Digital Platform Enterprise Architecture

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Agenda

I. Enterprise Architecture Introduction

II. EA Frameworks and Modelling Languages

III. ArchiMate

IV. ArchiMate in Practice

V. Summary of Assignments

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Learning objective

General understanding of enterprise architecture (EA)

Differentiation between EA frameworks

Ability to analyze ArchiMate case studies

Ability to model simple EAs using ArchiMate

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Why enterprise architecture?

https://www.youtube.com/watch?v=qDI2oF1bASk

https://www.youtube.com/watch?v=9TVc32M_gIY

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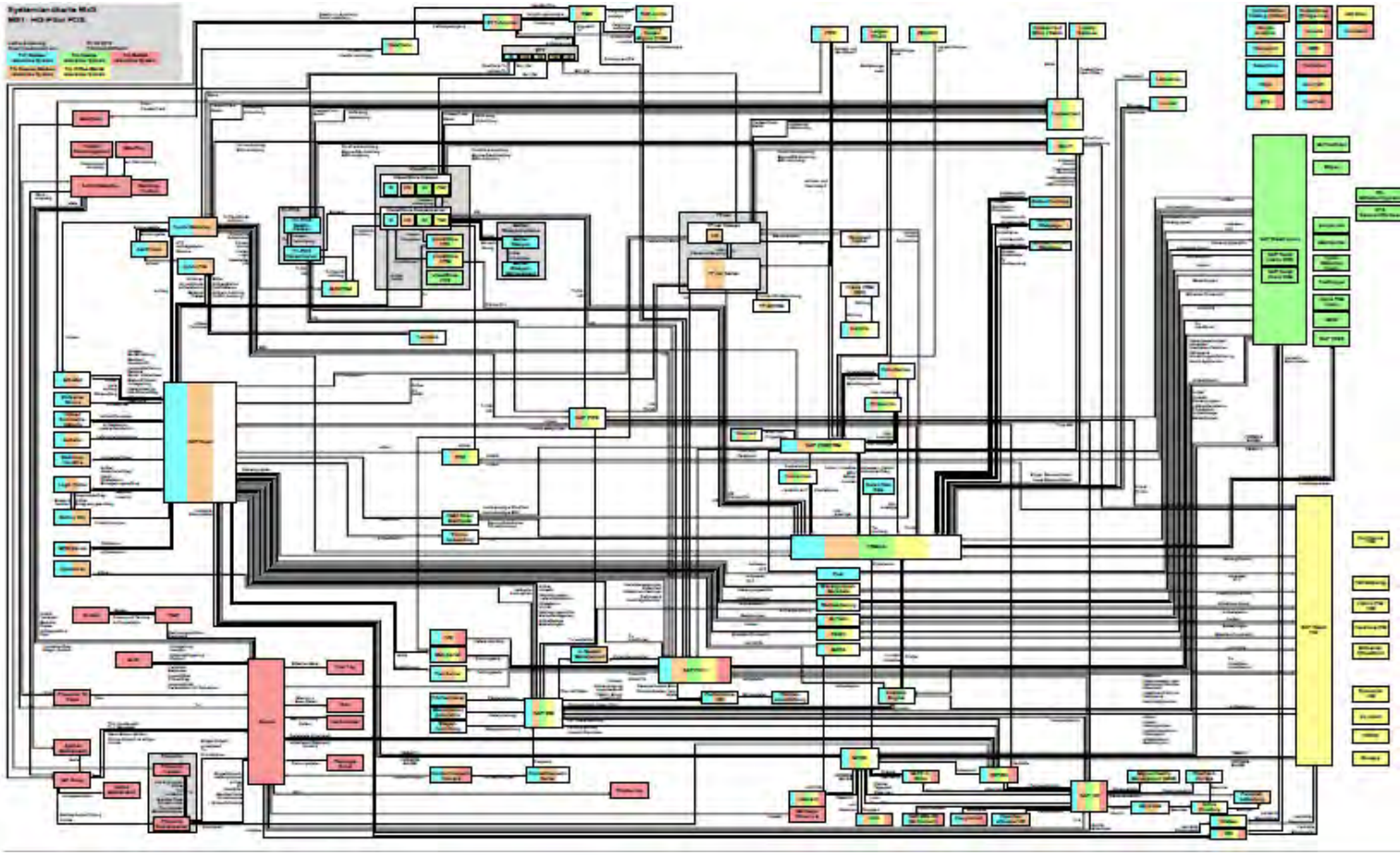
Motivation

- Growing number of integrated applications, reaching over 2000 applications for single large companies
- Cost efficient maintenance and management of such systems
- Allow for continuous innovation within the system and evolution of the architecture



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Enterprise Architecture(EA)

- Aligns business processes, applications, IT infrastructure, and data with an organization's overall objectives
- Provides a comprehensive framework for designing, planning, and managing an organization's IT capabilities
- Key components of EA include business processes, applications, IT infrastructure, and data
- Benefit enterprises with streamlined operations, cost reduction, and alignment with business goals.
- Support digital transformation and innovation in today's digital age

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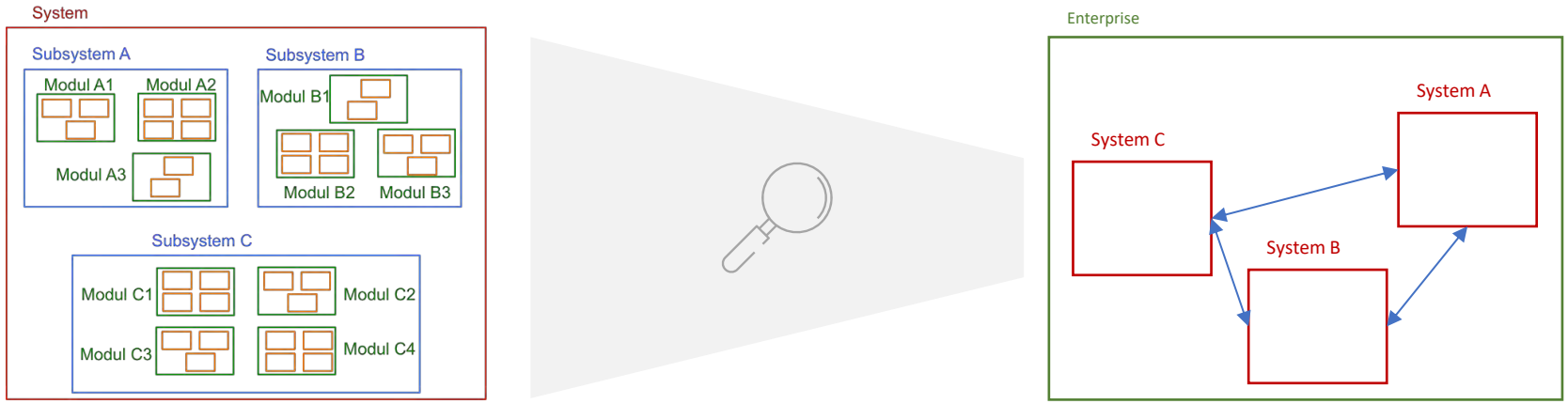
Architecture Scopes

Software architecture / solution architecture

- Research topic since early 1990s (CMU SEI)
- Interest in individual information system and its composition

Enterprise architecture

- Research topic since early 2000s
- Looks into how multiple IS of an enterprise function and interact with each other



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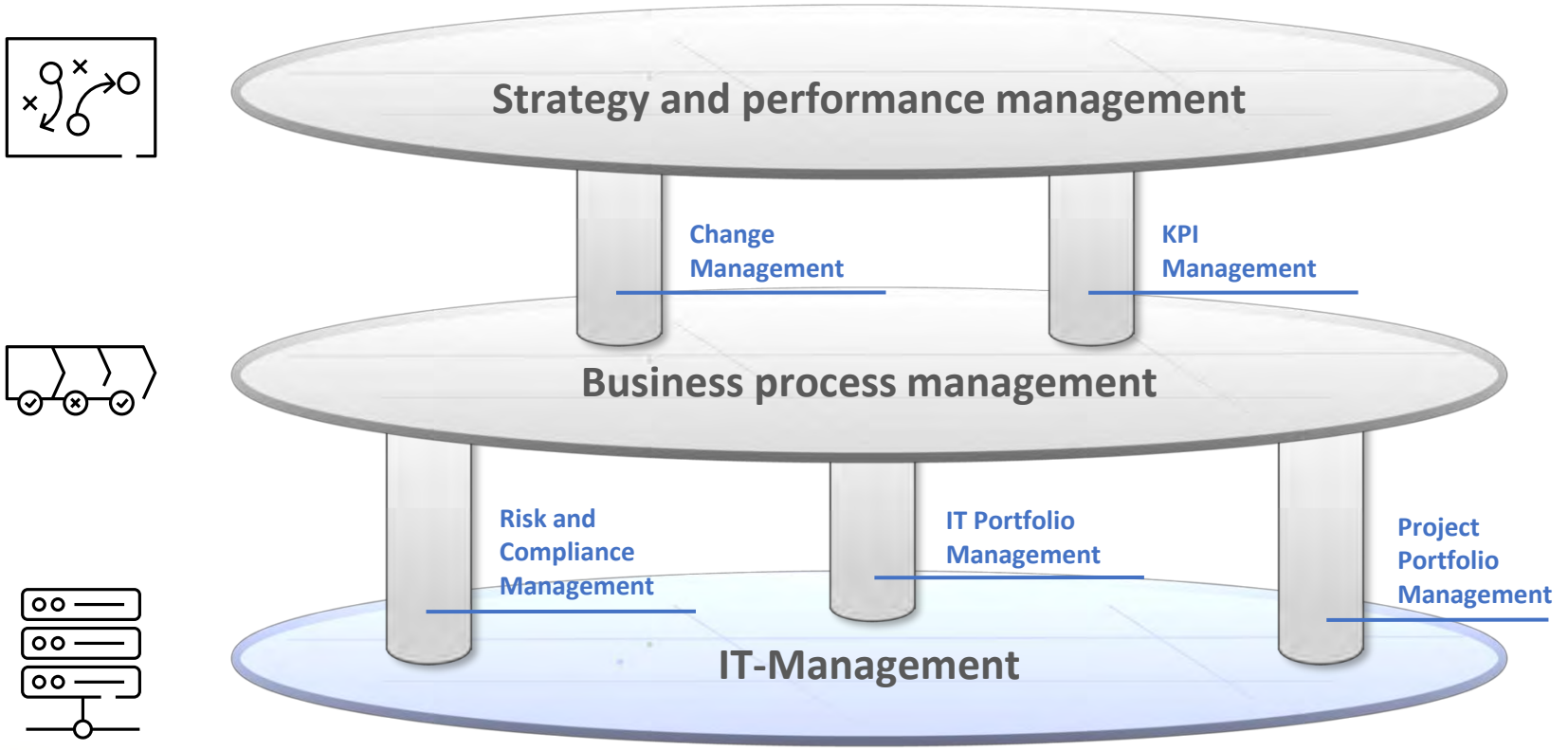
Enterprise Architecture Layers



