Overview on Smart City

Smart City for Beginners

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Scuola di Ingegneria di Firenze

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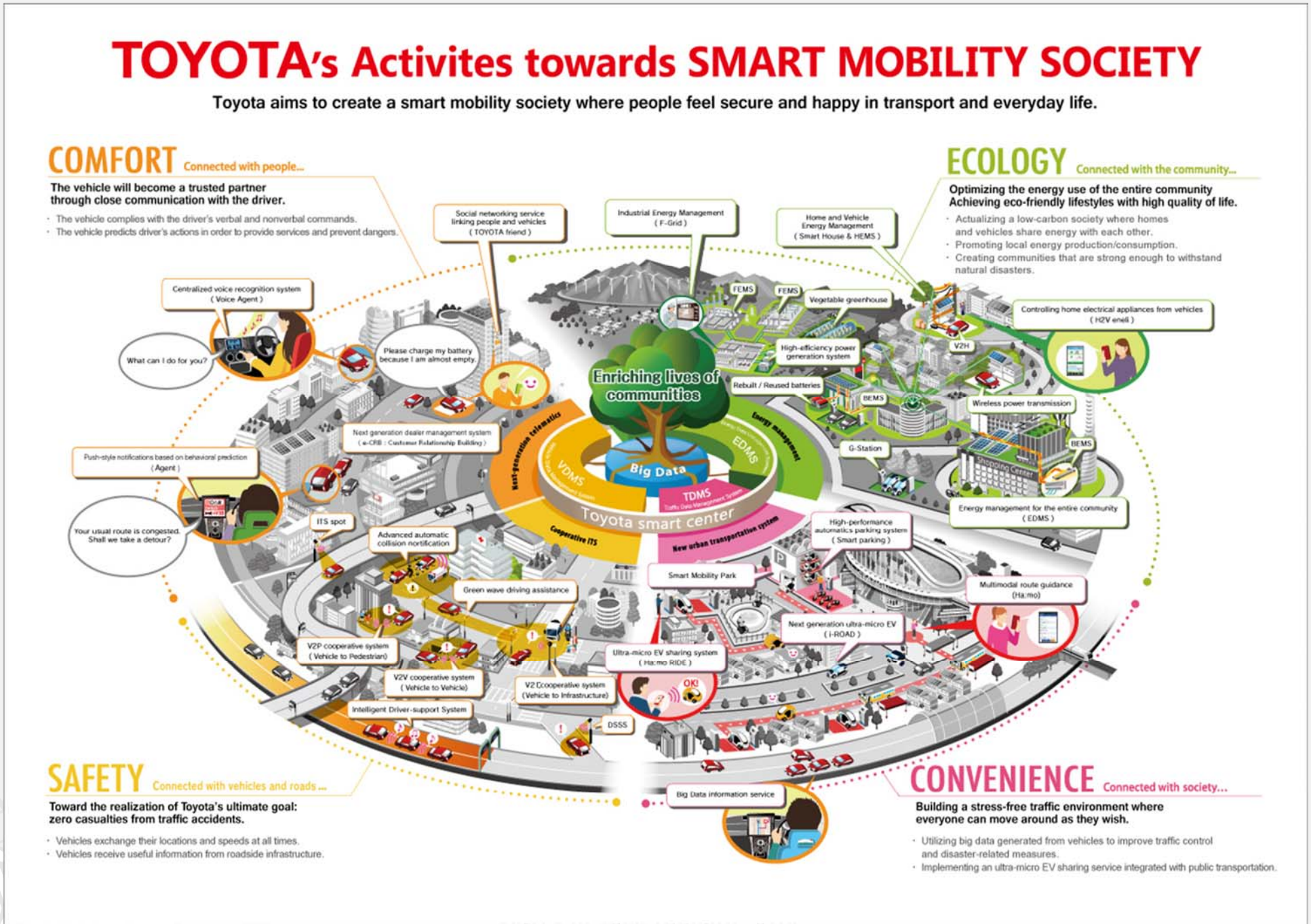
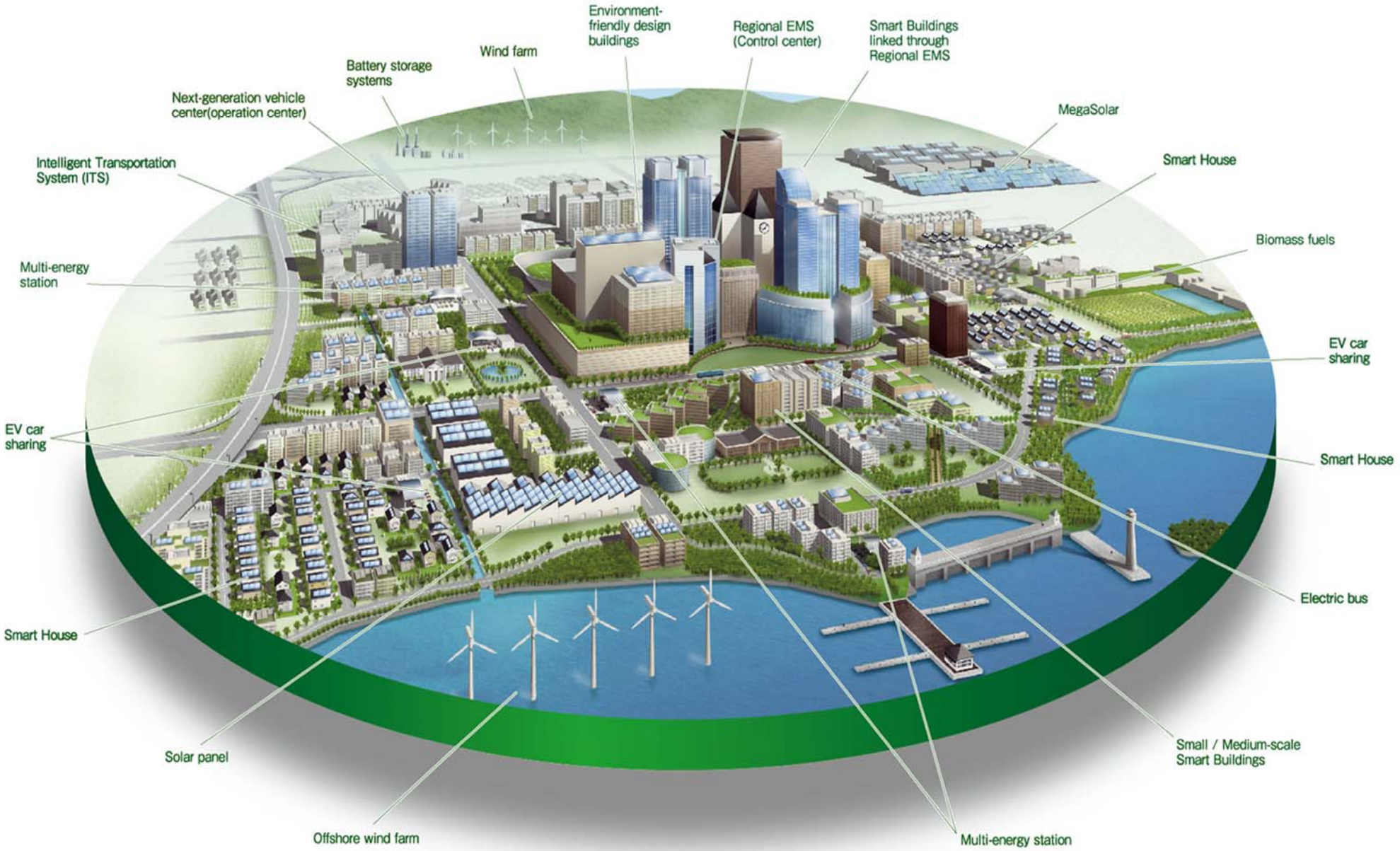
Major topics addressed

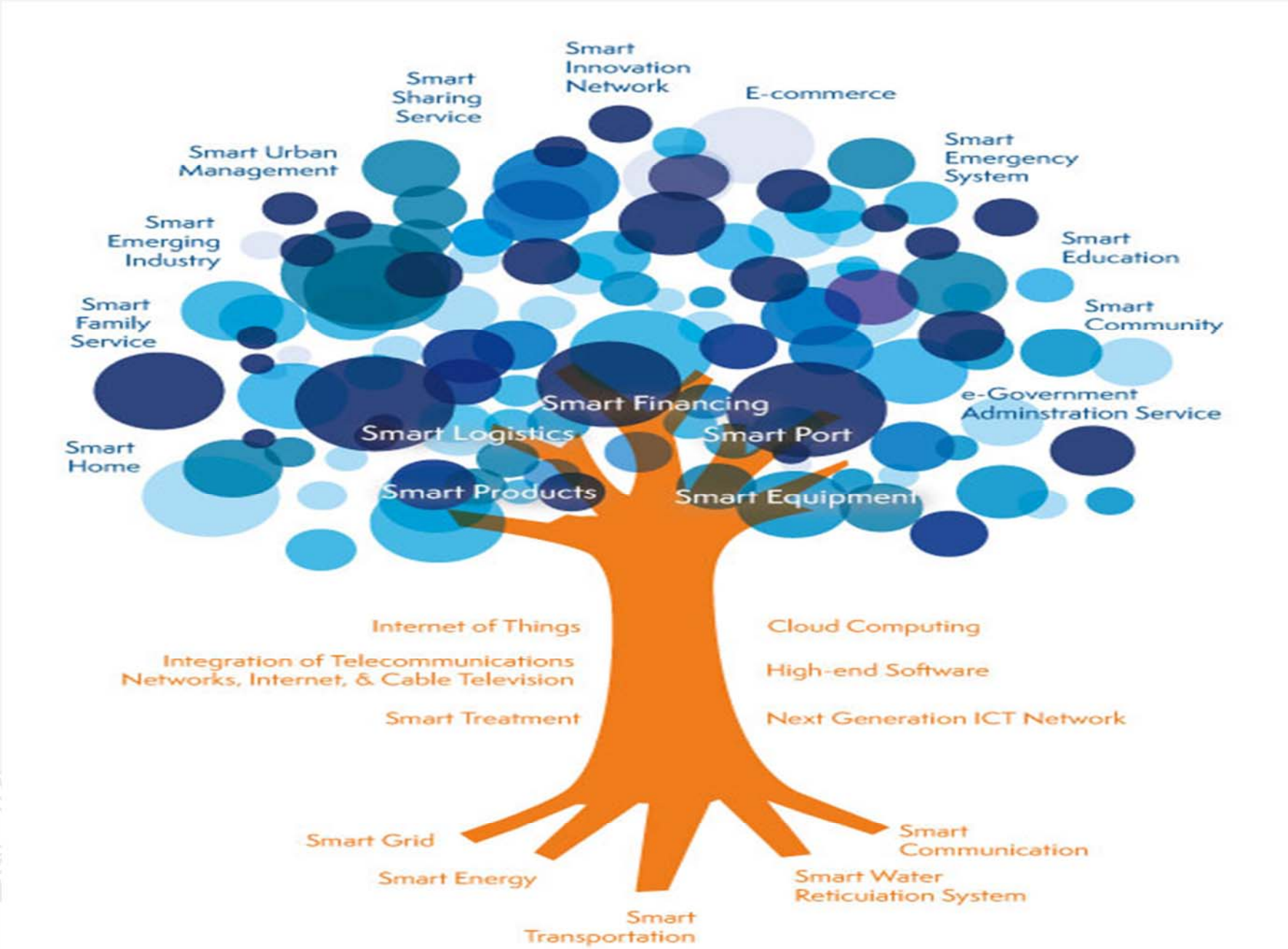
- Smart City Concepts
- Architecture of Smart City Infrastructures
  - Peripheral processors
  - Data ingestion and mining
  - Reasoning and Deduction
  - Data Acting processors
- SmartCity Project Coll@bora
- SmartCity Project Sii-Mobility
- Data Mining and smart City problematic
  - DISIT Smart City Ontology
  - Data ingestion and integration
  - Service Map and Linked Open Graph
- Blog Vigilance via Natural Language Processing

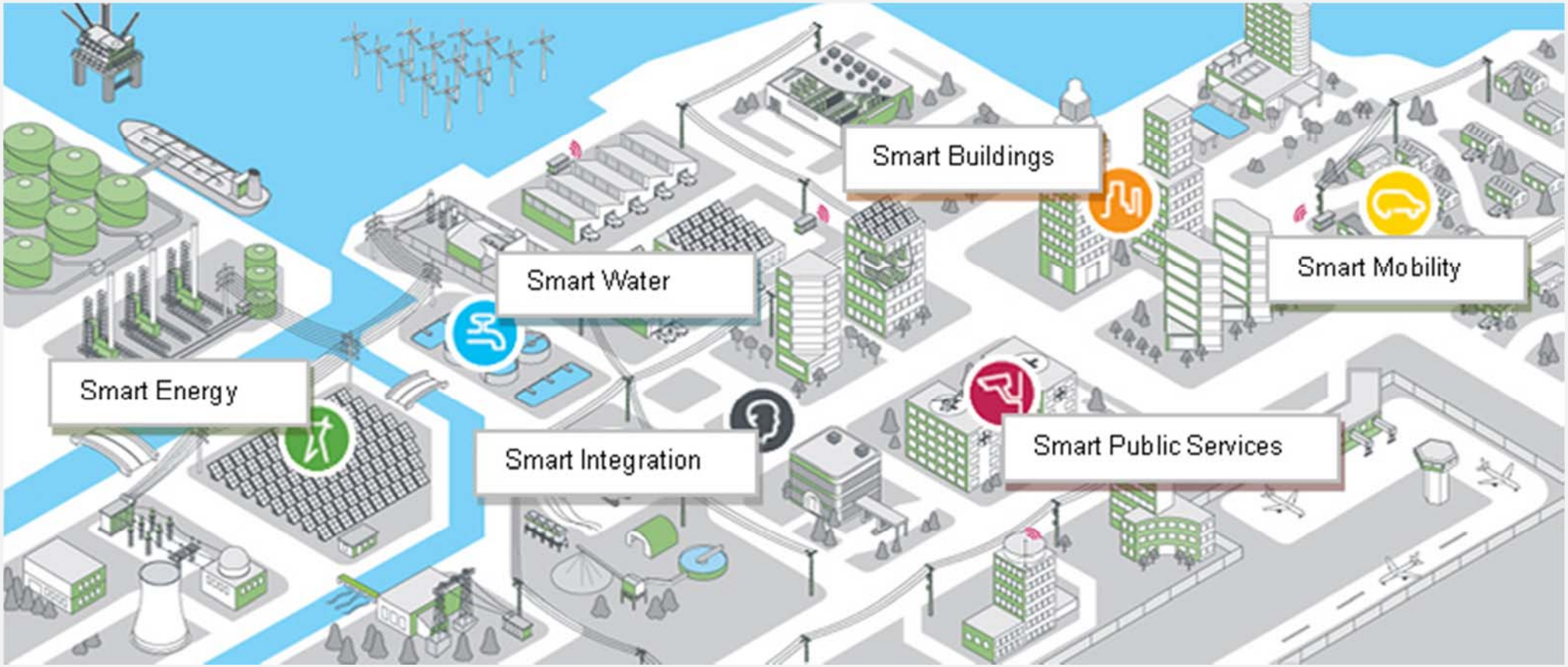
Motivations

- **Societal challenge**
  - We see a strong increment of population of our cities, since in the cities the life is simple and of higher quality in term of services and working opportunities
  - The cities needs to be adapted to the increment of population, to new evolving ages, to the new technologies and expectations of population
- → Sustainability of the growth


TOYOTA's Activites towards SMART MOBILITY SOCIETY
Toyota aims to create a smart mobility society where people feel secure and happy in transport and everyday life.
COMFORT Connected with people...
The vehicle will become a trusted partner through close communication with the driver.
The vehicle complies with the driver's verbal and nonverbal commands.
The vehicle predicts driver's actions in order to provide services and prevent dangers.
ECOLOGY Connected with the community...
Optimizing the energy use of the entire community Achieving eco-friendly lifestyles with high quality of life.
Actualizing a low-carbon society where homes and vehicles share energy with each other.
Promoting local energy production/consumption.
Creating communities that are strong enough to withstand natural disasters.
Social networking service linking people and vehicles (TOYOTA friend)
Industrial Energy Management (F-Grid)
Home and Vehicle Energy Management (Smart House & HEMS)
Centralized voice recognition system (Voice Agent)
What can I do for you?
Please charge my battery because I am almost empty.
FEMS
FEMS
Vegetable greenhouse
Controlling home electrical appliances from vehicles (H2V ene8)
V2H
High-efficiency power generation system
Rebuilt / Reused batteries
BEMS
Wireless power transmission
BEMS
G-Station
Enriching lives of communities
Big Data
VDMS
EDMS
TDMS
Toyota smart center
Next generation dealer management system (e-CRB : Customer Relationship Building)
Push-style notifications based on behavioral prediction (Agent)
Your usual route is congested. Shall we take a detour?
ITS spot
Advanced automatic collision notification
Green wave driving assistance
V2P cooperative system (Vehicle to Pedestrian)
V2V cooperative system (Vehicle to Vehicle)
V2I Cooperative system (Vehicle to Infrastructure)
Intelligent Driver-support System
DSSS
Energy management for the entire community (EDMS)
High-performance automatics parking system (Smart parking)
Smart Mobility Park
Multimodal route guidance (Ha:mo)
Next generation ultra-micro EV (i-ROAD)
Ultra-micro EV sharing system (Ha:mo RIDE)
OK!
Big Data information service
SAFETY Connected with vehicles and roads ...
Toward the realization of Toyota's ultimate goal: zero casualties from traffic accidents.
Vehicles exchange their locations and speeds at all times.
Vehicles receive useful information from roadside infrastructure.
CONVENIENCE Connected with society...
Building a stress-free traffic environment where everyone can move around as they wish.
Utilizing big data generated from vehicles to improve traffic control and disaster-related measures.
Implementing an ultra-micro EV sharing service integrated with public transportation.


