GUCCI: Ground station Uplink Command and Control Interpreter

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GUCCI: Ground station Uplink Command and Control Interpreter

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(ABSTRACT)

For a successful CubeSat mission, it is imperative to schedule events in a fashion that will generate maximum useful science data. Intuitive uplink commanding software is required for the Lower Atmosphere/Ionosphere Coupling Experiment (LAICE) CubeSat to ensure best results. The ground station up-link software is created with this aim in mind. This will make the operation center for the LAICE project efficient. This will also help in evaluating the effect of a particular schedule on LAICE instrument interface board (LIIB) before sending the commands to it. The interactive User Interface (UI) that makes the entire process intuitive guides the user to create an uplink schedule without any human error. The control software creates the command sequence taking in to account all the limitations and specification of the systems and instruments on LAICE. These data are backed up in an efficient format in Virginia Tech's database for future processing. This web-based application ensures a smooth scheduling process without any errors. Assistive flight-ready software is provided on the flight computer on the LAICE CubeSat to upload the correct uplink sequence to the LIIB.

GUCCI: Ground station Uplink Command and Control Interpreter

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(GENERAL AUDIENCE ABSTRACT)

Lower Atmosphere/Ionosphere Coupling Experiment (LAICE) is a satellite with three instruments on it that will generate scientific data. GUCCI is designed to send specific commands to LAICE to control these instruments. It is designed to help the users generate error free commands to be sent to the satellite. It aims at generating the best scientific data to facilitate future analysis thus making the ground station operating center of LAICE efficient. GUCCI can be used to deploy error preventive measures that can analyze the effect of a command on the instruments before up-linking them. The user interface aims at providing an intuitive experience and minimizing the human error. GUCCI also backs up all the scheduling data on a database for future processing.

Dedication

To my parents; Sujata and Rajiv Kedia, and brother; Rishabh Kedia for always believing in me. You are my greatest strength.

To my grandparents, Radha Kedia, Kailashrani and Bansidhar Poddar for encouraging me towards becoming a better version of myself.

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Unless otherwise noted, all photos by author, 2016.

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List of Acronyms

UTC Coordinated Universal Time

GUI Graphical User Interface

UI User Interface

LAICE Lower Atmosphere/Ionosphere Coupling Experiment

NSF National Science Foundation

PPS Points Per Sweep

RG Retarding Grid

RPA Retarding Potential Analyzer

SNeuPI Swept Neutral Pressure Instrument

LINAS LAICE Ionization gauge Neutral Atmosphere Sensor

LIIB LAICE Instrument Interface Board

UIUC University of Illinois at UrbanaChampaign

DB Database

EMU Energy Management Utility

MOC Mission Operation Center

STG Schedule Title Generator

UCG Uplink Command Generator

HRC High res correlation

LRC Low res correlation

HV High Voltage

TK Thermal Knife

Chapter 1

Introduction

The LAICE Cube Satellite will systematically observe gravity waves and map active gravity wave regions in the ionosphere over multiple seasons and times (Westerhoff et al., 2015). Figure 1.1 is a representation of the LAICE satellite. LAICE is a joint venture between Virginia Tech and the University of Illinois (UIUC), and is funded by the National Science Foundation (NSF) (Ghosh et al., 2014). Virginia Tech's payload includes three instruments: Retarding Potential Analyzer (RPA), Swept Neutral Pressure Instrument (SNeuPI) and LAICE Ionization Gauge Neutral Atmosphere Sensor (LINAS) for gathering appropriate science data (Fanelli, 2015) and (Garg, 2015). The LAICE Instrument Interface Board (LIIB) is responsible for controlling these instruments based on the operational mode it receives every second from the flight computer.

For this project I designed and tested ground station software to schedule uplink commands to the LIIB. This includes an intuitive user interface to plan and create the uplink command sequence to be sent to the LIIB. It meets various design specifications that were outlined for the LIIB and the three instruments. It also complies with UIUC's design constraints. This software creates a fail-safe for any errors that were present in the instruments. The major specifications of this software are outlined below.

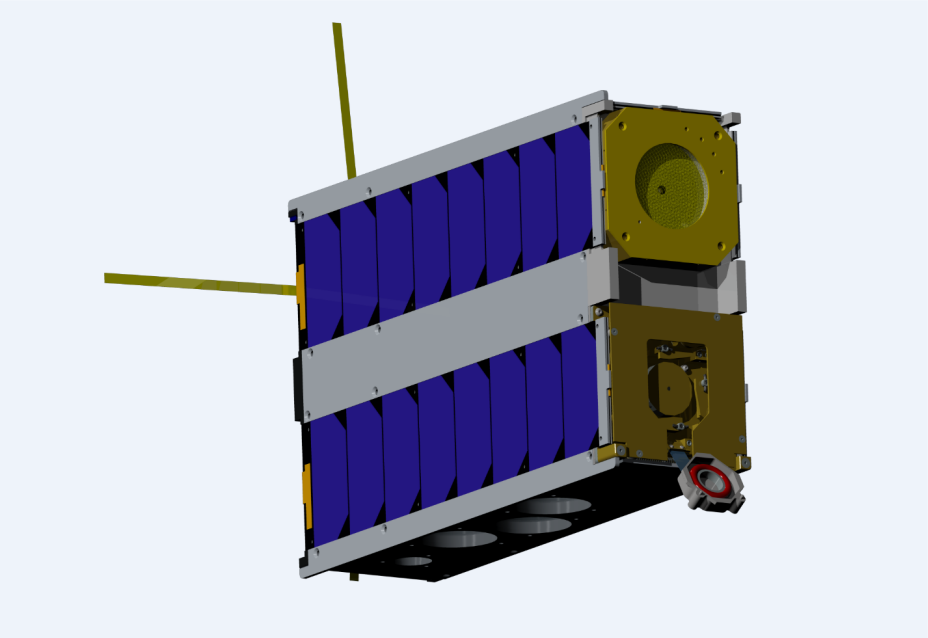

Figure 1.1: **LAICE CubeSat.** Representation of the LAICE CubeSat. Stephen E. Noel. *A Framework for Validation and Testing of a CubeSat Retarding Potential Analyzer* 2015 Masters thesis, Virginia Tech. Used under fair use, 2016.

Objectives:

1. Develop an intuitive Graphical User Interface (GUI) to specify the Virginia Tech payload uplink commands;
2. Engineer a launcher for the web-based user interface;
3. Design an uplink schedule generator;
4. Create a relational database to store the uplink command schedules;
5. Engineer an *expander* to generate two command sequences to be sent to the LIIB from the flight computer at a cadence of one second.

Figure 1.2 represents the overview of the uplink sequence for LAICE. Blocks with the orange

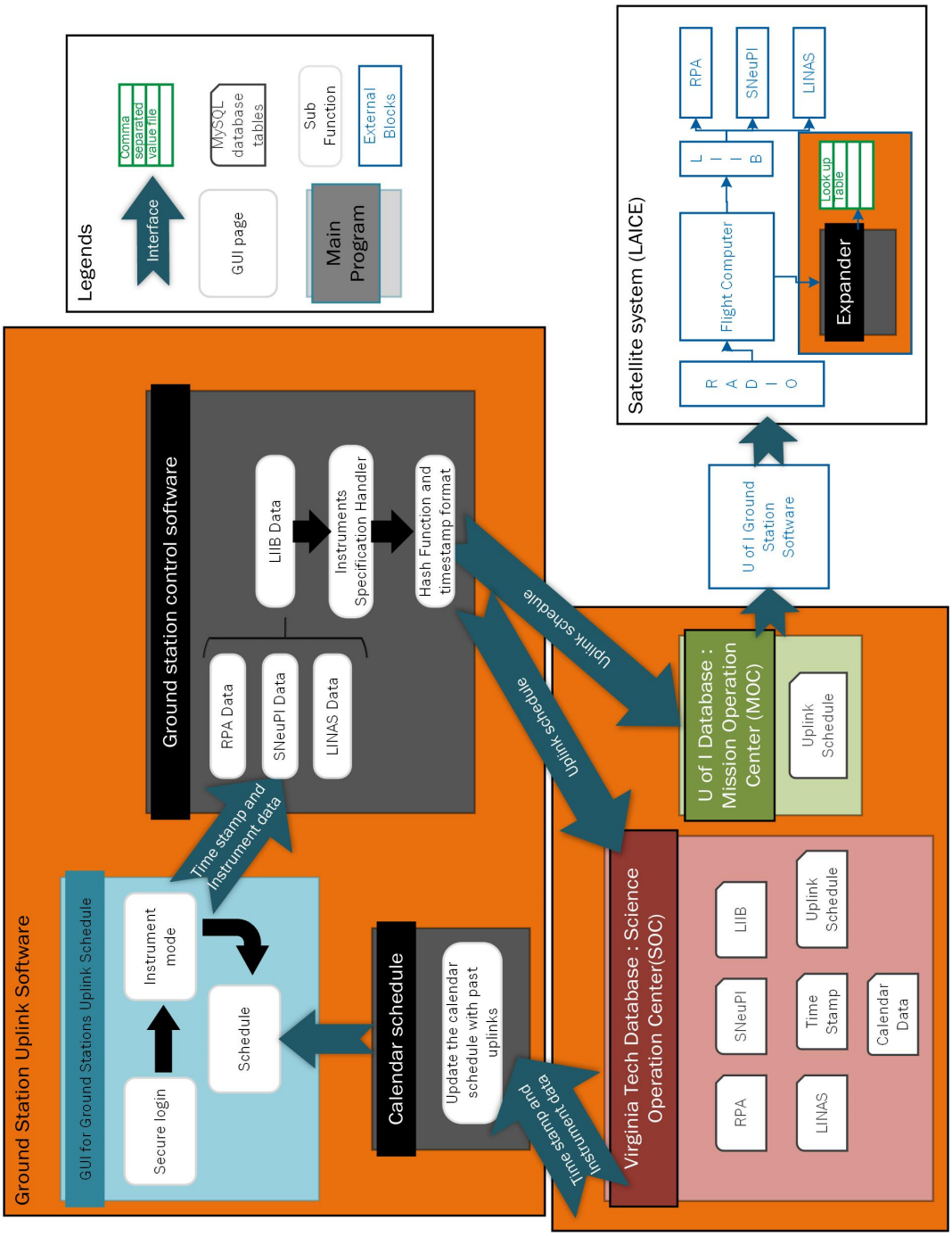

Figure 1.2: **Flow chart for the LAICE mission uplink.** The figure depicts the ground station uplink software's position in the LAICE mission uplink flow.

background represents an overview of the Ground station Uplink Command and Control Interpreter (GUCCI) software package discussed in this thesis. The user selects the operating mode for the three instruments (RPA, LINAS and SNeuPI) on LAICE using the GUI (light blue main program block) (Chapter 2). The data are sent to the processing unit or the ground station control software (grey main program block) to generate the appropriate uplink command (Chapter 3). These data are stored in data centers at Virginia Tech (red main program block) and UIUC (green main program block) (Chapter 4). The data are sent on to the satellite where further processing is done using the *Expander* (Chapter 5). These different components of the GUCCI are discussed in more detail in the following chapters. Each chapter states some specifications that the sub-system had to meet followed by its software design.

Overview of the thesis:

Chapter 2 discusses the interactive user interface that makes the instrument mode selection process intuitive. Chapter 3 explains the control software that forms the base of this application. It includes the launcher for the user interface, the uplink command generator and various other assistive tools for the application. Chapter 4 gives an overview of the databases (DB) created to store all the uplink information and how it can later be procured for scientific analysis. Chapter 5 discusses the design of the encoder software responsible for providing the LIIB with the correct command sequence. The thesis is concluded with Chapter 6 which provides a checklist of the specifications that were met.

Chapter 2

Graphical User Interface

2.1 Specification

The design of the ground station uplink user interface (front-end) is intended to be as simple and intuitive as possible. It must ensure that no errors enter the uplink commands that are sent to the spacecraft and then to the LIIB board. Figure 2.1 represents the flow of the interactive GUI used to schedule an uplink command. The specifications communicated below were developed to ensure that properly formatted uplink commands can be communicated to the LAICE satellite. They are as follows:

1. An intuitive and a simple user interface, with built-in checks that prevent erroneous inputs;
2. Access for multiple users with specific privileges;
3. A graphical calendar display to facilitate scheduling decisions;
4. An error check mechanism.

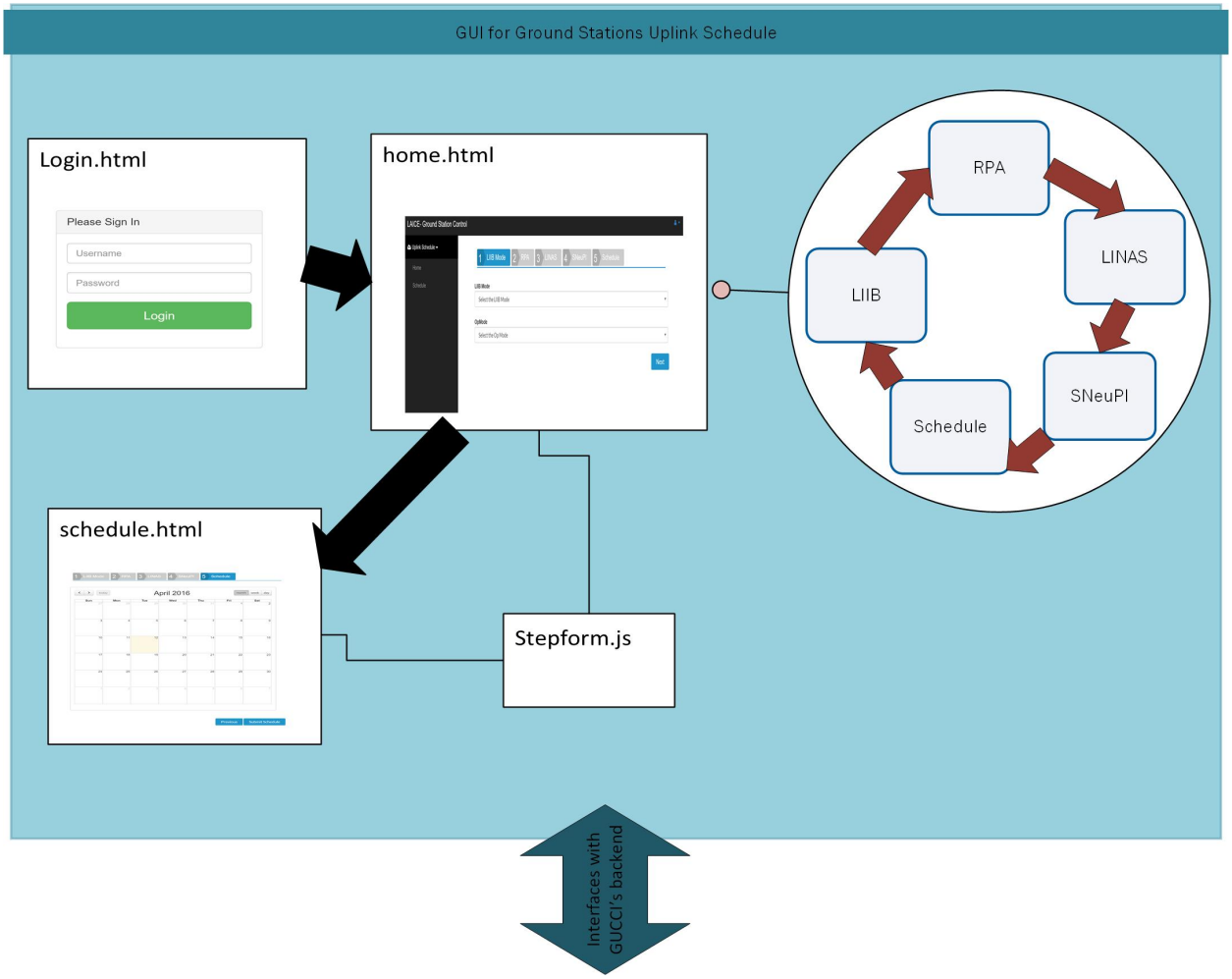

Figure 2.1: **GUI for uplink to the LAICE CubeSat.** The figure depicts the main files that facilitate the user interface. Together this interface meets the design specifications for uplink commanding.

2.2 Software design

The uplink software uses a web-based user interface to help the user schedule uplink commands. Different sections of the web-application are explained below.

Login page:

The application enables multiple users with different access privileges to access the ground station software for the LAICE CubeSat. A large group of individuals may study the schedule

and make future decisions for better science data but only a small subset may be allowed to edit the schedule. Another advantage of the web application is the ease with which peripheral software can be integrated to this system. This allows the integration process of software like the Energy Management Utility (EMU) (Harlow, 2014) that enable informed scheduling decisions.

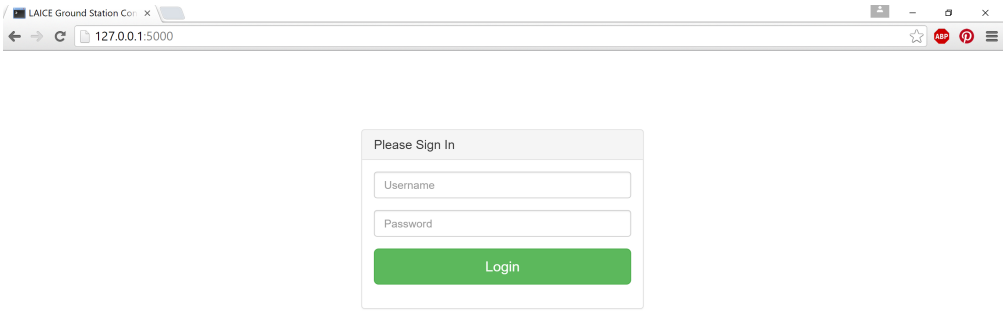

Figure 2.2: **Login page.** Users must login to the uplink user interface with the correct credentials.

The web application is hosted on the internal Virginia Tech server. Anybody having access to the right credentials will be able to access the user interface. Users are first directed to the login page represented in Figure 2.2. There are two login privileges. The first is the *administrative privilege* that allows the user to commit and edit a schedule. Any changes made by this user are communicated to the UIUC database, which creates specific scheduling commands for uplink to the flight computer on the LAICE satellite. The second is the *student privilege* where students can view the existing scheduled commands and create possible future schedules. These schedules will be stored in a separate database. This safeguards against any erroneous uplink commands entering the scheduling sequence and being sent to the flight computer by an unqualified user.

The login credentials are represented in Table 2.1. The user is notified if any wrong credentials

Table 2.1: **Login page credentials for different users.**

Username	Password
admin	laice123
student	trial123

are added on the login page. The error message displayed when he does so is *Error: Invalid Credentials. Please try again.* If the user forgets to enter a field, a pop up is generated on that field asking the user to fill the details. This helps the user understand what has gone wrong and take the correct steps towards logging in to the user interface. The *administrator* has access to a log file that keeps track of all the login attempts. This helps track down any suspicious logins to the application. There is also a limit of three login attempts to this application to ensure its security.

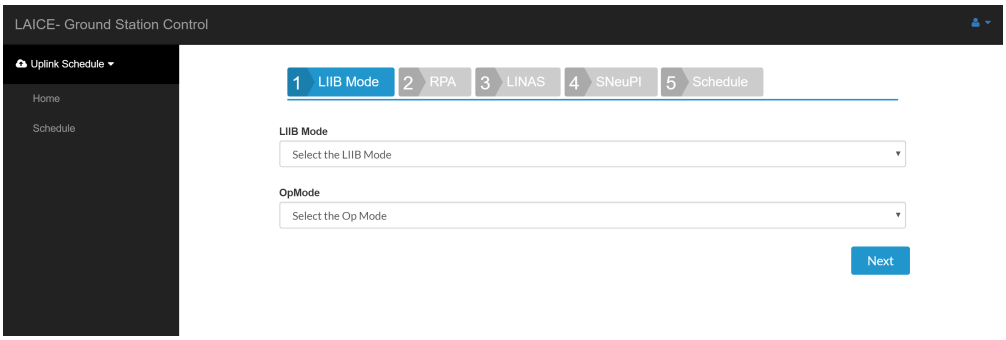

Figure 2.3: **Home page.** The user is directed to the home page of the GUI from the login page. Here he can set the instrument modes and decide on a schedule.

Once the user enters acceptable credentials he is directed to the home page for the LAICE ground station user interface.

Home page:

Here the user can select the mode they want the instruments to be in for a specific date and time. The form through which the user selects the instrument modes is broken down into discrete ordered steps, which correspond to the instruments and systems on the LAICE CubeSat. Figure 2.3 clearly depicts the five major elements, which are numbered and labeled on top of the screen. Users can click on these buttons and navigate through the different

instruments. There are two buttons labeled *next* and *previous* at the bottom of the form which help navigate through the form with ease.

The user cannot navigate to the calendar schedule and view the past schedule uplinks without filling in the instrument and system mode in the form. For example, when the *home* page is loaded for the first time, if the user clicks on the *schedule* tab on the top of the screen, he will be prompted with an error. There is another schedule button on the *home* page that helps the user view the calendar before it makes any schedule decision. When the user clicks the drop down button named (*Uplink Schedule*) on the left side of the screen, it displays two subsections. The first subsection (*Home*) directs the user to the beginning of the step, where he can select the modes of the instruments for a new schedule. The second subsection *Schedule* directs the user to the last step of the form, where the user can look at all the previous uplink commands which he has scheduled in a calendar view. He can then direct himself to the beginning of the form where he can choose the instrument command to be uploaded and schedule the new uplink.

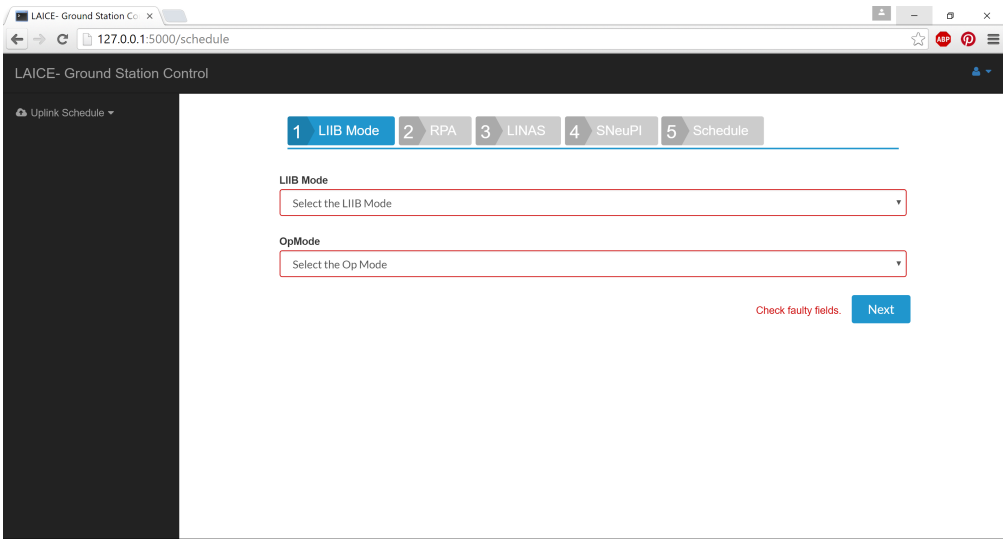

Figure 2.4: **Error message example on the home page.** If the user fails to provide the necessary inputs to the required field settings, he is prompted with an error message when he tries to leave that page. This prevents the user from scheduling an incomplete or erroneous uplink schedule.

Error check mechanism:

The design of this application makes the process intuitive and prevents the user from making errors as far as possible. These fail-safe options ensure that the user does not reach an ill-defined state. To help the user navigate through the user interface, various error messages prompt the user to make necessary changes. Certain settings that are required for a meaningful generation of the uplink command are set to a *required* field. An error message is generated if the user forgets to make these *required* selections. The user will not be allowed to go on the *Schedule* page until all the required selections are made. If the user clicks on the *Submit Schedule* button without making any schedule decisions on the calendar, he will be prompted with a *"Check Faulty fields"* error.

If the user tries to go on to the next step in the form without selecting all the required values, he will be prompted with an error. All the fields that are incomplete will be highlighted and the error message will be displayed in red. An example of this scenario is shown in Figure 2.4 when the user forgets to select the operational mode he wants the LIIB to be in and clicks on the *next* button.

LIIB:

User can decide the mode he wants the LIIB to operate in and the operational modes of the three instruments (RPA, LINAS or SNeuPI) on the *Home* page. The selections for the LIIB are represented in Table 2.2. The user needs to select the LIIB mode before he selects the operational mode (opmode) he wants the LIIB to operate in. The selection of the opmode determines the instrument for which additional information is required. The application prevents the user from entering mode information for instruments that otherwise need to be OFF for the particular opmode. For example, If the opmode is selected to be *Neutral* the user can make mode selections only for LINAS and SNeuPI, which are the two instruments that measure properties of the neutral gas.

The *thermal knife* mode is a special mode only used once, when the CubeSat is first inserted into the orbit. The user will be warned if he selects the *thermal knife* opmode. If the thermal knife mode is chosen, the user's ability to select specific instrument modes is disabled.

Table 2.2: **LIIB and opmode selection**

LIIB Modes	**opmodes**
Normal Mode	Standby (Instruments OFF)
Normal Mode	SNeuPI ON
Normal Mode	LINAS ON
Normal Mode	Neutral (LINAS, SNeuPI ON)
Normal Mode	Plasma (RPA ON)
Normal Mode	High res correlation (RPA, SNeuPI ON)
Normal Mode	Low res correlation (RPA, LINAS ON)
Normal Mode	Prime Science (All Instruments ON)
TK1 Charge	Standby (Instruments OFF)
TK1 Discharge	Standby (Instruments OFF)
TK2 Charge	Standby (Instruments OFF)
TK2 Discharge	Standby (Instruments OFF)
TK Override	Standby (Instruments OFF)

RPA:

The RPA instrument mode selection page on the GUI is depicted in Figure 2.5 . Table 2.6 shows all the possible mode specifications for the RPA that are required.

