NetSim - MATLAB Interfacing for UAV/Drone/Flying Adhoc, network simulations.

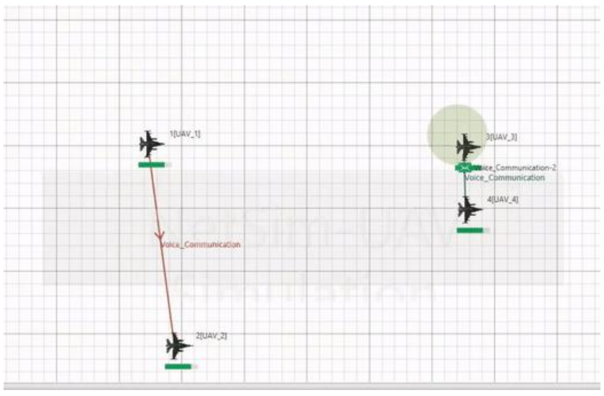
Applicable Versions	**NetSim Pro**	**NetSim Standard**
Applicable Releases	**v12.2**	
MATLAB Version	**R2019b or above**	
MATLAB Toolbox	MATLAB, Simulink, Robotics and System Toolbox	
FE Project	Robotics System Toolbox UAV Library	
Visual Studio	Community Edition	

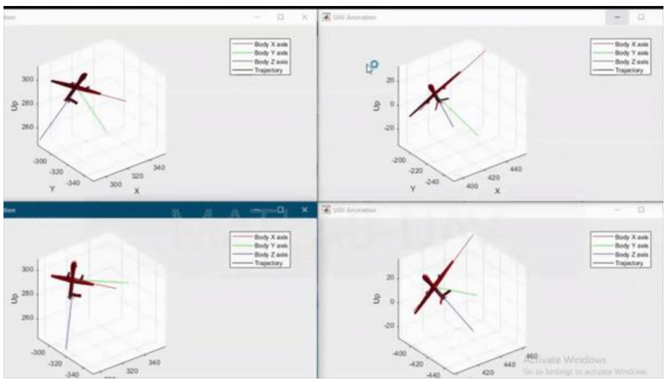
Contents

Objective

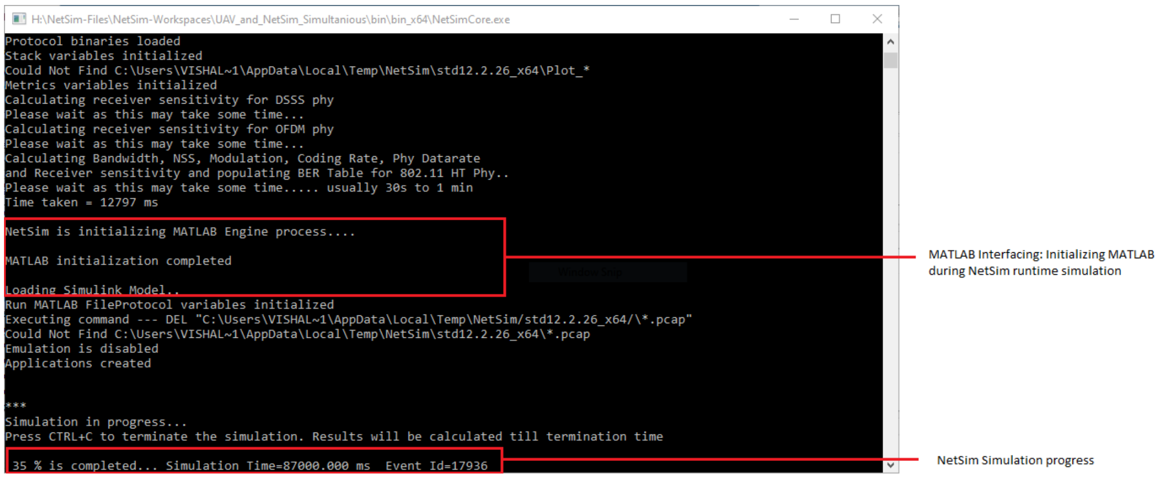
In this article, we are going to explain how users can simulate UAV device in NetSim by interfacing with MATLAB's Simulink.

