SE 463
Final System Requirements Specification Deliverable

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1 Introduction

1.1 Purpose

This document describes the software requirements and specification for a small telephone exchange and its associated information system.

The document is intended to be viewed by the customer and the developers of the system (designers, testers, maintainers). Readers are assumed to have a sound understanding of the workings of the underlying phone system. Readers also require an understanding of UML 2.0 diagrams.

Once approved by all primary stakeholders, this document serves as a contract specifying the functional and non-functional requirements of the telephone exchange information system.

1.2 Scope

The described software system, entitled “SkyNet”, will ensure that the underlying telephone system operates in such a way that all customer-provided requirements are satisfied. The system facilitates basic call processing and ensures that the appropriate charges are applied to customers. Customers have individual accounts in the system and will be able to have multiple phone accounts associated to them. Customers will be able to use blocked lists and incoming/outgoing filters in order to customize their phone usage experience.

The system will uniquely identify phones by their assigned extension and IP address. The system can handle emergency extensions and assign them to available phones.

The system allows administrators to manage all customer accounts in the system and their associated phones. Administrators can issue bills and record customer payments, and also manage the billing plans in the system. The system must handle concurrent access to customer and phone accounts appropriately.

The system is not concerned with connecting to any other systems. The system does not implement any form of replication or redundancy. The security features of the administration interface are limited to an administrator username and password.

This document does not describe the physical interface of the phones in the telephony exchange. Payment processing and the delivery mechanism used for bills are also out of the scope of this system.

1.3 Definitions, acronyms, abbreviations

Dedicated server: A computer used exclusively as a network server.

GUI: Graphical User Interface - An UI based on visual shapes and icons rather than only text.

Payment: An amount of money that is transferred from a system customer to the system operator.

SRS: Software Requirements Specification - a document that specifies the functional and non-functional requirements of a system, often serving as a contract between customer and software provider.

SSD: System State Diagram - models the transitions and states within the system

UC: Use Case - a typical scenario of how an end user may use the system

UI: User Interface - provides affordances for the user to interact with the system.

VoIP: Voice over Internet Protocol - a process for transmitting telephone calls and voice data over an Internet Protocol based network.

1.4 References

Customer Meetings
The set of minutes taken during private group meetings with the customer/TA. Please see Appendix B.

Customer Press-conference Minutes
The set of minutes taken during the press-conference style meetings with the customer. Please see Appendix B.

Software Engineering Sequence SE1 SE2 SE3: Overview of the Course Project
Project overview document made available on the course website. Please see:
http://www.student.cs.uwaterloo.ca/~cs445/Fall2006/Project/se1-2-3-project-overview.pdf

1.5 Overview

Going forward, this document is structured as follows:

Section 2 contains an overall description of the aforementioned software system, including a list of features. This section also contains a list of the various factors affecting the requirements placed on the system.

Section 3 contains a set of functional and non-functional system specifications. These include use cases, user interface diagrams, function tables and a collection of non-functional requirements.

Appendix A contains the document glossary, which lists and defines various domain-specific terms, states, classes, attributes, operations, events, activities, and variables used throughout this specification.

Appendix B contains a complete set of minutes taken during press conferences and customer/TA meetings.

The document appendices are used as supporting material throughout the document and do not constitute extra requirements of the software.

2. Overall description

This section of the document describes the context within which the system will operate, as well as the various factors that affect the requirements of the system.

2.1 Product perspective

The software system works together with the customer-selected telephony VOIP hardware in order to perform its functions. The software will consist of two parts – one which resides on a central server and a second part which resides on each phone subsystem.

The software interacts with the following hardware components:

- Phones – Software is embedded within each phone subsystem to facilitate call processing. The phone subsystem software transmits voice data via the central server.
- Central Server – This server contains the majority of the software solution. It communicates with each phone subsystem to connect calls and to ensure that calls are properly recorded in the system for billing purposes. This part of the system also keeps track of all user accounts, phone accounts and billing information.
- Terminals – The terminals communicate with the central server in order to display the system console to the administrators.

The only user interface component provided by the software will be the system console. The system console is displayed on terminals connected to the central server.

The context in which SkyNet operates is shown below in Figure 1.

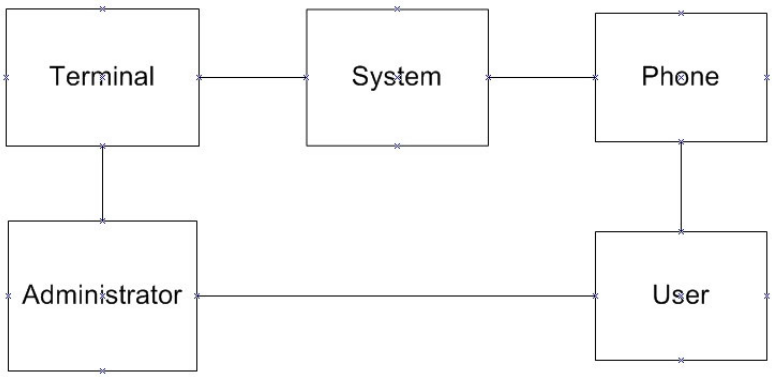


Figure 1 - Context diagram for SkyNet

2.2 Product features

The primary functions of the system include call processing, billing, and administrator access to the system. In more detail, the system must support the following:

- Basic call processing – The software facilitates the establishing of calls between phones in the telephone system. This involves the establishment and termination of audio connections between phones as well as dealing with any problems which might arise.
- Phone mapping – Phone IP addresses are mapped to four digit extensions for use by customers. The software performs the necessary conversions between IPs and extensions in order to successfully connect customer calls. Administrators can add and remove specific IP addresses from the system.
- Emergency extensions - Some extensions are used as special numbers and can not be associated with customers.
- Administrator console – The software provides a graphical user interface to system administrators which will allow them to manage the telephone system. Administrators must log into the console in order to perform any functionality.
- User and phone accounts – The system represents all customers by associating user accounts to them (in such a way that one customer can have only one user account). Each user account can have multiple phone accounts and each phone account can be associated with at most one phone.
- Adding users to the system – Administrators are able to add new users to the system by creating user accounts for them
- Deleting users from the system – Administrators are able to remove user accounts from the system
- Editing phone accounts – Administrators are allowed to edit any phone accounts belonging to a user.
- Deleting phone accounts – Administrators may remove a phone account that is associated with a particular user
- Performing system tests – The system is able to run hardware tests (both automatically and on administrator request) in order to determine if there are phones in the system with malfunctioning hardware. If such phones are found, the system alerts the administrators as soon as possible.

- View system error logs – Administrators can view the complete set of errors that have occurred in the system
- System maintenance – Administrators can change the state of phones within the system by enabling or disabling them.
- System state management – Administrators can start and stop the telephone system at will.
- Ongoing call termination – Administrators can terminate any currently ongoing calls.
- Load balancing – The system allows administrators to set a maximum allowable concurrent calls boundary. If this maximum is reached, the system disallows the processing of any new calls.
- Manage billing plans – Administrators can add, edit and remove billing plans. A billing plan is assigned to each phone account, giving the base rate to be used for charging calls and the service charge to be levied against the phone account. A billing plan may also have one or more discount periods within which the base call rate is discounted by a given percent.
- Charging for calls – user's phone accounts are charged for any calls
- Viewing bills - An administrator may view the bill for any billing period and any phone account belonging to a user.
- Record bill payments – The system allows an administrator to record bill payments against a user's phone account.
- Apply service fees – The system applies service charges to users at the end of each billing period. Phone accounts with outstanding balances for longer than 90 days are automatically suspended.
- Manage users' filter lists – Administrators are able to add and remove phone extensions from the incoming and outgoing filter lists of specific phone accounts.
- Manage administrators – Administrators are able to add, edit and delete other administrator accounts within the system.
- Blocked number management – Users are able to specify a set of extensions which are blocked from calling the user. Users are able to manually add and remove extensions from their blocked list.

2.3 User characteristics

The following two kinds of users are envisioned to be using the system:

- Customers – these are users with sufficient knowledge of proper phone usage. Besides the knowledge of how to perform basic phone functionality (such as initiating and receiving a call), these users may have some training if they have call blocking as an option for at least one phone accounts.
- Administrators – these are individuals who are entrusted by the customer to manage the telephone system. They are assumed to have a relatively advanced knowledge of telephony, computer systems and the chosen hardware platform in particular. These individuals have been trained in how to use the software (particularly the administrator user interface) and are familiar with all its aspects.

2.4 Constraints

The performance of the system is restricted by the capabilities of the underlying server hardware.

Multiple administrators must be able to use the system concurrently. The system ensures that concurrent access does not corrupt the integrity of the system data.

Administrators must authenticate with the system by using a username and password.

Administrators can not be logged in at two terminals at the same time.

Administrators must be automatically logged out after 10 minutes of inactivity.

The source code of the system must always be available to the customer.

2.5 Assumptions and dependencies

The software system specifications presented in this document are based on the following assumptions:

- The computer systems running the server and the system administration console never fail
- The customer is responsible for the deployment of the software and all related hardware components
- All the necessary external precautions against physical damage have been taken
- The telephone system can never experience a sudden loss of power
- Daylight savings time does not affect the billing of the system
- No person will maliciously try to gain access to the administrator console

3 Specific Requirements

This section describes in detail the requirements and specifications for the telephone system software.

3.1 External Interfaces

3.1.1 User Interfaces

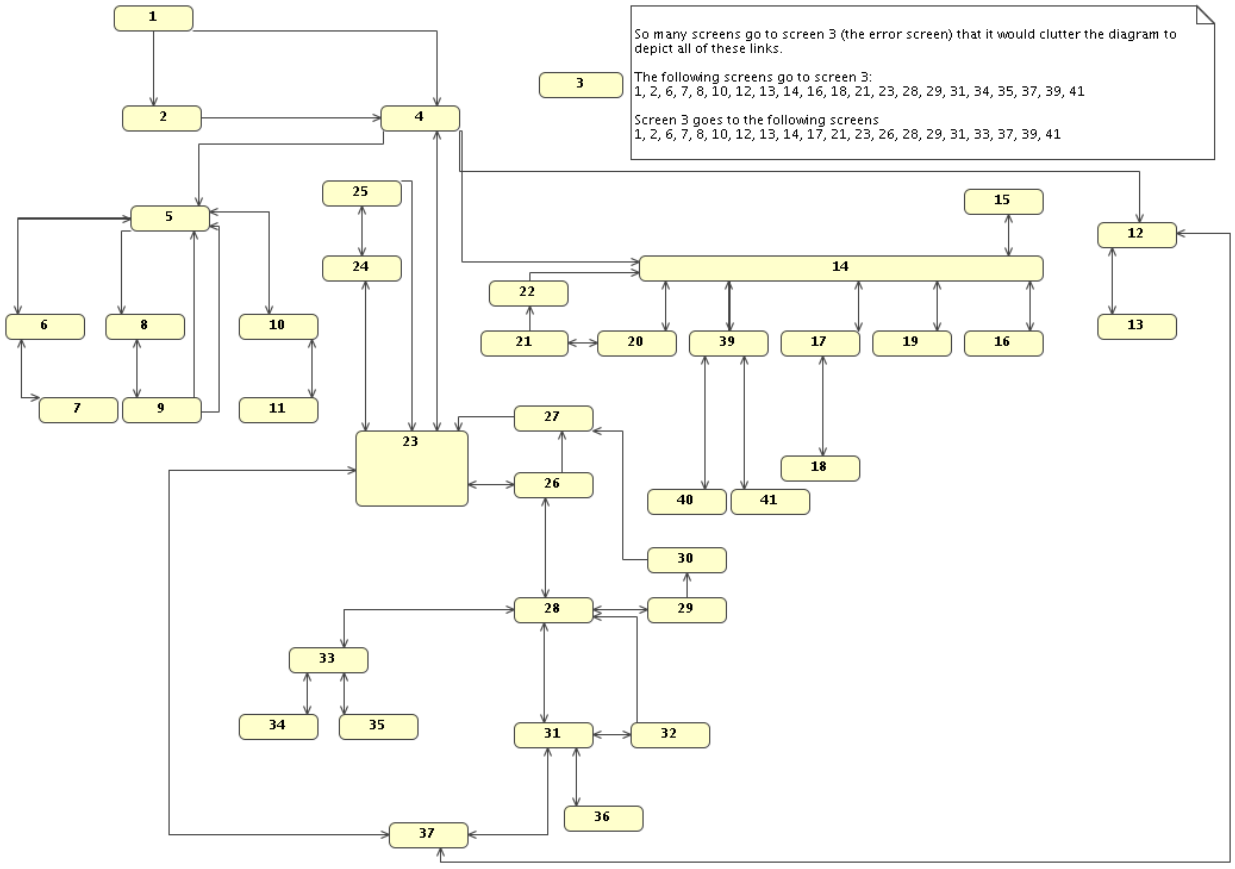


Figure 2 – Navigability diagram

1: System on

1) **Input Button (Turn on)** - Button which initiates the startup of the phone system.
   Events Triggered: turnSystemOn (sent to all administrators)
2) **Input Button (Log Out)** - Button which logs out the current administrator
   Events Triggered: clickLogout

2: Login administrator

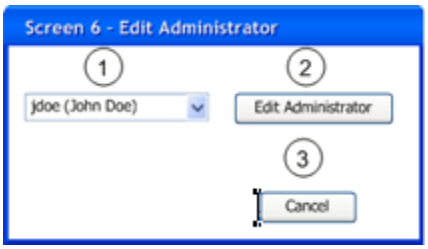
1) **Text box (Username)** - Text box for the administrator to type in their user name.
2) **Text box (Password)** - Holds the password entered by the administrator. Characters are denoted by *'s to hide the exact entry.
3) **Input Button (Login)** - Clicked by an administrator to initiate login to the system.
Events Triggered: clickLogin(loginInfo*)
*loginInfo refers to the username/password pair

3: Generic Error/Warning Message - *Omitted for space reasons.*

4: Main screen – *Omitted for space reasons.*

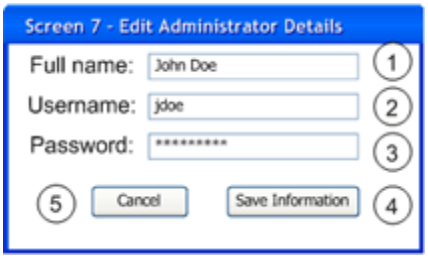
5: Administrator Management Screen – *Omitted for space reasons.*

6: Edit administrator list



1) **Combo Box (UserName)** - Dropdown is populated with the username of all administrator accounts currently in the system.
2) **Input Button (Edit Administrator) -** Initiates the modification of an administrator account.
Events Triggered: clickChange(adminName*)
3) **Input Button (Cancel)** - Cancels the edit an administrator accounts.
Events Triggered: clickCancel
* Parameter adminName is provided by the selection in combo box 1.

7: Edit administrator details



1) **Text Box (Full Name)** - Contains the full name of the administrator allowing for it to be changed

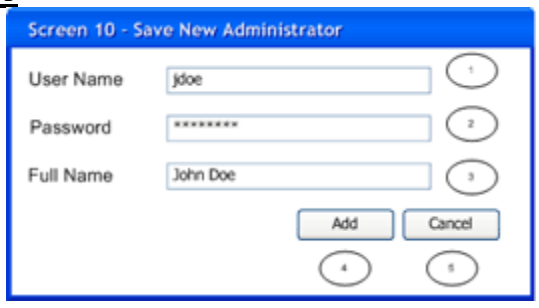
2) **Text Box (Username)** - Contains the username of the administrator allowing for it to be changed
3) **Text Box (Password)** - The new password for the administrator.
4) **Input Button (Save)** - Initiates the commitment of the change to the administrator account information.
Events Triggered: clickSave(adminDetails*)
5) **Input Button (Cancel)** - Initiates a cancellation of the modification of an administrator account.
Events Triggered: clickCancel
*adminDetails is the (possibly) new full name (1), username (2) and password (3) of the admin.

8: Remove administrator list

1) **List Box (List of Usernames)** - Displays a list of all administrators excluding the administrator who invoked the remove administrator functionality.
2) **Input Button (Remove Selected)** - Initiates process to remove selected administrators
Events Triggered: clickDeleteAdmin(adminRemoveArray[]*)
3) **Input Button (Cancel)** - Cancel initiates canceling the remove administrator operations.
Events Triggered: clickCancel
* Parameter adminRemoveArray is defined by the selections in element 1

9: Remove Administrator Confirmation – *Omitted for space reasons.*

10: Add new administrator



1) **Text Box (Username)** - Contains the entry of the administrator's username.
2) **Text Box (Password)** - Defines the password for the administrator.
3) **Text Box (Full Name)** - Contains the full name of the administrator.
4) **Input Button (Add)** - Initiates the addition of the defined administrator account.

Events Triggered: clickAdd(adminData*)

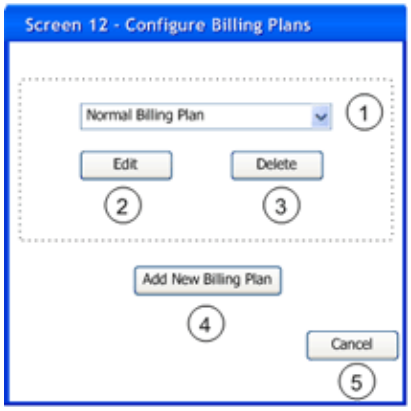
5) **Input Button (Cancel)** - Initiates a cancellation of the addition of the administrator account.

Events Triggered: clickCancel

* adminData includes the username (1), password(2) and full name(3)

11: Add New Administrator Confirmation – *Omitted for space reasons.*

12: Configure Billing Plans



1) **Combo Box (Billing Plans)** - A list containing the names of all the available billing plans in the system.

2) **Input Button (Edit)** - Initiates the modification of a billing plan.

Events Triggered: clickEdit(billingPlan*)

3) **Input Button (Delete)** - Initiates the deletion of a billing plan.

Events Triggered: clickDeleteBillingPlan(billingPlan*)

4) **Input Button (Add Billing Plan)** - Initiates the addition of a billing plan.

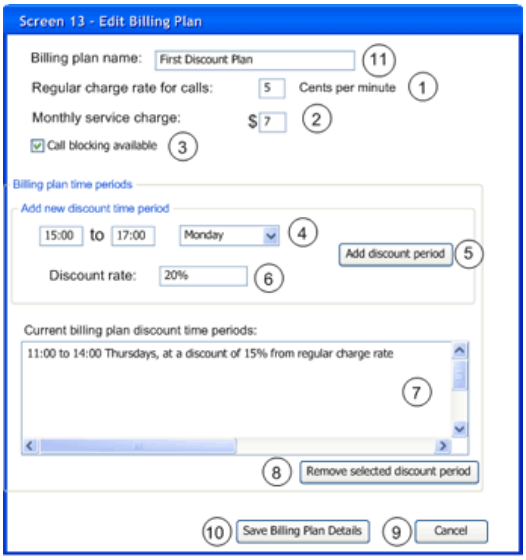
Events Triggered: clickAddNewBillingPlan

5) **Input Button (Cancel)** - Cancels the selection of billing plan options.

Events Triggered: clickBack

*billingPlan is the billing plan selected in combo box 1.

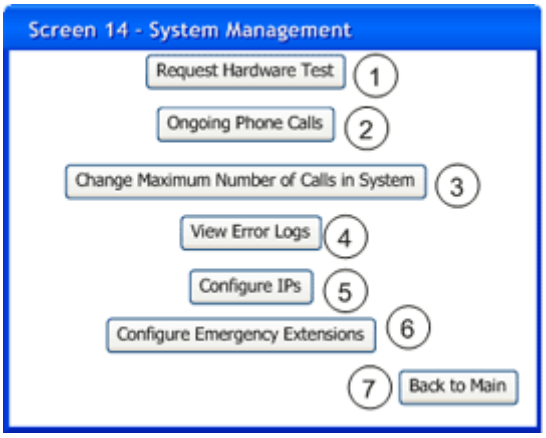
13: Edit Billing Plan



1) **Text Box (Charge Rate)** - Defines the charge per minute for the billing plan.
2) **Text Box (Service Charge)** - Defines the service charge for the billing plan.
3) **Check Box (Call Blocking)** - Specifies whether or not the billing plan has the call blocking feature.
4) **Period Definition Widget (Discount Periods)** - Defines a day of the week and a range of hours on that day (the time period for the discount plan).
5) **Input Button (Add discount period)** - Initiates the addition of the discount period defined in 4 & 6 to the billing plan.
    Events Triggered: clickAddNewDiscountPeriod(period*)
6) **Text Box (Discount Rate)** - Defines the percentage discount rate for the discount period.
7) **List Box (Discount Periods)** - A list containing all of the discount periods associated to the billing plan.
8) **Input Button (Remove Discount Period)** - Initiates the removal of the discount period defined in 7 from the billing plan.
    Events Triggered: clickDeleteDiscountPeriod(period*)
9) **Input Button (Cancel)** - Initiates the cancellation of billing plan modifications.
    Events Triggered: clickCancel
10) **Input Button (Save)** - Initiates a save of the modifications made to the billing plan.
    Events Triggered: clickSaveBillingPlan(billingPlan**)
11) **Text box (Billing Plan Name)** - Defines the name of the billing plan.

* period includes a time from, a time to, a day of the week (4) and a discount rate (6).
** billingPlan includes the set of discount periods(7), name (11), regular charge rate(1), monthly service charge(2) and call blocking available(3)

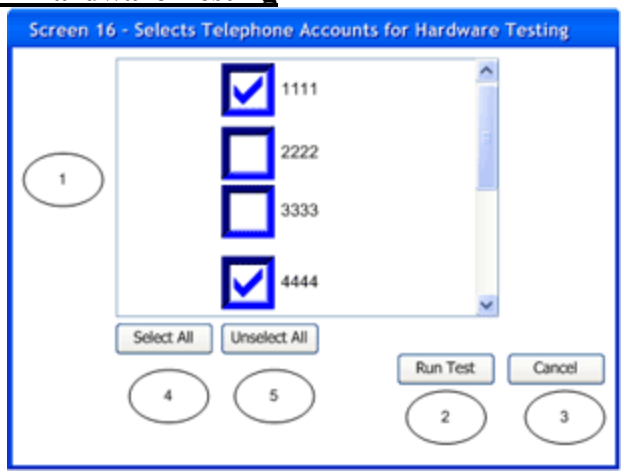
14: System Management



1) **Input Button (Request Hardware Test)** - Moves the user to the request hardware test UI screen.
   Events Triggered: clickRequestSystemTest
2) **Input Button (Ongoing Phone Calls)** - Moves the user to the ongoing phone calls UI screen.
   Events Triggered: clickCallsInSystem
3) **Input Button (Change Maximum Number of Calls)** - Moves the user to the change maximum number of calls in system UI screen.
   Events Triggered: clickMaxCallsInSystem
4) **Input Button (View Error Logs)** - Moves the user to the view error logs UI screen.
   Events Triggered: clickViewErrorLogs
5) **Input Button (Configure IPs)** - Moves the user to the configure IPs UI screen.
   Events Triggered: clickIPs
6) **Input Button (Configure Emergency Extensions)** - Moves the user to the configure emergency extensions UI screen.
   Events Triggered: clickConfigureEmergencyExtensions
7) **Input Button (Back to main)** - Moves the user back to the main screen
   Events Triggered: clickBack

15: View System Error Logs – *Omitted for space reasons.*

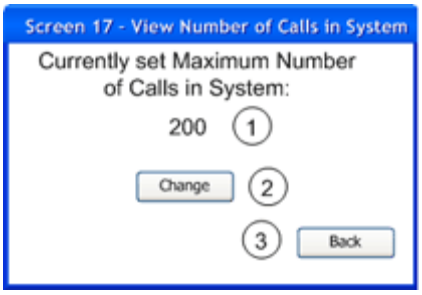
16: Select Telephone for Hardware Testing



1) **Checkbox list (Phone Accounts)** - A list of all extensions of all phone accounts in the system.

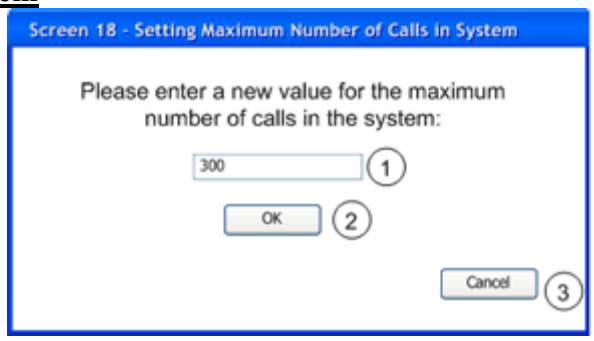
2) **Input Button (RunTests)** -Initiates the start of hardware tests on phones defined in element 1.
Events Triggered: clickRunTests(adminID*, IPs**)
3) **Input Button (Cancel)** - Cancels the selection of tests to run.
Events Triggered: clickCancel
4) **Input Button (Select All)** - Initiates the selection of all checkboxes in element 1.
5) **Input Button (Unselect All)** - Initiates the deselection of all checkboxes in element 1.
* adminID is the username of the currently logged in admin
** IPs holds all phones defined in element 1

17: View Max Calls in System



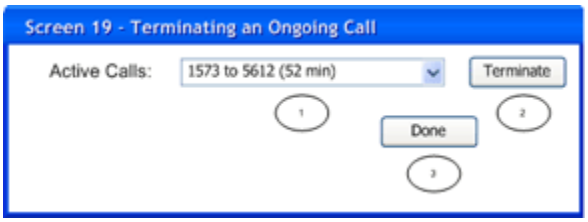
1) **Text field (Maximum number of calls)** - This box displays the current maximum number of allowed calls in the system.
2) **Input Button (Edit)** - Takes the user to the edit maximum number of calls page.
Events Triggered: clickEdit
3) **Input button (Go back)** - Go to the previous screen.
Events Triggered: clickBack

18: Set max calls in system



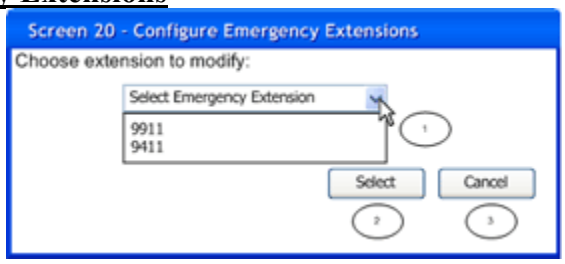
1) **Text box (Maximum number of calls)** - The user enters the new maximum number of calls in this text box.
2) **Input button (Ok)** - Attempts to set a new maximum number of allowed calls in the system.
Events Triggered: clickOK(num*)
3) **Input button(Cancel)** - Cancels modification and returns to the page that displays the maximum number of calls.
Events Triggered: clickCancel
* Parameter num is the number value entered in Text box 1.

