VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI - 590018

Dissertation Report on

"THERMAL MODELING AND TEMPERATURE COMPARISON OF IRNSS FLEET OF SPACECRAFTS"

Submitted in partial fulfilment of the requirements for the degree

BACHELOR OF ENGINEERING
IN
ELECTRONICS AND COMMUNICATION ENGINEERING

Submitted By

AJITH H.G	**4GH11EC003**
DARSHAN C.D	**4GH11EC017**
PRAJWAL GOWDA H.S	**4GH11EC043**
VAISHNAVI M	**4GH11EC061**

Under the Guidance of

Mrs. BHAGYALAKSHMI R, B.E, M. Tech
(Internal Guide)
Assistant Professor,
Dept. of ECE, GEC
Hassan – 573 201

Mr. RAJESH ANIL ALVA, BE, M.Tech
(External Guide)
Sci/Engr – SF, SO Group
Master Control Facility, ISRO
Hassan – 573 201

Department of Electronics and Communication Engineering

GOVERNMENT ENGINEERING COLLEGE,

HASSAN-573201

2014-2015

GOVERNMENT ENGINEERING COLLEGE

Dairy circle, Hassan-573 201

Department of Electronics & Communication Engineering

DECLARATION

We, **AJITH H.G, DARSHAN C.D, PRAJWAL GOWDA H.S AND VAISHNAVI M** the students of eighth semester BE, in **Electronics and Communication Engineering, Government Engineering College, Hassan**, declare that the project entitled **"THERMAL MODELING AND TEMPERATURE COMPARISON OF IENSS FLEET OF SPACECRAFTS"** has been carried out by us and submitted in partial fulfillment of the course requirement for the award of **Bachelor of Engineering in Electronics & Communication Engineering** of **Visveswaraya Technological University, Belgaum**, during the year 2014-2015. The matter embodied in this report has not submitted to any other university or institution for the award of any other degree or diploma.

AJITH H.G	**(4GH11EC003)**
DARSHAN C.D	**(4GH11EC017)**
PRAJWAL GOWDA H.S	**(4GH11EC043)**
VAISHNAVI M	**(4GH11EC061)**

ORGANISATION PROFILE

Master Control Facility

Master Control Facility (MCF) is a facility set up by Indian Space Research Organisation (ISRO) in the city of Hassan in the Indian state of Karnataka. Master Control Facility (MCF), Hassan is the prime control centre for all the geostationary communication satellites of India. This facility of national importance was established in 1980 – 81 at Hassan, based on the studies conducted on various aspects like low electromagnetic radiation noise, wide visibility of geo-synchronous etc.

MCF is currently controlling the fourteen geostationary belonging to the Indian National Satellite System (INSAT). INSAT is the one of the domestic satellite systems in Asia. INSAT – the multipurpose operational satellite system provides nation-wide TV broadcasting, domestic long distance telecommunication, meteorological Earth observation and radio relay networking. In recent times, INSATs are also being used for satellite based distance education, telemedicine applications, disaster warning etc.

MCF, being the prime control center for all these satellites is the focal point for analysis, operation scheduling and ground support for the various geo-stationary satellites programs of ISRO.

MCF supports telemetry, tracking, ranging and command operations of Geo-stationary satellites missions in all the phases like launch, the initial orbit raising, station acquisition and In-orbit of payloads and On-orbit operations till the end of the mission.

MCF is an integrated facility, consisting of multiple satellite control Earth Stations (SCES), Satellite Control Center (SCC), Mission Control Center (MCC), Computer networks, communication systems and utility support systems.

In a typical launch operation, MCF acquires the first signals from the newly launched satellite, immediately after its separation from the launch vehicle. After this, the satellite orbit raising operations, deployment of antennas and solar panels are carried out in a sequential manner as per pre-planned time line. Once the orbit is raised to a Geo-stationery altitude of 36000 km characterization of satellite transponders are done from MCF, Hassan.

MCF has radio visibility coverage extending from the Persian Gulf in the west to Australia in the East. This excellent geographical advantage makes MCF, Hassan an ideal location for controlling the Geo-stationery satellites.

The control operation at MCF is carried out on a round the clock basis, by a highly skilled manpower consisting of Engineers and Technician backed up with state of the art technical facilities.

ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without mentioning the people who made it possible. Many responsible for the knowledge and experience gained during work course. So, with deep gratitude I acknowledge all those guidance and encouragement served as bacon light and crowned my efforts with success.

We are very thankful to our beloved Principal **Dr. KARISIDDAPPA** for his kind support and encouragement

We express our deep sense of gratitude to **Mr. S PARAMESHWARAN**, Director, Master Control Facility, Hassan for approving our project and giving an opportunity to carry out the project at MCF.

We express our sincere thanks to **Mr. R THYAGARAJAN**, Manager-PPE, MCF Hassan for allowing us to carry out project and also for providing the technical facilities for the project.

We owe our profound gratitude to **Dr. PARAMESHA,** Head of the department, Electronics & Communication Dept, GEC, Hassan for the valuable guidance and encouragement lent by him right through.

We would like to express our sincere thanks to **Mrs. BHAGYALAKSHMI R,** Asst. professor and project co-ordinator and guide, Electronics & Communication Dept, GEC, Hassan whose kind consent and guidance helped me to successfully complete this work.

With due respect, We sincerely thank our external guide **Mr. RAJESH ANIL ALVA,** Scientist/Engineer, MCF Hassan whose has given his full effort in guiding the team in achieving the goal as well as his encouragement to maintain our progress in track.

And also we would like to express our gratefulness towards all the faculty members of Electronics & Communication Department, for their timely suggestions.

Lastly, we express our sincere gratitude for all the inspiration, enthusiasm and help given by our parents and friends.

ABSTRACT

Indian Regional Navigational Satellite System (IRNSS) is an autonomous regional satellite navigation system being developed by Indian Space Research Organisation (ISRO) which would be under complete control of the Indian government. The requirements of such a navigation system is driven by the fact that access to foreign government controlled GPS is not guaranteed in hostile situation. IRNSS would provide two services with the standard positioning service open for civilian use and the restricted service encrypted for authorised users. The objective of the IRNSS is to implement an independent and indigenous regional space borne navigation system for national applications. The objective of our project contains thermal modelling and temperature comparison of seven satellites of IRNSS. All the seven IRNSS satellites are similar in their outer geometry and in their inner thermal conditions. Thus in our project we are about to find the deviations in thermal conditions inside the IRNSS satellites which have a bearing on the precise frequency of the atomic clocks which are the prime payload of the IRNSS satellites.

TABLE OF CONTENTS

LIST OF FIGURES

Page No.

CHAPTER - 1

PREAMBLE

1.1 INTRODUCTION:

Navigation is the heart of getting from one place to another safely and efficiently. Navigation components used earlier were Polestar, Magnetic Compass, Astrolabe, Chip log. The 20th century has been advantageous for navigation tools for gyroscopic compass, Radar, Loran, Long range navigation. GPS initiated in 1973 is operated and maintained by US dept. This space based radio navigation system consists of 24 satellites and provides accurate positioning to about 30 feet as well as voltage and time in worldwide in any condition.

ISRO is developing a satellite based navigation system, called Indian Regional Navigation Satellite System (IRNSS), with a constellation of 7 satellites and complementary ground infrastructure. Four spare satellites are also planned. The IRNSS is expected to provide positional accuracies similar to the Global Positioning System (10 m over Indian landmass and 20 m over the Indian Ocean) in a region centred around the country with a coverage extending up to 1,500 km from India between longitude 40° E to 140° E and between latitude ± 40°. Besides accurate real time position, the system is designed to provide Navigation and Time (PNT) services to users on a variety of platforms with 24x7 service availability under all weather conditions. As in the case of GPS, IRNSS will provide a more accurate restricted service for special authorized users.

The proposed system would consist of a constellation of seven satellites and a support ground segment. Such an arrangement would mean all seven satellites would have continuous radio visibility with Indian control stations. The satellite payloads would consist of atomic clocks and electronic equipment to generate the navigation signals.

The navigation signals themselves would be transmitted in the S-band frequency (2–4 GHz) and broadcast through a phased array antenna to maintain required coverage and signal strength. The satellites would weigh approximately 1,330 kg and their solar panels generate 1,400 watts. The system is intended to provide an absolute position accuracy of better than 10 meters throughout Indian landmass and better than 20 meters in the Indian Ocean as well as a region extending approximately 1,500 km around India.

The ground segment of IRNSS constellation would consist of a Master Control Centre (MCC), ground stations to track and estimate the satellites orbits and ensure the integrity of the network (IRIM), and additional ground stations (TT&C stations) to monitor the satellites with the capability of issuing radio commands to them. The MCC would estimate and predict the position of all IRNSS satellites, calculate integrity, makes necessary ionospheric and clock corrections and run the navigation software. In pursuit of an independent system, an Indian standard time infrastructure would also be established.

1.2 AIM OF THE PROJECT:

The objective of our project contains thermal modelling and temperature comparison of the available IRNSS satellites.

- All the IRNSS satellites are similar in their outer geometry and in their inner thermal conditions and the space temperature varies from -200^0 C to +200^0 C.
- The atomic clock is the heart of a satellite which provides a greater accuracy in navigation. The atomic clock device like rubidium clock has a very low error as low as once in million sec. The precision of atomic clock depends on the temperature of the satellite. Hence maintaining the required thermal conditions is of greater importance.
- Thus, in our project we are going to calculate the bulk temperature of the each satellite and the thermal comparison of the components of each IRNSS satellite.
- And also we are comparing the thermal conditions of the IRNSS satellites.

1.3 MOTIVATION FOR THE PROJECT:

The requirements of a navigation system is driven by the fact that access to foreign government controlled GPS is not guaranteed in hostile situation. IRNSS would provide two services with the standard positioning service open for civilian use and the restricted service encrypted one for authorised users. With development of these satellites it also became necessary to monitor the inner region of the satellites as they are similar in design.

The accuracy of IRNSS is of greater importance when the matter of restricted uses like military application comes. As the accuracy of the navigation system depends on the atomic clock of the satellite which in turn depends on the temperature of it, there is a need of day to day evaluation of the thermal conditions of the IRNSS.

1.4 LITERATURE SURVEY:

The concept of satellite navigation was started from 1973 with the very first introduction of GPS. As the time passed in 1995 GPS navigation system becomes the very first global navigation system. There are various other systems for navigation, some are global navigation systems and some are regional navigation systems. This is the literature study on IRNSS systems and the modulation format which evolves through the time with special description for IRNSS.

In 1970s US military's Department of Defense (DOD) brings the concept of satellite navigation system. In the mid of 1990s, they started the world's first navigation system known as the global navigation system. For a long time there hadn't been any other navigation system available, but recently in 2010 Russia has launched their GLONASS global navigation system and the only other alternative for GPS. With the advancement in technology and need of positioning and tracking services of civil users various other countries has joined the race for their navigation system. Some systems are the global systems and some become regional navigation systems i.e. monitoring, tracking only a particular geographical region. The different navigation systems available are USA's GPS, Russia's GLONASS, Europe's Galileo Navigation System, India's IRNSS, Japan's QZSS, China's Compass.

1.4.1. Thermal analysis of GPS:

Thermal Analysis (ATH) extends the capability of GPS, allowing designers to understand the thermal behavior of their designs. The steady-state or transient temperature distribution can be calculated in response to the direct heating of a surface, the flow of a fluid past a surface, or the specified temperature of the surface. The thermal material properties can be temperature-dependent. When analyzing assemblies, the conductivity across the interface between contacting parts can be specified. ATH allows the temperature distribution in a part or an assembly to be determined, allowing designers to understand the thermal behavior of their designs. The calculated temperature distribution can be used to perform a thermal stress analysis in Nonlinear Structural Analysis (ANL) to study the effect of thermal-induced stresses and potential fatigue problems that they may cause. The steady-state capability allows the long-term temperature distribution to be determined. ATH also has the ability to analyze the transient thermal response, such as the effect of a thermal shock or a start-up event [1].

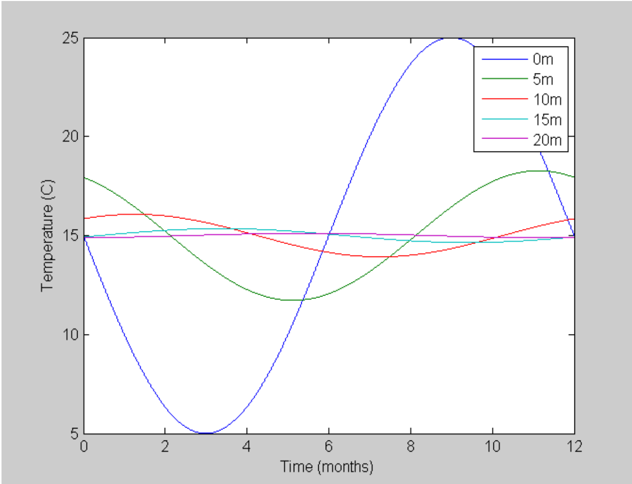


Fig 1.4.1: Thermal analysis of GPS

1.4.2. Thermal analysis of INSAT:

Earlier the thermal analysis was done for satellites like INSAT-1A, INSAT-1B etc., since the thermal analysis was done for each satellite and the components and the structure of every satellite was different, there was a no need of comparison of the satellite components. But when the matter of IRNSS comes, all the seven satellites have the same structure and similar components. Thus it became necessary to monitor the thermal conditions of the fleet as a whole by the MCF, Hassan.

1.5 PROBLEM DEFINITION:

For a fleet of IRNSS satellites monitoring the thermal conditions necessary, because of variable atmospheric conditions in space which makes very difficult to maintain uniformity in all fleet of satellites. This problem can be rectified by monitoring the thermal variations of the satellites and comparing them by plotting graph. In our project we have used java programming to rectify the problem.

1.6 METHODOLOGY:

1.6.1 Profile Matching

1.6.2 Rate of Rise of Temperature due to Thermal Degradation

1.6.3 Bulk Temperature

1.7 ADVANTAGES OF THE PROJECT:

1. Helps in day to day evaluation of the temperature of similar components of the IRNSS fleet by giving a table of comparison.
2. Can give advance information of an impending failure of a component or degradation, by its gradual rise in temperature compared to similar components in other spacecrafts.
3. The Bulk temperature comparison will help in predicting future temperature conditions and will also help to strategise replacement satellites if the temperature of the Atomic clocks or other components becomes unmanageable.

1.8 ORGANISATION OF THE REPORT:

Chapter 1: This includes introduction to the IRNSS satellites, aim of the project, motivation for our project, literature survey, problem definition, methodology, advantages of our project.

Chapter 2: This provides a brief theory relevant to our project.

Chapter 3: This chapter encloses the software utilised.

Chapter 4: This chapter provides what are the methodology we have undertaken for the purpose of our project.

Chapter 5: Provides review of our project that is about the coding part.

Chapter 6: Results and analysis will be provided in this chapter.

Chapter 7: Final conclusion of our project and future work.

CHAPTER – 2

THEORY RELEVANT TO PROJECT

2.1 IRNSS SATELLITES:

Each IRNSS satellite will weigh about 1,380 kg and their solar panels generate 1,400 Watt of power. The satellites will be configured with an optimized I-1K bus (compatible for launch onboard PSLV) with a power handling capability of around 1600W.

The satellite is designed for a nominal life of 7 years. Its payload will consist of electronic equipment to generate navigation signals and extremely accurate on-board atomic clocks. The navigation signals in S-band (2-4 GHz) are fed to a high performance phased array antenna for the required coverage. There is a ranging payload consisting of a C-band transponder that facilitates accurate determination of the range of the satellite. IRNSS-1A also carries corner-cube retro-reflectors for laser ranging [2-12].