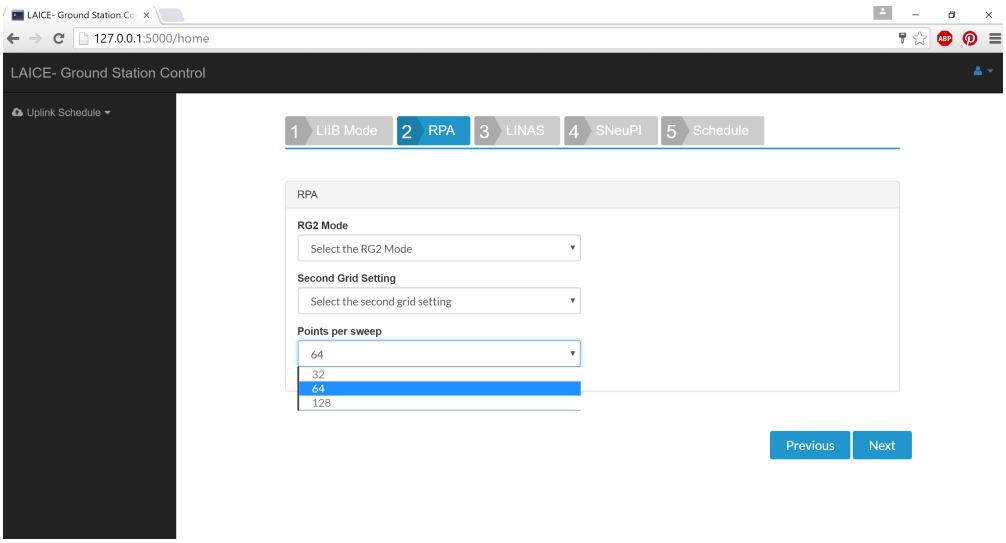

Figure 2.5: **RPA settings.** The user selects the operating specifications for the RPA on this page, including the grid bias modes, sweep modes and the number of points per sweep.

Second grid setting
Retarding grid
Aperture

RG2 Mode
Linear Sweep
Constant Voltage
Smart Sweep

Points per Sweep Value
32
64
128

Figure 2.6: **RPA mode selections.** The RPA mode selections are shown in this table. The points per sweep is defaulted to 64 for the LAICE mission.

LINAS:

The LINAS instrument mode selection page on the GUI is depicted in Figure 2.7. Figure 2.8 shows all the possible mode specifications for LINAS. The *Grid setting* for LINAS is set to the value of 0010 by default for the LAICE mission and cannot be changed.

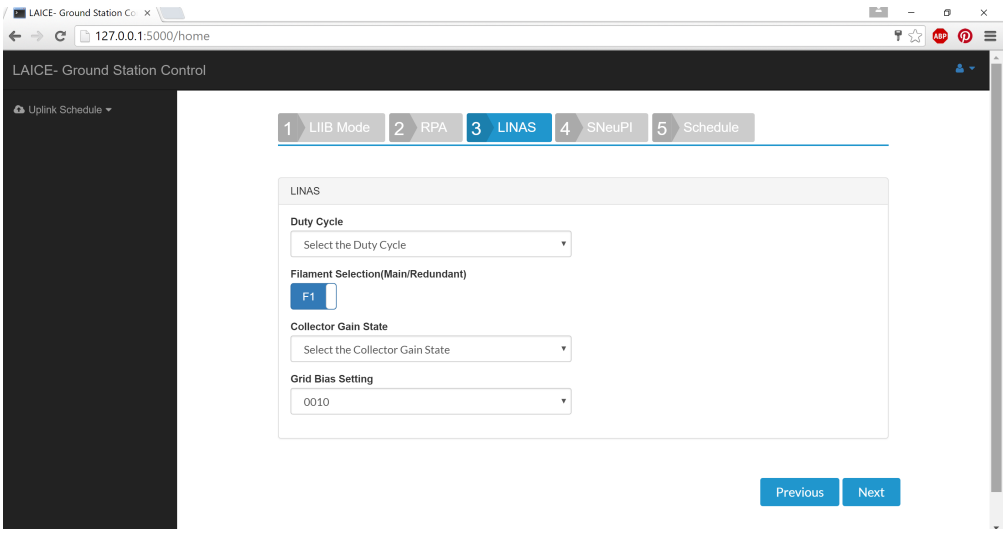

Figure 2.7: **LINAS settings.** The user can select the specifications for LINAS on this page including duty cycle, filament type, collector gain state and the grid bias setting.

SNeuPI:

The SNeuPI instrument mode selection page on the GUI is depicted in Figure 2.9 . Table 2.10 shows all the possible mode specifications for SNeuPI.

Control of the elements on this web page is handled mainly by the file named *stepforms.js*. More information about the algorithm used for the user interface is available in Appendix B.

Duty Cycle
10
20
50
100

Collector Gain State
Gain State at 10^-5 Torr
Low Pressure Sensitive
High Pressure Sensitive

Filament Select
Filament 1 (Main)
Filament 2 (Redundant)

Grid bias setting
0001
0010
0011
0100
0101
0110
0111
1000

Figure 2.8: **LINAS mode selections.** The LINAS mode selections are shown in this table.

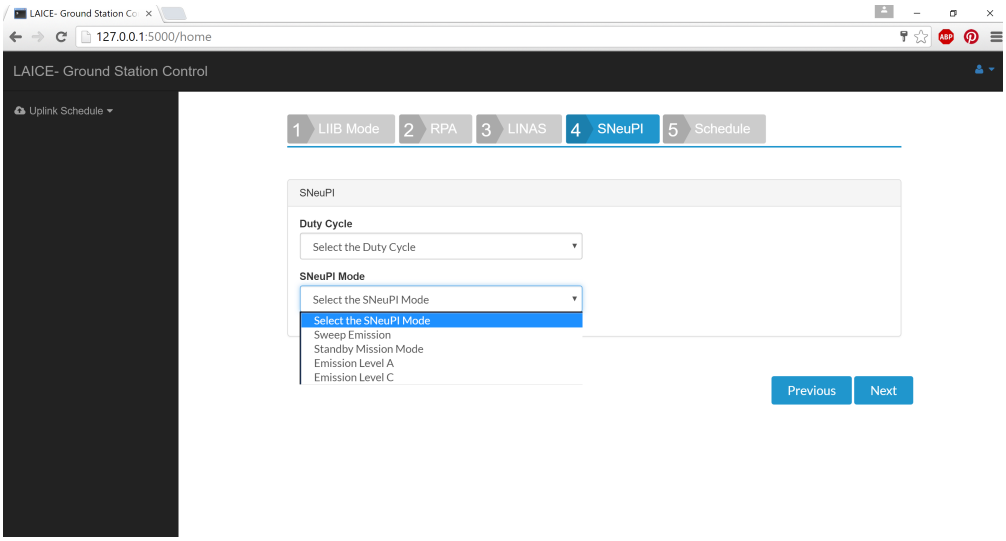

Figure 2.9: **SNeuPI settings.** The user can select the specifications for SNeuPI on this page, including the duty cycle and the emission mode.

Emission Mode	Duty Cycle
Sweep Emission	10
Emission OFF	20
Emission Level A	50
Emission Level C	100

Figure 2.10: **SNeuPI mode selections.** The SNeuPI mode selections are shown in this figure.

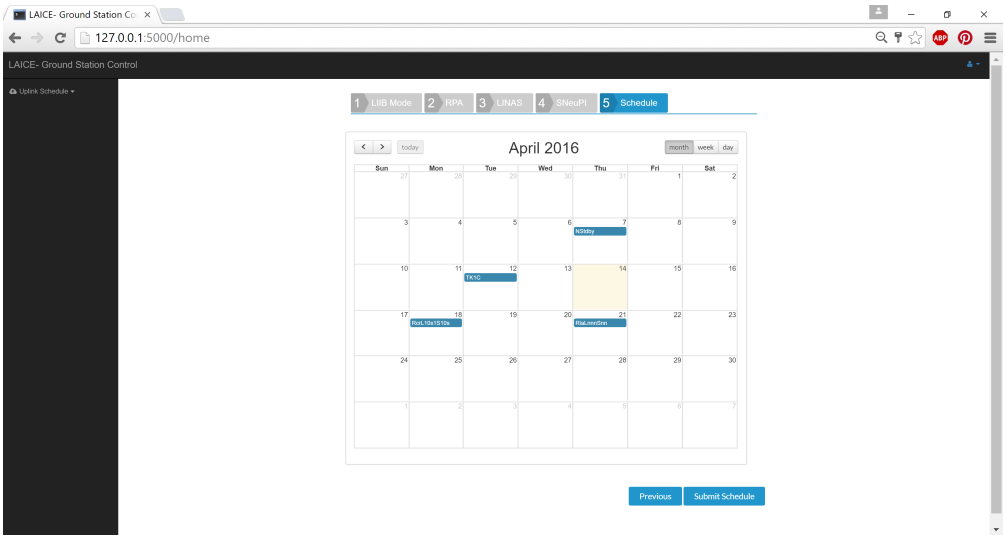

Figure 2.11: **Schedule settings.** This page displays a calendar view to assist the user in creating a schedule for the selected instrument modes.

Schedule:

Once the user makes all the *required* instrument mode selections he is directed to the calendar scheduler. A few specifications about the calendar view are listed below:

1. This is a JavaScript event calendar that enables the user to schedule an event with a cadence ranging from a minimum of thirty minutes to a maximum of several days.
2. The user can shift to different views to display the calendar for a month, week or a day by clicking on their respective buttons on the upper right side of the calendar.
3. Next and the previous buttons on the upper left side of the calendar allows navigation through sequential views.
4. Two conflicting uplink commands cannot be scheduled at the same time instant.
5. The current date in the calendar is highlighted with a yellow background.
6. Once the instrument mode specifications have been selected, the user can choose multiple calendar locations to schedule this event.

7. The calendar represents the date and the time in the UTC format.

Once the user has selected the time frame he wants for a particular instrument command, he can submit the schedule to the database by clicking on the *Submit Schedule* button. The database to which this uplink schedule will be committed depends on the privileges of the user. If the user is an *admin*, the data will be written on to the *UofIData* table of the Virginia Tech database and later copied to the UIUC database. This will form the actual schedule for the uplink. If the user has *student* privileges, the schedule will be written on the *trial* table of the Virginia Tech database which can be reviewed by the administrators and conveniently used to form the actual schedule to be uplinked.

Whenever the user reaches the *schedule* page in the user interface, he can view all the previous uplink schedules and make his decision for the new schedule. This is done by reading the data file comprised of all the uplink commands that were scheduled form the Virginia Tech database. This database can later be changed so that the calendar can display all the schedules that were sent to the flight control system aboard the CubeSat. Each of the schedules are represented by a unique name that represents the modes in which each of the instruments on LAICE will operate. This name is automatically generated depending on the user's mode selections. The main aim of the calendar view is to provide the entire schedule along with the instrument mode details at a glance.

Uplink mode representation on calendar:

The instrument mode is represented using the nomenclature defined in Figure 2.12. For example, an uplink schedule marked *RlaL10c0Snn* corresponds to the LIIB being in the 'Normal mode' with operational mode as Low resolution correlation (RPA and LINAS are ON). The three instruments: RPA, LINAS and SNeuPI are represented in this title in capital letters R, L an S respectively. The lower case letters correspond to the mode specification in each of the instruments. If the instrument is OFF, these mode specifications are represented as **n** (null). If they are ON (as in the current example) then they represent mode specifications as discussed. Here, RPA is in linear sweep mode represented by the letter '*l*'and its aperture

grid is selected which is denoted by '*a*'. While the LINAS has a duty cycle of 10 depicted by the number '*10*', constant value shown as '*c*' and Filament 0 represented with '*0*' as its selections. SNeuPI is not turned ON, which is denoted by '*n*' for each of its mode specification.

In another example, if the uplink schedule is marked as *TK1C* that means that the LIIB is in the thermal Knife 1 Charge mode.

Chapter summary:

In this chapter we have described the user interface, defined the operating modes and scheduling procedures, and provided examples and screenshots to illustrate the functionality of the front end code. Chapter 3 builds on this by describing GUCCI's control interface (backend).

LIIB Mode	Operational Mode	Title
Normal	Standby	NStdby
Normal	Plasma	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
Normal	SNeuPI	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
Normal	LINAS	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
Normal	Neutral	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
Normal	High Correlation Resolution	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
Normal	Low Correlation Resolution	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
Normal	Prime Science	R_(l/c/s)_(a/r)L_(10/20/50/100)_(s/l/h)_(0/1)S_(10/20/50/100)_(s/sb/a/c)
TK1C	Standby	TK1C
TK1D	Standby	TK1D
TK2C	Standby	TK2C
TK2D	Standby	TK2D
TKO	Standby	TKO

RPA:'R'		LINAS:'L'		SNeuPI:'S'	
Representation	Instrument mode	Representation	Instrument mode	Representation	Instrument mode
RG2 mode: '_(l/c/s)'		Duty cycle: '_(10/20/50/100)'		Duty cycle: '_(10/20/50/100)'	
l	linear sweep	Collector Gain State:'_(s/l/h)'		SNeuPI mode:'_(s/sb/a/c)'	
c	constant value	c	constant value	s	sweep emission
s	smart sweep	s	switch gain	sb	standby emission
		h	high pressure sensitive	a	Emission level A
Second Grid Setting: '_(a/r)'		Filament selection:'(0/1)'		c	Emission level C
a	Aperture	0	F1		
r	retarding grid	1	F2		

Figure 2.12: **Instrument mode nomenclature.** This is a look up table for the instrument mode information of the scheduled uplink commands on the calendar view in the UI. The table on top represents the mode representation based on the opmode of the LIIB. The bottom table represents the specifications for each of the instruments if they are turned ON.

Chapter 3

Ground station control software

3.1 Specifications

A significant challenge in developing of the ground station control software (back-end) is to comply with the specifications of the various software and hardware interfaces. A comprehensive list of these specifications is given below.

The final system must provide:

1. A web-based user interface launched on the operation center's IP address.
2. A secure web GUI.
3. Software to automatically fill the calendar view with the schedule history.
4. Automatic creation of a concise title that represents the modes of the instruments and the schedule in a human-readable format.
5. Uplink command generating software that is capable of handling the data received from the Mission Operation Center (MOC) at UIUC.
6. Data processing software to comply with the format required for communication with

MOC at UIUC.

7. A link between the ground station software and the Virginia Tech and UIUC databases.
8. A software layer to ensure the correct format for the data being written in to the databases.
9. The ability to schedule start and end time in seconds from the LINUX epoch, and a 32-bit unsigned unique integer representing the uplink command mode.
10. A buffer to prevent a one second command miss by the LIIB whenever it has to turn a new instrument ON.
11. A mode specification handler for each instrument.

3.2 Design

Figure 3.1 describes the different back-end processing software that launches the web user interface, handles its mode command data and sends these data to the uplink command generating software. It also creates a link to the databases and stores the information in them for future processing. This forms the heart of the ground station control software design.

Uplink command sequence design decision:

A single uplink command sequence to the LIIB is 96-bits long. The bit representation of this sequence is discussed in Appendix D. This 96-bit uplink command is converted to a unique 32-bit unsigned integer which is then sent to the flight computer. In some operating modes, the mode sent to the LIIB changes every second. More specifically, it toggles between two values for a long duration. The flight computer module sends a mode command to the LIIB every second but it processes a new mode only when the current mode changes. In this special case scenario, the new mode needs to be processed by the flight computer every second. This increases its computation. For example, when SNeuPI is in sweep emission mode, it toggles between sweep emission and emission level A to generate sensible data. Two

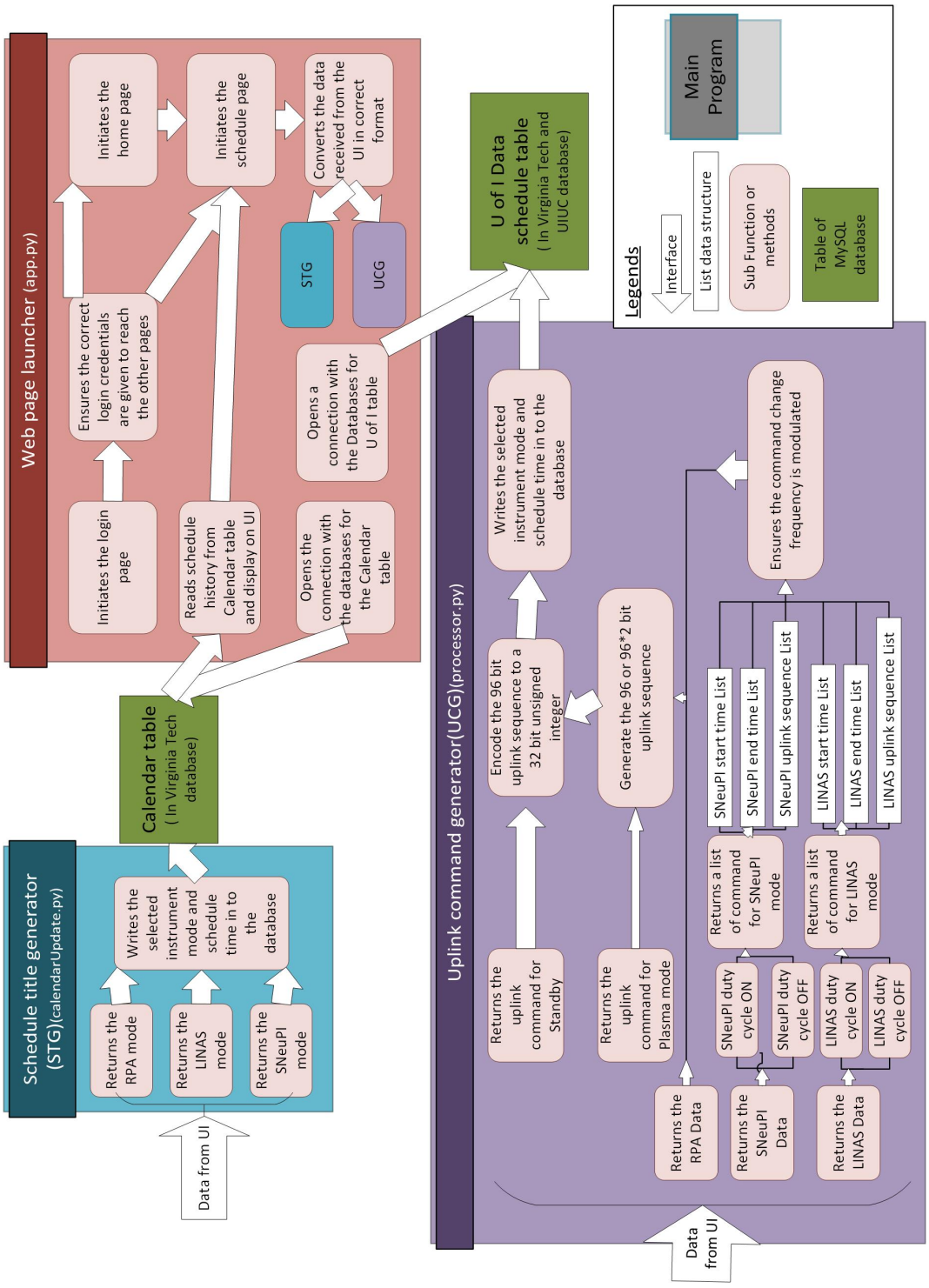

Figure 3.1: **Ground station control software block diagram.** The Ground Station's GUI uses different programs to create the uplink command schedule and handle these data for future processing. The block diagram shows the complete control flow of the ground station software.

different 96 bit commands are generated for a single selection by the user. If these two 96 bit commands are converted into two 32-bit mode ID's and sent to the flight computer, the new mode would have to be loaded by the flight computer every one second.

To reduce the computational load in the mode a design decision was made to create a single 32-bit mode ID to represent the two separate 96-bit command strings as one mode. In the current scenario, if LIIB had to run in sweep emission mode for 30 minutes, the flight computer would not have to load the *expander* and generate a new 96-bit command sequence every second. Instead, it would load the *expander* just once and generate both the 96-bit command sequences which would be sent to the LIIB in an alternating fashion by the flight computer. Figure D.5 in Appendix D describes all the cases where a 2*96-bit command string is generated.

3.2.1 Web page launcher

Flask (http://flask.pocoo.org/)is a python based web-framework used to host the web pages that form the user interface. Flask is a light framework that caters to all the needs of the ground station software. Here, Python is used in the back end, keeping in mind the possible expansion of the project to include the downlink software. Since most of the science data processing of the downlink data is being done using Python, this would provide a natural extension.

The web page launcher is the *app.py* file. This is the main file that executes the ground station uplink software. Running the GUCCI module launches a web page with a specific URL on the IP address of the operations center. The urls for different web pages forming the GUI are specified in the web launcher. The login page is the very first page that is initiated. Depending on the login credentials entered, the user is directed to the home page; url: */home*. To make the web based user interface secure, additional checks have been added. For example, a user cannot access any of the other pages without logging in to the application, even if the url is known. To secure the session data, it is encrypted using a secret key. This ensures that the data on the server remain secure from attacks.

When the user clicks the *Submit Schedule* button, he is directed to the *scheduleUpload* url. Here, the instrument mode data selected for the currently scheduled uplink are sent to the uplink schedule generating software. A schedule is generated complying with all the specifications, and the results are recorded in the database. At the same time, the title for this uplink is generated automatically by the *schedule title generator*. This human-readable title is then loaded on the calendar view of the schedule. The user is then directed to the *schedule* page at the url: */schedule* where the currently scheduled uplink can be viewed along with all the past uplink schedules. This forms a confirmation that an uplink is scheduled successfully.

The instrument mode information that was collected by the form is posted on the back end as soon as the form is submitted. This information is in the form of a JavaScript Object Notation(JSON). It is then converted to a Python *list* to help create the 96 bit or 2*96-bit uplink sequence based on the user input.

The calendar view sends a start and end time for an uplink schedule to the back-end. These data are sent to the Schedule Title Generator (STG) and Uplink Command Generator (UCG) for further processing. The data set for the calendar schedule is a dictionary of lists representing all the times that the same event needs to be scheduled. This is in compliance with the possibility of the same event being scheduled at multiple times on the calendar in the same instance. The schedule timings are recorded in UTC format, to align with the LAICE mission timing specifications. This information is then converted in date time format for further processing. The instrument mode data along with the duration for which they are scheduled are then sent to *calendarUpdate.py* and *processor.py* in its correct format.

The web page launcher connects to the Virginia Tech and UIUC databases. To gain entry the user must specify the correct login credentials of the database. This database will be launched on the server at port 3306 until specified otherwise. Specific connections are made to the tables where the data need to be written or read. This software layer ensures that the data written in to the database (DB) are in the right format to avoid errors. At the same

time, it formats the data queried from the DB to be passed to the UI.

3.2.2 Schedule title generator

Once the user submits the form, a 96 or 96*2 bit uplink sequence is generated by the *uplink command generator*. Each bit directly represents the state of the instrument. It would be impossible for the user to comprehend the uplink command by looking at this binary structure, so a unique naming convention is used to represent the different modes defined by the uplink command. Figure 2.12 represents this naming convention. The *calendarUpdate.py* module generates the mode titles automatically once the user submits the form. The flowchart for this software is depicted in Figure 3.2. The STG receives the required data from the web page launcher (app.py). It checks if the LIIB would work in the 'Normal' mode. Then the opmode of the instrument is found. Depending on the instrument that is turned ON, detailed mode specifications of each of those instruments are found and a string in the format *RnnLnnSnn* is written in to the database. If not, then the 'Thermal Knife' mode name is written in the database as the schedule title. The title is stored in the *calendar* table in an archive of all the uplink schedules. The Virginia Tech database consists of this table *calendar* which stores the schedule start time, end time, title for the schedule and other related information. The *calendar* table is called to retrieve the past history of all the uplinks and display it in the calendar view of the GUI, in response to the user input.

3.2.3 Uplink command generator

The uplink command generator *processor.py* takes as input the list of all the instrument mode selections for one of the scheduled instants and the schedule time. It then generates an appropriate 96 bit or 2*96-bit uplink command. The algorithm it uses to achieve this is represented by the flowcharts depicted in Figures 3.3, 3.4, and 3.6.

If the *opmode* selected by the user in the GUI is *Standby* then a 96-bit binary representation is returned. The bits representing the three instruments are all set to zero, indicating that they are powered OFF. The LIIB mode is represented by a selection made by the user. If

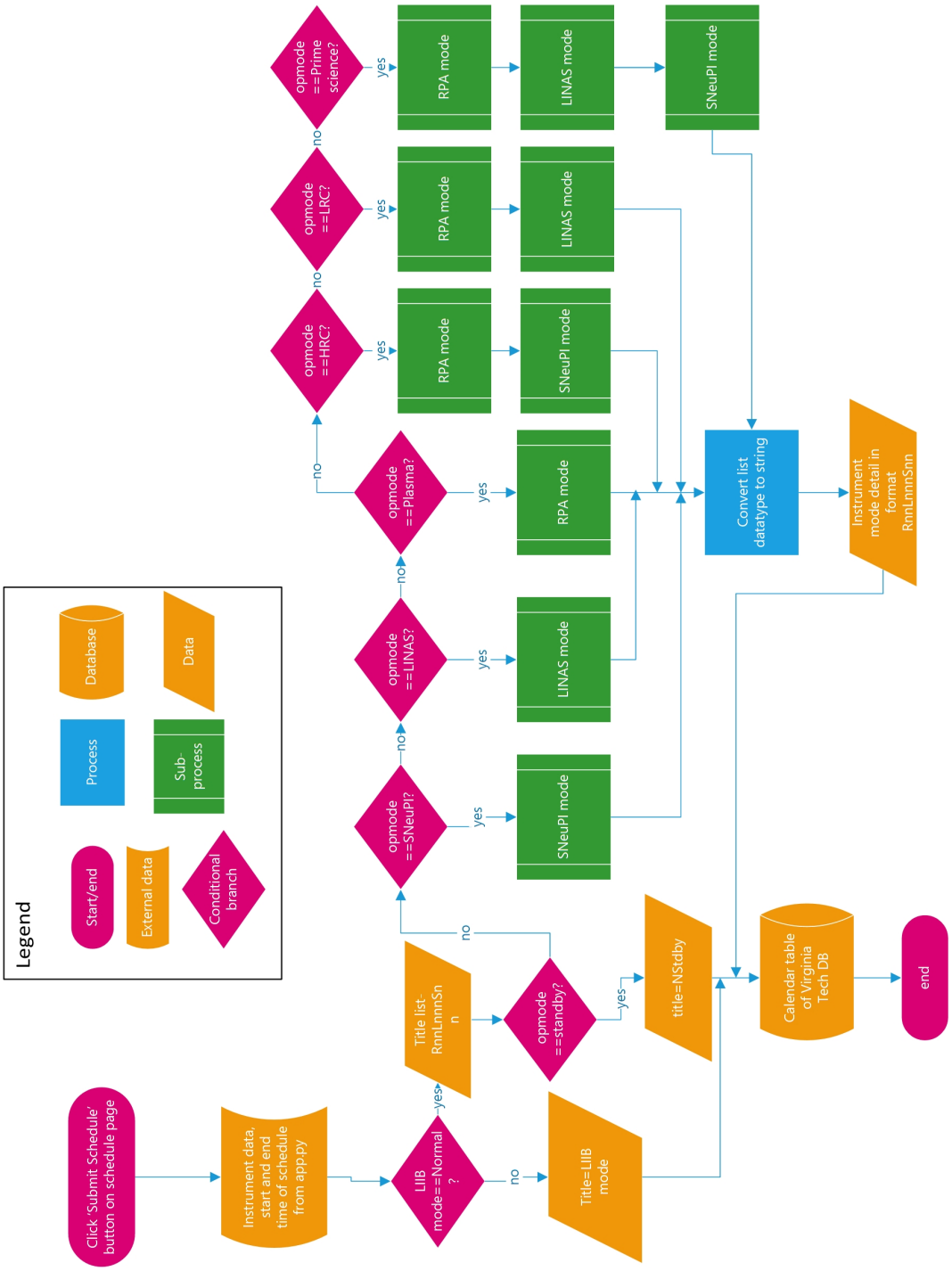

Figure 3.2: **Flowchart of schedule title generator.** The flowchart represents the algorithm that generates the title for the uplink which contains a condensed version of its instrument mode details. The sub process for each of the instrument modes depicts the mode representation obtained from Figure 2.12. LIIB mode definitions will be found in appendix D.

