

# Carleton University Bank System

Course 95.304  
Second Iteration Report

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# 1 Introduction

The objective of this project is to design and implement a Carleton University Bank (CUB) system. The CUB system described in this document is a bank transaction system consisting of a set of geographically distributed automated teller machines (ATMs) and a central bank system (CBS). The ATMs provide standard banking services such as deposits, cash withdrawals, bill payments, account updates, and printed transaction records. To facilitate these services, ATMs accept (the appropriate) bank cards, maintain a graphical user interface (for presenting information to a user and receiving user input), and communicate with the CBS to verify accounts and update the CBS based on completed transactions.

This report begins by describing the overall CUB system and listing any assumptions that have been made. Subsequent sections are dedicated to the CUB system requirements (functional and non-functional), scenario textual descriptions (STDs), use case maps (UCMs) and message sequence charts (MSCs). Traceability (from system description to requirements, from requirements to STDs, from STDs to UCMs, and from UCMs to MSCs) is provided in table form.

Text that is in *underlined italics* denotes functionality that was not able to be completed by the due date of this report.

## 2 Description of the system

1. The CBS maintains a database that includes a list of accounts for every User and a log of every transaction carried out. The CBS validates all PINs provided by secure ATMs, updates the User account information in the database, and logs all the transactions that were received. CBS communication with its ATMs is secure and constant (if communication breakdown occurs, it is detected and appropriate steps are taken). Each bank card has an associated chequing, savings or other type of account that can be withdrawn from and deposited into. Each account can only be associated with one bank card.

2. The ATM components consist of a display, a card reader, a cash dispenser, an envelope drawer, an envelope feeder, a keypad and a printer.

- The display shows the user messages and transaction choices.
- The card reader accepts valid bank cards, and determines the account number. When there is suspected fraud or security risk, the card reader will withhold a user's card, otherwise the card is returned upon request or completion of transaction. A qualified ATM maintenance administrator empties any swallowed cards.
- The cash dispenser gives the cash in \$20 denominations to the User. It ensures that the money to be dispensed was competed successfully. A qualified ATM maintenance administrator adds cash to the cash dispenser when necessary.
- The envelope drawer dispenses envelopes for bill payment and deposit. The drawer dispenses one envelope at a time and knows when there are no more envelopes. A qualified ATM maintenance administrator refills the envelopes.
- The envelope feeder accepts envelopes for bill payment and deposit. It will stop accepting after one envelope has been inserted. A qualified ATM maintenance administrator empties the envelopes.
- The keypad is the user's interface to the ATM. It is a set of buttons that includes the following: 10 buttons labeled with numbers 0 to 9, an OKAY button, a CLEAR button, a CANCEL button, and dynamic buttons that perform different actions.
- The printer prints a transaction record to the user. It also keeps track of the paper and ink levels. A qualified ATM maintenance administrator refills the ink and paper.

3. The ATM remains idle until it is triggered by the insertion of a bank card into the card reader. The user is then prompted for a four-digit PIN (Personal Identification Number) on the keypad. The PIN must be entered within 20 seconds. After 20 seconds it

is assumed there is a security risk and the card is swallowed and the account is withheld by the CBS.

4. Upon completion of a user's transactions, the ATM returns to the idle state. If an error occurs, the ATM will automatically shutdown and return the card to the user. The ATM can be shutdown for maintenance and / or restarted to the idle state.

5. A main menu will be output to the display after validation of the PIN by the CBS. The User selects one of four options representing a banking service:

- **Withdrawal** – The User selects Withdraw from the menu and withdraws cash from the ATM.
- **Deposit** – The User selects Deposit option from the menu and deposits cash or cheques into the ATM.
- **Bill Payment** – The User selects Payment from the menu and enters bills into the ATM that are to be paid. The User also has the ability to enter up to 3 bills in one transaction.
- **Account Update** – The User selects Account Update from the menu and a balance is displayed for the account.
- **Print Transaction Record** – ATM prints a record after a transaction.
- **Exit** – User completes sessions with ATM and retrieves card.

6. A transaction may be canceled at any time before the transaction is sent to CBS, and the necessary components of the system will be reset if the CANCEL button is pressed.

### 3 Assumptions

For simplicity, the following assumptions have been made.

ID	Assumption Description	Section 2, Paragraph #
S-1	The ATM only dispenses multiples of \$20.	2
S-2	The card inserted into the ATM is valid (i.e. readable).	2
S-3	Communication between the ATM and CBS is secure and constant.	1
S-4	The envelope drawer dispenses one envelope at a time.	2
S-6	The ATM does not handle credit cards or any other non-bank cards.	2
S-7	If a User has a bank card, then the User has a bank account that can be withdrawn from and deposited to.	1
S-8	Any account can have only one associated bank card.	1

## 4 Requirements

This section contains functional and non-functional requirements for the ATM and CBS. A functional requirement describes how a system operates, while non-functional requirements describe abstract conditions a system must satisfy.

Requirements are labeled according to their type. Functional requirements are labeled FR-x and non-functional requirements are labeled NFR-x where x is a unique identifying integer. All requirements concerning ATM are prefixed with A (i.e. A-FR-1; A-NFR-1), and CBS requirements are prefixed with C (i.e. C-FR-1, C-NFR-1).

### 4.1 ATM Functional Requirements

ID	Description	Section 2.0, Paragraph #
A-FR-1	The card reader determines the account number from the entered card.	2
A-FR-2	The ATM is in the idle state when there is no operation.	3
A-FR-3	The User is prompted to enter a PIN after a card is entered.	3
A-FR-4	A menu is displayed to the User with the following options: Withdraw, Deposit, Pay Bill, Account Update, and Exit.	4
A-FR-5	The cash dispenser has the ability to dispense cash.	2
A-FR-6	A transaction record can be printed upon demand.	2
A-FR-7	The card is ejected when the session is completed.	2
A-FR-8	The cash dispenser is aware of the cash amount available.	2
A-FR-9	The envelope feeder accepts envelopes.	2
A-FR-10	The envelope feeder is aware when an envelope has been inserted.	2
A-FR-11	The printer determines whether there is sufficient paper and ink.	2
A-FR-12	The ATM defaults to the idle state.	4
A-FR-13	The User is prompted to make between 1 and 3 bill payments.	5
A-FR-14	The keypad accepts input from the User.	2
A-FR-15	The ATM is aware of the state of the envelope drawer	2

	(which can be either empty or full).	
A-FR-16	The ATM can withhold a bank card.	2
A-FR-17	Transactions can be canceled at any prompt by the User pressing the CANCEL button.	6

## 4.2 ATM Non-functional Requirements

ID	Description	Section 2.0, Paragraph #
A-NFR-1	The ATM unit consists of a display, a card reader, a cash dispenser, an envelope drawer, an envelope slot, a keypad, and a printer.	2
A-NFR-2	The keypad is a set of buttons that includes the following: 10 buttons labeled with numbers 0 to 9, an OKAY button, a CLEAR button, a CANCEL button, and dynamic buttons that perform different actions.	2
A-NFR-3	A PIN must be entered within 20 seconds.	3
A-NFR-4	The User must enter the PIN correctly within three attempts.	3
A-NFR-7	ATM suspends further access using a particular card if the associated PIN is entered incorrectly 3 times in succession.	3
A-NFR-8	The ATM must be secure.	1
A-NFR-9	The ATM can be shut down and restarted.	5
A-NFR-10	The envelope drawer can be open and refilled with envelopes.	2
A-NFR-11	The envelope feeder can be opened so any envelopes that have been deposited can be removed.	2
A-NFR-12	The cash dispenser can be opened and refilled with cash.	2
A-NFR-13	The printer can be opened and refilled with paper.	2

### **4.3 CBS Functional Requirements**

ID	Description	Section 2.0, Paragraph #
C-FR-1	CBS provides the following User account information: PIN, accessible accounts, and an account balance	1
C-FR-2	The CBS authenticates the PIN and associated account number.	5
C-FR-3	The CBS updates account information according to ATM transactions.	1
C-FR-4	The CBS can suspend an account. Accounts can be reactivated by a qualified Administrator.	3

### **4.4 CBS Non-Functional Requirements**

ID	Description	Section 2.0, Paragraph #
C-NFR-1	A User can have a single chequing, savings or other accounts per bank card.	1
C-NFR-2	CBS must reply to the ATM within 20 seconds.	1

## 5 Scenario Textural Descriptions

This section contains the Scenario Textural Descriptions (STDs) for Card Entry, Withdraw, Deposit, Bill Payment, Account Update, Print Transaction Record, Exit, Maintenance and Communication Failure. A reference number is provided in the upper right hand corner of each STD. Every STD corresponds to a set of associated requirements, which is provided in this report for traceability.

### 5.1 Table of Scenario Textual Descriptions

STD#	Identifier	Section	Page
STD1	Card Entry	5.2	12
STD2	Withdraw	5.3	13
STD3	Deposit	5.4	14
STD4	Bill Payment	5.5	15
STD5	Account Update	5.6	16
STD6	Print Transaction Record	5.7	17
STD7	Exit	5.8	18
STD8	Maintenance	5.9	19
STD9	Communication Failure	5.10	20

## 5.2 STD1 – Card Entry

STD Identifier: STD1 Card Entry	Responsibilities
Description: ATM is in idle state. User inserts a card. The CBS validates the PIN and the ATM displays the menu options to the customer. The ATM is now in transaction state.	
External Actors: User	
Precondition: ATM is in the idle state.	
Triggering Event: User inserts a card into the card reader.	
1. User inserts a card into the card reader which reads the card information.	A-FR-1
2. ATM prompts the User to enter the PIN.	A-FR-3
3. User enters the PIN.	
4. The PIN is collected.	A-FR-14
5. CBS validates the account number and PIN.	C-FR-2
6. ATM displays a menu with the following options: Withdraw, Deposit, Bill Payment, Account Update, Exit.	A-FR-4
Postcondition: ATM is in the transaction state.	
Resulting event: The transaction menu is shown on the display.	
Alternatives:	
ALT-1 If the User enters three invalid PINs successively;	A-NFR-7
7. The card is withheld .	A-FR-16
8. CBS suspends the account.	C-FR-4
ALT-2 After 20 seconds a PIN hasn't been entered;	A-NFR-3
9. If there is no response, the card is withheld.	A-FR-16
10. CBS suspends the account.	C-FR-4
ALT-3 If the card's account number isn't recognized by the CBS;	C-FR-2
11. The card is returned.	A-NFR-1
Nonfunctional Requirements:	
Comments: The User pressing the CANCEL button at any input prompt results in the ATM returning to the transaction state.	A-FR-16

### 5.3 STD2 – Withdraw

STD Identifier: STD2 Withdraw	Responsibilities	
Description: The User selects Withdraw from the menu and withdraws cash from the ATM.		
External Actors: User		
Precondition: ATM is in the transaction state.		
Triggering Event: User selects Withdraw from the menu.		
<ol style="list-style-type: none"> <li>1. The User selects Withdraw from the menu.</li> <li>2. CBS provides a list of accessible User accounts.</li> <li>3. ATM displays the accounts.</li> <li>4. The User selects an account to withdraw from.</li> <li>5. The ATM collects the information.</li> <li>6. ATM prompts the User to enter the amount to withdraw.</li> <li>7. The User enters the amount.</li> <li>8. The ATM collects the information.</li> <li>9. The ATM verifies that the amount is a multiple of \$20 and that there is sufficient cash for the withdrawal.</li> <li>10. CBS validates that the User has enough cash in the bank account.</li> <li>11. ATM opens the cash dispenser and dispenses the cash.</li> <li>12. User prompted to take money.</li> <li>13. The cash dispenser is closed.</li> <li>14. The CBS updates the account information and the transaction log.</li> <li>15. The User is prompted to print a transaction record.</li> </ol>	<p>A-FR-4 C-FR-1 A-NFR-1  A-FR-14 A-NFR-1  A-FR-14 S-7, A-FR-8  C-FR-1 A-FR-5 A-NFR-1  C-FR-3 A-FR-6</p>	
Postcondition: ATM is in the print state.		
Resulting event: The User makes a choice at the prompt.		
<p>Alternatives:</p> <p>ALT-1 If the amount entered exceeds the amount of cash in the ATM: 16. The ATM returns to the transaction state.</p> <p>ALT-2 If the User doesn't have enough money in the bank account: 17. The User is prompted to try a different account.</p> <p>ALT-3 If the User enters an amount that is not a multiple of 20: 18. The User is notified that it must be a multiple of \$20. 19. The User is then prompted to choose another amount.</p>		<p>A-FR-8 S-7</p>
<p>Nonfunctional Requirements:</p> <ul style="list-style-type: none"> <li>- If a User has a bank card, then the User has a bank account that can be withdrawn from.</li> <li>- A User can have chequing, savings or other accounts per bank card</li> </ul>		<p>S-7 C-NFR-1</p>
Comments: The User pressing the CANCEL button at any input prompt results in the ATM returning to the transaction state.		A-FR-16

## 5.4 STD3 – Deposit

STD Identifier: STD3 Deposit	Responsibilities
Description: The User selects the Deposit option from the main menu and deposits cash or cheques into the ATM.	
External Actors: User	
Precondition: ATM is in the transaction state.	
Triggering Event: User selects Deposit from the menu.	
<ol style="list-style-type: none"> <li>1. User selects Deposit from the menu.</li> <li>2. The envelope drawer is unlocked and it is verified that there are a sufficient number of envelopes.</li> <li>3. CBS provides a list of accessible User accounts.</li> <li>4. ATM displays the accounts.</li> <li>5. The User chooses an account from the list.</li> <li>6. ATM collects the information.</li> <li>7. ATM prompts the User for the amount to be deposited.</li> <li>8. User enters an amount.</li> <li>9. ATM collects the information.</li> <li>10. The User puts the deposit item (cash or cheques) into an envelope then the envelope feeder accepts it.</li> <li>11. ATM locks the envelope drawer.</li> <li>12. The CBS updates the account information and the transaction log.</li> <li>13. The User is prompted to print a transaction record.</li> </ol>	<p>A-FR-4 A-FR-15 C-FR-1 A-NFR-1 A-FR-14 A-NFR-1 A-FR-14 A-FR-9; A-FR-10 A-NFR-1 C-FR-3 A-FR-6</p>
Postcondition: ATM is in the print state.	
Resulting Event: The User makes a choice at the prompt.	
<p>Alternatives:</p> <p>ALT-1 If the ATM is out of envelopes; 14. The User will be notified and returned to the menu</p>	A-FR-15
<p>Nonfunctional Requirements:</p> <ul style="list-style-type: none"> <li>- If the User has a bank card, then the User has at least one bank account that can be deposited into.</li> </ul>	S-7
Comments: The User pressing the CANCEL button at any input prompt results in the ATM returning to the transaction state.	A-FR-16

## 5.5 STD4 – Bill Payment

STD Identifier: STD4 Bill Payment	Responsibilities
Description: The User selects Payment from the menu and enters bills into the ATM that are to be paid.	
External Actors: User	
Precondition: ATM is in transaction state.	
Triggering Event: The User selects Payment from the menu.	
<ol style="list-style-type: none"> <li>1. The User selects Payment from the menu.</li> <li>2. The envelope drawer is unlocked and it is verified that there are a sufficient number of envelopes.</li> <li>3. CBS provides a list of accessible User accounts.</li> <li>4. ATM displays the accounts.</li> <li>5. The User chooses an account from the list.</li> <li>6. The ATM collects the information.</li> <li>7. ATM prompts the User to enter the number of bills that will be paid.</li> <li>8. The User enters the number between 1 and 3.</li> <li>9. ATM collects the information.</li> <li>10. The User is prompted to enter an amount for each bill.</li> <li>11. For each bill, the User enters an amount to be paid.</li> <li>12. ATM collects the information.</li> <li>13. CBS validates that the User has enough cash in the bank account.</li> <li>14. The User puts the bill stub(s) into an envelope then the envelope feeder accepts it.</li> <li>15. The CBS updates the account information and the transaction log.</li> <li>16. ATM locks the envelope drawer.</li> <li>17. The User is prompted to print a transaction record.</li> </ol>	<p>A-FR-14</p> <p>A-FR-15</p> <p>C-FR-1</p> <p>A-NFR-1</p> <p>A-FR-14</p> <p>A-FR-13</p> <p>A-FR-14</p> <p>A-NFR-1</p> <p>A-FR-14</p> <p>C-FR-1</p> <p>A-FR-9; A-FR-10</p> <p>C-FR-3</p> <p>A-NFR-1</p> <p>A-FR-6</p>
Postcondition: ATM is in print state.	
Resulting Event: The User makes a choice at the prompt.	
Alternatives:	
ALT-1 If the User doesn't have enough money in the bank account;	C-FR-1
18. The User will be notified and returned to the menu.	
ALT-2 If the ATM is out of envelopes;	A-FR-15
19. The User will be notified and returned to the menu.	
Nonfunctional Requirements:	
Comments: The User pressing the CANCEL button at any input prompt results in the ATM returning to the transaction state.	A-FR-16

