Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

Interoperability in the Smart City: a semantic approach for merging flexibility with strictness

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- **The context and the problem**
- The approach, the IES-City and NCT activities
- The Smart City Platform Specification (SCPS)
  - The Information Level
  - The Semantic Level
- Conclusion and next steps

The current scenario

- **The Smart City is happening**
  - Finally people perceive the Smart City as engine for the growth
  - SC applications are become part of the real life of cities and citizen
  - A lot of initiatives flourished in the field of the Smart Cities services

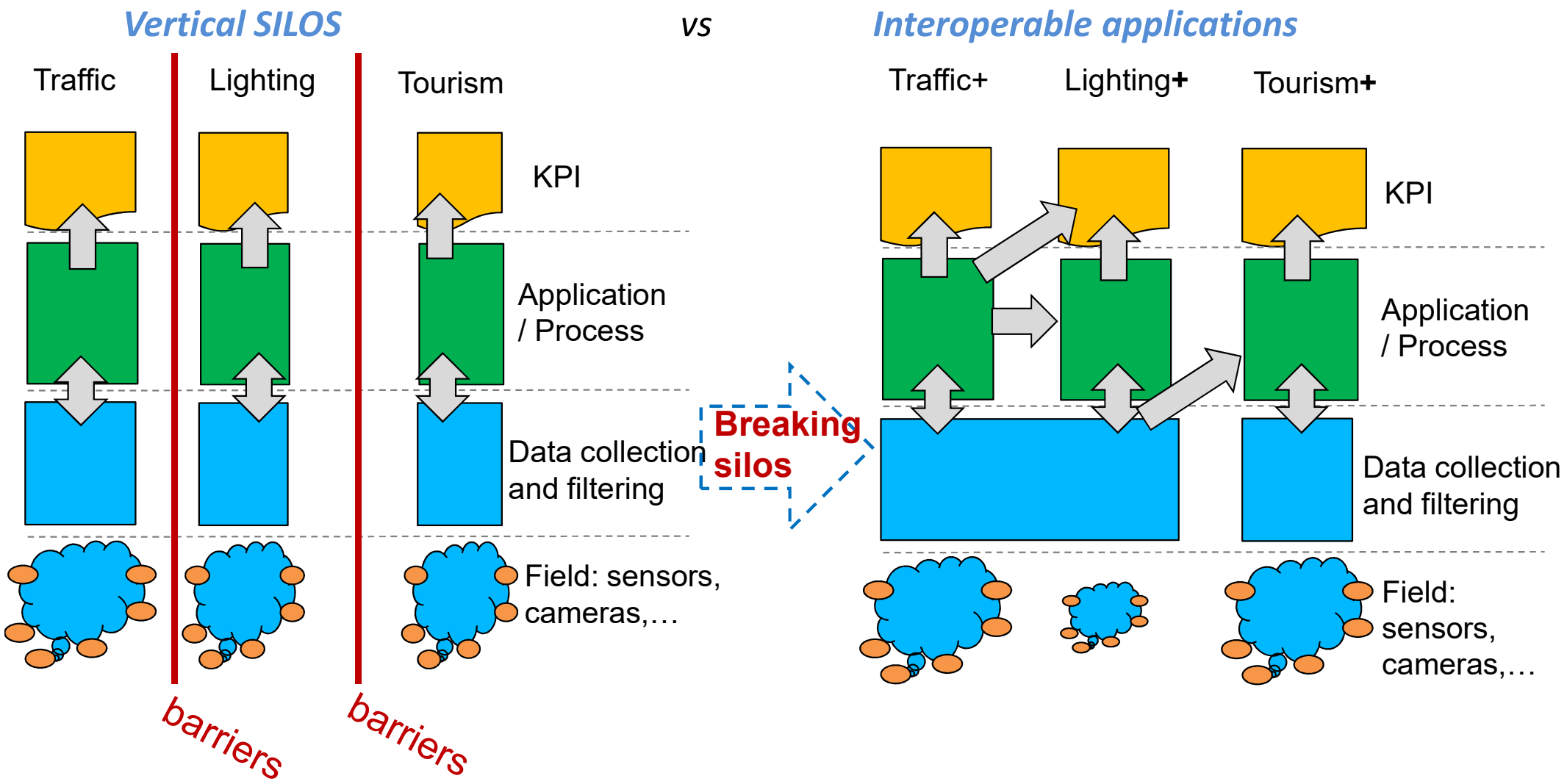
- **New opportunities are opening up**
  - Technological feasibility has been largely demonstrated
  - A lot of ideas about services and applications have been though, demonstrated and delivered in real cities
  - New services can be activated combining and exchanging data collected by several and heterogeneous systems and applications

The current scenario (2)

- **Criticalities**
  - The issue of **sustainability** has come in evidence as one of the most hampering factors, especially towards small and medium sized cities
  - **Non-interoperability** between different smart city services, systems, citizen and local administrators impacts badly on the smart city economic systems

- **New priorities**
  - To conceive SC applications as a part of complex ecosystems, with subsystems and components able to interact each other, and to change over time
  - To make the applications able to speak each other directly

The challenges



The concept of “interoperability”

“**Interoperability**” is the ability of a system or a product to work with other systems or products without special effort on the part of the customer.