Environment-friendly design buildings
Regional EMS (Control center)
Smart Buildings linked through Regional EMS
Wind farm
Battery storage systems
Next-generation vehicle center(operation center)
MegaSolar
Intelligent Transportation System (ITS)
Smart House
Biomass fuels
Multi-energy station
EV car sharing
EV car sharing
Smart House
Electric bus
Smart House
Solar panel
Small / Medium-scale Smart Buildings
Offshore wind farm
Multi-energy station


Smart Innovation Network
Smart Sharing Service
E-commerce
Smart Urban Management
Smart Emergency System
Smart Emerging Industry
Smart Education
Smart Family Service
Smart Community
e-Government Adminstration Service
Smart Financing
Smart Logistics
Smart Port
Smart Home
Smart Products
Smart Equipment
Internet of Things
Cloud Computing
Integration of Telecommunications Networks, Internet, & Cable Television
High-end Software
Smart Treatment
Next Generation ICT Network
Smart Grid
Smart Communication
Smart Energy
Smart Water Reticuiation System
Smart Transportation


Smart Buildings
Smart Water
Smart Mobility
Smart Energy
Smart Integration
Smart Public Services

Sustainability of the Growth

- To be **planned and managed** with respect to increment of population and their needs
  - increment of efficiency:
    - compensation of the increments of costs
  - Increment of quality of life:
    - compensation of the decrement of quality of life
  - provisioning of new services:
    - compensation of the inadequacy of services
  - Decision support for strategic aspects
    - Corrections, prediction, new services, etc.
- **Towards citizens**
  - Informing citizens on the new adaptations, making them aware about that
  - Forming citizens to adopt virtuous behaviour in the usage of services and resources

Smartness, smart city needs 6 features

- Smart Health
- Smart Education
- Smart Mobility
- Smart Energy
- Smart Governmental
  - Smart economy
  - Smart people
  - Smart environment
  - Smart living
- Smart Telecommunication

Smart health

(can be regarded as smart governmental)

- Online accessing to health services:
  - booking and paying
  - selecting doctor
  - access to EPR (Electronic Patient Record)
- **Monitoring** services and users for,
  - learn people behavior, create collective profiles
  - personalized health
  - Inform citizens to the risks of their habits
  - Improve efficiency of services
  - redistribute workload, thus reducing the peak of consumption

Smart Education

(can be regarded as smart governmental)

- Diffusion of ICT into the schools:
  - LIM, PAD, internet connection, tables, ..
- Primary and secondary schools → university → industry & services
- **Monitoring** the students and quality of service,
  - learn student behavior, create collective profiles,
  - personalized education
- suggesting behavior to
  - Informing the families
  - moderate the peak of consumption
  - increase the competence in specific needed sectors, etc.
  - Increase formation impact and benefits

Smart Mobility

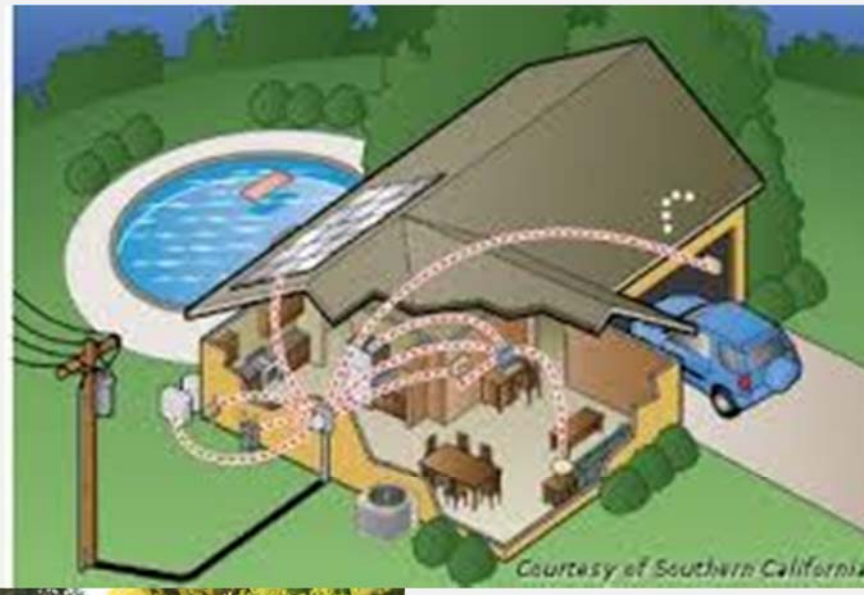
- Public transportation:
  - bus, railway, taxi, metro, etc.,
- Public transport for services:
  - garbage collection, ambulances,
- Private transportation:
  - cars, delivering material, etc.
- New solutions (public and/or private):
  - electric cars, car sharing, car pooling, bike sharing, bicycle paths
- Online:
  - ticketing, monitoring travel, infomobility, access to RTZ, parking, etc.

Smart Mobility and urbanization

- **Monitoring** the city status,
  - learn city behavior on mobility
  - learn people behavior
  - create collective profiles
  - tracking people flows
- **Providing Info/service**
  - personalized
  - **Info** about city status to
  - help moving people and material
  - education on mobility,
  - moderate the peak of consumption
- **Reasoning to**
  - make services sustainable
  - make services accessible
  - Increase the quality of service

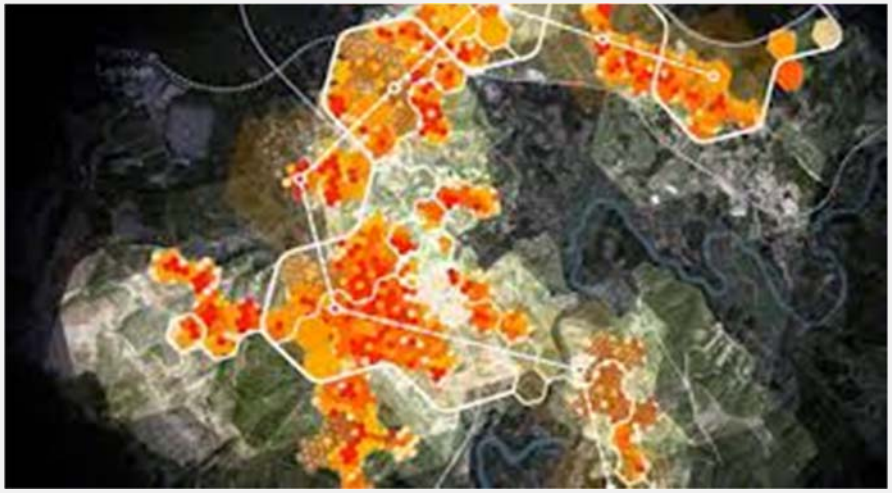
Smart Energy

- **Smart building:**
  - saving and optimizing energy consumption, district heating
  - renewable energy: photovoltaic, wind energy, solar energy, hydropower, etc.
- **Smart lighting**:
  - turning on/off on the basis of the real needs
- **Energy points for electric**: c
  - ars, bikes, scooters,
- **Monitoring** consumption, learn people/city behavior on energy consumption, learn people behavior, create collective profiles
- Suggesting consumers
  - different behavior for consumption: different time to use the washing machine
- Suggesting administrations
  - restructuring to reduce the global consumption,
  - moderate the peak of consumption



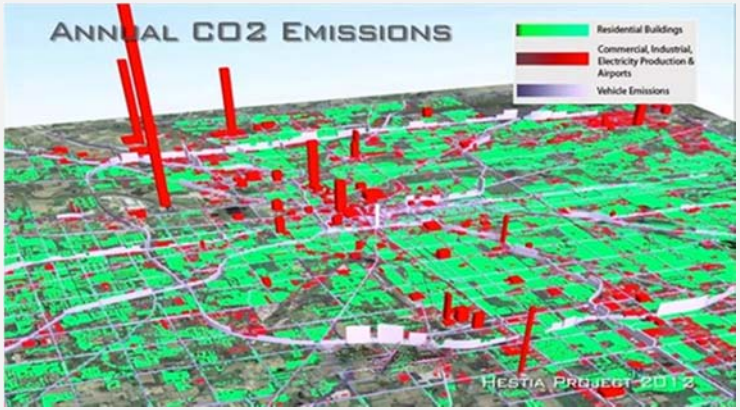
Smart Governmental Services

- Service toward citizens:
  - on-line services:
    - register, certification, civil services,
      taxes, use of soil, …
  - Payments and banking:
    - taxes, schools, accesses
  - Garbage collection:
    - regular and exceptional
  - Quality of air:
    - monitoring pollution
  - Water control:
    - monitoring water quality, water dispersion, river status



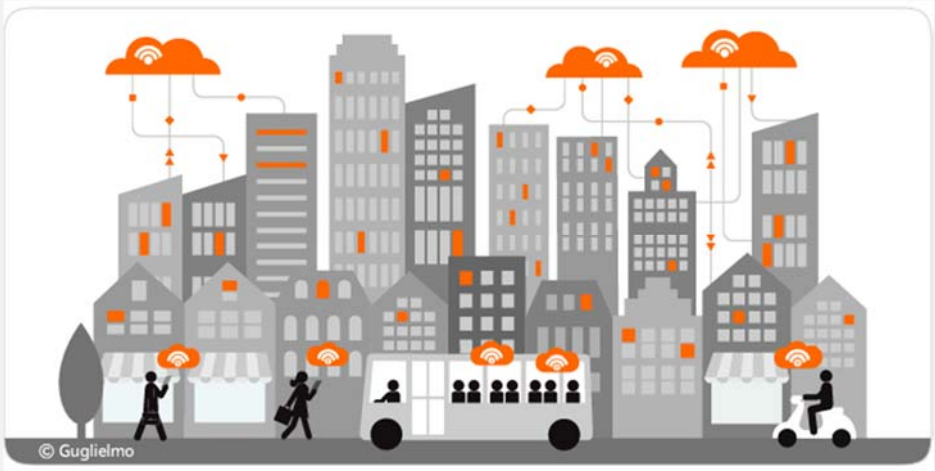
Smart Governmental Services

- **Service toward citizens**:
  - **Cultural Heritage**: ticketing on museums,
  - **Tourism**: ticketing, visiting, planning, booking (hotel and restaurants, etc.)
  - **social networking:** getting service feedbacks, monitoring
- **Social sustainability of services**:
  - crowd services
- **Social recovering** of infrastructure,
  - New services, exploiting infrastructures
- **Monitoring** consumption and exploitation of services, learn people behavior, create collective profiles
  - Discovering problems of services,
  - Finding collective solutions and new needs…



Telecommunication, broadband

- **Fixed Connectivity**:
  - ADSL or more, fiber,
- **Mobile Connectivity**:
  - Public wifi, Services on WiFi, HSPDA, LTE
- **Monitoring** communication infrastructure
- Providing information and formation on:
  - how to exploit the communication infrastructure
  - Exploiting the communication for the other services,
  - moderate the peak of consumption



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Smart City Paradigm




eGov Data collection

Sensors control

Traffic control

Energy central

eHealth Agency

Telecom. Services

.....

Social Media

Peripheral processors

Data Sensors

Data Harvesting

Real Time Data

Social Data trends

Data Ingesting and mining

Smart City Engine

Data processing

Real Time Computing

Reasoning and Deduction

Profiled Services

Profiled Services

Citizens Formation

Data / info Rendering

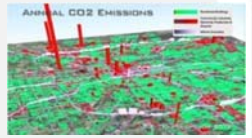
Data / info Exploitation

Suggestions and Alarms

Data Acting processors

Applications



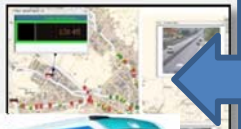



Interoperability


Challenges (addressed by DISIT)








eGov Data collection

Sensors control

Traffic Control

Energy Central

eHealth Agency

Telecom. Services

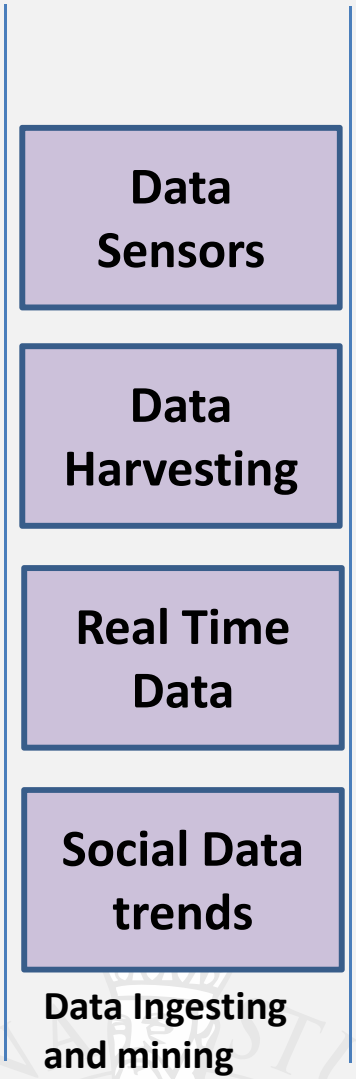
…….

