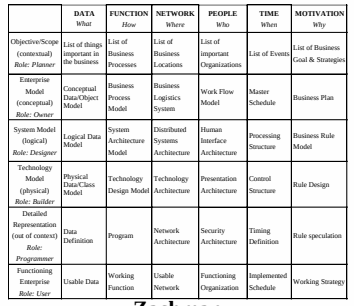
Mapping and Integration of Architecture and Modelling Frameworks

Qing Li*, Bohang Liang*, Zhixiong Fang*

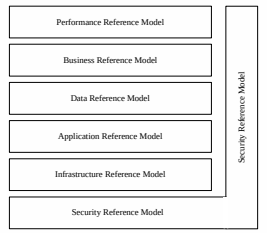
**Department of Automation, Tsinghua University, Beijing 100084, China*
(Tel: +86-10-62771152; e-mail: liqing@tsinghua.edu.cn)

1. Introduction

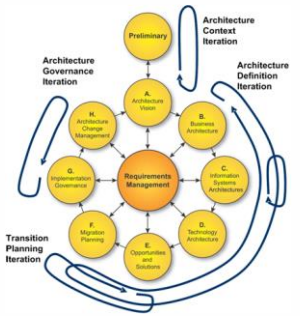
- Architecture, methodology and modelling methods are effective ways to analyse systems, software and enterprises (SSE).
- Experts from different professional domains developed a set of significant Architecture Frameworks.
  - Zachman Framework, CIM-OSA, PERA, ARIS, GERAM, FEAF, DoDAF, TOGAF, IMPACS, UAF
- Many of them have some extended version when applied in different fields.
  - Base on DoDAF, many organization develop their own extended defense-based architecture framework: MODAF (developed by the UK Ministry of Defence), NAF (NATO defense standrad), AGATE (the France DGA Architecture Framework).
  - TEAF (Treasury Enterprise Architecture Framework, based on Zachman Framework)



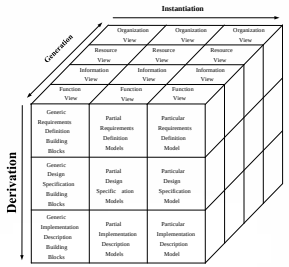
Zachman Framwork



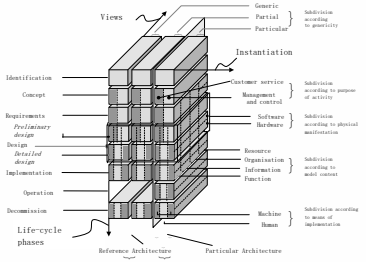
Federal Enterprise Architecture Framework



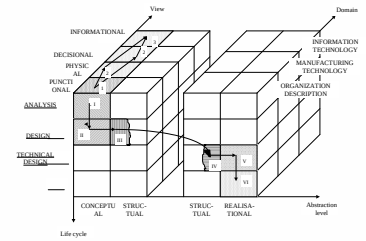
TOGAF



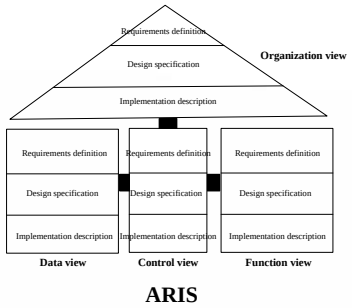
CIM-OSA



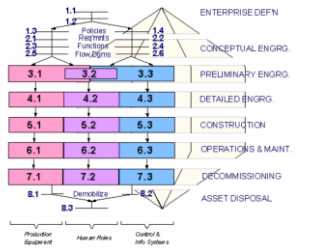
GERAM



IMPACS



ARIS



PERA

. . .

Figure 1: The major existing schemes of system architecture

1. Introduction

- International standards such as ISO 15704, 19439, 19440, and 42010 were published to identify requirements for models, establish modelling framework and modelling methodology respectively.
- In addition to systems, software, enterprises (SSE) architecture, modelling methods and languages develop very quickly in order to satisfy the demanding analysis requirements for complex systems.
  - IDEF, UML, DFD, ERD, EPC, BPMN, UPDM, BPEL, Gellish, SoaML, ESL, AADL, Petri net, ArchiMate, SysML.
- Currently, industrial design and development is facing an important mode-change, which is that model-based systems engineering (MBSE) is replacing Traditional/Text-based Systems Engineering (TSE).
- More and more system development projects include different architecture, methodologies and modelling methods. How to integrate these architecture, methodologies and modelling methods becomes a big challenge.
  - This paper presents a General Architecture Framework (GAF) and a relative General Modelling Framework (GMF).
  - The paper also discusses the mapping and integration relationship between GAF, GMF with mainstream architecture and modelling frameworks.

2. General Architecture Framework And General Modelling Framework

- General architecture framework(GAF) is a stepwise framework of three dimensions.
- General modelling framework includes several modelling methods to describe different views.
- FEAF is introduced into to form the basis of GAF analysis, design and implementation framework.

