MIT 2.680

UNMANNED MARINE VEHICLE AUTONOMY, SENSING, AND COMMUNICATIONS

Lecture 8 – Multi-Vehicle Mission Debugging

March 10th, 2026

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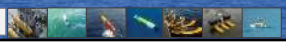
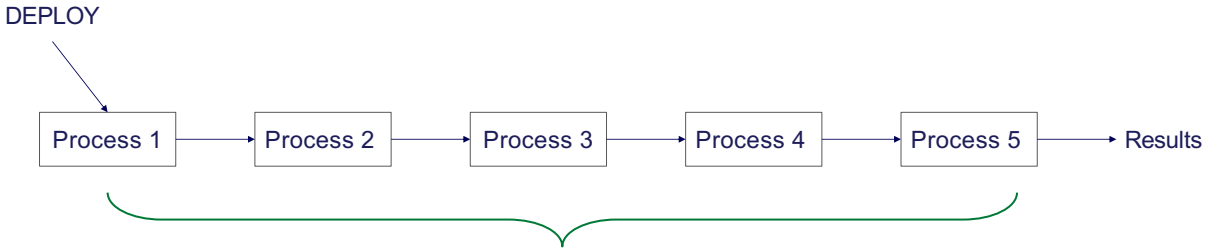


Photo by Arjan Vermeij
GLINT '09

1

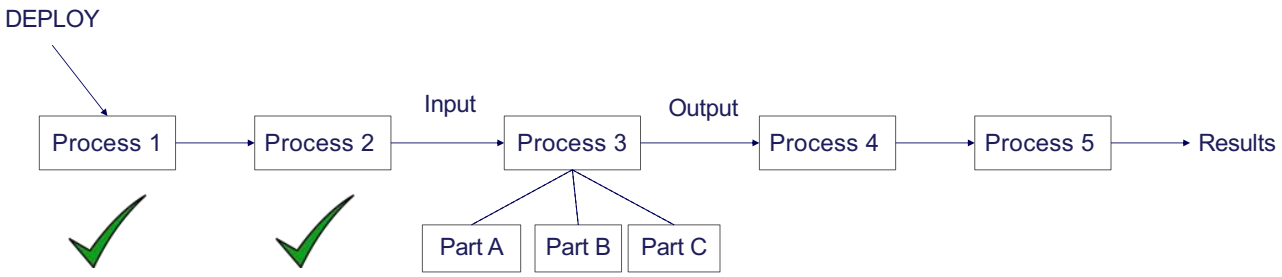
Know Your Pipeline



- A pipeline may involve several processes (e.g., MOOS Apps), handing a portion of the problem
- In development, and debugging, it is usually preferable to focus step by step.

2

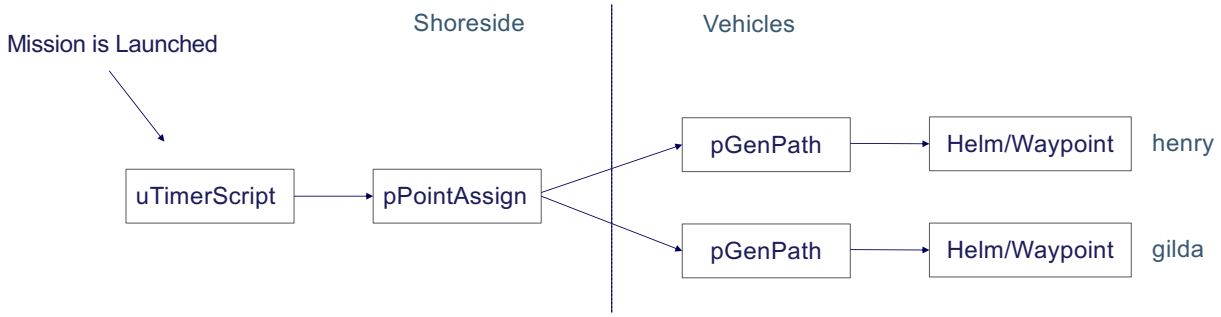
Know Your Pipeline



- Every stage typically has its own input and output
- If you can, build the components of the pipeline, step by step and verify

