The Intelligible Contract

Luca Cervone, Monica Palmirani, Fabio Vitali

CIRSFID- DISI - Legal Blockchain Lab
Alma Mater – University of Bologna

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Smart Contracts

- **Smart Contracts** are **small software procedures** run on **BlockChains to ensure their correct execution**
- Smart Contracts can **execute automatically simple legal terms ([*Legal*] *Contract*)** between parties
- **Not all *legal contracts*** can be modelled with **Smart Contracts**
- Smart Contracts cannot supply **the complex features** of **traditional legal contracts like recession, retroactive modifications, exceptions, etc.**
- In addition, one of **the most important features** of traditional digital contracts is the **legal prose**, that **must be preserved** to make the **contract intelligible by humans**

Smart Contract and [*Legal*] *Contract*

- A Smart Contract can be considered a specific expression, i.e., an **interpretation** and **translation** (codification) of the legal prose of a contract
- The legal prose is the written expression of a **mutual assent** of the parties about the contractual terms.
  - Will of the parties: “meeting of the minds”
  - Mutual assent: **when** and **where is concluded**
  - Transparency/Intelligibility/Trust and duties to inform
  - Forms (e.g., written)
  - Clear and legal scope
  - Defined object

- The **Intelligibility** of a legal contract is a mandatory requirement in order to have a full awareness of the content and a valid mutual assent and then enforceability

Smart contract and [*Legal*] *Contract*

What are the regulations about smart contracts and their enforceability under a legal point of view?

- UNCITRAL – United Nations Commission on International Trade Law
- eIDAS EU Regulation
- Uniform Electronic Transactions Act (UETA) and Global and National Commerce Act (E-SIGN) – Arizona, Nevada, Ohio, Tennessee
- National Laws (e.g., Italy, Lichtenstein, Estonia, Switzerland, France, Germany, etc.)

Open questions

- Territoriality and jurisdiction
- Liability (e.g., developers, platform, parties, etc.)
- Enforceability (e.g., identification of the parties, digital signature, custody requirements)
- Data protection

Ricardian Contracts

- **Ricardian Contracts** try to **fill the gap between the legal prose and executable code**
- The developer **describes a triple <P, C, M>** where:
  - **P** describes the **denotational semantic** of contracts (the **legal prose**);
  - **C** describes the **operational semantic** of contracts (the **code executable** by machines)
  - **M** is a **mapping**, in the form of key values, parameters, between the **operations expressed in C** and the **legal prose expressed in P**.

Smart Contract Templates

- **Smart Contract Templates** are an **implementation of Ricardian Contracts** whose **operational code is standardised** and whose **behaviour is controlled by parameters** contained in an electronic representation of the contract.
- **Smart Contract Templates** facilitate the management of the **life-cycle of contracts** by taking care of **four aspects**:
  1. **Legal drafting tools** allow developers and legal expert **to create smart contracts templates** together
  2. **legal prose is serialised** by means of **standard and flexible vocabularies**
  3. **the mark-up of documents link items of contracts to standard ontologies**
  4. features **link the legal prose to operational code**

What is missing

- **Ricardian Contracts** and **Smart Contracts Templates expose mandatory features** to bridge the **gap between legal prose of contracts and automatically-executable contracts**

BUT… this is not enough

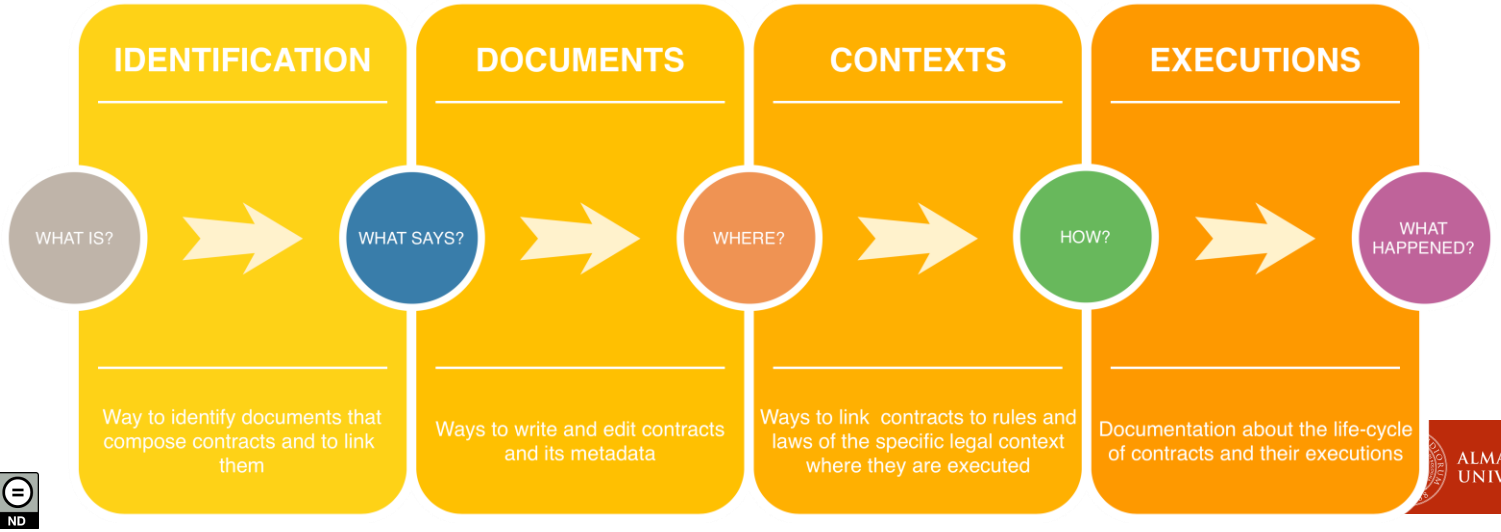
- they **do not provide important features** for the **intelligibility of contracts**, more specifically:
  - No **links between contracts and other legal and non legal resources** (e.g., **normative references in contracts**)
  - No **description of the legal context of contracts** (e.g., **jurisdiction of the facts**)
  - No information concerning **the operational context of contracts** (e.g., **type of Blockchain**)
  - No **report of the automatic execution of contracts**.