## 5.6 STD5 – Account Update

STD Identifier: STD5 Account update	Responsibilities
Description: The User selects Account Update from the menu and a balance is displayed for the account.	
External Actors: User	
Precondition: ATM is in the transaction state.	
Triggering Event: User selects Account Update from the menu.	
<ol style="list-style-type: none"> <li>1. User selects Account Update from the menu.</li> <li>2. CBS provides a list of accessible User accounts.</li> <li>3. ATM displays the accounts.</li> <li>4. The User chooses an account from the list.</li> <li>5. ATM collects the information.</li> <li>6. CBS sends the account information to the ATM.</li> <li>7. ATM displays the account balance to the User.</li> <li>8. User is prompted to print the transaction</li> </ol>	<p>A-FR-4</p> <p>C-FR-1</p> <p>A-NFR-1</p> <p>A-FR-14</p> <p>C-FR-1</p> <p>A-NFR-1</p> <p>A-FR-6</p>
Postcondition: ATM is in transaction state.	
Resulting Event: The User makes a choice at the prompt.	
Alternatives:	
<p>Nonfunctional Requirements:</p> <ul style="list-style-type: none"> <li>- If the User has a bank account, then the User should be able to view account balances from an ATM.</li> </ul>	<p>S-7</p>
<p>Comments: The User pressing the CANCEL button at any input prompt results in the ATM returning to the transaction state.</p>	<p>A-FR-16</p>

### 5.7 STD6 – Print Transaction Record

STD Identifier: STD6 Print Transaction Record	Responsibilities
Description: ATM prints a record after a transaction.	
External Actors: User	
Precondition: ATM is in the print state.	
Triggering Event: The User chooses to print after a transaction.	
<ol style="list-style-type: none"> <li>1. The User chooses to print after a transaction.</li> <li>2. Printer checks for sufficient ink and paper to print a record.</li> <li>3. Printer gets the balance from the CBS.</li> <li>4. Printer prints the transaction record.</li> <li>5. ATM returns to transaction menu.</li> </ol>	<p>A-FR-14</p> <p>A-FR-11</p> <p>C-FR-1</p> <p>A-FR-6</p> <p>A-FR-4</p>
Postcondition: ATM is in transaction state.	
Resulting Event: The User is returned to the transaction menu.	
Alternatives:	
ALT-1 If the User does not choose to print after a transaction; <ol style="list-style-type: none"> <li>6. The ATM returns to the transaction menu.</li> </ol>	A-FR-6
ALT-2 If there are insufficient materials; <ol style="list-style-type: none"> <li>7. The User will be notified of insufficient materials.</li> <li>8. The User will be returned to the transaction menu.</li> </ol>	A-FR-11
Nonfunctional Requirements:	
Comments:	

## 5.8 STD7 – Exit

STD Identifier: STD7 Exit	Responsibilities
Description: User completes session with ATM and retrieves card.	
External Actors: User	
Precondition: ATM is in transaction state	
Triggering Event: The User selects Exit from the menu.	
<ol style="list-style-type: none"> <li>1. User selects Exit from the menu.</li> <li>2. ATM returns the card.</li> </ol>	<p>A-FR-14</p> <p>A-FR-7</p>
Postcondition: The ATM is in the idle state.	
Resulting Event: The User retrieves the card from ATM.	
<p>Alternatives:</p> <p>ALT-1 <u>If the card isn't retrieved;</u></p> <p>3. <u>The ATM withholds the card and the CBS suspends the account.</u></p>	<p>A-FR-16;</p> <p>C-FR-4</p>
Nonfunctional Requirements:	
Comments:	

## 5.9 STD8 – Maintenance

STD Identifier: STD8 Maintenance	Responsibilities
Description: User completes session with ATM and retrieves card.	
External Actors: Administrator	
Precondition: ATM is in idle state.	
Triggering Event: The ATM is shut down.	
1. The ATM is shut down.	A-NFR-9
2. The Administrator removes from the card reader any cards that have been swallowed.	A-FR-16
3. The Administrator refills the envelope drawer with envelopes.	A-NFR-10
4. The Administrator removes any envelopes that have been deposited into the envelope feeder.	A-NFR-11
5. The Administrator refills the cash dispenser cash supply.	A-NFR-12
6. The Administrator refills the printer paper supply.	A-NFR-13
7. The Administrator reboots the ATM.	A-NFR-9
Postcondition: The ATM is in the idle state.	
Resulting Event: The ATM resumes operation.	
Alternatives:	
Nonfunctional Requirements:	
Comments: The Administrator shuts down the ATM by inserting a key into ATM housing unit. On unlocking the housing, the ATM shuts down. Once the housing is locked, the ATM reboots.	A-NFR-8

### 5.10 STD9 – Communication Failure

STD Identifier: STD9 Communication Failure	Responsibilities
Description: During a session, when the ATM is unable to communicate with the CBS, the ATM shuts down and returns the card to the User.	
External Actors: User	
Precondition: ATM is in transaction state.	
Triggering Event: The ATM does not receive a response from the CBS.	
<ol style="list-style-type: none"> <li>1. The ATM attempts to establish or use a connection with the CBS.</li> <li>2. The CBS does not respond within 20 seconds.</li> <li>3. The User's card is returned.</li> <li>4. The ATM is shut down.</li> </ol>	<p>S-3 C-NFR-2 A-FR-7 A-NFR-9</p>
Postcondition: The ATM is shut down.	
Resulting Event: The User retrieves the card from the ATM.	
Alternatives:	
Nonfunctional Requirements:	
Comments:	

## 6 Use Case Maps

This section shows the Use Case Maps (UCMs) for the CUB system. UCMs are provided for Card Entry, Withdraw, Deposit, Bill Payment, Account Update, Print Transaction Record, Exit, Maintenance and Communication Failure. For traceability the first portion of this section provides a cross-referencing table for referencing between the Scenario Textural Descriptions and the Use Case Maps. For clarity and simplicity, each UCM contains a minimal set of (significant) alternatives.

Use Case Map notation is as follows:

- teX – where X is a unique integer. Denotes the UCM's triggering event.
- reX – where X is a unique integer. Denotes the UCM's resulting event.
- rX – where X is a unique integer. Denotes a UCM responsibility.
- ALT-X – where X is a unique integer. Denotes an alternate event.

### 6.1 Cross Referencing Table

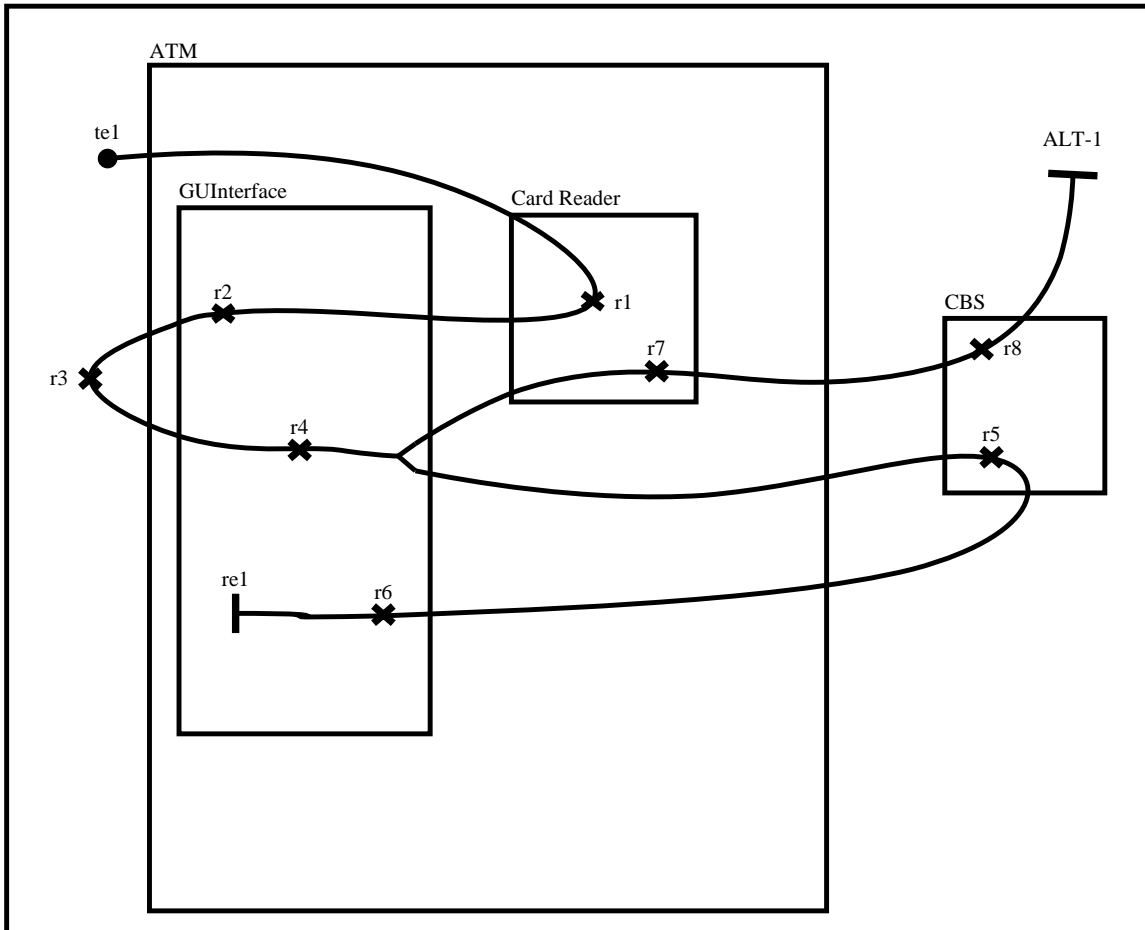
The cross-reference table provides a cross-referencing mechanism for the Use Case Maps and the Scenario Textural Descriptions. The responsibilities of the Use Case Maps are cross-referenced to the numbered steps of the Scenario Textural Descriptions.

UCM-#, responsibility	STD-#, step number
UCM-1, r1	STD-1, 1
UCM-1, r2	STD-1, 2
UCM-1, r3	STD-1, 3
UCM-1, r4	STD-1, 4
UCM-1, r5	STD-1, 5
UCM-1, r6	STD-1, 6
UCM-1, r7	STD-1, 7
UCM-1, r8	STD-1, 8
UCM-2, r1	STD-2, 1
UCM-2, r2	STD-2, 2
UCM-2, r3	STD-2, 3
UCM-2, r4	STD-2, 4
UCM-2, r5	STD-2, 5
UCM-2, r6	STD-2, 6
UCM-2, r7	STD-2, 7
UCM-2, r8	STD-2, 8
UCM-2, r9	STD-2, 9
UCM-2, r10	STD-2, 10
UCM-2, r11	STD-2, 11
UCM-2, r12	STD-2, 12
UCM-2, r13	STD-2, 13
UCM-2, r14	STD-2, 14

UCM-2, r15	STD-2, 15
UCM-3, r1	STD-3, 1
UCM-3, r2	STD-3, 2
UCM-3, r3	STD-3, 3
UCM-3, r4	STD-3, 4
UCM-3, r5	STD-3, 5
UCM-3, r6	STD-3, 6
UCM-3, r7	STD-3, 7
UCM-3, r8	STD-3, 8
UCM-3, r9	STD-3, 9
UCM-3, r10	STD-3, 10
UCM-3, r11	STD-3, 11
UCM-3, r12	STD-3, 12
UCM-3, r13	STD-3, 13
UCM-4, r1	STD-4, 1
UCM-4, r2	STD-4, 2
UCM-4, r3	STD-4, 3
UCM-4, r4	STD-4, 4
UCM-4, r5	STD-4, 5
UCM-4, r6	STD-4, 6
UCM-4, r7	STD-4, 7
UCM-4, r8	STD-4, 8
UCM-4, r9	STD-4, 9
UCM-4, r10	STD-4, 10
UCM-4, r11	STD-4, 11
UCM-4, r12	STD-4, 12
UCM-4, r13	STD-4, 13
UCM-4, r14	STD-4, 14
UCM-4, r15	STD-4, 15
UCM-4, r16	STD-4, 16
UCM-4, r17	STD-4, 17
UCM-5, r1	STD-5, 1
UCM-5, r2	STD-5, 2
UCM-5, r3	STD-5, 3
UCM-5, r4	STD-5, 4
UCM-5, r5	STD-5, 5
UCM-5, r6	STD-5, 6
UCM-5, r7	STD-5, 7
UCM-5, r8	STD-5, 8
UCM-6, r1	STD-6, 1
UCM-6, r2	STD-6, 2
UCM-6, r3	STD-6, 3
UCM-6, r4	STD-6, 4
UCM-6, r5	STD-6, 5

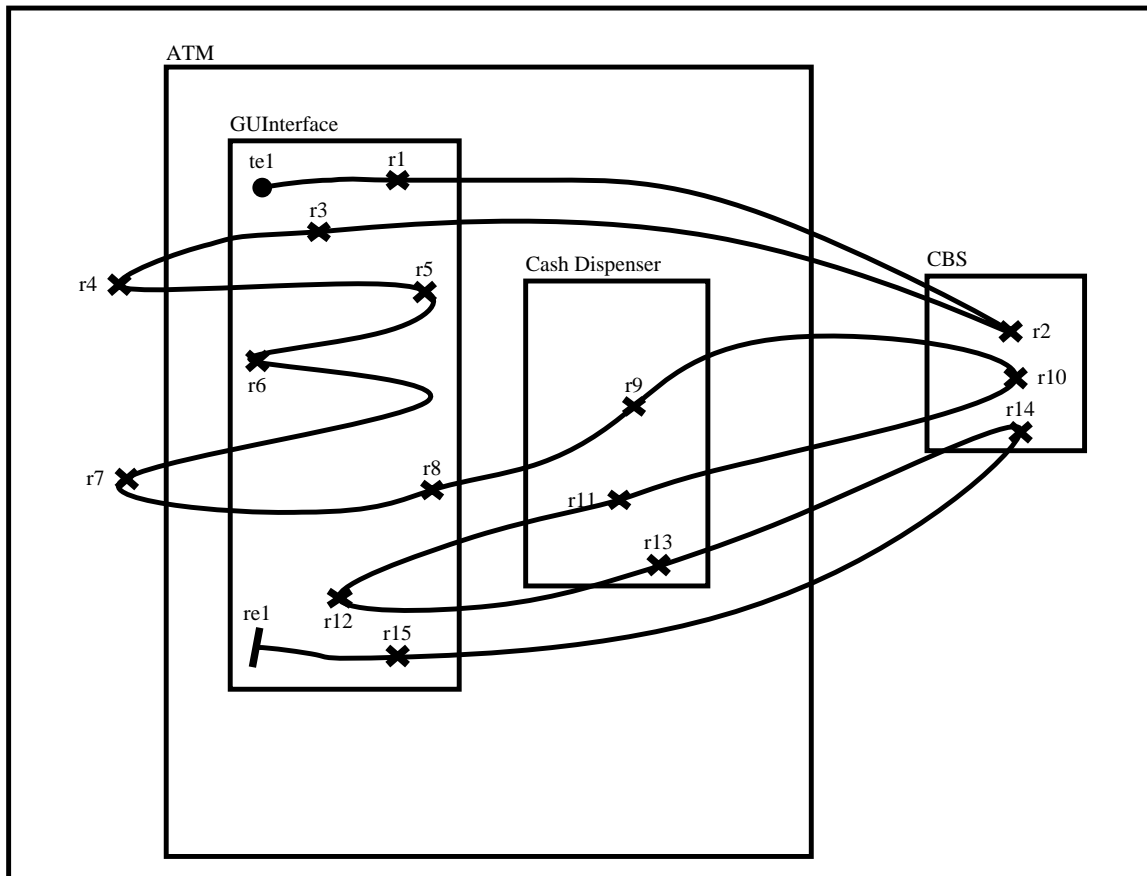
UCM-6, r7	STD-6, 7
UCM-6, r8	STD-6, 8
UCM-7, r1	STD-7, 1
UCM-7, r2	STD-7, 2
UCM-8, r1	STD-8, 1
UCM-8, r2	STD-8, 2
UCM-8, r3	STD-8, 3
UCM-8, r4	STD-8, 4
UCM-8, r5	STD-8, 5
UCM-8, r6	STD-8, 6
UCM-8, r7	STD-8, 7
UCM-9, r1	STD-9, 1
UCM-9, r2	STD-9, 2
UCM-9, r3	STD-9, 3
UCM-9, r4	STD-9, 4

## 6.2 UCM – 1 Card Entry



- te1      User inserts a card into the card reader.
- re1      The transaction menu is shown on the display.
- ALT-1    The ATM returns to the idle state.
- r1        User inserts the card into the reader.
- r2        ATM prompts the User to enter the PIN.
- r3        User enters the PIN.
- r4        The PIN is collected.
- r5        CBS validates the account number and PIN.
- r6        The transaction menu is shown on the display.
- r7        The bank card is withheld.
- r8        CBS suspends the account.