3D View in MATLAB and 2D View in NetSim





2D- Animation in NetSim **3D Animation in MATLAB**


H:\NetSim-Files\NetSim-Workspaces\UAV_and_NetSim_Simultanious\bin\bin_x64\NetSimCore.exe

```
Protocol binaries loaded
Stack variables initialized
Could Not Find C:\Users\VISHAL~1\AppData\Local\Temp\NetSim\std12.2.26_x64\Plot_*
Metrics variables initialized
Calculating receiver sensitivity for DSSS phy
Please wait as this may take some time...
Calculating receiver sensitivity for OFDM phy
Please wait as this may take some time...
Calculating Bandwidth, NSS, Modulation, Coding Rate, Phy Datarate
and Receiver sensitivity and populating BER Table for 802.11 HT Phy..
Please wait as this may take some time..... usually 30s to 1 min
Time taken = 12797 ms

NetSim is initializing MATLAB Engine process....

MATLAB initialization completed

Loading Simulink Model..
Run MATLAB FileProtocol variables initialized
Executing command --- DEL "C:\Users\VISHAL~1\AppData\Local\Temp\NetSim/std12.2.26_x64/\*.pcap"
Could Not Find C:\Users\VISHAL~1\AppData\Local\Temp\NetSim\std12.2.26_x64\*.pcap
Emulation is disabled
Applications created

***
Simulation in progress...
Press CTRL+C to terminate the simulation. Results will be calculated till termination time

 35 % is completed... Simulation Time=87000.000 ms  Event Id=17936
```

MATLAB Interfacing: Initializing MATLAB during NetSim runtime simulation
NetSim Simulation progress

NetSim Simulation Window

How to download this project?

Follow the instructions specified in the following link to clone/download the project folder from GitHub using Visual Studio:

https://tetcos.freshdesk.com/support/solutions/articles/14000099351-how-to-clone-netsim-fileexchange-project-repositories-from-github

Other tools such as GitHub Desktop, SVN Client, Sourcetree, Git from the command line, or any client you like to clone the Git repository.

Secure URL for the GitHub repository:

https://github.com/NetSim-TETCOS/UAV-Simulation-MATLAB-Interfacing_v12.2

NetSim - Simulink Interfacing

Upon interfacing NetSim with MATLAB the following tasks are performed during simulation start:

- MATLAB Engine process is initialized
- MATLAB Desktop window is loaded
- SIMULINK Model is loaded

Upon simulating a network created in NetSim the following tasks are performed periodically:

- SIMULINK Model is simulated
- SIMULINK Model is paused
- NetSim reads the data generated by SIMULINK from MATLAB workspace
- Updates the co-ordinates of the devices.

During the Simulation, the SIMULINK Model is started and paused several times for NetSim and SIMULINK simulations to run synchronously. The X, Y and Z coordinates obtained from SIMULINK are read from MATLAB workspace and given as input to NetSim's Mobility model. In this example, coordinates are taken every one second and updated to the device mobility.

Output/Metrics specific to this example

- NetSIm Animation- Mobility of the devices configured in NetSim is given as input from MATLAB

Modifications done to NetSim Source codes:

Project: Mobility
Files:

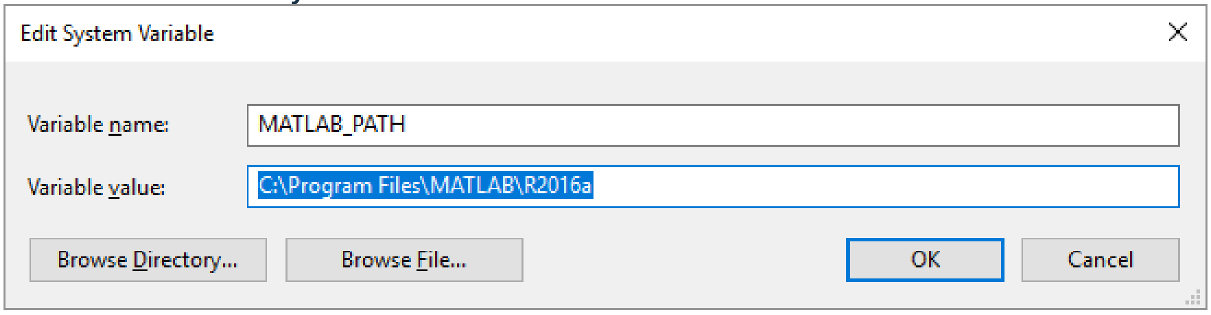
- Mobility.c,
- Mobility.h,
- Added - UAVBasedMobility.c
- Mobility.vcxproj (Project file)

