# CRMgeo: Integration of CIDOC CRM with OGC Standards to model spatial information

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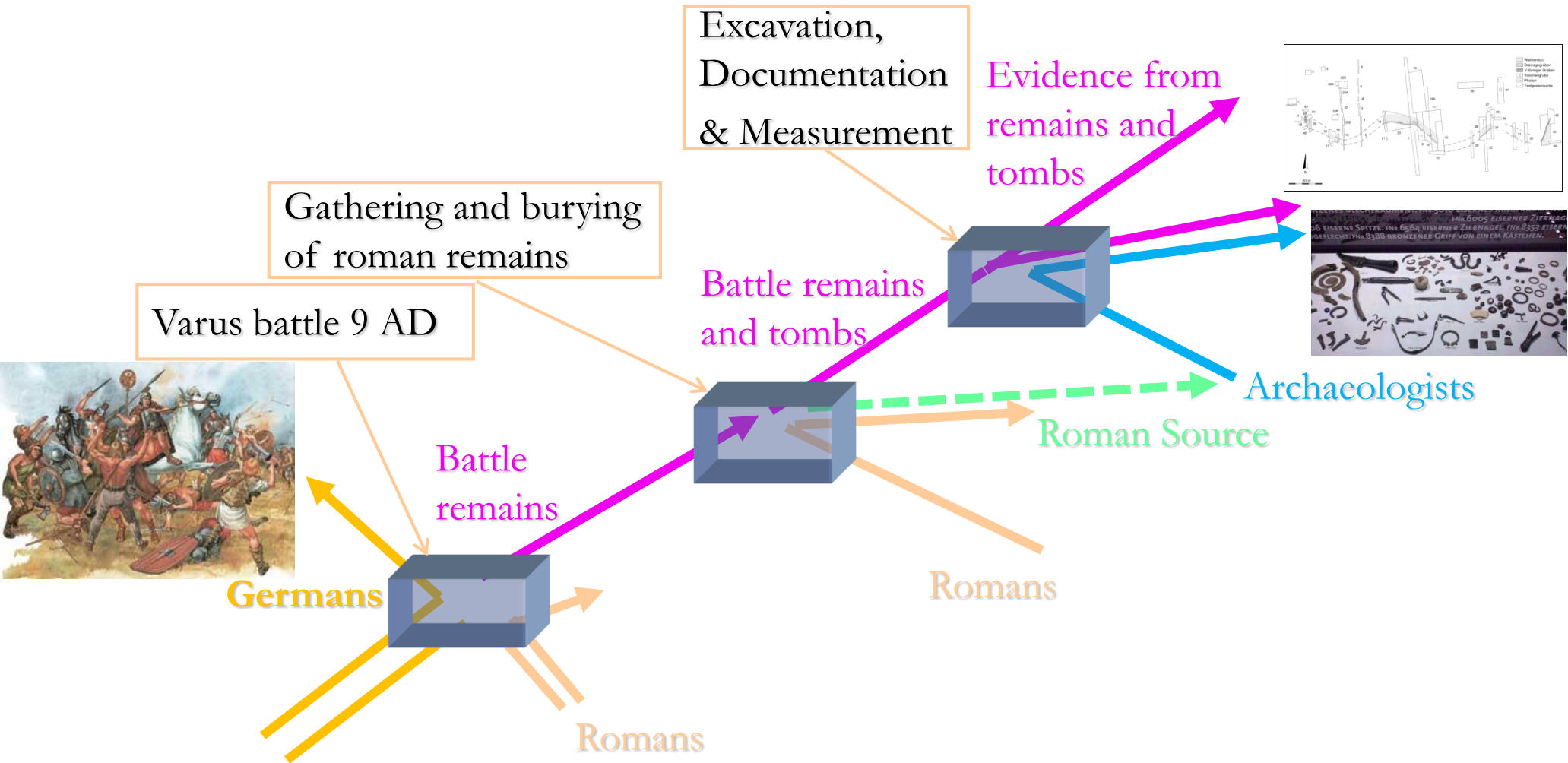Foundation for Research and Technology – Hellas, Crete, Greece