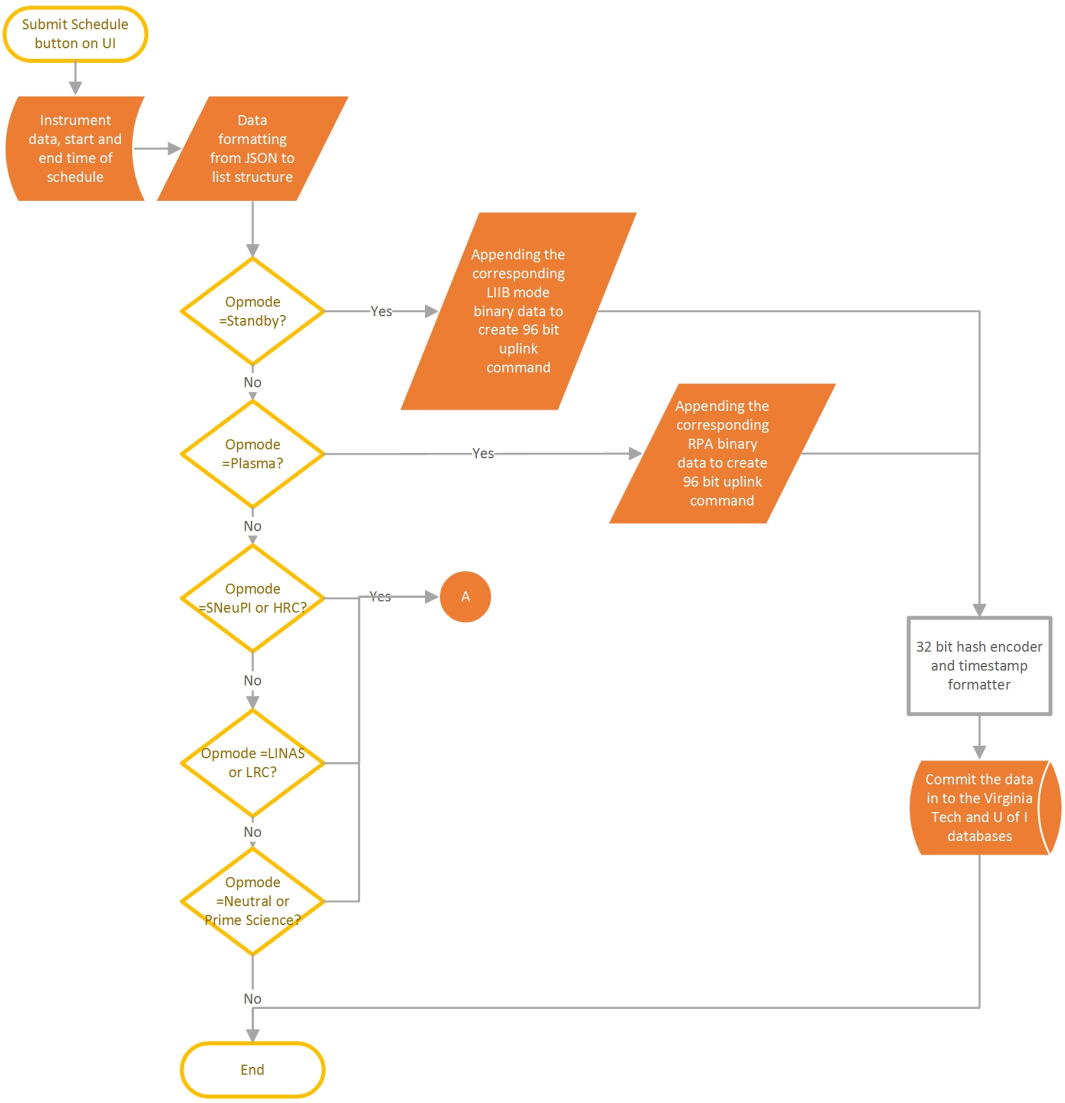

Figure 3.3: **Flowchart of uplink command generator(1).** The flowchart represents the algorithm to generate the uplink that needs to be scheduled. The sequence followed by the control code when the opmode is *Plasma* or *Standby* has been depicted in this figure. *Node A* represents the code flow when either SNeuPI or LINAS are powered ON. This is represented in Figure 3.4.

the *opmode* is selected to be *Plasma*, a 96-bit representation with the RPA bits representing the settings selected by the user is returned. The bits representing SNeuPI and LINAS are all set to zero. This is represented in Figure 3.3.

When the *opmode* turns SNeuPI or LINAS ON, the uplink sequence that is returned gets

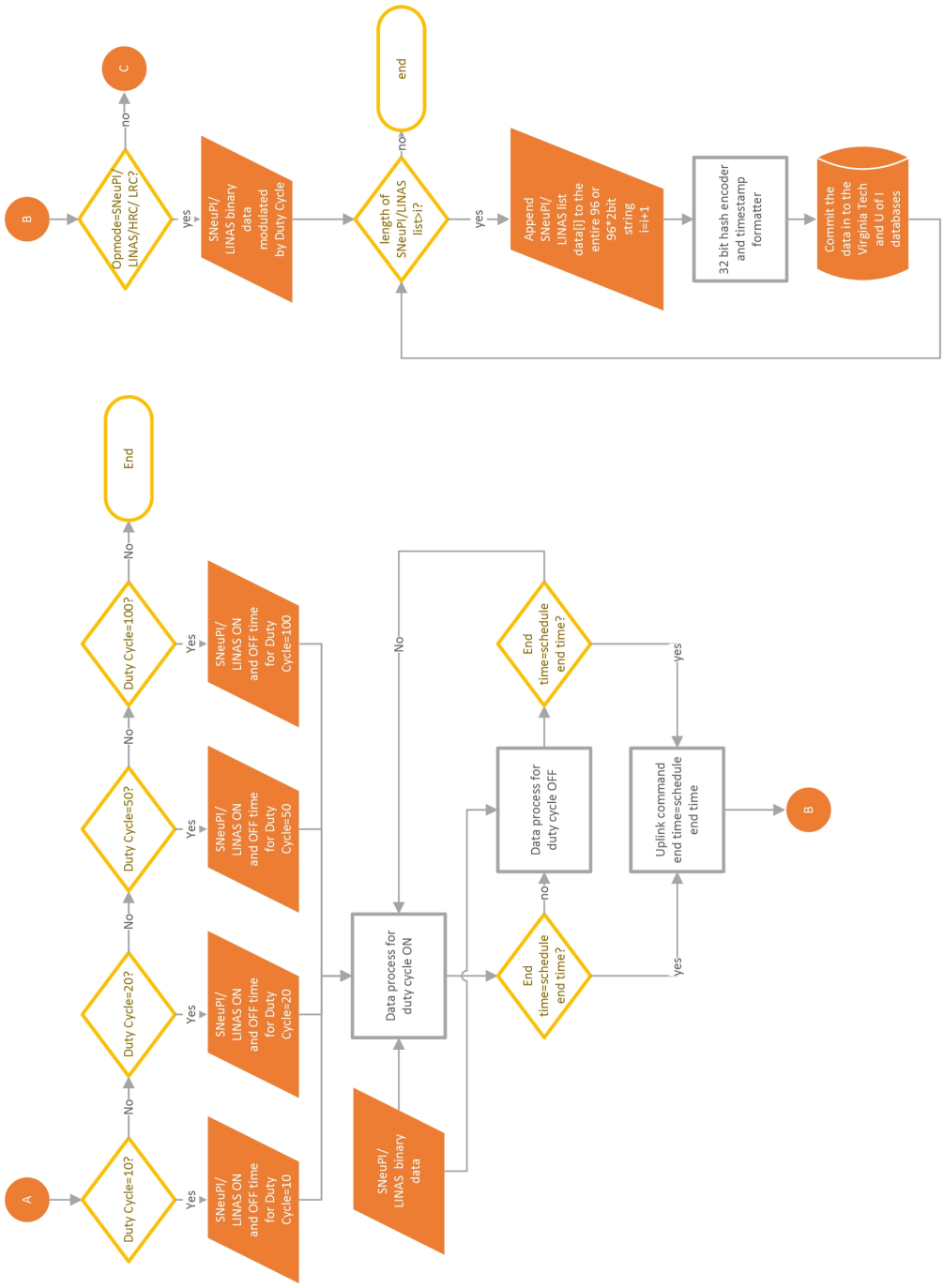

Figure 3.4: **Flowchart of uplink command generator(2).** The flowchart represents the algorithm to generate the SNeuPI and LINAS command bits in the uplink schedule depending on their duty cycling. These uplink command schedules along with their schedule timings are saved in three arrays respectively. These are used to create the 96 or 2*96 bit uplink command schedule. *Node B* in this figure represents the flow of the algorithm to accommodate the frequency modulated uplink command schedules due to the duty cycling. If only SNeuPI or LINAS are ON at a given time, the number of uplink commands scheduled is directly proportional to the length of their 'array'. However if both are ON at the same time then the control code is as depicted in Figure 3.6.

more complicated, because of the more complex duty cycle at which these instruments need to operate. Depending on the instrument settings and the duty cycle multiple uplink commands are generated for a single schedule selected by the user on the GUI. These uplink commands are 96 or 2*96 bits long, depending on the instrument mode specifications. This is represented in Figure 3.4. The uplink command sequences for each of the three instruments are generated separately and appended in the end. As represented in Figure 3.4 for SNeuPI and LINAS, the duty cycles for these instruments are associated with specific ON/OFF intervals over a predefined amount of time. Table 3.1 represents the ON and OFF timings for the two instruments.

Duty cycling:

Duty cycling of LINAS and SNeuPI is defined in Table 3.1. Duty cycling of LINAS decreases the total power drawn by this instrument during the course of this mission, which is important since the LINAS ion gauge is not power efficient and the battery state of charge aboard the spacecraft must be closely monitored. The filaments in LINAS create a huge power demand. Keeping that in mind, the duty cycling of LAICE is set such that LINAS can be operated with a short ON duration. Similarly, the duty cycling of SNeuPI is set so that the power drawn by the instrument can be decreased. Since SNeuPI takes a minimum of 15 minutes to start operating at a high voltage (ramp up), the duty cycle ON time of the instrument is always more than 15 minutes. So the net effect of duty cycling is to conserve the satellite battery, at the expense of reduced satellite data.

The resulting uplink command sequence due to the duty cycle is discussed below.

Description of LINAS and SNeuPI command sequence including duty cycling effect:

SNeuPI generates two uplink sequences in its duty cycle ON time. This represents the ramp up time when the instrument is powered ON and the actual instrument mode settings as indicated by the user in the GUI. The duty cycle OFF is represented by a single uplink command sequence. The start, end time and the uplink command sequence for the entire

Table 3.1: **Duty cycle of the instruments.** The table defines the duty cycling of LINAS and SNeuPI for their scheduled interval.

Instrument	**Duty Cycle**	**ON Time(mins)**	**OFF Time(mins)**
LINAS	10	3	27
	20	6	24
	50	15	15
	100	All the time	0
SNeuPI	10	18	162
	20	36	144
	50	90	90
	100	All the time	0

schedule duration are stored in arrays. A similar control code flow is followed when LINAS is powered ON. However, LINAS has three uplink commands in its duty cycle ON state. The first command is when the LINAS filament is turned OFF and housekeeping data are collected. The second command represents the transition to the filament ARM state, and the third command represents the instrument RUN state. This is represented with an example in Figure 3.5.

The number of uplink commands in a single schedule selection on the GUI is determined by the length of the arrays that store the LINAS or SNeuPI commands. Three arrays are created for SNeuPI and LINAS, respectively to store the individual uplink command sequence, its start time and end time. Since RPA does not have a specific duty cycling seclection, it does not generate different uplink commands for a single schedule mode specified by the UI. The 40 bits representing the RPA will simply be appended to the uplink command schedules discussed below. This example ignores the commanding state of RPA.

As shown in the first table in Figure 3.5, the code generates three uplink commands if SNeuPI is powered ON at a duty cycle of 10 percent and LINAS remains OFF for a schedule time of 1 hour in the SNeuPI arrays. The final 96-bit command structure is created by appending the SNeuPI data to it. The 40 bits representing the RPA data in the 96-bit string are either all zeros or correspond to the user's selections if the instrument is ON. The 24 bits of LINAS

will be all zeros in this case. The three uplink schedules that are generated in this example are on account of SNeuPI's ramp up and duty cycling. In the Table, iS refers to the index of SNeuPI commands, which represents 3 commands in this case. The startS[ ] and endS[ ] denote the timing for these three commands, while aS[ ] represents the SNeuPI (16 bit) representation of the three commands. A first 96 bit command sequence denotes the first four seconds in which the *emission mode* of SNeuPI is OFF and its *High Voltage (HV)* is OFF. The next command is a 96-bit command string representing the emission mode ('XX' represents any of the valid emission mode inputs) of SNeuPI and its HV being ON. However, if the emission mode is *sweep mode*, this command would be a 2*96 bit command sequence. The third command sequence representing the DC OFF time is when HV=0 and emission is also turned OFF.

In the second table, LINAS is ON while SNeuPI is OFF. Here, jL represents the index for the number of LINAS commands, startL[ ] and endL[ ] represent the time for which the command needs to operate on LIIB and aL[ ] represents 24 bits of the LINAS representation of the 96 bit command sequence. In this example, the duty cycling for LINAS is assumed to be 10 percent. Here, three uplink commands symbolize the DC ON state while one command represents the DC OFF state. The first command is a 96-bit string with filament turned OFF for two seconds. The second command is a 2*96-bit string with the filament in the ARM state in the first second of this command and being in the RUN state in the next second. The third command is a 96-bit sequence with the filament being in the RUN state. The DC OFF command is with filament in the OFF state for the entire DC OFF duration. This sequence of commands will be repeated till the schedule time comes to an end.

Table three in Figure 3.5 depicts the duty cycle modulation when both SNeuPI and LINAS are powered ON. This duty cycle modulation is explained below.

When both LINAS and SNeuPI are powered ON (as in the *Neutral* or *Prime Science* mode), the frequency at which the two instruments duty cycle needs to be taken in to account before creating the final schedule. This is represented in the flowchart in Figure 3.6. Figure 3.5

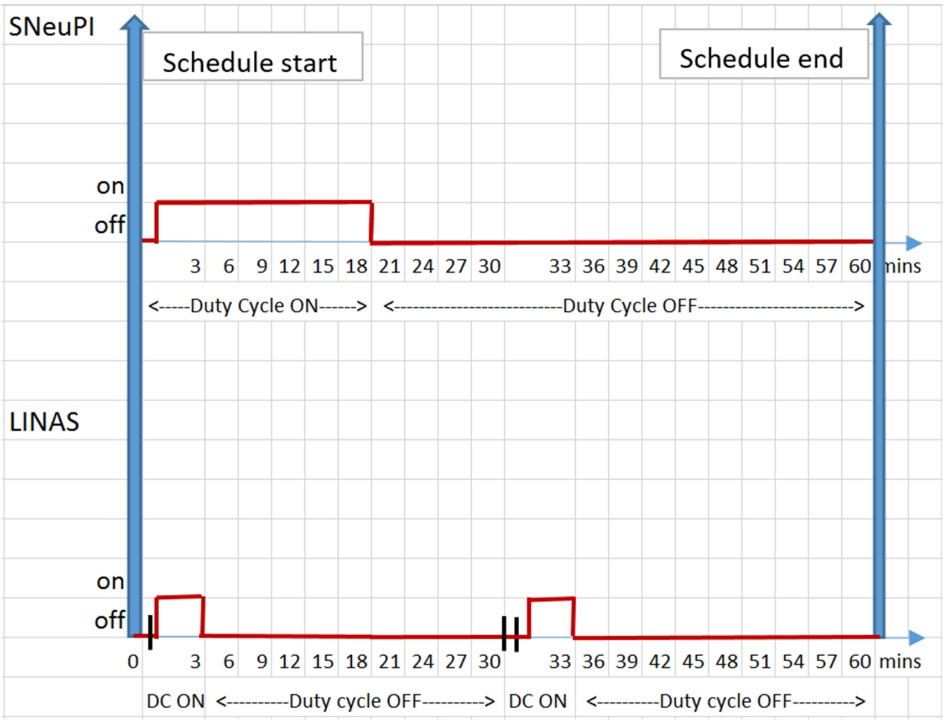

Figure 3.5: **Example of duty cycle modulation of uplink command generator.** The example shows the uplink sequence generated by LINAS and SNeuPI when scheduled over a 60-minute interval at a duty cycle of 10 percent. It also shows the values stored in the lists when either of the two instruments are powered ON or both are powered ON together.

shows this frequency modulation of the uplink command schedule with an example. Here both SNeuPI and LINAS are turned ON and the state of RPA does not affect the schedule time. The schedule time arrays of LINAS and SNeuPI are compared. The stop time of the uplink schedule will be that of the instrument with the *earlier* end time, and the start time will be the *later* start time specified for either of the two instruments. The schedule times form a breakpoint at which new uplink schedules are generated with their appropriate instrument command sequence. This is to ensure the schedules for all the instruments are included in the final sequence. For example, if SNeuPI has two uplink commands in the same time duration in which LINAS has one uplink command, the final sequence would be of two commands with the time duration of the schedule reflecting that of SNeuPI. The uplink schedules are generated untill all the instrument commands stored in the array data structure for each of the instruments are included in the final uplink schedule.

LIIB one second delay during instrument power ON:

One of the specifications of the uplink command generator states that the first second of a new uplink schedule needs to be redundant. This is because the LIIB requires one second for its instrument power ON sequencing. Thus the uplink command sequence needs to be fail safe against an important command being missed by LIIB at this time. A buffer is therefore inserted in every uplink command sequence, where the first command sequence is repeated twice.

Format of the uplink schedule to UIUC:

Once the 96 or 2*96-bit command sequence and the duration it will be ON is computed, the information is stored in the UIUC and Virginia Tech databases. However, the uplink command schedule represented in the UIUC database needs to be in a format specified by the UIUC team. The entire schedule needs to be represented as a 32-bit unsigned unique integer (refer to the hash function explanation below for more details). The start and end times for this uplink schedule need to be specified in seconds from the epoch time of Linux, 00:00:00 UTC, Thursday, 1 January 1970.

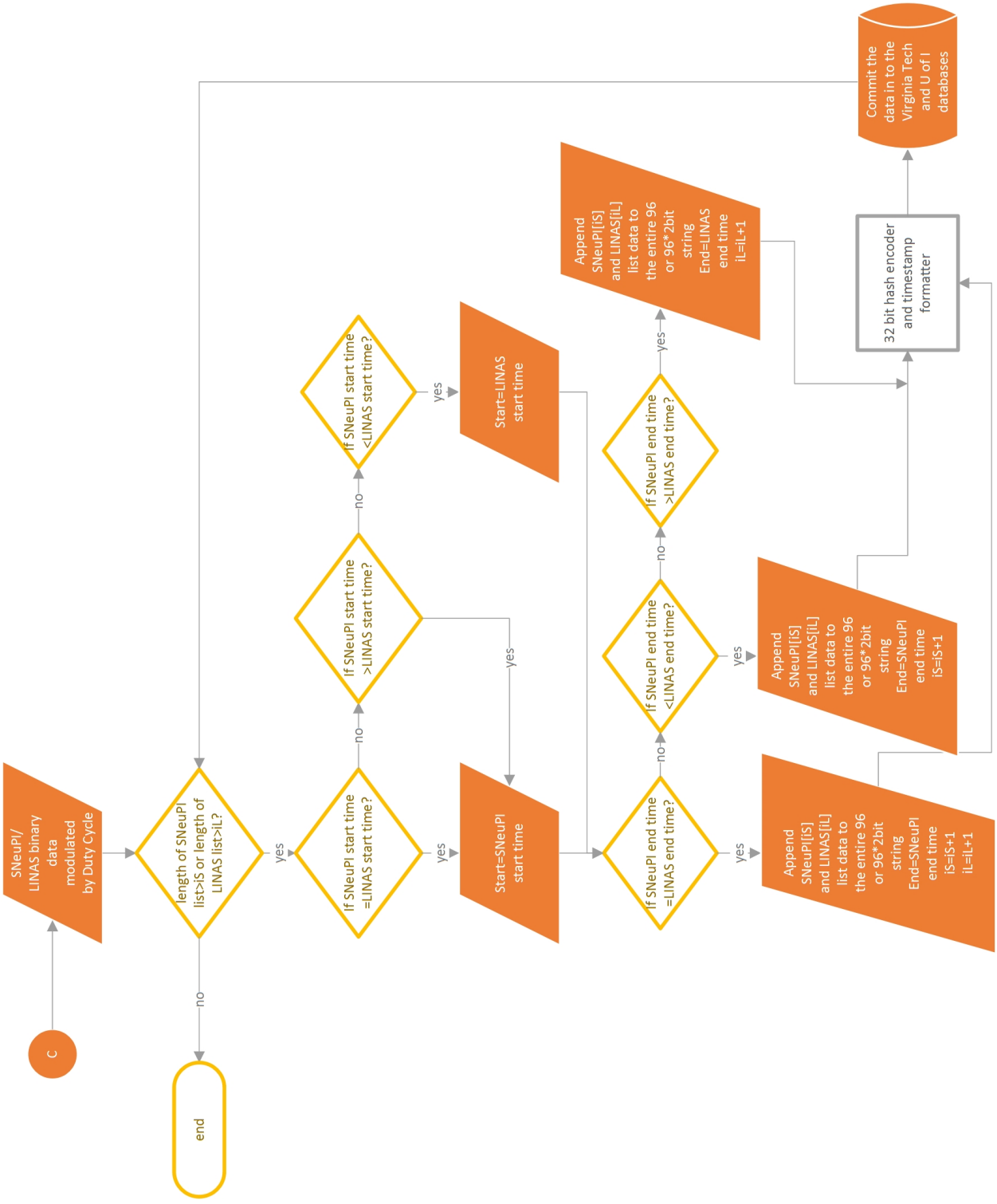

Figure 3.6: **Flowchart of uplink command generator(3).** The flowchart represents the algorithm to generate the uplink schedule taking the frequency modulation due to LINAS and SNeuPI in to consideration. The entry point C shown in the flowchart is depicted in the flowchart represented in Figure 3.4.

Conversion of the 96 or 2*96-bit uplink schedule to 32 bit mode ID:

UIUC requires the uplink command bit sequence to be represented by a 32-bit unsigned integer mode ID. We could use a simple look up table that assigns a mode ID for each of the 1545 defined modes. This would require a smaller integer to represent all the modes, but would make the process inefficient because the look-up table would have to be iterated every time a new mode is generated. Instead, we use a well-defined mathematical function to compute the mode ID directly when the 96 or a 2*96-bit sequence is given as an input to it. This mathematical function is known as the hash function. It takes a 96 or a 2*96-bit sequence as an input and generates a 32-bit unsigned integer as an output. The hash function used determines the length of the output. To determine the smallest possible length of the mode ID that could be used, CRC-16 (https://pypi.python.org/pypi/crc16/0.1.1) and CRC-32(https://docs.python.org/2/library/binascii.html) were the two hash functions used to generate a 16-bit and 32-bit output respectively. A number of clashes were observed when CRC-16 was used as represented in Figure 3.7. That means more than one 96 or 96*2-bit uplink command sequence had the same mode ID representation. One would assume that a 16-bit unsigned integer would be sufficient to represent the 1545 possible uplink modes since the 16-bit ID can represent 65535 values. But this was proved otherwise. This is in confluence with the birthday paradox theory (Shoup, 2005). The theory states that the probability of two children in a small class having the same birthday is very high.

It is a hard requirement that the mode ID be unique for each of the uplink command sequences. There are almost 70 clashes in this application when CRC-16 is used and zero clashes when CRC-32 is used. Thus CRC-32 is used as the hash function to generate a 32-bit unique mode ID.

Chapter summary:

This chapter discusses the workings of the web-application launcher, automatic schedule name generator and the uplink command sequence generator in detail. It also details the specific duty cycling of the instruments and resulting 96 or 2*96 uplink command sequence.

