SWAT
Initial steps & thoughts in Europe

SWAT Meeting

Washington DC – 24 August 2015

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EUROCONTROL

Content

- Setting the scene
- Information Management
    - Integration
    - Access
    - Metadata
- Towards Knowledge Management
- Conclusion

SWAT: where are we in European ATM?

- **Still early days – formally speaking**
  - No explicit goal/plans, but relating activity.
- **What is to be done at the European ATM level?**
  - Target concrete practical results.
  - Evolve and stepwise progress.

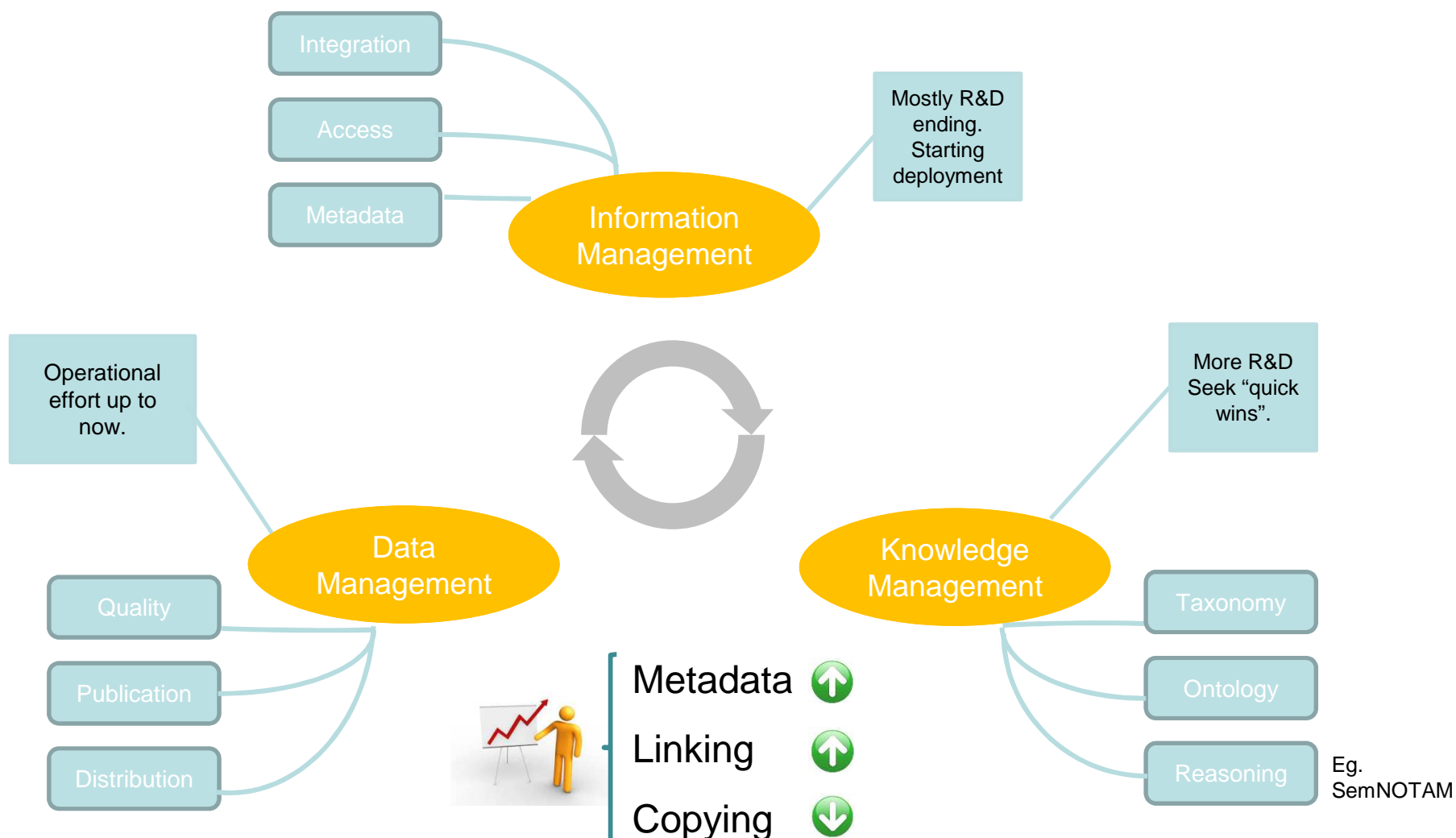## Data is hot these days

Data is a hot topic in todays ICT

- Open Data
- Linked Data
- Big Data

	Variety	Volume	Velocity
Data characteristic	Structured, semi-structured and unstructured	Large volumes of data	Streams, sensors, near real-time data, IoT
Challenge	Data integration	Reasoning and querying	Reasoning & querying
Solution	Semantic technologies are a good fit	Distributed storage & processing, parallel processing	Stream reasoning & querying

Courtesy TENFORCE

Evolution towards SWAT?

Integration

Access

Metadata

Information Management

Mostly R&D ending. Starting deployment

Operational effort up to now.

More R&D Seek "quick wins".

