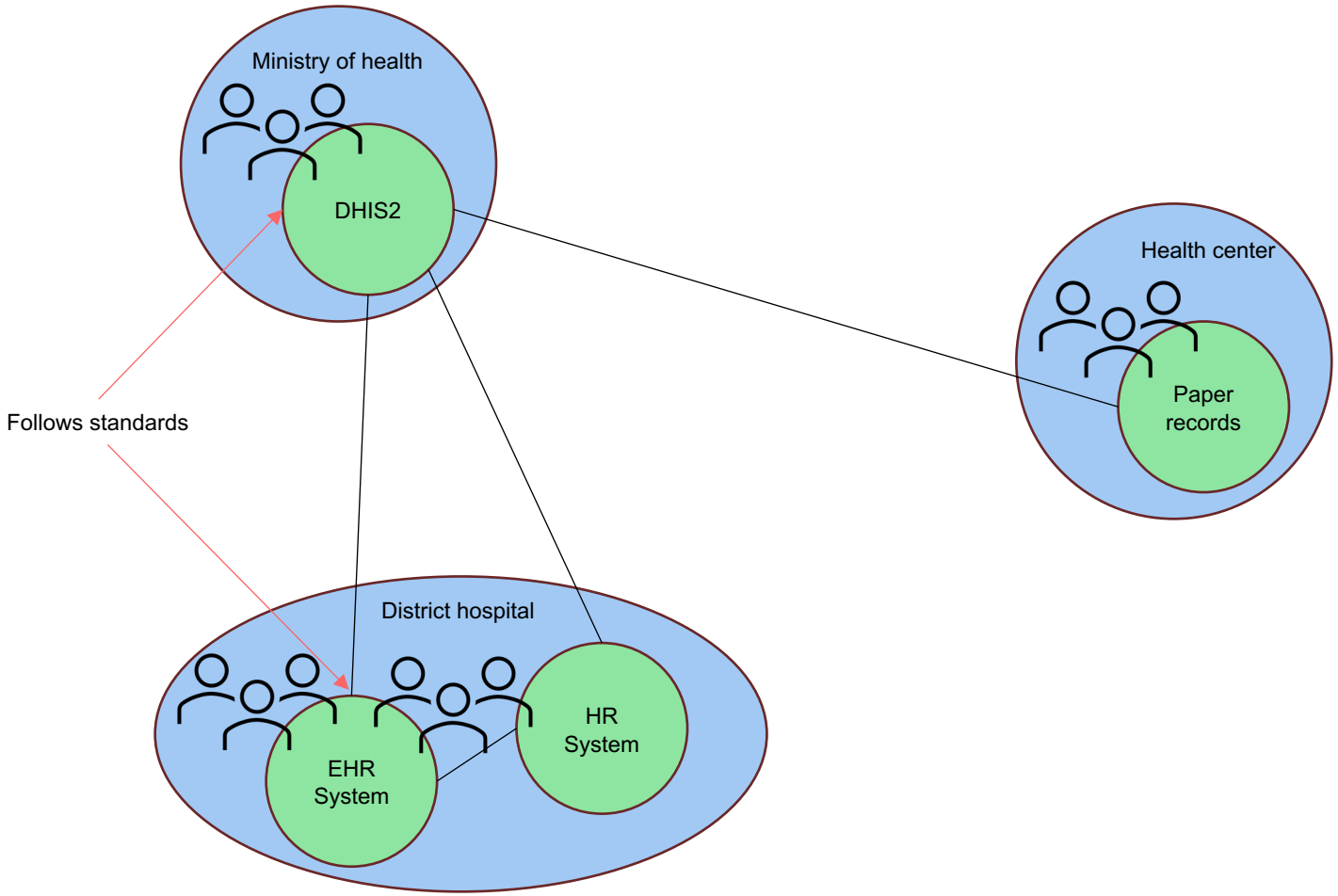
- What problems do you think needs to be solved at each interoperability level in this case?
- (technical, semantic, organizational)



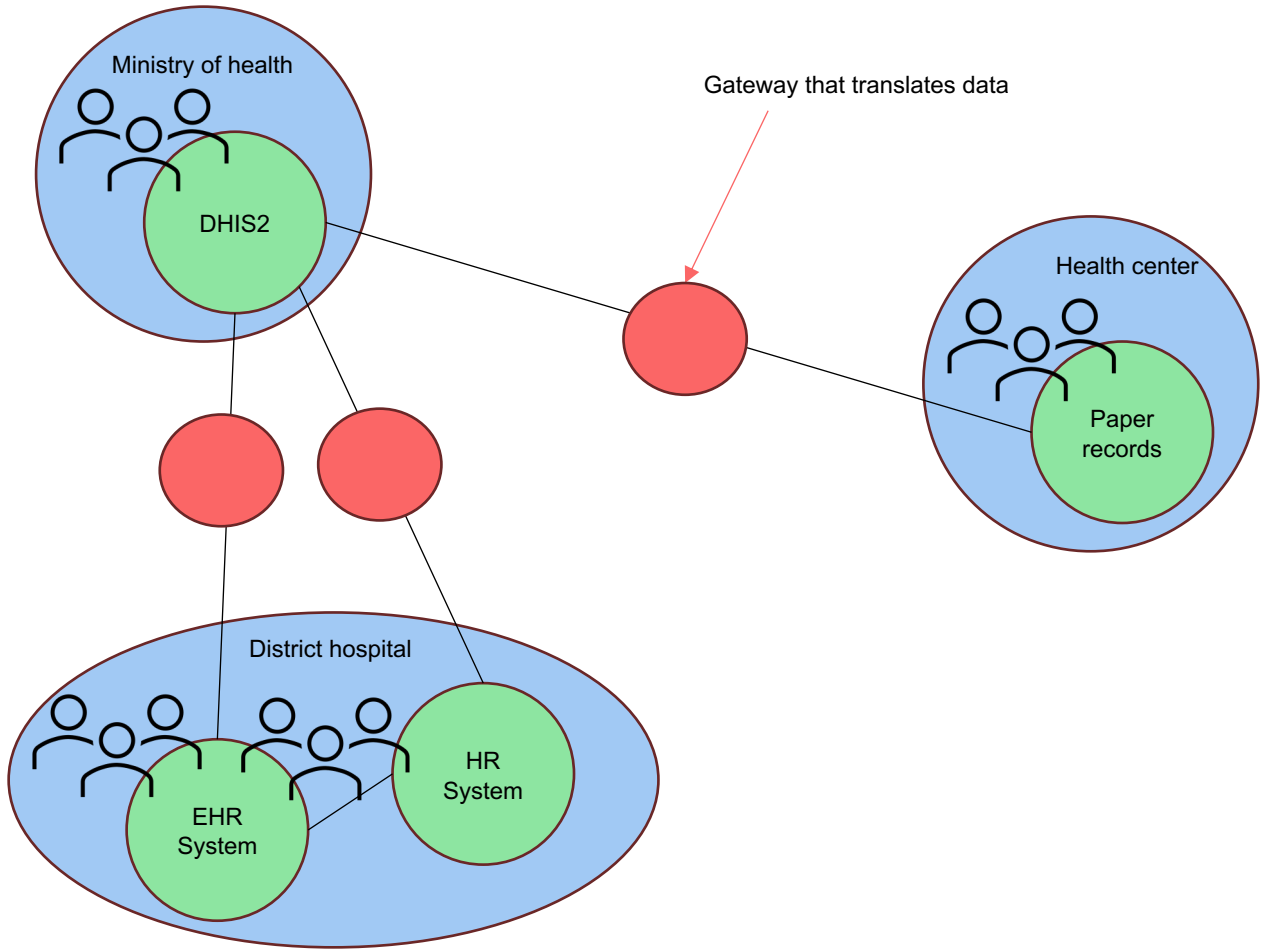
How do you enable interoperability at different levels in this infrastructure?