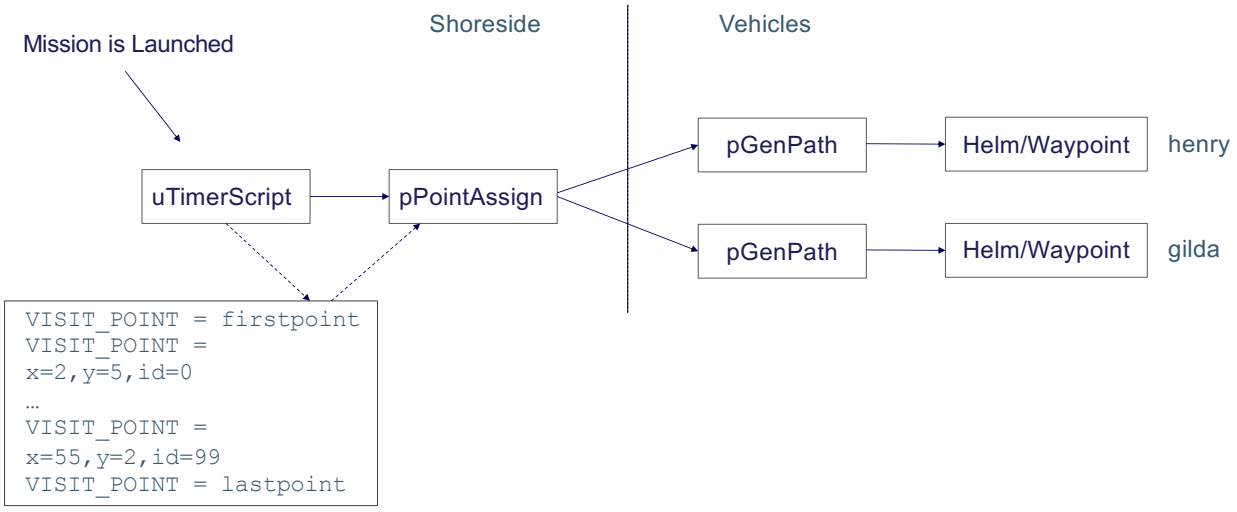
The Distributed TSP Pipeline

The Distributed TSP Pipeline



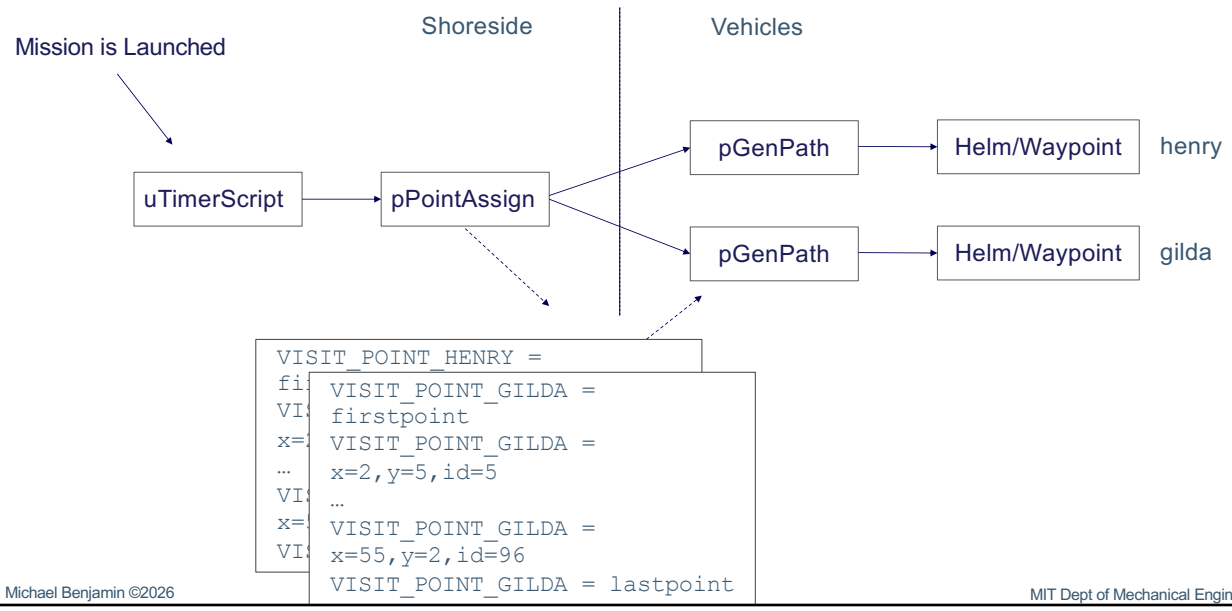
5

The Distributed TSP Pipeline

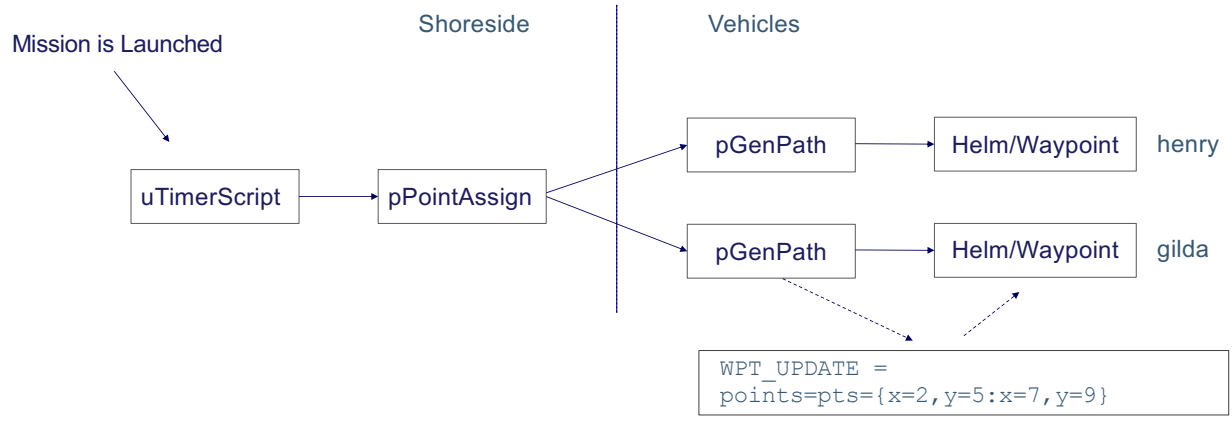


6

The Distributed TSP Pipeline



The Distributed TSP Pipeline



Implementing the Distributed TSP Pipeline

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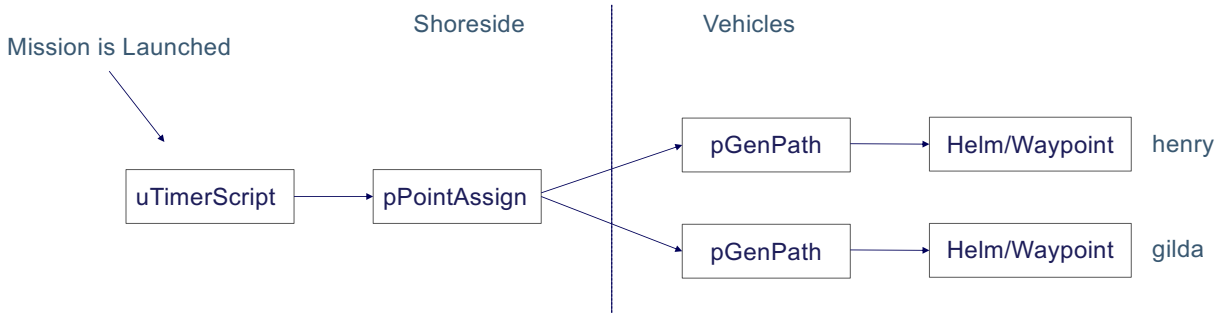
The Distributed TSP Pipeline Posting Points




```
VISIT_POINT = firstpoint
VISIT_POINT =
x=2,y=5,id=0
…
VISIT_POINT =
x=55,y=2,id=99
VISIT_POINT = lastpoint
```

- A timer script is added to the shoreside MOOS community
- See the uTimerScript documentation (Section 9.1) for a similar example
- Use the block_on parameter to ensure that pPointAssign is listening before posting

```
block_on = pPointAssign
```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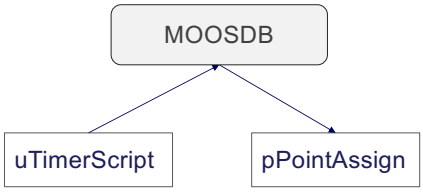
The Distributed TSP Pipeline Posting Points

What happens if uTimerScript starts well before pPointAssign?



shoreside.moos

```
Processconfig = ANTLER
{
  MSBetweenLaunches = 200

  Run = MOOSDB           @ NewConsole = false
  Run = uTimerScript     @ NewConsole = false
  Run = pShare           @ NewConsole = false
  Run = pMarineViewer    @ NewConsole = false
  Run = pLogger          @ NewConsole = false
  Run = pHostInfo        @ NewConsole = false
  Run = uFldShoreBroker  @ NewConsole = false
  Run = pPointAssign     @ NewConsole = false
}
```

Recall that when an app connects to the MOOSDB, it only gets the most recent mail for any registered variables.

