Architecture as Linked Data

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🗖 archıxl



Agenda

- Why Architecture as Linked Data
- Demonstrator Architecture as Linked Data
- Linked Data vocabularies for Architecture als Linked Data
- Example: European Interoperability Reference Architecture



Problem: what is a data object?

ArchiMate specification:

- "A data object represents data structured for automated processing."
- "A data object should be a self-contained piece of information with a clear meaning to the business, not just to the application level. Typical examples of data objects are a customer record, a client database, or an insurance claim."



In ArchiMate you can apparently call a lot of different things a data object. What exactly you mean by that remains unclear.

If you are working with data, you would like to distinguish between more specific data objects such as record, database, document, dataset, distribution, catalog



Architecture content also needs to be FAIR

Findable

The first step in (re)using data is to find them. Metadata and data should be easy to find for both humans and computers. Machine-readable metadata are essential for automatic discovery of datasets and services, so this is an essential component of the FAIRification process.

- F1. (Meta)data are assigned a globally unique and persistent identifier
- F2. Data are described with rich metadata (defined by R1 below)
- F3. Metadata clearly and explicitly include the identifier of the data they describe
- F4. (Meta)data are registered or indexed in a searchable resource

Accessible

Once the user finds the required data, they need to know how they can be accessed, possibly including authentication and authorisation.

- A1. (Meta)data are retrievable by their identifier using a standardised communications protocol
- A1.1 The protocol is open, free, and universally implementable
- A1.2 The protocol allows for an authentication and authorisation procedure, where necessary
- A2. Metadata are accessible, even when the data are no longer available

Interoperable

The data usually need to be integrated with other data. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

11. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.

- 12. (Meta)data use vocabularies that follow FAIR principles
- 13. (Meta)data include qualified references to other (meta)data

Reusable

The ultimate goal of FAIR is to optimise the reuse of data. To achieve this, metadata and data should be well-described so that they can be replicated and/or combined in different settings.

R1. Meta(data) are richly described with a plurality of accurate and relevant attributes

- R1.1. (Meta)data are released with a clear and accessible data usage license
- R1.2. (Meta)data are associated with detailed provenance
- R1.3. (Meta)data meet domain-relevant community standards



Architecture intrinsically is about cohesion and as such about relationships and linking





Why Architecture as Linked Data?

- ArchiMate definitions are abstract and leave a lot of room for interpretation
 - Specific Linked Data vocabularies offer more specific meanings
- It is important to publish architecture in an accessible way
 - Linked Data is specifically aimed at publishing in an accessible manner via the web
- ArchiMate requires specific knowledge of architectural concepts
 - Linked Data vocabularies use concepts that are more widely recognized and used
- ArchiMate models can only be used in architecture tools
 - There are many different tools for Linked Data
- ArchiMate standardizes only types and no properties
 - Specific Linked Data vocabularies also standardize the properties of types
- ArchiMate specifies and relates only architecture elements
 - Linked Data makes it possible to capture and connect all data elements



Linked Data representations of ArchiMate

ArchiMate2RDF

https://github.com/bp4mc2/archimate2rdf

Linked Enterprises: deriving a hypermodel from ArchiMate

https://www.linkedin.com/pulse/from-archimate-languageweb-ontology-dr-nicolas-figay

Experimentation on OWL derivations

https://github.com/nfigay/archimate.owl

OWL Exchange Plug-in for Archi

https://github.com/archimatetool/OWLExchange

How to export Archi(mate) file into RDF or OWL

https://forum.archimatetool.com/index.php?topic=309.0

Using RDF/OWL to analyse ArchiMate models

https://groups.google.com/forum/#!topic/open-archimateforum/poUR2BRqve0

ArchiMate TTL

https://github.com/ikmgroup/ArchiMEO/blob/master/ARCHIMEO/ARCHIMATE/ArchiMate.ttl

