From Data to Insights: Constructing Spatiotemporal Knowledge Graphs for City Resilience Use Cases

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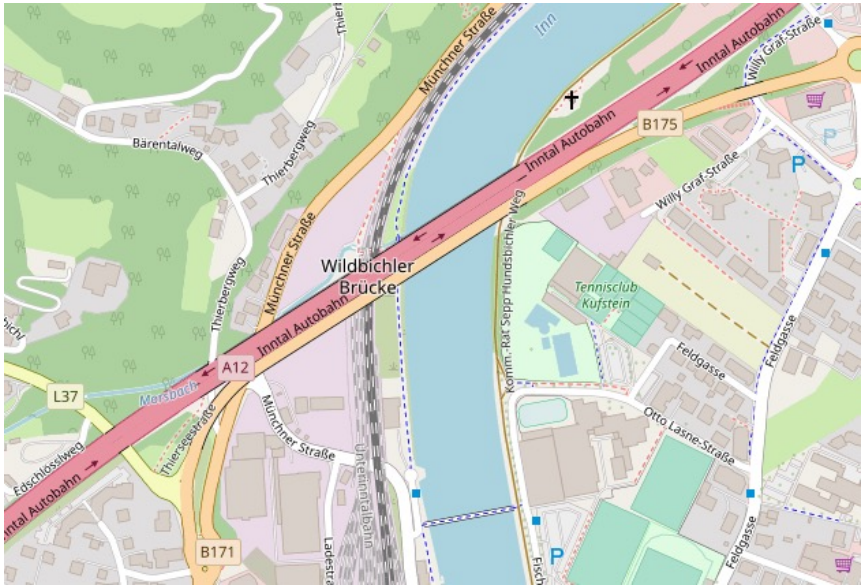
Introduction

- Our built environment is made up of various complex and interrelated systems and services that draw upon various infrastructure networks.
- Data may be scattered across multiple systems, organizations, and agencies.
- During a crisis, scattered data makes it difficult to obtain a complete picture of the situation.
- Furthermore, Understanding the interdependencies of these networks is of great importance for crisis management.

