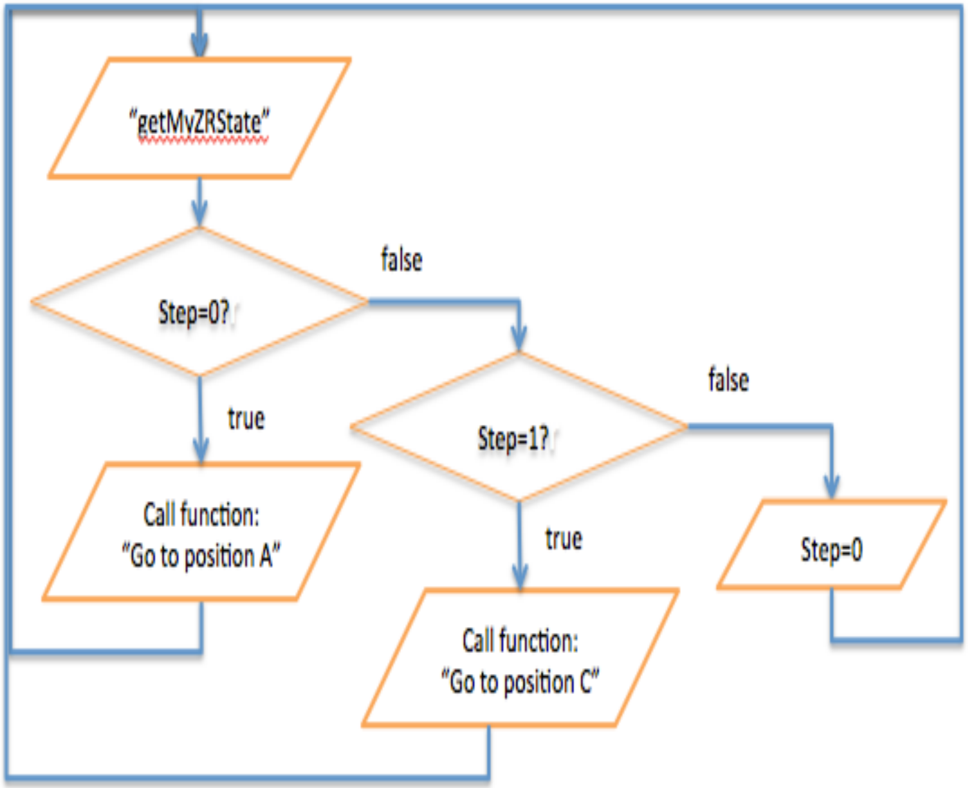
ZERO ROBOTICS

ISS PROGRAMING CHALLENGE

Functions and the Step Counter Model

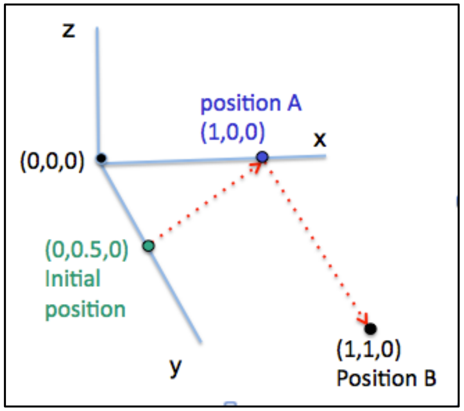
Goals

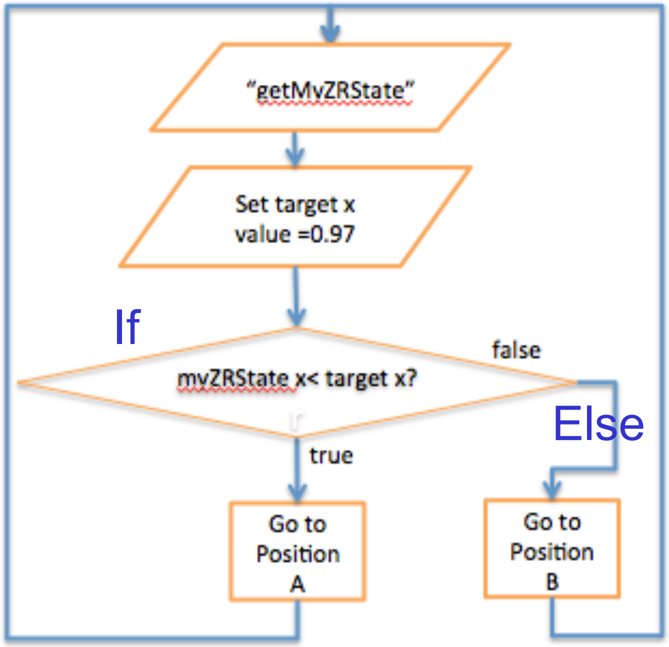
- In this tutorial you will:
  - Learn to use a step counter in your program
  - Practice creating functions
- Important note: There will be several slides at the beginning of this tutorial to read and understand before you begin to create your next program.


"getMyZRState"
Step=0?
false
true
Call function: "Go to position A"
Step=1?
false
true
Call function: "Go to position C"
Step=0

Review of previous tutorial

- The sketch and flow diagram on the right describe the program you wrote in a previous tutorial (*Applied Conditionals*)
- What would happen if the location of Position B were changed? Would this program always move the SPHERES satellite to Position B?
- On the next slide you will be given an example of a location where the program would not work and the reason why.





"getMyZRState"

Set target x value =0.97

If

myZRState.x< target x?

false

Else

true

Go to Position A

Go to Position B

Example that doesn't work

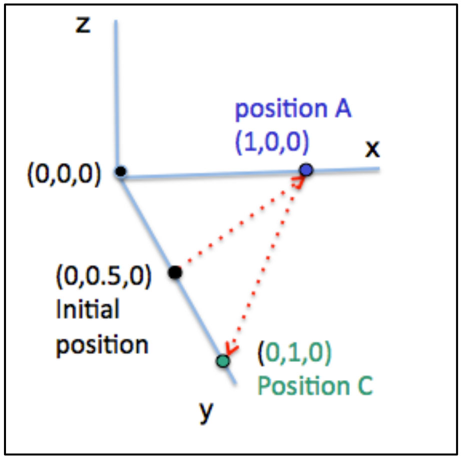
- Look at the new position called Position C.
  - Q: How does the *x*-coordinate of the satellite change as it moves from position A (1,0,0) to position C (0,1,0) in the picture?
  - A: The satellite starts with *x*-coordinate = 1 and moves towards *x* coordinate = 0
- The program sets target x = 0.97 then states:

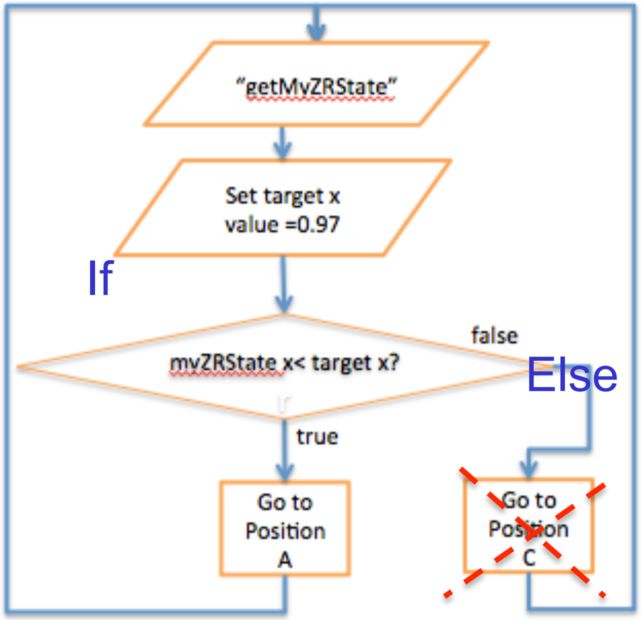
  If myZRState[0] < target [0],

  (which means If SPHERES *x*-coordinate < 0.97)

  Then go to position A

  Else go to position C
- As the satellite moves from position A toward position C, its *x*-coordinate becomes < 0.97 and it will be sent back to position A.
  - The program will not allow the satellite to move to position C (which has *x*-coordinate < 0.97)



