The Semantic Container Approach

Techniques for ontology-based data description and discovery in a decentralized SWIM knowledge base

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BEST Project

- SESAR 2020 exploratory research project (TRL 1)
- June 2016 – June 2018

BEST applies semantic technologies for:

- **Description** of the data you want/have
- **Discovery** of the information you are seeking
- **Filter** information
- **Value-added** information
Semantic Containers in SWIM

Database

Knowledge base

Semantic Container

Semantic Container

Information Service

Information

Technical Infrastructure (BP/YP)
Semantic Containers in SWIM

Query → Result

SWIM Enabled Application

+BEST

Database

Knowledge base

Semantic Container

Semantic Container

Information Service

Information

Technical Infrastructure (BP/YP)

Technical Infrastructure (BP/YP)

Technical Infrastructure (infrastructure)

IP-Based Network
The semantic container approach considers packages of ATM information, which SWIM services store in a repository and retrieve as needed.

- For example, a SWIM service filters and prioritizes METARs & TAFs for individual flights.
- From that SWIM service, a briefing application requests all METARs & TAFs relevant for flight \(<\text{IAD-FRA, 2018-02-23}>\).
- The SWIM service returns a semantic container with exactly that information.
- The semantic container can then be redundantly allocated at multiple sites, e.g., inside the aircraft or on airport servers, for improved availability.
- The SWIM service, knowing that many applications request MET Airport Container relevant to the flight from Washington to Frankfurt, may keep a semantic container with all METARs & TAFs relevant for the route in cache.
Semantic Container

- **Membership condition**
  - Description of the content
  - The semantic container comprises all data items that fulfil the membership condition
  - Serves to find containers that satisfy application’s information need

- **Administrative metadata**
  - Technical metadata (format, encoding, etc.)
  - Quality metadata (last update, last check, etc.)
  - Provenance metadata (What SWIM service produced the container?)

- **Content**
  - The actual ATM information
  - A set of data items, where each data item fulfils the membership condition
  - Can be materialized or just a pointer

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**Membership Condition**

Data item type: METAR
Origin: DWD
Location: FRA
Time: 2018-02-23

---

**Administrative Metadata**

Data format: XML
Last change: 2018-02-23T11:00:00

---

**Content**

METARs<FRA, 23/2/2018>

--- Membership Condition ---
Data item type: METAR
Origin: DWD
Location: FRA
Time: 2018-02-23

--- Administrative Metadata ---
Data format: XML
Last change: 2018-02-23T11:00:00

---

**Content**

METAR

<raw_text>
PHTO 161053Z
24005KT 10SM
FEW027 BKN070 20/18
A3013 RMK AO2
RAB21E46 SLP201
P0000 T02000178
</raw_text>

...
Semantic Containers and Ontologies

(a) Semantic containers

(b) Concepts in Ontology
Semantic Containers and Ontologies

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Semantic Containers and Ontologies

(a) Semantic containers

(b) Concepts in Ontology
Semantic Containers and Ontologies

(a) Semantic containers

(b) Concepts in Ontology

METARs <FixedWingAircraft>
--- Membership Condition ---
Data item type: METAR
Aircraft: FixedWingAircraft
--- Administrative Metadata ---
...

narrower

METARs <RotaryWingAircraft>
--- Membership Condition ---
Data item type: METAR
Aircraft: RotaryWingAircraft
--- Administrative Metadata ---
...

METARs <SeaPlane>
--- Membership Condition ---
Data item type: METAR
Aircraft: SeaPlane
--- Administrative Metadata ---
...

Aircraft

FixedWingAircraft

SeaPlane

Helicopter

RotaryWingAircraft
Semantic Container Derivation Chains

**Combine**
- E1<f1>
- E1<f2>
- E1<f3>

Combine
- E1<f1> U f2 U f3

**Compose**
- E1<f1>
- E2<f2>
- A1<f3>

Compose
- E1<f1> > U E2<f2> > U A1<f3>

**Filter**
- E1<f1>

Filter
- E1<f2>

Constraint: f2 subsumed by f1

**Derive**
- E1<f1>

Derive A1<f2>
- A1<f2>

Constraint: f2 subsumed by f1
Combine METARs for Specific Areas

METARs <Region 1>
Provider 1

METARs <Region 2>
Provider 2

METARs <Region 3>
Provider 3

...

Combine TAFs for Specific Areas

TAFs <Region 1>
Provider 1

TAFs <Region 2>
Provider 2

TAFs <Region 3>
Provider 3

...

Filter METARs for <ADEP - ADES, Date>

Filter TAFs for <ADEP - ADES, Date>

AERODROMEs
<relevant for ADEP - ADES, Date>

METAR Container
<ADEP - ADES, Date>

TAF Container
<ADEP - ADES, Date>
Combine METARs for Specific Areas
Filter METARs for <ADEP - ADES, Date >

Combine TAFs for Specific Areas
Filter TAFs for <ADEP - ADES, Date >

AERODROMEs <relevant for ADEP - ADES, Date >

METAR Container <ADEP - ADES, Date >
METARs <Region 1 and ADEP - ADES, Date >
METARs <Region 2 and ADEP - ADES, Date >
METARs <Region 3 and ADEP - ADES, Date >

TAF Container <ADEP - ADES, Date >
TAFs <Region 1 and ADEP - ADES, Date >
TAFs <Region 2 and ADEP - ADES, Date >
TAFs <Region 3 and ADEP - ADES, Date >

Compose & Filter METAR/TAF for a specific <Flight Number, Aircraft Type, Date>
Rules relevant for a specific <Aircraft Type>

Enriched MET Airport Container <Flight Number, Date, Aircraft Type>
MetAR <Region 1 and Flight Number, Date, Aircraft Type>
MetAR <Region 2 and Flight Number, Date, Aircraft Type>

TAF Annotation Container <Flight Number, Date, Aircraft Type>
TAF <Region 1 and Flight Number, Date, Aircraft Type>
TAF <Region 2 and Flight Number, Date, Aircraft Type>
Scenario: Semantic Container & SWIM

Semantic Container Management System

Database

Knowledge base

Semantic Container

Semantic Container

BEST Services

SWIM Registry

SWIM Network

Organization

+BEST Services

SWIM Integration Platform

+BEST

SWIM Enabled Application

+BEST

SWIM Enabled Application

+BEST

SWIM Enabled Application
Mcsr
Frequentis Semantic Container - Service Registry

If you want to sign in, you can try the default accounts:
- Administrator (login="admin" and password="admin")
- User (login="user" and password="user").

You don't have an account yet? Register a new account

For more information check out the following resources:
- Container Management
- API Management
- Electronic Flight Briefing
- Service Registry bug tracker
Scenario: Semantic Container & SWIM

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SWIM Enabled Application

SWIM Network
Benefits

Value-added Information like semantic, temporal and spatial facets and technical, quality and provenance metadata leads to the following benefits:

▪ **Defined Quality of Information**
  - freshness
  - provenance
  - quality

▪ **High Availability of Information**
  - better reliability through decentralized information

▪ **Decreased Network Load**
  - performant SWIM
Future Work

- Real SWIM services are needed to validate the concept (TRL 5-7).
  - Especially to validate freshness and distribution possibilities.

- Knowledge Graph instead of Ontologies

- Integration into the SESAR world and beyond
  - SWIM real-time Registry
  - SWIM Integration Platform
  - SWIM Applications

- Joint Undertaking with NASA/FAA to compare the semantics
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