19: Terminating an Ongoing Call



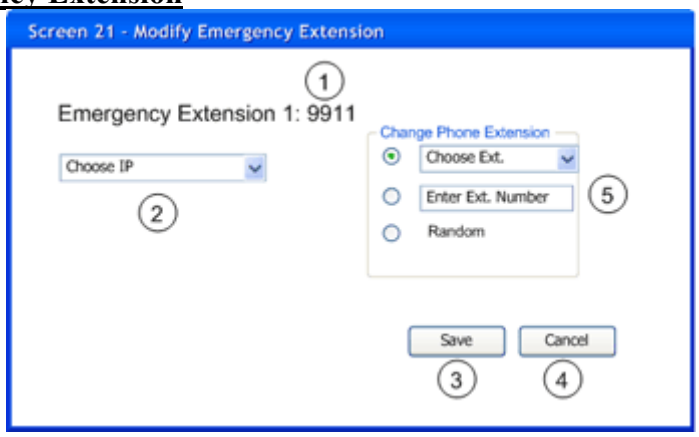
1) **Selection List (List of active calls)** - This box contains a list of all active calls. Exactly one active call can be selected at a time.
2) **Input Button (Terminate)** - Initiates termination of the selected call.
Events Triggered: clickTerminate(call*)
3) **Input Button (Done)** - Returns to the previous screen.
Events Triggered: clickDone
* Parameter call consists of the two extensions that are participating in call selected in Selection list 1

20: Configure Emergency Extensions



1) **Selection List (Emergency Extensions)** - List of possible emergency extensions that can be selected (there will only be exactly 2)
2) **Input Button (Select)** - Initiates the editing of an emergency extension.
Events Triggered: clickEdit(index*)
3) **Input Button (Cancel)** - Moves the user back to the system management page.
Events Triggered: clickBack
* index is the extension to be modified (emergency extension1 or emergency extension 2)

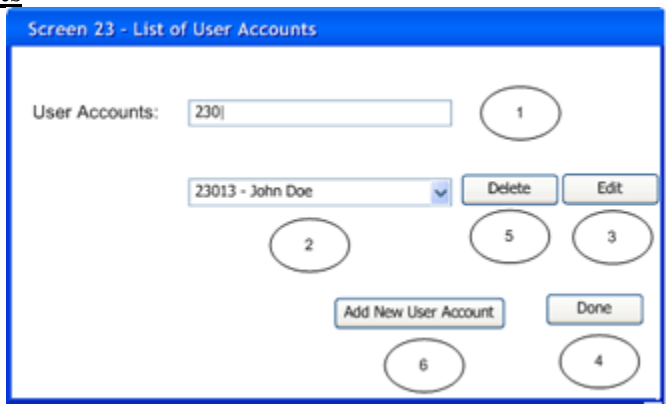
21: Modify Emergency Extension



1) **Text field (Extension)** - Current extension assigned to emergency extension.
2) **Dropdown Box (IP list)** - List of all unassigned IPs in the system. Widget is used to select a new IP for the emergency extension. The dropdown box defaults to the IP currently assigned to the emergency extension.
3) **Input Button (Save)** - Initiates a save of the emergency extension.
Events Triggered: clickSave(extension*, IP**)
4) **Input Button (Cancel)** - Initiates a cancel of modification to the emergency extension.
Events Triggered: clickCancel
5) **Extension Selector (Extension)** - UI element enabling the selection of an extension. Has 3 options, select randomly, enter manually, or pick from dropdown box. Used to assign a new extension to the emergency extension. The default selection is the current extension.
Events Triggered: clickPickRandomExt
* extension is the extension entered by element 5
** IP is the IP selected by element 2

22: Change Emergency Extension Confirmation Screen – *Omitted for space reasons.*

23: List User Accounts



1) **Text Box (User Account #)** - Text box used to search user accounts.
2) **Dropdown Box (User Accounts)** - Dropdown box containing all user accounts narrowed by the search criteria in element 1.
3) **Input Button (Edit)** - Initiates and edit of the user account selected in element 2.
Events Triggered: clickEdit(userAccount*)

4) **Input Button (Done)** - Returns to main menu.
Events Triggered: clickDone
5) **Input Button (Delete)** - Initiates a deletion of the user account selected in element 2.
Events Triggered: clickDelete(userAccount*)
6) **Input Button (Add new user)** - Initiates the addition of a new user account to the system.
Events Triggered: clickAddNewUser
* userAccount is the user ID as selected by element 2

24: Remove User Account Prompt – *Omitted for space reasons.*

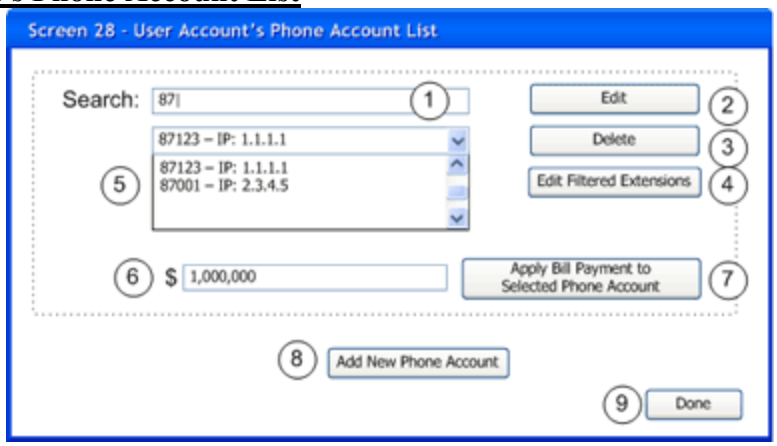
25: User Deletion Success – *Omitted for space reasons.*

26: Edit User Account

1) **Radio buttons (Suspend)** - Choice of whether or not the user's phone accounts should be/are suspended.
2) **Text box (User Name)** - Text box with alphanumeric characters for user name.
3) **Text box (Address)** - Text box which holds the user's street address.
4) **Text box (Alternate Phone)** - Text box which holds the alternate phone number of the user.
5) **Text box (birth date)** - Widget which holds the date of birth of the user.
6) **Input Button (Edit phone account)** - Moves administrator to the page where they can edit phone accounts.
Events Triggered: clickEditPhoneAccounts(userAccount*)
7) **Input button (Cancel)** - Initiates a cancellation of the modification of a particular user.
Events Triggered: clickCancel
8) **Input button (Save)** - Initiates a save of the entered user information.
Events Triggered: clickSave(userAccount*)
9) **Text field (Account#)** - Non-editable text field of the user's account number
* Parameter userAccount consists of the values in the text field 1 and text boxes 26

27: Editing User Account Success – *Omitted for space reasons.*

28: User Account's Phone Account List

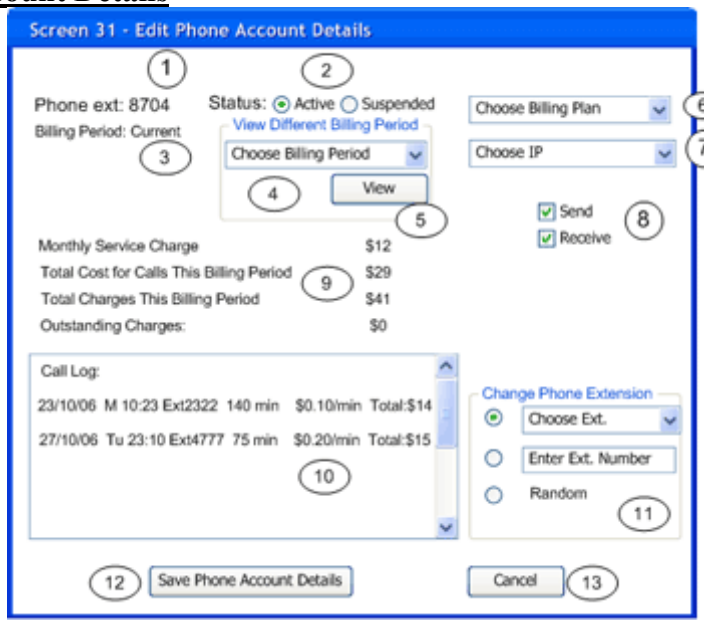


1) **Text Box (Search)** - Text box containing the search criteria for phone accounts.
2) Input Button (Edit) - Initiates the modification of the phone account selected in 5.
Events Triggered: clickEditPhoneAccount(phoneAccount*)
3) **Input Button (Delete)** - Initiates the deletion of the phone account selected in 5.
Events Triggered: clickDeletePhoneAccount(phoneAccount*)
4) **Input Button (Edit Filtered Extensions)** - Moves the administrator to the page where they can edit filtered extensions for the phone account selected in 5.
Events Triggered: clickFilteredExt(phoneAccount*)
5) **List Box (Phone Account)** - List box containing entries for all phone accounts associated to the current user that meet the search criteria in 1.
6) **Text Box (Bill Payment)** - The bill payment amount which can be applied to the chosen phone account.
7) **Input Button (Apply Bill Payment)** - Initiates the application of a bill payment in 6 to the selected phone account in 5.
Events Triggered: clickRecordBillPayment(amount**, phoneAccount*)
8) **Input Button (Add New Phone Account)** - Initiate the addition of a new phone account to the user.
Events Triggered: clickAddPhoneAccount
9) **Input Button (Done)** - Goes back to the user account page.
Events Triggered: clickDone
* phoneAccount is the phone account selected in list box 5.
** amount is the numeric amount entered in text box 6.

29: Delete Phone Account Prompt – *Omitted for space reasons.*

30: Delete Phone Account Success – *Omitted for space reasons.*

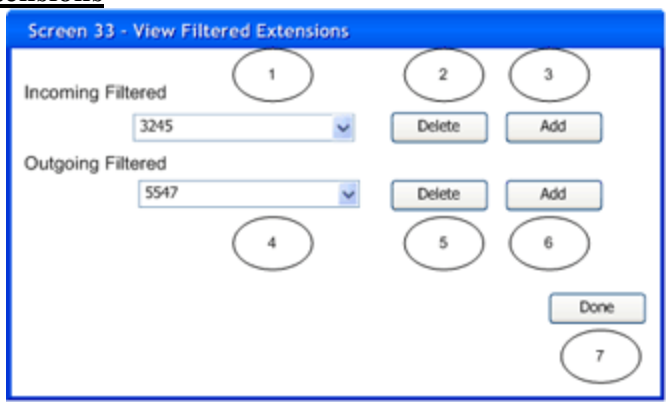
31: Edit Phone Account Details



1) **Text field (Extension)** - Text indicating the extension of the phone account being edited.
2) **Radio Button (Suspended)** - Radio buttons denoting the state of the phone account (Active or Suspended).
3) **Text field (Billing Period)** - Text indicating the billing period which is being displayed in 7 and 10.
4) **Dropdown Box (Billing Periods)** - Box populated with all billing periods where the phone account has a bill.
5) **Input Button (View)** - Initiates the viewing of the bill from the billing period selected in 4.
Events Triggered: clickViewBillingPeriod(period*)
6) **Dropdown Box (Billing Plans)** - List populated with all active billing plans in the system. The selection in this dropdown denotes the billing plan of the phone account.
7) **Selection list (Phone IP)** - Selection list populated with all available IPs. Used to select IP for a phone account.
8) **Send/Receive Checkbox Widgets (Send/Receive)** - Checkboxes denoting the phone account's ability to send and receive calls.
9) **Text Fields (Bill Information)** - Field denoting the total cost of service charges, calls, total charges, and outstanding charges for a billing period specified in 4.
10) **Text Fields (Call Information)** - Text of the bill denoting call start and end times. It also includes changes to the phone account's billing plan.
11) **Extension Selector (Extension)** - UI element enabling the selection of an extension. Has 3 options, select randomly, enter manually, or pick from dropdown box. Used to assign a new extension to the emergency extension. The default selection is the current extension.
Events Triggered: clickPickRandomExt
12) **Input Button (Save)** - Initiates the modification of the phone account.
Events Triggered: clickSave(phoneAccount*)
13) **Input Button (Cancel)** - Initiates a cancel of modification to the phone account.
Events Triggered: clickCancel
*period is the billing period selected in combo box 4.
**phoneAccount includes fields 6-8, 11

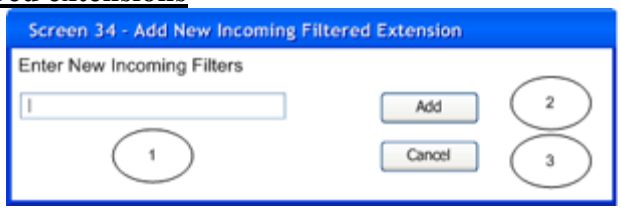
32: Phone Account Save Success – *Omitted for space reasons.*

33: View Filtered Extensions



1) **Selection list (List of incoming filtered extensions)** - Displays a list of all extensions that cannot call the current phone account.
2) **Input button (Delete incoming filtered extension)** - Deletes the selected incoming filtered extension.
Events Triggered: clickDeleteIncoming(incExt*)
3) **Input button (Add incoming filtered extension)** - Goes to a screen where a new incoming filtered extension can be added.
Events Triggered: clickAddIncoming
4) **Selection list (List of outgoing filtered extensions)** - Displays a list of all extensions the current phone account cannot call.
5) **Input button (Delete outgoing filtered extension)** - Deletes the selected outgoing filtered extension.
Events Triggered: clickDeleteOutgoing(outExt**)
6) **Input button (Add outgoing filtered extension)** - Goes to a screen where a new outgoing filtered extension can be added.
Events Triggered: clickAddOutgoing
7) **Input button (Done)** - Returns to the edit phone account page.
Events Triggered: clickDone
* Parameter incExt consists of the incoming filtered extension (which may include wildcards) that is selected in Selection list 1.
** Parameter outExt consists of the outgoing filtered extension (which may include wildcards) that is selected in Selection list 4.

34: Add incoming filtered extensions



1) **Text box (New incoming filter)** - The user enters a new incoming filtered extension here.
2) **Input button (Add)** - Adds the entered extensions to the list of the incoming filtered extensions.

Events Triggered: clickIncomingOK(ext*)

3) **Input button (Cancel) -** Cancels addition and returns to the page that displays the incoming and outgoing filtered extensions.

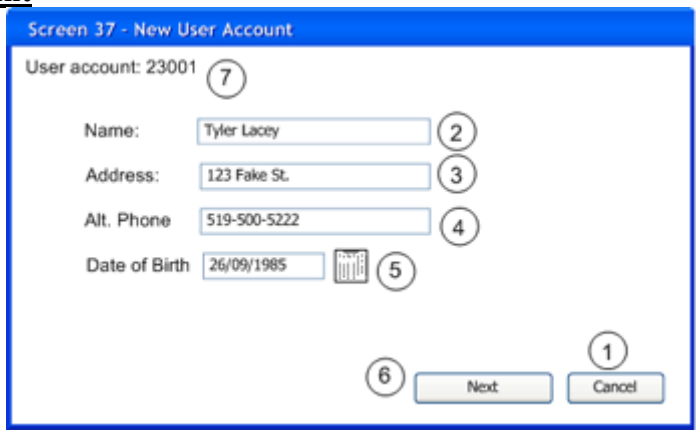
Events Triggered: clickCancel

* The parameter ext is the string entered into Text box 1

35: Add outgoing filtered extensions – *Omitted for space reasons. Identical to 34.*

36: Create Phone Account Success – *Omitted for space reasons.*

37: New User Account



1) **Input button (Cancel)** - Cancels addition and returns to the edit user page.

Events Triggered: clickCancel

2) **Text box (User Name)** - Text box with alphanumeric characters for user name.

3) **Text box (Address)** - Text box which holds the user's street address.

4) **Text box (Alternate Phone)** - Text box which holds the alternate phone number of the user.

5) **Text box (birth date)** - Widget which holds the date of birth of the user.

None

6) **Input Button (Next)** - Initiates the addition of a new user account.

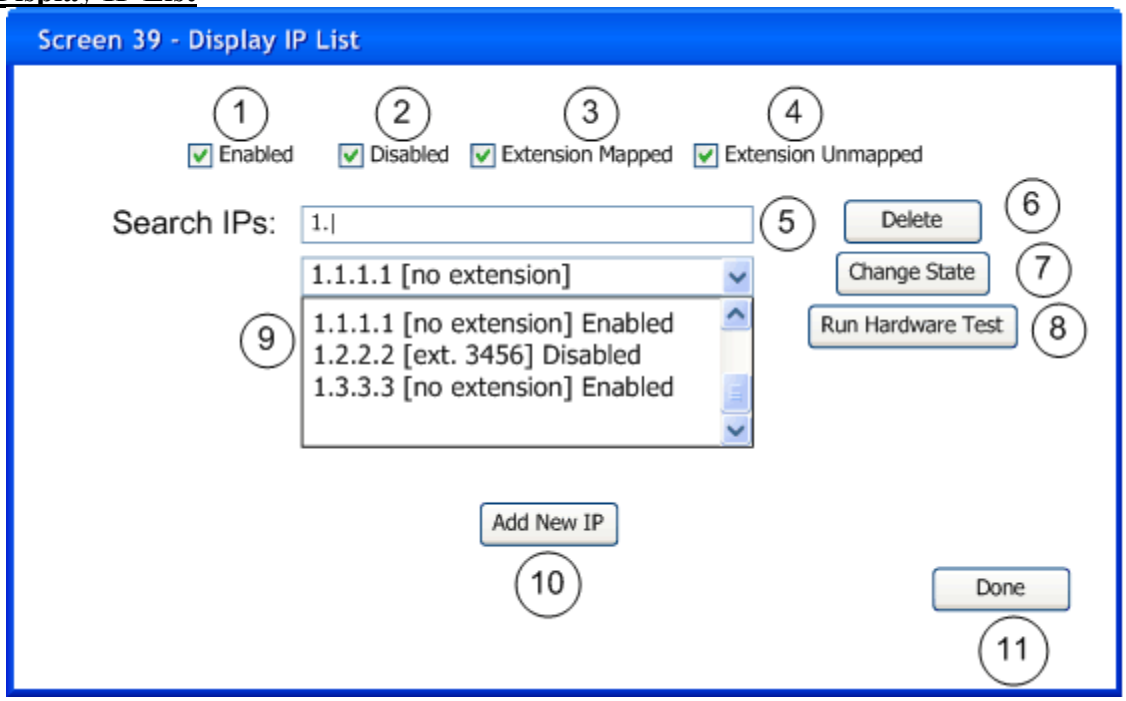
Events Triggered: clickNext(userAccount*)

7) **Text Field (Account #)** - The automatically assigned account # of the user account to be added.

*The parameter userAccount is the data in fields 2-5, 7

38: New User Account Creation Successful – *Omitted for space reasons. Identical to 34.*

39: Display IP List



1) **Check box (Enabled filter)** - If checked, enabled IPs are eligible to be displayed in the list of IPs.
2) **Check box (Disabled filter)** - If checked, disabled IPs are eligible to be displayed in the list of IPs.
3) **Check box (Extension mapped filter)** - If checked, IPs with extensions mapped are eligible to be displayed in the list of IPs.
4) **Check box (Extension unmapped filter)** - If checked, IPs without extensions mapped are eligible to be displayed in the list of IPs.
5) **Text box (IP filter)** - When an IP or partial IP is entered into this box, the entries in combo box 9 are filtered.
6) **Input button (Delete)** - Initiates the deletion of the IP selected in combo box 9.
Events Triggered: clickDeleteIP(IP*)
7) **Input button (Change state)** - Allows the user to change the state of the IP selected in combo box 9. *Events Triggered:* clickChangeState(IP*)
8) **Input button (Run hardware test)** - Initiates the hardware testing of the phone mapped to the IP selected in combo box 9
Events Triggered: clickRequestSystemTest(IP*)
9) **Combo box (IP list)** - Lists all of the IPs that exist in the system, as well as their state and extension (if mapped)
10) **Input button (Add new IP)** - Initiates the addition of a new IP to the system
Events Triggered: clickAddIP
11) **Input button (Done)** - Returns to the system management screen.
Events Triggered: clickDone
* IP is the IP selected in combo box 9.

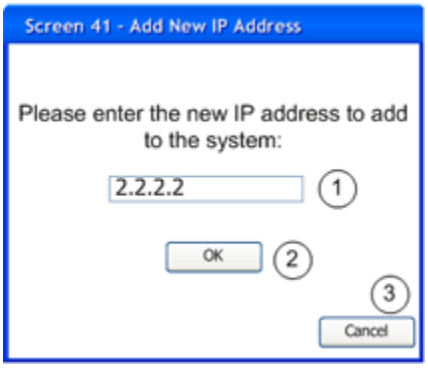
40: Change IP State

1) **Text Field** - Text displaying the IP of which the state is being changed.
2) **Radio buttons** - Allows the user to choose the state of the IP address.
3) **Input button (Done)** - Changes the state of the IP to the value selected using the radio buttons.

Events Triggered: clickDone(state*)

* the state selected in radio buttons 2

41: Add New IP Address



1) **Text box (New IP address)** - The user enters the new IP address in this text box.
2) **Input button (Ok)** - Attempts to add a new IP to the system.

Events Triggered: clickOK(IP*)

3) **Input button (Cancel)** - Cancels modification and returns to the page that lists all of the IPs in the system.

Events Triggered: clickCancel

* Parameter IP is the IP value entered in Text box 1.

3.1.2 Hardware Interface Event Mapping

Every hardware interface event is implicitly associated to a particular phone's state machine. When the hardware generates a signal, it is sent to the associated phone's state machine. When a phone's state machine generates a hardware output signal or activity, the event is sent to the physical phone associated with the state machine.

3.1.2.1 Hardware Input Signals

keyPressed(key)
Sent to a phone's state machine whenever a key is pressed on the phone's keypad. The character printed on the physical key is passed as a parameter. This event corresponds to the hardware interface KeyPressed message. It is assumed that pressing a key will automatically play the tone associated with the key.

keyReleased(key)
Sent to a phone's state machine whenever a key is released on the phone's keypad. The character printed on the physical key is passed as a parameter. This event corresponds to the hardware interface KeyReleased message. It is assumed that releasing a key will automatically stop playing the tone associated with the key.

pickUp
Sent to a phone's state machine whenever the receiver is taken off the cradle. This event corresponds to the hardware interface OffHook message.

hangUp
Sent to a phone's state machine whenever the receiver is placed on the cradle. This event corresponds to the hardware interface OnHook message.

3.1.2.2 Hardware Output Signals

startRinging
Sent by a phone's state machine to make the physical phone ring. This maps to the StartRinging message on the hardware interface.

stopRinging
Sent by a phone's state machine to make the physical phone stop ringing. This maps to the StopRinging message on the hardware interface.

connect(myPhone, otherPhone)
Sent by a phone's state machine to cause the phone to start sending and receiving data to/from the given phone IP. This corresponds to sending the two hardware interface messages StartAudioSend and StartAudioReceive.

disconnect(myPhone, otherPhone)
Sent by a phone's state machine to cause the phone to stop sending and receiving data to/from the given phone IP. This corresponds to the sending of two hardware interface messages StopAudioSend and StopAudioReceive.

handsetOn
Sent by a phone's state machine to turn the handset of the phone on. This corresponds to the HandsetOn message in the hardware interface.

handsetOff
Sent by a phone's state machine to turn the handset of the phone off. This corresponds to the HandsetOff message in the hardware interface.

3.1.2.3 Hardware Output Activities

playDialTone
Causes a phone to play its dial tone. When this activity is interrupted, the phone returns to being silent. This maps to two events on the hardware interface: PlayTone(DialTone, Constant) to start playing and PlayTone(ToneOff, Constant) to stop.

playBusyTone
Causes a phone to play a busy tone. When this activity is interrupted, the phone returns to being silent. This maps to two events on the hardware interface: PlayTone(Busy, Medium) to start playing and PlayTone(ToneOff, Constant) to stop.

playFastBusyTone
Causes a phone to play a fast busy tone. When this activity is interrupted, the phone returns to being silent. This maps to two events on the hardware interface: PlayTone(Busy, Fast) to start playing and PlayTone(ToneOff, Constant) to stop.

playErrorTone
Causes a phone to play an error tone. When this activity is interrupted, the phone returns to being silent. This maps to two events on the hardware interface: PlayTone(Busy, Constant) to start playing and PlayTone(ToneOff, Constant) to stop.

playRingbackTone
Causes a phone to play a ringback tone. When this activity is interrupted, the phone returns to being silent. This maps to two events on the hardware interface: PlayTone(Ringing, Ringing) to start playing and PlayTone(ToneOff, Constant) to stop.

3.2 Functional Requirements

3.2.1 Use Cases

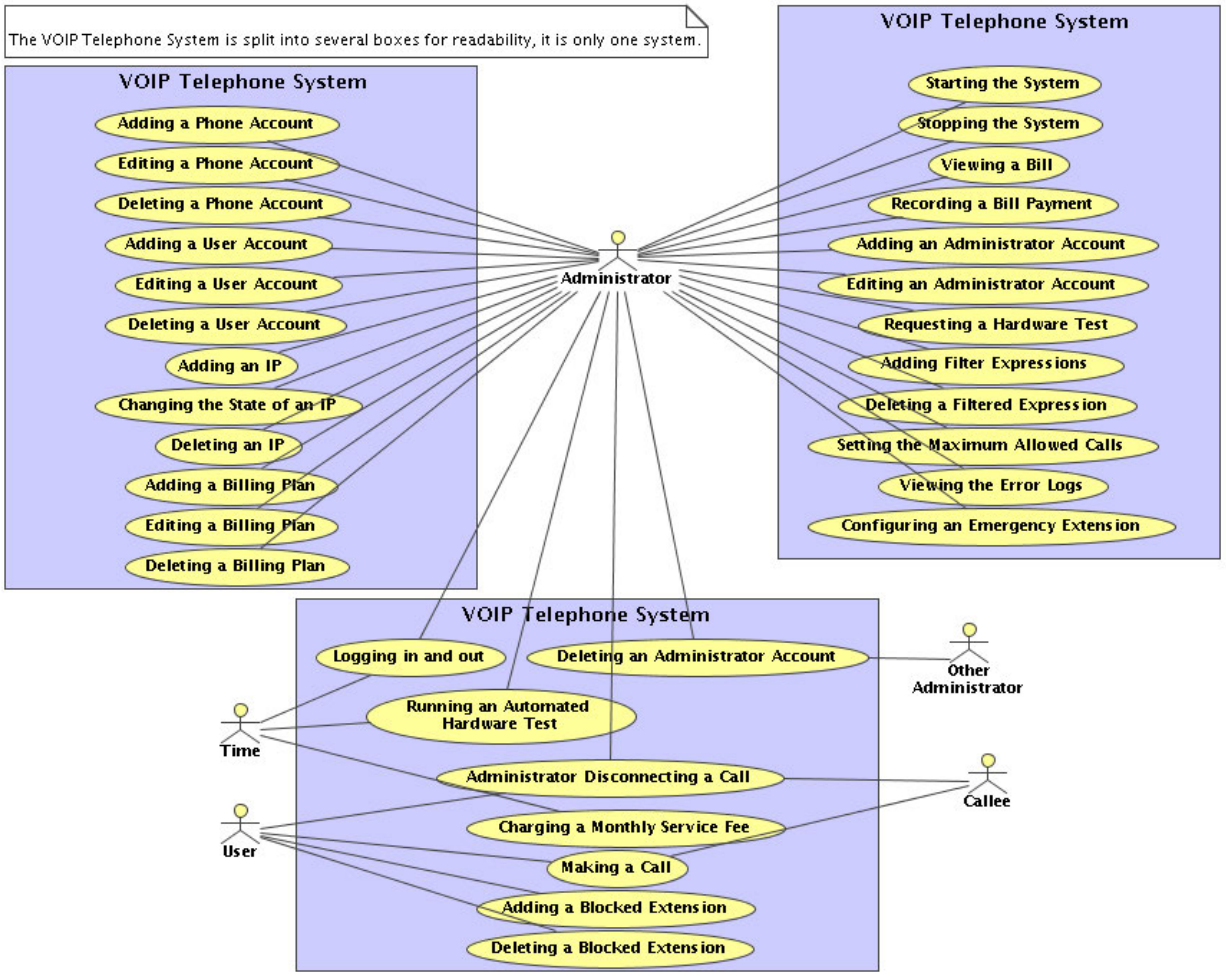


Figure 3 – Use Cases Diagram

Name:

Making a Call

Number: UC01
Authors: SE1_06
System: A VoIP telephone system
Actors: Caller (Initiator)

- Callee

Event/Precondition: The caller has a phone on the hook and picks up the receiver.
Overview/Postcondition: Both parties hang up and the caller is charged for the call.
References:

Course Project Overview: 7, 8
Minutes #1: 1.1, 1.2, 1.7, 1.9, 1.11
Minutes #2: 1.2, 1.6, 1.8, 1.14
Minutes #3: 1.7, 1.13

Related Use Cases:

UC03

Typical process description:		
Caller Actions	***System Response***	***Callee Actions***
1. Caller picks up the receiver		
	2. System signals caller's phone to play a dial tone	
3. While caller has pressed fewer than 4 digits Caller enters a digit Caller waits less than ten seconds before entering the next digit		
	4. System checks that the maximum number of simultaneous calls has not been reached	
	5. System checks that the number dialed corresponds to a phone that is in the "in service" state and a phone account that is not suspended	
	6. System verifies that the caller can[1] call the callee	
	7. System signals callee's phone to start ringing, signals the caller's phone to play a ringback tone[2], and updates the number of calls currently in progress	
		8. Callee picks up the receiver
	9. System signals callee's phone to stop ringing and signals caller's phone to stop playing ringback tone	
	10. System establishes audio connection between caller and callee, and begins timing the call	
	11. System adds the call between the caller and the callee to the list of ongoing calls. The information stored includes the two extensions and the duration of the call.	
	12. While neither party has hung up If discount period ends or billing period ends Split the call and charge the caller for the portion that has elapsed	
13. Caller hangs up phone		
	14. System breaks audio connection between caller and callee, updates the number of calls in system, and removes the call from the list of current calls	
	15. The system stops timing the call and charges the caller[4]	

		16. Callee hangs up phone

Notes:
[1] Phone account A can call phone account B when B's extension does not match[3] an entry in A's outgoing filter list, A's extension does not match an entry in B's incoming filter list, B does not have A in its block list, A is allowed to make outgoing calls, and B is allowed to receive incoming calls.
[2] A ringback tone is the tone played on a caller's phone while the callee's phone is ringing.
[3] An extension matches an entry in the list if all digits, other than the wild character (*), are the same.
[4] If the call has been split, then the system will charge for the final portion of the split call during this step. The charge for the previous portions would have been applied when the call was split.

Name:

Charging a Monthly Service Fee

Number: UC02
Authors: SE1_06
System: A VoIP telephone system
Actors: Time (Initiator)
Event/Precondition: An unsuspended phone account exists in the system, and its current billing period has ended.
Overview/Postcondition: The service fee has been charged to the phone account. If the account has an outstanding charge on a bill over 90 days old, it is automatically suspended.
References:
Minutes #1: 7.13, 7.15
Related Use Cases:
UC03

Typical process description:	
Time Actions	***System Response***
1. A billing period for the unsuspended phone account ends[1].	
	2. System adds a service fee[2] for that phone account.
	3. If the phone account has an outstanding charges on a bill over 90 days old System suspends the phone account

Notes:
[1] A billing period is 30 days long. This billing period ends 30 days after the previous billing period has ended.
[2] If the phone account's billing plan was changed over the last 30 days, then the service fee is prorated for the new billing plan. If the phone system was down for some time over the past 30 days, then the service fee is prorated for the amount of time that the system was up.

Name:

Recording a Bill Payment

Number: UC03
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The user has submitted a bill payment for a particular phone account.
Overview/Postcondition: The amount paid has been credited to the phone account.
References: Course Project Overview: 51
Related Use Cases:
UC01, UC02

Typical process description:	
Administrator Actions	***System Response***
1. Administrator submits the existing user whose bill payment they want to record	
	2. System verifies that no administrator is viewing/editing the user account
	3. System displays user's list of phone accounts
4. Administrator selects the phone account for which to record a payment	
	5. System verifies that no administrator is viewing/editing the phone account
	6. System displays phone account's current outstanding balance and prompts for payment amount
7. Administrator submits payment amount	
	8. System verifies that the payment amount is valid[1]
	9. System records bill payment applies the credits to the phone account's bills[2]

Notes:
[1] A valid payment amount is a positive real number, and can have up to two decimal places.
[2] The heuristic is to apply credits to the phone account's oldest bills first. If the credits exceed the total amount owed, a credit is added to the user account.