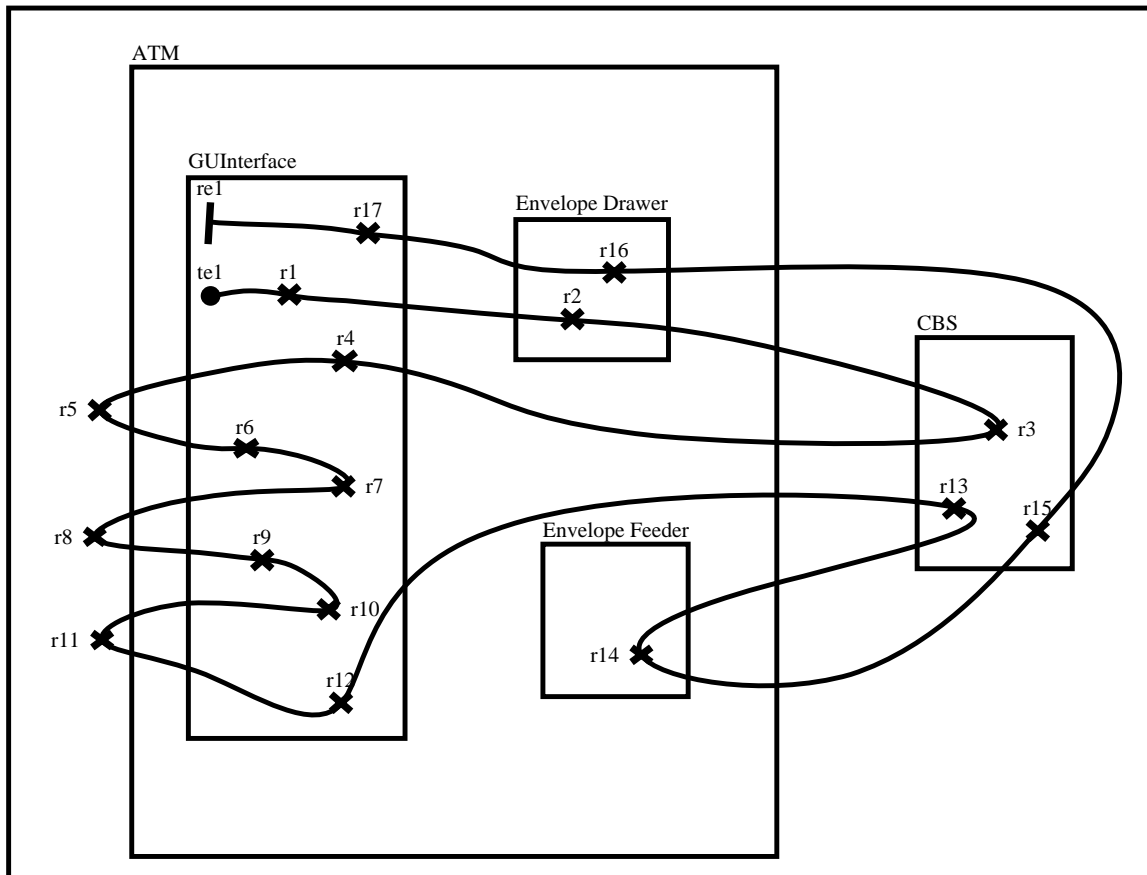
### 6.3 UCM – 2 Withdraw



- te1 User selects withdraw from the menu.
- re1 User is prompted to print a transaction record.
- r1 User selects withdraw from the menu
- r2 CBS provides a list of accessible User accounts.
- r3 ATM displays the accounts.
- r4 The User selects an account to withdraw from.
- r5 The ATM collects the information.
- r6 ATM prompts the User to enter the amount to withdraw.
- r7 The User enters the amount.
- r8 The ATM collects the information.
- r9 The ATM verifies that the amount is a multiple of 20 and that there is sufficient cash for the withdrawal.
- r10 CBS validates that the User has enough cash in the bank account.
- r11 ATM opens the cash dispenser and dispenses the cash.
- r12 User prompted to take money.
- r13 The cash dispenser is closed.
- r14 The CBS updates the account information and the transaction log.
- r15 The User is prompted to print a transaction record.

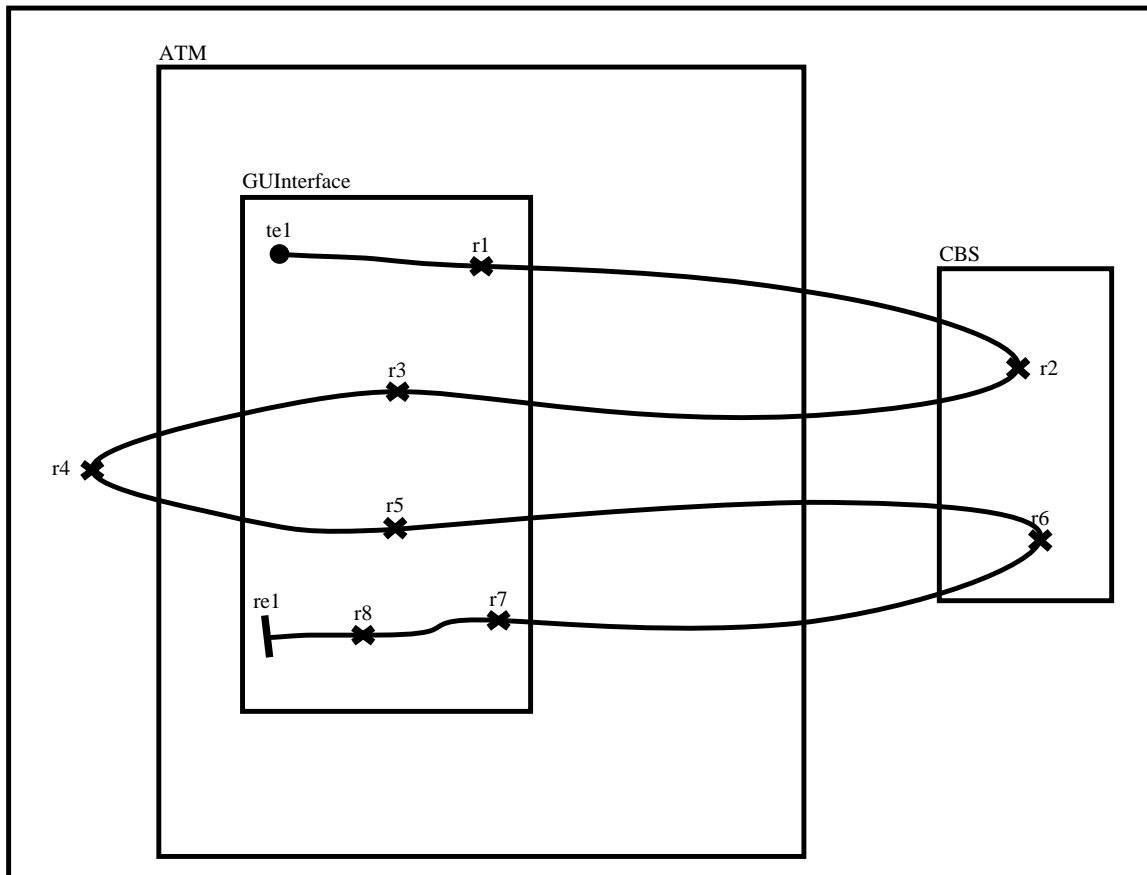


## 6.5 UCM – 4 Bill Payment



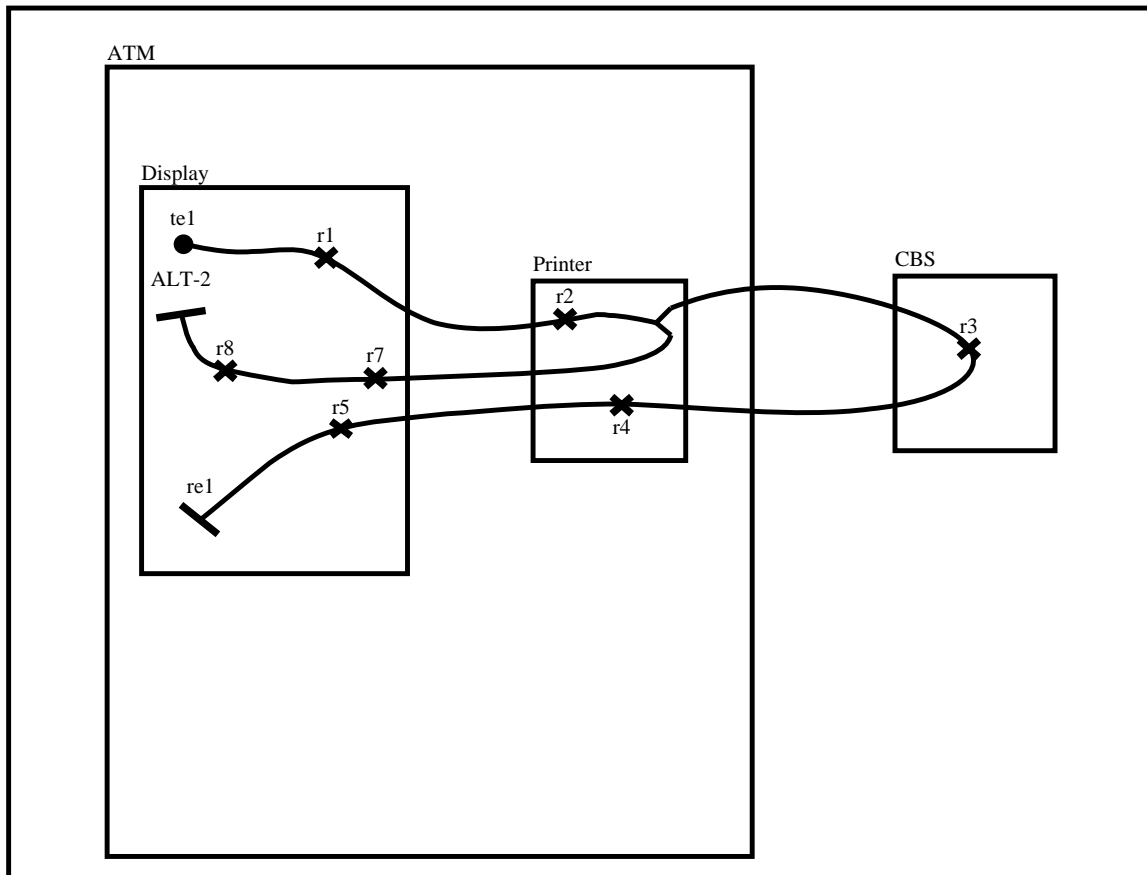
- te1 The User selects Payment from the menu.
- re1 The User makes a choice at the prompt.
- r1 The User selects Payment from the menu.
- r2 The envelope drawer is unlocked and it is verified that there are a sufficient number of envelopes.
- r3 CBS provides a list of accessible User accounts.
- r4 ATM displays the accounts.
- r5 The User chooses an account from the list
- r6 The ATM collects the information.
- r7 ATM prompts the User to enter the number of bills that will be paid.
- r8 The User enters the number between 1 and 3.
- r9 ATM collects the information.
- r10 The User is prompted to enter an amount for each bill.
- r11 For each bill, the User enters an amount to be paid.
- r12 ATM collects the information.
- r13 CBS validates that the User has enough cash in the bank account.
- r14 The User puts the bill stub(s) into an envelope then the envelope feeder accepts it.
- r15 The CBS updates the account information and the transaction log.
- r16 ATM locks the envelope drawer.
- r17 The User is prompted to print a transaction record.

## 6.6 UCM – 5 Account Update



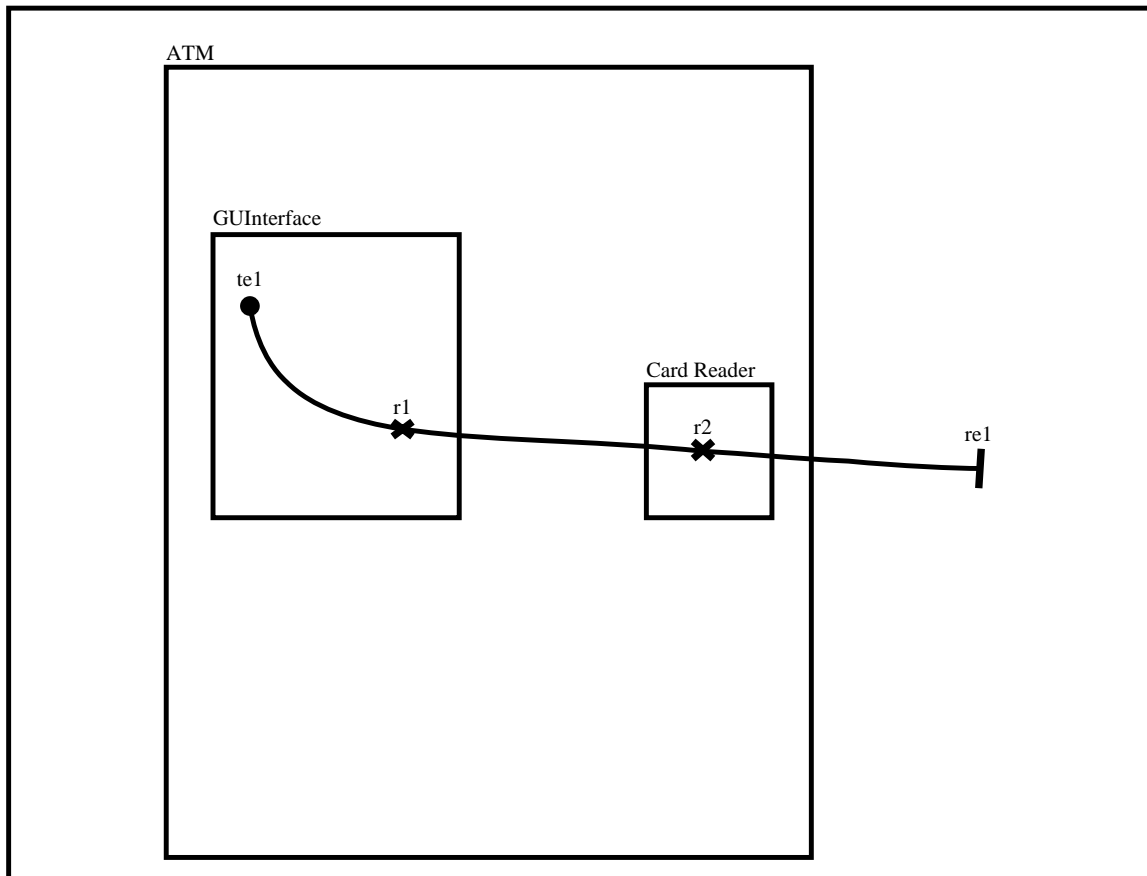
- te1 User selects Account Update from the menu.
- re1 The User makes a choice at the prompt.
- r1 User selects Account Update from the menu.
- r2 CBS provides a list of accessible User accounts.
- r3 ATM displays the accounts.
- r4 The User chooses an account from the list.
- r5 ATM collects the information.
- r6 CBS sends the account information to the ATM.
- r7 ATM displays the account balance to the User.
- r8 User is prompted to print the transaction.