Sections of source code modified

- Mobility.c
  - fn_NetSim_Mobility_Init(): call to init_uav() function
  - fn_NetSim_Mobility_Run(): Call to uav_run() function
  - fn_NetSim_Mobility_Finish(): Call to finish_uav() function
- Mobility.h
  - MATLAB Engine variable - Used to initiate and interact with MATLAB Engine process
- Mobility.vcxproj - This is a Visual Studio project file used to load and manage the source codes related to the Mobility in NetSim
  - path to MATLAB application
  - path to MATLAB include directory
  - path to MATLAB lib directory
  - information related to dependent MATLAB library files
- UAVBasedMobility.c
  - init_uav(): Initializes MATLAB, Loads SIMULINK Model, starts and pauses SIMULINK simulation , and initializes the UAV devices in MATLAB to start simulation along with NetSim's simulation.
  - uav_run(): Starts NetSim and MATLAB simulation simultaneously and gets the co-ordinates from MATLAB workspace for every step size set in NetSim.
  - uavcorr(): Function to get co-ordinates from MATLAB.

Procedure to setup MATLAB for this example

- Create a system environment variable with name as "**MATLAB_PATH**" and value as "**<path of MATLAB Root directory>**"



Edit System Variable

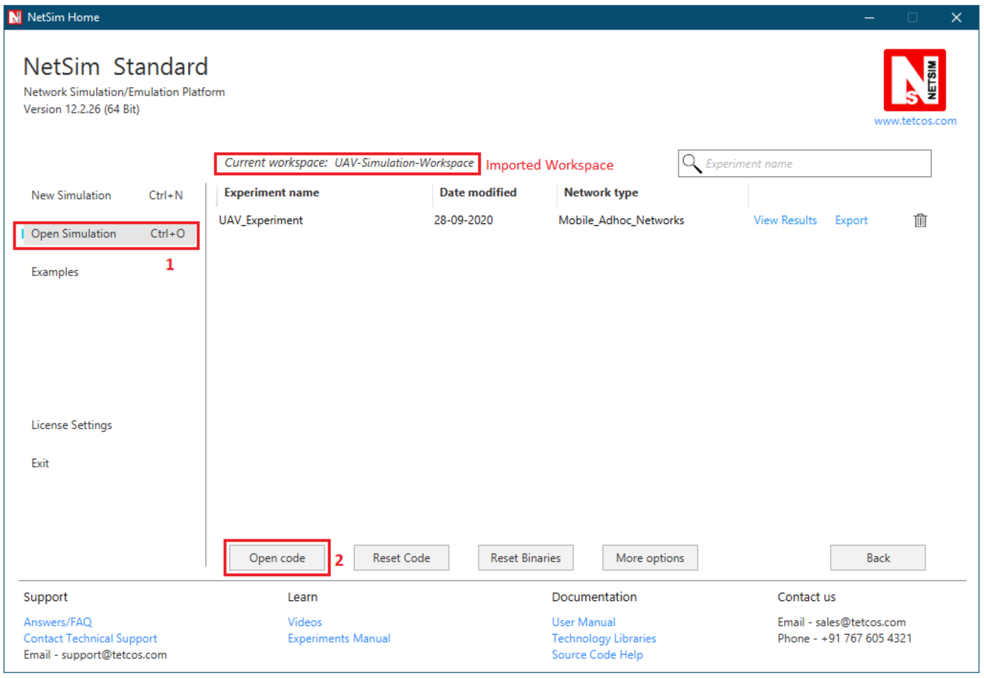
Variable name: MATLAB_PATH

Variable value: C:\Program Files\MATLAB\R2016a

Note: The procedure to create an environment variable and the path of the MATLAB root directory will vary based on the Windows OS version and the MATLAB software version respectively.