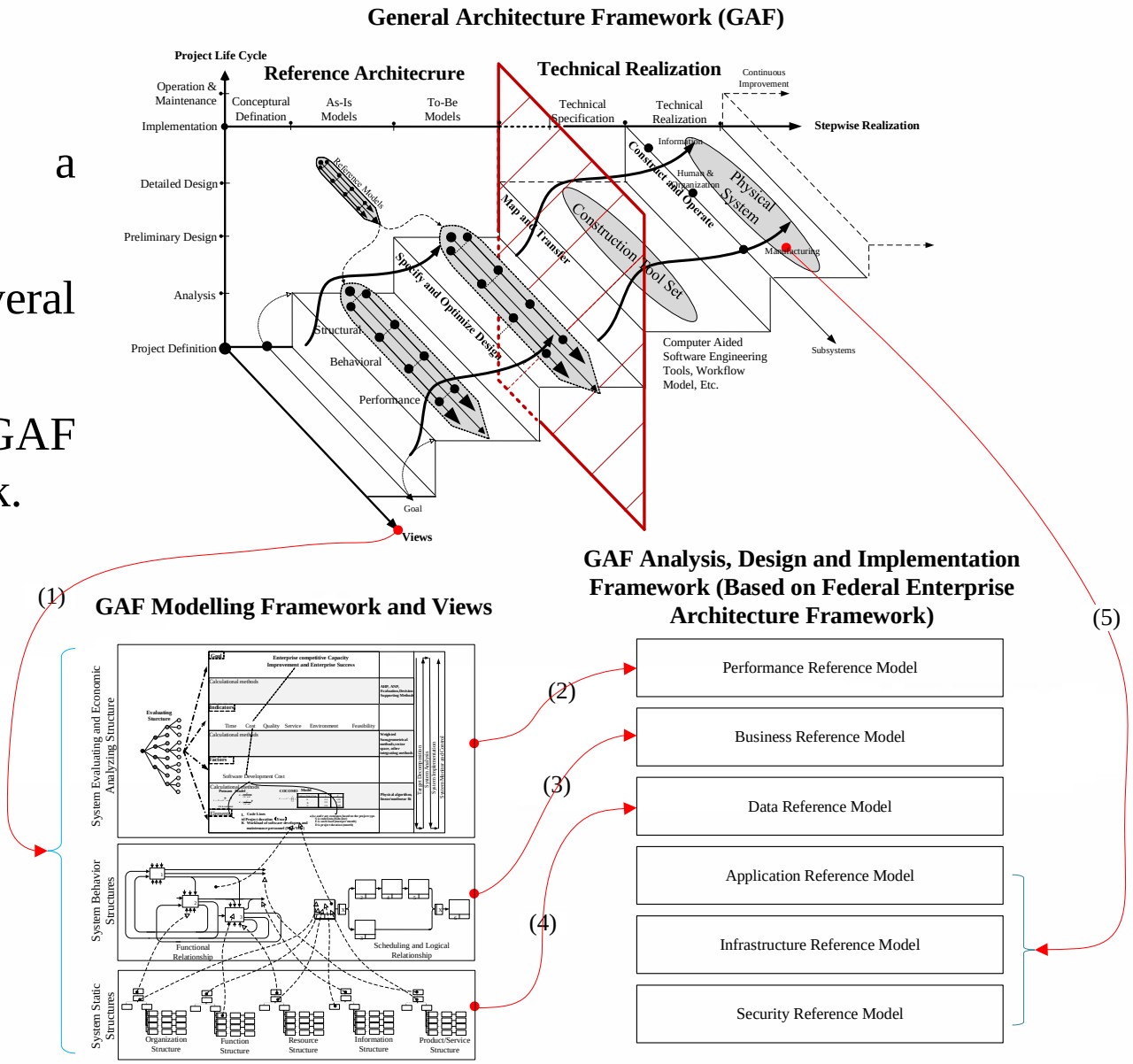


Figure 2: General architecture framework and general modelling framework

2. General Architecture Framework And General Modelling Framework

- Three dimensions of GAF
  - The view dimension includes different views describing the structure of the system.
  - The lifecycle dimension starts from project definition and ends up with operation & maintenance.
  - The realization dimension reflects how to use the methodology of the architecture in different stages.
- The main features of GAF
  - The identification and construction of the system are gradually evolving.

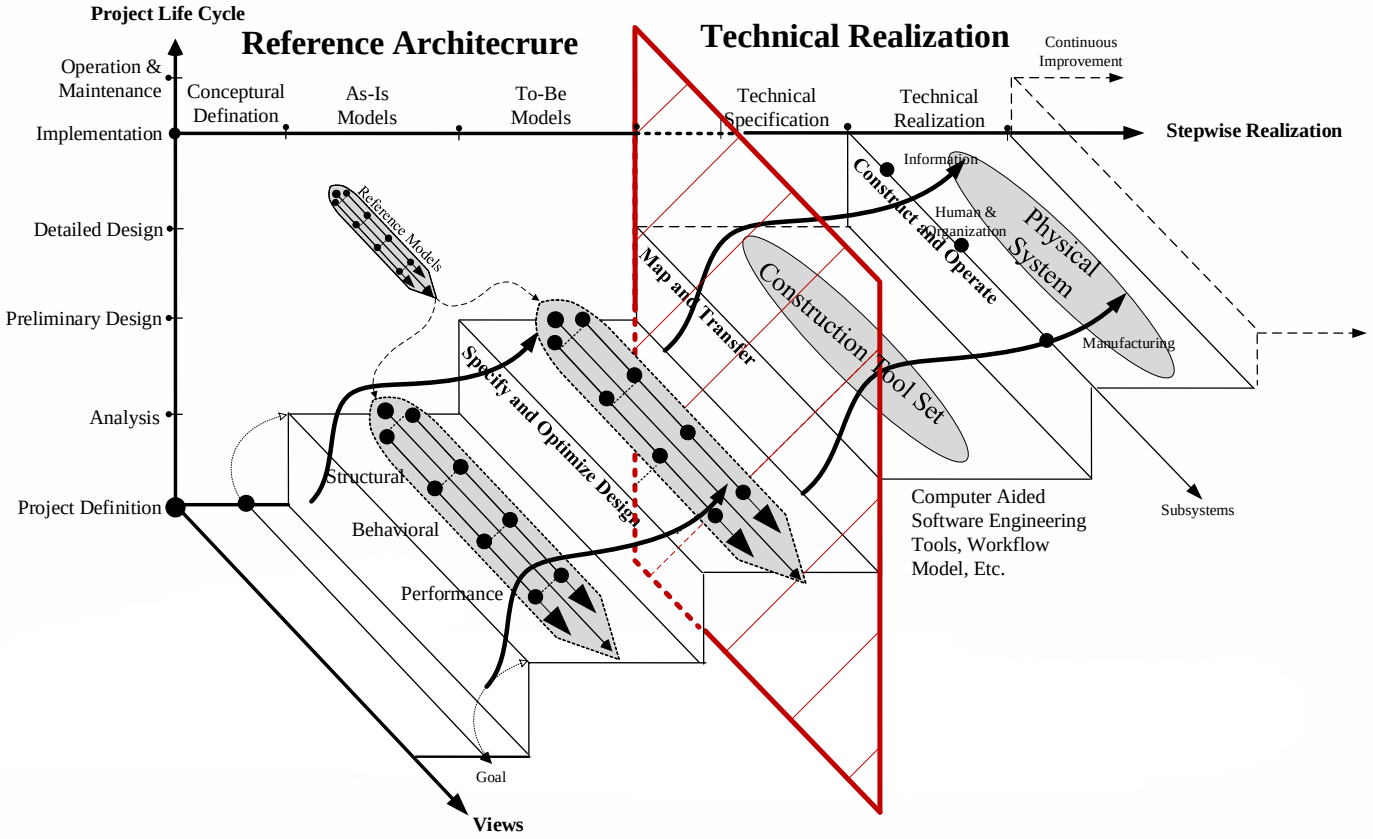


Figure 3: General architecture framework

2. General Architecture Framework And General Modelling Framework

- GMF describes three structures of the system
  - The system static structure answers the question of what the system is with models of organization, function, resource, information and product/service.
  - The system behavior structure answers the question of how the system runs with models describing functional, sequential and logical relationship.
  - The performance & evaluation structure answers the question of what the target of the system.

