

# Semantic Modeling of Smart City Data

*... and related challenges/opportunities*

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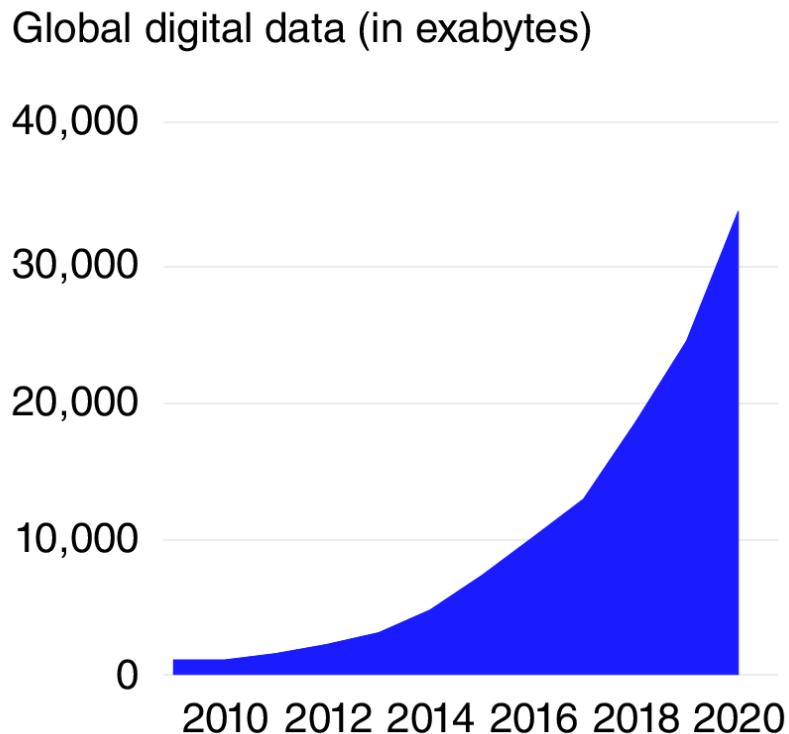
*INSIGHT Center for Data Analytics, National University of Ireland Galway*

*(Formerly known as DERI, Digital Enterprise Research Institute)*

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# BIG Data: what are we facing

**FIGURE 3: BY 2020, DIGITAL RECORDS  
WILL BE 44 TIMES LARGER THAN IN 2009**



Source: IDC

**“90% of the data in the world today has been created in the last two years alone” – IBM**

**“The bringing together of a vast amount of data from public and private sources [...] is what Big Data is all about” – IDC**

**Over the next few years we'll see the adoption of scalable frameworks and platforms for handling streaming, or near real-time, analysis and processing.” – O'Reilly**

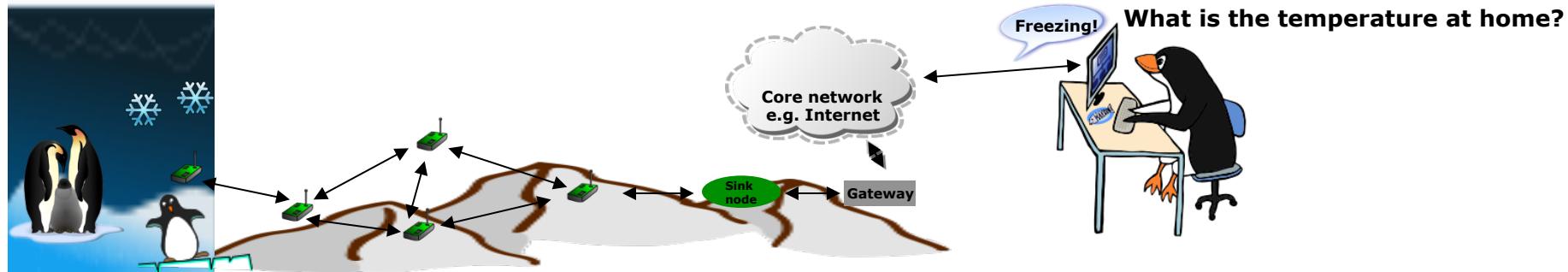
**Big Data represents a number of developments in technology that have been brewing for years and are coming to a boil. They include an explosion of data and new kinds of data, like from the Web and sensor streams; [...].” – IDC**

The background consists of a 3D perspective view of a cube made of binary code. The cube is composed of numerous green binary digits (0s and 1s) arranged in a grid pattern. The perspective creates a sense of depth, with the front face being more prominent and the back face receding into the distance.

