ETSI

The Standards People

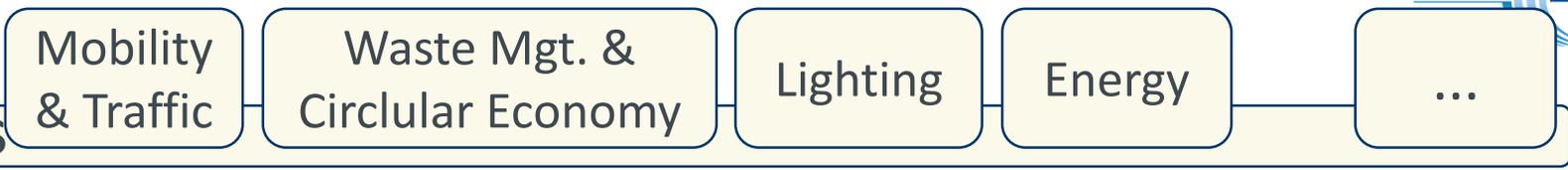*With added technical details*

Managing Information using NGSI-LD API

NEC Laboratories Europe
ETSI Board Member
ETSI ISG CIM Chairman
SF-SSCC Delegate
MSP DEI Delegate

Presented by: **Lindsay Frost,
Chairman ETSI ISG CIM**

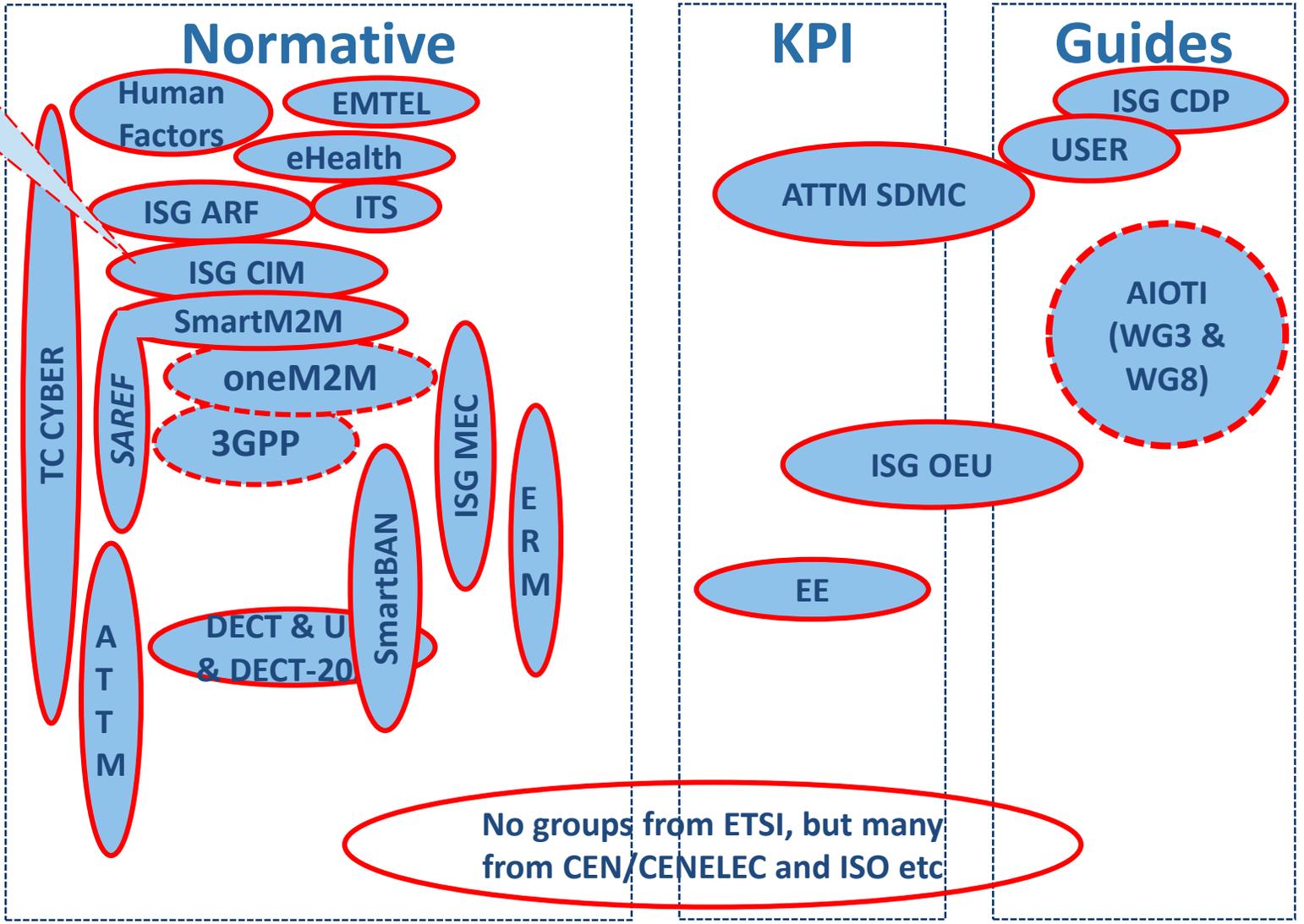For: **Connected Smart Cities
Conference 2019, Brussels**

17 January 2019

You are here

EXAMPLE DOMAINS: Mobility & Traffic | Waste Mgt. & Circular Economy | Lighting | Energy | …

Normative | **KPI** | **Guides**

User Interface Business Process
- Services
- Services Intrastructure

Context Information
- M2M Infrastructure
- WAN Connectivity

Semantics
- Gateway / Aggregator
- Local Network
- IoT Devices
- Chipsets

Specs for real-world City Infrastructure (buildings, roads, lampposts etc)

Normative groups: Human Factors, EMTEL, eHealth, ISG ARF, ITS, ISG CIM, SmartM2M, oneM2M, 3GPP, TC CYBER, SAREF, ATTM, DECT & U & DECT-20, SmartBAN, ISG MEC, ERM

KPI groups: ATTM SDMC, ISG OEU, EE

Guides: ISG CDP, USER, AIOTI (WG3 & WG8)

No groups from ETSI, but many from CEN/CENELEC and ISO etc

2

ETSI activites related to IoT (alphabetical links)

3GPP (3rd Generation Partnership Project)

ATTM (Access, Terminals, Transmission and Multiplexing)

ATTM SDMC (Sustainable Digital Multiservice Cities)

CYBER (CyberSecurity)

DECT & ULE (Digital Enhanced Cordless Telecommunications)

EE (Environmental Engineering)

eHealth

EMTEL (Emergency Communications)

ERM (EMC and Radio Spectrum Matters)

Human Factors

ISG ARF (Augmented Reality Framework)

ISG CDP (City Digital Profile)

ISG CIM (Context Information Management)

ISG MEC (Multi-access Edge Computing)

ISG OEU (Operational Energy Efficiency for Users)

ITS (Intelligent Transport Systems)

oneM2M

SmartBAN (Smart Body-Area Networks)

SmartM2M & SAREF (*) (Smart Appliances REFerence Ontology)

USER

Context Information Management using NGSI-LD API: Introduction, Whitepaper, Use Cases, Specification

ETSI

1

Introduction

Context Information Management using NGSI-LD API

Presented by: ETSI ISG CIM   For: Public review

15 January 2019

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Introduction in 9 Sections

☐ ETSI ISG CIM Mission: link up all data sources

☐ How info-exchange can help cities

☐ How can all THAT Information be handled ?

☐ Example: The happy policeman

☐ Information Model and Query Language

☐ Architectures

☐ Problem: A babel of Ontologies

☐ Not alone !

☐ NGSI-LD CURRENT STATUS

3

ETSI GR CIM 002 V1.1.2 (2018-09)

GROUP REPORT

Context Information Management (CIM);
Use Cases (UC)

USE CASES

PUBLISHED

2

ETSI White Paper No. 31

NSGI-LD API:
for Context Information Management

1st edition – January 2019
ISBN No. 1234

Whitepaper explains concepts

This whitepaper explains the main concepts behind a new data exchange protocol called NGSI-LD which aims to make it easier to find and exchange information with open databases, mobile Apps and IoT platforms. It fills the gap between brief press releases and detailed specification documents for NGSI-LD API and related use cases .

4

Draft ETSI GS CIM 004 V0.0.11 (2018-02)

GROUP SPECIFICATION

NGSI-LD API

Context Information Management (CIM);
Application Programming Interface (API)

PUBLISHED

© ETSI 2019

4

MISSION OF ETSI ISG CIM

... to make it easier
for END-USERS
and CITY DATABASES
and IoT internet-of-things
and 3rd-party APPS
to exchange INFO
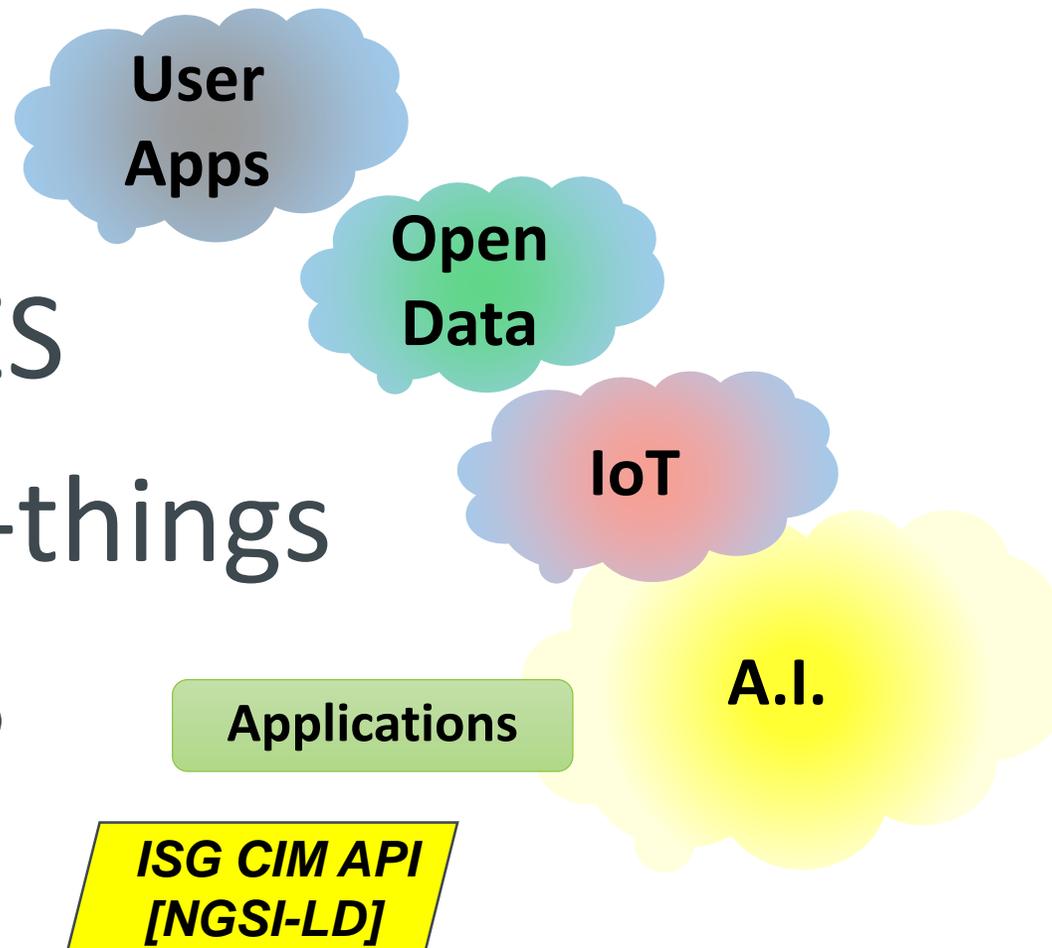
User Apps

Open Data

IoT

A.I.

