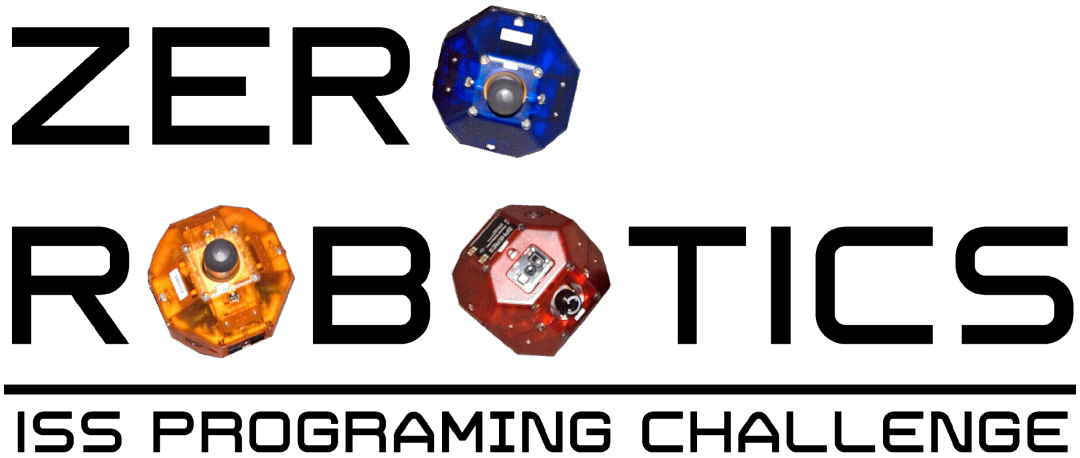
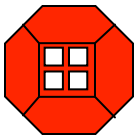


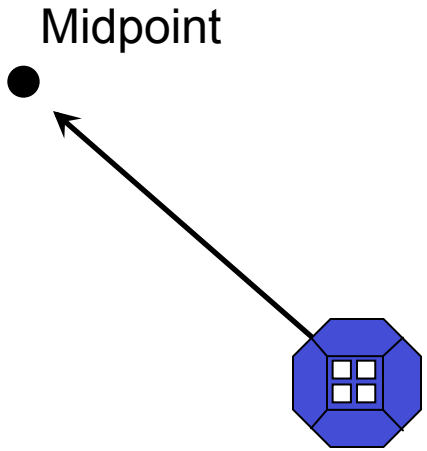
For Loops

Goals



In this tutorial you will:

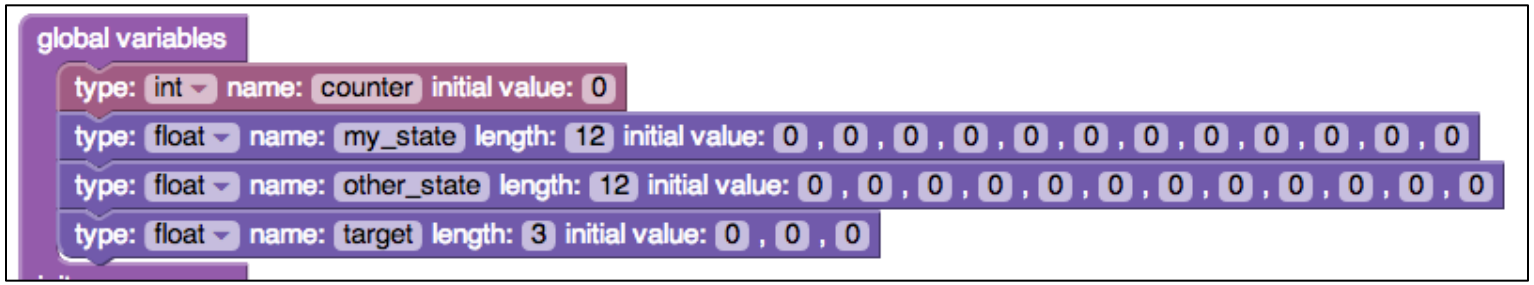
- Use a **for loop** to repeat an action a set number of times
- Find the position of the other satellite
- Program your satellite to move toward the other satellite, but stop halfway