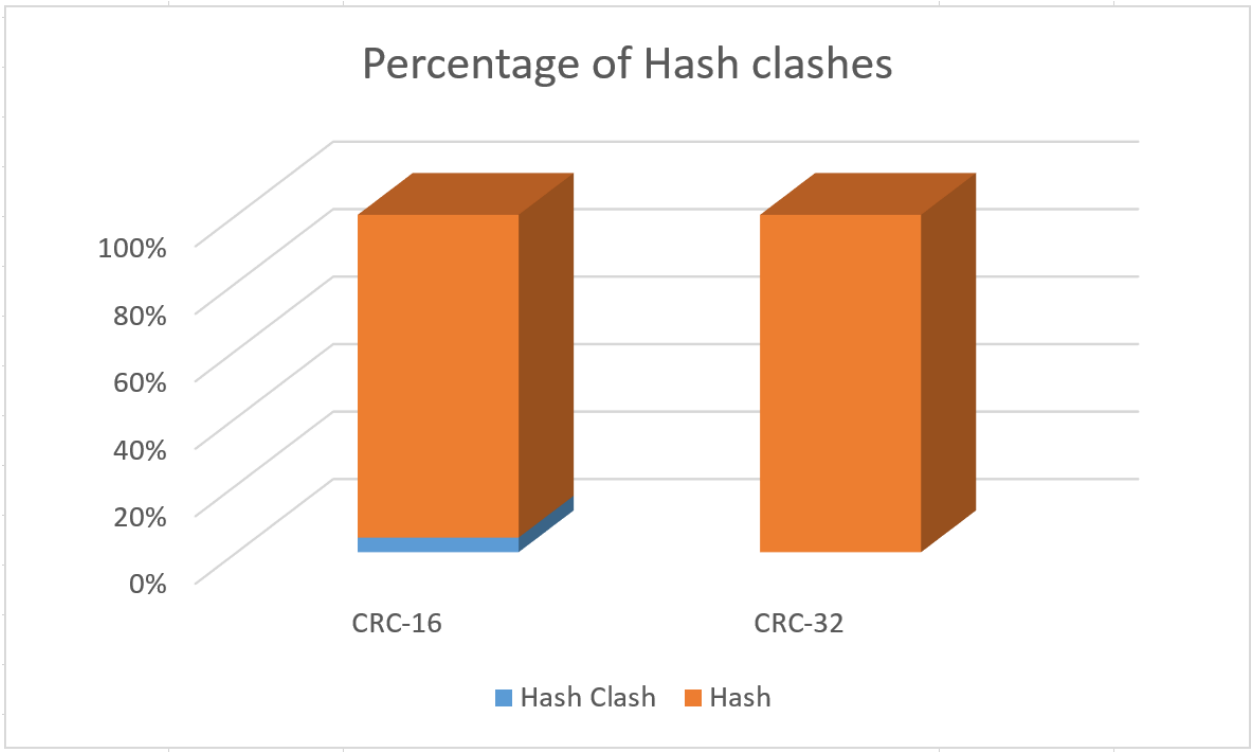

Figure 3.7: **Bar graph of percentage of hash clashes.** The percentage of hash clashes when CRC-16 and CRC-32 are used.

It explores the hash generator that converts this sequence into a specific 32-bit unique ID. This forms the backend of GUCCI. The next chapter examines the database used to store and later process the Virginia Tech payload schedule.

Chapter 4

Database

A relational database is used for storing the uplink schedule information. Whenever the user submits the schedule on the UI, a connection is created between the web launcher *app.py* and the database. This is done using the SQLAlchemy (http://flask-sqlalchemy.pocoo.org/2.1/) plugin of Flask. For security the login credentials to the database need to be specified to open a secure connection. This database executes on port 3306 until specified otherwise. The Virginia Tech database design is discussed below.

4.1 Virginia Tech Database

The Virginia Tech database has *tables* to store the uplink schedule information. The *U of I* table consists of the start and end time of the schedule in seconds and the 32 bit unsigned integer as mode ID. The table specifications are as shown in Figure 4.1. An example of a table with collected values is shown in Figure 4.2. The *administrator* has access to this table. Users with other access privileges will have a similar table to store their temporary schedules. A copy of this U of I table is provided for each user.

The second table in the database is the calendar table which maintains a history of all the previous schedules sent to U of I. This is useful in displaying all the current and previous

Column Name	Datatype	PK	NN	UQ	B	UN	ZF	AI	G	Default/Expression
id	INT(11)	☑	☑	☑	☐	☐	☐	☑	☐	
startTime	INT(4)	☐	☑	☐	☐	☑	☐	☐	☐	
endTime	INT(4)	☐	☑	☐	☐	☑	☐	☐	☐	
instrumentCommand	INT(4)	☐	☑	☐	☐	☑	☐	☐	☐	
		☐	☐	☐	☐	☐	☐	☐	☐	

Figure 4.1: **Uplink schedule table** The table represents the format of the various columns in the uplink schedule table and their properties. The data type for all the columns is integer and the values specified in the braces is the size of the integer in bytes. PK: Primary Key, NN: Not Null, UQ: Unique Index, B: Binary column, UN: Unsigned datatype and AI: Auto Increment.

id	startTime	endTime	instrumentCommand
2	1459987200	1460073600	1118074860
3	1460419200	1460505600	2308061640
4	1461196800	1461283200	604232948
5	1460937600	1460937602	822589472
6	1460937602	1460937604	1893535533
7	1460937604	1460937780	3178421713
8	1460937780	1460938680	693200192
9	1460938680	1460939400	822589472

Figure 4.2: **Uplink schedule table with sample data** Here the *startTime* and *endTime* represent the duration a mode will run in seconds from the time of epoch. The mode is represented in the *instrumentCommand* column.

schedules on the calendar view on the UI. Figure 4.3 represents the format of the data being stored in the table. A sample data set of this table is represented in Figure 4.4.

4.2 Connection of application with the database

The connection to the database is established in the web-launcher file *app.py*. Here, the login credentials of the database are mentioned to open a secure connection on port 3306 on the IP address as defined in the database. MySQL is the relational database used for this application. Create, read, update and delete the data are the four basic functions of the application. Before manipulating the data on any of the tables, each column in the table needs to be defined. Checks are placed in the system to ensure that no erroneous data are written to the database. The uplink schedule information in an unprocessed form from the

Column Name	Datatype	PK	NN	UQ	B	UN	ZF	AI	G	Default/Expression
id	INT(11)	☑	☑	☑	☐	☐	☐	☑	☐	
startTime	VARCHAR(25)	☐	☑	☐	☐	☐	☐	☐	☐	
endTime	VARCHAR(25)	☐	☑	☐	☐	☐	☐	☐	☐	
title	VARCHAR(15)	☐	☑	☐	☐	☐	☐	☐	☐	
allDay	VARCHAR(5)	☐	☐	☐	☐	☐	☐	☐	☐	'False'
className	VARCHAR(5)	☐	☑	☐	☐	☐	☐	☐	☐	
		☐	☐	☐	☐	☐	☐	☐	☐	

Figure 4.3: **History of the uplink schedule** The table represents the format of the various columns in the uplink schedule table and their properties. The data type for all the columns is integer or a character and the values specified in the braces are the size of the datatype in bytes. PK: Primary Key, NN: Not Null, UQ: Unique Index, B: Binary column, UN: Unsigned datatype and AI: Auto Increment. If no value is entered in the specified column, then it is the default value.

id	startTime	endTime	title	allDay	className
6	2016-04-07T00:00:00.000Z	2016-04-08T00:00:00.000Z	NStdby	True	old
7	2016-04-12T00:00:00.000Z	2016-04-13T00:00:00.000Z	TK1C	True	old
8	2016-04-21T00:00:00.000Z	2016-04-22T00:00:00.000Z	RlaLnnnSnn	True	old
9	2016-04-18T00:00:00.000Z	2016-04-19T00:00:00.000Z	RcrL10s1S10s	True	old
10	2016-05-04T00:00:00.000Z	2016-05-05T00:00:00.000Z	RcaL10s1S10s	True	old
NULL	NULL	NULL	NULL	NULL	NULL

Figure 4.4: **Sample data of the history of the schedule** Here the *startTime* and *endTime* represent the duration a mode will run in seconds from the time of epoch. The *title* represents the uplink schedule in human readable format. This is in reference to the STG discussed in chapter 3. Column *className* is set to 'old' if they have already been scheduled.

UI is stored in the database. Also, the final uplink sequence obtained from the UCG that needs to be sent to the flight control is written to this database.

Chapter summary:

The database provides a succinct yet detailed description of all the commands sent to UIUC for uplink to the LAICE satellite, along with the times in which they are valid. This will allow experimenters to unambiguously determine the state of the instruments versus time, which is crucial information when analyzing scientific and satellite state-of-health data. For example, if the battery charge state is ever driven to critical levels, it will be important to review the string of satellite commands leading up to this condition so that it can be avoided in the future. Similarly, the database may be consulted to identify modes of operation that

cause interference between satellite subsystems.

Chapter 5

Expander

The UIUC team is responsible for uploading the uplink schedule to the flight computer on the CubeSat. This schedule specifies the mode in which the LIIB should operate for a particular time. This mode is represented as a 32-bit unsigned integer, and the start and stop times are denoted as the number of seconds from the epoch time. The LIIB needs a 96-bit command sequence sent to it every second, so each 32-bit mode ID needs to be expanded to its correct 96-bit representation and scheduled on the LIIB at the predetermined time. Figure 5.1 depicts the role of the *expander* in the flight computer. The process of converting this uplink schedule to a 96-bit command sequence is explained below.

The uplink command that needs to be scheduled on the LIIB is sent from the ground station to the LAICE flight control center. The flight control software has a block called the *scheduler* which is responsible for sending the right schedule command to the software block *command handler* based on its internal clock.

An example to understand the data processing on the flight computer:

Let us assume that the internal clock on the flight computer shows the time to be 1st April 2017, 8am UTC and there is an uplink command with mode 573059563 to be scheduled from 1st April 2017, 8am UTC to the 2nd April 2017, 8am UTC in the schedule list. The *scheduler*

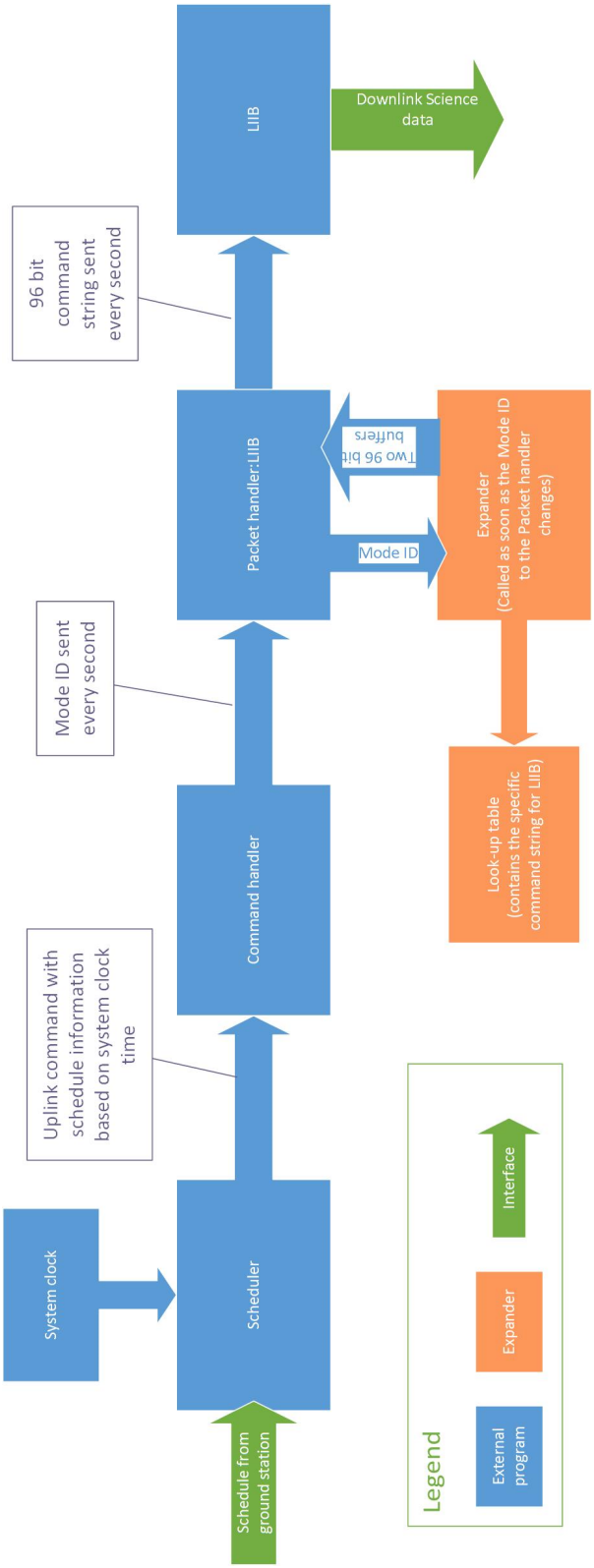

Figure 5.1: **Block diagram depicting the role of the *expander* in the flight computer on LAICE.** The block diagram shows how the uplink command is being scheduled on the LIIB with the help of the *expander*.

will send the command with the start time matching its internal clock to the *command handler*. Here the *command handler* will continue sending Mode 573059563 to the *payload handler* block every second until it receives a new uplink command from the *scheduler*. The *payload handler* in turn is responsible for sending a 96 bit command string to the LIIB every second. The payload handler calls the *expander* to care of this.

The *expander* is called every time the input to the *payload handler* changes. It takes the 32-bit mode ID as an input and processes it to create *two* 96-bit command uplink sequences that will be alternately and sequentially sent to the LIIB. The design of the *expander* is explained below.

Every time the code reaches a corner case,i.e. when the lookup table file is not found or the mode that is sent to the expander is not present in the lookup table, specific error messages are written in the *system log* file. This file will be sent to the ground station and appropriate error correction methods can be deployed based on the error messages.

The *expander* reads the 32-bit unsigned integer as the input and generates an expanded uplink sequence from the look up table. The look up table is a comma-separated file with the mode ID and its bit representation for all the 1545 modes. The *expander* uses a lookup table to generate a 96 or a 96*2 bit string as an output for every new mode ID given to it as an input. Here, the mode ID can correspond to two separate uplink commands to the LIIB (alternating every second) or a single 96-bit uplink command that continues until the mode is changed. The *expander* writes to two buffers which are read by the *payload handler*. The *payload handler* sends the data written in the two buffers alternatingly to the LIIB every second. So if the Mode 573059563 corresponds to a 96-bit command sequence then this 96-bit command sequence would be copied in both the buffers. However, if it corresponds to 2*96-bit command sequence then the first 96-bit command would be written in *buffer one* and the next 96-bit command would be written in *buffer two*. Figure 5.2 represents the flowchart of the *expander* software.

Chapter summary:

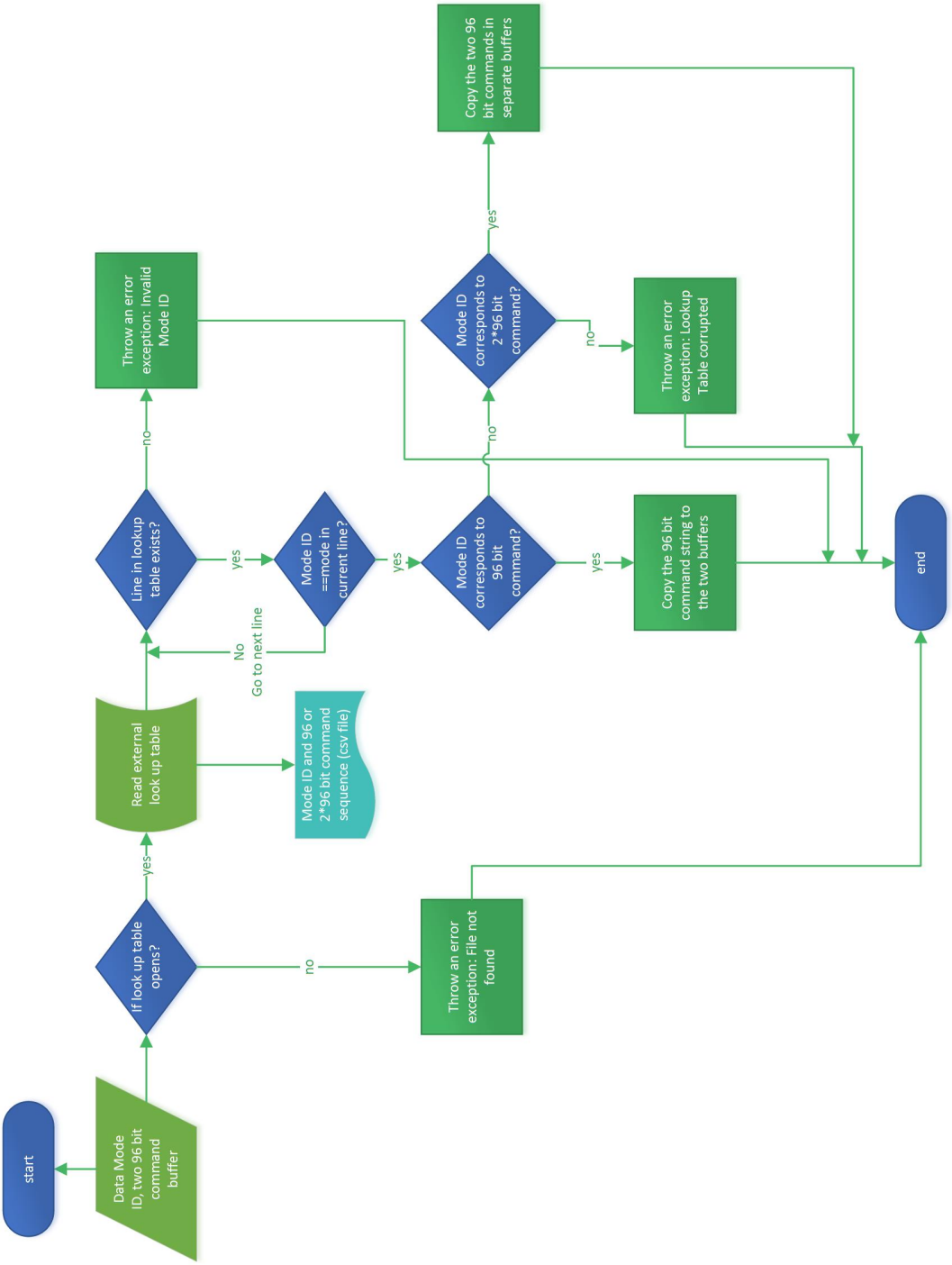

Figure 5.2: **Flow chart of *expander* software.** The working of the*expander* to generate a correct uplink command to the LIIB is represented in this flow chart. Corner cases are handled by sending appropriate error messages in the log file.

The uplink received by the LAICE satellite is a 32-bit unsigned integer with its schedule start and stop timings. The LIIB however requires a 96-bit command sequence every second. This conversion is provided by the *expander*. This chapter discusses the *expander* that will switch to a default mode if it encounters problems. Also, the specific error messages that will be sent back to the ground station to help figure out the problem the software faced. The next chapter discusses all the specifications that were met by GUCCI.

Chapter 6

Conclusion

This thesis presents the web-application designed for the uplink scheduling process to the LAICE CubeSat. The main goals were to make the process simple, intuitive and error free. This application complies with the specifications listed in Table 6.1 and helps ensure that no error is introduced in the schedule. GUCCI forms the foundation for any CubeSat project and is flexible to changes.

A comprehensive view of all the specifications met by the software package is given in Table 6.1.

Specification	**Sub-sections**	**Status**	**Details**
An intuitive GUI.	Multiple users with specific access privileges. Graphical calendar for scheduling decisions. Error check mechanism.	✓	Chapter 2
A launcher for the web-based UI.	A web-based user interface launched on the operation center's IP address. A secure web GUI.	✓	Chapter 3
Calendar view with schedule history.		✓	Chapter 3
Automated title generator for schedule in calendar view.		✓	Chapter 3
An uplink schedule generator.	Data processing software to comply with the format required for communication with MOC at UIUC. A mode specification handler for each instrument.	✓	Chapter 3
A relational database to store the uplink command schedule.	A link between the ground station software and the Virginia Tech and UIUC DB. A software layer to ensure the correct format for the data being written in to the DB.	✓	Chapter 4
An *expander* to generate a two command sequences to be sent to the LIIB from flight computer at a cadence of one second.	A look-up table. Comply to UIUC specifications. Unit tests and logger statements to make code flight-ready.	✓	Chapter 5

Table 6.1: **Specification table for ground station uplink software.** The table outlines the main and the sub-specifications of GUCCI and the status of completion of these specifications. It also mentions the section of the thesis that contains more details about the same.

Chapter 7

Future Work

There are a number of tasks that can be performed to make the system even more useful. For instance:

1. Interface this software with the energy management utility (EMU) tool to better evaluate the uplink command being scheduled on LIIB;
2. Test the functionality of GUCCI by interfacing to the LIIB hardware, once it is ready;
3. Investigate whether this uplink software can be integrated with a commercial product that is being evaluated for downlink communication and data processing.

These additional tasks will make GUCCI more useful and powerful, and will help it become the cornerstone for LAICE and future satellite projects.

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Appendix A

File Structure

The file structure for the ground station uplink software is explained below for reference. The main folder contains the following sub-sections:

–static

-js

-css

-font-awesome

-lib

–template

-home.html

-layout.html

-log.html

-profile.html

-signin.html

-signup.html

-schedule.html

–app.py

–calendarUpdate.py

–processor.py

The *app.py* is the main file that launches this web application on the IP address specified in it. It first launches the *signin.html* page to get the users credentials. The *home.html* and *schedule.html* pages are launched when the user enters the correct login credentials. Sub-folder *template* contains all the HTML web-pages. We can see the signed in users profile on the *profile.html* page. The administrator has access to the *log.html* and *signup.html* pages to keep track of suspicious sign-in attempts and signing up a new user respectively.

Sub-folder *static* contains all the folders that contain the libraries that add the functionality and appearance to the web-pages. The files in *css* and *font-awesome* are responsible for the appearance of the UI. The *js* and *lib* provides the web application with its functionality. Most of these are standard library plugins. However, the *stepform.js* is the custom made library developed to provide the web-application with its special functionality.

Once the user submits the schedule, the data are sent to the app.py file (back end) and further processed. *processor.py* is responsible for generating the 96 or 2*96-bit uplink command sequence and converting it into the right mode ID. *calendarUpdate* is responsible for creating the unique human readable schedule name for the calendar view.

The codes are discussed in Appendices B and C.