Multiple management aspects to establish a coherent planning foundation throughout the layers

Source: adapted from EAM course Unviversity of Vienna

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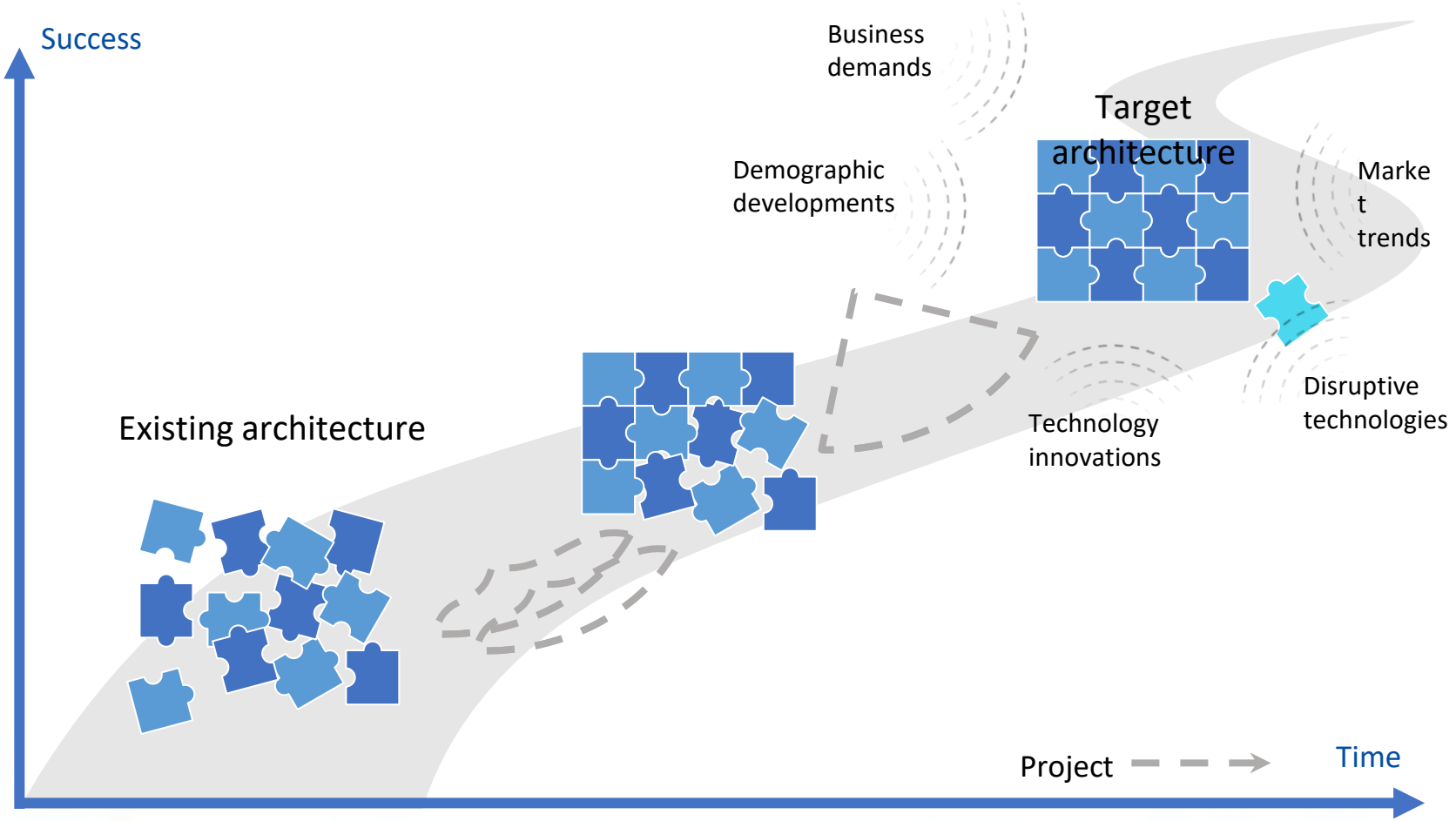
Enterprise Architecture Management



EA management iteratively over projects organises and standardizes to facilitate success.
Enterprise Architectures are in constant evolution influenced by internal and external factors, requiring continuous management.

A1: Reflect of current external/internal factors which influenced existing EA. How did these factor affect EA, what were required changes.

Source: EAM course Unviversity of Vienna

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EA Frameworks

To capture the architectural components of a digital system, it is necessary to follow a framework to identify and specify them in a structured and consistent manner.

Motivated by to the increasing complexity of information technology systems, a variety of frameworks emerged such as

- Zachman Framework (1987)
- Open Group Architecture Framework (TOGAF) (1995)
- Federal Enterprise Architecture (FEA) (2001)

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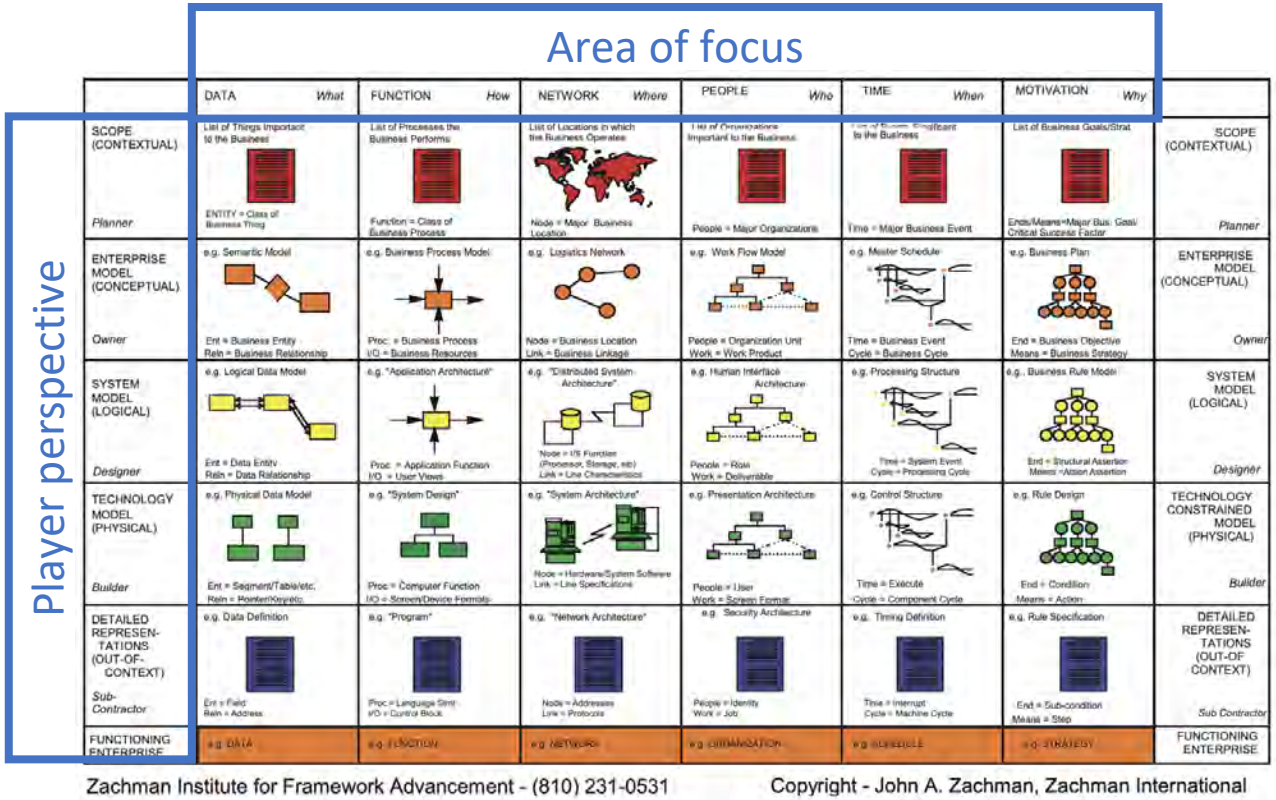
Zachman Framework

- Developed in 1987
- Template for the organization of architectural artifacts
- Reasonings originate from the building industry
- The artefacts classified in **six areas of focus**
- and **six player perspectives**



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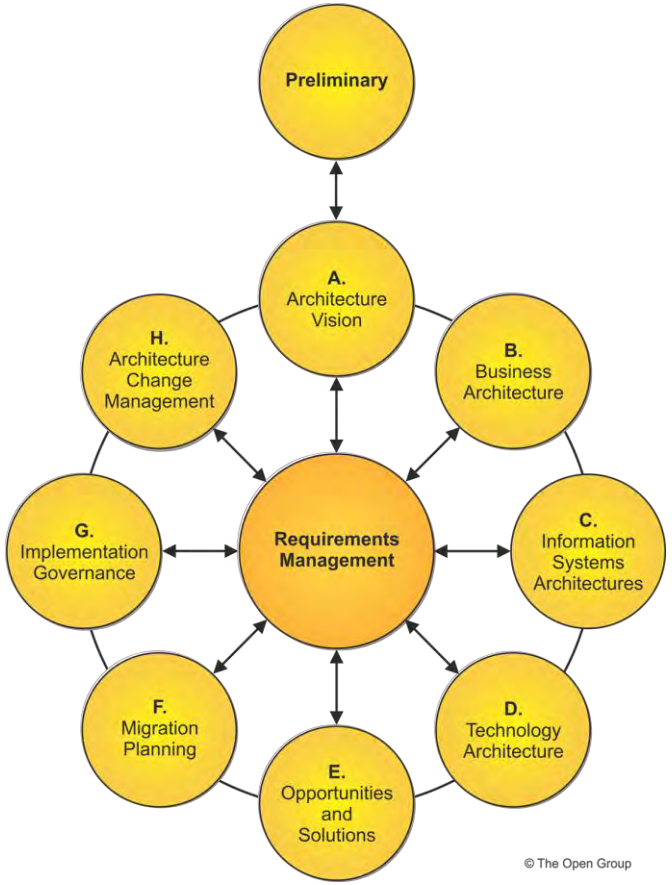
TOGAF

