

SOFTWARE REQUIREMENT SPECIFICATION (v. 0.9)

Personalized Learning Assistant

Software System for Adaptive and Personalized Learning



January 2022

DUE DATES

	Scope of AD	Due Date	Length Limit
Interim Report	Chapters 1~4	1/20(Th) 9pm	30± Pages
Pre-Final Report	Chapter 5	2/06(Sun) 9pm	50± Pages
Final Report	Chapters 6~7	2/21(Mon) 9pm	70± Pages

CEP INSTRUCTOR

Soo Dong Kim, Ph.D.

Professor, School of Software

Soongsil University, Seoul, Korea

sdkim777@gmail.com 010-7392-2220

삼성전자 첨단기술연수소

TABLE OF CONTENTS

1. Purpose of the Document.....	3
2. Comprehensive Evaluation Project (CEP)	3
2.1. About Associate Architect (AA) Program.....	3
2.2. How is the CEP problem prepared?	3
2.3. Architecture Design Reports in CEP.....	4
2.4. Template for Architecture Design.....	4
3. Overview of the Target System	6
3.1. Conventional Learning Courses	6
3.2. What is Personalized Learning?.....	6
3.3. What is Personalized Learning Assistant system?	8
3.4. Benefits of Personalized Learning Assistant	8
3.5. Deployment of the Target System	8
4. Functional Requirements	9
4.1. Learning Program Management.....	9
4.2. Course Management	9
4.3. Offering Management	9
4.4. User Profile Management	9
4.5. Conducting Offering with Personalization.....	10
4.6. Optimizing 'Personal Learning Recommendation Model'	11
4.7. Achievement Report Generation.....	11
5. Non-Functional Requirements	12
5.1. NFR-1. High Effectiveness of Personalized Learning	12
5.2. NFR-2. High QoS of the Cloud Service	12
6. Guidelines for Conducting CEP.....	13
6.1. Guidelines for Designing the Architecture	13
6.2. Guidelines for Submitting Reports	14
6.3. Evaluation Form for CEP Reports.....	14

Personalized Learning Assistant

1. Purpose of the Document

The purpose of this document is to specify the requirement for developing the target system in this CEP. The requirement will become the basis for designing the software architecture of a target system, which is required as a fulfillment to acquire the Samsung Associate Architect (AA) certification.

2. Comprehensive Evaluation Project (CEP)

2.1. About Associate Architect (AA) Program

Associate Architect Program of Samsung Electronics is to provide participants with two sets of software architecture design proficiency.

- ❑ **Body of Knowledge (BoK) on Software Architecture**

This set includes the fundamental theories and methods for designing SW architecture

- ❑ **Skillset for Designing SW Architecture**

This set includes the practical skill for applying architecture design methods to a given SRS.

CEP is designed to fulfill the second set of AA program through an individual design project.

2.2. How is the CEP problem prepared?

The CEP problem is prepared by the instructor, based on the following principles.

- ❑ **Principle 1. Utilizing the Whole BOK of Software Architecture Design**

- Utilizing Architecture Styles
- Designing Architecture for multiple Views
- Designing Architecture for Non-Functional Requirements

- ❑ **Principle 2. Handling the Complexity of Industrial Systems**

The target system to design in CEP is an industry-level complex software system, i.e., not an academic problem appeared in books or literature.

- ❑ **Principle 3. Solution Not Available in Public**

CEP problem is not a reproduction of already existing exercise problem in books, and hence the architecture design solution for the CEP problem is not available in public.

2.3. Architecture Design Reports in CEP

Each participant designs and submits the design of software architecture for the target system in incremental manner.

- Interim Report
This report includes the context analysis model and the skeleton architecture design of the target system.
- Prefinal Report
This report includes the architecture design for multiple views of the system; functional view, information view, behavior view, and deployment view.
- Final Report
This report includes the architecture design for non-functional requirements and the validation of the architecture design.