Procedure to setup NetSim for this example

- Clone the project using the Git-Hub link provided ar the beginning of this article. And here is the procedure on How to clone NetSim File Exchange project repositories from GitHub.
- Import the workspace to NetSim. *Refer Chapter 4, Section 4.9 of User Manual.*
- Place MATLAB files in a system location with both read and write permissions.
- Backup and Replace GenerlProperty.xml file provided in NetSim-Files folder in the cloned project to <NetSim-Installation-Directory>/Docs/XML/Properties folder.
- Open code from NetSim Home Screen. (NetSim Home Screen > Open Simulation > Open code)

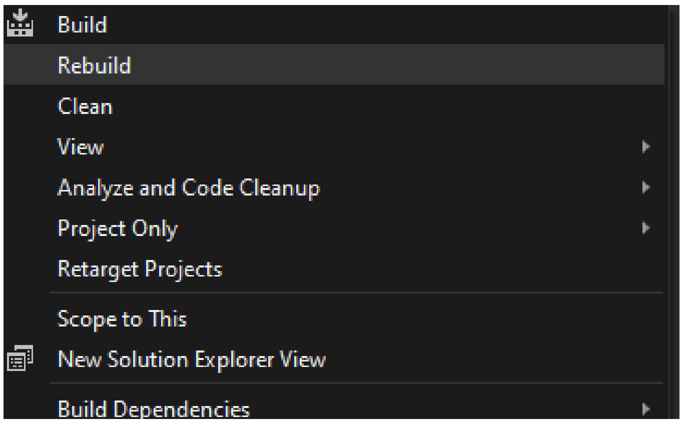


NetSim Standard
Network Simulation/Emulation Platform
Version 12.2.26 (64 Bit)

Current workspace: UAV-Simulation-Workspace   Imported Workspace

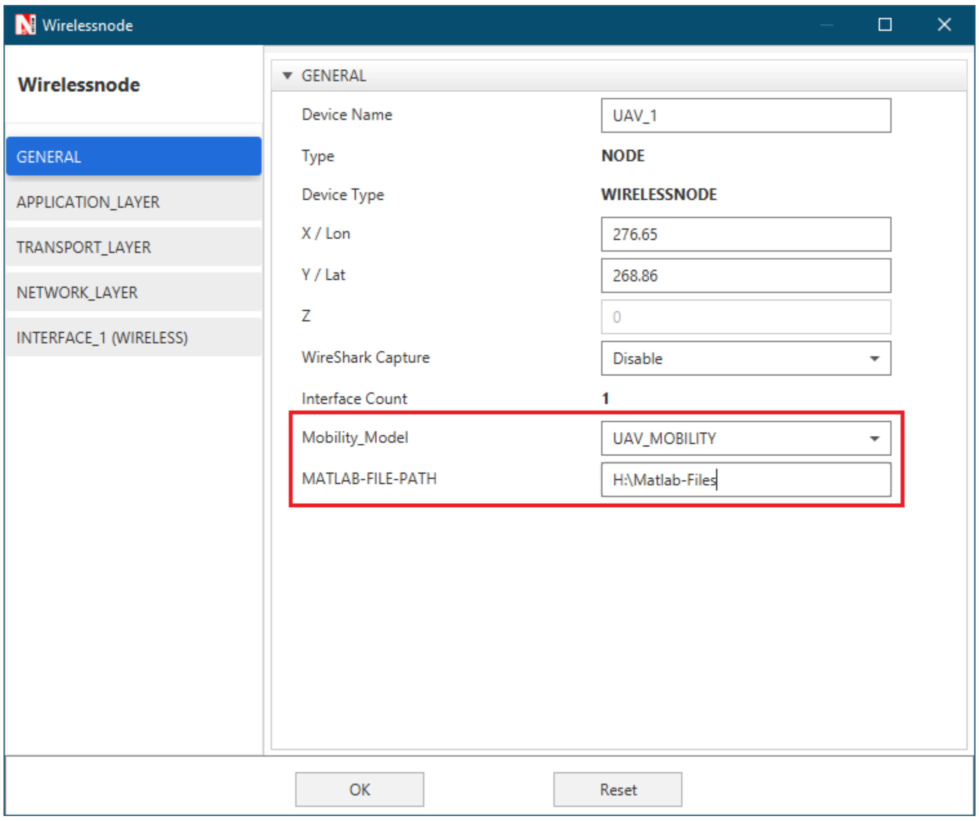
Experiment name	Date modified	Network type
UAV_Experiment	28-09-2020	Mobile_Adhoc_Networks