- TOGAF complements the Zachman Framework
- **Process** for the creation of architectural artefacts = Architecture Development Method (ADM).
- Describes the creation of an architecture
- Process from generic to specific
- Divides an enterprise architecture in four categories:
  - **business** architecture
  - **application** architecture
  - **data** architecture
  - **technical** architecture
- Divided in eight phases, started by an initial preliminary phase



Source: TOGAF 9.2 Specification

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TOGAF Architecture domains

EA is divided into four subdomains, all supported by TOGAF:

- Business architecture
  Defines Business strategy, governance, organization and central processes
- Data architecture
  Defines logical und physical structure of the data and data management resources
- Application architecture
  Defines a blueprint of the individual applications, their dependencies and relations and der relation to the key processes of the enterprise
- Technology architecture
  Describes software and hardware functions which support the business, data and application. It entails the infrastructure, middleware, network, communication and standards.

Source: TOGAF 9.2 Specification

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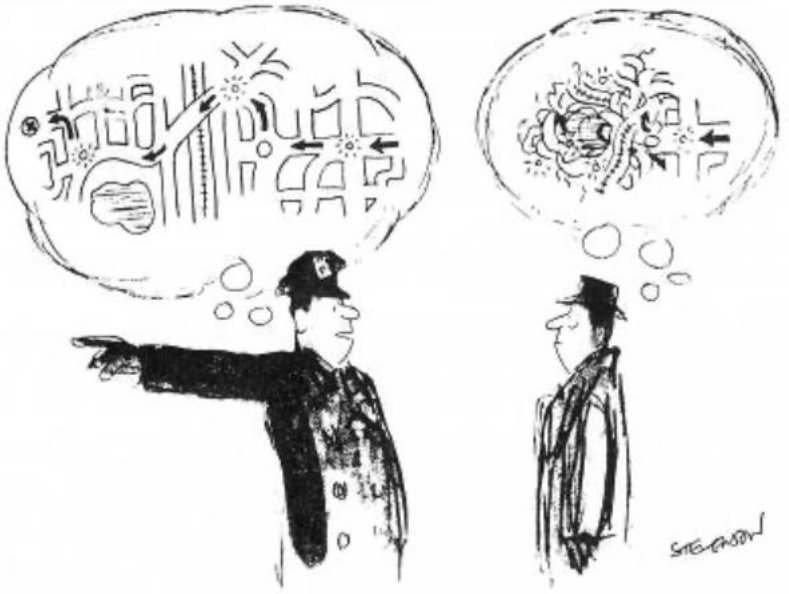
EA Modelling Languages

- Represent **components** and **relationships**
- Describe **business**, **information** and **technology architectures**
- Standardized way to describe and analyze the **structure**, **behavior**, and **functionality**
- The most common utilized modelling language
  - **ArchiMate**
  - Unified Modelling Language (UML)
  - Business Process Model and Notation (BPMN)
  - Entity-Relationship Diagrams (ERD)



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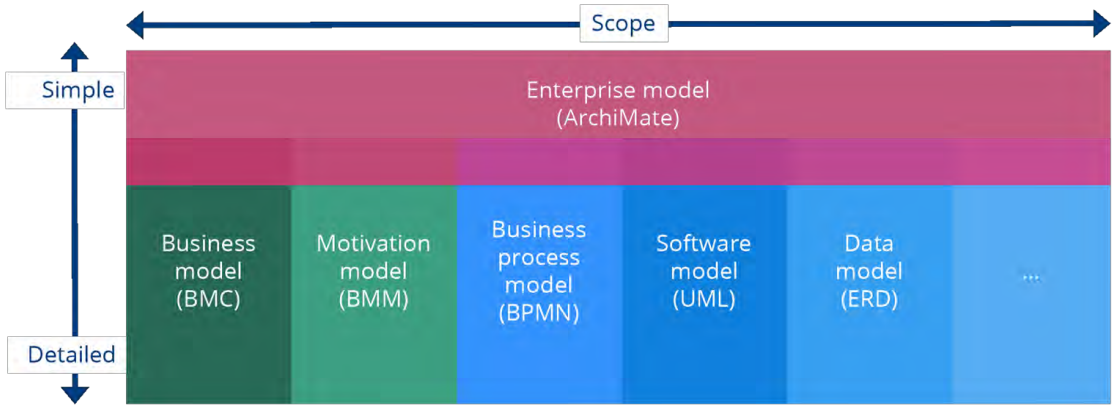
Selecting EA Modelling Languages

- Differentiating **levels of detail** and **scopes**
- ArchiMate model functions as high-level "umbrella"
- ArchiMate focus broader enterprise context
- ArchiMate ties together more detailed models
- Combination of modelling languages depending on project requirements



- E.g.: BPMN vs ArchiMate
  - Both model business processes
  - ArchiMate show relations to enterprise, such as application supporting the process
  - BPMN support for detailed sub-processes and tasks down to execution specification

Source: The Open Group, ArchiMate 3.2 Specification

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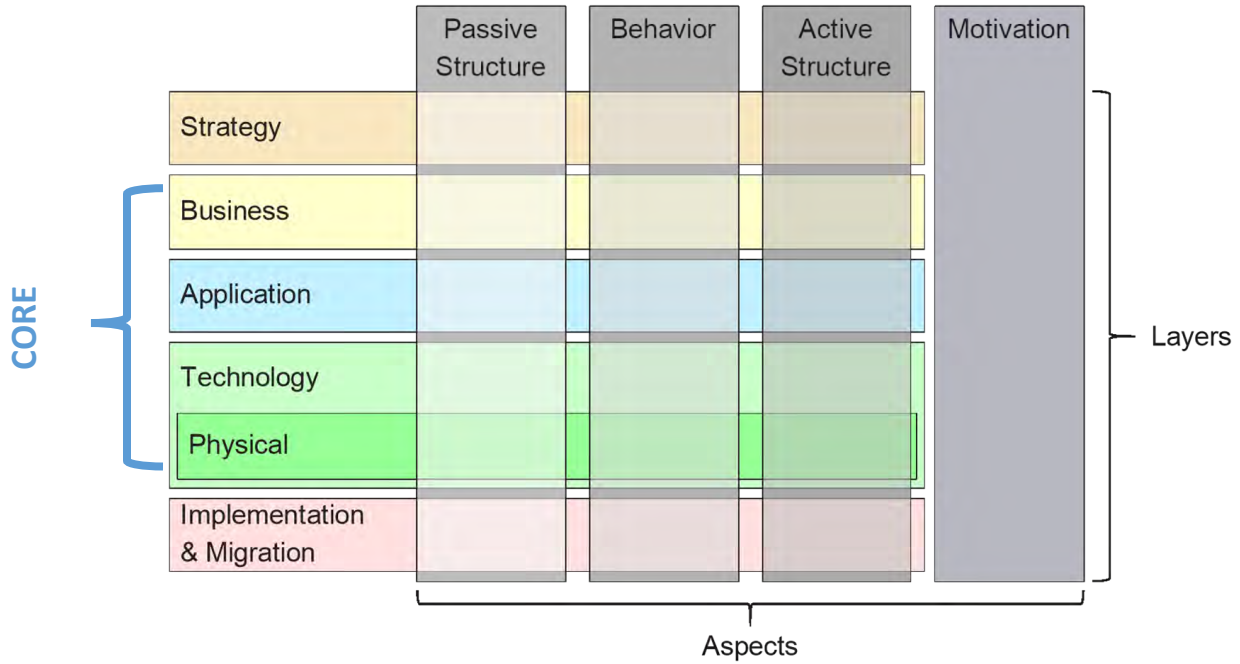
ArchiMate - What is it?

- A **language** with concepts to describe architectures
- A **framework** to organize these concepts
- A **graphical** notation for these concepts
- A **vision** to visualize for different stakeholders
- An **open standard**, curated by the Open Group



Source: The Open Group, ArchiMate 3.2 Specification

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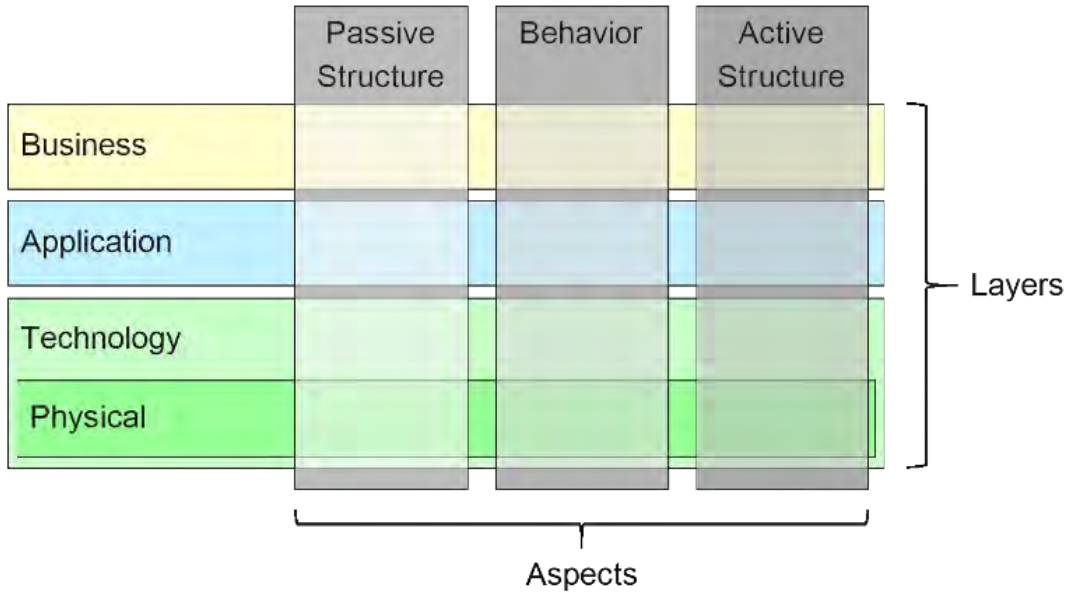
ArchiMate – Core Layers