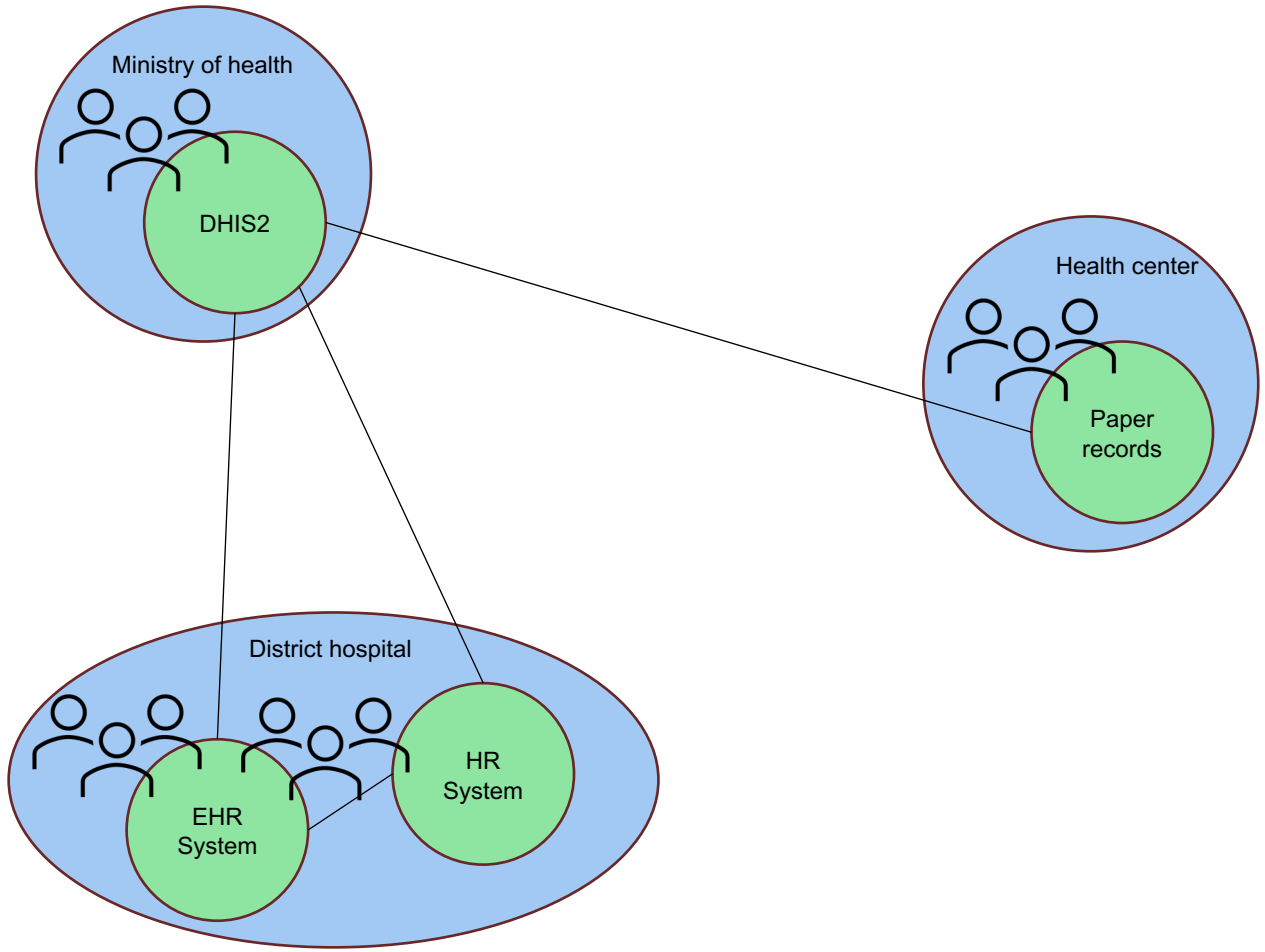
Solution 1: Standardization



Solution 2: Architecture

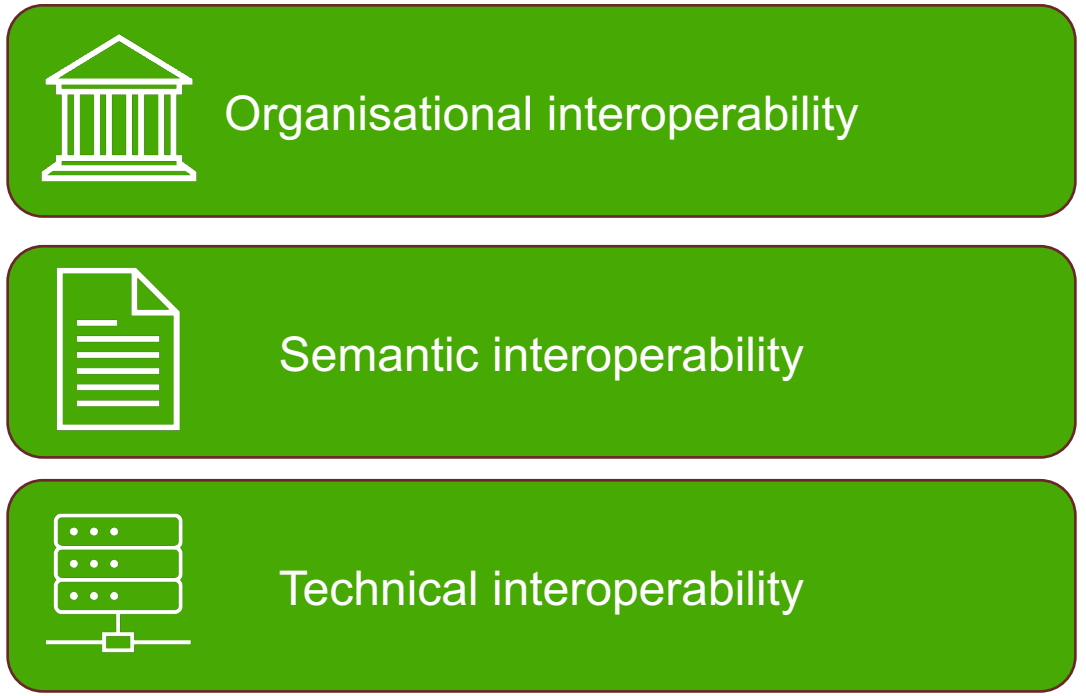


Both solutions require governance



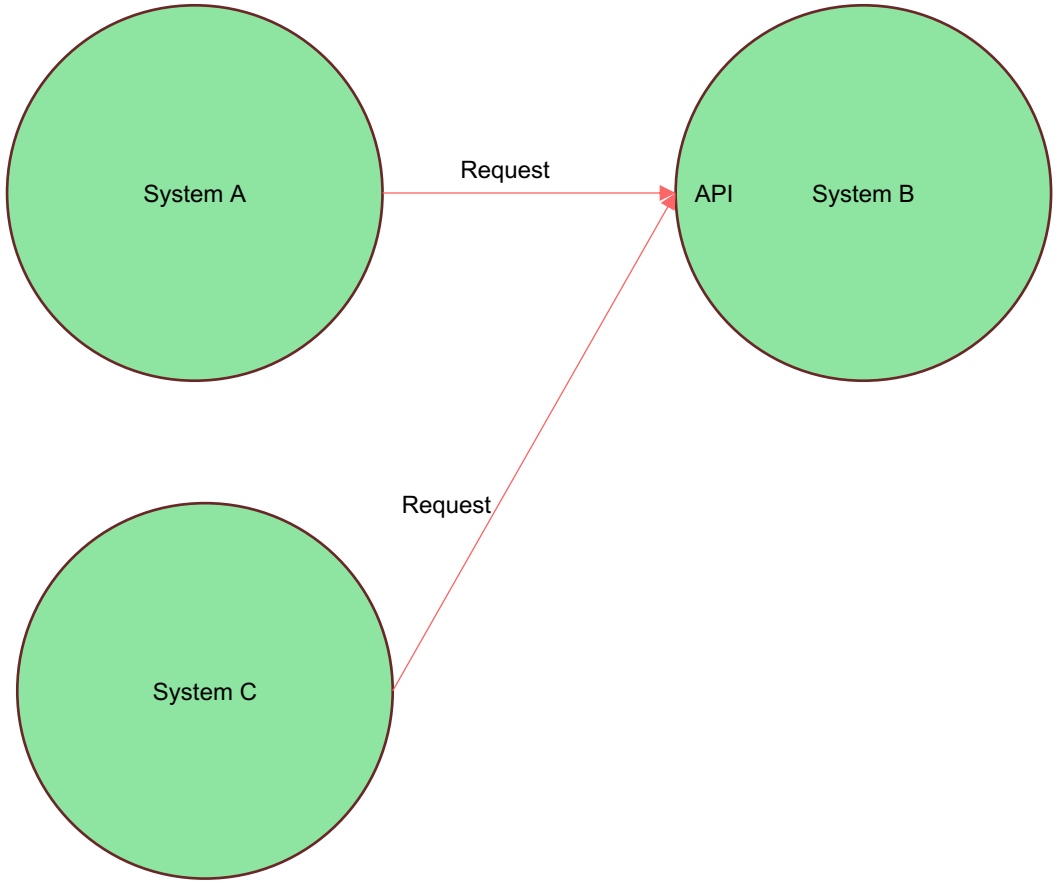
Standards

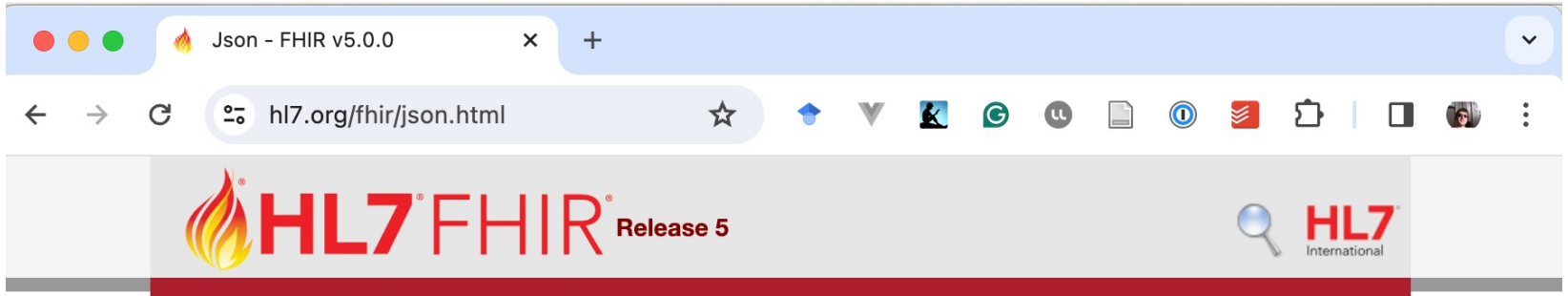
- Technical standard
- Semantic standards
- (Organizational standards)



Technical standards

- (Most) Systems can only accept and process values that are formatted in a predefined way
- Many technical standards in the health domain
- HL-7 FHIR recommended for intersystem communication





This page is part of the FHIR Specification (v5.0.0: R5 - STU). This is the current published version. For a full list of available versions, see the Directory of published versions. Page versions: **R5** R4B R4 R3 R2

Definitions | Formats | UML | XML | JSON | ND-JSON | RDF

2.1.6.4 JSON Representation of Resources

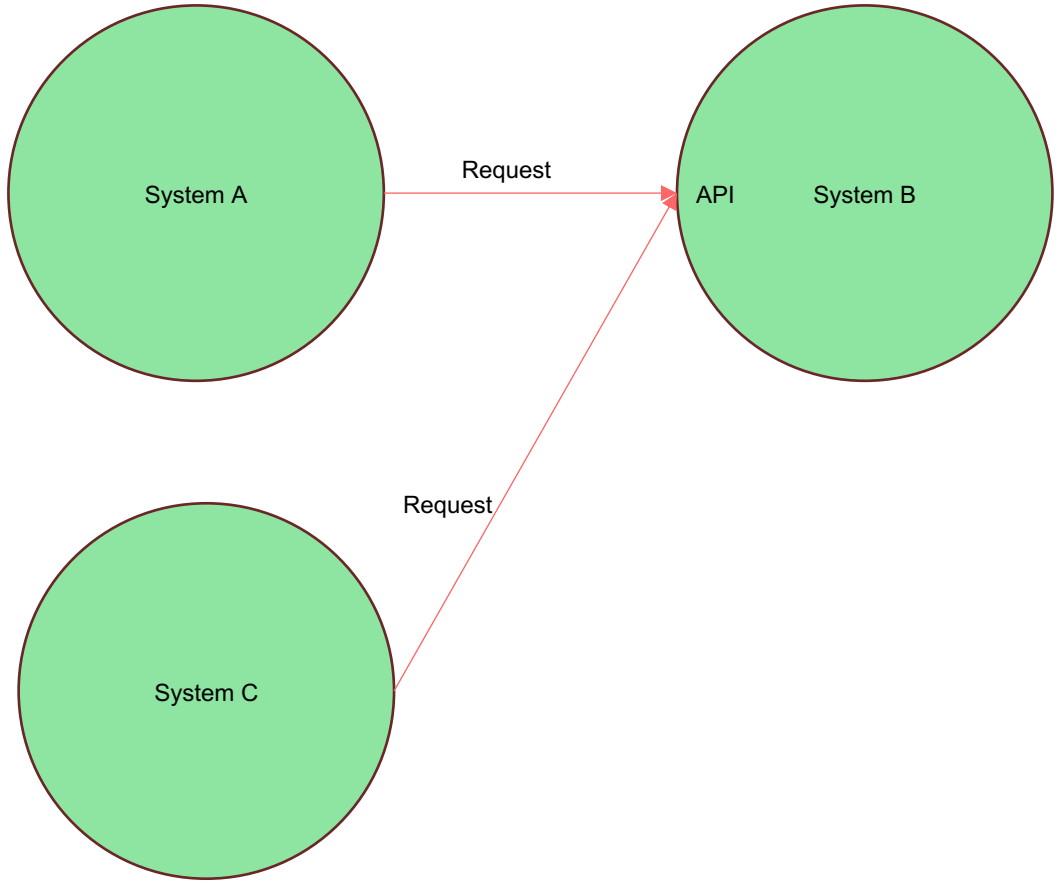
Implementable Technology Specifications Work Group	Maturity Level: Normative	Standards Status: Normative

The JSON representation for a resource is based on the JSON format described in STD 90 (RFC 8259), and is described using this format:

```
{
  "resourceType" : "[Resource Type]",
  // from Source: property0
  "property1" : "<[primitive]>", // short description
  "property2" : { [Datatype] }, // short description
  "property3" : { // Short Description
    "propertyA" : { CodeableConcept }, // Short Description (Example)
  },
  "property4" : [{ // Short Description
    "propertyB" : { Reference(ResourceType) } // R!  Short Description
  }]
}
```

Request


```
{
  "resourceType": "Observation",
  "id": "blood-pressure",
  "status": "final",
   "code": {
    "coding": [
     {
       "system": "http://loinc.org",
       "code": "85354-9"}
   ]
"component": [
   {
     "code": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8462-4",
           "display": "Systolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