based on: https://github.com/bp4mc2/archimate2rdf





□ bp4mc2 / archimate2rdf Public

⊙ Watch 3 ▾ 양 Fork 3 ▾

- ☆ Star 7

<> Code 💿 Issues 1 11 Pull requests 🕟 Actions 🖽 Projects 🕛 Security 🗠 Insights

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.gitignore Added json output BEADME.md http to https 3 years ago Releases 1	Added option for custom stylesheet	4 years ago v 3 forks
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	http to https	3 years ago Releases 1
Image: Image	h Update for release	4 years ago S Release 0.1.0 Latest
create-ontology.sh Added custom properties in translator 4 years ago	y.sh Added custom properties in translator	on 14 Jan 2019 4 years ago
fetch-xsd.sh First version transformator 4 years ago	First version transformator	4 years ago
pom.xml Added json output Packages	Added json output	4 years ago
publish-ontology.sh Added json output No packages published	gy.sh Added json output	4 years ago

 \equiv README.md

archimate2rdf

Translating the ArchiMate Model Exchange File Format to RDF

The Open Group has published the ArchiMate Model Exchange File format - a standard file format for the exchange of ArchiMate models between different tools. Resources can be found at: https://www.opengroup.org/open-group-archimate-model-exchange-file-format

Languages

• XSLT 58.9% • Java 37.5%

• Shell 3.6%



Extensions to archimate2rdf

- Creation of URI's that are dereferenceable
- Promotion of Linked Data properties in ArchiMate (that start with "http" or contain a ":") to true RDF properties
- Inclusion of namespaces of a number of popular vocabularies, allowing shorthand reference in ArchiMate properties or their values
- The option to generate a SKOS enriched version of the model
- Translation of model metadata to a SKOS ConceptScheme
- The option to refer to images, generated by Archi, in SKOS output
- Translation of views to SKOS concepts
- Generation of SKOS Collections for all ArchiMate concepts in ArchiMate ontology
- Inclusion of ArchiMate definitions in ArchiMate ontology.ttl



Enrich ArchiMate with semantics



Alfabetish	Hiërarchie					
Alfabetish -BIBIT -BIBIT Server -Board -Business Coope -Business Functi -Business Produc -Calculate Premi -Calculate Risk -Call center appl -Car -Car Insurance Pr -Check and Sign -CICS -CIS -Claim Data Man -Claim Files Serv -Claim Form -Claim Serv -Claim Serv -Claims Payment -Client -Client Satisfacti -Close Contract -Collaboration -Collect Premium -Contracting -Cont	Hiërarchie ration View on View ss View ct View um ication olicy Contract agement ice on Service on Goal					
-Contracting -Contracting -Costs Goal -Create Contract						
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Customer File Data Distribution Customer File Service Customer Information Service Customer Relations Customer's Bank Damage Claim Damage Claim Data						
Damage Occure	u					

Groepen

VOORKEURSTERM	Customer File Data 🗘
ТҮРЕ	DataObject Dataset
IS GERELATEERD AAN	Application Behaviour View Application Structure View DataSets view Information Structure View
BEHOORT TOT GROEP	Data Object
UITGEVER	ArchiSurance
TITEL	Customer File
DISTRIBUTION	Customer File Data Distribution
REALIZATION	Customer File
URI 1	http://begrippenxl.nl/archisurance/en/page/archisurance/id/DataObject/ as2-4990 ற
DOWNLOAD DIT CONCEPT:	RDF/XML TURTLE JSON-LD
ustomer File Data	21



Alfabetish Hiërarchie -BIBIT BIBIT Server Board -Business Cooperation View Business Function View Business Process View Business Product View -Calculate Premium Calculate Risk Call center application -Car -Car Insurance Policy -Check and Sign Contract CICS CIS -Claim Data Management Claim Files Service Claim Form -Claim InfoServ Claim Registration Service Claims Handling -Claims Payment Service Client Client Satisfaction Goal Close Contract -collaboration Collect Premium -Component Principle -Contracting -Contracting -Costs Goal Create Contract Create Policy CRM System Customer Customer -Customer Data Access Customer data mutation Service -Customer data mutation Service Customer File -Customer File Data Customer File Data Distribution -Customer File Service Customer Information Service -Customer Relations -Customer's Bank -Damage Claim Damage Claim Data Damage Occured