Social Media

Peripheral processors

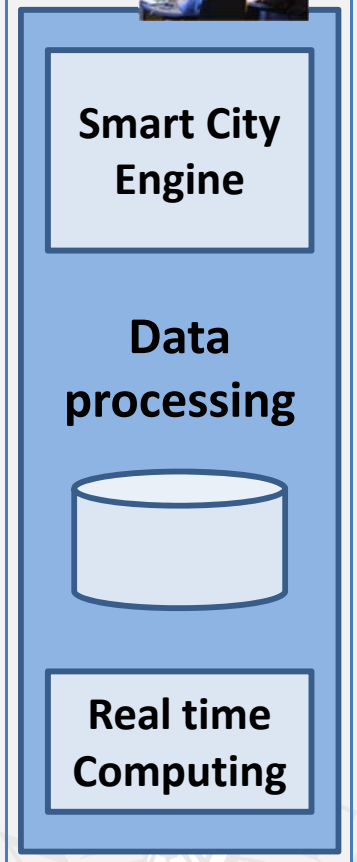
- Social Media blog analysis
- Energy Control for bike sharing
- Wi-Fi as a sensor for people mobility
- Internet of Things as sensors
  - Low costs Bluetooth monitoring devices
  - Vehicle kits with sensors
  - Sensors networks spread in the city and managed by centrals
  - Traffic flow sensors
- ..

Challenges (addressed by DISIT)



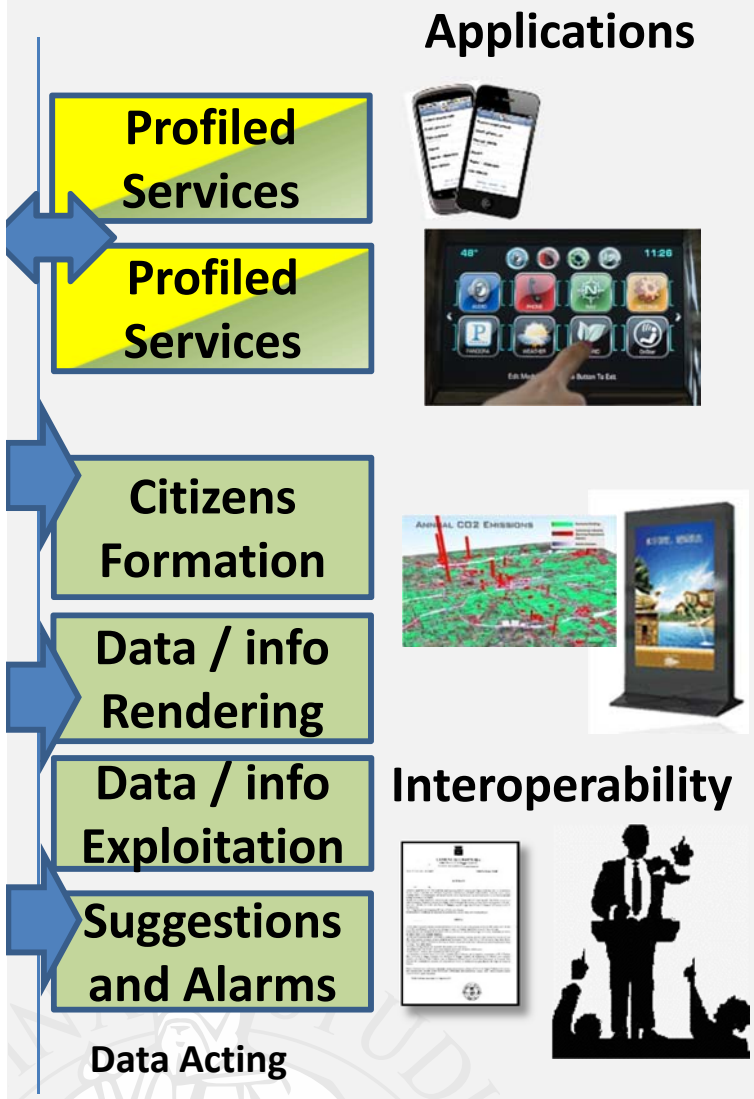
- OD/LOD, Open Data/Linked Open Data:
  - gathering, collection,
- Data Mining:
  - ontology mapping, integration, semantically interoperable
  - reconciliation, enrichment,
  - quality assessment and improvement
- Data Filtering on Streaming
- Blog Vigilance

Challenges (addressed by DISIT)



- **Reasoning and Data processing**
  - Data analytics, Semantic computing
  - Link Discovering
  - Inferential reasoning
  - Identification of critical condition
  - unexpected correlations
  - predictions, etc.
- "Real time" Computing out of peripherals
  - Action / reaction
- **Activation of rules**
  - Firing conditions for activating computing
  - Acceptance of external rules

Challenges (addressed by DISIT)



- User profiling, collective profiles
- Computing Suggestions:
  - Information and formation
  - Virtuous behavior stimulation
  - For citizens and administrators
  - …
- Data export:
  - API, LOD, ..
  - Connection with other Smart City

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Contesto: Smart City

Sii-Mobility (Smart City) nuove tecnologie e soluzioni intelligenti per migliorare l'interoperabilità dei sistemi di gestione, di infomobilità urbana e metropolitana, e di accesso a dati integrati collegati. (TRASPORTI E MOBILITÀ TERRESTRE)

Coll@bora (Smart City → Social Innovation) strumenti collaborativi e di protezione nel supporto fra strutture sanitarie, associazioni e famiglie con disabili. (TECNOLOGIE WELFARE E INCLUSIONE)

Coll@bora

- **Title**: Collaborative Support for Parents and Operators of Disabled
- **Objectives**: providing strong advantages for
  1. Relatives interested in facilitating relations with the management team;
  2. Associations in order to offer a better service to the families and people with disabilities by providing a collaborative support to the involved teams, but also to manage the wealth of knowledge, to support the training of the staff, etc.

  Coll@bora provides a secure collaboration tool for the teams and for the association to support the families and the disabled people.
- **Link**: http://www.disit.dinfo.unifi.it/collabora.html

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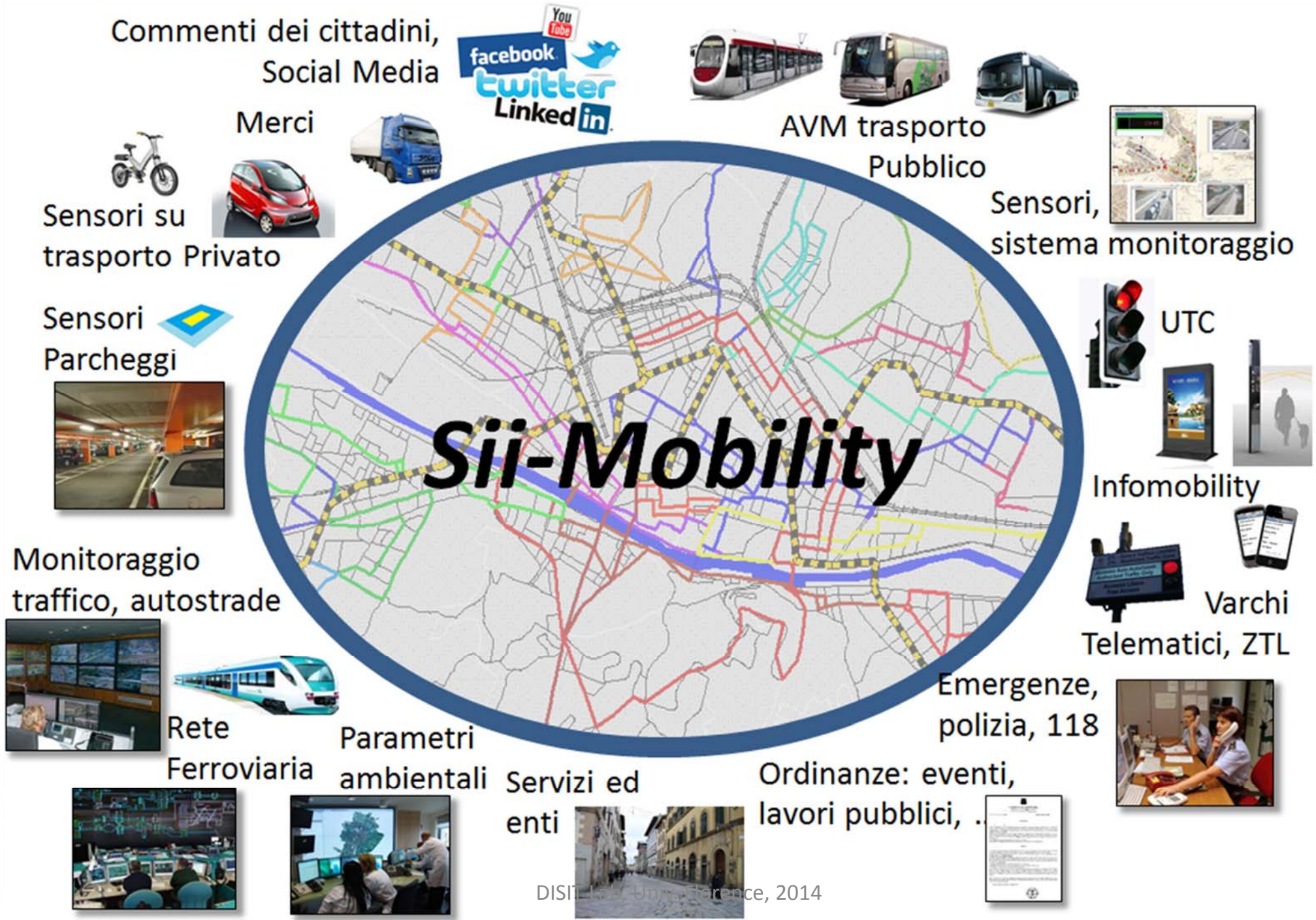
Sii-Mobility

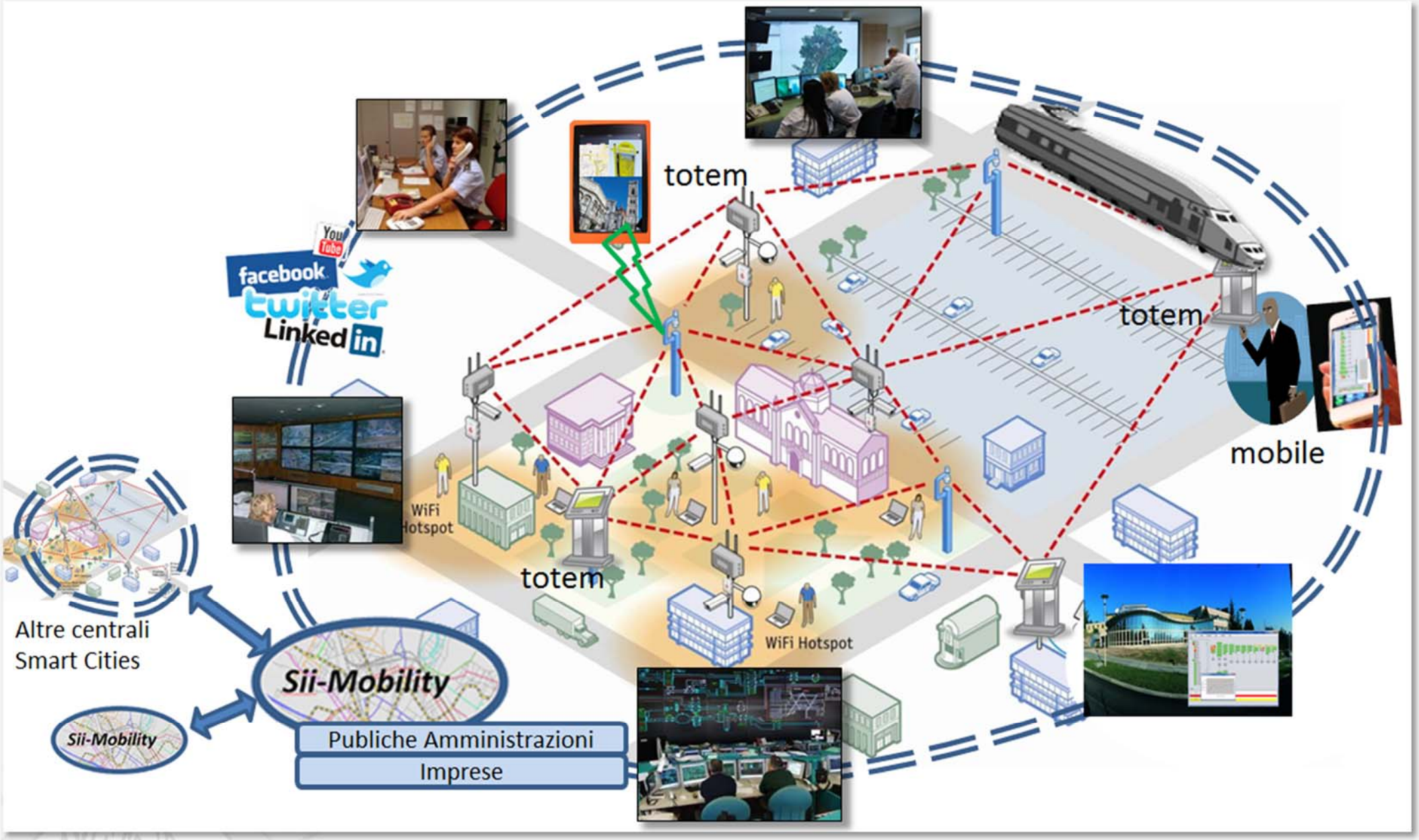
- **Title**: Support of Integrated Interoperability for Services to Citizens and Public Administration
- **Objectives**:
  1. Reduction of social costs of mobility;
  2. Simplify the use of mobility systems;
  3. Developing working solutions and application, with testing methods;
  4. Contribute to standardization organs, and establishing relationships with other smart cities' management systems.

The Sii-Mobility platform will be capable to provide support for SME and Public Administrations. Sii-Mobility consists in a federated/integrated interoperable solution aimed at enabling a wide range of specific applications for private services to citizen and commercial services to SME.