Data Management

Knowledge Management

Quality

Publication

Distribution

Taxonomy

Ontology

Reasoning

Eg. SemNOTAM

Metadata ⬆

Linking ⬆

Copying ⬇

Steps & lines of work heading to SWAT

"*Build – add value – harvest ; repeat…*"

Information Management

Information Integration

AIRM – cross domain semantic interoperability

Information Management

Information Access

Services: ISRM, SDCM
SWIM Registry
- Exchange information about SWIM assets

CP

Information Management

Metadata

ADQ IR
- Focus on aeronautical information

More aspects emerging

Knowledge Management

"First Signs"

SemNOTAM
Services Taxonomy
Controlled Vocabularies

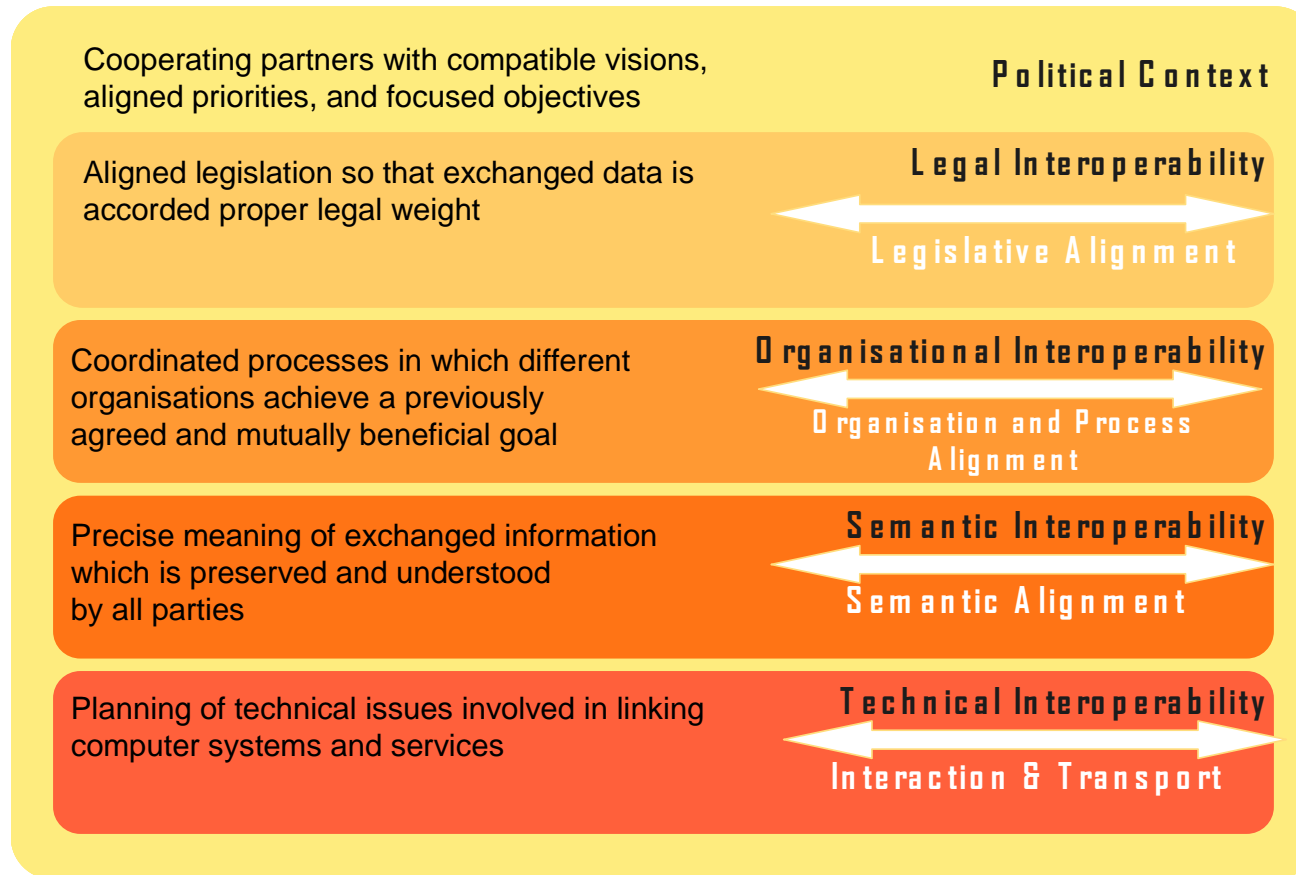# Content

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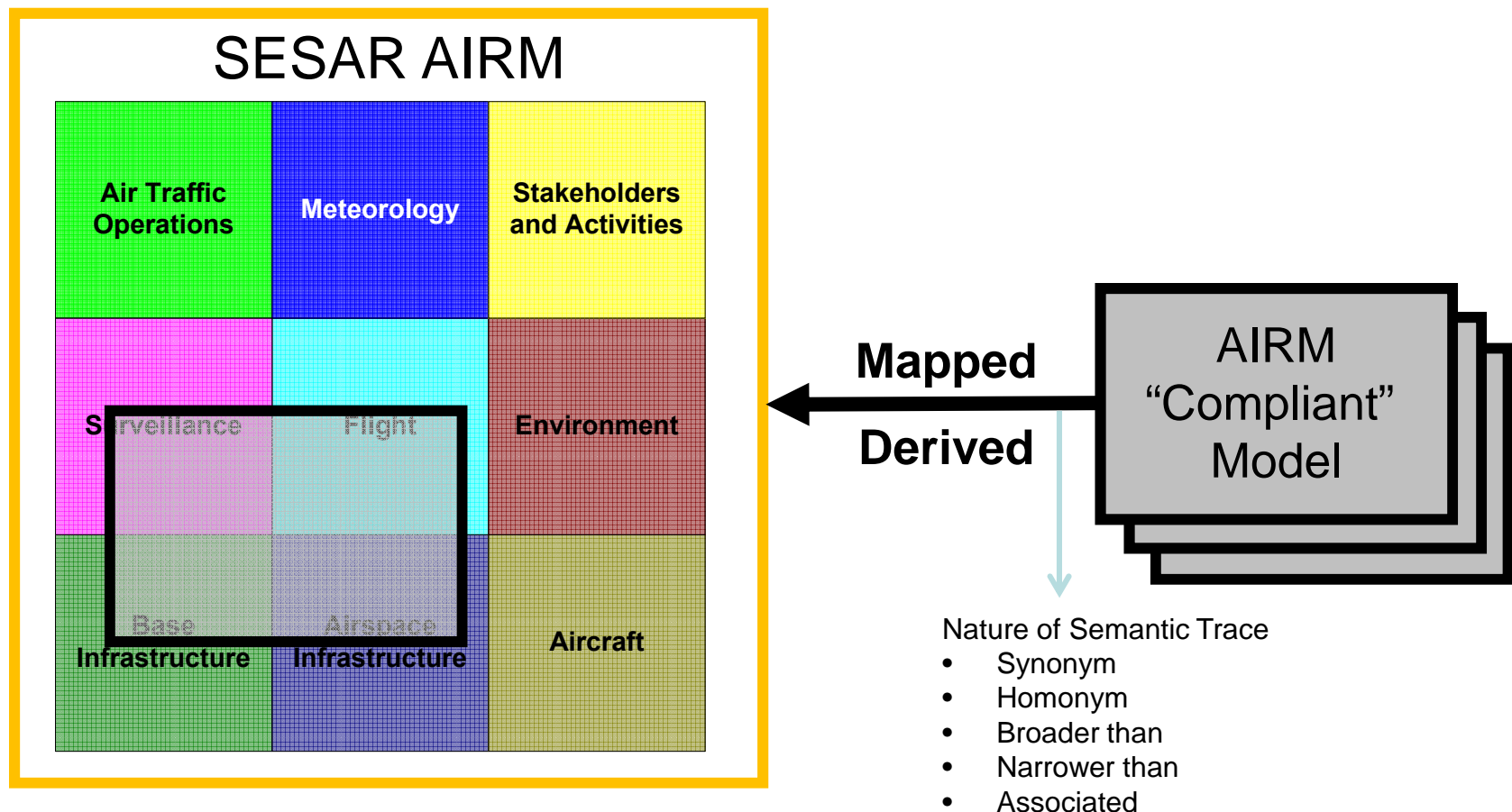# European Interoperability Framework:
Interoperable European Public Administrations