In the context of SC applications interoperability is crucial both:

1. **vertical level** (between the different levels of a solution)
   - *to enable the combination, replacement and reuse of the individual components*
1. **horizontal level** (between different solutions)
   - *to avoid the creation of vertical silos and to ensure the replicability of the solutions*

The IES-City Framework

1. The **IES-City Framework** is a public initiative, launched on 2016 by the U.S. National Institute of Standards and Technology (NIST) together with many international partners.

2. The aim was to identify “common choices” that can simplify the integration. These common choices have been named **Pivotal Points of Interoperability (PPI)**

3. It **provides** the analysis of current architecture which comparing them and start to reasoning about possible PPI

4. In IES-City a set of solutions have been analysed to understand if they address these common concerns and, in case, what technology solution they adopted.

«Output» from the IES-CITY

The Application Framework Working Group analyzed the Smart City application space and produced a tool that associate to different categories of SC application the following information:

1. **Breadth:** List of applications and related metrics
2. **Readiness**: A framework for assessing City's Readiness
3. **Benefits**: A Framework to Measure Benefits

Support for the SCPS:

1. facilitate the emergence of Interoperable, Composable, and Harmonized technologies that can be used to realize Smart Cities
2. provide a common language and shared architectural principles for the huge number of existing smart cities applications
3. it built a public working group for reasoning about the chance of defining a minimum set of commonalities to achieve the composable vision of a smart city

The National Convergence Table (NCT)

The National Convergence Table (NCT) is an initiative launched by ENEA (15-4-2016) to identify a subset of common principles, key PPI fitting with national requirements, and to **propose a roadmap for their adoption.**

The focus is on the definition of a **common strategy,** shared between all the involved stakeholders at district, city, or national level, that should be defined to make them effective.

The first public document (in Italian) has been released and are available online: http://sue.enea.it/wp-content/uploads/2018/05/ENEA-Smartitaly-Goal-2018-Energia-Media.pdf

«Output» from the NCT

Priorities identified by NCT:

1. **No vendor lock-in** arising from costly services based on proprietary architecture and interfaces
2. **High replicability/reuse** of a solution in different cities
3. Creation of an **open market** for third party services (especially for citizens) based on already collected data
4. Easy definition of **replicable best practices and indicators** in public tenders for services.

Identified solutions:

1. **adoption of horizontal ICT platforms** as the mean for enabling exchange of data among vertical Smart City applications
2. **public calls for tenders** and their technical annexes as powerful lever to put in practice common interoperability principles

Our approach

Defining general **specifications** for the horizontal ICT platform in order to enable interoperability among the vertical platforms

Why a platform?

The target are the City Administrations, which need:

- The get data from different utilities / urban service providers
- To monitor these utilities / service providers

Why specifications?

City administrations needs also:

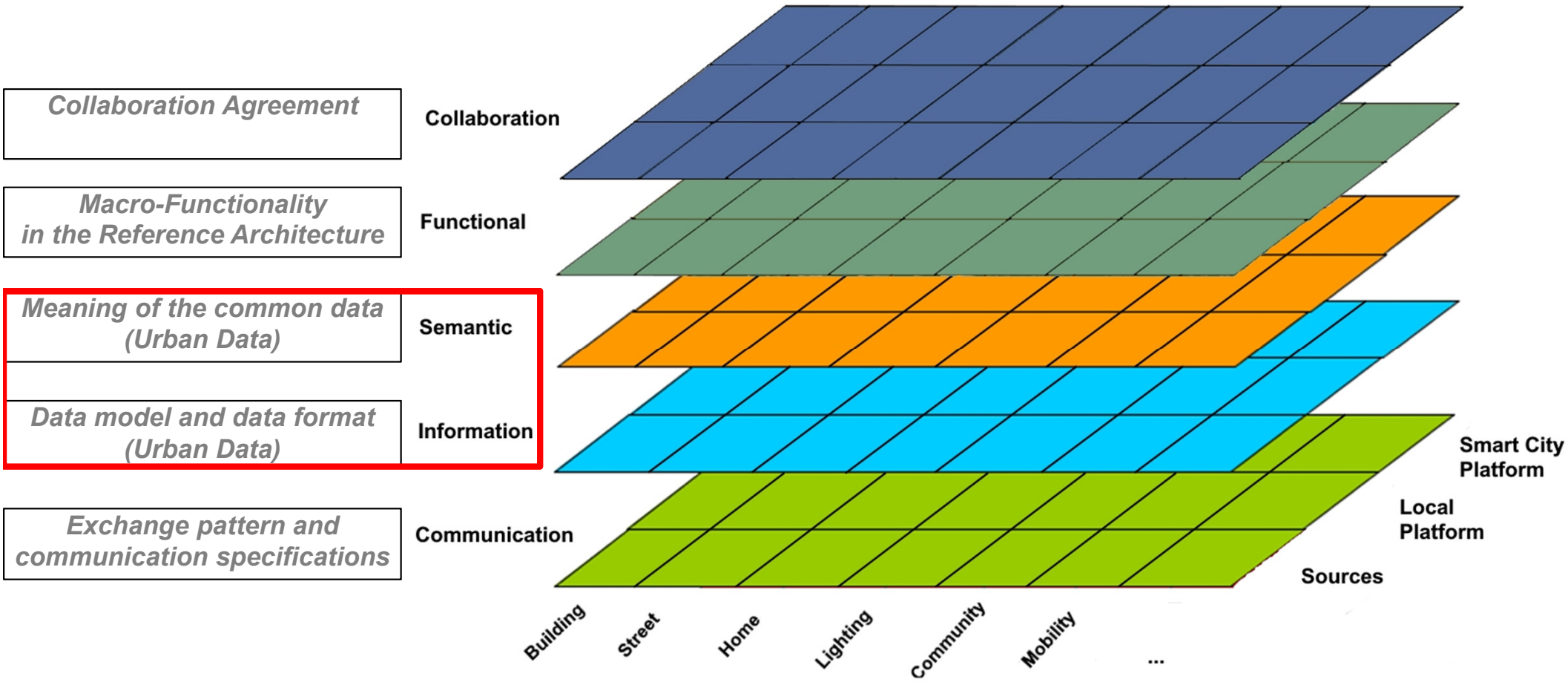
- To avoid “vendor lock-in”
- To be able to ask to their provider how they want the data