□ Weight Distribution of CEP Reports

Interim Report	Prefinal Report	Final Report	TOTAL
30 points	30 points	40 points	100 points

2.4. Template for Architecture Design

A template for designing the software architecture in CEP is provided and hence participants can utilize the template in specifying the architecture design. The template is devised to be consistent with the architecture design methodology provided by the instructor.

❑ Table of Contents for CEP Report

Associate Architect Program, 2021-A5 Comprehensive Evaluation Project (CEP)		SAMSUNG Sample Solution / FINAL																	
<p>Architecture Description</p> <p>PHOTO ARCHIVAL AND SEMANTICS SERVICE (PASS)</p> <p>Service for Photo Archival and Semantic Analysis</p>  <p>December 2021</p> <p>Revision History</p> <table border="1"> <thead> <tr> <th>Version</th> <th>Date</th> <th>Author</th> <th>Revisions Made</th> </tr> </thead> <tbody> <tr> <td>0.8</td> <td>11/04(Th) 9pm</td> <td>김수동</td> <td>(Interim) Defining the Skeleton Architecture</td> </tr> <tr> <td>0.9</td> <td>11/14(Sun) 9pm</td> <td>김수동</td> <td>(Pre-final) Designing Architecture with Viewpoints</td> </tr> <tr> <td>1.0</td> <td>11/29(Mon) 9pm</td> <td>김수동</td> <td>(Final) Architecture with All Activities Applied</td> </tr> </tbody> </table> <p>삼성전자 첨단기술연구소</p> <p>Architecture Description Photo Archival and Semantics Service (PASS) 1 / 97 Soo Dong Kim</p>		Version	Date	Author	Revisions Made	0.8	11/04(Th) 9pm	김수동	(Interim) Defining the Skeleton Architecture	0.9	11/14(Sun) 9pm	김수동	(Pre-final) Designing Architecture with Viewpoints	1.0	11/29(Mon) 9pm	김수동	(Final) Architecture with All Activities Applied	<p>TABLE OF CONTENTS</p> <p>1. INTRODUCTION 5</p> <p>1.1. Purpose of the Document 5</p> <p>1.2. System of Interest 5</p> <p>1.3. Definitions, Acronyms, and Abbreviations 6</p> <p>1.4. References 8</p> <p>1.5. Process applied to Architecture Design 8</p> <p>1.6. Template used for Architecture Description 10</p> <p>2. ACTIVITY 1. ARCHITECTURAL REQUIREMENT REFINEMENT 11</p> <p>2.1. [Step 1] Identify Stakeholders 11</p> <p>2.2. [Step 2] Refining Functional Requirements 12</p> <p>2.3. [Step 3] Architectural Concerns 12</p> <p>2.4. [Step 4] Refine Non-Functional Requirements 14</p> <p>2.5. [Step 5] Write Refined Software Requirement Specification 14</p> <p>3. ACTIVITY 2. SYSTEM CONTEXT ANALYSIS 15</p> <p>3.1. [Step 1] System Boundary Context 15</p> <p>3.1.1. Context Diagram 15</p> <p>3.1.2. Description of Context Diagram 16</p> <p>3.2. [Step 2] Functional Context 17</p> <p>3.2.1. Use Case Diagram for the System 17</p> <p>3.2.2. Description of Use Cases 21</p> <p>3.3. [Step 3] Information Context 21</p> <p>3.3.1. Class Diagram for the System 21</p> <p>3.3.2. Description of Classes 23</p> <p>3.4. [Step 4] Behavioral Context 23</p> <p>3.4.1. Activity Diagram for PASS Client Tier 25</p> <p>3.4.2. Activity Diagram for PASS Server Tier 26</p> <p>3.4.3. Description of the Diagrams 26</p> <p>3.5. [Step 5] Additional Contexts 26</p> <p>4. ACTIVITY 3. SKELETON ARCHITECTURE DESIGN 27</p> <p>4.1. [Step 1] Observation on Architectural Characteristics 27</p> <p>4.2. [Step 2] Candidate Architecture Styles 27</p> <p>4.3. [Step 3a] Evaluating Client-Server Architecture Style 28</p> <p>4.3.1. Evaluating the Situation 28</p> <p>4.3.2. Evaluating the benefits 28</p> <p>4.3.3. Evaluating the Drawbacks 28</p> <p>4.3.4. Summary of the Applicability 28</p> <p>4.4. [Step 3b] Evaluating MVC Architecture Style 29</p> <p>4.4.1. Evaluating the Situation 29</p> <p>Architecture Description Photo Archival and Semantics Service (PASS) 2 / 97 Soo Dong Kim</p>	
Version	Date	Author	Revisions Made																
0.8	11/04(Th) 9pm	김수동	(Interim) Defining the Skeleton Architecture																
0.9	11/14(Sun) 9pm	김수동	(Pre-final) Designing Architecture with Viewpoints																
1.0	11/29(Mon) 9pm	김수동	(Final) Architecture with All Activities Applied																

