SE 3030 – Software Architecture

Assignment 01 – Service Publisher Subscriber OSGi framework

Submitted by:

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Table of Contents

Introduction

We are implementing a publisher-subscriber program for an Educational Institute Management System using the OSGi framework. This encompasses student management, teacher management, financial management, and timetable management. Users can interact with the system using simple inputs.

```
 _____     __                 __  _                   __   _____            __  _  __        __
/ ____/____/ /_  _____ ____ _/ /_(_)___  ____  ____ _/ /  /  _/ /_  _____   / /_(_)/ /___  __/ /____
```

(``·._.··,.-~*´¨¯¨`*·~-.SELECT AN ACTION.-~*´¨¯¨`*·~-,.··_.·´`)

```
                    1. Student Management
                    2. Teachers Management
                    3. Financial Management
                    4. Timetable Management
                    5. Exit
         -------------------------------------------------------
Enter your choice:
```

Student Management – IT21704970

Student Publisher

The Student Publisher bundle is responsible for managing and providing access to student information within an educational institution. It represents student IDs, names, grades, emails, and contact information.

The StudentService interface declares methods such as:

- Feature to add new students.

- Feature to remove a specific Student.

- Feature to search for students by ID.

- Feature to retrieve all the staff members.

- Feature to retrieve all student records.

- Feature to determine subjects for a specific grade.

- Feature to update specific student details.

The StudentServiceImpl class implements the interface and provides the actual functionality for adding, retrieving, deleting, updating student records, and determining subjects based on grade.

Student Subscriber

The Student Subscriber bundle is designed to receive and utilize student information supplied by the Student Publisher. Its activator class functions as the trigger for starting and stopping the Student Subscriber bundle.

Communication between Publisher and Subscriber:

The OSGi framework enables seamless communication between bundles. The Student Publisher bundle offers its services, while the Student Subscriber bundle utilizes these services. This interaction occurs through clearly defined interfaces, promoting a modular and decoupled system design.

User interaction:

The Student Subscriber bundle offers a user-friendly command-line interface for accessing the student management system. Through this interface, users can seamlessly perform various actions such as adding new students, browsing through the complete list of available students, updating existing student details, and deleting specific student records as needed. This intuitive interface empowers users to interact with the system effortlessly, enhancing their ability to manage student information effectively. Whether it's creating, browsing, updating, or removing student records, the bundle provides a streamlined experience, ensuring users can perform their desired tasks efficiently and with ease.
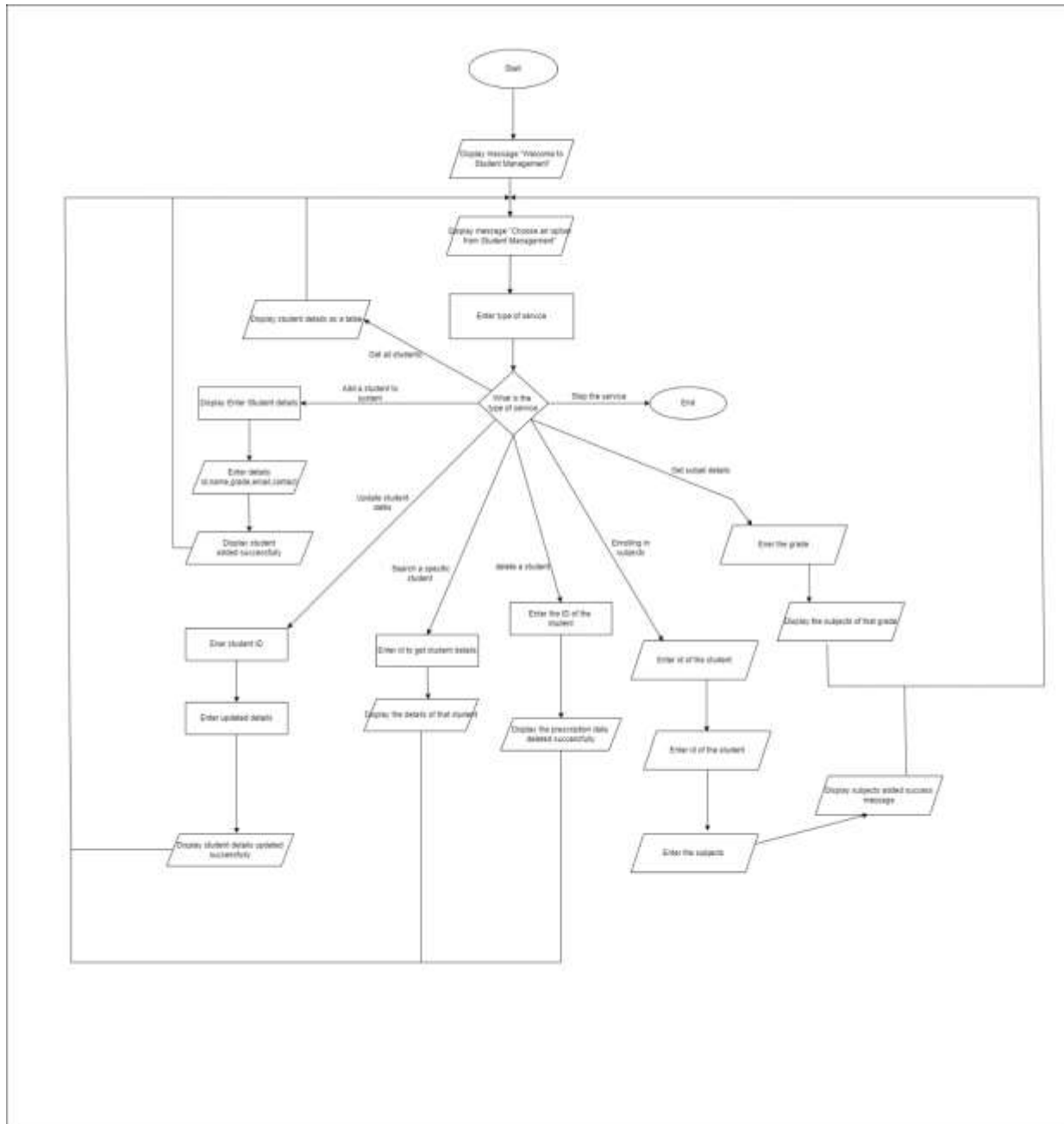
Diagrammatic explanation

Publisher Bundle Manifest:

```
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: StudentPublisher
 4 Bundle-SymbolicName: StudentPublisher
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: studentpublisher.StudentPublisherActivator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-17
 8 Automatic-Module-Name: StudentPublisher
 9 Import-Package: org.osgi.framework;version="1.3.0"
10 Bundle-ActivationPolicy: lazy
11 Export-Package: studentpublisher
12
```