## 6.7 UCM – 6 Print Transaction Record



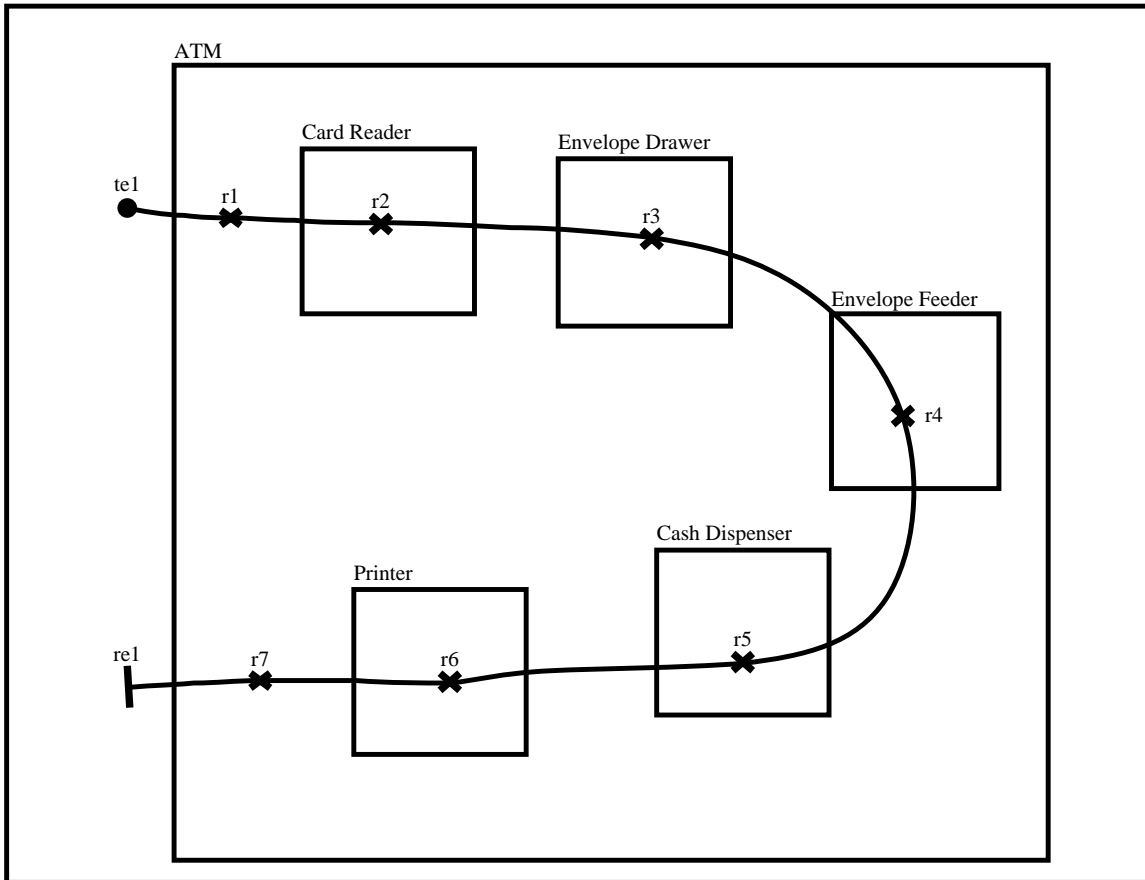
- te1        The User chooses to print after a transaction.
- re1        The User is returned to the transaction menu.
- ALT-2     There are insufficient materials in the printer.  
User returned to transaction menu.
- r1         The User chooses to print after a transaction.
- r2         Printer checks for sufficient ink and paper to print a record.
- r3         Printer gets the balance from the CBS.
- r4         Printer prints the transaction record.
- r5         ATM returns to transaction menu.
- r7         The User will be notified of insufficient materials.
- r8         The User will be returned to the transaction menu.

## 6.8 UCM – 7 Exit



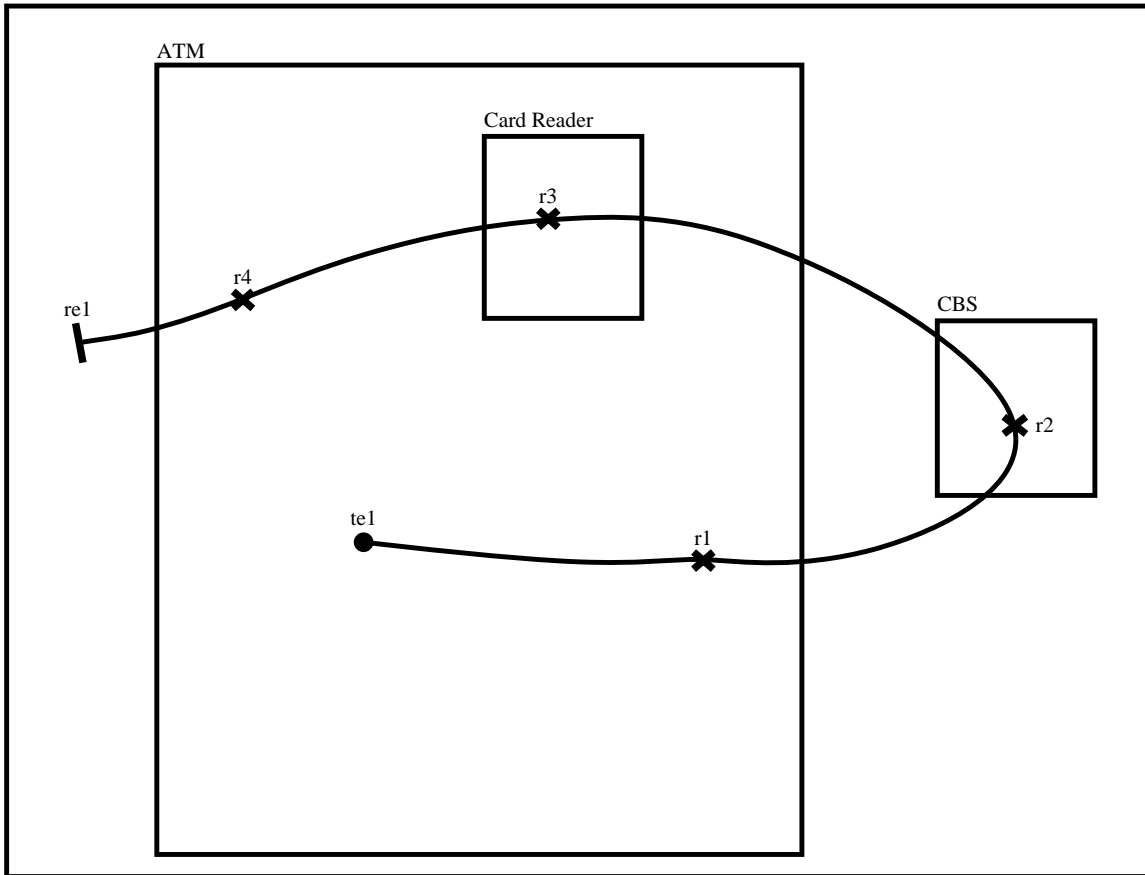
te1      The User selects Exit from the menu.  
re1      The User retrieves the card from ATM.  
r1      User selects Exit from the menu.  
r2      ATM returns the card.

## 6.9 UCM - 8 Maintenance



- tel      The ATM is shut down.  
rel      The ATM resumes operation.  
r1      The ATM is shut down.  
r2      The Administrator removes from the card reader any cards that have been swallowed.  
r3      The Administrator refills the envelope drawer with envelopes.  
r4      The Administrator removes any envelopes that have been deposited into the envelope feeder.  
r5      The Administrator refills the cash dispenser cash supply.  
r6      The Administrator refills the printer paper supply.  
r7      The Administrator reboots the ATM.

## 6.10 UCM – 9 Communication Failure



- te1 The ATM does not receive a response from the CBS.
- re1 The User retrieves the card from the ATM.
- r1 The ATM attempts to establish or use a connection with the CBS.
- r2 The CBS does not respond within 20 seconds.
- r3 The User's card is returned.
- r4 The ATM is shut down.

## 7 Message Sequence Charts

### 7.1 Responsibility Cross- Reference Table

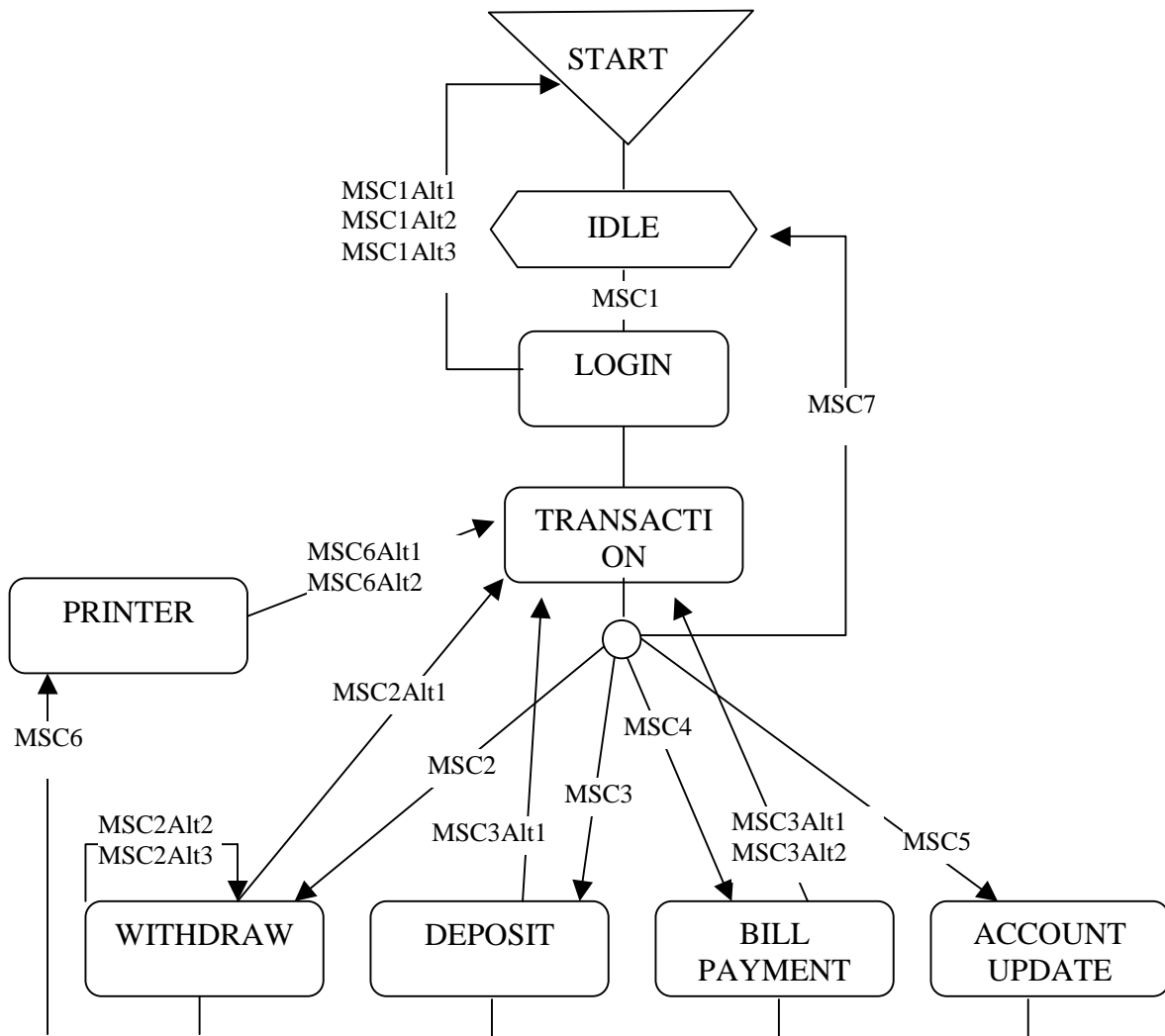
This table provides a cross-reference between the responsibilities shown in the simplified Use Case Maps and the messages in the Message Sequence Charts. Further alternate MSCs are available for viewing, but are not cross-referenced to any UCMs.

r# corresponds to a responsibility in a particular Use Case Map and MSC Message corresponds to a particular message name in a Message Sequence Chart .

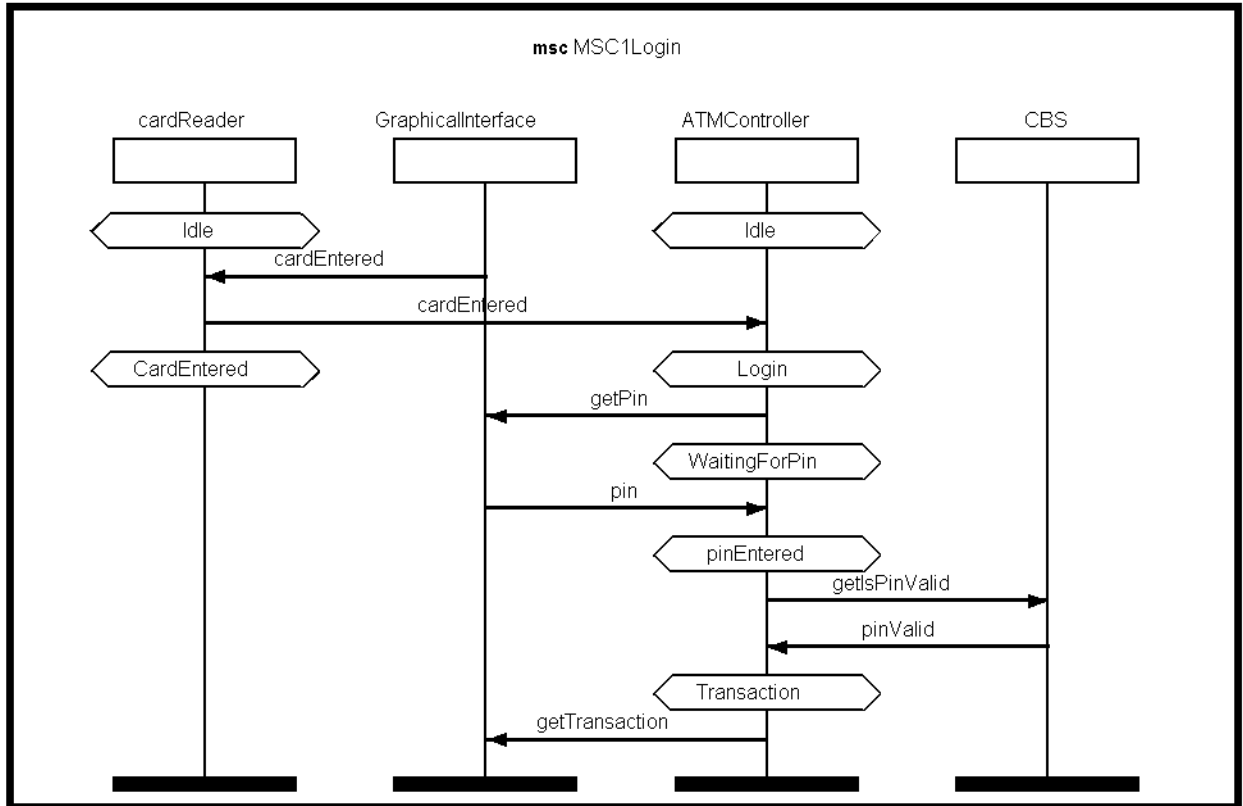
MSC Name	UCM-# Responsibility	MSC Message
MSC1Login	UCM-1 r1 UCM-1 r2 UCM-1 r4 UCM-1 r5 UCM-1 r6	cardEntered getPin pin getsPinValid, pinValid getTransaction
MSC1LoginAlt1	UCM-1 r7 UCM-1 r8	swallowCard lockAccount
MSC2Withdraw	UCM-2 r1 UCM-2 r2 UCM-2 r3 UCM-2 r4 UCM-2 r6 UCM-2 r8 UCM-2 r9 UCM-2 r10 UCM-2 r11 UCM-2 r12 UCM-2 r13 UCM-2 r14	withdraw getAccounts, sendAccounts getAccount account getAmount amount getSufficientBills, sufficientBills getDebitValid, debitValid dispenseCash cashTaken cashTaken debitAccount
MSC3Deposit	UCM-3 r1 UCM-3 r2  UCM-3 r3 UCM-3 r4 UCM-3 r5 UCM-3 r6 UCM-3 r7 UCM-3 r9 UCM-3 r10  UCM-3 r11 UCM-3 r12 UCM-3 r13	deposit checkDrawerEmptiness, drawerNotEmpty, openDrawer getAccounts sendAccounts getAccount account getAmount amount startEnvelopeFeeder, envelopeFeederDone closeDrawer creditAccount creditRegistered