Create a new project

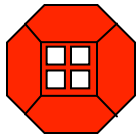
- Create a new project
- Name it “Project8” and choose “FreeMode” and “Graphical Editor”
- Create the following variables and arrays on the init page:
  - **`int counter`**
    - Set initial value to 0
  - **`float my_state[12]`**
  - **`float other_state[12]`**
  - **`float target[3]`**

leave initial values blank

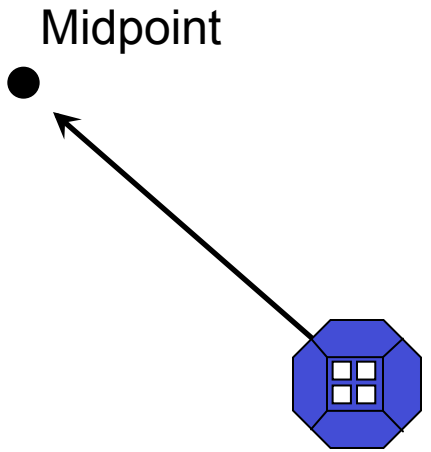


Program outline

In this tutorial, you will move your blue satellite half the distance toward the red satellite.



- First, you will use two API functions, **`getMyZRState`** and **`getOtherZRState`**, to find the starting positions of the two satellites.
- You will find the coordinates of the midpoint between the satellites.
- You will move to that position using **`setPositionTarget`**.



`getMyZRState` and `getOtherZRState`

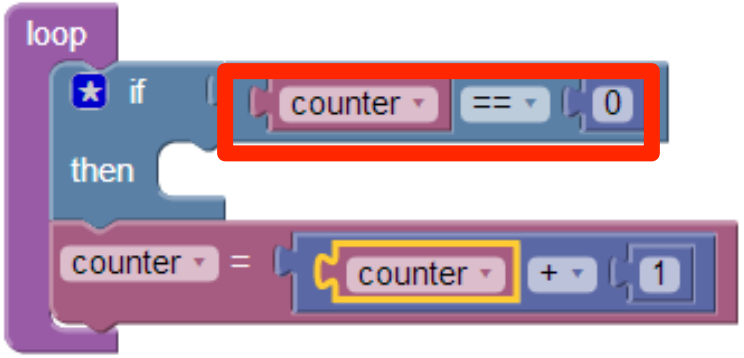
- **`getMyZRState`** finds the position of your satellite (blue) and writes it to an array.
- The array must consist of 12 floats. The first three members (index numbers 0 to 2) contain the x, y, and z coordinates of your current position.
- The other numbers in the 12-member array contain other information about your current state (for example, your current velocity) that you will not use in this tutorial.
- **`getOtherZRState`** does the same thing, but it sets the array to the state of the other satellite (red.)

Array members:

xxx[0] : x coordinate
xxx[1] : y coordinate
xxx[2] : z coordinate
xxx[3] to xxx[11]: other things