**A Smart City driver of change will be Data.**

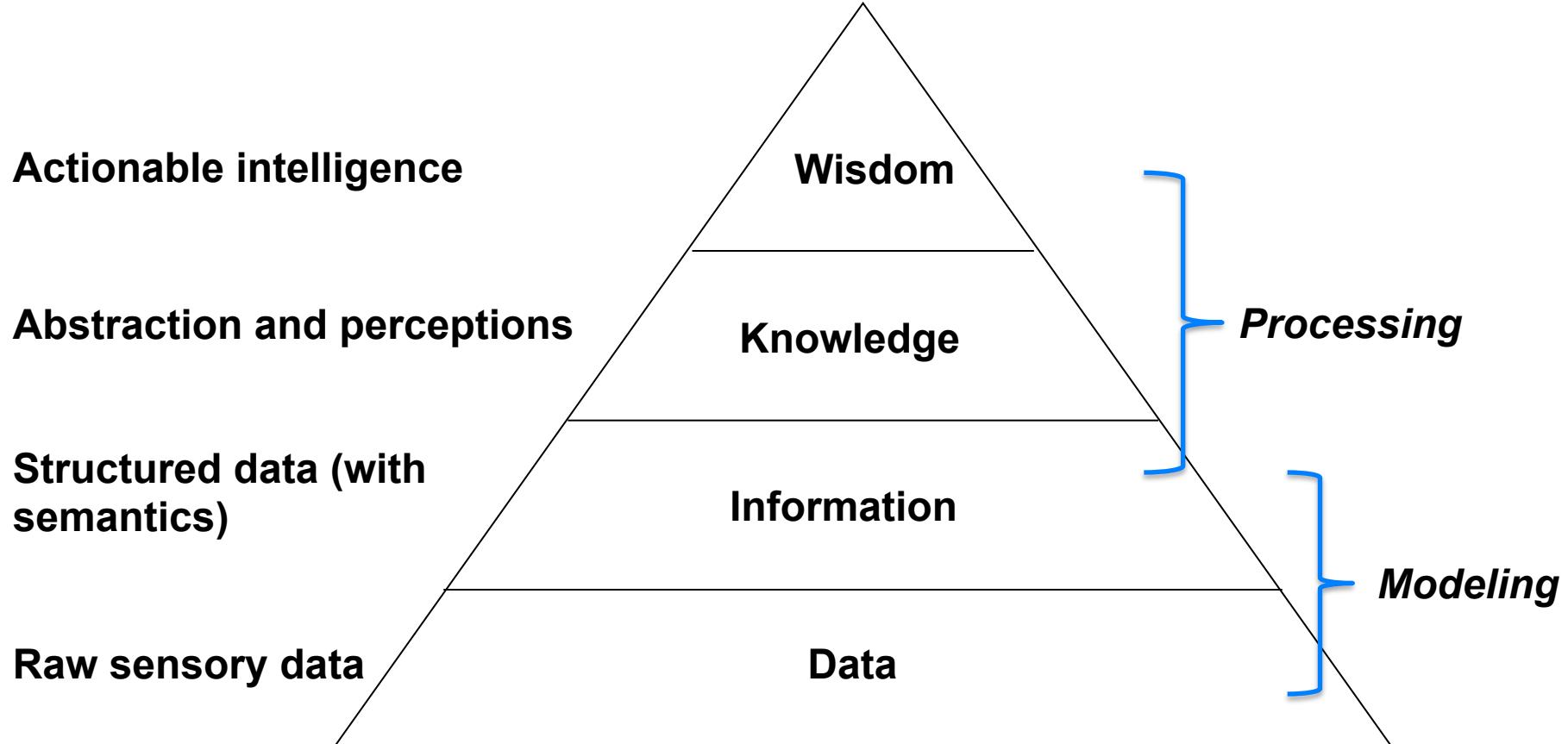
**Smart Cities as an opportunity  
to render WoT-enabled services**