MSC4BillPayment	UCM-4 r1 UCM-4 r2  UCM-4 r3 UCM-4 r4 UCM-4 r6 UCM-4 r7 UCM-4 r9 UCM-4 r10 UCM-4 r12 UCM-4 r13 UCM-4 r14 UCM-4 r15 UCM-4 r16	billPayment checkDrawerEmptiness, drawerNotEmpty, openDrawer getAccounts, sendAccounts getAccount account getNumberOfBills numberOfBills getAmount amount debitValid startEnvelopeFeeder, envelopeFeeder debitAccount, closeDrawer
MSC5AccountUpdate	UCM-5 r1 UCM-5 r2 UCM-5 r3 UCM-5 r5 UCM-5 r6 UCM-5 r7	accountUpdate getAccounts, sendAccounts getAccount account getAccountBalance balanceForCurrentAccount, displayUpdate
MSC6Printer	UCM-6 r1 UCM-6 r2 UCM-6 r3  UCM-6 r4 UCM-6 r5	getPrintoutRequest, printout checkPrintWorking, printerWorking getAccountBalance, balanceForCurrentAccount printData getTransaction
MSC6PrinterAlt2	UCM-6 r7	checkPrintWorking, printerBroken
MSC7Exit	UCM-7 r1 UCM-7 r2	cancelButton ejectCard
MSC8Maintenance	UCM-8 r1 UCM-8 r3 UCM-8 r4 UCM-8 r5 UCM-8 r6 UCM-8 r7	shutdown addEnvelopesToDrawer removeEnvelopesFromFeeder addBillsToDispenser addPaperToPrinter resume
MSC9CommFailure	UCM-9 r2 UCM-9 r3 UCM-9 r4	start, timeout, stop ejectCard cbsBroken