       "value": 120,
       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]"
     }
   },
   {
     "code": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8480-6",
           "display": "Diastolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
       "value": 80,
       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]"
     }
   }
  ]
}
```

Code running on System B

```
@app.route('/blood-pressure', methods=['POST'])
    def receive_blood_pressure_observation():
        observation = request.json

        systolic_value = None
        diastolic_value = None

        for component in observation.get('component', []):
            if component['code']['coding'][0]['code'] == '8462-4':
                systolic_value = component['valueQuantity']['value']
            elif component['code']['coding'][0]['code'] == '8480-6':
                diastolic_value = component['valueQuantity']['value']

    process_blood_pressure(systolic_value, diastolic_value)

    return jsonify({"message": "Blood pressure observation received",
            "systolic": systolic_value,
            "diastolic": diastolic_value}), 200
```

Request from System A

```
{
  "resourceType": "Observation",
  "id": "blood-pressure",
  "status": "final",
   "code": {
    "coding": [
     {
       "system": "http://loinc.org",
       "code": "85354-9"}
   ]
"component": [
   {
     "code": {
       "coding": [
         {
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           "code": "8462-4",
           "display": "Systolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
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       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]"
     }
   },
   {
     "code": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8480-6",
           "display": "Diastolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
       "value": 80,
       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]
```