Applications

ISG CIM API [NGSI-LD]

Context Information Management: exchange data AND definitions (ontology)

Solve the issues

ETSI

A.I.

APPs
APPs
APPs

User Apps

Provenance

IoT

Context Information Management

Open Data

Usage

Proprietary Data

Context Information Management:
exchange data AND definitions (ontology)

Solve the issues

Simple coding!

Highly diverse databases

User Apps

A.I.

APPs
APPs
APPs

Open Data

Context Information Management

Privacy!

Provenance

Usage

High data rate

Ontology re-use

Restricted access

IoT

Proprietary Data
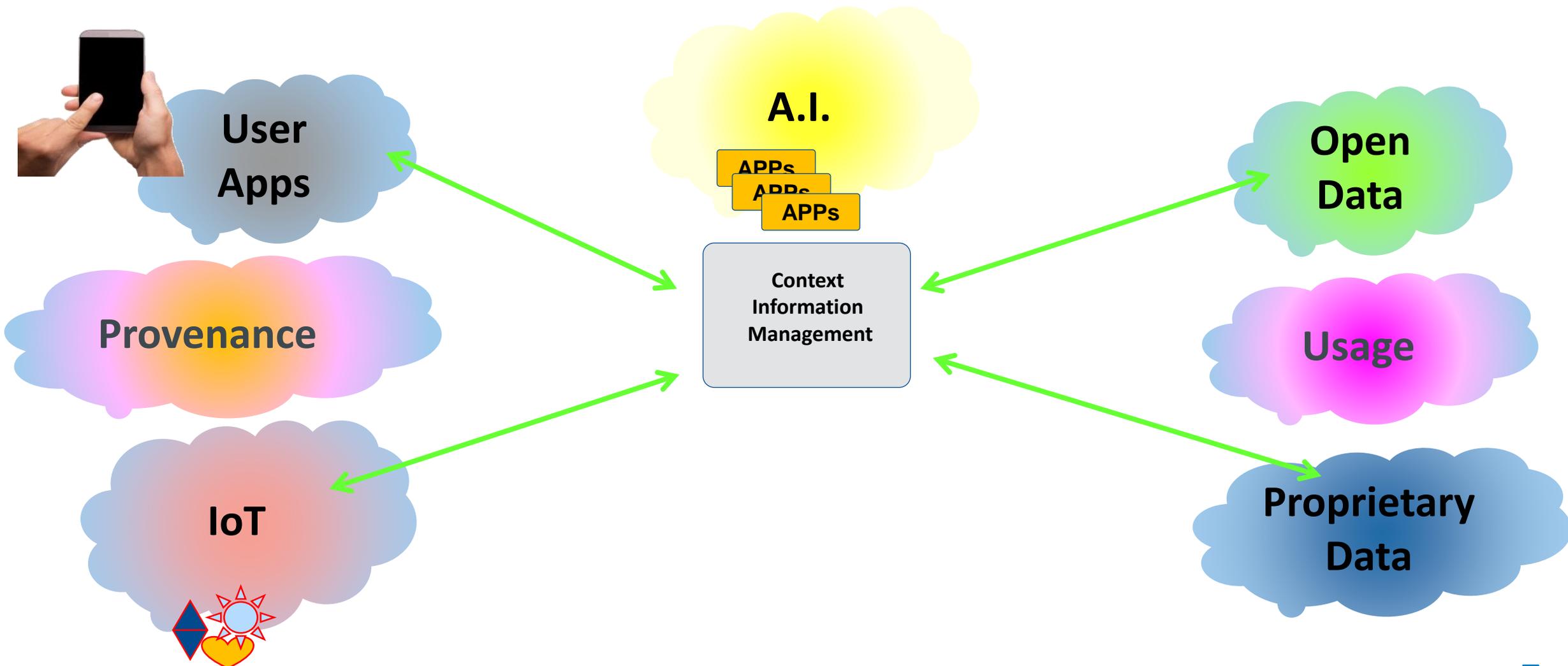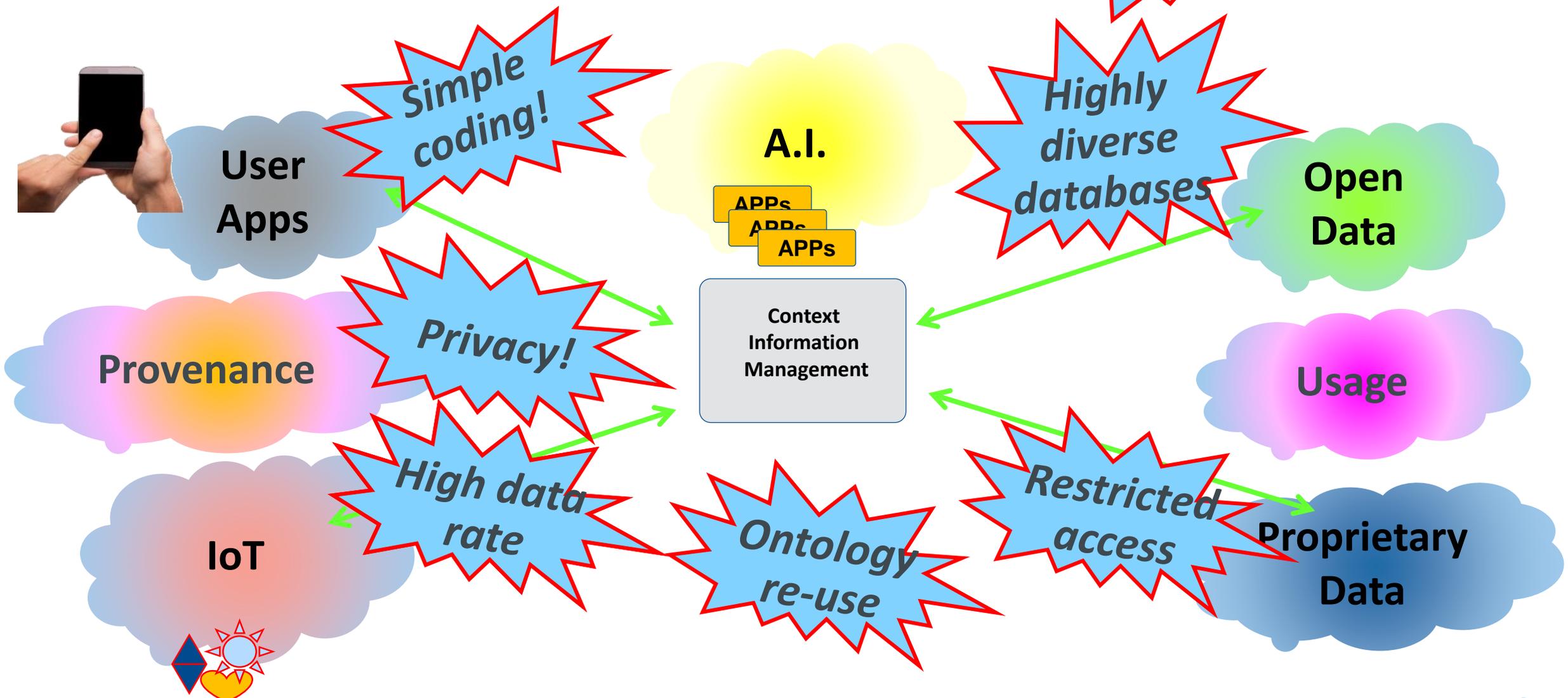
HOW INFO-EXCHANGE CAN HELP CITIES

Common Smart City Components

Smart homes	Smart parking lot	Healthcare	Weather & water systems	Transportation & Vehicular traffic	Environmental pollution	Surveillance Systems
Demand Response	Number of cars	Tracking	Weather condition	Camera monitoring	Green house gas monitoring	CCTV
Fire detection	Departure & arrivals	Identification	Water quality	Environment Monitoring	Energy efficiency monitoring	Violent detection
Temperature monitoring	Environment Monitoring	Data gathering	Water leakage	Travel scheduling	Renewable energy usage	Public place monitoring
Security systems	Mobile ticketing	Sensing	Water level	Traffic jam reduction	Air quality monitoring	People & object tracking
Social network supporting	Traffic congestion control		Water contamination	Assisted driving	Noise pollution monitoring	Traffic police

"Review of Smart Cities based on IoT". https://pdfs.semanticscholar.org/3f4b/5b92464281610010c0c4264d62893567e03c.pdf Energies 2017, 10, 421
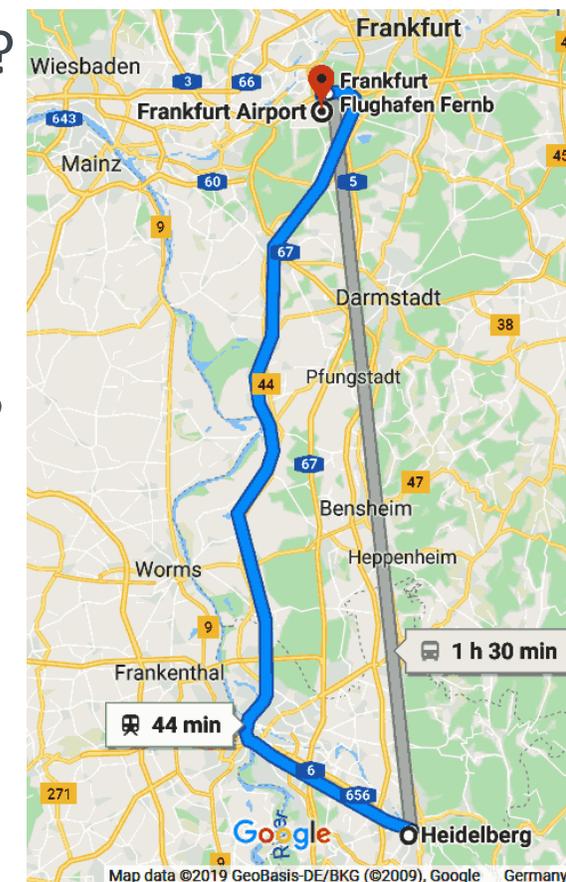
10

Example: Multi-Modal Transport

Lots of people use Google to find public transport from A→ B ?