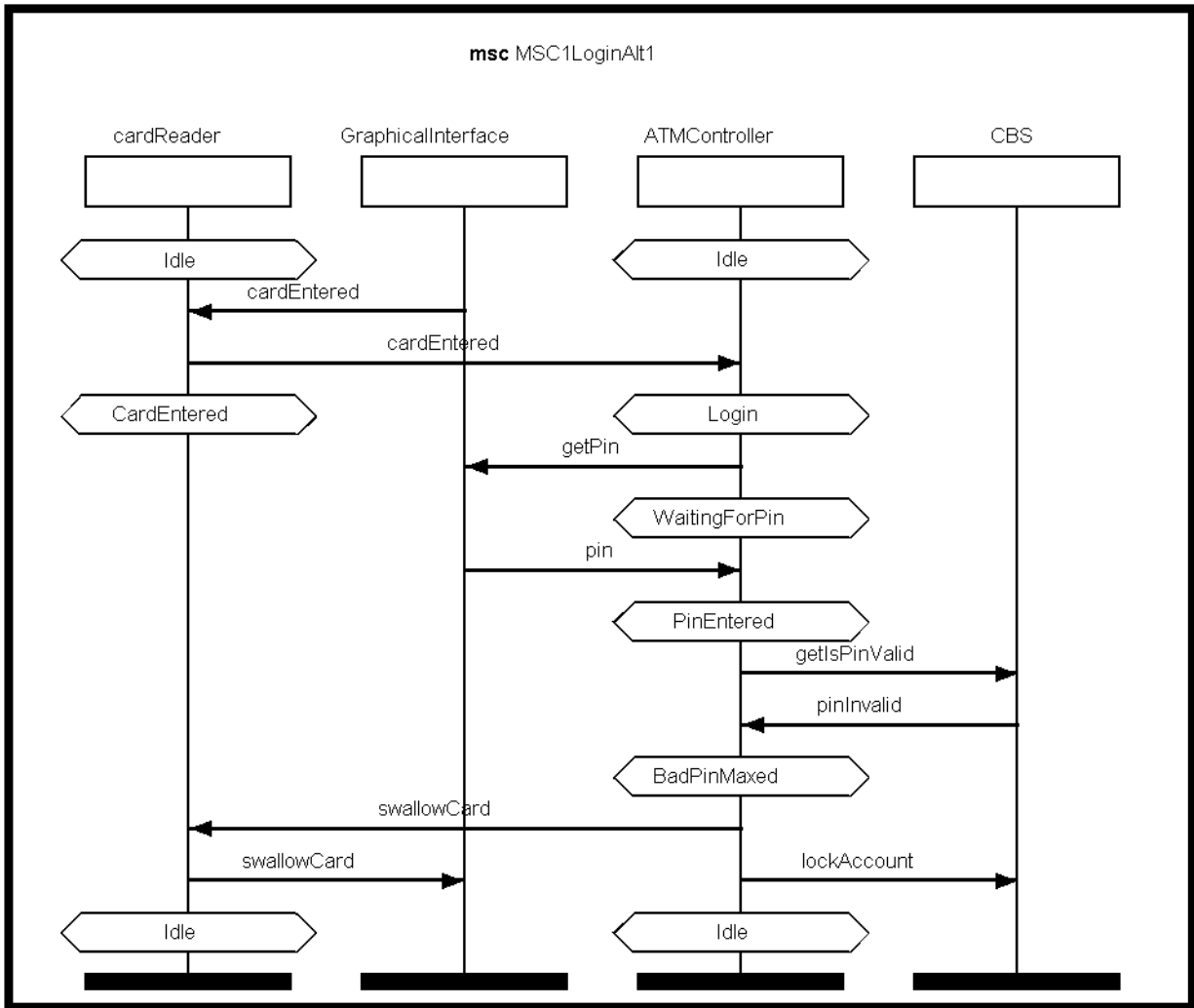
## 7.2 High Level MSC



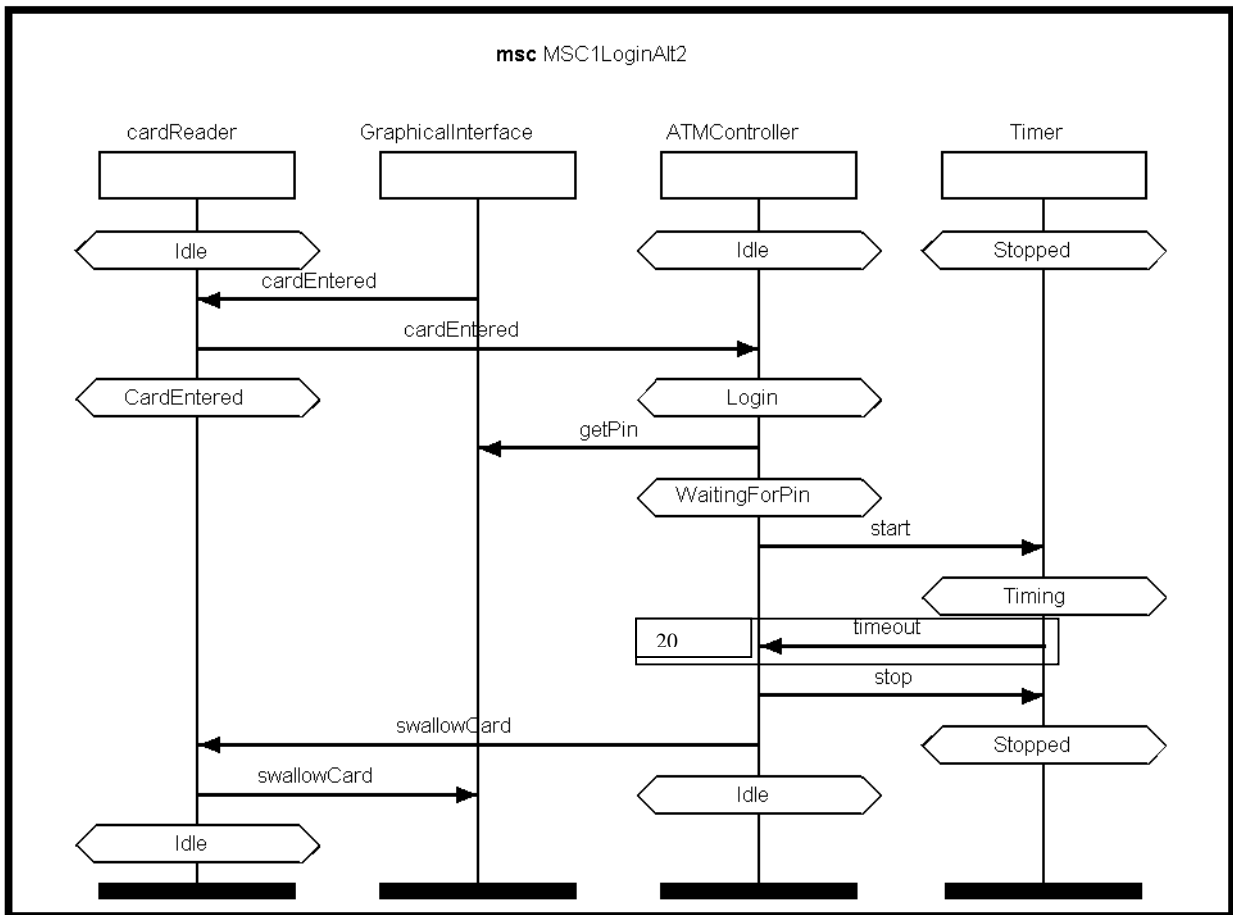
### 7.3 Login



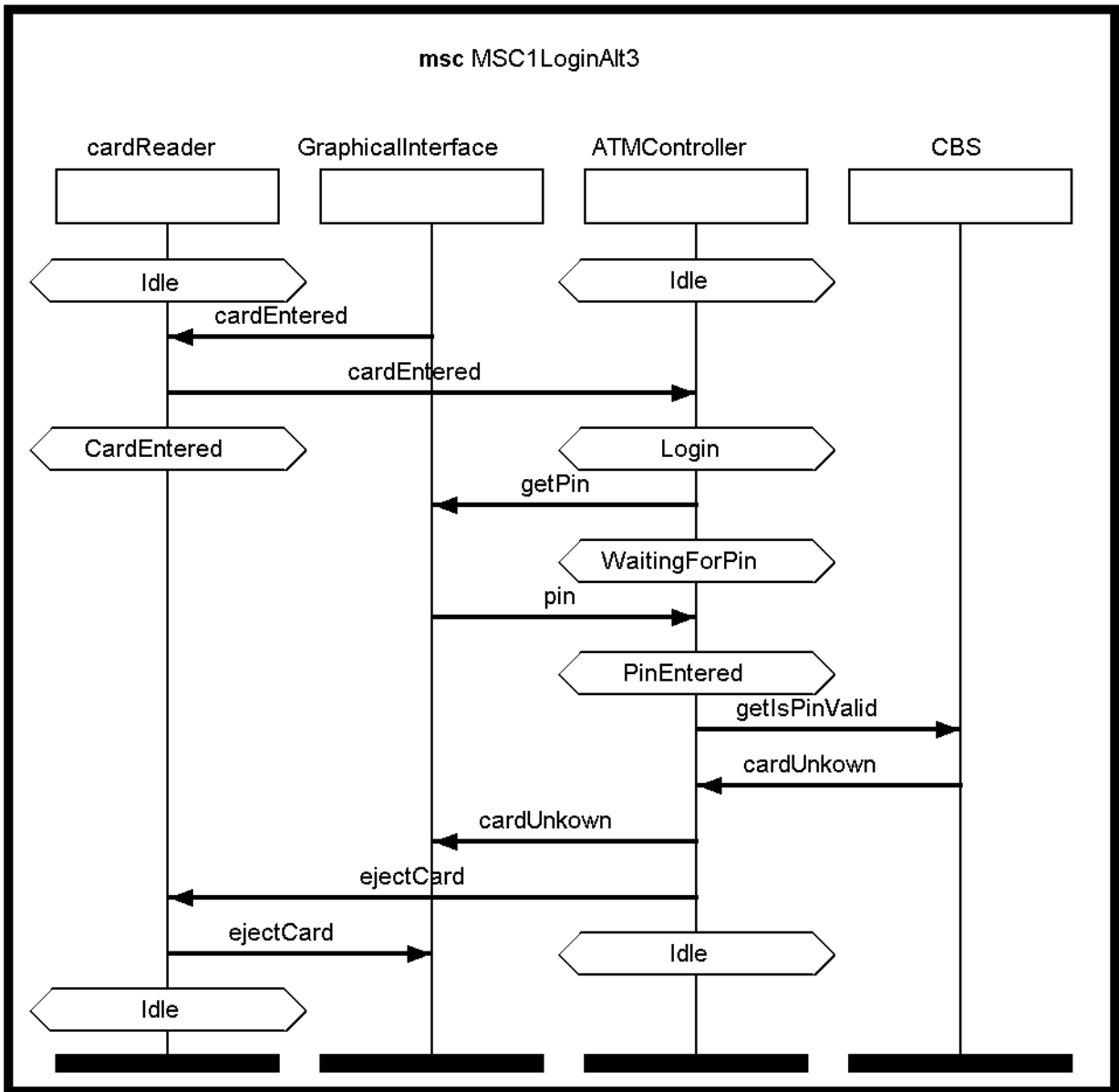
## 7.4 Login Alternate 1



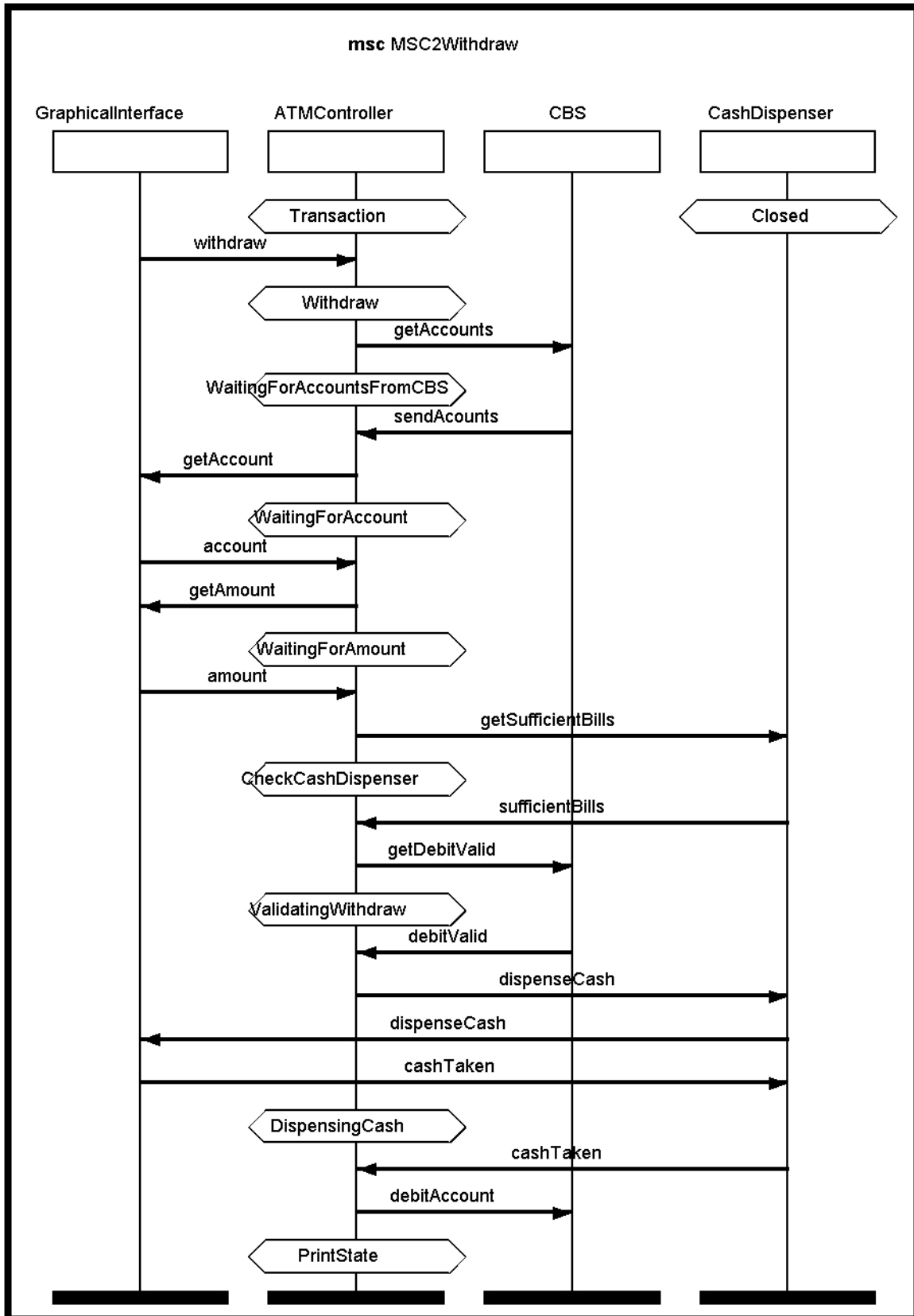
## 7.5 Login Alternate 2



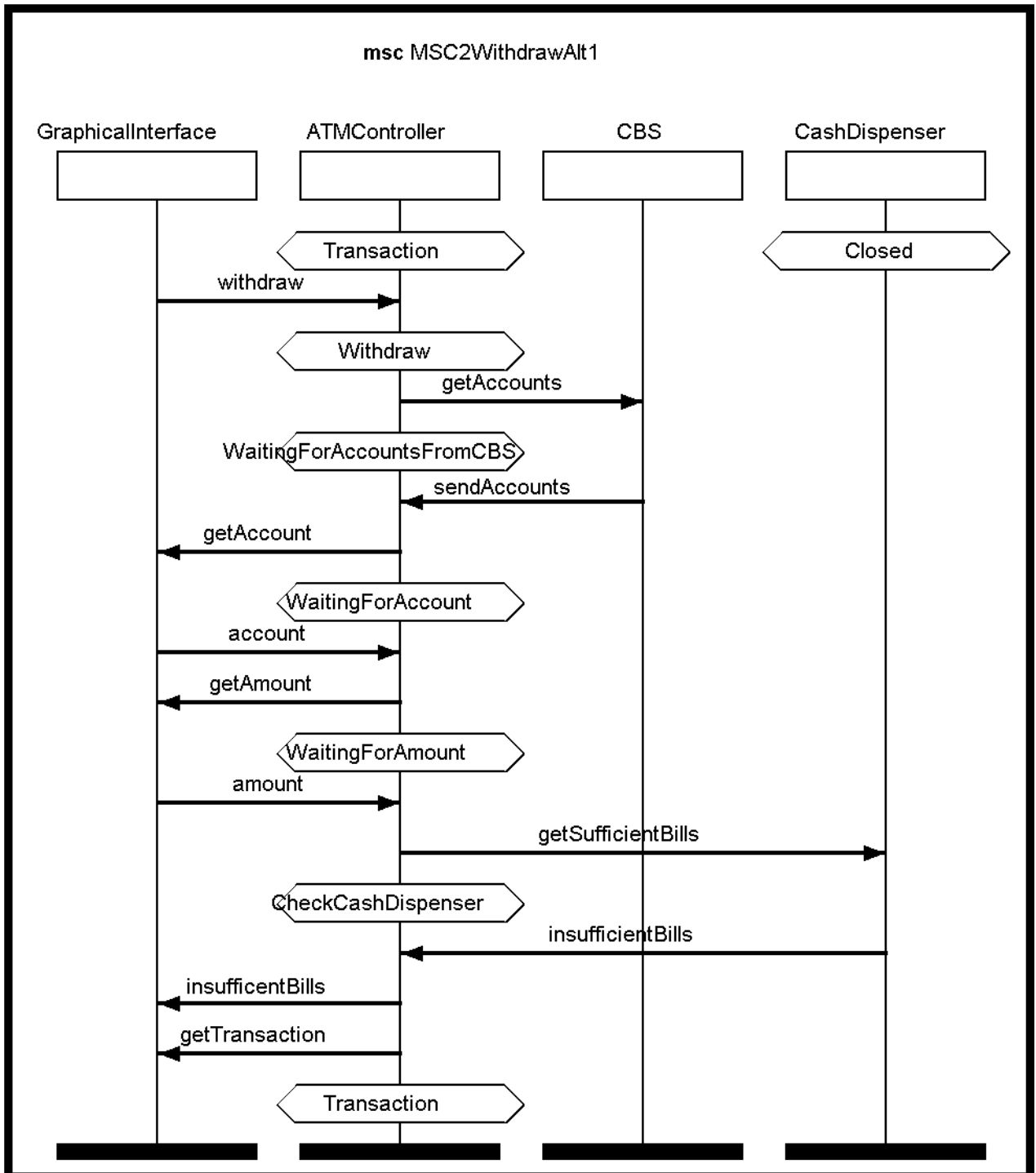
### 7.6 Login Alternate 3



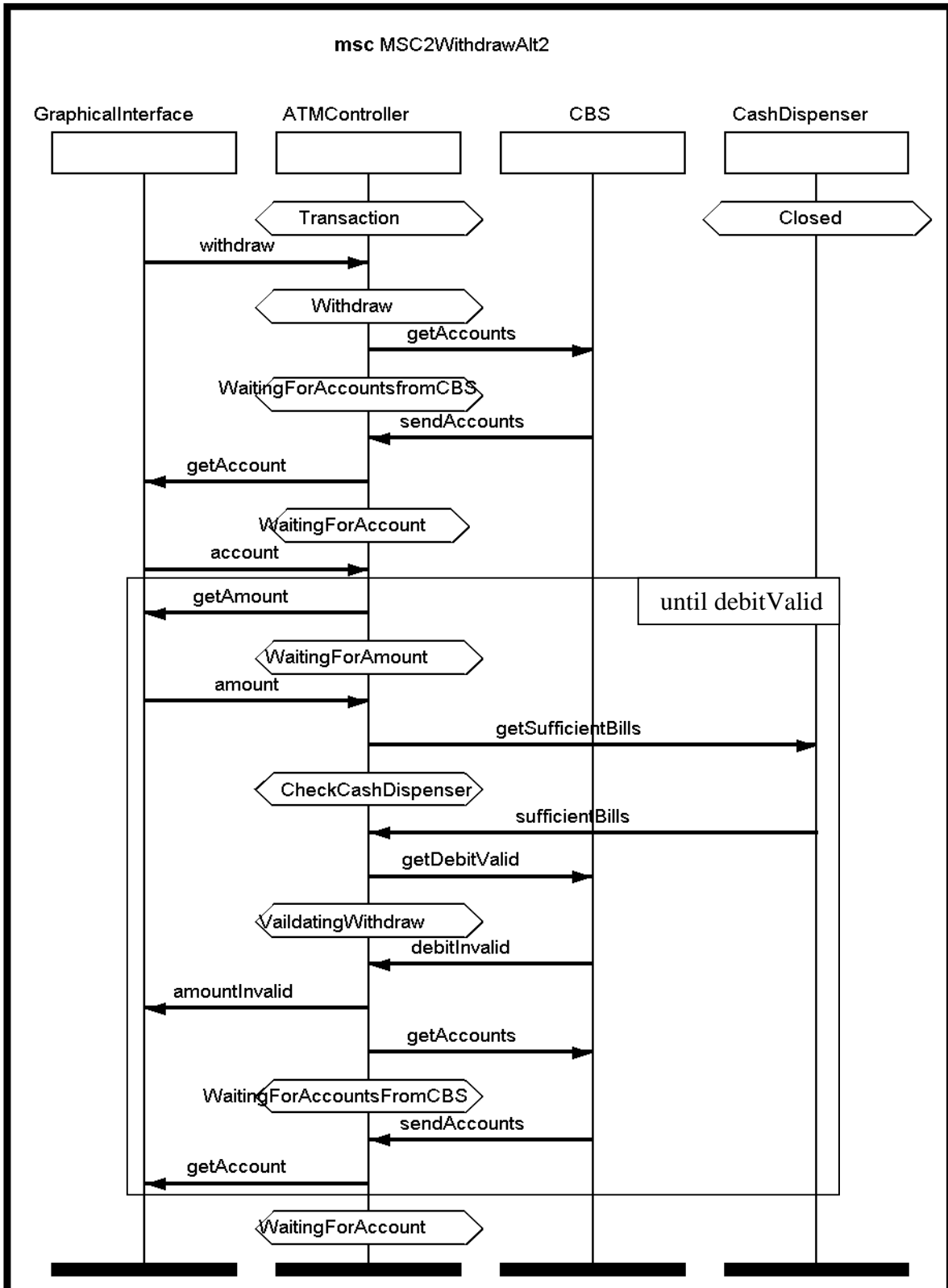
## 7.7 Withdraw



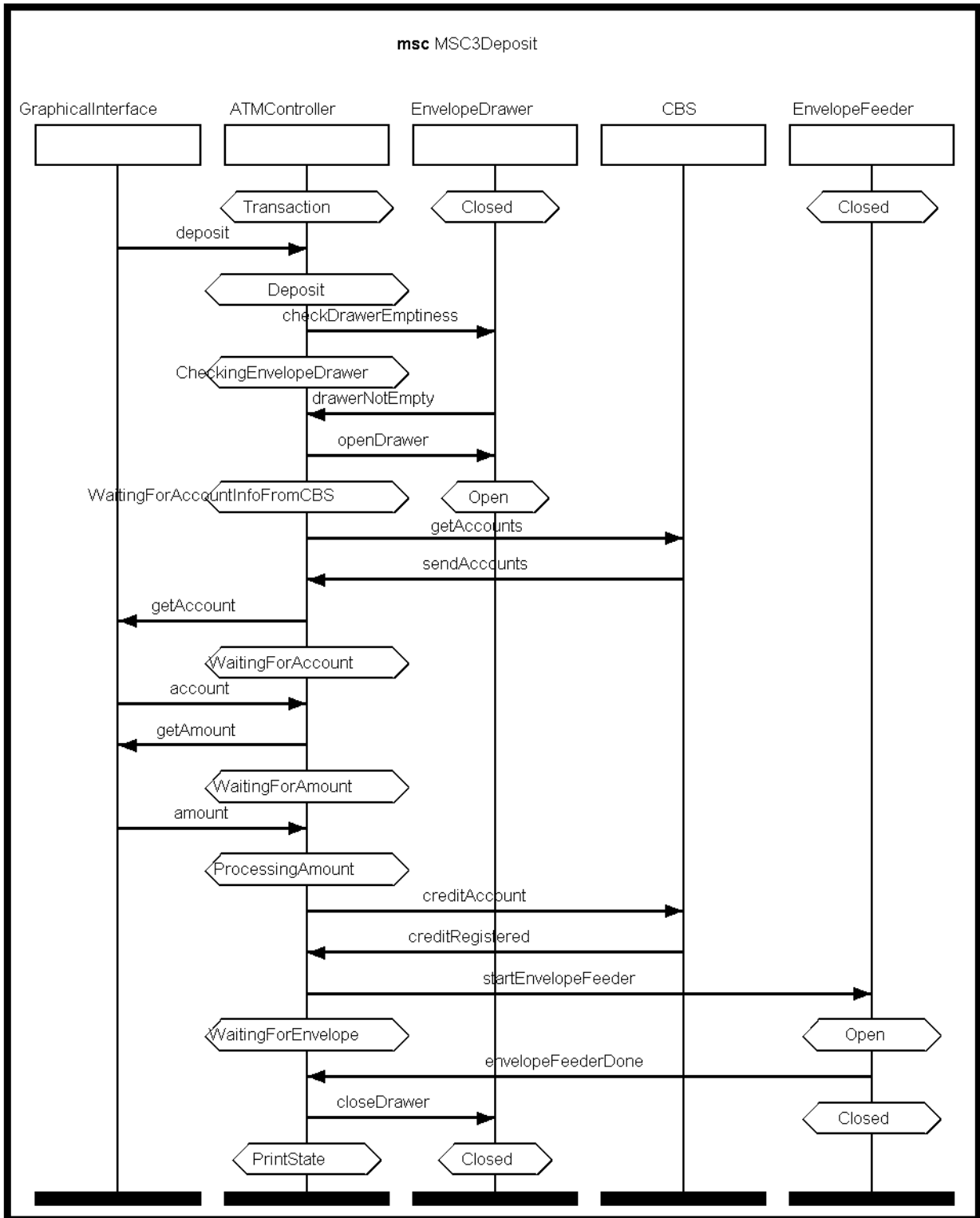
## 7.8 Withdraw Alternate 1



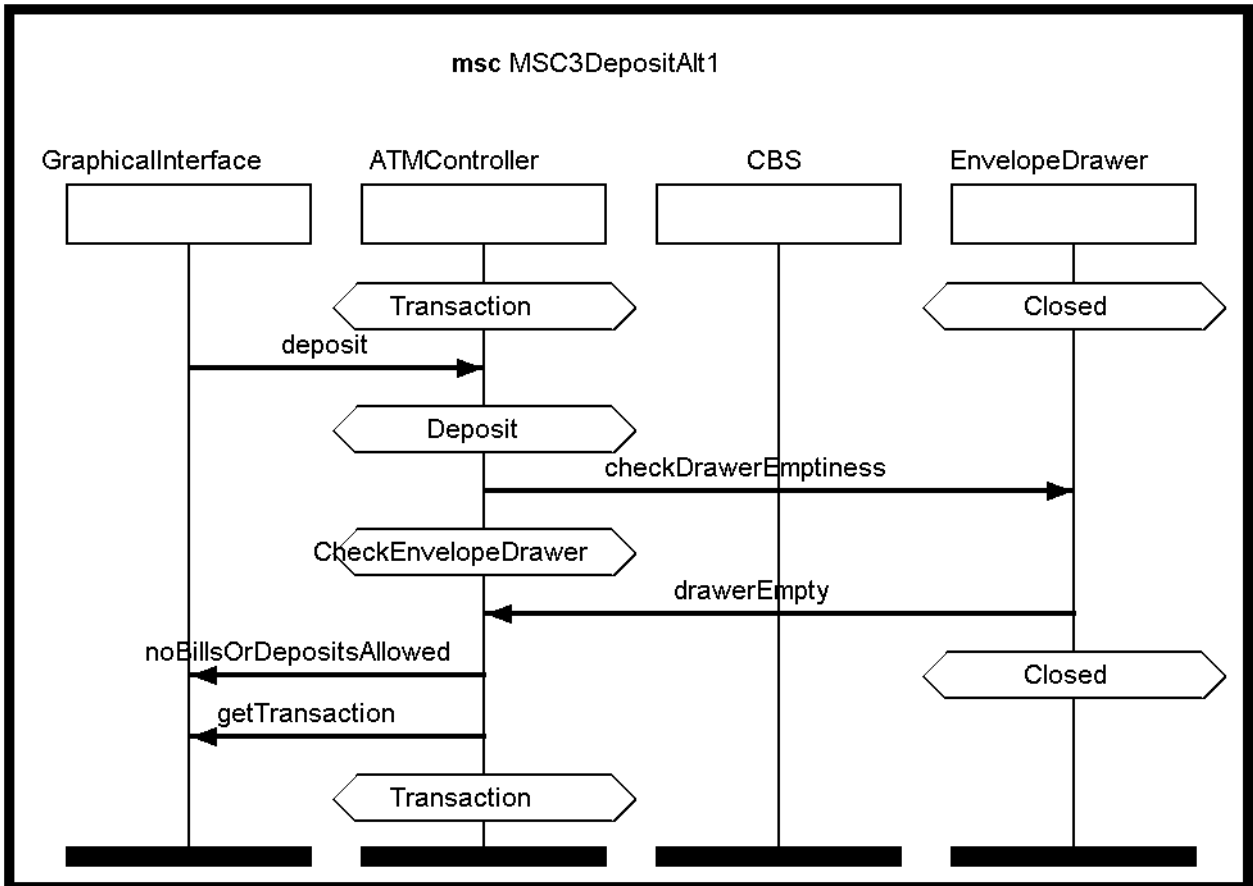
## 7.9 Withdraw Alternate 2



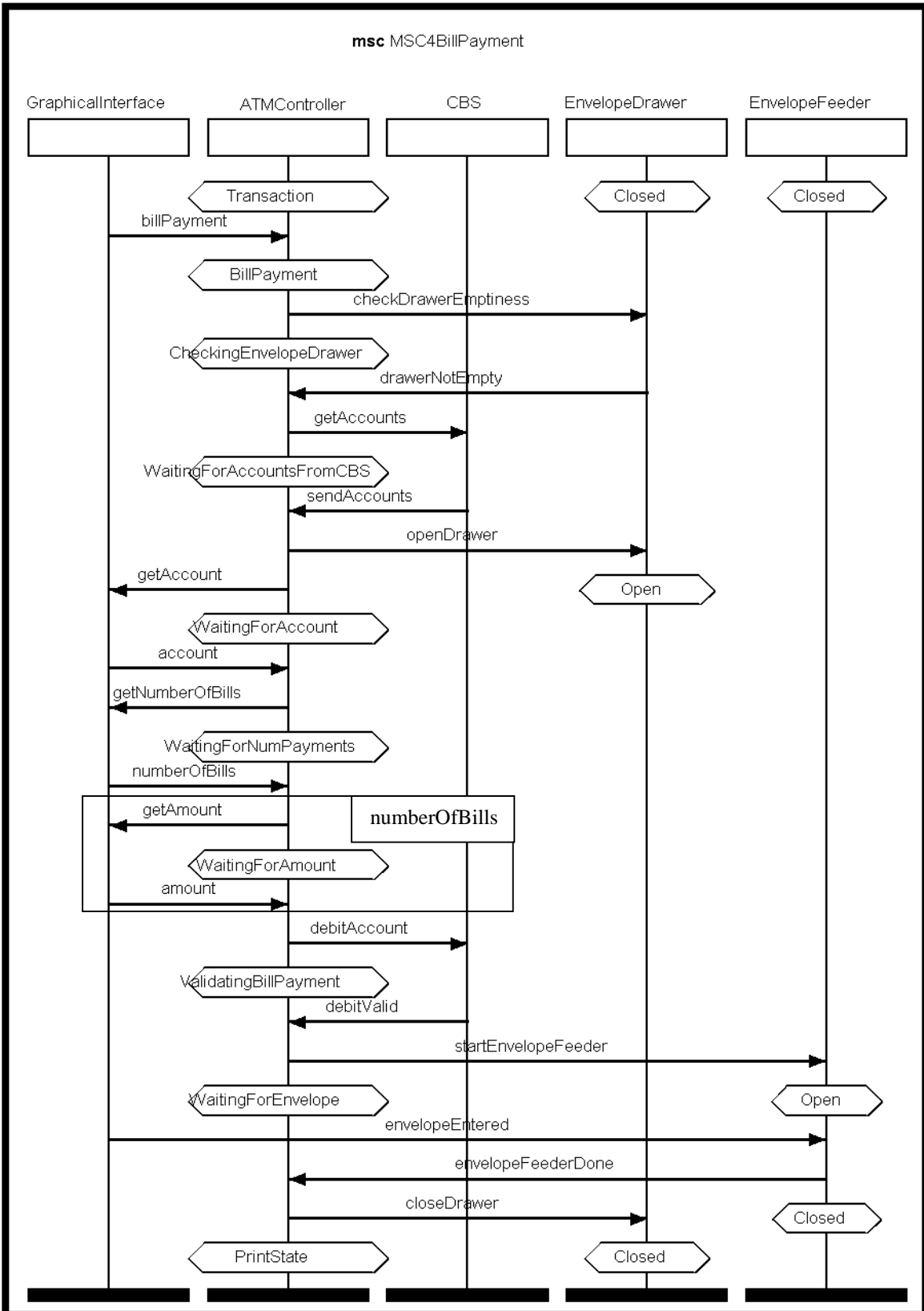
## 7.10 Deposit



### 7.11 Deposit Alternate 1

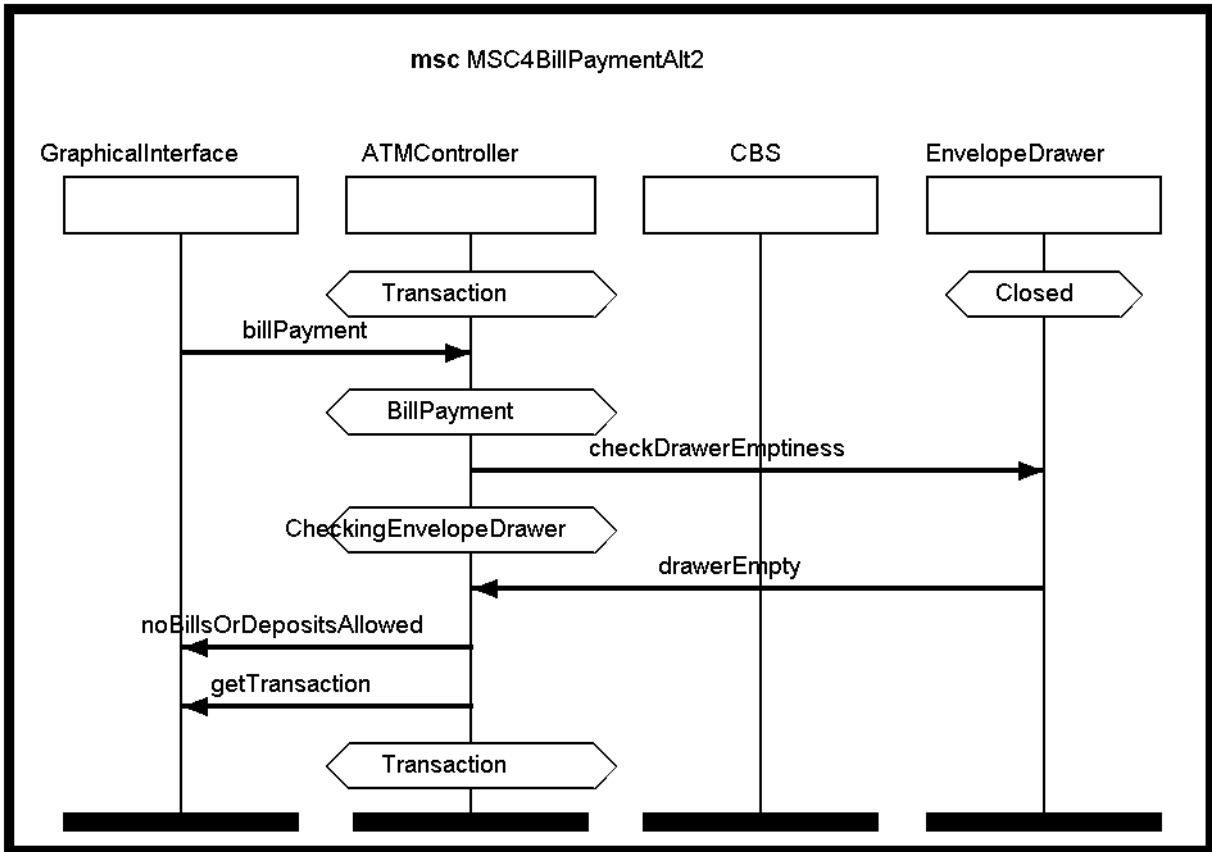


## 7.12 Bill Payment

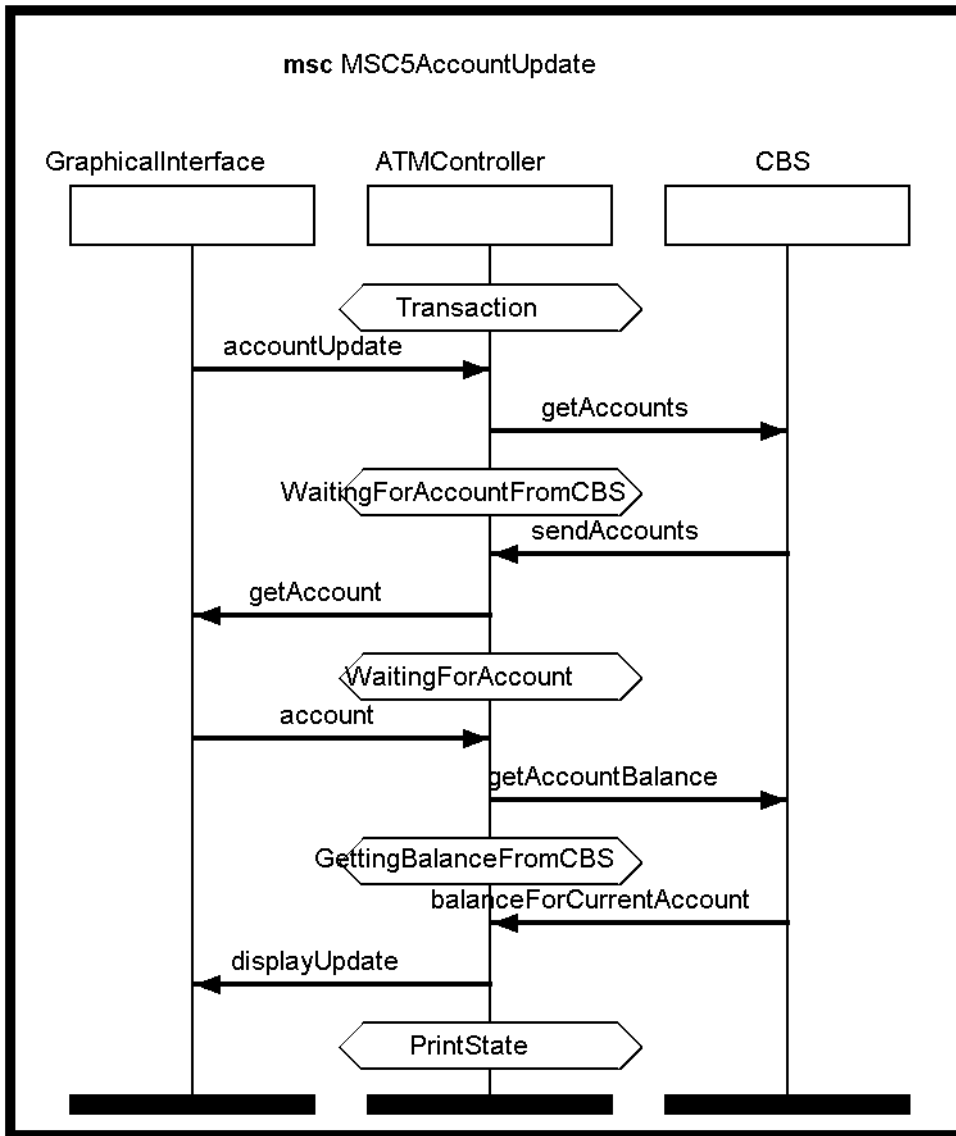




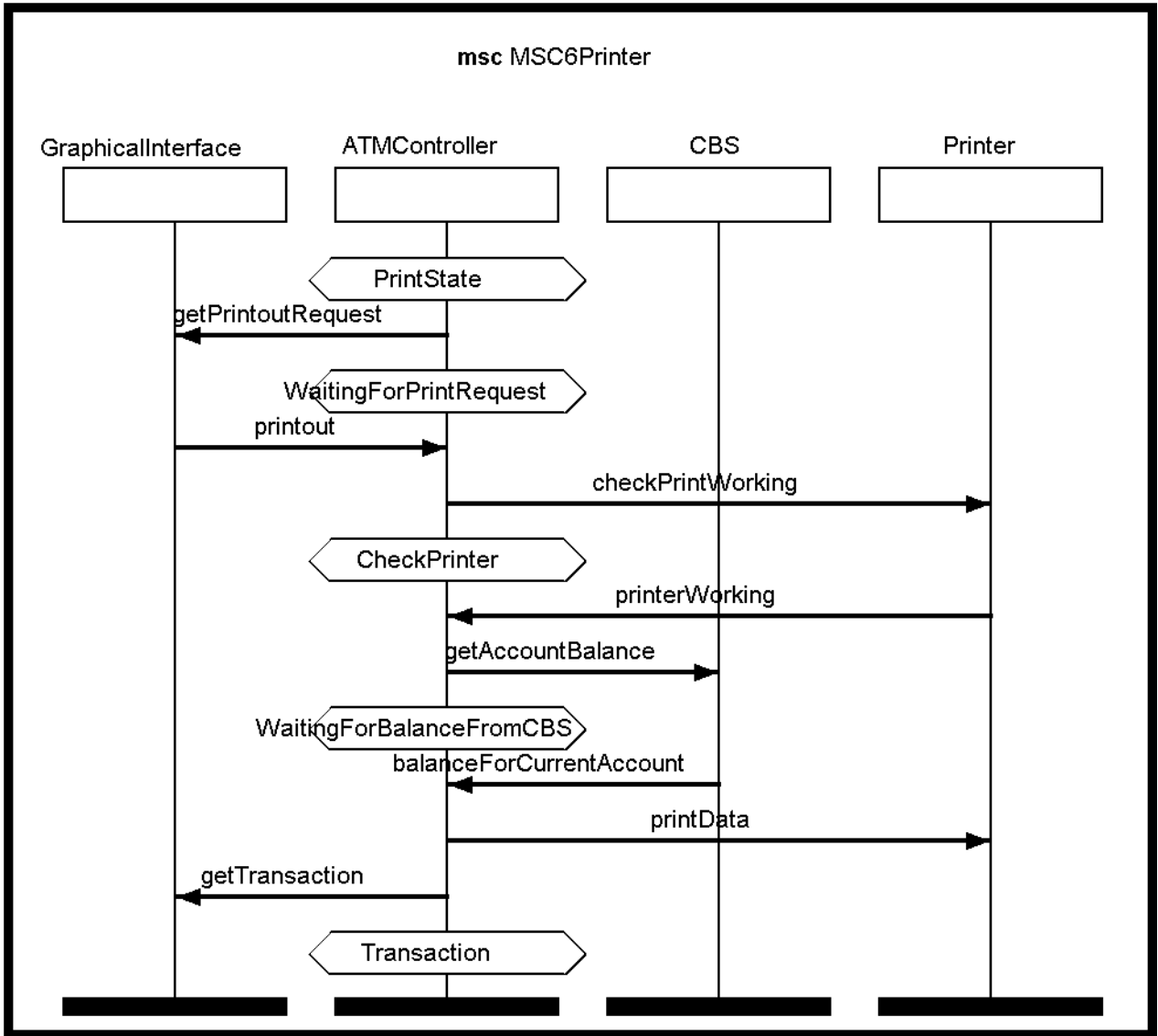
### 7.14 Bill Payment Alternate 2



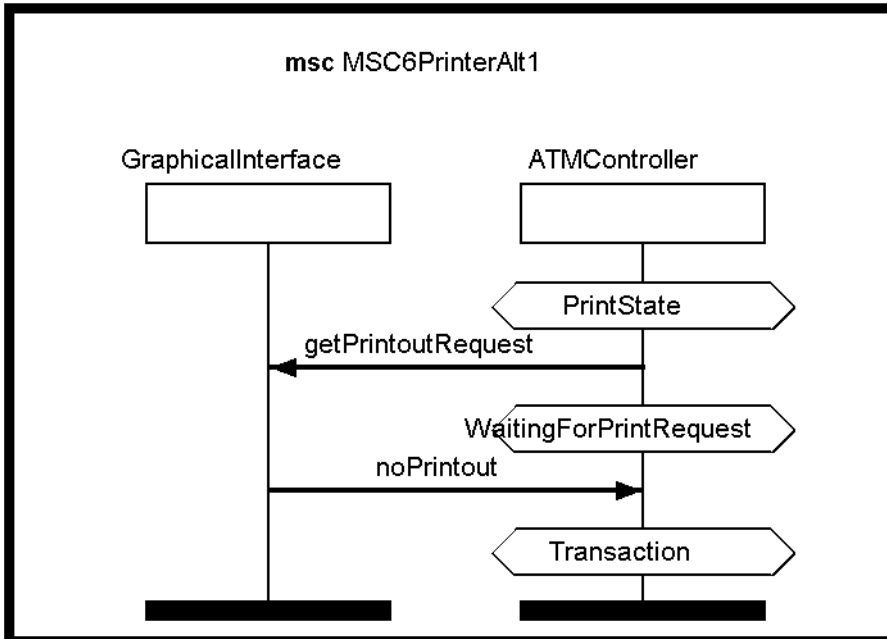
### 7.15 Account Update



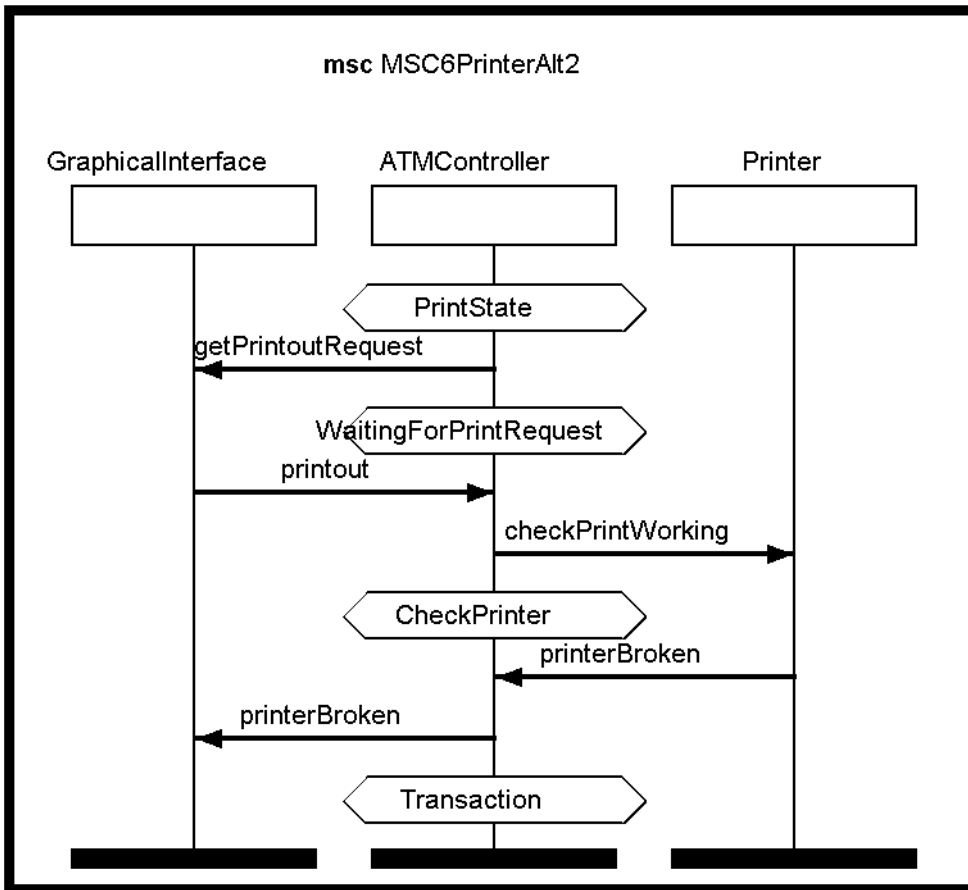
## 7.16 Printer



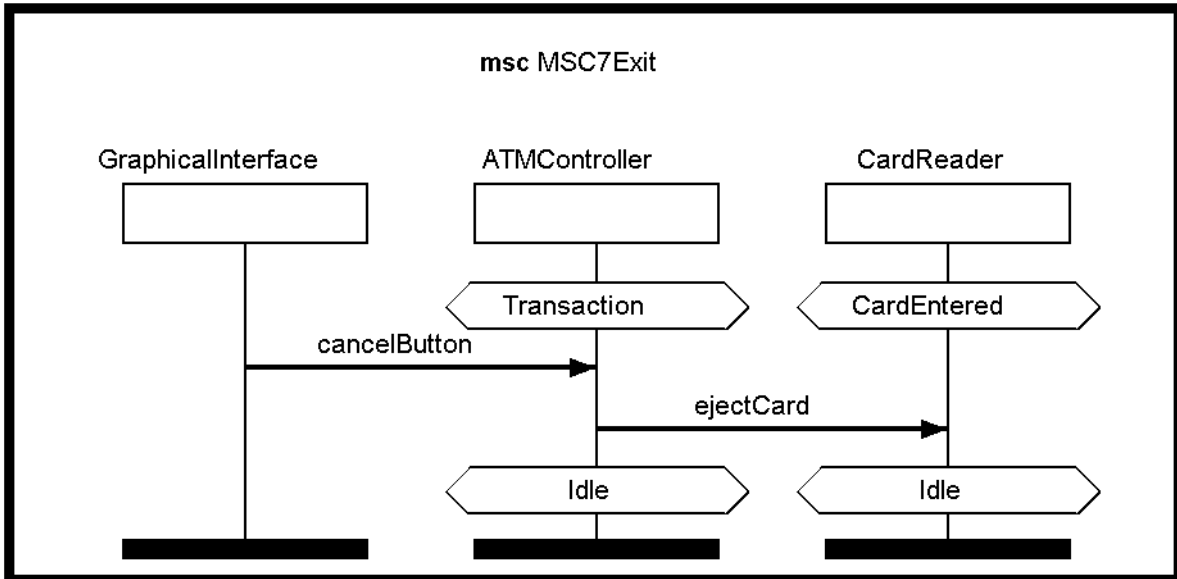
### 7.17 Printer Alternate 1



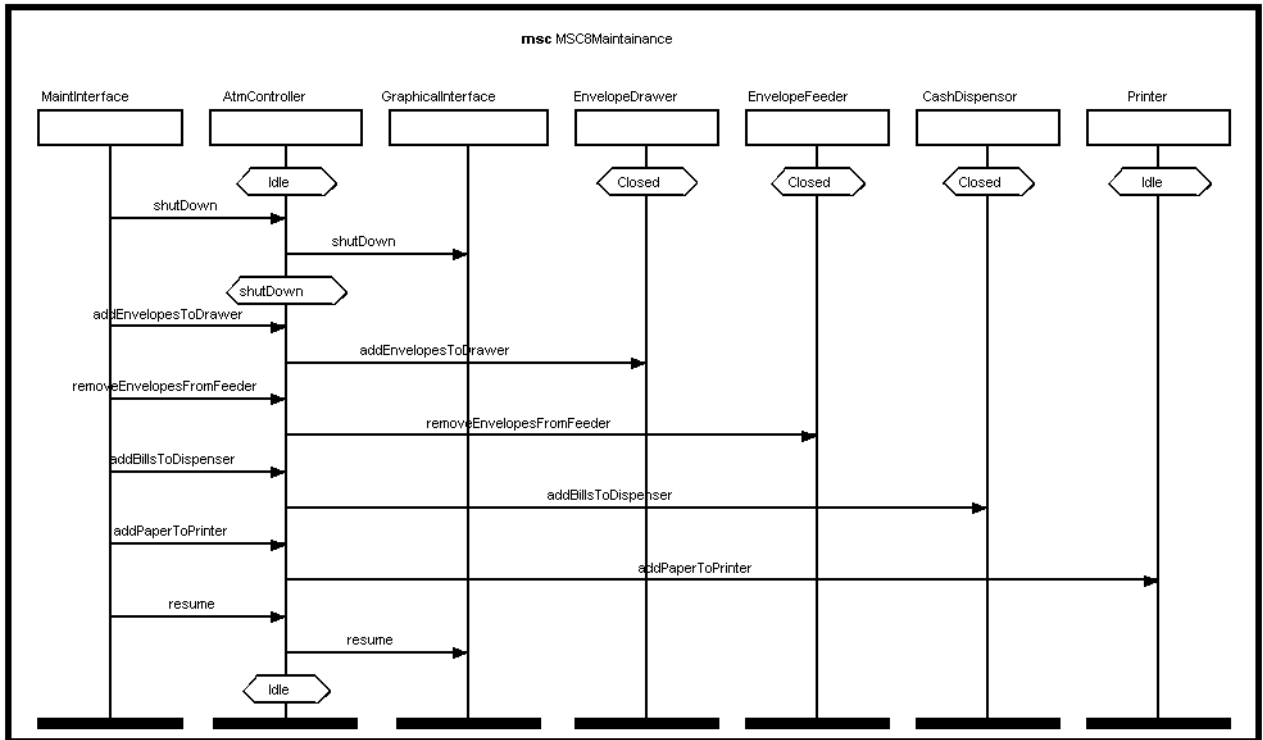
### 7.18 Printer Alternate 2



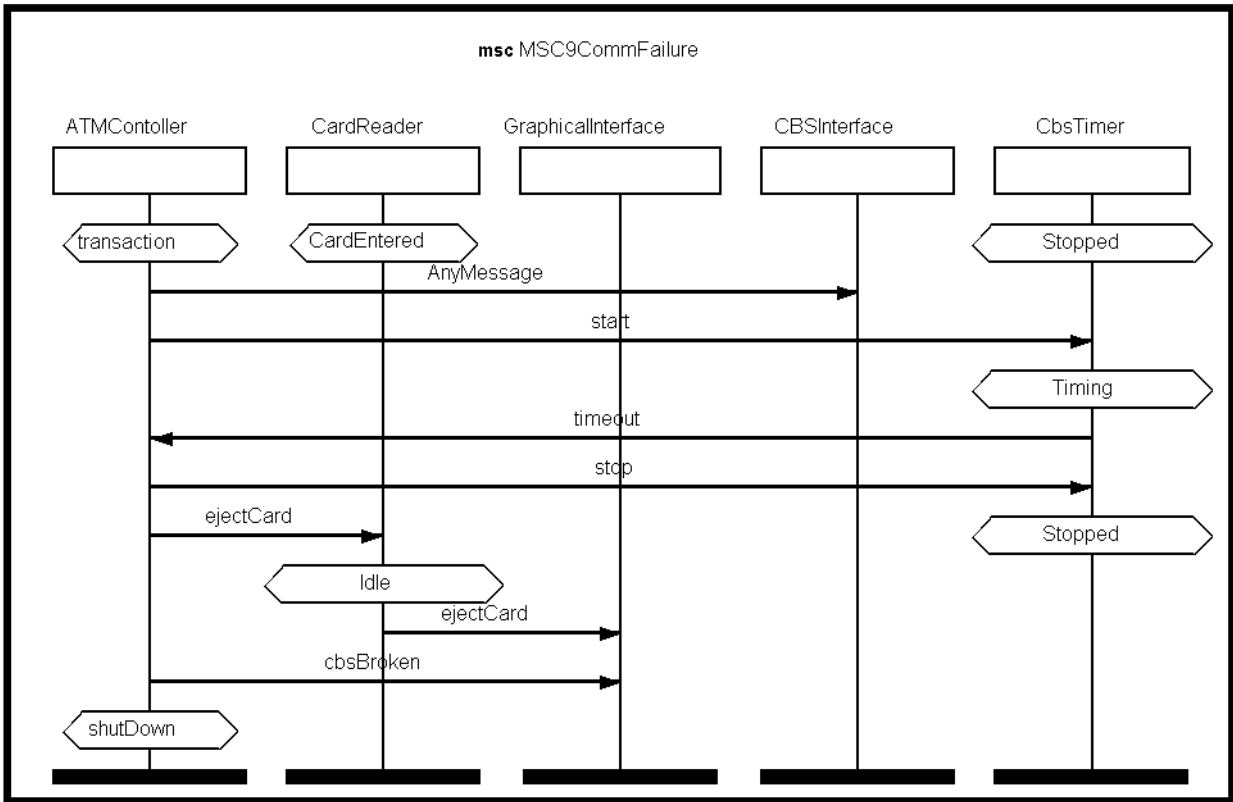
### 7.19 Exit



## 7.20 Maintenance



## 7.21 Communication Failure



## 8 Design Decisions

The following are the decisions considered for the design of the ATM and CBS. Due to time and personnel constraints, we were unable to implement everything we would have ideally liked to include.