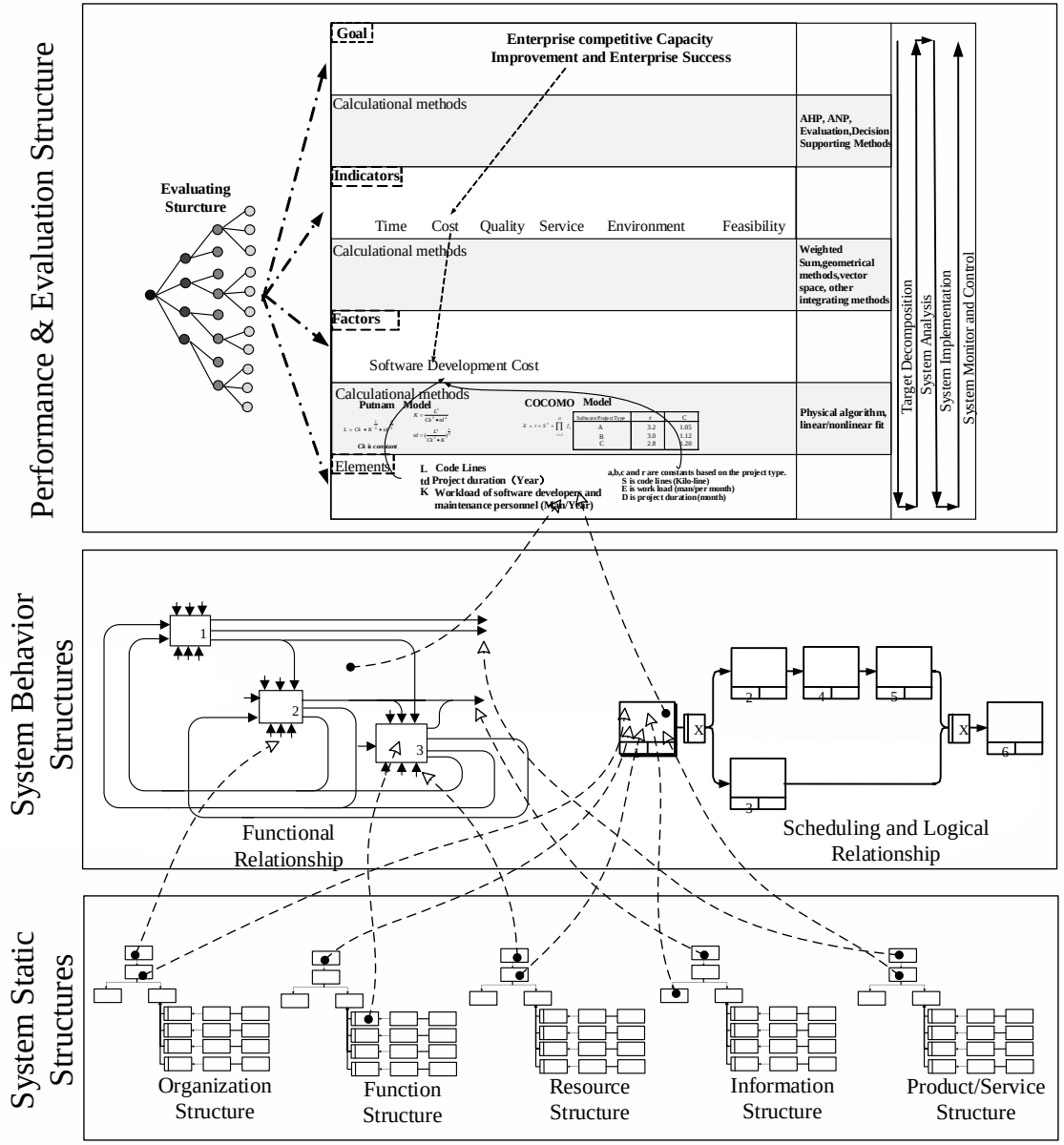


Figure 4: General modelling framework

2. General Architecture Framework And General Modelling Framework

- FEAF is introduced into GAF to form the basis of GAF analysis, design and implementation framework
  - Analyze the performance of the system
  - Design a business model to meet performance requirements
  - Explain what data is needed in business process
  - Implement the above design, including developing application, deploying infrastructure and establishing security management methods

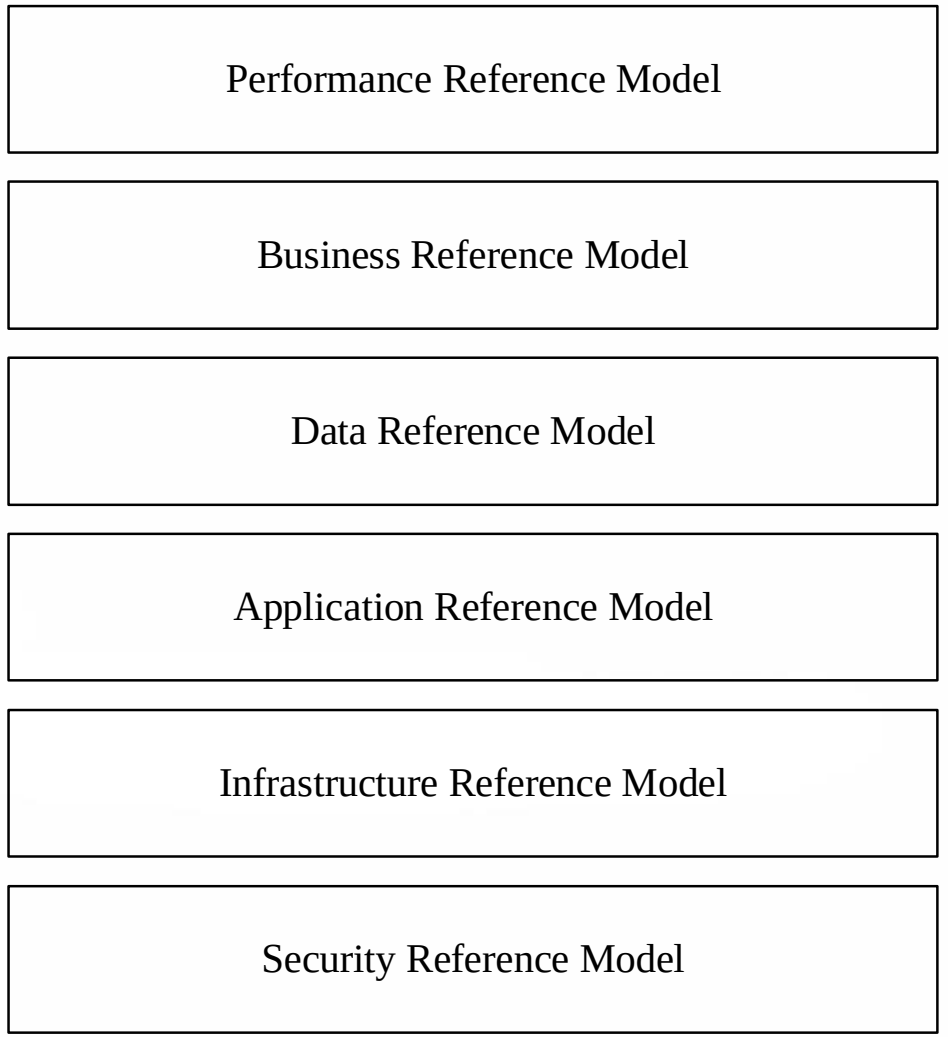


Figure 5: Federal Enterprise Architecture Framework 2.0

3. Mapping Between GAF and other Architectures

- Four mainstream architecture frameworks are introduced.
  - CIM-OSA includes 3 dimensions of generation, derivation and instantiation.
  - FEAF includes 6 reference views of performance, business, data, application, infrastructure and security.
  - GERAM includes 3 dimensions of lifecycle, views and instantiation.
  - Zachman Framework includes 2 dimensions of views and roles.
- These architectures can be mapped to GAF.
- There is also a mapping relationship in these mainstream architectures.

