Supporting Smart Cities Modeling with Graphical and Textual Editors

Francesco Basciani[1] Maria Teresa Rossi[2] Martina De Sanctis[2]

University of L'Aquila, Italy
francesco.basciani@univaq.it

Gran Sasso Science Institute, L'Aquila, Italy
{mariateresa.rossi,martina.desanctis}@gssi.it

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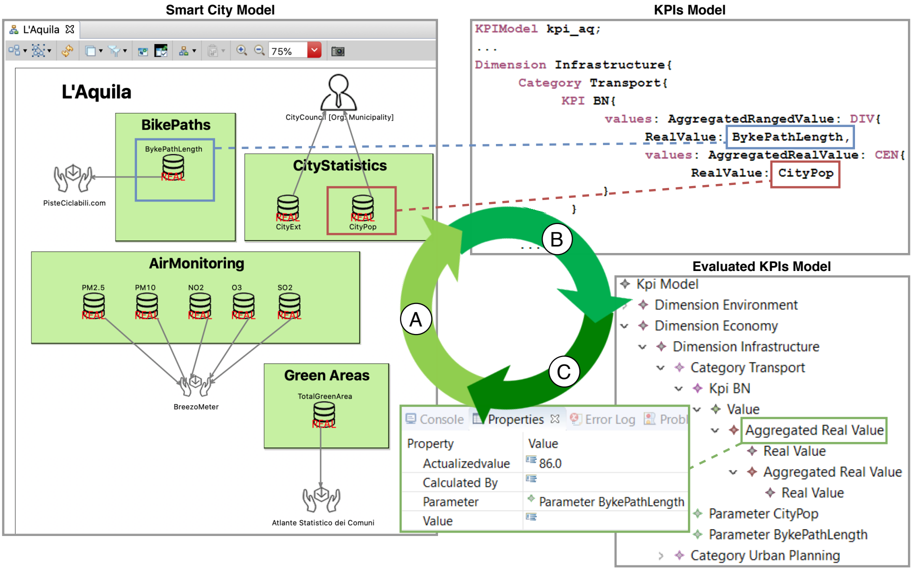
Context: Quality Assessment of Smart Cities



```
KPIModel kpi_aq;
...
Dimension Infrastructure{
      Category Transport{
          KPI BN{
              values: AggregatedRangedValue: DIV{
                   RealValue: BykePathLength,
                   values: AggregatedRealValue: CEN{
                        RealValue: CityPop
              }
          }
   ...
```

Property	Value
Actualizedvalue	86.0
Calculated By	
Parameter	Parameter BykePathLength
Value	

- Kpi Model
  - Dimension Environment
  - Dimension Economy
    - Dimension Infrastructure
      - Category Transport
        - Kpi BN
          - Value
            - Aggregated Real Value
              - Real Value
              - Aggregated Real Value
                - Real Value
        - Parameter CityPop
        - Parameter BykePathLength
      - Category Urban Planning

The Smart City Domain

In the literature[1], Smart Cities are defined as instrumented, interconnected, and intelligent cities.

- **Instrumented**: heterogeneity of sources of real-world data.
- **Interconnected**: integration of those data into computing platforms and communication of such information among the various city services.
- **Intelligent**: inclusion of complex analytics, modeling, optimization, and visualization in business processes to make better operational decisions.

[1] C. Harrison, B. Eckman, R. Hamilton, P. Hartswick, J. Kalagnanam,J. Paraszczak, and P. Williams. Foundations for smarter cities. IBM Journal of Research and Development, 54(4):1–16, 2010.

Modeling Editors

These challenges raise up the need of abstract and understandable **smart city models**.

In the literature, modeling editors are used to design real-world contexts enabling the **interoperability** between different ecosystems and the management of their **complexity**[2].

It does not exist as a **modeling editor for smart cities** devoted to their heterogeneous contexts.