- **Business Layer**

  offers products and services to external customers, which are realized in the organization by business processes performed by business actors
- **Application Layer**

  supports the business layer with application services which are realized by (software) applications
- **Technology Layer**

  offers infrastructural services (e.g., processing, storage and communication services) needed to run applications, realized by computer and communication hardware and system software



Source: The Open Group, ArchiMate 3.2 Specification

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ArchiMate – Aspects

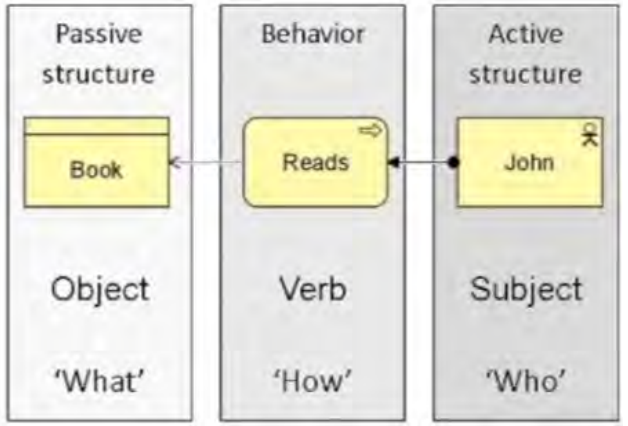
The ArchiMate structure is split into aspects resembling a **subject-verb-object** sentence structure.

- **Active Structure: “John”**

  Represent structures (business actors, application components, devices) which actively perform a behavior
- **Behavior: “reads”**

  Represent the action (processes, functions, events, services) done
- **Passive Structure: “book”**

  Represents objects utilized for the behavior



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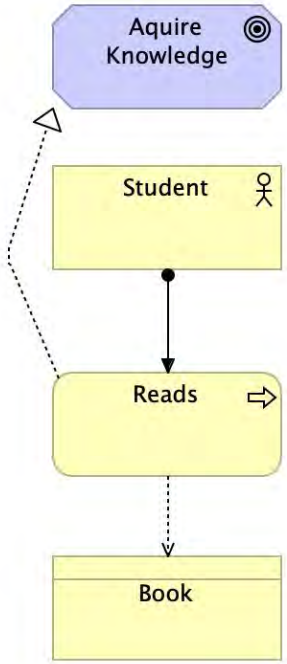
ArchiMate – Notation

- ArchiMate's notation consists of boxes and lines diagrams
- Lines represent relations, and boxes the concepts
- Corners of the "boxes" identify the main class:
  - Square corners are used to denote **structure** elements
  - Round corners are used to denote **behavior** elements
  - Diagonal corners are used to denote **motivation** elements



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ArchiMate – Layers and aspects

	Passive structure	Behavior	Active structure	Motivation
Strategy	resources	courses of action, capabilities	resources	stakeholders, drivers, goals, principles and requirements
Business	business objects	business services, functions and processes	business actors and roles	
Application	data objects	application services, functions and processes	application components and interfaces	
Technology	artifacts	technology services, functions and processes	devices, system software, communication networks	
Physical	material		facilities, equipment, distribution networks	
Implementation & migration	deliverables	work packages	plateaus	

Source: M. Lankhurst (2017), Enterprise Architecture at Work, p. 79

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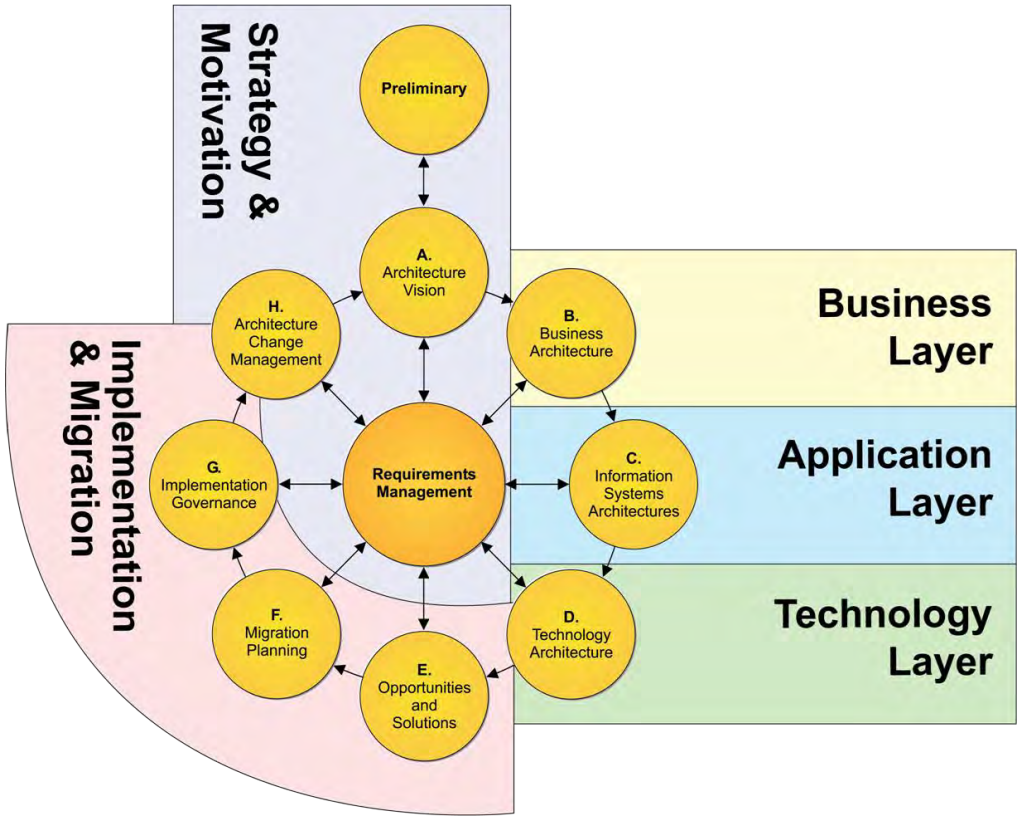
ArchiMate alignment to TOGAF

- ArchiMate and TOGAF complement each other
- TOGAF-Standard focuses on development and adoption of architecture while ArchiMate-language on a consistent notation to model architecture concepts
- ArchiMate fully aligns with TOGAF
- Adopts the same known layered view on the core entities of the enterprise



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ArchiMate in Practice

- Overview
  - A municipality in Austria is aiming to become more sustainable and reduce CO2 emissions through increase in eMobility, optimize the existing public transportation system and cover the increasing demand in electric energy
  - The city wants to achieve this by better integrating eMobility services, the required energy services to charge them and the citizens through digital services
- Goals
  - Achieve smart urban transportation
  - Increase the use of eMobility throughout the city
  - Provide develop digital services for citizen trough data and visualization interfaces
  - Follow a more open strategy by utilizing and providing open data
  - Integrate data and energy technologies

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ArchiMate in Practice

- Approach
  - Divide the overall problem into layers by focusing in each layer on its respective field of interest
  - Make use of the ArchiMate as EA modelling language
  - Model the architecture of the city
- Layers
  - Strategy & Motivation
  - Business
  - Application
  - Technology

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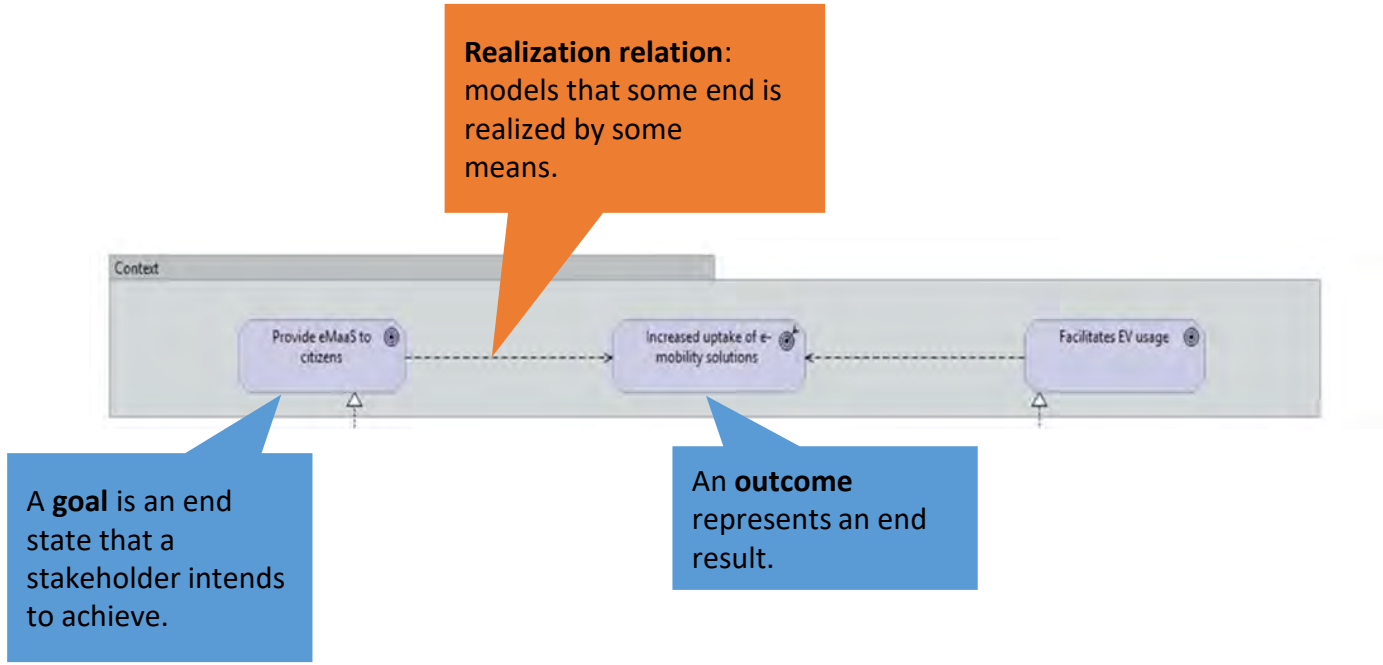
Strategy & Motivation

- The strategy & motivation/context layer captures the interests of city stakeholders and citizens (Pourzolfaghar et al., 2019).
- Comprises the set of goals, constraints, principles and main requirements (Anthony et al., 2019)
- Entails desires, needs, and requirements that relate to stakeholders' concerns, and associated Key Performance Indicators (KPIs) that improve quality of life of citizens (Petersen et al., 2019; Jnr et al., 2020).