VOORKEURSTERM	Customer File Data Distribution 🗘
ТҮРЕ	DataObject Distribution
IS GERELATEERD AAN	DataSets view
BEHOORT TOT GROEP	Data Object
DOWNLOAD URL	http://www.archisurance.org/customerfile.zip
URI 1	http://begrippenxl.nl/archisurance/en/page/archisurance/id/DataObject/i d-103816079aa6439e8de078a9451c7704 ப
DOWNLOAD DIT CONCEPT:	RDF/XML TURTLE JSON-LD

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Groepen



Alfabetish	Hiërarchie	Groepen	VOORKEURSTERM	Application Structure View 🗘
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			BEHOORT TOT GROEP	View
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Tel.

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S	Т	U	۷	W											

Accept Actor Cooperation view Admin Server Application Behaviour View Application Cooperation View Application Structure View Archimate View Archisurance Asset Management

Woordenlijst informatie

TITEL	ArchiSurance thesaurus				
ONDERWERP	Architecture, ArchiMate, Linked Data				
BESCHRIJVING	A Linked Data publication of the ArchiMate ArchiSurance case, enriched to show the added value of Linked Data publication.				
UITGEVER	ArchiXL B.V.				
AUTEUR	Danny Greefhorst				
RECHTEN	https://creativecommons.org/licenses/by/4.0/deed.nl				
TAAL	English				
DATUM	2022-07-15				
FORMAAT	ArchiMate, SKOS				
ТҮРЕ	http://www.w3.org/2004/02/skos/core#ConceptScheme				
URI	http://begrippenxl.nl/archisurance/en/page/				
Aantal bronnen per type					
Туре	Aantal				
Begrip	139				
• http://www.w3.org/ns/dcat#R	undefine				
ole	d				
 Deprecated concept 	0				
Collectie	25				
Aantal termen per taal					
Taal Voorkeurstermen Alte	rnatieve termen Zoekterm				
Engels 139 0	0				

ArchiSurance

Class Property Alignments	Customer File (en)	http://begrippenxl.nl/archisurance/en/page/archisurance/id/DataObject/as2-4990	8	Α	C 🗘	-
A 2 🌣	Туре	archimate:DataObject				
		dcat:Dataset				
	Label	Customer File Data (en)				
I owl:Thing	Deallandian					
archimate:ApplicationCollaboration	Realization	http://begrippenxi.ni/archisurance/en/page/archisurance/id/BusinessObject/as2-4943				
archimate:ApplicationComponent	Title	Customer File (en)				
archimate:ApplicationEvent	Publisher	ArchiSurance (en)				
archimate:ApplicationFunction	Distribution	http://begrippenxl.nl/archisurance/en/page/archisurance/id/DataObject/id-103816079aa6439e8de078a9451c7704				
archimate:ApplicationInteraction						
archimate:ApplicationInterface						
archimate:ApplicationProcess						
archimate:BusinessActor						
 archimate:BusinessCollaboration 						
archimate:BusinessEvent						
archimate:BusinessFunction						
archimate:BusinessInteraction						
archimate:BusinessInterface						
archimate:BusinessObject						
archimate:BusinessProcess						
archimate:BusinessRole						
archimate:BusinessService						
Search Q ^ $\alpha_{}$						
A 2 🌣						
 Customer File Data (en) 						
Customer File Data Distribution (en)						
Damage Claim Data (en)						
 Insurance Policy Data (en) 						
Insurance Request Data (en)						