During run time the package is exported:
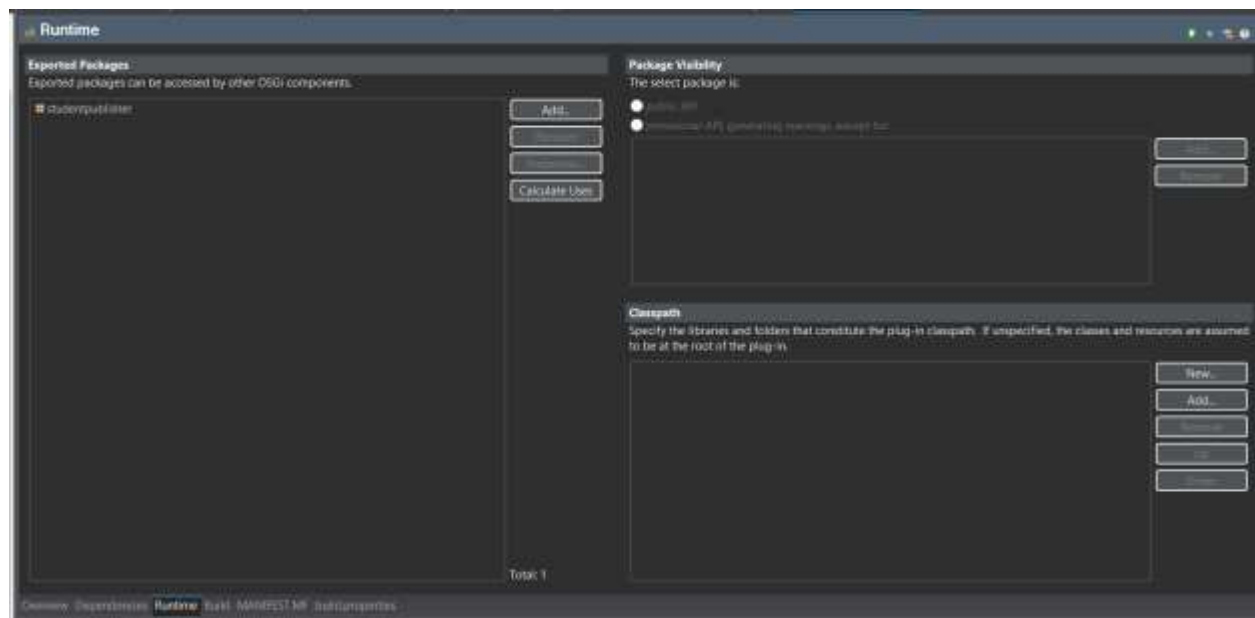
Subscriber Bundle Manifest:

```
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: StudentSubscriber
 4 Bundle-SymbolicName: StudentSubscriber
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: studentsubscriber.StudentSubscriberActivator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-17
 8 Automatic-Module-Name: StudentSubscriber
 9 Import-Package: org.osgi.framework;version="1.3.0",
10  studentpublisher
11 Bundle-ActivationPolicy: lazy
12 Export-Package: studentsubscriber
13
```

Publisher is added/imported as a dependency in the Subscriber bundle:
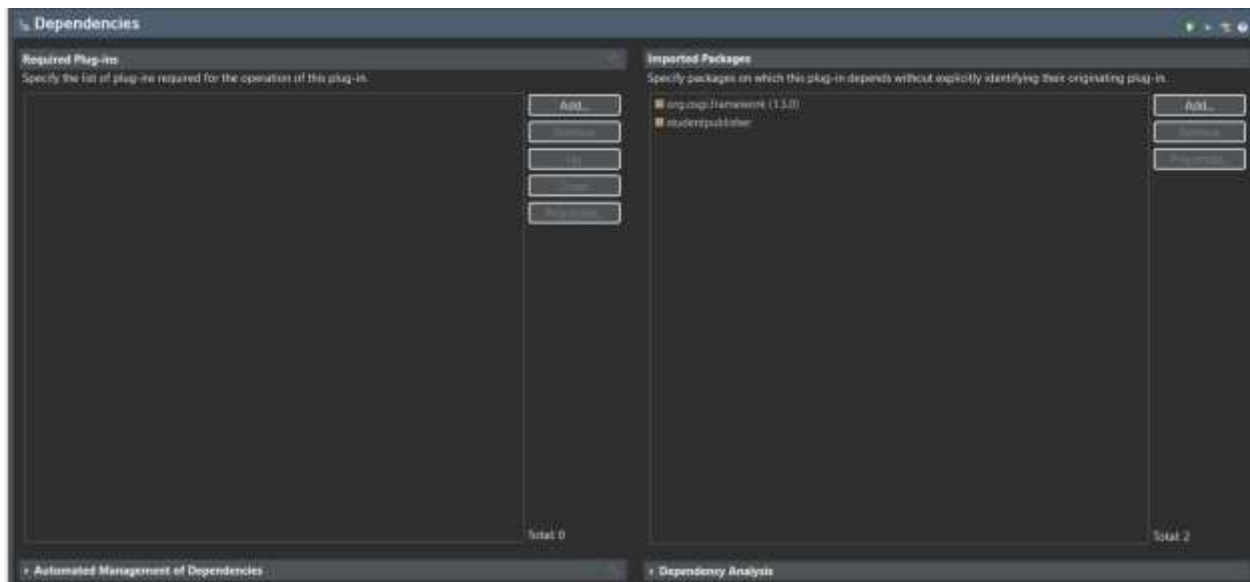
Sample screenshots of its behavior &outputs

```
Student Producer Start
Student Subscriber Start

--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
```

Add Functionality – Add new students to the system

```
Student Producer Start
Student Subscriber Start

--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
Enter your choice: 1

------- Register New Student To System --------
Enter Student's ID: 007
Enter Student's name: Kasun
Enter Student's grade: 10
Enter Student's email: kasun@gmail.com
Enter Student's contact number: 0703159274
Student with ID 007 added Successfully.
```

View All Student details

```
--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
Enter your choice: 2
Student ID      Name               Grade     Email                       Contact
---------------------------------------------------------------------------------
003             pamitha            8         pami@gmail.com              011234567
004             tharuka            11        tharu@gmail.com             025478954
005             nipun              12        nipun@gmailcom              12455666
```