Request from System C

```
{
  "resourceType": "Observation",
  "id": "blood-pressure",
  "status": "final",
   "code": {
    "coding": [
     {
       "system": "http://loinc.org",
       "code": "85354-9"}
   ]
”result": [
   {
     "codes": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8462-4",
           "display": "Systolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
       "value": 120,
       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]"
     }
   },
   {
     "code": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8480-6",
           "display": "Diastolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
       "value": 80,
       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]"
```

Code running on System B

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            elif component['code']['coding'][0]['code'] == '8480-6':
                diastolic_value = component['valueQuantity']['value']

    process_blood_pressure(systolic_value, diastolic_value)

    return jsonify({"message": "Blood pressure observation received",
                    "systolic": systolic_value,
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```

Request from System A

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  "id": "blood-pressure",
  "status": "final",
   "code": {
    "coding": [
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     "code": {
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           "system": "http://loinc.org",
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       ]
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       "value": 120,
       "unit": "mmHg",
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     }
   },
   {
     "code": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8480-6",
           "display": "Diastolic blood pressure"
         }
       ]
     },
     "valueQuantity": {
       "value": 80,
       "unit": "mmHg",
       "system": "http://unitsofmeasure.org",
       "code": "mm[Hg]"
```

Request from System C

```
{
  "resourceType": "Observation",
  "id": "blood-pressure",
  "status": "final",
   "code": {
    "coding": [
     {
       "system": "http://loinc.org",
       "code": "85354-9"}
    ]
”result": [
   {
     "codes": {
       "coding": [
         {
           "system": "http://loinc.org",
           "code": "8462-4",
           "display": "Systolic blood pressure"
         }
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     "valueQuantity": {
       "value": 120,
       "unit": "mmHg",
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         {
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            elif component['code']['coding'][0]['code'] == '8480-6':
                diastolic_value = component['valueQuantity']['value']

    process_blood_pressure(systolic_value, diastolic_value)