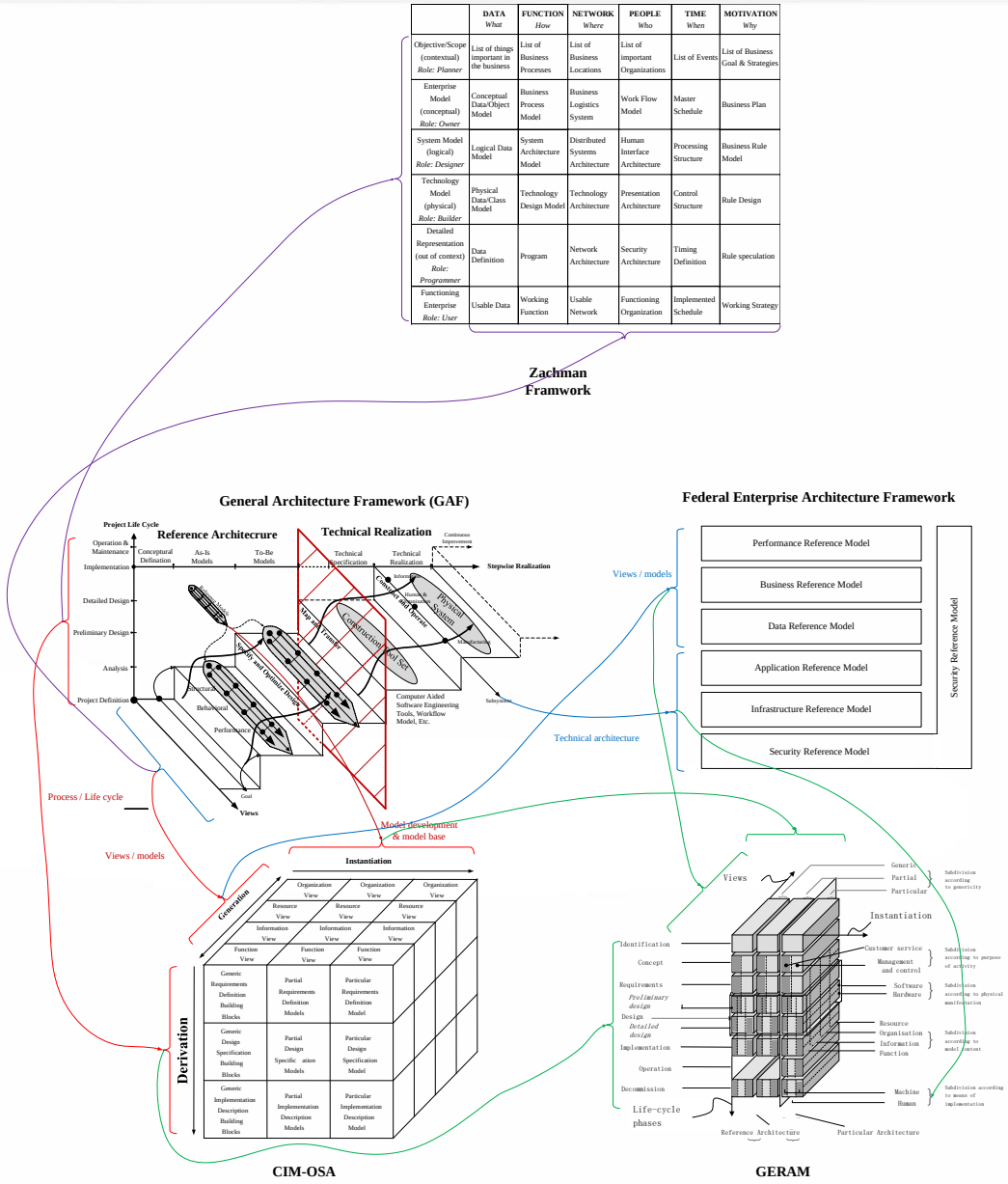
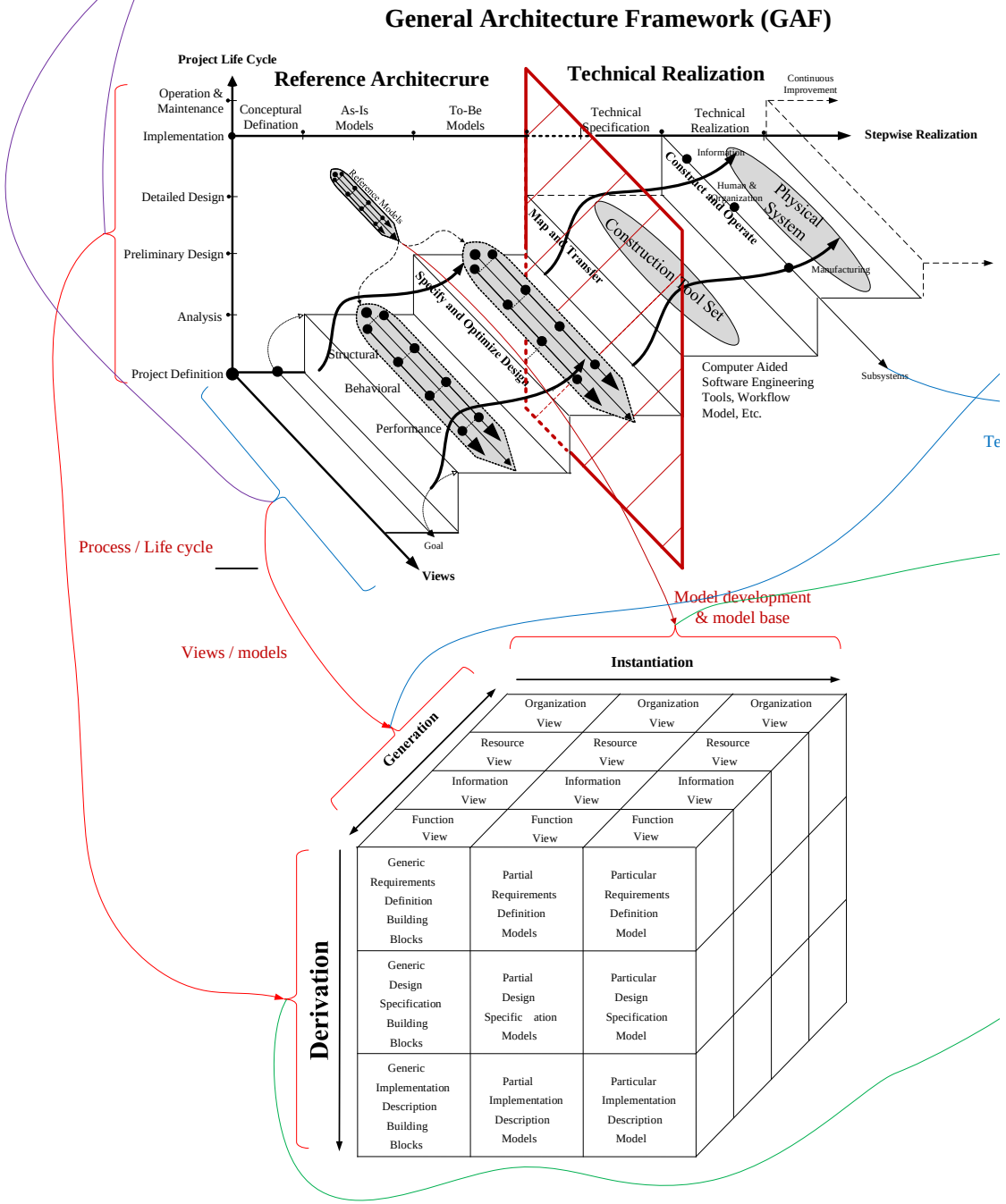
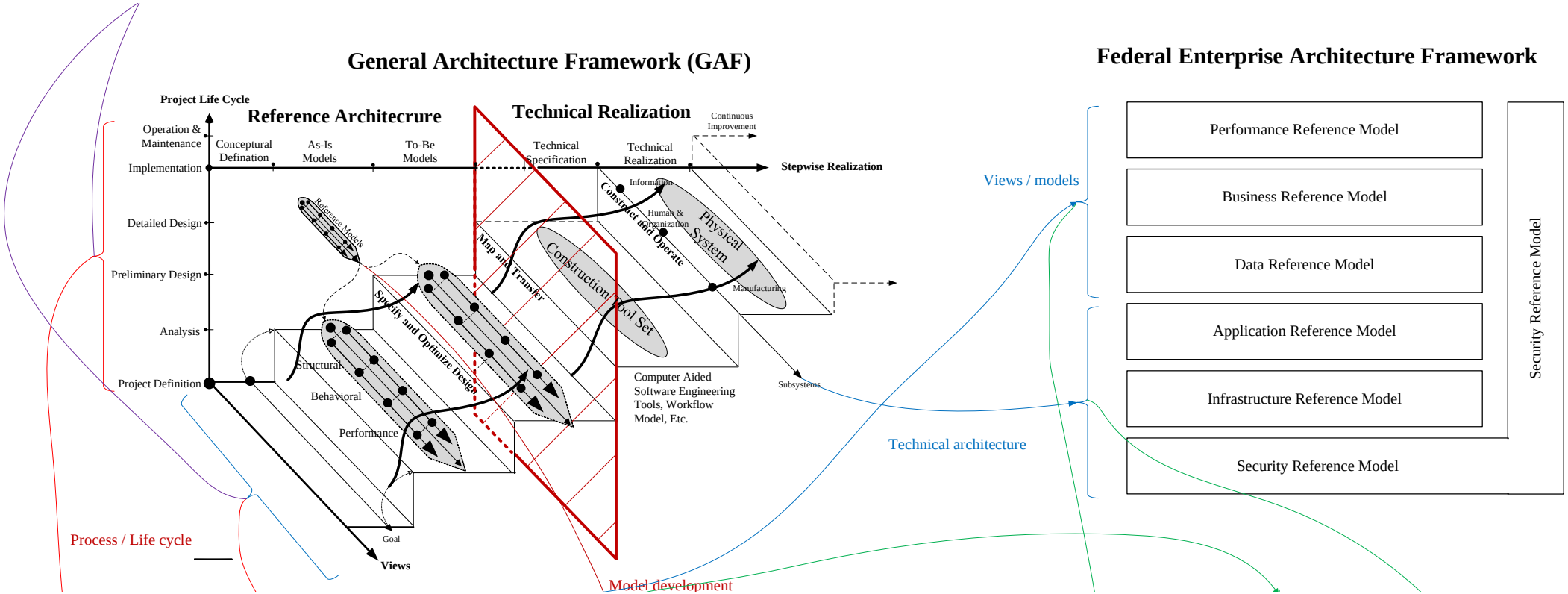


