Mapping FHIR to JSON-LD with W3C Vocabulary

ToIP Input and Semantics , FHIR Focus Group

Handling W3C-CCG vocabularies, FHIR profiles & extensions

Agenda

1. Project background and design goals
2. Semantic Data pipeline - mapping the FHIR resource model
3. Demonstrate Vaccination Certificate issuance using W3C vocabulary and ZKP BBS+ signature
4. Demonstrate OCA base schema and overlay(s) generation

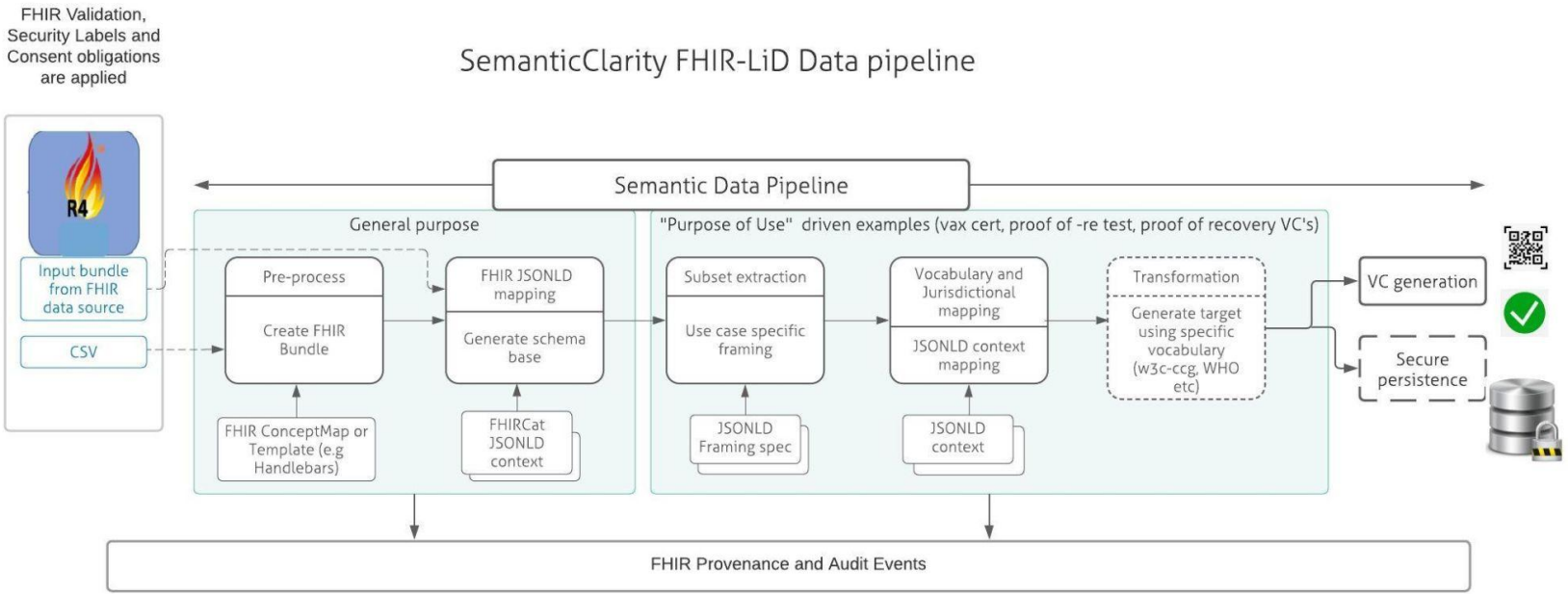
FHIR Focus Group - Project Implementation goals

- Work effort began at ToIP , Input and Semantics Workstream , FHIR to OCA mapping
- Clinical payload (data) validation - Use existing FHIR Validation tools prior to transformation in to W3C-CCG artifacts.
- Support Compliance controls (JSON LD mappings) - based on PoU
  - FHIR Provenance resource (emit W3C PROV-O events)
  - FHIR AuditEvent resource
  - HL7 Security labels (Processed at system of record per compliance obligations)
  - FHIR Consent resource (Processed at system of record per compliance obligations)
  - Mapping all of the above to jurisdictional requirements such as GDPR etc.
  - Mapping to jurisdictional CodeSystem and ValueSet as required (via JSONLD Context files)
- Leverage existing vocabularies and resource models
  - Clinical data - FHIR R4/R5 JSONLD (FHIRCat)
  - Identity data - Extend W3C-CCG vocabulary as required