“People want answers, not numbers” (Steven Glaser, UC Berkley)



Going from Data to Answers is the “smart” bit

# Perceptions and Intelligence



# CityPulse: Real-Time IoT Stream Processing and Large-scale Data Analytics for Smart City Applications



# CityPulse Consortium



## Partners:

<b>Industrial</b>	SIE, ERIC
<b>SME</b>	AI
<b>Higher Education</b>	UNIS, NUIG, UASO, WSU
<b>City</b>	BR, AA



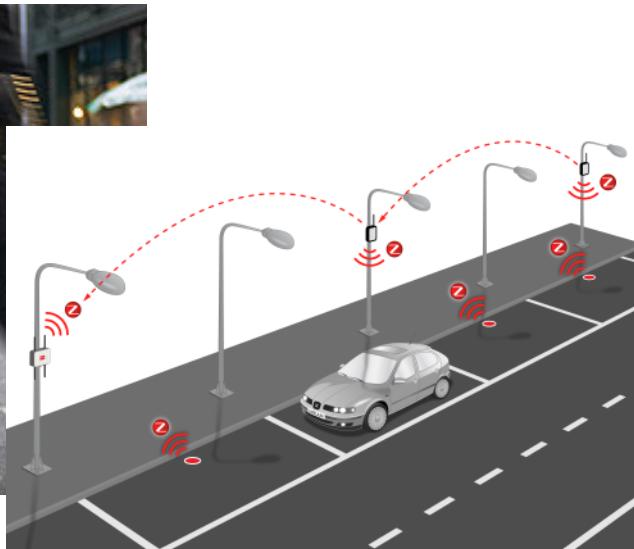
A Smart City removes silos moving towards a connected digital layer.