### 8.1 ATM Decisions

For the structural design of the ATM Model in ObjecTime, an ATMControllor actor was created to serve as a mediator between the other component actors. The main benefit of this approach was that it brought all of the main states and transitions of the model together into one place, making the model much easier to upgrade and maintain. Having the other components of the ATM encapsulated in separate actor classes also increased maintainability of the model, largely through efficient use of protocol class modification.

The GUIInterface made up a significant part of the model, with a transition existing for every signal between the ATM and the Java interface. This made the Java interface heavily reliant on the ObjecTime model. The main benefit of this approach was that the ObjecTime model was much cleaner and easier to maintain and understand, since in each transition a single distinct message was sent to the GUIController.

A very difficult aspect of designing this system was the communication with the CBS ObjecTime model. To deal with the issue of the connection between the two models failing, a timer was used to count the number of elapsed seconds between a signal being sent from the ATM to the CBS and having the appropriate signal returned. If this count exceeds 20 seconds, the connection is deemed to be broken, and the ATM shuts down after returning the user's card. Ideally, a more elegant solution would have been employed, where the ATM would have the ability to recover from a broken connection to the CBS model. The current solution is not ideal since discrepancies in the CBS records can occur.

### 8.2 CBS Decisions

For the structural design of the CBS model, a CBSController actor was created, that is composed solely of transitions that move from and to it's idle state. This design was necessary to allow for possible simultaneous requests from ATM models.

A GUIFileInterface actor was also implemented that served as an interface between the CBSController and the Java interface. The CBS' Java interface is slightly less reliant on the CBS model than the ATM Java interface. The CBS' Java interface provides a graphical interface to the common CBS administrator tasks, but also maintains a running collection of current accounts that are saved to a text file after each change made by the ObjecTime model. This proved to be one of the most viable ways to load accounts and save changes to accounts to a file from the ObjecTime model.

To store the accounts in the model, an array of accounts was used (as opposed to a linked-list approach) in order to minimize development time and to take advantage of the indexing capabilities of arrays.

The CBSLog actor was made responsible for logging every account modification, which is a very useful tool for recovering from possible malfunctions or account discrepancies caused by a connection failure between an ATM and the CBS.