Source: Source: Themistocleous, Marinos, and Maria Papadaki, 2020

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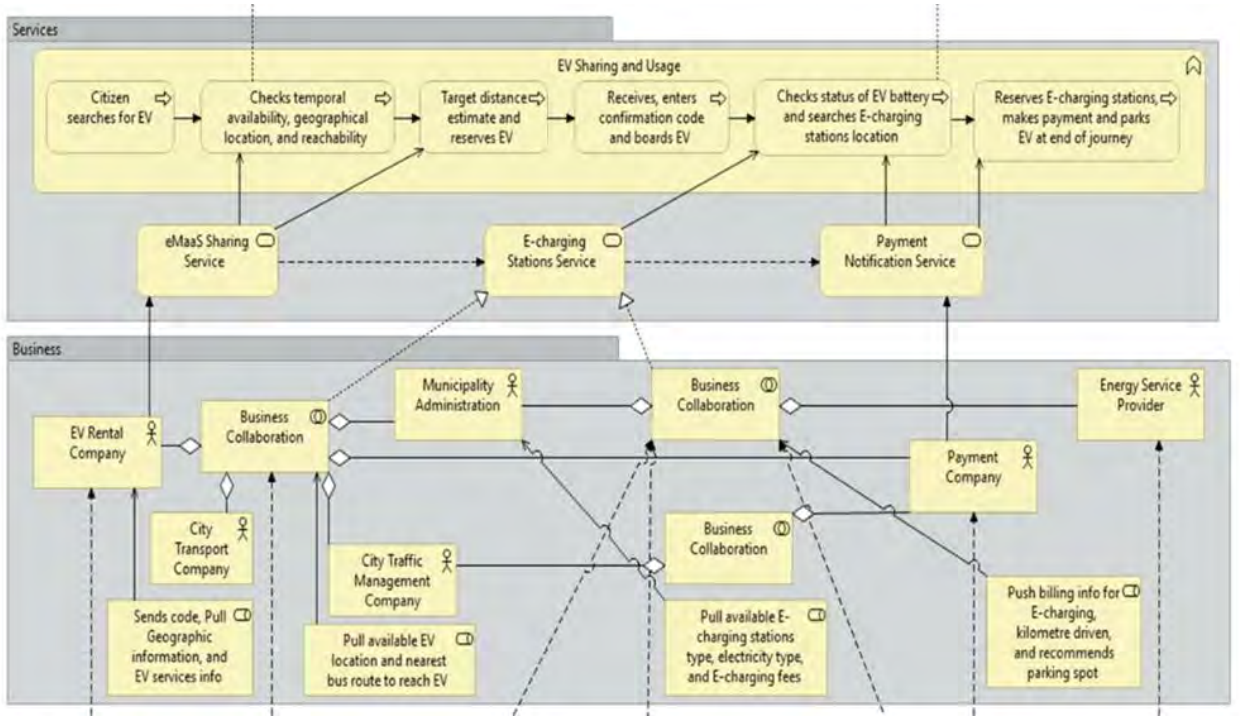
Business Layer

- Is responsible for presenting the municipality's action plans, resources and capabilities (Bokolo and Petersen, 2020)
- It consists of high-level processes provided by the municipality facilitating enterprises collaborating to provide digital services to citizens (Berkel et al., 2018).
- Aims to effectively implement specified outputs and competently realizing specified key performance goals towards smart urban transformation (Anthony et al., 2019).
- presents all partners or enterprises collaborating to providing pervasive platforms (Jonkers et al., 2017), and orchestrating activities in order to deliver digital services to citizens (Caetano et al., 2017).
- operational activities that provide and deliver business services (Berkel et al., 2018).
- virtual enterprises that cooperate in providing digital services (Anthony et al., 2019)



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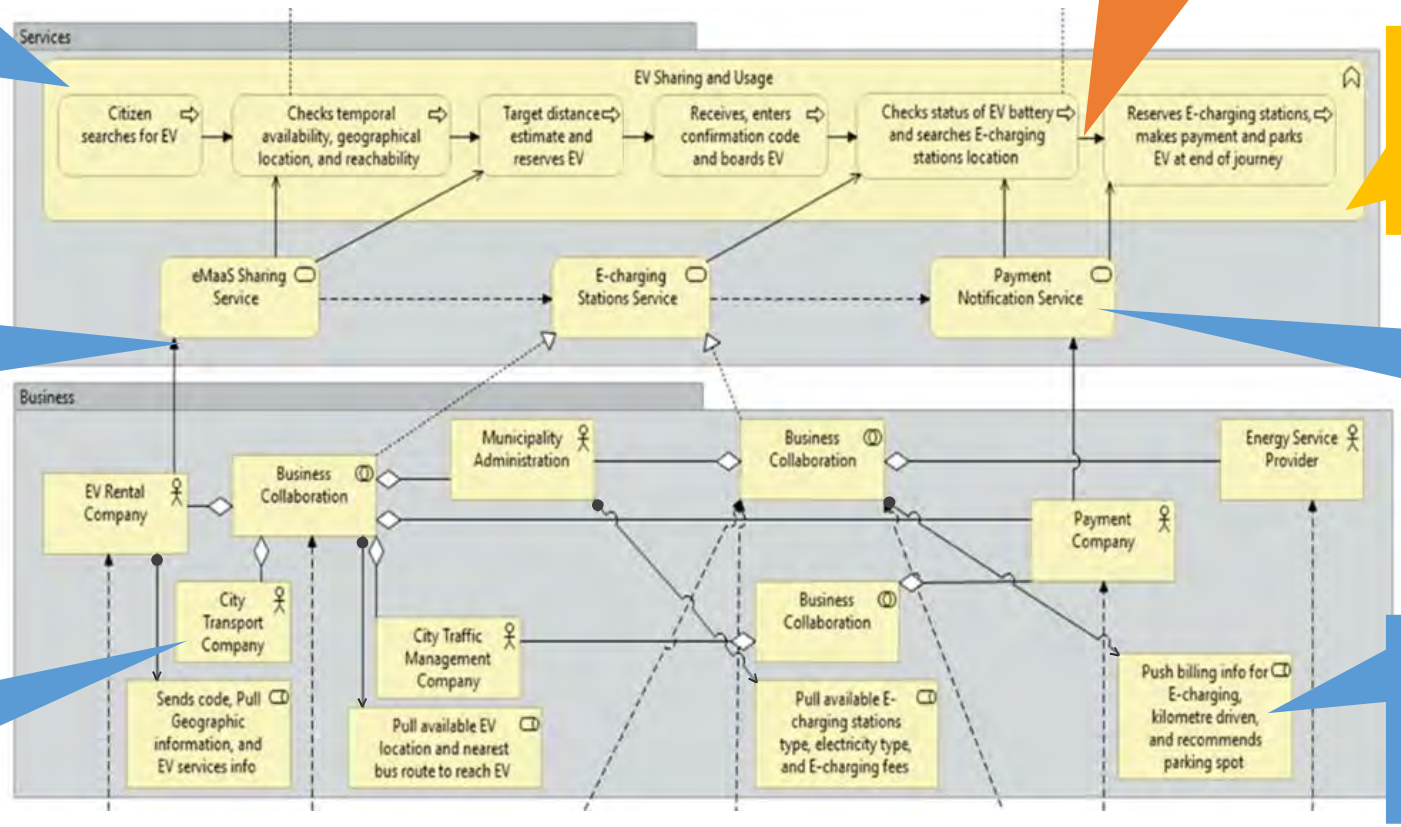
Business Layer Metamodel

A **process** is an ordering of activities.

Triggering relation: one step comes after the other.

Graphic nesting helps to reduce visual complexity. Under the hood: **aggregation**.