The Intelligible Contract

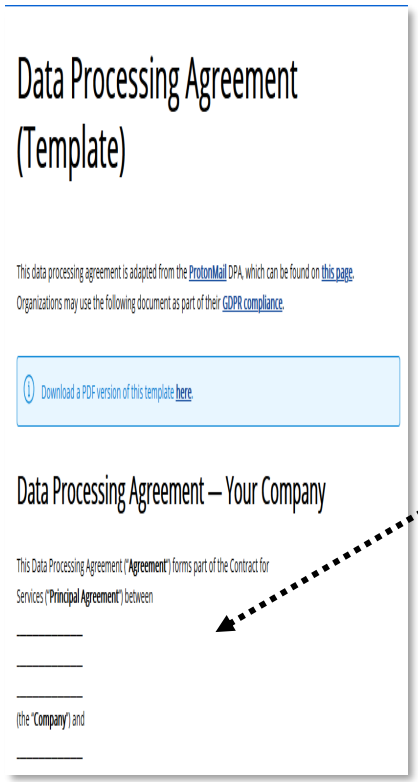
- **To fulfil the gaps** of Smart Contracts, Ricardian Contracts and Smart Contracts Templates, **we introduce *Intelligible Contracts*.**
- **Intelligible Contracts** are **[*legal*] contracts** written in **natural language** that can be **mapped, entirely or partially, to operational code** living on Blockchains.
- **Intelligible Contracts extend** Ricardian Contracts and Smart Contract Templates by supplying **specifications for the intelligibility of digital contracts.**

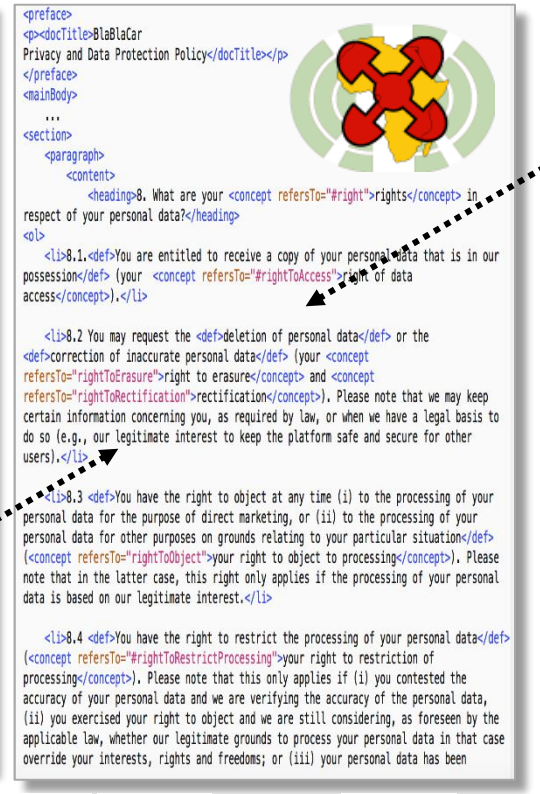
Features of Intelligible Contracts

- More specifically, **Intelligible Contracts** supply **specification for linking**:
  - **all resources** that **compose contracts** or **define their legal contexts**
  - **agents** that are **involved in the life-cycle of contracts**
  - **the digital resources** that **describe how to execute the operational code**
  - **digital resources** that **report what happens during the executions** of contracts.



Scenario



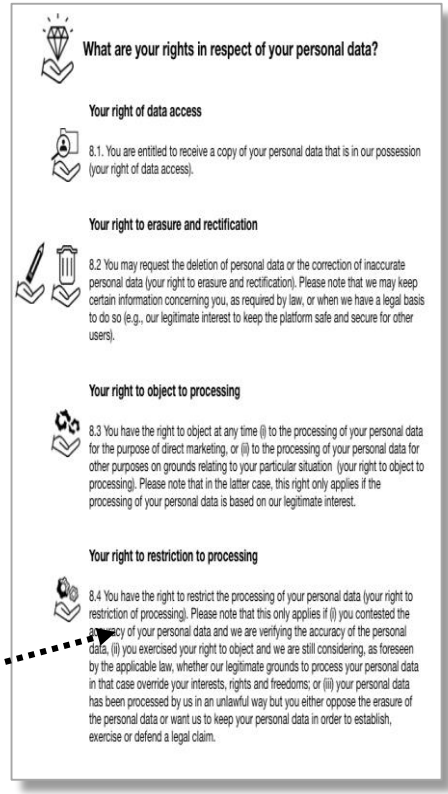


Logic Rules
in natural Language

Formal Logic Rules

LegalRuleML

Smart Contract



Human-readable
(at least *Lawyer-readable*)

Machine-readable

Reasoning and
Machine-executable

Human-readable
Explainable







ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Components of Intelligible Contracts

- **Intelligible Contracts** are composed **of four parts:**
  - **identification and referencing component:** a Uniform Resource Identifier and a hash
  - **document component:** UID+Document
  - **context component:** a legal context and an operational context. The operational context contains execution parameters, references to operational environment, operational agents and operational code
  - **execution reports:** UID + the report of the execution of the contract

Formal definition of Intelligible Contracts

Intelligible Contract::=
UID and
Document+ and,
Context+ and,
Execution Report+

UID::= URI => HASH

Context::=
UID and
Legal Context+ and
Operational Context+ and
Legal Context::=
(Legal Document Ref or
Legal Document)+
Operational Context::=
Operational Environment Ref+ and
Operational Agent Ref+ and
Operational Code Ref+
Execution Report::=
UID,
Document+,