    return jsonify({"message": "Blood pressure observation received",
                    "systolic": systolic_value,
                    "diastolic": diastolic_value}), 200
```
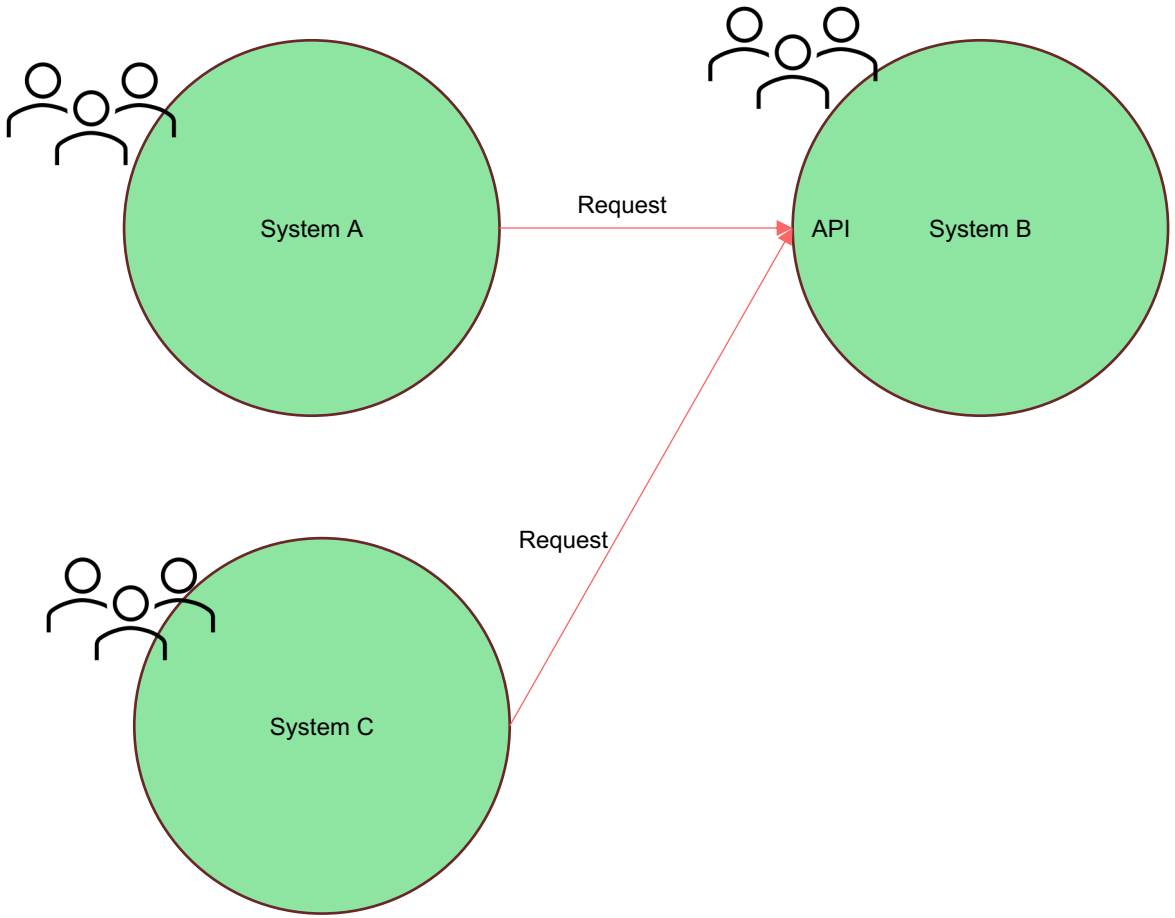

Semantic standards

- Ensuring that data has the same meaning across contexts
- Many different semantic standards that cover different domains
- “Standards for data and indicators, data dictionaries and metadata; for example, on procedures for calculating indicators, health facility lists, and coding schemes like ICD10.” (Braa and Sahay 2012)



Example: Snomed CT

- Consistent terminology across contexts
- “If one doctor enters 'high blood pressure' into the system while another enters 'hypertension,' today's systems may not necessarily capture that these are the same condition. When both are linked to the same code in SNOMED CT, this problem is solved. “

https://www.dagensmedisin.no/en-innbygger-en-journal-helseplattformen/banebrytende-arbeid-for-felles-klinisk-sprak/254627

Example: Snomed CT

- Each concept is assigned a unique Concept ID, which is a numeric code
- Alongside the Concept ID, there are human-readable terms that describe the concept. For example:
  - Concept ID: 44054006
  - Fully Specified Name: Pneumonia (disorder)
  - Synonyms: Pulmonary infection, Lung infection
- Also defines relationships between concepts to express things like hierarchy (a concept is a type of another concept), causation (a disease is caused by an organism), or attribute (a procedure targets a body structure).