Appendix B

GUI Code Discussion

The codes for the GUI discussed in Chapter 2 are given here. *signin.html*, *home.html*, *signup.html*, *log.html* and *schedule.html* are the different web-pages of the application. The JavaScript file, *stepsFrm.js* is responsible for creating the discrete ordered step form. The functionality of the UI is dependent on this file. The main file *app.py* launches these files using the Flask framework.

```
<!--************************************home.html***********************************************-->
<!DOCTYPE html>
<html lang="en">

<head>

    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="description" content="">
    <meta name="author" content="">

    <title>LAICE- Ground Station Control</title>

    <!-- Bootstrap Core CSS -->
    <link href="../static/css/bootstrap.min.css" rel="stylesheet">

    <!-- Custom CSS -->
    <link href="../static/css/sb-admin.css" rel="stylesheet">

    <!-- Morris Charts CSS -->
    <link href="../static/css/plugins/morris.css" rel="stylesheet">

    <!-- Custom Fonts -->
    <link href="../static/font-awesome/css/font-awesome.min.css" rel="stylesheet" type="text/css">
 <link href="../static/css/demo.css" rel="stylesheet">
 <link href="../static/css/stepsForm.css" rel="stylesheet">
 <link rel='stylesheet' href='../static/lib/cupertino/jquery-ui.min.css' />
 <link href='../static/css/fullcalendar.css' rel='stylesheet' />
 <link href='../static/css/fullcalendar.print.css' rel='stylesheet' media='print' />
 <link href="../static/css/bootstrap-toggle.css" rel="stylesheet">

 <style>

  body {
   margin: 30px 12px;
   padding: 0;
   font-family: "Lucida Grande",Helvetica,Arial,Verdana,sans-serif;
   font-size: 13px;
  }

  #calendar {
   max-width: 750px;
   margin: 0 auto;
  }

 .fc-event-container {
  position: relative;
 }

 .closon {
  position: absolute;
  top: -2px;
  right: 0;
  cursor: pointer;
        background-color: #FFF
 }

 </style>
```

```
</head>

<body>

    <div id="wrapper">


        <!-- Navigation -->
        <nav class="navbar navbar-inverse navbar-fixed-top" role="navigation">
            <!-- Brand and toggle get grouped for better mobile display -->
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-ex1-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a class="navbar-brand" href="home">LAICE- Ground Station Control</a>
            </div>

            <ul class="nav navbar-top-links navbar-right" style="padding-right: 0.5cm; padding-top: 0.1cm;">
                <li class="dropdown">
                    <a class="dropdown-toggle" data-toggle="dropdown" href="#">
                        <i class=" fa fa-user fa-fw"></i>  <i class="fa fa-caret-down"></i>
                    </a>
                    <ul class="dropdown-menu dropdown-user">
                        <li><a href="/profile"><i class="fa fa-user fa-fw"></i> User Profile</a>
                        </li>
    {% if current_user.urole == 'admin' %}
                        <li>
    <a href="javascript:;"  data-toggle="collapse" data-target="#demo1"><i class="fa fa-gear fa-fw"></i> Settings <i
class="fa fa-fw fa-caret-down"></i></a></a>
                        <ul id="demo1" class="collapse ">
                       <li>
      <a href="/signup">Sign up new student</a>
                            </li>

                            <li>
                               <a href="/log">Sign in log</a>
                            </li>

                        </ul>

                        </li>

    {% endif %}
    <li class="divider"></li>
                        <li><a href="/signout"><i class="fa fa-sign-out fa-fw"></i> Signout</a>
                        </li>
                    </ul>
                    <!-- /.dropdown-user -->
                </li>
                <!-- /.dropdown -->
            </ul>
            <!-- /.navbar-top-links -->

            <!-- Sidebar Menu Items - These collapse to the responsive navigation menu on small screens -->
            <div class="collapse navbar-collapse navbar-ex1-collapse">
```

```
            <ul class="nav navbar-nav side-nav">

                <li>
                  <a href="javascript:;"  data-toggle="collapse" data-target="#demo"><i class="fa fa-fw fa-cloud-
upload"></i>  Uplink Schedule<i class="fa fa-fw fa-caret-down"></i></a></a>
                    <ul id="demo" class="collapse ">

                  <li>
       <a href="">Home</a>
                      </li>

                      <li>
                        <a href="schedule">Schedule</a>
                      </li>




                    </ul>


                </li>
    </ul>
          </div>
          <!-- /.navbar-collapse -->
        </nav>

        <div class="container">
        <!--STEPS FORM START ---------- -->
        <div class="stepsForm">
            <form role="form" method="post" action="scheduleUpload" id="myForm"  enctype="multipart/form-data">
                <div class="sf-steps">
                    <div class="sf-steps-content">
                      <div>
       <span>1</span> LIIB Mode
      </div>
      <div>
       <span>2</span> RPA
      </div>
      <div>
       <span>3</span>LINAS
      </div>
      <div>
       <span>4</span> SNeuPI
      </div>
      <div>
       <span>5</span> Schedule
      </div>



                </div>
            </div>
            <div class="sf-steps-form sf-radius">

                <ul class="sf-content"> <!-- form step one -->


     <div class="form-group">
      <label>LIIB Mode</label>
```

```
 <select  class="form-control" name="LIIBMode" id="LIIBMode" data-required="true" >
  <option value="" selected="selected" >Select the LIIB Mode</option>
  <option value="Normal">Normal Mode</option>
  <option value="TK1C">TK1 Charge</option>
  <option value="TK1D">TK1 Discharge</option>
  <option value="TK2C">TK2 Charge</option>
  <option value="TK2D">TK2 Discharge</option>
  <option value="TKO">TK Override</option>
 </select>
</div>
<div class="form-group">
 <label>OpMode</label>
 <select class="form-control" name="opmode" id="opmode" data-required="true">
  <option value="" selected="selected" >Select the Op Mode</option>
  <option value="Standby">Standby</option>
  <option value="SNeuPI">SNeuPI</option>
  <option value="LINAS">LINAS</option>
  <option value="Neutral">Neutral   (SNeuPI+LINAS) </option>
  <option value="Plasma">Plasma  (RPA)</option>
  <option value="HRC">High res correlation  (RPA+SNeuPI)</option>
  <option value="LRC">Low res correlation   (RPA+LINAS)</option>
  <option value="Prime Science">Prime Science   (RPA+LINAS+SNeuPI)</option>
 </select>
</div>

</ul>


<ul class="sf-content" id="RPA"> <!-- form step tree -->
 <div id="page-wrapper">
  <div class="row">
   <div class="col-lg-12">
    <div class="panel panel-default">
     <div class="panel-heading">
      RPA
     </div>
     <div class="panel-body">
      <div class="row">
       <div class="col-lg-6">



        <!--div class="form-group">
         <label>Duty Cycle</label>
         <select class="form-control">
          <option>10</option>
          <option>20</option>
          <option>50</option>
          <option>100</option>
         </select>
        </div-->
        <div class="form-group">
         <label>RG2 Mode</label>
         <select class="form-control" name="RG2Mode" id="RG2Mode" data-required="true">
          <option value="" selected="selected" >Select the RG2 Mode</option>
          <option>Linear Sweep</option>
          <option>Constant Value</option>
          <option>Smart Sweep</option>
         </select>
        </div>
```

```
            <!--div class="col-lg-6">// still need to put the data in backend
             <label>RG Voltage</label>
             <div class="center ">
              <div class="input-group center">
                  <span class="input-group-btn">
                   <button type="button" class="btn btn-default btn-number" disabled="disabled" data-type="minus" data-
field="quant[1]">
                  <span class="fa fa-minus-circle"></span>
                   </button>
                  </span>
                  <input type="text" name="quant[1]" class="form-control input-number" value="1" min="1" max="10">
                  <span class="input-group-btn">
                   <button type="button" class="btn btn-default btn-number" data-type="plus" data-field="quant[1]">
                  <span class="fa fa-plus-circle"></span>
                   </button>
                  </span>
              </div>
             </div>
            </div-->
            <div class="form-group">
             <label>Second Grid Setting</label>
             <select class="form-control" name="Second Grid Setting" id="SecondGridSetting" data-required="true">
              <option value="" selected="selected" >Select the second grid setting</option>
              <option>Aperture</option>
              <option>Retarding Grid</option>
             </select>
            </div>

            <div class="form-group">
             <label>Points per sweep</label>
             <select class="form-control" name="Points per sweep" data-required="true">
              <option disabled>32</option> <!-->DO NOT TOUCH TILL CONSIDERED<-->
              <option selected="selected">64</option>
              <option disabled>128</option><!-->DO NOT TOUCH TILL CONSIDERED<-->
             </select>
            </div>

           </div>
           <!-- /.col-lg-6 (nested) -->
          </div>
          <!-- /.row (nested) -->
         </div>
         <!-- /.panel-body -->
        </div>
        <!-- /.panel -->
       </div>
       <!-- /.col-lg-12 -->
      </div>
      <!-- /.row -->
     </div>
     <!-- /#page-wrapper -->

                 </ul>


    <ul class="sf-content" id="LINAS"> <!-- form step two -->
                    <div id="page-wrapper">
      <div class="row">
       <div class="col-lg-12">
```

```
        <div class="panel panel-default">
         <div class="panel-heading">
          LINAS
         </div>
         <div class="panel-body">
          <div class="row">
           <div class="col-lg-6">
            <div class="form-group">
             <label>Duty Cycle</label>
             <select class="form-control" name="Duty Cycle linas" id="DutyCyclelinas" data-required="true">
              <option value="" selected="selected" >Select the Duty Cycle</option>

              <option>10</option>
              <option>20</option>
              <option>50</option>
              <option>100</option>
             </select>
            </div>
            <div class="form-group">
             <label>Filament Selection(Main/Redundant)</label>
             <br>
             <input type="checkbox" name="Filament (Main/Redundant)" checked data-toggle="toggle" data-on="F1"
data-off="F2" value="1">
             <input type="hidden" name="Filament (Main/Redundant)"  data-toggle="toggle" data-on="F1" data-off="F2"
value="0">
             </div>
            <div class="form-group">
            <label>Collector Gain State</label>
            <select class="form-control" name="Collector Gain State" id="CollectorGainState" data-required="true">
             <option value="" selected="selected" >Select the Collector Gain State</option>
             <option>Switch Gain at 10^-5 Torr</option>
             <option>Low Pressure Sensitive</option>
             <option>High Pressure Sensitive</option>
            </select>
            </div>
            <div class="form-group">
            <label>Grid Bias Setting</label>
            <select class="form-control" name="Grid Bias Setting">
             <option disabled>0001</option>
             <option>0010</option>
             <option disabled>0011</option>
             <option disabled>0100</option>
             <option disabled>0101</option>
             <option disabled>0110</option>
             <option disabled>0111</option>
             <option disabled>1000</option>
            </select>
            </div>
           </div>
           <!-- /.col-lg-6 (nested) -->
          </div>
          <!-- /.row (nested) -->
         </div>
         <!-- /.panel-body -->
        </div>
        <!-- /.panel -->
       </div>
       <!-- /.col-lg-12 -->
      </div>
      <!-- /.row -->
```

```
 </div>
 <!-- /#page-wrapper -->

             </ul>

<ul class="sf-content" id="SNeuPI"> <!-- form step four -->
 <div id="page-wrapper">
  <div class="row">
   <div class="col-lg-12">
    <div class="panel panel-default">
     <div class="panel-heading">
      SNeuPI
     </div>
     <div class="panel-body">
      <div class="row">
       <div class="col-lg-6">

        <div class="form-group">
         <label>Duty Cycle</label>
         <select class="form-control" name="Duty Cycle Sneupi" id="DutyCycleSneupi" data-required="true">
          <option value="" selected="selected" >Select the Duty Cycle</option>

          <option>10</option>
          <option>20</option>
          <option>50</option>
          <option>100</option>
         </select>
        </div>


        <!--div class="form-group">
         <label>High Voltage ON/OFF</label>
         <br>
         <input type="checkbox" name="High Voltage ON/OFF" checked data-toggle="toggle" value="1">
         <input type="hidden" name="High Voltage ON/OFF"  data-toggle="toggle" value ="0">


        </div-->

        <div class="form-group">
         <label>SNeuPI Mode</label>
         <select class="form-control" name="SNeuPI Mode" id="SNeuPIMode" data-required="true">
          <option value="" selected="selected" >Select the SNeuPI Mode</option>

          <option>Sweep Emission</option>
          <option>Standby Mission Mode</option>
          <option>Emission Level A</option>
          <option>Emission Level C</option>
         </select>
        </div>

       </div>
       <!-- /.col-lg-6 (nested) -->
      </div>
      <!-- /.row (nested) -->
     </div>
     <!-- /.panel-body -->
    </div>
    <!-- /.panel -->
   </div>
```

```
      <!-- /.col-lg-12 -->
     </div>
     <!-- /.row -->
    </div>
    <!-- /#page-wrapper -->

   </ul>

   <ul class="sf-content"> <!-- form step five -->
   <div class="row">
   <div class="col-lg-12">
    <div class="panel panel-default">
     <div class="panel-body">

<button type="button" class="btn btn-primary btn-circle" data-toggle="modal" data-target="#myModal">
  <span title="Information"><i class="fa fa-info"></i></span>
</button>

<!-- Modal -->
<div class="modal fade" id="myModal" tabindex="-1" role="dialog" aria-labelledby="myModalLabel">
  <div class="modal-dialog" role="document" style="width:704px;height:628px;">
    <div class="modal-content">
      <div class="modal-header">
        <button type="button" class="close" data-dismiss="modal" aria-label="Close"><span aria-
hidden="true">&times;</span></button>
        <h4 class="modal-title" id="myModalLabel">Mode Title</h4>
      </div>
      <div class="modal-body text-center" >
        <img src="../static/modeName.jpg" alt="Mode Name" style="width:604px;height:428px;">
      </div>
      <div class="modal-footer">
        <button type="button" class="btn btn-default" data-dismiss="modal">Close</button>
        </div>
    </div>
  </div>
</div>
  <!--button type="button" class="btn btn-primary" data-dismiss="modal"><span title="Delete an existing
schedule.">Delete</span></button>
    <button type="button" class="btn btn-primary" data-dismiss="modal"><span title="Change the timing of an existing
schedule">Edit</span></button-->

        <div id='calendar'></div>
        <div class="form-group">
         <input type="hidden" id="eventdata"  name="eventdata" >


        </div>
       </div>
      </div>
     </div>
     <!-- /.col-lg-12 -->
    </div>
    <!-- /.row -->

     </ul>

            </div>
            <div class="row">

            <div class="sf-steps-navigation sf-align-right">
```

```
                <span id="sf-msg" class="sf-msg-error"></span>
                <button id="sf-prev" type="button" class="sf-button">Previous</button>
                  <button id="sf-next" type="button" class="sf-button">Next</button>
               </div>
    </div>
          </form>
        </div>
        <!--STEPS FORM END ---------- -->

    </div>


</div>
 <script>
 var globalEvent= {{ r|tojson|safe }};
 var safety=0;
 var newEventsFromCalendar = [];
 </script>
    <!-- jQuery -->
    <script src="../static/js/jquery.js"></script>

    <!-- Bootstrap Core JavaScript -->
    <script src="../static/js/bootstrap.min.js"></script>

    <!-- Morris Charts JavaScript -->
    <script src="../static/js/plugins/morris/raphael.min.js"></script>
    <script src="../static/js/plugins/morris/morris.min.js"></script>
    <script src="../static/js/plugins/morris/morris-data.js"></script>

    <!-- Flot Charts JavaScript -->
    <!--[if lte IE 8]><script src="js/excanvas.min.js"></script><![endif]-->
    <script src="../static/js/plugins/flot/jquery.flot.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.tooltip.min.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.resize.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.pie.js"></script>
    <script src="../static/js/plugins/flot/flot-data.js"></script>
 <script src="../static/js/jquery-2.1.1.min.js"></script>
 <script src='../static/lib/moment.min.js'></script>
 <script src='../static/js/fullcalendar.min.js'></script>
 <script src="../static/js/bootstrap-toggle.js"></script>
 <script src="../static/js/stepsForm.js"></script>
 <script>
$('#LIIBMode').change(function(e){
  if($(this).val() == "TK1C" || $(this).val() == "TK1D" || $(this).val() == "TK2C" ||$(this).val() == "TK2D" || $(this).val() ==
"TKO" ){
   alert("Thermal Knife mode!!");
   $("#opmode option[value='LINAS']").prop('disabled',true);
   $("#opmode option[value='SNeuPI']").prop('disabled',true);
   $("#opmode option[value='Neutral']").prop('disabled',true);
   $("#opmode option[value='Plasma']").prop('disabled',true);
   $("#opmode option[value='HRC']").prop('disabled',true);
   $("#opmode option[value='LRC']").prop('disabled',true);
   $("#opmode option[value='Prime Science']").prop('disabled',true);
  }
  else {
   $("#opmode option[value='LINAS']").prop('disabled',false);
   $("#opmode option[value='SNeuPI']").prop('disabled',false);
   $("#opmode option[value='Neutral']").prop('disabled',false);
   $("#opmode option[value='Plasma']").prop('disabled',false);
   $("#opmode option[value='HRC']").prop('disabled',false);
```

```
  $("#opmode option[value='LRC']").prop('disabled',false);
  $("#opmode option[value='Prime Science']").prop('disabled',false);
  }
 $("#opmode option[value='']").prop('selected', true);
 });

$('#opmode').change(function(e){

 $("#RG2Mode option[value='']").prop('selected', true);
 $("#SecondGridSetting option[value='']").prop('selected', true);
 $("#DutyCyclelinas option[value='']").prop('selected', true);
 $("#CollectorGainState option[value='']").prop('selected', true);
 $("#DutyCycleSneupi option[value='']").prop('selected', true);
 $("#SNeuPIMode option[value='']").prop('selected', true);
 if(document.getElementById("opmode").value == "Standby") {
  $("#RPA :input").attr("disabled", true);
  $("#LINAS :input").attr("disabled", true);
  $("#SNeuPI :input").attr("disabled", true);
   var length=document.getElementById("myForm").elements.length;
  for (i = 0; i < length; i++) {
   var x = document.getElementById("myForm").elements[i].name;
   document.getElementsByName(x)[0].removeAttribute("data-required");
  }
 }
 else if(document.getElementById("opmode").value == "SNeuPI") {
  $("#RPA :input").attr("disabled", true);
  $("#LINAS :input").attr("disabled", true);
  $("#SNeuPI :input").attr("disabled", false);
  document.getElementsByName("RG2Mode")[0].removeAttribute("data-required");
  document.getElementsByName("Second Grid Setting")[0].removeAttribute("data-required");
  document.getElementsByName("Duty Cycle linas")[0].removeAttribute("data-required");
  document.getElementsByName("Collector Gain State")[0].removeAttribute("data-required");
  document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
  document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
 }
 else if(document.getElementById("opmode").value == "LINAS") {
  $("#RPA :input").attr("disabled", true);
  $("#LINAS :input").attr("disabled", false);
  $("#SNeuPI :input").attr("disabled", true);
  document.getElementsByName("RG2Mode")[0].removeAttribute("data-required");
  document.getElementsByName("Second Grid Setting")[0].removeAttribute("data-required");
  document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
  document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle Sneupi")[0].removeAttribute("data-required");
  document.getElementsByName( "SNeuPI Mode")[0].removeAttribute("data-required");
 }
 else if(document.getElementById("opmode").value == "Neutral") {
  $("#RPA :input").attr("disabled", true);
  $("#LINAS :input").attr("disabled", false);
  $("#SNeuPI :input").attr("disabled", false);

  document.getElementsByName("RG2Mode")[0].removeAttribute("data-required");
  document.getElementsByName("Second Grid Setting")[0].removeAttribute("data-required");
  document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
  document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
  document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
 }
 else if(document.getElementById("opmode").value == "Plasma") {
  $("#RPA :input").attr("disabled", false);
```

```
  $("#LINAS :input").attr("disabled", true);
  $("#SNeuPI :input").attr("disabled", true);

  document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
  document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle linas")[0].removeAttribute("data-required");
  document.getElementsByName("Collector Gain State")[0].removeAttribute("data-required");
  document.getElementsByName("Duty Cycle Sneupi")[0].removeAttribute("data-required");
  document.getElementsByName( "SNeuPI Mode")[0].removeAttribute("data-required");
 }
 else if(document.getElementById("opmode").value == "HRC") {
  $("#RPA :input").attr("disabled", false);
  $("#LINAS :input").attr("disabled", true);
  $("#SNeuPI :input").attr("disabled", false);

  document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
  document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle linas")[0].removeAttribute("data-required");
  document.getElementsByName("Collector Gain State")[0].removeAttribute("data-required");
  document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
  document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
}
 else if(document.getElementById("opmode").value == "LRC") {
  $("#RPA :input").attr("disabled", false);
  $("#LINAS :input").attr("disabled", false);
  $("#SNeuPI :input").attr("disabled", true);

  document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
  document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
  document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle Sneupi")[0].removeAttribute("data-required");
  document.getElementsByName( "SNeuPI Mode")[0].removeAttribute("data-required");
 }

 else {
  $("#RPA :input").attr("disabled", false);
  $("#LINAS :input").attr("disabled", false);
  $("#SNeuPI :input").attr("disabled", false);

  document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
  document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
  document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
  document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
 }


});

</script>

<script>
 $(document).ready(function(e) {

  $(".stepsForm").stepsForm({
   width   :'100%',
   active   :0,
   errormsg  :'Check faulty fields.',
```

```
  sendbtntext  :'Submit Schedule',
  theme    :'grey',

 });
 $(".container .themes>span").click(function(e) {
  $(".container .themes>span").removeClass("selectedx");
  $(this).addClass("selectedx");
          $(".stepsForm").removeClass().addClass("stepsForm");
  $(".stepsForm").addClass("sf-theme-"+$(this).attr("data-value"));
       });


 $('#calendar').fullCalendar({

  header: {
   left: 'prev,next today',
   center: 'title',
   right: 'month,agendaWeek,agendaDay'
  },
/*   eventClick: function(calEvent, jsEvent) {
  var permission;
  if (confirm("Do you want to delete the event?") == true) {
   permission = 1;
  } else {
   permission = 0;
  }


      if (permission) {

  $('#calendar').fullCalendar( 'removeEvents', calEvent.id)
  $('#calendar').fullCalendar('updateEvent', calEvent);
      }
  },*/
  eventLimit: true, // allow "more" link when too many events
  timezone:'UTC',
  selectable: true,
  selectHelper: true,
  selectOverlap: false, //no two events can be scheduled at the same time!(do we put an alert??)
  editable:true,
  events:JSON.parse(globalEvent),

  eventAfterAllRender: function(view) {
   $(".fc-event-container").append( "<span class='closon'>X</span>" );},
  select: function(start, end) {
   safety=1;
   $('#calendar').fullCalendar( 'removeEvents');
   var title = prompt('Event Title:');
   var eventData;
   if (title) {
    eventData = {
     title: title,
     start: start,
     end: end
    };

    $('#calendar').fullCalendar('renderEvent', eventData, true); // stick? = true
    newEventsFromCalendar= [];
    $.each($('#calendar').fullCalendar('clientEvents'), function(index,value) {
     var event = new Object();
```

```
      event.id_calendar = value.id_calendar;
      event.start = value.start;
      event.end = value.end;
      event.title = value.title;
      event.allDay=value.allDay;
      event.className=value.className
      if(event.className!='old')
      {
       newEventsFromCalendar.push(event);
      }
     });

   }
    $('#calendar').fullCalendar('unselect');
   },

   });


    });


</script>
</body>

</html>

<!--**************************************signin.html************************************************-->

<!DOCTYPE html>
<html lang="en">

<head>

    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="description" content="">
    <meta name="author" content="">

    <title>LAICE- Ground Station Control</title>

    <!-- Bootstrap Core CSS -->
    <link href="../static/css/bootstrap.min.css" rel="stylesheet">

    <!-- Custom CSS -->
    <link href="../static/css/sb-admin.css" rel="stylesheet">

    <!-- Morris Charts CSS -->
    <link href="../static/css/plugins/morris.css" rel="stylesheet">

    <!-- Custom Fonts -->
    <link href="../static/font-awesome/css/font-awesome.min.css" rel="stylesheet" type="text/css">
 <link href="../static/css/demo.css" rel="stylesheet">
 <link href="../static/css/stepsForm.css" rel="stylesheet">
 <link rel='stylesheet' href='../static/lib/cupertino/jquery-ui.min.css' />
 <link href='../static/css/fullcalendar.css' rel='stylesheet' />
 <link href='../static/css/fullcalendar.print.css' rel='stylesheet' media='print' />
 <link href="../static/css/bootstrap-toggle.css" rel="stylesheet">
```

```
</head>

<body>

    <div id="wrapper">


        <!-- Navigation -->
        <nav class="navbar navbar-inverse navbar-fixed-top" role="navigation">
            <!-- Brand and toggle get grouped for better mobile display -->
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-ex1-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a class="navbar-brand" href="index.html">LAICE- Ground Station Control</a>
            </div>

        </nav>
  <div class="container">
   <div class="row">
    <div class="col-md-6 col-md-offset-2">
     <div class="login-panel panel panel-primary">
      <div class="panel-heading">
       <h3 class="panel-title">Sign In</h3>
      </div>
      <div class="panel-body">
       <form method="post" action="">
       <feildset>
        {{ form.hidden_tag() }}

        <div class="form-group">
         {{ form.username.label }}
         <br>{{ form.username }}<br>
        </div>


        <div class="form-group">

        {{ form.password.label }}<br>
        {{ form.password }}
        <br>
        </div>
        <div class="form-group ">

            {{ form.submit }}
        </div>
       </feildset>
       </form>
        {% for message in form.username.errors %}
       <div class="flash">{{ message }}</div>
        {% endfor %}


        {% for message in form.password.errors %}
```

```
      <div class="flash">{{ message }}</div>
       {% endfor %}
      </div>
     </div>
    </div>
   </div>
  </div>
    </div>


 <!-- jQuery -->
    <script src="../static/js/jquery.js"></script>

    <!-- Bootstrap Core JavaScript -->
    <script src="../static/js/bootstrap.min.js"></script>

    <!-- Morris Charts JavaScript -->
    <script src="../static/js/plugins/morris/raphael.min.js"></script>
    <script src="../static/js/plugins/morris/morris.min.js"></script>
    <script src="../static/js/plugins/morris/morris-data.js"></script>

    <!-- Flot Charts JavaScript -->
    <!--[if lte IE 8]><script src="js/excanvas.min.js"></script><![endif]-->
    <script src="../static/js/plugins/flot/jquery.flot.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.tooltip.min.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.resize.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.pie.js"></script>
    <script src="../static/js/plugins/flot/flot-data.js"></script>
 <script src="../static/js/jquery-2.1.1.min.js"></script>
 <script src='../static/lib/moment.min.js'></script>
 <script src='../static/js/fullcalendar.min.js'></script>
 <script src="../static/js/bootstrap-toggle.js"></script>
 <script src="../static/js/stepsForm.js"></script>
 </body>

</html>

<!--**************************************log.html**************************************************-->

<!DOCTYPE html>
<html lang="en">

<head>

    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="description" content="">
    <meta name="author" content="">

    <title>LAICE- Ground Station Control</title>

    <!-- Bootstrap Core CSS -->
    <link href="../static/css/bootstrap.min.css" rel="stylesheet">

    <!-- Custom CSS -->
    <link href="../static/css/sb-admin.css" rel="stylesheet">

    <!-- Morris Charts CSS -->
    <link href="../static/css/plugins/morris.css" rel="stylesheet">
```

```
    <!-- Custom Fonts -->
    <link href="../static/font-awesome/css/font-awesome.min.css" rel="stylesheet" type="text/css">
 <link href="../static/css/demo.css" rel="stylesheet">
 <link href="../static/css/stepsForm.css" rel="stylesheet">
 <link rel='stylesheet' href='../static/lib/cupertino/jquery-ui.min.css' />
 <link href='../static/css/fullcalendar.css' rel='stylesheet' />
 <link href='../static/css/fullcalendar.print.css' rel='stylesheet' media='print' />
 <link href="../static/css/bootstrap-toggle.css" rel="stylesheet">




</head>

<body>

    <div id="wrapper">


        <!-- Navigation -->
        <nav class="navbar navbar-inverse navbar-fixed-top" role="navigation">
            <!-- Brand and toggle get grouped for better mobile display -->
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-ex1-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a class="navbar-brand" href="index.html">LAICE- Ground Station Control</a>
            </div>

            <ul class="nav navbar-top-links navbar-right" style="padding-right: 0.5cm; padding-top: 0.1cm;">
                <li class="dropdown">
                    <a class="dropdown-toggle" data-toggle="dropdown" href="#">
                        <i class=" fa fa-user fa-fw"></i>  <i class="fa fa-caret-down"></i>
                    </a>
                    <ul class="dropdown-menu dropdown-user">
                        <li><a href="#"><i class="fa fa-user fa-fw"></i> User Profile</a>
                        </li>

      {% if current_user.urole == 'admin' %}
                        <li>
      <a href="javascript:;"  data-toggle="collapse" data-target="#demo1"><i class="fa fa-gear fa-fw"></i> Settings <i
class="fa fa-fw fa-caret-down"></i></a></a>
                        <ul id="demo1" class="collapse ">
                       <li>
        <a href="/signup">Sign up new student</a>
                            </li>

                            <li>
                               <a href="/log">Sign in log</a>
                            </li>

                        </ul>

                        </li>

      {% endif %} <li class="divider"></li>
```

```
                    <li><a href="/signout"><i class="fa fa-sign-out fa-fw"></i> Signout</a>
                    </li>
                </ul>
                <!-- /.dropdown-user -->
            </li>
            <!-- /.dropdown -->
        </ul>
        <!-- /.navbar-top-links -->

        <!-- Sidebar Menu Items - These collapse to the responsive navigation menu on small screens -->
        <div class="collapse navbar-collapse navbar-ex1-collapse">
            <ul class="nav navbar-nav side-nav">

                <li>
                  <a href="javascript:;"  data-toggle="collapse" data-target="#demo"><i class="fa fa-fw fa-cloud-
upload"></i>  Uplink Schedule<i class="fa fa-fw fa-caret-down"></i></a></a>
                    <ul id="demo" class="collapse ">

                  <li>
      <a href="home">Home</a>
                    </li>

                    <li>
                      <a href="schedule">Schedule</a>
                    </li>




                </ul>


            </li>
    </ul>
        </div>
      </nav>
 <div class="container">
  <div class="row">
   <div class="col-md-12 ">
    <div class="login-panel panel panel-primary">
     <div class="panel-heading">
      <h3 class="panel-title">Sign in log</h3>
     </div>
     <div class="panel-body">

      <pre>
      <h3> Multiple signin attempts log</h3>
      <br>{{ content }}</pre>
     </div>
    </div>
   </div>
  </div>
 </div>


<!-- jQuery -->
   <script src="../static/js/jquery.js"></script>

   <!-- Bootstrap Core JavaScript -->
   <script src="../static/js/bootstrap.min.js"></script>
```

```
    <!-- Morris Charts JavaScript -->
    <script src="../static/js/plugins/morris/raphael.min.js"></script>
    <script src="../static/js/plugins/morris/morris.min.js"></script>
    <script src="../static/js/plugins/morris/morris-data.js"></script>

    <!-- Flot Charts JavaScript -->
    <!--[if lte IE 8]><script src="js/excanvas.min.js"></script><![endif]-->