3. Overview of the Target System

Personalized Learning Assistant is a software system that provides effective guidelines for learning given subjects through *personalization*. Personalized learning provides highly effective methods for learning with less effort beyond the conventional lecture-based group learning.

The personalization of the learning process and methods is made by considering the current learning achievement level, strength and weakness of individual trainee. It can be enabled by utilizing advanced machine learning algorithm such as incremental learning or Reinforcement_ learning.

3.1. Conventional Learning Courses

The conventional learning is characterized by in-class lecture by an instructor, group-level learning, and one-way delivery of subject contents, as shown in the following figure.



❑ Characteristics of Conventional Learning

- *Group-level* Education
- *One-way delivery* of subject content, from instructor to all trainees
- *Generic and same* subject content to all trainees
- *Generic and same* learning process and progress to all trainees
- Limited Assessment of trainees' proficiency
 - Lack of Details in Assessment
- Limited Reflection on Individual Achievement level

3.2. What is Personalized Learning?

Personalized Learning is a learning paradigm that remedies the limitations of conventional learning paradigm through detailed assessment of trainees' achievements and personalization

of subject contents and learning process. That is, the strength and weakness of individual trainee are evaluated in detail and the subject content to learn and the learning process are personalized for each trainee based on his or her achievement level. Hence, the personalized education provides the similar learning effectiveness of private tutoring as shown in the following figure.



❑ **Characteristics of Personalized Learning**

- The proficiency of trainee's proficiency is assessed in detail.
- The subject content to study and process are prepared for the specific needs of each trainee.
- Individual Tutoring-like learning in addition to Group Learning
- The effectiveness of the personalized learning applied to each trainee is assessed and reflected in refining the further personalization.
- the assessment result is utilized in refining the personalization model for each trainee.

The personalization of training is applied to the following training contents.

- Subject Content to study
- Process of Learning Activities such as Assignment, Exercise, Laboratory, etc.

3.3. What is Personalized Learning Assistant system?

Personalized Learning Assistant is a cloud service that provides a comprehensive set of functionalities for personalized learning. Users can access the service using a mobile app, web browser, or an OS-specific native app.

3.4. Benefits of Personalized Learning Assistant

The benefits of the system are summarized as the following.

- ❑ **High Effectiveness of Learning**

Trainees are provided with the training contents that meet individual training needs.

- ❑ **High Productivity of Learning**

With personalized training, trainees learn more contents with less effort.

- ❑ **High Proficiency Level**

Trainers are able to acquire a high proficiency in terms of the learning contents and depths.

3.5. Deployment of the Target System

The target system is provided as a cloud service, and hence its cloud server should be deployed in reliable manner.

- ❑ **Personalized Learning Assistant SERVER**

The server provides a whole functionality of the system and maintains the master database.

- ❑ **Personalized Learning Assistant CLIENT**

The system can be used by users through mobile app, web browser, or native application.

