



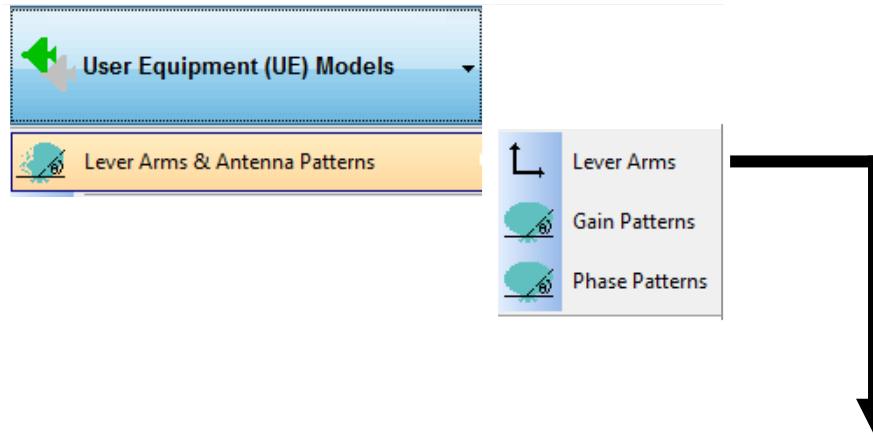
## ANTENNA MODELS

- **1° x 1° User Receiver Antenna Power Pattern as a function of Azimuth and Elevation**
- **1° x 1° User Receiver Antenna Phase-Shift Pattern as a function of Azimuth and Elevation**
- **1° x 1° GPS SV Broadcast Power Pattern as a function of Azimuth and Elevation.**
- **L<sub>1</sub> L<sub>2</sub> L<sub>5</sub> versions of all patterns**
- **Antenna Bore-sight Orientation for multiple antennas within multiple RF output systems.**
- **GPS and Inertial Measurement effects resulting from Antenna Lever Arms (Vehicle) dynamics. In addition to GPS lever arms, Inertial Measurement Unit (IMU) lever arms are provided.**

This document provides a description of the implementation.



# ANTENNA LEVER ARMS



Use these controls to access specific  
Antennas

Access Antenna Patterns / Masks  
for Edit

ANTENNA LEVER ARM

GPS ANTENNA LEVER ARMS

VEHICLE 1 ▾ ANTEENA 1 ▾ LI ▾ RF 1 ▾

GAIN ANTEENA\_GL1\_PATTERN\_RF1\_1

PHASE ANTEENA\_PL1\_PATTERN\_RF1\_1

X [NOSE] 3.0000 Meters Y [RIGHT-WING] -1.0000 Meters Z [DOWN] 2.5000 Meters

Relative to Vehicle-CG  Relative to IMU

**Antenna Platform Orientation**

$\theta$  BORESIGHT ELEVATION 90.00<sup>0</sup> RELATIVE TO LEVEL IN VEHICLE BODY FRAME

$\phi$  BORESIGHT AZIMUTH 0.00<sup>0</sup> RELATIVE TO VEHICLE NOSE/VELOCITY VECTOR

$\psi$  CONE ANGLE 180.00<sup>0</sup> RELATIVE TO VEHICLE BORESIGHT

$\theta = 90^{\circ}$   $\phi = 0^{\circ}$   $\psi = 180^{\circ}$  = all-in-view patch antenna

Assignment Matrix

CANCEL X APPLY ▶

Check this to reference  
the GPS Lever Arm to  
the IMU Frame.

Default settings for an Antenna pointed up



## Lever Arm Coordinate Frame (xyz)

By convention, the GPS measurement and auxiliary Sensor Data is modeled at the Vehicle Center of Gravity (cg). To translate the GPS antenna tip elsewhere, enter the Vector Offset of the GPS Antenna Tip relative to the Vehicle cg. The sense is POSITIVE from the cg to the Antenna Tip. Tapestry models the magnitude and dynamics associated with the Vehicle. The (pseudo) range, rate and acceleration effects are ADDED to the nominal cg data.

