The fundamentals of the ground segment are shown in this slide. Starting from the left there is an antenna and a radio handling the signals used for communication between the ground and the satellite. Moving further to the right a command and data handling unit is shown. This is the main computer system on ground. The command and data handling organizes communication that is tele commands and telemetry in a way that enables staff on the ground to monitor and control the satellite.

Unlike conventional control rooms monitoring and controlling should not just be handled locally. This means that mission control staff must be able to carry out their work from different working locations. To obtain this distribution a web server is connected to the command and data handling unit. The web server should offer different access to information and control of the satellite depending on what type of user that connects to the system.

Finally the slide shows a number of clients connecting to the web server via the Internet. These clients can be public users wanting to see pictures taken by the satellite. If so no login is required. On the other hand if someone from the mission control staff logs on, additional information and opportunities become available.
This figure illustrates what kind of jobs the ground segment users can carry out and the access privileges of the different users. There are six main jobs and three user types for the Ground segment. The user types are:

**Mission Control Staff (MCS):** Those who plan the mission and act if the satellite needs nursing. There is only one MCS at a time connected to the ground segment.

**Scientific Control Staff (SCS):** Those who monitor different subsystems and curious AAU-sat project members. Many users of this type can be connected at a time.

**Public users:** People that want to access pictures and some data that can be of their interest.

The system jobs are:

**Status:** Information that can be interesting for public are gathered and shown

**Image:** Everything about the pictures that the satellite has taken and will take in the future.

**Log:** The log from the satellite.

**Housekeeping:** The housekeeping data from the satellite

**SW-update:** Software update

**Flight plan:** Flight plan for the satellite
Basic idea of the flight plan

- Tasks are scheduled
- The flight plan is uploaded to the CubeSat
- Examples: Take picture, get housekeeping, reboot

All commands from the ground to the CubeSat are issued as a part of a flight plan. This means that commands are scheduled as tasks in a flight plan, which is prepared on ground and then transmitted to the CubeSat when it is in range for communication.

The advantage of this way of communication is the achievement of a general method for commanding the CubeSat and that tasks can be scheduled at arbitrary time without taking care if anybody is at the ground station to upload the command when the CubeSat is in range for communication.

Conversely it will not be possible to issue commands in real time by a prompt or similar.

Examples of tasks are: Take picture, get housekeeping, reboot etc. It is your job to specify if you need more types of tasks!
Flight plan task definition

- Type
- Schedule information
  - Execution time
  - Maximum duration
  - Absolute / relative / periodic
- Parameters

A task consists of the following parts:

Type:
This specifies what the task is going to do, for example take a picture.

Schedule information:
This is used to tell when and how the task is executed. It must be known when the task is to be executed and how long time it will take. This is used to test if it will interfere with other tasks. It must also be specified if the execution time is relative to another task or absolute. Some tasks may be scheduled for periodic execution.

Parameters:
This can be any information which is specific for the selected type of task. For example a position or a voltage.
This use case illustrates how a user interacts with the flight plan. When the user has entered the flight plan management he can add a new task and specify the parameters for it.

The user may also select a task to modify or delete it.

Finally there has to be a way to tell the ground segment when the flight plan is ready for upload to the CubeSat. This is done by approving the part of the flight plan which is ready for upload. When a part of the flight plan is approved it will be locked for changes.
The system consists of three basic modules:

- A database for storing data. This includes housekeeping, event log, flight plan, images and software updates. The basic idea of the database is that it stores all information sent and received from the satellite in order to provide easy data collection and analysis of the complete mission.

- A web-server used for communication with the clients. This server provides the basic facilities to access the different modules in the system. This is basically the functionality used to manage the flight plan and provide a complete view of the housekeeping and logging.

- A communication manager responsible for communication with the satellite using the transport protocol defined in the T55X specification (Group 554 and group 555).

At the present time the exact definition of the clients is not specified, but they will be some kind of Internet browser using plain html or maybe some java applet.

The communication between the client and web-server is based on a secure line with user authorization for the mission control staff and the scientific staff. The public are using a non-secure line to view the images and satellite status.