[2] J. Guerson, T. P. Sales, G. Guizzardi, and J. P. A. Almeida. Ontouml lightweight editor: A model-based environment to build, evaluate and implement reference ontologies.
F. Pereira, F. Moutinho, J. Ribeiro, and L. Gomes. Web based iopt petri net editor with an extensible plugin architecture to support generic net operations.
M. Gonzalez-Garcıa, L. Moreno, P. Martinez, R. Minon, and J. Abascal. A model-based graphical editor to design accessible media players.
M. Lipaczewski, S. Struck, and F. Ortmeier. Saml goes eclipse — combining model-based safety analysis and high-level editor support.

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Requirements for Modeling Editors for Smart Cities

R1 *Modeling support* to users (e.g., syntax highlighting, auto-completion, code snippets).

R2 *Error detection*, both in the syntax and semantics at modeling time.

R3 *Automation of the model transformation and analysis* by means of model checkers into the editor.

R4 *Understandable representation* of the results of the model checkers.

R5 *Project versioning support* by the integration of external versioning tools (e.g., svn, git).

R6 *Staging and evolution support* of the realized models.

R7 *Modeling support of a great amount of data* generated by the smart cities infrastructure.

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A Modeling Editor for Smart Cities: the Metamodel

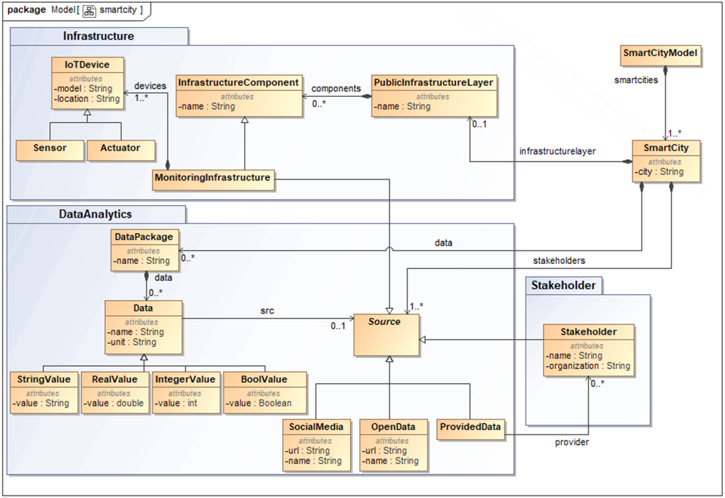

Figure: Smart City Metamodel

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A Modeling Editor for Smart Cities: the Editor

Used technologies:

- The *textual editor* has been developed by means of *Xtext*[3] framework, which is an Eclipse project for developing DSLs.
- The *graphical editor* relies on *Sirius*[4], an Eclipse project supporting the development of graphical modeling workbenches.