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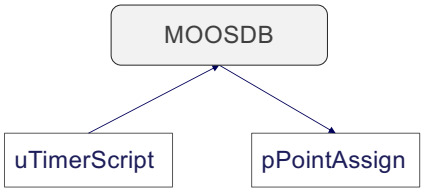
The Distributed TSP Pipeline Posting Points

We can “fix” this problem by moving uTimerScript to be the last app launched.



shoreside.moos

```
Processconfig = ANTLER
{
  MSBetweenLaunches = 200

  Run = MOOSDB           @ NewConsole = false
  Run = pPointAssign     @ NewConsole = false
  Run = pShare           @ NewConsole = false
  Run = pMarineViewer    @ NewConsole = false
  Run = pLogger          @ NewConsole = false
  Run = pHostInfo        @ NewConsole = false
  Run = uFldShoreBroker  @ NewConsole = false
  Run = uTimerScript     @ NewConsole = false
}
```

This is a brittle solution. Even if the person editing the .moos file were to put a comment in the file explaining why uTimerScript must be launched last.

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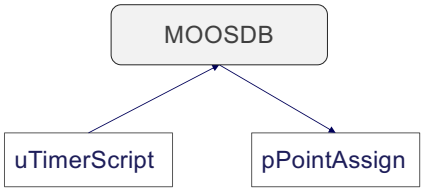
The Distributed TSP Pipeline Posting Points

Another arguably better fix is to delay the timer script for some number of seconds.



shoreside.moos

```
ProcessConfig = uTimerScript
{
  AppTick   = 3
  CommsTick = 3

  paused     = false
  reset_time = all-posted
  reset_max  = 0
  delay_start = 10

  rand_var   = …
  rand_var   = …

  event = …
}
```

This is still feels brittle. What's the right amount of time?

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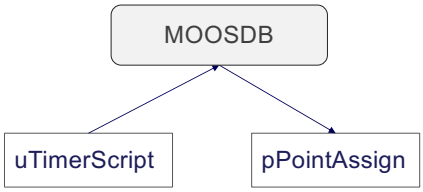
The Distributed TSP Pipeline Posting Points

A more durable fix is to ask uTimerScript to wait until pPointAssign is connected to the MOOSDB.