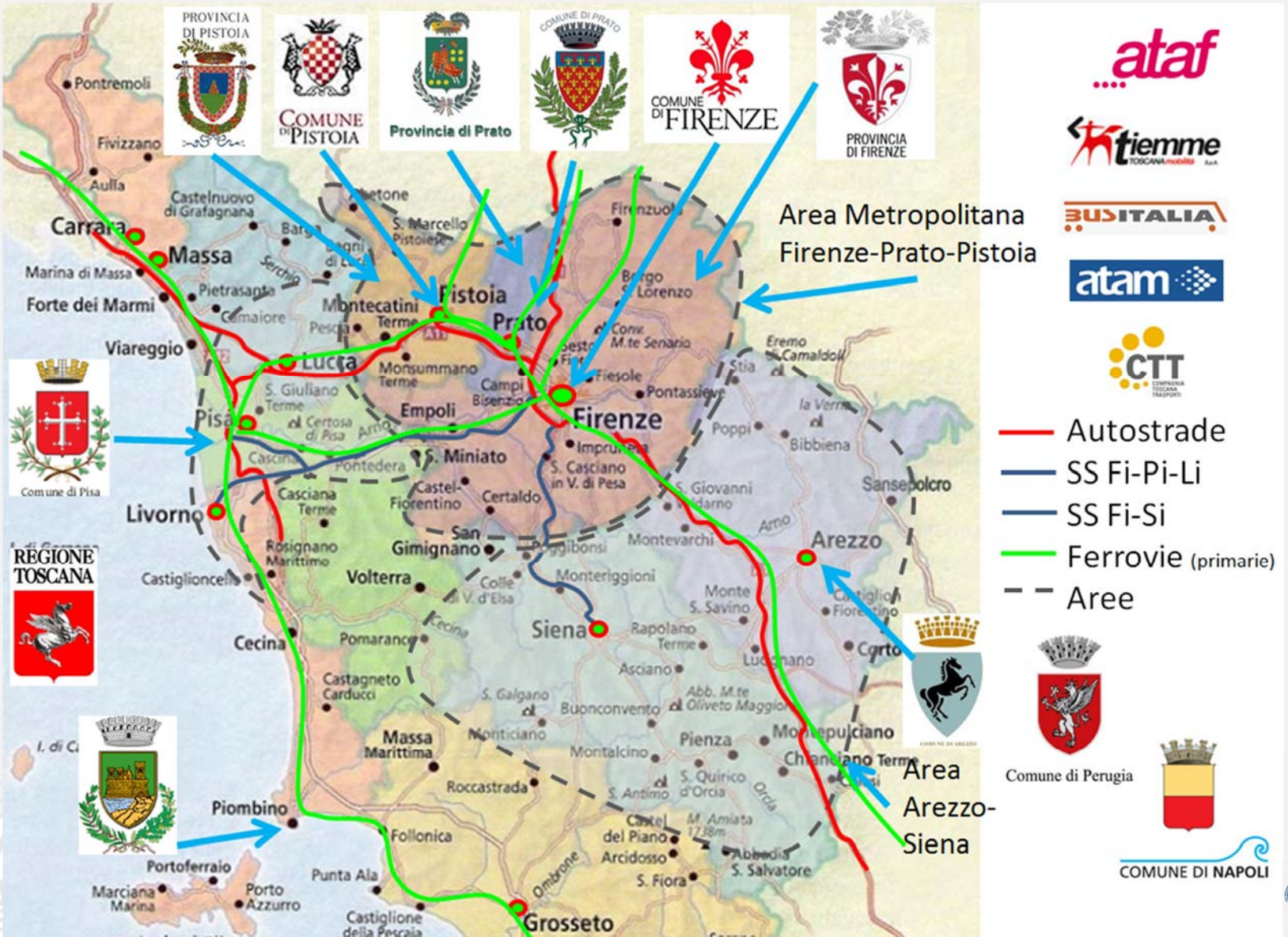
- **Coordinatore Scientifico: *Paolo Nesi, DISIT DINFO UNIFI***
- **Partner:** ECM; Swarco Mizar; University of Florence (svariati gruppi+CNR); Inventi In20; Geoin; QuestIT; Softec; T.I.M.E.; LiberoLogico; MIDRA; ATAF; Tiemme; CTT Nord; BUSITALIA; A.T.A.M.; Sistemi Software Integrati; CHP; Effective Knowledge; eWings; Argos Engineering; Elfi; Calamai & Agresti; KKT; Project; Negentis.
- **Link**: http://www.disit.dinfo.unifi.it/siimobility.html


Commenti dei cittadini, Social Media
Merci
AVM trasporto Pubblico
Sensori, sistema monitoraggio
Sensori su trasporto Privato
Sensori Parcheggi
UTC
Sii-Mobility
Infomobility
Varchi Telematici, ZTL
Monitoraggio traffico, autostrade
Rete Ferroviaria
Parametri ambientali
Servizi ed enti
Ordinanze: eventi, lavori pubblici, ..
Emergenze, polizia, 118

Sii-Mobility



- Sperimentazioni principalmente in Toscana
- Sperimentazioni piu' complete in aree primarie ad alta integrazione dati
- Integrazione con i sistemi presenti



Sii-Mobility: Scenari principali

- **soluzioni di guida/percorso connessa/o**
  - servizi personalizzati, segnalazioni, il veicolo/la persona riceve comandi e informazioni in tempo reale ma modo personalizzato e contestualizzato;
- **Piattaforma di partecipazione e sensibilizzazione**
  - per ricevere dal cittadino informazioni, il cittadino come sensore intelligente, informare e formare il cittadino, tramite totem, applicazioni mobili, web applications, etc.;
- **gestione personalizzata delle politiche di accesso**
  - Politiche di incentivazione e di dissuasione dell'uso del veicolo, Crediti di mobilità, monitoraggio flussi;
- **interoperabilità ed integrazione dei sistemi di gestione**
  - contribuzione a standard, verifiche e validazione dei dati, riconciliazione dei dati, etc.;
- **integrazione di metodi di pagamento e di identificazione**
  - Politiche pay-per-use, monitoraggio comportamento degli utenti;
- **gestione dinamica dei confini delle aree a traffico controllato**
  - tariffazione dinamica e per categoria di veicoli;
- **gestione rete condivisa di scambio dati fra servizi (PA e privati)**
  - affidabilità dei dati e separazione delle responsabilità, Integrazione di open data, riconciliazione, ….;
- **monitoraggio della domanda e dell'offerta di trasporto pubblico in tempo reale**
  - soluzioni per l'integrazione e l'elaborazione dei dati.

Architettura Sii-Mobility

Kit veicoli e Attuatori

Gestori:
Gestori Flotte, AVM, TPL, Parcheggi, Autostrade, Car Sharing, Bike sharing, ZTL, direzionatori …..

Agregazione dati, propagazione azioni

Sistemi di Gestione

Supporto di Interoperabilita' Integrato

Centrale Operativa: Supporto alle decisioni, simulazioni, …

Interfaccia di Controllo e Monitoraggio

Supporto: data analytics, semantic computing

Supporto: bigliettazione, prenotazione, pianificazione, …

Infomobilità e publicazione

Piattaforma di partecipazione e di Sensibilizzazione

Orari, percorsi, fermate, Valori attuali, politiche di azione, etc.

profiles, modelli di costo, users, ..

Data Processing: validation, integration, geomap.., reconcil, …

Additional algorithms, …….

Big Data processing grid

API Data publication verso altri centri di Servizi o Utenti

Info. Services for Totem, Mobile, ..

Applicazioni Web e Totem

Applicazioni Mobili

Sensori e Apparati di Rilevazione

Open Data:
ambientali, energia, ordinanze, grafo, ….

Social Media:
twitter FaceBook, Blogs

Acq Dati Emegenza

Data ingestion and pre processing

Dati integrati dal territorio

API altri Sii-Mobility

API altre Centrali SC

API Centrali nazionali

Interoperabilità da e verso altri sistemi di gestione integrata e SC

Infrastruttura HW Sii-Mobility

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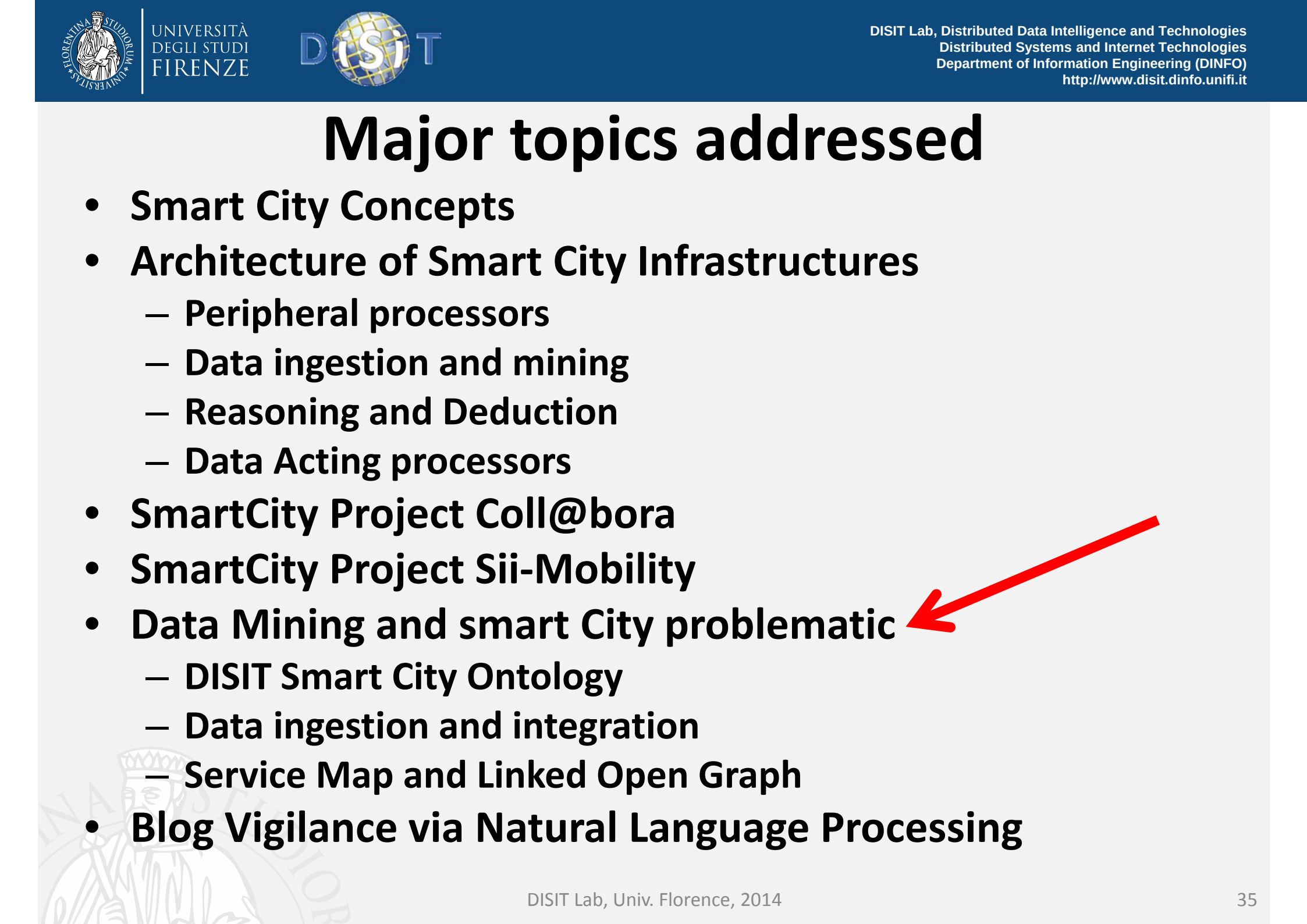


Problematiche di Ricerca "Smart"

- ***Modellazione della conoscenza con semantica coerente per effettuare deduzioni corrette sfruttando informazioni numeriche e simboliche, su grandi volumi e flussi di dati, automazione***
  - ***Problematiche*** derivate da oltre **1000 OD e PD**, servizi con modelli diversi e formati diversi: resilienza, qualità, misura, accesso, integrazione real time, …
  - ***Tecniche di:*** modellazione, semantic computing, scheduling, …
- **Ricerca su integrazione e modellazione dati**:
  - ***Alto livello***: predizione su servizi e comportamenti, correlazioni inattese, situazioni critiche, flusso dei viaggiatori, …
  - ***Problemi e algoritmi*** di riconciliazione del dato, tracciamento e versionamento, reputazione, filtraggio, integrazione OD e LOD internazionali/nazionali, validazione e verifica formale, …. …. ….

Research objectives

- **Why**: Create an ontology that allows to combine all data provided by the *city of Florence* and the *Tuscan region*.
- **Problems**: data have different formats, they must be reconciled in order to be effectively interconnected to each other, but sometimes information is incomplete.
- **Objective**: take advantage of the created repository and ontology to implement new integrated services related to mobility; to provide repository access to *SMEs* to create new services.

Analysis of Available Data

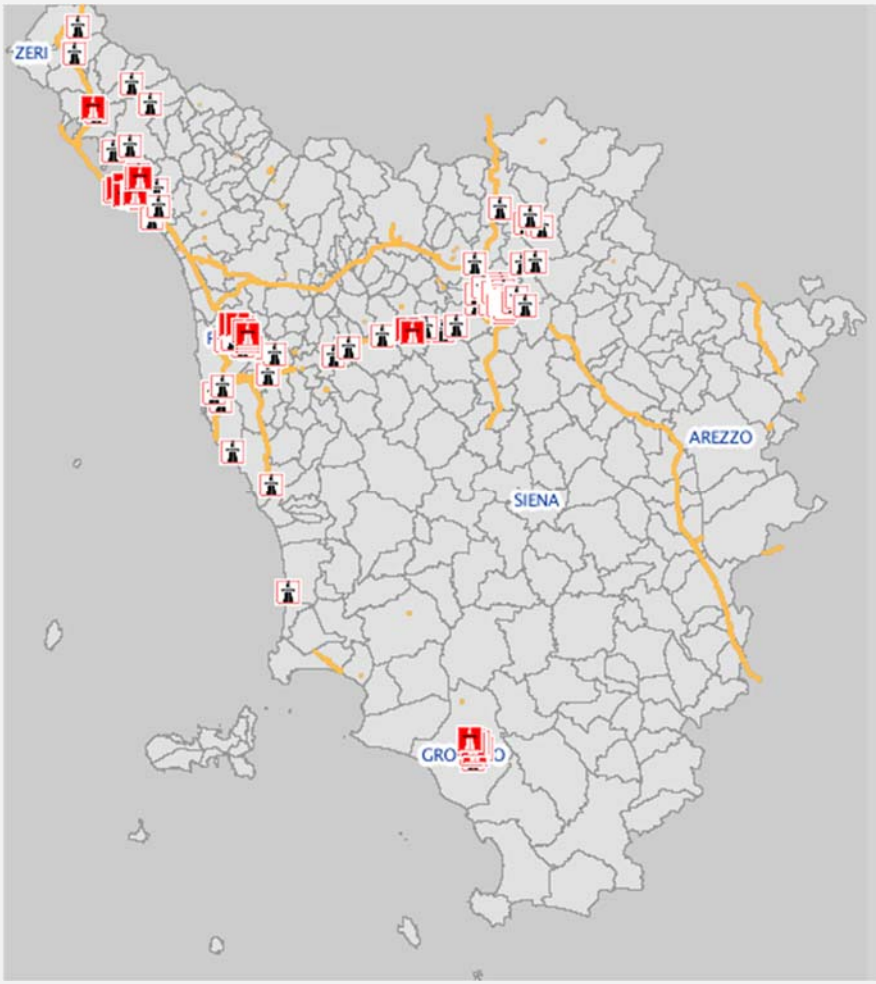
- 519 OpenData (Municipality of Florence)
- 145 OpenData (Tuscany Region)
- TPL Timetable and TPL Route
- Street Graph
- Point of Interest
- Real Time Data from traffic sensors
- Real Time Data from parking sensors
- Real Time Data from AVM systems
- Weather Forrecast (consortium Lamma)

DataSet already integrated

- From MIIC web services (real time)
  - Parking payloadPublication (updated every h)
  - Traffic sensors payloadPublication (updated every 5-10min)
  - AVM client pull service (updated every 24h)
  - Street Graph
- From Municipality of Florence:
  - Tram line: KMZ file that represents the path of tram in Florence
  - Statistics on monthly access to the LTZ, tourist arrivals per year, annual sales of bus tickets, accidents per year for every street, number of vehicles per year
  - Municipality of Florence resolutions
- From Tuscany Region:
  - Museums, monuments, theaters, libraries, banks, courier services, police, firefighters, restaurants, pubs, bars, pharmacies, airports, schools, universities, sports facilities, hospitals, emergency rooms, doctors' offices, government offices, hotels and many other categories
  - Weather forecast of the consortium Lamma (updated twice a day)