Current state of specification (W3C-CCG mapping to FHIR)

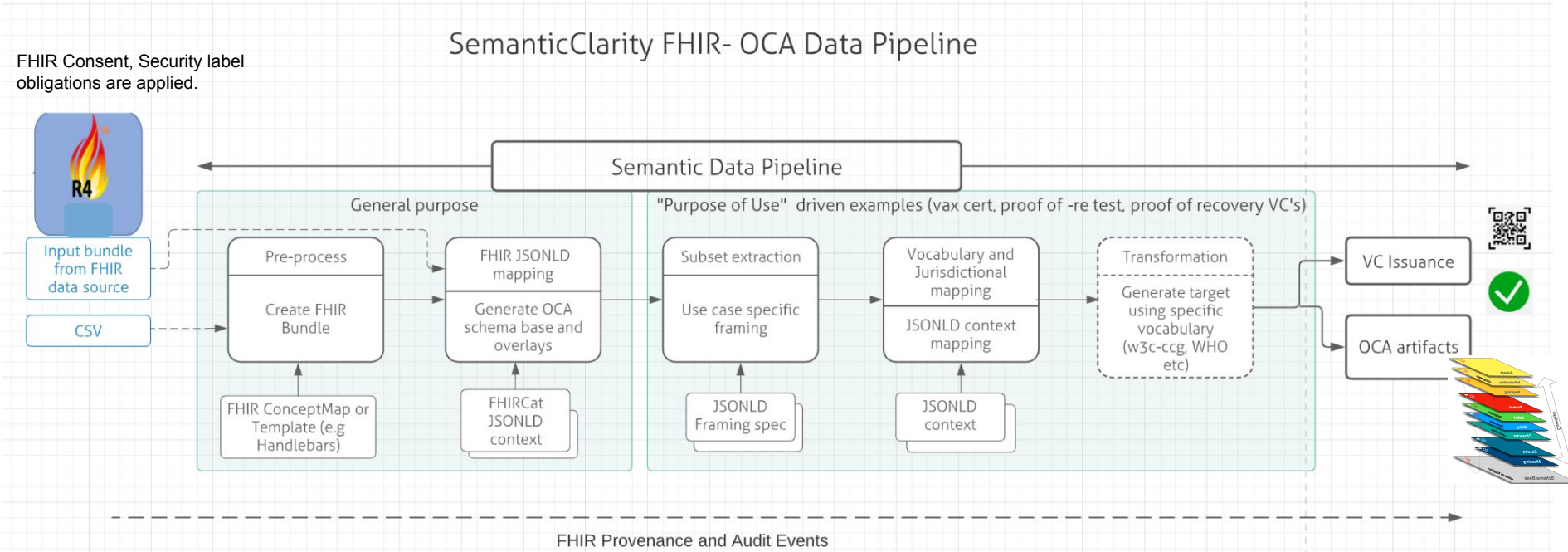
Guidelines	CDC	EU DGC (Specification available)	WHO SVC (Specification WIP)	W3C JSON LD ZKP BBS+ Credential
Proof of vaccination	Requirements & Guidelines only, CVRS for IIS use case	✅	✅	✅
Proof of Negative COVID-19 Test	Requirements & Guidelines only, CVRS for IIS use case	✅	❌	Proposed
Proof of Recovery from COVID-19	Requirements & Guidelines only, CVRS for IIS use case	☑️	❌	Proposed