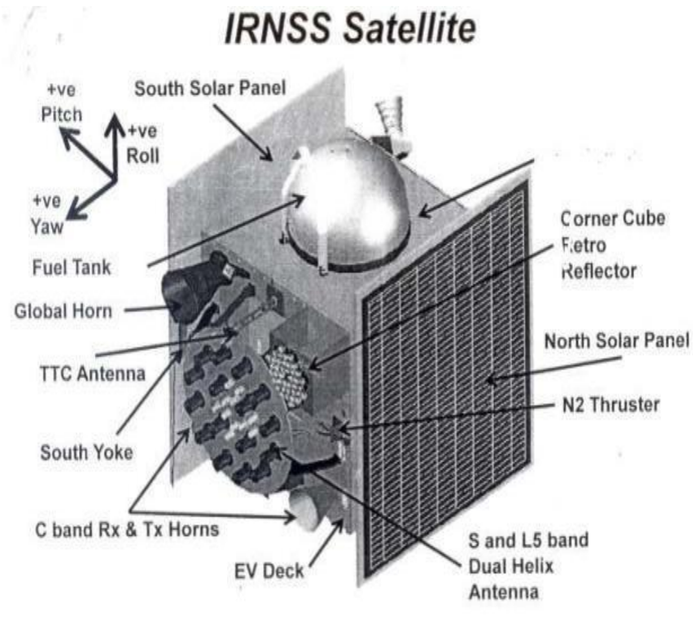


Fig 2.1: IRNSS Satellite

2.2 IRNSS ARCHITECTURE:

IRNSS is planned to have 7 satellites complemented with the appropriate ground infrastructure as a minimum. As it is traditional in GNSS systems, the architecture is described next in three different segments:

1. The space segment
2. The ground segment and
3. The user segment.

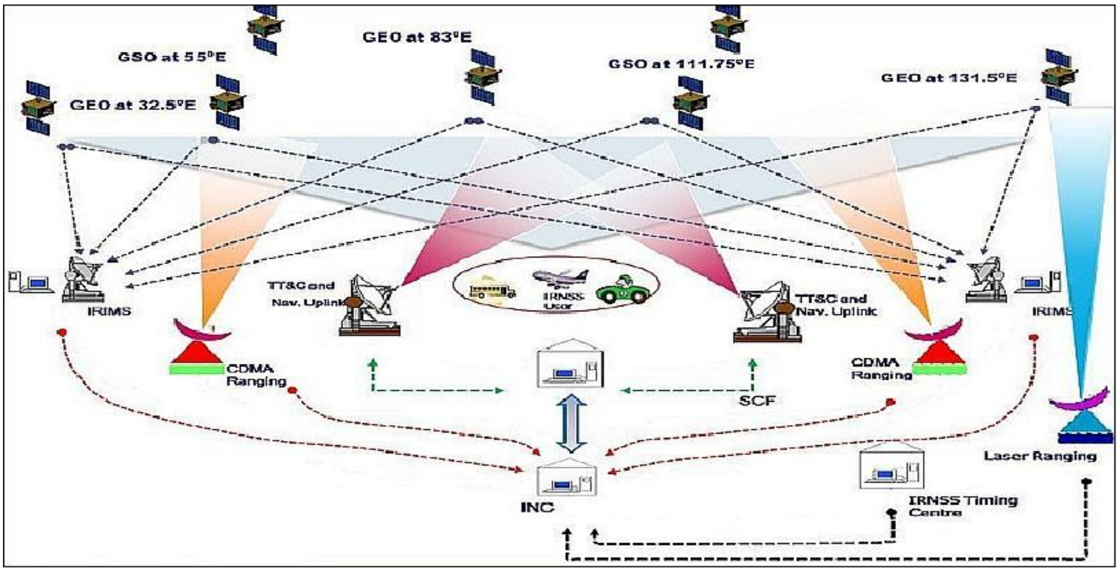


Fig 2.2: IRNSS Architecture

2.3 PARTS OF SATELLITES:

There are many kinds of satellites and many ways of building a satellite. Most satellites have similar parts however these parts include (1) radios to talk to people on earth; (2) rockets to move the satellite in space; (3) batteries to supply energy; and (4) computers to control the satellite.

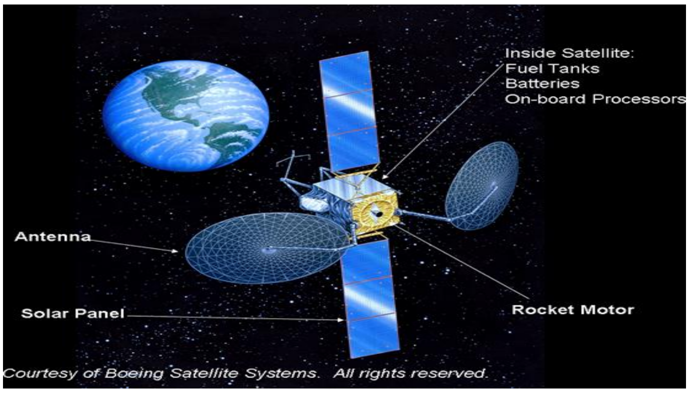


Fig 2.3: Parts of Satellite

- **Antennas and transceivers** send and receive radio signals to and from the Earth or another satellite;
- **Rocket motors** move the satellite in space;
- **Fuel tanks** store the fuel for the rocket;
- **Solar panels** use solar cells to turn the sun's energy into electricity;
- **Batteries** store the electricity generated by the solar panels; and.
- **On-board processors** provide the "brain" of the satellite and tell the satellite to do what humans want it to do [13].

2.4 SATELLITE SUBSYSTEMS:

Satellites have a great deal of equipment packed inside them. Most satellites have five subsystems and each one has special work to do.

1. The propulsion subsystem.
2. The Attitude Control Subsystem
3. The Power Subsystem
4. The Thermal Control Subsystem
5. Telemetry, Tracking and Command:

2.5 THERMAL CONTROL SUBSYTEM:

It keeps the active parts of the satellite cool enough to work properly. Without thermal control, electronics would overheat and cease to work. The thermal control system releases unnecessary heat into space, so that it will not interfere with satellite operations. It does this by directing the heat that is generated by satellite operations out into space, where it won't interfere with the satellite.

The thermal control subsystem design is configured for simple and reliable temperature control that provides the flexibility to accommodate variations in the spacecraft heat load. The approach to thermal control of the spacecraft uses conventional passive techniques such as selective placement of power dissipating components, application of surface finishes, and regulation of conductive heat paths. The passive design is augmented with heaters for certain components (particularly those with relatively narrow allowable temperature limits) and with louvers for the imager and sounder.

Overall temperature control of the main body is achieved by:

- Thermal energy dissipation of components and compensation heaters in the main body
- Absorption of solar energy, particularly by the optical solar reflectors (OSRs) on the north and south panels.
- Emission of infrared energy into space by the OSRs.

CHAPTER – 3

SOFTWARE REQUIREMENTS

The software that we have used in our project is JAVA. Java is an object-oriented programming language developed by Sun Microsystems. Java is a platform-independent, multi-threaded programming environment designed for creating programs and applications for the Internet and Intranets.

With Java Support for Microsoft Internet Explorer, Microsoft provides Java implementation that supports running Java programs in Microsoft Internet Explorer. Java is a general-purpose computer programming language that is concurrent, class-based, object-oriented and specifically designed to have as few implementation dependencies as possible. Programs written in Java have a reputation for being slower and requiring more memory.

The reason for choosing Java language for our project is:

- It is "simple, object-oriented and familiar".
- It is "robust and secure".
- It is "architecture-neutral and portable".
- It executes with "high performance".
- It is "interpreted, threaded, and dynamic" [14].

NetBeans is software development platform written in JAVA. The NetBeans Platform allows applications to be developed from a set of modular software components called modules. Applications based on the NetBeans Platform, including the NetBeans integrated development environment (IDE). NetBeans is cross-platform and runs on Microsoft Windows, Mac OS X, Linux, Solaris and other platforms supporting a compatible JVM.

The platform offers reusable services common to desktop applications, allowing developers to focus on the logic specific to their application. Among the features of the platform are:

- User interface management (e.g. menus and toolbars)
- User settings management
- Storage management (saving and loading any kind of data)
- Window management
- Wizard framework (supports step-by-step dialogs)
- NetBeans Visual Library

- Integrated development tools

NetBeans IDE is a free, open-source, cross-platform IDE with built-in-support for Java Programming Language.

Thus for these features we have used NetBeans software. The version we are using is NetBeans IDE 8.0.2. NetBeans IDE 8.0.2 provides out-of-the-box code analyzers and editors for working with the latest Java 8 technologies--Java SE 8, Java SE Embedded 8, and Java ME Embedded 8.0 [15].

CHAPTER - 4

METHODOLOGY

4.1 PROFILE MATCHING:

In this part we will match the thermal components of 1 IRNSS satellite with the other remaining satellites. Using Schemacs utilities we take the real time data of selected components of all satellites. The components can be selected with the PId (Parameter Identity) number they are assigned with. The data taken from the satellite is taken as the input and data is formatted and then these formatted data are plotted for each satellite components. The plot we obtain is temperature v/s time. From the obtained simulation the deviation of the temperature from one satellite to the other satellite can be matched. Thus the simulation of temperature v/s time (hours, days, months or years) is obtained by using JAVA programming.

4.2 RATE OF RISE OF TEMPERATURE PER YEAR DUE TO THERMAL DEGRADATION:

In this part we will take the data containing maximum, minimum and mean temperature. This data is also formatted and then they are made visible in tale format which makes easily to identify mean, maximum and minimum values of the satellite components. With the table format we will be able to know the rise of temperature per year due to thermal degradation.

4.3 BULK TEMPERATURE:

The satellite will be made of several components. Each component has its own thermal temperature. For each component, the average temperature is calculated. The average of average temperature of all the components in a satellite gives bulk temperature of the satellite.

4.4 DESIGNS FOR METHODOLOGY:

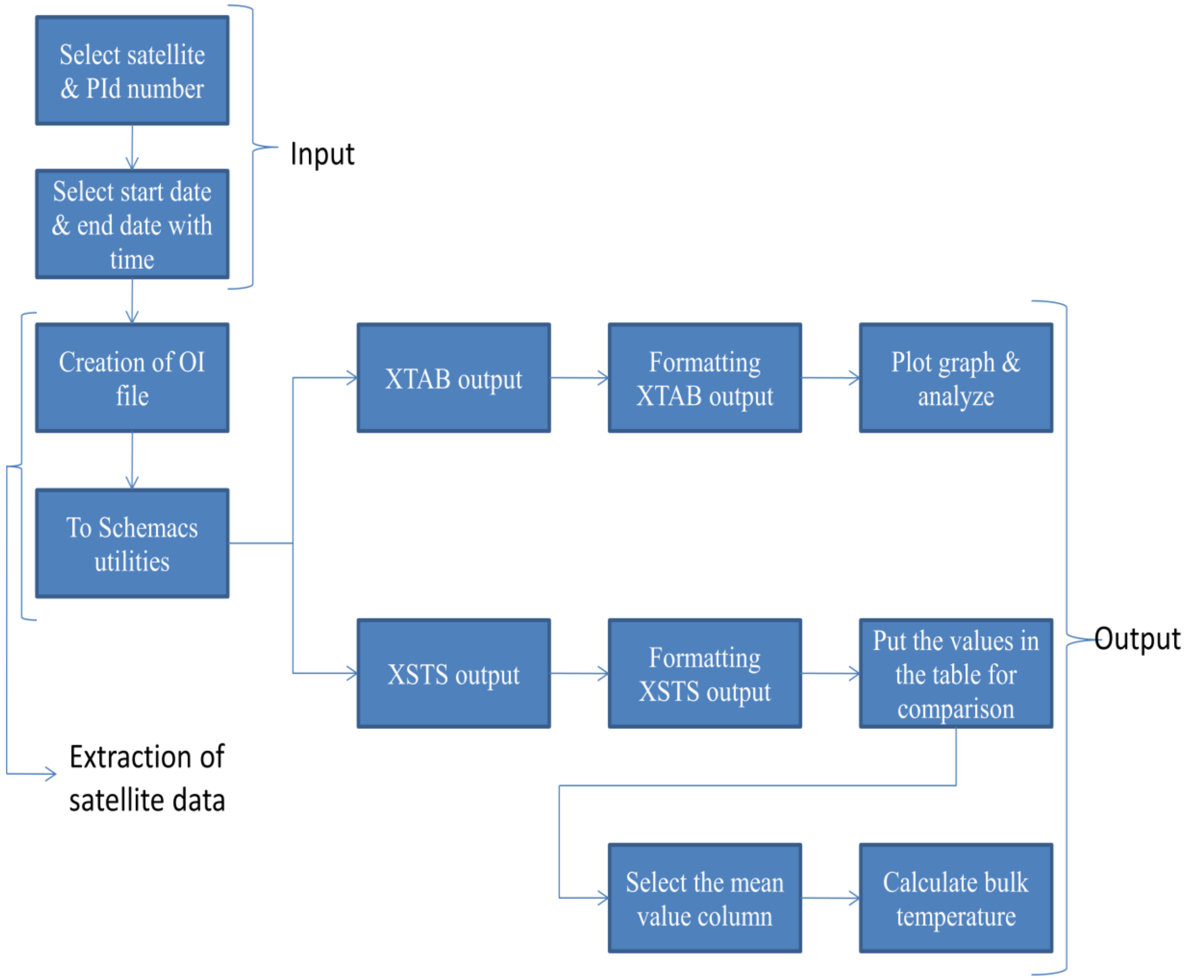


Fig 4.4: Block diagram for methodology

4.4.1 Steps involved:

Step 1: Select the input satellites to be compared monitored for thermal comparison and the Pid (Parameter Identity) numbers.

Step 2: Select the start date and end date so as to select the required period for analysis. With the selection of above parameters this produces the satellite data from Schemacs utilities.

Step 3: After obtaining the data select XTAB which provides data in the form of temperature components v/s time and XSTS which provides data in as mean, maximum and minimum temperature of the selected components of selected satellites.

Step 4: Create as many oi files as many satellites selected (dynamic).

Step 5: Create as many output files as many oi files created (dynamic).

Step 6: On passing an oi files in SCHEMACS utilities the corresponding output file to the oi file gets the satellite data for the defined period and selected PId.

Step 7: Format the obtained output files and save the files.

Step 8: From the formatted XTAB file plot the graph for each satellite. And also plot the graph for each parameter of all the satellites.

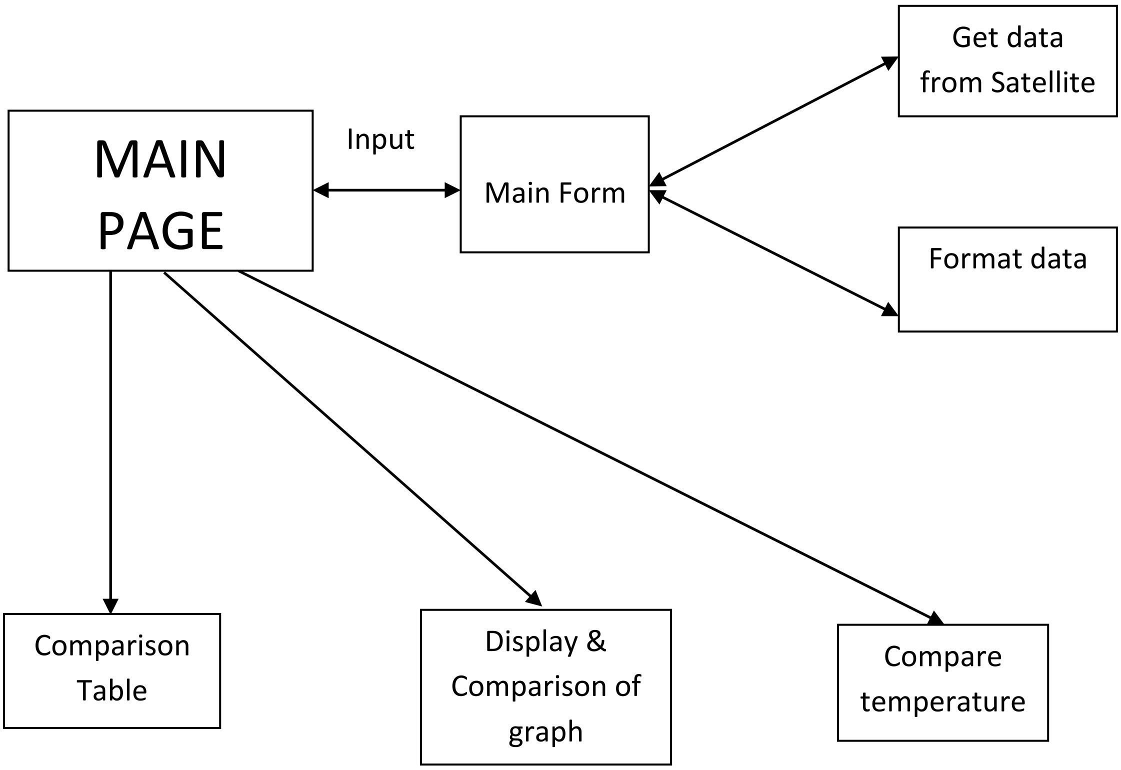
Step 9: From the formatted XSTS file put the minimum, maximum and means values of all the satellites selected to the comparison table.

Step 10: Extract the mean values of each satellite and calculate the average of averages so as to obtain the bulk temperature of each satellite.