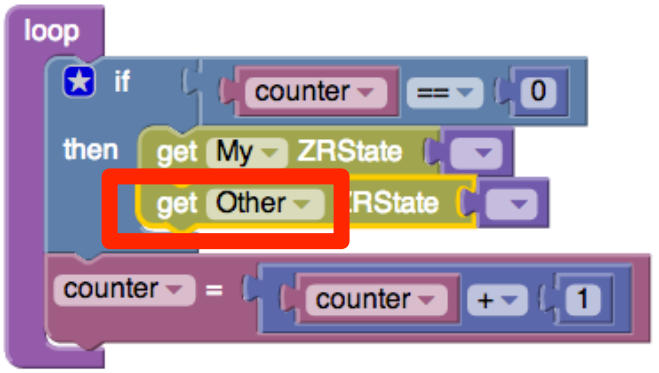
Set up counter

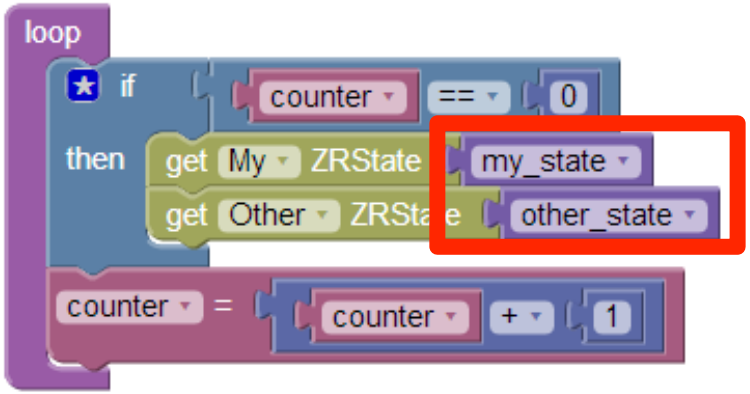
- Go to the “Logic” accordion
  - Drag an “if - then” block into the loop
  - Drag an “__==__“ block onto the “if” end of this block.
- Go to the Variables accordion
  - Drag a **`pink variable`** block (“--Select--”) into the first empty space
- Go to the math accordion
  - Drag a number block into the second empty space. (Set to 0)
- Any calculations put in this “if-then statement” will happen only once, at the start when *counter* is 0. This will be important to keep your target from changing as your position changes.
- Finally, add **`counter = counter + 1`** outside the “if-then” block as shown.



Set *my_state* and *other_state*

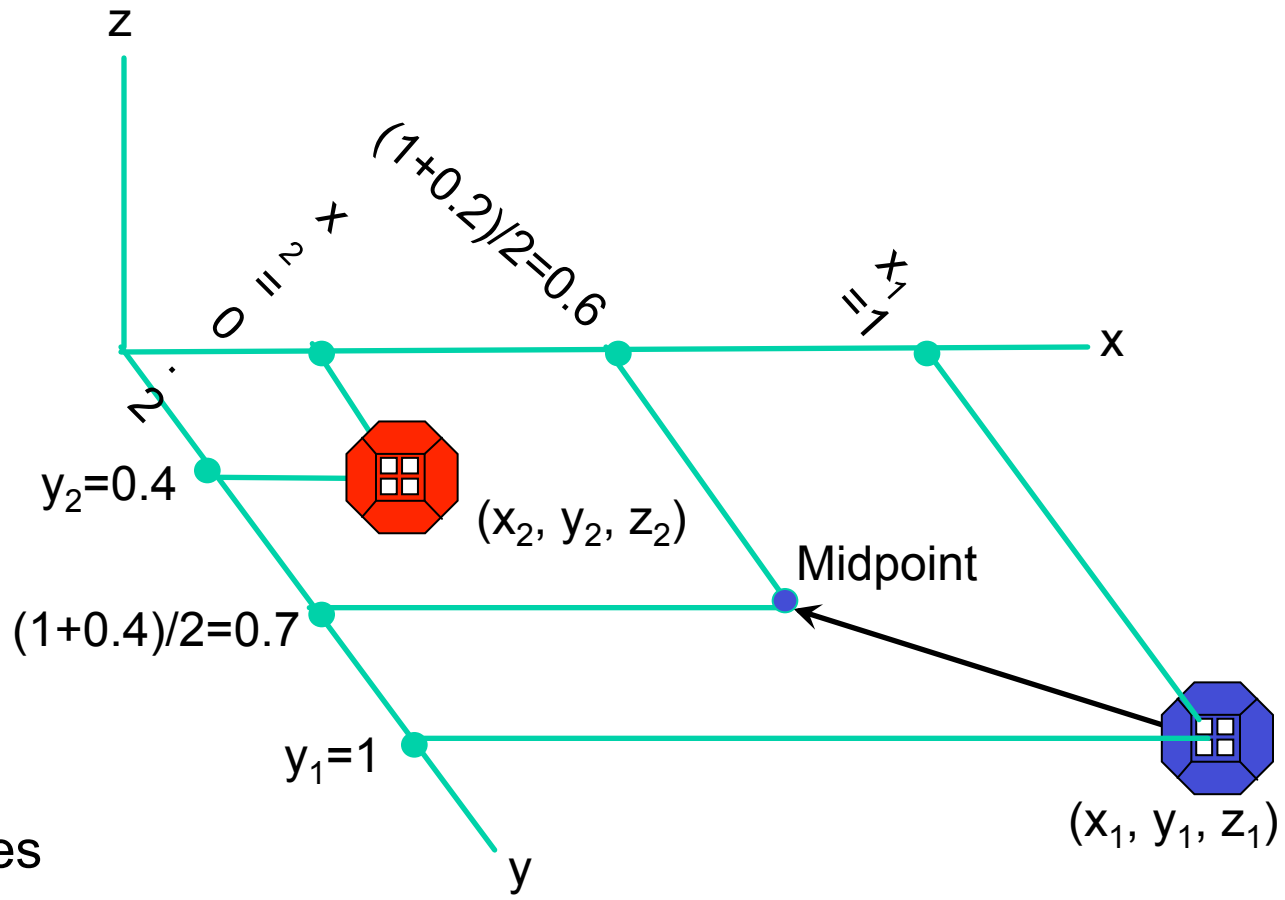
- Now you will find the positions of the two satellites so you can calculate your target.
- Go to the SPHERES Controls accordion and drag two **`getMyZRState`** blocks into the if-then block.
- Change the first drop-down menu on the second block to "**`Other`**"
- Change the drop-down menus of **`getMyZRState`** to **`my_state`** and **`getOtherZRState`** to **`other_state`**.
- The arrays **`my_state`** and **`other_state`** have now been set to the states of the two satellites.