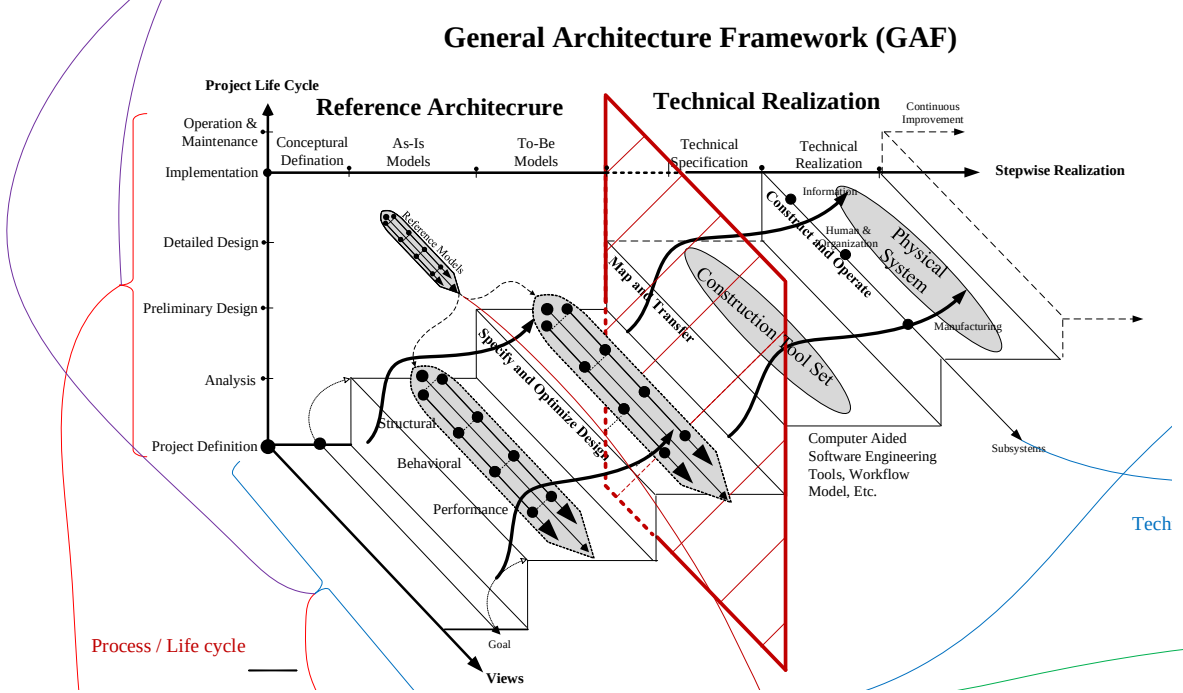
Figure 6: Mapping between GAF and other architecture

- Mapping relationship between CIM-OSA and GAF
  - The generation dimension of CIM-OSA describes four views in GAF.
  - The derivation dimension can be related to the front part of GAF's lifecycle.
  - The instantiation dimension shows the same idea about how to construct reference models in the realization dimension of GAF.