Semantic Data Pipeline

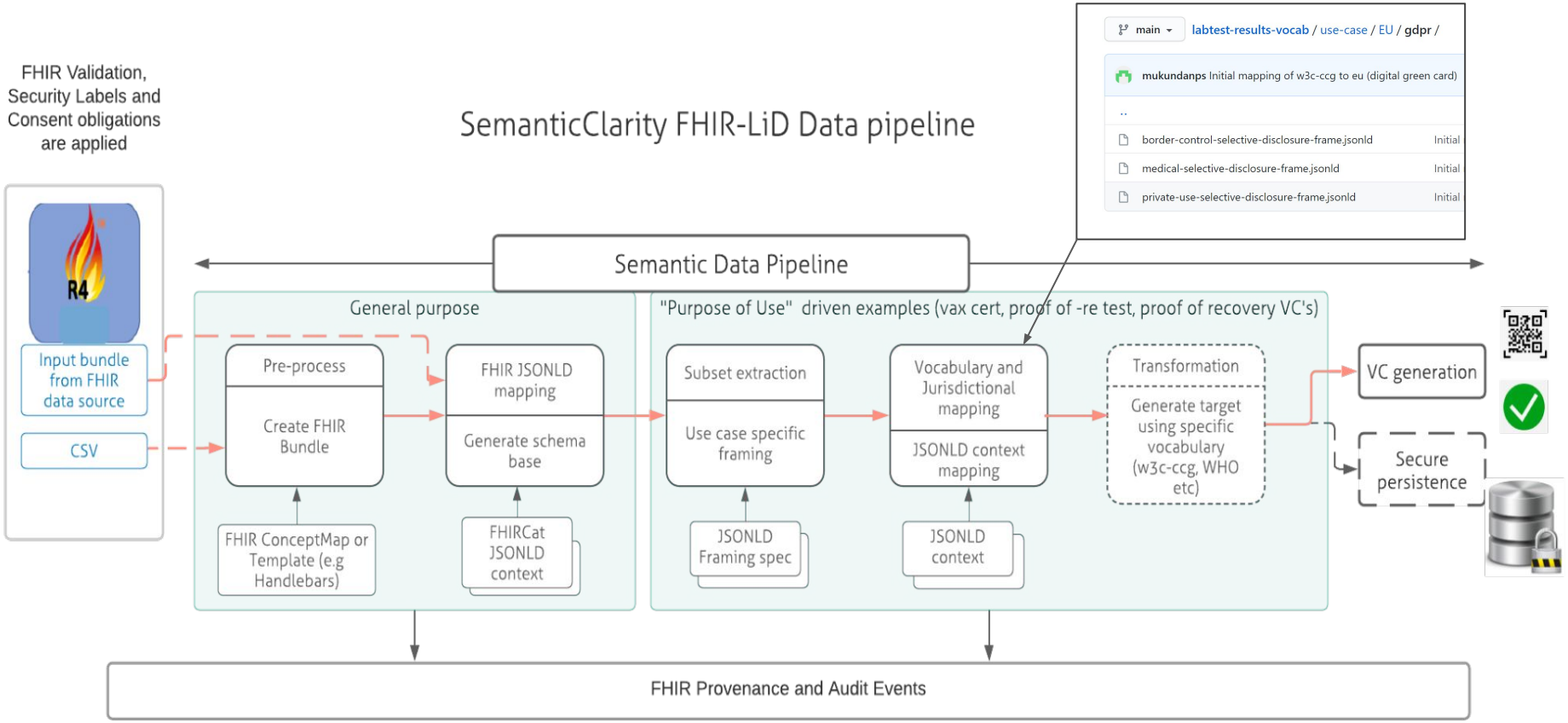


Semantic Data Pipeline

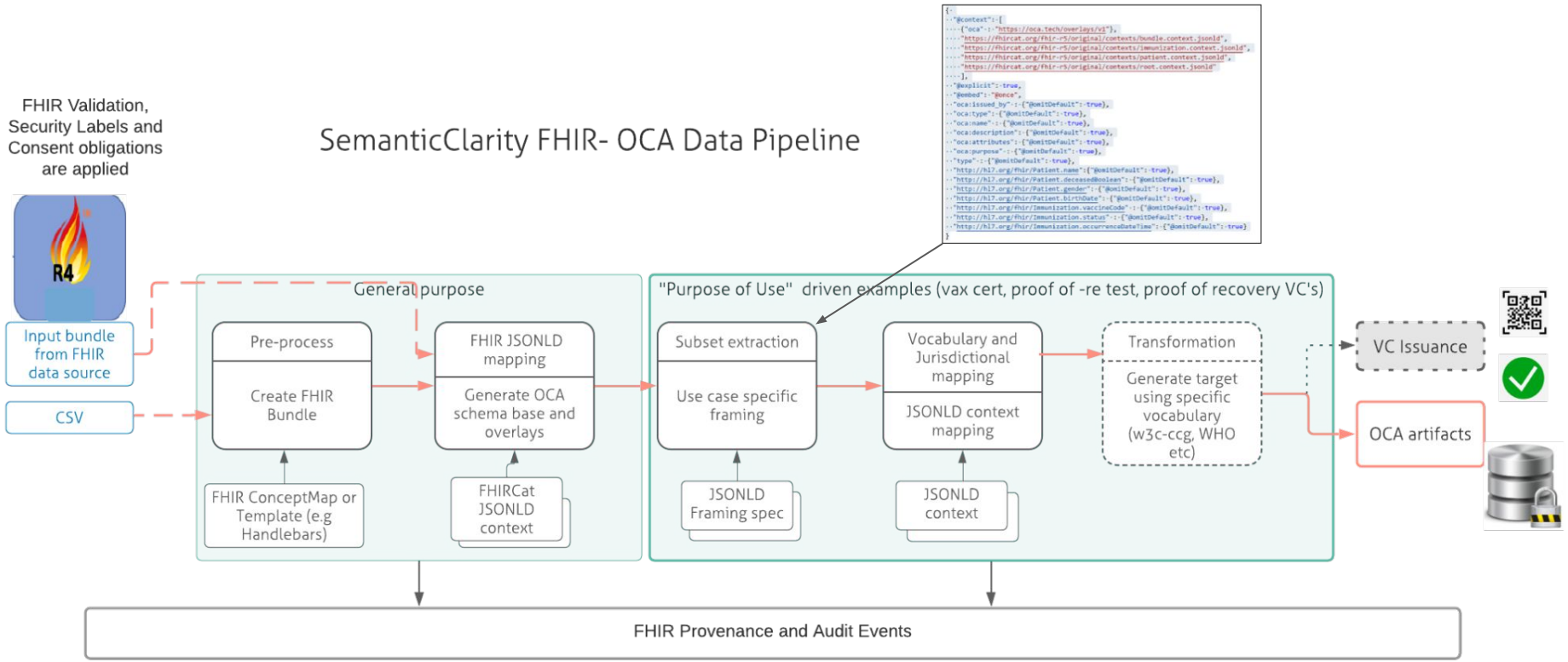
FHIR Consent, Security label obligations are applied.



Semantic Data Pipeline - VC Generation with W3C Vocabularies



Semantic Data Pipeline - VC Generation with W3C Vocabularies



Example JSON LD OCA framing spec

```
{
  "@context": [
    {"oca" : "https://oca.tech/overlays/v1"},
    "https://fhircat.org/fhir-r5/original/contexts/bundle.context.jsonld",
    "https://fhircat.org/fhir-r5/original/contexts/immunization.context.jsonld",
    "https://fhircat.org/fhir-r5/original/contexts/patient.context.jsonld",
    "https://fhircat.org/fhir-r5/original/contexts/root.context.jsonld"
    ],
  "@explicit": true,
  "@embed": "@once",
  "oca:issued_by" : {"@omitDefault": true},
  "oca:type": {"@omitDefault": true},
  "oca:name" : {"@omitDefault": true},
  "oca:description": {"@omitDefault": true},
  "oca:attributes": {"@omitDefault": true},
  "oca:purpose" : {"@omitDefault": true},
  "type" : {"@omitDefault": true},
  "http://hl7.org/fhir/Patient.name":{"@omitDefault": true},
  "http://hl7.org/fhir/Patient.deceasedBoolean": {"@omitDefault": true},
  "http://hl7.org/fhir/Patient.gender": {"@omitDefault": true},
  "http://hl7.org/fhir/Patient.birthDate": {"@omitDefault": true},
  "http://hl7.org/fhir/Immunization.vaccineCode" : {"@omitDefault": true},
  "http://hl7.org/fhir/Immunization.status" : {"@omitDefault": true},
  "http://hl7.org/fhir/Immunization.occurrenceDateTime": {"@omitDefault": true}
}
```

Follow link (ctrl + click)