Cooperating partners with compatible visions, aligned priorities, and focused objectives

Political Context

Aligned legislation so that exchanged data is accorded proper legal weight

Legal Interoperability

Legislative Alignment

Coordinated processes in which different organisations achieve a previously agreed and mutually beneficial goal

Organisational Interoperability

Organisation and Process Alignment

Precise meaning of exchanged information which is preserved and understood by all parties

Semantic Interoperability

Semantic Alignment

Planning of technical issues involved in linking computer systems and services

Technical Interoperability

Interaction & Transport

Source: European Commission, EIF

Semantic Interoperability in SES
SESAR ATM Information Reference Model (AIRM)

Precise, non-overlapping meanings are preserved.
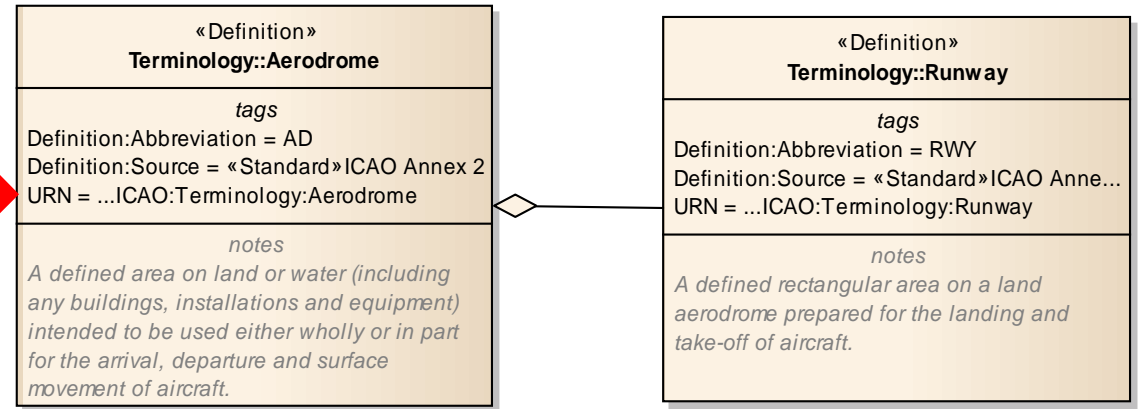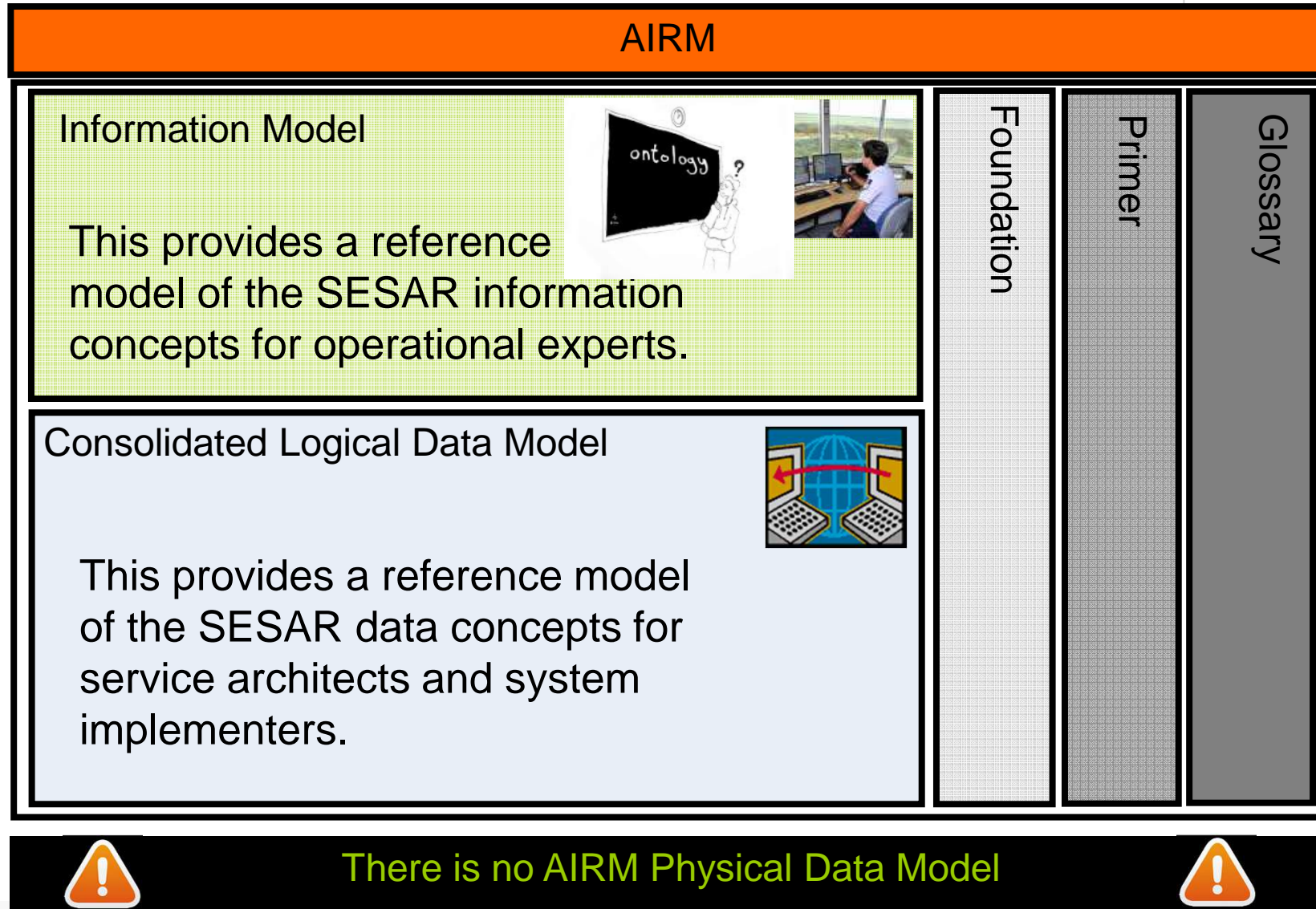Different formats – shared meaning.