Get specific student details .

```
--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. Quit
Enter your choice: 3

Enter the sID of student to display details
005
Student Details:
ID: 005
Name: nipun
Grade: 12
Email: nipun@gmailcom
Contact: 12455666
```

Validation – If the staff ID does not exist.

```
Problems  @ Javadoc  Declaration  Console ×
studentSubscriber [OSGi Framework] C:\Users\DELL\.p2\pool\plugins\org.eclipse.justj.openjdk.hots
--------------Choose an option from Student Management----------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
Enter your choice: 4

Enter the Student ID of student to Update details
004
Student with ID 004 not found.
```

Remove a student from the system

```
Problems  Javadoc  Declaration  Console ×
studentSubscriber [OSGi Framework] C:\Users\DELL\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x
Student Producer Start
Student Subscriber Start

--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
Enter your choice: 5

Enter the sID of the Member you want to Delete
004

Student Deleted Successfully.
```

Update the existing student details

```
--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. Quit
Enter your choice: 4

Enter the Student ID of student to Update details
004
Enter updated details for student with ID 004:
Name: Wasana
Grade: 1
Email: Ruwani@gmail.com
Contact: 011234567
Student details updated successfully.
```

Get the subject details when enter the grade

```
Student Producer Start
Student Subscriber Start

--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
Enter your choice: 7

Enter the Grade for view subjects
grade10
Subjects for Grade grade10:
----------------------------------
| Subject          |
----------------------------------
| Physics          |
| Chemistry        |
| Biology          |
----------------------------------

          Choose an option from Student Management
```

Enrolling students in the subjects

```
--------------Choose an option from Student Management--------------
1. Insert a New Student
2. Get All Student Details
3. Search Student Details
4. Update Student Details
5. Delete Student
6. Enroll Student for Subjects
7. View subjects of the Grade
8. Exite
Enter your choice: 6

Enter the sID of the student t add subjects
003
Enter subjects to enroll (comma-separated):
Maths,Science,English
Student with ID 003 enrolled for subjects: [Maths, Science, English]
```

Teacher Management – IT21271328

Teacher Publisher

The Teacher Publisher bundle orchestrates the management and dissemination of teacher-related data within an educational framework. It encapsulates essential details such as teacher identifiers, names, assigned subjects, and contact information.

The TeacherService interface declares methods such as:

- Facilitate the addition of new teachers.
- Enable the display of all registered teachers.
- Provide the capability to update specific teacher information.
- Support the deletion of individual teacher records.
- Offer the functionality to assign subjects to teachers
- Feature to search for teachers by ID.

The TeacherServiceImpl class serves as the concrete implementation of the interface, furnishing the necessary logic for the addition, retrieval, modification, deletion, and search of teacher records, along with the assignment of subjects.

Teacher Subscriber

The Teacher Subscriber bundle is engineered to consume and leverage teacher data dispensed by the Teacher Publisher. Its activator class acts as the initiator for initializing and terminating the Teacher Subscriber bundle.

Communication between Publisher and Subscriber:

The OSGi framework serves as the conduit for seamless interaction between bundles. While the Teacher Publisher bundle extends its services, the Teacher Subscriber bundle capitalizes on these services. This exchange transpires through meticulously defined interfaces, fostering a modular and loosely coupled system architecture.

User interaction:

The Teacher Subscriber bundle extends a user-friendly command-line interface to interface with the teacher management system. Through this interface, users can effortlessly execute various tasks, including the addition of new teachers, the display of existing teacher profiles, the update of teacher information, the removal of specific teacher records, the assignment of subjects to teachers and searching for teachers by ID. This intuitive interface empowers users to navigate the system effortlessly, augmenting their proficiency in managing teacher-related data. Whether it entails the addition, display, update, deletion, or subject assignment for teachers, the bundle streamlines operations, ensuring users can accomplish their objectives efficiently and seamlessly.

Diagrammatic explanation
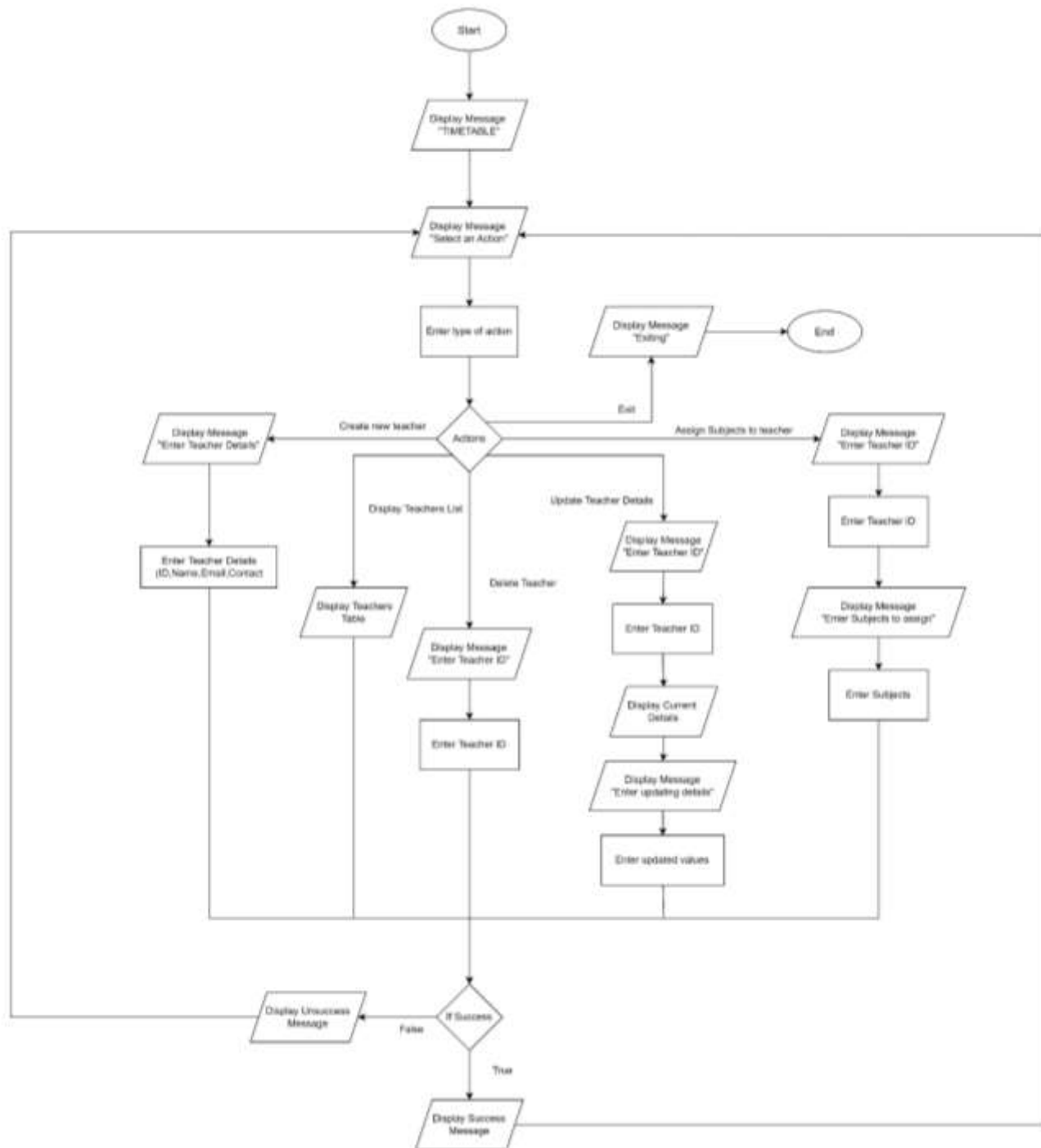
Publisher Bundle Manifest:

```
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: TeacherPublisher
 4 Bundle-SymbolicName: TeacherPublisher
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: teacherpublisher.TeacherActivator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-21
 8 Automatic-Module-Name: TeacherPublisher
 9 Import-Package: org.osgi.framework;version="1.10.0"
10 Bundle-ActivationPolicy: lazy
11 Export-Package: teacherpublisher
12
```