shoreside.moos

```
ProcessConfig = uTimerScript
{
  AppTick   = 3
  CommsTick = 3

  paused     = false
  reset_time = all-posted
  reset_max  = 0
  block_on   = pPointAssign

  rand_var   = …
  rand_var   = …

  event = …
}
```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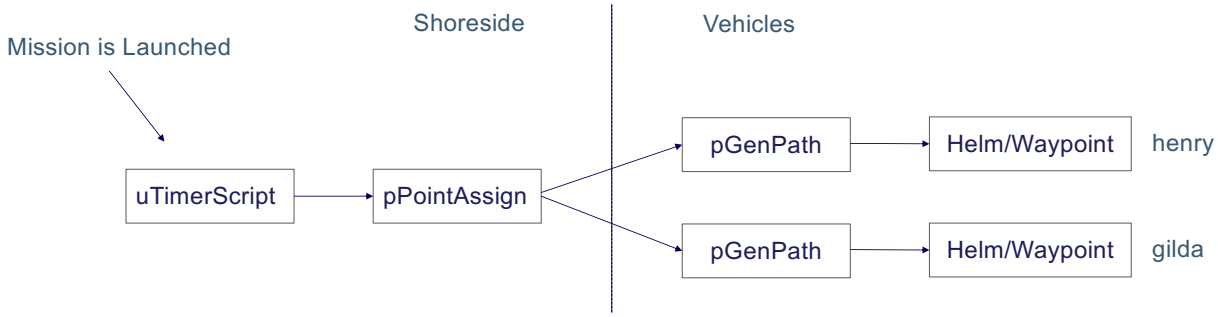
The Distributed TSP Pipeline Posting Points




```
VISIT_POINT = firstpoint
VISIT_POINT =
x=2,y=5,id=0
…
VISIT_POINT =
x=55,y=2,id=99
VISIT_POINT = lastpoint
```

- A timer script is added to the shoreside MOOS community
- See the uTimerScript documentation (Section 9.1) for a similar example
- Use the block_on parameter to ensure that pPointAssign is listening before posting

```
block_on = pPointAssign
```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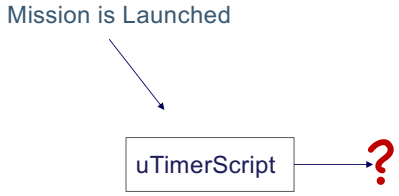
The Distributed TSP Pipeline Posting Points



How do we know that uTimerScript has done its job?

```
VISIT_POINT = firstpoint
VISIT_POINT =
x=2,y=5,id=0
…
VISIT_POINT =
x=55,y=2,id=99
VISIT_POINT = lastpoint
```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The Distributed TSP Pipeline Posting Points

Mission is Launched

uTimerScript → ?

```
VISIT_POINT = firstpoint
VISIT_POINT =
x=2,y=5,id=0
…
VISIT_POINT =
x=55,y=2,id=99
VISIT_POINT = lastpoint
```

How do we know that uTimerScript has done its job?

uTimerScript is an AppCasting MOOS App, and it will publish output indicating the number of postings.

```
uTimerScript shoreside                                    0/0(500)
Current Script Information:
     Elements: 102(102)
      Reinits: 0
    Time Warp: 1
 Time Zero is: At uTimerScript launch time (not MOOSDB start time)
  Delay Start: 0
  Delay Reset: 0
    Reset Max: 0

Run criteria:
   Block Apps: (ok) no blocking apps
       Paused: (ok) Not paused
 ConditionsOK: (ok) No un-met conditions

RandomVar  Type     Min   Max  Parameters
---------  -------  ----  ---  ----------
X          uniform  -25   200
Y          uniform  -175  -25

Total Random Pairs: 0

Var1  Var2  Type  Parameters
----  ----  ----  ----------

#/Tot  #/Loc  T/Total  T/Local  Variable/Var
-----  -----  -------  -------  ------------
94     94     2.77     0.27     VISIT_POINT = x=174.62,y=-68.44,id=94
95     95     2.77     0.27     VISIT_POINT = x=-22.975,y=-164.77,id=95
96     96     2.77     0.27     VISIT_POINT = x=42.972,y=-71.575,id=96
97     97     2.77     0.27     VISIT_POINT = x=76.768,y=-105.55,id=97
98     98     2.77     0.27     VISIT_POINT = x=59.578,y=-103.735,id=98
99     99     2.77     0.27     VISIT_POINT = x=57.62,y=-25.57,id=99
100    100    2.77     0.27     VISIT_POINT = x=189.718,y=-161.35,id=100
101    101    2.77     0.27     VISIT_POINT = lastpoint

Most Recent Events (1):
[0.26]: Script Start. Warp=1, DelayStart=0.0, DelayReset=0.0
```


The Distributed TSP Pipeline Posting Points

Mission is Launched

uTimerScript → ?

```
VISIT_POINT = firstpoint
VISIT_POINT =
x=2,y=5,id=0
…
VISIT_POINT =
x=55,y=2,id=99
VISIT_POINT = lastpoint
```

Assuming you are running pLogger, after the mission has been stopped, the aloggrep tool can be used to see all postings to a particular variable, or all postings made by a particular app:

```
$ aloggrep SHORESIDE.alog VISIT_POINT
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% LOG FILE:       SHORESIDE.alog
%% FILE OPENED ON  Wed Dec 31 19:00:00 1969
%% LOGSTART        6470836882.04
2.747        VISIT_POINT          uTimerScript    firstpoint
2.747        VISIT_POINT          uTimerScript    x=174.935,y=-171.595,id=1
2.747        VISIT_POINT          uTimerScript    x=-18.61,y=-119.68,id=2
2.747        VISIT_POINT          uTimerScript    x=137.428,y=-76.165,id=3
2.747        VISIT_POINT          uTimerScript    x=195.275,y=-128.785,id=4
2.747        VISIT_POINT          uTimerScript    x=179.435,y=-141.25,id=5
2.747        VISIT_POINT          uTimerScript    x=160.535,y=-94.015,id=6
2.747        VISIT_POINT          uTimerScript    x=184.137,y=-36.055,id=7
     o o o
2.753        VISIT_POINT          uTimerScript    x=174.62,y=-68.44,id=94
2.753        VISIT_POINT          uTimerScript    x=-22.975,y=-164.77,id=95
2.753        VISIT_POINT          uTimerScript    x=42.972,y=-71.575,id=96
2.753        VISIT_POINT          uTimerScript    x=76.768,y=-105.55,id=97
2.753        VISIT_POINT          uTimerScript    x=59.578,y=-103.735,id=98
2.753        VISIT_POINT          uTimerScript    x=57.62,y=-25.57,id=99
2.753        VISIT_POINT          uTimerScript    x=189.718,y=-161.35,id=100
2.753        VISIT_POINT          uTimerScript    lastpoint
```