Example Input FHIR Bundle


```
{
  "resourceType": "Bundle",
  "id": "CdcCvrsBundleExample1",
  "meta": {
    "profile": [
      "http://example.org/StructureDefinition/CdcCvrsEuaBundle"
    ],
    "security": [
      {
        "code": "HTEST",
        "system": "http://terminology.hl7.org/CodeSystem/v3-ActReason"
      }
    ]
  },
  "type": "collection",
  "entry": [
    {
      "resource": {
        "resourceType": "Patient",
        "id": "CdcCvrsPatientExample1",
```

Example Input FHIR Bundle (Composition)


```
{
  "resourceType": "Bundle",
  "id": "ips-Bundle-01",
  "type": "document",
  "timestamp": "2021-02-10T14:30:00+01:00",
  "entry": [
    {
      "fullUrl": "urn:uuid:81332b57-f5e7-46a7-951b-d289906379d6",
      "resource": {
        "resourceType": "Composition",
        "id": "81332b57-f5e7-46a7-951b-d289906379d6",
        "identifier": {
          "system": "urn:oid:2.16.724.4.8.10.200.10",
          "value": "b3d57a47-3144-4c3d-a852-52afc780fc46"
        },
        "status": "final",
        "type": {
          "coding": [
            {
              "code": "82593-5",
              "system": "http://loinc.org",
              "display": "Immunization summary report"
            }
          ]
        },
        "subject": {
          "reference": "urn:uuid:cb6fc6f7-cc14-4abf-a4a8-39280fd12abc"
        },
        "date": "2021-02-10T14:30:00+01:00",
        "author": [
          {
            "reference": "urn:uuid:d7a490a1-d267-4785-ac98-db56748827fb"
          }
        ],
        "title": "Yellow Fever Vaccination Digital Certificate",
        "attester": [
```

Example - EU DGC mapping to W3C-CCG

```
{
  "@context": [
    "https://www.w3.org/2018/credentials/v1",
    "https://w3c-ccg.github.io/vaccination-vocab/context/v1/EU/unstable.json",
    "https://w3id.org/security/bbs/v1"
  ],
  "type": [
    "VerifiableCredential",
    "VaccinationCertificate"
  ],
  "id": "urn:uvci:af5vshde843jf831j128fj",
  "name": "COVID-19 Vaccination Certificate",
  "description": "COVID-19 Vaccination Certificate",
  "issuanceDate": "2019-12-03T12:19:52Z",
  "expirationDate": "2029-12-03T12:19:52Z",
  "credentialSubject": {
    "type": "VaccinationEvent",
    "batchNumber": "1183738569",
    "administeringCentre": "MoH",
    "healthProfessional": "MoH",
    "countryOfVaccination": "CH",
    "recipient": {
      "type": "VaccineRecipient",
      "givenName": "JOHN",
      "familyName": "SMITH",
      "gender": "Male",
      "birthDate": "1958-07-17"
    },
    "vaccine": {
      "type": "Vaccine",
      "disease": "COVID-19",
      "atcCode": "J07BX03",
      "medicinalProductName": "COVID-19 Vaccine Moderna",
      "marketingAuthorizationHolder": "Moderna Biotech"
    }
  }
}
```

Vocabulary mapping (JSON LD context) by jurisdiction, in this case EU

Example Vocabulary - EU DGC mapping

Proof of Negative Test (Lab test, partial view)