Calculating the target coordinates

- The target is the midpoint between the two spheres.
- We can find the coordinates of the midpoint by taking the average of each coordinate as shown.
- example, the x coordinate is
  $(x_1 + x_2) / 2$
- Using a **for loop** makes this calculation simpler.



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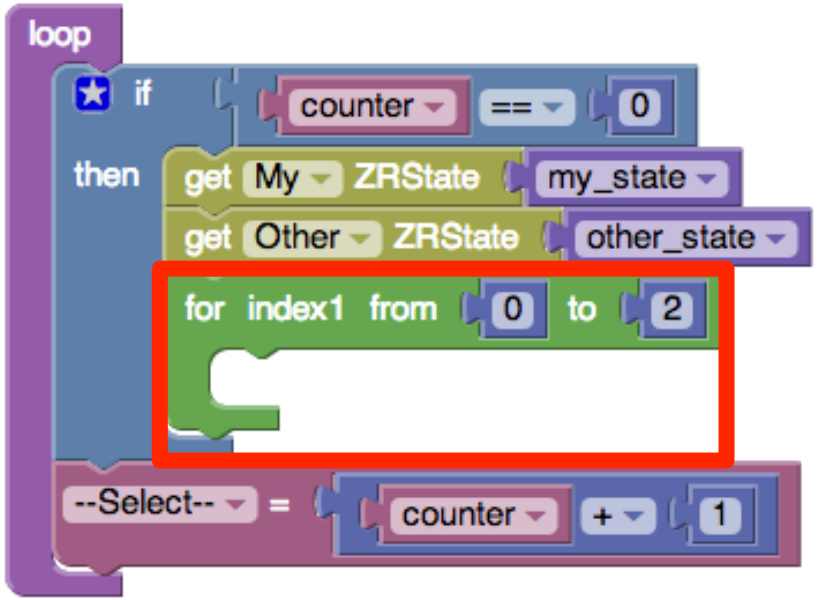
Using **for loops**

- Go to the Loops accordion and drag a "**`for index1 from 0 to 9`**" block inside the if-then block below **`getOtherZRState`**.
- Change the number blocks to **"0 to 2"** as shown.
- Everything inside the "for loop" block will be executed three times.
- The statement automatically creates a new **`int`** variable called **`index1`** that increases like a counter each time (shown in the following slides).