Features of the Specifications

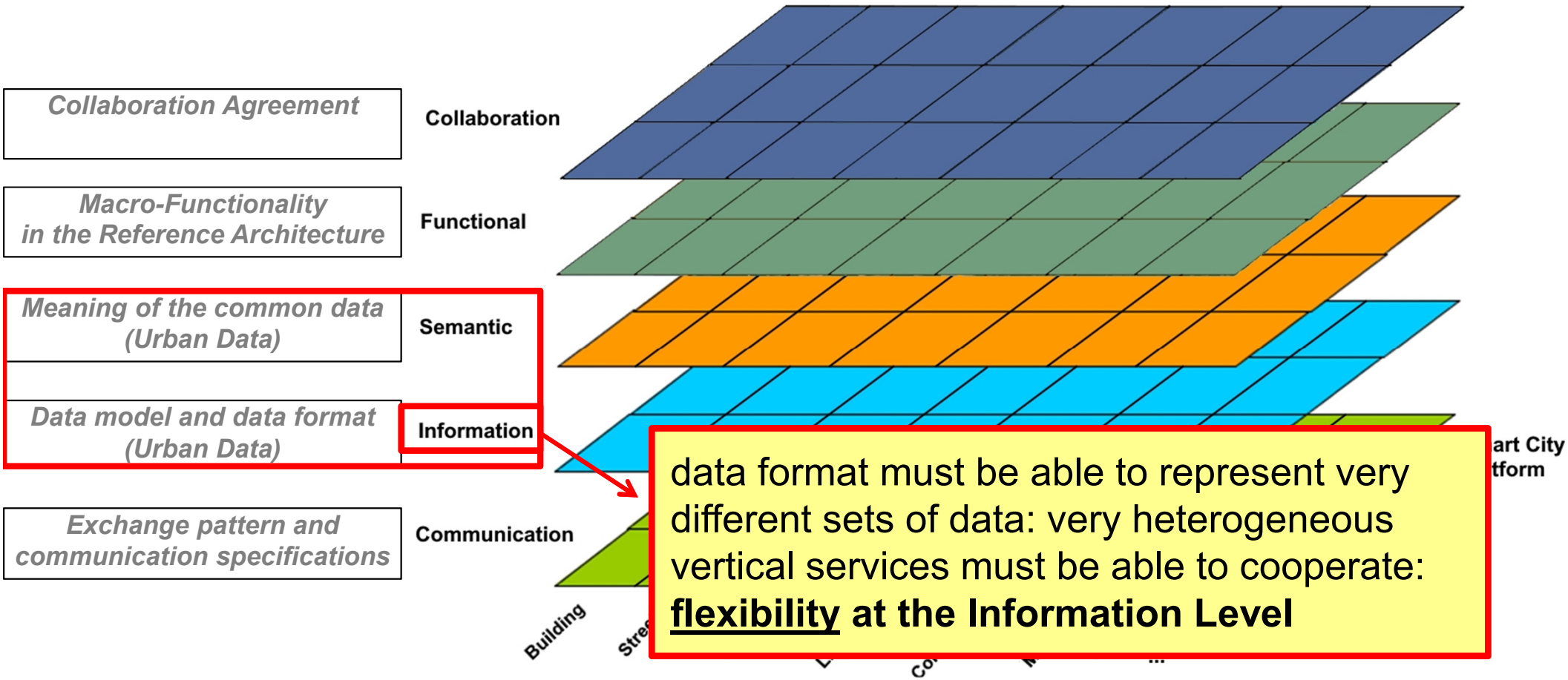
1. Split in layers, according to Interoperability definition (*)
2. Focused on the interfaces
3. Considering the different kinds of applications and the different aggregation levels (sources, local platform, Smart City Platform)

(*) Capability of two o more networks/systems/devices *(FUNCTIONAL Layer)* to externally exchange (*COMMUNICATION Layer*) information (*INFORMATION Layer*) – securely, effectively and with little inconvenience to the user – sharing a common meaning (*SEMANTIC Layer*) for them. This exchange will elicit agreed upon types of response (*COLLABORATION Layer*)