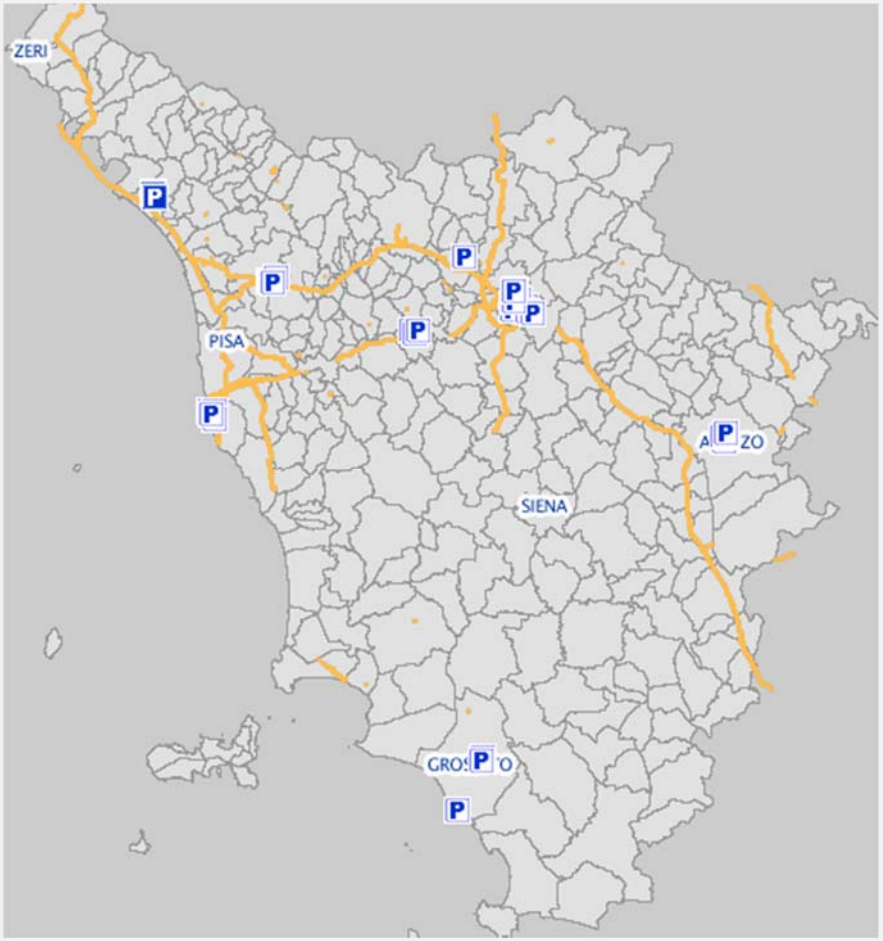
Analisi dei dati attuali MIIC

- **Sensori traffico**: dati relativi alla situazione della viabilità stradale provenienti da gestori di sistemi di rilevamento a sensori
  - Le misurazioni comprendono dati come distanza media tra veicoli, velocità media di transito, percentuale di occupazione della strada, transiti orari, ecc.
  - I sensori sono divisi in gruppi, ciascuno identificato da un codice di catalogo che viene passato come parametro in fase di invocazione del web service
  - Un gruppo è un insieme di sensori che monitora un tratto stradale
  - I gruppi producono una misurazione ogni 5 o ogni 10 minuti
  - Attualmente sono attivi 71 gruppi su tutto il territorio toscano, per un totale di 126 sensori



Analisi dei dati attuali MIIC

- **Parcheggi**: dati relativi allo stato di occupazione dei parcheggiprovenienti da gestori di aree di parcheggio.
  - Lo stato di un parcheggio viene descritto da dati come il numero di posti totali e occupati, il numero di veicoli in entrata e in uscita, ecc.
  - I parcheggi sono divisi in gruppi, ciascuno identificato da un codice di catalogo che viene passato come parametro in fase di invocazione del web service
  - Un gruppo corrisponde all'insieme di parcheggi appartenenti a un comune
  - La situazione di ogni parcheggio viene pubblicata circa ogni minuto
  - Attualmente vengono monitorati 50 parcheggi



Models for Knowledge Representation

- Explicit typologies of Knowledge which can be made *machine-readable* and *machine-understandable*:
  - Structured Knowledge (Ontologies, Taxonomies etc.)
  - Semi-structured (DBMS)
  - Weakly structured (HTML, Tables etc.)
  - Not structured (Natural Language unstructured text, images, drawings etc.)

Web Ontologies and Languages

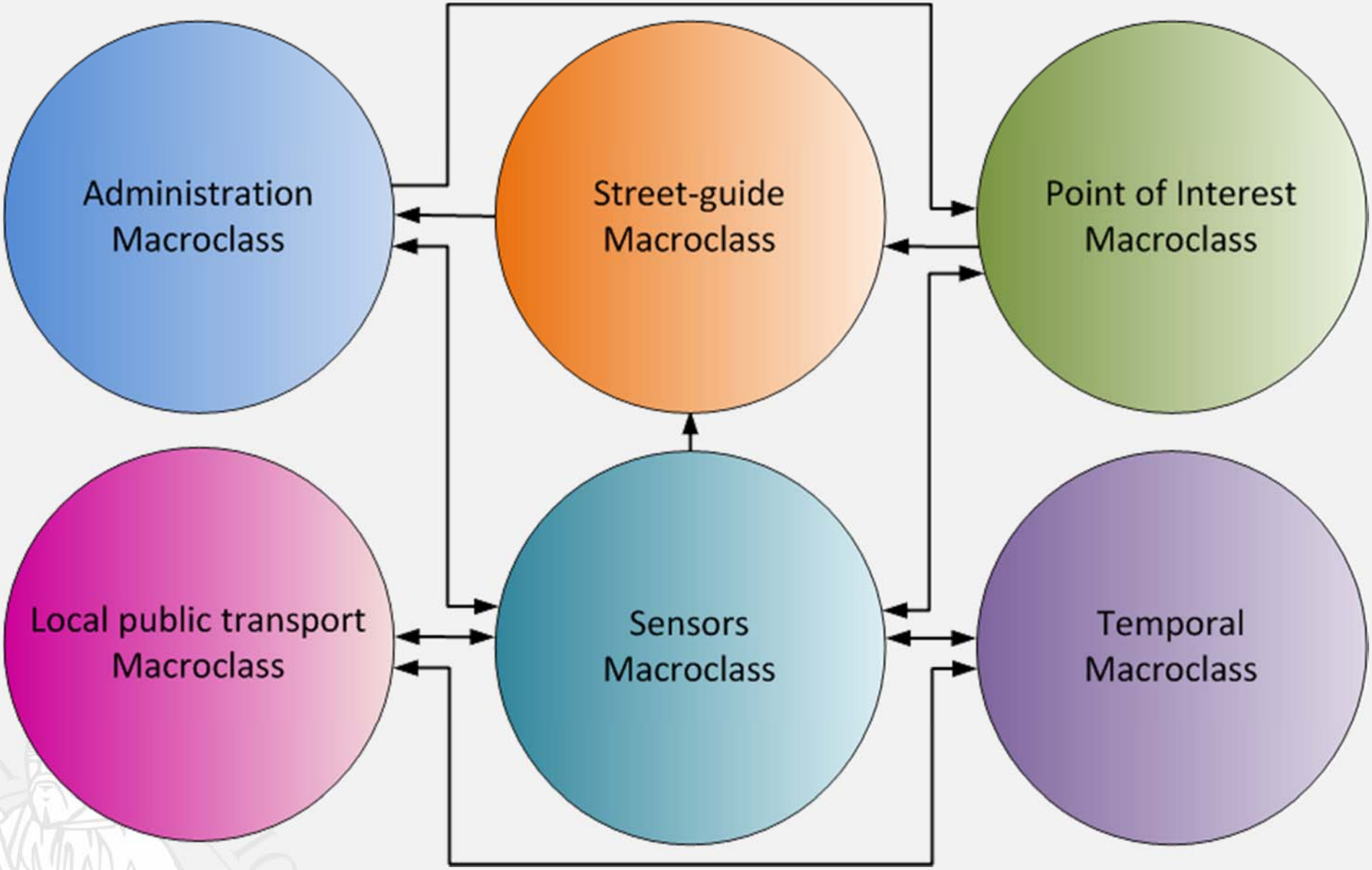
- In Computer/Information Science, an Ontology is defined as the conceptualization of a specific domain of interest, expressed through entities (***Classes***), descriptors (***Attributes***), relationships (***Properties***) and a pre-defined rule corpus (***Semantics***).

- Representation syntax can be equivalently expressed in *XML-based* formats, as well as in the following *triple* format: `<subject> <predicate> <object>.`

- Language used for Ontologies representation:
  - **OWL** (***Web Ontology Language***) is the W3C standard for Ontology definition for Semantic Web.
  - **RDF/XML**
  - **N-triples**, **N3** etc.

- Interrogation / Query languages:
  - **SPARQL**
  - **SERQL**

Macroclasses' Connections



Ontology' Macroclasses

- **Maps and Geographical information**: formed by classes *Road, Node, RoadElement, AdministrativeRoad, Milestone, StreetNumber, RoadLink, Junction, Entry,* and *EntryRule, Manoeuver*, is used to represent the entire road system of Tuscany region.
- **Point of Interest**: economical services (public and privates), activities, which may be useful to the citizen and who may have the need to search for and to arrive at. Classification will be based on the division into categories planned at regional level.
- **Weather**: including *status* and *forecasts* from the consortium Lamma in Tuscany.

Ontology' Macroclasses

- **Transport**: data coming from major LPT companies including scheduled times, the rail graph, data relating to real time passage at bus stops. *Classes*: *bus line, Ride, Route, record, RouteSection, BusStopForeast, RouteLink*.
- **Sensors**: concerning data coming from sensors; they may include information such as *pressure, humidity, pollution, car flow, car velocity, number of passed cars* and tracks, etc.
- **Administration**: includes information coming from public administrations such as *resolutions* issued by each administration, *planned events, changes in the traffic arrangement, planned VIP visits, sports events*, etc.

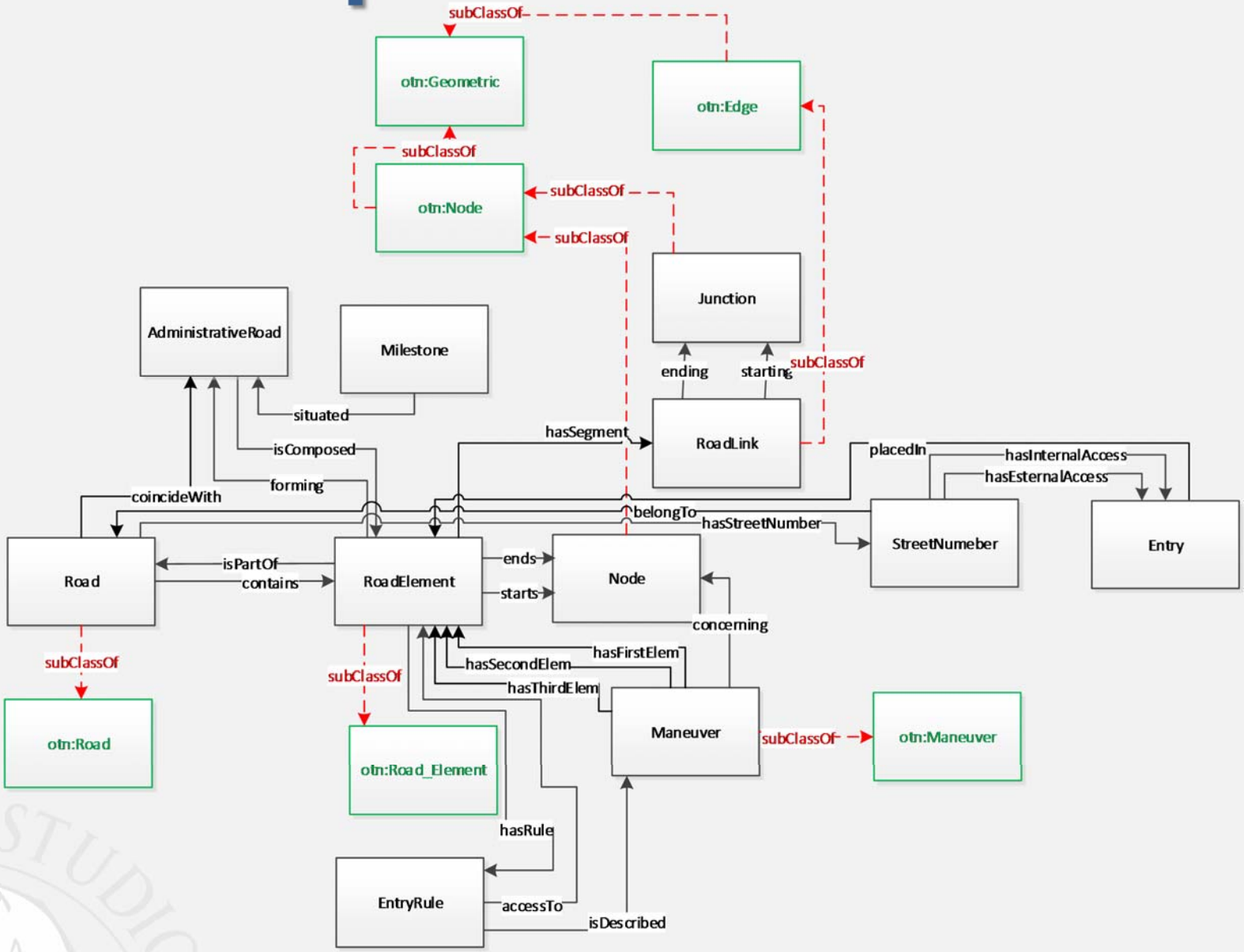
Maps Macroclass

- **RoadElement**: delimited by a start node and an end node (ObjectProperties "starts" e "ends");
- **Road**: composed by RoadElement and Node ("contains")
- **AdministrativeRoad**: connected to RoadElement (“isComposed” e “forming”), to Road (“coincideWith”). *Road : AdministrativeRoad = N:M*. Both in a 1:N relation with RoadElement;
- **EntryRule**: connected to RoadElement ("hasRule", "accessTo ");
- **Maneouvre**: linked to EntryRule ("isDescribed"). Described through "hasFirstElem", "hasSecondElem" and "hasThirdElem". "concerning" fastes a maneouvre to the concerned junction.

Maps Macroclass

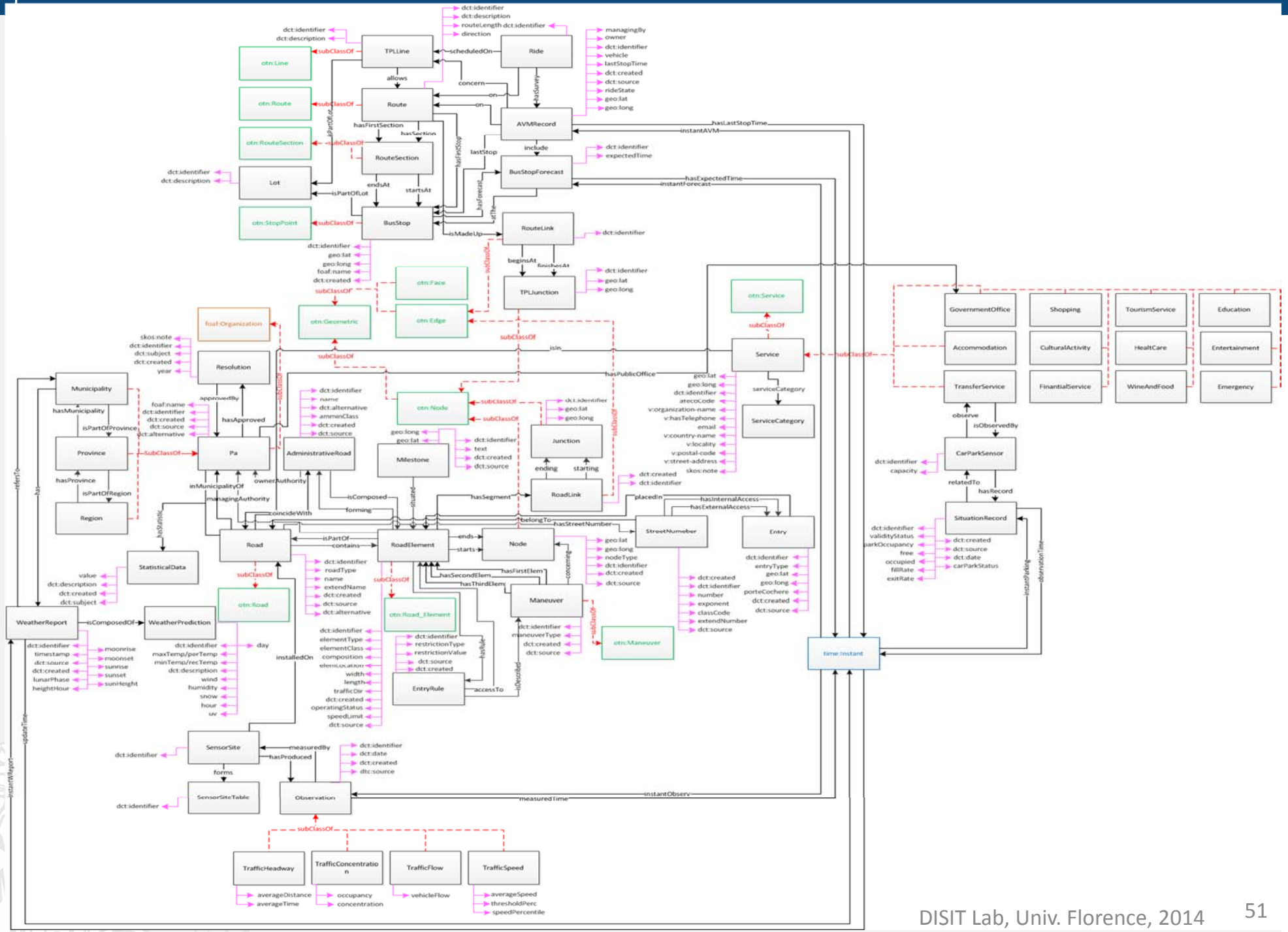
- **Node**: georeferenced through geo:lat and geo:long.
- **Milestone**: associated with 1 AdministrativeRoad ("placedIn"), georeferenced through geo:lat and geo:long.
- **StreetNumber**: always related to at least 1entry (internal or external). Connected to RoadElement and Road ("standsIn" and "belongTo"); reverse:"hasStreetNumber".
- **Entry**: connected to StreetNumber through "hasInternalAccess" and "hasExternalAccess", with cardinality resrictions, subclass of geo:SpatialThing, maximum cardinality restriction 1 to geo:lat and geo:long
- "ownerAuthority" and "managingAuthority": linked to *PA macroclass.*