Metadata Data Sparql



Aanmelden

Architecture as Linked Data in the DERA

netwerk digitaal	Pagina Overleg Brontekst bekijken Geschiedenis weergeven Meer • Doorzoek DERA	Q							
erfgoed	Begrippenlijst								
Hoofdpagina	Actor syn: business actor <i>î</i> : <i>chap08.html i</i> : Samenwerkingsverband, Gebruiker, Leverancier, Erfgoedinstelling Een persoon of organisatorische entiteit die in staat is gedrag uit te voeren. Een actor kan verschillende rollen vervullen.								
Bedrijfsarchitectuur Inleiding	Actualiteit <i>î</i> : <u>Niet-functionele requirement</u> De actualiteit van erfgoedinformatie betreft de mate waarin die informatie de meest recente inzichten en kennis representeert.								
Bedrijfsobjecten Actoren Rollen	Administratieve metadata †: Metadata Metadata die zich richten op beheer en gebruik van objecten.								
Bedrijfsfuncties Linked Data Diensten	Alignment Relatie tussen erfgoedinformatie, waarmee de gelijk(waardig)heid van de verbonden informatie wordt uitgedrukt.								
Begrippenlijst	Applicatiefunctie †: chap09.html 1: H2M-interactie, IAA, M2M-interactie Een applicatiefunctie representeert geautomatiseerd gedrag dat door een referentiecomponent kan worden uitgevoerd.								
Applicatiearchitectuur Inleiding Applicatiefuncties	Auteursrechtelijke status transference in the status transference in the status transference in the status and end of the status								
Referentiecomponenten Netwerkvoorzieningen	Authenticatie en autorisatie t: Bedrijfsfunctie Authenticatie en autorisatie betreft het zorgdragen dat alleen afnemers die hier recht op hebben toegang krijgen tot digitale informatieobjecten, zoals scans of films.								
Architectuurpatronen	Authenticiteit 1: Niet-functionele requirement Authenticiteit van een informatieobject betreft de mate van betrouwbaarheid van de originaliteit en herkomst van dat object.								
Inleiding Vindbaar maken van gestandaardiseerde	Bedrijfsfunctie syn: Business function \uparrow : <i>chap08.html</i> \downarrow : Beheer netwerkvoorziening, Beheer, Publicatie digitale informatieobjecten, Publicatie metadata van termen, Inwinning, Publicatie datasets, Beheer metadata termen, Publicatie metadata, Authenticatie en autorisatie, Beheer metadata van datasets, Registratie metadata van datasets bij dienst 'Vindbare datasets', Beheer metadata, Ontsluiting, Beheer metadata van organisatie, Integratie,								
termen Vindbaar maken van organisaties en datasets	Publicatie metadata van datasets, Beheer datasets, Beschikbaarstelling, Publicatie metadata cultuurhistorische objecten, Beheer metadata verrijkingen, Dienstverlening, Publicatie meta Beheer metadata cultuurhistorische objecten of informatieobjecten, Beheer digitale informatieobjecten Collectief gedrag dat voldoet aan vestgestelde criteria (veek gebeseerd on benodigde middelen of benodigde kennis)	<u>Jata van organisatie,</u>							
Vindbaar maken van verbindingen in	Redrifenhiert to Object aban09 html 1: Erfandinfermatic Material philot Metadata terminologishron Verseek becehrilving dataset. Digital hern erfand Versikte metadata. Digital informationhie	et Terminologishron							

https://dera.netwerkdigitaalerfgoed.nl/index.php/Begrippenlijst



WikiXL - Semantic Wiki as Linked Data editor

			& WikiSysop Overleg Kop	pelingen vo	or beheerders \	/oorkei
- mine - l	Categorie	Overleg	Lezen Bewerken Brontekst bewerken Geschiedenis weergeven	Meer 🗸	Doorzoek 🗙	Jaster
kadaster wiki	Cate	Concept aan	Gebruik je de Wiki, dit zijn de regels! nmaken: boom			
Hoofdpagina Recente wiizigingen	Deze cate	Eigenschap	Keuze			
Nieuwe pagina's	Voer hier	Elementtype	Concept			
Help Begrippenlijst		Label (nl) 🕕	boom			
Afkortingen	boom	Label (en) 🕕				
Gebruikerslijst Zandbak Contact	Pagina	Synoniem (nl) 🚺				
	Deze cate	Afkorting 1				
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			V C 🐼 💌 > Uitgebreid > Speciale tekens > Hulp			
		Beschrijving			-	