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# *Overview - Methodology*

- Refining the place concept of the CIDOC CRM ontology
  - **Phenomenal Place** based on Spacetime Volume and Reference Space
  - **Declarative Place** based on Place Expression and Coordinate System
- Geoinformation Standards
  - Abstract and Implementation Specifications
  - "GeoSPARQL" Standard
- CRM Extension in RDFS implements refined Place concepts to link CRM with GeoSPARQL
- Model applied to Gazetteers
- Spatiotemporal extension CRMgeo

# Phenomenal and Declarative Place
## Example of the Varus battle



Excavation, Documentation & Measurement

Evidence from remains and tombs

Gathering and burying of roman remains

Varus battle 9 AD

Battle remains and tombs

Battle remains

Archaeologists

Roman Source

Germans

Romans

Romans

# Phenomenal Places

*based on* Spacetime Volumes and Reference Spaces

- *The Varus battle was a true **event** -> it happened in a **Phenomenal Space Time Volume***
- *It happened in a **Reference Space** that still exists (a space at rest in relation to today's middle european continental plate)*
- *The event of the Varus Battle has a reasonable projection on the reference space which we want to call a "**Phenomenal Place**"*

**Phenomenal Places** *derive their identity through **events** or **physical things** over the **phenomenal spacetime volume** that they occupy*
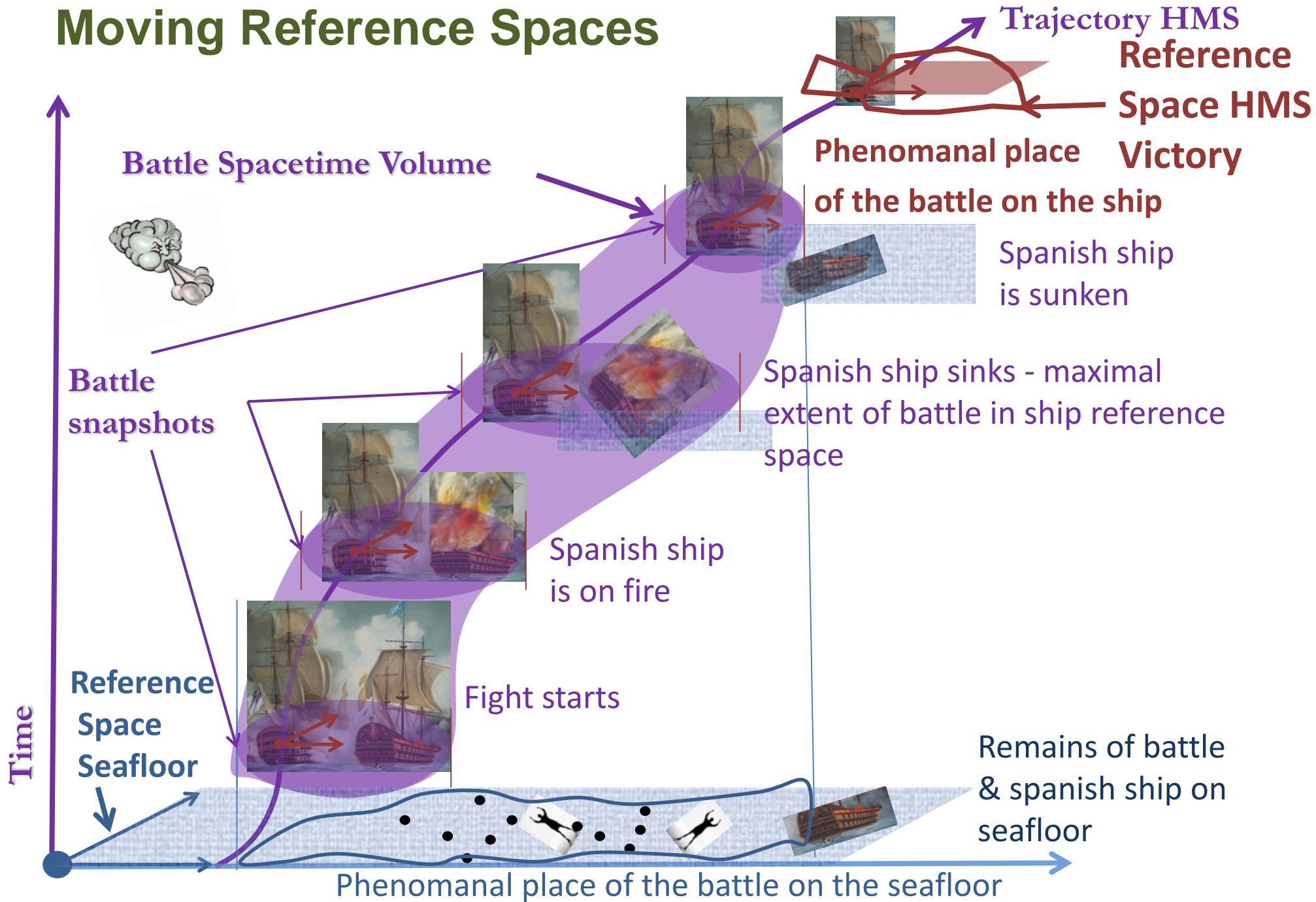
# Phenomenal Places