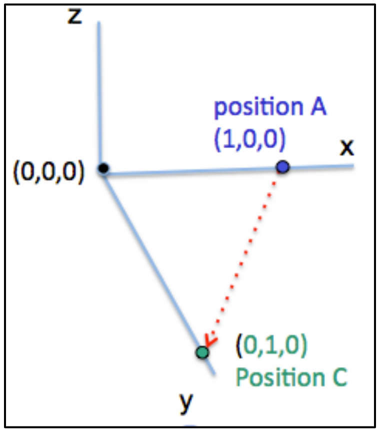


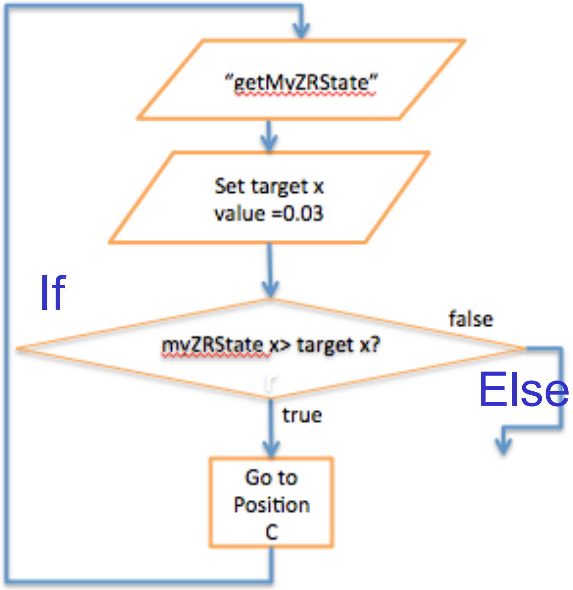
Picking a target value for Position C

- So what is the target value that you would choose to move the satellite from position A to position C?
  - Since the satellite starts with *x*-coordinate=1 and moves towards *x*-coordinate=0:
  - Pick a target close to zero.
  - Pick target[0]=0.03 to include margin for error
- In this case the satellite's *x*-coordinate is **greater than** 0.03 until it reaches the target
- So the conditional statement for this example would be:

"If myZRState[0] **>** target[0]

Then continue to position C"





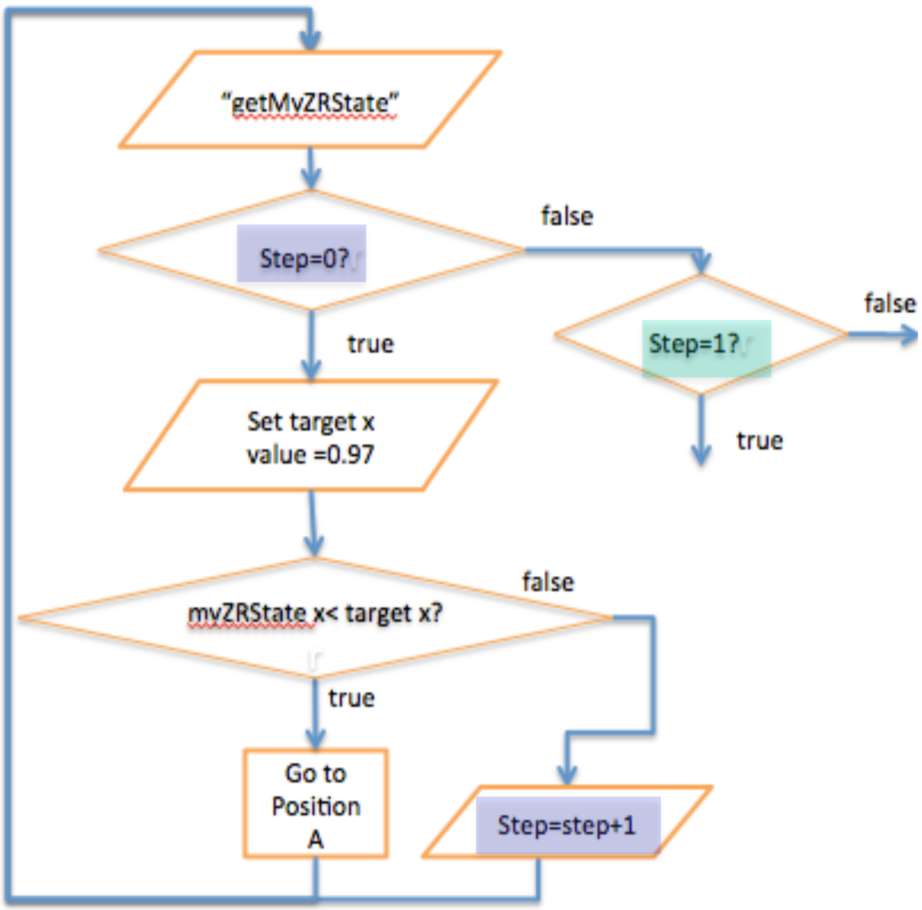
Solution to problem

- We need to write a program that allows us to pick different target values depending on where we want the satellite to move

- We can solve this problem using a step counter (as described on the following slides)

Using a step counter

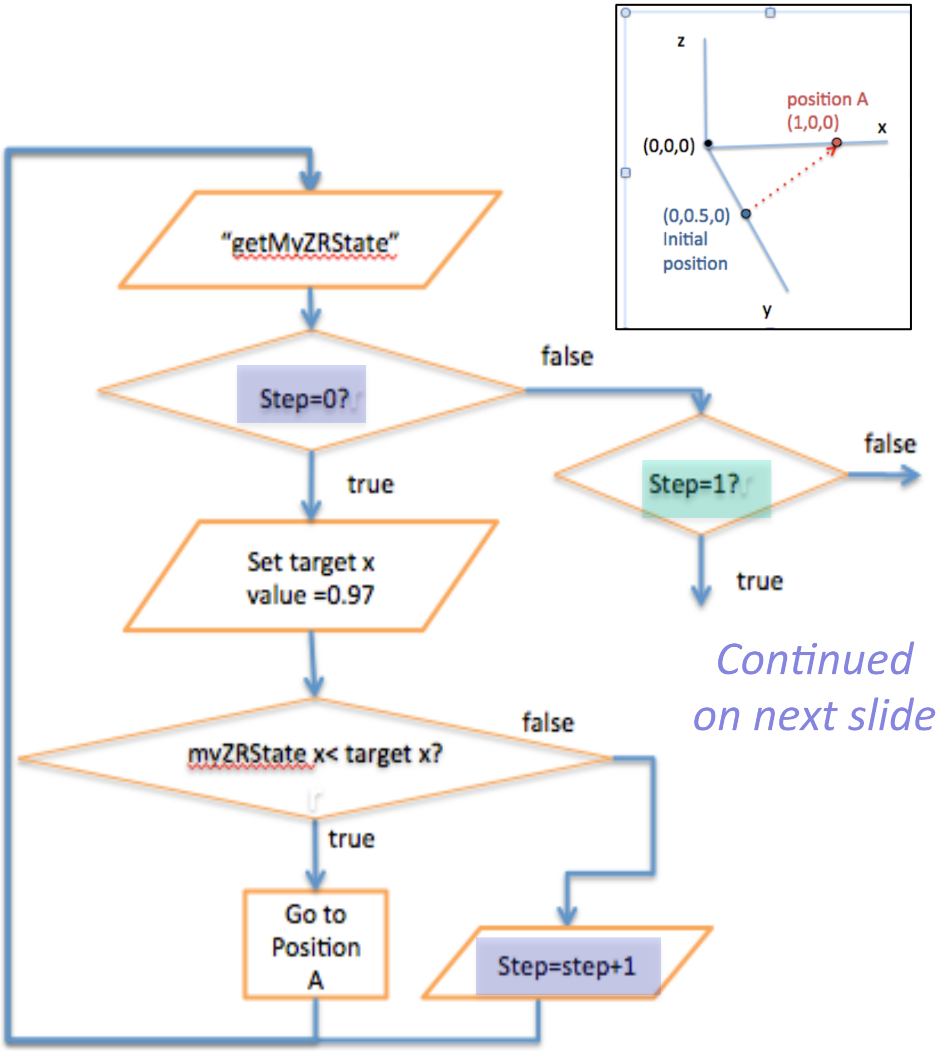
- A step counter is one way you can organize a program. It is particularly useful in a game like ZR.
- To use a step counter:
  - Break up the program into steps (for example, moving to a point is one step)
  - Use a variable to keep track of how many steps have been performed
  - Use conditionals to make sure you execute only the next step in the process
  - This process ensures that all steps happen in the right order
- An example of this process is provided on the next several slides



Using a step counter (cont.)