UID (URI+HASH_IPFS)

Document+
(UID + Document)

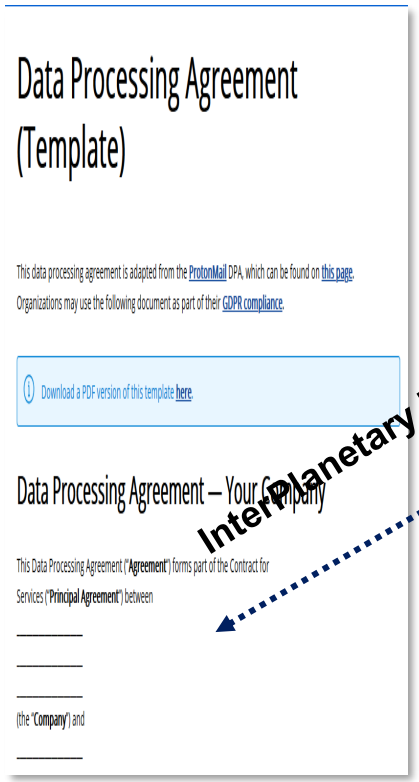
Context+
(UID +Legal Context+ Operational Context)

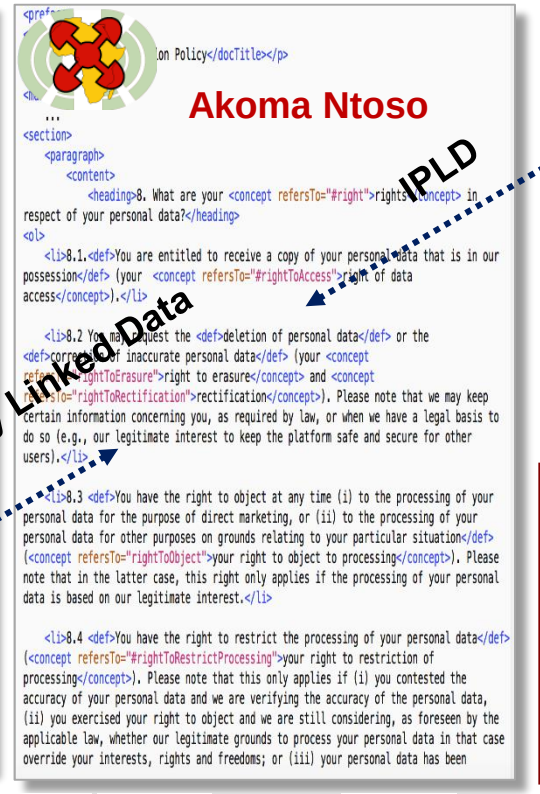
Execution_Report+
(UID+Document)

An implementation of Intelligible Contracts

- We propose an i**mplementation of Intelligible Contracts** that relies its functioning **on three technologies**:
  - The **Akoma Ntoso (LegalDocML) standard,** used to **markup the legal prose of contracts**, to **identify documents**, and to **markup all other legal and plain documents** related to the life-cycle of contracts;
  - The **InterPlanetary Linked Data**, used to **link resources that belong to Intelligible Contracts** by means of their **hashes** and their **Akoma Ntoso identifiers**;
  - The **LegalRuleML standard**, used to **re-express the legal prose contained in legal document**, highlighting business rules and **connecting them to automatic legal reasoners** and to **operational code deployed on blockchains**.

Intelligible Contract model

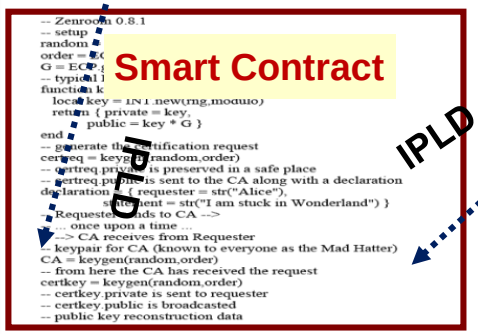




Logic Rules
in natural Language

Formal Logic Rules

LegalRuleML



Execution
and Context
information report

IPLD

IPLD

IPLD

Interplanetary Linked Data

Human-readable
(at least *Lawyer-readable*)