**E4 Period**

**Q1 occupied**

**SP1 Phenomenal Spacetime Volume**

# Moving Reference Spaces

Trajectory HMS

Reference Space HMS Victory

Battle Spacetime Volume

Phenomanal place of the battle on the ship

Spanish ship is sunken

Battle snapshots

Spanish ship sinks - maximal extent of battle in ship reference space

Spanish ship is on fire

Reference Space Seafloor

Fight starts

Remains of battle & spanish ship on seafloor

Time

Phenomanal place of the battle on the seafloor

# Declarative Places
## based on Coordinate Systems and Place Expressions

- *Locations within the Reference Space can be described using some kind of **Spatial Coordinate Reference System** that is fixed on **Reference Points (Features)***

- ***Geometric Place Expressions** can be expressed in this Spatial Coordinate Reference System either to:*
  - state hypothesis of the location of the battle place derived of historic sources
  - describe locations of measurements and interpolations

- *Geometric Place Expressions define "**Declarative Places**" that are believed to **approximate** real locations ("Phenomenal Places") of the battle or of measurements*

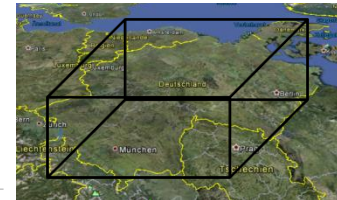**Declarative Places** derive their identity through **Place Expressions**

Declarative Places may **approximate** Phenomenal Places

# Declarative Places

# Standards in Geoinformation-
# OGC and ISO 19100 Series

## Open Geospatial Consortium (OGC)

Purpose: development of open standards for geospatial content

**ISO/TC 211 (Geographic Information/Geomatics)  ->**

## ISO 19100 Series - Geographic information

- extensive volume of ISO Standards on Geographic Information
- Abstract Specifications – defined in UML

    e.g. Spatial Schema, Temporal Schema, Spatial Referencing by Coordinates or Geographic Identifiers

- Implementation Specifications

    e.g. Geography Markup Language (GML), Portrayal  Services (WMS, WFS,…)

# OGC Standard "GeoSPARQL"

## Overview

- framework how to implement the OGC Standards (Abstract and Implementation Specifications) with semantic technologies through RDF/OWL encoding

- definitions of SPARQL queries

**OGC :**

*The goal for the OGC GeoSPARQL standard is to support representing and querying geospatial data on the Semantic Web. GeoSPARQL defines a vocabulary for representing geospatial data in RDF, and it defines an extension to the SPARQL query language for processing geospatial data.*