4. Functional Requirements

The functionality of the software is classified into functional categories.

4.1. Learning Program Management

A training program specifies the target technology or knowledge discipline which is taught to the registered trainees. The program may consist of lectures, laboratories, assignments, and tests. An example of the training program can be the Associate Architect of Samsung Electronics.

When registering, all the key attributes of training programs should be entered including *program name, program ID, program_start_date, program level, training duration, courses, and offering conditions*.

4.2. Course Management

A training program consists of one or more courses to teach. Each course in a training program covers a cohesive set of detailed topics. For example, the Associate Architect' program consists of multiple sources including OOAD with UML, Design Patterns, Requirement Engineering, Architecture Design, Detailed Design, Architecture Validation, SW Reengineering, and Comprehensive Evaluation Project (CEP).

When registering, all the key attributes of courses should be entered including *course ID, course title, course level, teaching methods, and passing conditions*.

4.3. Offering Management

A program offering is an occurrence of a training program. Hence, a training program can be offered multiple times over the time. For example, the Associate Architect program is offered 12 times a year. Hence, there are 12 program offerings such as AA2019-01, AA2019-02, ... AA2019-12.

When registering, all the key attributes of program offerings should be entered including *offering ID, offering_start_date, maximum number of trainees, minimum number of trainers, and program status*.

4.4. User Profile Management

This functionality is to manage the profiles of various users. When registering, a user enters his/her identification information, contact information, and login information. There are three types of users in this system.

☐ Program Manager as Staff

This is a staff who manages given learning programs.

❑ **Course Manager**

This is a staff who manages courses learning programs.

❑ **Offering Manager**

This is a staff who manages the offerings of courses.

❑ **Instructor**

This is an instructor who provides group-level lecture for course topics.

❑ **Teaching Assistant (TA)**

This is an assistant instructor who helps instructors and personalized learning activities.

❑ **Trainee**

This is a trainee, i.e., who participates in course offerings.

4.5. Conducting Offering with Personalization

This functionality is to apply the whole process of personalized learning, as defined below.

❑ **Step 1. Conduct a group or a personalized lecture on specific topic(s).**

This is to conduct group-level lecture or personalized lecture on selected topics. In the very beginning of the offering, one or more group-level lectures are given. Since then, personalized lecture contents are recommended by the system and provided to each trainee.

❑ **Step 2. Apply personalized learning activities for the given lecture.**

- In-class Exercise
- In-class Laboratory
- Assignment
- Project
- Presentation
- Test

❑ **Step 3. Evaluate the proficiency of trainees through learning activities.**

The performance of trainees' learning activities is evaluated, and the achievement level is computed.

❑ **Step 4. Optimize the 'Personal Learning Recommendation Model'**

Update the recommendation model based on the effectiveness of the learning activities performed. This is to consider the *different effectiveness levels of trainees for a same learning activity* such as assignment or laboratory.

❑ **Step 5. Personalized the further subject content to study and learning activities to apply.**

- Personalizing further subject contents to learn
- Personalizing further learning activities to apply
- ❑ **Step 6. Repeating Steps 1 through 5**
If the achievement level of a given trainee is lower than the passing level, i.e., threshold value, then repeat step 1 through 6.
- ❑ **Step 7. Generate 'Achievement Report' for each Course Offering**
This is to generate a detailed achievement report for each trainee.

4.6. Optimizing 'Personal Learning Recommendation Model'

This functionality is to update the 'Personal Learning Recommendation Model' based on the effectiveness of learning activities performed on given learning topics. This is where an incremental learning algorithm or Reinforcement_ learning can be applied.

4.7. Achievement Report Generation

This functionality is to generate detailed achievement reports for trainees in course offerings. An achievement report includes the whole learning process and learning activities applied and the results of achievement evaluations on learning activities such as assignments and tests.

5. Non-Functional Requirements

There can be several non-functional requirements that are essential in the target system. For CEP, we consider only 2 NFR items.