*abstracts*

# Not just Heterogeneity and Volume...



... but also Data Dynamicity, Data Quality and Contextual Relevance



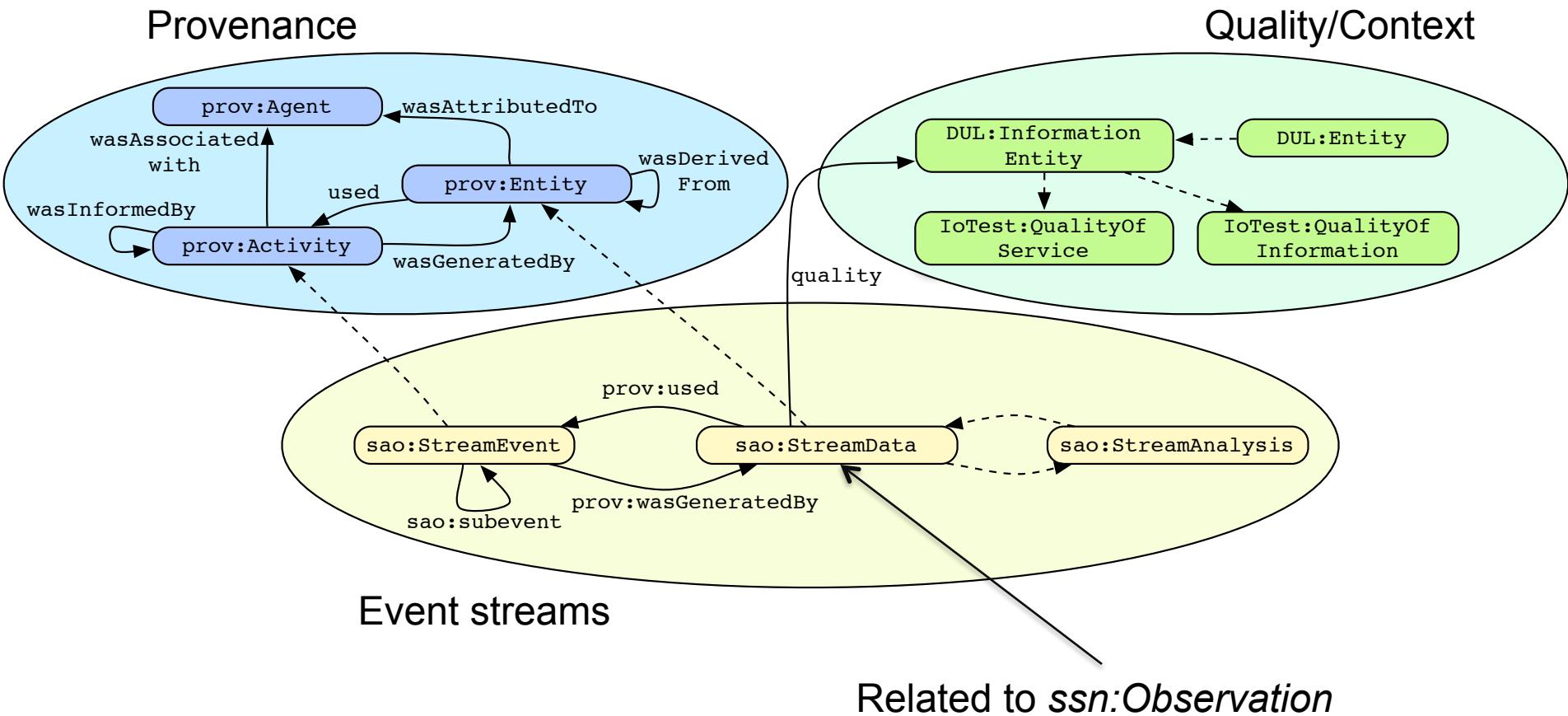
# Challenges of Smart City Data



- Data heterogeneity: interoperability
- Data quality: source selection, reliability
- Data context: source discovery/adaptation
- Data privacy: aggregation, access control
- Data dynamicity: semantic stream processing