Maps Macroclass



Reused Vocabulary

- ***OTN:*** *an ontology of traffic networks that is* more or less a direct encoding of GDF (Geographic Data Files) in OWL;
- ***dcterms:*** *set of properties* and classes maintained by the Dublin Core Metadata Initiative;
- ***foaf:*** *dedicated to the description of* the relations between people or groups;
- ***vCard:*** *for a description of people and organizations;*
- ***wgs84_pos:*** *vocabulary representing latitude and longitude, with the WGS84 Datum, of geo-objects.*


TPLLine
Ride
Route
RouteSection
AVMRecord
BusStopForecast
Lot
BusStop
RouteLink
TPLJunction
otn:Line
otn:Route
otn:RouteSection
otn:StopPoint
otn:Face
otn:Edge
otn:Geometric
otn:Service
otn:Node
otn:Road
otn:Road_Element
otn:Maneuver
foaf:Organization
Resolution
Municipality
Province
Region
Pa
AdministrativeRoad
Milestone
Junction
RoadLink
Road
RoadElement
Node
Maneuver
StreetNumber
Entry
Service
ServiceCategory
GovernmentOffice
Shopping
TourismService
Education
Accommodation
CulturalActivity
HealtCare
Entertainment
TransferService
FinantialService
WineAndFood
Emergency
CarParkSensor
SituationRecord
StatisticalData
WeatherReport
WeatherPrediction
SensorSite
SensorSiteTable
Observation
EntryRule
time:Instant
TrafficHeadway
TrafficConcentration
TrafficFlow
TrafficSpeed

Major topics addressed

- Smart City Concepts
- Architecture of Smart City Infrastructures
  - Peripheral processors
  - Data ingestion and mining
  - Reasoning and Deduction
  - Data Acting processors
- SmartCity Project Coll@bora
- SmartCity Project Sii-Mobility
- Data Mining and smart City problematic
  - DISIT Smart City Ontology
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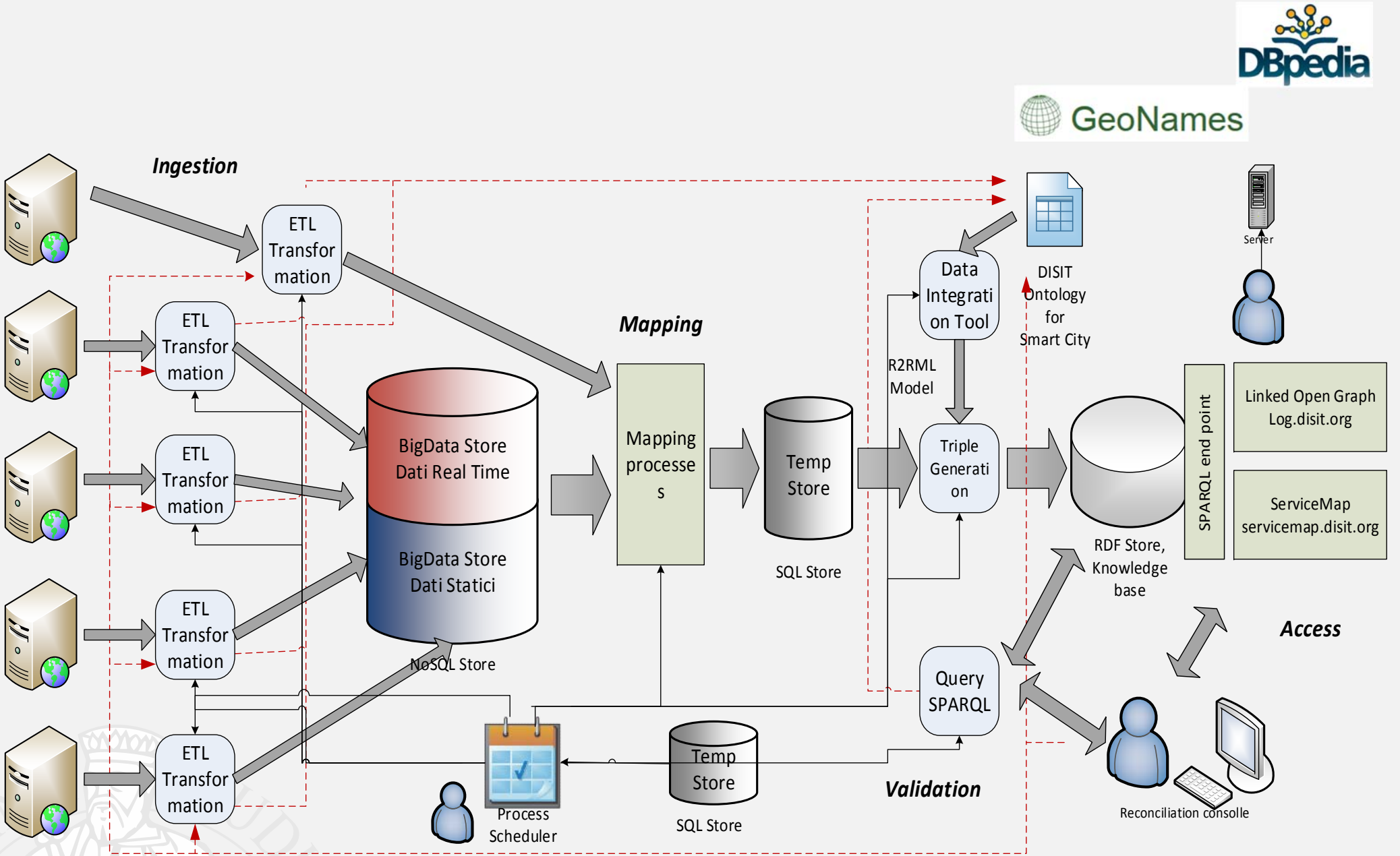
  - Service Map and Linked Open Graph
- Blog Vigilance via Natural Language Processing


DBpedia
GeoNames
Ingestion
ETL Transformation
ETL Transformation
ETL Transformation
ETL Transformation
ETL Transformation
BigData Store Dati Real Time
BigData Store Dati Statici
NoSQL Store
Mapping
Mapping processes
Temp Store
SQL Store
Data Integration Tool
R2RML Model
Triple Generation
DISIT Ontology for Smart City
Server
RDF Store, Knowledge base
SPARQL end point
Linked Open Graph Log.disit.org
ServiceMap servicemap.disit.org
Access
Query SPARQL
Reconciliation consolle
Validation
Process Scheduler
Temp Store
SQL Store

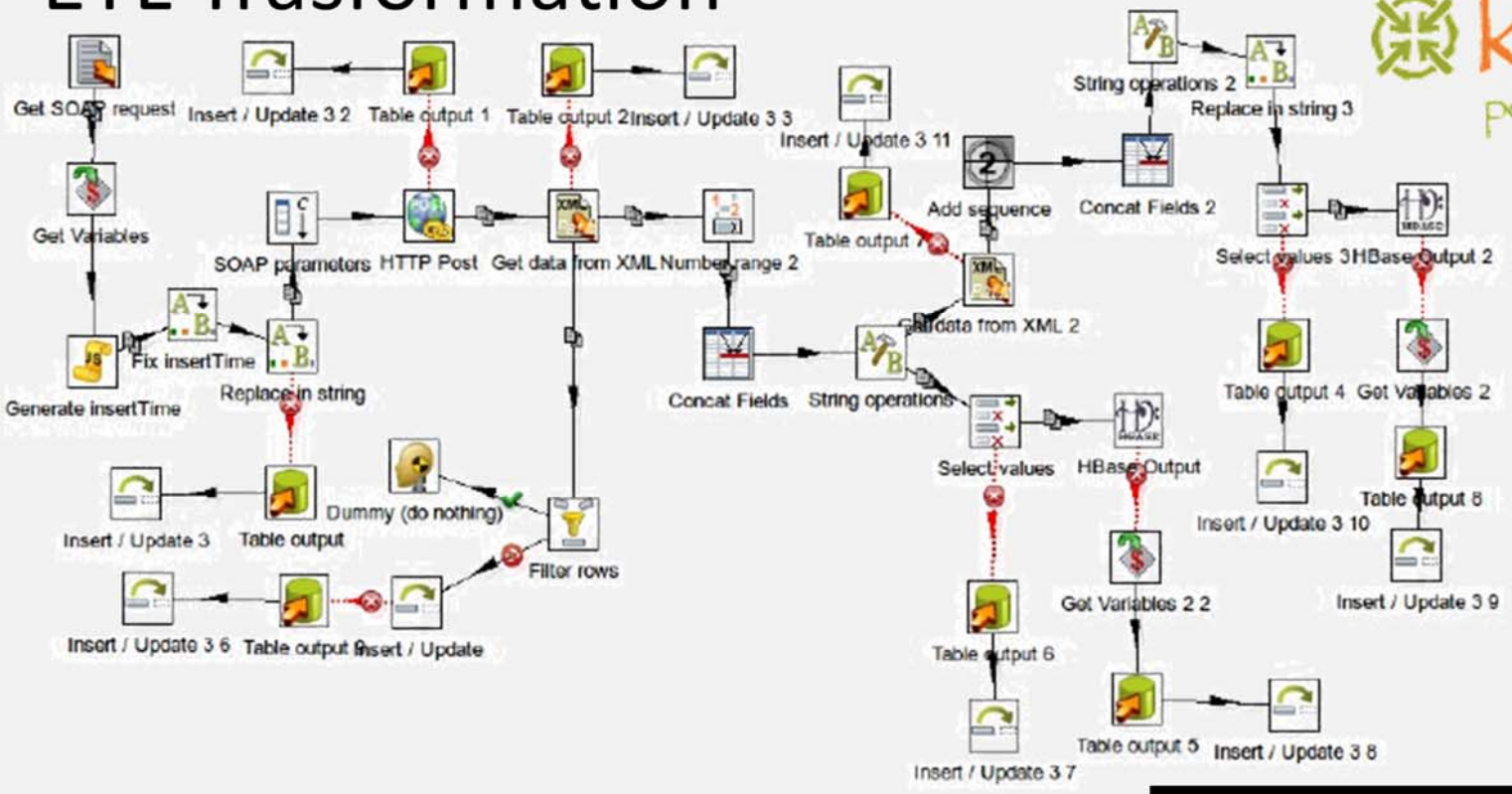
From Open Data to Triples

- **Phase 1**: collect data from different sources (MIIC Web Service, Portale dell'Osservatorio dei Trasporti e della Mobilita', Municipality of Florence and Tuscany Region Web Sites).
- **Phase 2**: first processing means ETL tool and NoSQL database storage.
- **Phase 3**: second transformation using ETL tools and RDF triples creation.
- **Phase 4**: Saving triple in RDF store.