Look more closely at the example: Let’s say the first step in the program (step 0) is for the satellite to go to position A

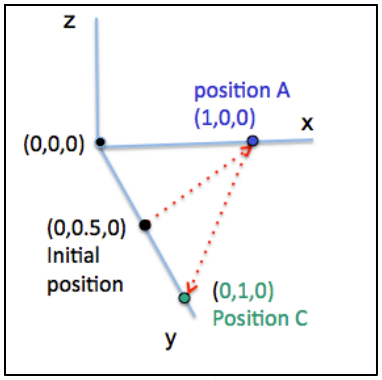
- The flow diagram to the right includes a step counter. Note that:
  - A conditional statement is added to the program to check if the program is in the first step (Step=0?)
  - The step is increased by 1 (Step=step+1) after the satellite completes the first step by reaching position A
  - Another conditional statement is added to check whether or not the program has moved to the next step (Step=1?).



Continued on next slide

Using a step counter (cont.)

- Next we want the satellite to leave position A and go to position C (as shown in the sketch)
- By using a step counter we don't have the same problem that we had before because the variable target x can be given a new value inside each step.
- For Step=0: target x was set to a value appropriate for position A (see previous slide)
- For Step=1? target x is set to a new value appropriate for position C (shown here)
- Next, Step=0 resets the step counter



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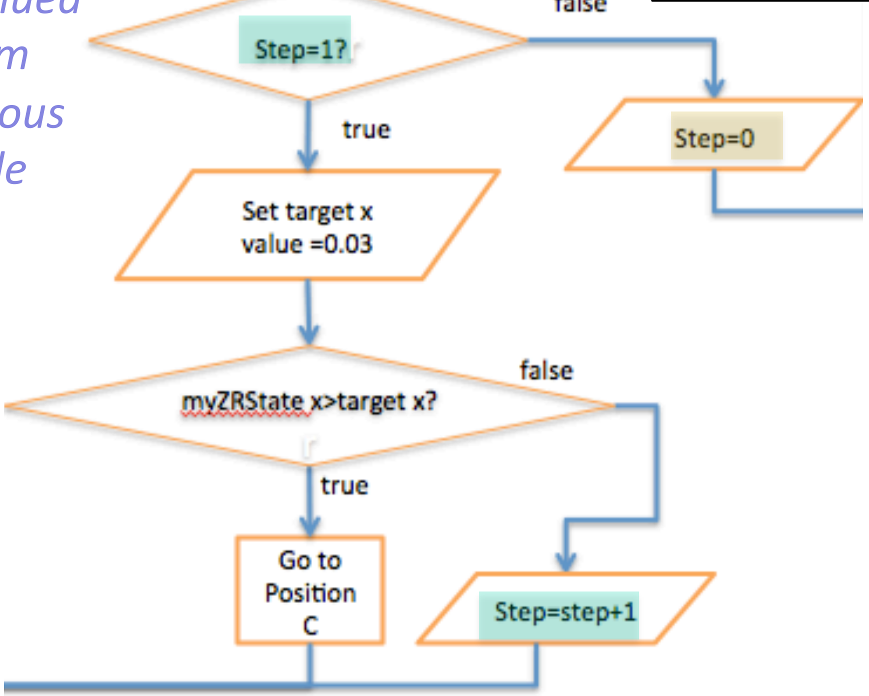
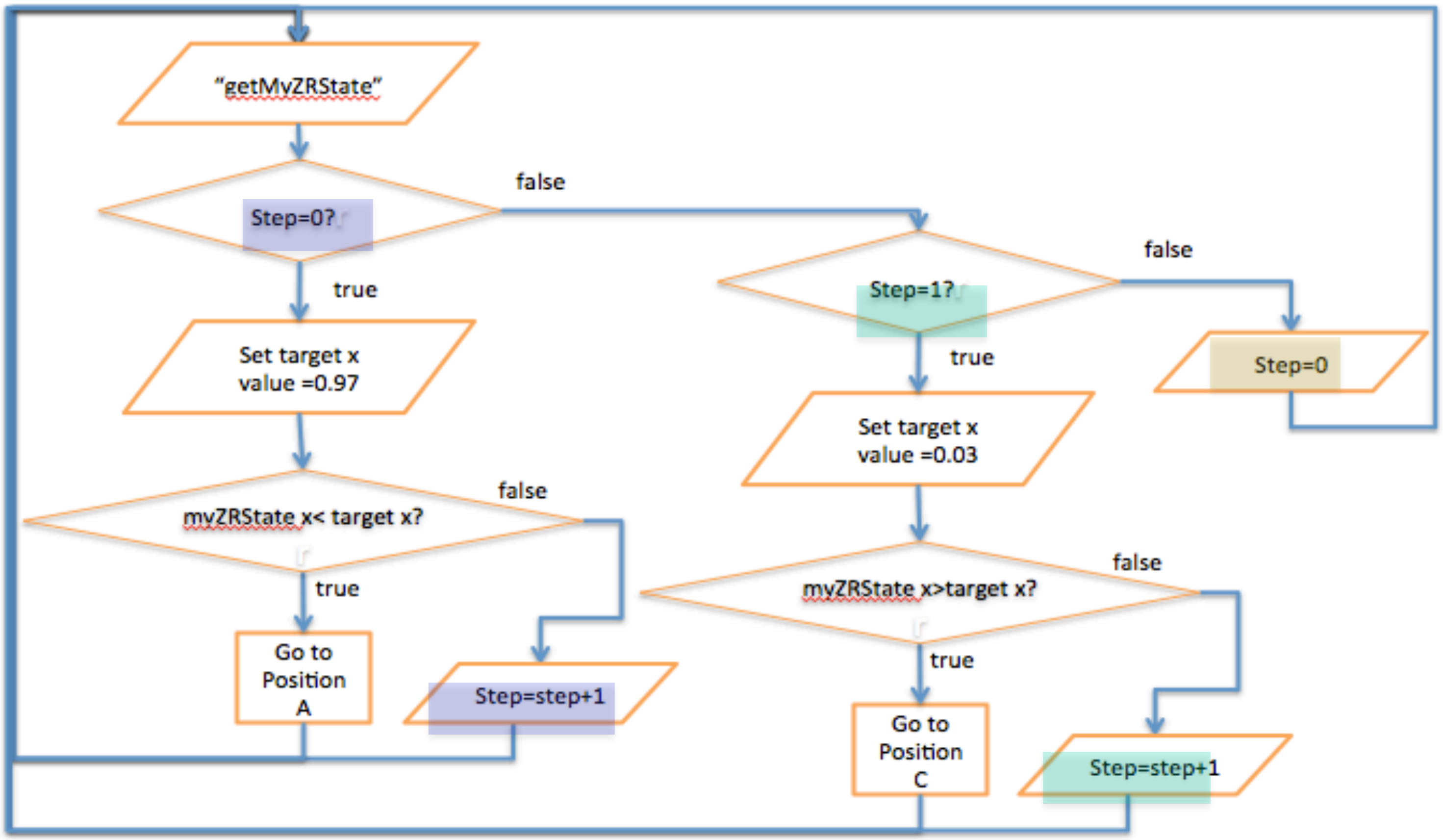