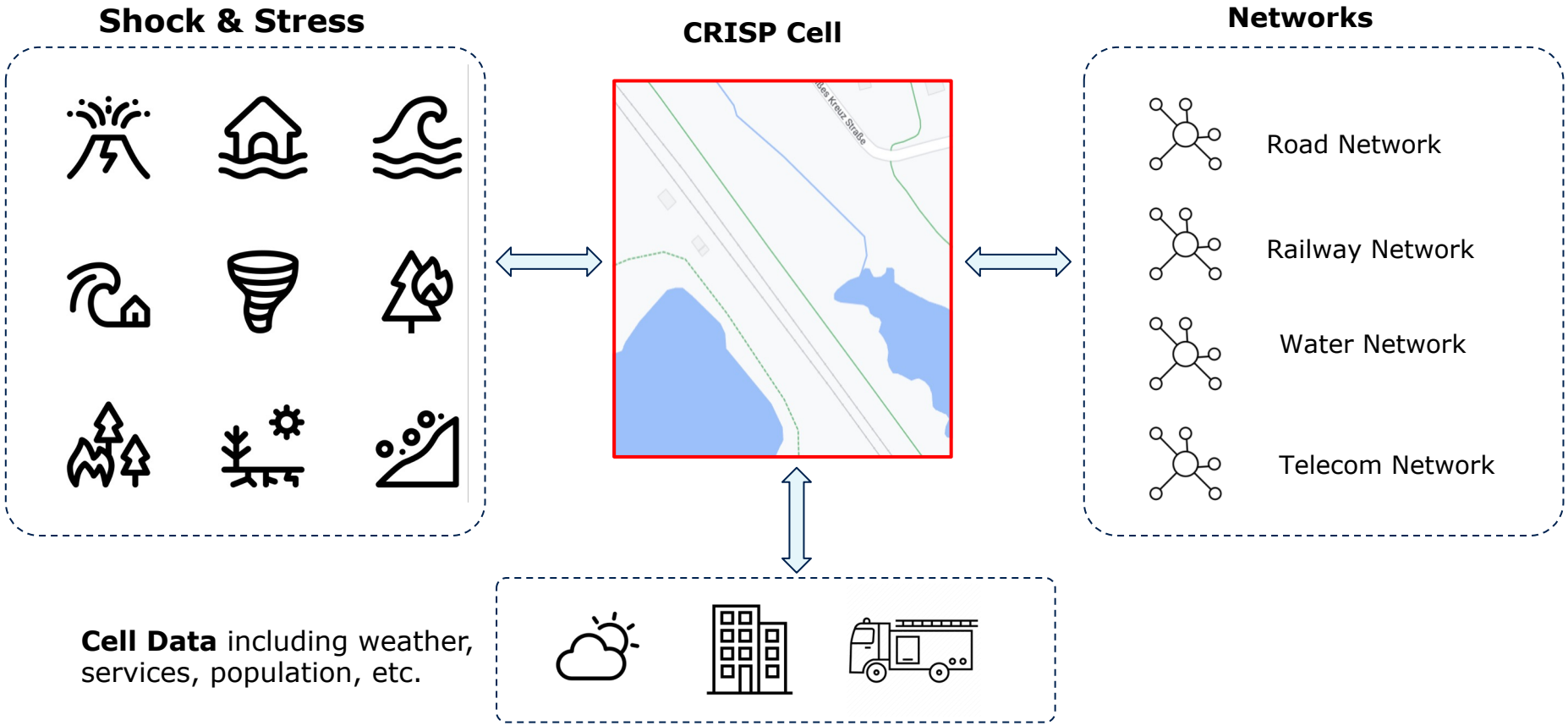


Wildbichler (Kufstein) bridge in Tirol, Austria, was blocked in June 1990 due to the danger of collapse. River transit and rail lines under the bridge were also closed