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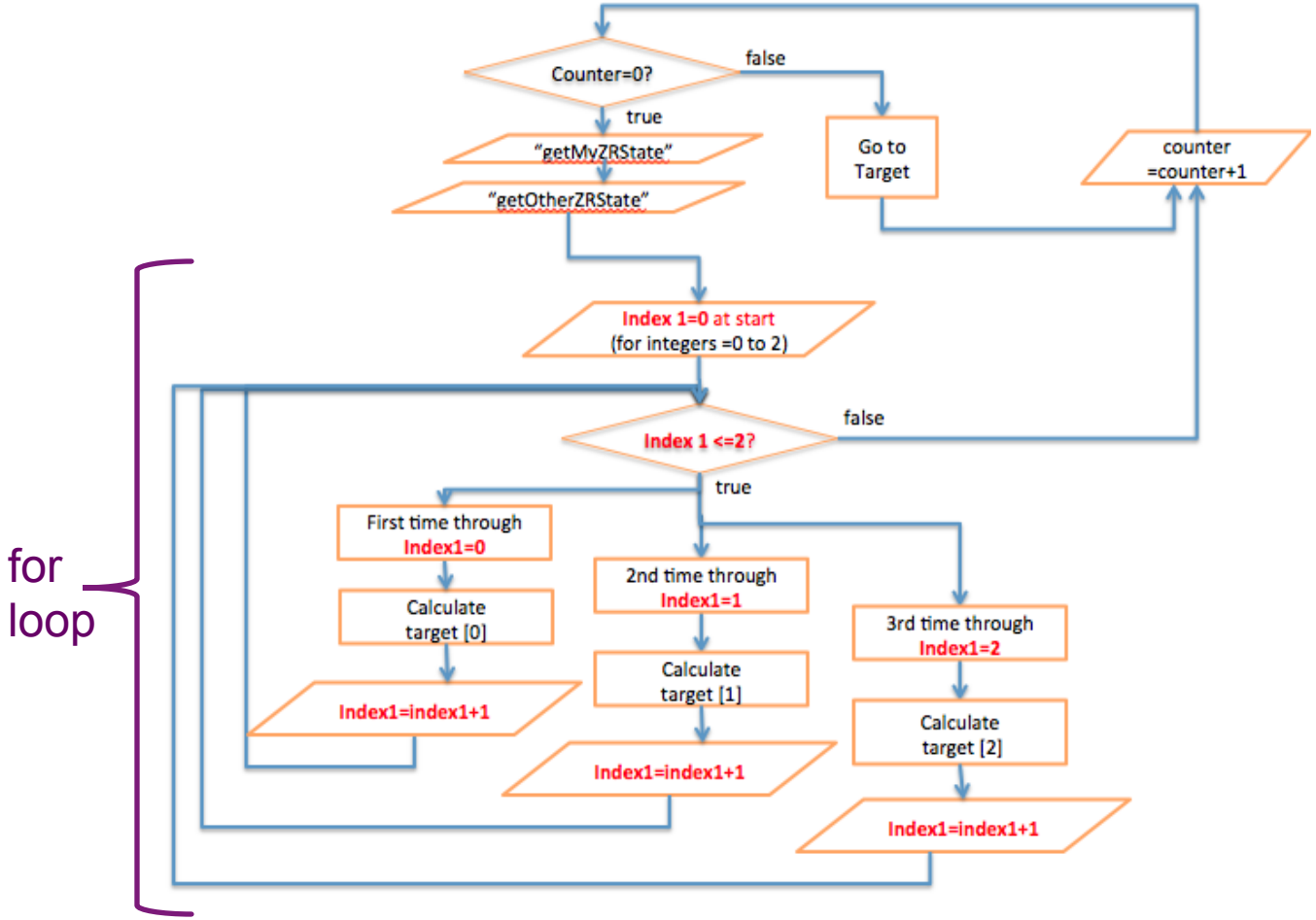
For loop flowchart

- The **for loop** is a loop inside the main SPHERES loop as shown in the flowchart
- The variable **`index1`** is highlighted
- Do you see that the **for loop** in this example executes three times inside the main loop?



target[0] = x coordinate
target[1] = y coordinate
target[2] = z coordinate

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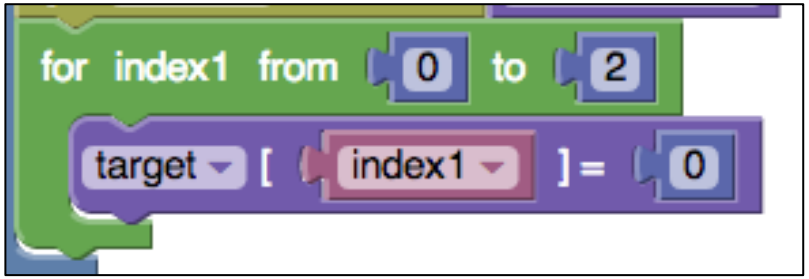
Calculating target position

- Go to the Variables accordion
  - Drag a purple array "**`Select [0]=0`**" block into the **for loop**.
  - Change the drop-down menu to **`target`**.
- Drag a pink variable ("--Select--") block into the first empty space and change its drop-down menu to **`index1`**.
- Because **`index1`** goes from 0 to 2, the first time the loop will set **`target[0]`** (the x coordinate), then **`target[1]`** (y), then **`target[2]`** (z.)