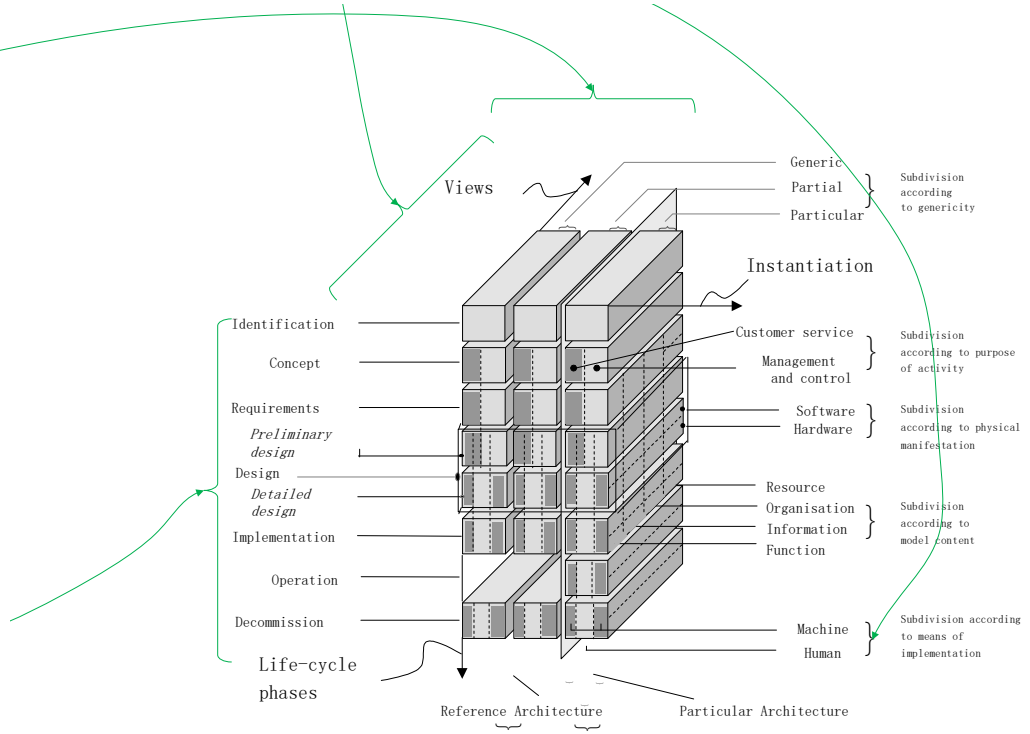




- Mapping relationship between FEAF and GAF
  - The top 3 layers of FEAF are directly related to GAF's modelling framework.
  - The left 3 layers of FEAF are related to the right part of GAF's realization dimension.



- Mapping relationship between GERAM and GAF
  - They have a similar lifecycle dimension and a similar view dimension.
  - The instantiation dimension is related to reference model in GAF.



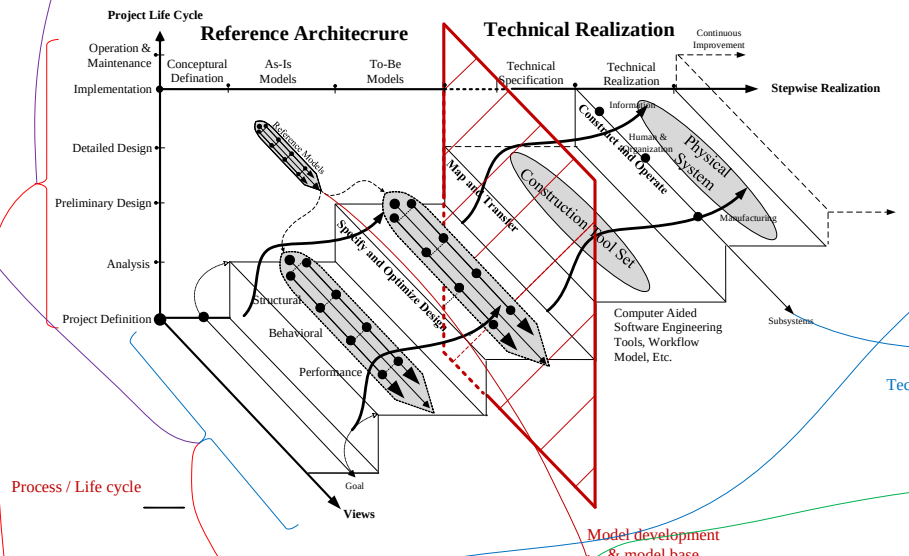
GERAM

- Mapping relationship between Zachman Framework and GAF
  - Zachman Framework's view dimension is related to GAF's view dimension.
  - Zachman Framework's different roles can be related to GAF's different lifecycle stages.

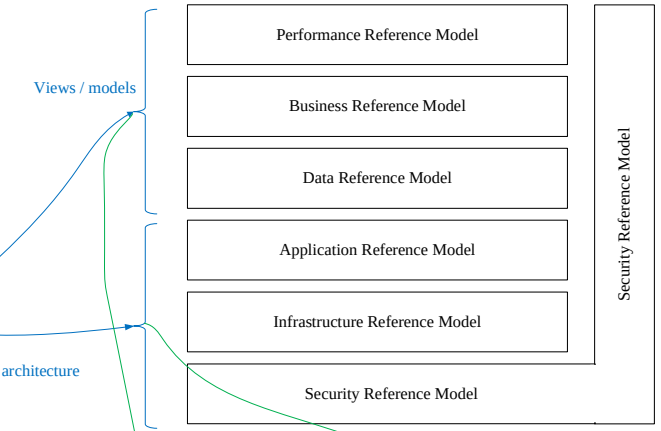
	DATA *What*	FUNCTION *How*	NETWORK *Where*	PEOPLE *Who*	TIME *When*	MOTIVATION *Why*
Objective/Scope (contextual) *Role: Planner*	List of things important in the business	List of Business Processes	List of Business Locations	List of important Organizations	List of Events	List of Business Goal & Strategies
Enterprise Model (conceptual) *Role: Owner*	Conceptual Data/Object Model	Business Process Model	Business Logistics System	Work Flow Model	Master Schedule	Business Plan
System Model (logical) *Role: Designer*	Logical Data Model	System Architecture Model	Distributed Systems Architecture	Human Interface Architecture	Processing Structure	Business Rule Model
Technology Model (physical) *Role: Builder*	Physical Data/Class Model	Technology Design Model	Technology Architecture	Presentation Architecture	Control Structure	Rule Design
Detailed Representation (out of context) *Role: Programmer*	Data Definition	Program	Network Architecture	Security Architecture	Timing Definition	Rule speculation
Functioning Enterprise *Role: User*	Usable Data	Working Function	Usable Network	Functioning Organization	Implemented Schedule	Working Strategy

Zachman Framwork

General Architecture Framework (GAF)



Federal Enterprise Architecture Framework



Views / models

Technical architecture

Process / Life cycle

Model development & model base

4. Mapping Between GMF and other Modelling Architectures

- Models in the analysis and design stage of FEAF 2.0 can be mapped to GMF directly. They have the same hierarchical structure.
  - The bottom three layers of FEAF 2.0 are related to technical realization, they are mapped to SSE realization of GAF.
  - Data reference models are part of System Static Structure.
  - Business reference models are related to enterprise behavior.
  - Performance reference models are mapped with Performance & Evaluation Structure.