Name:

Editing a Phone Account

Number: UC04
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator chooses to edit a phone account. The input is the phone account that the administrator wants to modify.
Overview/Postcondition: The changes to the phone account have been saved. If a billing plan change occurred or the account was suspended, its service fee has been prorated.
References:

Course Project Overview: 24
Minutes #1: 4.2, 4.3, 4.13, 6.1
Minutes #3: 5.3, 5.6

Related Use Cases:

UC05, UC06, UC07

Typical process description:	
Administrator Actions	***System Response***
1. Administrator submits choice to view a specific user account	
	2. System verifies that no administrator is viewing/editing the user account
	3. System displays the list of phone accounts associated with the user
4. Administrator submits choice to modify a specific phone account of that user	
	5. System verifies that no administrator is viewing/editing the phone account
	6. System displays the phone account's details to the administrator and prompts the administrator to enter new information[1] for the phone account
7. Administrator enters new information for the phone account[2]	
	8. System validates[3] phone account information
	9. System updates the phone account with the new information
	10. If the administrator suspended the phone account or changed its billing plan System prorates[4] the service fee for the phone account

Notes:
[1] The information for a phone account is the associated telephone IP, the billing plan, the extension, suspended/unsuspended and a combination of send and/or receive privileges
[2] If the administrator is changing the extension, he has the option of picking extensions from a list of available extensions, specifying an extension, or using a randomly generated extension
[3] The new phone account information is valid if
- the extension did not change, or the new extension is not already mapped, and
- the IP did not change, or the new IP exists and is not already mapped, and
- the billing plan exists in the system

[4] The prorated service fee is the service fee for a billing plan for the entire 30 days scaled by the proportion of time that the phone account was actually using that billing plan

Name:

Deleting a Phone Account

Number: UC05
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator chooses to delete a phone account. The input is the phone account that the administrator wants to delete.
Overview/Postcondition: The phone account has been marked as deleted, its extension has been freed, and a final service fee has been applied.
References:
Course Project Overview: 24
Minutes #1: 4.2, 4.3, 4.13, 6.1
Minutes #3: 5.3, 5.6
Related Use Cases:
UC04, UC06, UC07

Typical process description:	
Administrator Actions	***System Response***
1. Administrator submits choice to view a specific user account.	
	2. System verifies that no administrator is viewing/editing the user account.
	3. System displays the list of phone accounts associated with the user.
4. Administrator submits choice to delete a specific phone account.	
	5. System verifies that no administrator is viewing/editing the phone account and that the account does not have an outstanding balance.
	6. System marks the selected phone account as deleted, frees up its extensions, and charges the final service fee.

Name:

Adding a User Account

Number: UC06
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator chooses to set up a new user account and an associated phone account.
Overview/Postcondition: The new user account and its associated phone account has been saved in the system.
References:

Course Project Overview: 6, 15, 21, 22, 24
Minutes #1: 4.2, 4.3, 4.4, 4.8, 5.1, 7.6
Minutes #2: 2.4, 2.8, 6.3
Minutes #3: 4.2, 4.3

Related Use Cases:

UC04, UC05, UC07

Typical process description:	
Administrator Actions	***System Response***
1. Administrator submits selection choice to set up a new user account	
	2. System prompts administrator for user information[1]
3. Administrator enters user information	
	4. System prompts administrator to choose an IP from a list of all unassigned telephone IPs
5. Administrator selects an unassigned telephone IP	
	6. System prompts administrator to choose how he/she would like to enter the telephone extension
7. Administrator selects to see a list of all available telephone extensions	
	8. System displays a list of all available telephone extensions
9. Administrator selects an extension from the list	
	10. System prompts the administrator to select a billing plan
11. Administrator selects an available billing plan	
	12. System prompts administrator to enable send/receive on the new phone account
13. Administrator enters a combination of send/receive for the new phone account	
	14. System creates a new user account with the entered user information
	15. System creates a new phone account with the

	selected telephone IP, telephone extension, billing plan and send/receive options and associates the phone account with the new user account
Alternative 1	
7. Administrator selects to manually enter an extension	
	8. System prompts for a telephone extension
9. Administrator enters telephone extension	
	10. System checks that the entered extension is valid[2] and unassigned
	11. Return to main flow step 10
Alternative 2	
7. Administrator selects to assign a randomly generated available extension to the telephone	
	8. System assigns a randomly generated available extension to the telephone
	9. Return to main flow step 10
Notes: [1] User information contains name, address, alternate phone number, account number and date of birth. [2] Valid extensions are exactly 4 digits.	

Name:

Deleting a User Account

Number: UC07
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator chooses to delete a user account. The input is the user account that the administrator wants to delete.
Overview/Postcondition: The user account has been marked as deleted, and its phone accounts have been marked as deleted.
References:

Course Project Overview: 24
Minutes #1: 4.2, 4.3, 4.13, 6.1
Minutes #3: 5.3, 5.6

Related Use Cases:

UC04, UC05, UC06

Typical process description:	
Administrator Actions	***System Response***
1. Administrator submits choice to view a specific user account	
	2. System verifies that no administrator is viewing/editing the user account
	3. System shows the list of phone accounts associated with

	the user
4. Administrator submits choice to delete the user account	
	5. System verifies that no administrator is viewing/editing the phone accounts of that user and that all phone accounts of that user have no outstanding balance
	6. System charges the final service fee to all phone accounts associated with that user, and deletes all phone accounts associated to the selected user account
	7. System marks the selected user account as deleted

Name:

Editing a Billing Plan

Number: UC08
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator knows which billing plan he/she would like to change.
Overview/Postcondition: The requested modifications to the billing plan have been committed.
References:

Course Project Overview: 54, 56, 57, 58
Minutes #1: 7.6
Minutes #2: 6.2
Minutes #3: 1.2, 6.2, 6.3, 6.4

Related Use Cases:

None

Typical process description:	
Administrator Actions	***System Response***
1. Administrator requests a list of billing plans	
	2. System displays the list of billing plans in the system
3. Administrator selects a billing plan to edit	
	4. System verifies that no administrator is viewing/editing that billing plan
	5. System displays that billing plan, and prompts the administrator to enter information[1] related to the billing plan
6. Administrator defines and submits new billing plan information	
	7. System verifies[2] entered billing plan information
	8. System commits modifications to billing plan
Notes: [1] Each billing plan specifies: (a) the regular charge rate for calls (b) one or more time periods, such as days of the week and times of the day	

(c) the discount rate for each of these periods (percentage of regular rate)
(d) monthly flat fee; and
(e) call blocking
[2] Validation checks that:
(a) Regular charge rate is a valid positive dollar amount
(b) Discount days are days of the week, and discount times are times of the day
(c) Discount rates must be valid positive percentages
(d) No two discount periods overlap
(e) Monthly flat fee must be a valid non-negative dollar amount.

Name:

Adding an Administrator Account

Number: UC09
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: An administrator chooses to add a new administrator account to the system.
Overview/Postcondition: The new administrator account has been added to the system.
References:
Course Project Overview: 20
Minutes #1: 3.2
Minutes #2: 5.5
Related Use Cases:
UC10

Typical process description:	
Administrator Actions	***System Response***
1. Administrator selects to add a new administrator account	
	2. System prompts the administrator to enter the username and password of the new administrator
3. Administrator enters the username and password of the new administrator	
	4. System checks that the username is unique and that the username and password are valid[1]. The system creates the new administrator account

Notes:
[1] A valid password must consist of alphanumeric characters, or characters in the set {!@#$%^&*()}. Passwords must be at least 8 characters long and at most 256 characters long. A valid username must be at least 8 character long and at most 256 characters long, consisting only of alphanumeric characters.

Name:

Deleting an Administrator Account

Number: UC10
Authors: SE1_06
System: A VoIP telephone system

Actors: Administrator (Initiator)
Event/Precondition: Administrator chooses to delete an administrator account from the system.
Overview/Postcondition: The administrator account has been removed from the system, and the deleted administrator has been logged out.
References:
Minutes #1: 3.2, 4.15
Minutes #3: 5.4
Related Use Cases:
UC09

Typical process description:	
Administrator Actions	***System Response***
1. Administrator chooses to delete an administrator account	
	2. System displays a list of existing administrator accounts, excluding the account of the logged in administrator
3. Administrator chooses which administrator account to remove	
	4. System verifies that no administrator is viewing/editing that administrator account
	5. System removes the selected administrator account
	6. If the deleted administrator is logged in System logs out the deleted administrator

Name:

Adding Filter Expressions

Number: UC11
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator chooses to add filter expressions to a phone account. The input will be the phone account to which the administrator wants to add filtered expressions.
Overview/Postcondition: The new filter expressions have been added to the phone account.
References:
Minutes #1: 4.1, 4.10, 4.11, 4.12
Minutes #3: 1.3, 1.12, 4.1
Related Use Cases:
None

Typical process description:	
Administrator Actions	***System Response***
1. Administrator submits the phone account to edit	
	2. System verifies that no administrator is viewing/editing that phone account
	3. System displays the lists of currently filtered incoming/outgoing expressions
4. Administrator chooses to add a new	

expression to either of the filter lists	
	5. System prompts for the expressions to be added
6. Administrator enters list of expressions to be added	
	7. System checks that the entered expressions are valid[1]
	8. System adds all valid expressions to the filtered list and displays errors about invalid input
Notes: [1] Valid expressions are exactly 4 digits in length. A wildcard '*' character can be used in place of any digit to represent that all digits will match that spot. For example, 0000, 1234, ****, and 1*2* are valid entries, but 123, 12345, *1234, and * are not.	

Name:

Adding a Blocked Extension

Number: UC12
Authors: SE1_06
System: A VoIP telephone system
Actors: User (Initiator)
Event/Precondition: The user is at their telephone and has picked up the receiver.
Overview/Postcondition: The extensions that the user wish to add/remove have been added/removed from his blocked extension list.
References:
Minutes #1: 8.1, 8.4
Minutes #2: 7.1, 7.3, 7.4, 7.5, 7.6
Minutes #3: 2.1, 2.2
Related Use Cases:
None

Typical process description:	
User Actions	***System Response***
1. User dials #70 to edit their call blocking list	
	2. System prompts the user to press 1 for adding extensions to their blocked extensions list, to press 2 to remove extensions from their blocked extensions list, or to press 3 to clear all blocked extensions
3. User presses 1 to add blocked extensions from their list	
4. User enters an extension, followed by the delimiter key (*)	
	5. System validates[1] the extension that the user entered
	6. System adds the extension to the user's blocked extension list
7. If user does not press the terminate key (#) Go to main flow step 4	
Notes:	

[1] A valid sequence is four digits followed by a #. A valid sequence can be terminated by pressing the * after pressing the #. All other sequences are invalid.

Name:

Adding an IP Address

Number: UC13
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The administrator is logged into the system. The administrator chooses to add an IP to the system.
Overview/Postcondition: The new IP has been added to the system.
References: Press Conference #3: 12
Related Use Cases:
None

Typical process description:	
Administrator Actions	***System Response***
1. Administrator chooses to add an IP to the system	
	2. System prompts administrator to enter an IP to add
3. The administrator enters an IP	
	4. System validates[1] the IP and makes sure the IP isn't already in the system
	5. System adds the IP, setting its default status to "disabled"
Notes: [1] A valid IP is in IPv4 format: x.y.z.w, where x, y, z, w are integers between 0 and 255, inclusive.	

Name:

Running a Hardware Test

Number: UC14
Authors: SE1_06
System: A VoIP telephone system
Actors: Time (initiator)
Event/Precondition: 30 seconds have elapsed since the previous test on the phone has completed
Overview/Postcondition: The next test on the phone has completed.
References:
Course Project Overview: 27, 28, 35
Minutes #2: 5.6, 5.7
Minutes #3: 5.2
Related Use Cases:
None

Typical process description:		
Time Actions	***System Response***	***Phone Response***
1. 30 seconds have elapsed since the previous test on		

the phone has finished		
	2. System sends test signal to phone	
		3. Phone responds to test signal, indicating that the phone is still in operation
	4. System places phone in "in service" state	

Name:

Starting the System

Number: UC15
Authors: SE1_06
System: A VoIP telephone system
Actors: Administrator (Initiator)
Event/Precondition: The system is off.
Overview/Postcondition: The system is back online and ready to process calls.
References: Meeting #2: 5.15, 8.2
Related Use Cases:

UC14

Typical process description:	
Administrator's Actions	***System Response***
1. Administrator starts the system	
	2. System turns back on, and becomes ready to accept hardware events from the phones
	3. System charges all phone accounts no service fee for the duration that it was down
	4. System begins an automated test for each of the phones

3.2.2 Domain Model

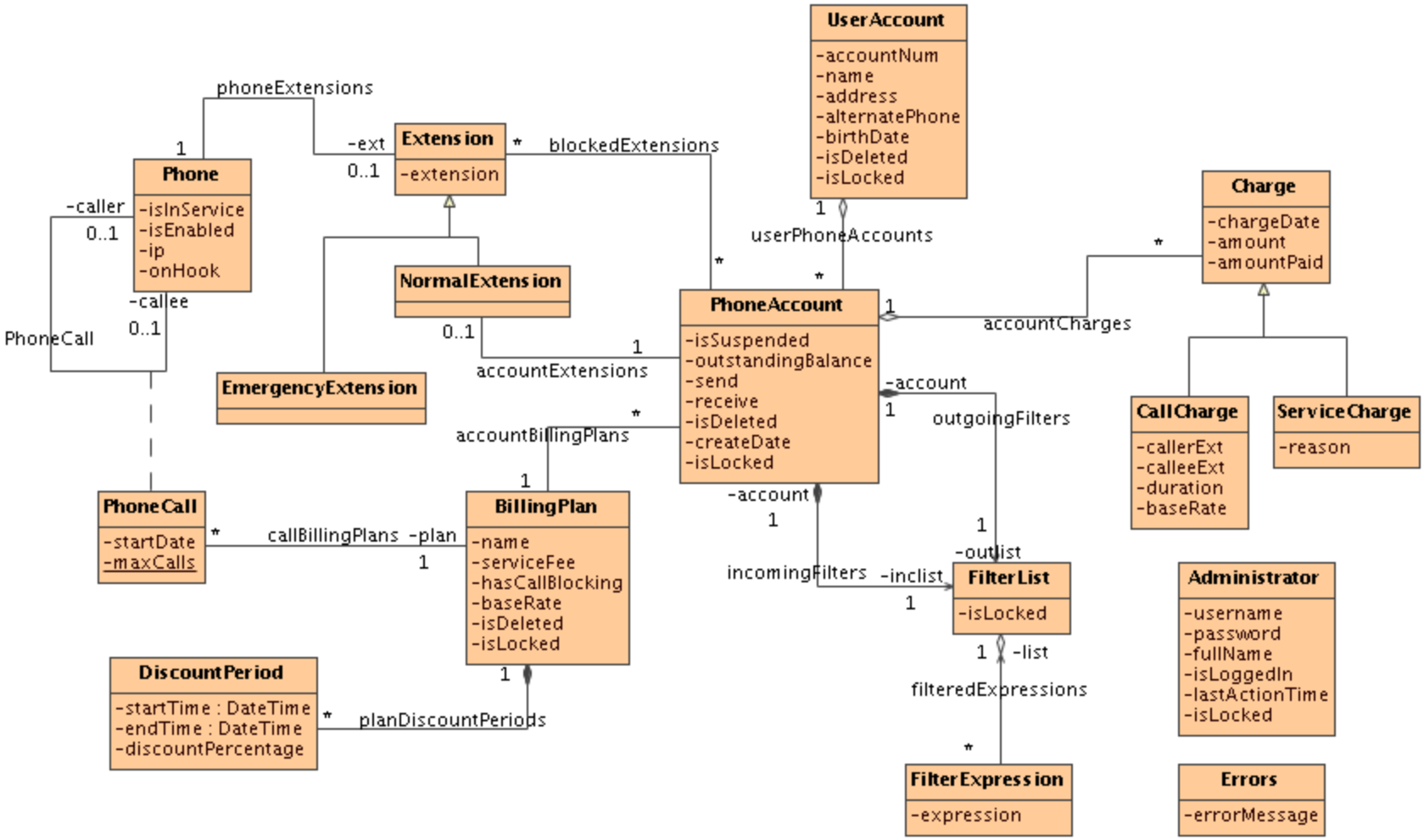


Figure 4 - Domain class diagram

3.2.3 Functional Specifications

Naming Conventions for Objects and Links

Our group used a general naming convention to simplify the naming of sets and links. In all cases, the set of entities named "A" is called "As". For example, the set of "PhoneAccount" entities is called "PhoneAccounts". For relations (links) we used the name of the association on the class diagram. For example, the links between the "Extension" entities and "PhoneAccount" entities is called "blockedExtensions," as is labeled on the diagram. Our group followed this convention to simplify the task of reading the document and also to alleviate the needs to define sets in the class diagram or in each function table. All sets that do not follow this convention are specifically mentioned and defined in the function tables. There is an extra set of Extension objects, called "Blocked", used to store the list of blocked extensions.

ID: 01 Importance: E

Making a Call

Overview:

Making a call to another phone

Inputs:

myExt, otherExt : Integer

Preconditions:

$0 \leq myExt < 10000$,
$0 \leq otherExt < 10000$,
$|PhoneCalls| < PhoneCall.maxCalls$,
$\exists\ p \in Phones : (p.Extension.extension = myExt \text{ AND } p.onHook = false)$,
$\exists\ p \in Phones : (p.Extension.extension = otherExt \text{ AND } p.onHook = true)$,
$\exists\ acct \in PhoneAccounts : ($
    acct.NormalExtension.extension = myExt AND
    acct.send = true AND
    acct.isSuspended = false),
$\exists\ acct \in PhoneAccounts : ($
    acct.NormalExtension.extension = otherExt AND
    acct.receive = true AND
    acct.isSuspended = false),
$\text{NOT } \exists\ c \in PhoneCalls : ($
    c.caller.Extension.extension = myExt OR
    c.callee.Extension.extension = myExt OR
    c.caller.Extension.extension = otherExt OR
    c.callee.Extension.extension = otherExt),
$\text{NOT } \exists\ b \in blockedExtensions : ($
    b.Extension.extension = myExt AND
    b.BlockList.PhoneAccount.NormalExtension.extension = otherExt),
$\text{NOT } \exists\ f \in filteredExpressions : ($
    f.FilterList.PhoneAccount.NormalExtension.extension = myExt AND

f.FilterList.type = “outgoing” AND
f.FilterExpression.expression MATCH[1] otherExt),
NOT ∃ f ∈ filteredExpressions : (
f.FilterList.PhoneAccount.NormalExtension.extension = otherExt AND
f.FilterList.type = “incoming” AND
f.FilterExpression.expression MATCH[1] myExt)

Modifies:
PhoneCalls, callBillingPlans, new newCall’ : PhoneCall

Postconditions:
let me = p ∈ Phones : p.Extension.extension = myExt
let other = p ∈ Phones : p.Extension.extension = otherExt
new newCall’ = (me, other, currentTime)
PhoneCalls’ = PhoneCalls ∪ {newCall’}
callBillingPlans’ = callBillingPlans ∪ {(newCall’, me.PhoneAccount.BillingPlan)}

Exceptions:
If any precondition does not hold
PhoneCalls’ = PhoneCalls
callBillingPlans’ = callBillingPlans

References:
Course Project Overview: 7, 8
Minutes #1: 1.1, 1.2, 1.7, 1.9, 1.11
Minutes #2: 1.2, 1.6, 1.8, 1.14
Minutes #3: 1.7, 1.13

Notes:
[1] An expression MATCHes a number when all four characters in the expression match the respective four digits in the extension. A character matches a digit if
a) the character is the same as the digit
b) the character is an asterisk (*)
[2] currentTime is a variable that contains the current date/time.

ID: 02 Importance: E

Ending a Call

Overview:
Hanging up the phone during a call. Note that this function does not charge for the final portion of the call. There is another function that charges, and that function will be called to charge the caller when the call ends.

Inputs:
myExt, otherExt : Integer

Preconditions:

∃ c ∈ PhoneCalls : (
    (c.caller.Extension.extension = myExt AND
       c.callee.Extension.extension = otherExt
) OR (c.callee.Extension.extension = myExt AND
       c.caller.Extension.extension = otherExt
)
)

Modifies:
PhoneCall

Postconditions:
let me = p ∈ Phones : p.Extension.extension = otherExt
let other = p ∈ Phones : p.Extension.extension = otherExt
if ∃ c ∈ PhoneCalls : (c.caller = me AND c.callee = other)
    let endedCall = c ∈ PhoneCalls : (c.caller = me AND c.callee = other)
else
    let endedCall = c ∈ PhoneCalls : (c.caller = other AND c.callee = me)
PhoneCalls' = PhoneCalls - {endedCall}

Exceptions:
If any precondition does not hold
    PhoneCalls' = PhoneCalls

References:
Course Project Overview: 9, 33

Notes:
[1] A date CONTAINs a time if date.start ≤ time and time ≤ date.end

ID: 03 Importance: D

Charging For Part of a Call

Overview:
The system charges a single call in a single discount period. This function should be called multiple times if a call spans multiple discount periods. This function should also be called when a phone call terminates, before disconnecting the call.

Inputs:
callerExt, calleeExt : Integer

Preconditions:
∃ call ∈ PhoneCalls : (
    call.caller.Extension.extension = callerExt AND
    call.callee.Extension.extension = calleeExt
)

Modifies:
new charge' : CallCharge, accountCharges, PhoneAccounts, call, Charges, CallCharges

Postconditions:
let c = call∈ PhoneCalls : (
    call.caller.Extension.extension = callerExt AND
    call.callee.Extension.extension = calleeExt)
let startTime = c.startTime
let billingPlan = c.BillingPlan
let phoneAccount = billingPlan.PhoneAccount
if ∃ p ∈ billingPlan.discountPeriod : (
    p.startTime < call.startTime AND
    p.endTime > call.startTime
) then
    let rate = billingPlan.baseRate * p.discountPercentage
    if call.endTime > p.endTime then
        let duration = ⌈p.endTime - call.startTime⌉
        call'.startTime = p.endTime
    else
        let duration = ⌈call.endTime - call.startTime⌉
        call'.startTime = call.endTime
else
    let rate = billingPlan.baseRate
    if ∀ p ∈ billingPlan.discountPeriod : (
        call.endTime < p.startTime OR
        p.endTime < call.startTime
) then
        let duration = ⌈call.endTime - call.startTime⌉
        call'.startTime = call.endTime
    else
        let nextDP ∈ billingPlan.discountPeriod : (
            nextDP.startTime > call.startTime AND
            ∀ dp ∈ billingPlan.discountPeriod : (
                (dp.startTime > call.startTime AND dp ≠ nextDP) ⇒
                    nextDP.startTime < dp.startTime
)
)
        let duration = ⌈nextDP.startTime - call.startTime⌉
        call'.startTime = nextDP.startTime
if phoneAccount.outstandingBalance < 0 then
    if |phoneAccount.outstandingBalance| > rate * duration then
        new charge' = (currentTime, rate * duration, rate * duration, callerExt,
            calleeExt, duration, rate)
    else
        new charge' = (currentTime, rate * duration,
            phoneAccount.outstandingBalance, callerExt, calleeExt, duration, rate)

else
    new charge' = (currentTime, rate * duration, 0, callerExt, calleeExt, duration, rate)
Charges' = Charges ∪ {charge'}
CallCharges' = CallCharges ∪ {charge'}
phoneAccount'.outstandingBalance = phoneAccount.outstandingBalance + rate * duration
accountCharges' = accountCharges ∪ {(phoneAccount', charge')}

Exceptions:
If preconditions are not met
    Charges' = Charges
    CallCharges' = CallCharges
    accountCharges' = accountCharges
    PhoneAccounts' = PhoneAccounts
    call' = call

References:
Course Project Overview: 44
Minutes #1: 7.10
Minutes #2: 6.6
Minutes #3: 6.6, 6.7, 8.1

ID: 04 Importance: D

Charging Monthly Service Fee

Overview:
Recording a monthly service fee for an account, and suspend it if a charge hasn't been paid for over 90 days.

Inputs:
p : PhoneAccount

Preconditions:
30 days have elapsed since the last billing date,
p.isLocked = false

Modifies:
p, new c' : Charges, ServiceCharges, accountCharges

Postconditions:
let newest = c ∈ p.Charge | (
    c ∈ ServiceCharges AND
    ∀ ch ∈ p.Charge : (
        (ch ∈ ServiceCharges AND ch ≠ newest) ⇒ ch.chargeDate < newest.chargeDate)
)
let amount = (currentTime – newest.chargeDate) * p.BillingPlan.serviceFee / 30
if p.outstandingBalance < 0 then

```
        if |p.outstandingBalance| > rate * duration then
                new c' = (currentTime, rate * duration, rate * duration, "Service Fee")
        else
                new c' = (currentTime, rate * duration, p.outstandingBalance, "Service Fee")
else
        new c' = (currentTime, rate * duration, 0, "Service Fee")
p'.outstandingBalance = p.outstandingBalance + amount
let oldest = c ∈ p.Charge | (
        oldest.amountPaid < oldest.amount AND
        ∀ ch ∈ p.Charge : (
                (ch ≠ oldest AND ch.amountPaid < ch.amount) ⇒
                        oldest.chargeDate < ch.chargeDate)
)
let difference = currentTime - oldest.chargeDate
let numBillingPeriods = (difference – (difference % 30)) / 30
if (numBillingPeriods >= 3) then
        p'.isSuspended = true
accountCharges' = accountCharges ∪ {(phoneAccount', c')}
ServiceCharges' = ServiceCharges ∪ {c'}
Charges' = Charges ∪ {c'}
```

Exceptions:
If any precondition does not hold
```
        p' = p
        accountCharges' = accountCharges
        Charges' = Charges
        ServiceCharges' = ServiceCharges
```

References:
Minutes #1: 7.13, 7.15

ID: 05 Importance: D

Recording Bill Payment

Overview:
Record a Bill Payment for a particular phone account

Inputs:
requestor : Administrator
p : PhoneAccount
amount : dollarAmount

Preconditions:
requestor initiates a bill payment,
requestor ∈ Administrators,
requestor.isLoggedIn = true,

p ∈ PhoneAccounts,
amount > 0

Modifies:
requestor, p, {c ∈ Charges | c.amountPaid < c.amount}

Postconditions:
requestor'.lastActionTime = currentTime
p'.outstandingBalance = p.outstandingBalance – amount
outstandingCharges = {c ∈ p.Charge | c.amountPaid < c.amount}
while (amount > 0 AND |outstandingCharges| > 0)
∀ c ∈ outstandingCharges : (
∀ c2 ∈ outstandingCharges : (
(c ≠ c2 ⇒ c.chargeDate < c2.chargeDate) ⇒
if amount ≥ (c.amountPaid - c.amount) then
amount = amount - (c.amountPaid - c.amount)
c'.amountPaid = c.amount
let difference = currentTime - c.chargeDate
let numBPeriods = (difference – (difference % 30)) / 30
if (numBPeriods < 3 AND p.isSuspended = true) then
p'.isSuspended = false
else
c'.amountPaid = c.amountPaid + amount
amount = 0
outstandingCharges = outstandingCharges - c
))
)

Exceptions:
If any precondition does not hold
requestor' = requestor
p' = p
∀ c ∈ Charges : (c' = c)

References:
Course Project Overview: 51

ID: 06 Importance: D

Prorating a Service Fee

Overview:
Prorate the service fee of an account

Inputs:
phoneAccount : PhoneAccount

Preconditions:
phoneAccount ∈ PhoneAccounts,
phoneAccount.isDeleted = false

Modifies:
phoneAccount, new c' : ServiceCharge, accountCharges, Charges, ServiceCharges

Postconditions:
let newest = c ∈ phoneAccount.Charge | (
    c ∈ ServiceCharges AND
    ∀ ch ∈ phoneAccount.Charge : (
        (ch ∈ ServiceCharges AND ch ≠ newest) ⇒ ch.chargeDate < newest.chargeDate)
)
let baseFee = phoneAccount.BillingPlan.serviceFee
let amount = (currentTime – newest) * baseFee / 30
new c' = (currentTime, amount, 0, "Prorated Service Fee")
Charges' = Charges ∪ {c'}
ServiceCharges' = ServiceCharges ∪ {c'}
accountCharges' = accountCharges ∪ {(phoneAccount', charge')}

Exceptions:
If any precondition does not hold
    phoneAccount' = phoneAccount
    accountCharges' = accountCharges
    Charges' = Charges
    ServiceCharges' = ServiceCharges

References:
Minutes #1: 7.11
Minutes #3: 8.1

ID: 07 Importance: D

Editing a Phone Account

Overview:
Edit an existing phone account

Inputs:
phoneAccount : PhoneAccount,
isSuspended, send, receive : boolean,
extension : int,
phone : Phone,
billingPlan : BillingPlan,
requestor : Administrator

Preconditions:

requestor initiates editing a phone account,
requestor ∈ Administrators,
requestor.isLoggedIn = true
phoneAccount.isLocked = false,
phoneAccount.isDeleted = false,
phoneAccount ∈ PhoneAccounts,
phone ∈ Phones,
billingPlan ∈ billingPlans,
0 ≤ extension < 10000,
∀ ae ∈ accountExtensions : (ae.NormalExtension = extension ⇒
    ae.PhoneAccount = phoneAccount)
(phone.Extension = ∅ OR phone.Extension = phoneAccount.NormalExtension)

Modifies:
requestor, phoneAccount, new ext': NormalExtension, Extensions, NormalExtensions, phoneExtensions, accountExtensions, accountBillingPlans, new c' : Charge, Charges, ServiceCharges

Postconditions:
requestor'.lastActionTime = currentTime
if (phoneAccount.isSuspended = true AND isSuspended = false) then
    new c' = (currentTime, 0, 0, "No service fee while suspended")
else if (phoneAccount.isSuspended = false AND isSuspended = true) then
    let newest = c ∈ phoneAccount.Charge | (
        c ∈ ServiceCharges AND
        ∀ ch ∈ phoneAccount.Charge : (
            (ch ∈ ServiceCharges AND ch ≠ newest) ⇒
                ch.chargeDate < newest.chargeDate)
)
    let baseFee = phoneAccount.BillingPlan.serviceFee
    let amount = (currentTime – newest) * baseFee / 30
    new c' = (currentTime, amount, 0, "Prorated service fee before suspension")
Charges' = Charges ∪ {c'}
ServiceCharges' = ServiceCharges ∪ {c'}
accountCharges' = accountCharges ∪ {(phoneAccount', c')}
phoneAccount'.isSuspended = isSuspended
phoneAccount'.send = send
phoneAccount'.receive = receive
phoneAccount'.createDate = phoneAccount.createDate
new ext' = (extension)
let oldExt = phoneAccount.NormalExtension
accountExtensions' = accountExtensions - {(phoneAccount, oldExt)} ∪ {(phoneAccount', ext')}
Extensions' = Extensions - {oldExt} ∪ {ext'}
NormalExtensions' = NormalExtensions - {oldExt} ∪ {ext'}
phoneExtensions' = phoneExtensions - {(oldExt, oldExt.Phone)} ∪ {(ext', phone)}

if (phoneAccount.BillingPlan ≠ billingPlan) then
    let newest = c ∈ phoneAccount.Charge | (
        c ∈ ServiceCharges AND
        ∀ ch ∈ phoneAccount.Charge : (
            (ch ∈ ServiceCharges AND ch ≠ newest) ⇒
                ch.chargeDate < newest.chargeDate)
)
    let baseFee = phoneAccount.BillingPlan.serviceFee
    let amount = (currentTime – newest) * baseFee / 30
    new c' = (currentTime, amount, 0, "Prorated service fee before billing plan change")
    Charges = Charges ∪ {c'}
    ServiceCharges = ServiceCharges ∪ {c'}
    accountCharges' = accountCharges ∪ {(phoneAccount', c')}
    accountBillingPlans' = accountBillingPlans -
        {(phoneAccount, phoneAccount.BillingPlan)} ∪ {(phoneAccount', billingPlan)}
phoneAccount'.isLocked = false

Exceptions:
If any precondition does not hold
    requestor' = requestor
    phoneAccount' = phoneAccount
    Extensions' = Extensions
    NormalExtensions' = NormalExtensions
    phoneExtensions' = phoneExtensions
    accountExtensions' = accountExtensions
    accountBillingPlans' = accountBillingPlans
    Charges' = Charges
    ServiceCharges' = ServiceCharges

References:
Course Project Overview: 24
Minutes #1: 4.2, 4.3, 4.13, 6.1
Minutes #3: 5.3, 5.6

ID: 08 Importance: D

Deleting a Phone Account

Overview:
Delete a phone account from the system.