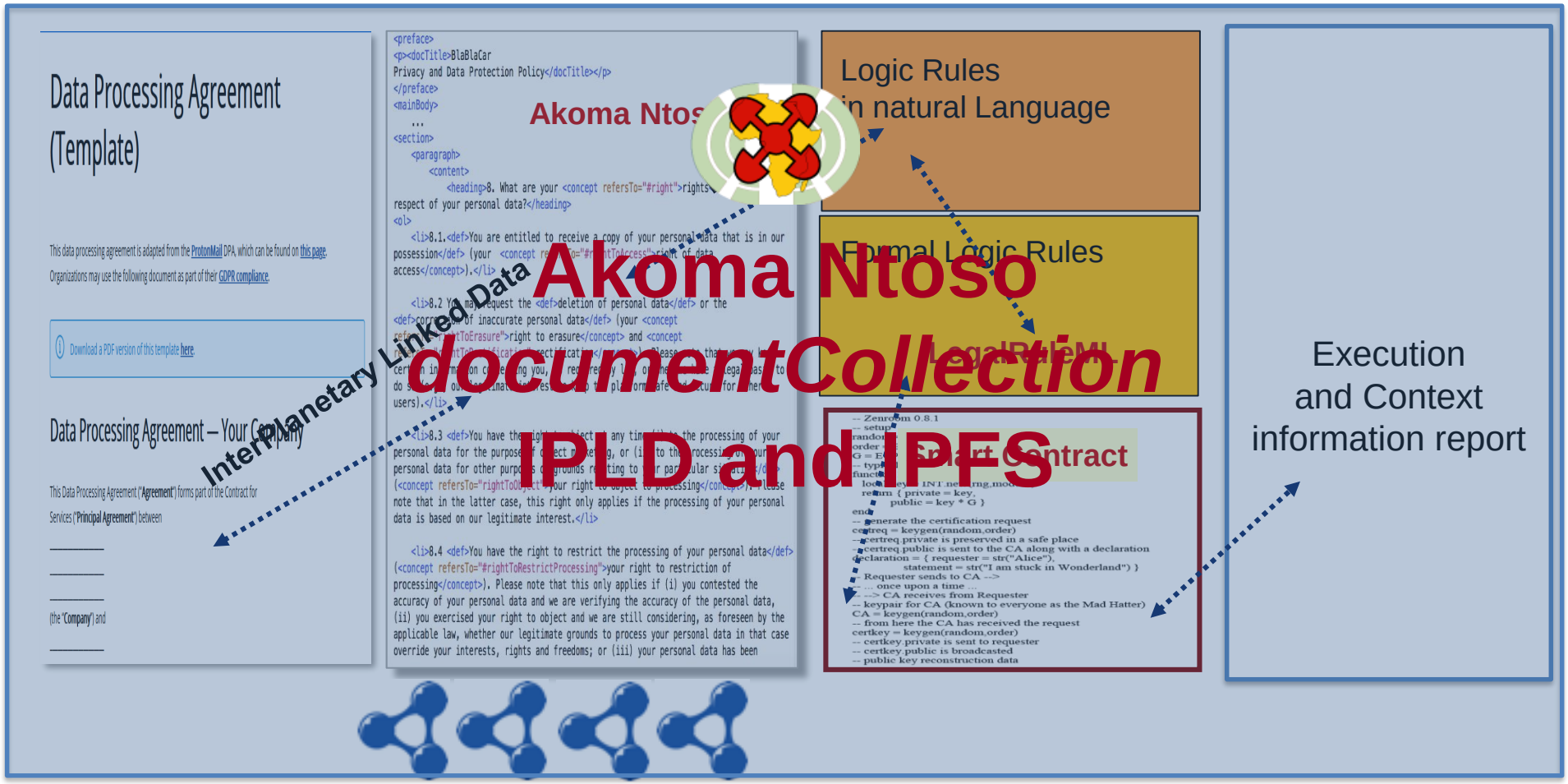
Machine-readable

Reasoning and
Machine-executable

Human-readable
Explainable

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Intelligible Contract model



Lawyer-readable

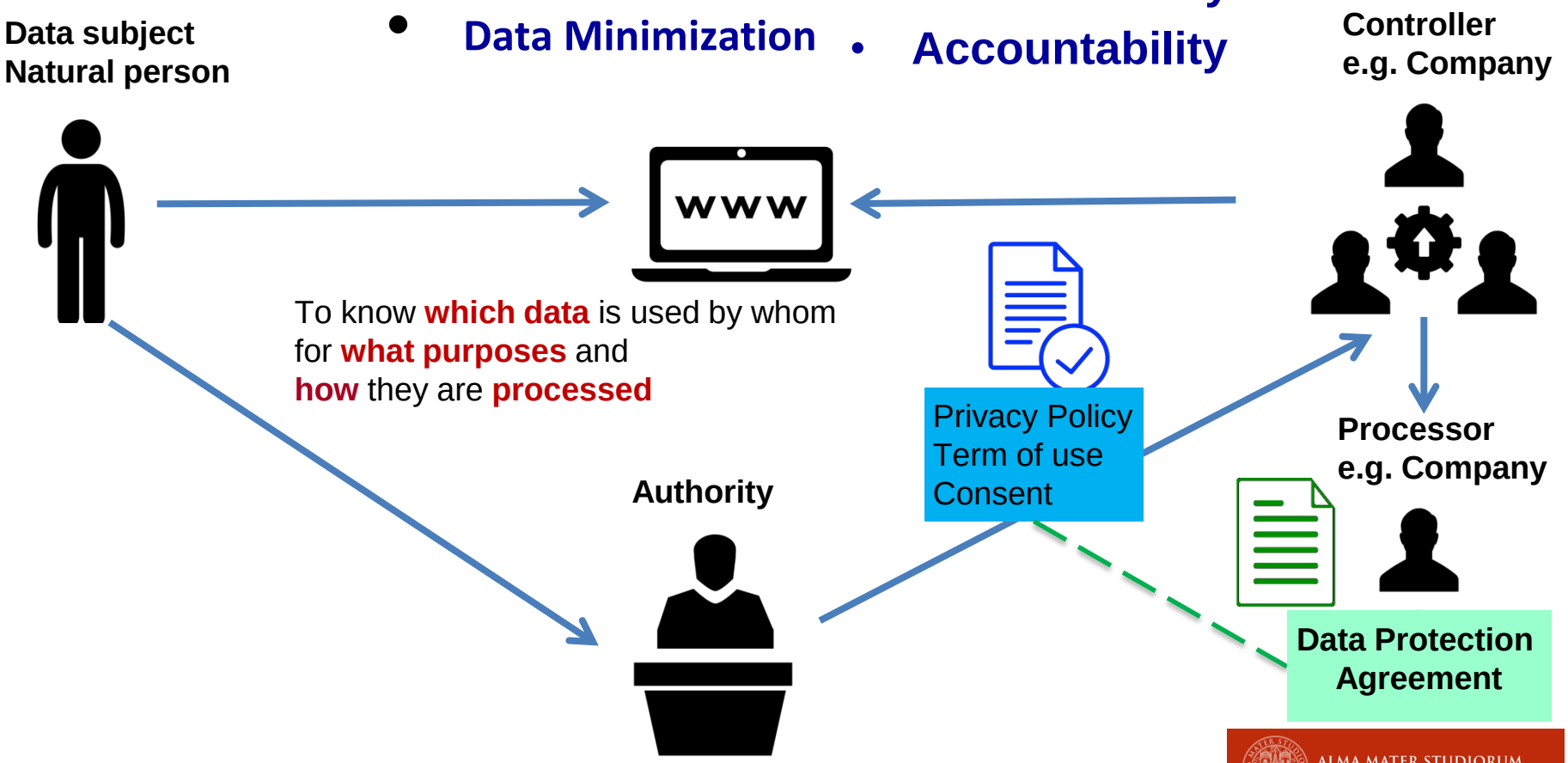
Machine-readable

Reasoning and Machine-executable

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

Use-Case GDPR and DPA

- Lawfulness
- Fairness
- Transparency
- Purpose limitation
- Data Minimization
- Accuracy
- Storage limitation
- Integrity
- Confidentiality
- Accountability



Use-Case GDPR and DPA


Data Processing Agreement (Template)

This data processing agreement is adapted from the ProtonMail DPA, which can be found on this page. Organizations may use the following document as part of their GDPR compliance.

Download a PDF version of this template here.

Data Processing Agreement — Your Company

This Data Processing Agreement ("**Agreement**") forms part of the Contract for Services ("**Principal Agreement**") between

(the "**Company**") and

Privacy Policy
Term of use
Consent

GDPR
EU Regulation
International Law

Data Protection Agreement