ArchiMate elements





ArchiMate elements expressed with schema.org

Place, GeoShape	Business (D) interaction	Software Application	Application event	Node	Technology (D) interaction
Person, Organization	Service	Application collaboration	Dataset, DataDownload, DigitalDocument	device	WebAPI
Organization Role	Event	Application	Facility	operatingSysten	Technology event
Consortium	Class, DefinedTerm	Application process	Equip- 🖑 ment	Technology collaboration	WebPage, Software SourceCode
Business -O interface	Order	Application function	material	Technology ^{-O} interface	Communication # network
НоwТо	DigitalDocument	Application (D) interaction	Grouping	Technology process	< <mark><</mark> ∢ Path
Business function	Product	WebAPI		Technology function	⇔ Distribution network



ArchiMate elements expressed with schema.org



SoftwareApplication A Schema.org Type

Thing > CreativeWork > SoftwareApplication

A software application.

[more...]

Property	Expected Type	Description						
Properties from SoftwareApplic	Properties from SoftwareApplication							
applicationCategory	Text or URL	Type of software application, e.g. 'Game, Multimedia'.						
applicationSubCategory	Text or URL	Subcategory of the application, e.g. 'Arcade Game'.						
applicationSuite	Text	The name of the application suite to which the application belongs (e.g. Excel belongs to Office).						
availableOnDevice	Text	Device required to run the application. Used in cases where a specific make/model is required to run the application. Supersedes device.						
countriesNotSupported	Text	Countries for which the application is not supported. You can also provide the two-letter ISO 3166-1 alpha-2 country code.						
countriesSupported	Text	Countries for which the application is supported. You can also provide the two-letter ISO 3166-1 alpha-2 country code.						
downloadUrl	URL	If the file can be downloaded, URL to download the binary.						
featureList	Text or URL	Features or modules provided by this application (and possibly required by other applications).						
fileSize	Text	Size of the application / package (e.g. 18MB). In the absence of a unit (MB, KB etc.), KB will be assumed.						
installUrl	URL	URL at which the app may be installed, if different from the URL of the item.						
memoryRequirements	Text or URL	Minimum memory requirements.						
operatingSystem	Text	Operating systems supported (Windows 7, OSX 10.6, Android 1.6).						
permissions	Text	Permission(s) required to run the app (for example, a mobile app may require full internet access or may run only on wifi).						
processorRequirements	Text	Processor architecture required to run the application (e.g. IA64).						



ArchiMate elements expressed with other vocabularies





ArchiMate elements expressed with popular vocabularies





Products

European Interoperability Reference Architecture

EUROPEAN INTEROPERABILITY REFERENCE ARCHITECTURE The European Interoperability Reference Architecture (EIRA[©]) is a reference architecture for delivering interoperable digital public services across borders and sectors

- ✓ Focus is on interoperability
- ✓ Aligned to the EIF and TOGAF[®], uses SOA and ArchiMate[®]

Structure

Defines concepts as Architecture Building Blocks (ABBs)

- ABBs organised in four views (Legal, Organisational, Semantic, Technical)
- Solution Architecture Templates (SATs) to model requirements
 - HL*: IoP goals and principles
 - DL*: Specifications per ABB
- Solution models

^{*} High-Level (HL), Detail-Level (DL)



EIRA[©] structure





EIRA[©] main distribution

- <u>EIRA v5.0.0 Online documentation</u>; a Joinup page containing an introduction to the EIRA, including its key concepts, used ArchiMate notation, tool support and views.
- <u>EIRA v5 0 0 ArchiMate.archimate</u>; the 'Archi' version of the model.
- <u>EIRA v5 0 0 ArchiMate.xml</u>; the Open Group ArchiMate Exchange File Format, containing the model.
- <u>EIRA v5.0.0 SKOS</u>; the EIRA as controlled vocabulary in SKOS format.
- <u>EIRA v5.0.0 web version (zip)</u>; a compressed folder containing the web-version of the EIRA model.
- EIRA v5 0 0 release notes.pdf; the release notes of this release.
- <u>EIRA v5 0 0 release.zip</u>; an archive containing each of the above mentioned files.
- <u>ISA Product License v1.4</u>; the license under which the EIRA is released

https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/solution/eira/release/v500



EIRA Ontology v1.0.0

Latest release

4 months ago

The EIRA ontology v1.0.0 is aligned with <u>EIRA</u>© v4.1.0. The content of the release has been developed through an agile project management approach. Tickets from EC internal and external stakeholders have been analysed in order to address their feedback and requirements.