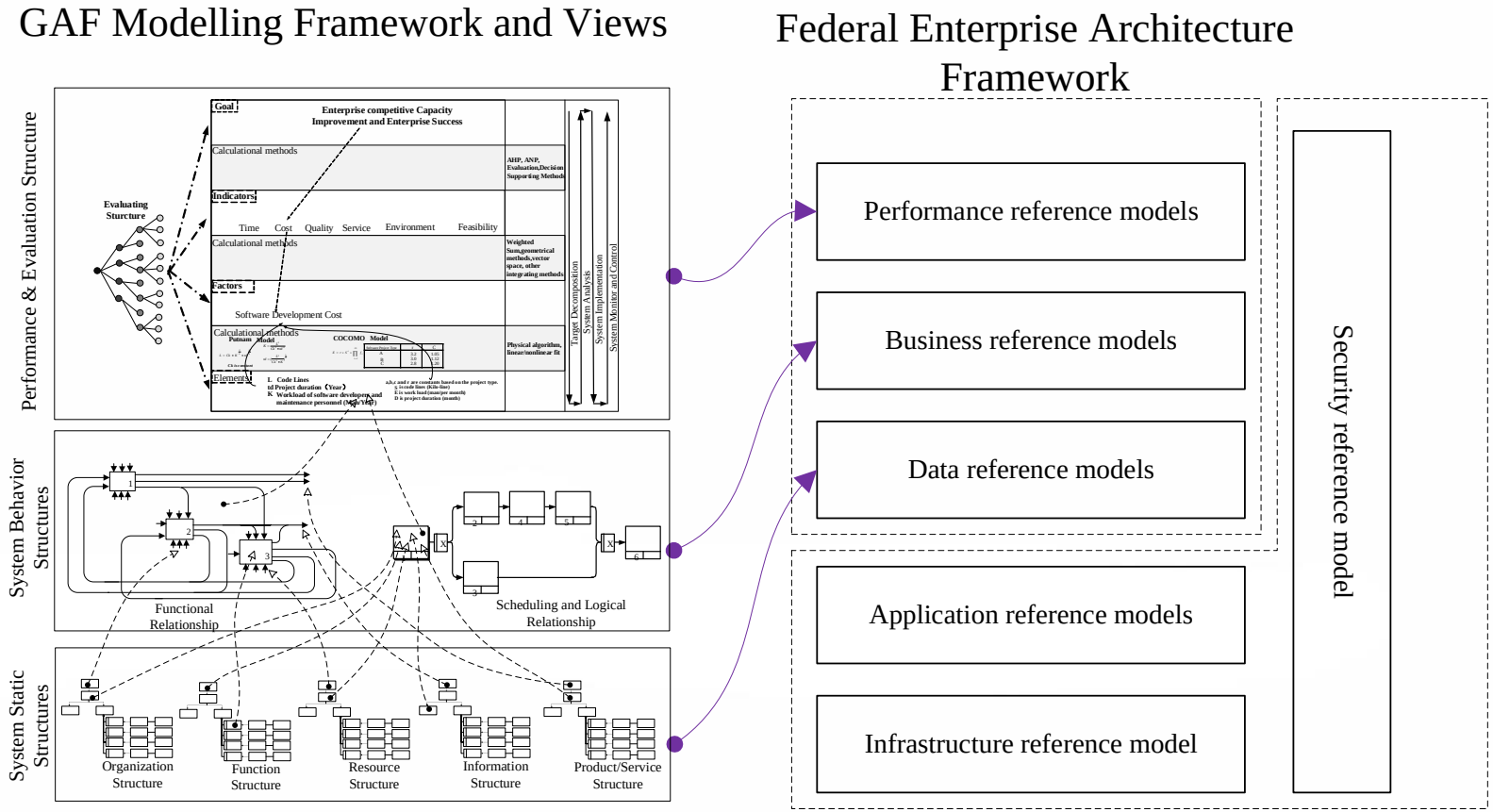
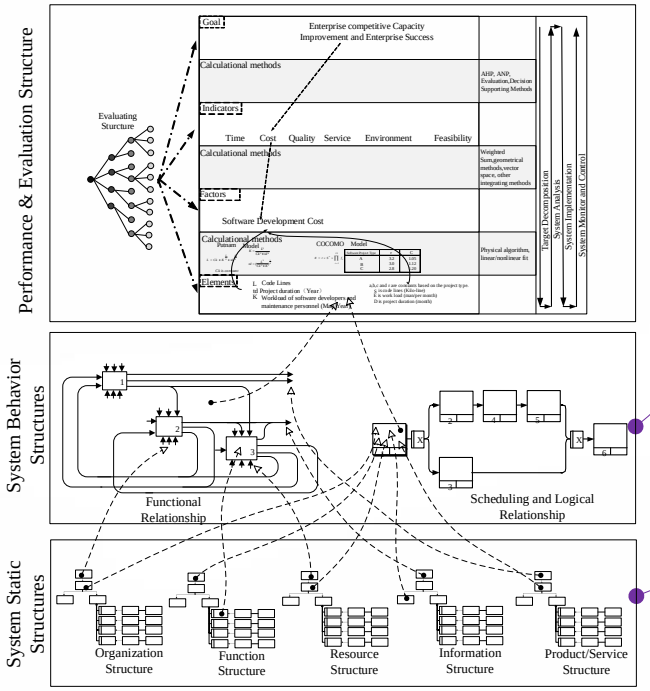


Figure 7: GMF and FEAF 2.0

4. Mapping Between GMF and other Modelling Architectures

- UML divided its diagrams into two parts: Structure Diagram and Behaviour Diagram.
  - Both the GMF and UML model system contain views of structure and behaviour.
  - The GMF emphasizes the importance of performance modelling.

GAF Modelling Framework and Views



UML2.4 Framework

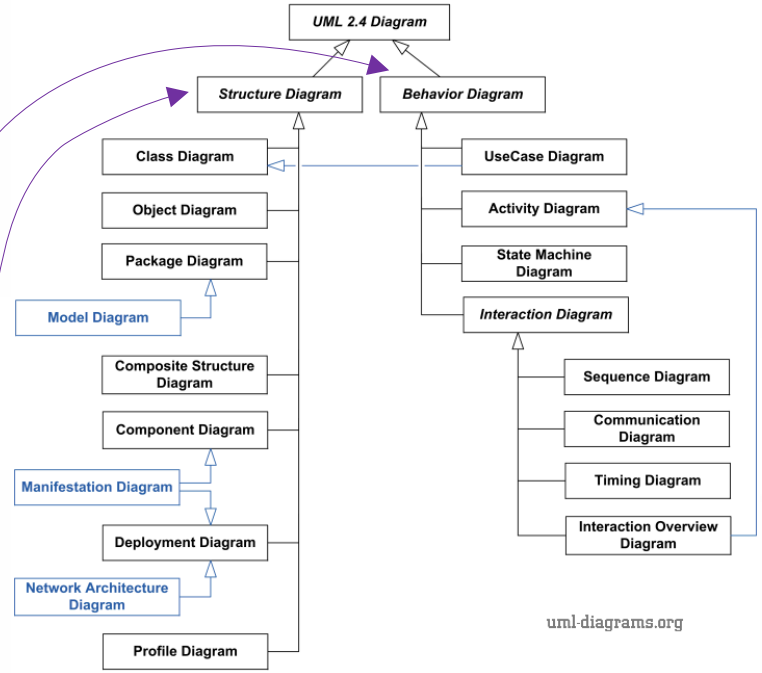


Figure 8: GMF and UML

4. Mapping Between GMF and other Modelling Architectures

- SysML is developed based on UML
  - There are two new diagrams: Requirement Diagram and Parametric Diagram, which are related to the performance of the system.
  - SysML has also modified several UML diagrams such as Block Definition Diagram and Internal Block Diagram, in order to better describe the structure of the system.
- The GMF is consistent with the SysML model framework.

