Welcome to the course: “The ATHENA Interoperability Framework”.
The course presents the ATHENA Interoperability Framework (AIF). The AIF is used for capturing the research elements and solutions to interoperability issues (metamodels, languages, methodologies, modelling tools, execution environments, etc.).

In order to understand how the solutions derived from the AIF can be applied, the course presents four real scenarios and their interoperability issues. These scenarios are:

• Electronic procurement (e-Procurement) inside Furniture sector.
• Collaborative Product Development (CPD) inside Aeronautics and Aerospace sector.
• Product Portfolio Management (PPM) inside Telecommunication sector.
• Supply Chain Management (SCM) inside Automotive sector.
Introduction

Interoperability is not only a technology problem.

Interoperability also concerns the business processes and the business context of an enterprise.

The ATHENA Interoperability Framework follows a model-driven approach to solving the interoperability problems.

IEEE defines interoperability as “the ability of two or more systems or components to exchange information and to use the information that has been exchanged”.

Interoperability should not only be considered a property of ICT systems, but also concerns the business processes and the business context of an enterprise.

Interoperability difficulties are consequence of new business paradigms like extended enterprises and networked organisations that require business to work together.

There is a need for a framework that takes a more comprehensive approach to interoperability.

The framework adopts a holistic perspective on interoperability in order to analyse the business needs and the technical requirements.

The framework follows a model-driven approach to solving the interoperability problems.
The ATHENA Interoperability Framework (AIF) is structured into three parts:

1. Conceptual integration which focuses on concepts, models, metamodels, and languages.
   It provides with a modelling foundation for systemising various aspects of interoperability.

2. Applicative integration which focuses on methodologies, Uses cases and Reference Examples.
   It provides us with guidelines, principles and patterns that can be used to solve interoperability issues.

3. Technical integration which focuses on Modelling Tools and Execution Environments.
   It provides us with ICT tools and platforms for developing and running enterprise application and software systems.
The figure is a simplistic view of the Conceptual Integration Framework. Interoperations can take place at the various levels: enterprise, process, service and information. For each of these levels the reference model defines a set of metamodels and languages that can be supported by tools and methods to construct the models in question.
Interoperability at business is the ability of an enterprise to cooperate with external organisations.

Enterprise Modelling is rapidly developing and transforming into providing visual languages, best-practice patterns and visual knowledge spaces.

Enterprise Modelling aims to support enterprises by dealing with the several aspects of interoperability.

However a lot of Enterprise Modelling languages and tools are developed in the meantime to support enterprises for defining their own entire architecture.

In order to collaborate enterprises have to share their models across modelling languages.

The POP* metamodel defines a core set of enterprise issues to be defined in an enterprise model as a flexible intermediate language to facilitate model exchange between different enterprise modelling tools.
Interoperability of processes aims to make various processes work together.
A process defines the sequence of the services according to some specific needs of a company.

In a networked enterprise, it is also necessary to study how to connect internal processes of two companies to create cross-organisational business process (CBP).

This is supported by the CBP metamodel.

The **CBP metamodel** defines language constructs for modelling cross-organisational business processes using the concepts of view process and private process.

A view process combine different (internal) private processes to an abstract level that enables companies to hide critical information from unauthorized partners.
Interoperability of services is concerned with identifying, composing and executing various applications.

Services are an abstraction and an encapsulation of the functionality provided by an autonomous entity.

Modelling flexible execution and composition of services can be supported by the PIM4SOA metamodel.

PIM4SOA stands for platform-independent model for service-oriented architecture.

PIM4SOA model can be used to represent SOA solutions in a platform-independent way and bridge the gap between the enterprise layer and the technical layer.
Interoperability of information/data refers are related to the management, exchange and processing of different documents, messages and/or structures by different collaborating entities.

The **XSD** (XML Schema Definition Language) is seen as a key enabling technology for achieving information interoperability.
Semantic concerns with represent the actual meaning of concepts. Semantic barrier is result of different interpretations of syntactic descriptions. In order to facilitate interoperability: Semantics should be exchangeable and based on a common understanding. Precise computer meaning must be associated with each concept. This can be achieved using an ontology and a formal annotation mechanism for meaning. The OPAL (Object, Process, Actor modelling language) offers a number of modelling notions to more precisely define the meaning of concepts.
The applicative integration framework is influenced by the Enterprise Unified Process (EUP).