# 5 Components of GeoSPARQL
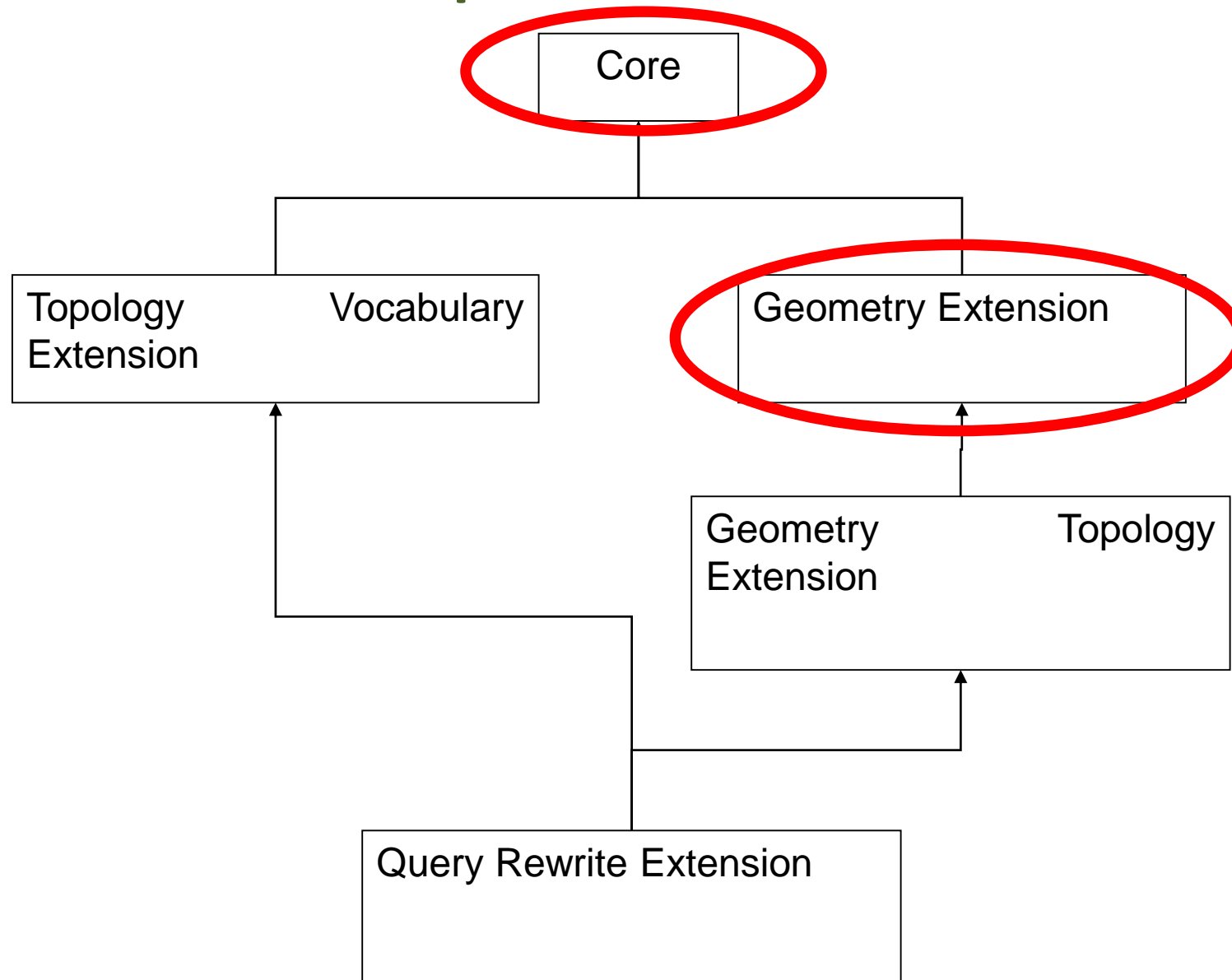
# GeoSPARQL Core Component

## Core Component

top-level RDFS/OWL classes for spatial objects

### SpatialObject

- superclass of everything feature or geometry that can have a spatial representation
- root class within the hierarchy of the GeoSPARQL ontology

