INFORMATICS INSTITUTE OF TECHNOLOGY

UNIVERSITY OF WESTMINSTER

Informatics Institute of Technology

In collaboration with

University of Westminster

BEng. (Hons) in Software Engineering

MODULE: 6SENG004C.1 Concurrent Programming

Coursework Report

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1 FSP Process Composition Analysis & Design Form

1.1 FSP Composition Process Attributes

Attribute	Value
Name	BANKING_SYSTEM
Description	BANKING_SYSTEM composite process includes 5 primitive processes, such as BANK_ACCOUNT, STUDENT, GRANDMA, LOAN_COMPANY and UNIVERSITY. The primitive processes were labelled to create and maintain mutual exclusiveness among the processes. Composite process refers to a typical banking system which includes transactions between different processes through different actions.
Alphabet (Use LTSA's **compressed notation**, if alphabet is large.)	alphabet(BANKING_SYSTEM) = {grandma.{addB[2..3], calculateB[1..7], readB[4], sendBCard, updateB[1..7]}, loan.{addB[2..3], calculateB[1..7], readB[4], updateB[1..7]}, student.{buyPhone, calculateB[1..7], readB[4], substractB[2..3], updateB[1..7]}, uni.{calculateB[1..7], readB[4], substractB[2..3], updateB[1..7]}}
Sub-processes (List them.)	BANK_ACCOUNT, STUDENT, GRANDMA, LOAN_COMPANY, UNIVERSITY
Number of States	59
Deadlocks (yes/no)	No
Deadlock Trace(s) **(If applicable)**	N/A

1.2 FSP "main" Program Code

FSP Program:

```
const MIN_DEPOSIT_WITHDRAW = 2
const MAX_DEPOSIT_WITHDRAW = 3

range TRANSACTION = MIN_DEPOSIT_WITHDRAW..MAX_DEPOSIT_WITHDRAW

range CURRENT_BALANCE = 4..4
range NEW_BALANCE = 1..7

set ACTOR_LABELS = {student,grandma,loan,uni}

|| BANKING_SYSTEM = ( student:STUDENT || grandma:GRANDMA ||
loan:LOAN_COMPANY || uni:UNIVERSITY || {ACTOR_LABELS}:: BANK_ACCOUNT ).
```

1.3 Combined Sub-processes

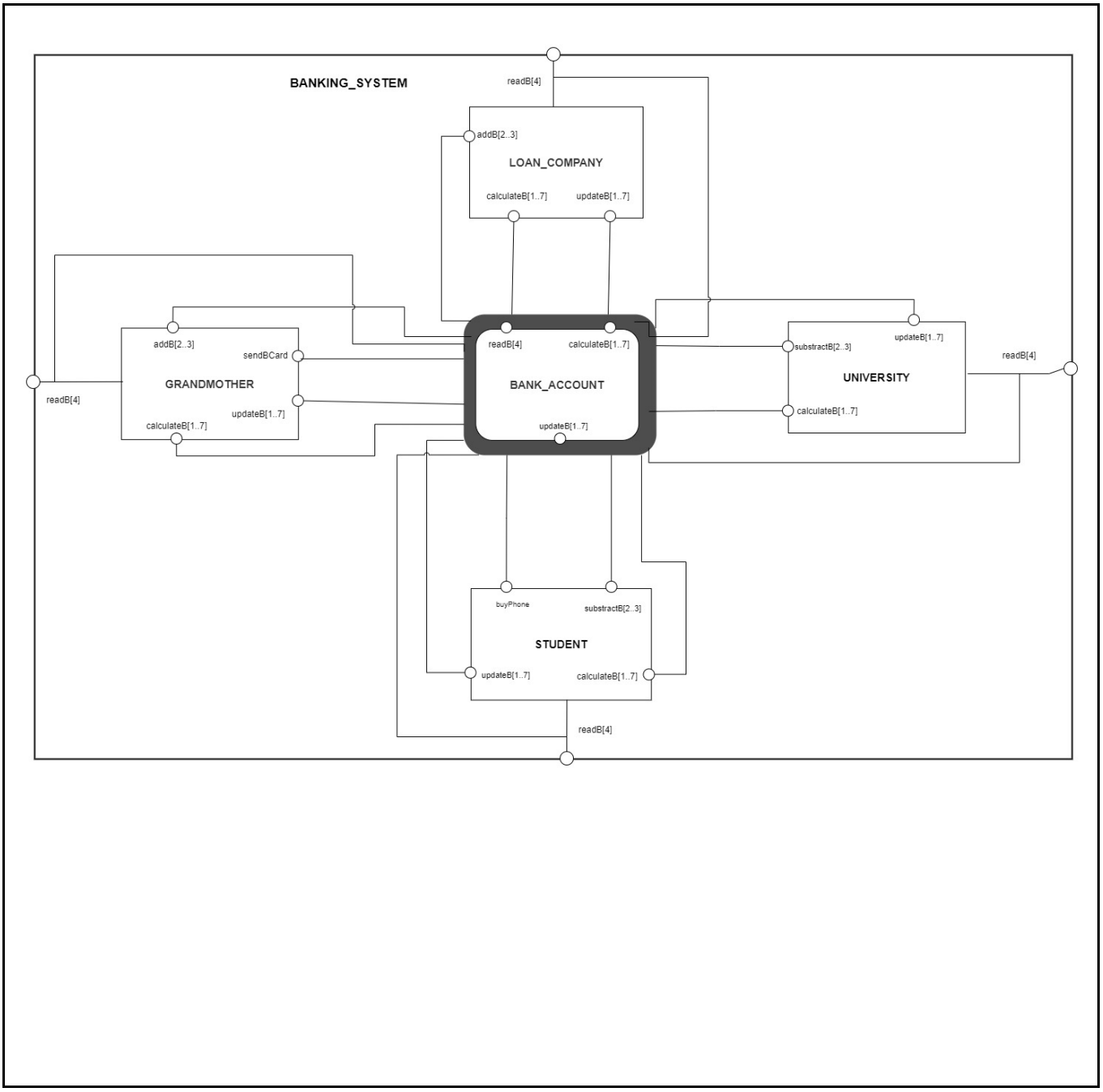
Process	Description
BANK_ACCOUNT	The primitive process represents a process of a bank account which includes several synchronous actions like read, calculate and update the balance of the account.
STUDENT	The primitive process represents a role of a student related to the banking system and the student perform all the synchronous actions related to the system while performing one asynchronous action of buying a Samsung phone.
GRANDMA	The primitive process represents a role of the grandmother of the previously discussed Student process. GRANDMA process performs actions to the Student's Bank account by depositing money for her grandson/ granddaughter and sending a birthday card.
LOAN_COMPANY	The primitive process represents a loan company that provides loan facilities for the Student hence Student gets money deposits from the actions of the LOAN_COMPANY.
UNIVERSITY	The primitive process represents a University that is related to the Student and it performs actions to withdraw and reduce the money from Student's account for University fees.