# Semantic Model example

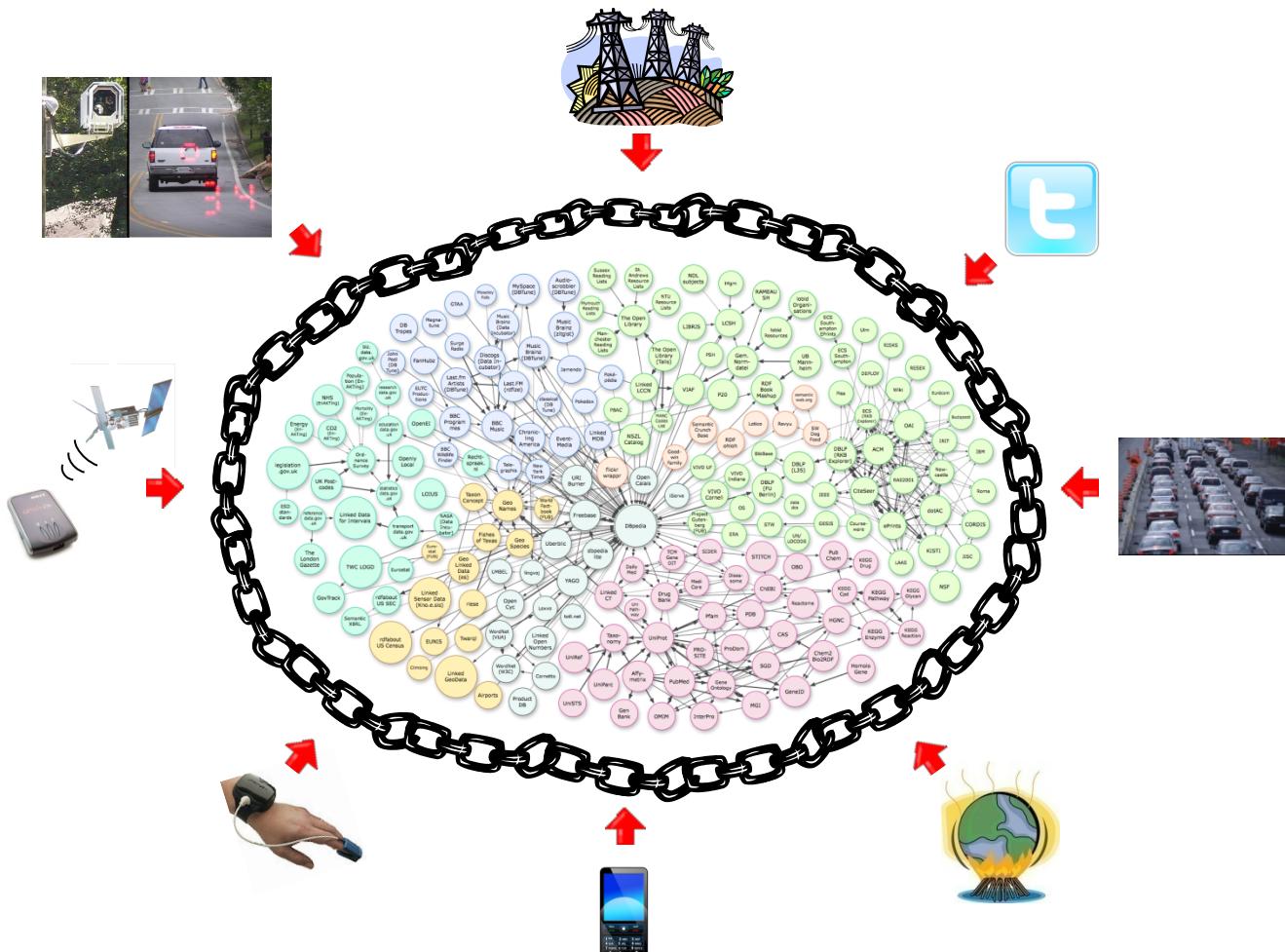
Key concept: ***Reuse!***