### Feature

- Superclass of everything feature in GeoSPARQL

"A feature is an abstraction of a real world phenomenon" [ISO 19101]

# GeoSPARQL - Geometry Component

- **RDFS/OWL classes** for geometry object types

  **Geometry**: root geometry class

    subclass of SpatialObject

- **RDFS data types** for serializing geometry data

  **Serialization**: coordinates are stored in a format which defines the sequence of the characters

  - Well Known Text (WKT) as defined by Simple Features or ISO 19125

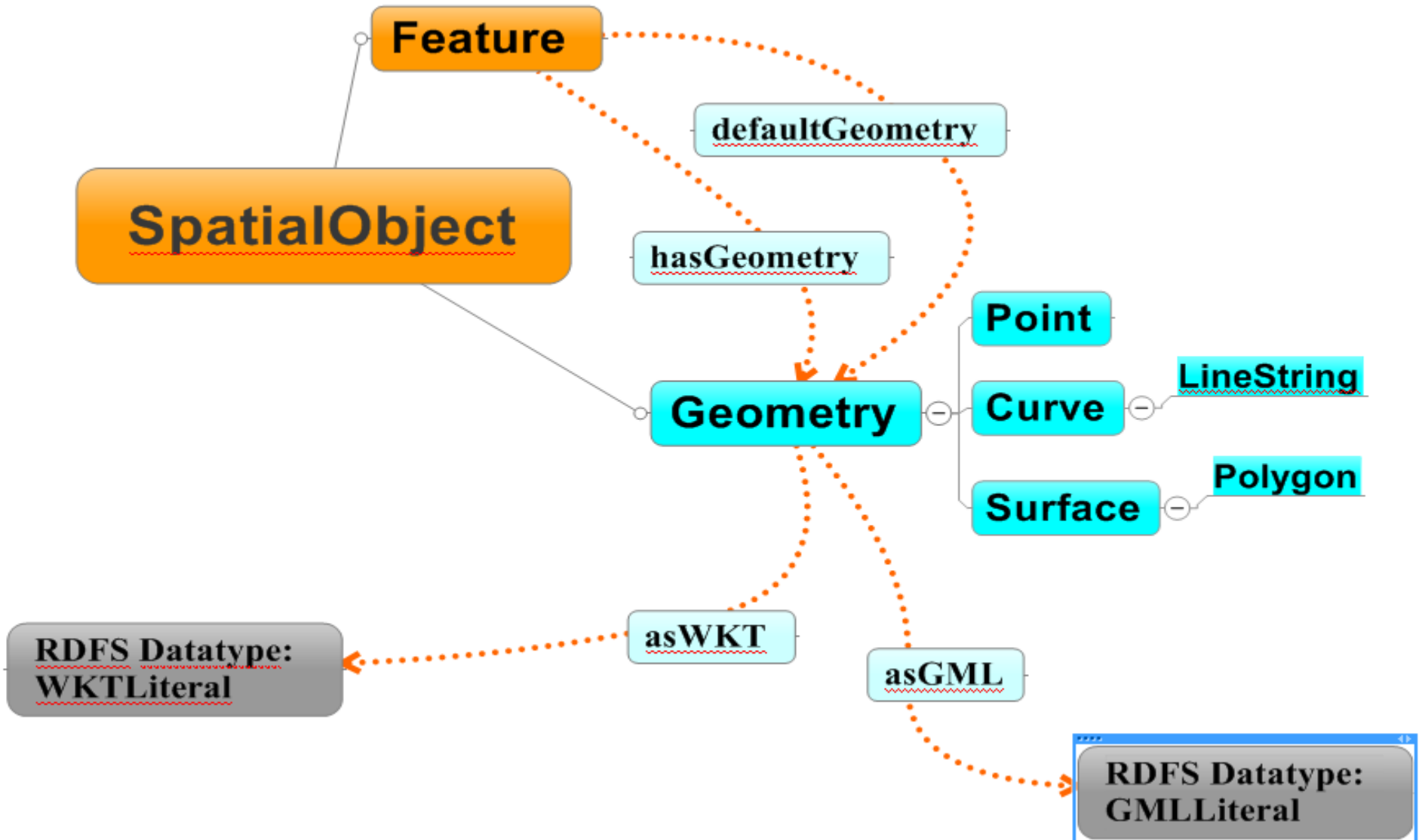      POINT(49.40 -123.26)