SNOMED CT Concept for Pneumonia

•**Concept ID**: 44054006

•**Fully Specified Name**: Pneumonia (disorder)

•**Synonyms**: Includes terms such as "Pulmonary infection" and "Lung infection."

•**Definition**: Described as an infectious process affecting the lungs, typically caused by bacteria, viruses, or fungi.

Relationships with Other Concepts:

1.Is a Type Of:

1. **Concept ID**: 19829001
2. **Name**: Respiratory tract infection (disorder)
3. Pneumonia is categorized under respiratory tract infections.

2.Associated Morphology (Characteristic or Nature of the Disorder):

1. **Concept ID**: 41553000
2. **Name**: Inflammation (morphologic abnormality)
3. The inflammation associated with pneumonia is captured by linking to the concept of inflammation.

3.Finding Site (Location of the Disorder):

1. **Concept ID**: 39607008
2. **Name**: Lung structure (body structure)
3. The site of the infection, in the case of pneumonia, is the lungs.

But there are diverging perspectives on standardized terminology

https://tidsskriftet.no/2022/03/leder/fagspraket-ingen-leger-har-hort-om

“Good healthcare is based on knowledge and experience, not simplified models. It requires a medical terminology that allows doctors and other healthcare personnel to document the nuances and degrees of uncertainty they deem necessary for professionally sound practice. This is essential for conducting professionally sound practice. A professional language evolves in step with the field, without needing approval from a company or agency.”