SESAR AIRM

Air Traffic Operations	Meteorology	Stakeholders and Activities
Surveillance	Flight	Environment
Base Infrastructure	Airspace Infrastructure	Aircraft

Mapped

Derived

AIRM "Compliant" Model

Nature of Semantic Trace
- Synonym
- Homonym
- Broader than
- Narrower than
- Associated

SESAR ATM Information Reference Model
Some more points.

- **Preservation of meaning**
  - Traceable concepts
  - Linking

«Definition» Terminology::Aerodrome
tags   Definition:Abbreviation = AD   Definition:Source = «Standard»ICAO Annex 2   URN = ...ICAO:Terminology:Aerodrome
notes   *A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.*

«Definition» Terminology::Runway
tags   Definition:Abbreviation = RWY   Definition:Source = «Standard»ICAO Anne...   URN = ...ICAO:Terminology:Runway
notes   *A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.*

- **Agreed understanding**
  - Common language elements across ATM
  - Common data elements across ATM

- **Bridging the operational and system discourses**

SESAR AIRM Product Structure

EUROCONTROL

AIRM

Information Model

This provides a reference model of the SESAR information concepts for operational experts.

Consolidated Logical Data Model

This provides a reference model of the SESAR data concepts for service architects and system implementers.

Foundation

Primer

Glossary

There is no AIRM Physical Data Model

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SESAR
JOINT UNDERTAKING

SESAR AIRM
AIRM & Communities of Interest

EUROCONTROL

AIRM
- IM
- LM

Semantic trace

Community of Interest

COI_XM
- CM
- LM
- PM

Applic Stndrds

Agreed formalisation

AIRM
- IM
- LM

Semantic trace

Community of Interest

AIXM5.1
- AIXM 5.1 UML
- AIXM 5.1 Schema

AIRM
- IM
- LM

Semantic trace

Community of Interest

AMXM
- AMXM UML
- AMXM XML Schema
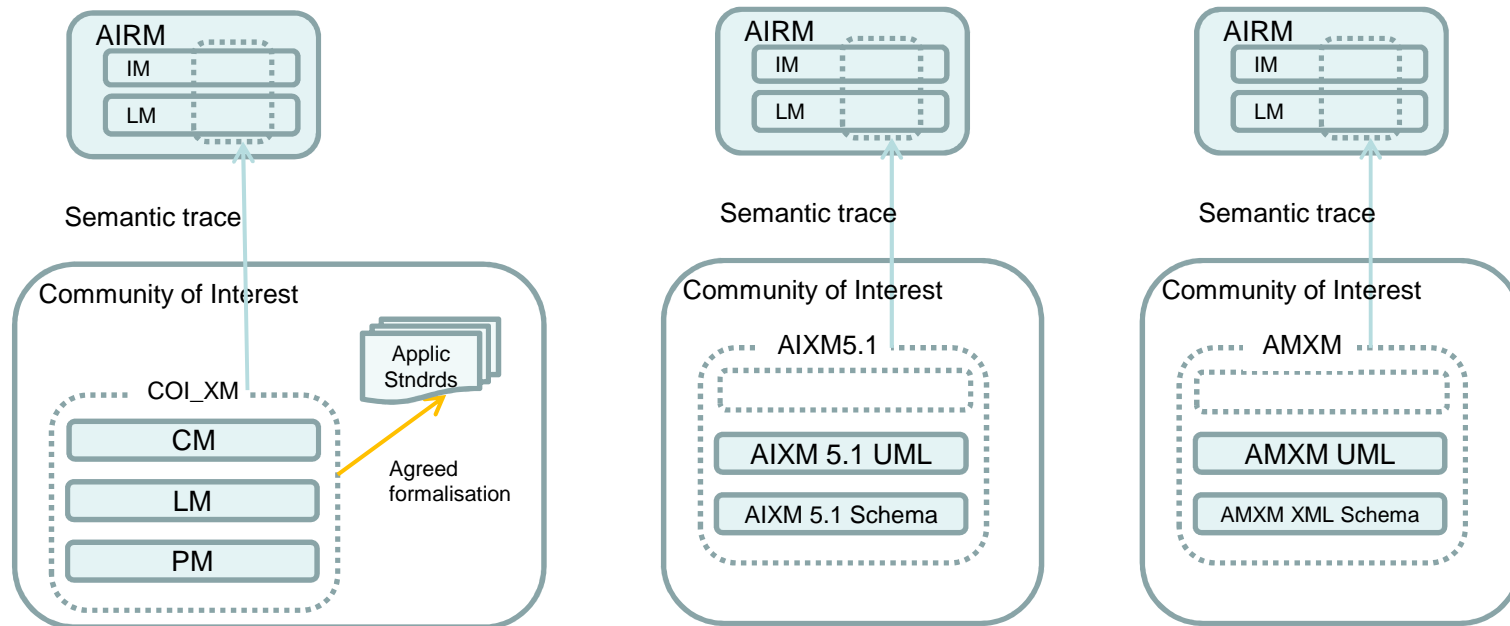
Semantic interoperability:
Aerodrome Mapping Example
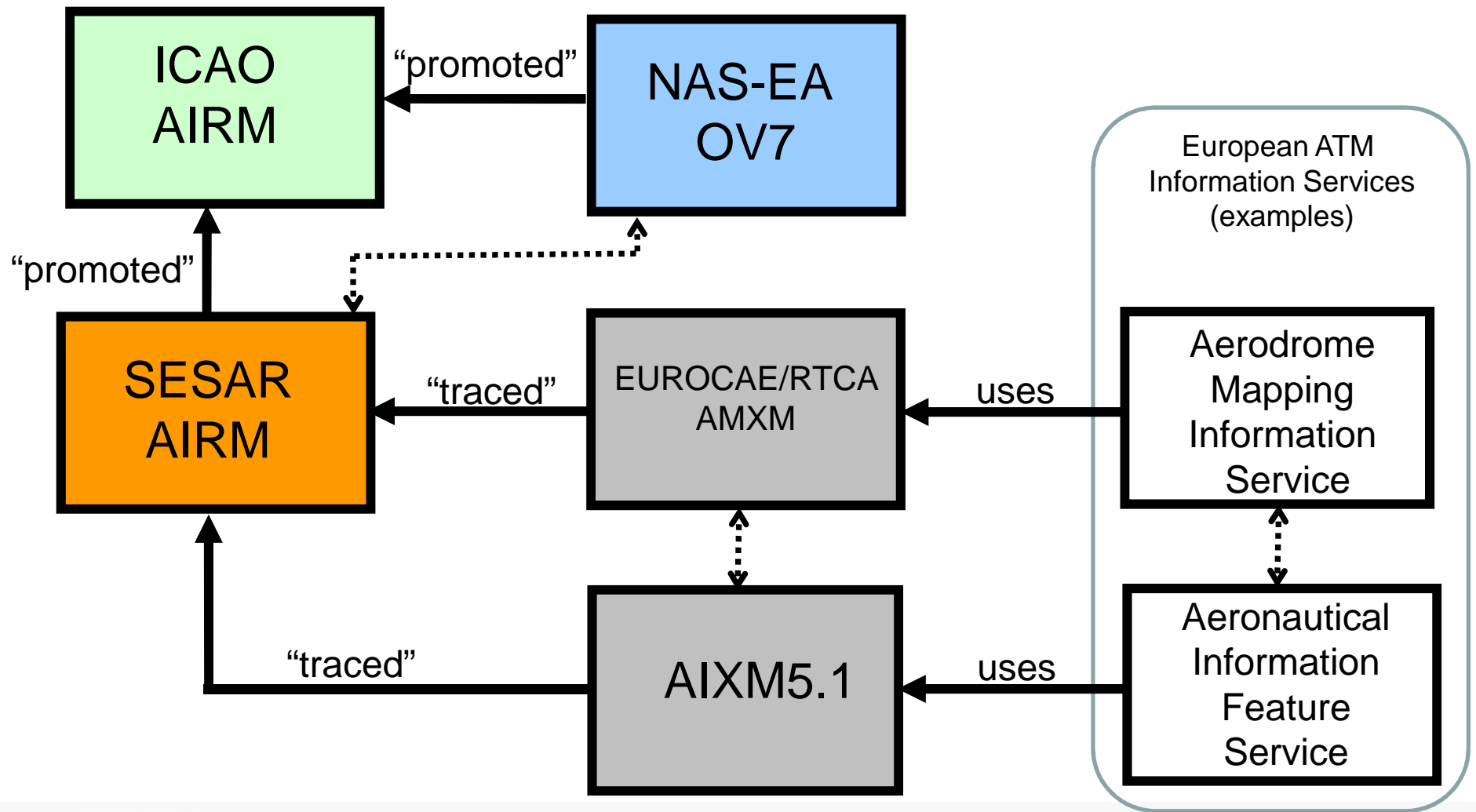
Semantic Interoperability:
Flight Information Example

A lot of terms for talking about Flight-related matters… which are not synonyms… but which are not that different!