During run time the package is exported:

Subscriber Bundle Manifest:

```
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: TeacherSubscriber
 4 Bundle-SymbolicName: TeacherSubscriber
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: teachersubscriber.TeacherSubscriberActivator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-21
 8 Automatic-Module-Name: TeacherSubscriber
 9 Import-Package: org.osgi.framework;version="1.10.0",
10   teacherpublisher
11 Bundle-ActivationPolicy: lazy
12 Export-Package: teachersubscriber
13
```

Publisher is added/imported as a dependency in the Subscriber bundle:

Sample screenshots of its behavior & outputs

Starting of the system

```
            STAFF MANAGEMENT

+------------------------------------------------+
|    Choose an option from Teacher Management    |
+------------------------------------------------+
|    1. Insert a New Teacher                     |
|    2. Display Teachers List                    |
|    3. Update Teacher Details                   |
|    4. Delete Teacher                           |
|    5. Assign Subjects for Teacher              |
|    6. Search Teacher                           |
|    7. Quit                                     |
+------------------------------------------------+

 Enter your choice:
```

Create new teachers

```
            STAFF MANAGEMENT

+------------------------------------------------+
|    Choose an option from Teacher Management    |
+------------------------------------------------+
|    1. Insert a New Teacher                     |
|    2. Display Teachers List                    |
|    3. Update Teacher Details                   |
|    4. Delete Teacher                           |
|    5. Assign Subjects for Teacher              |
|    6. Search Teacher                           |
|    7. Quit                                     |
+------------------------------------------------+

 Enter your choice: 1
--------------------------------------------------------------------------------

 Register New Teacher To System

 Teacher's ID: 005
 Teacher's Name: Mr.Dinesh
 Teacher's Email: dinesh@gmail.com
 Teacher's Contact Number: 0712343567

 Teacher with ID 005 registered successfully.
```

Display all teachers' details

```
+----------------------------------------------+
|   Choose an option from Teacher Management    |
+----------------------------------------------+
|   1. Insert a New Teacher                     |
|   2. Display Teachers List                    |
|   3. Update Teacher Details                   |
|   4. Delete Teacher                           |
|   5. Assign Subjects for Teacher              |
|   6. Search Teacher                           |
|   7. Quit                                     |
+----------------------------------------------+

Enter your choice: 2
-----------------------------------------------------------------------------------------

                          Teachers' Details
+-----------+---------------+---------------------+-----------------+
| TeacherID | Name          | Email               | Contact No      |
+-----------+---------------+---------------------+-----------------+
| 001       | Mrs.Neha      | sneha@gmail.com     | 0712345432      |
| 004       | Mrs. Wasana   | wasana@gmail.com    | 0764534567      |
| 002       | Mr.Ranul      | ranul@gmail.com     | 0786785677      |
| 003       | Miss Janani   | janani@gmail.com    | 0723453453      |
| 005       | Mr.Dinesh     | dinesh@gmail.com    | 0712343567      |
+-----------+---------------+---------------------+-----------------+
```

Edit teacher details.

```
+----------------------------------------------+
|   Choose an option from Teacher Management    |
+----------------------------------------------+
|   1. Insert a New Teacher                     |
|   2. Display Teachers List                    |
|   3. Update Teacher Details                   |
|   4. Delete Teacher                           |
|   5. Assign Subjects for Teacher              |
|   6. Search Teacher                           |
|   7. Quit                                     |
+----------------------------------------------+

Enter your choice: 3
-----------------------------------------------------------------------------------------

Edit Teacher Profile

Enter Teacher's ID: 005

Current Details:
1. Name   - Mr.Dinesh
2. Email  - dinesh@gmail.com
3. Contact - 0712343567

Enter the indexes of the properties you want to edit (comma-separated): 1,3
Enter new name: Mr. Dinesh Pathirana
Enter new contact: 0712005008

Teacher details updated for ID 005:
Name: Mr. Dinesh Pathirana
Email: dinesh@gmail.com
Contact: 0712005008
```

Delete teacher.

```
+-------------------------------------------+
|    Choose an option from Teacher Management |
+-------------------------------------------+
|    1. Insert a New Teacher                 |
|    2. Display Teachers List                |
|    3. Update Teacher Details               |
|    4. Delete Teacher                       |
|    5. Assign Subjects for Teacher          |
|    6. Search Teacher                       |
|    7. Quit                                 |
+-------------------------------------------+

Enter your choice: 4
-----------------------------------------------------------------------------------

Delete Teacher

Enter the ID of the teacher you want to delete: 004

Teacher with ID 004 Deleted Successfully.
```

Assign subjects for teacher

```
+-------------------------------------------+
|    Choose an option from Teacher Management |
+-------------------------------------------+
|    1. Insert a New Teacher                 |
|    2. Display Teachers List                |
|    3. Update Teacher Details               |
|    4. Delete Teacher                       |
|    5. Assign Subjects for Teacher          |
|    6. Search Teacher                       |
|    7. Quit                                 |
+-------------------------------------------+

Enter your choice: 5
-----------------------------------------------------------------------------------

Assign Subject to the Teacher

Enter the ID of the teacher: 005

Enter subjects to assign (comma-separated): Biology,Chemestry
Subjects assigned successfully.
```