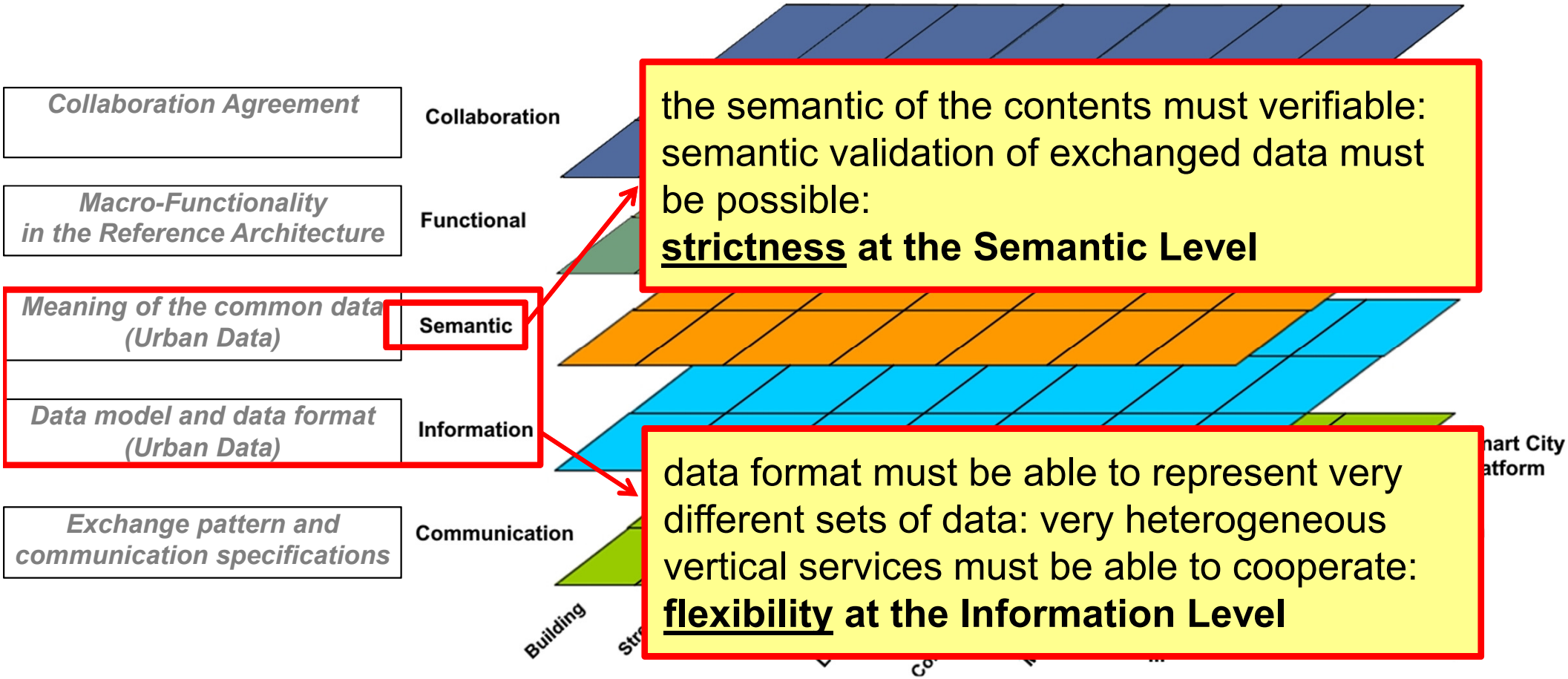
Interoperability reference model



Interoperability reference model



Interoperability reference model



Urban Data specification

- Urban Data specification provides a data format **to exchange** significant **information** on relevant aspects of the Smart City
- *Requirements*:
  - To support the **space aggregation** of the information from a single device (item) to the entire city
  - To support the **time horizon** from instantaneous measures to long time average values
  - To transfer **different kind of information** (measurements from devices/applications, description of the smart city network/nodes,…)
  - To **contextualize** the exchanged information

Examples of Smart City domains are: **economy, energy, environment, health, transportation**