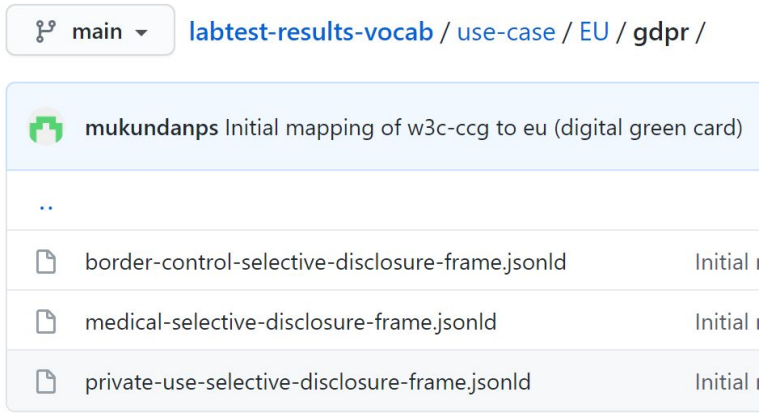

```
"TestEvent": {
    "@id": "https://w3id.org/antigentestresults#TestEvent",
    "@context": {
        "@version": 1.1,
        "@protected": true,
        "id": "@id",
        "type": "@type",
        "testName": {
            "@id": "http://hl7.eu/fhir/ig/dgc/ValueSet/loinc-tests-covid-19",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "testType" : {
            "@id": "http://hl7.eu/fhir/ig/dgc/ValueSet/covid-19-lab-methods",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "sampleOriginType": {
            "@id": "http://hl7.org/fhir/ValueSet/body-site",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "sampleCollectionDateTime": {
            "@id": "http://hl7.eu/fhir/ig/dgc/DiagnosticReport.specimen.collectedDateTime",
            "@type": "http://www.w3.org/2001/XMLSchema#dateTime"
        },
        "testResult" : {
            "@id": "http://hl7.org/fhir/ValueSet/observation-interpretation",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "testCenter" : {
            "@id": "http://hl7.eu/fhir/ig/dgc/Location",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "testValidatorId" : {
            "@id":"http://hl7.eu/fhir/ig/dgc/DiagnosticReport.resultsIntepreter",
            "@type":"http://www.w3.org/2001/XMLSchema#string"

        },
        "countryOfTestAdminstration" : "https://w3id.org/vaccination#countryOfVaccination"
    }
}
```

Example Vocabulary - EU DGC mapping

Proof of Negative Test

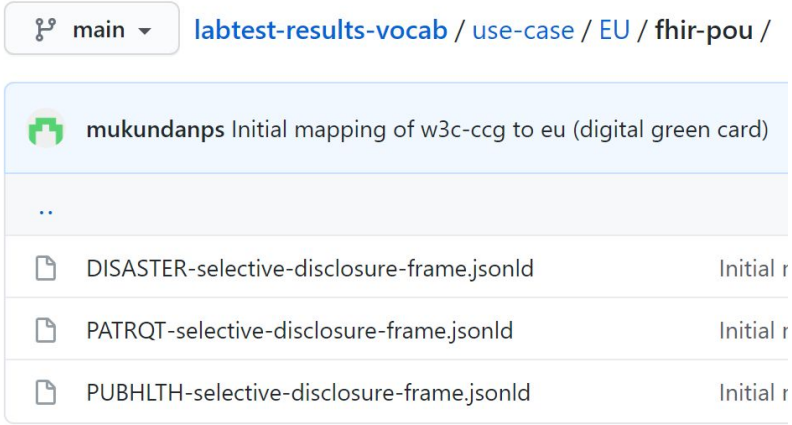
(Selective disclosure using JSON LD framing, by generic use case, and jurisdiction)



Example Vocabulary - EU DGC mapping

Proof of Negative Test

(Selective disclosure using JSON LD framing, by specific security label indicating Purpose of Use or other HL7 criteria and jurisdiction)



Example Vocabulary - EU DGC mapping

Proof of Recovery Certificate example (partial view)


```
"RecoverySubject": {
    "@id": "https://w3id.org/antigentestresults#TestRecipient",
    "@context": {
        "@version": 1.1,
        "@protected": true,
        "id": "@id",
        "type": "@type",
        "birthDate": {
            "@id": "http://hl7.eu/fhir/ig/dgc/ImmunizationDGC.reasonReference.subject.birthDate",
            "@type":"http://www.w3.org/2001/XMLSchema#string"
        },
        "familyName":{
            "@id": "http://hl7.eu/fhir/ig/dgc/ImmunizationDGC.reasonReference.subject.name.familyName",
            "@type":"http://www.w3.org/2001/XMLSchema#string"
        },
        "gender": {
            "@id":"http://hl7.org/fhir/gender-identity",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "givenName": {
            "@id":"http://hl7.eu/fhir/ig/dgc/ImmunizationDGC.reasonReference.subject.name.givenName",
            "@type":"http://www.w3.org/2001/XMLSchema#string"
        }
    }
},
"InfectionObservation" : {
    "@id": "https://w3id.org/citizenrecovery#InfectionObservation",
    "@context": {
        "dateFirstPositive":{
            "@id": "http://hl7.eu/fhir/ig/dgc/DiagnosticReport.result.effectiveDateTime",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
        },
        "diseaseRecoveredFrom":{
            "@id":"http://hl7.eu/fhir/ig/dgc/DiagnosticReport.result.component.code",
            "@type": "http://www.w3.org/2001/XMLSchema#string"
         },
        "countryOfTest" : "https://w3id.org/vaccination#countryOfVaccination"
    }
}
}
```