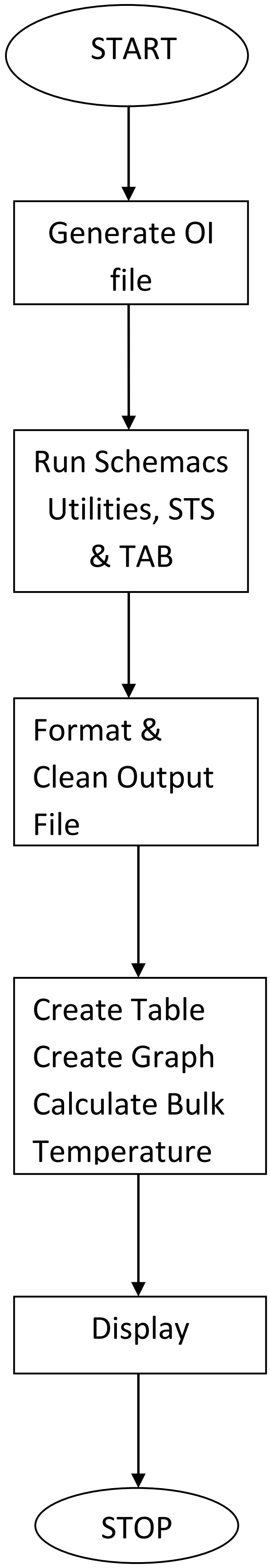
CHAPTER – 5

REVIEW OF THE PROJECT

5.1 LOGIC IMPLEMENTED IN DATA FLOW:



5.2 DATA FLOW DIAGRAM:

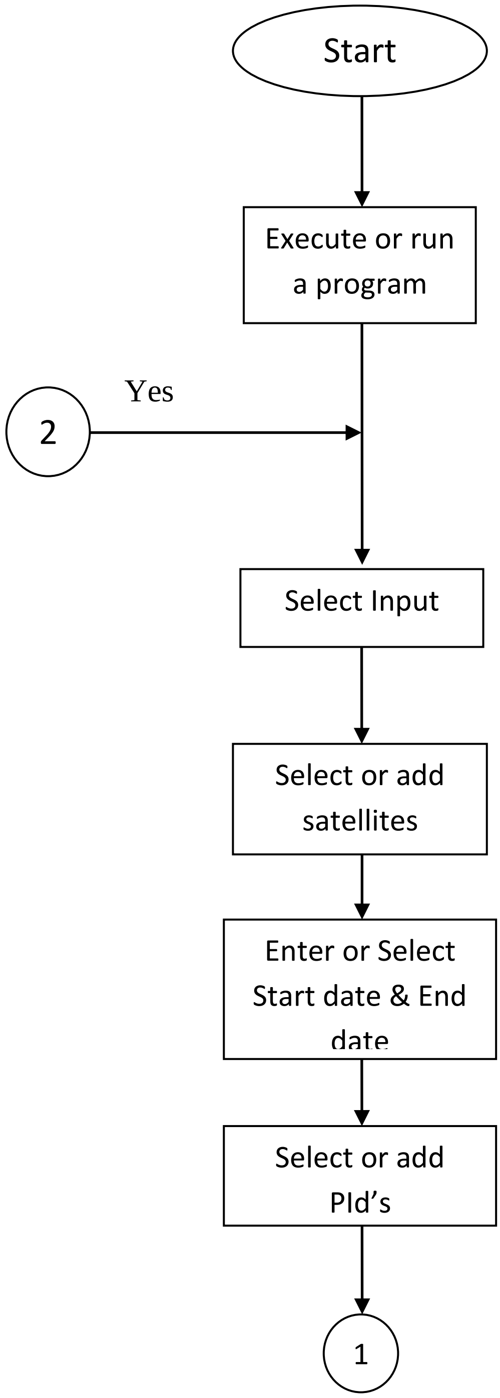


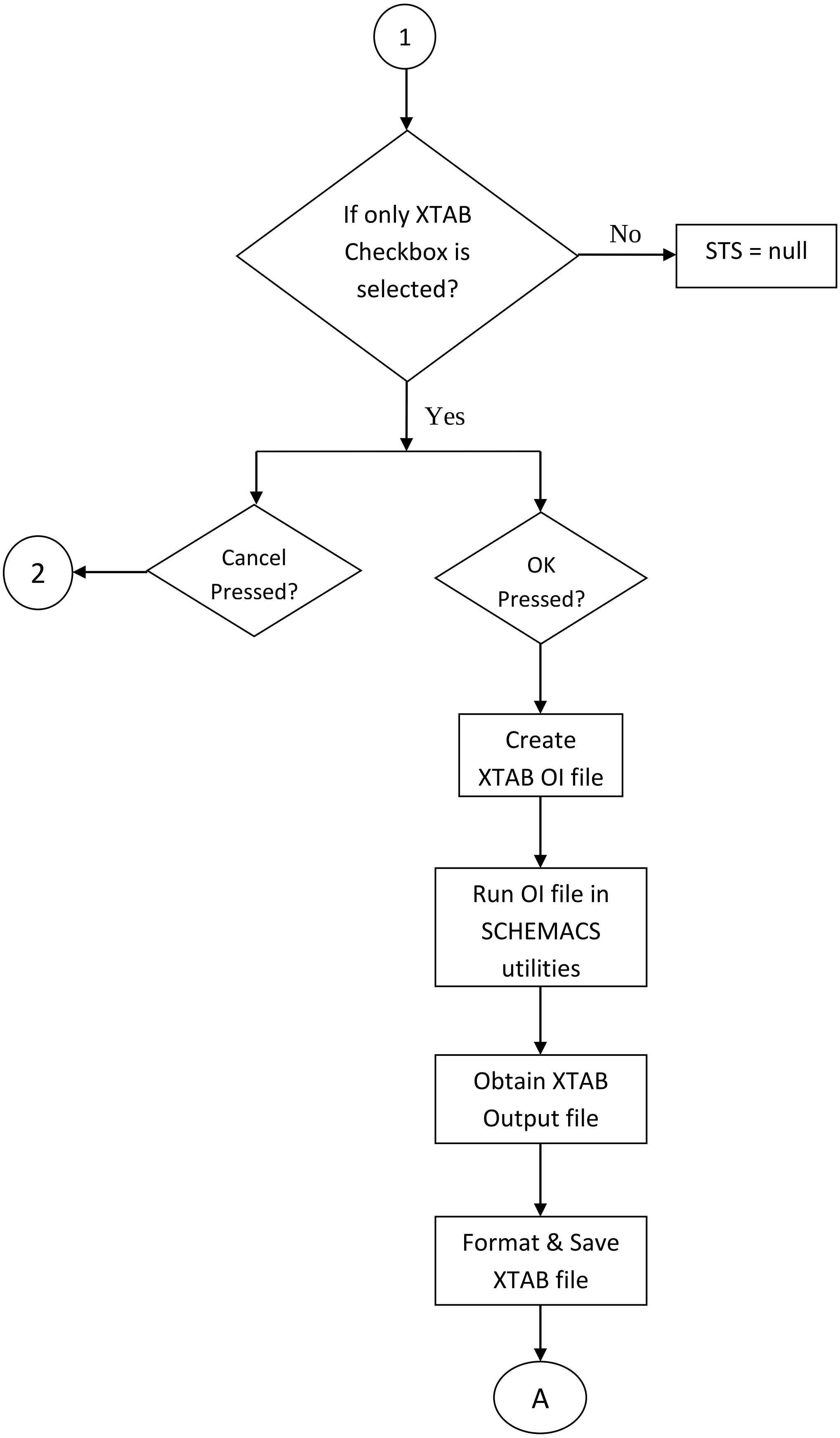
5.3 PROGRAM DESIGN:

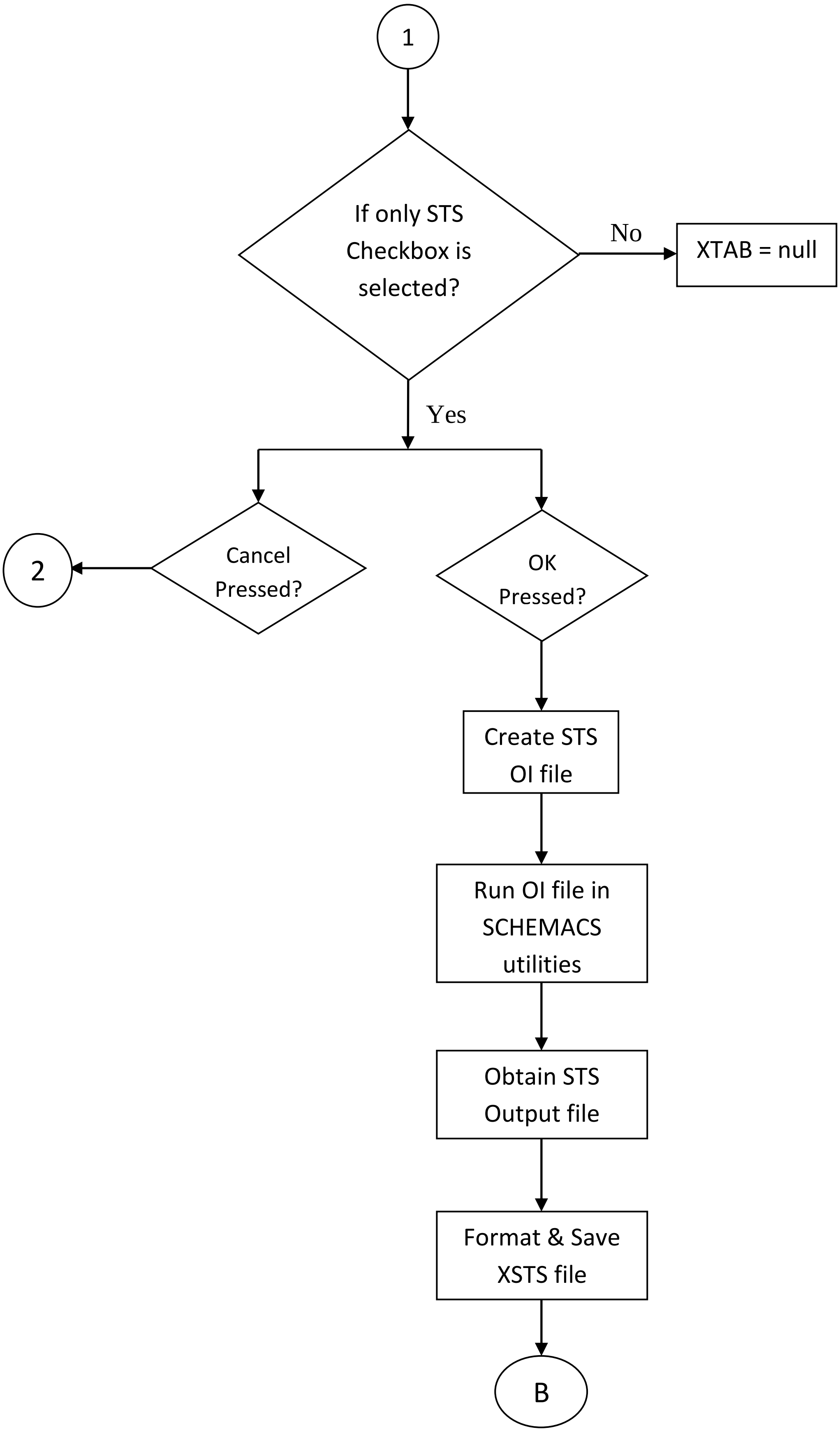
5.3.1 Creation of a main form for input:

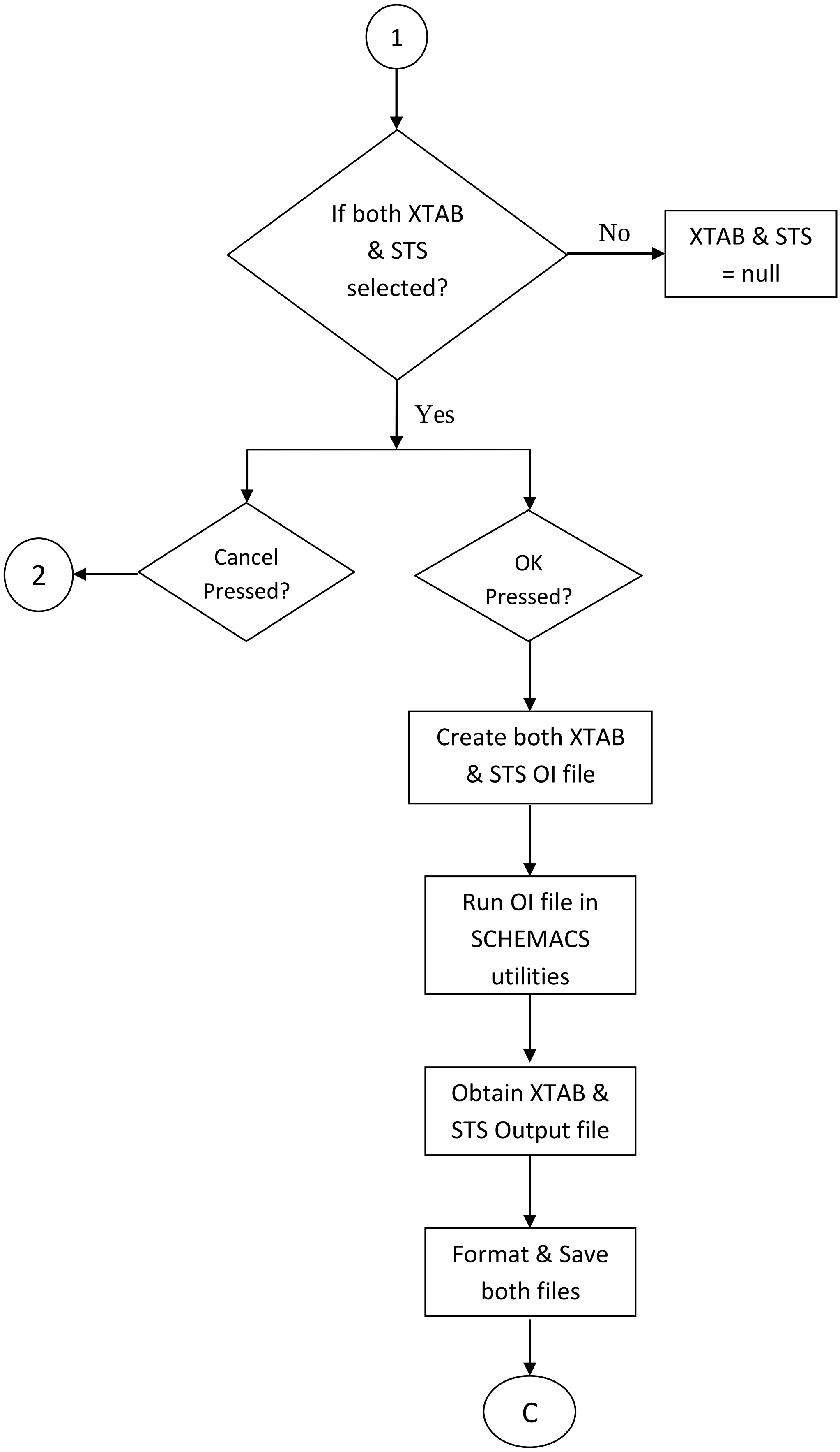
A button to select the satellite and the provision to add the satellite upon further launchings is given