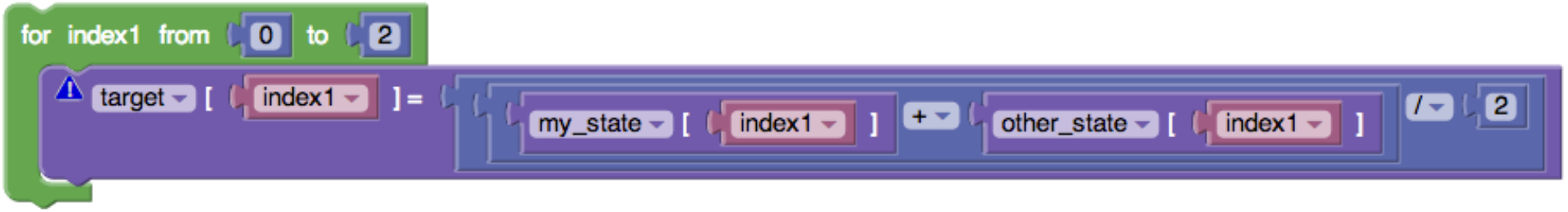
Calculating target position (cont.)

- Go to the Math accordion and drag a "__/__" block onto the 0 in the block you just added. (toggled from the "__+__" block)
- Drag a "__+__" block into the first empty space in the block (the numerator.)
- Drag a number block into the second empty space set to 2.

- Drag a **--Select--[0]** block from the Variables accordion onto each side of the "__+__" block.
- Change to: **my_ state [0]+ other_state [0]**

Calculating target position (cont.)

- Now drag two **`pink variable`** ("—Select--") blocks onto the 0 in the index of the **`my_state[0]`** and **`other_state[0]`** blocks and change them to **`index1`**.



- Do you see how this line of code sets each coordinate of *target* to the average of **`my_state`** and **`other_state`**?
- Finally, outside the if statement at the very end of the loop, add **`setPositionTarget(target)`** (shown on next slide).

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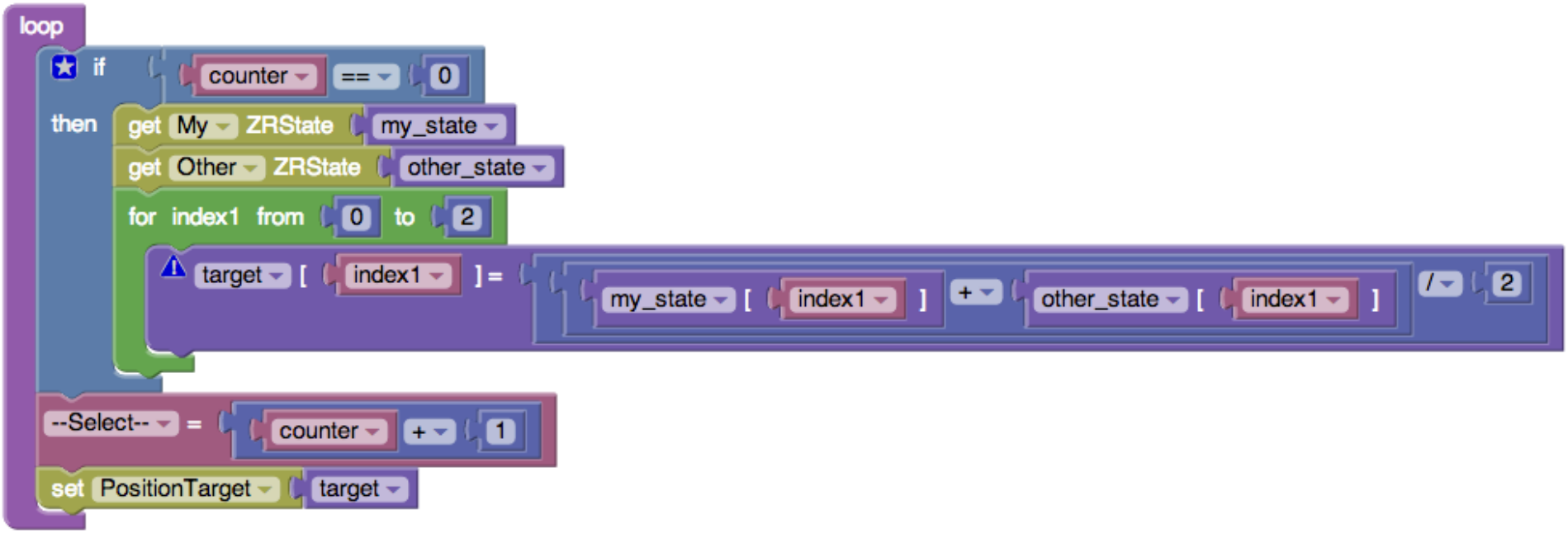
Your final program



- Before you simulate: See instructions on the next 2 pages including!
  - Warning
  - Changing the starting coordinates in the simulation settings window

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WARNING!