The **EIRA ontology** is the machine-readable knowledge representation of <u>EIRA</u>© including classes and axioms, which provide stakeholders of different backgrounds – including technical and business - with the capabilities to search, access and analyse the <u>EIRA</u>© concepts.

Distributions



https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/solution/eira-ontology/release/v100





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Interoperable Europe Interoperability Solutions Q



Start typing to search ...

Need more search options? Use our advanced search

/intercerable europe

Discover more ...

WHAT'S JOINUP ABOUT?

Joinup is a collaborative platform to help e-Government professionals.

The European Commission created Joinup to provide a common venue that enables public administrations, businesses and citizens to share and reuse IT solutions and good practices, and facilitate communication and collaboration on IT projects across Europe.

WHO IS IT FOR?

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Joinup offers several services that aim to help **e**-**Government professionals** share their experience with each other. Joinup supports them to find, choose, re-use, develop and implement interoperability solutions.

up: The repository of open source IT solutions

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Remember my choice. Your choice will be saved in a cookie managed by europa.eu until you've closed your browser.

https://joinup.ec.europa.eu/



ADMS lowers interoperability barriers & facilitates reuse

There are many standardisation organisations, public administrations, and software vendors that have created reusable interoperability solutions for e-Government systems, such as frameworks, methodologies, specifications, tools, and services. **Unfortunately**, these solutions are not always well documented and they are scattered around on many different websites. As a result, it is impossible for anyone to get a comprehensive overview. The lack of documentation and oversight is a major barrier to the reuse of interoperability solutions.

The ISA Programme intends to overcome this barrier by creating a set of interoperability agreements for metadata management in the form of a common vocabulary, i.e. the Asset Description Metadata Schema (ADMS), and by putting in place a federation of interoperability repositories in Europe on Joinup.



ADMS-AP for joinup





The number of solutions per EIRA[©] architecture building block (1)

```
PREFIX dcat: <http://www.w3.org/ns/dcat#>
PREFIX dct: <http://purl.org/dc/terms/>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
```

```
SELECT ?eira_abb_name count(?solution) as ?number_solutions
WHERE {
    ?solution a dcat:Dataset .
    OPTIONAL {
        ?solution dct:type ?eira_abb_uri .
        ?eira_abb_uri skos:prefLabel ?eira_abb
    }
    BIND ( IF( BOUND(?eira_abb), ?eira_abb, "No ABB linked!" ) AS ?eira_abb_name)
}
GROUP BY ?eira_abb_name
ORDER BY DESC(?number_solutions)
```

https://joinup.ec.europa.eu/collection/joinup/technical-documentation



The number of solutions per EIRA[©] architecture building block (1)

eira_abb_name	number_solutions
"No ABB linked!"	3437
"Organisational Interoperability Agreement"@en	560
"Interoperability Specification"@en	94
"Organisational Interoperability Enabler"@en	52
"Public Administration"@en	21
"Data"@en	21
"Interoperable European Solution"@en	20
"Solution"@en	19
"Semantic Interoperability Specification"@en	18
"Interoperable European Solution Service"@en	15
"Technical Interoperability Specification"@en	13
"Core Data Model"@en	12
"Data Model"@en	12
"Human Interface"@en	11
"Key Interoperability Enabler"@en	11
"Specification"@en	11



Conclusions

- Architecture should be published as Linked Data
- You can enrich ArchiMate with Linked Data vocabularies
- You can also decide to model architectures with just Linked Data vocabularies
- There are already a number of architectures published as Linked Data