Inputs:
requestor : Administrator
phoneAccount : PhoneAccount

Preconditions:

requestor initiates deleting a phone account,
requestor ∈ Administrators,
requestor.isLoggedIn = true,
phoneAccount.isLocked = false,
phoneAccount.outstandingBalance >= 0

Modifies:
requestor, phoneAccount, accountCharges, new c' : ServiceCharge, Charges, ServiceCharges, accountExtensions, incomingFilters, outgoingFilters, FilterLists, filteredExpressions, FilterExpressions

Postconditions:
requestor'.lastActionTime = currentTime
phoneAccount'.isDeleted = true
accountExtensions' = accountExtensions – {(phoneAccount, phoneAccount.NormalExtension)}
outgoingFilters' = outgoingFilters – {(phoneAccount, phoneAccount.outlist)}
incomingFilters' = incomingFilters – {(phoneAccount, phoneAccount.inclist)}
FilterLists' = FilterLists - {phoneAccount.outlist} - {phoneAccount.inclist}
let oldFilteredExpressions = {(f, fe) ∈ filteredExpressions |
    (f ∈ phoneAccount.outlist OR f ∈ phoneAccount.inclist)}
filteredExpressions' = filteredExpressions – oldFilteredExpressions
let oldFilterExpressions = {fe ∈ FilterExpressions |
    ∃ fde ∈ oldFilteredExpressions : fde.FilterExpression = fe}
FilterExpressions = FilterExpressions - oldFilterExpressions
let newest = c ∈ phoneAccount.Charge | (
    c ∈ ServiceCharges AND
    ∀ ch ∈ phoneAccount.Charge : (
        (ch ∈ ServiceCharges AND ch ≠ newest) ⇒ ch.chargeDate < newest.chargeDate)
)
let baseFee = phoneAccount.BillingPlan.serviceFee
let amount = (currentTime – newest) * baseFee / 30
new c' = (currentTime, amount, 0, "Prorated service fee for final billing period")
accountCharges' = accountCharges ∪ {(phoneAccount', c')}
Charges = Charges ∪ {c'}
ServiceCharges = ServiceCharges ∪ {c'}

Exceptions:
If any precondition does not hold
    requestor' = requestor
    phoneAccount' = phoneAccount
    accountCharges' = accountCharges
    ServiceCharges' = ServiceCharges
    Charges' = Charges
    accountExtensions' = accountExtensions
    incomingFilters' = incomingFilters
    outgoingFilters' = outgoingFilters

FilterLists' = FilterLists
filteredExpressions' = filteredExpressions
FilterExpressions' = FilterExpressions

References:
Course Project Overview: 24
Minutes #1: 4.2, 4.3, 4.13, 6.1
Minutes #3: 5.3, 5.6

ID: 09 Importance: D

Adding a User Account

Overview:
Add a user account to the system.

Inputs:
name, address, alternatePhone : String
birthDate : Date
isSuspended, send, receive : Boolean
extension : int
phone : Phone
billingPlan : BillingPlan
requestor : Administrator

Preconditions:
requestor initiates adding a user account,
requestor ∈ Administrators,
requestor.isLoggedIn = true,
phone ∈ Phones,
billingPlan ∈ BillingPlans,
$0 \leq$ extension $<$ 10000,
|Extensions| $<$ 10000,
phone.Extension = ∅,
NOT ∃ ext ∈ Extensions : ext.extension = extension

Modifies:
requestor, new user': UserAccount, UserAccounts, new phoneAccount': PhoneAccount, PhoneAccounts, new ext': NormalExtension, Extensions, NormalExtensions, userPhoneAccounts, accountExtensions, phoneExtensions, accountBillingPlans

Postconditions:
requestor'.lastActionTime = currentTime
if |UserAccounts| > 0 then
    let mostRecent = u ∈ UserAccounts |
        (∀ u2 ∈ UserAccounts : u ≠ u2 ⇒ u.accountNum > u2.accountNum)
    let id = mostRecent.accountNum + 1

else
    let id = 0
new user' = (id, name, address, alternatePhone, birthDate, false, false)
new phoneAccount' = (isSuspended, 0, send, receive, false, currentTime ,false)
new ext' = (extension)
UserAccounts' = UserAccounts ∪ {user'}
PhoneAccounts' = PhoneAccounts ∪ {phoneAccount'}
NormalExtensions' = NormalExtensions ∪ {ext'}
Extensions' = Extensions ∪ {ext'}
userPhoneAccounts' = userPhoneAccounts ∪ {(user', phoneAccount')}
accountExtensions' = accountExtensions ∪ {(phoneAccount', ext')}
phoneExtensions' = phoneExtensions ∪ {(ext', phone)}
accountBillingPlans' = accountBillingPlans ∪ {(phoneAccount', billingPlan)}

Exceptions:
If any precondition does not hold
    requestor' = requestor
    UserAccounts' = UserAccounts
    PhoneAccounts' = PhoneAccounts
    NormalExtensions' = NormalExtensions
    Extensions' = Extensions
    userPhoneAccounts' = userPhoneAccounts
    accountExtensions' = accountExtensions
    phoneExtensions' = phoneExtensions
    accountBillingPlans' = accountBillingPlans

References:
Course Project Overview: 6, 15, 21, 22, 24
Minutes #1: 4.2, 4.3, 4.4, 4.8, 5.1, 7.6
Minutes #2: 2.4, 2.8, 6.3
Minutes #3: 4.2, 4.3

ID: 10 Importance: D

Deleting a User Account

Overview:
Delete a phone account from the system.

Inputs:
requestor : Administrator
userAccount : UserAccount

Preconditions:
requestor initiates deleting a user account,
requestor ∈ Administrators,

requestor.isLoggedIn = true,
userAccount.isLocked = false,
∀ p ∈ userAccount.PhoneAccount : (p.isLocked = false AND p.outstandingBalance ≤ 0)

Modifies:
requestor, userAccount, p'∈ userAccount.PhoneAccount, accountCharges, new c' :
ServiceCharge, ServiceCharges, Charges, accountExtensions, incomingFilters, outgoingFilters,
FilterLists, filteredExpressions, FilterExpressions

Postconditions:
requestor'.lastActionTime = currentTime
userAccount'.isDeleted = true
let phoneAccts = userAccount.PhoneAccount
accountExtensions' - accountExtensions - {(p, p.NormalExtension) | p ∈ phoneAccts}
outgoingFilters' = outgoingFilters – {(p, p.outlist) | p ∈ phoneAccts}
incomingFilters' = incomingFilters – {(p, p.inclist) | p ∈ phoneAccts}
FilterLists' = FilterLists - {p.outlist | p ∈ phoneAccts} - {p.inclist | p ∈ phoneAccts}
let oldFilters = {p.outlist | p ∈ phoneAccts} ∪ {p.inclist | p ∈ phoneAccts}
let oldFilteredExpressions = {(f, fe) ∈ filteredExpressions | f ∈ oldFilters}
filteredExpressions' = filteredExpressions – oldFilteredExpressions
let oldFilterExpressions = {fe ∈ FilterExpressions |
    ∃ fde ∈ oldFilteredExpressions : fde.FilterExpression = fe}
FilterExpressions = FilterExpressions - oldFilterExpressions
∀ phoneAccount ∈ phoneAccts : (
    phoneAccount'.isDeleted = true
    let newest = c ∈ phoneAccount.Charge | (
        c ∈ ServiceCharges AND
        ∀ ch ∈ phoneAccount.Charge : (
            (ch ∈ ServiceCharges AND ch ≠ newest) ⇒
                ch.chargeDate < newest.chargeDate)
)
    let baseFee = phoneAccount.BillingPlan.serviceFee
    let amount = (currentTime – newest) * baseFee / 30
    new c' = (currentTime, amount, 0, "Prorated service fee for final billing period")
    accountCharges' = accountCharges ∪ {(phoneAccount', c')}
    ServiceCharges' = ServiceCharges ∪ {c'}
    Charges' = Charges ∪ {c'}

Exceptions:
If any precondition does not hold
    userAccount' = userAccount
    phoneAccount' = phoneAccount
    accountExtensions' = accountExtensions
    accountCharges' = accountCharges
    ServiceCharges' = ServiceCharges

Charges' = Charges
incomingFilters' = incomingFilters
outgoingFilters' = outgoingFilters
FilterLists' = FilterLists
filteredExpressions' = filteredExpressions
FilterExpressions' = FilterExpressions

References:
Course Project Overview: 24
Minutes #1: 4.2, 4.3, 4.13, 6.1
Minutes #3: 5.3, 5.6

ID: 11 Importance: D

Editing a Billing Plan

Overview:
A old Billing Plan is modified

Inputs:
requestor : Administrator
bp : BillingPlan
name : String
serviceFee, baseRate : dollarAmount
hasCallBlocking : boolean
discountPeriods : set of DiscountPeriod

Preconditions:
requestor initiates modifying a billing plan,
requestor $\in$ Administrators,
requestor.isLoggedIn = true,
bp.isLocked = false
bp isn't locked by another administrator,
serviceFee $\geq$ 0,
baseRate $\geq$ 0,
bp $\in$ BillingPlans,
$\forall$ dp $\in$ discountPeriods : (
$\forall$ dp2 $\in$ discountPeriods : (
dp $\neq$ dp2 $\Rightarrow$ (dp.endTime < dp2.startTime OR
dp2.endTime < dp.startTime)) AND
dp.discountPercentage $\geq$ 0 AND
dp.startTime < dp.endTime AND
dp.startTime.Date = dp.endTime.Date)

Modifies:
requestor, bp, DiscountPeriods, planDiscountPeriods

Postconditions:
requestor'.lastActionTime = currentTime
bp'.name = name
bp'.serviceFee = serviceFee
bp'.hasCallBlocking = hasCallBlocking
bp'.baseRate = baseRate,
let oldPDPs = {pdp ∈ planDiscountPeriods| pdp.BillingPlan = bp}
let newPDPs = {(bp', y) | y ∈ DiscountPeriods}
planDiscountPeriods' = planDiscountPeriods - oldPDPs ∪ newPDPs
let oldDPs = {dp ∈ DiscountPeriods | dp.BillingPlan = bp}
DiscountPeriods' = DiscountPeriods - oldDPs ∪ discountPeriods
bp'.DiscountPeriods = discountPeriods
bp'.isLocked = false

Exceptions:
If any of the preconditions are not met
requestor' = requestor
bp' = bp
DiscountPeriods' = DiscountPeriods
planDiscountPeriods' = planDiscountPeriods

References:
Course Project Overview: 54, 56, 57, 58
Minutes #1: 7.6
Minutes #2: 6.2
Minutes #3: 1.2, 6.2, 6.3, 6.4

ID: 12 Importance: O

Adding an Administrator Account

Overview:
Adds a new administrator account to the system with the specified username, password and full name
Inputs:
requestor : Administrator
username, password, fullName : String

Preconditions:
requestor initiates adding a new administrator account,
requestor ∈ Administrators,
requestor.isLoggedIn = true,
NOT ∃ admin ∈ Administrators : (admin.username = username),
password is alphanumeric or containing characters in set {!@#$%^&*()} and has length [8, 256] characters,
username is alphanumeric and has length [8, 256] characters

Modifies:
requestor, Administrators, new admin' : Administrator

Postconditions:
requestor'.lastActionTime = currentTime
new admin' = (username, password, fullName, false, currentTime, false)
Administrators' = Administrators ∪ {admin'}

Exceptions:
If any precondition does not hold
requestor' = requestor
Administrators' = Administrators

References:
Course Project Overview: 20
Minutes #1: 3.2
Minutes #2: 5.5

ID: 13 Importance: O

Deleting an Administrator Account

Overview:
Deletes an administrator account

Inputs:
requestor, deleted : Administrator

Preconditions:
requestor initiates deleting an administrator account,
requestor ∈ Administrators,
requestor.isLoggedIn = true,
deleted ∈ Administrators,
deleted.isLocked = false

Modifies:
requestor, Administrators, deleted

Postconditions:
requestor'.lastActionTime = currentTime
deleted'.isLoggedIn = false
Administrators = Administrators - deleted

Exceptions:
If any precondition does not hold
requestor' = requestor
Administrators' = Administrators

deleted' = deleted

References:
Minutes #1: 3.2, 4.15
Minutes #3: 5.4

ID: 14 Importance: O

Adding an Incoming Filter Expression

Overview:
A Incoming Filtered Extension is created

Inputs:
requestor : Administrator
p : PhoneAccount
ext : String

Preconditions:
requestor initiates the creation of an incoming filtered expression,
requestor ∈ Administrators,
requestor.isLoggedIn = true,
p.isLocked = false,
p ∈ PhoneAccounts,
ext is a 4 digit extension (allowing wildcards),
NOT ∃ fe ∈ FilterExpressions : (fe.expression = ext AND fe.list.account = p)

Modifies:
requestor, filteredExpressions, new fe' : FilterExpression, FilterExpressions

Postconditions:
requestor'.lastActionTime = currentTime
new fe' = (ext)
filteredExpressions' = filteredExpressions ∈ {(p.incList, fe')}
FilterExpressions' = FilterExpressions U {fe'}
p.isLocked = false

Exceptions:
If any precondition does not hold
requestor' = requestor
filteredExpressions' = filteredExpressions
FilterExpressions' = FilterExpressions

References:
Minutes #1: 4.1, 4.10, 4.11, 4.12
Minutes #3: 1.3, 1.12, 4.1

ID: 15 Importance: D

Adding a Blocked Extension

Overview:
The user adds a blocked extension to the blocked numbers list, using the #701 special number mechanism.

Inputs:
blockingAccount : PhoneAccount
blockedExtension : integer

Preconditions:
phone user initiates adding a blocked number,
blockingAccount $\in$ PhoneAccounts,
blockingAccount.isSuspended = false,
blockingAccount.accountBillingPlans.hasCallBlocking = true
$0 \leq$ blockedExtension < 10000
NOT $\exists$ b $\in$ blockedExtensions : (
    b.Extension.extension = blockedExtension AND
    b.PhoneAccount = blockingAccount)

Modifies:
Blocked, blockedExtensions, new ext' : Extension

Postconditions:
if $\exists$ e $\in$ Blocked : e.extension = blockedExtension
    blockedExtensions' = blockedExtensions $\cup$ {(blockingAccount, e)}
else
    new ext' = (blockedExtension)
    Blocked' = Blocked $\cup$ {ext'}
    blockedExtensions' = blockedExtensions $\cup$ {(blockingAccount, ext')}

Exceptions:
If preconditions are not met
    Blocked'= Blocked
    blockedExtensions' = blockedExtensions

References:
Minutes #1: 8.1, 8.4
Minutes #2: 7.1, 7.3, 7.4, 7.5, 7.6
Minutes #3: 2.1, 2.2

ID: 16 Importance: E

Adding an IP Address

Overview:
An administrator informs the system that there a phone on the network at the given IP address.

Inputs:
ip : String
requestor : Administrator

Preconditions:
requestor requests to add an ip address,
requestor $\in$ Administrators,
requestor.isLoggedIn = true,
$\forall$ p $\in$ Phones : p.ip $\neq$ ip

Modifies:
requestor, Phones

Postconditions:
requestor'.lastActionTime = currentTime
Phones' = Phones $\cup$ (false, false, ip, true)

Exceptions:
If preconditions are not met
requestor' = requestor
Phones' = Phones

References:
Minutes #3: 12

ID: 17 Importance: D

Running a Hardware Test

Overview:
Either an administrator requests a hardware test for a particular phone, or the system's periodic testing triggers a hardware test for a particular phone.

Inputs:
ip : String

Preconditions:
Administrator or system initiates a hardware test,
$\exists$ p $\in$ phone : p.ip = ip

Modifies:

Errors, p

Postconditions:
if hardware failure was detected on phone p
    Errors' = Errors ∪ {("Hardware failure at ip address " + ip)}
    p'.isInService = false
else
    Errors' = Errors
    p'.isInService = true

Exceptions:
If preconditions are not met
    Errors' = Errors
    p' = p

References:
Course Project Overview: 27, 28, 35
Minutes #1: 1.7, 5.2
Minutes #2: 5.6, 5.7, 5.10, 5.14
Minutes #3: 5.1, 5.2

3.2.4 State Machine Models

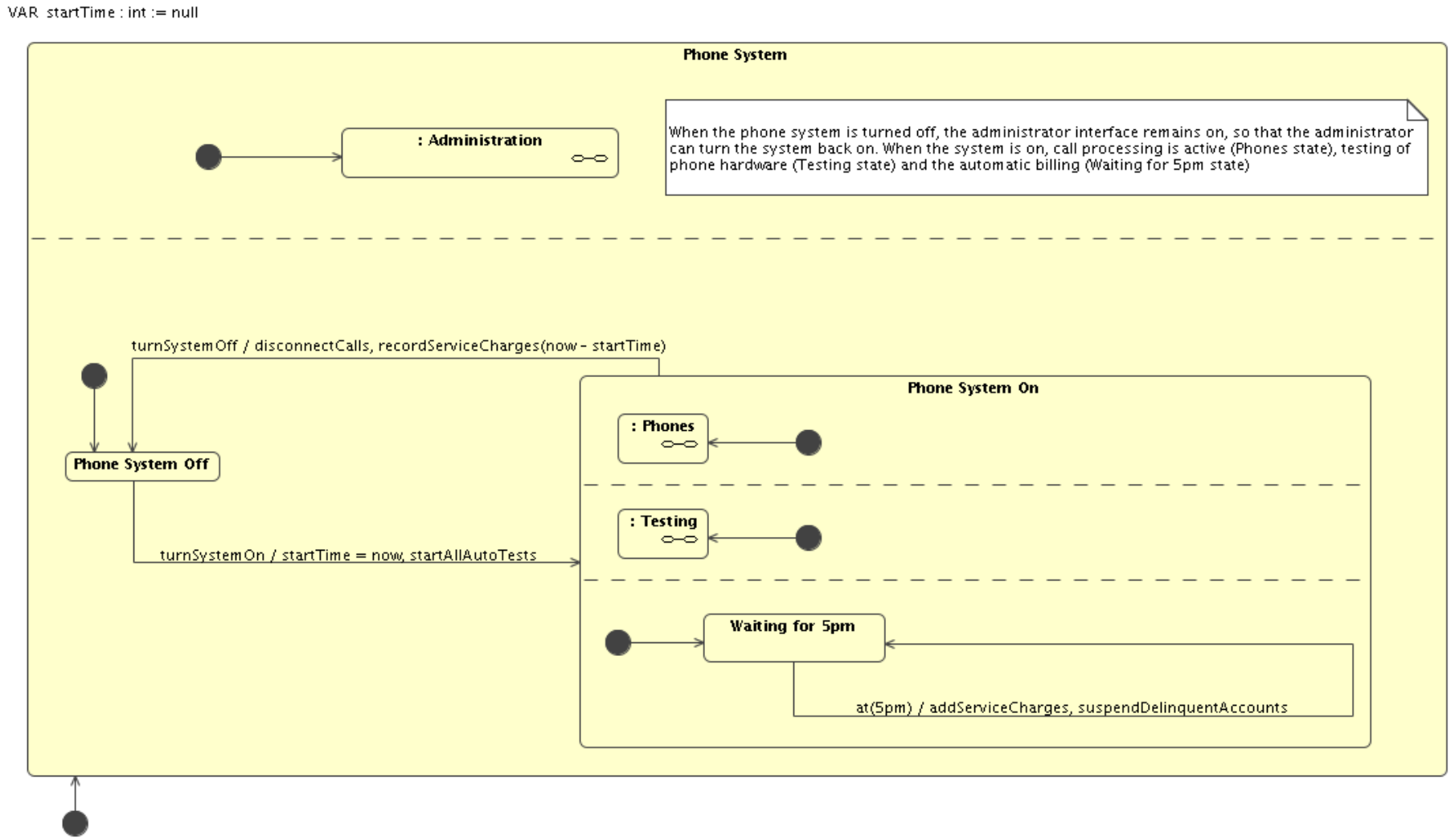


Figure 5 - Phone System SSD
The highest level SSD that contains all functionality of the system.

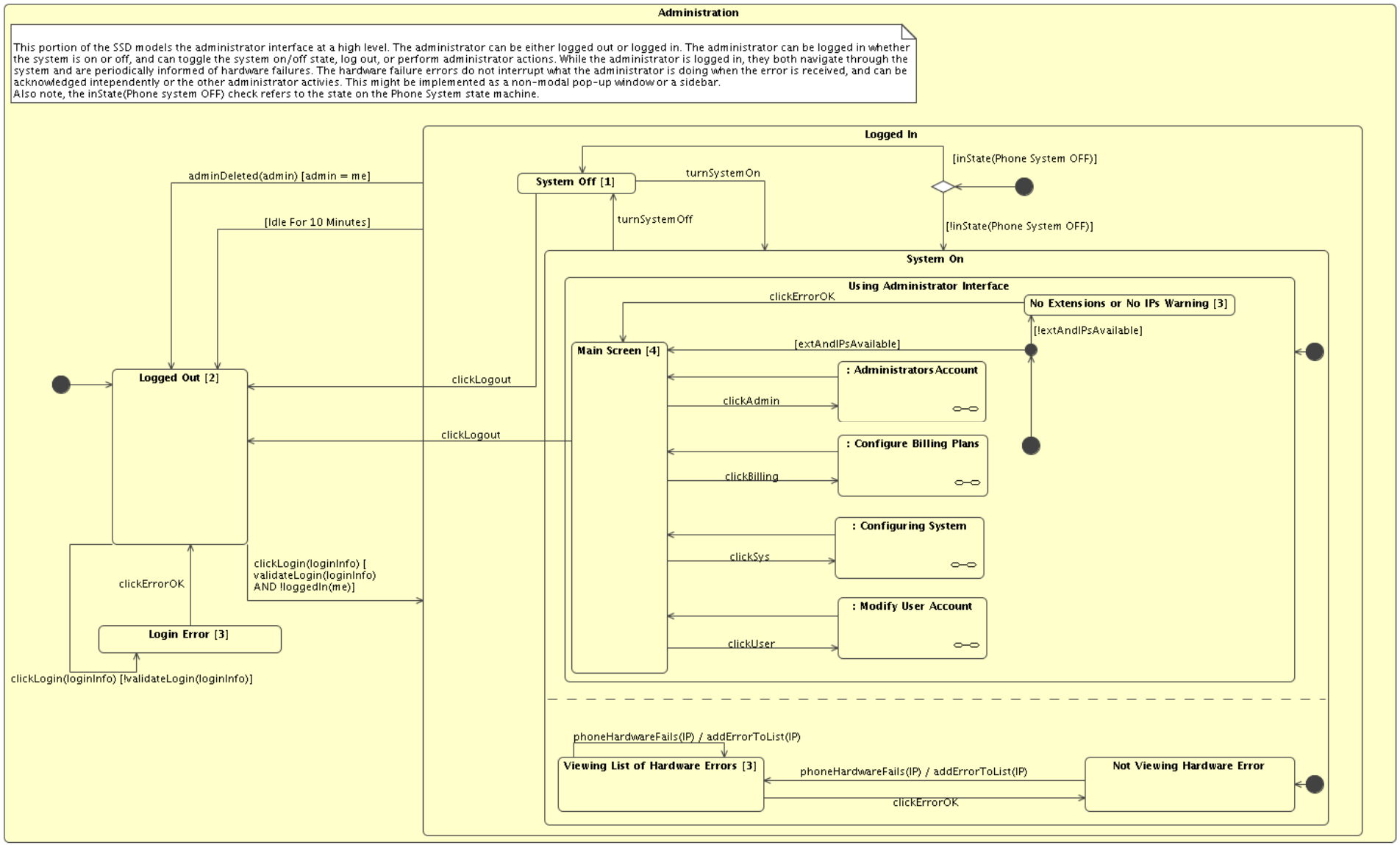


Figure 6 - Administration SSD
Models the administrator's GUI at the highest level.

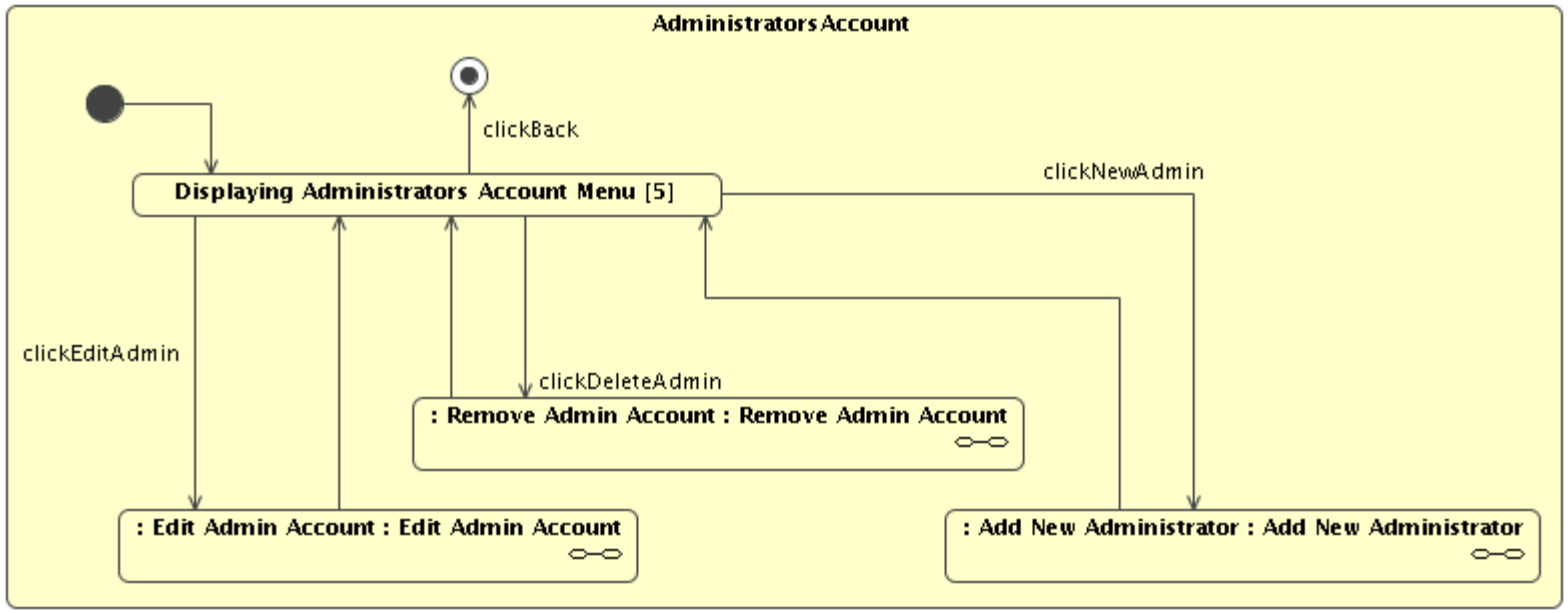


Figure 7 - Administrators Account SSD
Navigation screens for managing the administrators of the system.

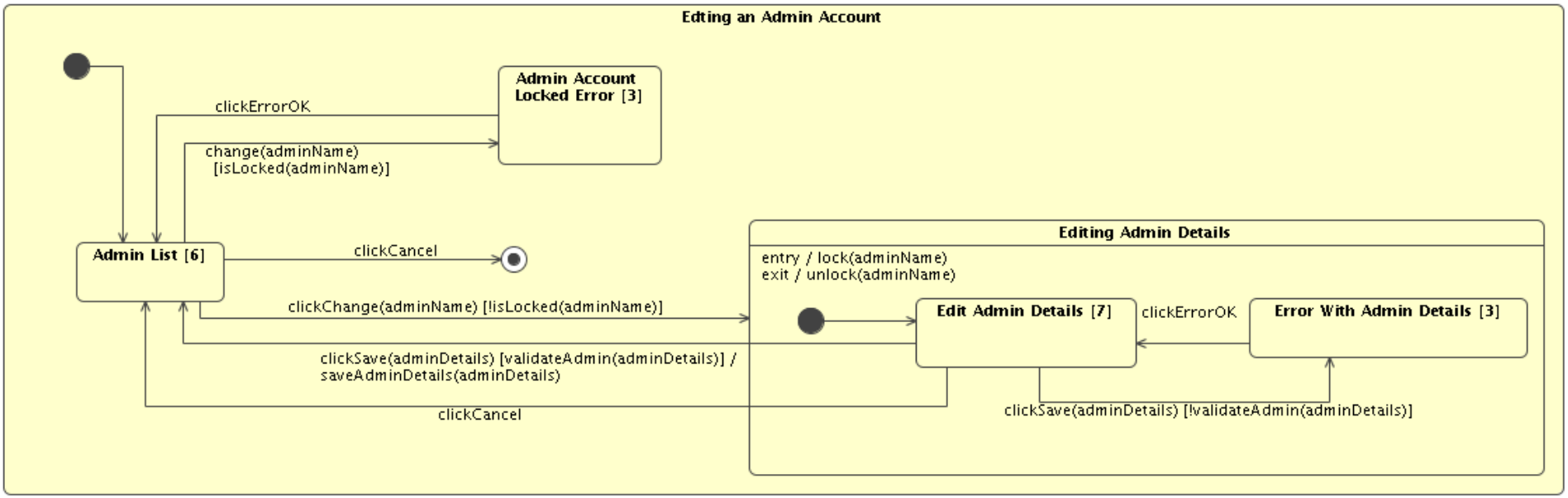


Figure 8 - Editing an Admin Account SSD
Models the process of editing an administrator's account.