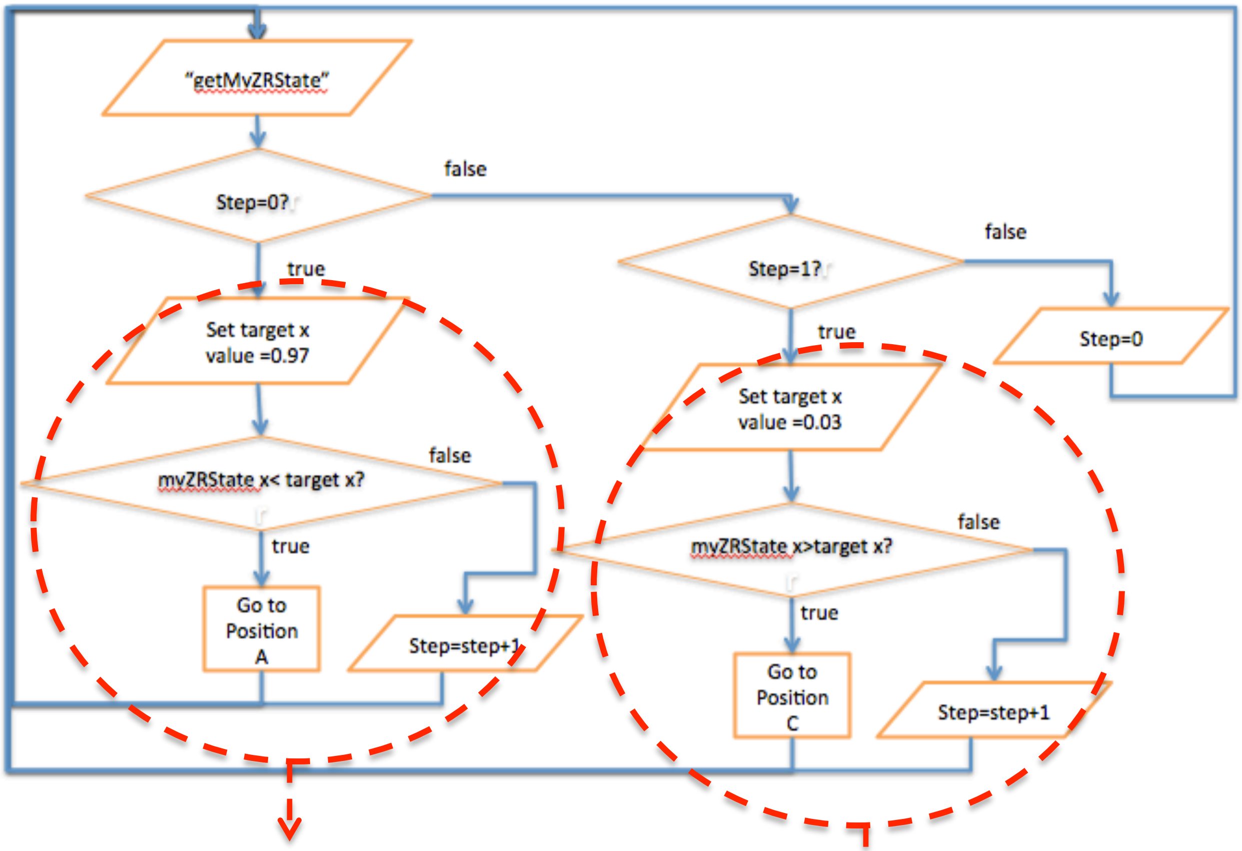
Using a step counter (cont.)

- This slide shows the complete flow chart



Functions

- We can make this program simpler to read by breaking it down into smaller pieces.
- This is done by creating procedural functions
- For example, we can create two functions
  - One that includes the parts of the program that sends the satellite to position A
  - One that includes the parts of the program that send the satellite to position C

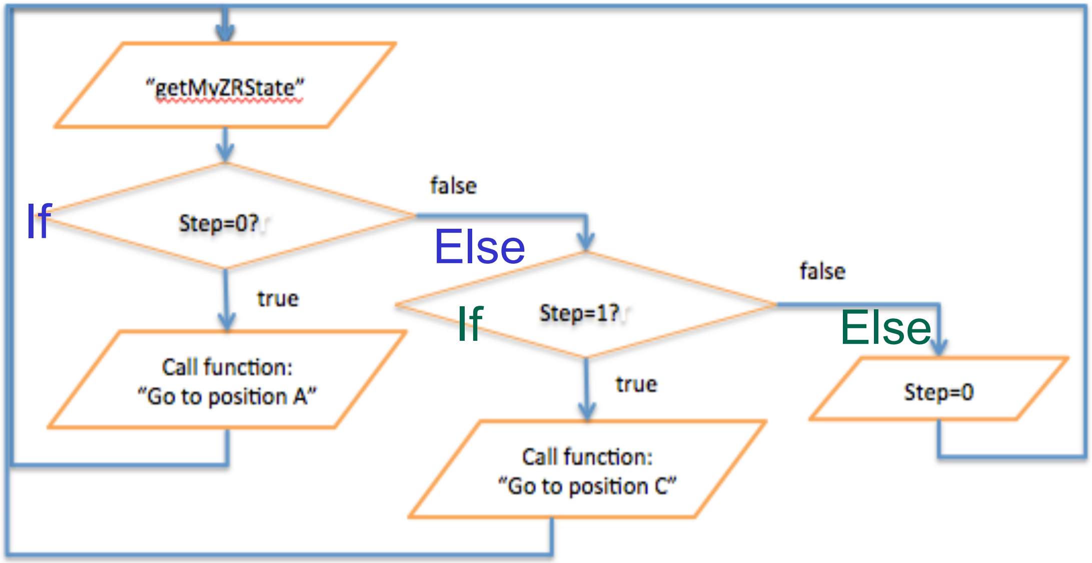


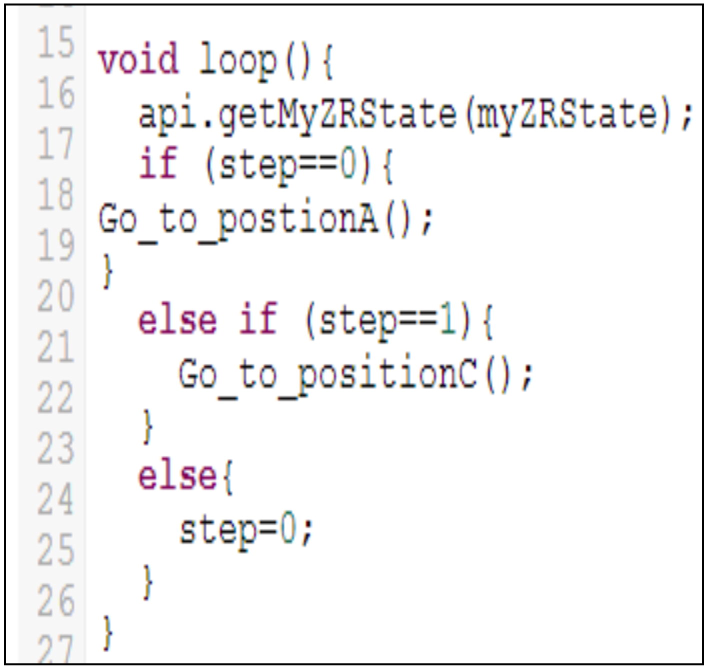
Create function called "Go to position A"

Create function called "Go to position C"

Functions (cont.)

- This is what the example program’s flow diagram and text editor program would look like if written using two functions: one called “Go to position A” and one called “Go to position C”



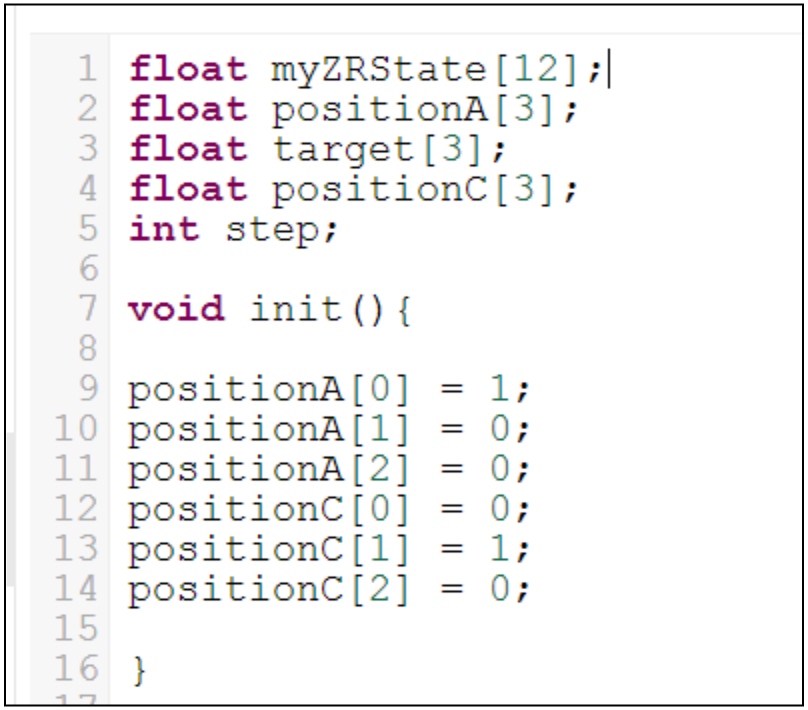


```
void loop(){
  api.getMyZRState(myZRState);
  if (step==0){
Go_to_postionA();
}
  else if (step==1){
    Go_to_positionC();
  }
  else{
    step=0;
  }
}
```

- You don’t see Step=step+1 here because it is included inside each function.