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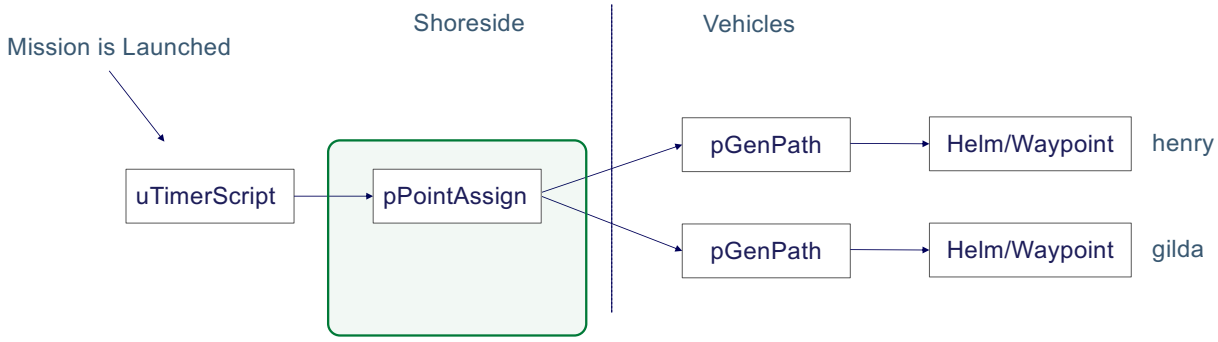
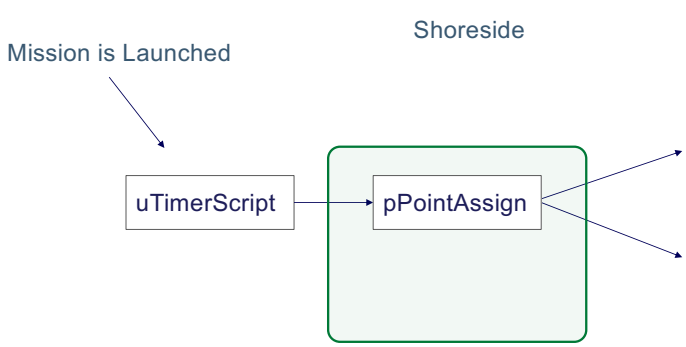
The Distributed TSP Pipeline
pPointAssign



How can we tell whether pPointAssign is working?

The Distributed TSP Pipeline
pPointAssign



How can we tell whether pPointAssign is working?

Answer #1: Check its output (options)

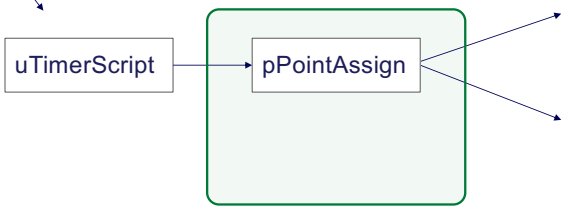
```
VISIT_POINT_HENRY =
firstpoint
VISIT_POINT_HENRY =
x=2,y=5,id=5
…
```

```
VISIT_POINT_GILDA =
firstpoint
VISIT_POINT_GILDA =
x=2,y=5,id=5
…
VISIT_POINT_GILDA =
x=55,y=2,id=96
VISIT_POINT_GILDA = lastpoint
```

The Distributed TSP Pipeline
pPointAssign

Mission is Launched

Shoreside



How can we tell whether pPointAssign is working?

Answer #1: Check its output (options)

- The uXMS utility
- Realmcasting Output
- aloggrep (post-mission)

Using RealmCasting to Scope output of pPointAssign

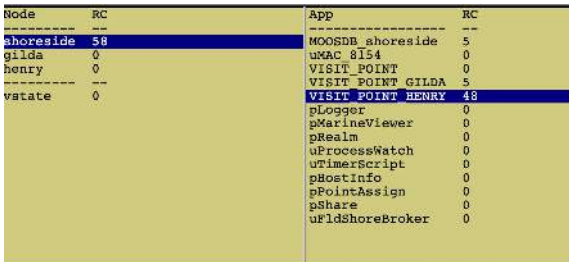
Step 1: Make sure pRealm is running in the shoreside MOOS community (we will want it on the vehicles too)

Step 2: Add a Config block in the shoreside.moos file for pRealm with:

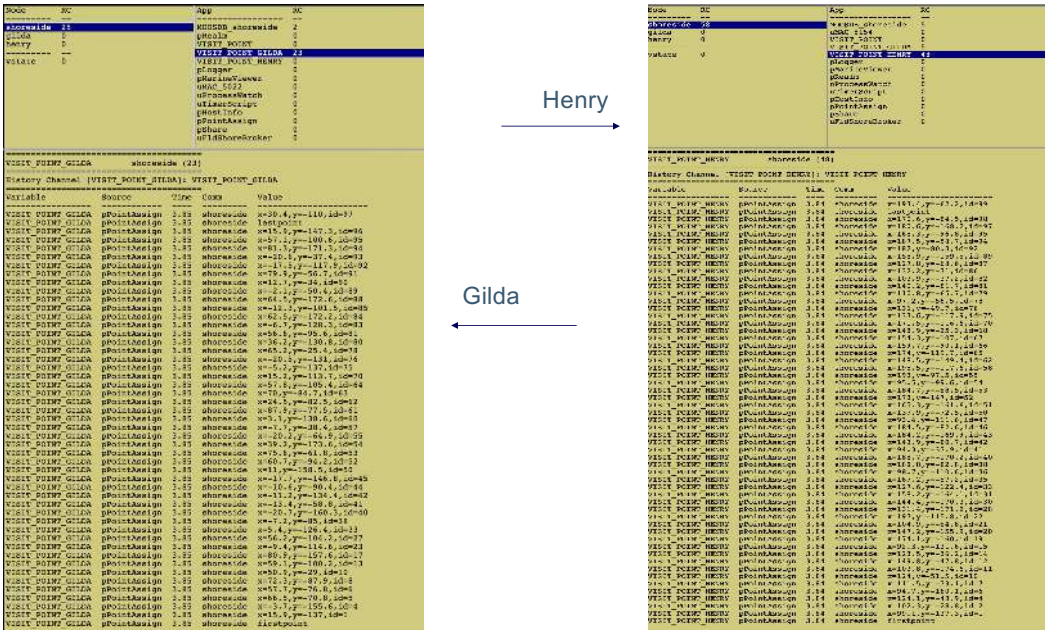
```
ProcessConfig = pRealm
{
  AppTick    = 2
  CommsTick  = 2

  hist_var = VISIT_POINT
  hist_var = VISIT_POINT_HENRY
  hist_var = VISIT_POINT_GILDA

  msg_max_hist = 120

}
```

Step 3: Re-Launch your mission, and toggle to RealmCasting from AppCasting mode with the ‘a’ key

Step 4: Select the “shoreside” in the Nodes panel, and select VISIT_POINT_HENRY in the Apps panel:



VISIT_POINT Output



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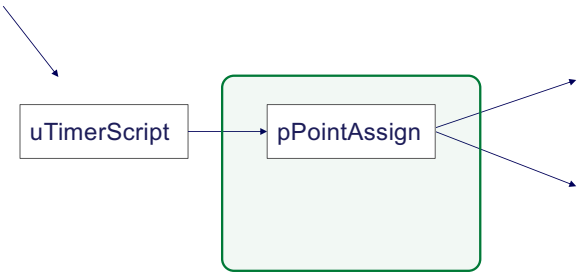
The Distributed TSP Pipeline

pPointAssign

Shoreside

Mission is Launched



Monitoring the output is great for ***confirming*** that things work, but what if things are not working and there is no output?

How can we tell whether pPointAssign is working?

Answer #2: Monitor its internal state using AppCasting

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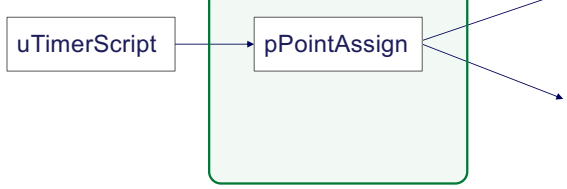
The Distributed TSP Pipeline
pPointAssign

Shoreside

Mission is Launched



Monitoring the output is great for ***confirming*** that things work, but what if things are not working and there is no output?

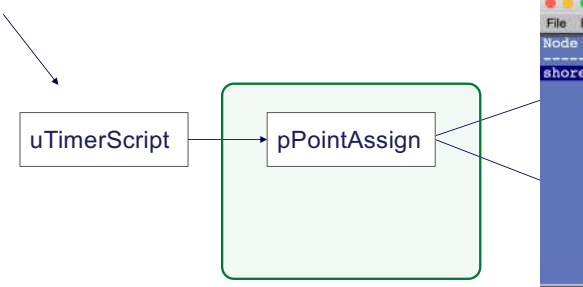
How can we tell whether pPointAssign is working?

Answer #2: Monitor its internal state using AppCasting

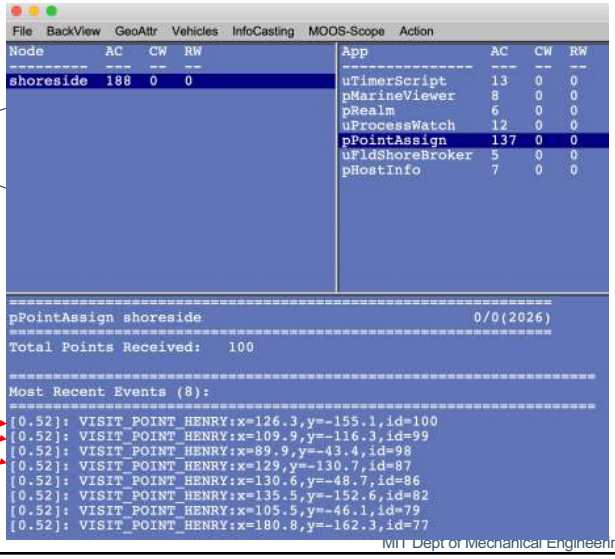
The Distributed TSP Pipeline
pPointAssign

