

Summary of what actually happened...

Gyro A is deactivated to preserve life span
Gyro B gain set to "high" for flywheel management
Flywheel management ends, but Gyro B left "high"
High gain causes non-existent roll to be detected
ESR-5 triggered to correct the non-existent roll
Missing reading from Gyro A causes an actual roll
Gyro B detects actual roll and initiates ESR-6
Readings from Gyroscopes A & B differ (A is off !)
Ground control assume Gyro B faulty so disables it
Satellite now has no working gyros for navigation !
Satellite is slowly becoming misaligned with Sun
ESR-7 is triggered (with no working Gyroscopes !)
Total loss of power, telemetry and thermal control

Recovery Steps

1. Confirm orbit position via Deep Space Network
2. Make radio contact via Deep Space Network
3. Receive Spacecraft Telemetry
4. Thaw Hydrazine Fuel Tank
5. Thaw Hydrazine Fuel Pipes
6. Switch on gyroscopes (with correct gain) !
7. Perform Emergency Sun Reacquisition
8. Recommission science instruments

Recovery "milestones" taken from:

<https://soho.nascom.nasa.gov/about/Recovery/docs/>

What do WE need to do ?

The experiences of SOHO offer us valuable insights
A very similar situation to the loss of our satellite
We may well be able to recover in a similar way !

From our previous analysis of SOHO recovery,
we need additional behaviours from the simulator

Luckily there are some extra features available...

Channel of Communication

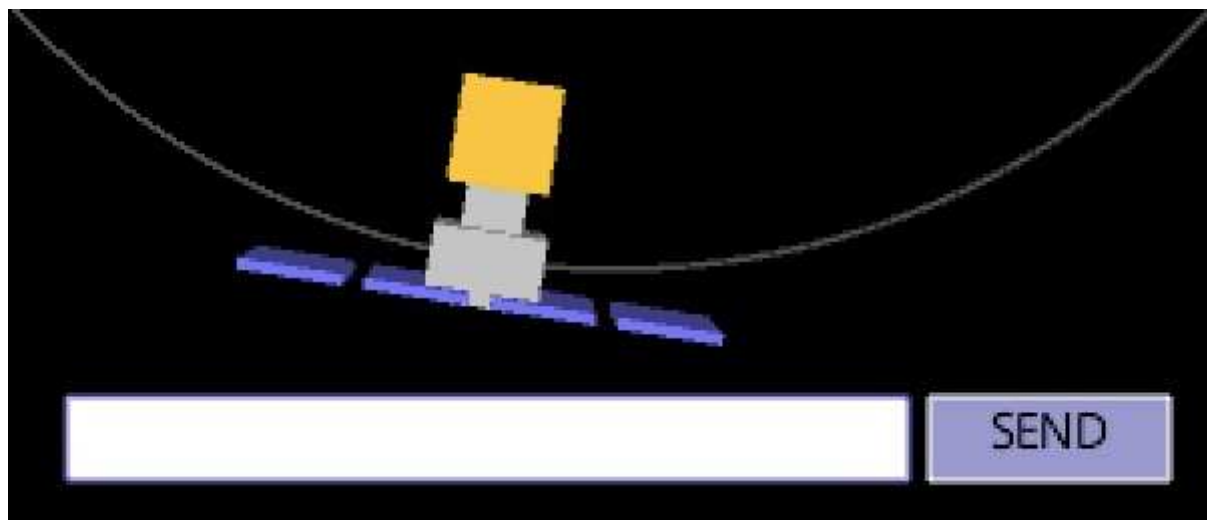
The radio antenna on the satellite is misaligned

As a result, the command prompt is disabled

We need an alternative channel of communication

Recovery of SOHO used the "deep space network"

Let us use a similar mechanism...



Command Line

We will need to make use of the command line
"terminal" on OSX or "CMD" on Windows
(don't use powershell - it can cause problems !)

Ensure you are in same the folder as the simulator
Echo commands and direct them to "deepspace"

```
echo GYR1 > deepspace
```

SatelliteController
open-folder
Terminal

All previously introduced control commands work

A set of additional new commands also provided...

Deep Space Radar Scan

It would be good to know if satellite is still there !

We can request a deep space radar scan using RAD

```
echo RAD > deepspace
```

Radar scan appears in a file called "radarscan.png"

Energy Levels

It is useful to know the current battery level:

```
echo BAT > deepspace
```

Battery level will appear in a file called "battery.txt"

Navigation will deplete the Hydrazine fuel level

So it is useful to know the current fuel tank level:

```
echo FTL > deepspace
```

Fuel tank level will appear in a file called "fuel.txt"

Temperature Control

To get current fuel tank and pipe temperatures:

```
echo TMP > deepspace
```

Data will appear in a file called "temperatures.txt"

Clearly we need to control on-board heating !

Turn on and off the fuel tank heaters:

```
echo FTH1 > deepspace
```

```
echo FTH0 > deepspace
```

Turn on and off the fuel pipe heaters:

```
echo FPH1 > deepspace
```

```
echo FPH0 > deepspace
```

Current Satellite Orientation

Satellite is currently not well aligned to the Sun
However, solar panels are collecting some energy
(although not very much !)

Make sure you turn off all unnecessary equipment
You'll have to wait some time to charge the battery
Once batteries have charge, you can use heaters

Over to you !

Have a go - see if you can recover the satellite

- SCI Switches the science experiments on and off
- GYR Switches the gyroscope on and off
- ESR Initiates Emergency Sun Reacquisition
- RAD Produces deep space network radar scan
- FTH Switches the fuel tank heater on and off
- FPH Switches the fuel pipe heater on and off
- TMP Outputs the fuel tank and pipe temperatures
- BAT Outputs the current battery power level
- FTL Outputs the current fuel tank level

Any Luck ? Want me to try ?

My Recovery Plan

In order to recover soho, we are going to need:

SCI0 to switch off the science experiments

FTH1 and FTH0 to switch on and off fuel tank heater

FPH1 and FPH0 to switch on and off fuel pipe heater

TMP to keep an eye of fuel tank & pipe temperatures

GYR1 to switch on gyroscope, then quickly...

ESR to perform an Emergency Sun Reacquisition

SCI1 to switch science experiments back on again
(to complete the recovery of the satellite)

Demo of Recovery

Let's take a look at that in action !

SatelliteController

open-folder

Terminal