Helpful Tools

- ETL Trasformation

kettle™ pentaho data integration



- To realize the R2RML model

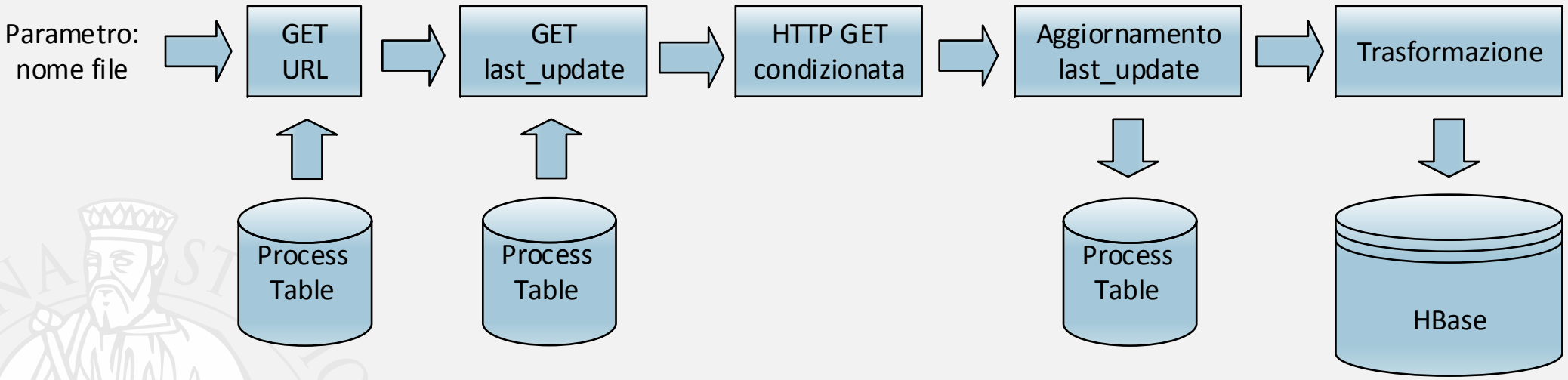
Karma v1.110

- RDF Store

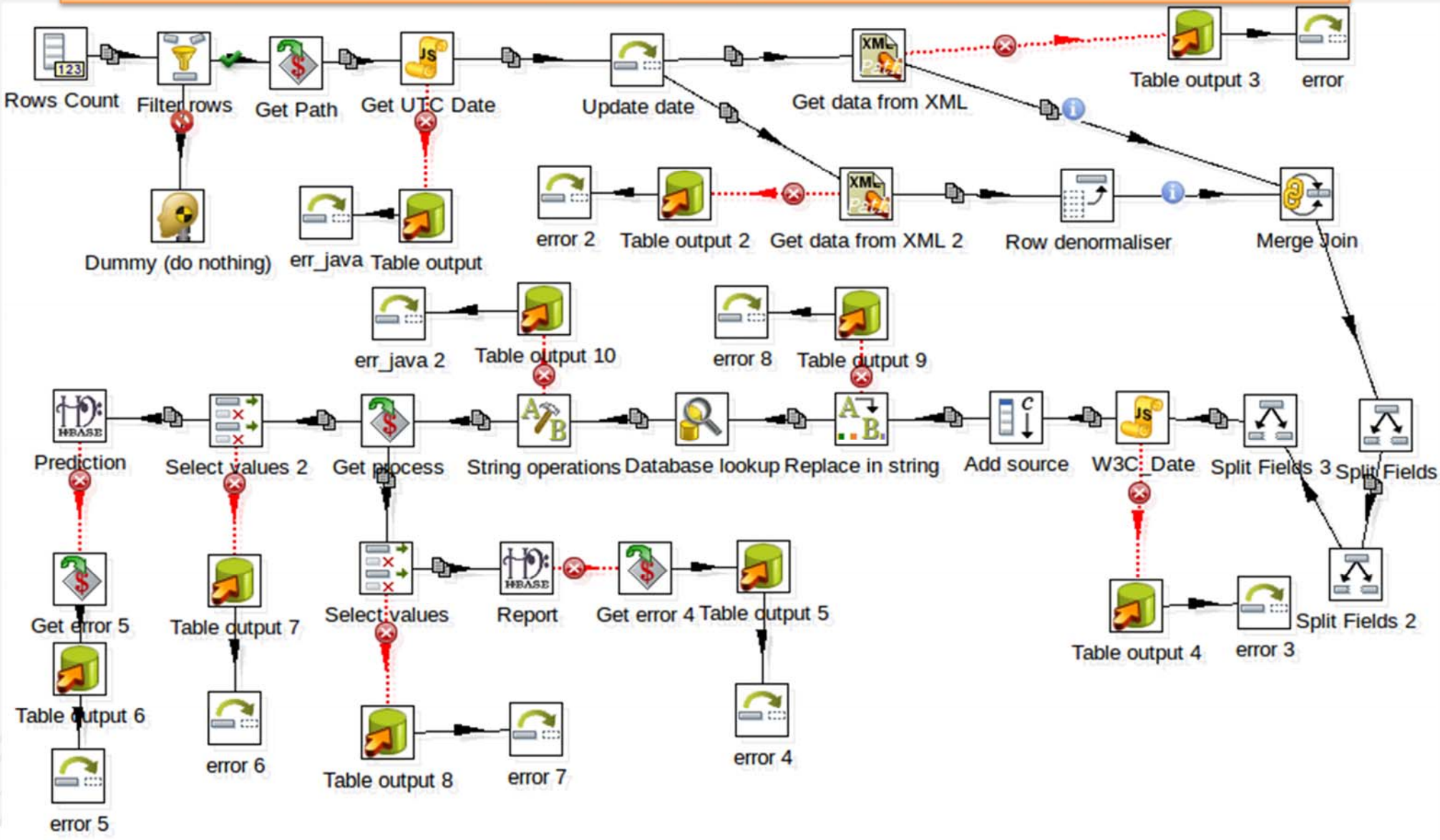
OWLIM

Ingestion, un esempio

- Eseguita da Pentaho Kettle (software ETL)
  1) Si passa il nome del file da processare
  2) Viene recuperato l'URL della risorsa
  3) Download del file (solo se è stato aggiornano dall'ultima volta)
  4) Aggiornamento della data di download
  5) Trasformazione risorsa: da XML a forma tabulare, eliminazione caratteri speciali, creazione chiavi, informazioni aggiuntive …
  6) Memorizzazione su HBase



Ingestion (un esempio)



Architecture

- To automate the different phases, we have created an **architecture** that includes a **process scheduler**.
- The process scheduler implementation was necessary **to repeat the 4 phases**, from ingestion to transformation in triple.
- We storing data in Hbase according to a programmed rate, which is closely linked to the type of data (static/real time):
  - Real-time data: every 10min;
  - Other data: 2 - 15 times a day;
  - Static data: once a month or more.

Data Validation & Reconciliation

- Major problems with the data:
  - inconsistent data (different municipality to the same service, city names that are not a municipality)
  - missing data (street number)
  - incorrect data (spelling errors)
- Need to validate the data, but above all to reconcile them to be able to connect with each other:
  - Service – Street Name Reconciliation
  - Service – Coordinate Reconciliation

Reconciliation Numbers

- **Services**: ~ 30.100 (all over Tuscan region) of which:
  - *Geolocalized* Services: ~ 12.400
  - Services *located at street level*: ~ 8.300
- **Remaining Services**: ~ 9.000 of which:
  - *Non-unique results* to locate the service at street level
  - Street Number *missing*
  - *Unusual letters* in municipality names or street names
  - Address *does not exist* on Street Graph: ~ 2.200 (next step: use the Google geocoding API)

Real Time Data Numbers

- **Weather**: 286 files uploaded twice a day → 270,000 Hbase rows/month → **~4 million triples/month**;
- **Sensors**: 126 active sensors → 18.000 Hbase rows/day, 50 supervised parking → **~10GB/mese**;
- **Street Graph**: 68M triples.
- **For an amount of ~ 80MTriples** on repository

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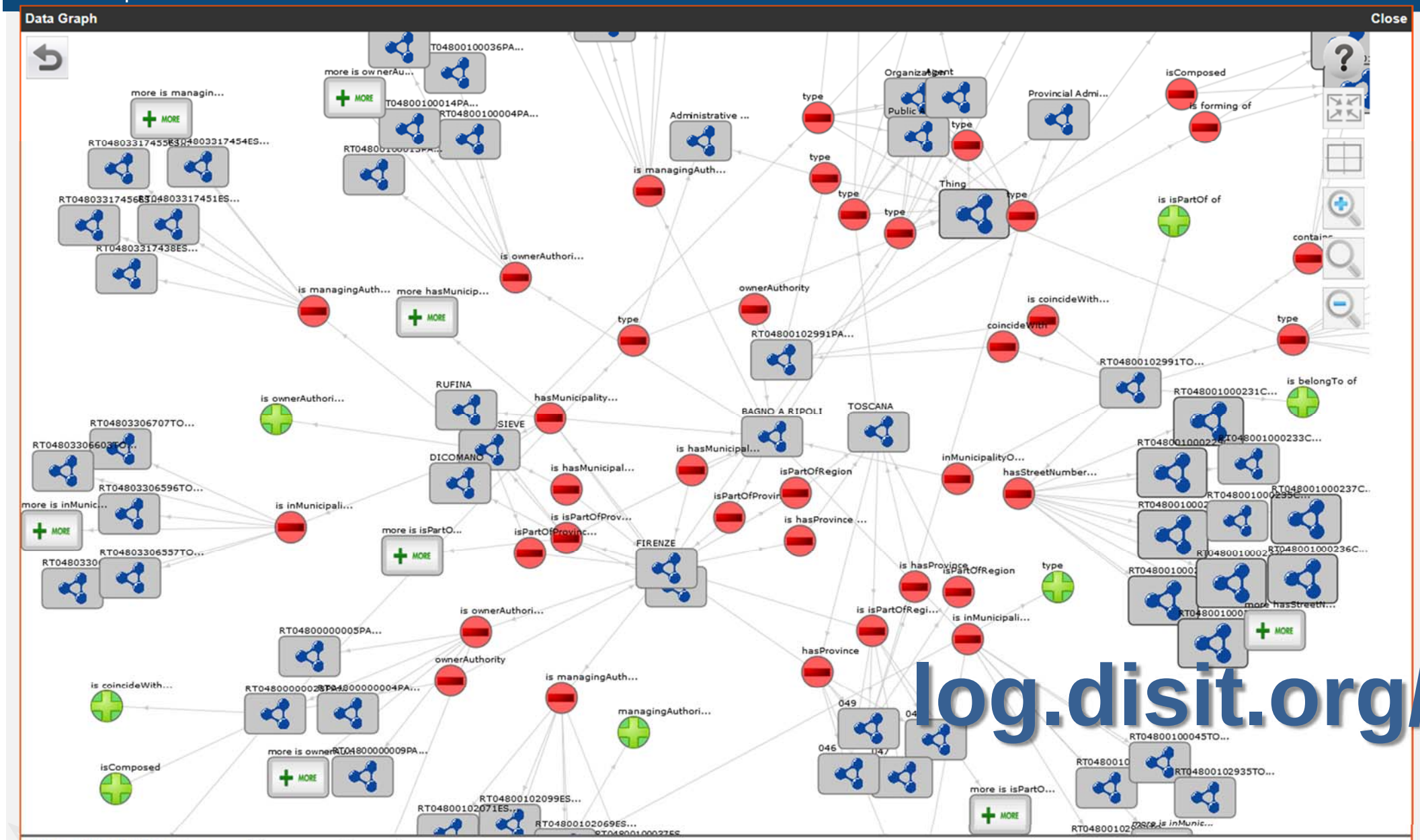
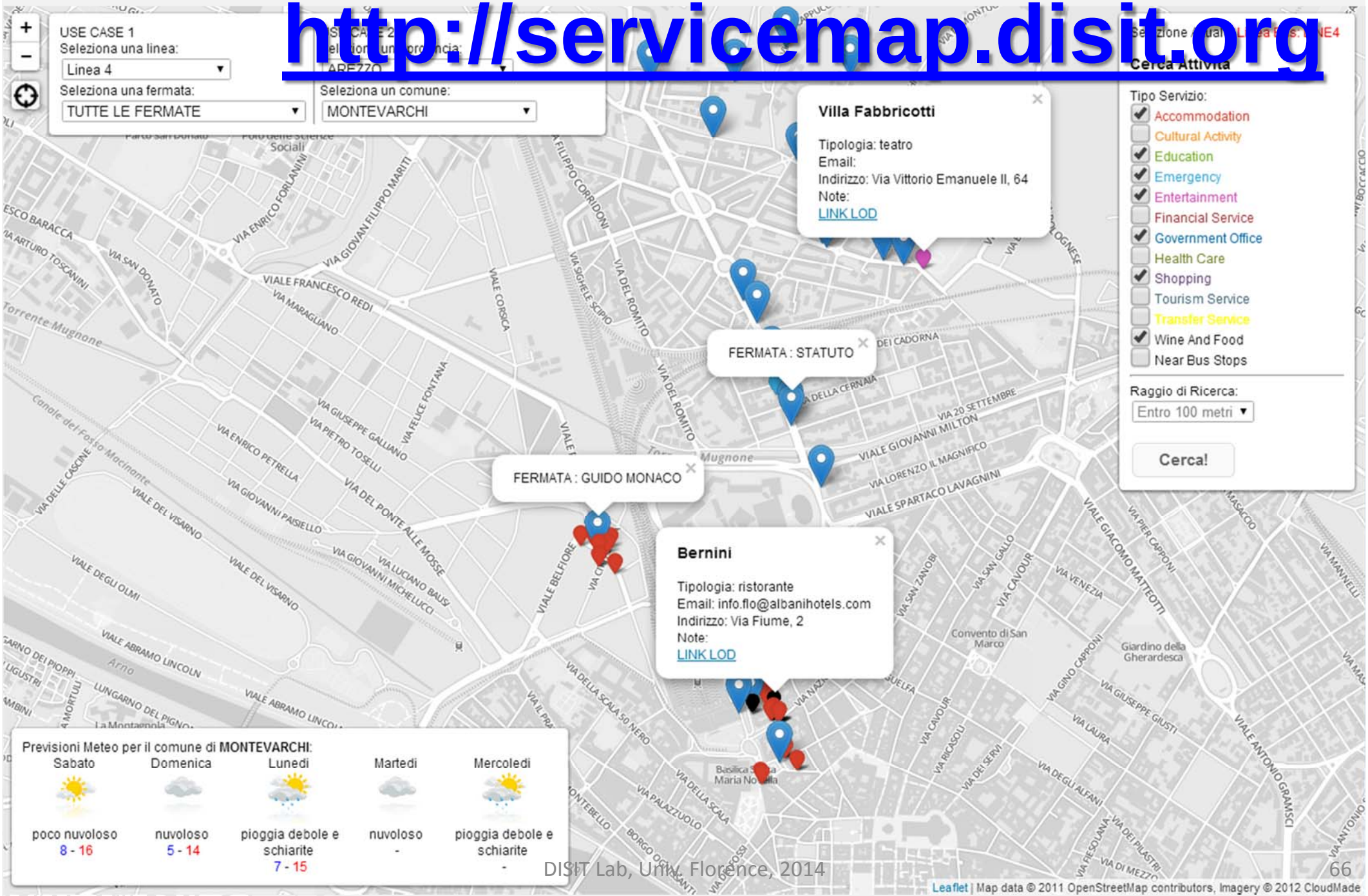
App Examples

- **Linked Open Graph (LOG)**: a tool developed to allow exploring semantic graph of the relation among the entities. It can be used to access to many different LOD repository. (http://log.disit.org/)
- **Maps**: service based on OpenStreetMaps that allows to search services available in a preset range from the selected bus stop. (http://servicemap.disit.org/)


Data Graph
Close
Type of relations
Select all
Deselect all
Invert
sameAs
depiction
seeAlso
type
contains
coincideWith
inMunicipalityOf
hasStreetNumber
is isPartOf of
is belongTo of
ownerAuthority
isComposed
is forming of
isPartOfProvince
is managingAuthority of
is hasMunicipality of
isPartOfRegion
is hasProvince of
ends
starts
is placedIn of
log.disit.org/

servicemap.disit.org

http://servicemap.disit.org



Future Works

- Integration of rail graph into the ontology;
- Insertion of other static datasets from the municipality of Florence and other Tuscany PA;
- Using Google Geocoding API to finish services reconciliation;
- Improvement of services' list and their geolocation;
- Creation of other apps that suggest to SME and PA how to use data.

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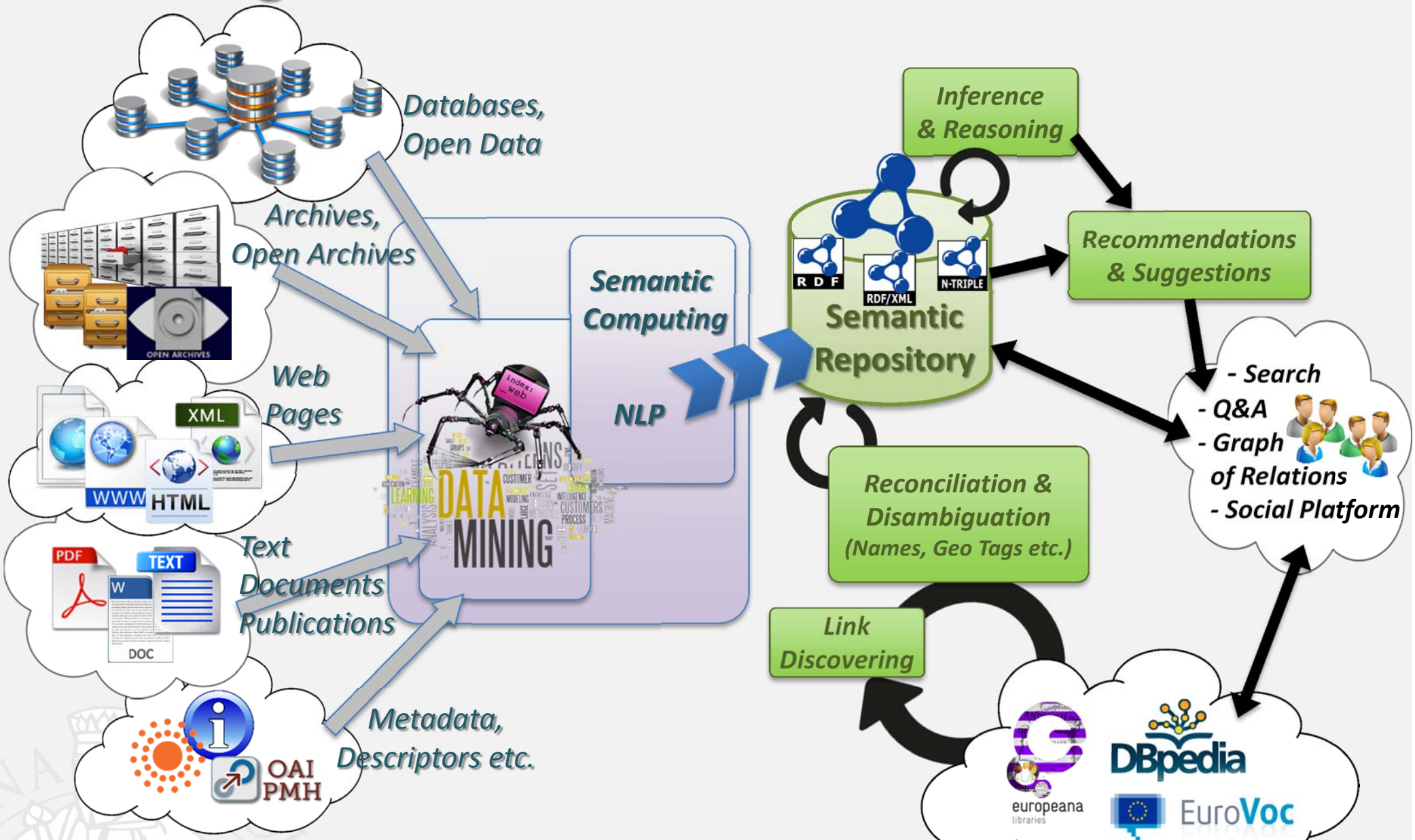
Knowledge Work-flow: from Sources to Final Users