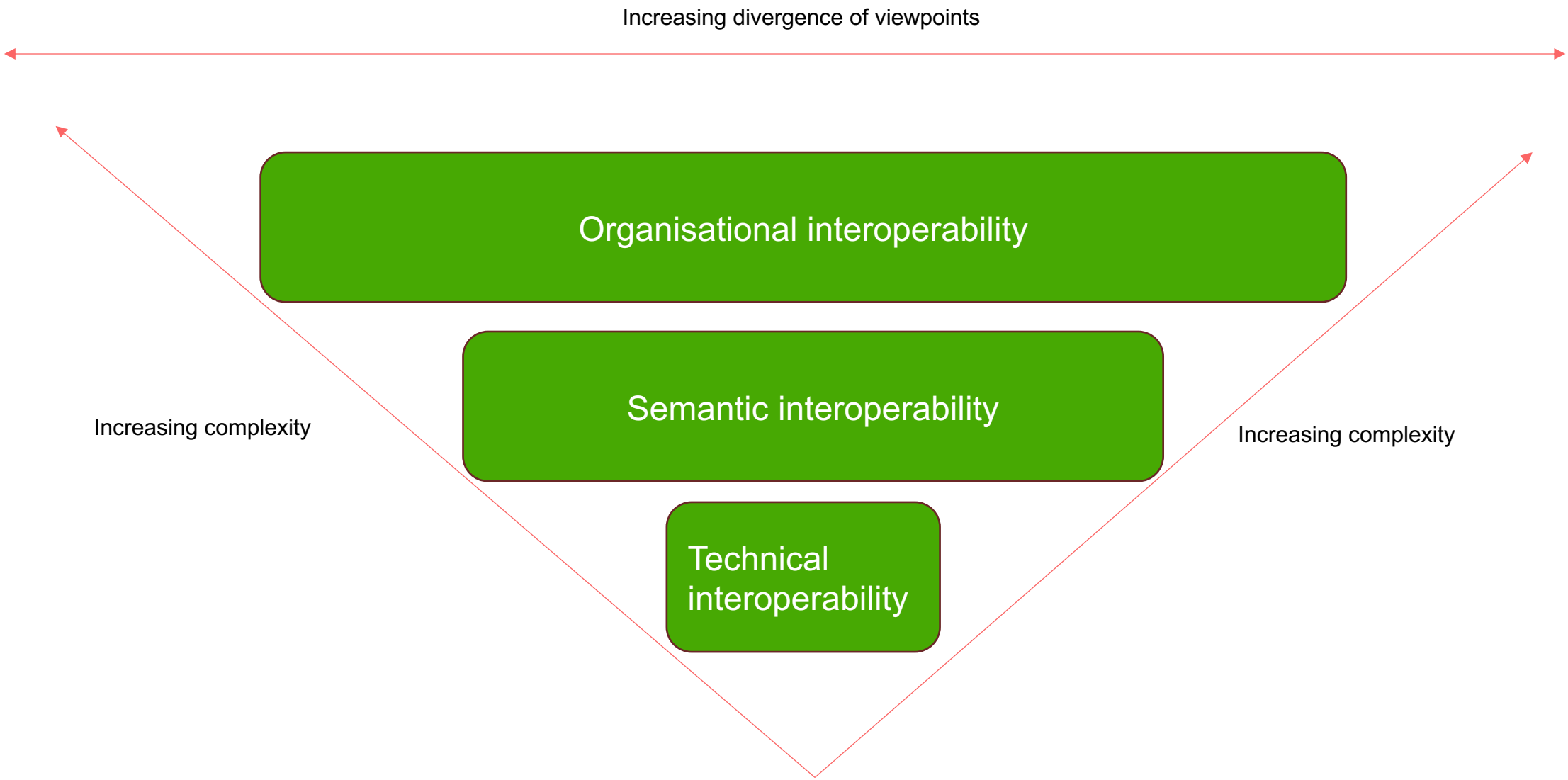
Homework

- Google "dagens medisin" "snomed ct”
- https://tidsskriftet.no/2023/08/kronikk/strukturerte-helsedata-frustrerende-eller-nyttig

Architecture and Governance

We can agree to standardize data using both technical and semantic standards, but this does not necessarily mean that we:

- enable communication between systems
- agree on what information to share



Based on Braa and Sahay 2012

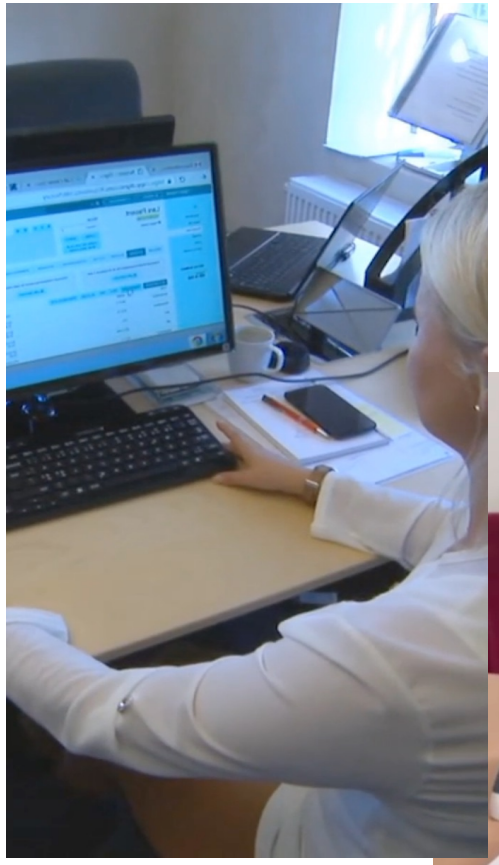
Architecture and Governance

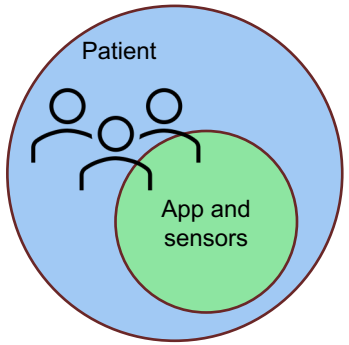
Architecture: How are the components of the infrastructure related to each other?

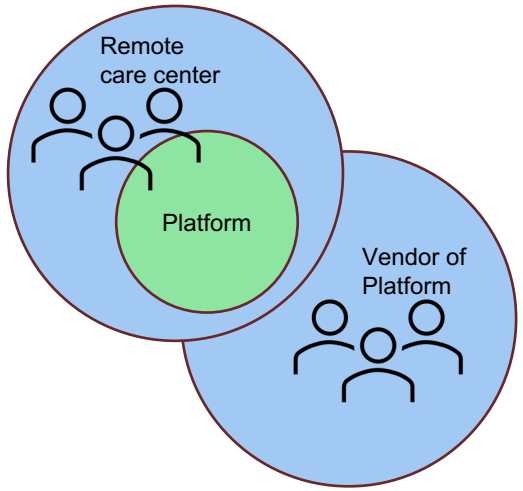
Governance: How are decisions made in the infrastructure, and who makes those decisions?

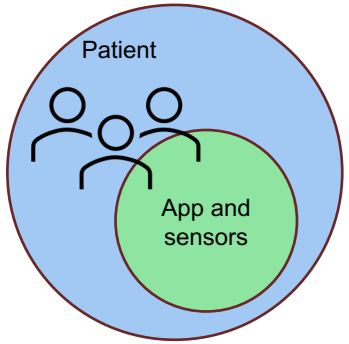
Example case: connected care (velferdsteknologi)

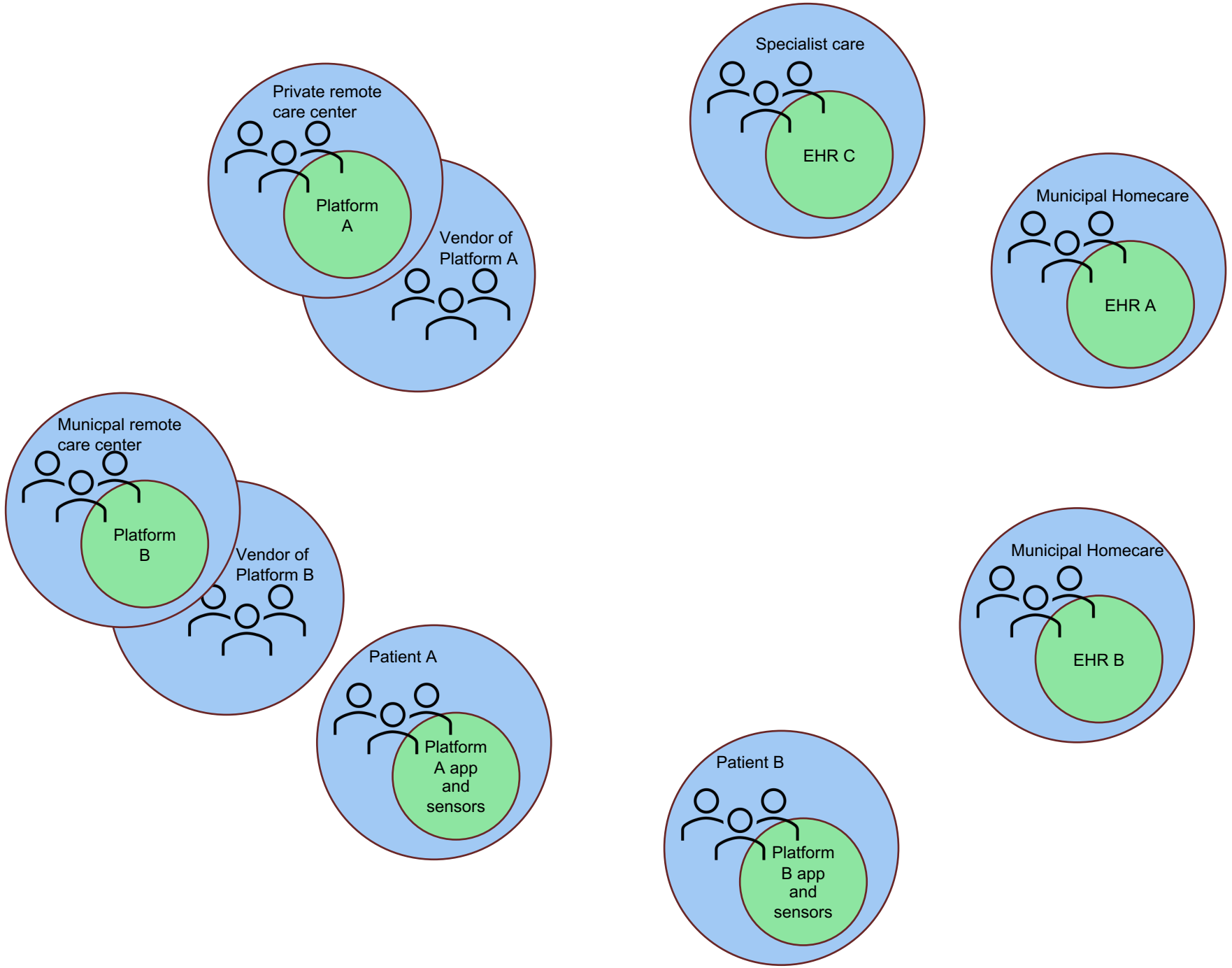
- New health services providing care digitally for patients staying at home
- Innovation both in local healthcare services and among private companies and startups
- New practices of generating data, combining data, interpreting data
- Understanding the potential of tracking what has not been tracked before

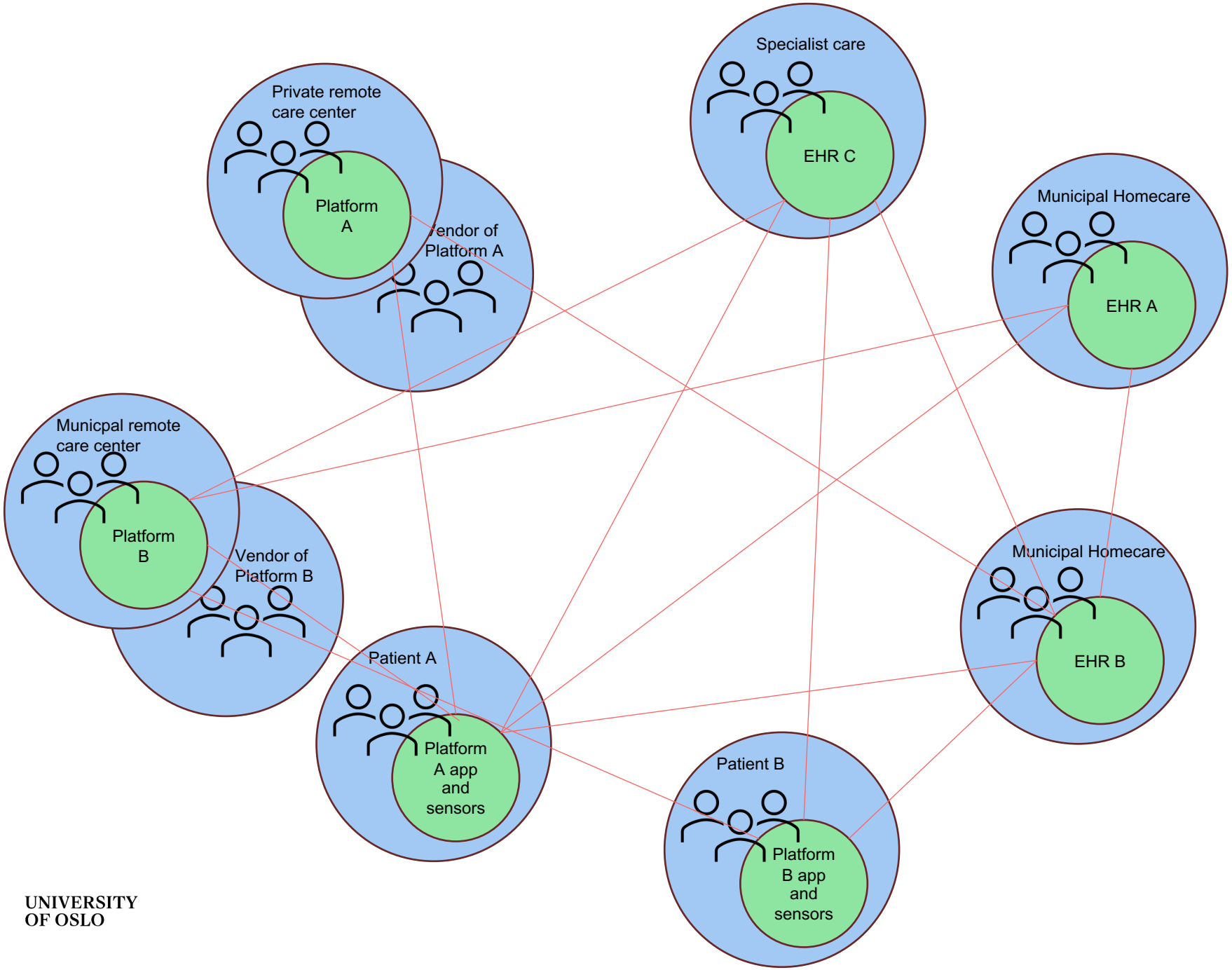



Patient
App and
sensors


Remote
care center
Platform
Vendor of
Platform


Patient
App and
sensors

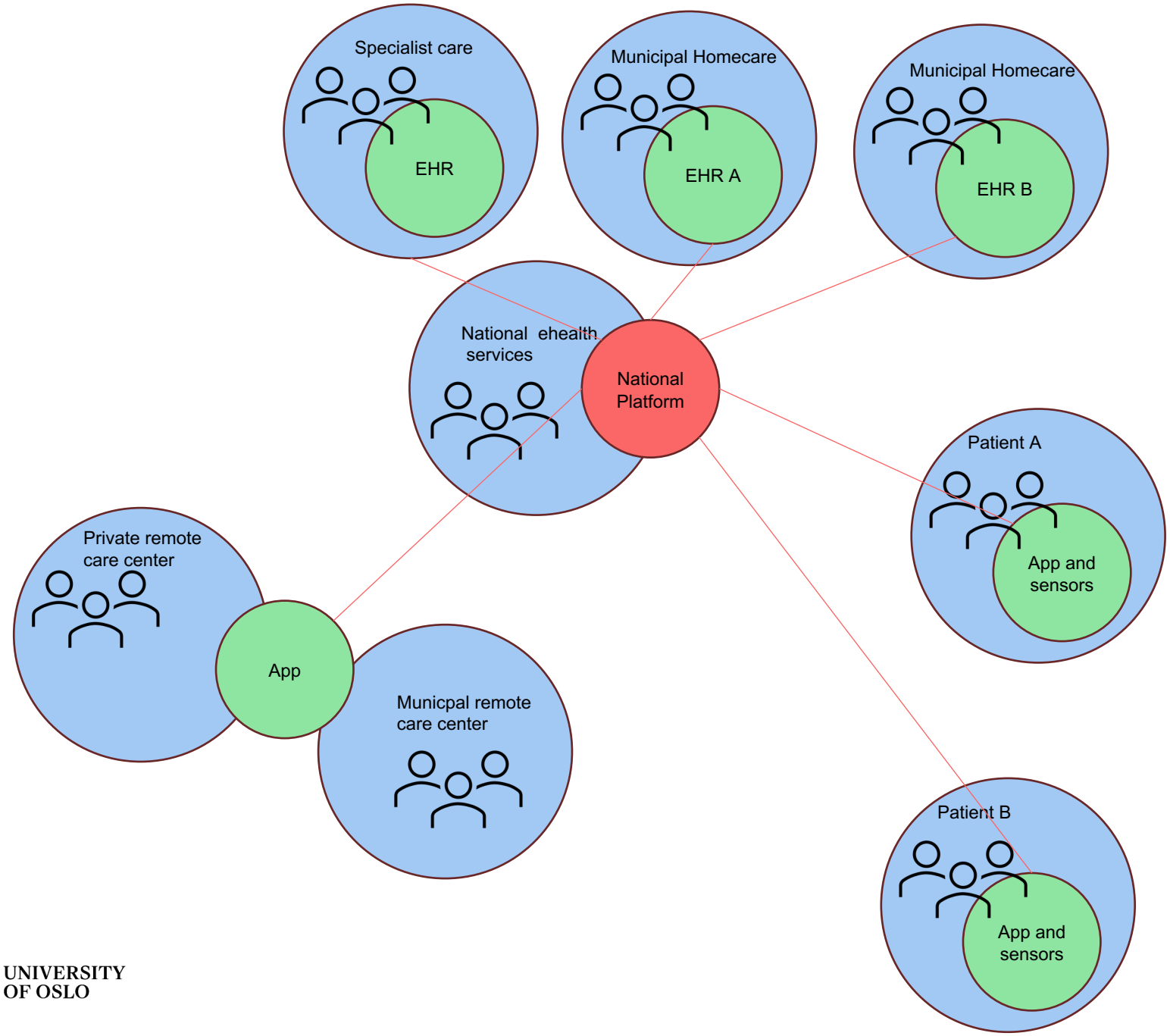

Private remote care center
Platform A
Vendor of Platform A