Create a New Project Using “Save As”

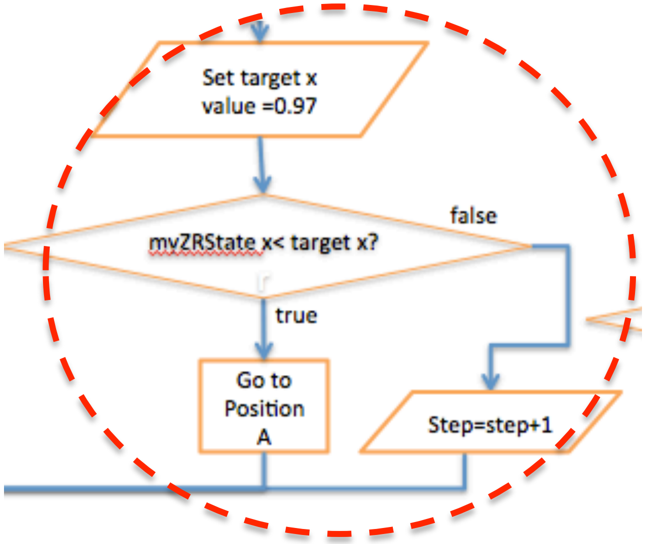
- To create this program with a step counter and functions, you will start from the program you created in the previous tutorial
  - Open the ZR IDE
  - Open Project 10
  - On the menu bar select “File” and then “Save As” from the drop down menu.
  - Type in **Project 11** and select **Free Mode**
- You will need to create two new variables
  - `float positionC [3]` : Set initial value to 0,1,0
  - `Int step :` Leave initial value blank
- Verify the remaining variables as follows:
  - `float positionA[3] :` Verify initial value is set to 1,0,0
  - `float myZRstate[12] :` Leave initial value blank
  - `float target[3] :` Leave initial value blank

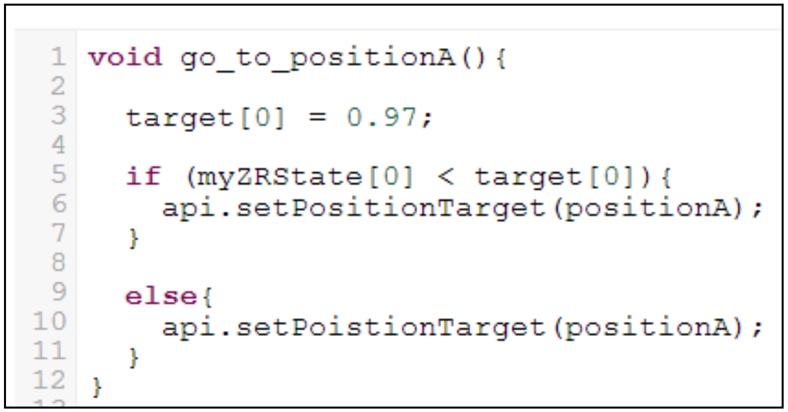


```
float myZRState[12];
float positionA[3];
float target[3];
float positionC[3];
int step;

void init(){

positionA[0] = 1;
positionA[1] = 0;
positionA[2] = 0;
positionC[0] = 0;
positionC[1] = 1;
positionC[2] = 0;

}
```

Create “go_to_positionA” Function

- Your program already has a function to send the SPHERES to position A that is very similar to the one shown in the flow diagram
- Click on the page “`Go_To_PositionA`”
- Can you see the difference between the part of the flow diagram that we want to make into a function called “`go_to_PositionA`” and your program?
- (Hint:
  - Compare your program’s **`else`** statement with the flow diagram
    - your old program continues to set the SPHERES position to positionA
    - the new program increments the step counter (step=step+1)



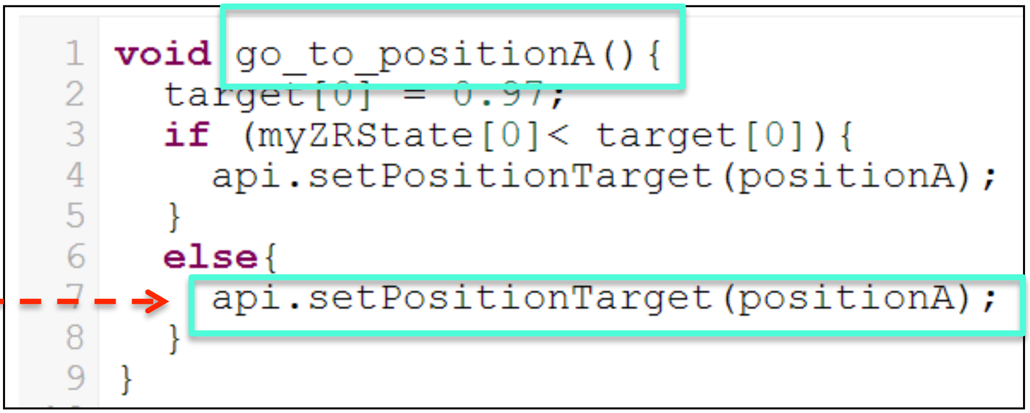


```
void go_to_positionA(){

  target[0] = 0.97;

  if (myZRState[0] < target[0]){
    api.setPositionTarget(positionA);
  }

  else{
    api.setPoistionTarget(positionA);
  }
}
```

Create “go_to_positionA” Function (cont.)

- Delete **api.setPositionTarget(positionA)** block from the else statement in your function “go_to_positionA”.

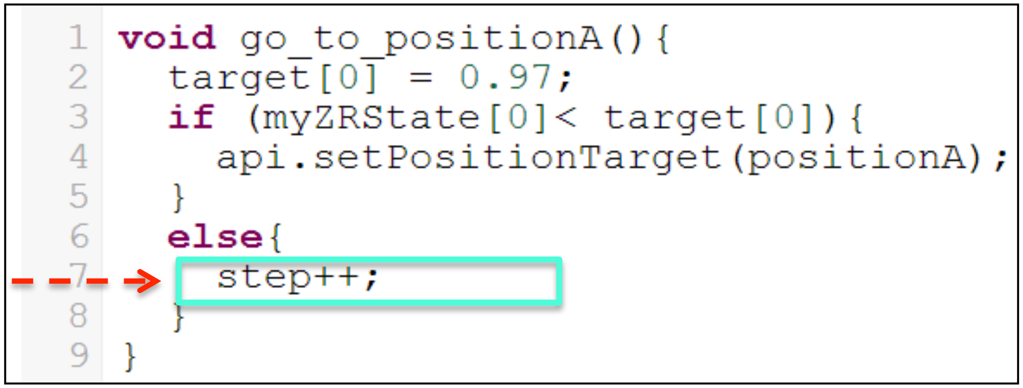
delete



```
void go_to_positionA(){
  target[0] = 0.97;
  if (myZRState[0]< target[0]){
    api.setPositionTarget(positionA);
  }
  else{
    api.setPositionTarget(positionA);
  }
}
```