- **Data Processing Agreements** compliant to the **General Data Protection Regulation (GDPR) of the EU regulation**.

- **DPAs involve several legal and non-legal resources**
- **DPAs may be impacted by many jurisdictions,** because they are often related to **world-wide services (e.g., cloud computing services)**
- a **template of the legal prose of GDPR-compliant DPA is publicly available** at: https://gdpr.eu/ data-processing-agreement/

Intelligible Contract URI – FRBR Model

Evolution over the time

Work:

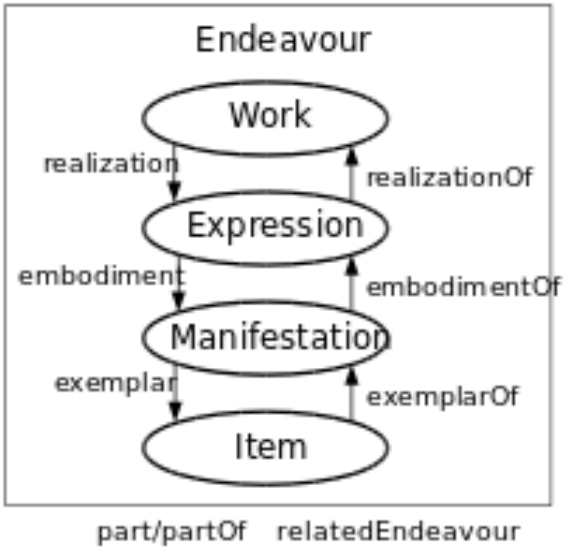
1. /akn/it/documentCollection/dpa/ company/2019-07-12/1

Expressions:

1. /akn/it/documentCollection/dpa/ company/2019-07-12/1/ita@2019-09-12
2. /akn/it/documentCollection/dpa/ company/2019-07-12/1/eng@2019-11-12/!main
3. /akn/it/documentCollection/dpa/ company/2019-07-12/1/eng@2019-11-12/!schedule_1

Manifestations:

1. /akn/it/documentCollection/contract/ company/2019-07-12/1/ita@2019-09-12/!main.akn
2. /akn/it/documentCollection/contract/ company/2019-07-12/1/eng@2019-11-12/!main.akn
3. /akn/it/documentCollection/contract/ company/2019-07-12/1/eng@2019-11-12/ !schedule_1.akn



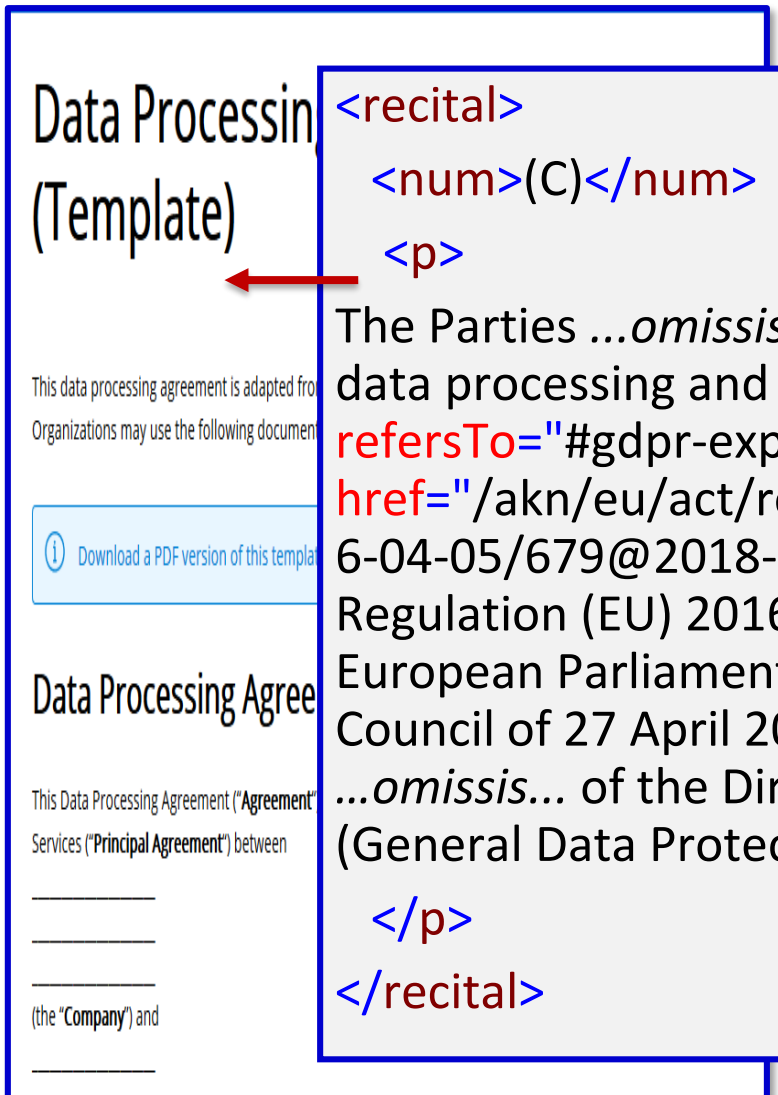
UID (URI+HASH_IPFS)