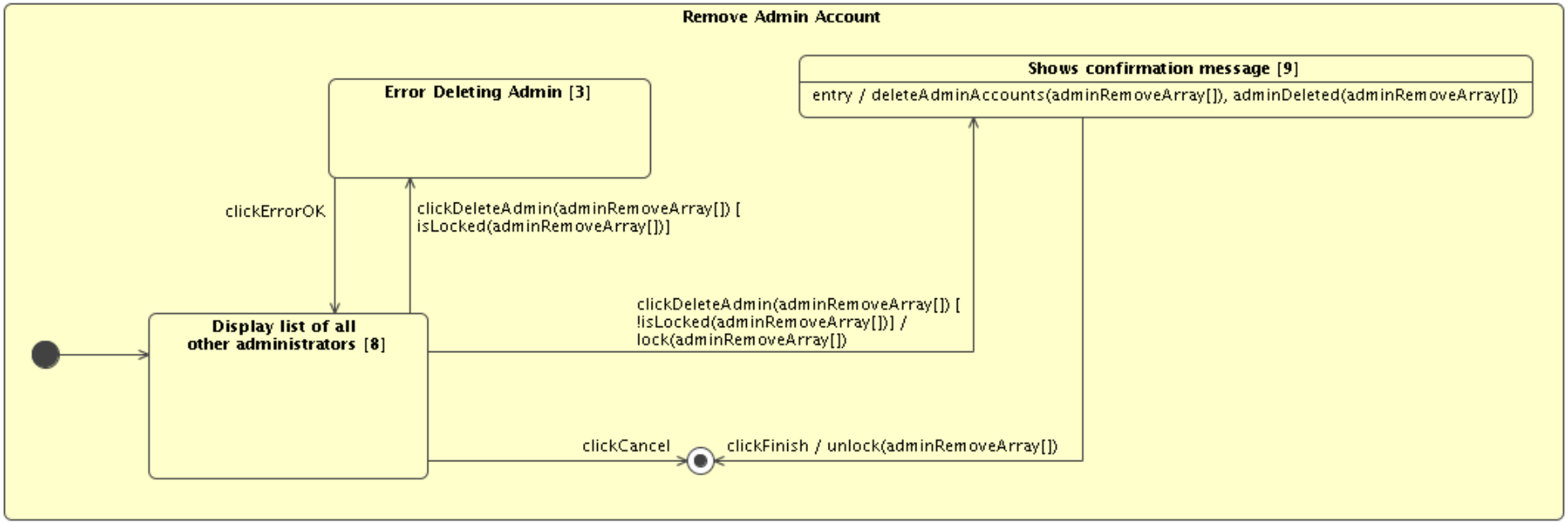


Figure 9 - Remove Admin Account SSD
Modes the process of removing an administrator or set of administrators from the system.

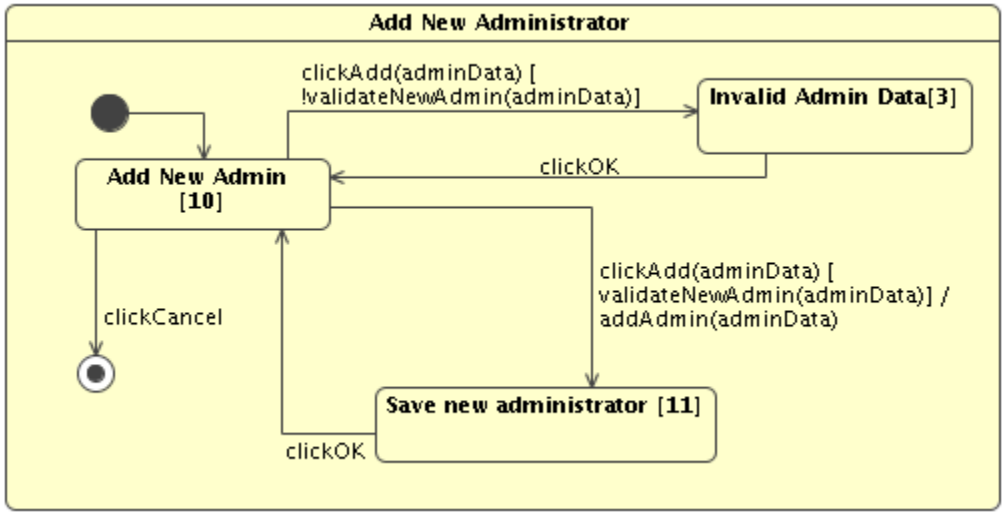


Figure 10 - Add New Administrator SSD
Models the process of adding an administrator to the system.

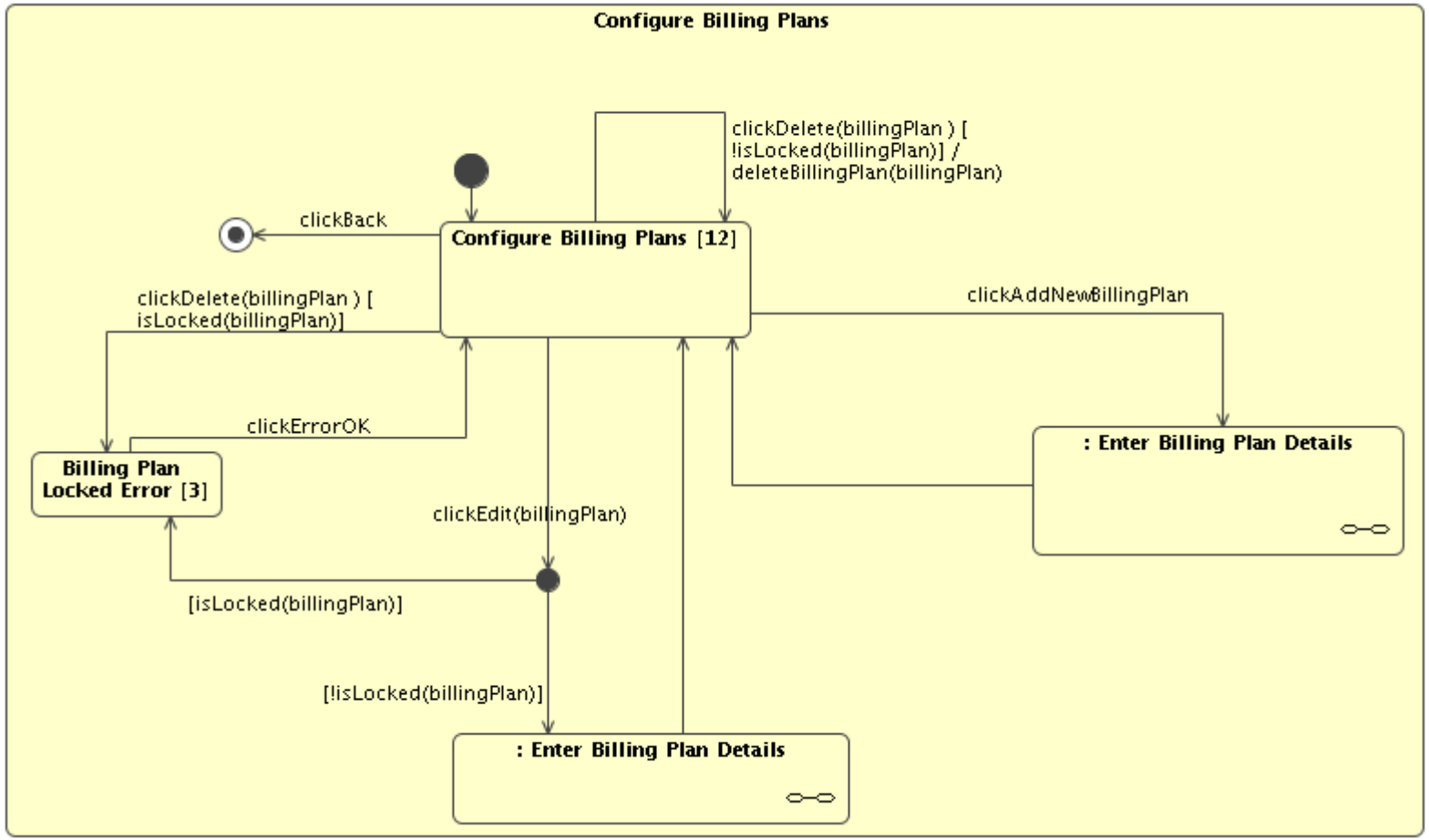


Figure 11 - Configure Billings Plans SSD
Navigation screens for the managing of the billing plans.

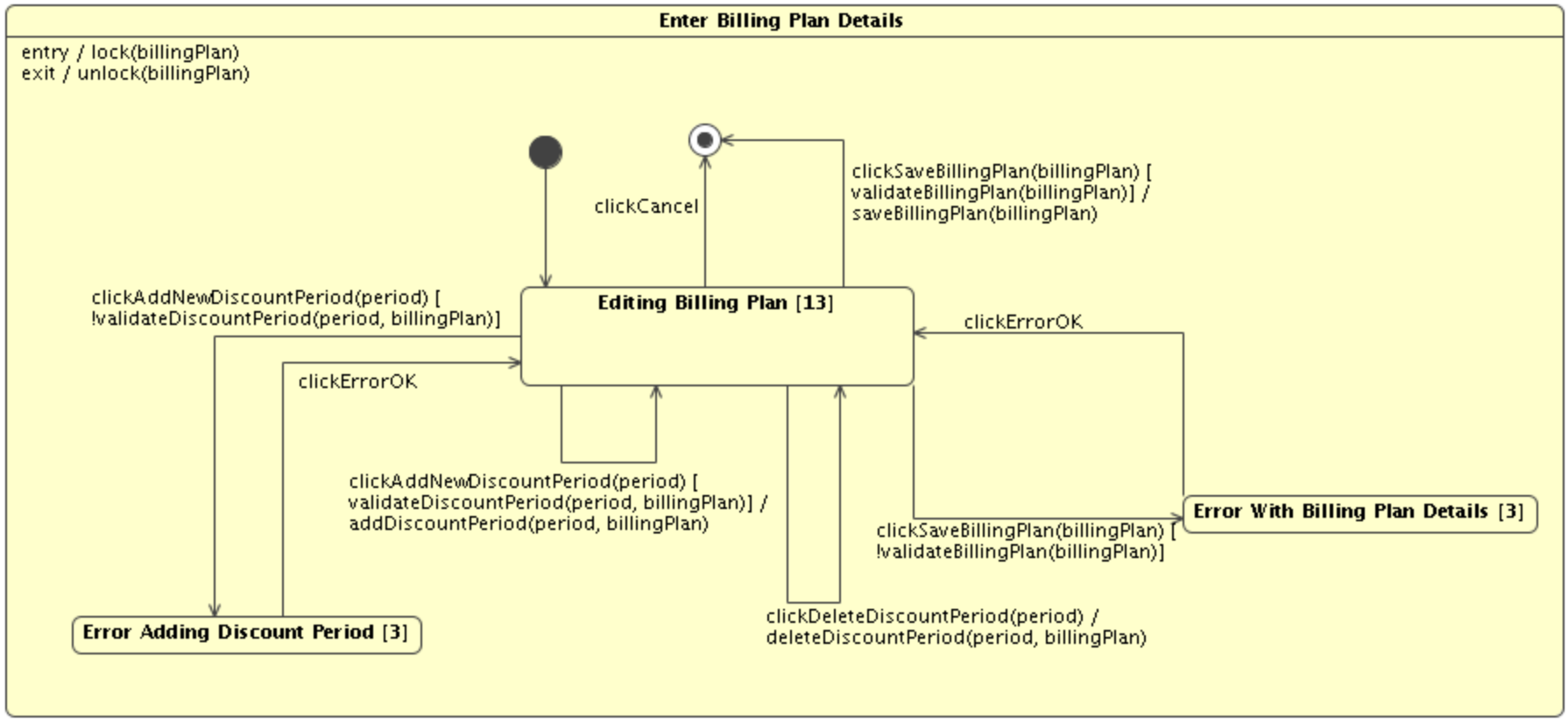


Figure 12 - Enter Billing Plan Details SSD
Models the process of entering billing plan details for a new or existing administrator account.

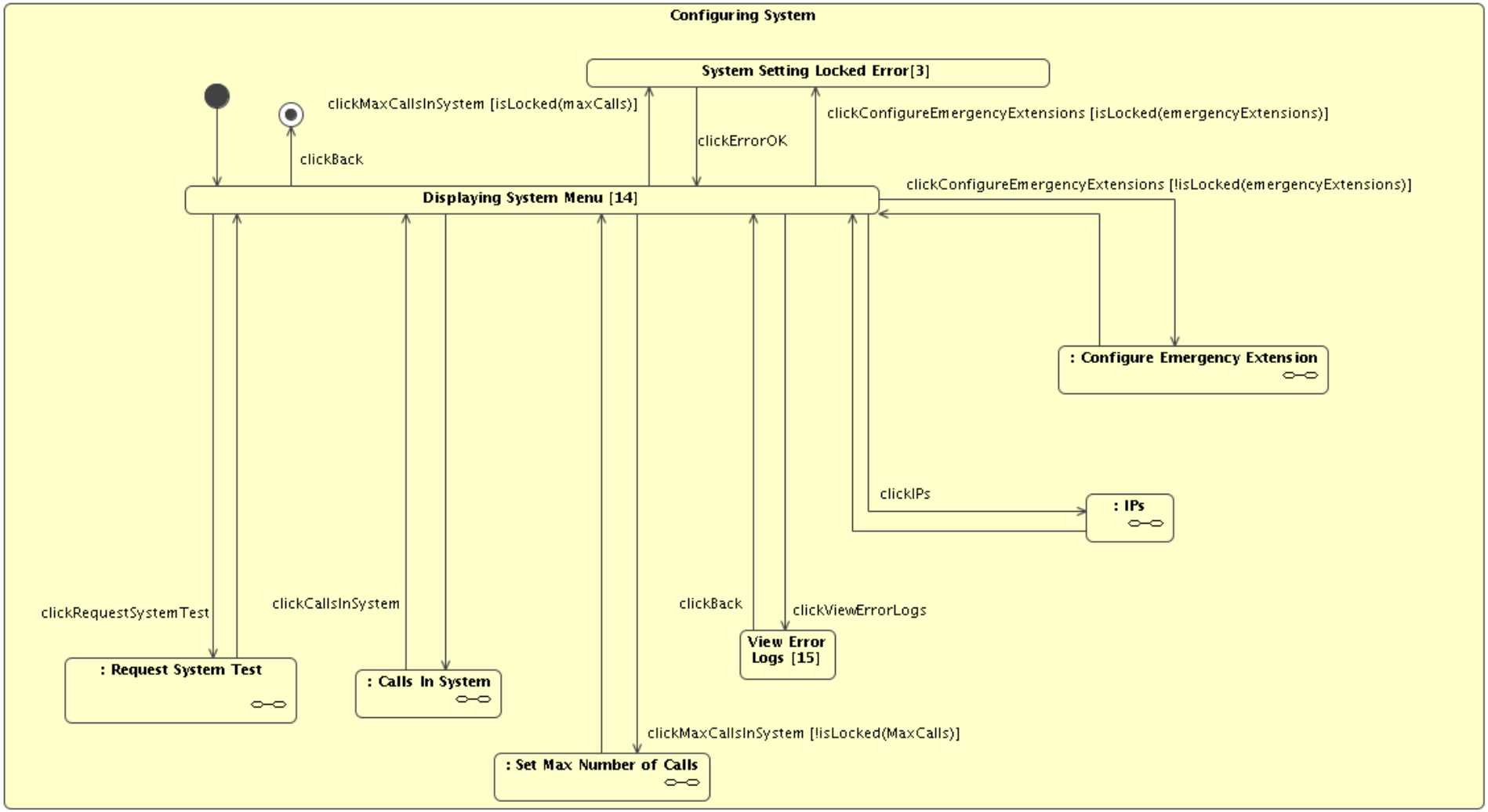


Figure 13 - Configuring System SSD
Navigation screens for configuring the system.

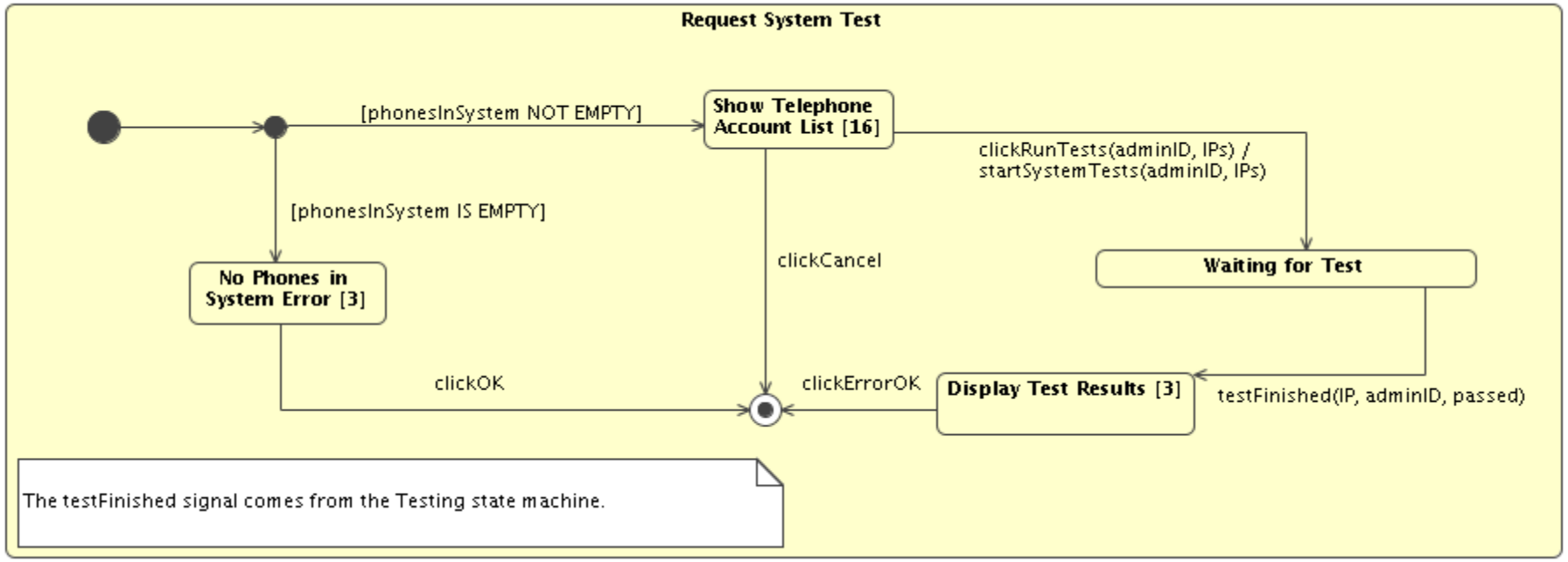


Figure 14 - Request System Test SSD
Models the process of requesting a hardware test on one or more phones.

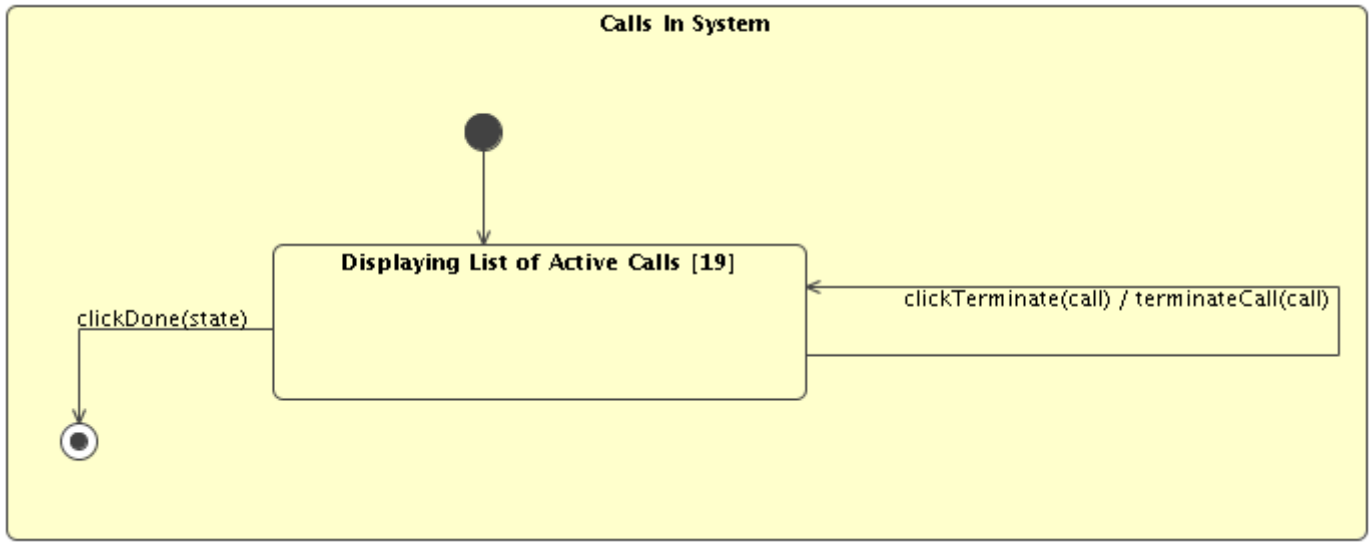


Figure 15 - Calls In System SSD
Models the process of viewing and terminating active calls in the system.

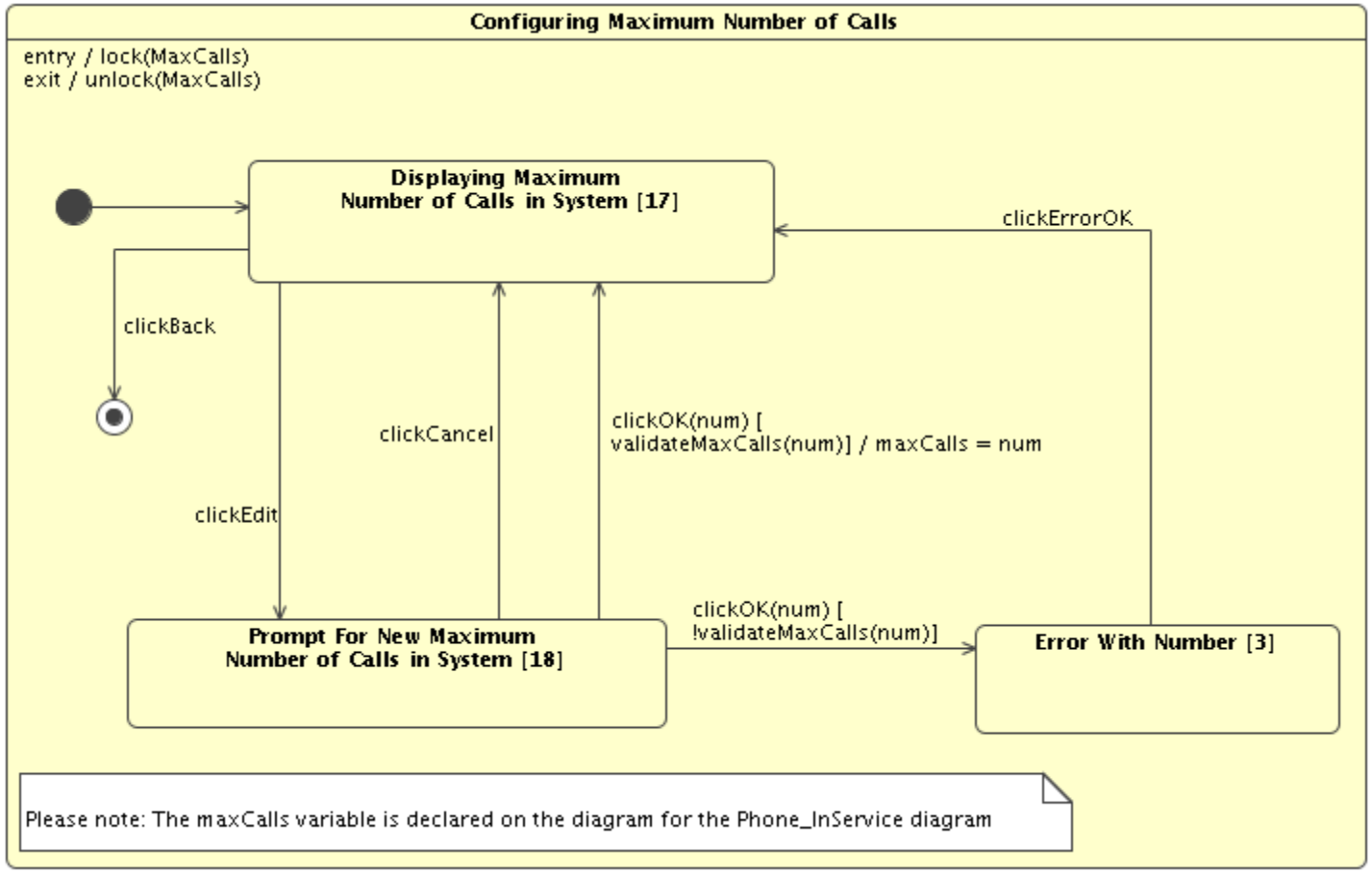


Figure 16 - Configuring Maximum Number of Calls SSD
Models the process of viewing and modifying the maximum number of calls in the system.

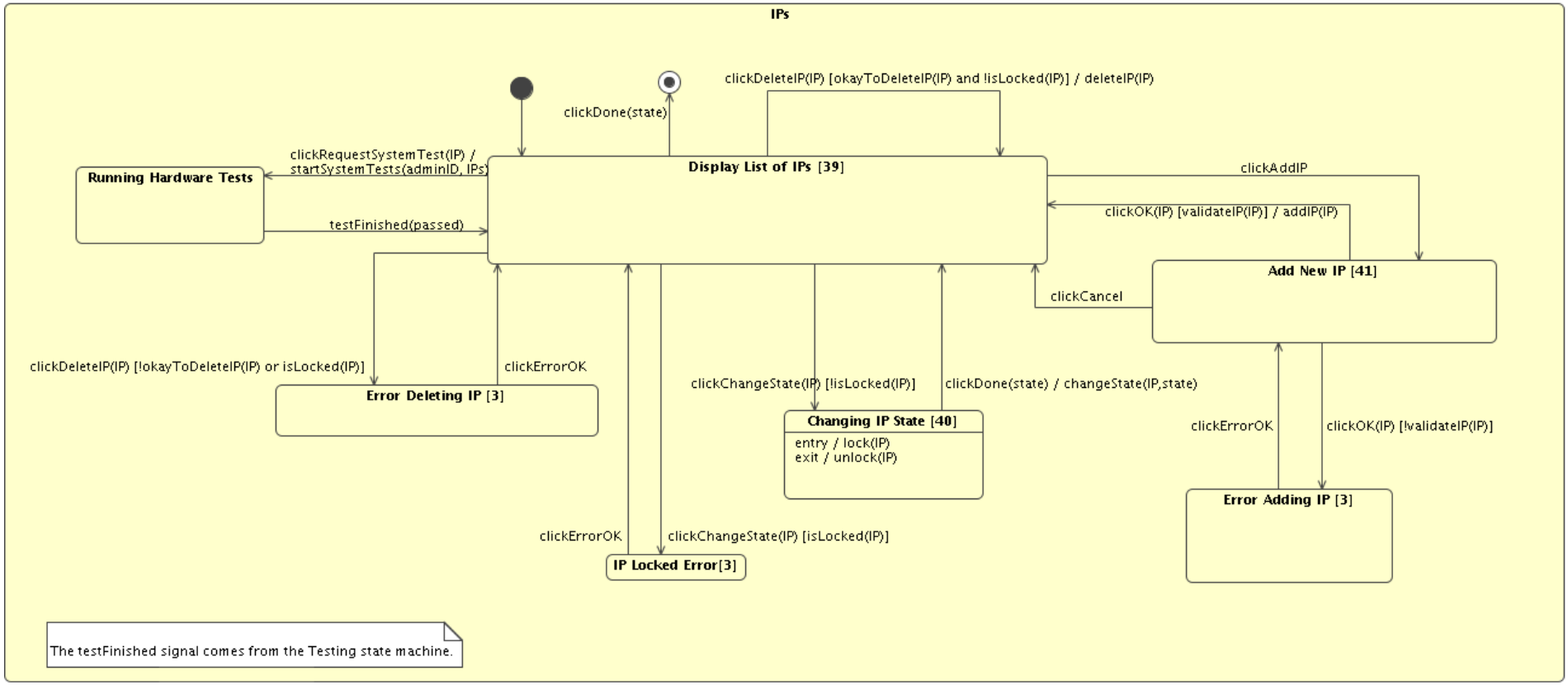


Figure 17 - IPs SSD
Models the process of adding IPs to the system, removing IPs from the system and changing the state of IPs.

