Geo-coding in Smart Environments: Smart-M3 and Geo2Tag Integration Principles

Kirill Krinkin, FRUCT LLC, ETU
Kirill Yudenok, FRUCT OSLL, ETU

Agenda

- Geo-coding (LBS) and smart spaces;
- Context and it's location data;
- Smart-M3 and Geo2Tag platforms;
- Problems, tasks and related works;
- Geo-coded Smart Space (GCSS);
- It's system requirements and high-level design;
- GCSS high-level requirements;
- GCSS layered architecture;
- Location based engine.

Geo-coding (LBS) and smart spaces

- ***Geo-coding*** allows to markup any kind of data by geographical coordinates and time (media, events, documents, etc.):
  - semantic information search;
  - M2M interactions;
- ***Smart Spaces*** as the basis for seamless distributed communication field for software services provides semantic level for data processing:
  - continuous distributed semantic data;
  - communication field for software services;

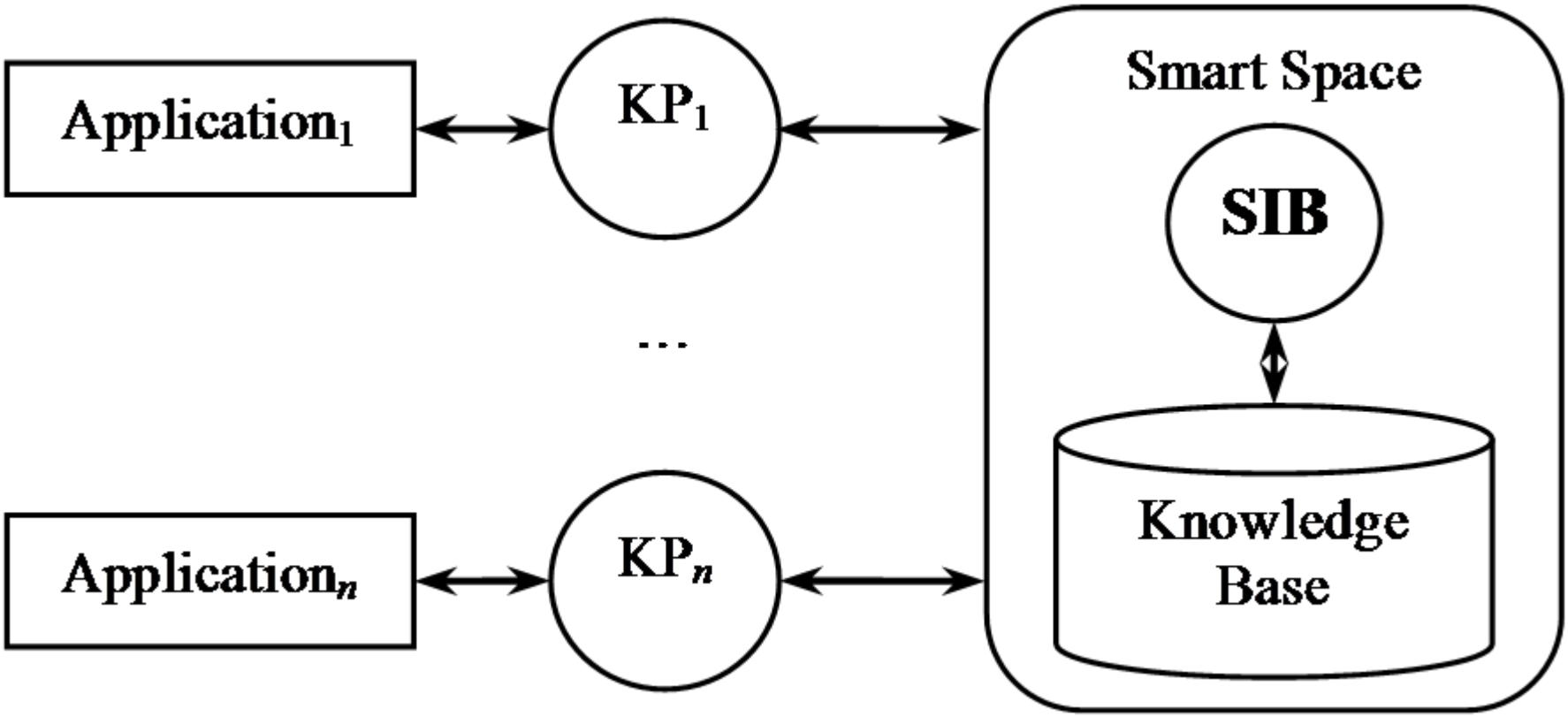
Context and it's location data

"***Context*** is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves." [Abowd et al'99]

- One of the important part of context is ***location based data***, that is being used for:
  - clarifying semantic meaning of queries;
  - limitation of space search;

Smart-M3 platform

Smart-M3 is an open source software platform that aims to provide Semantic Web information sharing infrastructure between software entities and various types of devices.