- Add a step counter into the “else” slot
  - It should read: “**Step++;**”

add

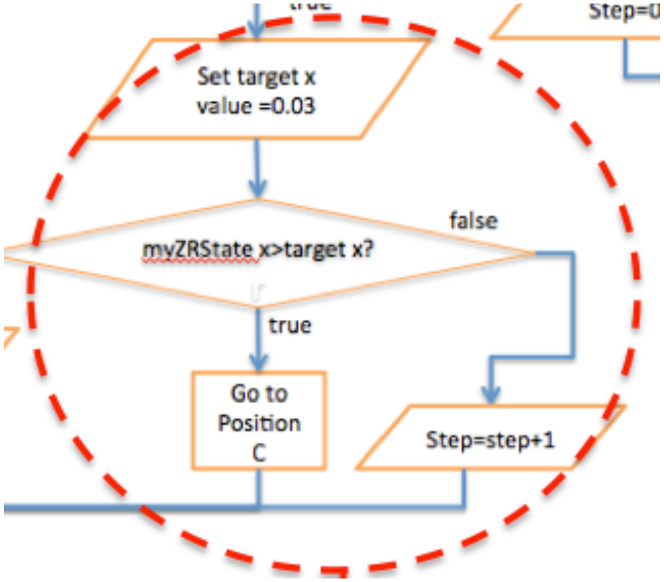


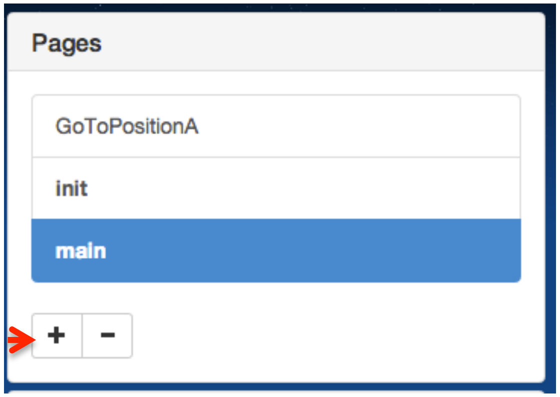
```
void go_to_positionA(){
  target[0] = 0.97;
  if (myZRState[0]< target[0]){
    api.setPositionTarget(positionA);
  }
  else{
    step++;
  }
}
```

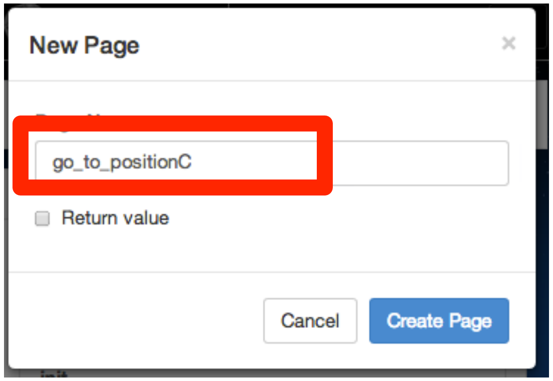
- Your function “go_to_PositionA” is complete!

Create "go_to_positionC" Function

- Now let's create the second function in the flow diagram "go_to_positionC"
- The first step is to create a new page called "go_to_positionC"
- Click on the "+" button on the "pages" window
- For Page Name type: go_to_positionC. This will be the name of your function
  - Leave Return Value blank
  - Click the "Create Page" button





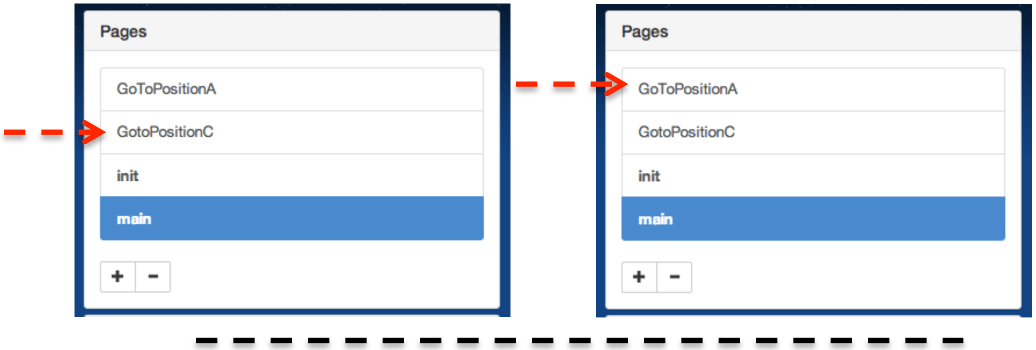


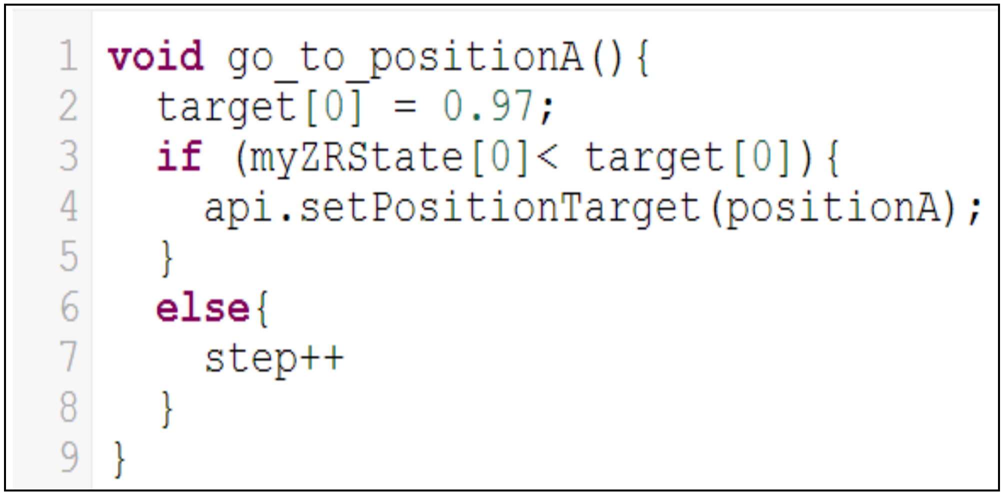
go_to_positionC

□ Return value

Create “go_to_positionC” Function (cont.)

- Your new page will show up in the list of pages
- Click on the “go_to_positionA” page.
- Because the two functions are similar, you will copy and paste the code from the “Go_to_positionA” page into the “Go_to_positionC” page and then edit.
- This code now needs to be edited to send the satellite to positionC (instead of positionA) as described on the next slide

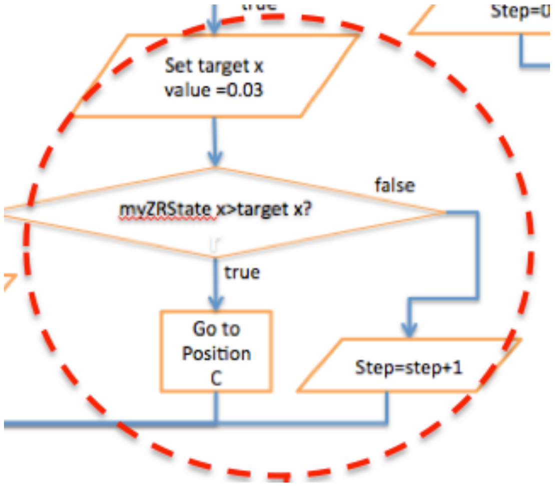


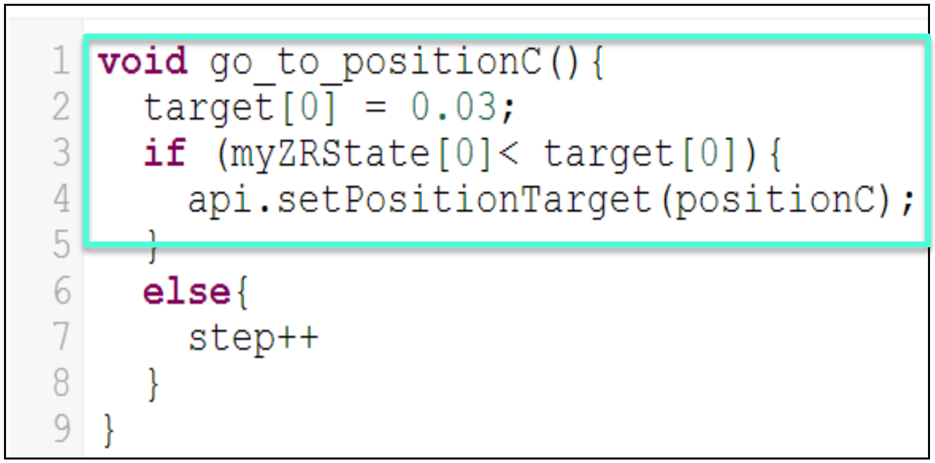


```
void go_to_positionA(){
  target[0] = 0.97;
  if (myZRState[0]< target[0]){
    api.setPositionTarget(positionA);
  }
  else{
    step++
  }
}
```

Create “go_to_positionC” Function (cont.)