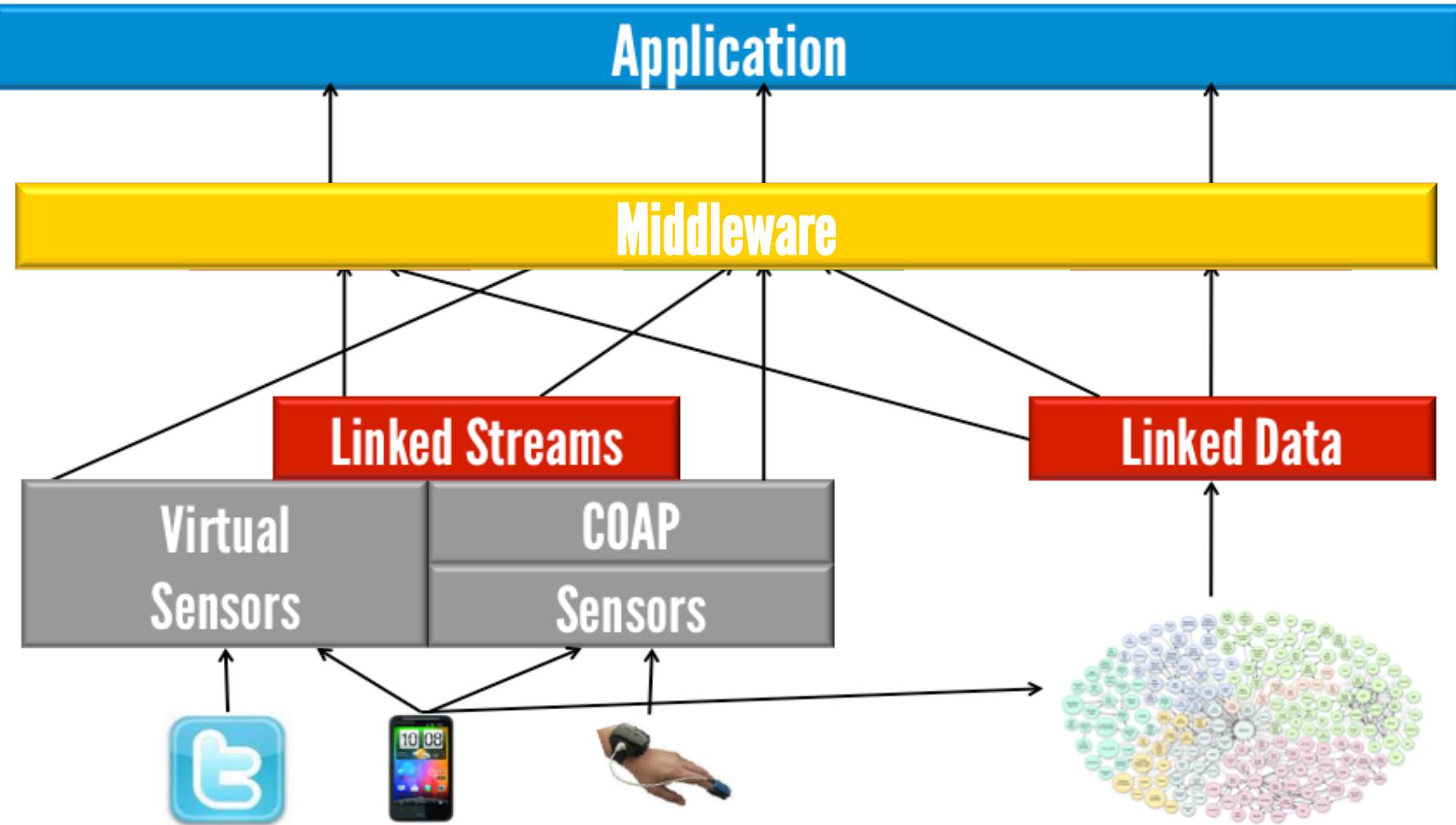
# Linked Stream Processing



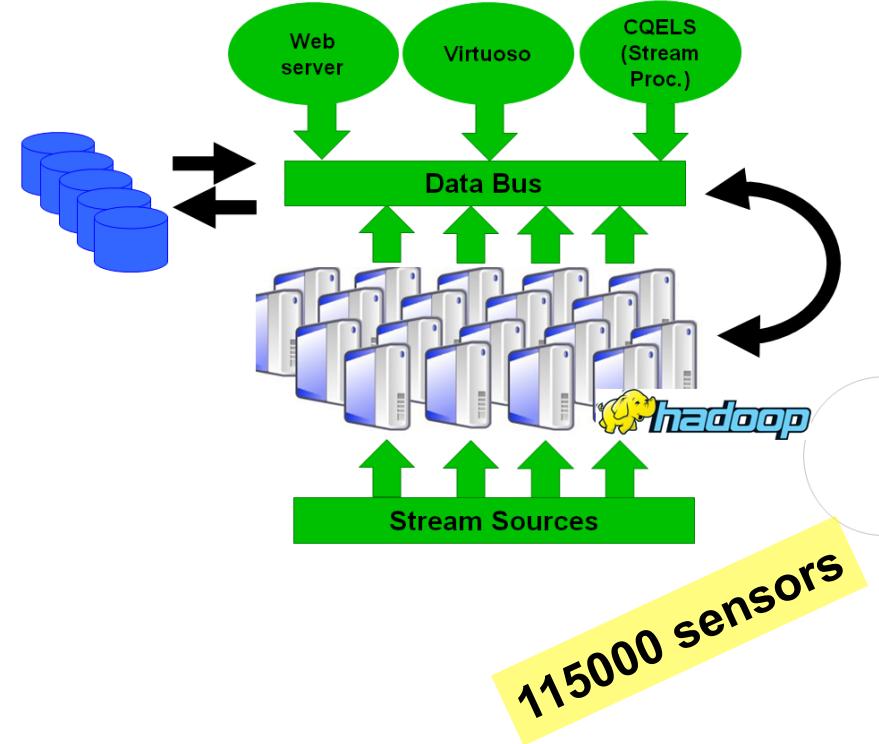