EUP is an extension to the Unified Software Development Process (UP) which is a recognized and commonly used software development methodology.

Whereas the UP defines a software development lifecycle, the EUP extends it to cover the entire ICT lifecycle.
The framework defines a baseline methodology which integrates the methods developed in the ATHENA project. This methodology should be considered a baseline which should be configured and/or extended to the specific needs of the interoperability project in question.

The figure depicts a view of the methodology as a V-model.

The methodology integrates the following methods:

- **Business Interoperability Framework (BIF)** is a framework for determining business challenges related to interoperability according to strategic business needs. The BIF can be used to define the level of business interoperability for a given co-operation scenario. The co-operation model allows us to find optimization potential for one collaboration and compare results with other collaborations.

- **Enterprise Interoperability Maturity Model (EIMM)** method defines a set of area of concerns and a set of maturity levels that provide the means to determine the current ability of an enterprise to collaborate with external entities and to specify the path to improve this ability.

- **Interoperability analysis** method focuses on the common understanding of the enterprise artefacts needed to achieve interoperability on the different levels. This involves understanding and relating different enterprise models, defining cross-organisational business process models, agree on service interfaces over which the partners communicate and exchange messages.

- **Requirements – solution mapping** method takes as input the business needs and technical requirements identified in the interoperability analysis. The mapping methodology is helping different kinds of users to find potential solutions regarding their requirements.

- **Testing Framework** (which includes the activities test definition and testing) is a framework to support conformance and interoperability testing.

- **Implementation** activity focuses on the solution implementation. Depending on the indicated solution approach given by the requirements – solution mapping, different alternative methods can be chosen.

The implementation methods should follow an engineering approach, where the individual components can be characterised according to the AIF conceptual framework.

- **Interoperability Impact Analysis Method (IIAM)** focuses on the return of investment (ROI) and the impact of the interoperability measures.
The technical framework describes an integrated architecture supporting collaborative enterprises.

The architecture centres on a set of tools and infrastructure services to support collaborative product design and development, cross-organisational business process, service composition and execution, and information interoperability.

The figure depicts an overview of the technical framework illustrating some of the main components.
The **MPCE** (Modelling Platform for Collaborative Enterprises) supports the POP* language and provides model management and model exchange services. The MPCE can be used as a web-service hosted somewhere or can be locally installed.

The major advantage of the POP* concept and the MPCE is the capability to keep models consistent even by using different modelling tools.

Involved Modelling tools are:
- METIS
- ARIS,
- MO²GO
- GRAITools.
Regarding cross-organisational business processes we distinguish the following modelling levels:

**Business level:** This level represents the business view on the cooperation and the cross-organisational process that describes the interaction of the partners. The CBPs modelled on this level are not executed.

This level mainly supports the perspective of a business analyst.

**Technical level:** This level provides a more detailed view on the CBP representing the complete control flow of the process.

For instance, single tasks and messages exchanged are modelled on this level. However, the control flow is specified in a platform independent manner, so that the CBP models at this level are still not executable by a business process engine.

**Execution level:** The CBP model on this level contains platform specific interaction information and may be executed in an appropriate execution engine.

Platform specific information is e.g. the concrete message formats sent or received during CBP execution or the transport protocols used.
The CBP Tool Suite consists of Maestro, Nehemiah and Gabriel.

- **Maestro** is a Business Process Modeling Tool on a technical level that allows for modeling of private processes, view processes, CBPs and their links. Processes modeled in Maestro can be exported into the Nehemiah enactment engine for execution.

- **Nehemiah** is a Business Process Management Engine that executes cross-organisational business processes in a distributed environment and supports the process view approach. Nehemiah has a Web front end for controlling and monitoring the execution state of the CBP in a Web browser.

- **Gabriel** is an integration tool between business process and services, responsible for defining the concept of a task.
The SOA Framework is composed of three parts: the modelling part, the services part and the agents part.

1. The **modelling part** defines models and transformations between a Platform Independent Model (PIM) for SOA and Platform Specific Models for describing Web services, agents and BPEL processes.