Why is it so successful?

⩗ OK, it has good maps … ☺

⩗ Google has convinced many/most municipalities to publish transport routes/schedules in a **simple common format GTFS**
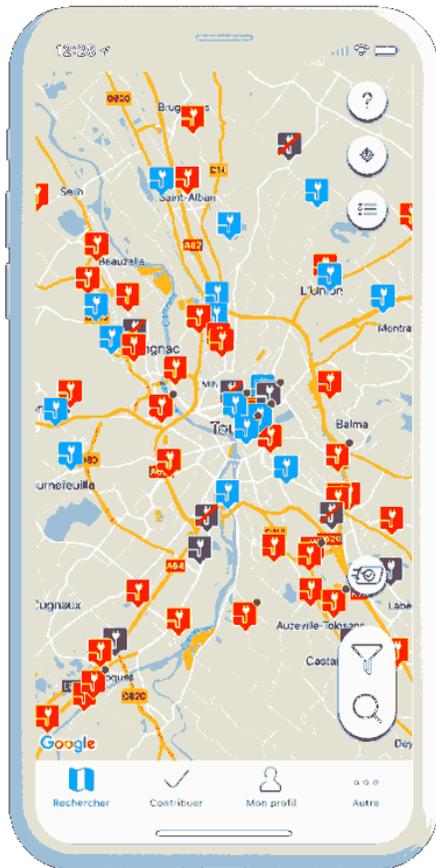

Google. 'GTFS General Transit Feed Spec'. Accessed 20180315 at
https://developers.google.com/transit/gtfs/reference/

Image © Google
https://goo.gl/maps/Bz7thKruraR2

Can ETSI Enable such open systems?
e.g. Electric Vehicle charger Maps ?

See commercial examples
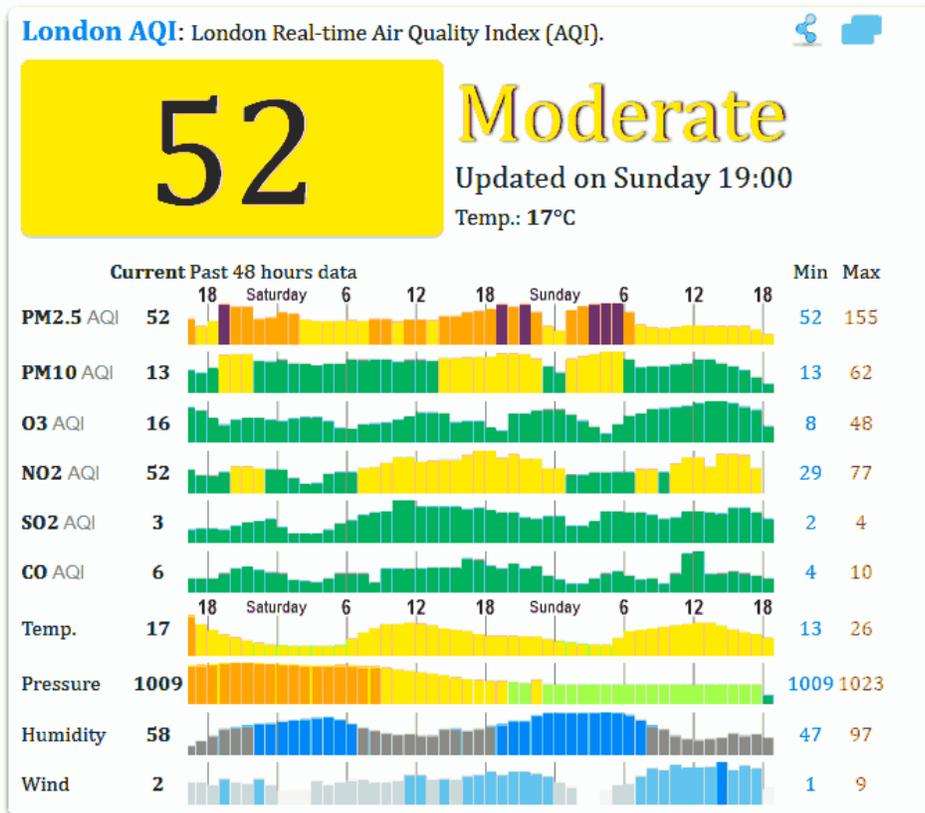https://chargemap.com   or   www.zap-map.com/live/

Can ETSI Enable such open systems?
e.g. Environmental Data overviews?

London Air Pollution: Real-time Air Quality Index (AQI)

| LONDON | BIRMINGHAM | PARIS | BRUSSELS | ROTTERDAM | CHARLEROI | LOCATE THE NEAREST CITY | SEARCH FOR YOUR CITY |

London AQI: London Real-time Air Quality Index (AQI).

52 Moderate
Updated on Sunday 19:00
Temp.: 17°C

Current Past 48 hours data

	Current	Min	Max
PM2.5 AQI	52	52	155
PM10 AQI	13	13	62
O3 AQI	16	8	48
NO2 AQI	52	29	77
SO2 AQI	3	2	4
CO AQI	6	4	10
Temp.	17	13	26
Pressure	1009	1009	1023
Humidity	58	47	97
Wind	2	1	9

2018 was hottest London Marathon !

(C) BBC

20xx London Marathon cancelled: PM10 !

Source: http://aqicn.org/city/london (no endorsement implied)

Examples where NGSI-LD could help create open Apps?

e.g. Show the air-pollution geomap near you

e.g. Show the combined traffic/crime/rental "heat map"
    to help locate a new appartment
    to help city-planners

e.g. Combine public-transport usage data with "special deals"
    on tickets data, to help determine optimum usage ?

e.g. Compare hospital admissions data, with weather and pollution data,

    to help plan emergency services (i.e. reduce spare capacity,
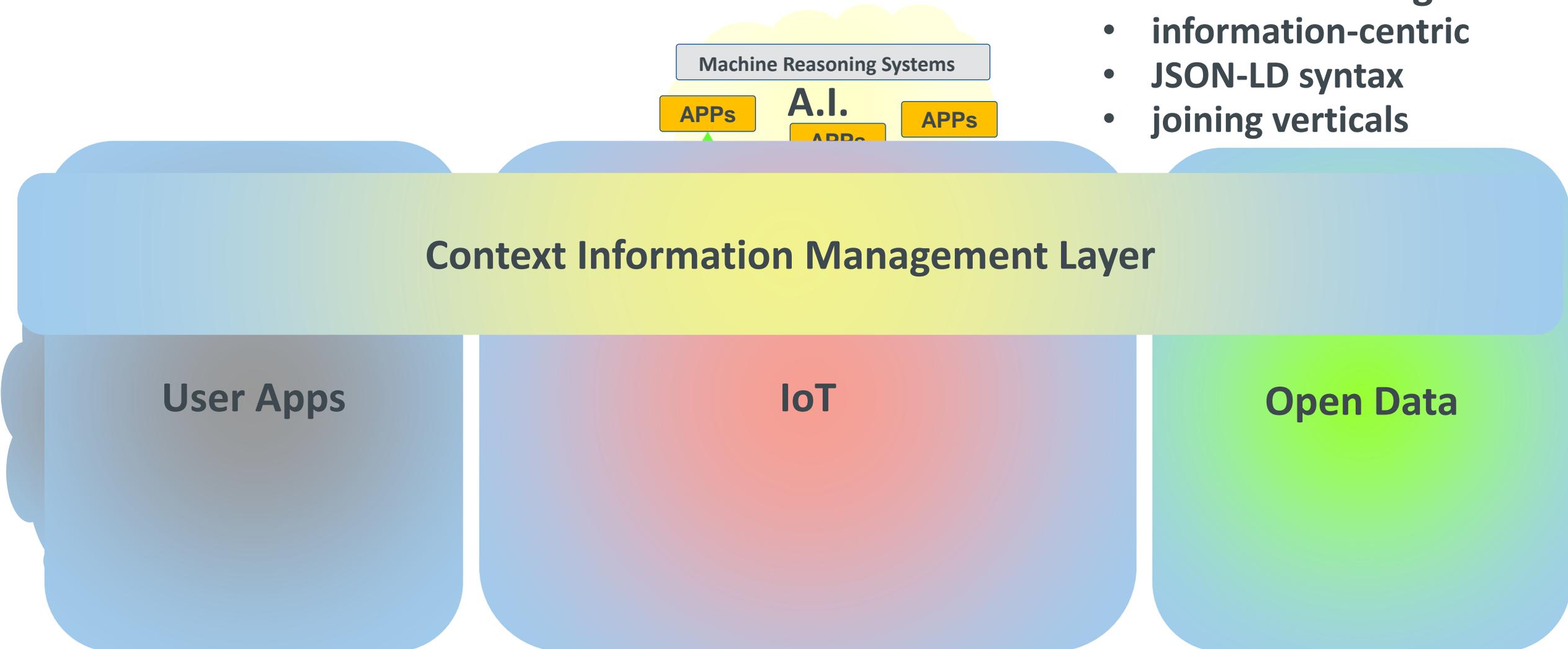   but make sure surges can be covered)

…

HOW CAN ALL THAT INFORMATION BE HANDLED ?

Context Information Management: Joining Verticals Information-centric with developer-friendly NGSI-LD
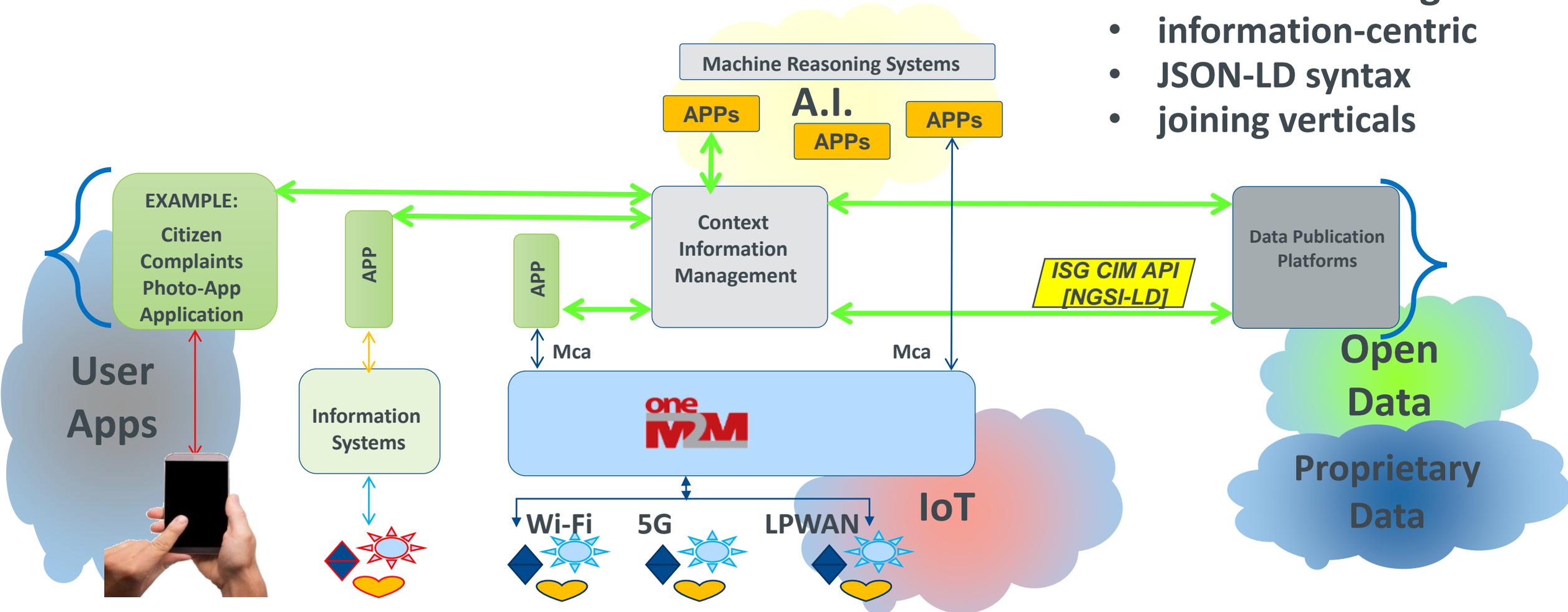

NGSI-LD Advantages
- **information-centric**
- **JSON-LD syntax**
- **joining verticals**

Machine Reasoning Systems

APPs

A.I.