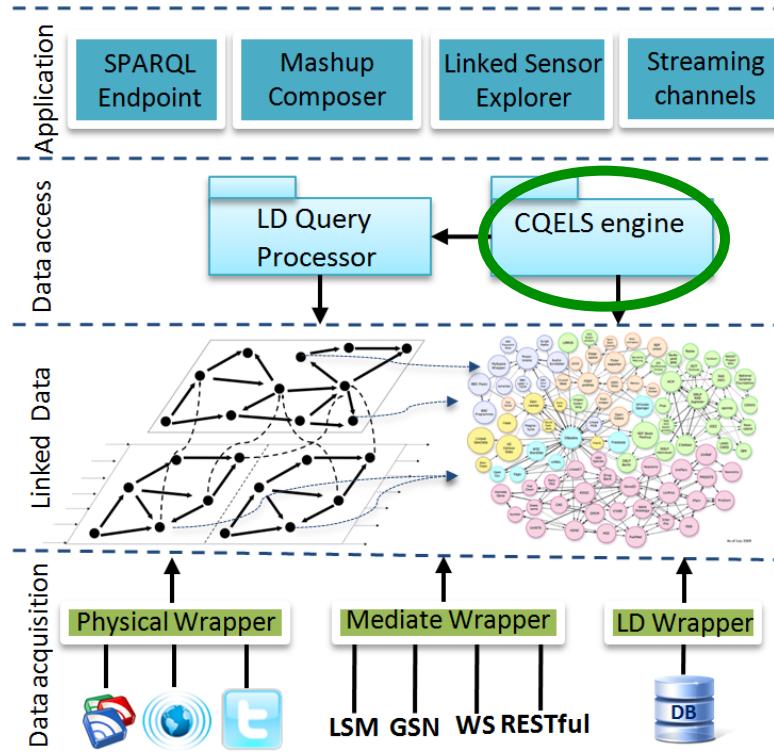
*Web of Things = Web of Devices/Services + Web of Data*