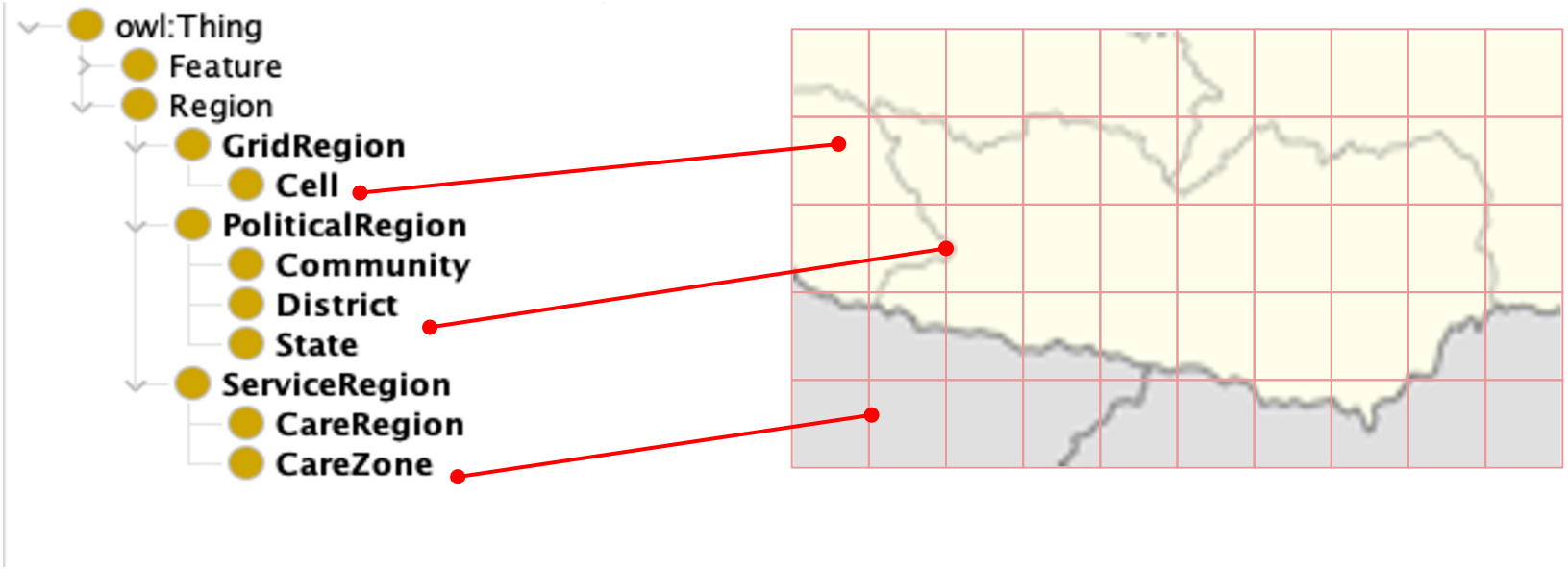
CRSIP Project

- The CRISP Project (Crisis Response and Intervention Supported by Semantic Data Pooling) represents a data-driven approach to Crisis Response and Intervention.
- CRISP aims to increase the transparency of crisis response and intervention processes via a uniform and comprehensive knowledge graph that includes
  - relevant information about infrastructure elements,
  - service networks, and
  - vulnerability of infrastructure and networks to different types of shock and stress.
- The CRISP KG aims to provide a data backbone of Austrian infrastructure systems.
- By connecting data on population, medical services, weather, transport, and utilities, CRISP KG gives users a way to understand how interconnected systems react to crisis and shock situations.

Overview of CRISP Information Resources



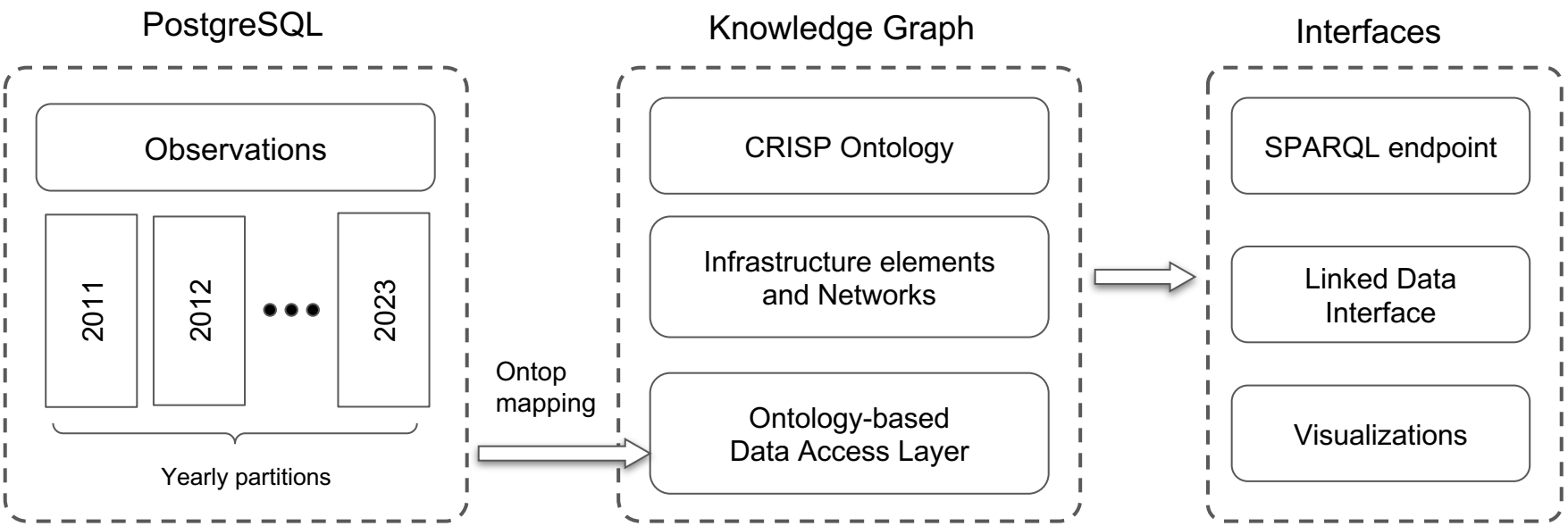
CRISP Spatial Concept



Infrastructure-Cell Mapping


```
crsp:hospital.K102 a crsp:Hospital,
        geo:Feature,
        vcard:Organization ;
    rdfs:label "Krankenhaus der Barmherzigen Brüder Eisenstadt GmbH"@de ;
    crsp:providesFor crsp:VR.11 ;
    geo:hasGeometry [ a sf:Point ;
          geo:asGeoJSON "{\"type\": \"Point\", \"coordinates\": [47.84763,
16.5138]}"^^geo:geoJSONLiteral ] ;
    geo:sfWithin crsp:cell.L1.223.622 ;
    vcard:hasAddress [ vcard:country-name "Austria"@en ;
          vcard:locality "Eisenstadt" ;
          vcard:postal-code "7000" ;
          vcard:street-address "Johannes von Gott-Platz 1" ] ;
    vcard:hasTelephone [ a vcard:Fax,
             vcard:Work ;
          vcard:hasValue <tel:+4326826011099> ],
       [ a vcard:Voice,
             vcard:Work ;
          vcard:hasValue <tel:+4326826010> ] ;
    vcard:hasUrl <http://www.barmherzige-brueder.at> .
```