    <script src="../static/js/plugins/flot/jquery.flot.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.tooltip.min.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.resize.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.pie.js"></script>
    <script src="../static/js/plugins/flot/flot-data.js"></script>
 <script src="../static/js/jquery-2.1.1.min.js"></script>
 <script src='../static/lib/moment.min.js'></script>
 <script src='../static/js/fullcalendar.min.js'></script>
 <script src="../static/js/bootstrap-toggle.js"></script>
 <script src="../static/js/stepsForm.js"></script>
 </body>

</html>

<!--**************************************profile.html**************************************************-->

{% extends "layout.html" %}
{% block content %}
  <div class="jumbo">
    <h2>Profile<h2>
    <h3>This is {{ session['username'] }}'s profile page<h3>
  </div>
{% endblock %}


<!--**************************************layout.html**************************************************-->

<!DOCTYPE html>
<html>
  <head>
    <title>GUCCI</title>
<link href="static/css/main.css" rel="stylesheet">


  </head>
  <body>

  <header>
    <div class="container">
      <h1 class="logo">Ground Station Uplink Software</h1>
          </div>
  </header>

    <div class="container">
      {% block content %}
      {% endblock %}
    </div>
 <nav>
        <ul class="menu">
          <li><a href="{{ url_for('home') }}">Home</a></li>
          {% if 'username' in session %}
          <li><a href="{{ url_for('profile') }}">Profile</a></li>
```

```
          <li><a href="{{ url_for('signout') }}">Sign Out</a></li>
          {% else %}
          <li><a href="{{ url_for('signup') }}">Sign Up</a></li>
          <li><a href="{{ url_for('signin') }}">Sign In</a></li>
          {% endif %}
        </ul>
      </nav>

  </body>
</html>


<!--**************************************schedule.html*************************************************-->

<!DOCTYPE html>
<html lang="en">

<head>

    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="description" content="">
    <meta name="author" content="">

    <title>LAICE- Ground Station Control</title>

    <!-- Bootstrap Core CSS -->
    <link href="../static/css/bootstrap.min.css" rel="stylesheet">

    <!-- Custom CSS -->
    <link href="../static/css/sb-admin.css" rel="stylesheet">

    <!-- Morris Charts CSS -->
    <link href="../static/css/plugins/morris.css" rel="stylesheet">

    <!-- Custom Fonts -->
    <link href="../static/font-awesome/css/font-awesome.min.css" rel="stylesheet" type="text/css">
 <link href="../static/css/demo.css" rel="stylesheet">
 <link href="../static/css/stepsForm.css" rel="stylesheet">
 <link rel='stylesheet' href='../static/lib/cupertino/jquery-ui.min.css' />
 <link href='../static/css/fullcalendar.css' rel='stylesheet' />
 <link href='../static/css/fullcalendar.print.css' rel='stylesheet' media='print' />
 <link href="../static/css/bootstrap-toggle.css" rel="stylesheet">

 <style>

  body {
  margin-top: 40px;
  text-align: center;
  font-size: 14px;
  font-family: "Lucida Grande",Helvetica,Arial,Verdana,sans-serif;
  }
  #calendar {
   max-width: 750px;
   margin: 0 auto;
  }

.fc-event-container {
  position: relative;
```

```
}

.closon {
  color:white;
 position: absolute;
 top:-9px;
 right:0px;
   width:13px;
   height: 13px;
   text-align:center;
   border-radius:50%;
   font-size: 10px;
 cursor: pointer;
       background-color: maroon;
   }
</style>


</head>

<body>

    <div id="wrapper">


        <!-- Navigation -->
        <nav class="navbar navbar-inverse navbar-fixed-top" role="navigation">
            <!-- Brand and toggle get grouped for better mobile display -->
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-ex1-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
                <a class="navbar-brand" href="index.html">LAICE- Ground Station Control</a>
            </div>

            <ul class="nav navbar-top-links navbar-right" style="padding-right: 0.5cm; padding-top: 0.1cm;">
                <li class="dropdown">
                    <a class="dropdown-toggle" data-toggle="dropdown" href="#">
                        <i class=" fa fa-user fa-fw"></i>  <i class="fa fa-caret-down"></i>
                    </a>
                    <ul class="dropdown-menu dropdown-user">
                        <li><a href="#"><i class="fa fa-user fa-fw"></i> User Profile</a>
                        </li>{% if current_user.urole == 'admin' %}
                        <li>
      <a href="javascript:;"  data-toggle="collapse" data-target="#demo1"><i class="fa fa-gear fa-fw"></i> Settings <i
class="fa fa-fw fa-caret-down"></i></a></a>
                        <ul id="demo1" class="collapse ">
                       <li>
        <a href="/signup">Sign up new student</a>
                            </li>

                            <li>
                               <a href="">Sign in log</a>
                            </li>

                        </ul>
```

```
                </li>

    {% endif %}

                <li class="divider"></li>
                <li><a href="/signout"><i class="fa fa-sign-out fa-fw"></i> Signout</a>
                </li>
              </ul>
              <!-- /.dropdown-user -->
            </li>
            <!-- /.dropdown -->
          </ul>
          <!-- /.navbar-top-links -->

          <!-- Sidebar Menu Items - These collapse to the responsive navigation menu on small screens -->
          <div class="collapse navbar-collapse navbar-ex1-collapse">
            <ul class="nav navbar-nav side-nav">

              <li>
                <a href="javascript:;"  data-toggle="collapse" data-target="#demo"><i class="fa fa-fw fa-cloud-
upload"></i>  Uplink Schedule<i class="fa fa-fw fa-caret-down"></i></a></a>
                <ul id="demo" class="collapse ">

               <li>
      <a href="home">Home</a>
                  </li>

                  <li>
                    <a href="">Schedule</a>
                  </li>




                </ul>


              </li>
    </ul>
          </div>
          <!-- /.navbar-collapse -->
      </nav>

      <div class="container">
      <!--STEPS FORM START ------------ -->
      <div class="stepsForm">
          <form role="form" method="post" action="scheduleUpload" id="myForm"  enctype="multipart/form-data">
              <div class="sf-steps">
                  <div class="sf-steps-content">
                    <div>
      <span>1</span> LIIB Mode
     </div>
     <div>
      <span>2</span> RPA
     </div>
     <div>
      <span>3</span>LINAS
     </div>
     <div>
      <span>4</span> SNeuPI
```

```
 </div>
 <div>
  <span>5</span> Schedule
 </div>



            </div>
          </div>
          <div class="sf-steps-form sf-radius">

             <ul class="sf-content"> <!-- form step one -->


<div class="form-group">
 <label>LIIB Mode</label>
 <select  class="form-control" name="LIIBMode" id="LIIBMode" data-required="true" >
  <option value="" selected="selected" >Select the LIIB Mode</option>
  <option value="Normal">Normal Mode</option>
  <option value="TK1C">TK1 Charge</option>
  <option value="TK1D">TK1 Discharge</option>
  <option value="TK2C">TK2 Charge</option>
  <option value="TK2D">TK2 Discharge</option>
  <option value="TKO">TK Override</option>
 </select>
</div>
<div class="form-group">
 <label>OpMode</label>
 <select class="form-control" name="opmode" id="opmode" data-required="true">
  <option value="" selected="selected" >Select the Op Mode</option>
  <option value="Standby">Standby</option>
  <option value="SNeuPI">SNeuPI</option>
  <option value="LINAS">LINAS</option>
  <option value="Neutral">Neutral   (SNeuPI+LINAS) </option>
  <option value="Plasma">Plasma  (RPA)</option>
  <option value="HRC">High res correlation  (RPA+SNeuPI)</option>
  <option value="LRC">Low res correlation   (RPA+LINAS)</option>
  <option value="Prime Science">Prime Science   (RPA+LINAS+SNeuPI)</option>
 </select>
</div>

 </ul>


<ul class="sf-content" id="RPA"> <!-- form step tree -->
 <div id="page-wrapper">
  <div class="row">
   <div class="col-lg-12">
    <div class="panel panel-default">
     <div class="panel-heading">
      RPA
     </div>
     <div class="panel-body">
      <div class="row">
       <div class="col-lg-6">



        <!--div class="form-group">
         <label>Duty Cycle</label>
```

```
            <select class="form-control">
             <option>10</option>
             <option>20</option>
             <option>50</option>
             <option>100</option>
            </select>
           </div-->
           <div class="form-group">
            <label>RG2 Mode</label>
            <select class="form-control" name="RG2Mode" id="RG2Mode" data-required="true">
             <option value="" selected="selected" >Select the RG2 Mode</option>
             <option>Linear Sweep</option>
             <option>Constant Value</option>
             <option>Smart Sweep</option>
            </select>
           </div>

           <!--div class="col-lg-6">// still need to put the data in backend
            <label>RG Voltage</label>
            <div class="center ">
             <div class="input-group center">
                 <span class="input-group-btn">
                  <button type="button" class="btn btn-default btn-number" disabled="disabled" data-type="minus" data-
field="quant[1]">
                <span class="fa fa-minus-circle"></span>
                 </button>
                </span>
                <input type="text" name="quant[1]" class="form-control input-number" value="1" min="1" max="10">
                <span class="input-group-btn">
                 <button type="button" class="btn btn-default btn-number" data-type="plus" data-field="quant[1]">
                <span class="fa fa-plus-circle"></span>
                 </button>
                </span>
             </div>
            </div>
           </div-->
           <div class="form-group">
            <label>Second Grid Setting</label>
            <select class="form-control" name="Second Grid Setting" id="SecondGridSetting" data-required="true">
             <option value="" selected="selected" >Select the second grid setting</option>
             <option>Aperture</option>
             <option>Retarding Grid</option>
            </select>
           </div>

           <div class="form-group">
            <label>Points per sweep</label>
            <select class="form-control" name="Points per sweep" data-required="true">
             <option disabled>32</option> <!-->DO NOT TOUCH TILL CONSIDERED<-->
             <option selected="selected">64</option>
             <option disabled>128</option><!-->DO NOT TOUCH TILL CONSIDERED<-->
            </select>
           </div>

          </div>
          <!-- /.col-lg-6 (nested) -->
         </div>
         <!-- /.row (nested) -->
        </div>
        <!-- /.panel-body -->
```

```
        </div>
        <!-- /.panel -->
       </div>
       <!-- /.col-lg-12 -->
      </div>
      <!-- /.row -->
     </div>
     <!-- /#page-wrapper -->

                  </ul>


    <ul class="sf-content" id="LINAS"> <!-- form step two -->
                      <div id="page-wrapper">
       <div class="row">
        <div class="col-lg-12">
         <div class="panel panel-default">
          <div class="panel-heading">
           LINAS
          </div>
          <div class="panel-body">
           <div class="row">
            <div class="col-lg-6">
             <div class="form-group">
              <label>Duty Cycle</label>
              <select class="form-control" name="Duty Cycle linas" id="DutyCyclelinas" data-required="true">
               <option value="" selected="selected" >Select the Duty Cycle</option>

               <option>10</option>
               <option>20</option>
               <option>50</option>
               <option>100</option>
              </select>
             </div>
             <div class="form-group">
              <label>Filament Selection(Main/Redundant)</label>
              <br>
              <input type="checkbox" name="Filament (Main/Redundant)" checked data-toggle="toggle" data-on="F1"
data-off="F2" value="1">
              <input type="hidden" name="Filament (Main/Redundant)"  data-toggle="toggle" data-on="F1" data-off="F2"
value="0">
              </div>
             <div class="form-group">
             <label>Collector Gain State</label>
             <select class="form-control" name="Collector Gain State" id="CollectorGainState" data-required="true">
              <option value="" selected="selected" >Select the Collector Gain State</option>
              <option>Switch Gain at 10^-5 Torr</option>
              <option>Low Pressure Sensitive</option>
              <option>High Pressure Sensitive</option>
             </select>
             </div>
             <div class="form-group">
             <label>Grid Bias Setting</label>
             <select class="form-control" name="Grid Bias Setting">
              <option disabled>0001</option>
              <option>0010</option>
              <option disabled>0011</option>
              <option disabled>0100</option>
              <option disabled>0101</option>
              <option disabled>0110</option>
```

```
        <option disabled>0111</option>
        <option disabled>1000</option>
       </select>
       </div>
      </div>
      <!-- /.col-lg-6 (nested) -->
     </div>
     <!-- /.row (nested) -->
    </div>
    <!-- /.panel-body -->
   </div>
   <!-- /.panel -->
  </div>
  <!-- /.col-lg-12 -->
 </div>
 <!-- /.row -->
</div>
<!-- /#page-wrapper -->

            </ul>

<ul class="sf-content" id="SNeuPI"> <!-- form step four -->
 <div id="page-wrapper">
  <div class="row">
   <div class="col-lg-12">
    <div class="panel panel-default">
     <div class="panel-heading">
      SNeuPI
     </div>
     <div class="panel-body">
      <div class="row">
       <div class="col-lg-6">

        <div class="form-group">
         <label>Duty Cycle</label>
         <select class="form-control" name="Duty Cycle Sneupi" id="DutyCycleSneupi" data-required="true">
          <option value="" selected="selected" >Select the Duty Cycle</option>

          <option>10</option>
          <option>20</option>
          <option>50</option>
          <option>100</option>
         </select>
        </div>


        <!--div class="form-group">
         <label>High Voltage ON/OFF</label>
         <br>
         <input type="checkbox" name="High Voltage ON/OFF" checked data-toggle="toggle" value="1">
         <input type="hidden" name="High Voltage ON/OFF"  data-toggle="toggle" value ="0">


        </div-->

        <div class="form-group">
         <label>SNeuPI Mode</label>
         <select class="form-control" name="SNeuPI Mode" id="SNeuPIMode" data-required="true">
          <option value="" selected="selected" >Select the SNeuPI Mode</option>
```

```
                <option>Sweep Emission</option>
                <option>Standby Mission Mode</option>
                <option>Emission Level A</option>
                <option>Emission Level C</option>
               </select>
              </div>

             </div>
             <!-- /.col-lg-6 (nested) -->
            </div>
            <!-- /.row (nested) -->
           </div>
           <!-- /.panel-body -->
          </div>
          <!-- /.panel -->
         </div>
         <!-- /.col-lg-12 -->
        </div>
        <!-- /.row -->
       </div>
       <!-- /#page-wrapper -->

      </ul>

      <ul class="sf-content"> <!-- form step five -->
      <div class="row">
      <div class="col-lg-12">
       <div class="panel panel-default">
        <div class="panel-body">

<button type="button" class="btn btn-primary btn-circle" data-toggle="modal" data-target="#myModal">
  <span title="Information"><i class="fa fa-info"></i></span>

</button>
<button type="button" class="btn btn-danger btn-sm" onclick="editable()">Edit schedule</button>
<!-- Modal -->
<div class="modal fade" id="myModal" tabindex="-1" role="dialog" aria-labelledby="myModalLabel">
  <div class="modal-dialog" role="document" style="width:704px;height:628px;">
    <div class="modal-content">
      <div class="modal-header">
        <button type="button" class="close" data-dismiss="modal" aria-label="Close"><span aria-
hidden="true">&times;</span></button>
        <h4 class="modal-title" id="myModalLabel">Mode Title</h4>
      </div>
      <div class="modal-body text-center" >
        <img src="../static/modeName.jpg" alt="Mode Name" style="width:604px;height:428px;">
      </div>
      <div class="modal-footer">
        <button type="button" class="btn btn-default" data-dismiss="modal">Close</button>
        </div>
    </div>
  </div>
</div>
  <!--button type="button" class="btn btn-primary" data-dismiss="modal"><span title="Delete an existing
schedule.">Delete</span></button>
    <button type="button" class="btn btn-primary" data-dismiss="modal"><span title="Change the timing of an existing
schedule">Edit</span></button-->

        <br>
        <br>
```

```
        <div id='calendar'></div>
        <div class="form-group">
         <input type="hidden" id="eventdata"  name="eventdata" >



        </div>
       </div>
      </div>
     </div>
     <!-- /.col-lg-12 -->
    </div>
    <!-- /.row -->

      </ul>

              </div>
              <div class="row">

              <div class="sf-steps-navigation sf-align-right">
               <span id="sf-msg" class="sf-msg-error"></span>
               <button id="sf-prev" type="button" class="sf-button">Previous</button>
                  <button id="sf-next" type="button" class="sf-button">Next</button>
              </div>
    </div>
           </form>
        </div>
        <!--STEPS FORM END ---------- -->

    </div>


</div>
 <script>
  var globalEvent={{ r|tojson|safe }};
  var safety=0;
  var newEventsFromCalendar = [];
 </script>
    <!-- jQuery -->
    <script src="../static/js/jquery.js"></script>

    <!-- Bootstrap Core JavaScript -->
    <script src="../static/js/bootstrap.min.js"></script>

    <!-- Morris Charts JavaScript -->
    <script src="../static/js/plugins/morris/raphael.min.js"></script>
    <script src="../static/js/plugins/morris/morris.min.js"></script>
    <script src="../static/js/plugins/morris/morris-data.js"></script>

    <!-- Flot Charts JavaScript -->
    <!--[if lte IE 8]><script src="js/excanvas.min.js"></script><![endif]-->
    <script src="../static/js/plugins/flot/jquery.flot.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.tooltip.min.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.resize.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.pie.js"></script>
    <script src="../static/js/plugins/flot/flot-data.js"></script>
 <script src="../static/js/jquery-2.1.1.min.js"></script>
 <script src='../static/lib/moment.min.js'></script>
 <script src='../static/js/fullcalendar.min.js'></script>
 <script src="../static/js/bootstrap-toggle.js"></script>
```

```
 <script src="../static/js/stepsForm.js"></script>
 <script>
$('#LIIBMode').change(function(e){
  if($(this).val() == "TK1C" || $(this).val() == "TK1D" || $(this).val() == "TK2C" ||$(this).val() == "TK2D" || $(this).val() ==
"TKO" ){
   alert("Thermal Knife mode!!");
   $("#opmode option[value='LINAS']").prop('disabled',true);
   $("#opmode option[value='SNeuPI']").prop('disabled',true);
   $("#opmode option[value='Neutral']").prop('disabled',true);
   $("#opmode option[value='Plasma']").prop('disabled',true);
   $("#opmode option[value='HRC']").prop('disabled',true);
   $("#opmode option[value='LRC']").prop('disabled',true);
   $("#opmode option[value='Prime Science']").prop('disabled',true);
  }
  else {
   $("#opmode option[value='LINAS']").prop('disabled',false);
   $("#opmode option[value='SNeuPI']").prop('disabled',false);
   $("#opmode option[value='Neutral']").prop('disabled',false);
   $("#opmode option[value='Plasma']").prop('disabled',false);
   $("#opmode option[value='HRC']").prop('disabled',false);
   $("#opmode option[value='LRC']").prop('disabled',false);
   $("#opmode option[value='Prime Science']").prop('disabled',false);
   }
  $("#opmode option[value='']").prop('selected', true);
  });

$('#opmode').change(function(e){

  $("#RG2Mode option[value='']").prop('selected', true);
  $("#SecondGridSetting option[value='']").prop('selected', true);
  $("#DutyCyclelinas option[value='']").prop('selected', true);
  $("#CollectorGainState option[value='']").prop('selected', true);
  $("#DutyCycleSneupi option[value='']").prop('selected', true);
  $("#SNeuPIMode option[value='']").prop('selected', true);
  if(document.getElementById("opmode").value == "Standby") {
   $("#RPA :input").attr("disabled", true);
   $("#LINAS :input").attr("disabled", true);
   $("#SNeuPI :input").attr("disabled", true);
    var length=document.getElementById("myForm").elements.length;
   for (i = 0; i < length; i++) {
    var x = document.getElementById("myForm").elements[i].name;
    document.getElementsByName(x)[0].removeAttribute("data-required");
   }
  }
  else if(document.getElementById("opmode").value == "SNeuPI") {
   $("#RPA :input").attr("disabled", true);
   $("#LINAS :input").attr("disabled", true);
   $("#SNeuPI :input").attr("disabled", false);
   document.getElementsByName("RG2Mode")[0].removeAttribute("data-required");
   document.getElementsByName("Second Grid Setting")[0].removeAttribute("data-required");
   document.getElementsByName("Duty Cycle linas")[0].removeAttribute("data-required");
   document.getElementsByName("Collector Gain State")[0].removeAttribute("data-required");
   document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
   document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
  }
  else if(document.getElementById("opmode").value == "LINAS") {
   $("#RPA :input").attr("disabled", true);
   $("#LINAS :input").attr("disabled", false);
   $("#SNeuPI :input").attr("disabled", true);
   document.getElementsByName("RG2Mode")[0].removeAttribute("data-required");
```

```
 document.getElementsByName("Second Grid Setting")[0].removeAttribute("data-required");
 document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
 document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
 document.getElementsByName("Duty Cycle Sneupi")[0].removeAttribute("data-required");
 document.getElementsByName( "SNeuPI Mode")[0].removeAttribute("data-required");
}
 else if(document.getElementById("opmode").value == "Neutral") {
 $("#RPA :input").attr("disabled", true);
 $("#LINAS :input").attr("disabled", false);
 $("#SNeuPI :input").attr("disabled", false);

 document.getElementsByName("RG2Mode")[0].removeAttribute("data-required");
 document.getElementsByName("Second Grid Setting")[0].removeAttribute("data-required");
 document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
 document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
 document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
 document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
}
 else if(document.getElementById("opmode").value == "Plasma") {
 $("#RPA :input").attr("disabled", false);
 $("#LINAS :input").attr("disabled", true);
 $("#SNeuPI :input").attr("disabled", true);

 document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
 document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
 document.getElementsByName("Duty Cycle linas")[0].removeAttribute("data-required");
 document.getElementsByName("Collector Gain State")[0].removeAttribute("data-required");
 document.getElementsByName("Duty Cycle Sneupi")[0].removeAttribute("data-required");
 document.getElementsByName( "SNeuPI Mode")[0].removeAttribute("data-required");
}
 else if(document.getElementById("opmode").value == "HRC") {
 $("#RPA :input").attr("disabled", false);
 $("#LINAS :input").attr("disabled", true);
 $("#SNeuPI :input").attr("disabled", false);

 document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
 document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
 document.getElementsByName("Duty Cycle linas")[0].removeAttribute("data-required");
 document.getElementsByName("Collector Gain State")[0].removeAttribute("data-required");
 document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
 document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
}
 else if(document.getElementById("opmode").value == "LRC") {
 $("#RPA :input").attr("disabled", false);
 $("#LINAS :input").attr("disabled", false);
 $("#SNeuPI :input").attr("disabled", true);

 document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
 document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
 document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
 document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
 document.getElementsByName("Duty Cycle Sneupi")[0].removeAttribute("data-required");
 document.getElementsByName( "SNeuPI Mode")[0].removeAttribute("data-required");
 }

 else {
 $("#RPA :input").attr("disabled", false);
 $("#LINAS :input").attr("disabled", false);
 $("#SNeuPI :input").attr("disabled", false);
```

```
  document.getElementsByName("RG2Mode")[0].setAttribute("data-required","true");
  document.getElementsByName("Second Grid Setting")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle linas")[0].setAttribute("data-required","true");
  document.getElementsByName("Collector Gain State")[0].setAttribute("data-required","true");
  document.getElementsByName("Duty Cycle Sneupi")[0].setAttribute("data-required","true");
  document.getElementsByName( "SNeuPI Mode")[0].setAttribute("data-required","true");
 }


});

</script>

<script>
 $(document).ready(function(e) {

  $(".stepsForm").stepsForm({
   width   :'100%',
   active   :4,
   errormsg  :'Check faulty fields.',
   sendbtntext  :'Submit Schedule',
   theme   :'grey',
  });
  $(".container .themes>span").click(function(e) {
   $(".container .themes>span").removeClass("selectedx");
   $(this).addClass("selectedx");
            $(".stepsForm").removeClass().addClass("stepsForm");
   $(".stepsForm").addClass("sf-theme-"+$(this).attr("data-value"));
        });

  $('#calendar').fullCalendar({

   header: {
    left: 'prev,next today',
    center: 'title',
    right: 'month,agendaWeek,agendaDay'
   },
   eventLimit: true, // allow "more" link when too many events
   timezone:'UTC',
   selectable:true,
   selectHelper: true,
   selectOverlap: false, //no two events can be scheduled at the same time!(do we put an alert??)
   editable: true,
   eventLimit: true,
   events:JSON.parse(globalEvent),
   select: function(start, end) {
    safety=1;

    var title = prompt('Event Title:');
    var eventData;
    if (title) {
     e=JSON.parse(globalEvent)
     eventData = {
      title: title,
      start: start,
      end: end
     };
     $('#calendar').fullCalendar('renderEvent', eventData, true); // stick? = true
     newEventsFromCalendar= [];
     $.each($('#calendar').fullCalendar('clientEvents'), function(index,value) {
```

```
    var event = new Object();
    event.id_calander = value.id_calander;
    event.start = value.start;
    event.end = value.end;
    event.title = value.title;
    event.allDay=value.allDay;
    event.className=value.className
    if(event.className!='old')
    {
     newEventsFromCalendar.push(event);
    }
   });

   console.log(newEventsFromCalendar);

  }
  $('#calendar').fullCalendar('unselect');

 },
 eventClick: function(event){
  $(".closon").click(function() {
    var permission;
 if (confirm("Do you want to delete the event?") == true) {
  permission = 1;
 } else {
  permission = 0;
 }


      if (permission) {

 $('#calendar').fullCalendar( 'removeEvents', event._id)

      }
});
 },
eventRender: function(event, element) {
          element.append( "<span class='closon'>X</span>" );
          element.find(".closon").click(function() {
             //$('#calendar').fullCalendar('removeEvents',event._id);
    var permission;
 if (confirm("Do you want to delete the event?") == true) {
  permission = 1;
 } else {
  permission = 0;
 }


      if (permission) {

 $('#calendar').fullCalendar( 'removeEvents', event._id)
 }
          });
      }

 });


  });
```

```
</script>
</body>

</html>


<!--**************************************signup.html*************************************************-->

<!DOCTYPE html>
<html lang="en">

<head>

    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <meta name="description" content="">
    <meta name="author" content="">

    <title>LAICE- Ground Station Control</title>

    <!-- Bootstrap Core CSS -->
    <link href="../static/css/bootstrap.min.css" rel="stylesheet">

    <!-- Custom CSS -->
    <link href="../static/css/sb-admin.css" rel="stylesheet">

    <!-- Morris Charts CSS -->
    <link href="../static/css/plugins/morris.css" rel="stylesheet">

    <!-- Custom Fonts -->
    <link href="../static/font-awesome/css/font-awesome.min.css" rel="stylesheet" type="text/css">
 <link href="../static/css/demo.css" rel="stylesheet">
 <link href="../static/css/stepsForm.css" rel="stylesheet">
 <link rel='stylesheet' href='../static/lib/cupertino/jquery-ui.min.css' />
 <link href='../static/css/fullcalendar.css' rel='stylesheet' />
 <link href='../static/css/fullcalendar.print.css' rel='stylesheet' media='print' />
 <link href="../static/css/bootstrap-toggle.css" rel="stylesheet">




</head>

<body>

    <div id="wrapper">


        <!-- Navigation -->
        <nav class="navbar navbar-inverse navbar-fixed-top" role="navigation">
            <!-- Brand and toggle get grouped for better mobile display -->
            <div class="navbar-header">
                <button type="button" class="navbar-toggle" data-toggle="collapse" data-target=".navbar-ex1-collapse">
                    <span class="sr-only">Toggle navigation</span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                    <span class="icon-bar"></span>
                </button>
```

```
            <a class="navbar-brand" href="index.html">LAICE- Ground Station Control</a>
        </div>

        <ul class="nav navbar-top-links navbar-right" style="padding-right: 0.5cm; padding-top: 0.1cm;">
            <li class="dropdown">
                <a class="dropdown-toggle" data-toggle="dropdown" href="#">
                    <i class=" fa fa-user fa-fw"></i>  <i class="fa fa-caret-down"></i>
                </a>
                <ul class="dropdown-menu dropdown-user">
                    <li><a href="#"><i class="fa fa-user fa-fw"></i> User Profile</a>
                    </li>
                    <li><a href="#"><i class="fa fa-gear fa-fw"></i> Settings</a>
                    </li>
                    <li class="divider"></li>
                    <li><a href="/signout"><i class="fa fa-sign-out fa-fw"></i> Signout</a>
                    </li>
                </ul>
                <!-- /.dropdown-user -->
            </li>
            <!-- /.dropdown -->
        </ul>
        <!-- /.navbar-top-links -->

        <!-- Sidebar Menu Items - These collapse to the responsive navigation menu on small screens -->
        <div class="collapse navbar-collapse navbar-ex1-collapse">
            <ul class="nav navbar-nav side-nav">

                <li>
                  <a href="javascript:;"  data-toggle="collapse" data-target="#demo"><i class="fa fa-fw fa-cloud-
upload"></i>  Uplink Schedule<i class="fa fa-fw fa-caret-down"></i></a></a>
                    <ul id="demo" class="collapse ">

                  <li>
      <a href="home">Home</a>
                      </li>

                      <li>
                        <a href="schedule">Schedule</a>
                      </li>




                    </ul>


                </li>
    </ul>
        </div>
        <!-- /.navbar-collapse -->
      </nav>
<br>
<br>
  <div class="container">
   <div class="row">
    <div class="col-md-6 col-md-offset-3">
     <div class="login-panel panel panel-default">
      <div class="panel-heading">
       <h3 class="panel-title "><strong>Sign Up</strong></h3>
      </div>
```

```
      <div class="panel-body">

       <form method="post" action="">
       <feildset>
        {{ form.hidden_tag() }}

        <div class="form-group">
         {{ form.username.label }}
          <br>{{ form.username }}<br>
        </div>

        <div class="form-group">

          {{ form.email.label }}
         <br> {{ form.email }}<br>
        </div>
        <div class="form-group">

        {{ form.password.label }}<br>
        {{ form.password }}
        <br>
        </div>
        <div class="form-group ">

            {{ form.submit }}
        </div>
       </feildset>
       </form>
        {% for message in form.username.errors %}
       <div class="flash">{{ message }}</div>
        {% endfor %}

        {% for message in form.email.errors %}
       <div class="flash">{{ message }}</div>
        {% endfor %}

        {% for message in form.password.errors %}
       <div class="flash">{{ message }}</div>
        {% endfor %}
      </div>
     </div>
    </div>
   </div>
  </div>
    </div>


<!-- jQuery -->
    <script src="../static/js/jquery.js"></script>

    <!-- Bootstrap Core JavaScript -->
    <script src="../static/js/bootstrap.min.js"></script>

    <!-- Morris Charts JavaScript -->
    <script src="../static/js/plugins/morris/raphael.min.js"></script>
    <script src="../static/js/plugins/morris/morris.min.js"></script>
    <script src="../static/js/plugins/morris/morris-data.js"></script>

    <!-- Flot Charts JavaScript -->
    <!--[if lte IE 8]><script src="js/excanvas.min.js"></script><![endif]-->
```

```
    <script src="../static/js/plugins/flot/jquery.flot.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.tooltip.min.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.resize.js"></script>
    <script src="../static/js/plugins/flot/jquery.flot.pie.js"></script>
    <script src="../static/js/plugins/flot/flot-data.js"></script>
 <script src="../static/js/jquery-2.1.1.min.js"></script>
 <script src='../static/lib/moment.min.js'></script>
 <script src='../static/js/fullcalendar.min.js'></script>
 <script src="../static/js/bootstrap-toggle.js"></script>
 <script src="../static/js/stepsForm.js"></script>
 </body>

</html>
```