Document+ (UID + Document)

Context+ (UID +Legal Context+ Operational Context)

Execution Report+ (UID+Document)

Document: Legal prose of DPA




```
<recital>
  <num>(C)</num>
  <p>
The Parties ...omissis... in relation to data processing and with the <ref refersTo="#gdpr-expression" href="/akn/eu/act/regulation/eu/2016-04-05/679@2018-05-25">Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 </ref> ...omissis... of the Directive 95/46/EC (General Data Protection Regulation).
  </p>
</recital>
```

Manifestation IPLD

Tamper-proof

IPFS

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

UID (URI+HASH_IPFS)

Document+ (UID + Document)

Context+ (UID +Legal Context+ Operational Context)

Execution Report+ (UID+Document)

Auxiliary documents: Normative Reference

```
<recital>
  <num>(C)</num>
   <p>
The Parties ...omissis... in relation to data processing and with the <ref refersTo="#gdpr-expression" href="/akn/eu/act/regulation/eu/2016-04-05/679@2018-05-25"> Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 </ref> ...omissis... of the Directive 95/46/EC (General Data Protection Regulation).
  </p>
</recital>
```

Expression

```
<references source="#editor">
  <TLCReference GUID="gdpr-expression"name="GDPR"showAs="General Data Protection Rule" href="/akn/references/expression/eu/gdpr/ipfs/QmU...A3Nn">
  </TLCReference>
</references>
```

Manifestation

Tamper-proof

UID
(URI+HASH_IPFS)

Document+
(UID + Document)

Context+ *(UID +Legal Context+ Operational Context)*

Execution_Report+
(UID+Document)

Context: metadata and ontology

```
<TLCConcept eId="minor" showAs="minor"
href="/akn/ontology/concept/gdrp/minor"
refersTo="#minor-ontology" />
<TLCReference
GUID="minor-ontology“ name="minor“
showAs=“minor-gdpr"
href="/akn/references/expression/eu/gdpr/ipfs/srFm
U...A3Nn">
  </TLCReference>
```

```
</references>
...omissis...
<meta>
...omissis...
<clause eId="cls_6">
 <heading>
  Users of the Service
 </heading>
 <content>
  <p>
   This Service is provided exclusively to individuals who
   are not <concept referstTo="#minor">minors</concept> and
   <concept refersTo="#livingInACountry">live in
   </concept>  a  <location refersTo="#eu">
   EU country </location>  or in the
   <location refersTo="#us"> US </location>.
   </p>
  </content>
</clause>
...omissis...
```

Metadata and ontology

RDF

IPFS

UID (URI+HASH_IPFS)

Document+
(UID + Document)

Context+
(UID +Legal Context+ Operational Context)

Execution_Report+
(UID+Document)

Formal logic Legal Rules

```
<lrml:Statements >
 <lrml:PrescriptiveStatement key="ps1">
   <ruleml:Rule key=":ruletemplate2“
closure="universal">
     <ruleml:if>
       <ruleml:Atom key=":atom1">
             <ruleml:Rel iri=":child" />
             <ruleml:Var >X</ruleml:Var>
       </ruleml:Atom>
     <ruleml:then>
       <lrml:Obligation iri=":obligation">
             <ruleml:Atom key=":atom6">
               <ruleml:Rel iri=":ObtainConsent" />
                <ruleml:Var >X</ruleml:Var>
                <ruleml:Var >Y</ruleml:Var>
                <ruleml:Var >S</ruleml:Var>
             </ruleml:Atom>
       </lrml:Obligation>
    </ruleml:then>
 </ruleml:Rule>
 </lrml:PrescriptiveStatement>
</lrml:Statements>
```

```
<lrml:LegalReferences
refType="http://example.org/lrml#LegalSource">
<lrml:LegalReference
            refersTo="ref1“
            refID="/akn/eu/act/regulation/2016-04-27/2016-
            679/eng@2018-05-25/!main#art_8__para_1"
            refIDSystemName="AkomaNtoso3.0-2017-06" />
</lrml:LegalReferences>
<lrml:LegalReference
            refersTo="ref2“
            refID="/akn/references/expression/eu/gdpr/ipfs/
QmU...A3Nn1"
            refIDSystemName="IPFS" />
</lrml:LegalReferences>
```

Akoma Ntoso manifestation UID

Metadata with the reference to the legal text

Manifestation IPLD

Tamper-proof

LegalRuleML

IPFS

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

UID (URI+HASH_IPFS)

Document+
(UID + Document)

Context+
(UID +Legal Context+ Operational Context)

Execution_Report+
(UID+Document)

Document of Components (AKN)

IPFS HASH

URI+IPFS

```
<recital>
  <num>(C)</num>
  <p>
The Parties ...omissis... in relation to data processing and with the <ref refersTo="#gdpr-expression" href="/akn/eu/act/regulation/eu/2016-04-05/679@2018-05-25"> Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 </ref> ...omissis... of the Directive 95/46/EC (General Data Protection Regulation).
  </p>
</recital>
```