APPs

APPs

Context Information Management Layer

User Apps

IoT

Open Data

Context Information Management Layer: Information-centric with developer-friendly NGSI-LD

NGSI-LD Advantages
- information-centric
- JSON-LD syntax
- joining verticals

Machine Reasoning Systems

A.I.

APPs

APPs

APPs

EXAMPLE: Citizen Complaints Photo-App Application

APP

APP

Context Information Management

Data Publication Platforms

ISG CIM API [NGSI-LD]

User Apps

Information Systems

Mca

Mca

one M2M

Open Data

Proprietary Data

Wi-Fi   5G   LPWAN

IoT

EXAMPLE

Notation for instance diagrams

For reference only

`( Entity Type )` — NGSI-LD Categories/classes/types are round-edged rectangles

- ∨ Rdf/rdfs predicates (such as rdf:type rdfs:subclassof) are represented normally, as labels on the corresponding arcs between the instances or classes

`[ Entity Instance ]` — NGSI-LD Entity Instances are solid (square-angled) rectangles with text in bold

- ∨ text attached to the rectangle, not pasted as separate text block

`< Relationship >` — NGSI-LD Relationships are diamonds, optionally with four "buttons"

- ∨ with arc coming in and out
- ∨ relationship should be read as a label attached to the underlying arc (directed edge) of the main graph
- ∨ Use verbs to describe relationships (as in entity-relationhip diagrams)

`( Property )` — NGSI-LD Properties are ovals

- ∨ with corresponding arc coming in and out
- ∨ Properties can be read as a label attached to the underlying arc (directed edge) of the graph, à la RDF
- ∨ Arc may be omitted if the oval is represented as adjacent to the correponding entity or relationship, à la property graph
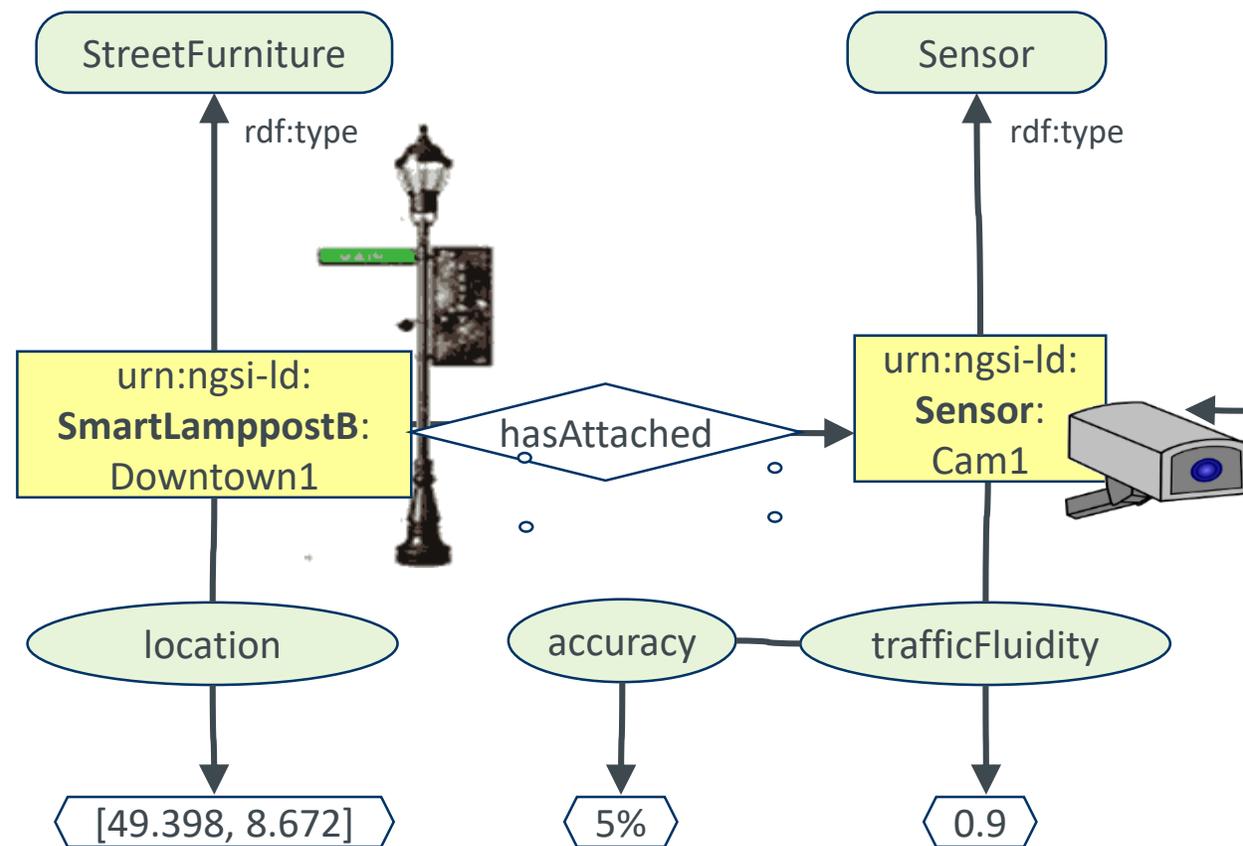
`< Value >` — Values are unfilled hexagons, rather long

All elements must have line boundaries for better printing and PDFs.
Any filled colours can be used to aid readability: except Values are white

19

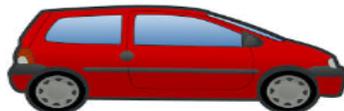# Example: City Hall has smart lampposts

StreetFurniture

Sensor

rdf:type

rdf:type

urn:ngsi-ld: **SmartLamppostB**: Downtown1

hasAttached

urn:ngsi-ld: **Sensor**: Cam1

location

accuracy

trafficFluidity

[49.398, 8.672]

5%

0.9

The townhall database has locations and functions of its smart lampposts

Town Hall and Police Department share info → both more efficient

Vehicle

LegalEntity
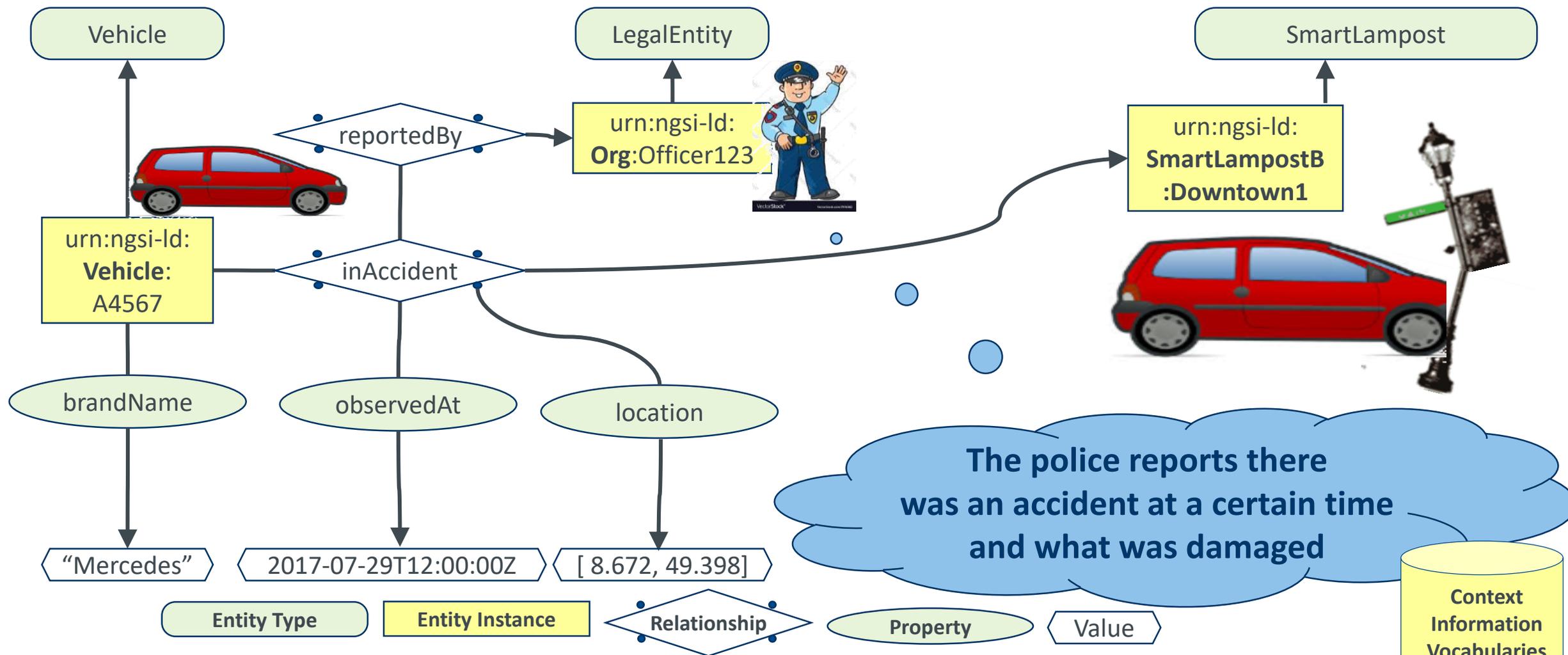
StreetFurniture

The police reports there
was an accident at a certain time
and what was damaged

Every Police Department generates tons of data (defined forms)