Data Integrity: Accuracy and Reliability of Data

- Big Data Mining issues
- Many different formats
- Ambiguities and inconsistencies of descriptors, metadata etc.
- Unstructured, decontextualized data does not allow to extract high level information
- Several different efforts of structure KBs, ontologies, taxonomies etc. in many fields of Knowledge

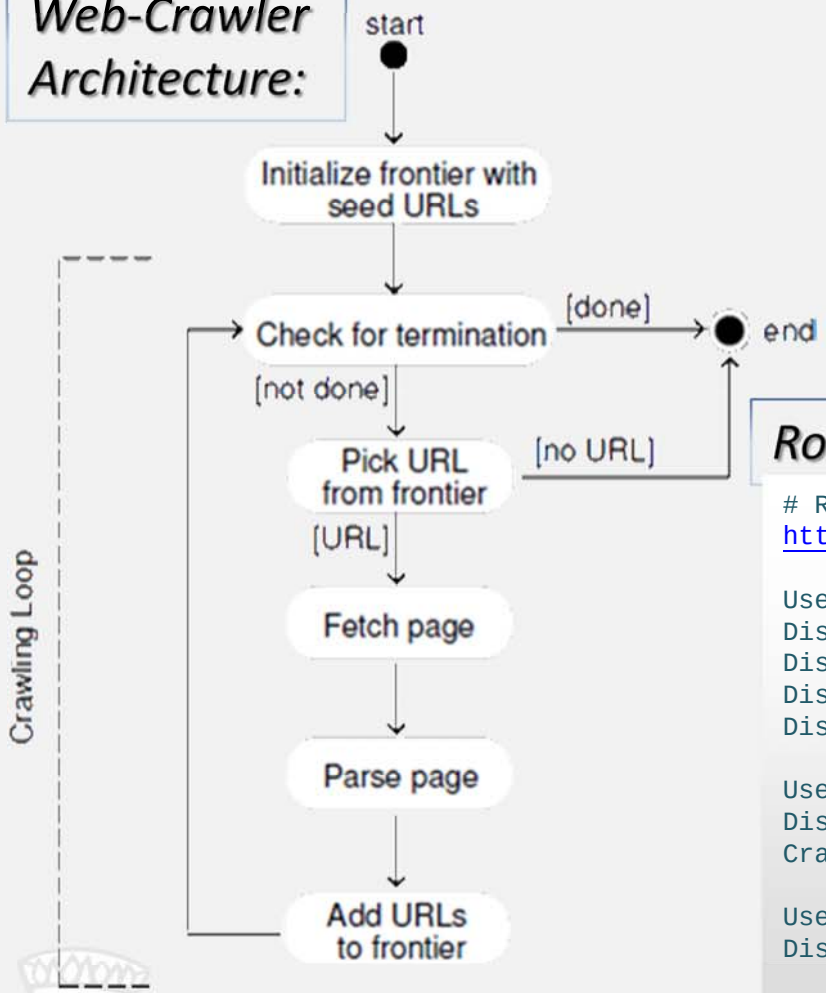
- There is necessity of:
  - Reconciliation and disambiguation of ingested data
  - Organize data into proper forms of structured knowledge
  - Standardize definitions, languages, vocabularies etc.
  - Link discovering among different knowledge bases
  - Make inference to produce additional knowledge
  - Detect unexpected correlations, produce suggestions and recommendations
  - Provide semantic interoperability among resources and applications.

New Approaches - The Semantic Web

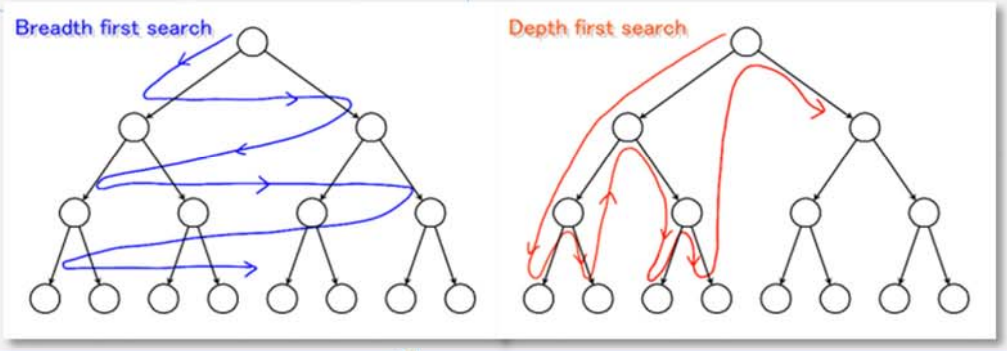
- Web of documents (HTML) ***VS*** Web of data (RDF Triples)
- Relational DBMS ***VS*** Semantic Datastores (Ontologies etc.)
- Keyword-based Search Engines ***VS*** NLP Q&A Tools

Web Crawling and Data Mining

Web-Crawler Architecture:



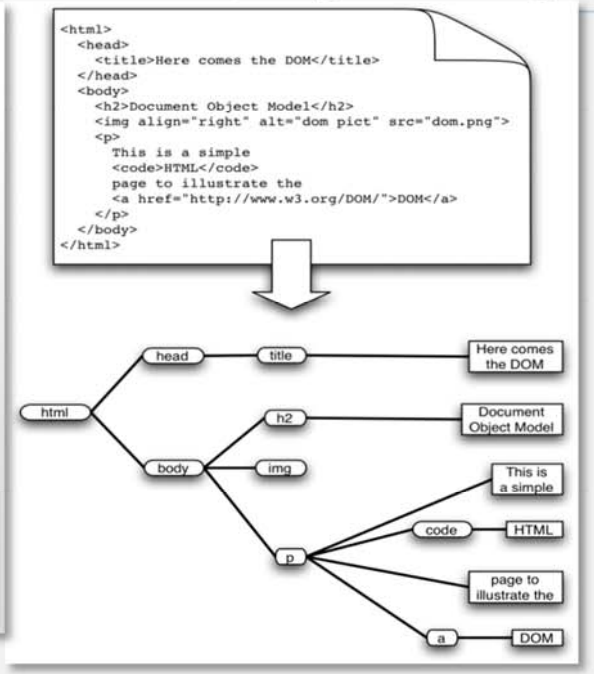
Crawling Strategies:



Robot Exclusion Protocol

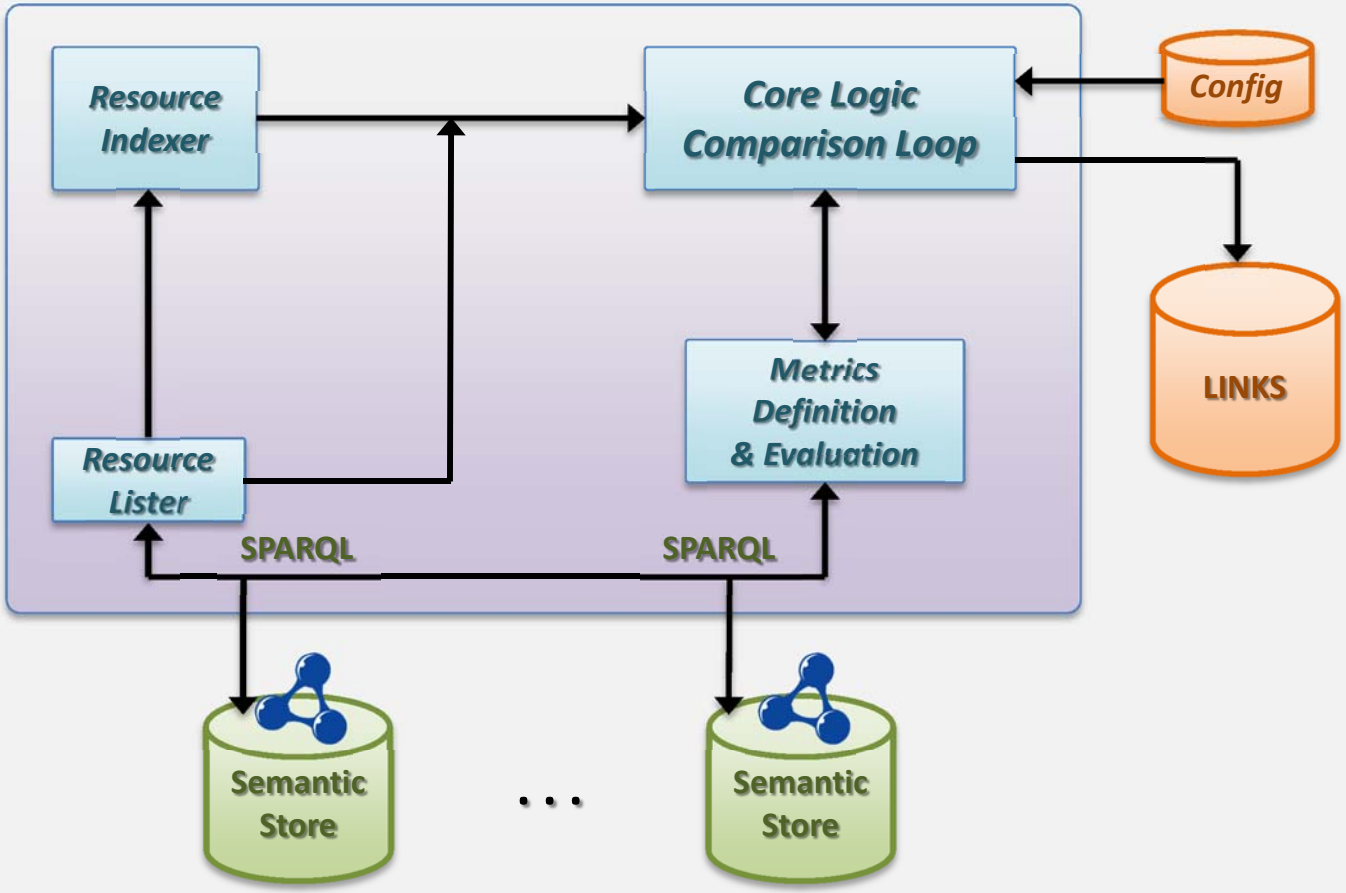
```
# Robots.txt for
http://www.springer.com (fragment)

User-agent: Googlebot
Disallow: /chl/*
Disallow: /uk/*
Disallow: /italy/*
Disallow: /france/*

User-agent: MSNBot
Disallow:
Crawl-delay: 2

User-agent: scooter
Disallow:

# all others
User-agent: *
Disallow: /
```

Document / Pages Parsing:



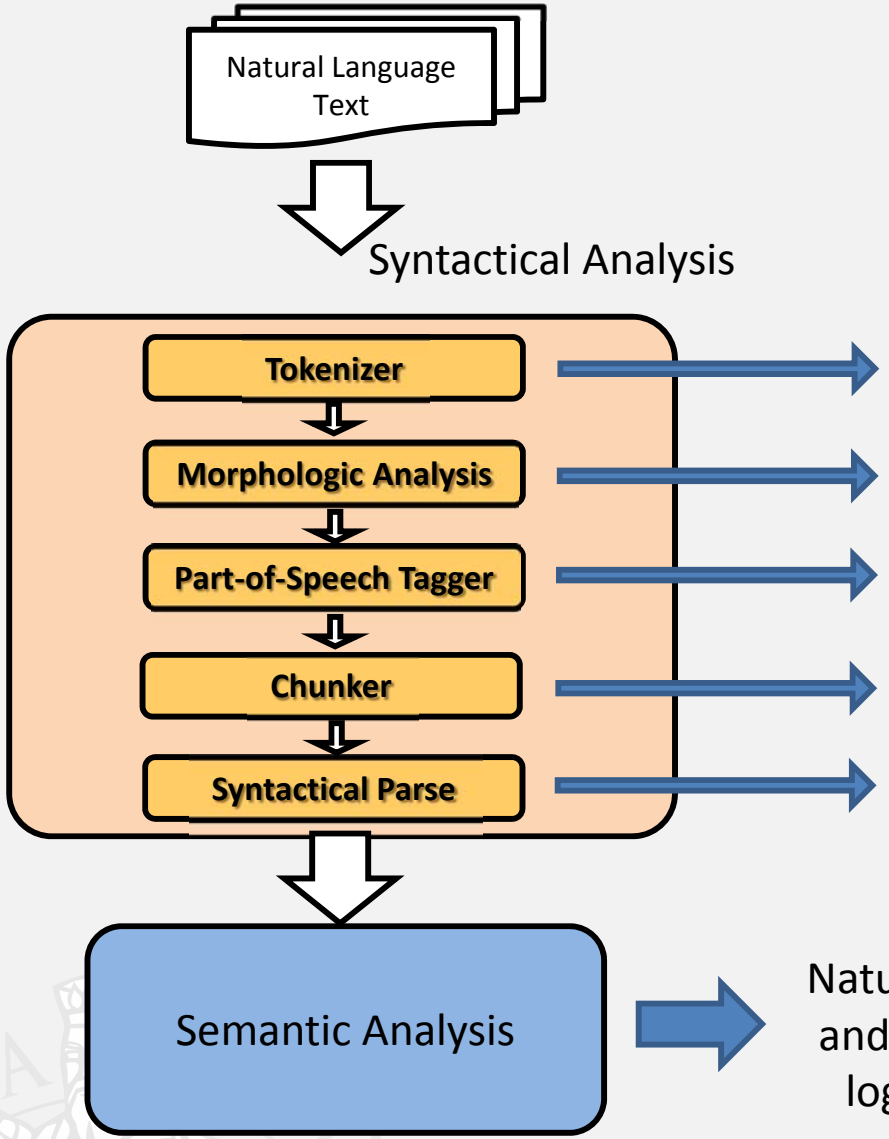
Link Discovering

- Finding relationships between entities, LODs etc., within different RDF data sources.



Source: SILK - http://events.linkeddata.org/ldow2009/papers/ldow2009_paper13.pdf

NLP - Natural Language Processing Phases



- ✓*Text is segmented into sequences of characters (tokens).*
- ✓*A grammar category is assigned to each token*
- ✓*Each word of a sentence/period is annotated with its logical rule (subject, predicate, complement etc.)*
- ✓*This phase uses previous annotations to group nominal and verbal phrases for each sentence*
- ✓*Produces the Syntactic Parse Tree for each sentence*

Natural Language sentences are subsequently processed and coded into a semantic representation (by means of logic formalisms, semantic networks and ontologies)

Overview on Smart City

Smart City for Beginners

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