An **actor** in a **role**, performing a process, offers a service to another actor in a role, performing another process



Services are used in processes, over a "serve" relation

Actors: business entities that are capable of performing behavior

Roles: help to specify areas of responsibility

component | relation | concept

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Business Layer Semantics

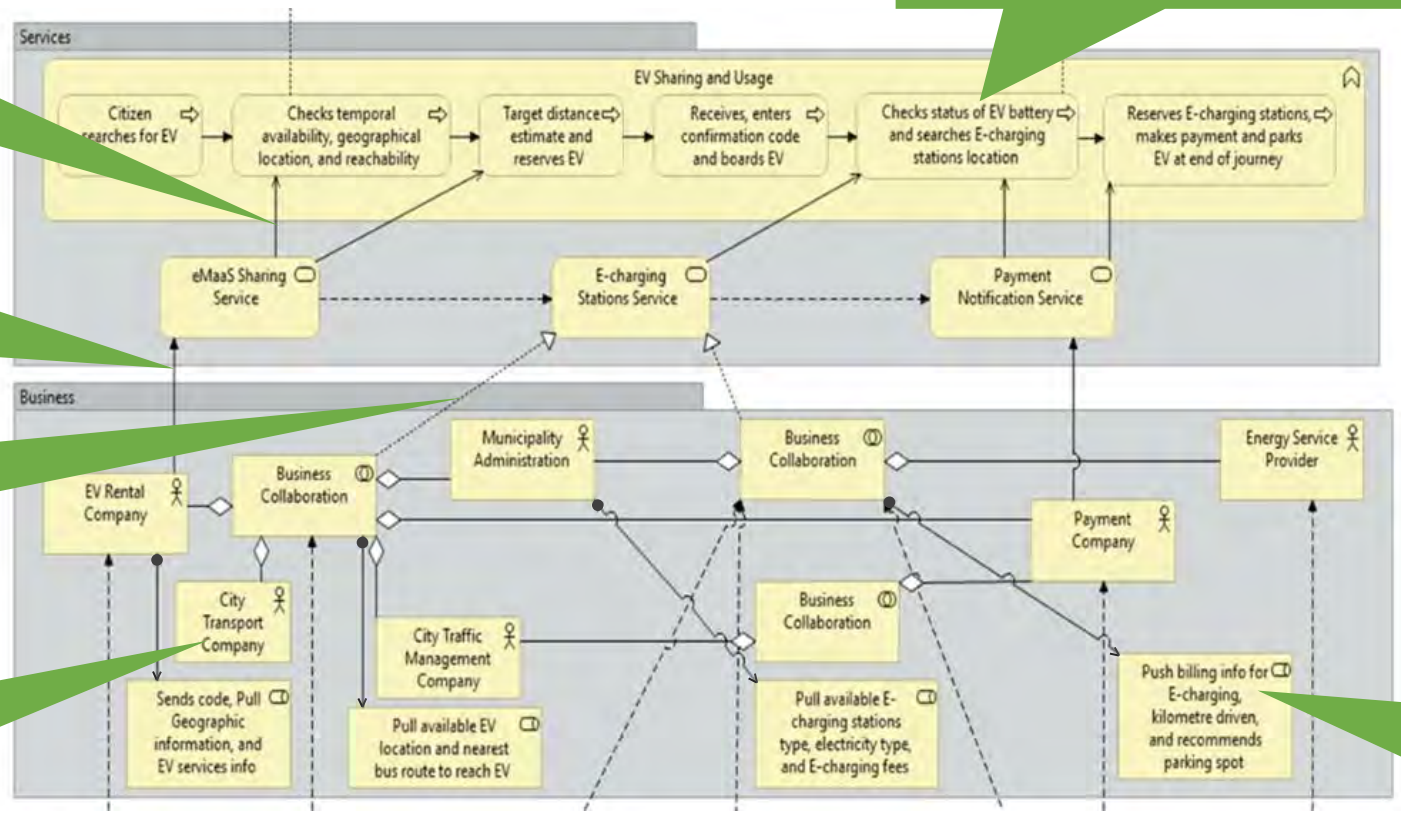
The **eMaaS service** is *used* to **check information on EVs**. It *serves* the process with its functionalities

The **EV Rental Company** *triggers* the **eMaaS service**

The **Business Collaboration** *realizes* the **E-charging station service**

The actors **City Transport Company** and **EV Rental Company** *form together* a **Business Collaboration**

The **EV Sharing and Usage** function *collects* its respective sequence of processes



Push billing info… are the responsibilities *assigned* to the **Business Collaboration** which it has to *perform*

Description: **object** and *relation*

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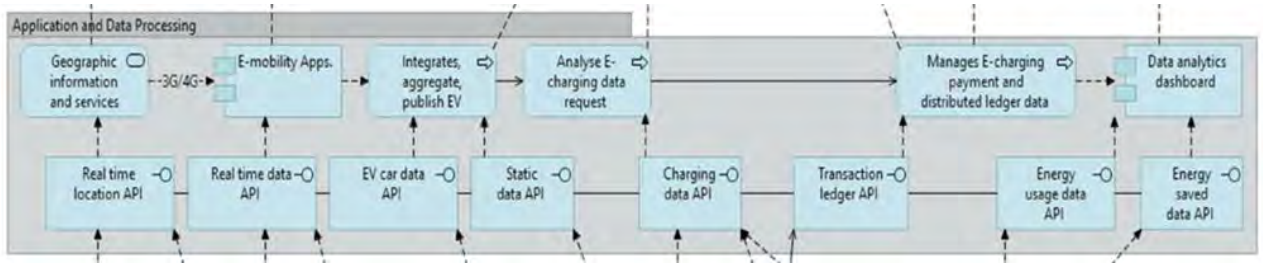
Application Layer

- includes all digital platforms deployed to provide digital services to citizens and stakeholders (Aulkemeier et al., 2016)
- This layer utilizes data from the data space layer in providing digital services (Caetano et al., 2017; Anthony et al., 2019)
- processes and transforms data into useful information to provide insights to decision makers (Berkel et al., 2018).
- provides applications that expose smart services to support the business (Anthony Jnr et al., 2020).



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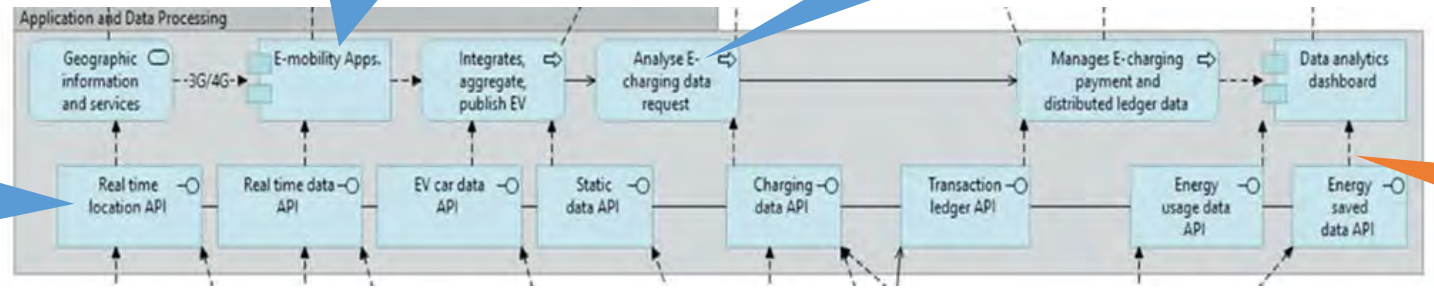
Application Layer Metamodel

Application components are a logical construct and should be deployed.

An **application process** represents a sequence of application behaviors that achieves a specific result



Application interface: where functionality can be accessed

Interface is used by an **application component** hence serves

component | relation | concept

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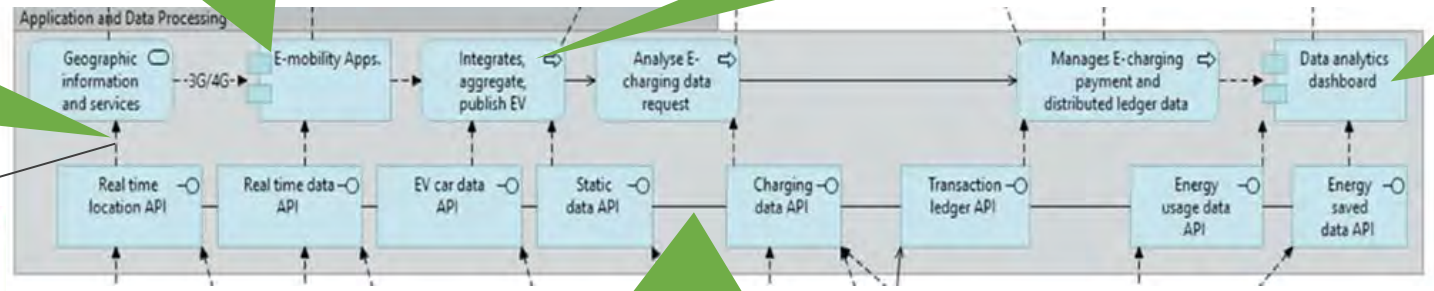
Application Layer Semantics

E-mobility app is an application making *use* of the **geographic information** and services over a *3G/4G* connection.

The **integrates, aggregate, publish EV** application process *takes in* data from the **E-mobility app** and the **EV car data API** processes it and *serves* it to further processes, while also providing the data to the business layer

As a dashboard, the **data analytics dashboard** *takes in data flows* from multiple sources and *provides* in this instance to stakeholders of the business layer

The data *flows* from the interface **for real time location** into the **Geographic information and service**



The **Location data** *associated* to the *flow* specifys what is flowing

The **static data API** is *associated* with the **charging data API** and the EV car data API