Big Data Challenge: Weather Data



Edit Triples Map

Mapping ID: ZAMG_max

Target (Triples Template):

```
:observation/max{property}/cell.{cell}/{obs_date} a sosa:Observation ;
  sosa:resultTime {obs_date}^^xsd:dateTime ;
  sosa:hasFeatureOfInterest crisp:cell.{cell} ;
  sosa:observedProperty :max{property} ;
  sosa:hasSimpleResult {result}^^xsd:double .
```

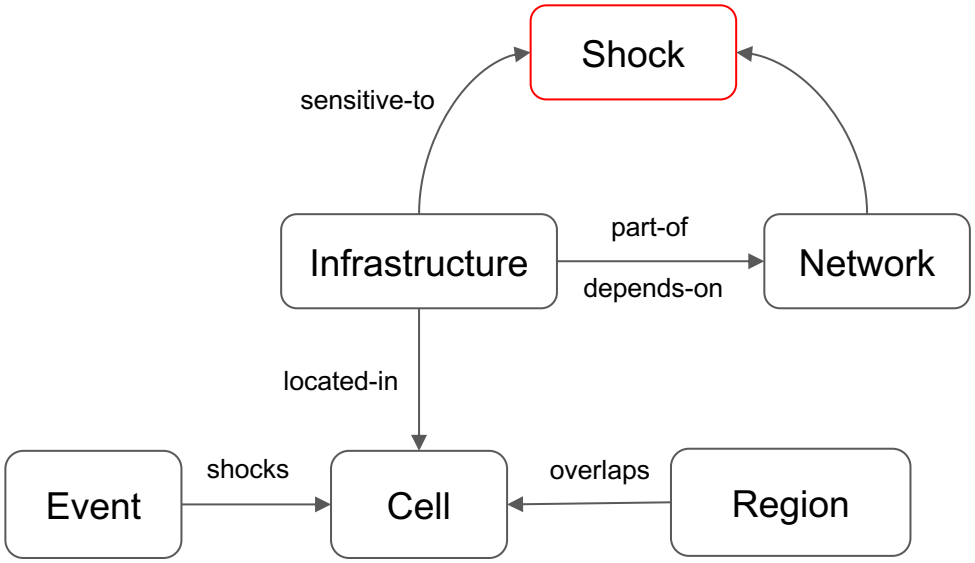
Source (SQL Query):

```
SELECT obs_date, cell, property, obs_max AS result FROM zamg_data;
```

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX sosa: <http://www.w3.org/ns/sosa/>
PREFIX zamg: <http://crisp.ai.wu.ac.at/crisp/zamg/>
PREFIX crisp: <http://crisp.ai.wu.ac.at/crisp/>

SELECT * WHERE {
  ?observation sosa:hasFeatureOfInterest crisp:cell.100.347 ;
               sosa:observedProperty zamg:maxAirTemperature ;
               sosa:resultTime ?obs_date ;
               sosa:hasSimpleResult ?obs_value .
  FILTER ((?obs_date >= "2011-06-01T00:00:00Z"^^xsd:dateTime) &&
          (?obs_date <= "2011-06-30T00:00:00Z"^^xsd:dateTime))
}
```

KG - Crisis management model



Conclusions and Future Work

- We utilize Knowledge Graph as a holistic and efficient medium for bridging the information gap among organizations and crisis management processes.
- Complex interdependencies of infrastructure elements and service networks within the CRISP KG inform us about the potential impact of different types of shocks and stresses.
- We are currently enriching the CRISP KG based on the proposed modelling approach presented in this paper and address the technical challenges of big data integration.
- The next step towards achieving semantic interoperability in crisis management use cases is the integration of relevant crisis management processes and including access control in order to secure sensitive data and processes in the knowledge graph.

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Thanks for your attention!

https://www.crisp-project.org/

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