Search teacher by ID

```
+-------------------------------------------+
|    Choose an option from Teacher Management |
+-------------------------------------------+
|    1. Insert a New Teacher                 |
|    2. Display Teachers List                |
|    3. Update Teacher Details               |
|    4. Delete Teacher                       |
|    5. Assign Subjects for Teacher          |
|    6. Search Teacher                       |
|    7. Quit                                 |
+-------------------------------------------+

Enter your choice: 6
-----------------------------------------------------------------------------------

Search Teacher

Enter the ID of the teacher you want to search: 001

Teacher Details:
Teacher ID    - 001
Name          - Mrs.Neha
Email         - sneha@gmail.com
Contact       - 0712345432
```

Finance Management – IT21559136

Finance Publisher

The Finance Publisher bundle manages and provides access to financial data within an organization. It includes information on payments, their details, associated fees, and subjects.

A FinanceService interface outlines functions such as.

- Adding new payments.

- Viewing all payment details.

- Calculating the total collected fees.

- Determining the total for a specific subject.

An implementation class, FinanceServiceImpl, realizes these functionalities, enabling the addition, retrieval, and calculation of financial records based on subjects.

Finance Subscriber

The Finance Subscriber bundle is tailored to receive and utilize financial data provided by the Finance Publisher. Its activator class serves to initiate and halt the Finance Subscriber bundle's operation.

Communication between Publisher and Subscriber:

Communication between the Publisher and Subscriber occurs seamlessly through the OSGi framework. The Finance Publisher bundle offers its services, while the Finance Subscriber bundle leverages these services, fostering a modular and loosely coupled system design.

User interaction:

The Finance Subscriber bundle presents users with a user-friendly command-line interface for accessing the financial management system. This interface facilitates various actions such as adding new payments, browsing through payment details, computing total collected fees, and determining totals for specific subjects. By offering an intuitive interface, the bundle empowers users to interact effortlessly with the system, enhancing their capability to manage financial data effectively. Whether users are performing tasks like adding, browsing, or calculating payment records, the bundle ensures a smooth experience, enabling efficient task execution.

Diagrammatic explanation
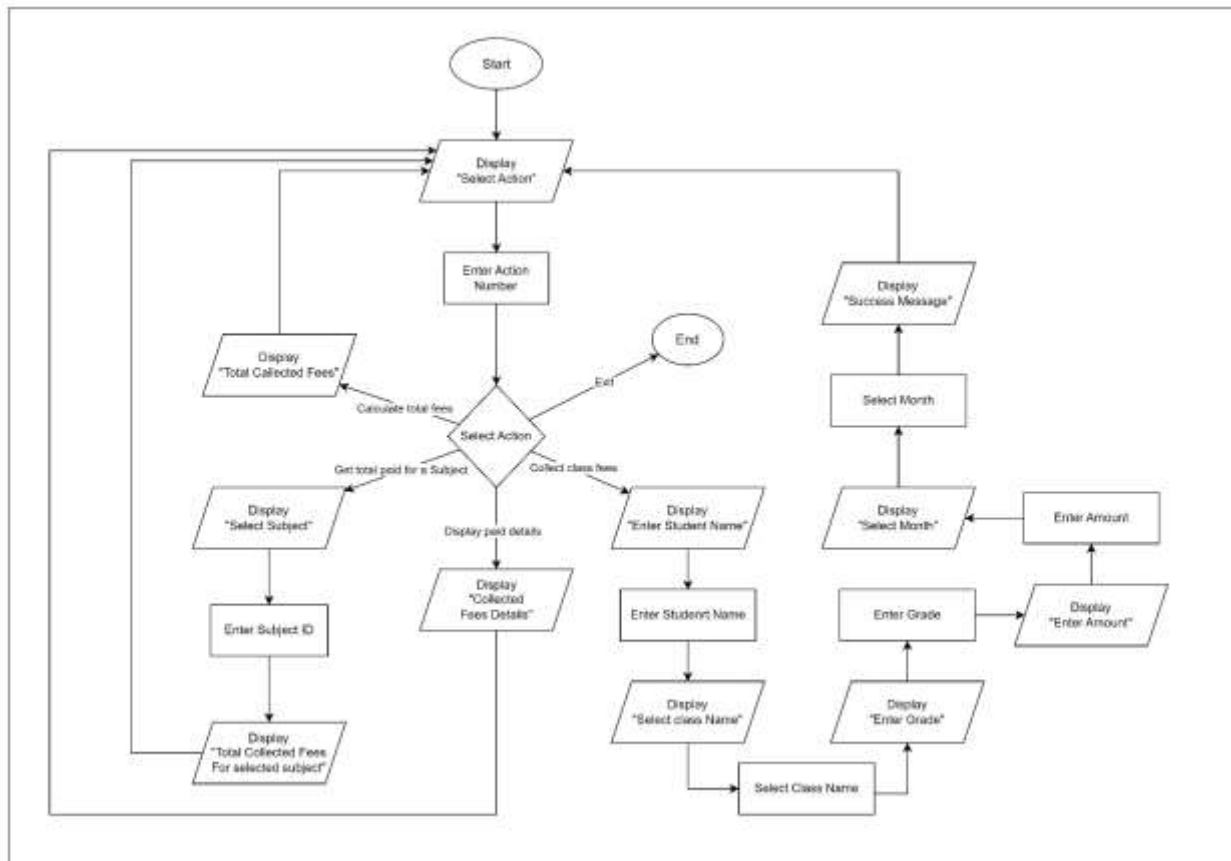
Publisher Bundle Manifest:

```
FinanceProducer ×
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: FinanceProducer
 4 Bundle-SymbolicName: FinanceProducer
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: financeproducer.FinanceProducerActivator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-17
 8 Automatic-Module-Name: FinanceProducer
 9 Import-Package: org.osgi.framework;version="1.10.0"
10 Bundle-ActivationPolicy: lazy
11 Export-Package: financeproducer
12
```

Subscriber Bundle Manifest:

```
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: FinanceConsumer
 4 Bundle-SymbolicName: FinanceConsumer
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: financeconsumer.FinanceConsumerActivator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-17
 8 Automatic-Module-Name: FinanceConsumer
 9 Import-Package: financeproducer,
10  org.osgi.framework;version="1.10.0"
11 Export-Package: financeconsumer
12
```