Description: **object** and *relation*

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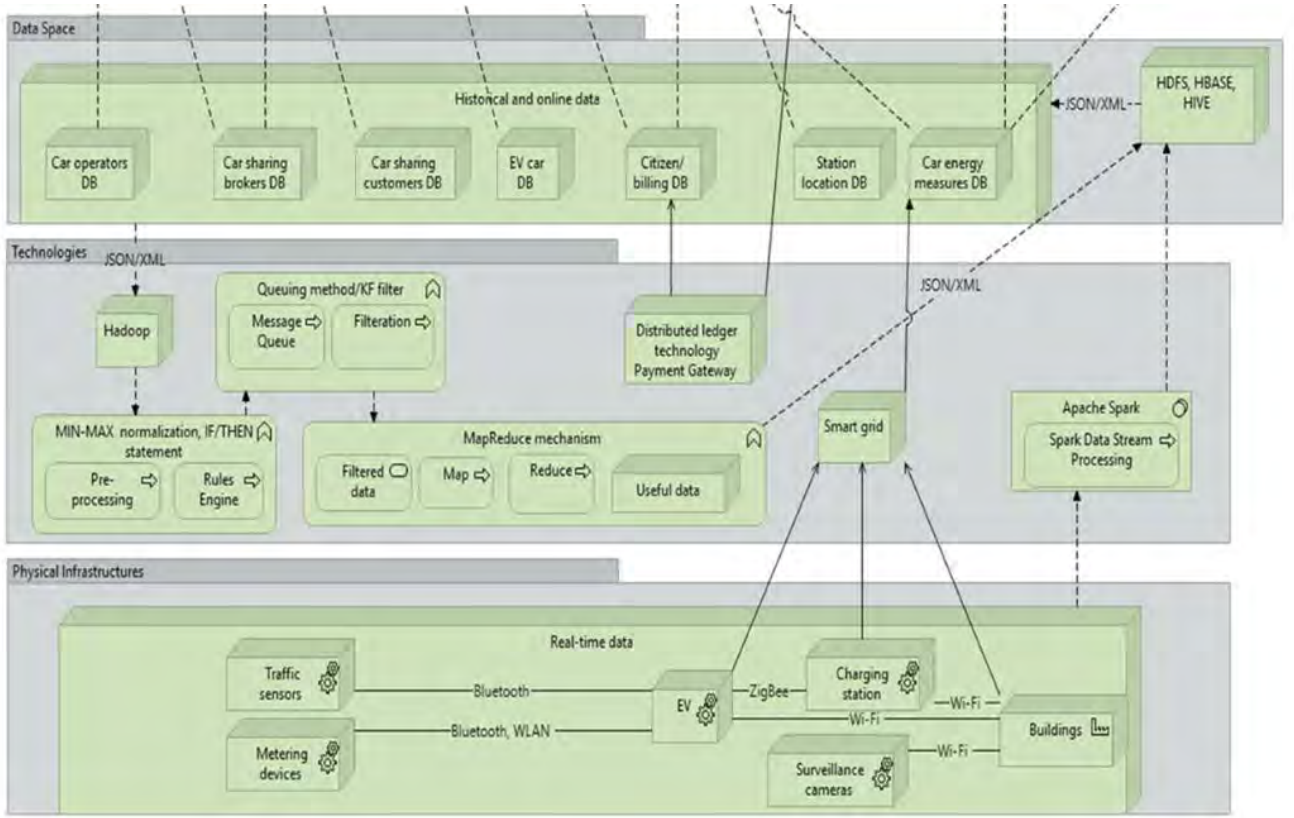
Technology Layer

- The data space layer is the intelligence processing of the architecture as it includes data required to facilitate digital services (Otto et al., 2017)
- Specifies which data is available and are utilized by enterprises collaborating to providing digital services (Petersen et al., 2019)
- Consists of data from pervasive platforms in urban environment. It includes real-time raw data (directly from the devices and sensors), processed online data from digital platforms deployed in cities, processed historical data and lastly third-party data (for external sources) (Anthony Jnr et al., 2020)
- The technologies layer entails all the technologies deployed across the municipality such as edge, fog, cloud computing, ubiquitous computing, big data, processing, service- oriented architecture, etc. (Jonkers et al., 2017)
- Provides the required software and hardware infrastructures needed to provide smart services (Berkel et al., 2018)
- Deploys either cloud-based or locally run servers (Aulkemeier et al., 2016)
- This layer also consists of infrastructures deployed to collect, process, handle and temporarily store real-time data (Caetano et al., 2017).



Source: Source: Themistocleous, Marinos, and Maria Papadaki, 2020

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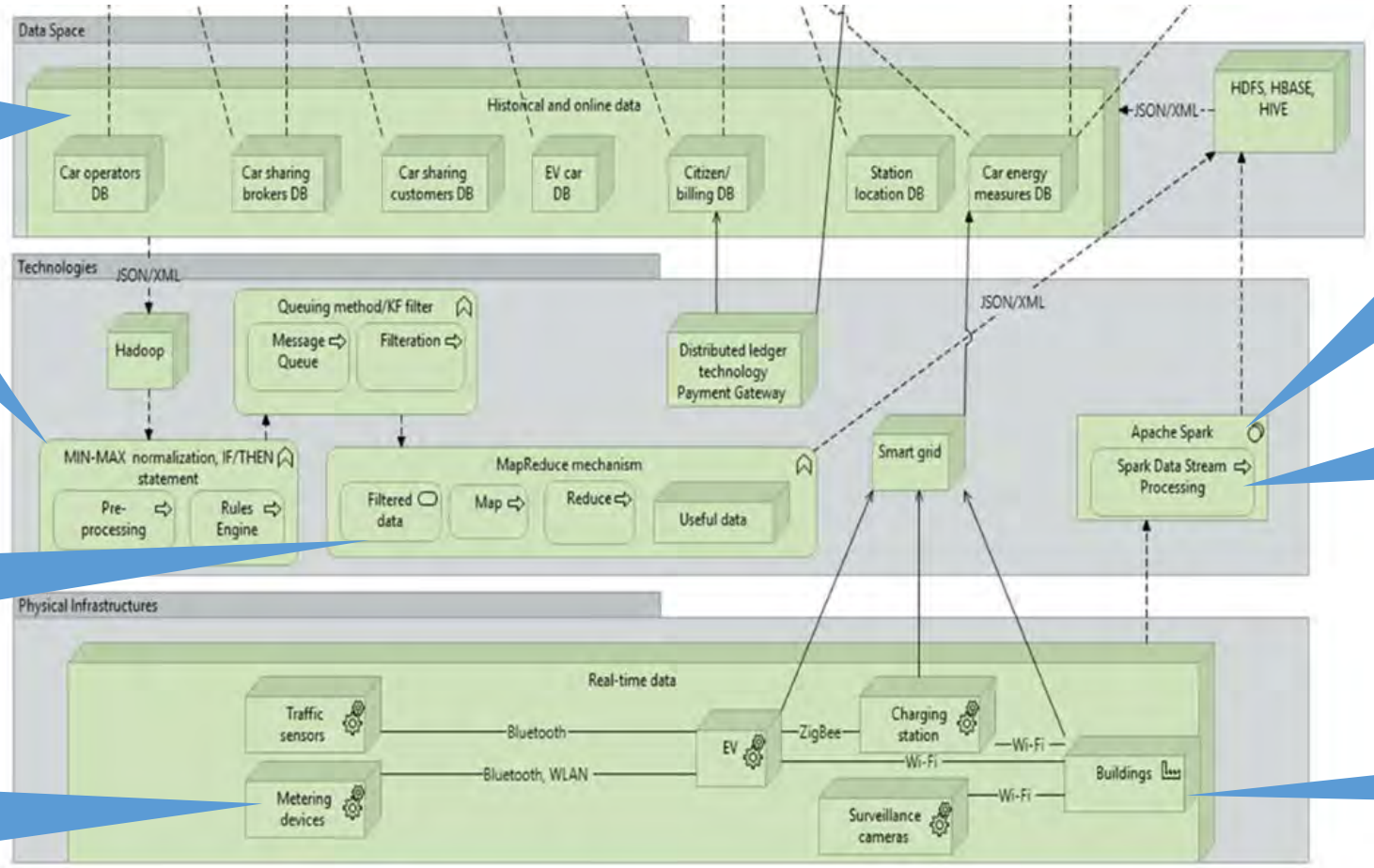
Technology Layer

Nodes are the grouping construct for hardware and software. In this case, only software is included

A **technology function** represents a collection of technology behavior that can be performed by a node.

Services represent what functionality we need to run the application

Equipment represents physical machines or tools. These can also produce data



System software represents software that contributes to an environment for storing, executing, and using software or data deployed within it

A **technology process** represents a sequence of technology behaviors that achieves a specific result.

A **facility** represents a physical structure or Environment

component | relation | concept

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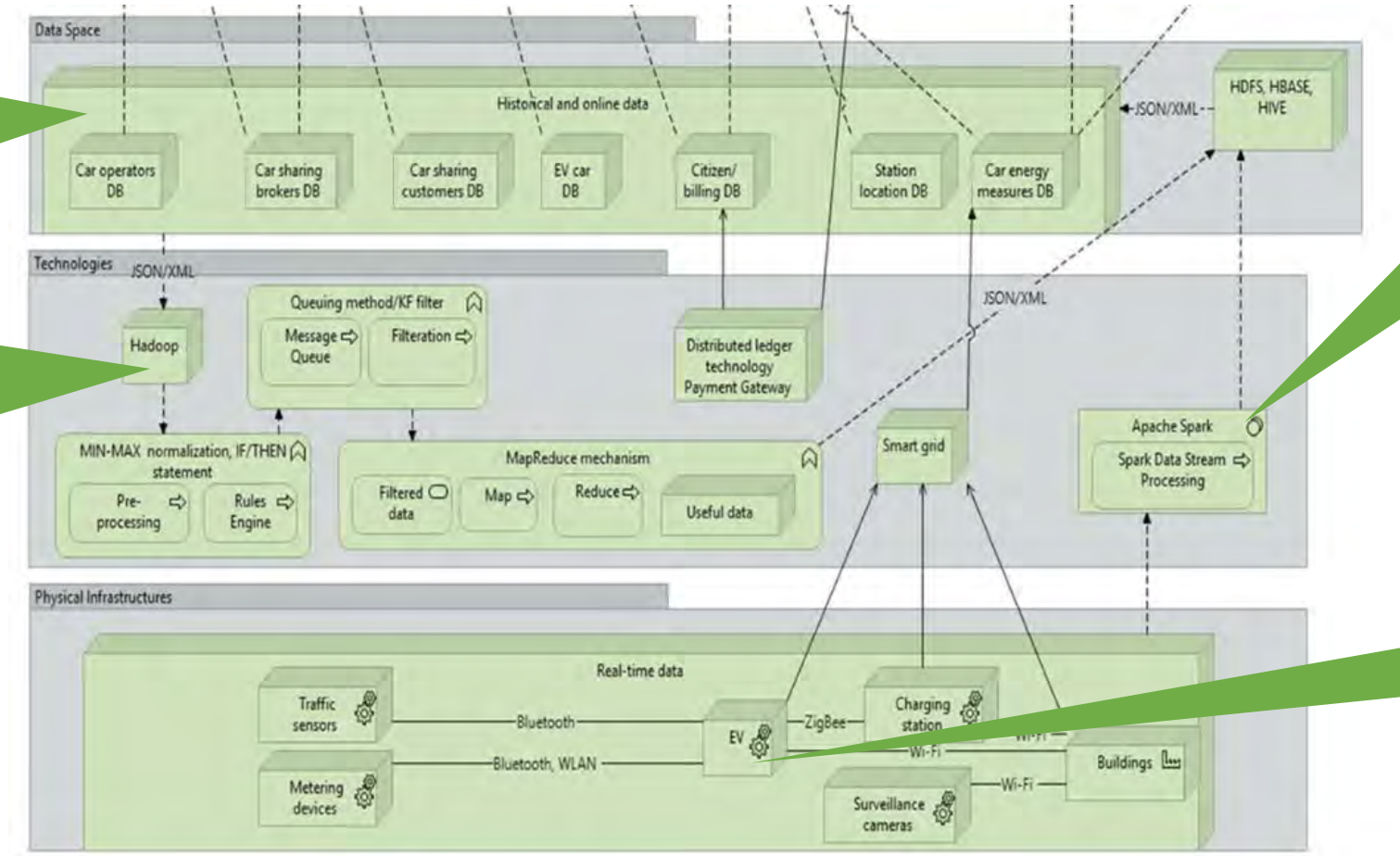
Technology Layer

The **Historical and online data** *groups* alle the **data nodes** for the individual data scopes.