- Rebuild the code



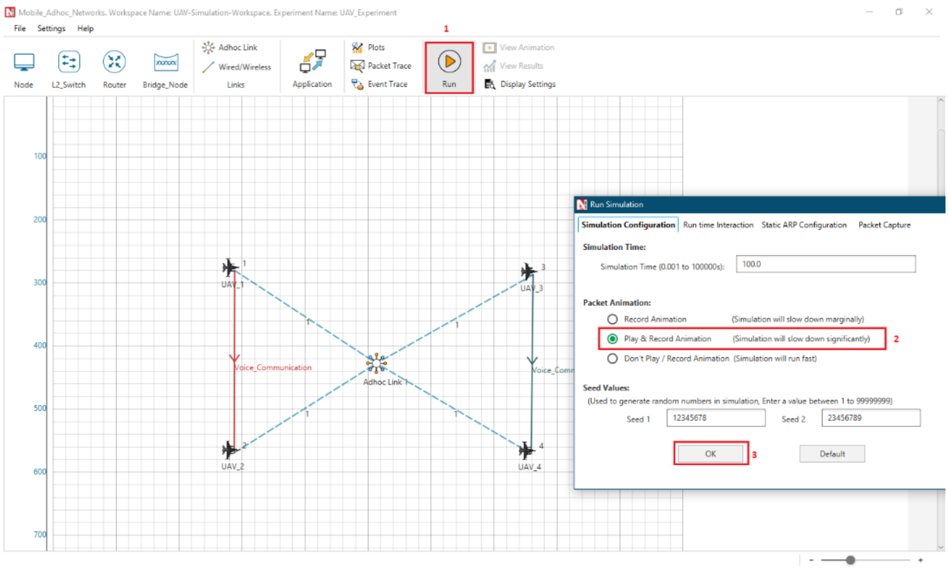
Running the NetSim scenario with UAV Based Mobility

- Before opening Example make sure that you have replaced the XML file in NetSim Installation directory mentioned above and then Open Example saved in the workspace.
- Make sure that all devices are UAV Mobility enabled and update path to MATLAB files that you downloaded with the attachment



Device Name	UAV_1
Type	NODE
Device Type	WIRELESSNODE
X / Lon	276.65
Y / Lat	268.86
Z	0
WireShark Capture	Disable
Interface Count	1
Mobility_Model	UAV_MOBILITY
MATLAB-FILE-PATH	H:\Matlab-Files

- Run the simulation with Play and record animation in order to have both Animations simultaneous


Mobile_Adhoc_Networks. Workspace Name: UAV-Simulation-Workspace. Experiment Name: UAV_Experiment

Run Simulation

Simulation Configuration | Run time Interaction | Static ARP Configuration | Packet Capture

Simulation Time:

Simulation Time (0.001 to 100000s): 100.0

Packet Animation:

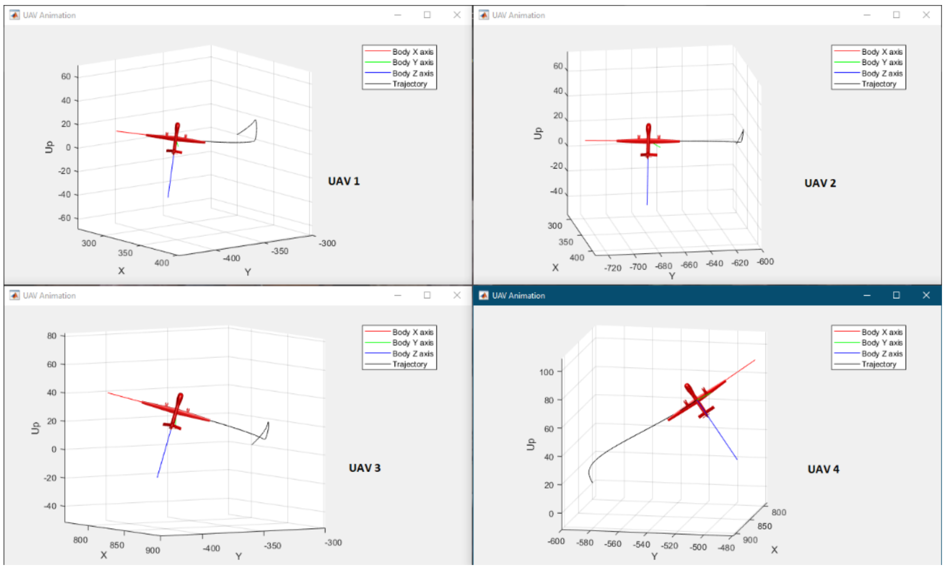
- Record Animation (Simulation will slow down marginally)
- [✓ Play & Record Animation] (Simulation will slow down significantly)
- Don't Play / Record Animation (Simulation will run fast)