Airborne Segment

Arrival Surface Segment

SMT

Aircraft Intent

OAT/GAT FPL

Expanded Route

iSBT

Planned Route   Trajectory   iSMT   RBT

SBT

4D Trajectory

iRBT   Improved OAT/GAT FPL   Planned Trajectory

FlightObject

Negotiating 4D Trajectory

Agreed 4D Trajectory   BDT

FlightScript

User Preferred Trajectory

EPP   User Preferred Route

FlightIntent (ICAO)

State Vector

MDT   FlightIntent (SESAR)

RMT   Aircraft State

Desired 4D Trajectory   Executed Trajectory

Departure Surface Segment

eFPL   EFPL   Aircraft State Vector

iRMT   FPL   Flight Route

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Capturing flight-related terms and definitions

The Information Architect
☺

The Flight Intent is the future aircraft trajectory expressed as a 4-D profile until destination (taking account of aircraft performance, weather, terrain, and ATM service constraints), calculated and "owned" by the aircraft flight management system, and agreed by the pilot.

Flight intent (FI) generalizes the concept of flight plan (a flight plan can be seen as an instance of flight intent) and includes, in addition to the strategic information typically included in a flight plan, such as departure and arrival airports, intended route, preferred cruise flight level and speed, estimated time of arrival (ETA), etc, other information of a more tactical and dynamic nature, such as intended SID and STAR, updates to the ETA, amendments to route/speed/level, descriptions of instructions issued by the controller, etc.

Operational experts sometimes talk differently ...

Flight Trajectory

Flight Intent   *Profile*

Arrival Sequence

Agree on meaning using AIRM
Standardise XM and map to AIRM

AIRM use cases summary

- Cross community semantic harmonisation
  - Transversal XM alignment
  - Alignments along the data chain
  - Regional alignments

- Define Information Exchange Requirements (IERs)

- Alignments of operational concepts

- Publication
  - Data Catalogues/Feature Catalogues
  - Glossaries/Vocabularies

SESAR SWIM Registry

Single Point of access to **SWIM Services** and related information resources
Mostly by reference approach.

Service Information Exchange

(Semantic Technology Based)

W3C SPARQL

FAA
Registry

Linked content.

Work on services taxonomy started.

Policies

Compliance Requirements

Information Reference Model (AIRM)

Exchange Data Models

Service Logical Models

Service Implementations

Infrastructure Profiles

Infrastructure Protocols

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Metadata Management
Intersects many IM activities

- MD standardisation = good measure for IM maturity
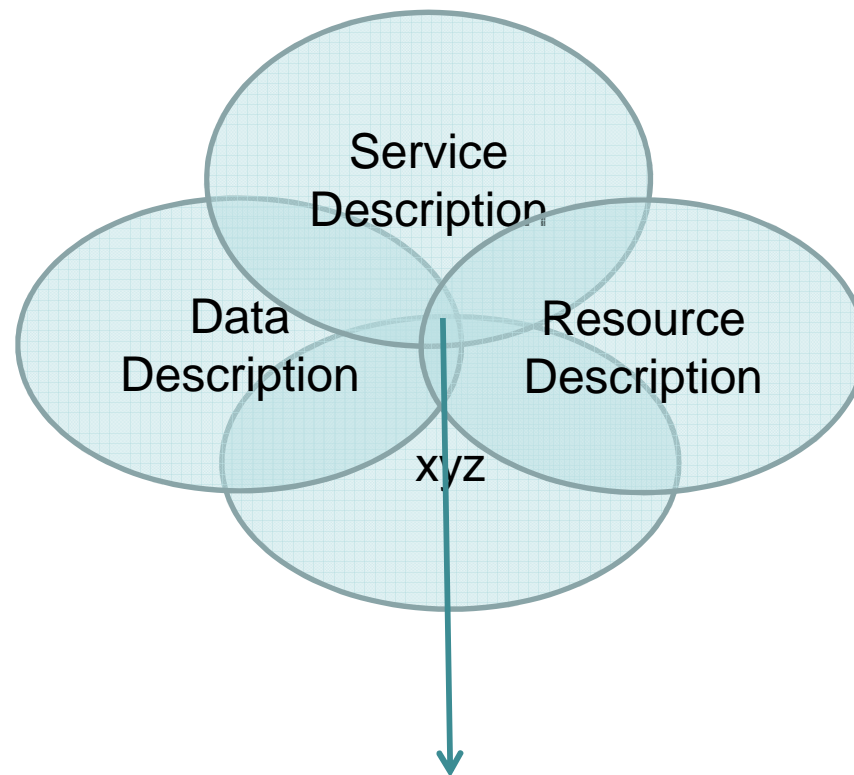
Define common semantics of metadata for re-use

Metadata – cross cutting concern
Aligning Metadata Management

Need to engage more
in a cross-cutting way.

Standardisation?

MD Sharing?