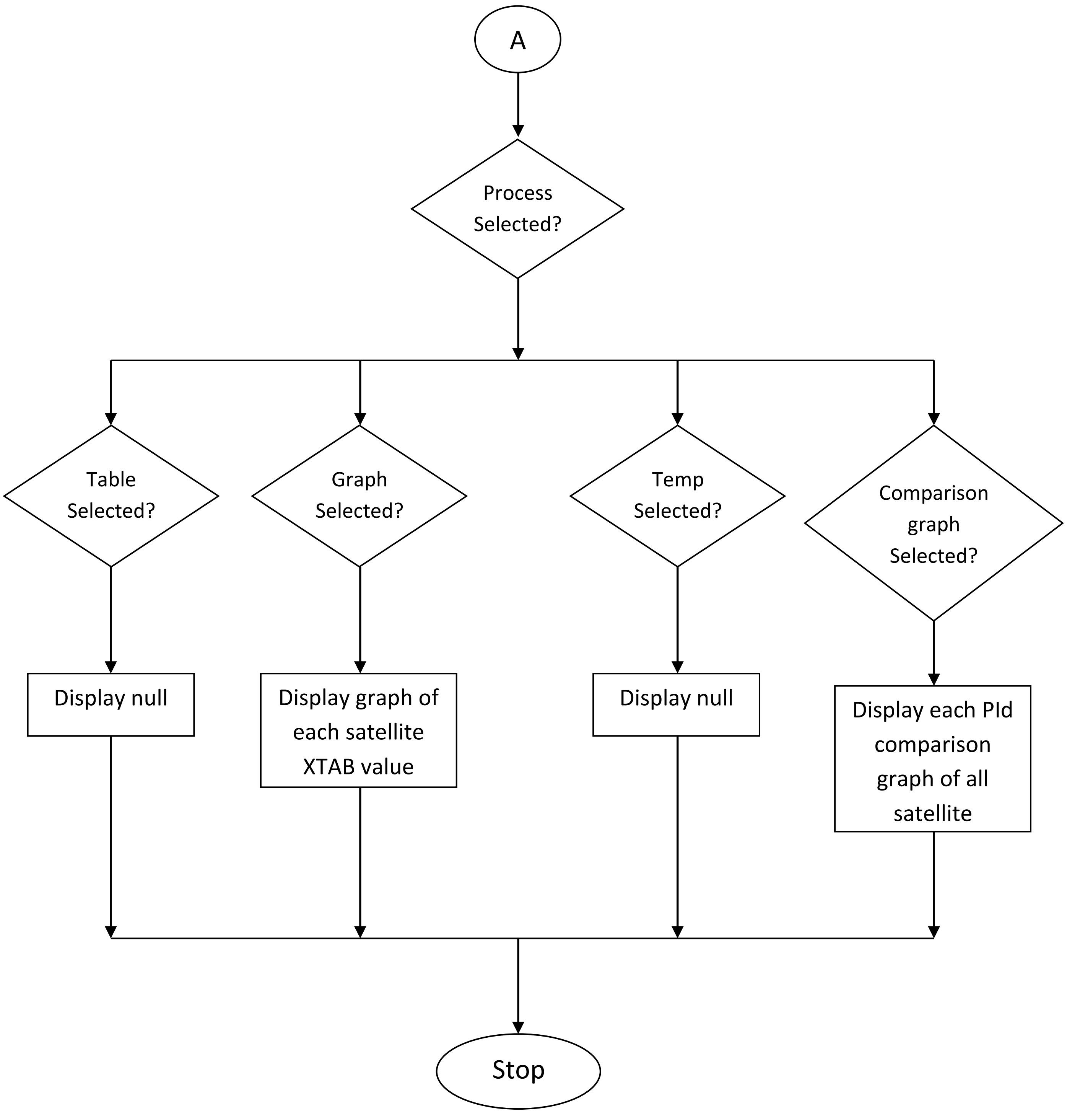
Main Flow Chart:

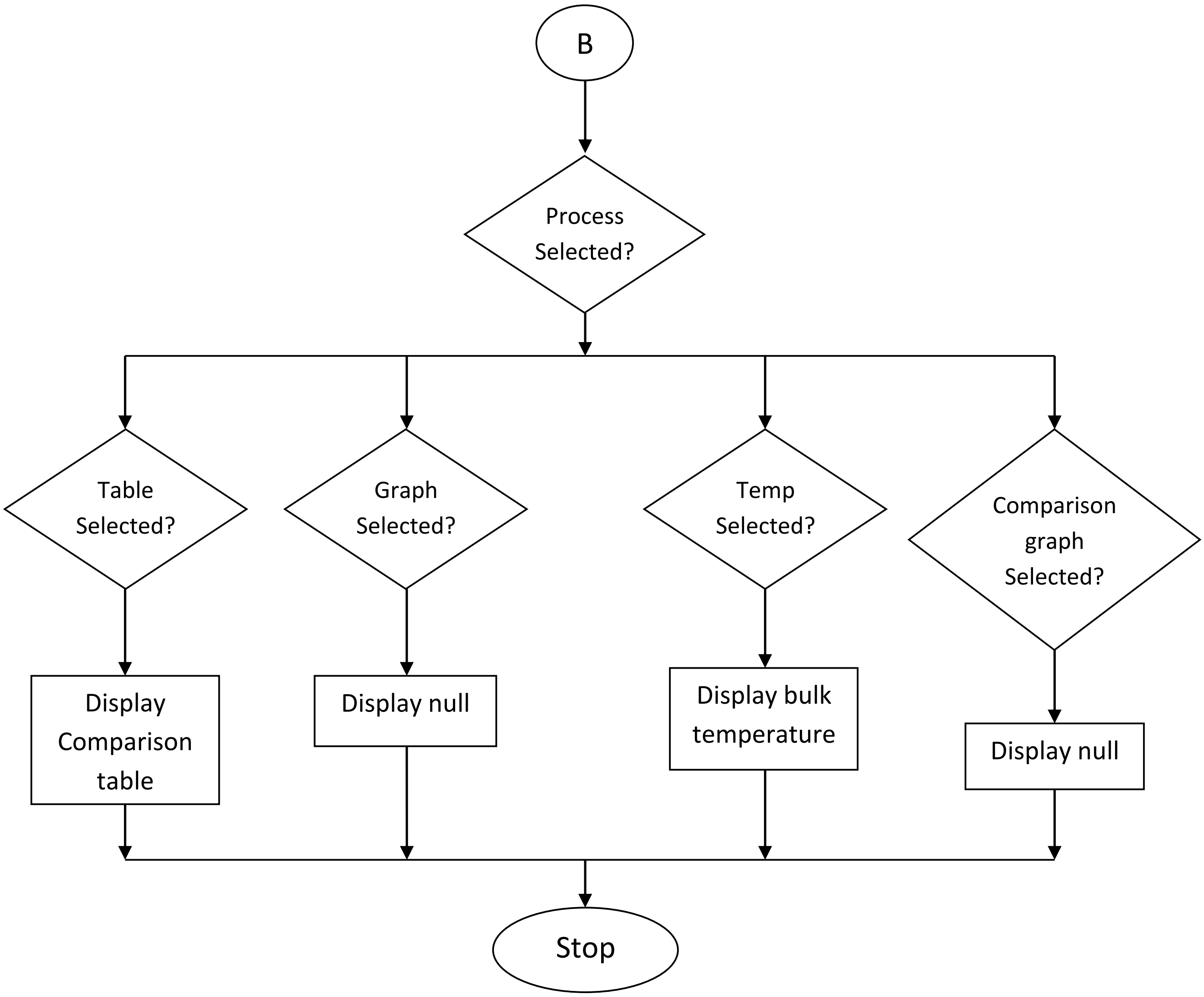


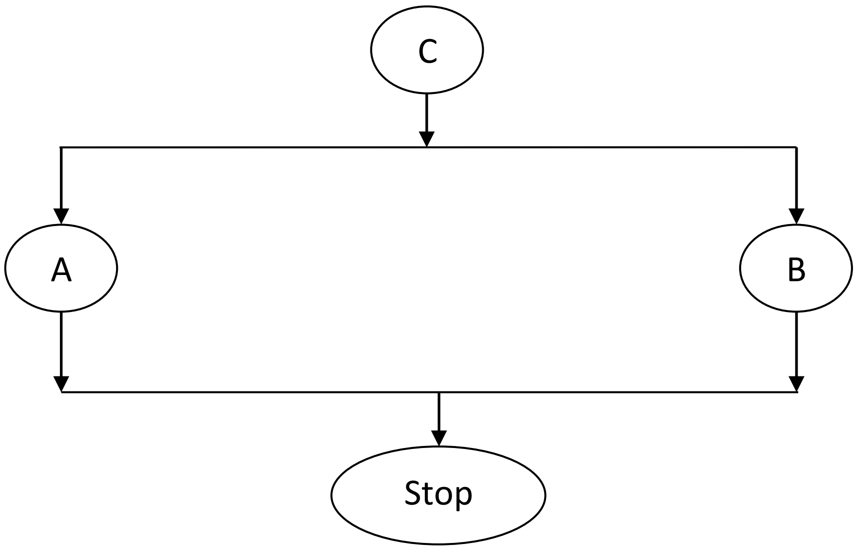

1
If only XTAB
Checkbox is
selected?
No
STS = null
Yes
2
Cancel
Pressed?
OK
Pressed?
Create
XTAB OI file
Run OI file in
SCHEMACS
utilities
Obtain XTAB
Output file
Format & Save
XTAB file
A


1
If only STS Checkbox is selected?
No
XTAB = null
Yes
Cancel Pressed?
2
OK Pressed?
Create STS OI file
Run OI file in SCHEMACS utilities
Obtain STS Output file
Format & Save XSTS file
B

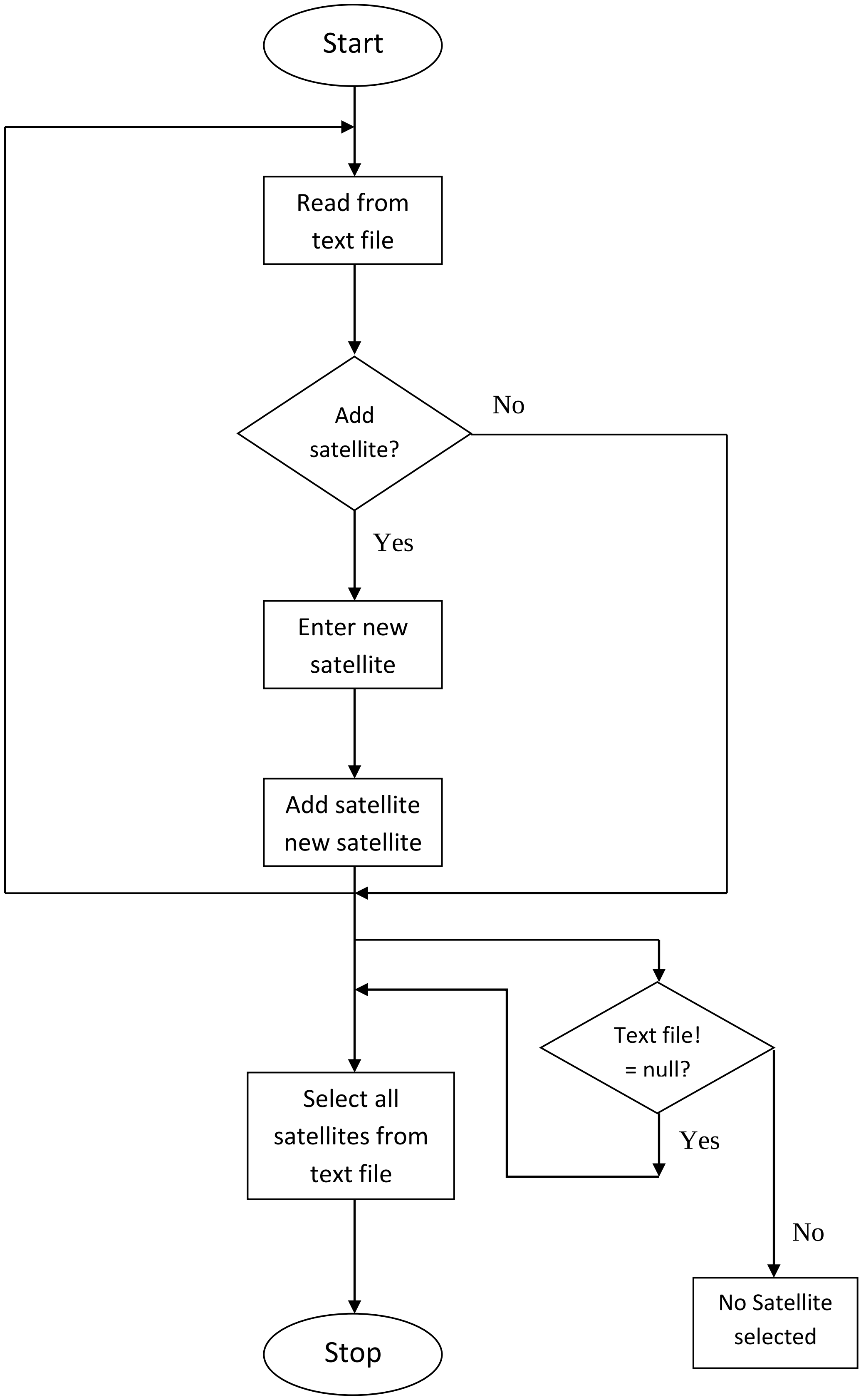

1
If both XTAB & STS selected?
No
XTAB & STS = null
Yes
Cancel Pressed?
2
OK Pressed?
Create both XTAB & STS OI file
Run OI file in SCHEMACS utilities
Obtain XTAB & STS Output file
Format & Save both files
C


A
Process Selected?
Table Selected?
Graph Selected?
Temp Selected?
Comparison graph Selected?
Display null
Display graph of each satellite XTAB value
Display null
Display each PId comparison graph of all satellite
Stop


B
Process Selected?
Table Selected?
Graph Selected?
Temp Selected?
Comparison graph Selected?
Display Comparison table
Display null
Display bulk temperature
Display null
Stop


C
A
B
Stop

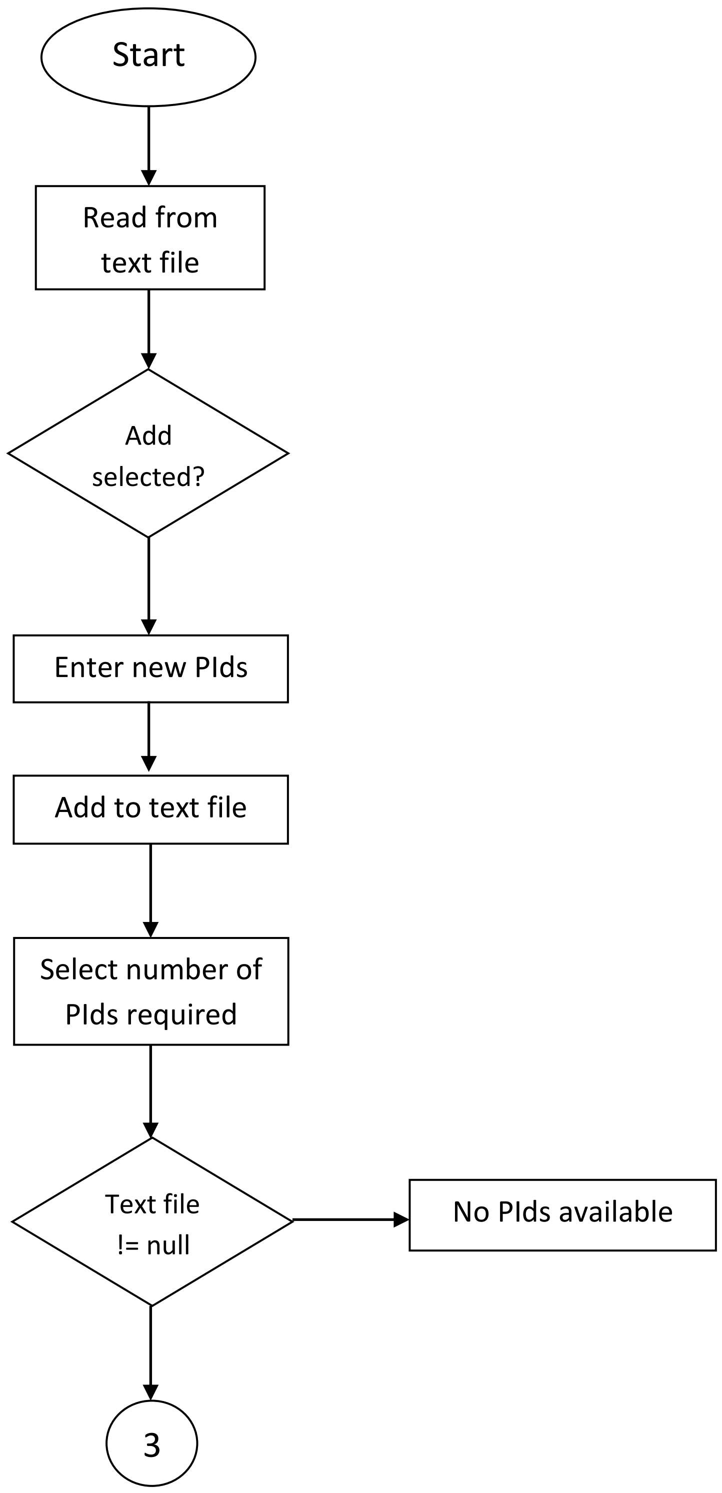
Flow Chart for Selecting or Adding Satellites:

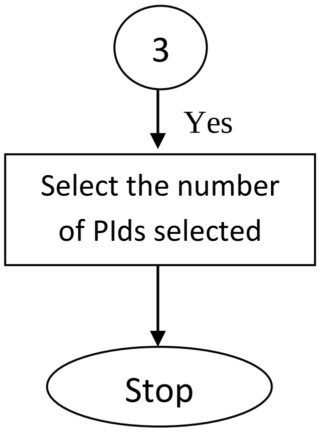


Adding PIds:

- A button to select the start date and end time should be given.
- Adding PIDs and selecting the PIDs option is given in an input pop up box.