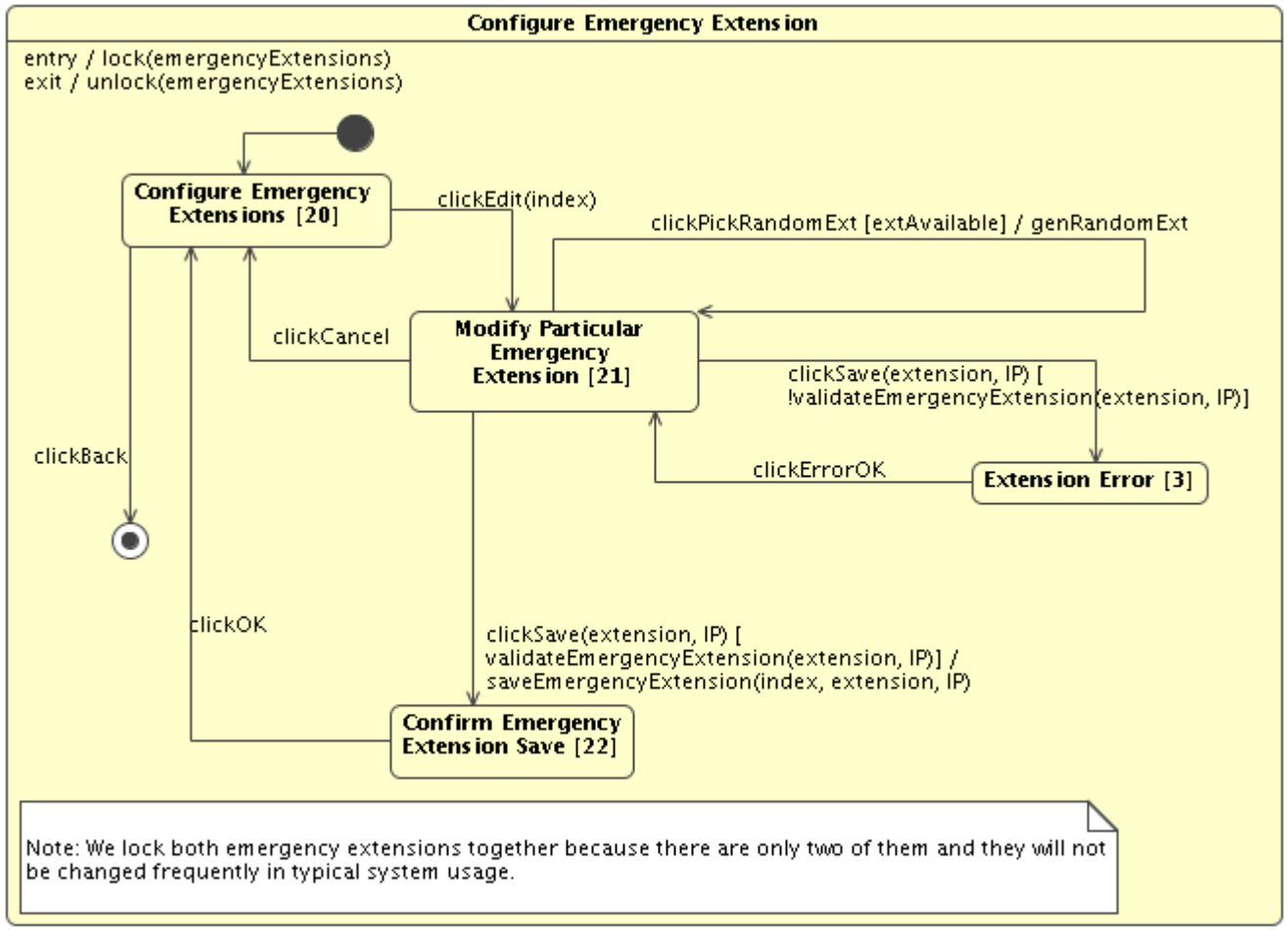


Figure 18 - Configure Emergency Extension SSD
Models the process of configuring the emergency extensions in the system.

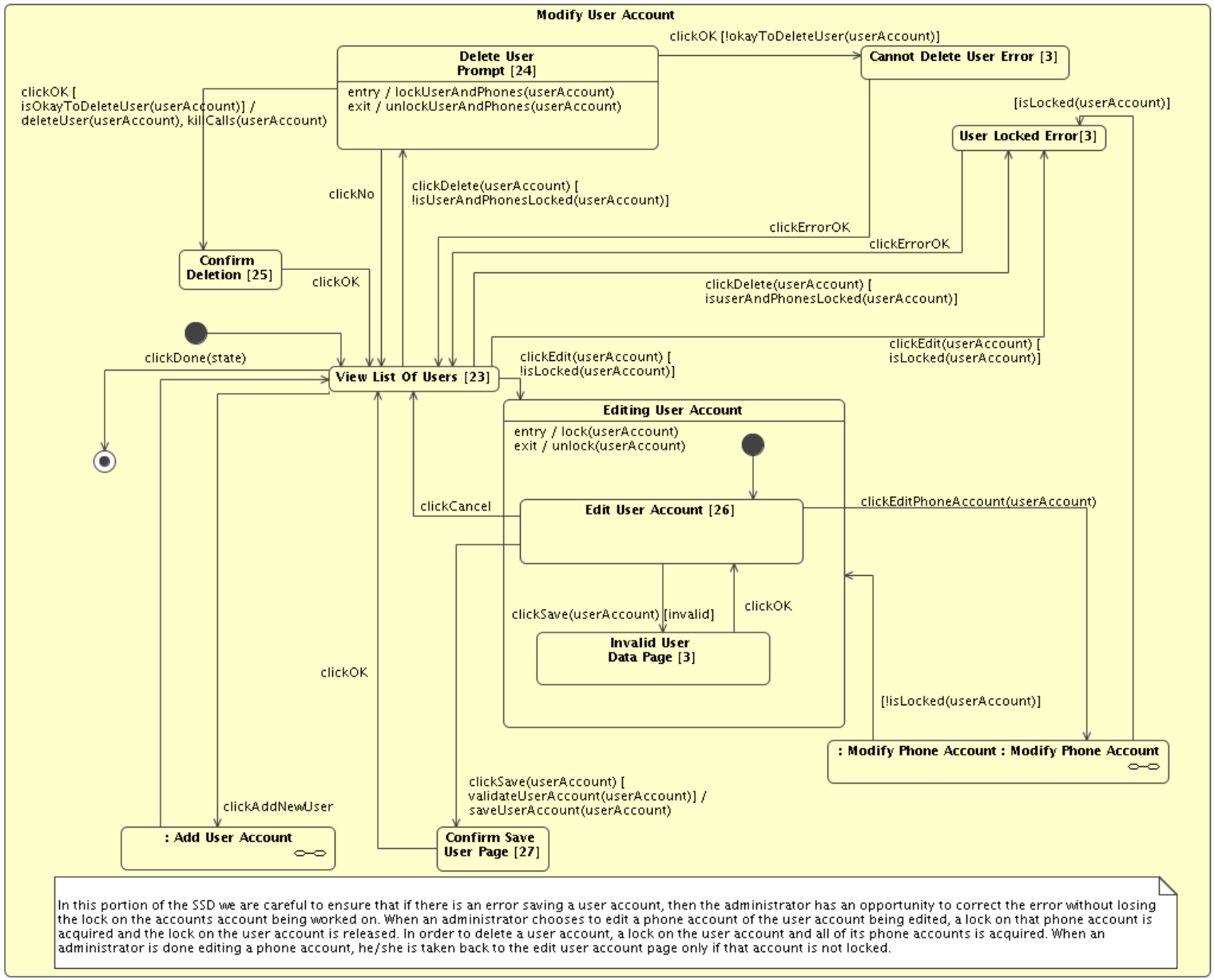


Figure 19 - Modify User Account SSD
Models the process of modifying the user accounts in the system.

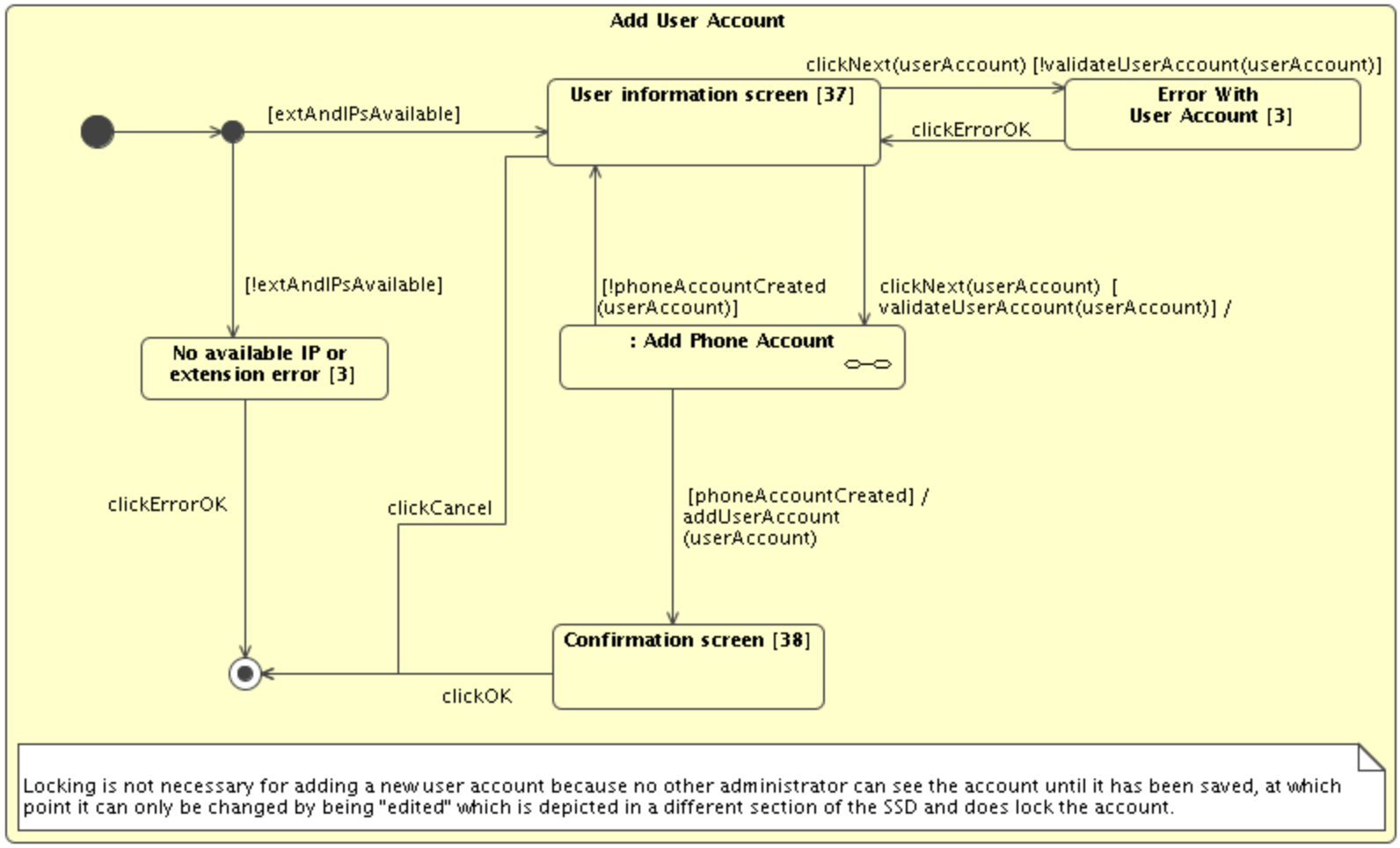


Figure 20 - Add User Account
Models the process of adding a user account to the system. This includes adding a phone account for the new user account.

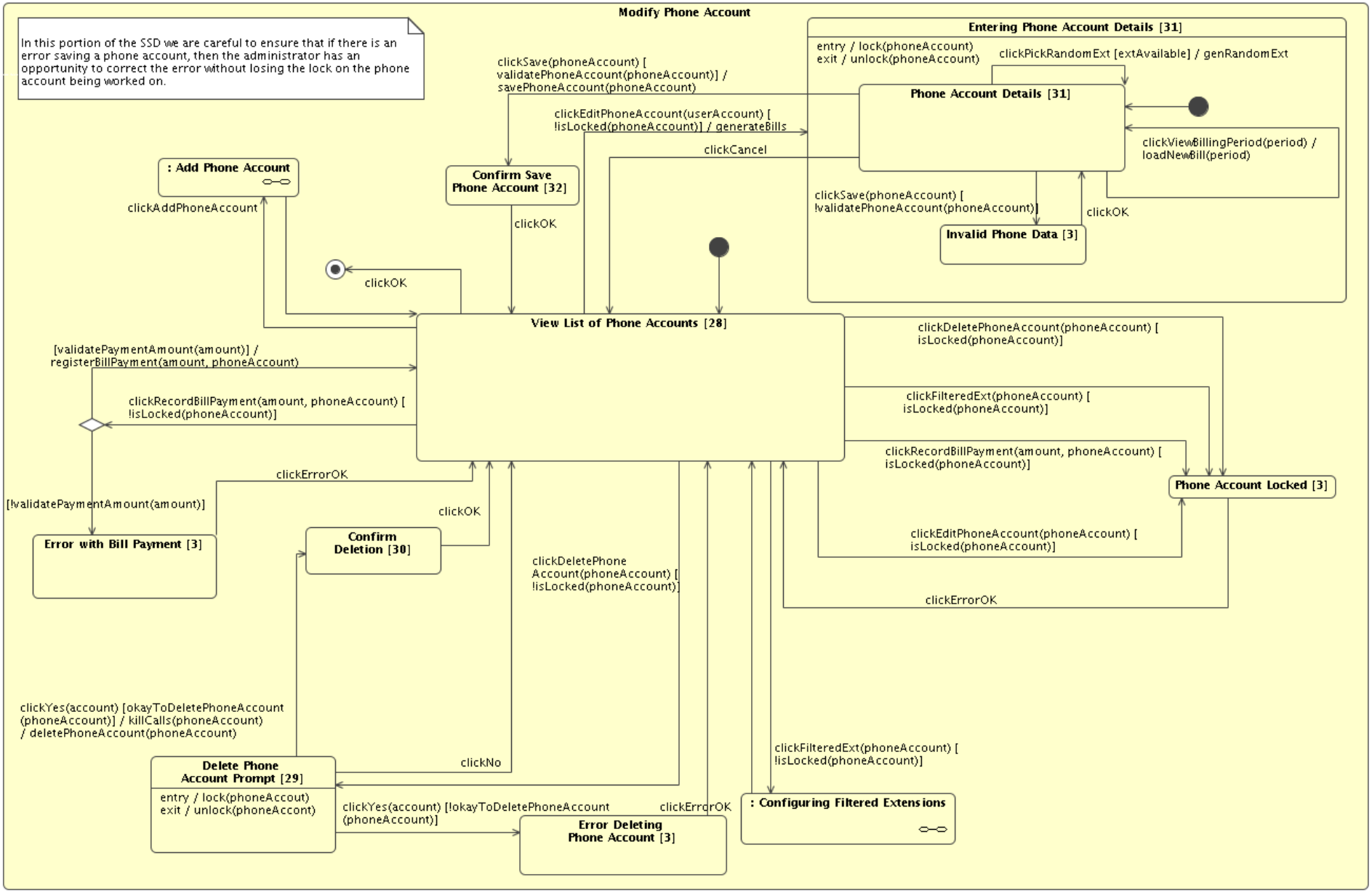


Figure 21 - Modify Phone Account SSD
Models the process of modifying and deleting phone accounts. This includes paying bills for that phone account.

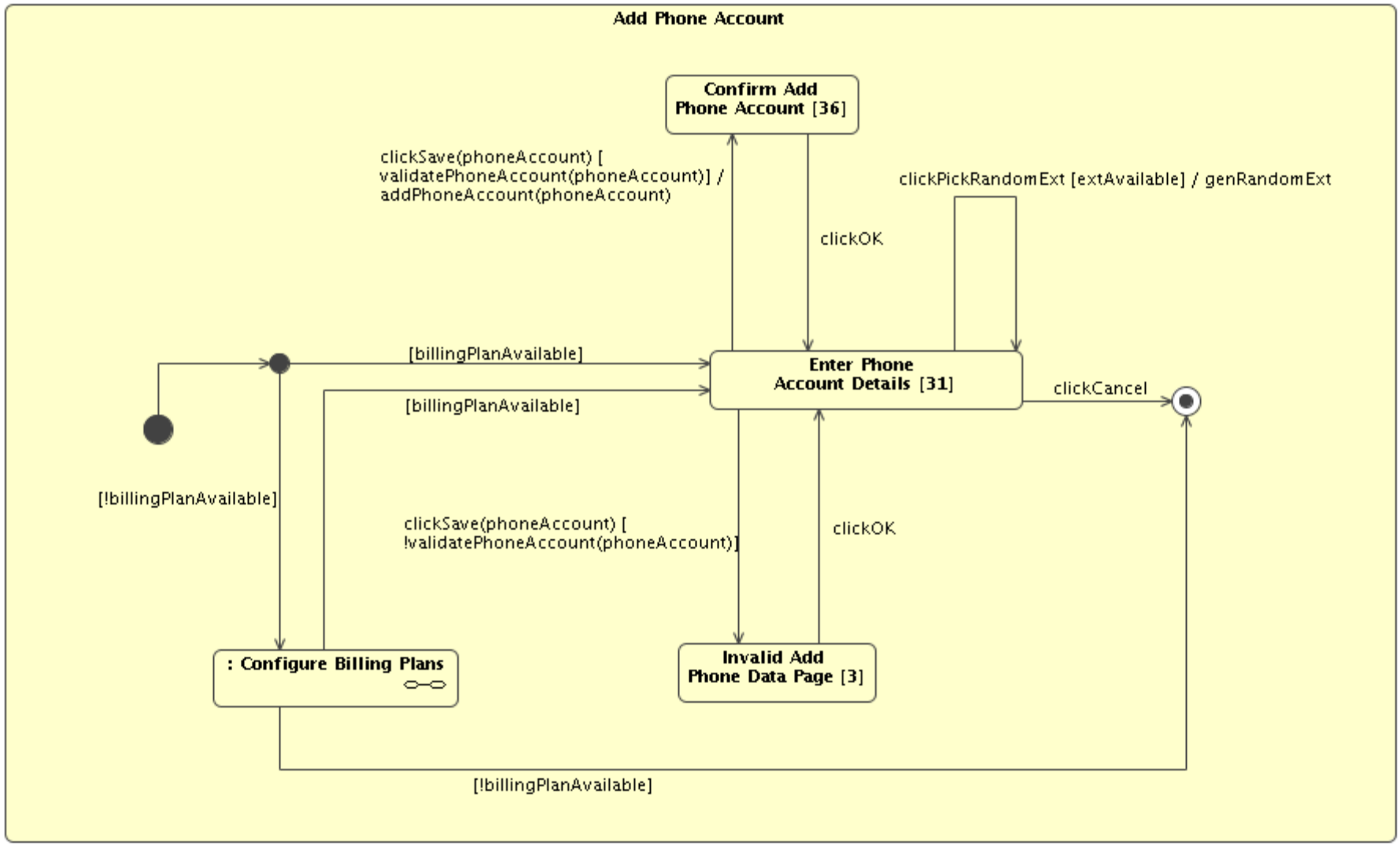


Figure 22 - Add Phone Account SSD
Models the process of adding a phone account to the system.

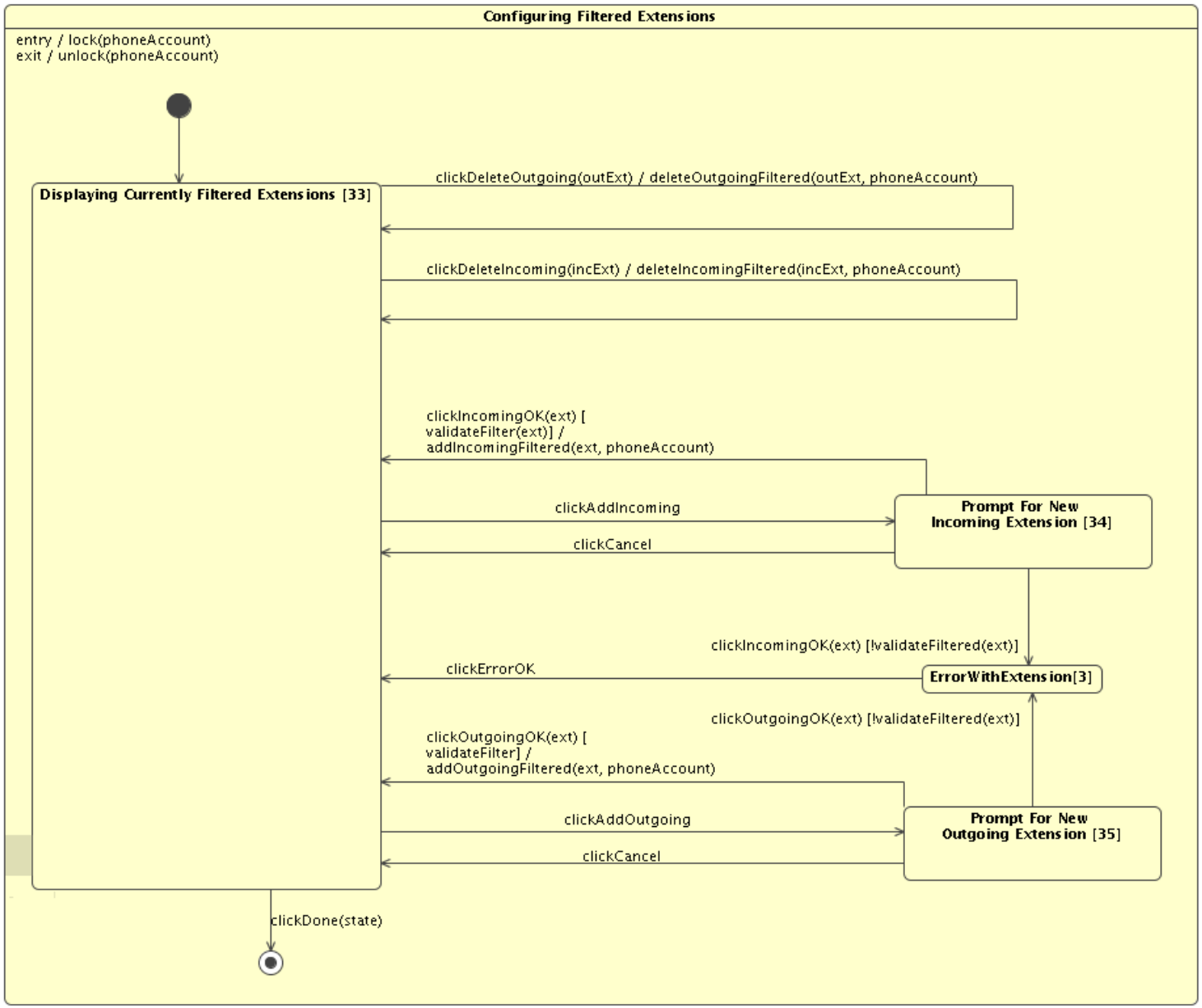


Figure 23 - Configure Filtered Extensions SSD
Models the process of configuring extensions in the system.

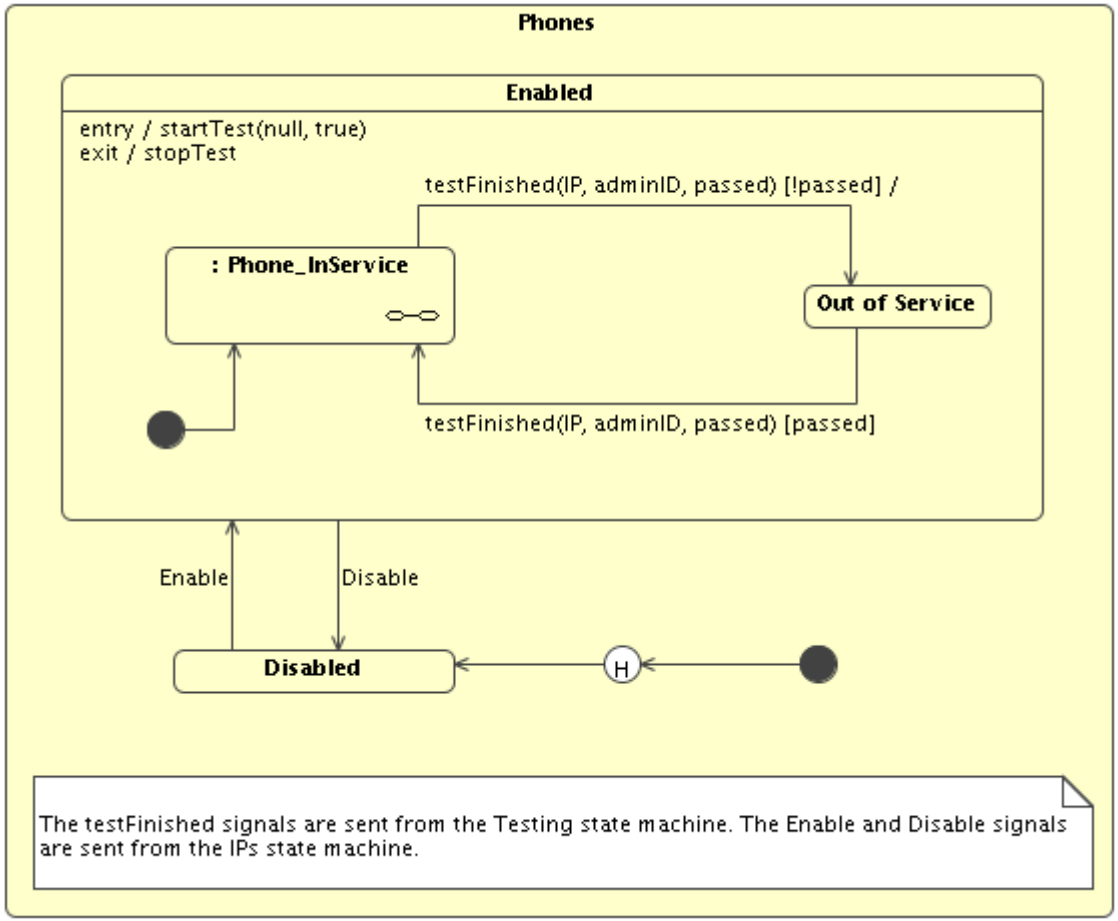


Figure 24 - Phones SSD
Models the phone hardware at a high level.