Seed Values:

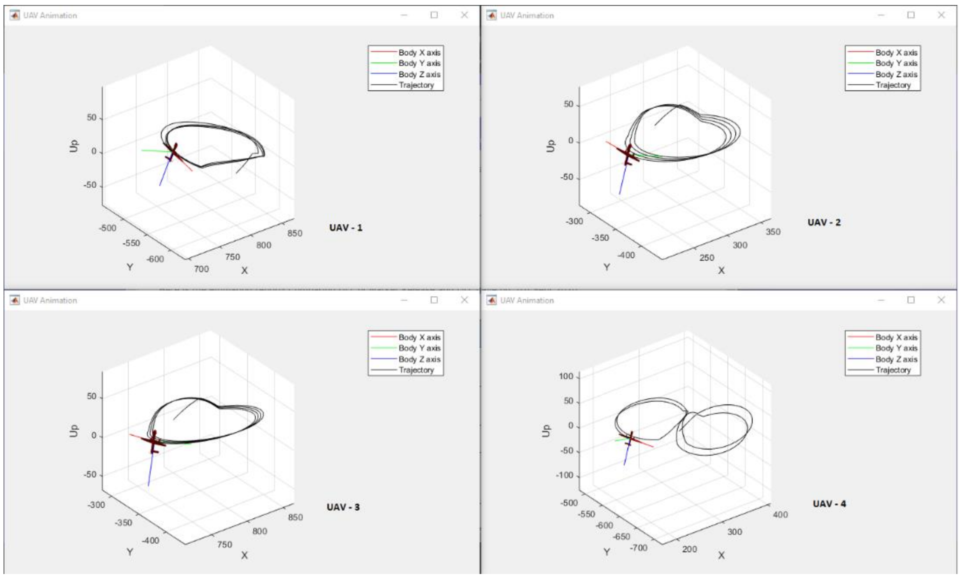
(Used to generate random numbers in simulation, Enter a value between 1 to 99999999)

Seed 1: 12345678 Seed 2: 23456789

- MATLAB Animation



End of Simulation:



Code modifications in NetSim

A new file UAVBasedMobility.c is added to the **Mobility** Project, which contains the following source code:

```
#include "main.h"
#include "Mobility.h"
#include "Animation.h"
double* uavcorr(char* id);
char* matlabloc;

/*init_uav() function is to initialize MATLAB Engine and start UAVs*/
void init_uav()
{
	static int nouav = 1;	// Declared as static, since we want it to be
declared and changed only once
	char buf[100] = "cd ";
	char wp[100];
	char sim[100] = "opSimulink";
	strcpy(wp, matlabloc);
	strcat(buf, wp);
	if (nouav)					// This will run only at the 1st
time
	{

		//MATLAB/SIMULINK INTERFACING
		fprintf(stderr, "\nNetSim is initializing MATLAB Engine
process....\n");
		if (!(ep = engOpen(NULL))) {
			MessageBox((HWND)NULL, (LPCWSTR)"Can't start MATLAB
engine",(LPCWSTR)"MATLAB_Interface.c", MB_OK);
			fprintf(stderr, "\nMATLAB Initialization Failed\nPress any key
to proceed without MATLAB...\n");
			_getch();
		}
		else
		{
			engEvalString(ep, "desktop");
			engEvalString(ep, buf); //Update user-path
			fprintf(stderr, "\nMATLAB initialization completed\n");
			fprintf(stderr, "\nLoading Simulink Model..");
			engEvalString(ep, sim);
		}
		//MATLAB/SIMULINK INTERFACING
		nouav = 0;
	}
}

/*This function is used to receive co-ordinates from MATLAB during run time*/
void uav_run()
{
	MOBILITY_VAR* pstruMobilityVar = (MOBILITY_VAR*)NETWORK-
>ppstruDeviceList[pstruEventDetails->nDeviceId - 1]->pstruDeviceMobility-
>pstruMobVar;//Define Mobility variable
	double dPresentTime = pstruMobilityVar->dLastTime;

	memcpy(NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruCurrentPosition,
		NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition,
		sizeof * NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId -
1]->pstruDeviceMobility->pstruCurrentPosition);

	if (pstruMobilityVar->dLastTime + pstruMobilityVar->dPauseTime * 1000000 <
pstruEventDetails->dEventTime + 1000000)	//Everytime Mobility being called
	{
		double* coordinates;		// Pointer for array of X and Y
coordinates
		coordinates = uavcorr(pstruEventDetails->nDeviceId);//Get
coordinates from matlab
		if (coordinates != NULL)
		{
			NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition->X = coordinates[0];	// Update the
coordinates in Network stack
			NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition->Y = coordinates[1];
			NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruNextPosition->Z = coordinates[2];
			free(coordinates);		// Free memory of pointer
		}

		//store the last time
		pstruMobilityVar->dLastTime = pstruEventDetails->dEventTime + 100;
			// Update Last time since we want to match timings with MATLAB
	}
	//update the device position
	memcpy(NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDevicePosition,
		NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId - 1]-
>pstruDeviceMobility->pstruCurrentPosition,
		sizeof * NETWORK->ppstruDeviceList[pstruEventDetails->nDeviceId -
1]->pstruDevicePosition);

	mobility_pass_position_to_animation(pstruEventDetails->nDeviceId,
		pstruEventDetails->dEventTime,
		DEVICE_POSITION(pstruEventDetails->nDeviceId));

	//Add event for next point
```

```
		pstruEventDetails->dEventTime += (1* SECOND);
		fnpAddEvent(pstruEventDetails);
		pstruEventDetails->dEventTime -= (1 * SECOND);
}

double* uavcorr(int id)
{
		double* coordinates;
		char buf[100];
		mxArray* xmat = NULL;
		mxArray* ymat = NULL;
		mxArray* zmat = NULL;
		double* xcor = NULL;
		double* ycor = NULL;
		double* zcor = NULL;
		if (id == 1)
			engEvalString(ep,
"set_param('UAV1','SimulationCommand','continue');set_param('UAV1','SimulationComm
and','pause');");
		else if (id == 2)
			engEvalString(ep,
"set_param('UAV2','SimulationCommand','continue');set_param('UAV2','SimulationComm
and','pause');");
		else if (id == 3)
			engEvalString(ep,
"set_param('UAV3','SimulationCommand','continue');set_param('UAV3','SimulationComm
and','pause');");
		else
			engEvalString(ep,
"set_param('UAV4','SimulationCommand','continue');set_param('UAV4','SimulationComm
and','pause');");

		engEvalString(ep, "[xa,c]=size(North)");
		engEvalString(ep, "x_out = North(xa, :)");
		engEvalString(ep, "[ya, c] = size(East)");
		engEvalString(ep, "y_out = East(ya, :)");
		engEvalString(ep, "[za, c] = size(Height)");
		engEvalString(ep, "z_out = Height(za, :)");
		xmat = engGetVariable(ep, "x_out");
		ymat = engGetVariable(ep, "y_out");
		zmat = engGetVariable(ep, "z_out");
		xcor = mxGetPr(xmat);
		ycor = mxGetPr(ymat);
		zcor = mxGetPr(zmat);
		coordinates = (double*)malloc(3 * sizeof * coordinates);
		coordinates[0] = xcor[0];
		coordinates[1] = ycor[0];
		coordinates[2] = zcor[0];
		return (coordinates);
}
```

MATLAB Code: OpSimulink.m

```
% This function is used to initialize and start Simulink model called in NetSim-
init_uav() function.

% Initiating UAV 1
model='UAV1';
```

```
load_system(model);
set_param(model,'SimulationCommand','start')
set_param(model,'SimulationCommand','pause')

% Initiating UAV 2
model1='UAV2';
load_system(model1);
set_param(model1,'SimulationCommand','start')
set_param(model1,'SimulationCommand','pause')

% Initiating UAV 3
model2='UAV3';
load_system(model2);
set_param(model2,'SimulationCommand','start')
set_param(model2,'SimulationCommand','pause')

% Initiating UAV 4
model3='UAV4';
load_system(model3);
set_param(model3,'SimulationCommand','start')
set_param(model3,'SimulationCommand','pause')
```