- You must always be careful when using **for loops** to set arrays.
- For example, if you change the 2 in the **for loop** block to a 3, the program will try to set **`target[3]`** to a value.
- But **`target[3]`** does not exist. *(target [0], target [1],target [2])*
- This can cause serious problems.
- Make sure you are only putting values into array members that actually exist!

Simulation

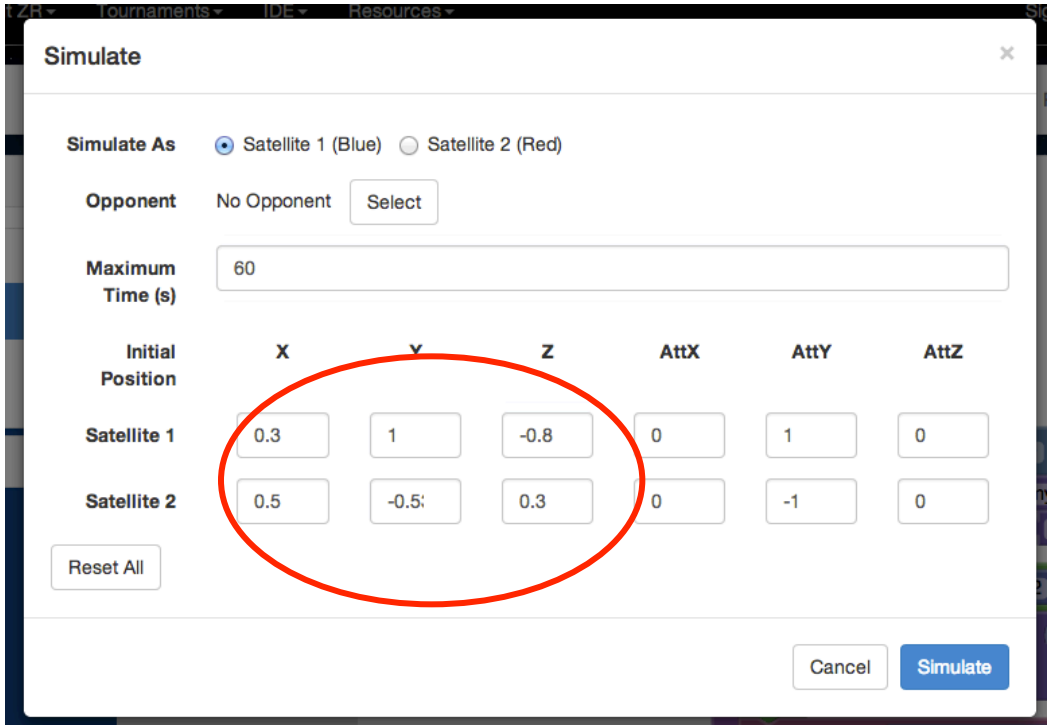
- Compile
- Simulate
  - Set Maximum Time to 60 seconds
  - Set the starting coordinates of

  Satellite1:
  - **x = 0.3, y = 1, z = -0.8**

  - Set the starting coordinates of

  Satellite 2:
  x = 0.5, y = -0.3, z = 0.3

- View simulation
- Change the starting coordinates to your own values and try it again.



Your program in C code


```
1  void loop() {
2    if (counter == 0) {
3      api.getMyZRState(my_state);
4      api.getOtherZRState(other_state);
5      for (int index1 = 0; index1 <= 2; index1++) {
6        target[index1] = (my_state[index1] + other_state[index1]) / 2;
7      }
8    }
9    counter = counter + 1;
10   api.setPositionTarget(target);
11 }
```

Review

Congratulations!

- You have found the positions of the satellites in your code.
- You have used a **for loop** to carry out repeated calculations.
- You have programmed one satellite to move halfway toward the other one.