The **Hadoop node** is computation node which takes a data *flow* from the datastore and processes it through a sequence of functions such as **min-max normalisation**



Apache Spark is a system software which processes the data *flowing* from its input to output through its **Data Stream Processing Process**

The **Electric Vehicle** are the physical cars which collect data and *serve* it to the **smart grid**

Description: **object** and *relation*

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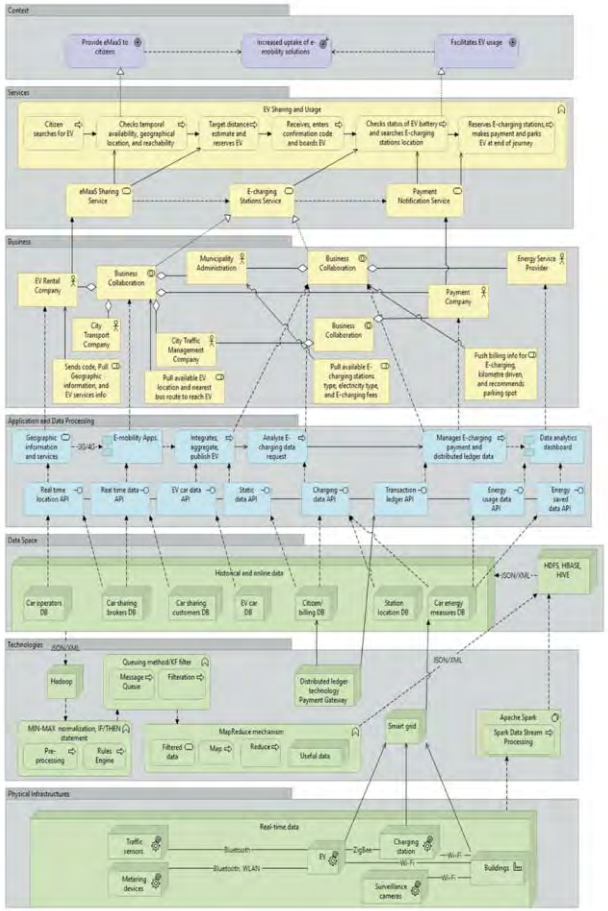
Sample architecture I

- Source: Themistocleous, Marinos, and Maria Papadaki. “**A Practice Based Exploration on Electric Mobility as a Service in Smart Cities**.” Information Systems, vol. 381, Springer International Publishing AG, 2020, pp. 3–17, https://doi.org/10.1007/978-3-030-44322-1_1.
- This study adopts Enterprise Architecture (EA) and integrates Application Programming Interfaces (APIs) to improve interoperability for acquisition, processing, retaining, and dissemination of mobility relevant data.



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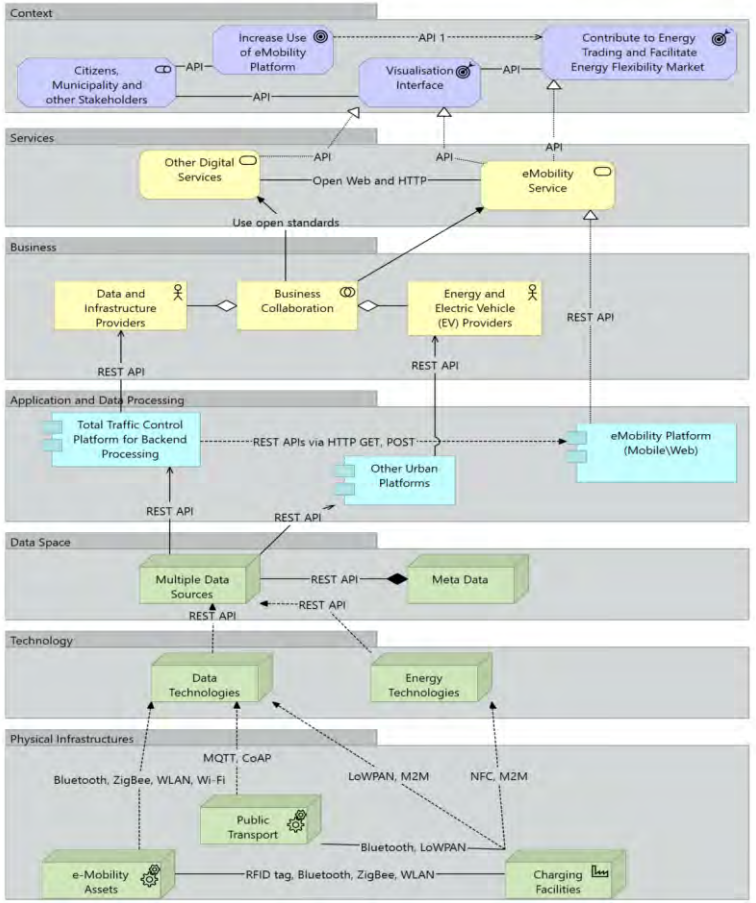
Sample architecture II

- Source: Anthony Jnr, Bokolo, et al. “**Modeling Pervasive Platforms and Digital Services for Smart Urban Transformation Using an Enterprise Architecture Framework.**” Information Technology & People (West Linn, Or.), vol. 34, no. 4, 2021, pp. 1285–312, https://doi.org/10.1108/ITP-07-2020-0511.



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Additional material

- Additional information on the ArchiMate specification is found in the respective pdf on Moodle
- https://pubs.opengroup.org/architecture/archimate3-doc/
- https://publications.opengroup.org/archimate-library
- https://sparxsystems.com/resources/tutorials/archimate/index.html
- https://www.archimatetool.com/

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Archi

- Archi is an open source modelling toolkit for ArchiMate
- Supports all levels of enterprise architecture

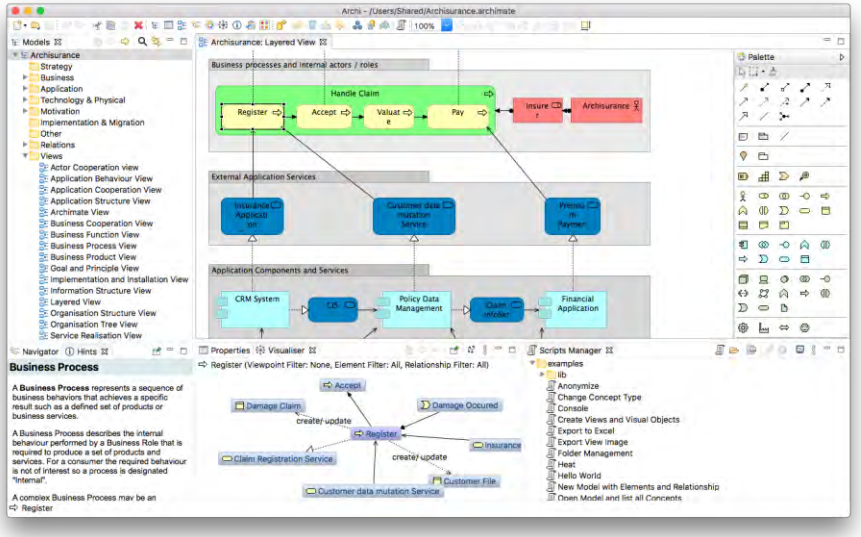
A2: *Download & install Archi on your device from*

https://www.archimatetool.com/

A3: *Think of an exemplar digital platform and describe its core concepts on one slide (can be done individually or in groups of 2)*

A4: *To get started with Archi modelling tool, model the main components of the business, application and technology layer of the digital platform you described in A3.*

Model it on a high level, as shown in case study II. As a guide, the model should give an overview on the main stakeholders, the offered services, the necessary applications and interfaces, possible require databases? Show a screenshot of the final architecture on a slide to present and discuss it (can be done individually or as a group of 2).



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Agenda

I. Enterprise Architecture Introduction

II. EA Frameworks and Modelling Languages

III. ArchiMate

IV. ArchiMate in Practice

V. **Summary of Assignments**

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Summary of individual questions and assignments

The following tasks should be completed individually. Your submission should consist of a slide deck containing one slide for each question. Submit the file as PDF on the courses Moodle page and have it ready to share and discuss during the live class session.

A1: *Reflect of current external/internal factors which influenced existing EA. How did these factor affect EA, what were required changes?*

A2: *Download & install Archi on your device from https://www.archimatetool.com/*

A3: *Think of an exemplar digital platform and describe its core concepts on one slide (can be done individually or in groups of 2)*

A4: *To get started with Archi modelling tool, model the main components of the business, application and technology layer of the digital platform you described in A3. Model it on a high level, as shown in case study II. As a guide, the model should give an overview on the main stakeholders, the offered services, the necessary applications and interfaces, possible require databases? Show a screenshot of the final architecture on a slide to present and discuss it (can be done individually or as a group of 2).*

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- Zachman, J. A. (1987). A framework for information systems architecture. IBM Systems Journal, 26(3), 454–470. https://doi.org/10.1147/sj.263.0276.
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- Hara, Yoshinori, and Dimitris Karagiannis. “Modeling Digital Enterprise Ecosystems with ArchiMate: A Mobility Provision Case Study.” Lecture Notes in Computer Science (including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol. 10371, Springer International Publishing AG, 2017, pp. 178–89, https://doi.org/10.1007/978-3-319-61240-9_17.

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