Video Demonstration

[3] https://www.eclipse.org/Xtext/

[4] https://www.obeodesigner.com/en/product/sirius

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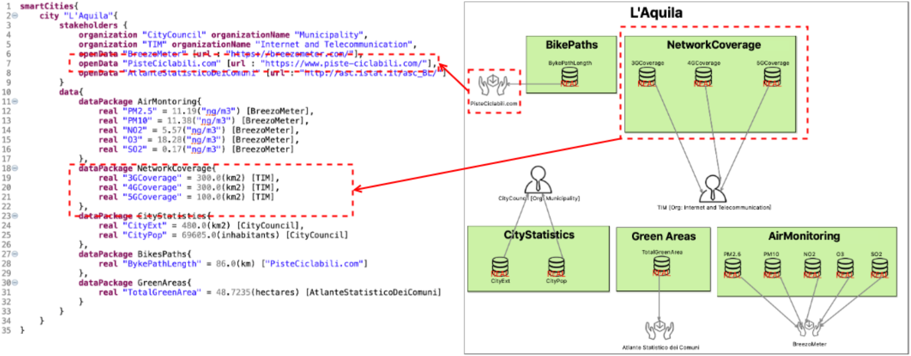
Use Cases: the City of L'Aquila



```
smartCities{
    city "L'Aquila"{
        stakeholders {
            organization "CityCouncil" organizationName "Municipality",
            organization "TIM" organizationName "Internet and Telecommunication",
            openData "BreezeMeter" [url : "https://breezometer.com/"],
            openData "PisteCiclabili.com" [url : "https://www.piste-ciclabili.com/"],
            openData "AtlanteStatisticoDeiComuni" [url : "http://asc.istat.it/asc_BL/"]
        }
        data{
            dataPackage AirMontoring{
                real "PM2.5" = 11.19("ng/m3") [BreezoMeter],
                real "PM10" = 11.38("ng/m3") [BreezoMeter],
                real "NO2" = 5.57("ng/m3") [BreezoMeter],
                real "O3" = 18.28("ng/m3") [BreezoMeter],
                real "SO2" = 0.17("ng/m3") [BreezoMeter]
            },
            dataPackage NetworkCoverage{
                real "3GCoverage" = 300.0(km2) [TIM],
                real "4GCoverage" = 300.0(km2) [TIM],
                real "5GCoverage" = 100.0(km2) [TIM]
            },
            dataPackage CityStatistics{
                real "CityExt" = 480.0(km2) [CityCouncil],
                real "CityPop" = 69605.0(inhabitants) [CityCouncil]
            },
            dataPackage BikesPaths{
                real "BykePathLength" = 86.0(km) ["PisteCiclabili.com"]
            },
            dataPackage GreenAreas{
                real "TotalGreenArea" = 48.7235(hectares) [AtlanteStatisticoDeiComuni]
            }
        }
    }
}
```

Figure: Graphical and textual representations of the model of the city of L'Aquila.

Use Cases: the City of Bolzano

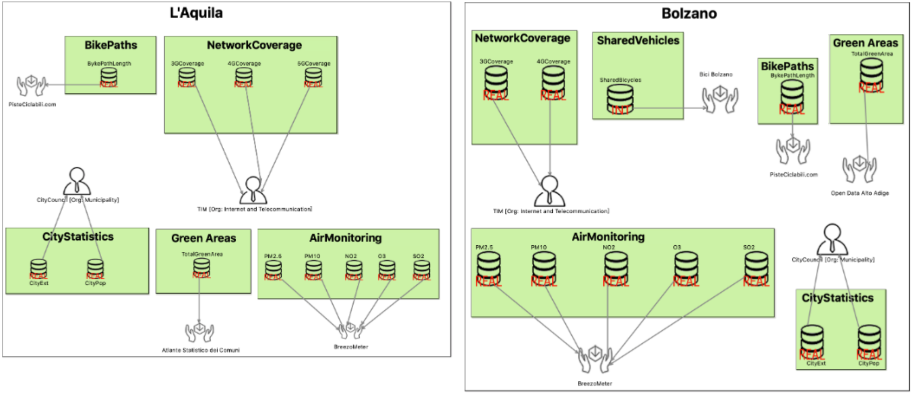


Figure: Graphical representations of the smart cities models.

Evaluation

R1 *Modeling support*: the textual editor features like syntax highlighting, code completion, and outlines.

R2 *Error detection*: EVL features, the semantics declared in the metamodel.

R3 *Automation of the model transformation and analysis*: combination between EVL for the model analysis and error detection and EOL for its ability to modify models.

R4 *Understandable representation*: *Validation* view of the editor.

R5 *Project versioning support*: integration of external versioning tools in Eclipse (e.g., *eGit*[5] plugin).

R6 *Staging and evolution support*: EMF Compare framework[6].

R7 *Modeling support of the great amount of data*: implemented commands to hide/show parts of the designed models.

[5] https://www.eclipse.org/egit/

[6] https://www.eclipse.org/emf/compare/overview.html

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Future Works

- Here, we focused on the *data analytics* context. We plan to make the smart city metamodel more complete and able to support the design of other smart city's contexts.
- Run an evaluation with real stakeholders.
- The presented editor is part of **smart cities quality assessment** system, which is under development.

Supporting Smart Cities Modeling with Graphical and Textual Editors

Thank you for your attention.

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