Appendix C

Ground station control software Code Discussion

The file *app.py* is the main file for running the application. It launches the web-application. It calls the *processor.py* and supplies this file with all the data the user has entered on the UI to generate the uplink schedule. This is the UCG as discussed in Chapter 3. The title of the mode scheduled is updated on the calendar view in the UI for users ease to schedule a new command. This is done by *calendarUpdate.py* as described in Chapter 3 under the subsection for STG.

```
#-----------------------------------app.py-------------------------------------
from flask import Flask, render_template, request, session, redirect, url_for
from functools import wraps
import json, ast, datetime,socket
import binascii,time
from bitstring import BitArray
from flask_sqlalchemy import SQLAlchemy
import processor
from flask import jsonify
from sqlalchemy.inspection import inspect
import logging
from calendarUpdate import writecalendarData
from flask.ext.login import LoginManager, login_required, login_user, logout_user, current_user

from flask.ext.bcrypt import Bcrypt
from flask_wtf import Form
from wtforms import TextField, PasswordField, SelectField, validators, SubmitField
from wtforms.validators import DataRequired

app = Flask(__name__)
login_manager = LoginManager()
login_manager.init_app(app)
r=""
app.config['SQLALCHEMY_DATABASE_URI'] = 'mysql://root:namrata@localhost/test'# insert database
passowrd:namrata and schema name:test
db = SQLAlchemy(app)
logger = logging.getLogger(__name__)
bcrypt = Bcrypt()

loginCount=0

app.secret_key = 'hahshatramans'
# login required decorator

def login_required(role="ANY"):
    def wrapper(fn):
        @wraps(fn)
        def decorated_view(*args, **kwargs):
            if not current_user.is_authenticated():
                return login_manager.unauthorized()
            if ( (current_user.urole  != role) and (role != "ANY")):
                return login_manager.unauthorized()
            return fn(*args, **kwargs)
        return decorated_view
    return wrapper

@login_manager.user_loader
def user_loader(user_id):
    """Given *user_id*, return the associated User object.

    :param unicode user_id: user_id (username) user to retrieve
    """
    return User.query.get(user_id)

class User(db.Model):
    """An admin user capable of viewing reports.

    :param str username: username of user
    :param str password: encrypted password for the user
```

```
    """
    __tablename__ = 'user'

    username = db.Column(db.String, primary_key=True)
    authenticated = db.Column(db.Boolean, default=False)
    urole = db.Column(db.String)
    email = db.Column(db.String(120), unique=True)
    pwdhash = db.Column(db.String)

    def __init__(self, username, urole, email, password, authenticated):
        self.username = username
        self.email = email.lower()
        self.urole = urole
        self.is_authenticated()
        self.set_password(password)

    def set_password(self, password):
        self.pwdhash = bcrypt.generate_password_hash(password)

    def check_password(self, password):
        return bcrypt.check_password_hash(self.pwdhash, password)

    def is_active(self):
        """True, as all users are active."""
        return True

    def get_id(self):
        """Return the username to satisfy Flask-Login's requirements."""
        return self.username

    def is_authenticated(self):
        """Return True if the user is authenticated."""
        return self.authenticated

    def is_anonymous(self):
        """False, as anonymous users aren't supported."""
        return False

class SigninForm(Form):

  username = TextField("Username",  [validators.Required("Please enter your username address.")])
  password = PasswordField('Password', [validators.Required("Please enter a password.")])
  submit = SubmitField("Sign In")

  def __init__(self, *args, **kwargs):
    Form.__init__(self, *args, **kwargs)

  def validate(self):
    global loginCount
    if not Form.validate(self):
      return False

    user = User.query.filter_by(username = self.username.data).first()
    if user and user.check_password(self.password.data):
      user.authenticated = True
      db.session.add(user)
      db.session.commit()
      login_user(user, remember=True)

      return True
```

```
    else:
      self.username.errors.append("Invalid username or password")
      loginCount=loginCount+1
      return False

class SignupForm(Form):
  username = TextField("Username",  [validators.Required("Please enter the username.")])
  email = TextField("Email",  [validators.Required("Please enter your email address."), validators.Email("Please enter
your email address.")])
  password = PasswordField('Password', [validators.Required("Please enter a password.")])
  submit = SubmitField("Create account")

  def __init__(self, *args, **kwargs):
    Form.__init__(self, *args, **kwargs)

  def validate(self):
    if not Form.validate(self):
      return False
    user = User.query.filter_by(username = self.username.data).first()

    if user:
      self.username.errors.append("That username is already taken.")
      return False
    user = User.query.filter_by(email = self.email.data).first()
    if user:
      self.email.errors.append(" That email is already registered.")
      return False
    else:
      return True

#redirects the web-application to log page to display multiple signin failure
@app.route("/log")
def log():

   with open("signInLog", "r") as f:
       content = f.read()
   return render_template("log.html", content=content)

#directs the web-application to signin page to login the user with correct credentials
@app.route('/', methods=['GET', 'POST'])
def signin():
  global loginCount
  form = SigninForm()
  if (loginCount%3==0 and loginCount!=0):
      f = open('signInLog', 'a')
      f.write("time:"+str(datetime.datetime.now())+"     IP:"+socket.gethostbyname(socket.gethostname())+"\n")
      loginCount=0
      f.close()
  if 'username' in session:
    return redirect(url_for('home'))
  if request.method == 'POST':
    if form.validate() == False:
      return render_template('signin.html', form=form)
    else:
      session['username'] = form.username.data
      return redirect(url_for('home'))
  elif request.method == 'GET':
    return render_template('signin.html', form=form)

#directs the web-application to signup page only for the admin
```

```
@app.route('/signup', methods=['GET', 'POST'])
@login_required(role="admin")
def signup():
  form = SignupForm()
  if request.method == 'POST':
    if form.validate() == False:
      return render_template('signup.html', form=form)
    else:
      newuser = User(form.username.data, "student", form.email.data, form.password.data,"0")
      db.session.add(newuser)
      db.session.commit()
      #session['username'] = newuser.username
      return redirect(url_for('home'))

  elif request.method == 'GET':
    return render_template('signup.html', form=form)

#directs the web-application to profile page to display the current users profile
@app.route('/profile')
@login_required(role="ANY")
def profile():

  if 'username' not in session:
    return redirect(url_for('signin'))

  user = User.query.filter_by(username = session['username']).first()

  if user is None:
    return redirect(url_for('signin'))
  else:
    return render_template('profile.html')


#redirects the web-application to signin page after signing out the current user
@app.route('/signout')
@login_required(role="ANY")

def signout():

  if 'username' not in session:
    return redirect(url_for('signin'))
  session.pop('username', None)
  return redirect(url_for('signin'))


#directs the web-application to home page
@app.route("/home", methods=['POST', 'GET'])
@login_required(role="ANY")

def home():
    global r
    r=retrievecalendarData()
    return render_template('home.html',r=r)


#uploads the calendar view web-page with schedule history

@app.route("/schedule", methods=['POST', 'GET'])
@login_required(role="ANY")
def schedule():
```

```
    global r
    r=retrievecalendarData()
    return render_template('schedule.html',r=r)
@app.route("/scheduleUpload", methods=['POST', 'GET'])
@login_required(role="ANY")
def scheduleUpload():
    global data
    data=request.form.to_dict()
    data=ast.literal_eval(json.dumps(data))
    process(data)
    return redirect(url_for ('schedule'))

#sends the data from frontend to the backend for processing
def process(data):
    global r #same as data['eventdata']

    eventDataString=data['eventdata']# event data is in string format
    #eventDataString=eventDataString.replace(r,"")
    eventData = ast.literal_eval(eventDataString)#convert event data from string to list format
    for event in eventData:
        writecalendarData(data,event["start"],event["end"],event["allDay"])
        c1 = event["start"].split("T")
        c2 = event["end"].split("T")
        start=startTime(c1,c2)
        end=endTime(c1,c2)
        processor.uOfIData(data,start,end)

#initiallizes the UIUC table
class uplink(db.Model):

    __tablename__ = 'uOfIData'
    id_uplink = db.Column('id', db.Integer, primary_key=True)
    start = db.Column('startTime', db.DateTime)
    end = db.Column('endTime', db.DateTime)
    data = db.Column('instrumentCommand', db.LargeBinary)


    def __init__(self, start, end, data):
        self.start=start
        self.end=end
        self.data = data

#Formats the data recieved from the database
class Serializer(object):

    def serialize(self):
        return {c: getattr(self, c) for c in inspect(self).attrs.keys()}

    @staticmethod
    def serialize_list(l):
        return [m.serialize() for m in l]

#initializes the calendar table
class calendar(db.Model,Serializer):

    __tablename__ = 'calendar'
    id_calendar = db.Column('id', db.Integer, primary_key=True)
    start = db.Column('startTime', db.DateTime)
    end = db.Column('endTime', db.DateTime)
    title = db.Column('title', db.LargeBinary)
```

```
    allDay = db.Column('allDay', db.LargeBinary)
    className = db.Column('className', db.LargeBinary)



    def __init__(self, title,start,end,allDay):
        self.title=title
        self.start=start
        self.end=end
        self.allDay=allDay
        self.className="old"


#reads data from calendar table
def retrievecalendarData():
    cal=calendar.query.all()
    return json.dumps(calendar.serialize_list(cal))

#forat data received from front end
def startTime(c1,c2):
    return datetime.datetime.strptime(c1[0]+" "+c1[1][:-5], "%Y-%m-%d %H:%M:%S")

def endTime(c1,c2):
    return datetime.datetime.strptime(c2[0]+" "+c2[1][:-5], "%Y-%m-%d %H:%M:%S")

if __name__ == "__main__":

    app.run(debug=True) #launches the web-application. State the IP address you want to host the application in HERE
```

```
#-----------------------------processor.py---------------------------------
import datetime
from bitstring import BitArray
import app
import binascii
from app import uplink,db

ston=[18*60,36*60,90*60]
stoff=[162*60, 144*60,90*60]
lton=[3*60,6*60,15*60]
ltoff=[27*60,24*60,15*60]
startS,endS,aS,startL,endL,aL=[],[],[],[],[],[]
i,j=0,0

def uOfIData(data,start,end):
    global startS,endS,aS,startL,endL,aL,i,j
    startS,endS,aS,startL,endL,aL=[],[],[],[],[],[]
    i,j=0,0
    if(data['opmode']=='Standby'):
        standbyMode(data,start,end)
    elif(data['opmode']=='Plasma'):
        plasmaMode(data,start,end)
    elif(data['opmode']=='LINAS' or data['opmode']=='LRC'):
        linas(data,start,end)
        writeToDatabase(data)
    elif(data['opmode']=='SNeuPI' or data['opmode']=='HRC'):
        sneupi(data,start,end)
        writeToDatabase(data)
    elif(data['opmode']=='Neutral' or data['opmode']=='Prime Science'):
        sneupi(data,start,end)
        linas(data,start,end)
        writeToDatabase(data)
    return

def new_command(data,iS,jL):
    global aS,aL
    a=BitArray(bin='')#reset a for new second packet
    temp=BitArray(bin='')#reset a for new second packet
    #copy=BitArray(bin='')#first second buffer when power turned on
    a.append('0b01000011')#LIIB start word
    a.append('0b00000') #Normal
    if(data['opmode']=='SNeuPI'):
        a.append('0b001')#SNeuPI opmode
        a.append(format(0, '#042b'))#RPA data
        a.append(aS[iS])#SNeuPI data
        a.append(format(0, '#026b'))#IINAS data
        if(a.find("0b00",70,72)):
            temp.append(a)
            temp.replace("0b00","0b10",70,72)
            a.append(temp)#192 bits rturned
    elif(data['opmode']=='LINAS'):
        a.append('0b010')
        a.append(format(0, '#042b'))#RPA data
        a.append(format(0, '#018b'))#SNeuPI data

        a.append(aL[jL])#LINAS opmode
        if(a.find("0b0110",84,88)):
            temp.append(a)
            temp.replace("0b0110","0b1001",84,88)
            a.append(temp)#192 bits rturned
```

```
    elif(data['opmode']=='Neutral'):
        a.append('0b011')
        a.append(format(0, '#042b'))#RPA data
        a.append(aS[iS])#SNeuPI data
        a.append(aL[jL])#LINAS data
        if(a.find("0b0110",84,88) or a.find("0b00",70,72)):
            temp.append(a)
            temp.replace("0b0110","0b1001",84,88)
            temp.replace("0b00","0b10",70,72)
            a.append(temp)#192 bits rturned
    elif(data['opmode']=='Plasma'):
        a.append('0b100')
        a.append(rpaData(data))
        a.append(format(0, '#018b'))#SNeuPI data
        a.append(format(0, '#026b'))#IINAS data
    elif(data['opmode']=='HRC'):
        a.append('0b101')
        a.append(rpaData(data))
        a.append(aS[iS])#SNeuPI data
        a.append(format(0, '#026b'))#IINAS data
        if(a.find("0b00",70,72)):
            temp.append(a)
            temp.replace("0b00","0b10",70,72)
            a.append(temp)#192 bits rturned
    elif(data['opmode']=='LRC'):
        a.append('0b110')
        a.append(rpaData(data))
        a.append(format(0, '#018b'))#SNeuPI data
        a.append(aL[jL])#LINAS data
        if(a.find("0b0110",84,88)):
            temp.append(a)
            temp.replace("0b0110","0b1001",84,88)
            a.append(temp)#192 bits rturned
    elif(data['opmode']=='Prime Science'):
        a.append('0b111')
        a.append(rpaData(data))
        a.append(aS[iS])#SNeuPI data
        a.append(aL[jL])#LINAS data
        if(a.find("0b0110",84,88) or a.find("0b00",70,72)):
            temp.append(a)
            temp.replace("0b0110","0b1001",84,88)
            temp.replace("0b00","0b10",70,72)
            a.append(temp)#192 bits rturned
    return a.bin



def encodeAndCommit(binData,start,end):
    epoch=datetime.datetime.utcfromtimestamp(0)
    start=(start-epoch).total_seconds()
    end=(end-epoch).total_seconds()
    n_c=binascii.crc32(binData) & 0xffffffff
    new_inp=uplink(start,end,n_c)
    db.session.add(new_inp)
    db.session.commit()
    return

def writeToDatabase(data):
    #iS and jS are local variables
    iS,jL=0,0
```

```
    if(data['opmode']=='SNeuPI' or data['opmode']=='HRC'):
        while(len(startS)>iS):
            n_c=new_command(data,iS,0)
            encodeAndCommit(n_c,startS[iS],endS[iS])
            iS=iS+1
    elif(data['opmode']=='LINAS' or data['opmode']=='LRC'):
        while(len(startL)>jL):
            n_c=new_command(data,0,jL)#128/256 bit command
            encodeAndCommit(n_c,startL[jL],endL[jL])
            jL=jL+1
    elif(data['opmode']=='Neutral' or data['opmode']=='Prime Science'):
        while (len(startS)>iS or len(startL)>jL):       #check!!
            if(startS[iS]==startL[jL]):
                start=startS[iS]
            elif(startS[iS]>startL[jL]):
                start=startS[iS]
            elif(startS[iS]<startL[jL]):
                start=startL[jL]
            if (endS[iS]<endL[jL]):
                n_c=new_command(data,iS,jL)
                encodeAndCommit(n_c,start,endS[iS])
                iS=iS+1
            elif (endS[iS]==endL[jL]):
                n_c=new_command(data,iS,jL)
                encodeAndCommit(n_c,start,endS[iS])
                iS=iS+1
                jL=jL+1
            elif (endS[iS]>endL[jL]):
                n_c=new_command(data,iS,jL)
                encodeAndCommit(n_c,start,endL[jL])
                jL=jL+1

    return


def standbyMode(data,start,end):
    a=BitArray(bin='')#reset a for new second packet
    a.append('0b01000011')#LIIB start word
    if(data['LIIBMode']=='Normal'):
        a.append('0b00000')
        a.append(format(0, '#085b'))#80(Inst)+3(opmode)+2
    elif(data['LIIBMode']=='TK1C'):
        a.append('0b00111')
        a.append(format(0, '#085b'))
    elif(data['LIIBMode']=='TK1D'):
        a.append('0b01010')
        a.append(format(0, '#085b'))
    elif(data['LIIBMode']=='TK2C'):
        a.append('0b11100')
        a.append(format(0, '#085b'))
    elif(data['LIIBMode']=='TK2D'):
        a.append('0b10101')
        a.append(format(0, '#085b'))
    elif(data['LIIBMode']=='TKO'):
        a.append('0b11011')
        a.append(format(0, '#085b'))
    encodeAndCommit(a.bin,start,end)
    return

def plasmaMode(data,start,end):
```

```
    n_c=new_command(data,0,0)
    encodeAndCommit(n_c,start,end)
    return

def sneupi(data,start,end):
    if(data['Duty Cycle Sneupi']=='10'):
        sneupiDutycycleOn(data,start,end,ston[0],stoff[0])
    elif(data['Duty Cycle Sneupi']=='20'):
        sneupiDutycycleOn(data,start,end,ston[1],stoff[1])
    elif(data['Duty Cycle Sneupi']=='50'):
        sneupiDutycycleOn(data,start,end,ston[2],stoff[2])
    elif(data['Duty Cycle Sneupi']=='100'):
        sneupiDutycycleOn(data,start,end,(start-end).total_seconds(),0)
    return

def sneupiDutycycleOn(data,start,end,sneupiOn,sneupiOff):
    global i,aS
    if(i==0):
        x=4
    else:
        x=2
    startS.insert(i,start)
    endS.insert(i,startS[i] + datetime.timedelta(0,x))
    aS.insert(i,sneupiData(data,0))

    startS.insert(i+1,endS[i])
    endS.insert(i+1,startS[i+1]+ datetime.timedelta(0,sneupiOn-x))
    aS.insert(i+1,sneupiData(data,1))
    if(endS[i+1]>=end):
        endS[i+1]=end

    else:
         sneupiDutycycleOff(data,endS[i+1],end,sneupiOn,sneupiOff)
    return

def sneupiDutycycleOff(data,start,end,sneupiOn,sneupiOff):
    global i,aS
    startS.insert(i+2,start)
    endS.insert(i+2,startS[i+2]+datetime.timedelta(0,sneupiOff))
    aS.insert(i+2,sneupiData(data,0))#appends the right bits to create instrument command
    if(endS[i+2]>=end):
        endS[i+2]=end
    else:
        start=endS[i+2]
        i=i+3
        sneupiDutycycleOn(data,start,end,sneupiOn,sneupiOff)
    return
def sneupiData(data,sm):
    s=BitArray(bin='')
    s.append('0b01010011') #SNeuPI startword
    s.append('0b00000') #SNeuPI zero padding
    if sm==0 :#rampup HV=0
        s.append('0b0')#  HV off
    else:
         s.append('0b1')
    if sm==0 :
         s.append('0b01')
    else:
        if(data['SNeuPI Mode']=='Sweep Emission'):
            s.append('0b00')
```

```
        elif(data['SNeuPI Mode']=='Standby Mission Mode'):
            s.append('0b01')
        elif(data['SNeuPI Mode']=='Emission Level A'):
            s.append('0b10')
        elif(data['SNeuPI Mode']=='Emission Level C'):
            s.append('0b11')
    return s

def linas(data,start,end):
    if(data['Duty Cycle linas']=='10'):
        linasDutycycleOn(data,start,end,lton[0],ltoff[0])
    elif(data['Duty Cycle linas']=='20'):
        linasDutycycleOn(data,start,end,lton[1],ltoff[1])
    elif(data['Duty Cycle linas']=='50'):
        linasDutycycleOn(data,start,end,lton[2],ltoff[2])
    elif(data['Duty Cycle linas']=='100'):
        linasDutycycleOn(data,start,end,(start-end).total_seconds(),0)

def linasDutycycleOn(data,start,end,linasOn,linasOff):
    global j
    startL.insert(j,start)
    endL.insert(j,startL[j]+datetime.timedelta(0,2))
    aL.insert(j,linasData(data,0))#appends the right bits to create instrument command(off)

    startL.insert(j+1,endL[j])
    endL.insert(j+1,startL[j+1]+datetime.timedelta(0,2))
    aL.insert(j+1,linasData(data,1))#appends the right bits to create instrument command(ARM)

    startL.insert(j+2,endL[j+1])
    endL.insert(j+2,startL[j+2]+datetime.timedelta(0,linasOn-4))
    aL.insert(j+2,linasData(data,2))#appends the right bits to create instrument command(ON)

    if(endL[j+2]>=end):
        endL[j+2]=end
    else:
        linasDutycycleOff(data,endL[j+2],end,linasOn,linasOff)
    return

def linasDutycycleOff(data,start,end,linasOn,linasOff):
    global j
    startL.insert(j+3,start)
    endL.insert(j+3,startL[j+3]+datetime.timedelta(0,linasOff))
    aL.insert(j+3,linasData(data,0))#appends the right bits to create instrument command
    if(endL[j+3]>=end):
        endL[j+3]=end
    else:
        start=endL[j+3]
        j=j+4
        linasDutycycleOn(data,start,end,linasOn,linasOff)
    return
def linasData(data,lm):
    l=BitArray(bin='')
    if(data['Filament (Main/Redundant)']=='1'):
        l.append('0b1')
    else:
        l.append('0b0')
    l.append('0b0')#Grid bias on/off
    l.append('0b0010')#Grid bias setting(change code here if u decide to enable other selections)
    if(data['Collector Gain State']=='Switch Gain at 10^-5 Torr'):
        l.append('0b001010')
```

```
    elif(data['Collector Gain State']=='Low Pressure Sensitive'):
        l.append('0b001001')
    elif(data['Collector Gain State']=='High Pressure Sensitive'):
        l.append('0b010010')
    if lm==0:
        l.append('0b0000')
    elif lm==1:
        l.append('0b0110')
    elif lm==2:
        l.append('0b1001')
    l.append('0b11111010')#LINAS end word
    return l


def rpaData(data):
    r=BitArray(bin='')
    r.append('0b10101010') #RPA startword
    if(data['RG2Mode']=='Constant Value'):#step size
        r.append(format(0, '#018b'))
    else:
        r.append('0b0000010000000000')
    r.append('0b01000000')
    r.append('0b00000')
    if(data['Second Grid Setting']=='Aperture'):
        r.append('0b1')
    elif(data['Second Grid Setting']=='Retarding Grid'):
        r.append('0b0')
    if(data['RG2Mode']=='Linear Sweep'):
        r.append('0b00')
    elif(data['RG2Mode']=='Constant Value'):
        r.append('0b01')
    elif(data['RG2Mode']=='Smart Sweep'):
        r.append('0b10')
    return r
```

```
#-----------------------------calendarUpdate.py----------------------------------
import app
import binascii
def writecalendarData(data,start,end,allDay):
    if(data['LIIBMode']=='Normal'):
        calendarData=['R','n','n','L','n','n','n','S','n','n']
        if (data['opmode']=='Standby'):
            calendarData="NStdby"
        elif (data['opmode']=='SNeuPI'):
            sneupiC(data,calendarData)

        elif(data['opmode']=='LINAS'):
             linasC(data,calendarData)

        elif(data['opmode']=='Neutral'):
            linasC(data,calendarData)
            sneupiC(data,calendarData)

        elif(data['opmode']=='Plasma'):
            rpaC(data,calendarData)

        elif(data['opmode']=='HRC'):
            rpaC(data,calendarData)
            sneupiC(data,calendarData)

        elif(data['opmode']=='LRC'):
            rpaC(data,calendarData)
            linasC(data,calendarData)

        elif(data['opmode']=='Prime Science'):
            rpaC(data,calendarData)
            linasC(data,calendarData)
            sneupiC(data,calendarData)

        calendarData = ''.join(calendarData)
    else:
        calendarData=data['LIIBMode']

    app.db.session.add(app.calendar(calendarData,start,end,allDay))
    app.db.session.commit()
    return

def rpaC(data,calendarData):
    if(data['RG2Mode']=='Linear Sweep'):
        calendarData[1]='l'
    elif(data['RG2Mode']=='Constant Value'):
        calendarData[1]='c'
    elif(data['RG2Mode']=='Smart Sweep'):
        calendarData[1]='s'
    if(data['Second Grid Setting']=='Aperture'):
        calendarData[2]='a'
    elif(data['Second Grid Setting']=='Retarding Grid'):
        calendarData[2]='r'
    return calendarData

def linasC(data,calendarData):
    calendarData[4]=data['Duty Cycle linas']
    if(data['Collector Gain State']=='Switch Gain at 10^-5 Torr'):
        calendarData[5]='s'
    elif(data['Collector Gain State']=='Low Pressure Sensitive'):
```

```
        calendarData[5]='l'
    elif(data['Collector Gain State']=='High Pressure Sensitive'):
        calendarData[5]='h'
    calendarData[6]=data['Filament (Main/Redundant)']
    return calendarData

def sneupiC(data,calendarData):
    calendarData[8]=data['Duty Cycle Sneupi']
    if(data['SNeuPI Mode']=='Sweep Emission'):
        calendarData[9]= 's'
    elif(data['SNeuPI Mode']=='Standby Mission Mode'):
        calendarData[9]='sb'
    elif(data['SNeuPI Mode']=='Emission Level A'):
        calendarData[9]='a'
    elif(data['SNeuPI Mode']=='Emission Level C'):
        calendarData[9]='c'
    return calendarData
```