Geo2Tag platform 1/2

Geo2Tag platform is the centralized high performance geo-tagging database with dedicated server, which is provided REST API for access to geo-tags.

- user management: registration, login, log-off, sessions;
- data retrieval about users and matching personal geographical spaces to the personal smart spaces;
- channel management: subscriprion/unsubscription
- sending geographical data from smart-space to the geo-tagging system;
- getting data from geo-tagging system;
- spatial filtration;

Geo2Tag platform 2/2

Geo2Tag data model:

User – data that represent human of Geo2Tag;

Channel – object that contain name, description and set of tags;

Tag – object that contain URL of multimedia object, name, description, time of creation and coordinates (L, B, H);

Problems and Tasks

Problems:

- investigation of the smart spaces and geo-coding platforms integration;

Tasks:

- design and development of system requirements, high-level design, architecture, data model (ontology) of the integration agent;
- integration smart system development by combining geo-coding and smart space platforms;
- testing and analysis of the system characteristics.

Related works

- ***Pervasive Computing Research Group*** (indoor Location Based Services and coding real world objects);

- ***[K. Kolomvatsos et al'07]***: spacial ontology, ontology driven map annotation, GIS-based ontology population and navigation algorithms;

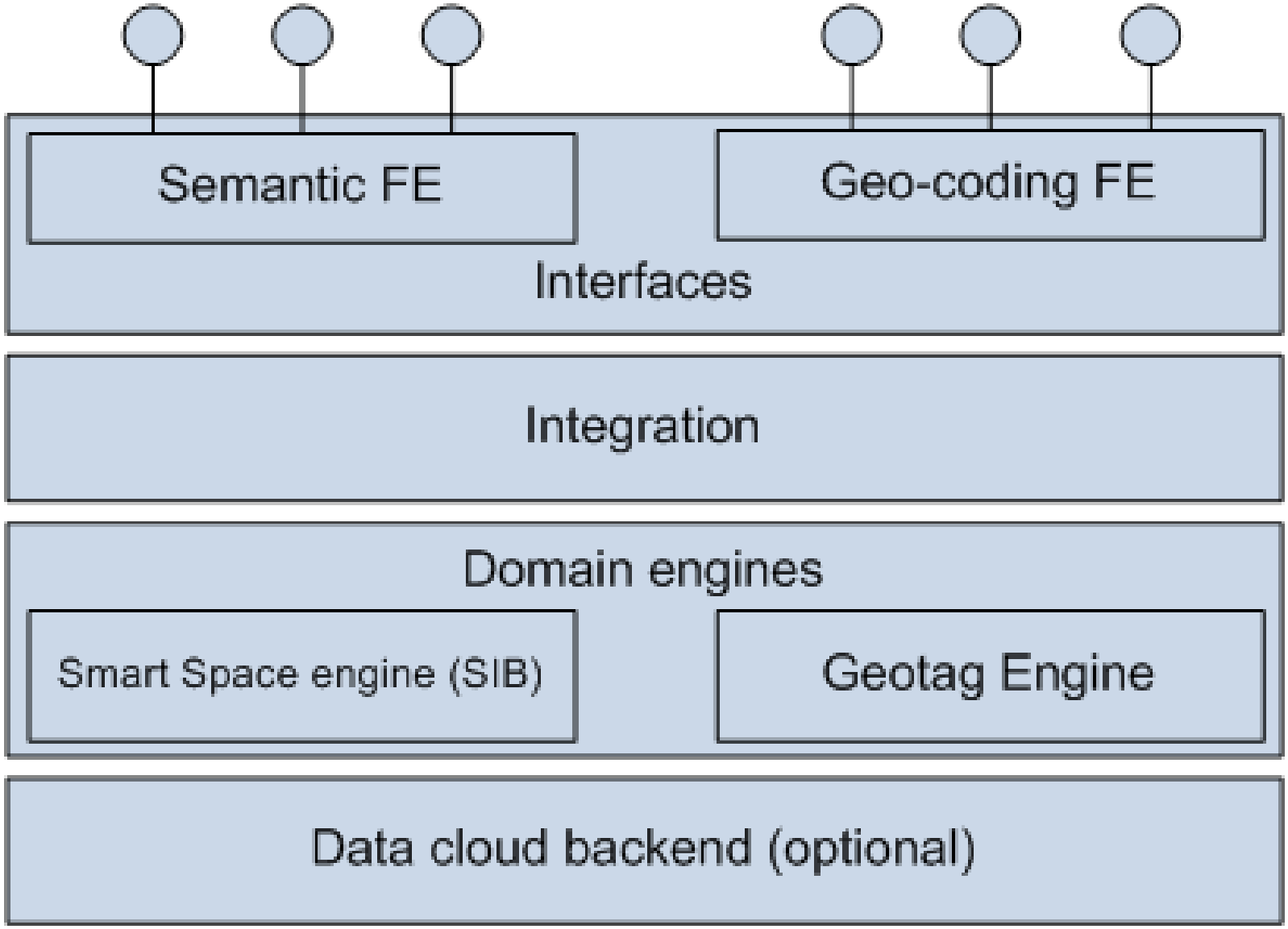
- ***[A. Dearle et al'03]***: tree-based region distribution of semantic information in global space (like geographical fractal structure of smart space data);