Example: Police report an accident
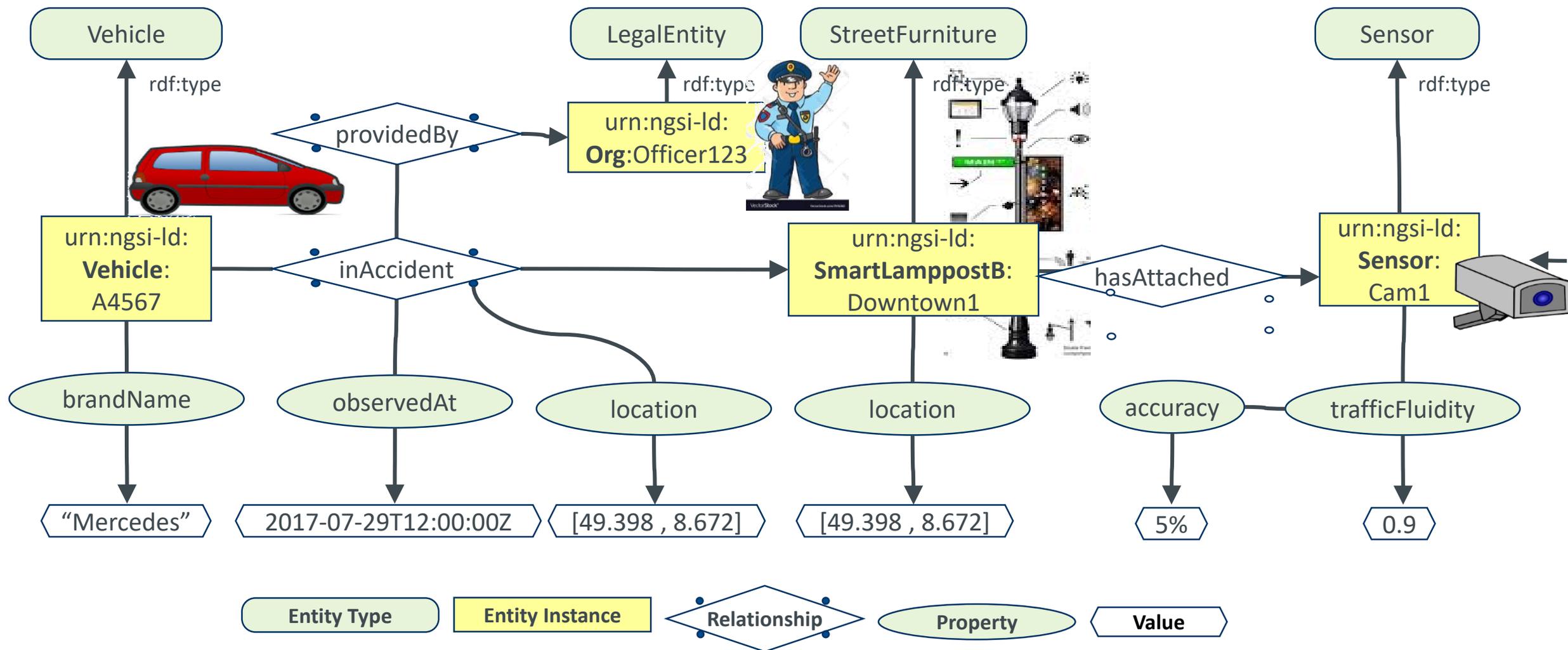
Vehicle

LegalEntity

SmartLampost

reportedBy

urn:ngsi-ld:
Org:Officer123

urn:ngsi-ld:
**SmartLampostB
:Downtown1**

urn:ngsi-ld:
Vehicle:
A4567

inAccident

brandName

observedAt

location

"Mercedes"

2017-07-29T12:00:00Z

[8.672, 49.398]

The police reports there
was an accident at a certain time
and what was damaged

Entity Type

Entity Instance

Relationship

Property

Value

Context
Information
Vocabularies

Town Hall and Police Department share info → *both more efficient*

Example: Combined data Exchange

© ETSI 2019

23

The townhall records smart lampposts in its databases

The town hall records e.g. that a webcam is attached to a specific lamppost and delivers videodata about the street
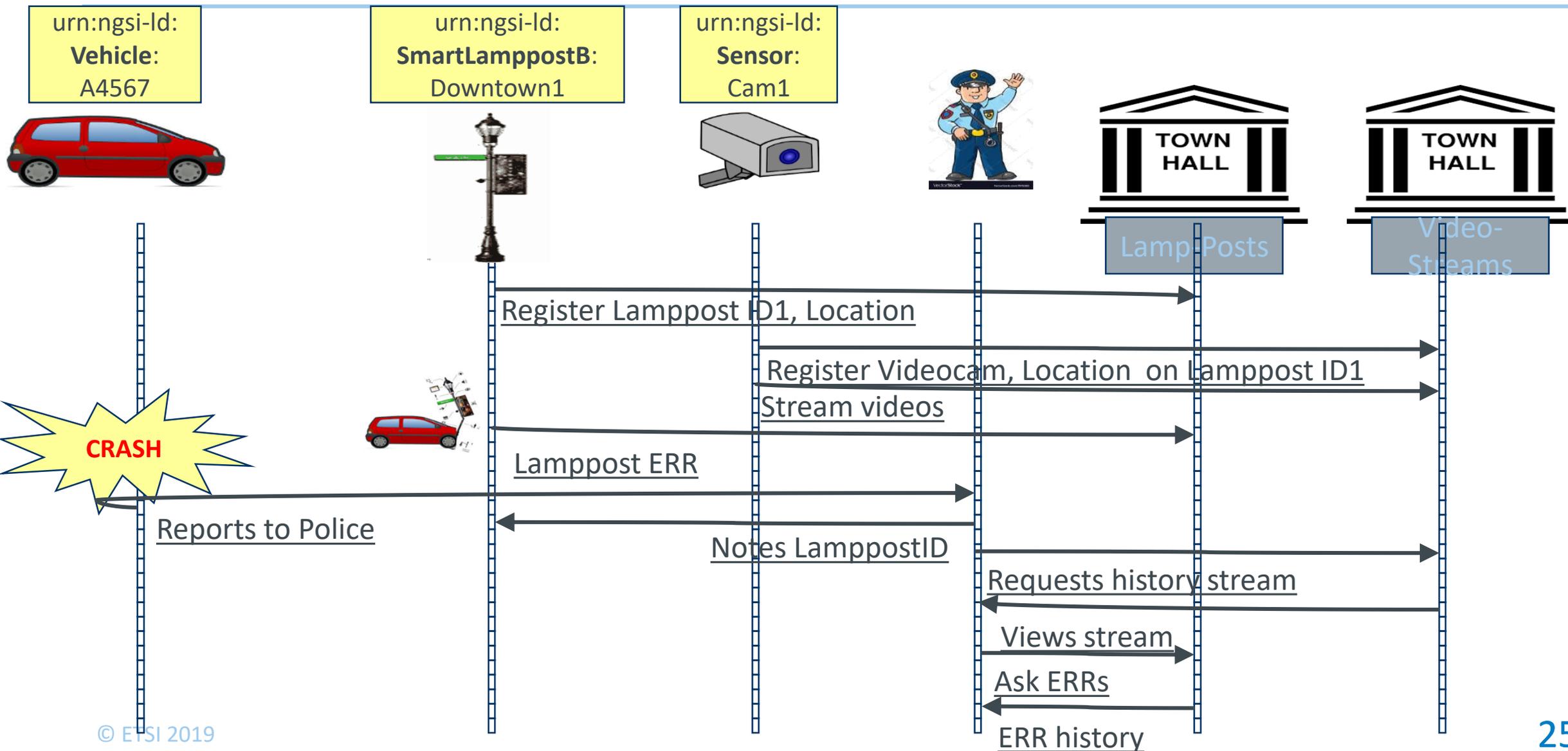
The police department records traffic accidents

A policeman records lamppost at position XY was hit by a car

Townhall can get a notification that a specific lamppost and the data from that lamppost may be affected

Police can query previous data from camera (nearby)

Example: Combined data Exchange: flows

urn:ngsi-ld: **Vehicle**: A4567

urn:ngsi-ld: **SmartLamppostB**: Downtown1

urn:ngsi-ld: **Sensor**: Cam1

TOWN HALL — Lamp-Posts

TOWN HALL — Video-Streams

CRASH

Register Lamppost ID1, Location

Register Videocam, Location on Lamppost ID1

Stream videos

Lamppost ERR

Reports to Police

Notes LamppostID

Requests history stream

Views stream

Ask ERRs

ERR history

25

```
{
    "id": "urn:ngsi-ld:Vehicle:A4567",
    "type": "Vehicle",
    "brandName": {
        "type": "Property",
        "value": "Mercedes"
    },
    "inAccident": {
        "type": "Relationship",
        "object": "urn:ngsi-ld:SmartLamppostB:Downtown1",
        "observedAt": "2017-07-29T12:00:00Z",
        "providedBy": {
            "type": "Relationship",
            "object": "urn:ngsi-ld:Org:Officer123"
        }
    },
}
```

```
"@context": [
        "http://uri.etsi.org/ngsi-ld/coreContext.jsonld",
        "http://example.org/cim/myUserTerms.jsonld"
]
```

- **All terms are defined inside the @context links**
- **The unique URI of each term is sufficient to guarantee whether two applications are using the same data definitions.**

NGSI-LD INFORMATION MODEL

NGSI Entity → Physical or virtual object.

- ᐁ It has (one) Entity Type.
- ᐁ Uniquely identified by an Entity Id (URI)

Entity has zero or more attributes identified by a name

- ᐁ Property --> Static or dynamic characteristic of an entity
  - ᐁ GeoProperty (geospatial context)
  - ᐁ TemporalProperty (time context)
- ᐁ Relationship → Association with a Linked entity (unidirectional)

Properties have a value

- ᐁ Can be a single value (Number, String, boolean), or complex (Array, Structured Value)