Publisher is added/imported as a dependency in the Subscriber bundle:
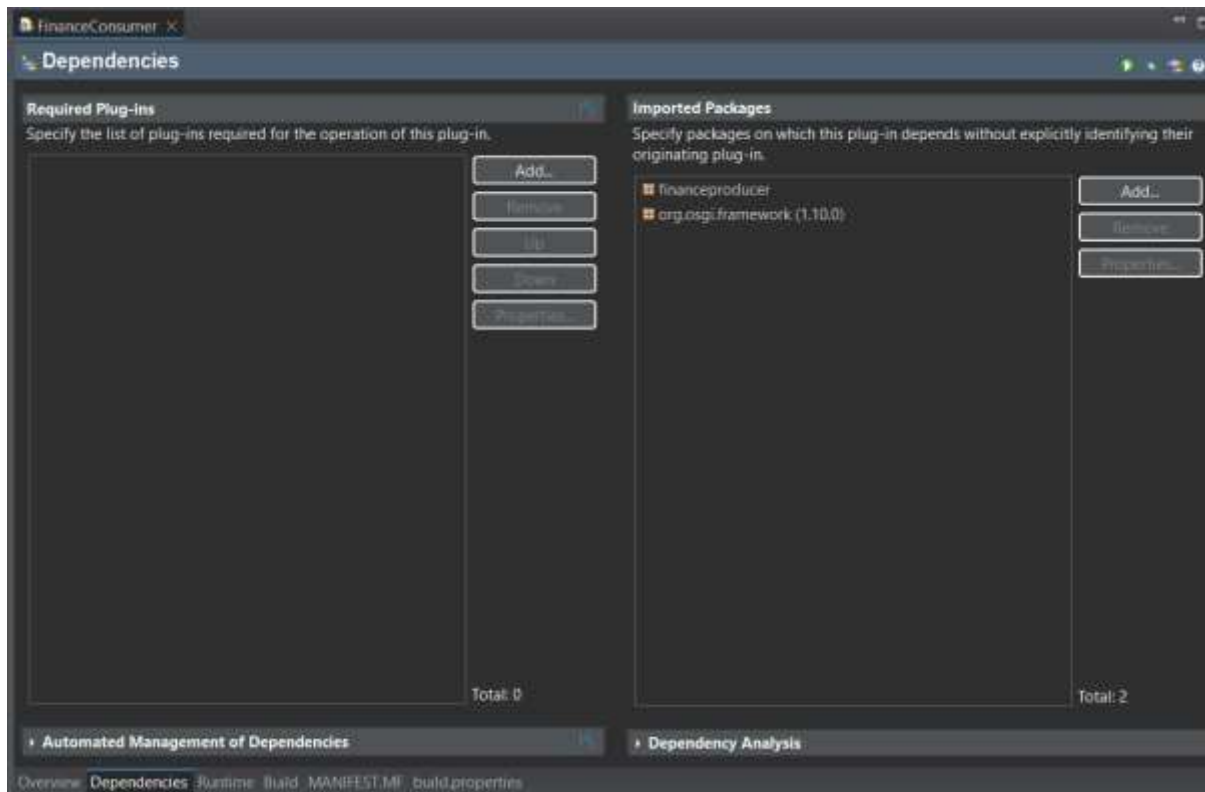
Sample screenshots of its behavior &outputs

```
Start FinanceConsumer
Finance Producer Start
------------------------------
Choose an action:
------------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 1
```

Add new payment

```
Start FinanceConsumer
Finance Producer Start
------------------------------
Choose an action:
------------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 1

Enter Student Name:Amaa
Select Class Name:Select Class Name:
|1. Maths|      |2. Science|    |3. English|    |4. History|    |5. Geography|

Enter the number corresponding to the class: 2
Enter Grade:10
Enter Amount:900
Select Month:
|1. January|    |2. February|   |3. March|      |4. April|      |5. May|        |6. June|       |7. July|

Enter the number corresponding to the month: 3
 Finance details added successfully!
=========================================
```

View All payment details

```
------------------------------
Choose an action:
------------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 2
| FeeID          | Student Name  | Class Name    | Grade | Date       | Amount        | Month |
------------------------------------------------------------------------------------------------
| 5498498878979| Amara          | Maths         | 6     | 2024-03-14 | 500.000000    | March |
| 5498498878980| Kamal          | Science       | 7     | 2024-03-14 | 600.000000    | March |
| 5498498878981| Nimal          | English       | 8     | 2024-03-14 | 450.000000    | March |
| 5498479878982| Nipun          | Maths         | 6     | 2024-03-14 | 550.000000    | March |
| 5498479878983| Sadun          | Science       | 7     | 2024-03-14 | 700.000000    | March |
| 1710430024096| Amaa           | Science       | 10    | 2024-03-14 | 900.000000    | March |
================================================================================================
```

Get Total of all payments

```
-----------------------------
Choose an action:
-----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 3
Total Collected Fees: 3700.0
=====================================
```

Get Total for a specific subject

```
-----------------------------
Choose an action:
-----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 4
Select Class Name:
|1. Maths|      |2. Science|    |3. English|    |4. History|    |5. Geography|

Enter the number corresponding to the class: 2
Total Paid for Science: 2200.0
=====================================
```

Exist from the system

```
-----------------------------
Choose an action:
-----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 5
```

Validations for Invalid Inputs

```
----------------------------
Choose an action:
----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: q
Invalid input. Please enter a number.


----------------------------
Choose an action:
----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice:
```

```
----------------------------
Choose an action:
----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 4
Select Class Name:
|1. Maths|      |2. Science|    |3. English|    |4. History|    |5. Geography|

Enter the number corresponding to the class: d
Invalid input. Please enter a number.
```

```
----------------------------
Choose an action:
----------------------------
1. Collect Class Fees
2. Display Paid Details
3. Calculate Total Collected Fees
4. Get Total Paid for a Subject
5. Exit

Enter your choice: 1

Enter Student Name:Select Class Name:Select Class Name:
|1. Maths|      |2. Science|     |3. English|     |4. History|     |5. Geography|

Enter the number corresponding to the class: 6
Invalid choice. Please enter a number between 1 and 5.
Select Class Name:
|1. Maths|      |2. Science|     |3. English|     |4. History|     |5. Geography|

Enter the number corresponding to the class: 3
Enter Grade:10
```

Timetable Management – IT21786464

Timetable Publisher

The Timetable Publisher bundle helps students know their schedules and ensures teachers are assigned to the right subjects in a school.