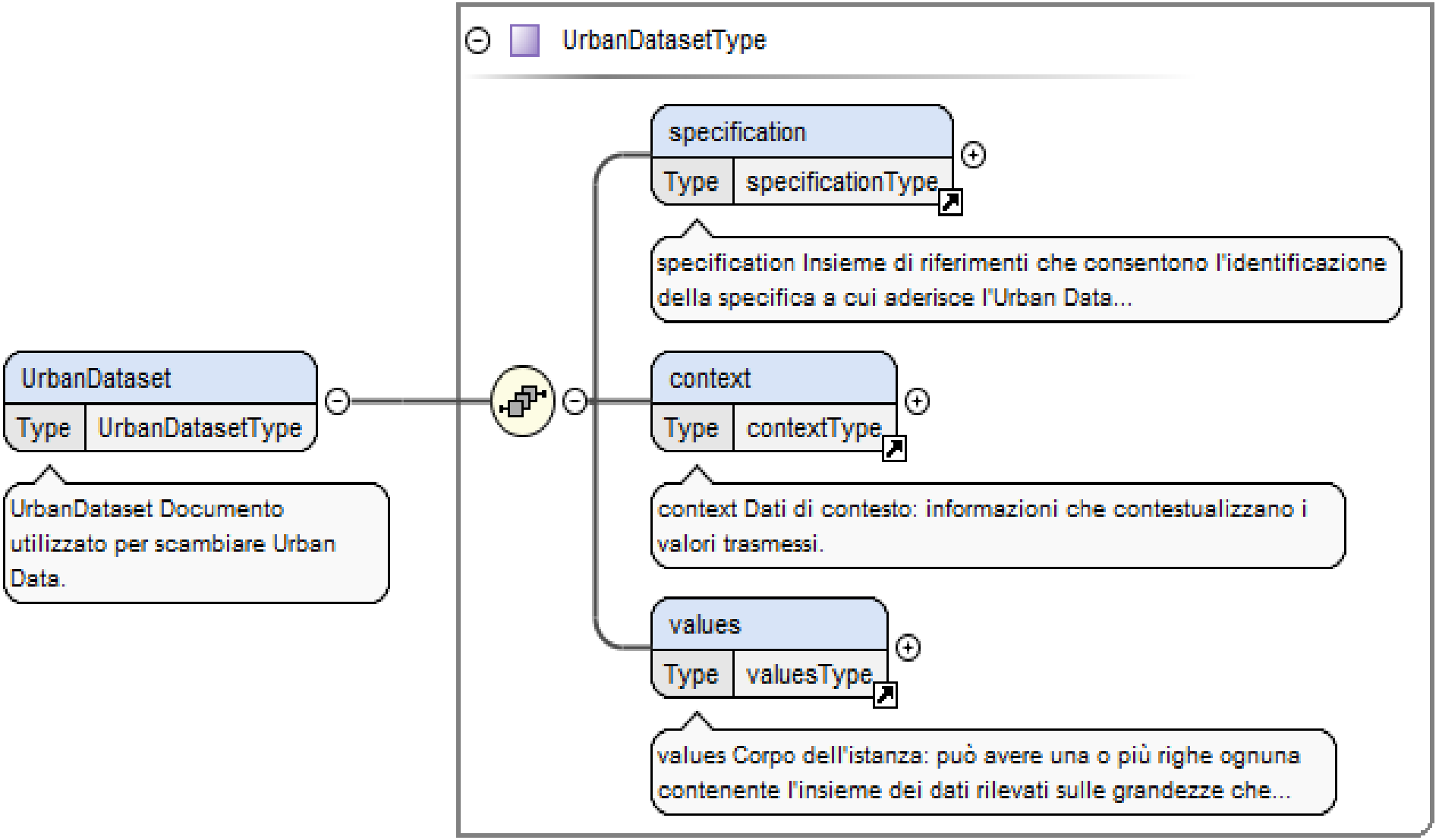
Structure of specification

The Urban Data specification is composed by:

- The **Abstract Data model** representing the Urban Data content, independently from the syntax
- Two **syntax** (JSON and XML) reference implementations of the abstract data model (the corresponding schemas are provided)
- **Supporting materials**: a Guide for the implementation in XML format, some Urban Data Templates in XML and JSON format (for example the Urban Data POD Reading, ...)
- An **Ontology** for the **semantic definition** of:
    - the Urban Data concepts and structure
    - a predefined set of Urban Data instances (e.g. Smart Building Anomalies, POD Reading, …)

In order to leave flexibility, the data model is general and flexible, so to represent each kind of Urban Data. This is the reason why the ontology definition is so important

Urban Data message structure (syntax)



The SPCS Semantic layer

The Semantic layer is the level where the specification of the contents is **officially defined** for the Urban Datasets. It aims also at providing a shared vocabulary and terms for the implementation of Smart City applications and a **normative reference** for them.