Flow Chart for adding the PIds:

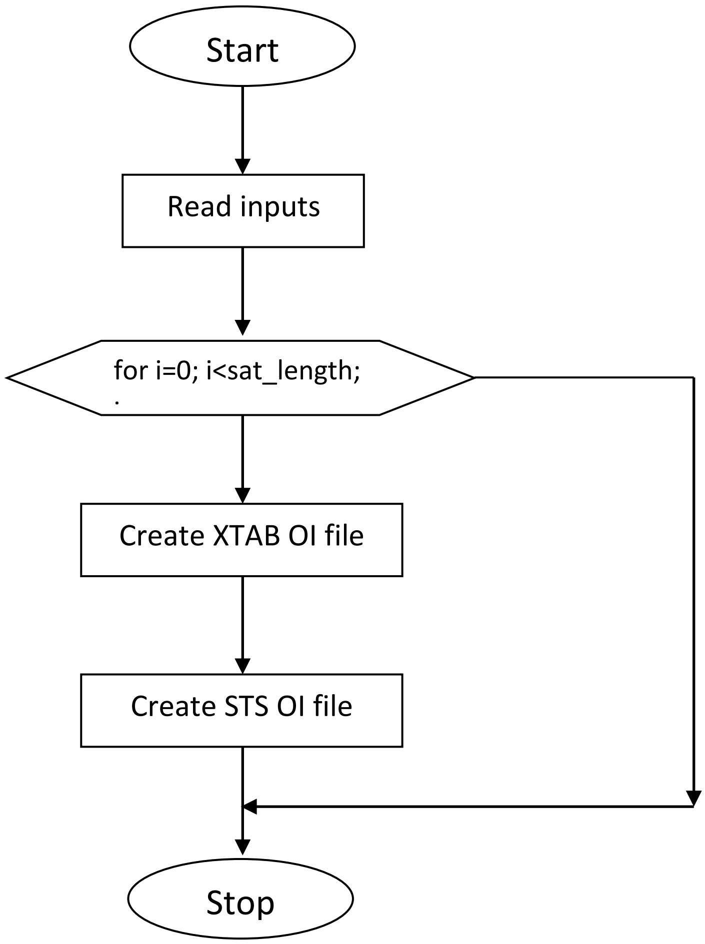




5.3.2 Creation of oi file:

- Upon selecting the satellites, start and end date, the PIDs and the type (XTAB and STS) and pressing the ok, OI file should be created in a background.

Flow Chart for the creation of XTAB & STS OI file:



5.3.3 Extracting The Satellite Data:

- The OI file created is passed through SCHEMACS utilities to get the satellite data using the command;

  String command="Xtab -f "+"oifiles/"+fname+".oi";

  Process1(command);

  Upon executing the above command XTAB type data of the satellites can be obtained.
- Similarly in order to obtain the STS type data the command used is

  String command="Xsts -f "+"oifiles/"+fname+".oi";

  Process1(command);

5.3.4 Formatting the Data:

- The XTAB and STS type of data obtained from the SCHEMACS utilities contains some unwanted columns or rows or empty lines which need to be formatted.

Xtab Formatting:

- The XTAB data extracted from SCHEMACS utilities by using OI file is formatted in a format of dd mm yyyy hh mm ss w1 w2 w3. (where w1, w2, w3 are the temperatures of the components of the satellites).

Sts Formatting:

- STS type data is formatted so as to extract the minimum, maximum and mean temperature of the satellites and to remove the other lines that we obtain from the SCHEMACS utilities.

5.3.5 Output:

Plotting a Graph for Xtab Format:

- The formatted XTAB data is used to plot that and used for comparison and thermal analysis.

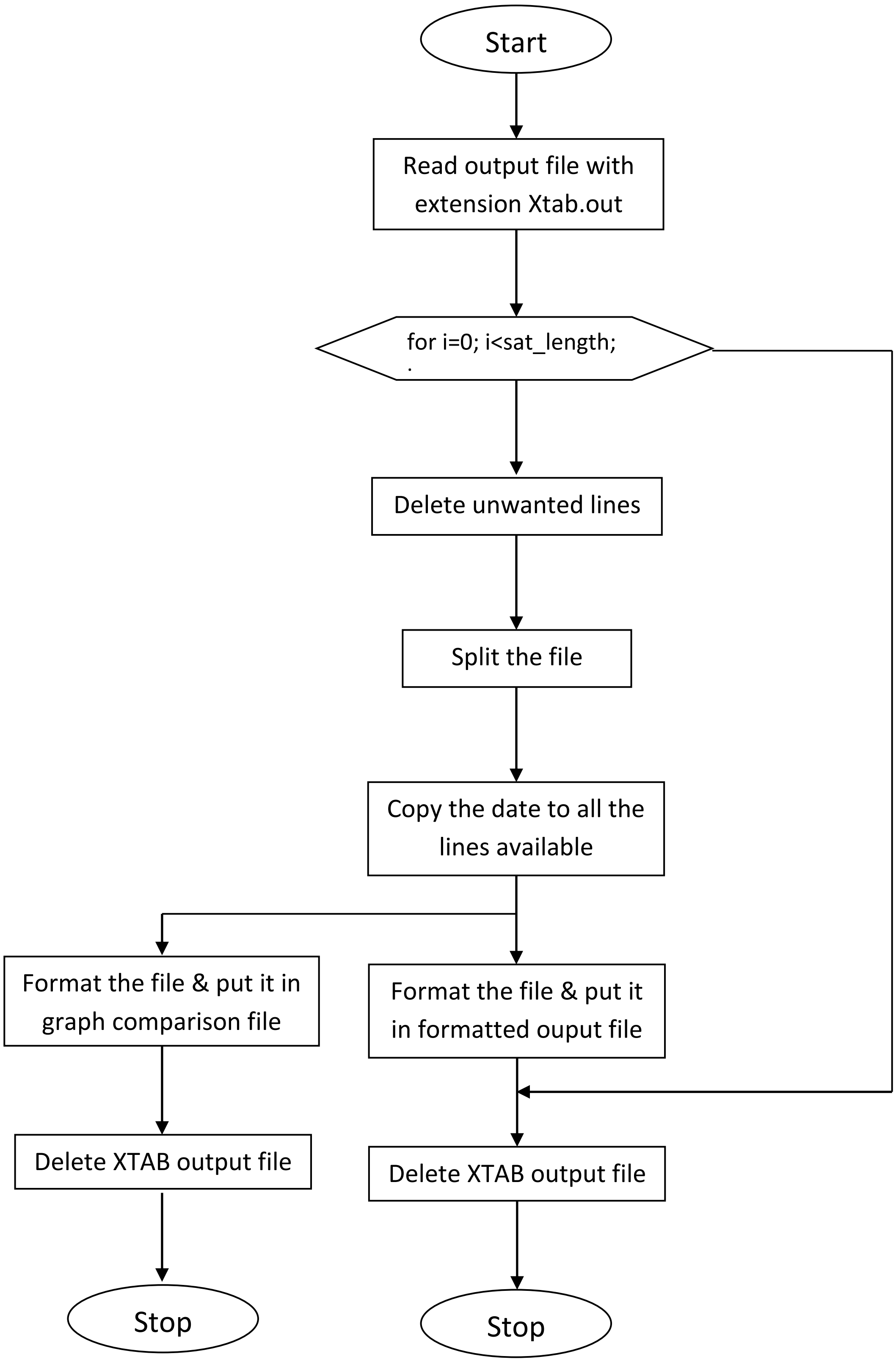
Putting the Sts formatted data to the table:

- The formatted STS data will be put on to the table as as to make it look easy for comparison of the temperature.

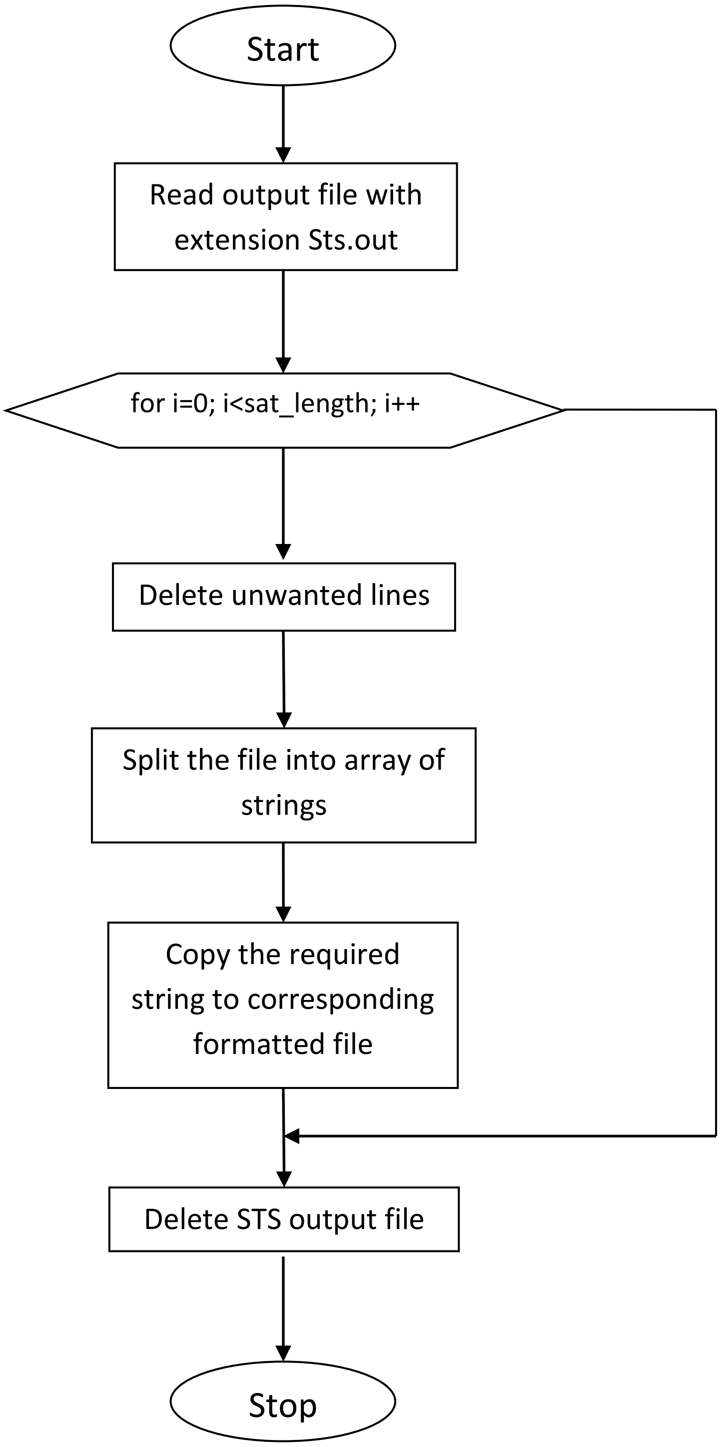
Bulk Temperature Calculation:

- The mean column of the STS format is extracted in put in a text file so as to use it to calculate the average of the mean temperature so as to obtain the bulk temperature of the satellite.

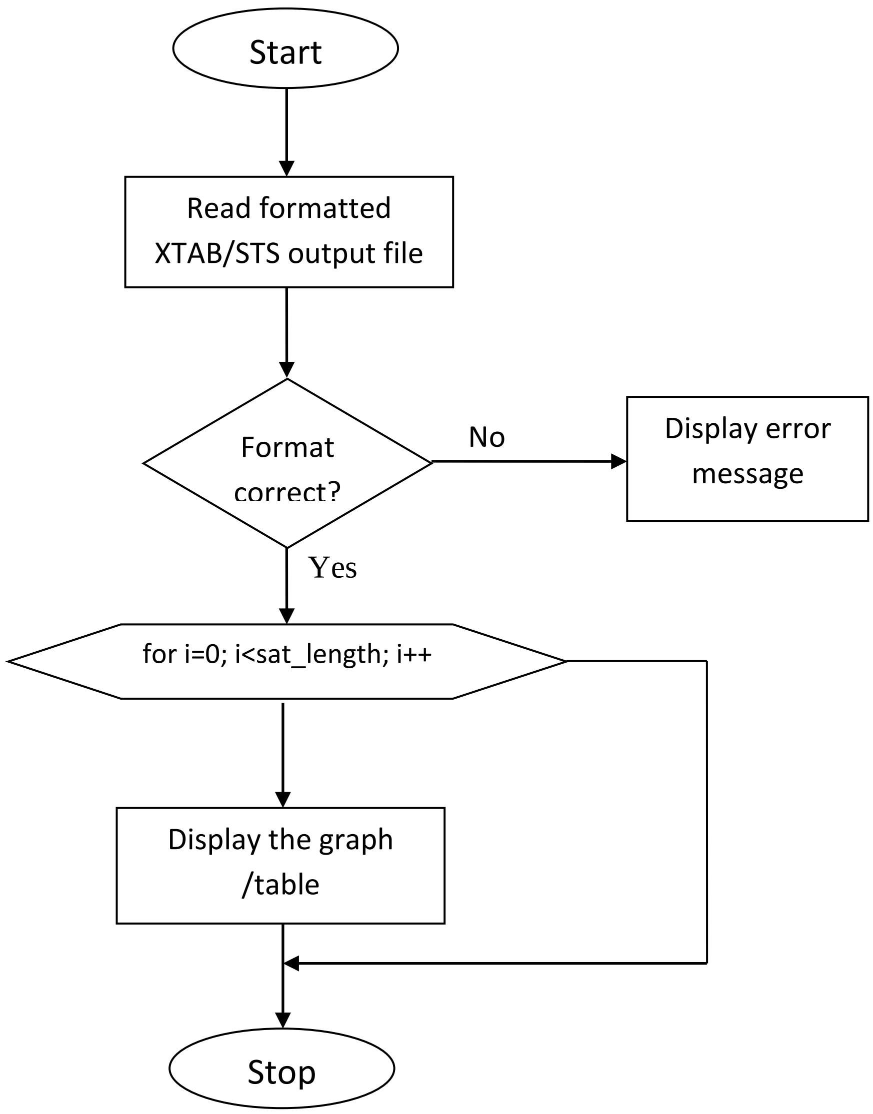
Flow Chart used for Formatting XTAB:



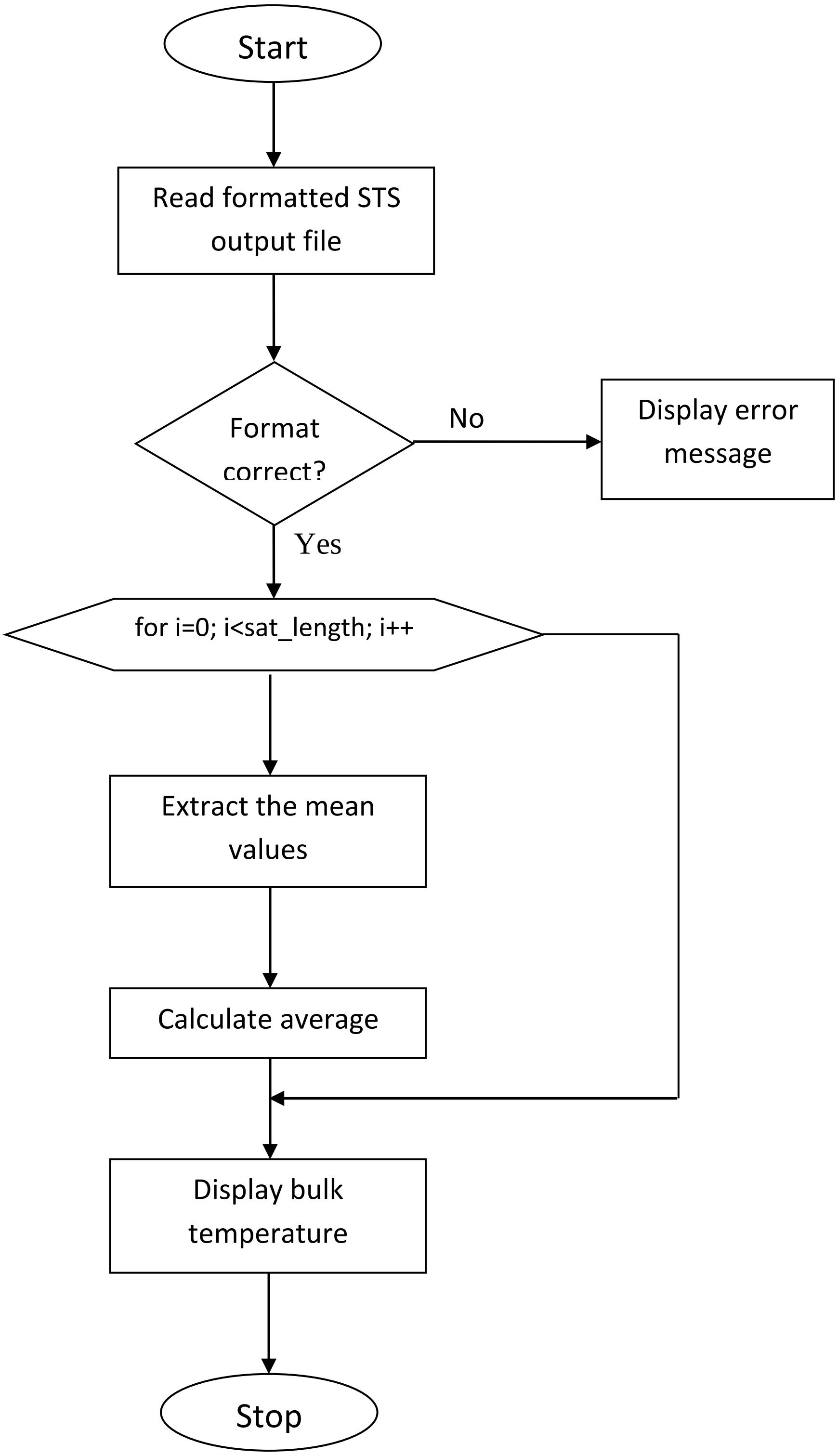
Flow Chart used for Formatting STS:



Flow Chart used for plotting graph & putting the output in table:



Flow Chart used for calculating Bulk temperature:



CHAPTER – 6

RESULTS AND ANALYSIS

For some dummy data the results of the methodology are obtained as follows: By running the program firstly we get dialog box as shown below.