1.4 Analysis of Combined Process Actions

Synchronous Actions	Synchronised by Sub-Processes (List)
readB[4]	BANK_ACCOUNT, STUDENT, GRANDMA, LOAN_COMPANY, UNIVERSITY
calculateB[1..7]	BANK_ACCOUNT, STUDENT, GRANDMA, LOAN_COMPANY, UNIVERSITY
updateB[1..7]	BANK_ACCOUNT, STUDENT, GRANDMA, LOAN_COMPANY, UNIVERSITY
substractB[2..3]	STUDENT, UNIVERSITY
addB[2..3]	GRANDMA, LOAN_COMPANY

Sub-Process	Asynchronous Actions (List)
STUDENT	buyPhone
GRANDMA	sendBCard

1.5 Parallel Composition Structure Diagram



2 Java Program Output

```
[Bank_System] - System started 2022-01-10 10:11:24.127

===== Student Transactions Starts =====
===== Grandmother transactions starts =====
===== Loan Company transactions =====
===== University transactions =====
[Current Account] - University's transaction of 50000 failed. Insufficient balance for the transaction. Wait...

[Loan Company]: Deposit action : [ Customer: Loan Company, Amount: 70000]
[Loan Company Transaction completed]

[University]: Withdraw action : [ Customer: University, Amount: 50000]
[University Transaction completed]

[GrandMother]: Deposit action : [ Customer: Grandmother, Amount: 10000]
[GrandMother Transaction completed]

[Current Account] - Athindu's transaction of 90000 failed. Insufficient balance for the transaction. Wait...

[Loan Company]: Deposit action : [ Customer: Loan Company, Amount: 70000]
[Loan Company Transaction completed]

[Student] - Withdraw action: [ Customer: Athindu, Amount: 90000]
[Student Transaction completed]

[GrandMother]: Deposit action : [ Customer: Grandmother, Amount: 5000]
[GrandMother Transaction completed]
===== Grandmother transactions over =====

[University]: Withdraw action : [ Customer: University, Amount: 50000]
[University Transaction completed]

[Student] - Withdraw action: [ Customer: Athindu, Amount: 9000]
[Student Transaction completed]

[Loan Company]: Deposit action : [ Customer: Loan Company, Amount: 70000]
[Loan Company Transaction completed]

===== Loan Company transactions Over =====

[Student] - Withdraw action: [ Customer: Athindu, Amount: 7000]
[Student Transaction completed]

[University]: Withdraw action : [ Customer: University, Amount: 50000]
[University Transaction completed]

[Student] - Deposit action: [ Customer: Athindu, Amount: 80000]
[Student Transaction completed]

[Student] - Deposit action: [ Customer: Athindu, Amount: 5000]
[Student Transaction completed]

===== University transactions over =====

[Student] - Deposit action: [ Customer: Athindu, Amount: 15000]
[Student Transaction completed]
```

```
===== Student Transactions Over =====

[Bank_System] - All the transactions have been terminated. 2022-01-10 10:11:24.134
[Bank_System] - Execution time: 8ms

------ FINAL BANK STATEMENT ------

Statement for Athindu's Account: 248995486
================================================
Customer                 Amount        Balance
================================================
Loan Company              70000        75000
Grandmother               10000        85000
University                50000        75000
Loan Company              70000       145000
University                50000        95000
Grandmother                5000       100000
Athindu                   90000        95000
Loan Company              70000       165000
Athindu                    9000       156000
University                50000       106000
Athindu                    7000        99000
Athindu                   80000       179000
Athindu                    5000       184000
Athindu                   15000       199000
================================================


Process finished with exit code 0
```