Steps & lines of work heading to SWAT
"*Build – add value – harvest ; repeat…*"
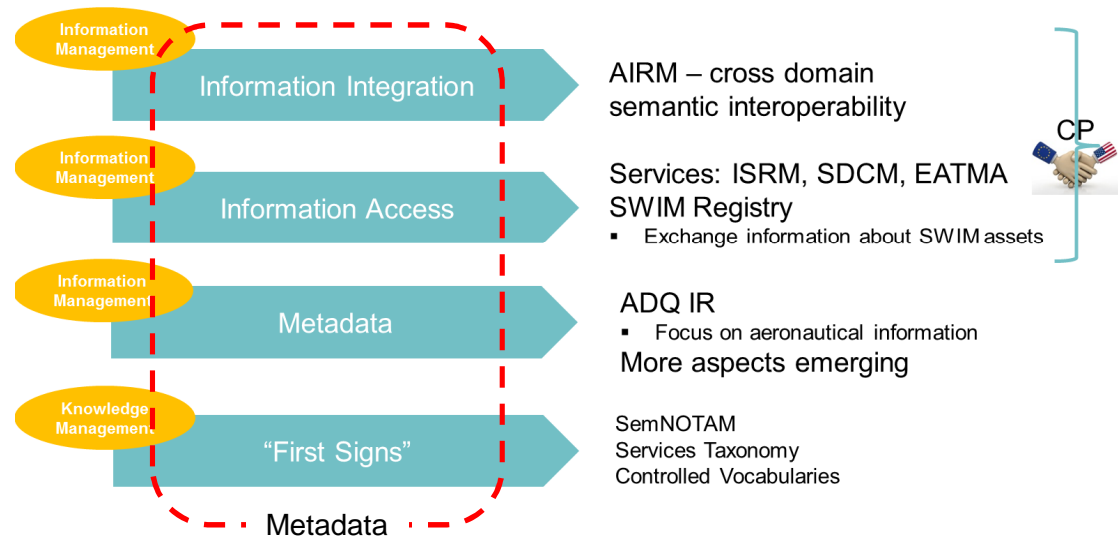
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Information Access	Services: ISRM, SDCM, EATMA SWIM Registry • Exchange information about SWIM assets
Information Management	
Metadata	ADQ IR • Focus on aeronautical information **More aspects emerging**
Knowledge Management	
"First Signs"	SemNOTAM Services Taxonomy Controlled Vocabularies

Metadata

CP

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Early days still…

Talking about Ontology to budget owners does not fly well…unless the boss is a 26yr old (=1/2 my age)☺

But preparing the field:

From Semantic Web to Semantic Technologies

Internet

World Wide Web

data web

web 2.0

Linked Data

Open Data

web 3.0

OWL

URI

Linked Open Data

semantic web

Ontology

semantic web technologies

semantic technology

RDF

semantic technologies

Courtesy TENFORCE

ICAO context.
Knowledge extraction.