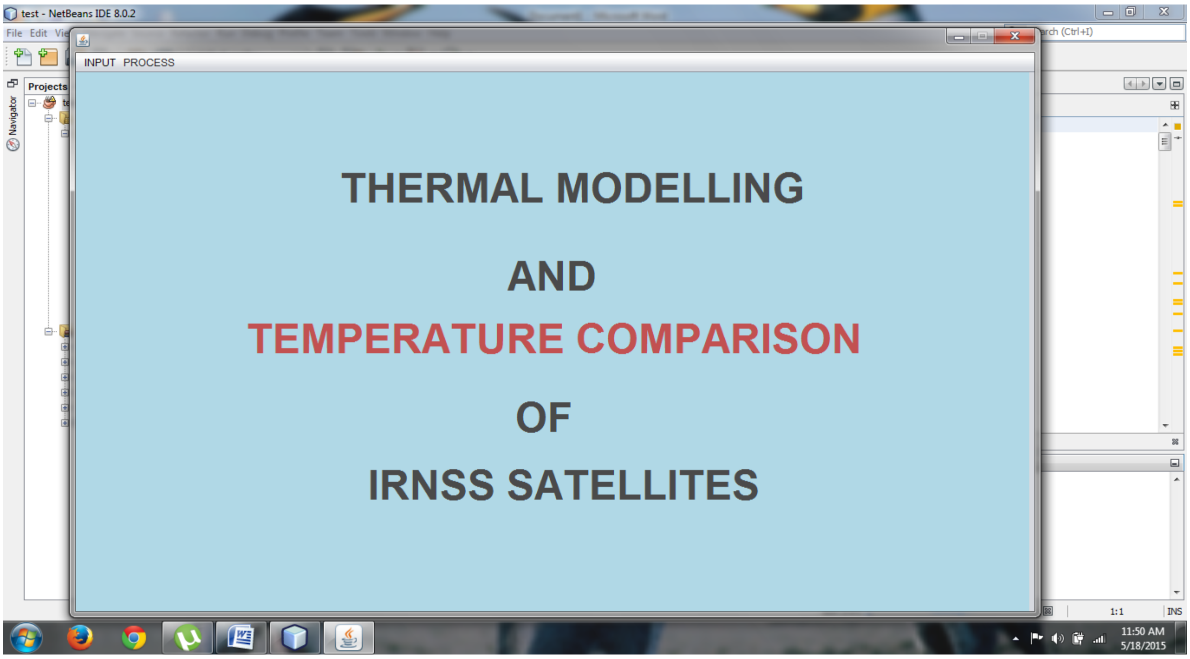


Fig 6.1: Snapshot of main page

In the figure shown above we get options to select for input and process. After selecting the input we get the dialog box as shown below:

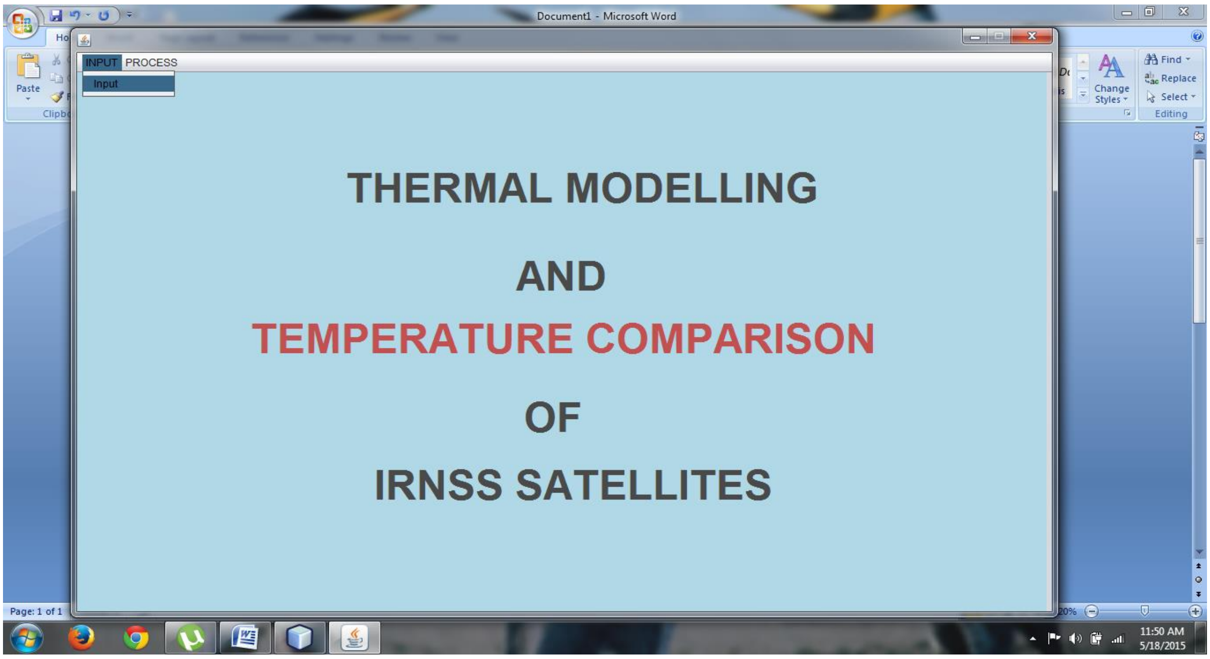


Fig 6.2: Snapshot of main page with selection of input

By selecting input, we will be able to select the satellites, start date , end date PID (Parameter Identity) number. With this we can also select XTAB or XSTS format.

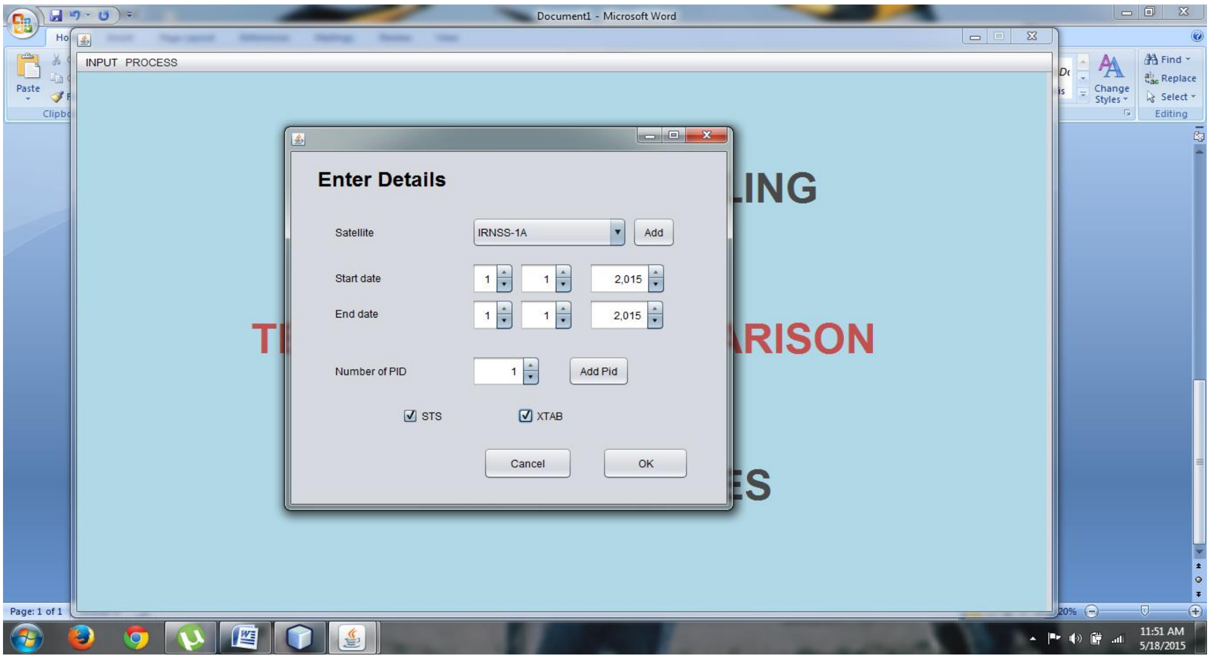


Fig 6.3: Snapshot of Enter details

As shown in above snapshot with the add option we can add satellites as shown in below snapshot.

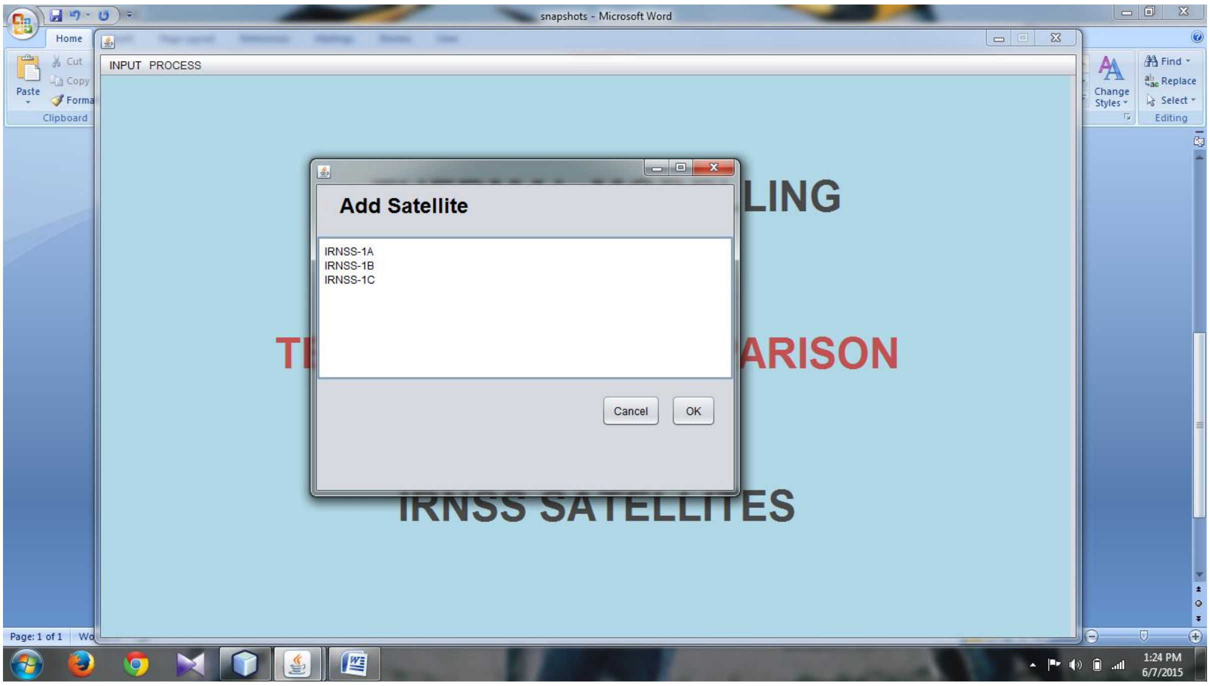


Fig 6.4: Snapshot to add a satellite

As shown in above snapshot with the add PId option we can add PIds as shown in below snapshot.

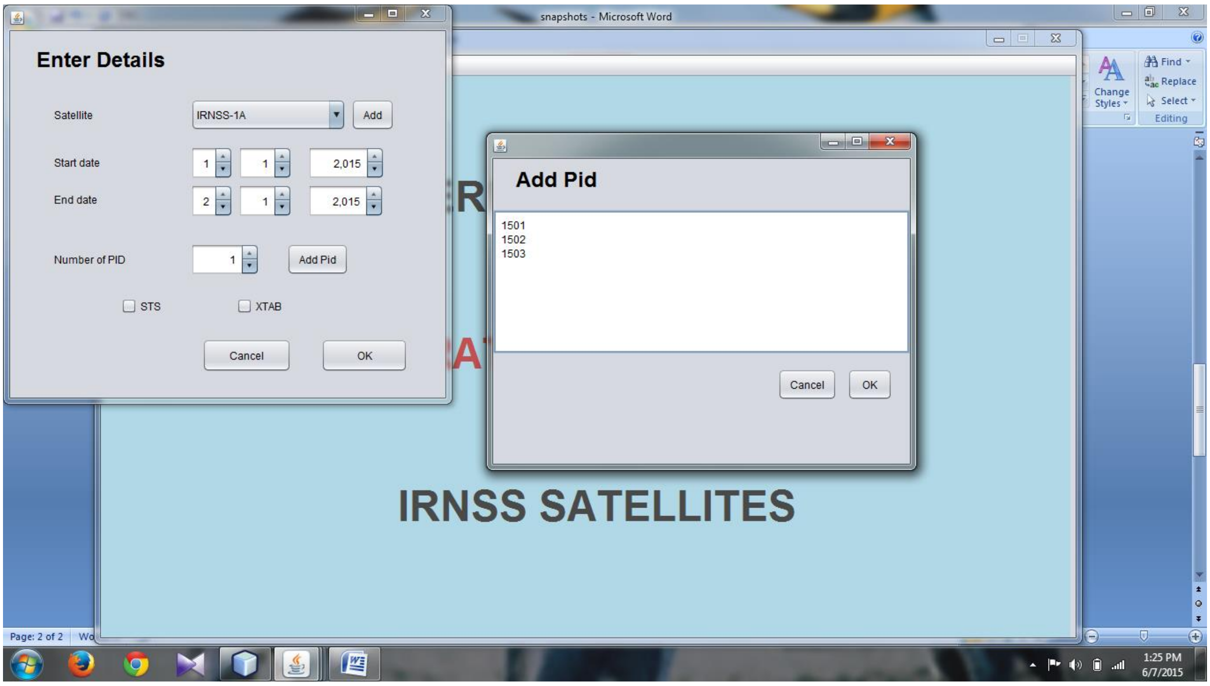


Fig 6.5: Snapshot to add PId

XTAB is the format in which we get the real time satellite data in terms of temperature and time, while XSTS is the format where we will be able to get minimum, maximum and mean temperature of the selected satellites. The below dialog appears after selecting input.