The TimetableService interface has these main features:

- Get Timetable: You can see your timetable by telling your grade.
- Assign Teachers: Teachers are matched with the subjects they teach.
- See Teacher Details: You can find out about a teacher and the subjects they teach.
- Update Teacher's Subjects: If needed, you can change the subjects a teacher teaches.

The DailyTimetable class makes all these features work, making it easy for students to check their schedules and for schools to manage teacher assignments

Timetable Subscriber

The Timetable Subscriber bundle is created to receive and make use of timetable information and teacher assignment details provided by the Timetable Publisher. Its activator class acts as the controller to initiate and halt the operation of the Timetable Subscriber bundle.

Communication between Publisher and Subscriber:

The OSGi framework enables seamless communication between bundles. The Timetable Publisher bundle offers its services, while the Timetable Subscriber bundle utilizes these services. This interaction occurs through clearly defined interfaces, promoting a modular and decoupled system design.

User interaction:

The Timetable Subscriber bundle provides a user-friendly command-line interface for accessing the timetable management system. Through this interface, users can easily perform various actions such as viewing the timetable, browsing through the complete list of available subjects, and viewing teacher assignments. This intuitive interface empowers users to interact with the system effortlessly, enhancing their ability to manage timetable information effectively. Whether it's viewing, browsing or updating timetable records and teacher assignments, the bundle offers a streamlined experience, ensuring users can accomplish their desired tasks efficiently and with ease.

Diagrammatic explanation
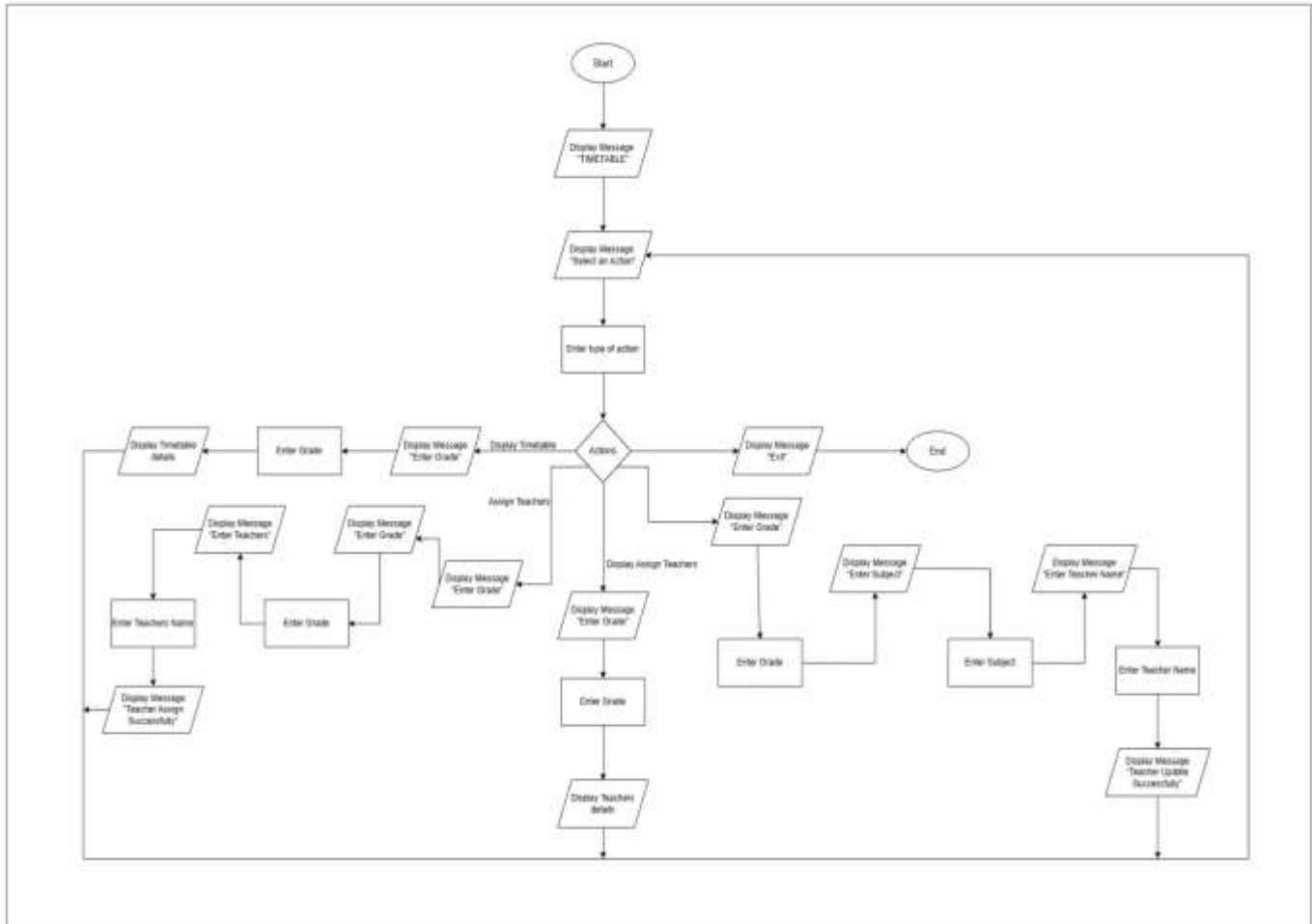
Timetable Service: Publisher/Subscriber Information

Publisher: Timetable_Producer Manifest


```
Timetable_Producer  ×

 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: Timetable_Producer
 4 Bundle-SymbolicName: Timetable_Producer
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: timetable_producer.Timetable_Service_Activator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-11
 8 Automatic-Module-Name: Timetable.Producer
 9 Import-Package: org.osgi.framework;version="1.3.0"
10 Bundle-ActivationPolicy: lazy
11 Export-Package: timetable_producer
12
```

Subscriber: Timetable_Consumer Manifest

```
Timetable_Consumer  ×
 1 Manifest-Version: 1.0
 2 Bundle-ManifestVersion: 2
 3 Bundle-Name: Timetable_Consumer
 4 Bundle-SymbolicName: Timetable_Consumer
 5 Bundle-Version: 1.0.0.qualifier
 6 Bundle-Activator: timetable_consumer.Timetable_Consumer_Activator
 7 Bundle-RequiredExecutionEnvironment: JavaSE-11
 8 Automatic-Module-Name: Timetable.Consumer
 9 Import-Package: org.osgi.framework;version="1.3.0",
10  teacher_producer,
11  timetable_producer
12 Bundle-ActivationPolicy: lazy
13 Export-Package: timetable_consumer
14
```

Timetable Service: Starting/Stopping providers.