Geo-coded Smart Space (GCSS)

GCSS is a smart system that looks like Smart-M3 agent (KP) by combining the work of two platforms ***Smart-M3*** and ***Geo2Tag***.

- ***Main difference*** from previous works – common platform for knowledge processing of Smart-M3 space;
- ***New property*** – location in space and time, that give the ability to search in a space (room, house).

GCSS layered architecture 1/2



GCSS layered architecture 2/2

- ***Interfaces*** – smart-spaces and geo-coding front-ends (FE) and their functionality;
- ***Integration*** – components for translating geo-tags from Geo2Tag format to Smart-Space format and vice versa;
- ***Domain engines*** – particular implementations of smart-space geo-coding middleware (Smart-M3 and Geo2tag);
- ***Data cloud backend*** – optional component, which providing services: offline data (pre-)processing, storage for BLOB objects, indexing, caching etc.

System requirements and high-level design

Use-cases of the GCSS system:

- geographical markup of smart space data;
- search set reduction;
- search context rectification.

The main task of the agent – the union of the Smart-M3 and Geo2Tag platforms.

- Agent is not an extension of the Smart-M3 platform, it is expanding the space with new data – geo-data;

GCSS high-level requirements

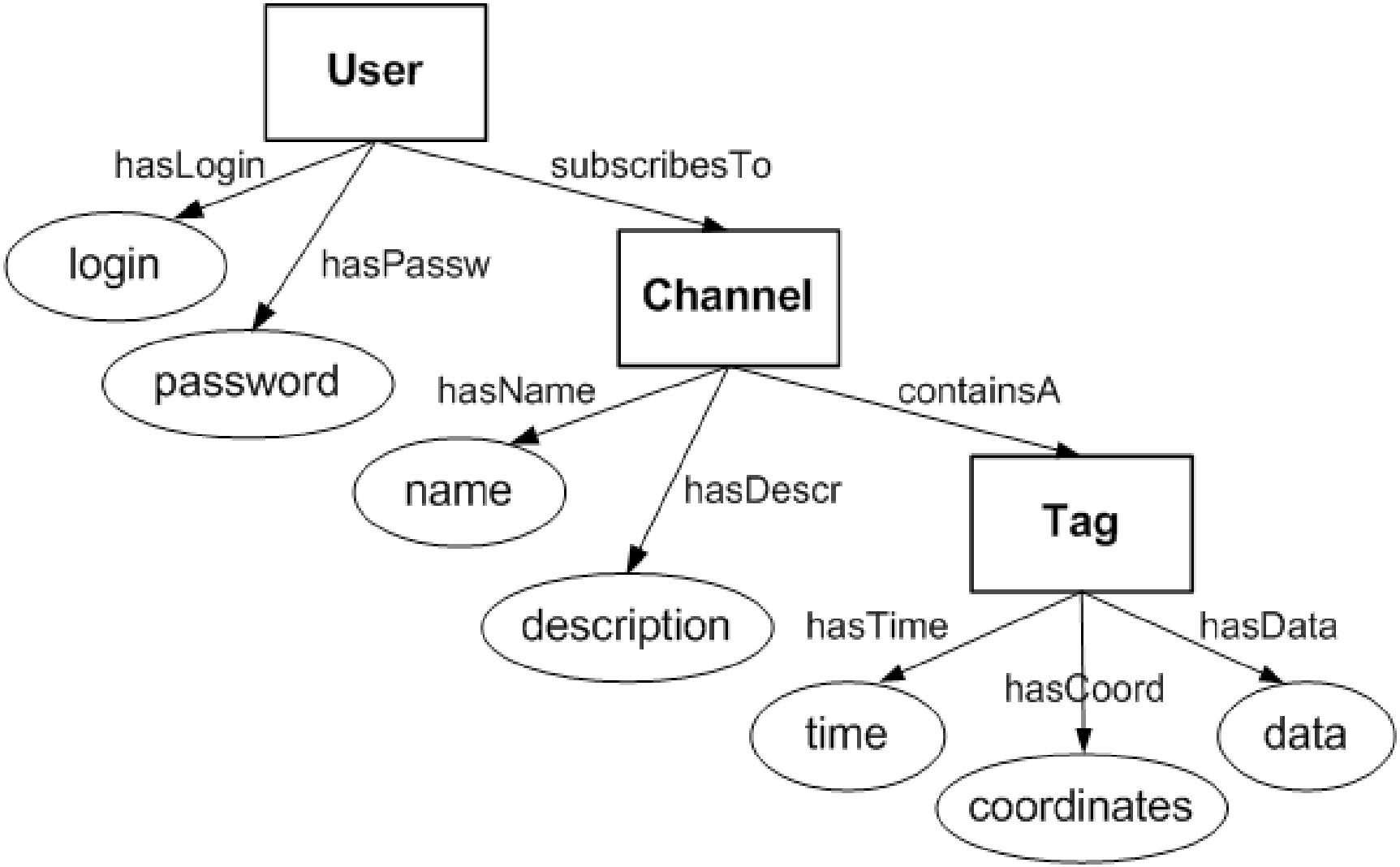
- providing interfaces for semantic data and access;
- distributed storage for semantic information;
- interfaces for association semantic objects with geo-tags;
- spatial and temporal filtration.

Non-functional requirements:

- Performance (cloud based massive offline processing and local context indexing/caching);
- Compatibility (legacy interfaces: SSAP, REST);

Location based engine

GCSS Geo2Tag ontology:

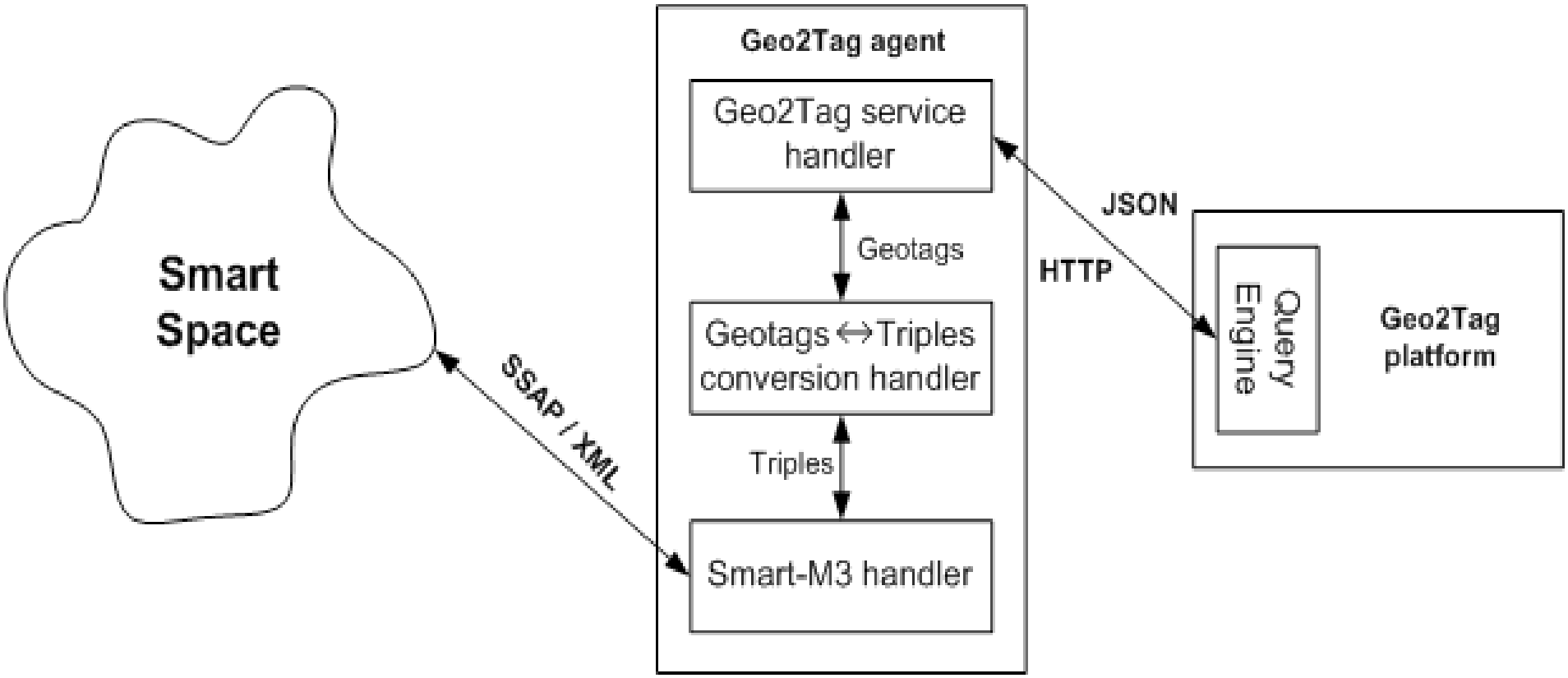


GCSS Geo2Tag ontology details

- The root element is the class ***User*** (all geographical data from personal geo-space);
- The ***Channel*** could contain any amount of geo-tags;
- The main object of this ontology is a ***geo-tag*** (class Tag); The size of a one geo-tag nearing ~1K;
- The property ***data*** plays significant role in integration mechanism, which allow to specify objects or relations in smart space.

Geo2Tag agent architecture

- Geo2Tag agent is a KP in terms of Smart-M3 platform;



Geo2Tag agent architecture details

- Main components: ***Geo2Tag service handler*** and ***Smart-M3 handler***;
- ***Geotags <-> Triples conversion handler*** responsible for converting geo-data (JSON format) to the space RDF-triplets;
- Geo-tag consists of a tuple ***<t, L, B, H, data>***, which can be easily converted into a space geo-data triplet of ***<time, coordinates, data>*** type;
- Agent is used ***object-oriented model*** *for ontological data processing* (all RDF triples are transforming into objects);

Future steps

- improvement of Geo2Tag agent architecture and it's ontology;
- Geo2Tag agent development process;

Still open questions:

- overall system performance;
- effective object monitoring;
- temporal and spatial filtration;
- integration with media objects.

Q&A

Kirill Krinkin {kirill.krinkin@fruct.org}
Kirill Yudenok {kirill.yudenok@gmail.com}
FRUCT & ETU OSLL {http://osll.fruct.org/}

Links

- G. D. Abowd, A. K. Dey, P. J. Brown, N. Davies, M. Smith and P. Steggles, "Towards a better understanding of context and context-awareness," in *Proc. 1st international symposium on Handheld and Ubiquitous Computing*, ser. HUC '99. London, UK: Springer-Verlag, 1999, pp. 304-307.
- Pervasive Computing Research Group (p-comp): http://p-comp.di.uoa.gr
- K. Kolomvatsos, V. Papataxiarhis, V. Tsetsos.: "Semantic Location Based Services for Smart Spaces", *2nd International Conference on Metadata and Semantics Research* (MTSR), Corfu, Greece, 2007
- A. Dearle, G. Kirby.: Architectural Support for Global Smart Spaces M.-S. Chen et al. (Eds.): *MDM 2003*, LNCS 2574, pp. 153-164, 2003