Shoreside

Mission is Launched

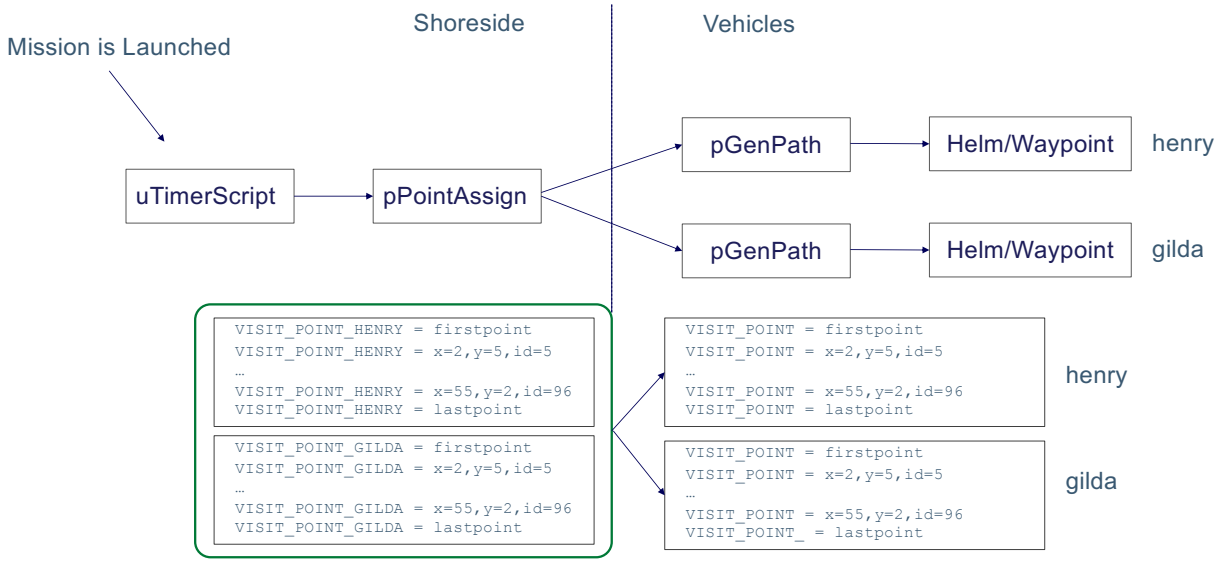


Example AppCasting output for pPointAssign



- Confirm points received
- Confirm postings
- You can add whatever helps

The Distributed TSP Pipeline
Sending Points to the Vehicles



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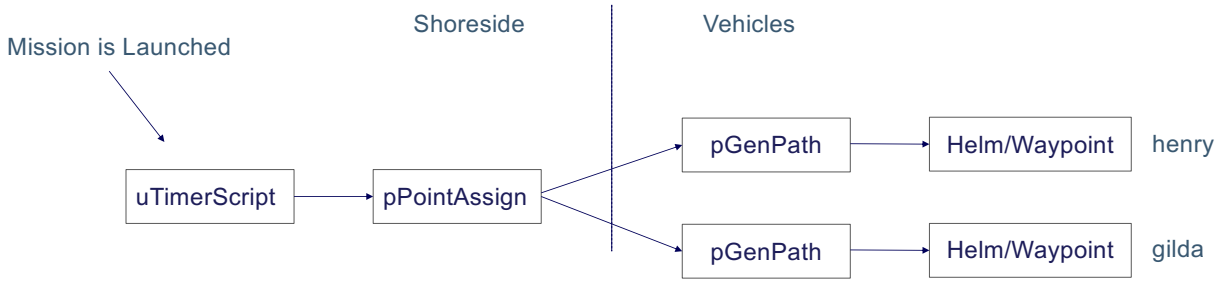
The Distributed TSP Pipeline
Sending Points to the Vehicles



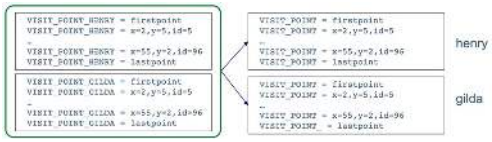
Step 1: Make sure the variable is shared. In uFldShoreBroker:

```
ProcessConfig = uFldShoreBroker
{
  AppTick    = 2
  CommsTick  = 2

  qbridge = VISIT_POINT
}
```

Step 2: Make sure pRealm is running, and add the below config parameters.

```
ProcessConfig = pRealm
{
  hist_var = VISIT_POINT
  msg_max_hist = 100
}
```