- The portion of the flow diagram that sends the satellite to position C is shown to the right as a reference
- Change first line to **go_to_positionC**
- Change “target [0] = 0.97”
  to: “target [0] = **0.03**”
- Change the conditional statement from myZRState[0]<target[0] to myZRState[0]>target[0]
- Change the api.setPositionTarget(positionA) to api.setPositionTarget(positionC)
- Step=step+1 should already be in your program
- Your function “Go_to_positionC” is complete!

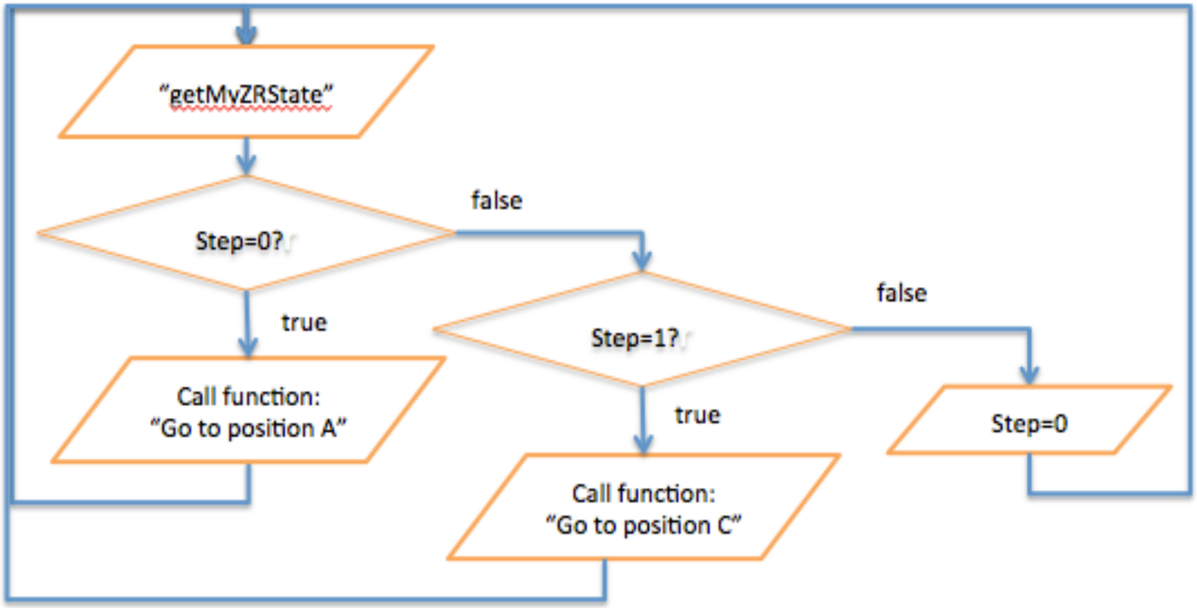




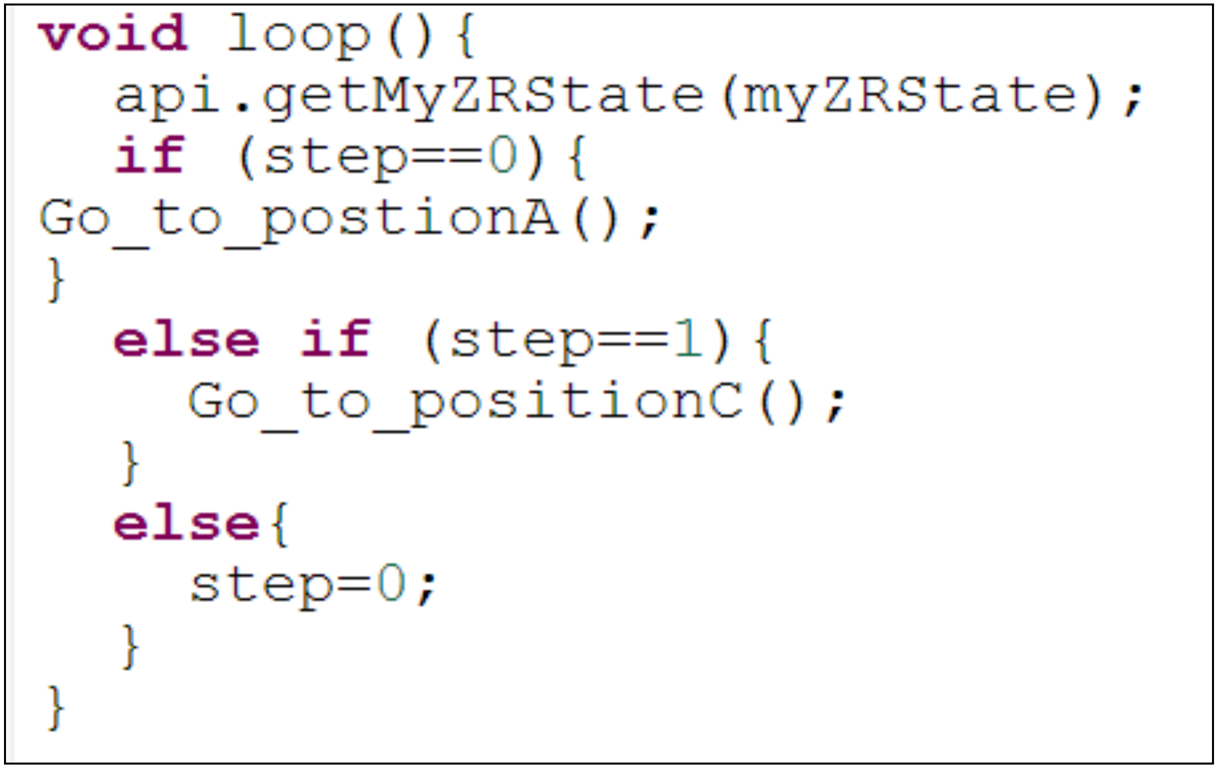
```
void go_to_positionC(){
  target[0] = 0.03;
  if (myZRState[0]< target[0]){
    api.setPositionTarget(positionC);
  }
  else{
    step++
  }
}
```

Using the Step Counter Model

- The next step is to go back to the main loop and create the program shown below
- This program uses a step counter and "calls" the functions
- Try creating the program on your own, and use the next slide to



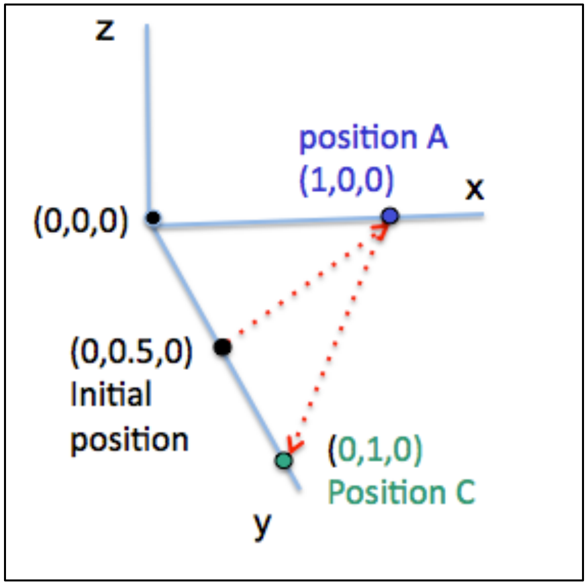
Using the Step Counter Model (cont.)



```
void loop(){
   api.getMyZRState(myZRState);
   if (step==0){
Go_to_postionA();
}
   else if (step==1){
      Go_to_positionC();
   }
   else{
      step=0;
   }
}
```