Relationships have an object

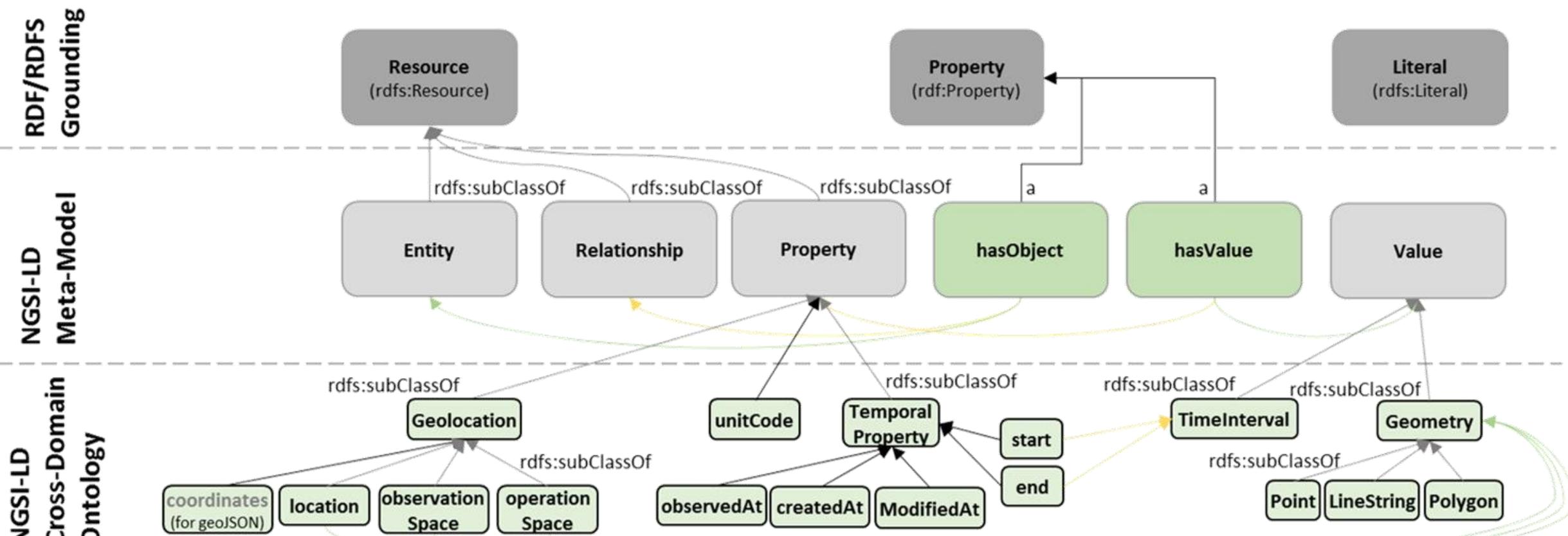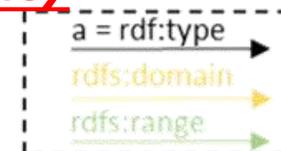- ᐁ A URI pointing to another entity (target of the relationship). Target can be a collection.

28

NGSI-LD Information Model:
Has Entities, Relationships, Properties, Values
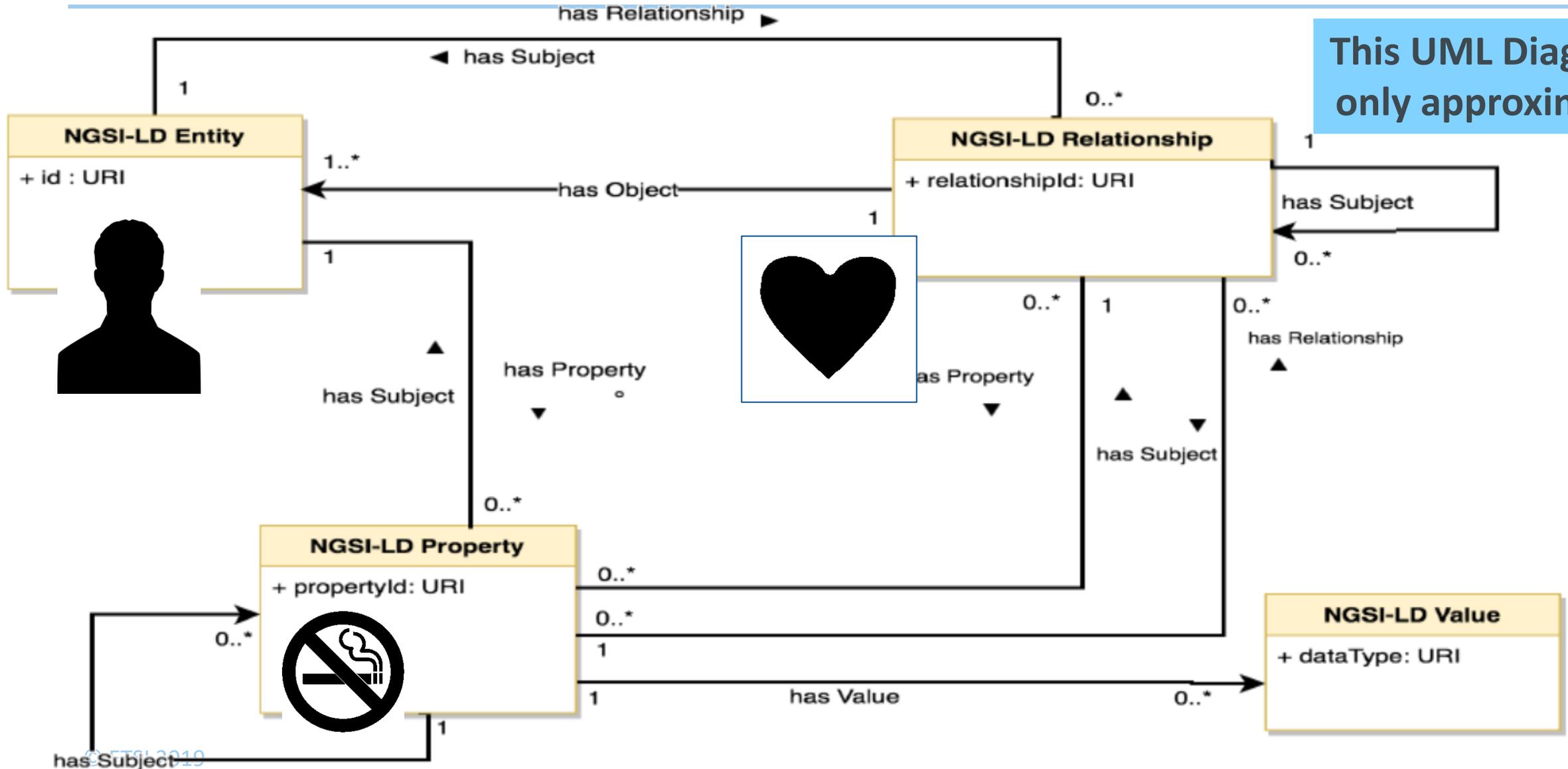
This UML Diagram only approximate
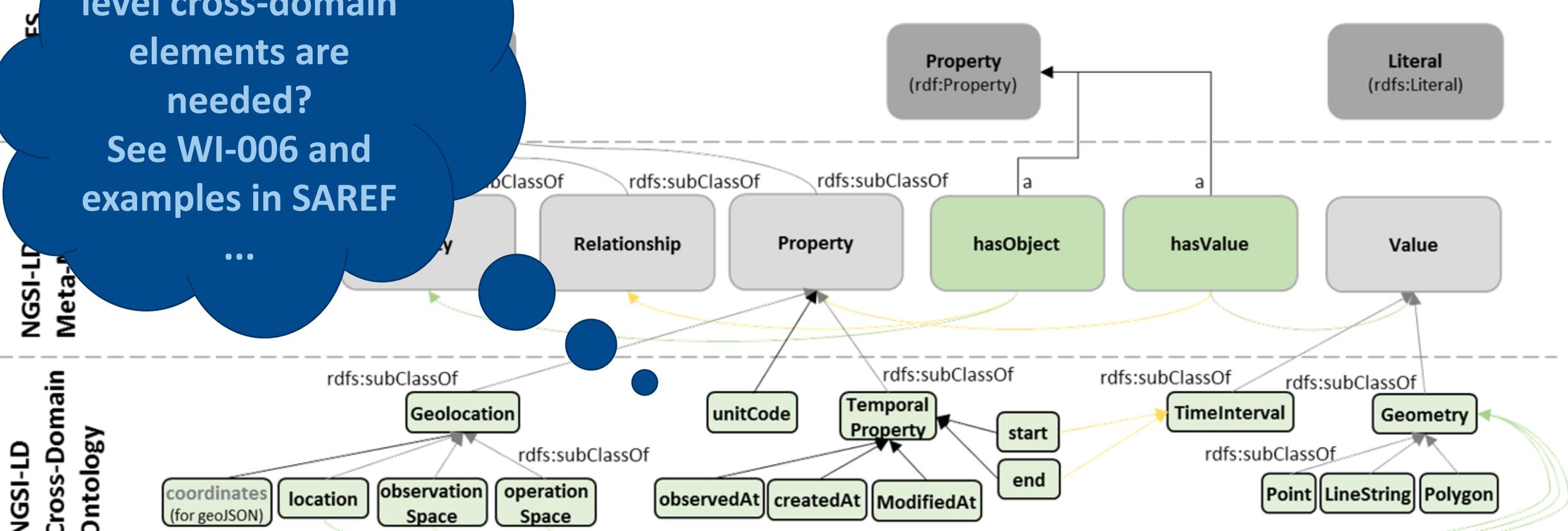
Cross-Domain Ontology provided in NGSI-LD

Need geospatial and temporal elements to be <u>uniquely defined for interoperability</u>

Need geospatial and temporal elements to be uniquely defined for interoperability

What further high-level cross-domain elements are needed?
See WI-006 and examples in SAREF ...

a = rdf:type
rdfs:domain
rdfs:range

Property (rdf:Property)

Literal (rdfs:Literal)

rdfs:subClassOf | rdfs:subClassOf | rdfs:subClassOf

a | a

Relationship | Property | hasObject | hasValue | Value

NGSI-LD Cross-Domain Ontology

rdfs:subClassOf

Geolocation

rdfs:subClassOf

coordinates (for geoJSON) | location | observation Space | operation Space

unitCode | Temporal Property | start | end

observedAt | createdAt | ModifiedAt

rdfs:subClassOf

TimeInterval | Geometry

rdfs:subClassOf

Point | LineString | Polygon

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31

Warning: There is a severe Lack of Meta-data: Provenance, Quality, Licensing

Do you label the source and measurement technique?

Do you use timestamps and geospatial attributes with accuracies?