Specialist care
EHR C
Municipal Homecare
EHR A
Municpal remote care center
Platform B
Vendor of Platform B
Municipal Homecare
EHR B
Patient A
Platform A app and sensors
Patient B
Platform B app and sensors



Architecture: Every component is related to every component

Governance: Every organization is autonomous in their decisions

Is this feasible?
What are the implications?



Architecture: One common national remote care platfrom

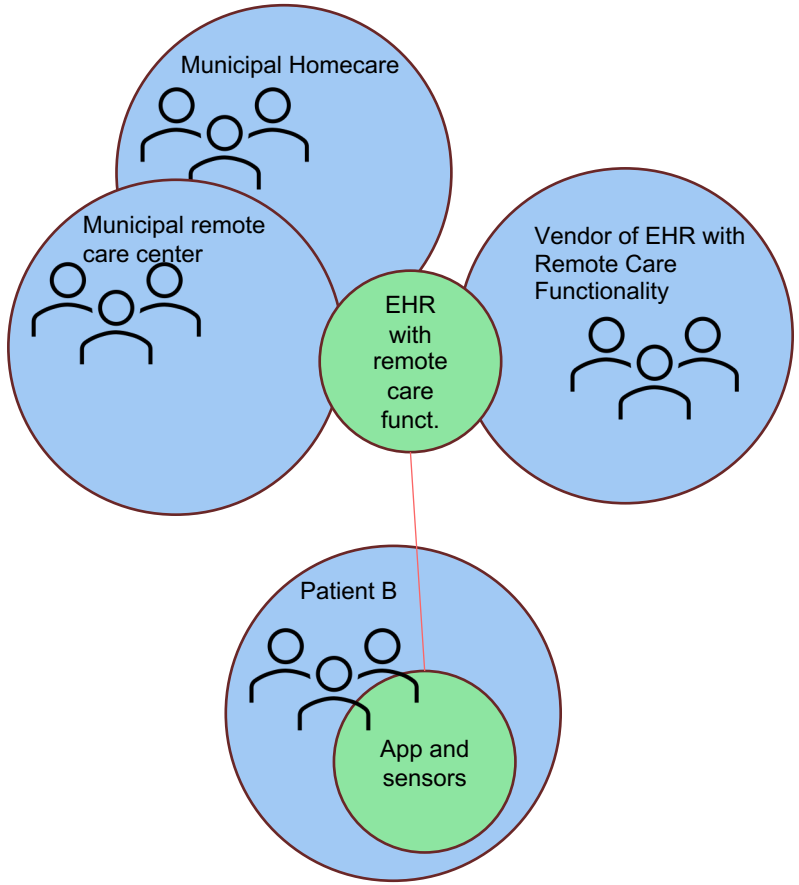
Governance: National ehealth services main decision maker

Is this feasible?
What are the implications?

Architecture: Integration between EHR and remote care solution

Governance: Vendor has main decision rights over system

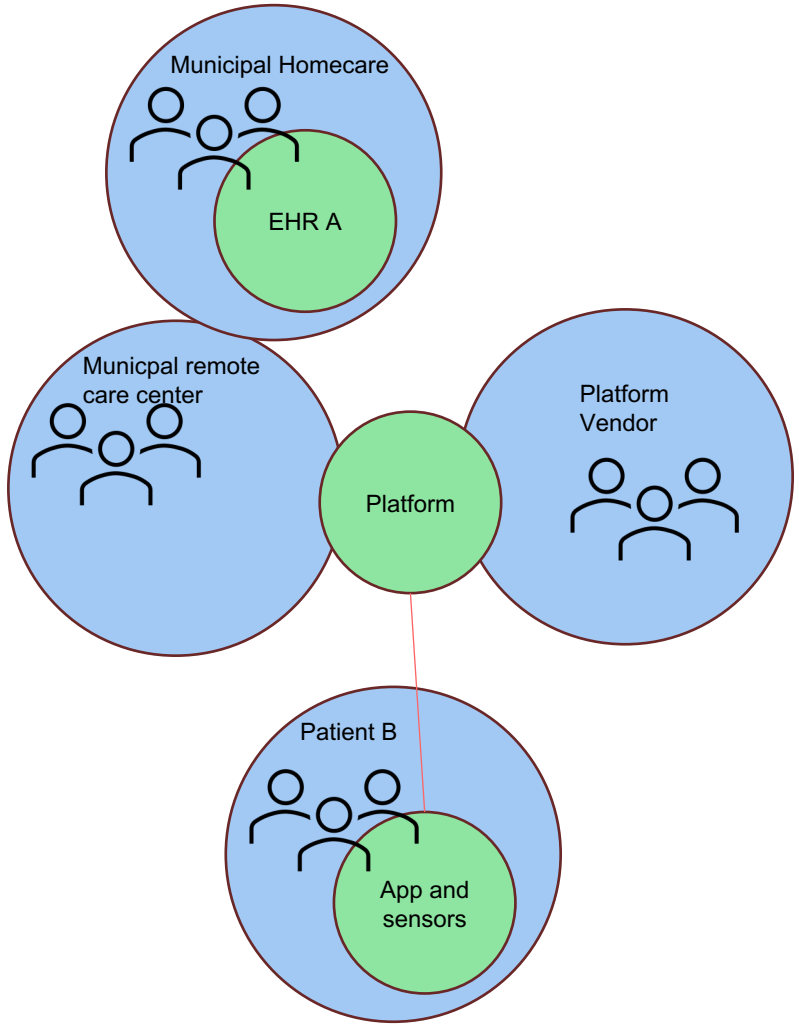
Is this feasible?
What are the implications?

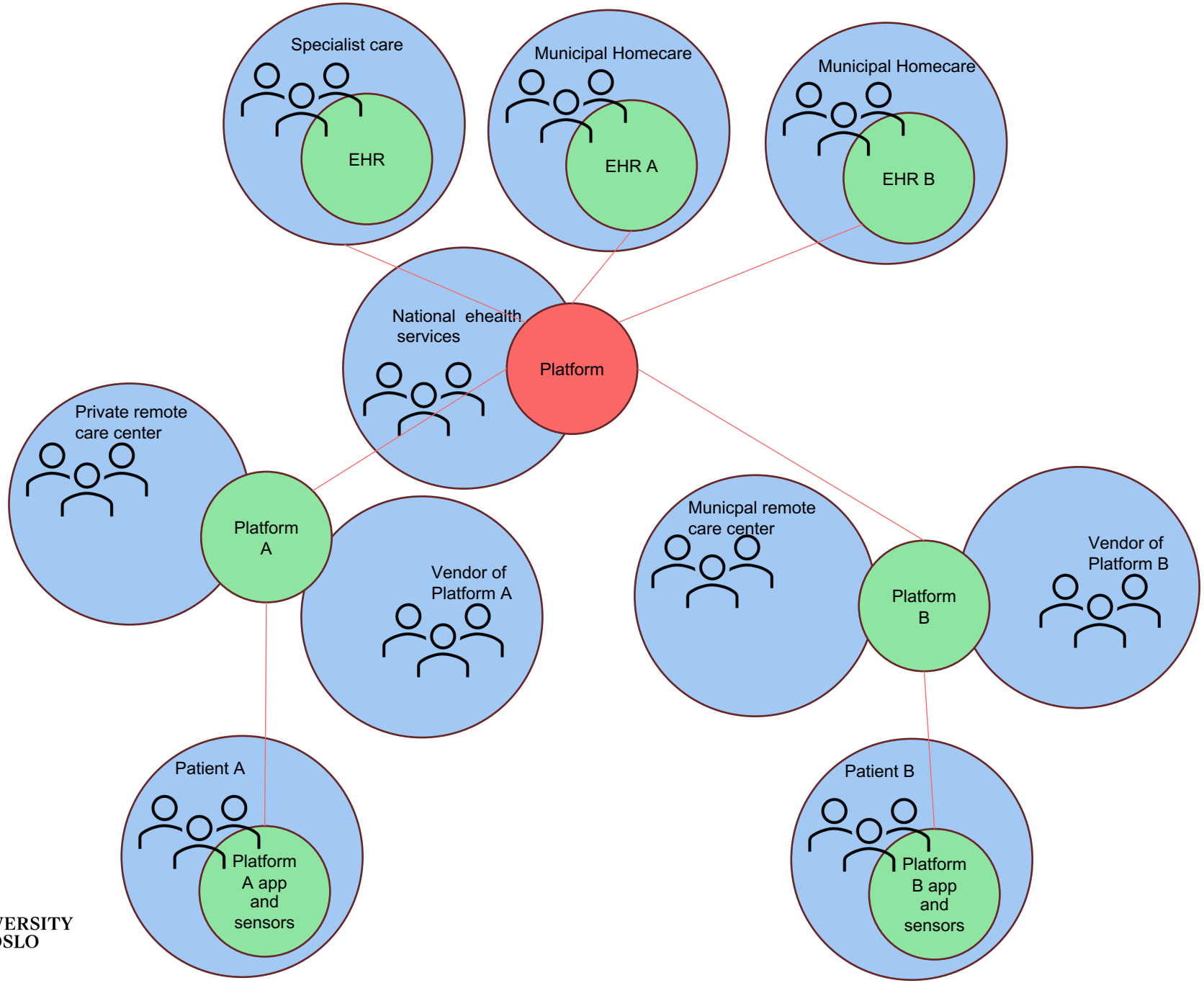


Architecture: Separate and non-interoperable EHR and Remote care platform

Governance: Municipality makes decisions over systems to procure, vendor decides systems functionality

Is this feasible?
What are the implications?




Specialist care
EHR
Municipal Homecare
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Platform B
Vendor of Platform B
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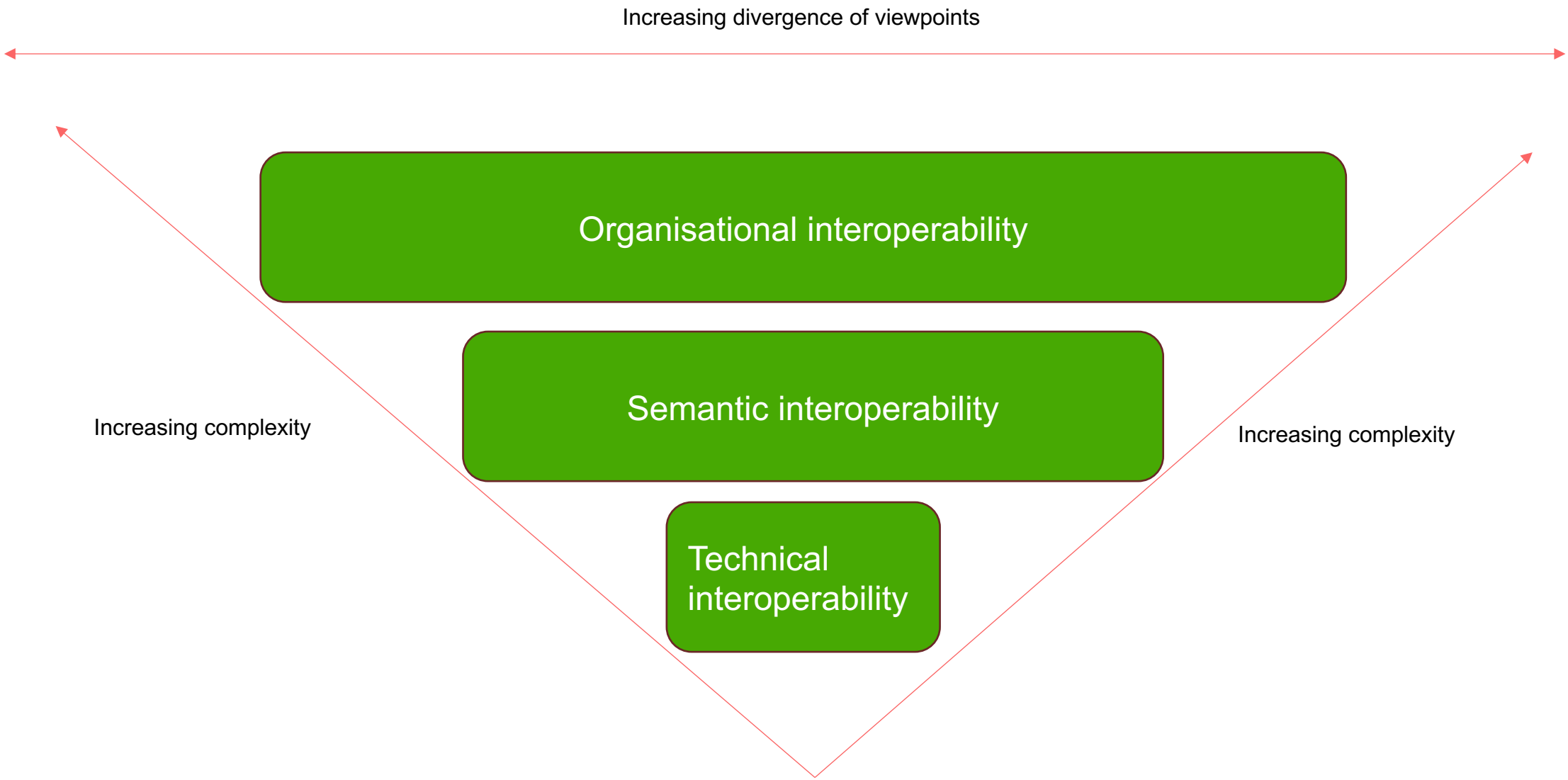
Platform A app and sensors
Patient B
Platform B app and sensors



Based on Braa and Sahay 2012

Agenda

- Infrastructures and interoperability
- Levels of interoperability
- Standardization and standards
- Architecture and governance