Proof of Negative COVID-19 VC - current status

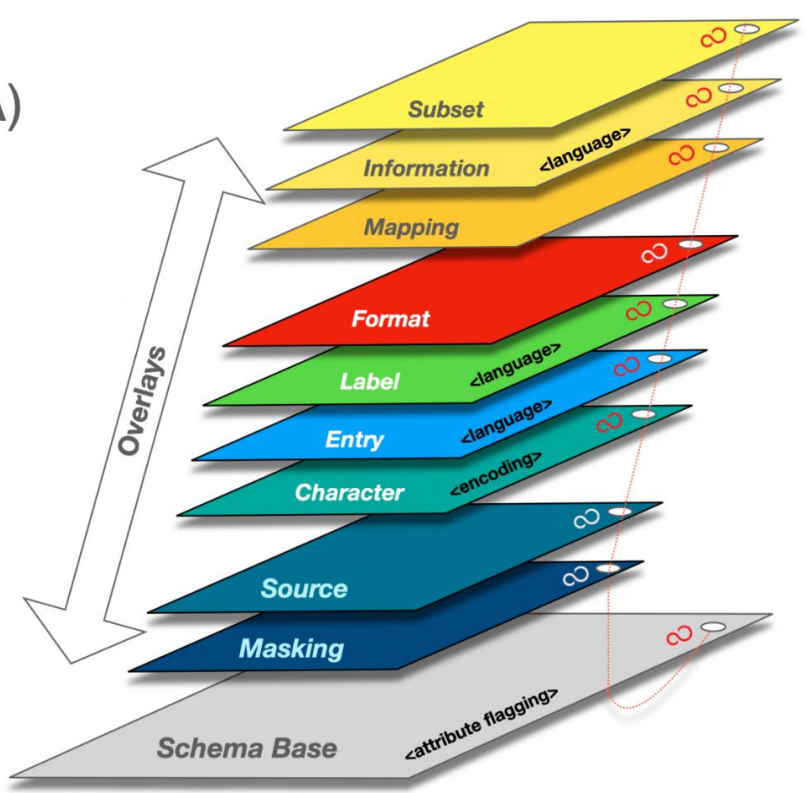
- Proposing a w3c-ccg vocabulary
- Clinical data component: Minimal FHIR (WHO International Patient Summary profile) mapping entails: Patient, DiagnosticReport (LOINC: 11502-2), Organization, Observation
- Identity data component: Similar to Vaccine Certificate
- VC/crypto data components: Similar to Vaccine Certificate

What is OCA?

OCA developed at the Human Colossus Foundation

Overlays Capture Architecture (OCA)

OCA is an architecture that presents a schema as a multi-dimensional object consisting of a stable *schema base* and interoperable *overlays*. Overlays are task-oriented linked data objects that provide additional extensions, coloration, and functionality to the schema base.



Thanks and Resources

- Contact: jwalker@semanticclarity.com, johnw.cci@lhph.io
- Contact: paul.knowles@humancolossus.org
- Reference/Links:
- Vaccination vocabulary: https://github.com/w3c-ccg/vaccination-vocab/tree/master/context/v1
- Proof of Negative (Lab) test vocabulary: https://github.com/SemanticClarity/labtest-results-vocab
- Proof of Recovery vocabulary: https://github.com/SemanticClarity/recovery-certificate-vocab
- FHIR OCA CLI: https://github.com/SemanticClarity/oca-fhir-cli
- OCA reference slides: https://drive.google.com/file/d/1-qXzfoxj-gdidSat-aC9L0RSdc8GQJIt/view