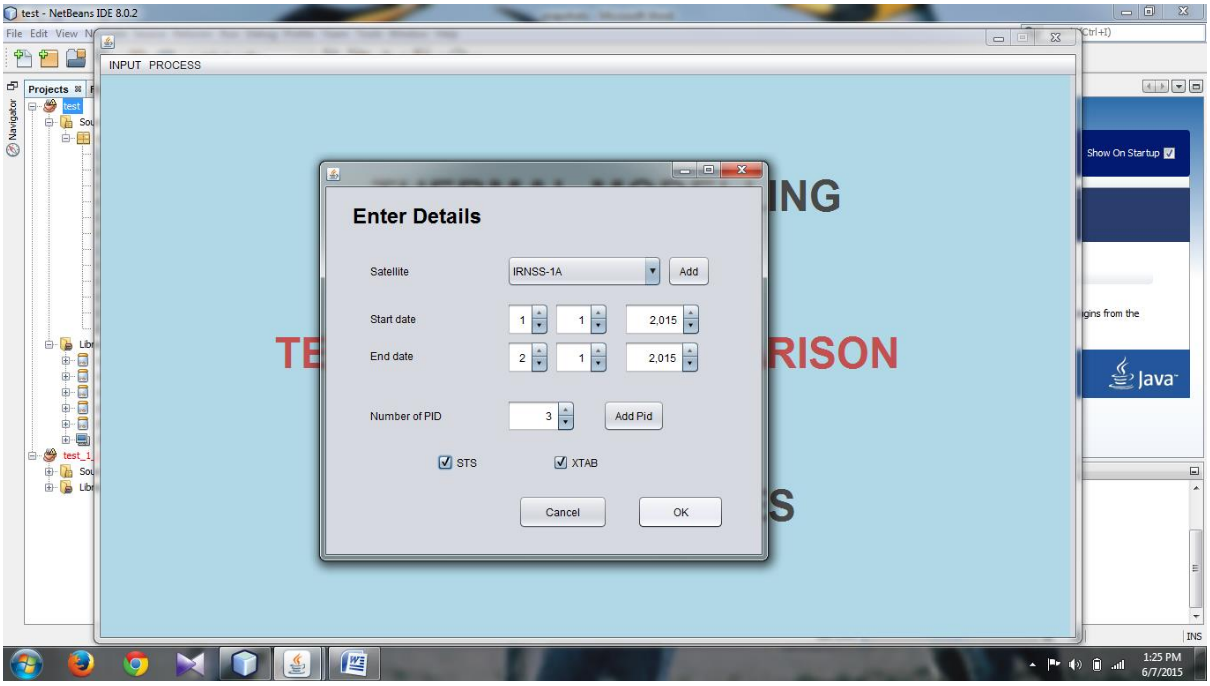


Fig 6.6: Snapshot of main page with selection of XTAB & STS

After clicking the ok button on a background the oi file will be created.
The XTAB OI file will be of the format :

```
SCID IRNSS-1A
TSTART 01-JAN-2015 00 00 00
TSTOP 01-JAN-2015 00 00 00
UFIL xxxxxxxxx
THIN 1
STAN ALL
DATFIL 5012IRNSS-1A
DATFMT H
PID 5012
DUPLI N
Eob
```

The STS OI file will be of the format :

```
SCID IRNSS-1A
TIMESLOTS 1
TSTART 01-JAN-2015 00 00 00
TSTOP 01-JAN-2015 00 00 00
UFIL xxxxxxxxx
THIN 1
STAN -1
OUTFORMAT T
DATFIL outputfiles/5012IRNSS-1A_sts.out
RESLN 3 1
PID 5012
Eob
```

Once the OI file is created the oi file is executed in SCHEMACS utilities so as to obtain the XTAB and STS format data. The XTAB data extracted using SCHEMACS utilities is as shown.

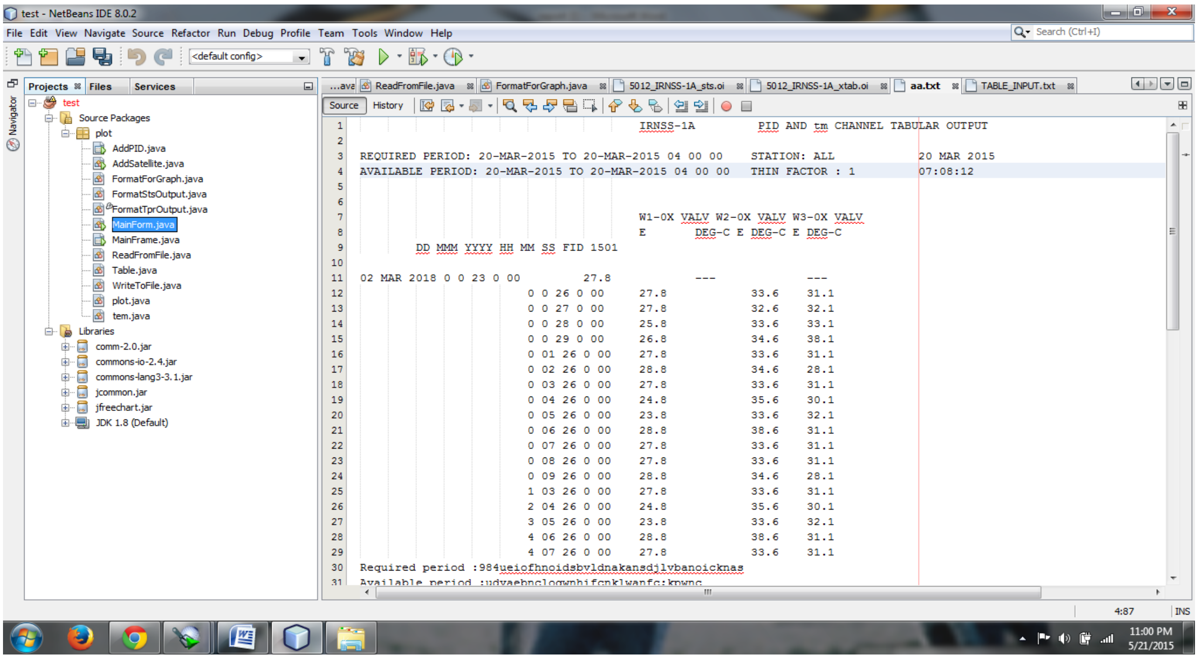


Fig 6.7: Snapshot of creation of XTAB OI file

The STS data obtained from the SCHEMACS utilities is as shown.

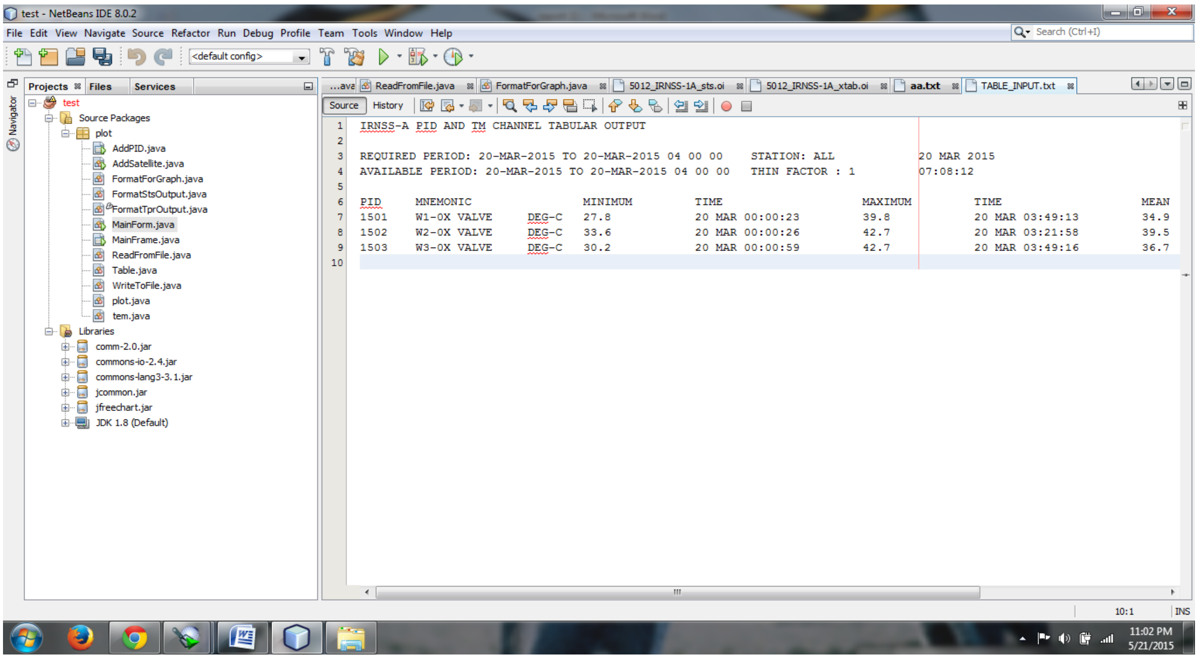


Fig 6.8: Snapshot of creation of STS OI file

Once the XTAB and STS file is obtained. The XTAB data is formatted as follows. The formatting is done in order to make the plotting for every date and not to miss any single data from the data file.

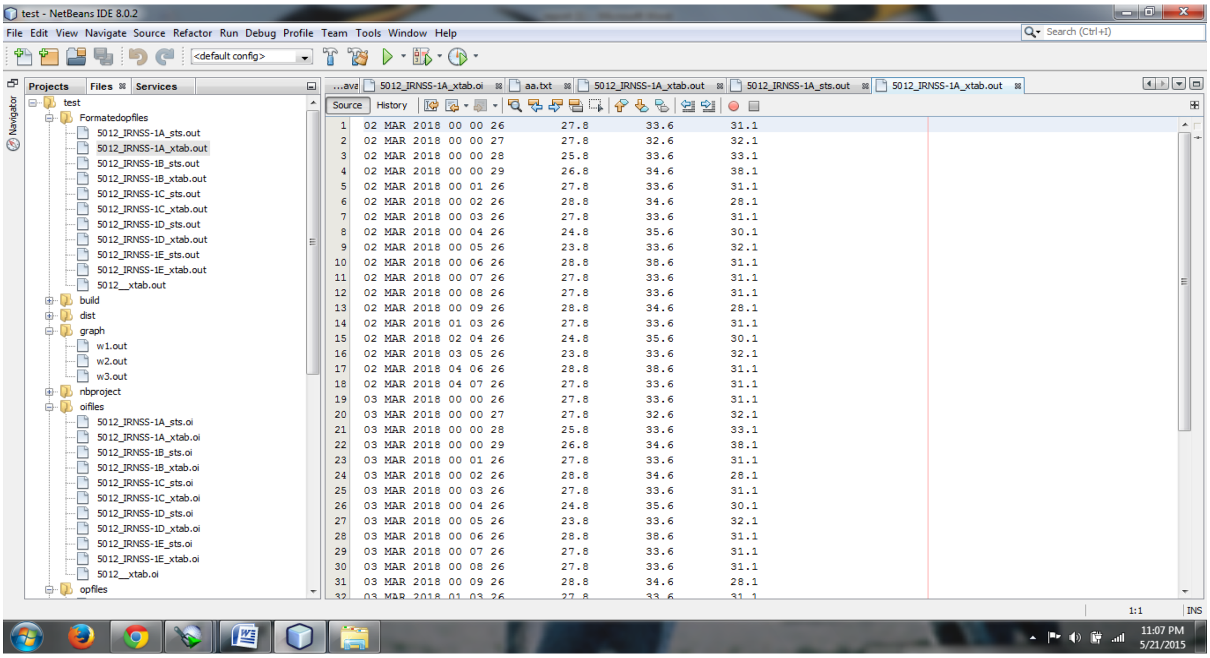


Fig 6.9: Snapshot of XTAB formatted data

Similarly there is need to format the STS type of data so as to extract only the required fields and to remove or erase the other data. The formatted STS output will be as follow

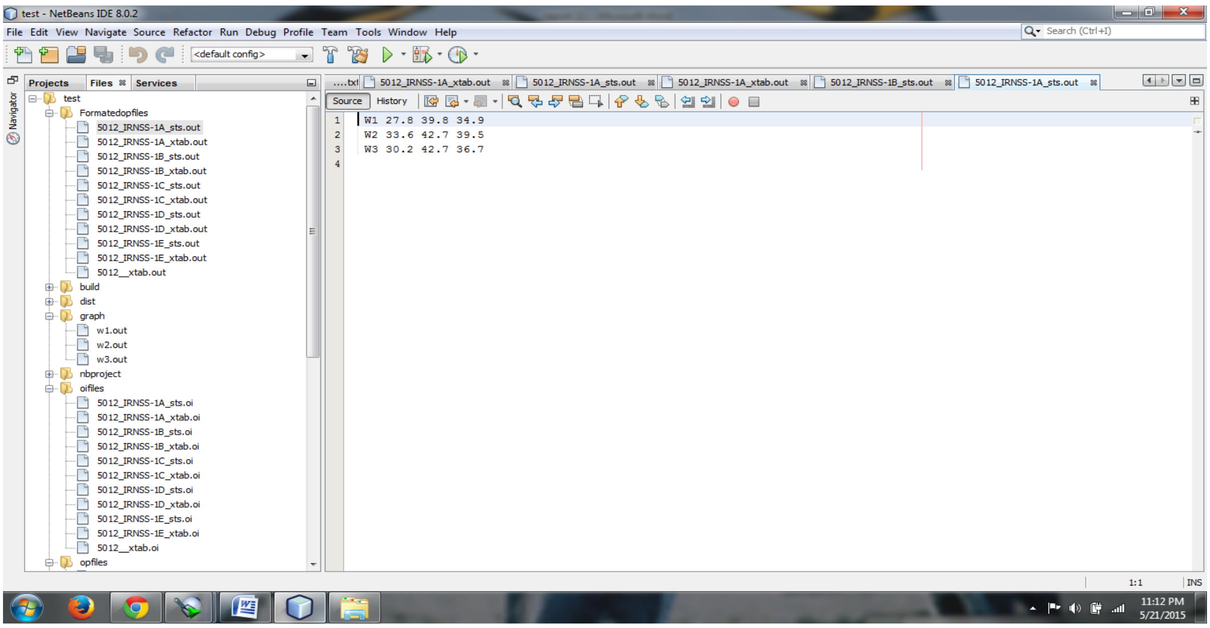


Fig 6.10: Snapshot of STS formatted data

All these steps i.e., creation of OI file, obtaining the XTAB and STS type data from SCHEMACS utilities and formatting them takes place in a background when we click on to ok after selecting the inputs. , then on clicking to process there will be four options as shown.

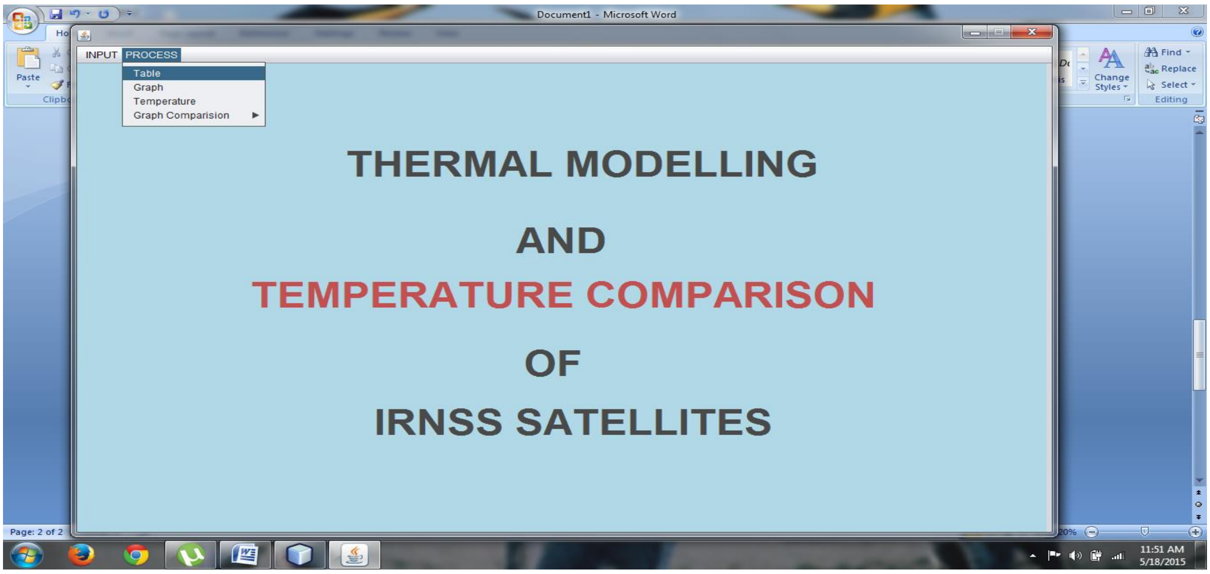


Fig 6.11: Snapshot of main page with selection of table

In a process, if we click on to the table, then the table formatted output of the STS containing the maximum, minimum and mean values of all the satellites which we selected will be displayed in a jtable as shown.