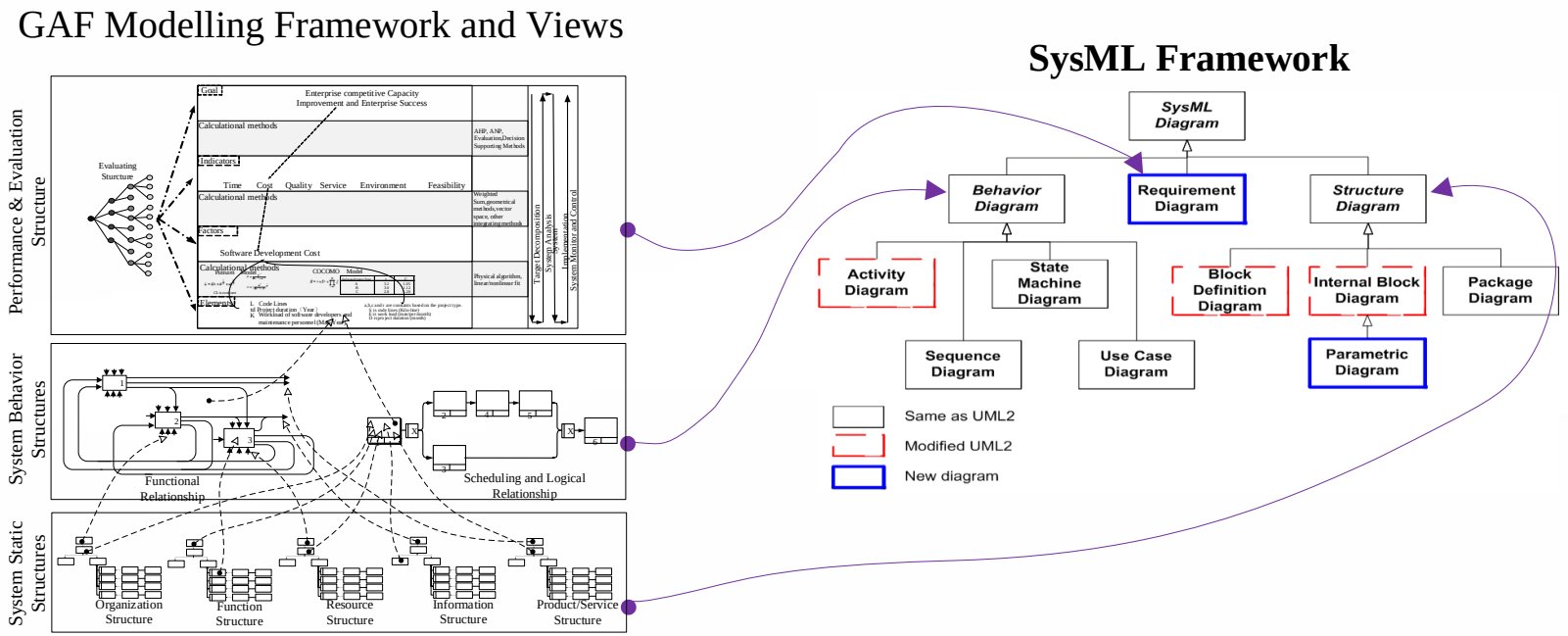
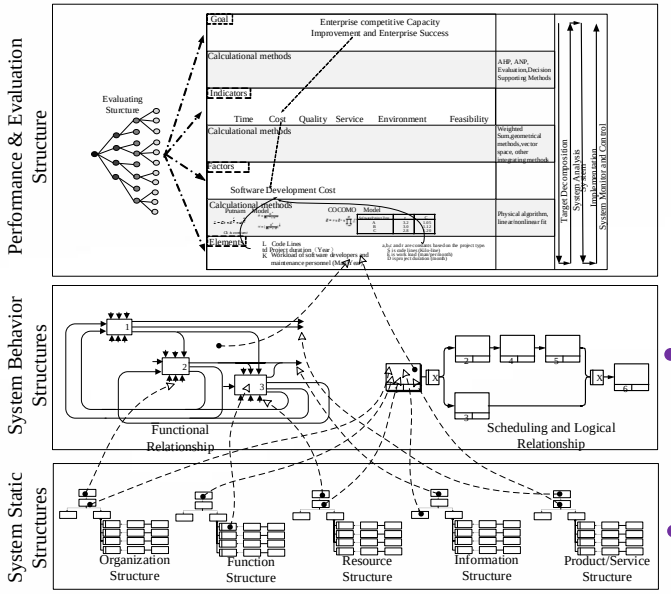


Figure 9: GMF and SysML

4. Mapping Between GMF and other Modelling Architectures

- The core layers of ArchiMate has three layers: Business layer, Application layer and Technology layer.
  - related to FEAF 2.0 business reference models, application reference models and infrastructure reference models.
- ArchiMate includes three aspects.
  - Active structure and Passive structure are related to static structure view of GMF.
  - The behaviour aspect related to behaviour view in GMF

GAF Modelling Framework and Views



ArchiMate Core Framework

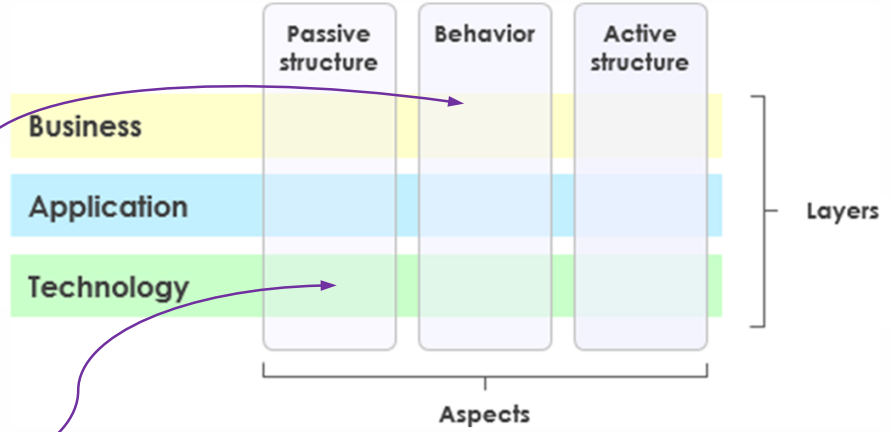


Figure 10: GMF and ArchiMate

5. Conclusions

- This paper presents the general architecture framework (GAF) and relative general modelling framework (GMF). GAF includes following features:
  - The division and relationships of views: GAF includes three layers and seven views, which presents a new consideration to the organization of enterprise model views.
  - Performance evaluation view: performance evaluation view identifies the development and optimization direction of SSE integration, and its corresponding modelling and analyzing methods support enterprise re-engineering and continuous improvement The GMF emphasizes the importance of performance modelling.
  - Model-based systems engineering (MBSE): continuous system evolvement from the As-Is model to the To-Be model is the key methodology of GAF, which is an important MBSE approach for system integration.
- Mapping between GAF and other architecture is also discussed, as well as mapping between GMF and SSE modelling methods sets.
- GAF can be used to organize model based SSE engineering projects and GMF can be used to manage modelling tasks and relative models.

Thank you!