  - Geography Markup Language  (GML)  as defined in ISO 19136

  ```
  <gml:Point srsDimension="2" srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
          <gml:pos>49.40 -123.26</gml:pos>
  </gml:Point>
  ```
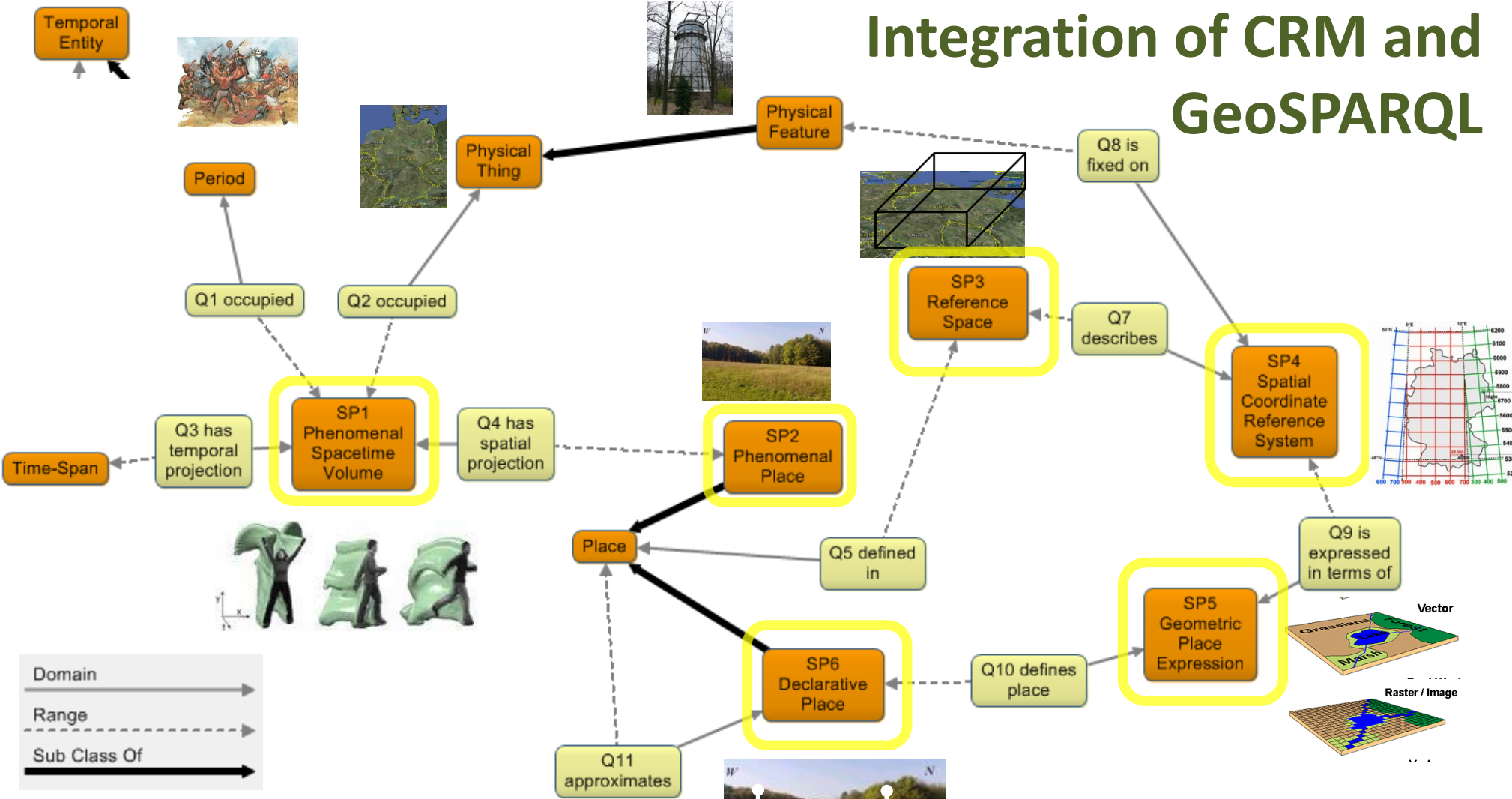
    These specifications (ISO 19125, ISO 19136) are also the base for subclasses of the geometry class. An RDF/OWL class hierarchy can be generated from the WKT or GML schema
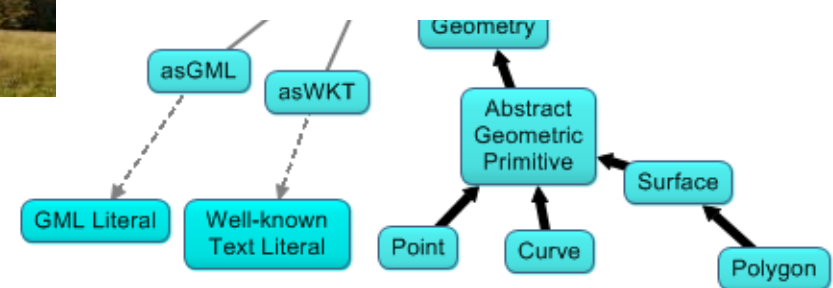
# GeoSPARQL - Geometry Component