Appendix D

Uplink command bit representation

The uplink command schedule generator creates a 96-bit or 2*96-bit representation based on the user selection. This appendix discusses the representation. The *green* selections in the tables mean that the user selects those values in the UI while the *blue* selection means that an appropriate value is hardcoded in the back-end based on the specifications. Each of the instruments and system specifications are discussed below.

LIIB (16 bits) The UCG first checks the LIIB mode entered by the user. It uses the Table D.1 to represent the user selection. The uplink command sequence always begins with the LIIB start word. It is followed by a five bit LIIB mode representation. Here, the LIIB can be in the *Normal*; data collection mode or one of the *Thermal Knife* modes. The *Normal* mode means that the instruments can be OFF (*Standby mode*) or any/all the instruments can be ON. Table D.1 defines each of the *opmodes*. If the *Thermal Knife* mode is ON, then the *opmode* is *Standby*(housekeeping data are gathered). If any of the instruments are turned OFF, their bits are represented as *zero* in the 96-bit command sequence.

RPA (40 bits) RPA data form the next 40 bits of the command sequence. Table D.2 represents the user selection. The *RG2 mode* and *Sweep mode* are based on the user's selection in the UI. The UCG adds the remaining bits to the sequence. The *step size* value

LIIB Mode Command Definition	
Start Word LIIB Value	Bit
Normal Operation LIIB	1000011
LIIB Mode	Bit
Normal	00000
TK1 Charge (TK1C)	00111
TK1 Discharge (TK1D)	01010
TK2 Charge (TK2C)	11100
TK2 Discharge (TK2D)	10101
TK Override (TKO)	11011
Op Mode (opmode)	Bit
Standby (Instruments OFF)	000
SNeuPI ON	001
LINAS ON	010
Neutral (LINAS, SNeuPI ON)	011
Plasma (RPA ON)	100
High res correlation (RPA, SNeuPI ON)	101
Low res correlation (RPA, LINAS ON)	110
Prime Science (All Instruments ON)	111

Figure D.1: **Table for LIIB command definition.**The LIIB command definition representation.

depends on the user's *sweep mode* selection.

SNeuPI(16 bits) SNeuPI forms the next 16 bits of the command sequence. Table D.3 represents the user selection. The *emission mode* is based on the user's selection on the UI. The UCG adds the remaining bits to the sequence. The *High Voltage(HV) status* is 0 for the first two seconds from SNeuPI being turned ON. Its value is 1 for the remaining ON time. If the instruments emission mode is selected to be *sweep emission* then the need for a special 2* 96 bit command sequence arises.

LINAS(24 bits) LINAS forms the last 24 bits of the command sequence. Table D.4 represents the user selection. The *collector gain state* and *filament* are based on the user's selection on the UI. The UCG adds the remaining bits to the sequence. The *Filament ON/OFF status* is OFF for the first two seconds from the time LINAS is turned ON. This is followed by one second of the filament being in the ARM state followed by it moving to

RPA Command Definition	
Start Word RPA Value	Bit
Start Word RPA	10101010
Step Size Value OR RG Voltage	Bit
Constant Voltage mode	00000000 00000000
Linear/Smart sweep mode	00000100 00000000
Points per Sweep Value	Bit
64	01000000
Zero Padding	Bit
Zero Padding	00000
RG2 Mode Value	Bit
Retarding (Swept w/ RG1)	0
Aperture (Grounded)	1
Sweep Mode Value	Bit
Linear Sweep	00
Constant Voltage	01
Smart Sweep	10

Figure D.2: **Table for RPA command definition.**The RPA command definition representation.

SNeuPI Command Definition	
Start Word SNeuPI Value	Bit
Start Word SNeuPI	01010011
Zero Padding	Bit
Zero Padding	00000
HV Status	Bit
HV OFF	0
HV Start/Stay ON	1
Emission Mode	Bit
Sweep Emission	00
Emission OFF	01
Emission Level A	10
Emission Level C	11

Figure D.3: **Table for SNeuPI command definition.**The SNeuPI command definition representation.

the ON state. This ramp up time specification gives rise to a 2*96-bit command sequence.

LINAS Command Definition	
Filament Select	Bit
Filament 1 (Main)	1
Filament 2 (Redundant)	0
Grid Bias On/Off	Bit
Grid Bias Off	0
Grid Bias Setting	Bit
187 V	0010
Collector Gain State (low range, high range)	Bit
Switch Gain State at 10^-5 Torr	001 010
Constant "Low Pressure Sensitive" State	001 001
Constant "High Pressure Sensitive" State	010 010
Filament On/Off	Bit
Filament OFF	0000
Filament ARM	0110
Filament ON	1001
End Word LINAS Value	Bit
End Word LINAS	11111010

Figure D.4: **Table for LINAS command definition.**The LINAS command definition representation.

A 96-bit command sequence is generated for all the mode selections except two special cases. Taking all the valid 96-bit command strings into consideration a total of 1202 uplink modes are possible. The two special cases result in a 2*96-bit command sequence, as discussed below.

Special case

Figure D.5 shows the two special cases. If the user makes a selection to turn SNeuPI ON in *sweep emission* mode, a 2*96-bit command sequence will be generated. This is because the emission mode toggles between *sweep* and *emission level A* in this mode. The SNeuPI special case is depicted in the top two tables of Figure D.5. The top-left table shows the SNeuPI representation in the first 96 bits of the command while the top-right table shows SNeuPI's representation for the second 96-bit command structure.

The second special case is depicted in the bottom tables of Figure D.5. When LINAS is turned ON, its filament remains OFF for two seconds followed by it being in the ARM state and then the RUN state for the remaining ON duration. It is imperative that the filament ON state comes immediately after filament ARM state. Thus a 2*96-bit mode is created for this purpose. The bottom left table shows LINAS in filament ARM state which forms the first half of LINAS's representation in the command string. The bottom right table represents the second half. The remaining 96 bits are not affected by this selection.

These special cases result in an added 343 modes representing the 2*96-bit commands. This results in a total of 1545 unique modes.

SNeuPI Command Definition	
Start Word SNeuPI Value	Bit
Start Word SNeuPI	01010011
Zero Padding	Bit
Zero Padding	00000
HV Status	Bit
HV OFF	0
HV Start/Stay ON	1
Emission Mode	Bit
Emission Level A	10

SNeuPI Command Definition	
Start Word SNeuPI Value	Bit
Start Word SNeuPI	01010011
Zero Padding	Bit
Zero Padding	00000
HV Status	Bit
HV OFF	0
HV Start/Stay ON	1
Emission Mode	Bit
Sweep Emission	00

LINAS Command Definition	
Filament Select	Bit
Filament 1 (Main)	1
Filament 2 (Redundant)	0
Grid Bias On/Off	Bit
Grid Bias Off	0
Grid Bias Setting	Bit
187 V	0010
ollector Gain State (low range, high range	Bit
Switch Gain State at 10^-5 Torr	001 010
Constant "Low Pressure Sensitive" State	001 001
Constant "High Pressure Sensitive" State	010 010
Filament On/Off	Bit
Filament ARM	0110
End Word LINAS Value	Bit
End Word LINAS	11111010

LINAS Command Definition	
Filament Select	Bit
Filament 1 (Main)	1
Filament 2 (Redundant)	0
Grid Bias On/Off	Bit
Grid Bias Off	0
Grid Bias Setting	Bit
187 V	0010
Collector Gain State (low range, high range)	Bit
Switch Gain State at 10^-5 Torr	001 010
Constant "Low Pressure Sensitive" State	001 001
Constant "High Pressure Sensitive" State	010 010
Filament On/Off	Bit
Filament ON	1001
End Word LINAS Value	Bit
End Word LINAS	11111010

Figure D.5: **Table for 2*96 bit command cases.**Top two tables represent the SNeuPI case resulting in 2*96 bit command sequence while the bottom tables represent the LINAS case causing a 2*96 bit command sequence specification.

Appendix E

Expander Code Discussion

The codes for creating the *expander* explained in Chapter 5 are given below. The main file is *expander.cpp* to comply with the flight computers conditions. It calls on a *look up table* which is a comma separated file to compare the mode ID with the 1545 possible modes.

```
//---------------------------------expander.cpp-------------------------------
// reading a text file
#include <iostream>
#include <fstream>
#include <string>
#include <sstream>
#include<stdint.h>
#include<stdlib.h>
#include<cstring>
#define SSTR( x ) static_cast< std::ostringstream & >( \
        ( std::ostringstream() << std::dec << x ) ).str()
using namespace std;
//give 2 pointers and mode as input

void expander(uint32_t mode, char *f_b, char *s_b)
{
  char temp1[100], temp2[200];
  std::string input = SSTR( mode );
  string command,mode_id;
  ifstream myfile ("lookupTable.csv");
  if (myfile.is_open())
  {
    while ( getline (myfile,command) )
    {
 string delimiter = ",";
 size_t pos = 0;
 mode_id="";
 while ((pos = command.find(delimiter)) !=string::npos) {
     mode_id = command.substr(0, pos);
     command.erase(0, pos + delimiter.length());

 }
  if(input.compare(mode_id)==0)
     {
  if(command.length()==96)
  {
   strcpy(temp1,command.c_str());
   for(int i=0;i<strlen(temp1);i++)
   {
    f_b[i]=temp1[i];
    s_b[i]=temp1[i];
   }

  }
  else
  {
   strcpy(temp2,command.c_str());
   int j=0;
   for(int i=0;i<strlen(temp2);i++)
   {
    if(i<96)
    {
     f_b[i]=temp2[i];
    }
    else
    {
     s_b[j]=temp2[i];
     j++;
    }
   }
```

```
  }

    }
 }
    myfile.close();
  }

  else cout << "Unable to open file";

  return;


}
int main () {
  uint32_t mode=1118074860;//32 bit mode ID
  char f_b[96],s_b[96];//constant buffers to LIIB
  expander(mode,f_b,s_b);
  for (int i=0;i<96;i++)
{
     cout<<f_b[i];

}
cout<<endl;
 for (int i=0;i<96;i++)
{
     cout<<s_b[i];

}
}
```

----------LookUpTable.csv----------

1118074860,01000011000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
2308061640,01000011001110000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
3839399705,01000011010100000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
573059563,01000011111000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
3587616080,01000011101010000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
3911090127,01000011110110000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
4083968492,01000011000000010000000000000000000000000000000000000000010100110000000000000000000000000000000000000000000000000000
1458043362,01000011000000010000000000000000000000000000000000000000010100110000000100000000000000000000000000000000000000000000
343003003,01000011000000010000000000000000000000000000000000000000010100110000001000000000000000000000000000000000000000000000
2985975669,01000011000000010000000000000000000000000000000000000000010100110000001100000000000000000000000000000000000000000000
2648732333,01000011000000010000000000000000000000000000000000000000010100110000010000000000000000000000000000000000000000000000
946594467,01000011000000010000000000000000000000000000000000000000010100110000010100000000000000000000000000000000000000000000
2063455290,01000011000000010000000000000000000000000000000000000000010100110000011000000000000000000000000000000000000000000000
3749069876,01000011000000010000000000000000000000000000000000000000010100110000011100000000000000000000000000000000000000000000
3766712851,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001010000011111010
2686075616,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001001000011111010
3377275073,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010010010000011111010
1638276916,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001010000011111010
557787079,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001000100100001111010
1214793190,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001001000011111010
3469725421,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001010011011111010
2388063774,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001001011011111010
3875640383,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010010010011011111010
1340779466,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001010011011111010
259232569,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001000100101101111010
1713697048,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001001001101111010
1818042943,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001010100111111010
751049420,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010001001100111111010
1167292653,01000011000000010000000000000000000000000000000000000000000000000000000000000000000000010010010100111111010

3984082712,01000011000000100000000000000000000000000000000000000000000000000000000000000100010001010100
111111010
2917236715,01000011000000100000000000000000000000000000000000000000000000000000000000000100010001001100
111111010
3300269514,01000011000000100000000000000000000000000000000000000000000000000000000000000100010010010100
111111010
1015719776,01000011000000100000000000000000000000000000000000000000000000010100110000000000000100010000
011111010
4106286109,01000011000000110000000000000000000000000000000000000000000000010100110000000100001000100000
011111010
3059139204,01000011000000110000000000000000000000000000000000000000000000010100110000001000001000100000
011111010
333271690,01000011000000110000000000000000000000000000000000000000000000010100110000001100001000101000000
11111010
1070038866,01000011000000110000000000000000000000000000000000000000000000010100110000010000001000100000
011111010
2588733276,01000011000000110000000000000000000000000000000000000000000000010100110000010100001000100000
011111010
3638221253,01000011000000110000000000000000000000000000000000000000000000010100110000011000001000100000
011111010
2102479307,01000011000000110000000000000000000000000000000000000000000000010100110000011100001000100000
011111010
298999008,01000011000000110000000000000000000000000000000000000000000000010100110000000000000100010000
11111010
3025784046,01000011000000110000000000000000000000000000000000000000000000010100110000000100001000100100
011111010
4140825207,01000011000000110000000000000000000000000000000000000000000000010100110000001000001000100100
011111010
1396992633,01000011000000110000000000000000000000000000000000000000000000010100110000001100001000100100
011111010
2136885153,01000011000000110000000000000000000000000000000000000000000000010100110000010000001000100100
011111010
3671447471,01000011000000110000000000000000000000000000000000000000000000010100110000010100001000100100
011111010
2554585398,01000011000000110000000000000000000000000000000000000000000000010100110000011000001000100100
011111010
1036546360,01000011000000110000000000000000000000000000000000000000000000010100110000011100001000100100
011111010
2021998273,01000011000000110000000000000000000000000000000000000000000000010100110000000000001001001000
011111010
3708726991,01000011000000110000000000000000000000000000000000000000000000010100110000000100001001001000
011111010
2677577814,01000011000000110000000000000000000000000000000000000000000000010100110000001000001001001000
011111010
974325848,01000011000000110000000000000000000000000000000000000000000000010100110000001100001001001000
11111010
369698176,01000011000000110000000000000000000000000000000000000000000000010100110000010000001001001000
11111010
3011687822,01000011000000110000000000000000000000000000000000000000000000010100110000010100001001001000
011111010
4044653335,01000011000000110000000000000000000000000000000000000000000000010100110000011000001001001000
011111010
1419711257,01000011000000110000000000000000000000000000000000000000000000010100110000011100001001001000
011111010
3496870196,01000011000000110000000000000000000000000000000000000000000000010100110000000010001000101000
011111010
1977979194,01000011000000110000000000000000000000000000000000000000000000010100110000000110001000101000
011111010
930326435,01000011000000110000000000000000000000000000000000000000000000010100110000001010001000101000
11111010

2465740717,0100001100000011000000000000000000000000000000000000000001010011000000111000100010100000111111010
3202488949,0100001100000011000000000000000000000000000000000000000001010011000001001000100010100000111111010
459901563,0100001100000011000000000000000000000000000000000000000001010011000001011000100010100000111111010
1509932258,0100001100000011000000000000000000000000000000000000000001010011000001101000100010100000111111010
4235472108,0100001100000011000000000000000000000000000000000000000001010011000001111000100010100000111111010
2432121287,0100001100000011000000000000000000000000000000000000000001010011000000001000100010010000111111010
897362377,0100001100000011000000000000000000000000000000000000000001010011000000011000100010010000111111010
2011864912,0100001100000011000000000000000000000000000000000000000001010011000000101000100010010000111111010
3529576286,0100001100000011000000000000000000000000000000000000000001010011000000111000100010010000111111010
4269482630,0100001100000011000000000000000000000000000000000000000001010011000001001000100010010000111111010
1542501000,0100001100000011000000000000000000000000000000000000000001010011000001011000100010010000111111010
426148881,0100001100000011000000000000000000000000000000000000000001010011000001101000100010010000111111010
3169653791,0100001100000011000000000000000000000000000000000000000001010011000001111000100010010000111111010
4188036070,0100001100000011000000000000000000000000000000000000000001010011000000001000100100100000111111010
1546374120,0100001100000011000000000000000000000000000000000000000001010011000000011000100100100000111111010
515767665,0100001100000011000000000000000000000000000000000000000001010011000000101000100100100000111111010
3140906367,0100001100000011000000000000000000000000000000000000000001010011000000111000100100100000111111010
2536259751,0100001100000011000000000000000000000000000000000000000001010011000001001000100100100000111111010
849858729,0100001100000011000000000000000000000000000000000000000001010011000001011000100100100000111111010
1882318384,0100001100000011000000000000000000000000000000000000000001010011000001101000100100100000111111010
3585766974,0100001100000011000000000000000000000000000000000000000001010011000001111000100100100000111111010
2131218669,0100001100000011000000000000000000000000000000000000000001010011000000000000100010100110111111010
3666624739,0100001100000011000000000000000000000000000000000000000001010011000000010000100010100110111111010
2551871098,0100001100000011000000000000000000000000000000000000000001010011000000100000100010100110111111010
1032971892,0100001100000011000000000000000000000000000000000000000001010011000000110000100010100110111111010
294374316,0100001100000011000000000000000000000000000000000000000001010011000001000000100010100111011111010
3019922338,0100001100000011000000000000000000000000000000000000000001010011000001010000100010100110111111010
4137053499,0100001100000011000000000000000000000000000000000000000001010011000001100000100010100110111111010
1394474293,0100001100000011000000000000000000000000000000000000000001010011000001110000100010100110111111010
1067378718,0100001100000011000000000000000000000000000000000000000001010011000000000000100010010110111111010

2585098256,01000011000000110000000000000000000000000000000000000000000001010011000000010000100010010110
11111010
3632483977,01000011000000110000000000000000000000000000000000000000000001010011000000010000010001001011
011111010
2097733255,01000011000000110000000000000000000000000000000000000000000001010011000000011000010001001011
011111010
1360196447,01000011000000110000000000000000000000000000000000000000000001010011000001000000010001001011
011111010
4103693137,01000011000000110000000000000000000000000000000000000000000001010011000001010000010001001011
011111010
3054458312,01000011000000110000000000000000000000000000000000000000000001010011000001100000010001001011
011111010
327468486,01000011000000110000000000000000000000000000000000000000000001010011000001110000100010010110
11111010
1456048703,01000011000000110000000000000000000000000000000000000000000001010011000000000000010010010011
011111010
4081195569,01000011000000110000000000000000000000000000000000000000000001010011000000010000010010010011
011111010
2983472296,01000011000000110000000000000000000000000000000000000000000001010011000000010000010010010011
011111010
341818534,01000011000000110000000000000000000000000000000000000000000001010011000000011000100100100110
11111010
944083326,01000011000000110000000000000000000000000000000000000000000001010011000001000000100100100110
11111010
2647523696,01000011000000110000000000000000000000000000000000000000000001010011000001010000010010010011
011111010
3747100649,01000011000000110000000000000000000000000000000000000000000001010011000001100000010010010011
011111010
2060691431,01000011000000110000000000000000000000000000000000000000000001010011000001110000010010010011
011111010
4263687626,01000011000000110000000000000000000000000000000000000000000001010011000000001000010001010011
011111010
1537811908,01000011000000110000000000000000000000000000000000000000000001010011000000011000010001010011
011111010
423564125,01000011000000110000000000000000000000000000000000000000000001010011000000101000100010100110
11111010
3165946707,01000011000000110000000000000000000000000000000000000000000001010011000000111000010001010011
011111010
2427367051,01000011000000110000000000000000000000000000000000000000000001010011000001001000010001010011
011111010
891633285,01000011000000110000000000000000000000000000000000000000000001010011000001011000100010100110
11111010
2008221724,01000011000000110000000000000000000000000000000000000000000001010011000001101000010001010011
011111010
3526924306,01000011000000110000000000000000000000000000000000000000000001010011000001111000010001010011
011111010
3199962425,01000011000000110000000000000000000000000000000000000000000001010011000000001000010001001011
011111010
456138039,01000011000000110000000000000000000000000000000000000000000001010011000000011000100010010110
11111010
1504062382,01000011000000110000000000000000000000000000000000000000000001010011000000101000010001001011
011111010
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