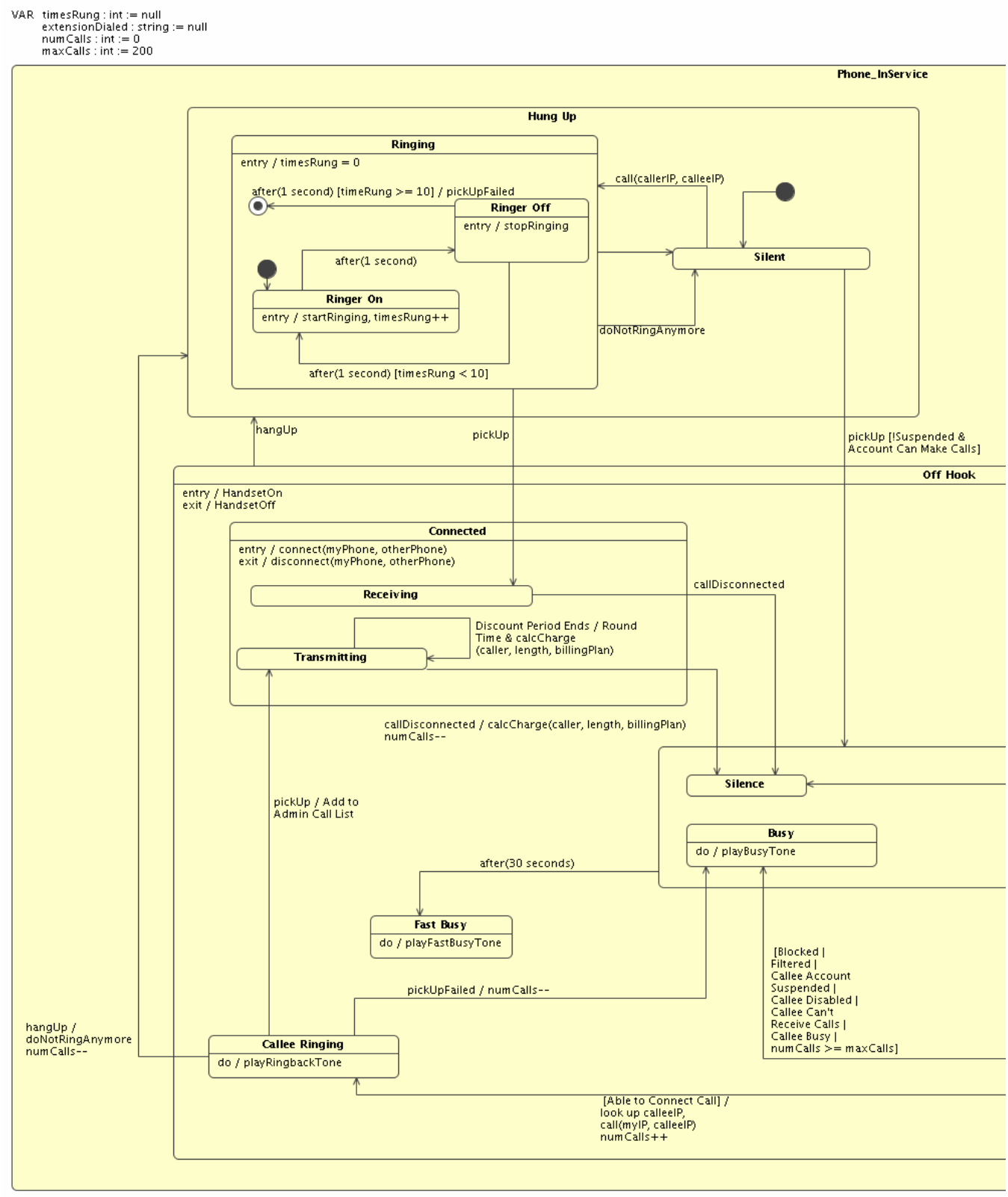
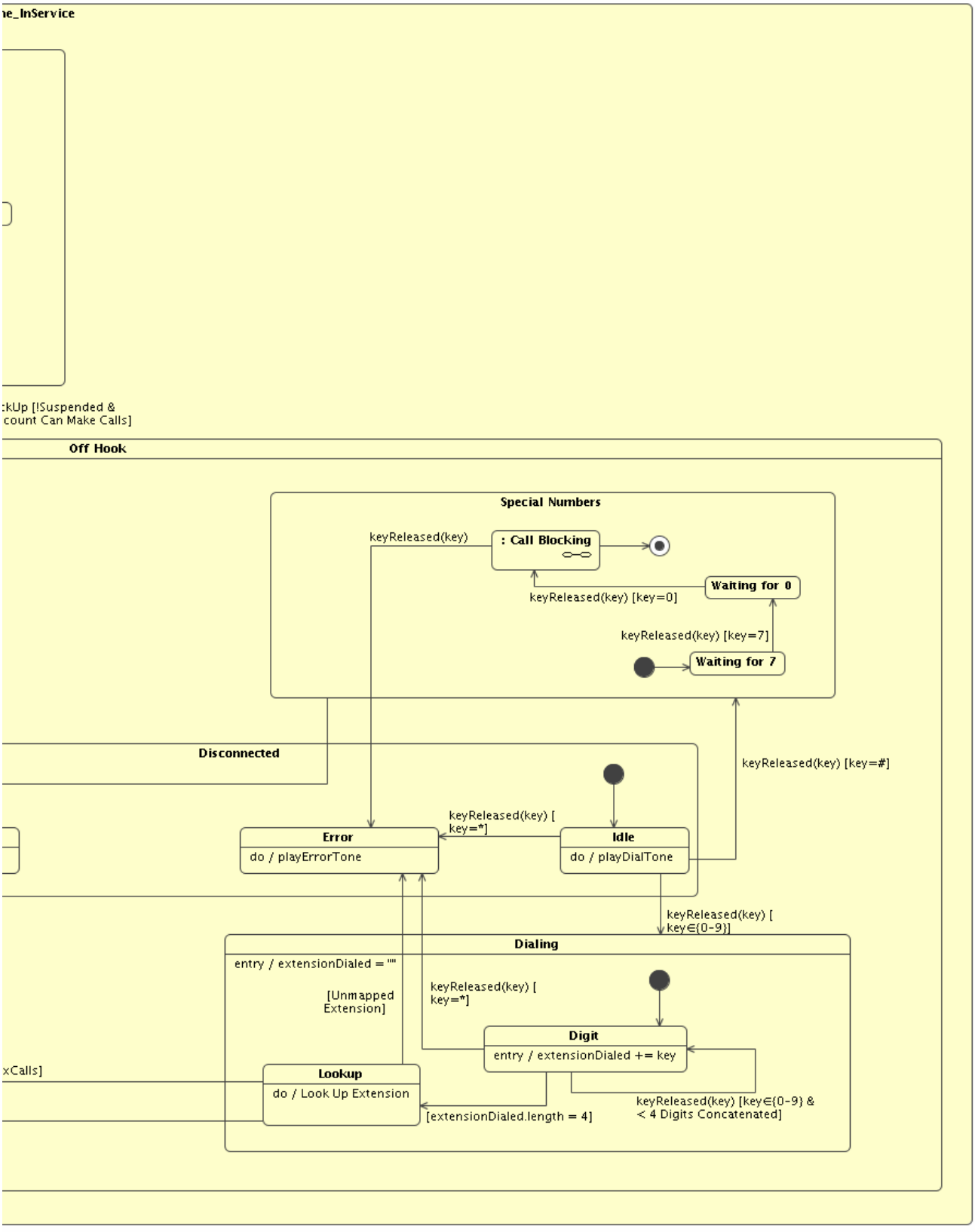


Figure 25 - Phone_inService SSD
Models call processing.


e_InService
kUp [!Suspended &
count Can Make Calls]
Off Hook
Special Numbers
keyReleased(key)
: Call Blocking
Waiting for 0
keyReleased(key) [key=0]
keyReleased(key) [key=7]
Waiting for 7
Disconnected
keyReleased(key) [key=#]
keyReleased(key) [
key=*]
Error
do / playErrorTone
Idle
do / playDialTone
keyReleased(key) [
key∈{0-9}]
Dialing
entry / extensionDialed = ""
[Unmapped
Extension]
keyReleased(key) [
key=*]
Digit
entry / extensionDialed += key
xCalls]
Lookup
do / Look Up Extension
[extensionDialed.length = 4]
keyReleased(key) [key∈{0-9} &
< 4 Digits Concatenated]

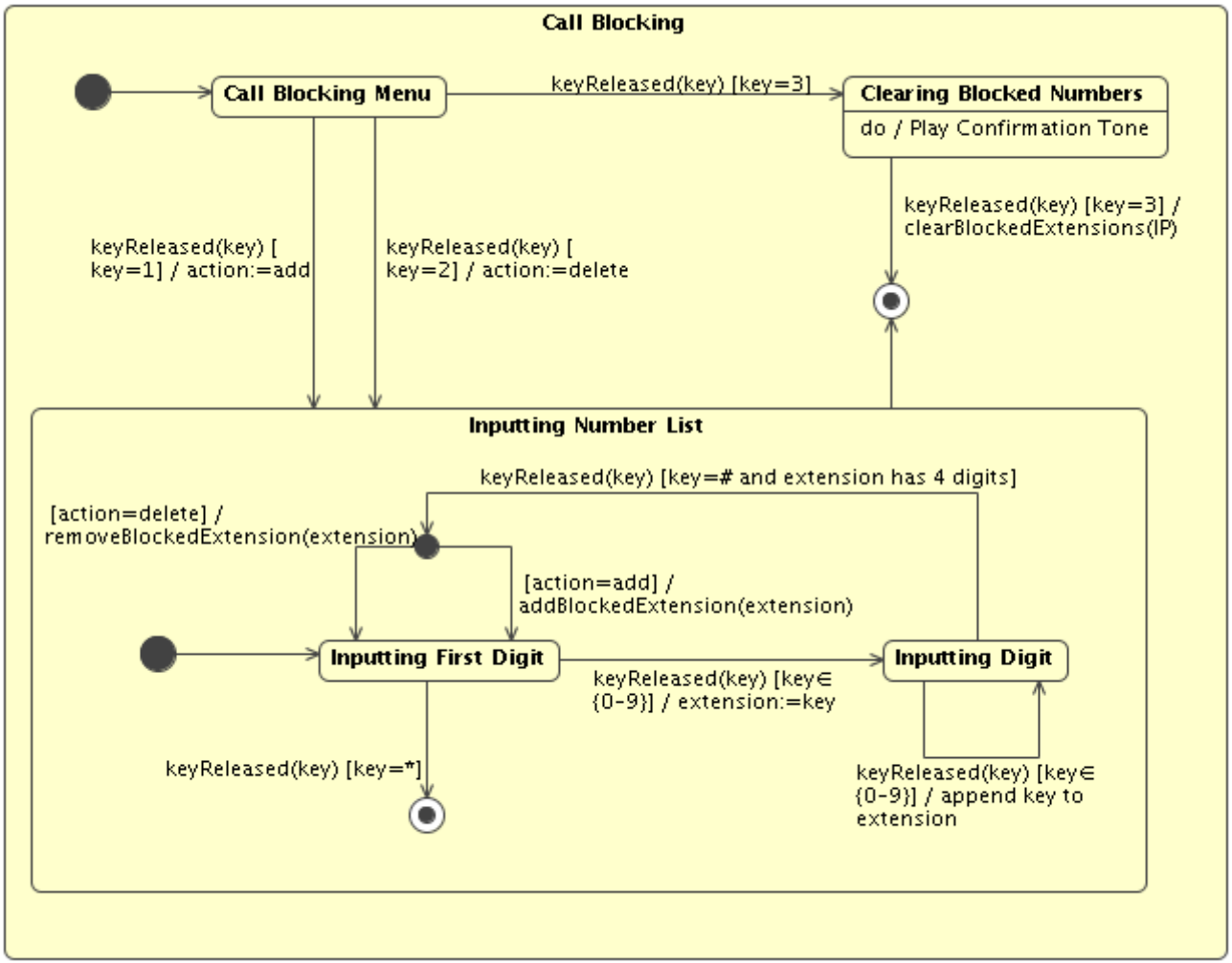


Figure 26 - Call Blocking SSD
Models the process of a user modifying their call blocking settings.

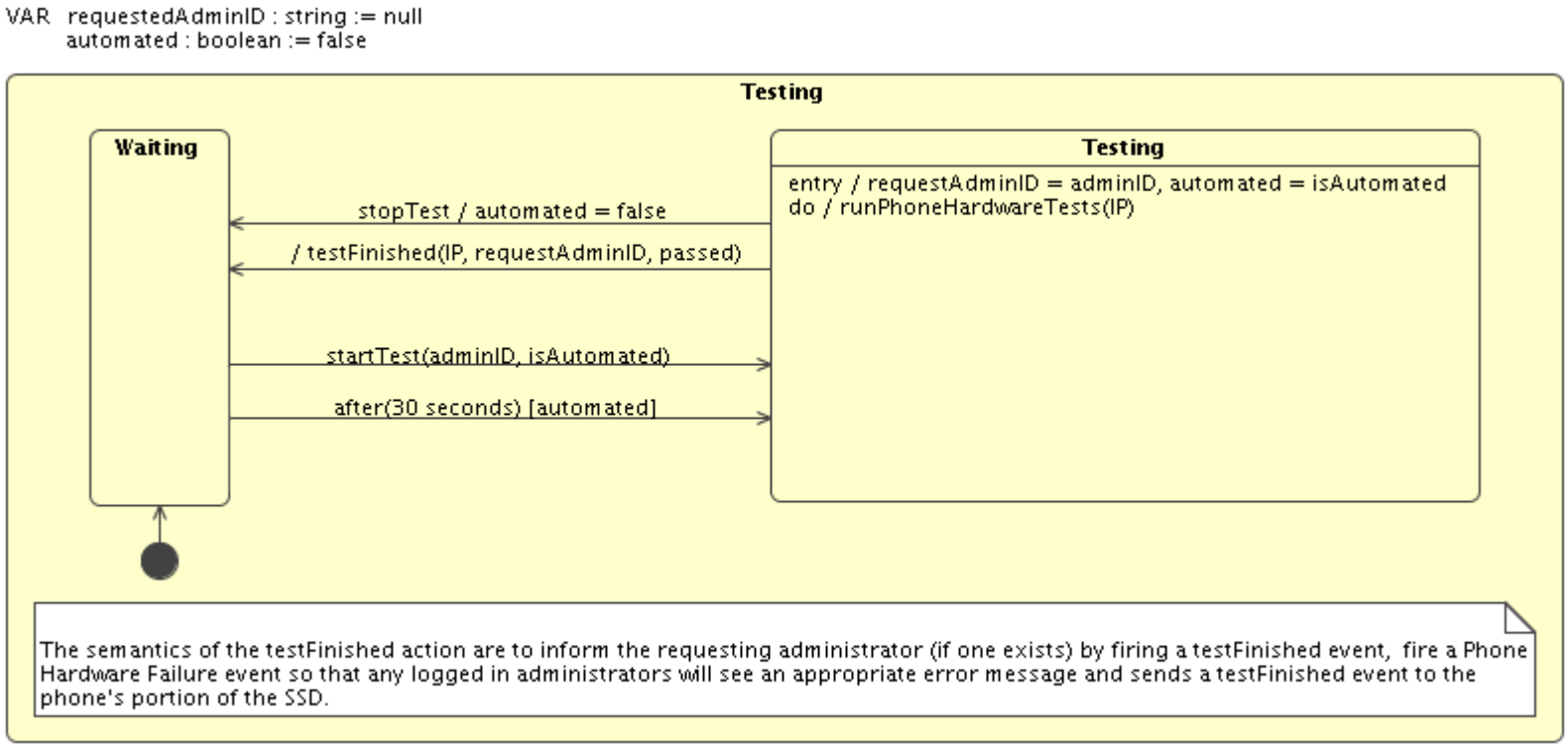


Figure 27 - Testing SSD
Models the automated and manual testing of phone hardware.

3.3 Performance

Performance is a critical aspect of the system (Minutes #5: 3.50); in situations where tradeoffs are to be considered, the first preference is given to its optimization.

Note: Performance is measured with respect to a typical system load, which consists of 500 calls. The benchmark used will be a Pentium dual core Xeon with 3 GB of memory and 1 TB of storage.

Recording Call's Charge		ID: NF01	Importance: E
Overview: Time required for a call to be recorded upon completion.			
Fit Criteria:	Outstanding	Target	Minimum
	0.1 s	0.5 s	5 s
References: Minutes #5: 3.2			

Phone Ringing		ID: NF02	Importance: E
Overview: Time required for callee's phone to ring after the extension is dialled.			
Fit Criteria:	Outstanding	Target	Minimum
	0.1 s	0.5 s	2 s
References: Minutes #5: 3.3			

Establish Audio Connections		ID: NF03	Importance: E
Overview: Time required to connect a call (audio connection) when the callee's receiver is picked up.			
Fit Criteria:	Outstanding	Target	Minimum
	0.1 s	0.5 s	2 s
References: Minutes #5: 3.4			

Responsiveness of the Administrator UI		ID: NF04	Importance: O
Overview: Time required for a UI screen update after an action has been taken (includes requesting hardware tests).			
Fit Criteria:	Outstanding	Target	Minimum
	0.5 s	5 s	20 s
References: Minutes #5: 3.5, 3.6			

Hardware Failure Detection		ID: NF05	Importance: D
Overview: Time required for a phone hardware failure to be detected.			
Fit Criteria:	Outstanding	Target	Minimum
		1 min	
References: Meeting #2: 5.6			

Notification of Errors		ID: NF06	Importance: D
Overview: Time required for administrators to be notified of detected errors.			
Fit Criteria:	Outstanding	Target	Minimum
		10 s	
References: Minutes #5: 3.7			

Modification of Billing Plans		ID: NF07	Importance: O
Overview: Time required to save modification of a phone account's billing plan			
Fit Criteria:	Outstanding	Target	Minimum
	0.1 s	0.5 s	1 s
References: Minutes #5: 3.8			

Maximum Simultaneous Calls		ID: NF08	Importance: E
Overview: Maximum simultaneous calls supported by the system.			
Fit Criteria:	Outstanding	Target	Minimum
	20 000	10 000	5000
References: Minutes #5: 3.10			

Maximum Simultaneous Administrators		ID: NF09	Importance: O
Overview: Maximum simultaneous logged in administrators supported by the system.			
Fit Criteria:	Outstanding	Target	Minimum
		15	
References: Minutes #5: 3.11			

Maximum Administrator Accounts	ID: NF10	Importance: O
Overview: Maximum number of total administrator accounts supported by the system.		

Maximum Administrator Accounts		ID: NF10	Importance: O
Fit Criteria:	Outstanding	Target	Minimum
		2000	
References: Minutes #5: 3.11			

User Data		ID: NF11	Importance: D
Overview: The initial number of user accounts and expected growth of user accounts supported by the system.			
Fit Criteria:	Outstanding	Target	Minimum
	10 000 + 200/day	5000 + 100/day	5000 + 5 / day
References: Minutes #5: 3.37			

3.4 Design Constraints

Portability, modifiability, and reuse are important aspects of the design constraint. Security is not a factor and will not be considered. (Minutes #5: 3.50)

The system will be completely isolated from external factors. External factors will not constrain the system.

The system will run on a dedicated server, so computer usage is not an issue.

Upgrade Constraints		ID: NF12	Importance: O
Overview: Time that the system can be down during upgrades.			
Fit Criteria:	Outstanding	Target	Minimum
		Zero-downtime upgrades	
References: Minutes #5: 3.28			

Time to Add Features		ID: NF13	Importance: D
Overview: Time required to add a new requested feature to the system.			
Fit Criteria:	Outstanding	Target	Minimum
		2 months	
References: Minutes #5: 3.31			

Security Standards	ID: NF14	Importance: O

Security Standards		ID: NF14	Importance: O
Overview: Security standards to which the system should adhere.			
Fit Criteria:	Outstanding	Target	Minimum
		SHA-256	MD5
References: Minutes #2: 5.11, Minutes #5: 3.34			

Supported Platform		ID: NF15	Importance: E
Overview: Platforms with which the system must be compatible.			
Fit Criteria:	Outstanding	Target	Minimum
		BSD, Linux 2.6+, Solaris, Windows	
References: Minutes #5: 3.36			

Cost of the System		ID: NF16	Importance: D
Overview: Expected cost, in Canadian dollars, to develop the system.			
Fit Criteria:	Outstanding	Target	Minimum
	$0	$3600	$10800
References: Minutes #5: 3.42			

Rounding Precision		ID: NF17	Importance: O
Overview: The rounding methods required to achieve desired precision.			
Fit Criteria:	Outstanding	Target	Minimum
		Banker's rounding, 1/100 cent	
References: Minutes #5: 3.40			

Delivery Time Line		ID: NF18	Importance: E
Overview: Time required to develop the software.			
Fit Criteria:	Outstanding	Target	Minimum
		4 months	
References: Minutes #5: 3.41			

Documentation	ID: NF19	Importance: D
Overview: Required documentation for system, phone users and administrators.		

Documentation		ID: NF19	Importance: D
Fit Criteria:	Outstanding	Target	Minimum
		– Manual for administrators – Manual for phones – Full system design document – Preconditions and postconditions for all functions	
References: Minutes #5: 3.43			

System Architecture Design		ID: NF20	Importance: D
Overview: The constraints imposed on the architecture of the software system.			
Fit Criteria:	Outstanding	Target	Minimum
		Modular, plug-in style architecture.	
References: Minutes #5: 3.46			

Programming Language Constraints		ID: NF21	Importance: E
Overview: The constraints put on the programming language used to develop the system.			
Fit Criteria:	Outstanding	Target	Minimum
		Must be written in C.	
References: Minutes #5: 3.47			

External Dependency		ID: NF22	Importance: D
Overview: The restrictions placed on the system's dependency on external sources (i.e. libraries)			
Fit Criteria:	Outstanding	Target	Minimum
		- Only have dependency on open source libraries.	
References: Minutes #5: 3.49			

Memory Restrictions		ID: NF23	Importance: D
Overview: The restriction on the memory footprint of the system.			
Fit Criteria:	Outstanding	Target	Minimum
	50 MB	100 MB	3 GB

Memory Restrictions	ID: NF23	Importance: D
References: Minutes #5: 3.38		

3.5 Quality Attributes

The critical quality measures are phone user usability, maintainability, and testability. Readability is less important, and administration interface usability is the least important. (Minutes #5: 3.50)

Administrator Training Time		ID: NF24	Importance: D
Overview: The median time required to train new administrators .			
Fit Criteria:	Outstanding	Target	Minimum
	2 days	1 week	2 weeks
References: Minutes #5: 3.12			

Intuitive Use		ID: NF25	Importance: O
Overview: The percentage of tasks that can be completed by the administrator without using a manual.			
Fit Criteria:	Outstanding	Target	Minimum
		90%	
References: Minutes #5: 3.14a			

Help Pages		ID: NF26	Importance: O
Overview: Help pages per UI screen.			
Fit Criteria:	Outstanding	Target	Minimum
		1	
References: Minutes #5: 3.14b			

Help Quality		ID: NF27	Importance: D
Overview: Percentage of questions resolved through system help without assistance.			
Fit Criteria:	Outstanding	Target	Minimum
	100%	100%	95%
References: Minutes #5: 3.14c			

Time to Add Customer Accounts		ID: NF28	Importance: D
Overview: Time required to modify/add customer and phone accounts.			
Fit Criteria:	Outstanding	Target	Minimum
		5 min (avg)	10 min (avg)
References: Minutes #5: 3.15			

Administrator Errors		ID: NF29	Importance: D
Overview: Permissible frequency and severity of administrator errors			
Fit Criteria:	Outstanding	Target	Minimum
	99.9% free, minor errors 100% free, major errors	98% free, minor errors 100% free, major errors	95% free, minor errors 100% free, major errors
References: Minutes #5: 3.16			

Customer Satisfaction		ID: NF30	Importance: D
Overview: Ratio of customers that respond with "Satisfied" or better when asked about their happiness with the system.			
Fit Criteria:	Outstanding	Target	Minimum
	10/10 users	9/10 users	7/10 users
References: Minutes #5: 3.17			

System Availability		ID: NF31	Importance: E
Overview: The required uptime of the system.			
Fit Criteria:	Outstanding	Target	Minimum
	100%	99.9%	99%
References: Minutes #5: 3.19			

Mean Time to Failure		ID: NF32	Importance: E
Overview: Mean time to failure of the system.			
Fit Criteria:	Outstanding	Target	Minimum
	20 000 days	10 000 days	
References: Minutes #5: 3.20a			

Dropped Calls	ID: NF33	Importance: E

Dropped Calls		ID: NF33	Importance: E
Overview: Number of calls dropped by the system permissible.			
Fit Criteria:	Outstanding	Target	Minimum
	1/20,000 calls	1/10,000 calls	1/8,000 calls
References: Minutes #5: 3.20b			

GUI Uptime		ID: NF34	Importance: D
Overview: Mean time before GUI becomes completely unresponsive (goes down).			
Fit Criteria:	Outstanding	Target	Minimum
		3 years	
References: Minutes #5: 3.20c			

Record Lifetime		ID: NF35	Importance: E
Overview: Length of time the system should keep records.			
Fit Criteria:	Outstanding	Target	Minimum
		Indefinitely	
References: Minutes #5: 3.20c			

Failure Recovery		ID: NF36	Importance: D
Overview: Time it takes for the system to be restored (operationally) after a failure.			
Fit Criteria:	Outstanding	Target	Minimum
	5 min	10 min	20 min
References: Minutes #5: 3.24			

Bugs Per Lines		ID: NF37	Importance: D
Overview: Number of bugs per lines of code written.			
Fit Criteria:	Outstanding	Target	Minimum
		1 bug/200 lines	
References: Minutes #5: 3.25			

Fault Tolerance	ID: NF38	Importance: E
Overview: The percentage of faults handled by the system		

Fault Tolerance		ID: NF38	Importance: E
Fit Criteria:	Outstanding	Target	Minimum
		The system must tolerate 100% of all non-critical faults. It should never have a segmentation fault.	
References: Minutes #5: 3.30			

Effectiveness of Hardware Tests		ID: NF39	Importance: E
Overview: The percentage of phone failures which should be detected by automated testing.			
Fit Criteria:	Outstanding	Target	Minimum
	99.9%		99%
References: Minutes #5: 3.6			

Efficacy of Maintenance		ID: NF40	Importance: E
Overview: What percentage of bug reports should be reviewed within one working day? What percentage of high priority bugs will be resolved within one day?			
Fit Criteria:	Outstanding	Target	Minimum
	-	95% of bug reports will be reviewed within 8 working hours. High priority defects will be resolved within 24h in 95% of cases.	-
References: Minutes #5: 3.27			

Duration of Maintenance		ID: NF41	Importance: E
Overview: How long will the software system be maintained and supported?			
Fit Criteria:	Outstanding	Target	Minimum
	-	10 years	10 years
References: Minutes #5: 3.26			

Appendix A - Glossary

Basic Terms

Administrator account: a username and password that an administrator can use to log in to the system

Alphanumeric: Containing either Roman letters or numerals

Billing plan: a monthly fee and cost per minute to call during periods of the day, that also specifies if a telephone account has call blocking or not

Bill: A document showing the amount owed by a phone system customer (along with a list of all applicable charges) for a specific billing period.

Billing Plan: A basic plan that is required by every phone account. Contains the base rate per minute for charging phone calls as well as the monthly service charge to be applied to a phone

Call (Phone call): the process of one phone user using one of his/her phones to place a telephone call to valid extension within the system

Cancel: The action of aborting a particular User Interface operation

Charge: A single amount representing the amount owed by a user for a single phone call or service fee.

Disabled: a phone is disabled if it is not part of the automatic hardware testing

Discount Period: a period during which calls a charged only a percentage of the base rate of the current billing plan associated with a phone account

Enabled: a phone is enabled if it is part of the automatic hardware testing

Extension: a four-digit number used to identify a telephone account. Some extensions are reserved for special numbers (such as emergency numbers)

Error: An indication that a certain operation has failed to complete successfully

Filter List:	a list of regular expressions and/or exact extension that apply to a particular incoming or outgoing filter
Filter Expression:	a valid expression that can be added to a particular filter list
Hardware tests:	remotely initiated tests to verify whether or not a phone is in working order
In-service:	a phone is in-service if the most recent hardware test for it passed
Input:	data which is provided by an entity outside the system to the system in order for the system to perform a certain action
Mechanism:	a technical manifestation that performs a certain process
Out-of-service:	a phone is out-of-service if the most recent hardware test for it failed
Phone (telephone):	a telecommunications device that allows for voice messages to be transmitted between two or more distinct units over any distance.
Phone account:	an entity used to represent one phone that is assigned to the user. Contains all billing plans associated with the phone, the block list, the incoming/outgoing filter lists and all the charges that have been applied to the particular phone.
Prorate:	divide proportionally according to the time used
Password:	A sequence of keyboard characters used to secure access to the system
Precondition:	A statement (usually expressed with formal logic) that has to be true for a certain function or procedure to be initiated
Postcondition:	A statement (usually expressed with formal logic) that expresses the state of the system upon the completion of a certain function or procedure
Ringback Tone:	the tone heard by the caller while the callee's phone is ringing
Suspended:	a suspended telephone account is unable to send and receive calls, is not billed, but still has an active extension
Screen:	A visual collection of widgets allowing the user to perform some desired functionality

String: An ordered sequence of alphanumeric characters. The sequence can be of varying length

Telephone Account: a collection of a telephone IP, extension, billing plan, filters, call blocking lists, and send/receive permissions

Telephone IP: an IP address that is statically associated to a phone

Telephone: see *phone*

User account: a user's account number, name, address, date of birth, and alternate phone number

Username: A word uniquely identifying a user of the system

User Interface (UI): A visual interface allowing a user to invoke software functionality

Wildcard: A character that can be substituted for any other valid character in a string

Domain Model

Phone: (class) A class modeling a phone

isInService: (attribute of Phone) Whether the phone is passing automated tests

isEnabled: (attribute of Phone) Whether the phone is part of automated testing

ip: (attribute of Phone) The ip of the phone

onHook: (attribute of Phone) Whether the receiver is on the hook

Extension: (class) A class modeling an extension

extension: (attribute of Extension) A 4 digit number

EmergencyExtension: (class, subclass of Extension) A class modeling an emergency extension

NormalExtension: (class, subclass of Extension) A class modeling a normal extension

PhoneCall: (class) A class modeling a call in progress

startDate: (attribute of PhoneCall) The starting date/time of the call

maxCalls: (attribute of PhoneCall) The maximum number of calls in the system

DiscountPeriod: (class) A class modeling a discount period, part of a billing plan

startTime: (attribute of DiscountPeriod) The date/time that the discount period starts

endTime: (attribute of DiscountPeriod) The date/time that the discount period ends

discountPercentage: (attribute of DiscountPeriod) The percentage of the base rate charged in this discount period

BillingPlan: (class) A class modeling a billing plan

name: (attribute of BillingPlan) The name of the billing plan

serviceFee: (attribute of BillingPlan) The service fee applied every 30 days

hasCallBlocking: (attribute of BillingPlan) Whether this billing plan contains the call blocking feature

baseRate: (attribute of BillingPlan) The rate per minute of this billing plan

isDeleted: (attribute of BillingPlan) Whether this billing plan has been deleted

isLocked: (attribute of BillingPlan) Whether the billing plan has been locked by an administrator for editing

UserAccount: (class) A class modeling a user account

accountNum: (attribute of UserAccount) The numerical identifier for the user account

name: (attribute of UserAccount) The name of the user

address: (attribute of UserAccount) The address of the user

alternatePhone: (attribute of UserAccount) The alternate phone number of the user

birthDate: (attribute of UserAccount) The user's birth date

isDeleted: (attribute of UserAccount) Whether this user account has been deleted

isLocked: (attribute of UserAccount) Whether this user account has been locked by an administrator for editing

PhoneAccount: (class) A class modeling a phone account

isSuspended: (attribute of PhoneAccount) Whether or not the phone account has been suspended

outstandingBalance: (attribute of PhoneAccount) The amount owed by the owner of the phone account

send: (attribute of PhoneAccount) Whether or not this phone account can make calls

receive: (attribute of PhoneAccount) Whether or not this phone account can receive calls

isDeleted: (attribute of PhoneAccount) Whether or not this phone account can make calls

createDate: (attribute of PhoneAccount) The date/time that this phone account has been created

isLocked: (attribute of PhoneAccount) this phone account has been locked by an administrator for editing

FilterList: (class) A class modeling a list of filter expressions

isLocked: (attribute of FilterList) Whether or not the list has been locked by an administrator for editing

FilterExpression: (class) A class modeling an expression used for a filter

expression: (attribute of FilterExpression) The expression (string of length 4, composed of digits and *)

Charge: (class) A class modeling a charge on a user's bill

chargeDate: (attribute of Charge) The date/time when the charge was applied

amount: (attribute of Charge) The total amount of the charge

amountPaid: (attribute of Charge) The amount of the charge that has been paid

CallCharge: (class, subclass of Charge) A class modeling a charge for making a call

callerExt: (attribute of CallCharge) The extension of the caller

calleeExt: (attribute of CallCharge) The extension of the callee

duration: (attribute of CallCharge) The duration of the call

baseRate: (attribute of CallCharge) The rate under which the charge is charged

ServiceCharge: (class, subclass of Charge) A class modeling a charge for reasons other than making a call

reason: (attribute of ServiceCharge) The reason the charge was applied

Administrator: (class) A class modeling an administrator

username: (attribute of Administrator) The username of the administrator account

password: (attribute of Administrator) The password of the administrator account

fullName: (attribute of Administrator) The administrator's full name

isLoggedIn: (attribute of Administrator) Whether or not the administrator is logged in

lastActionTime: (attribute of Administrator) The last time the administrator took an action

isLocked: (attribute of Administrator) Whether the administrator account is locked by an administrator for editing

Errors: (class) A class modeling an error

errorMessage: (attribute of Error) The body of the error message

Condition Functions

isLocked(entity):

(condition function) This tests if the boolean variable uniquely associated with the given entity is true.

isUserAndPhonesLocked(userAccount):

(condition function) This tests if the boolean variable uniquely associated with the given user account is true. It also tests to ensure that the boolean variable uniquely associated with each associated phone accounts is true.

validateLogin(loginInfo):

(condition function) Login information is considered valid if the username/password pair in the loginInfo matches the username and password for a valid admin in the system. This function returns true if the supplied loginInfo is valid.

validateAdmin(adminDetails):

(condition function) This function checks if an existing set of admin details is valid. Admin details are considered valid if the username is alphanumeric and is between 8 and 256 characters long, the password consists of characters in the set [A-Za-z0-9!@#$%^&*()], and the full name consists of printable characters. The username must also not already exist in the system.

validateNewAdmin(adminData):

(condition function) This function checks if a new set of admin details is valid. A new set of admin details is considered valid if validateAdmin(adminDetails) passes, and additionally the username does not already exist in the system.

validateBillingPlan(billingPlan):

(condition function) Billing plan details are a the regular charge rate for calls, a list of periods and their discount rates, the monthly service charge, and whether or not you can do call blocking. This action will ensure that the regular charge rate is a valid positive dollar amount, the monthly service charge is a non-negative dollar amount.

validateDiscountPeriod(period, billingPlan):

(condition function) This function checks that the discount rates are non-negative percentages, and that none of the discount periods overlap.

validateMaxCalls(num):

(condition function) This function checks that num is a positive number.

validateEmergencyExtension(extension, IP):

(condition function) This function verifies that the extension is a 4-digit number, the extension is not in use, and the IP is not already assigned an extension.

validateUserAccount:

(condition function) This function checks that the name, address, alternate phone number, account number, and date of birth are specified. It also checks that the date of birth is some date in the past.

validatePhoneAccount(phoneAccount):

(condition function) This function checks that the telephone IP, billing plan, and extension are specified.

validateFiltered(ext):

(condition function) This function verifies that the ext is 4 characters long, and each of the characters is from the set [0-9,*].

validatePaymentAmount(amount):

(condition function) This function checks that the amount is a positive dollar amount.

okToDeleteIP(IP):

(condition function) This function will return true if and only if the phone designated by the IP is not associated with a phone account.

validateIP(IP):

(condition function) This function checks if the IP is a string consisting of 4 numbers in the range 0-255, separated by dots (as in 192.168.1.55). Also check that the IP does not exist in the system.

okayToDeletePhoneAccont(phoneAccount):

(condition function) Returns true if phone account has no outstanding balances.

okayToDeleteUser(userAccount):

(condition function) This function checks will return true if none of user account's associated phone accounts have outstanding balances.

extAndIPsAvailable:

(condition function) Returns true if there is at least one unused extension and at least one unused IP available in the system.

extAvailable:

(condition function) Returns true if there is at least one unused extension available in the system.

billingPlanAvailable:

(condition function) Returns true if a non-deleted billing plan is available to be used.

phoneAccountCreated(userAccount):

(condition function) Returns true if a phone account was created for the defined user account.]

loggedIn(admin):

(condition function) Returns true if the specified admin is logged in.