Annex xx   SARP   Annex yy

PANS   AIM DC

FFICE FC   Guidance   ICAO Vocabulary

Links

AIRM
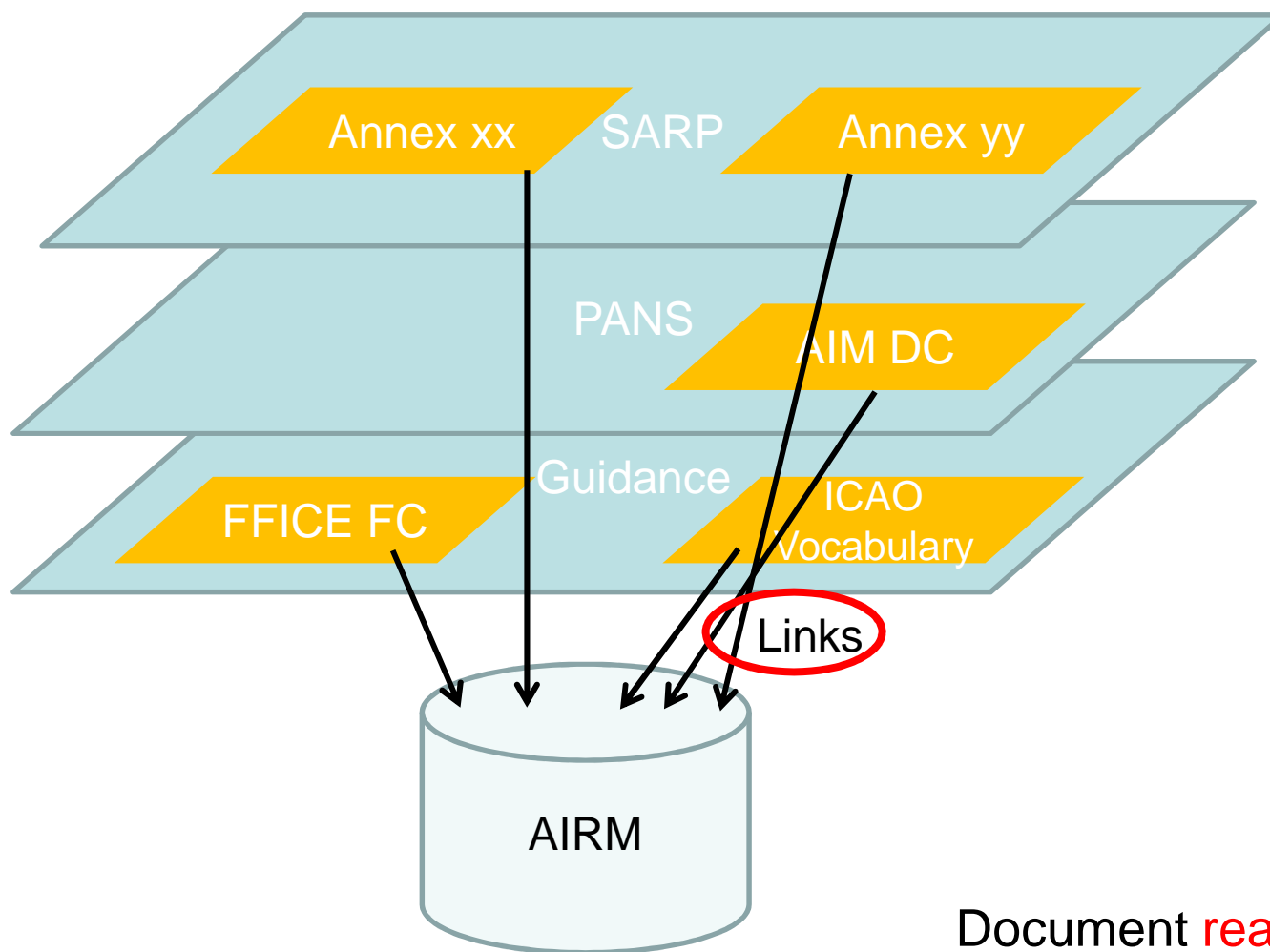
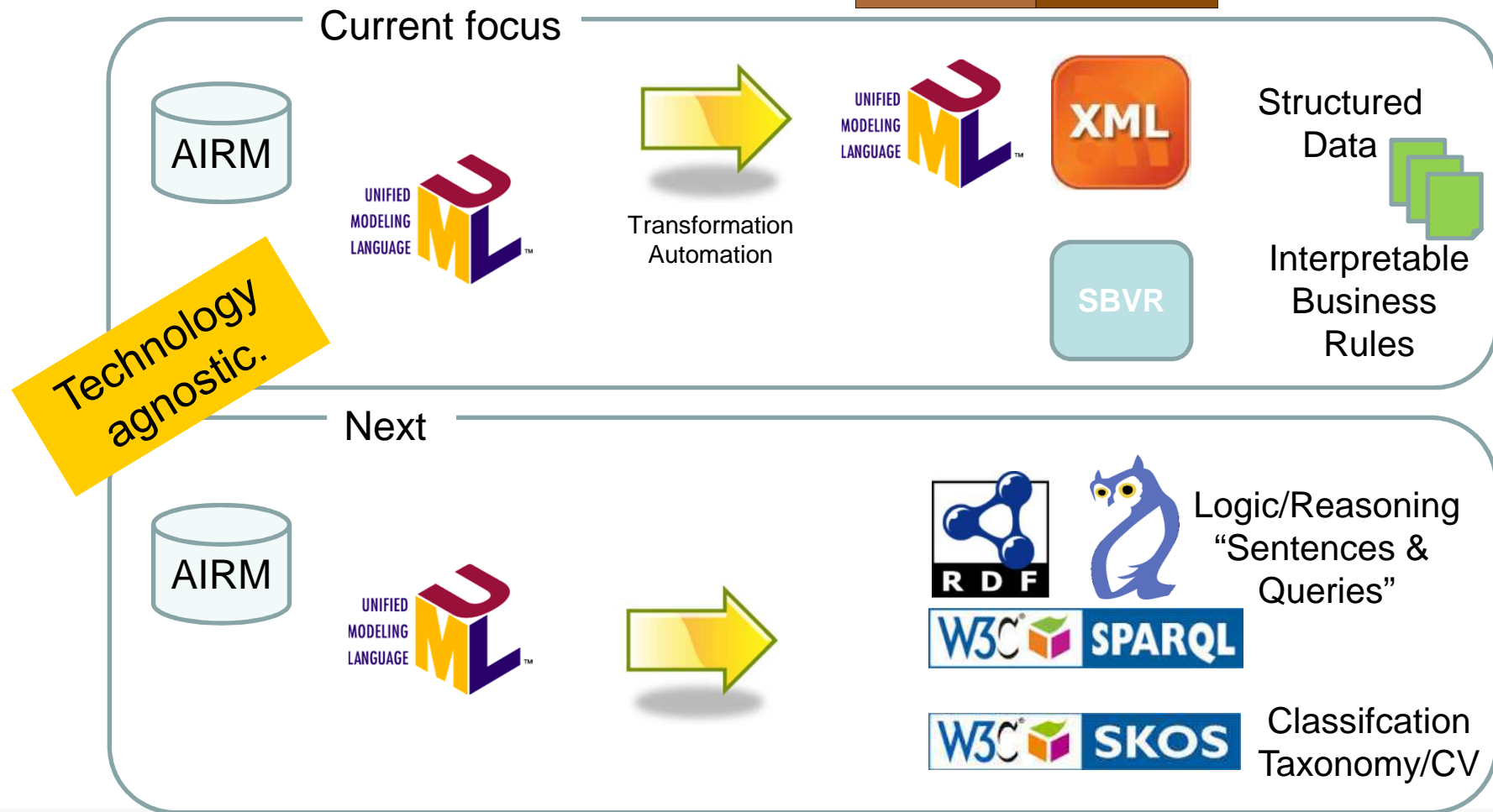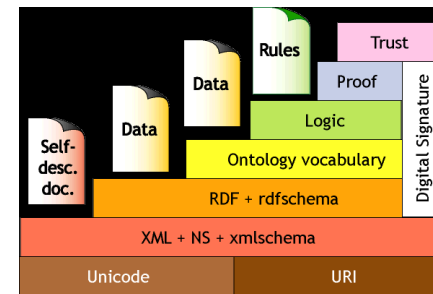Document reader view

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We're moving in the direction. End-stage?

Current focus

AIRM → UML → Transformation Automation → UML → XML → Structured Data

SBVR → Interpretable Business Rules

Technology agnostic.

Next

AIRM → UML → RDF / OWL / W3C SPARQL → Logic/Reasoning "Sentences & Queries"

W3C SKOS → Classifcation Taxonomy/CV

SWAT Techno opportunities

- Publication of linked semantic content
    - Including the ICAO level
- Standardisation of semantic content
    - Linked Data Catalogs, CVs, Taxonomies
        - CV of SWIM Terms (part of SWIM Foundation)
- SWIM Registry
    - Interoperable Service Exchange
- Operational knowledge
    - Business Rules, Ontologies
- Semantic NOTAM Filtering
- OGC Testbed: Linked Data and *Semantic* Enabling of *OGC* Web Services

Questions