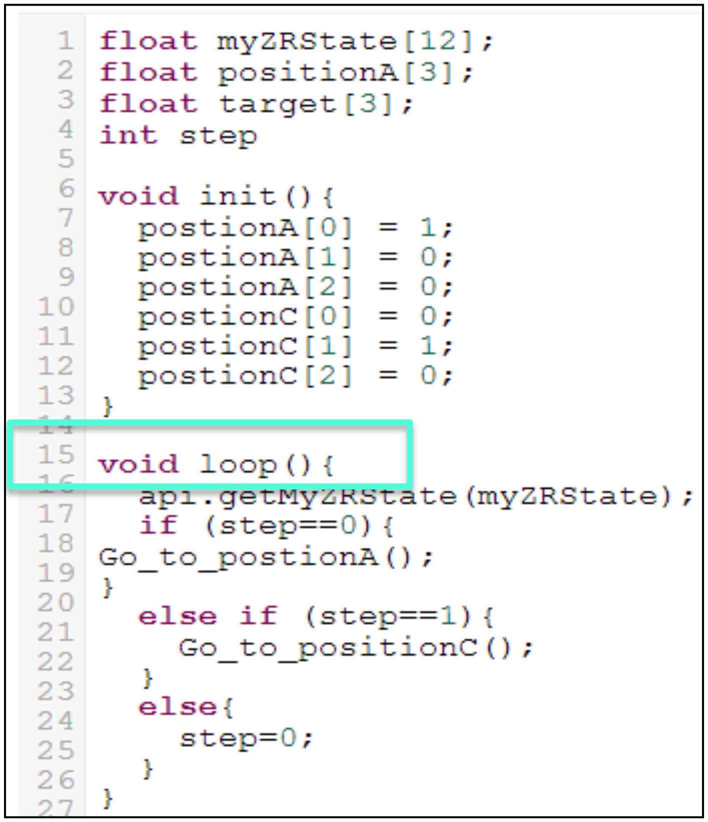
View Simulation

- Your code is complete!
- Compile, Simulate
  - Load settings: Tutorial _180
  - View simulation

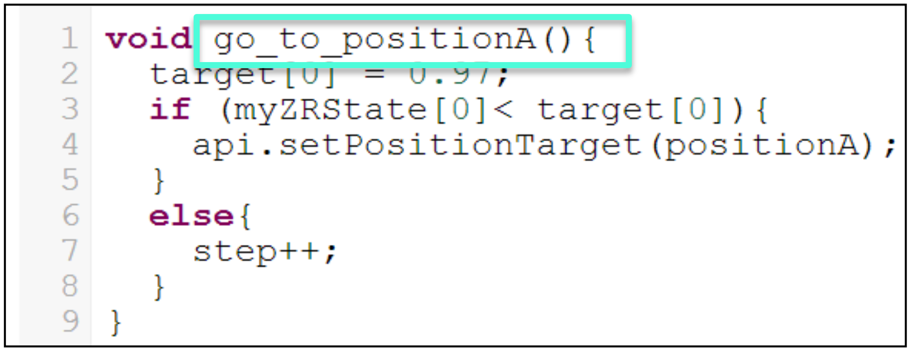


Your Code

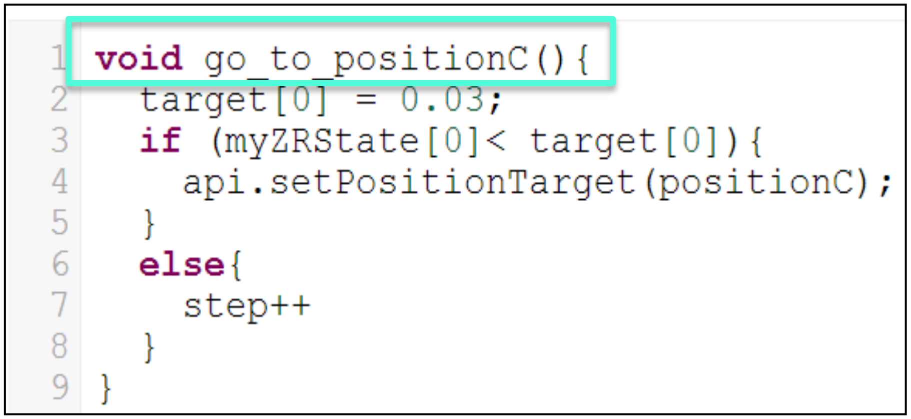
- The C Code for the separate pages “main”, “Go_to_positionA”, and “Go_to_positionC” is shown below:



```
float myZRState[12];
float positionA[3];
float target[3];
int step

void init(){
  postionA[0] = 1;
  postionA[1] = 0;
  postionA[2] = 0;
  postionC[0] = 0;
  postionC[1] = 1;
  postionC[2] = 0;
}

void loop(){
  api.getMyZRState(myZRState);
  if (step==0){
Go_to_postionA();
}
  else if (step==1){
    Go_to_positionC();
  }
  else{
    step=0;
  }
}
```



```
void go_to_positionA(){
  target[0] = 0.97;
  if (myZRState[0]< target[0]){
    api.setPositionTarget(positionA);
  }
  else{
    step++;
  }
}
```



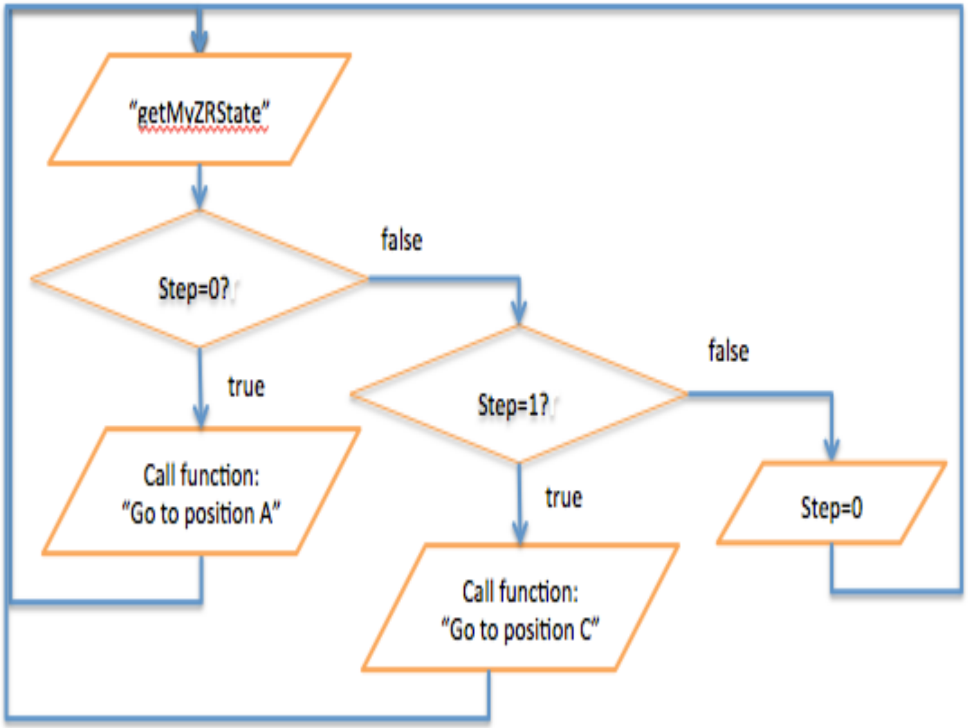
```
void go_to_positionC(){
  target[0] = 0.03;
  if (myZRState[0]< target[0]){
    api.setPositionTarget(positionC);
  }
  else{
    step++
  }
}
```

Using Functions

- The program you just created resets the step counter to zero.
- If you wanted to program the satellite to go to another position after going to positionC, can you see how this would be done?
  - You would:
    - Create a new function
    - Replace “step=0” with Else if statement for step =2
    - Call the new function
- When you program your SPHERES for the game you will probably use a series of nested Else if statements with multiple steps
- Using functions will also make it easier for you to figure out which part of your program needs debugging

Review

- Congratulations!
  - You have learned how to:
    - Use a Step Counter
    - Create multiple functions
  - You are just about ready to start programming your game!


"getMyZRState"
Step=0?
false
true
Call function: "Go to position A"
Step=1?
false
true
Call function: "Go to position C"
Step=0