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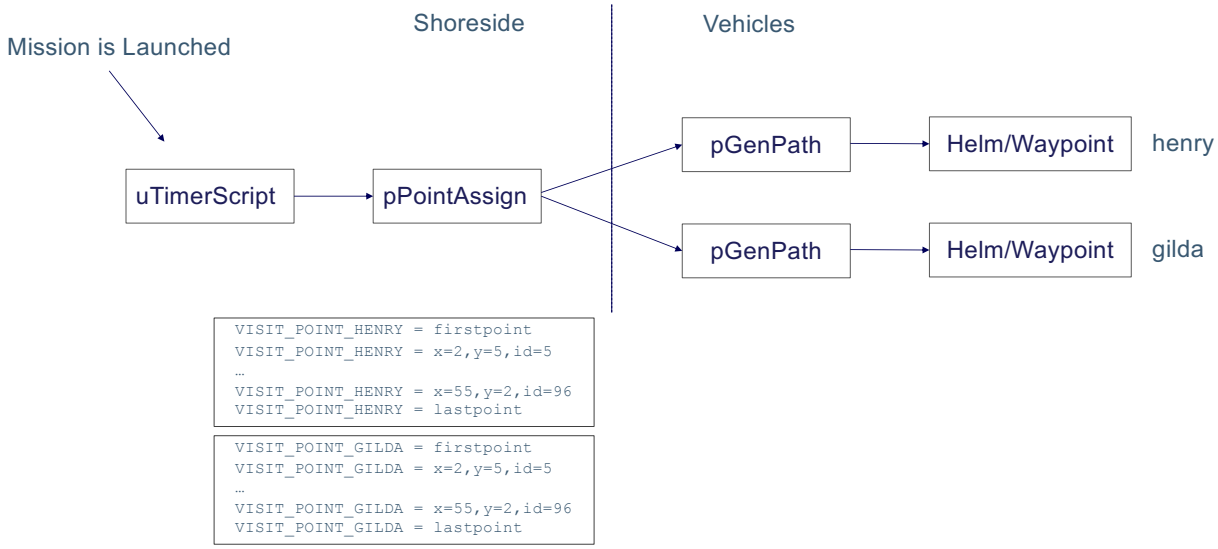
The Distributed TSP Pipeline

Sending Points to the Vehicles



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Points

Storing, Serializing and De-Serializing

Creating a point

```
#include ”XYPoint.h”

XYPoint my_point;
my_point.set_vx(24);
my_point.set_vy(68);
```

Serializing a point for posting

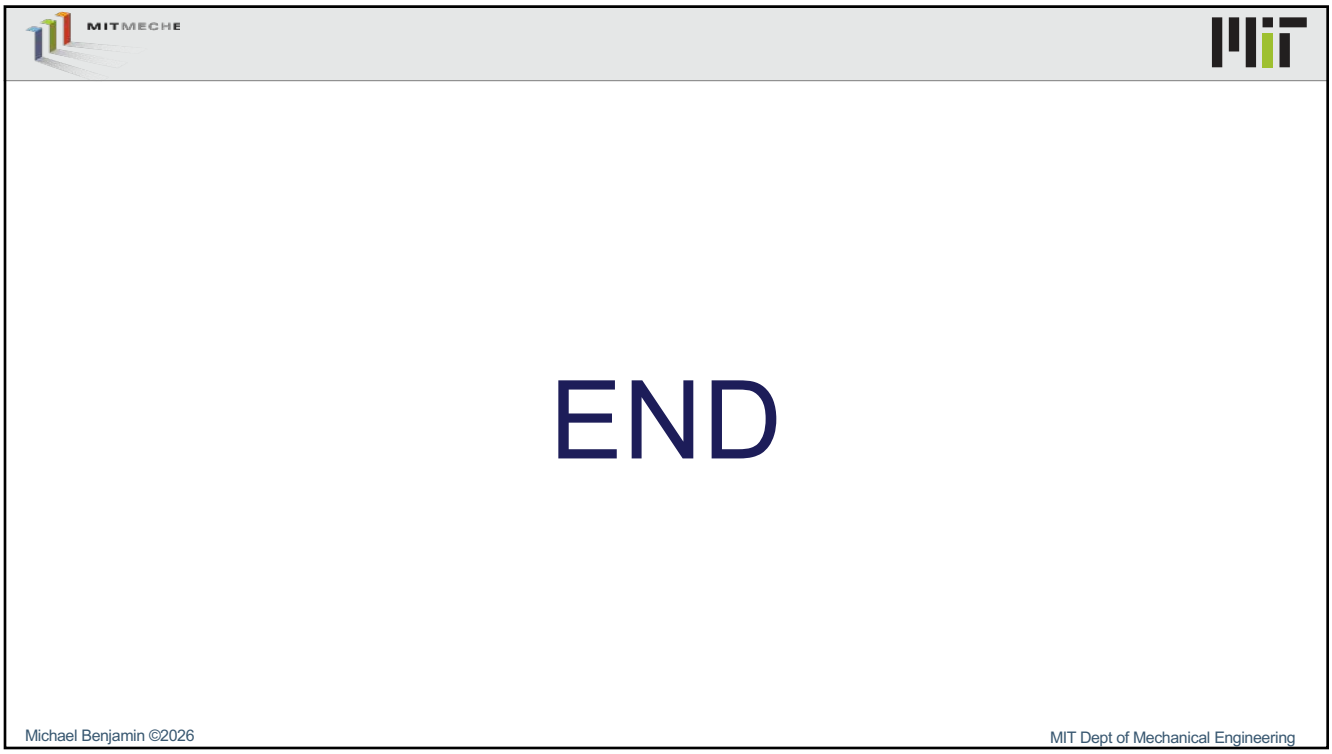
```
XYPoint my_point;
my_point.set_vx(24);
my_point.set_vy(68);
string str = my_point.get_spec();
Notify(“VISIT_POINT”, str);
```

DeSerializing (receiving) a point from a posting

```
#include ”XYFormatUtilsPoint.h”

string str = “x=24, y=68”;
XYPoint my_point = string2Point(str);
```


30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