Do you include a license condition? Or is it "only in the company"

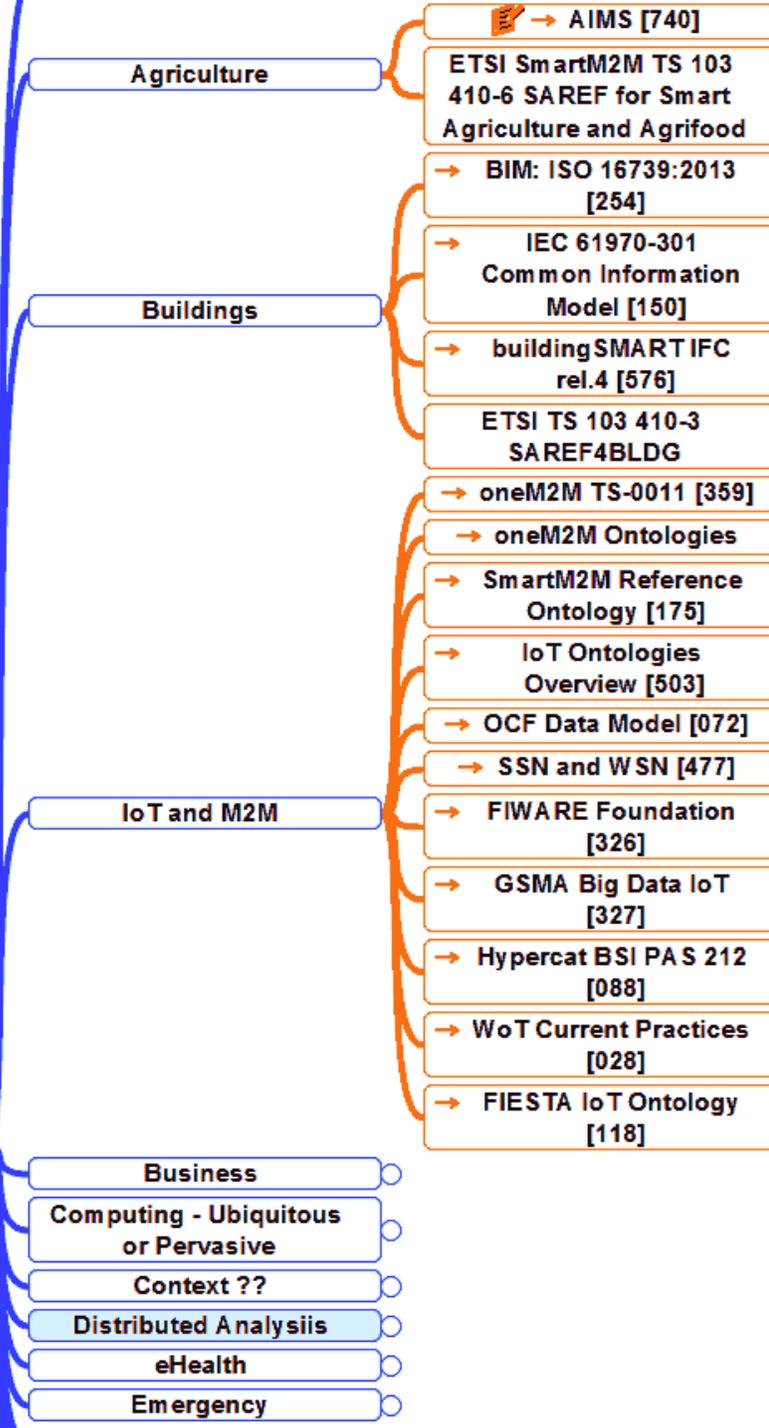Do you tag personal information for faster GDPR responses?

DO YOUR PARTNERS include this data?

Babel: Lack of Domain Consensus

Need consensus in each domain
e.g. Here we see 4 in Buildings
e.g. Here we see dozens in IoT ??

EC has begun regulating to reduce
these barriers to trade / efficiency !
e.g. INSPIRE Directive (deadline 2019)

„To ensure that the spatial data infrastructures
of the Member States are compatible and
usable in a Community and transboundary
context, the INSPIRE Directive requires that
common implementing Rules (IR) are adopted
…" Metadata, Data Specifications, Network Services, Data and Service
Sharing, Spatial Data Services, Monitoring and Reporting

Agriculture
- → AIMS [740]
- ETSI SmartM2M TS 103 410-6 SAREF for Smart Agriculture and Agrifood

Buildings
- → BIM: ISO 16739:2013 [254]
- → IEC 61970-301 Common Information Model [150]
- → buildingSMART IFC rel.4 [576]
- ETSI TS 103 410-3 SAREF4BLDG

IoT and M2M
- → oneM2M TS-0011 [359]
- → oneM2M Ontologies
- → SmartM2M Reference Ontology [175]
- → IoT Ontologies Overview [503]
- → OCF Data Model [072]
- → SSN and WSN [477]
- → FIWARE Foundation [326]
- → GSMA Big Data IoT [327]
- → Hypercat BSI PAS 212 [088]
- → WoT Current Practices [028]
- → FIESTA IoT Ontology [118]

Domain Specific Ontologies / Vocabularies

- Business
- Computing - Ubiquitous or Pervasive
- Context ??
- Distributed Analysiis
- eHealth
- Emergency

Babel: Thousands of Ontologies

Libraries of thousands of vocabularies/ontologies, overlapping

- ISO/IEC 11179 Metadata Registries
- FAIRsharing.org
- Project Open Data
- Open Metadata Registry
- BARTOC Basel Register of Ontologies
- Biomedical Ontologies
- …

Matching up ontologies is MUCH harder than (re)using same ones !

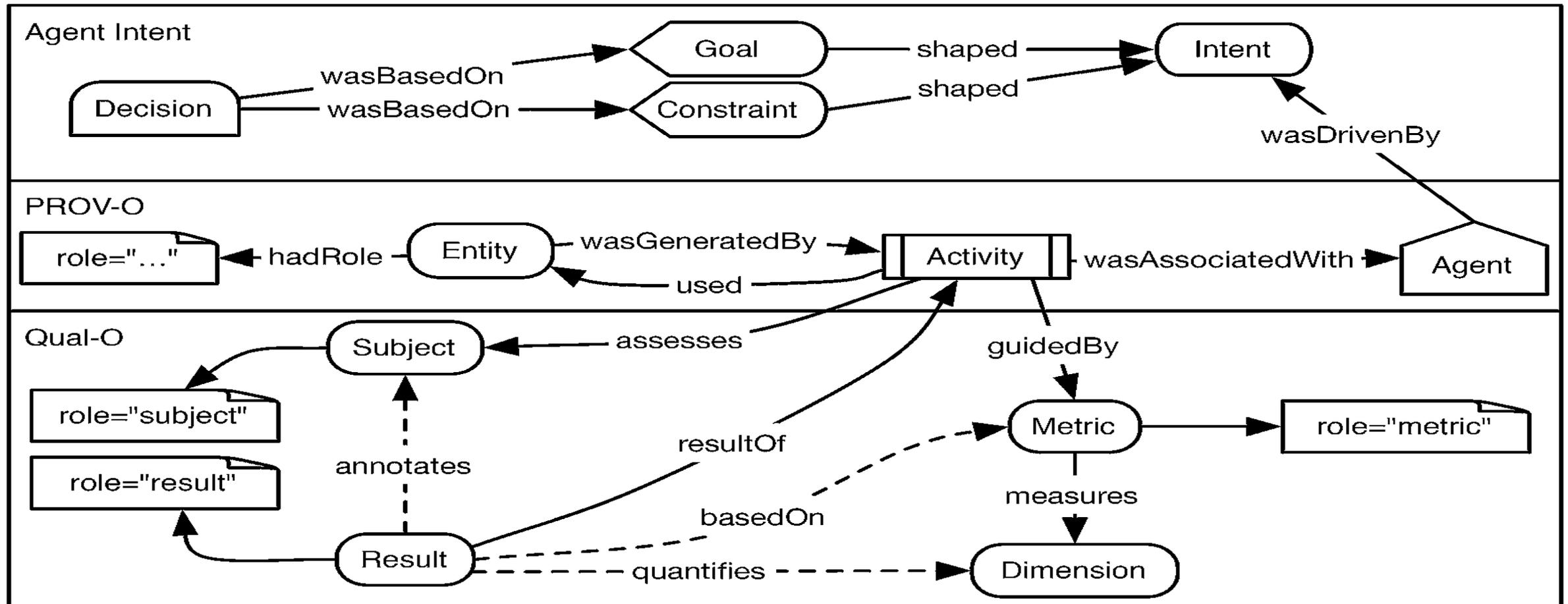**ETSI SmartM2M has SAREF working to help consolidate/bridge ontologies …**

Example extensible system to model KPIs, including key properties like accuracy
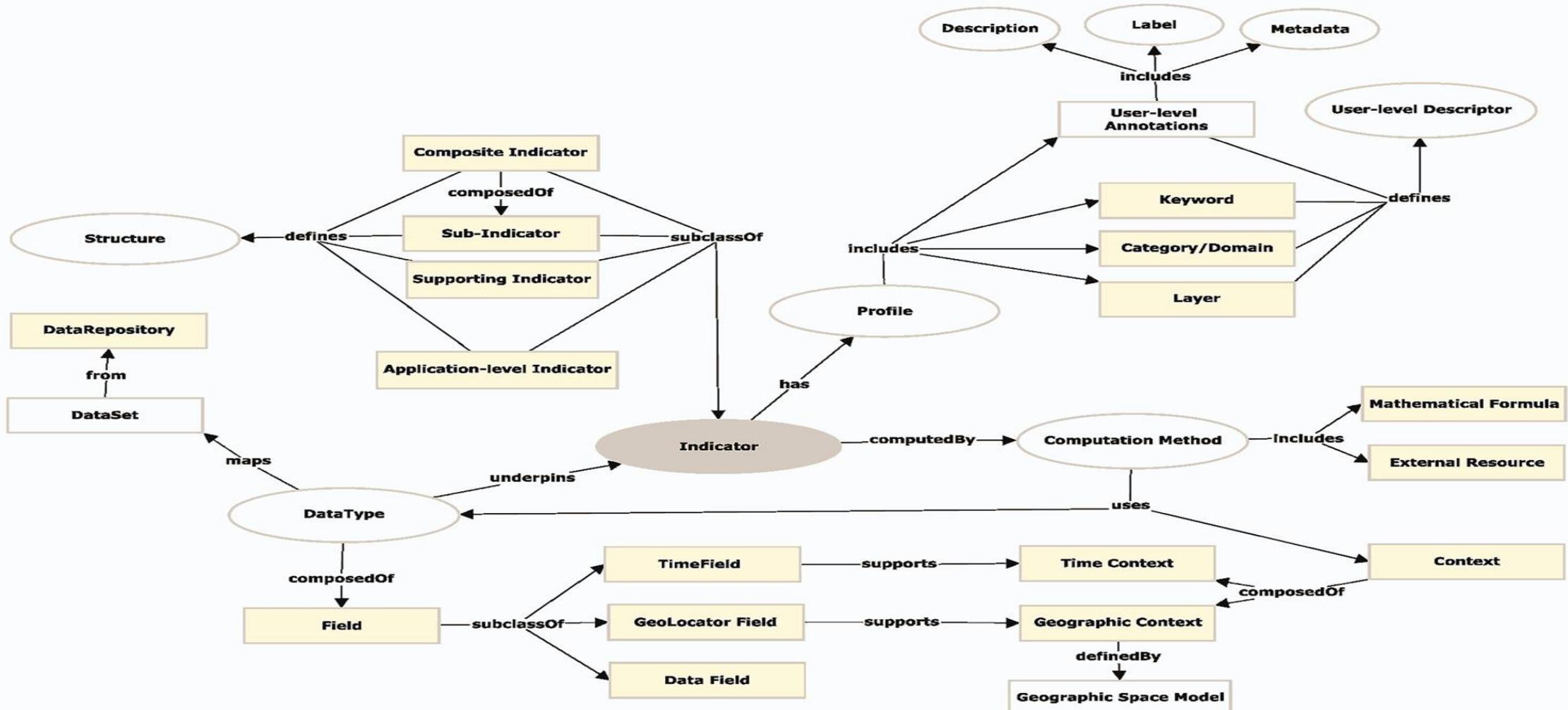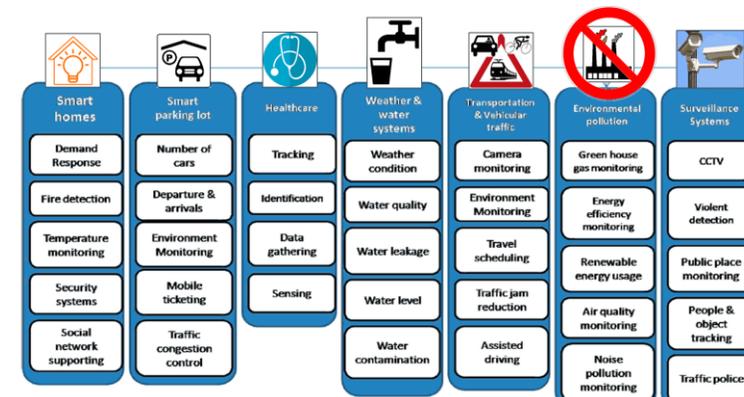
Non-Domain ontologies needed too:
Provenance is often needed, but not fully defined

Example of provenance-aware quality ontology

Conclusions re Information Management

So many Smart City services ….