# Integration of CRM and GeoSPARQL

Temporal Entity

Period

Physical Thing

Physical Feature

Q1 occupied

Q2 occupied

Q8 is fixed on

SP3 Reference Space

Q7 describes

SP4 Spatial Coordinate Reference System

Q3 has temporal projection

SP1 Phenomenal Spacetime Volume

Q4 has spatial projection

SP2 Phenomenal Place

Time-Span

Place

Q5 defined in

Q9 is expressed in terms of

SP5 Geometric Place Expression

SP6 Declarative Place

Q10 defines place

Q11 approximates

Domain

Range

Sub Class Of

**CIDOC CRM + CRM$_{spatial}$**

**Existing CRM properties**

**GeoSPARQL + RDF data types**

asGML

asWKT

Geometry

Abstract Geometric Primitive

GML Literal

Well-known Text Literal

Point

Curve

Surface

Polygon

Vector

Raster / Image

# Spatiotemporal extension CRMgeo

**1.1. Real world phenomena**

E5 Event

E4 Period

E18 Physical Thing

E18 Physical Thing → P56 bears feature → E26 Physical Feature

# Gazetteers

**Gazetteers (as defined in ISO 19112) for Phenomenal Places**

- Location Types define the kind of phenomenal places
  e.g. countries, cities, physiographic features, mountains

- Gazetteer Hierarchy can be split in phenomenal (is part of) and locational hierarchy (falls within)
  e.g. Mt. Everest (a mountain) **is part of** the Himalaya (mountain range)
  e.g. Stonehenge (archaeological site) **falls within** United Kingdom(country)

- Coordinates in Gazetteers are Geometric Place Expressions that create Declarative Places with the goal to approximate Phenomenal Places

- As Phenomenal Places are a projection of a Spacetime Volume the time of the phenomena  is important information which is often not provided

# Mapping of Gazetteers
## (ISO 19112 Spatial referencing by Geographic Identifiers)

# *Thank you*

# INSPIRE based on OGC/ISO standards

Inspire is the EU initiative to establish an infrastructure for spatial information in Europe that will help to make spatial or geographical information more accessible and interoperable

**Potential**

- Standards and methodology to build an interoperable infrastructure because services and encoding  are well defined
- Software to implement standards available
- Examples for implementation available
- EU Directive , politicaly enforced

**Pitfalls**

- ISO/OGC standards are very extensive
- 34 different topics which are not semanticly integrated