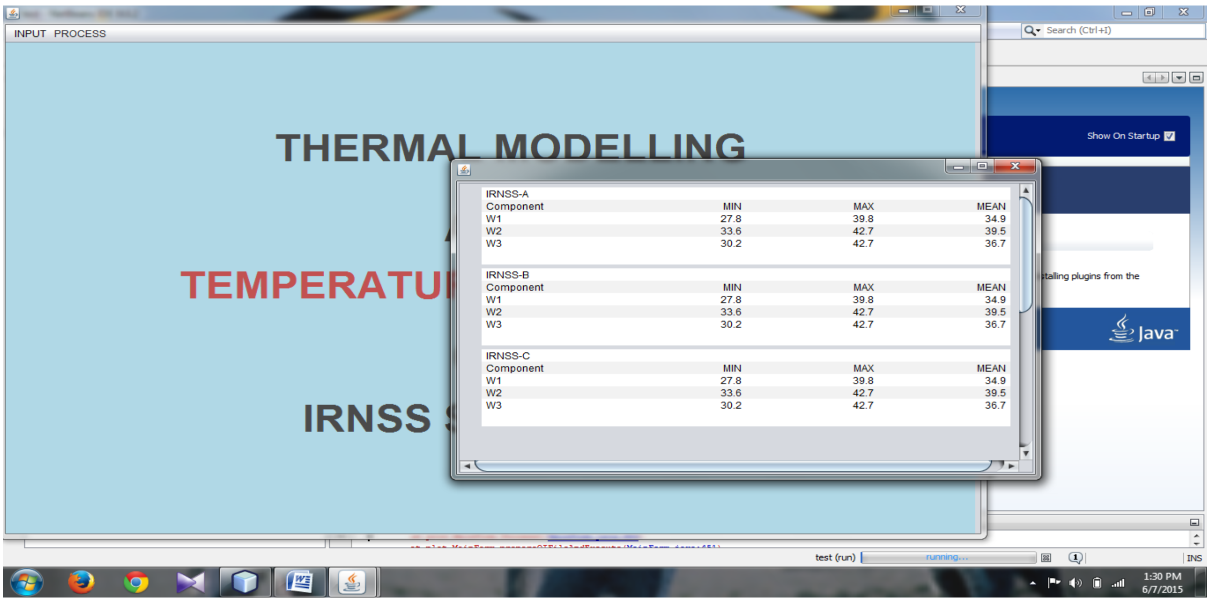


Fig 6.12: Snapshot of main page with STS table output

Next, in the process window, if we press on to the graph, the graph of the components of each satellite which we selected in the input will be obtained as shown,

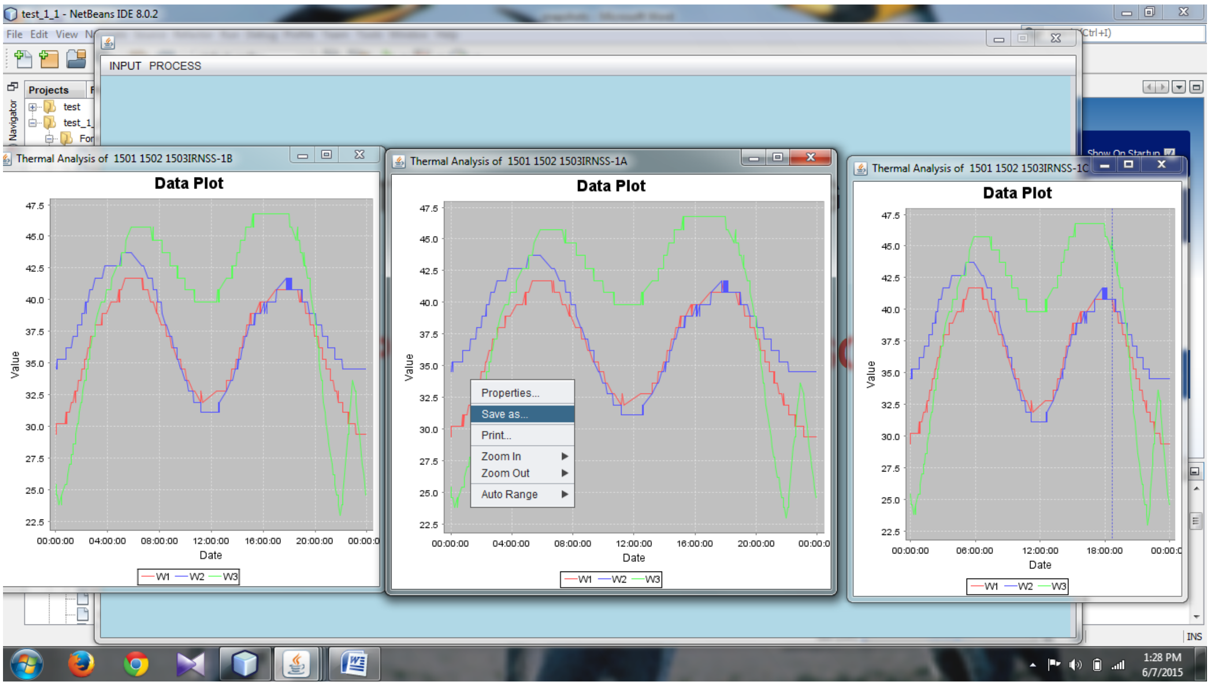


Fig 6.13: Snapshot of main page with XTAB graph

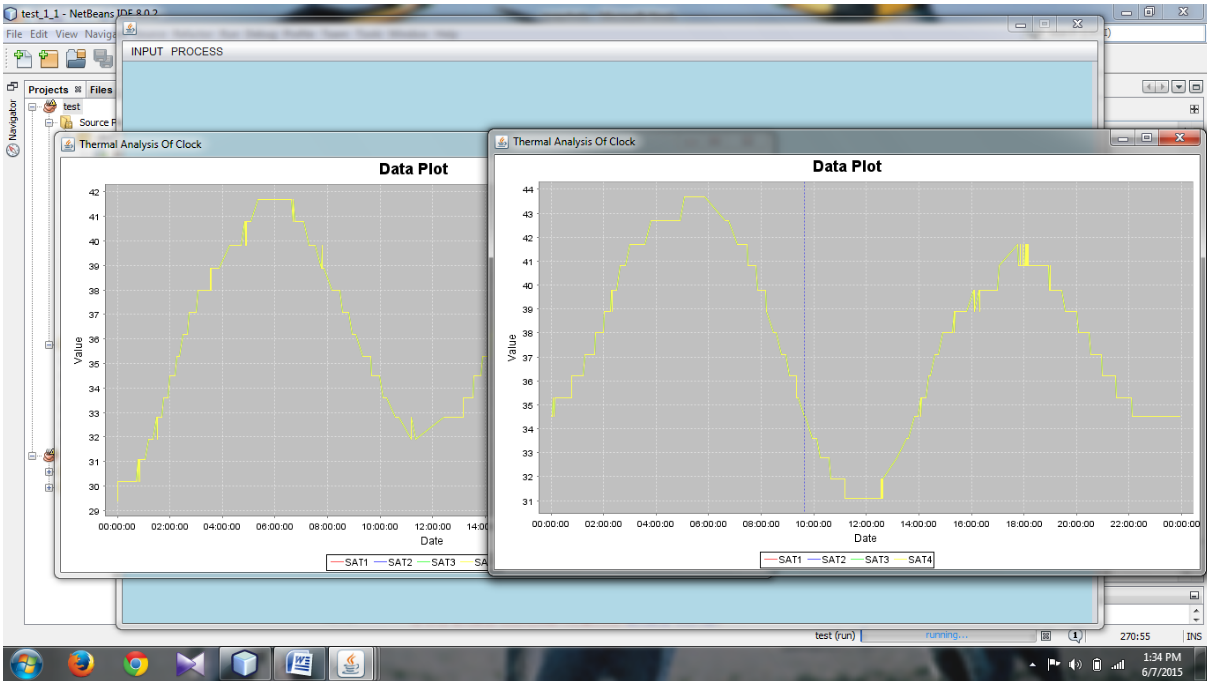


Fig 6.14: Snapshot of main page with STS table output

On clicking to the temperature, the bulk temperature will be calculated, that is the average of averages of temperature of components of each satellite. And the bulk temperature of all the satellites selected will be displayed as shown below.

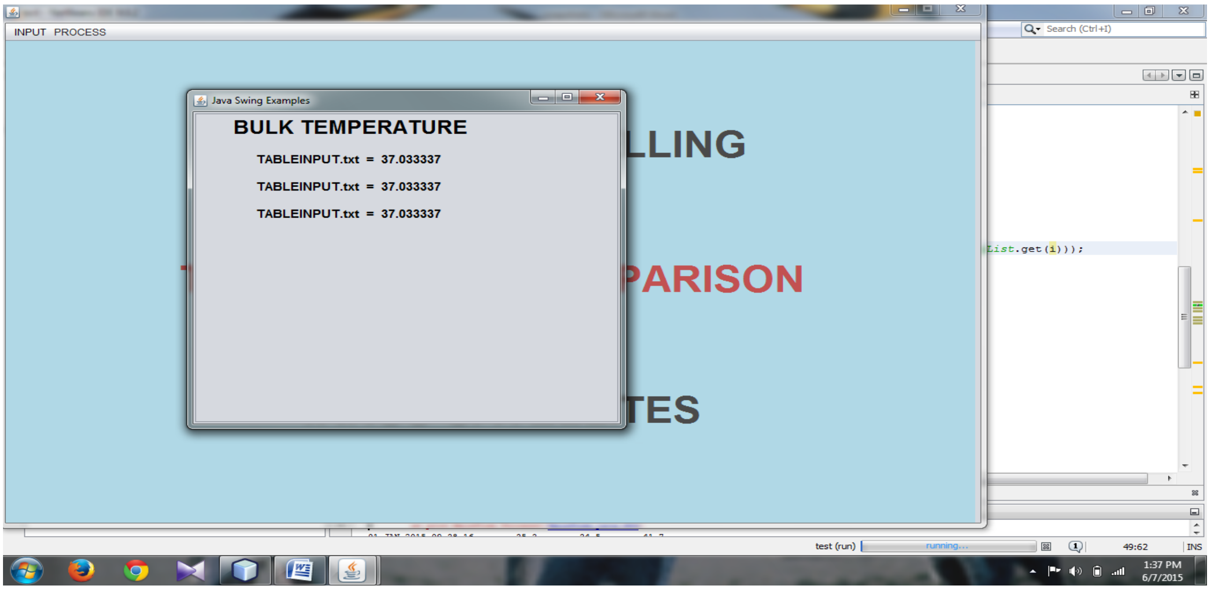


Fig 6.15: Snapshot of main page with bulk temperature output

In order to match the component on one satellite with the corresponding component of other satellites, compare graph option is given in a process, In the compare graph a options of the component that need to be compared is given.

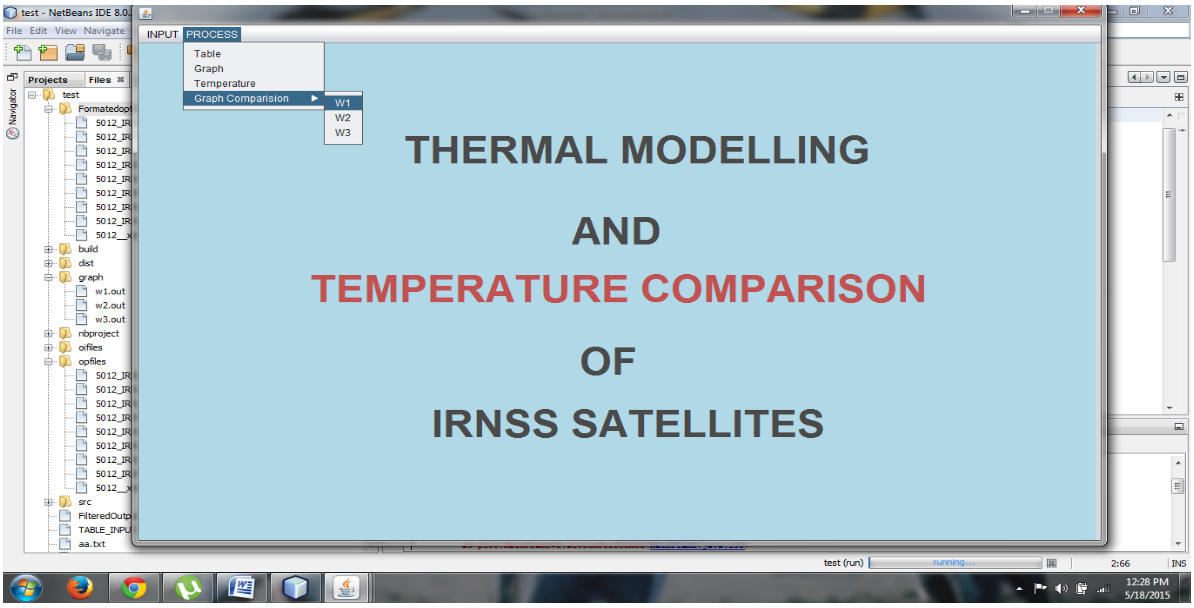


Fig 6.16: Snapshot of main page for selecting graph configuration

Thus on selecting the component, a comparison graph of the of that component with the other satellites will be displayed as shown,

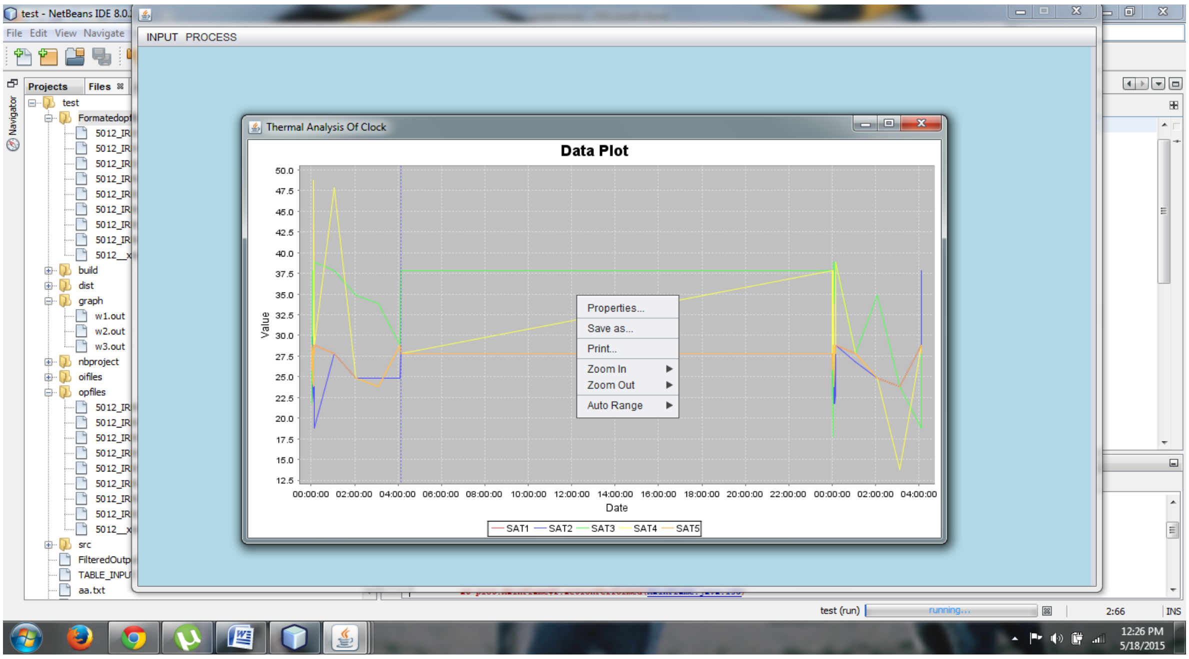


Fig 6.17: Snapshot of graph with some extra features

In the graph and comparing of graph, on right click on the graph, options of zooming in and out of the graph, selecting a range of the time for which the graph is required to examine, printing of the graph and saving the graph for future analysis is also given in the graph.

CHAPTER – 7

CONCLUSION & FUTURE WORK

7.1 CONCLUSION:

The data provided by the project will help the Thermal analyst at MCF as follows:

- Helps in day to day evaluation of the temperature of similar components of the IRNSS fleet by giving a table of comparison.
- Can give advance information of an impending failure of a component or degradation, by its gradual rise in temperature compared to similar components in other spacecrafts.
- The Bulk temperature comparison will help in predicting future temperature conditions and will also help to strategise replacement satellites if the temperature of the atomic clocks or other components becomes unmanageable.

7.2 FUTURE WORK:

- This can be extended after the launching of remaining satellites.
- Also this can be implemented to compare other conditions of the satellite components rather than thermal components.

REFERENCES

[1] Thermal Analysis for GPS.
http://www.intrinsys.com/software/catia/V5-6R2013/portfolio/analysis/thermal-analysis

[2] IRNSS in Wikipedia

[3] IRNSS and GAGAN status Presentation COSPAR Meeting, Montreal, July 2008

[4] IRNSS SIS ICD For SPS, Version 1.0, ISRO (Indian Space Research) Satellite Centre, Bangalore, June 2014

[5] IRNSS and GAGAN Status Presentation Second Meeting of the ICG Providers Forum, Vienna, Austria, February 2008

[6] GAGAN and IRNSS Status Presentation ICG-3 Meeting, Pasadena, United States of America, December 2008

[7] India Launches First Navigation Satellite, GPS World

[8] IRNSS Navigation Satellites

[9] IRNSS Press Release, July 2, 2013

[10] India launches its first dedicated navigation satellite, The Express Tribune

[11] Indian Regional Navigation Satellite Starts Signal Transmissions, GPS World, 25 July 2013

[12] Indian Launches Fourth IRNSS Spacecraft, Inside GNSS, March 28, 2015

[13] FCC Satellite Learning Center https://www.fcc.gov/.../satellite

[14] http://en.wikipedia.org/wiki/Java_%28programming_language%29

[15] http://en.wikipedia.org/wiki/NetBeans