URI+IPFS

```
<TLCConcept eId="minor" showAs="minor" href="/akn/ontology/concept/gdrp/minor" refersTo="#minor-ontology" />
<TLCReference GUID="minor-ontology“ name="minor“ showAs=“minor-gdpr" href="/akn/references/expression/eu/gdpr/ipfs/srFmU...A3Nn">
  </TLCReference>
```

URI+IPFS

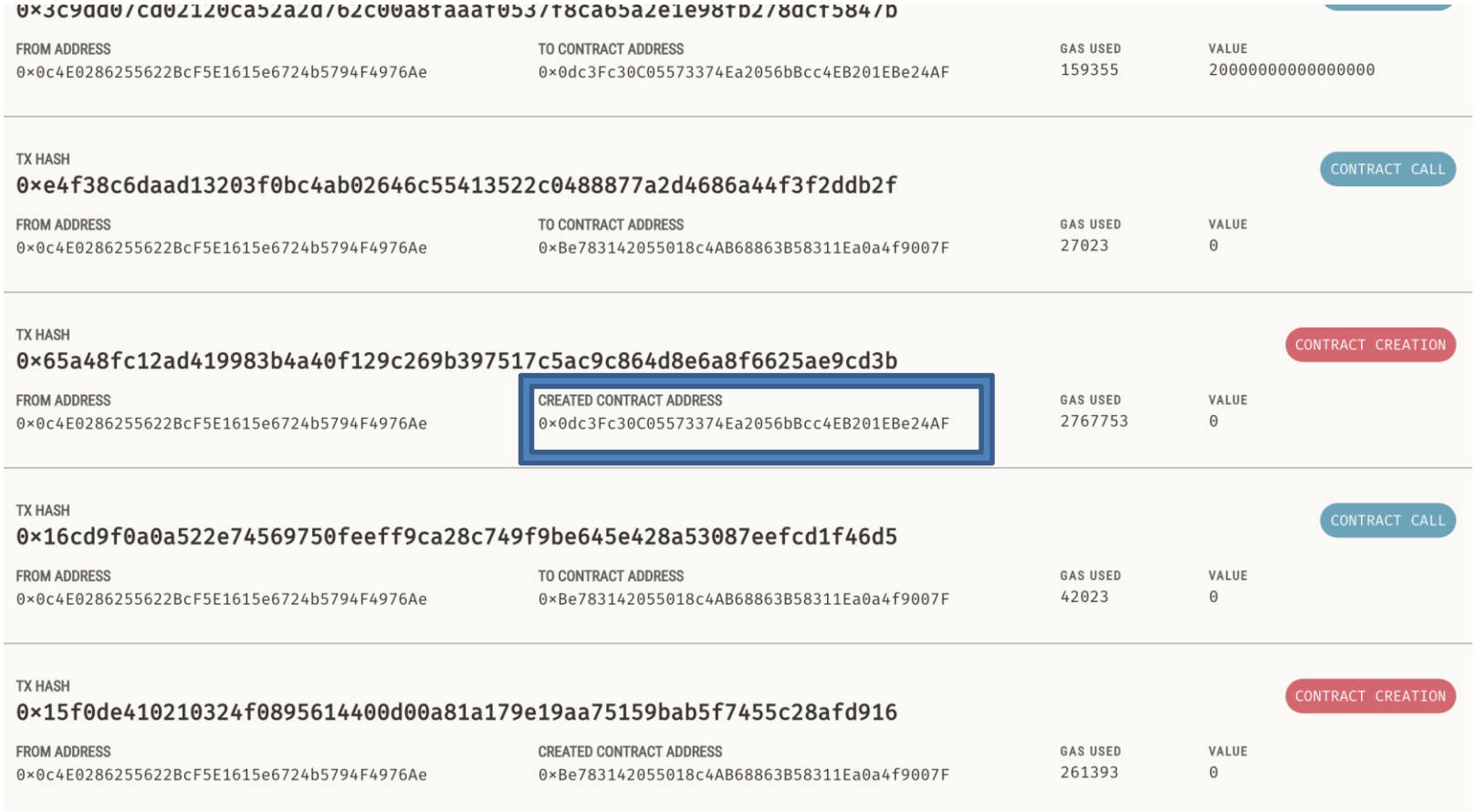
```
<lrml:Statements >
  <lrml:PrescriptiveStatement key="ps1">
    <ruleml:Rule key=":ruletemplate2“ closure="universal">
      <ruleml:if>
        <ruleml:Atom key=":atom1">
          <ruleml:Rel iri=":child" />
          <ruleml:Var >X</ruleml:Var>
        </ruleml:Atom>
      <ruleml:then>
        <lrml:Obligation iri=":obligation">
          <ruleml:Atom key=":atom6">
            <ruleml:Rel iri=":ObtainConsent" />
            <ruleml:Var >X</ruleml:Var>
            <ruleml:Var >Y</ruleml:Var>
            <ruleml:Var >S</ruleml:Var>
          </ruleml:Atom>
        </lrml:Obligation>
      </ruleml:then>
    </ruleml:Rule>
  </lrml:PrescriptiveStatement>
</lrml:Statements>
```

URI+IPFS

```
<references source="#editor">
  <TLCReference GUID="gdpr-expression"name="GDPR"showAs="General Data Protection Rule" href="/akn/references/expression/eu/gdpr/ipfs/QmU...A3Nn">
  </TLCReference>
</references>
```