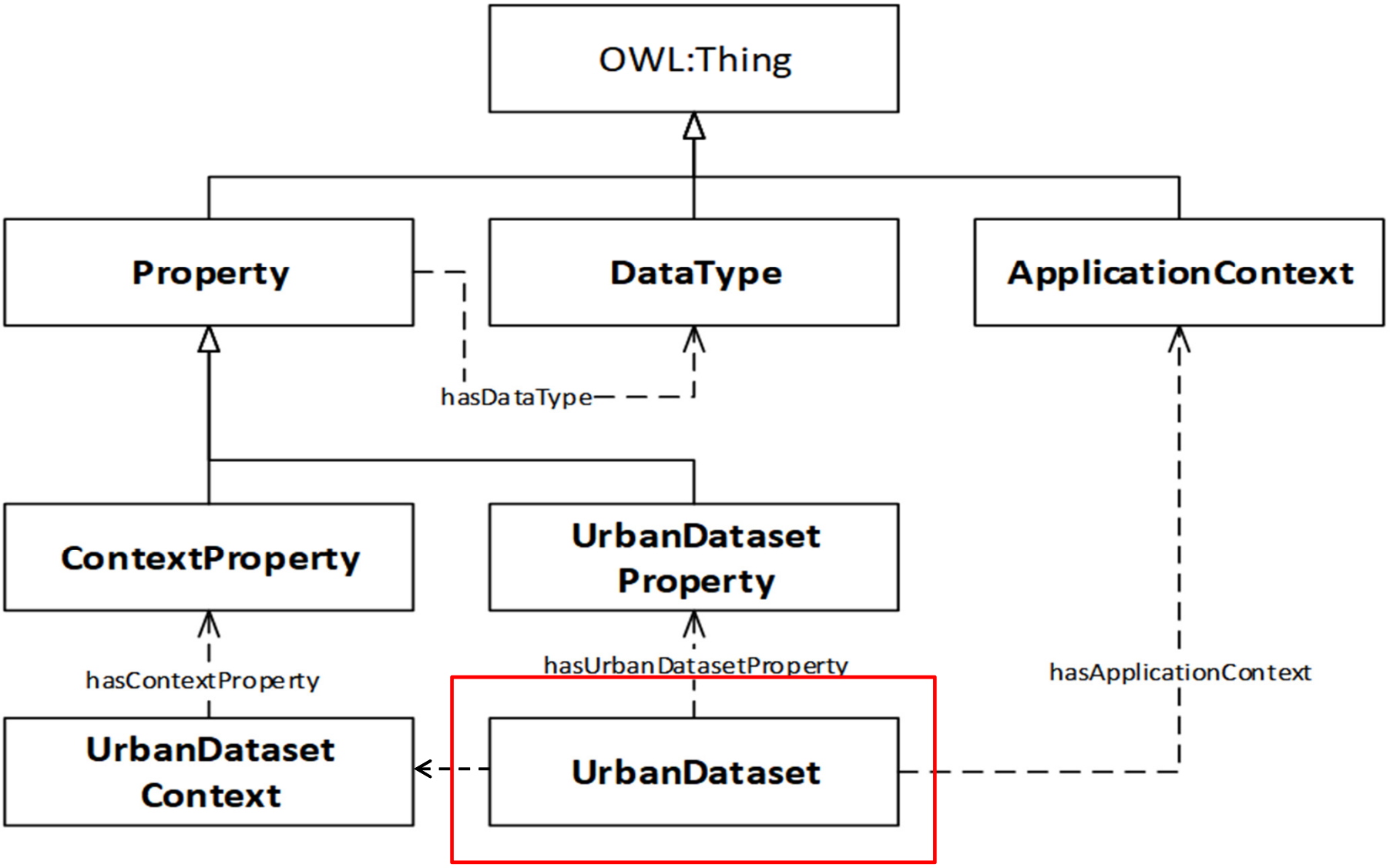
It contains two main components:

1. the **ontology**, that is the “place” in which the Urban Dataset, the properties and their relationships are defined
2. the **tools** for the semantic validation:
   - a tool for the **automatic creation** of Schematron files enabling the semantic validation of XML Urban Dataset instances
   - a **validation service**, powered by Schematron files, to validate the semantic correctness of the information
   - a **generator** of XML and JSON templates that could be a reference for the developers but also for who writes the public call for tender annexes

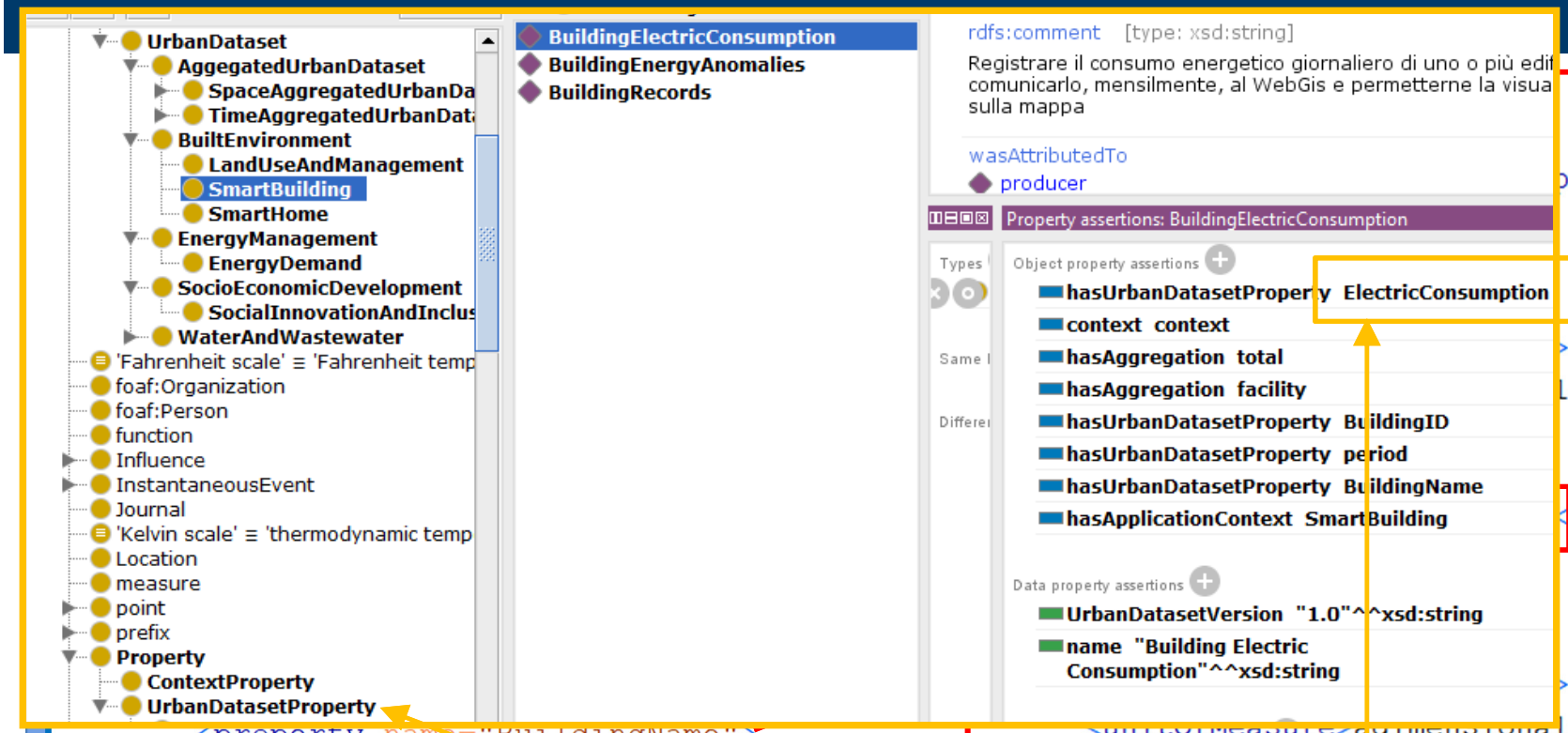
In progress:

- a tool for the validation of JSON Urban Dataset instances.
- a documentation generation system concerning diagrams, schemas, examples and ontology, related to the data formats of Urban Dataset

The SPCS Ontology



Urban Data message examples

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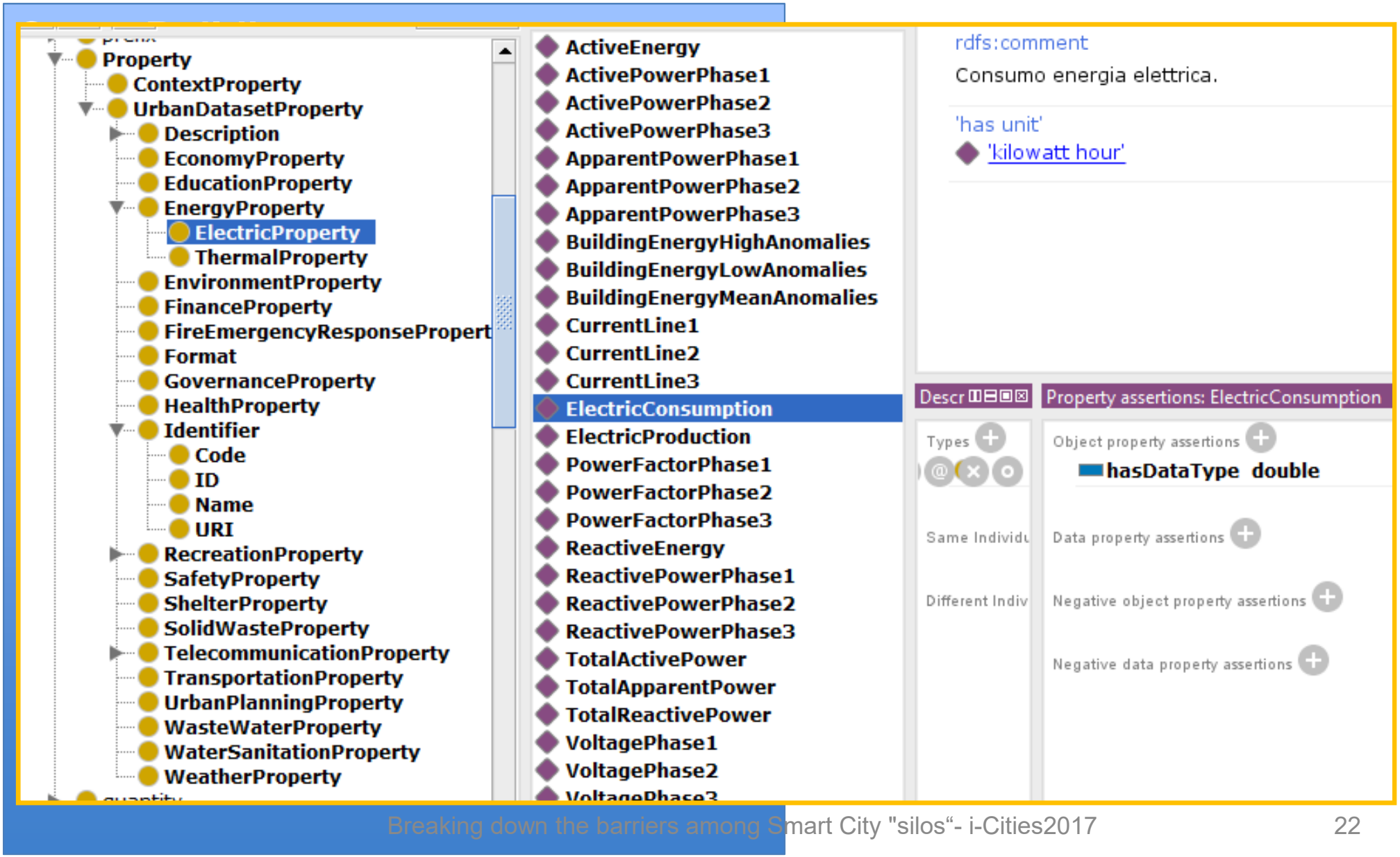
Taxonomy of the UDS Property



Conclusion

- In Smart Cities context, vertical applications are proliferating well integrated internally but unable to exchange data with each other
- This paper presents an approach and a set of open specification aiming to solve this problem, merging **flexibility** of the data-model and **strictness** of the semantic validation rules
- This specification is being tested in a laboratory context, and a set of available validation tools is being improved
- Next step will be their application in a real district

Thank you very much!