Action

disconnectCalls:

(action) This action causes the system to send a callDisconnected signal to every phone's state machine (rather than just an individual phone).

startSystemTests(adminID, IPs[]):

(action) This action causes the system to send a startTest(adminID, false) signal to the testing state machines for each IP.

recordServiceCharges(elapsedTimeRunning):

(action) This action prorates the service charges of all of the bills to only include time where the system was running.

saveAdminDetails(adminDetails):

(action) This action is used to save the username, password, and full name of an administrator in the system.

deleteAdminAccounts(adminRemoveArray[]):

(action) For each username specified in the argument array, this action removes the corresponding admin details from the system.

addAdmin(adminData):

(action) This action adds the given username, password and full name to the list of valid administrators in the system.

deleteBillingPlan(billingPlan):

(action) This action removes a billing plan from the list of available billing plans in the system.

saveBillingPlan(billingPlan):

(action) This action saves a billing plan to the list of available billing plans in the system. If the billing plan is already in the system, the previous values are overwritten.

addDiscountPeriod(period, billingPlan):

(action) This action adds a discount period to a billing plan, but does not save the result in the system.

deleteDiscountPeriod(period, billingPlan):

(action) This action removes a discount period from a billing plan, but does not save the result in the system.

setMaximumCalls(maxCalls):

(action) This action sets the maximum number of allowed calls in the system to the given value.

terminateCall(call):

(action) The call parameter contains two IPs. This action sends a callDisconnected signal to the phone state machine that handles each of these two IPs.

saveEmergencyExtension(index, extension, IP):

(action) This action saves the given extension and IP as emergency extensions in the system.

addUserAccount(userAccount):

(action) This action saves a new user to the set stored by the system.

saveUserAccount(userAccount):

(action) This action updates the user information stored by the system. If the user is suspended, then all phone accounts are suspended.

deleteUser(userAccount):

(action) This action deletes all of the users phone accounts as would happen using the deletePhoneAccount action. If all of the phone accounts are removed (i.e. the user has no outstanding balances), the user is also removed from the system. Deletion of a user account can only commence if the adiminstrator has a lock on the user and all associated phone accounts.

deletePhoneAccount(phoneAccount):

(action) If the phone account has a non-negative balance, then this action will remove the phone account from the system. If the phone account has a negative outstanding balance, then this action will generate a bill for the phone account, and will not remove the account from the system. This action also charges the last service fee for the account.

killCalls(phoneAccount):

(action) If the phone associated with this phone account is in a call, then this action will use the terminateCall action to disconnect the two calls.

killCalls(userAccount):

(action) If any of the phone accounts associated to the user have calls in progress, then this action will use the terminateCall action to disconnect the calls.

addPhoneAccount(phoneAccount):

(action) Adds a new phone account associated to a user account to the system.

savePhoneAccount(phoneAccount):

(action) This action updates the information stored for a phone account in the system.

loadNewBill(period):

(action) This action retrieves the bill for a particular historical billing period.

addIncomingFiltered(ext, phoneAccount):

(action) Add filters to a phone account's incoming filter list. Changes take effect immediately in the system (no save of the phone account is necessary).

addOutgoingFiltered(ext, phoneAccount):

(action) Add filters to a phone account's outgoing filter list. Changes take effect immediately in the system (no save of the phone account is necessary).

deleteIncomingFiltered(incExt, phoneAccount):

(action) Remove filters from a phone account's incoming filter list. Changes take effect immediately in the system (no save of the phone account is necessary).

deleteOutgoingFiltered(outExt, phoneAccount):

(action) Remove filters from a phone account's outgoing filter list. Changes take effect immediately in the system (no save of the phone account is necessary).

registerBillPayment(amount, phoneAccount):

(action) This action atomically increments the given phone account's balance by the given amount.

addIP(IP):

(action) This action adds an IP to the list of IPs managed by the system.

deleteIP(IP):

(action) This action removes an IP from the list of IPs managed by the system.

changeState(IP, state):

(action) This action will set whether or not a phone is enabled or disabled for automatic hardware tests. If state is disabled, it will send a Disable event to the associated phone. If state is enabled, it will send an Enable event to the associated phone.

addBlockedExtension(extension):

(action) This action is used by a phone's state machine in order to add an extension to the phone's list of blocked extensions. If the extension was blocked before, this action does nothing.

removeBlockedExtension(extension):

(action) This action is used by a phone's state machine in order to remove an extension from the phone's list of blocked extensions. If the extension was not blocked before, this action does nothing.

clearBlockedExtensions(IP):

(action) This action is used by a phone's state machine in order to clear all extensions from its blocked number list.

testFinished(IP, adminID, passed):

(action) This action fires a testFinished(IP, adminID, passed) event. If the passed variable is true, it sets the phone defined by IP to be in service. If passed is false, it sets the phone to be out of service, logs the error, and sends a “phoneHardwareFails(IP)” event to all logged in administrators. AdminId is null if it is not an administrator requested test.

addErrorToList(IP):

(action) This action adds an error message denoting the hardware failure of a phone with the given IP to the hardware faliure screen.

genRandomExt:

(action) Generates a unused random extension and populates it in the user interface element that initiated the action.

addServiceCharges:

(action) Adds service charges to every phone account whose billing period ends today at 5pm. The system will prorate service charges (defined in the billing plan) starting from the date of the last service charge in the current billing period of each qualifying phone account.

suspendDelinquintAccounts:

(action) Suspends the account of any user who has a bill that has had an outstanding balance for at least 3 months.

call(callerIP, calleeIP):

(action) Used to initiate a call with another phone. Sends a call(callerIP, calleeIP) event to the callee's phone.

adminDeleted(adminRemoveArray[]):

(action) Sends adminDeleted(adminID) event to each admin in the adminIDs array.

calcCharge(caller, length, billingPlan):

(action) Adds a charge the the specified caller's phone account, billing for a portion of a call of the specified length made under the specified billingPlan and its discount periods.

lock(entity):

(action) This sets the boolean variable uniquely associated with the given entity to true.

unlock(entity):

(action) This sets the boolean variable uniquely associated with the given entity to false.

lockUserAndPhones(userAccount):

(action) This sets the boolean variable uniquely associated with the given user account to true. It also sets the boolean variable for all associated phone accounts to true.

unlockUserAndPhones(userAccount):

(action) This sets the boolean variable uniquely associated with the given user account to false. It also sets the boolean variable for all associated phone accounts to false.

adminDeleted(admin):

(action) Triggered when the specified administrator's account is deleted.

runPhoneHardwareTest(IP):

(activity) This activity tests whether a phone, which is specified by the IP parameter, is responsive. The activity sends a test signal to a phone. If the phone responds, then the test passed and the activity concludes. If the phone does not respond within a certain amount of time, then the test fails and the activity concludes. The passed variable of the testFinished action is set accordingly.

Events

call(callerIP, calleeIP):

(event) Sent by call(callerIP, calleeIP) action from caller to callee to start the callee phone ringing.

pickUpFailed:

(event) Sent from callee to caller to indicate that the ten rings expired and a busy signal should be played to the caller.

doNotRingAnymore:

(event) Sent from caller to callee to indicate that the call was canceled and ringing should stop.

callDisconnected:

(event) Sent to a phone's state machine to indicate that the call has ended, either because an admin terminated the call or the other party hung up.

startTest(adminID, isAutomated):

(event) Sent to a testing state machine to initiate a test. The initiating administrator's user ID is passed as the first parameter, and the second parameter is used to indicate whether or not the state machine should either a) repeatedly perform automated tests, or b) send back feedback to the given admin.

testFinished(IP, adminID, passed):

(event) Event sent by the testFinished(IP, adminID, passed) action to the admin that initiated the test and the phones state diagram. The passed parameter is a boolean value indicating whether or not the test passed. AdminId is null if it is not an administrator requested test.

adminDeleted(adminID):

(event) Event sent by adminDeleted(adminIDs[]) action to an admin whenever that admin is deleted.

generateBills:
(event) Compiles the statistics necessary to display bills.

Enable:
(event) Sent by the changeState(IP, state) action to a phone to enable the phone.

Disable:
(event) Sent by the changeState(IP, state) action to a phone to disable the phone.

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(event) Event sent by adminDeleted(adminIDs[]) action to an admin whenever that admin is deleted.

generateBills:

(event) Compiles the statistics necessary to display bills.

Enable:
(event) Sent by the changeState(IP, state) action to a phone to enable the phone.

Disable:
(event) Sent by the changeState(IP, state) action to a phone to disable the phone.

GUI Events:
Almost of the GUI events correspond to clicking a button and are named "clickX" (e.g. clickCancel or clickErrorOK) where X is the name or behaviour of the button (e.g. cancel or errorOK). For brevity, they are omitted from the glossary. The exceptions to this rule are listed below:

turnSystemOn:
(GUI event) The event triggered by clicking the "Turn System ON" button on GUI screen 1.

turnSystemOff:
(GUI event) The event triggered by clicking the "Turn System OFF" button on GUI screen 4.

GUI Screenshots

1: System on:
(GUI screenshot) The GUI screen for turning the system on.

2: Login administrator:
(GUI screenshot) The GUI screen for logging into the system.

3: Generic Error/Warning Message:
(GUI screenshot) The GUI screen for displaying and confirming error messages.

4: Main screen:
(GUI screenshot) The GUI screen for navigating to other menu subsections.

5: Administrator Management Screen:
(GUI screenshot) The GUI screen for navigating to administrator management operations.

6: Edit administrator list:
(GUI screenshot) The GUI screen for chosing an administrator to modify.

7: Edit administrator details:

(GUI screenshot) The GUI screen for entering new information about an administrator.

8: Remove administrator list:
(GUI screenshot) The GUI screen for removing an administrator from the system.

9: Remove Administrator Confirmation:
(GUI screenshot) The GUI screen for confirming the removal of an administrator.

10: Add new administrator:
(GUI screenshot) The GUI screen for entering information about a new administrator.

11: Add New Administrator Confirmation:
(GUI screenshot) The GUI screen for confirming the addition of an administrator to the system.

12: Configure Billing Plans:
(GUI screenshot) The GUI screen for selecting which billing plan to modify and for selecting to add a billing plan.

13: Edit Billing Plan:
(GUI screenshot) The GUI screen for entering information about a billing plan.

14: System Management:
(GUI screenshot) The GUI screen for navigating to system management operations.

15: View System Error Logs:
(GUI screenshot) The GUI screen for viewing the system's error logs.

16: Select Telephone for Hardware Testing:
(GUI screenshot) The GUI screen for choosing which phones should be manually hardware tested.

17: View Max Calls in System:
(GUI screenshot) The GUI screen for viewing and selecting to modify the maximum calls in the system.

18: Set max calls in system:
(GUI screenshot) The GUI screen for entering new maximum calls in the system.

19: Terminating an Ongoing Call:
(GUI screenshot) The GUI screen for selecting to terminate a established call in the system.

20: Configure Emergency Extensions:
(GUI screenshot) The GUI screen for selecting an emergency extension to modify.

21: Modify Emergency Extension:

(GUI screenshot) The GUI screen for entering a new IP or extension for an emergency extension.

22: Change Emergency Extension Confirmation Screen:

(GUI screenshot) The GUI screen for confirming the modification of an emergency extension.

23: List User Accounts:

(GUI screenshot) The GUI screen for selecting to modify, add, or delete a user.

24: Remove User Account Prompt:

(GUI screenshot) The GUI screen for deciding to delete a user (saying Yes or No).

25: User Deletion Success:

(GUI screenshot) The GUI screen for confirming the removal of a user account from the system.

26: Edit User Account:

(GUI screenshot) The GUI screen for entering information about a user account.

27: Editing User Account Success:

(GUI screenshot) The GUI screen for confirming the modification of a user account's data.

28: User Account's Phone Account List:

(GUI screenshot) The GUI screen for selecting to add, edit, record a payment, or delete a phone account.

29: Delete Phone Account Prompt:

(GUI screenshot) The GUI screen for deciding to delete a phone account (saying Yes or No).

30: Delete Phone Account Success:

(GUI screenshot) The GUI screen for confirming the deletion of a phone account.

31: Edit Phone Account Detail:

(GUI screenshot) The GUI screen for entering (modifying) the information of a phone account.

32: Phone Account Save Success:

(GUI screenshot) The GUI screen for confirming the modification of a phone account's data.

33: View Filtered Extensions:

(GUI screenshot) The GUI screen for adding and deleting the filtered extensions of a phone account.

34: Add incoming filtered extensions:
(GUI screenshot) The GUI screen for entering an incoming filter to a phone account.

35: Add outgoing filtered extensions:
(GUI screenshot) The GUI screen for entering an outgoing filter to a phone account.

36: Create Phone Account Success:
(GUI screenshot) The GUI screen for confirming the successful addition of a phone account.

37: New User Account:
(GUI screenshot) The GUI screen for entering information for a new user account.

38: New User Account Creation Successful:
(GUI screenshot) The GUI screen for confirming the addition of a new user account.

39: Display IP List:
(GUI screenshot) The GUI screen for adding, deleting, or changing the state of a IP, or for running a hardware test.

40: Change IP State:
(GUI screenshot) The GUI screen for entering a new state for an IP.

41: Add New IP Address:
(GUI screenshot) The GUI screen for entering information for a new IP.

Functions

Making a Call:
(function) Checks if two parties can call each other and creates temporary call traching object, called before call connects

Ending a Call:
(function) Removes temporary call tracking object, called when call terminates

Charging for Part of a Call:
(function) Charges the caller for part of a split call, called when a discount period ends, when billing period ends, or before a call terminates

Charging Monthly Service Fee:

(function) Charges the prorated service fee for an account at the end of a billing period and suspends the phone account if a bill over 3 billing periods old has not been fully paid off, called when a billing period ends

Recording Bill Payment:

(function) Recording a user's bill payment, called when an administrator enters a bill payment

Prorating a Service Fee:

(function) Charges the prorated service fee for an account during a billing period, called when system turns back on, when a billing plan changes, and when a phone account is suspended

Editing a Phone Account:

(function) Changes the details of a phone account, such as extension, IP, or billing plan, and charges a prorated service fee if the billing plan changes, called when an administrator edits a phone account and saves changes

Deleting a Phone Account:

(function) Marks a phone account as deleted, called when the administrator deletes a phone account

Adding a User Account:

(function) Adds a user account and an associated phone account, called when the administrator adds a user account

Deleting a User Account:

(function) Marks a user account and its associated phone accounts as deleted, called when the administrator deletes a user account

Editing a Billing Plan:

(function) Saves the changes to a billing plan, called when the administrator edits a billing plan and saves changes

Adding an Administrator Account:

(function) Adds an administrator account, called when an administrator creates another administrator account

Deleting an Administrator Account:

(function) Deletes an administrator account and logs out the deleted administrator, called when an administrator deletes an administrator account

Adding an Incoming Filter Expression:

(function) Adds a filter expression to the incoming filter list of a telephone account, called when an administrator adds an incoming filter expression to a phone account

Adding a Blocked Extension:
(function) Adds a blocked extension to a phone account, called when a user adds a blocked extension to one of his/her phone account's blocked lists

Adding an IP Address:
(function) Adds an IP address to the system, called when an administrator adds an IP address to the system

Running a Hardware Test:
(function) Updates phone status the results of a hardware test and reports any errors, called when a hardware test on a phone has finished

States

Add New Admin:
(state) Prompts an administrator for details about a new administrator to be added

Add New Administrator:
(state) Allows an administrator to add a new administrator account

Add New IP:
(state) The state where an administrator is adding a new IP address to the system.

Add Phone Account:
(state) The state where a new phone account is added to the system.

Add user account:
(state) Composite state allowing for the addition of users to the system

Admin Account Locked Error:
(state) Informs an administrator that the the selected administrator account is locked and cannot be edited

Admin List:
(state) Allows an administrator to select an administrator from a list

Administrators Account:
(state) Allows administrators to add, edit, and remove other administrators.

Billing Plan Locked Error:
(state) Informs an administrator that the billing plan they requested to edit or delete was locked and could not be accessed

Busy:
(state) The state where a phone is playing a busy tone.

Call Blocking:
(state) The state where a user is modifying their call blocking settings.

Call Blocking Menu:
(state) The state where a phone is waiting for call blocking commands.

Callee Ringing:
(state) The state where a phone is causing another phone's ringer to sound.

Calls in system:
(state) Composite state that informs the administrator of the current calls in the system

Can not delete user error:
(state) State occurs when it is impossible to select a current user

Changing IP State:
(state) The state where an administrator is changing the state of an IP.

Clearing Blocked Numbers:
(state) The state where a phone is clearing all of its phone account's blocked extensions.

Configure Billing Plans:
(state) Prompts an administrator whether they would like to add, edit, or remove a billing plan

Configure Emergency Extension:
(state) The state where an administrator is configuring the emergency extensions in the system.

Configure Emergency Extensions:
(state) The state where an administrator is viewing the two emergency extensions in the system.

Configuring Filtered Extensions:
(state) The state which allows an administrator to modify the filtered extensions of a phone account.

Configuring Maximum Number of Calls:
(state) The state where an administrator views or defines the maximum calls in the system.

Configuring System:
(state) The state where an administrator is configuring the system (or navigating to configure the system).

Confirm Deletion:

(state) The state where the adminstrator is asked to confirm deleting an account

Confirm Add Phone Account:
(state) The state which allows an adinistrator to confirm the addition of a phone account.

Confirm Emergency Extension Save:
(state) The state where an administrator is viewing a message about the sucessful add of an emergency extension.

Confirm Save Phone Account:
(state) The state where the administrator is asked to confirm saving changes to a phone account

Confirmation screen:
(state) State informs the administrator that a the new user has been successfully added

Connected:
(state) The state where a phone is transmitting audio with another phone.

Delete Phone Account Prompt:
(state) The state where the administrator is being prompted on whether or not to delete a phone account

Delete user prompt:
(state) A state which prompts the administrator which user to delete

Dialing:
(state) The state where a user is dialing a number on a phone.

Digit:
(state) The state where a user has just entered a digit.

Disabled:
(state) The state which denotes a phone (ip) is disbled.

Disconnected:
(state) The state where a phone is not connected to another phone.

Display list of active calls:
(state) A state which displays a succinct list of all currently ongoing calls in the system

Display list of all other administrators:
(state) Prompts an administrator with a list of all administrator accounts, not including the current administrator

Display tests results:

(state) State which displayes the results of the test to the administrator

Displaying Administrators Account Menu:
(state) Allows an administrator to choose if they would like to add, edit, or delete an other administrator

Displaying Currently Filtered Extensions:
(state) The state which displays the incoming and outgoing extensions of a phone account.

Displaying List of IPs:
(state) The state where an administrator is viewing a list of IPs in the system.

Displaying Maximum Number of Calls in System:
(state) The state where the administrator can view the maximum number of calls in the system.

Displaying System Menu:
(state) The state where an administrator is able to navigate to certain system configuration options.

Edit Admin Account:
(state) Allows an administrator to edit the details of an administrator account

Edit Admin Details:
(state) Prompts an administrator for new administrator account details

Edit user accoung:
(state) State which awaits input of the new information for a specific user account

Editing Admin Details:
(state) Allows an administrator to edit the details of an administrator account

Editing user account:
(state) A composite state within which a user account is being edited

Enabled:
(state) The state denoting that a particular phone (ip) is enabled.

Enter Billing Plan Details:
(state) Prompts an administrator for details about the new or edited billing plan

Enter Phone Account Details:
(state) The state which allows the administrator to enter phone account information.

Entering Phone Account Details:

(state) The state where the administrator has a phone account locked and is ready to modify it

Error:

(state) The state where a phone is playing an error tone.

Error Adding Discount Period:

(state) Informs an administrator that there was an error adding the specified discount period

Error Adding IP:

(state) The state where an administrator is viewing an error about a failure to add an IP.

Error Deleting Admin:

(state) Informs an administrator that the requested delete of an administrator account could not be completed, due to a locking problem

Error Deleting IP:

(state) The state where an administrator is viewing an error about a failed deletion of an IP.

Error Deleting Phone Account:

(state) The state where the administrator is viewing an error due to a phone account being unable to be deleted

Error With Admin Details:

(state) Indicates to an administrator that the supplied administrator account details were not valid

Error with Bill Payment:

(state) The state where the administrator is viewing an error due to an invalid bil payment amount being entered

Error With Billing Plan Details:

(state) Informs an administrator that the given billing plan was not valid, so it could not be saved

Error With Extensions:

(state) The state which allows the administrator to view error information about an entered extension.

Error With Number:

(state) The state where an error pertaining to the entry of maximum number of calls is displayed.

Extension Error:

(state) The state where an administrator is viewing an error about a failed edit to an emergency extension.

Fast Busy:
(state) The state where a phone is playing a fast busy tone.

Hung Up:
(state) The state where a phone is on the hook.

Idle:
(state) The state where a phone is playing an idle tone.

Inputting Digit:
(state) The state where a user is entering non-first digit of an extension to add to or remove from their blocked number list.

Inputting First Digit:
(state) The state where a user is entering the first digit of an extension to add to or remove from their blocked number list.

Inputting Number List:
(state) The state where a user is entering a number to be added to or removed from their blocked number list.

Invalid Admin Data:
(state) Informs an administrator that the to-be-added administrator's data are not valid

IP Locked Error:
(state) The state where an administrator is viewing an error about an IP being locked.

IPs:
(state) The state where an administrator is managing the IPs in the system.

Invalid Add Phone Data Page:
(state) The state where input errors are displayed to the user.

Invalid Phone Data:
(state) The state where the administrator is viewing an error about invalid phone data

Logged In:
(state) Indicates that a particular administrator is logged in and can access system functionality

Logged Out:
(state) Indicates that a particular administrator is logged out and the system is prompting them for a username and password

Login Error:
(state) Indicates that a particular administrator has entered invalid login credentials

Lookup:
(state) The state where a phone is looking up an extension to see if it exists.

Main Screen:
(state) The top-level navigation screen that allows an administrator to access each of the main components of the administrator UI

Modify Particular Emergency Extension:
(state) The state where an administrator is editing the details of a single emergency extension.

Modify user account:
(state) State allows an administrator to modify user accounts

No available IP or extension error:
(state) State shows an error if no IPs or extensions are avialable in the system

No Extensions or No IPs Warning:
(state) Administrator is viewing an error message indicating that there are no extensions or no IPs in the system

No phones in system error:
(state) A state informing the administrator that no phones are available in the system for testing

Not Viewing Hardware Error:
(state) When an administrator dismisses the notifications of hardware errors, they are returned to this state

Off Hook:
(state) The state where a phone is off the hook.

Out of Service:
(state) The state which denotes a phone is out of service.

Phone Account Details:
(state) The state where the administrator is entering phone account details to modify the phone account

Phone Account Locked:
(state) The state where the administrator is viewing an error about a phone account being locked by another administrator

Phone System:
(state) Main container state that holds the entire system

Phone System Off:
(state) Indicates that the call processing, hardware testing, and automatic billing systems are not active

Phone System On:
(state) Indicates that the call processing, hardware testing, and automatic billing systems are not active

Phone_InService:
(state) The state which denotes that a phone is in service.

Phones:
(state) The state which defines the state a phone is in.

Phones:
(state) Container state for the call processing system

Prompt For New Maximum Number of Calls in System:
(state) The state where the administrator enters the maximum number of calls (for modification)

Prompt For New Incoming Extension:
(state) The state which allows the administrator to add a new incoming extension.

Prompt For New Outgoing Extension:
(state) The state which allows the administrator to add a new outgoing extension.

Receiving:
(state) The state where a phone is connected to an initiating phone.

Remove Admin Account:
(state) Allows an administrator to remove another administrator's account

Request system test:
(state) Composite state allowing an administrator to request that a system test be run

Ringer On:
(state) The state where the ringer of a phone is sounding.

Ringer Off:
(state) The state where the ringer of a phone is about to sound.

Ringing:
(state) The state where the ringer of a phone is sounding (or about to sound).

Running Hardware Tests:
(state) The state where an administrator is waiting for a requested hardware test to complete.

Save new administrator:
(state) Confirms to an administrator that they have successfully added a new administrator account to the system

Show telephone accounts list:
(state) A state providing the administrator with a list of all applicable phone accounts in the system

Shows confirmation message:
(state) Informs an administrator that the action that they most recently requested (deleting an administrator account) has been completed successfully

Silence:
(state) The state where a phone is not playing any sound.

Silent:
(state) The state where a phone is on the hook and is silent.

System Off:
(state) Administrators are in this state when they are properly logged in, but the system is off. This state allows an administrator to turn the system on

System On:
(state) Administrators are in this state when they are logged in, and the system is on

Testing (substate):
(state) The state where a phone is being tested.

Testing (superstate):
(state) Container state for the automatic hardware testing system

Transmitting:
(state) The state where a phone is connected to a phone and has initiated the connection.

User information screen:
(state) State displays where all necessary user information is entered

User locked error:
(state) State occurs when the selected user is currently locked by another administrator

Using Administrator Interface:
(state) Administrators are in this state when they are viewing any part of the administrator UI

View Error Log:
(state) The state where an administrator is viewing the error logs of the system.

View List of Phone Accounts:
(state) The state where the administrator is viewing a list of phone accounts

View list of users:
(state) State presents a list of all users in the system

Viewing List of Hardware Errors:
(state) When a hardware error occurs, an administrator is notified by being placed in this state and viewing the associated UI

Waiting:
(state) The state where a phone is waiting for a test to begin.

Waiting for test:
(state) A state which waits untill the requested system phones test is run

Waiting for 0:
(state) The state where a phone is waiting for the user to enter a 0 key.

Waiting for 5pm:
(state) Waits for the time to become 5pm, so that automatic billing can take place

Waiting for 7:
(state) The state where a phone is waiting for the user to enter a 7 key.

Variables

startTime:
(variable) A variable storing the time that the system was turned on.

timesRung:
(variable) A variable storing the number of times that a phone has rung.

extensionDialed:
(variable) A variable storing a partial extension as it is dialed.

maxCalls:

(variable) A variable storing the maximum number of allowed calls in the system.

requestedAdminID:
(variable) A variable storing the ID of the administrator that requested a hardware test.

automated:
(variable) A variable indicating whether a test was automatically or manually initiated.

Appendix B – Meeting Minutes

Minutes #1 – Press conference 1 (Sept 22nd)
Minutes #2 – Press conference 2 (Sept 29th)
Minutes #3 – Customer/TA meeting 1 (Oct 6th)
Minutes #4 – Press conference 3 (Oct 20th)
Minutes #5 – Customer/TA meeting 2 (Nov 23rd)

Please find the minutes attached with this document