# Keep It Simple

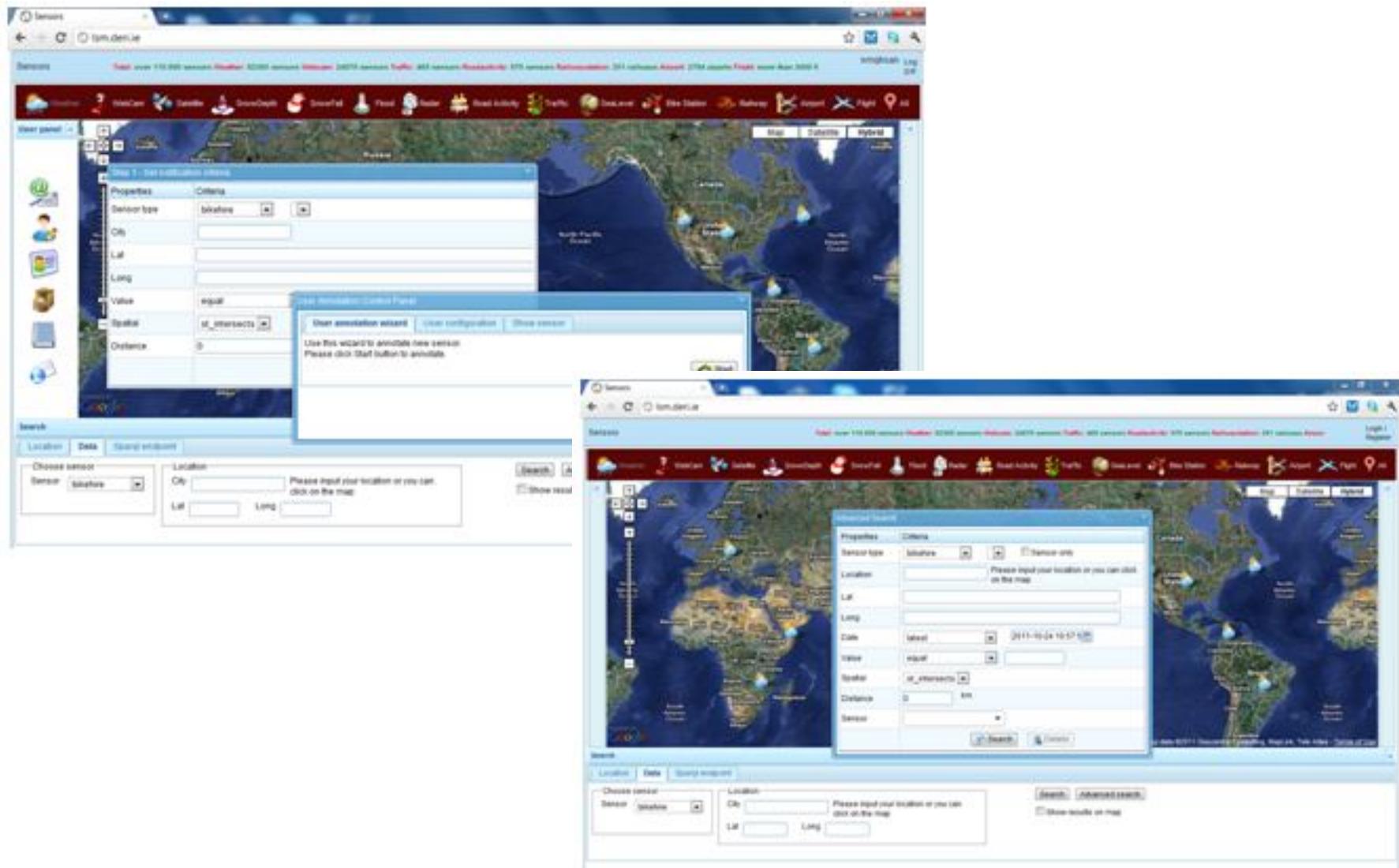


# Linked Stream Middleware (lsm.derि.ie)



## Continuous Query Processing Engine for Linked Streams

# Linked Stream Middleware



The image displays two side-by-side screenshots of the City Pulse web-based user interface. Both screens show a world map with various sensor locations marked by blue dots. A central search panel is visible on both.

**Left Screenshot:**

- Search Panel:** Shows a dropdown for "Choose sensor" set to "bikeshare". Below it are fields for "Location": "City" (input field), "Lat" (input field), and "Long" (input field). A note says "Please input your location or you can click on the map." There is also a checkbox "Show results on map".
- Annotation Wizard:** A modal window titled "User annotation wizard" is open. It contains fields for "Sensor type": "bikeshare", "City": (input field), "Lat": (input field), "Long": (input field), "Value": "equal", "Spatial": "st\_intersects", and "Distance": "0". Below these fields is a note: "Use this wizard to annotate new sensor. Please click Start button to annotate." At the bottom are "Start" and "Cancel" buttons.
- Top Bar:** Shows various service icons like Weather, Wind, Clouds, SnowDepth, SmogLevel, Heat, Radar, RealActivity, Traffic, Discover, BikeStation, RailWay, Airport, Flight, and a magnifying glass icon.

**Right Screenshot:**

- Search Panel:** Similar to the left, with "Choose sensor" set to "bikeshare". Fields for "Location": "City" (input field), "Lat" (input field), and "Long" (input field) are present. A note says "Please input your location or you can click on the map." There is also a checkbox "Show results on map".
- Annotation Wizard:** A modal window titled "User annotation wizard" is open. It contains fields for "Sensor type": "bikeshare", "City": (input field), "Lat": (input field), "Long": (input field), "Date": "2011-03-24 10:57:00", "Time": "equal", "Spatial": "st\_intersects", and "Distance": "0 km". Below these fields is a note: "Use this wizard to annotate new sensor. Please click Start button to annotate." At the bottom are "Start" and "Cancel" buttons.
- Top Bar:** Shows various service icons like Weather, Wind, Clouds, SnowDepth, SmogLevel, Heat, Radar, RealActivity, Traffic, Discover, BikeStation, RailWay, Airport, Flight, and a magnifying glass icon.

# Directions and Discussion

- *What are the principles for better design of a model for smart city data?*
  - Stream annotation using Linked Data description
  - Semantic properties for quality, context, privacy, simplify the connection with the processing steps, including discovery, indexing and continuous query processing
  - Contextualization via categorization of data in hierarchical form (from observations to complex events)
- *What about semantic processing of streams?*
  - RDF Stream Processing (RSP) W3C working group
  - Scope: to define a common model for producing, transmitting and continuously querying RDF Streams
  - Need to push this activity (e.g. via industry participation)



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