So many issues in enabling exchange
of meaninful, usable information

Do not wait for perfection …
Get started, collaborate, standardize, improve

"Review of Smart Cities based on IoT". https://pdfs.semanticscholar.org/3f4b/5b92464281610010c0c4264d62893567e03c.pdf Energies 2017, 10, 421

Context Information Management:
exchange data AND definitions (ontology)

PUBLISHED
NGSI-LD API

DON'T GO ALONE !

ETSI ISG CIM collaborations
for Context Information Management
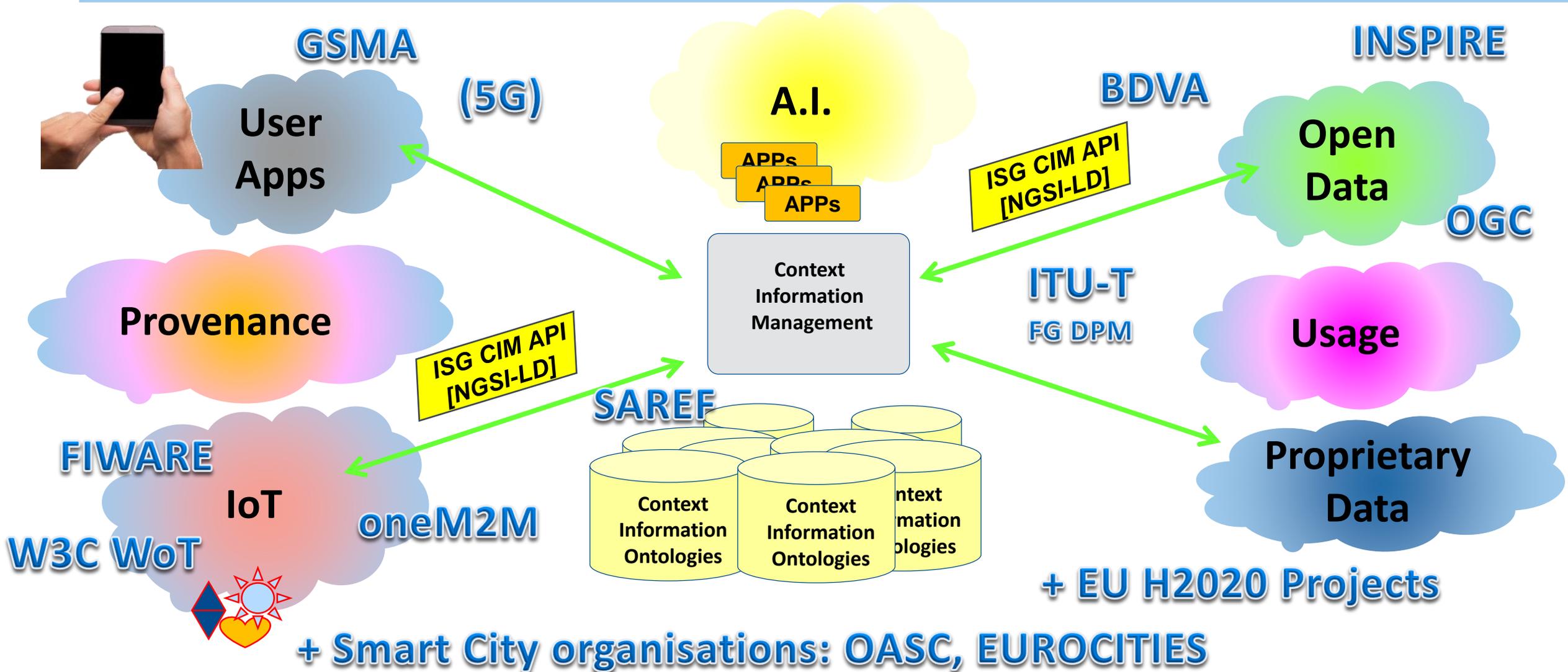
Why do you need context information management ?

A little bit of history ... of Information Management

2 Million BC	First *homo erectus*[1] explorers arrive in Europe from Africa
500,000 BC	Heidelbergensis and Neanderthals arrive using "grunts for hunts"
50-70,000 BC	Homo sapiens arrive. About 1000 wild tribes, immigrants and economic refugees roam Europe in groups of 50-200...talking
5500 B.C.	Hieroglyphics developed[2] in Upper Nile region
196 B.C.	Rosetta Stone (inscribed in Ancient Greek + Egyptian)
1886	First computation of statistics using punch cards[3] (at the New York City Board of Health, by a small startup later renamed as I.B.M.)
2011	Mobile-phones with Google audio translation software

Sources:
1. Salameh, Elias, Klaus Bandel, Ikhlas Alhejoj, and Ghaida Abdallat. "Evolution and Termination of Lakes in Jordan and Their Relevance to Human Migration from Africa to Asia and Europe." Open Journal of Geology 8 (2018): 1113-1132.
2. https://news.yale.edu/2017/06/20/yale-archaeologists-discover-earliest-monumental-egyptian-hieroglyphs
3. https://ethw.org/Early_Punched_Card_Equipment,_1880_-_1951

A little bit of history ... of economics

1776	Adam Smith showed in "An inquiry into the nature and causes of the wealth of nations" that specialization benefits traders
1913	Assembly-line (for Ford Model T) started October 7, Michigan, USA.
2014	More than billion smart phones sold[1] per year (and every year since!)
2019	Half of global shipments of mobile phones are manufactured in China

A little bit of history … of economics

1776	Adam Smith showed in "An inquiry into the nature and causes of the wealth of nations" that specialization benefits traders
1913	Assembly-line (for Ford Model T) started October 7, Michigan, USA.
2014	More than billion smart phones sold[1] per year (and every year since!)
2019	Half of global shipments of mobile phones are manufactured in China

Conclusions ?

Specialization → globalisation → enormous productivity (and resource consumption)
Globalisation + Digitalization → enormous sharing of _virtual_ goods and services globally
Sharing of digital goods/services → enormous reliance on Information Management

Sources:
1. The Economist, page 46 and 51, Jan. 12th 2019

Supply Chains

Virtual Design

Business Processes

BUT … We are still tribal   i.e. OUR CONCEPTS ARE "LOCAL"

A. Spanish and Portugese people in Germany have trouble with government databases because double names are not well recognized (say hallo María Poveda-Villalón !)

B. In Canada a new law permitted single names, e.g. " Rea " as the <u>only</u> name resulted in all government forms and databases needing to change (see guidelines).

C. House addresses in many (most) cities are sequentially numbered odd/even but try finding an address in Venice, Italy for fun ☺

BUT … We are still tribal   i.e. OUR CONCEPTS ARE "LOCAL"

A. Spanish and Portugese people in Germany have trouble with government databases because double names are not well recognized (say hallo María Poveda-Villalón !)

B. In Canada a new law permitted single names, e.g. " Rea " as the only name resulted in all government forms and databases needing to change (see guidelines).

C. House addresses in many (most) cities are sequentially numbered odd/even but try finding an address in Venice, Italy for fun ☺

Sottoportego	path that goes under a building
Canale	broad canal, e.g. Canale Grande
Rio	narrower canal
Rio terra	was once a canal but now a path
Riva	quay
Fondamenta	path along side a canal
Ramo	small street connecting two streets or canals
Calle	used in Venice to denote a street
Ruga	walkway with shop outlets on each side
Salizzada	main paved thoroughfare
Corte	courtyard (usually at end of a street)

Source: https://www.monasterystays.com/?a=newsletter&id=30

Sharing of digital goods/services → enormous reliance on Information Management

Information and Context Information changes from tribe to tribe

e.g. across languages, across nations, across vertical application domains ...

Conclusion: we need a GOOD way to share information ... AND context information

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e.g. did you know, the Rosetta Stone was a declaration of tax-free status for the local temple priests?
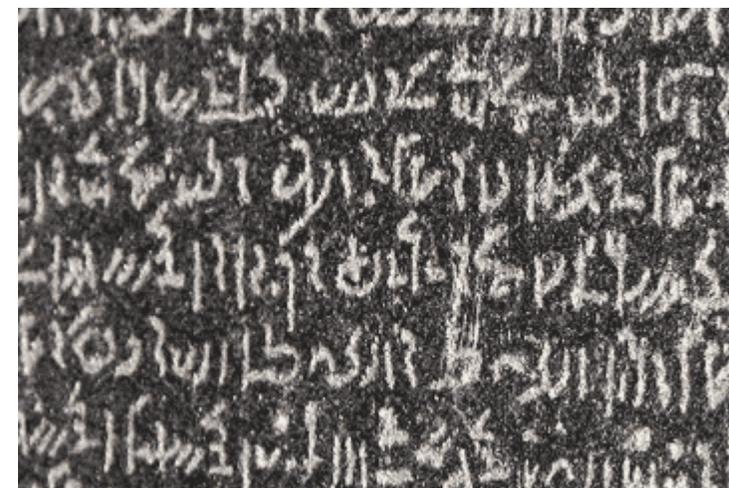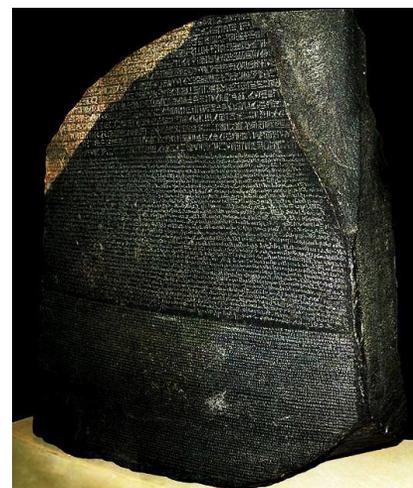
Thank You !

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    Lindsay Frost (NEC)
Vice-chairman:
    Christophe Colinet (EG4U)

Open pages for consensus material:
https://docbox.etsi.org/ISG/CIM/Open
+ visit at: https://portal.etsi.org/CIM

Thank You !

Dr. Lindsay Frost (NEC Labs Europe)

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(Industry Specification Group
Context Information Management)

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