2. The **services part** is composed of three tools: the WSDL Analyser, the Lyndon tool and the Johnson tool.
   - The **WSDL Analyzer** is a tool for detecting similarities between Web service descriptions. The tool can be used to find a list of similar services and produces a mapping between messages, thereby enabling brokering and mediation of services.
   - **Johnson** is a Web service execution infrastructure. Johnson allows users to call Web Services in a way that hides the technical details away from them.
   - The **Lyndon** tool can be seen as the design-time counterpart of the Johnson tool. It analyses WSDL files and automatically configures Johnson for playing either the role of consumer or provider of the service described.

3. The **agents part** provides a goal-oriented service composition and execution module within an SOA.
The set of semantic tools and services can be used by other components in order to include semantic support for solving interoperability issues.

**ATHOS**: It is the Ontology Management System. It provides a web user interface for helping the users in the process of building and managing reference ontologies.

**A***: It is the semantic annotation tool. Semantic annotation aims at giving a non ambiguous meaning to digital resources and represents a conceptual correspondence between resources and concepts in the ontology.

The semantic annotation expressions are used by Argos as starting point for the creation of specific reconciliation rules.

**ARGOS**: Starting from the knowledge captured by the semantic annotations, the tool provides a user friendly web interface for writing reconciliation rules. These rules can be used at run-time in order to apply forward and backward transformations among business documents.

**ARES**: It is the only tool of the framework which works at run-time. Its objective is to provide the semantic reconciliation service to external run-time environments.

The semantic reconciliation allows to reconcile documents and messages, starting from a common ontology and semantic annotations, without the human intervention at run-time.
**Usage of the Interoperability Framework**

**Scenarios at four Industrial Sectors:**

- **Furniture**
  - Electronic Procurement

- **Aeronautics**
  - Collaborative Product Development

- **Telecommunication**
  - Product Portfolio Management

- **Automotive**
  - Supply Chain Management

The AIF provides a framework for capturing the research elements and solutions to interoperability issues that address the problem in a holistic way.

In order to understand how the solutions derived from the AIF can be applied, the course presents four cases studies corresponding to four real scenarios and their interoperability problems.

These scenarios are:

- Electronic procurement (e-Procurement) inside Furniture sector.
- Collaborative Product Development (CPD) inside Aeronautics and Aerospace sector.
- Product Portfolio Management (PPM) inside Telecommunication sector.
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Interoperability Issues

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples of Interoperability Issues</th>
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<tbody>
<tr>
<td>Business</td>
<td><em>Link enterprise points of view in order to define a decisional structure of the networked organisation</em></td>
</tr>
<tr>
<td>Process</td>
<td><em>Definition of collaborative business processes</em></td>
</tr>
<tr>
<td>Knowledge</td>
<td><em>Product knowledge sharing within product life cycle phases</em></td>
</tr>
<tr>
<td>Software</td>
<td><em>Integrate applications, implemented with different technologies and executed on different platforms</em></td>
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</tbody>
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Interoperability issues are problems concerning interoperability extracted from analysis of business scenarios.

Interoperability issues are classified according different categories: Business management, Process management, Knowledge management, Information management, Software management, and Data management.

Examples of interoperability issues are:

- Link enterprise points of view in order to define a decisional structure of the networked organisation.
- Definition of collaborative business processes.
- Product knowledge sharing within product life cycle phases
- Integrate applications, implemented with different technologies and executed on different platforms.
The purpose of Interoperability profiles is to guide users in selecting the appropriate solution to solve interoperability issues.

*Solution* and *Interoperability issue* are the core concepts.

*Context element* represents the mapping between the issues and the solutions.

As standards are governing the selection of solutions, the corresponding *Standard* concept should be included.

In addition an Interoperability profile should provide a user guide and other means (such as form templates) to support the users.
The figure above describes the entire process followed for the definition of the Business Interoperability Profiles in four steps:

Step 1: Various case studies have been conducted within and outside the ATHENA project.

Step 2: After that stage seven Business Interoperability Profiles have been identified to cover a fairly large portion of interoperability issues.

Step 3: This grouping of Interoperability Issues has led to the identification of a dedicated technical approach that is required to implement the desired level of business interoperability.

Step 4: By knowing what needs to be done on a technical level, it is possible to determine general technical Interoperability Solutions that are applicable.
Learning Game Placeholder

Learning Game: Choices
Title: Choices
Learning Game Placeholder

Learning Game: Sequence
Title: Sequence
Learning Game Placeholder

Learning Game: Word Quiz
Title: Word Quiz