5.1. NFR-1. High Effectiveness of Personalized Learning

The most unique and noble feature of the system is the ability to personalize the learning contents and activities for each trainee. Hence, the system should be designed to provide the high effectiveness of personalizing the learning contents and activities.

In contrast to conventional group-level lecture, the system should consider all the achievement-related measures of each trainee and reflect them on the personalization. Especially, the learning effectiveness of a given learning activity such as a laboratory should be measured for each trainee and reflected in further personalization.

5.2. NFR-2. High QoS of the Cloud Service

The system should be designed to provide a high QoS as a cloud service on the following quality aspects.

❑ Reliability

The system should always be reliable.

❑ Availability

The system should always be available, not only being alive but also performing well.

❑ Scalability

The system should be scalable for potentially volatile invocation loads by users.

❑ Performance

The system should provide a high performance.

6. Guidelines for Conducting CEP

6.1. Guidelines for Designing the Architecture

Apply the following guidelines for writing CEP Reports.

- ❑ **Conformance to the given SRS**

The submitted AD should conform to the given SRS.

- ❑ **Conformance to UML Standards**

The submitted AD should conform to the notational and usage standards of UML.

- ❑ **Consistency among various Artifacts in AD**

There should be a high consistency among various artifacts (such as diagrams) in the submitted AD.

- ❑ **Comprehensibility of Textual Description**

The textual elaboration of the architecture design should be written in accurate, precise, and condensed way. Hence, the understandability of the AD becomes high. The textual description can be written in English, Korean, or their mixture.

- ❑ **Readability of Figures and Tables**

The figures and tables should be easily readable by applying good formats, right font size and special effects on them. For example, a use case diagram with 100 use cases should be well structured and enlarged if needed.

- ❑ **Reasonable Details of Machine Learning design**

The submitted AD would include a design for managing machine learning models. The description of the machine learning model generation should be written in reasonably details. The description typically includes machine learning algorithms utilized, training sets used, the details for designing the model generation components.

- ❑ **Originality of the AD**

The submitted AD should be an individual work. Any same or highly similar solutions would get a score penalty.

6.2. Guidelines for Submitting Reports

Apply the following guidelines for writing CEP Reports.

☐ Due Dates for Submission

The due dates and times for each CEP report are specified. The CEP reports should be submitted by the due. Late submissions of CEP reports are not accepted.

☐ Format of the CEP Report

Use the word processor, MS Word, for formatting your CEP reports. Submit the word files, not the PDF files.

☐ Submission

Submit your CEP report to the course manager, not to the instructor.

6.3. Evaluation Form for CEP Reports

The following form is used to evaluate the CEP report.

Evaluation of CEP Report		
Name: 홍길동		
Criteria	Max	Earned
Ch.1, Introduction	2	2
Ch.2, (A1) Architectural Requirement Refinement	2	2
Ch.3, (A2) System Context Analysis		
System Boundary Context	3	3
Functional Context	5	5
Information Context	5	5
Behavior Context	5	5
Ch.4, (A3) Skeleton Architecture Design		
Justification of Candidate Architecture Styles	6	6
Integrating Selected Styles into Architecture	2	2
Ch.5, (A4) Architecture with Views		
Applying Functional Viewpoint	8	8
Applying Information Viewpoint	8	8
Applying Behavior Viewpoint	8	8
Applying Deployment Viewpoint	6	6
Ch.6, (A5) Architecture with Quality-driven Design		
Design for NFR #1, Applying Process	8	8
Design for NFR #1, Quality Delivered	7	7
Design for NFR #2, Applying Process	8	8
Design for NFR #2, Quality Delivered	7	7
Ch.7, (A6) Architecture Evaluation		
Intermediate Steps of applying Evaluation	6	6
Correctness of the Evaluation	4	4
CEP Score	100	100
<input type="checkbox"/> Strength		
○		
<input type="checkbox"/> Weakness		
○		