Starting Timetable Publisher:

```
osgi> start 4
Timetable Service Publisher Start
osgi>
```

Starting Teacher Publisher:

```
osgi> start 2
Teacher Producer Start
osgi>
```

Starting Timetable Subscriber

```
osgi> start 3
Start Timetable Consumer
```
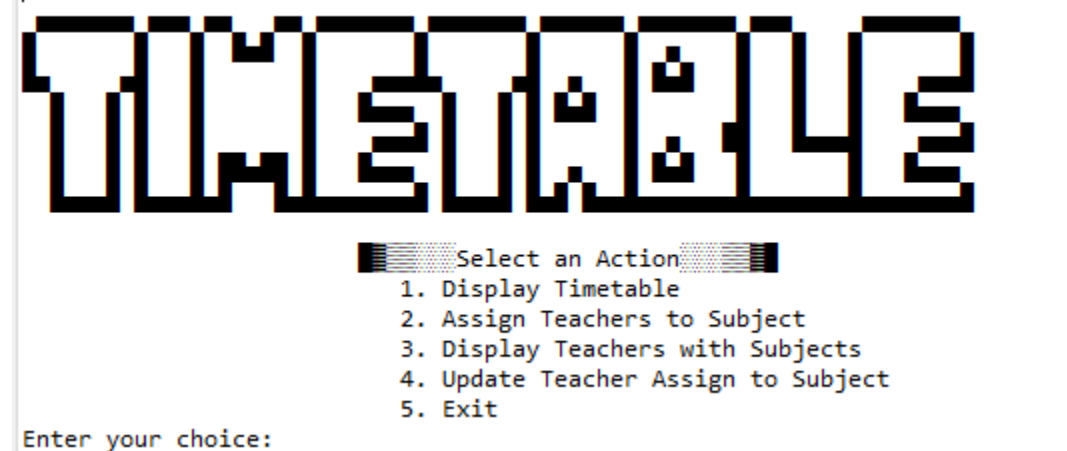


```
                    Select an Action
                1. Display Timetable
                2. Assign Teachers to Subject
                3. Display Teachers with Subjects
                4. Update Teacher Assign to Subject
                5. Exit
Enter your choice:
```

```
osgi> ss
"Framework is launched."


id      State       Bundle
0       ACTIVE      org.eclipse.osgi_3.18.0.v20220516-2155
                    Fragments=647
1       ACTIVE      org.eclipse.equinox.simpleconfigurator_1.4.0.v20210315-2228
2       ACTIVE      Teacher_Producer_1.0.0.qualifier
3       ACTIVE      Timetable_Consumer_1.0.0.qualifier
4       ACTIVE      Timetable_Producer_1.0.0.qualifier
5       ACTIVE      biz.aQute.bnd.util_6.0.0.202110041835
6       ACTIVE      biz.aQute.bndlib_6.0.0.202110041835
7       ACTIVE      ch.qos.logback.classic_1.1.2.v20171220-1825
                    Fragments=591
```

Timetable Service: Functional behavior and outputs (Screenshots).

Display Timetables


```
                        ▌▒▒▒▒▒▒Select an Action▒▒▒▒▒▒▌
                            1. Display Timetable
                            2. Assign Teachers to Subject
                            3. Display Teachers with Subjects
                            4. Update Teacher Assign to Subject
                            5. Exit
Enter your choice: 1
Enter the grade (6-11): 6
Grade 6 Time Table
+--------------------+-------------------+--------------------+
|         Day        |        Time       |       Subject      |
+--------------------+-------------------+--------------------+
| Monday             |   09:00 - 11:00   | Science            |
| Tuesday            |   11:00 - 13:00   | Maths              |
| Wednesday          |   14:00 - 16:00   | English            |
| Thursday           |   16:00 - 18:00   | History            |
| Friday             |   18:00 - 20:00   | Geography          |
+--------------------+-------------------+--------------------+
```

Assign Teachers to Subjects

```
                            ▓▓▓▓▓Select an Action▓▓▓▓▓▓ ▓
                            1. Display Timetable
                            2. Assign Teachers to Subject
                            3. Display Teachers with Subjects
                            4. Update Teacher Assign to Subject
                            5. Exit
Enter your choice: 2
Teachers List

▓[1m▓[33m                            Teachers' Details▓[0m
  +------------+--------------------+----------------------------+------------------+
  | TeacherID  | Name               | Email                      | Contact No       |
  +------------+--------------------+----------------------------+------------------+
  | 001        | Mrs.Neha           | sneha@gmail.com            | 0712345432       |
  | 004        | Mrs. Wasana        | wasana@gmail.com           | 0764534567       |
  | 002        | Mr.Ranul           | ranul@gmail.com            | 0786785677       |
  | 003        | Miss Janani        | janani@gmail.com           | 0723453453       |
  +------------+--------------------+----------------------------+------------------+
Enter the grade (6-11):
6
Enter the teacher for Science:
Mrs. Wasana
Enter the teacher for Maths:
Mr.Ranul
Enter the teacher for English:
Miss Janani
Enter the teacher for History:
Mrs.Neha
Enter the teacher for Geography:
Mrs.Neha
Teachers assigned successfully for grade 6.
```

Display Teachers with Subjects

```
                            ▓▓▓▓▓Select an Action▓▓▓▓▓ ▓
                            1. Display Timetable
                            2. Assign Teachers to Subject
                            3. Display Teachers with Subjects
                            4. Update Teacher Assign to Subject
                            5. Exit
Enter your choice: 3
Enter the grade (6-11): 6
Teachers assigned for grade 6:
Geography: Mrs.Neha
Maths: Mr.Ranul
English: Miss Janani
Science: Mrs. Wasana
History: Mrs.Neha
```

```
                         Select an Action
                    1. Display Timetable
                    2. Assign Teachers to Subject
                    3. Display Teachers with Subjects
                    4. Update Teacher Assign to Subject
                    5. Exit
Enter your choice: 4
Enter the grade (6-11):
6
Enter the subject to update the teacher:
English
Enter the new teacher for English:
Wasana
Teacher updated successfully for subject English in grade 6.
                         Select an Action
                    1. Display Timetable
                    2. Assign Teachers to Subject
                    3. Display Teachers with Subjects
                    4. Update Teacher Assign to Subject
                    5. Exit
Enter your choice: 3
Enter the grade (6-11): 6
Teachers assigned for grade 6:
Geography: Mrs.Neha
Maths: Mr.Ranul
English: Wasana
Science: Mrs. Wasana
History: Mrs.Neha
```