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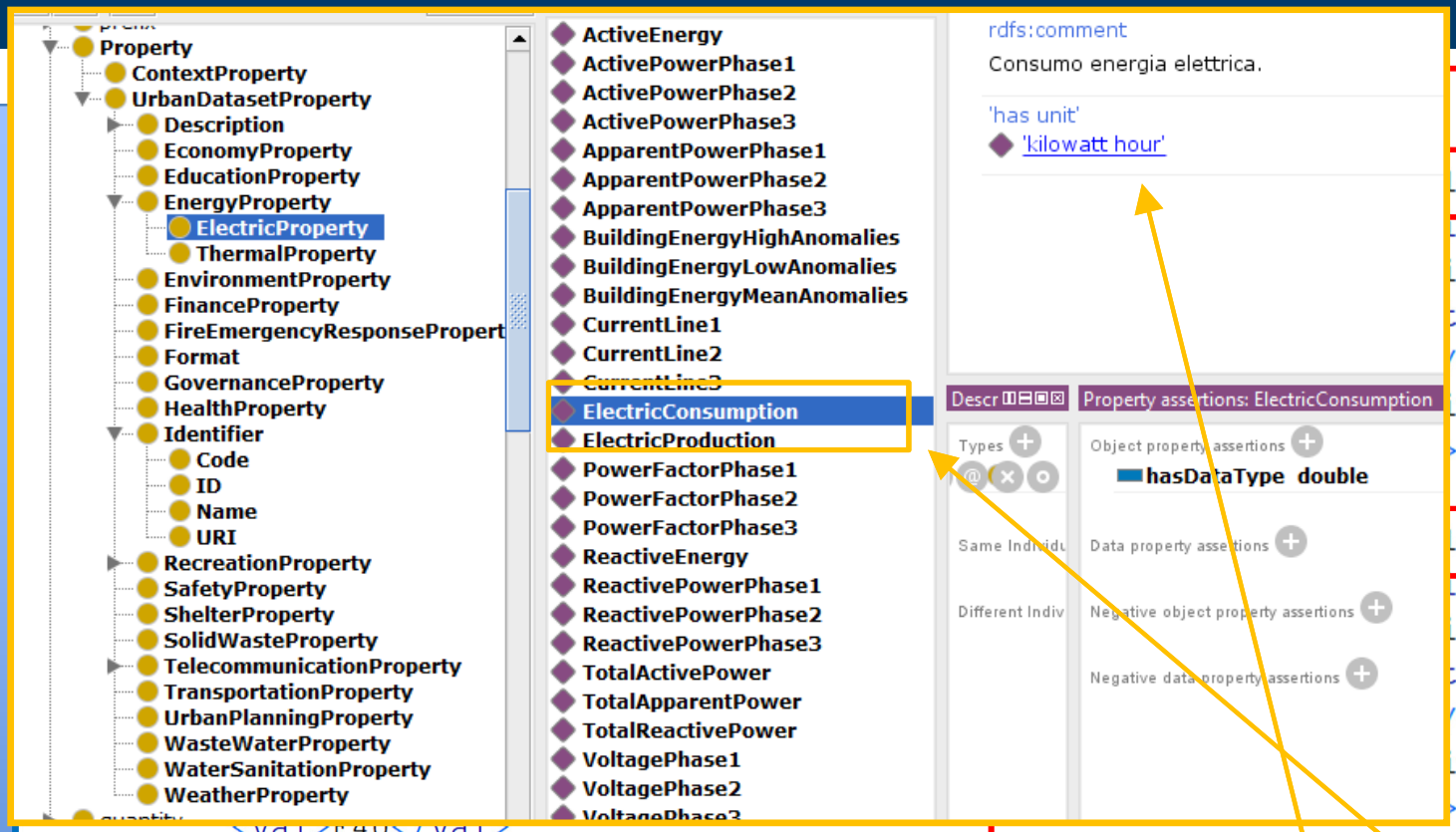
Urban Data message examples

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        </property>
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</values>
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```

ENEA

- **ENEA** is the Italian National Agency for New Technologies, Energy and Sustainable Economic Development
- The **Smart Energy (SEN) Division** of ENEA has, as mission, the research & development, application and rollout of a systemic approach for Smart Cities & Smart Regions
  - it is involved in a lot of project about Smart Cities; among them: RES NOVAE, City 2.0, Smart Village (a Smart District Model inside Casaccia Research Center)
- In the development of ENEA SEN **Smart City projects** the requirement for working in the context of an architecture for **interoperability** for Smart Cities services strongly arose
- So the definition of an open, scalable, standard-based **architecture aiming to interoperability and replicability of smart city platforms** and to foster the developing of ecosystems of services is, presently, one of the objective of SEN
- The **CROSS Laboratory** of SEN is the main responsible for this activities