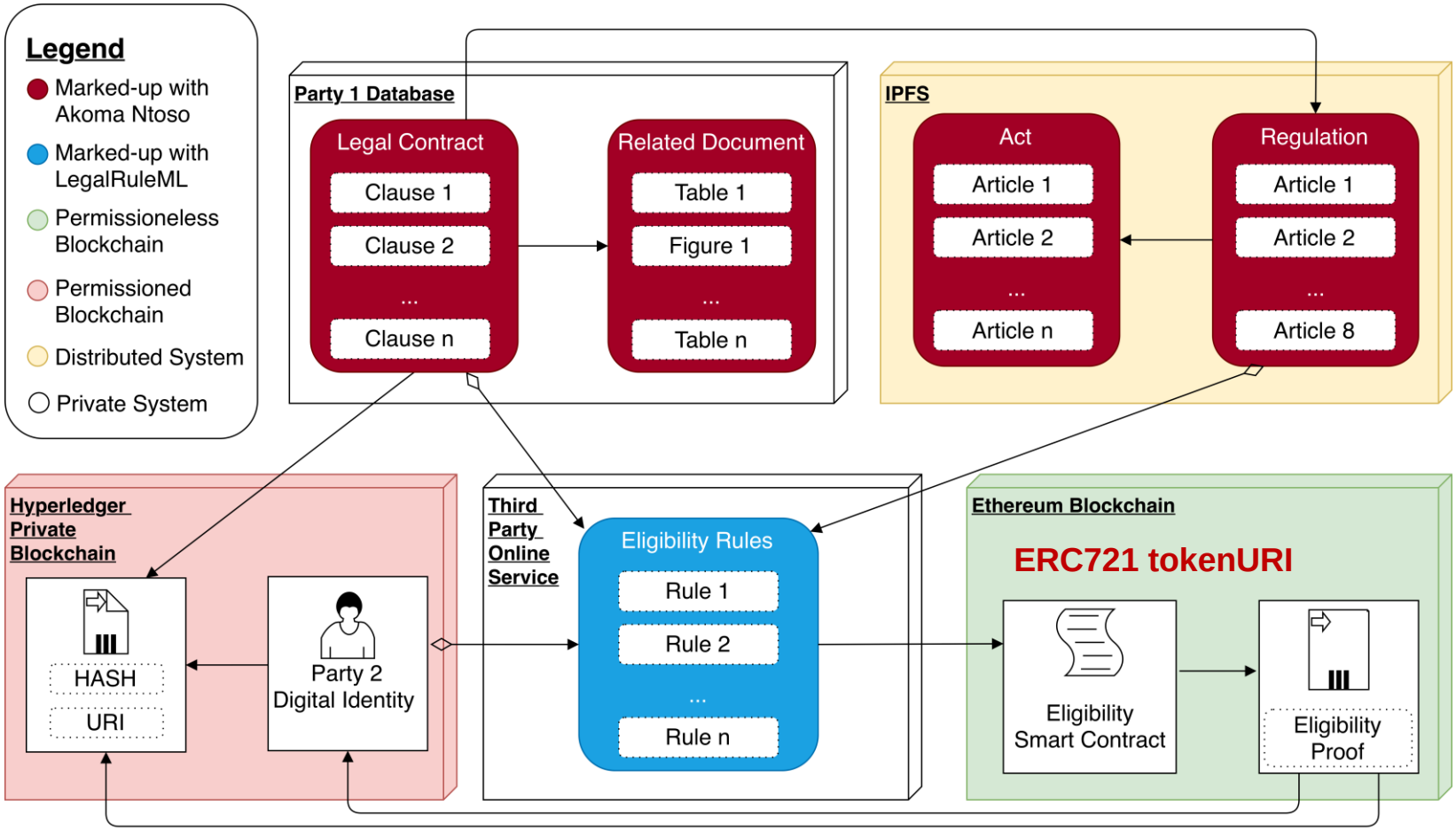
URI+IPFS

Component_1 URI+IPFS
Component_2 URI+IPFS
Component_3 URI+IPFS
Component_4 URI+IPFS
Component_5 URI+IPFS




```
▼<lifecycle source="#process">
    <eventRef eId="gen__s_1__ep_1" date="01-10-2020" source="#process" type="generation"/>
  </lifecycle>
▼<references source="#process"
    <TLCProcess GUID="process"  ref="/ipfs/processes/smartContract/0x0dc3Fc30C05573374Ea2056bBcc4EB201EBe24AF" showAs="The smart contract of the Catasto
    <TLCProcess GUID="normativa"  ref="/ipfs/processes/normativeSystems/ita/normativa.italiana" showAs="The Italian normative system"/>
    <TLCOrganization GUID="fao" href="/ipfs/organizations/un/fao" showAs="The FAO"/>
    <TLCOrganization GUID="efsa" href="/ipfs/organizations/eu/efsa" showAs="The EFSA"/>
  </references>
</meta>
▼<mainBody>
  ▼<section eId="sec_1">
    <num>1</num>
```

Architecture



Conclusions and Future Works

- I**ntelligible Contracts fill several technical and legal gaps on using digital contracts in blockchains**.
- Intelligible Contracts **help:**
  - **to analyze lack of willingness** in parties
  - to analyze **liability** in case of **torts**
  - to **overcome limitations** caused by the **immutability of Blockchains** (by **supplying a versioning system** inherited with the adoption of **Akoma Ntoso** and its naming convention)
  - To explain the execution of the smart contract

- In the **future** we plan:
  - **to model and implement full real-world scenario** in order to analyze pros and contra of our approach.
  - **to investigate benefits or limitations** of Intelligible Contracts in relation to specific blockchain environments (i.e. **permissioned** vs. **permissionless**)
  - to further customize **Akoma Ntoso** for better modelling of **the concepts of contracts** according to private law theory
  - to address the **standardisation of operational code** that executes **Intelligible Contracts** on blockchains
  - to **validate the LegalRuleML** rules before to implement the Smart Contract

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Luca Cervone, Monica Palmirani, Fabio Vitali

CIRSFID - DISI - Legal Blockchain Lab
Alma mater – University of Bologna

http://lbl.cirsfid.unibo.it