**X (NOSE):** The Lever Arm displacement positive along the Vehicle NOSE.

**Y (RIGHT WING):** The Lever Arm displacement positive along the RIGHT WING.

**Z (DOWN):** The Lever Arm displacement positive DOWN.

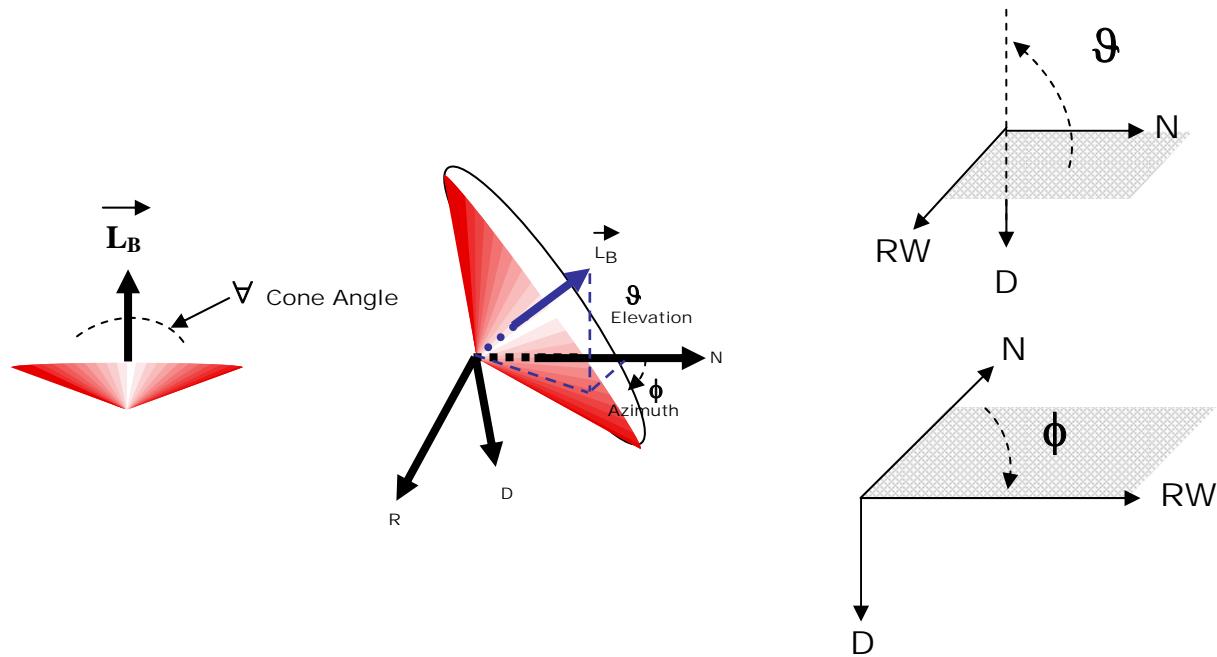
## Antenna Orientation ( bore-sight $\vartheta \phi \nabla$ )

Tapestry provides Antenna Orientation parameters to facilitate multiple Antenna's such as TOP / BOTTOM or FRONT / BACK.

Tapestry uses **Bore sight** as:

$\xrightarrow{\hspace{1cm}}$   
 $L_B = \text{The vector pointing outwards (+) along the geometric centerline of the antenna in Vehicle BODY Frame.}$

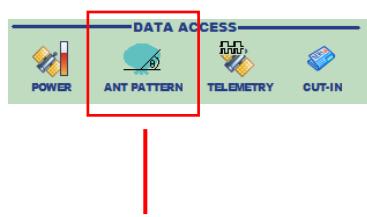
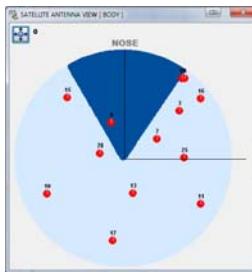
The [Default] Tapestry Antenna bore-sight points straight UP relative to the locally level tangent frame at the user position. This orientation maps to an Elevation Angle ( $\vartheta$ ) of 90° an Azimuth ( $\phi$ ) 0° and Cone Angle ( $\nabla$ ) 180° relative to the vehicle body coordinate frame.





# ANTENNA GAIN PATTERNS

## ANTENNA VIEW



**ANTENNA PATTERN TYPE**   **UE-VEHICLE GAIN/LOSS PATTERN**

**DISPLAYED ANTENNA PATTERN #** 1

**ELEVATION** (horizontal axis)

**AZIMUTH** (vertical axis)

**ATTENUATION** 1.0 dB

**LINE FILL** START CELL A: 0° E: 0° **AREA FILL** AZ ELEV **GLOBAL FILL**

**ATTENUATION** 1.0 dB

**UNDO** **FINISHED**

The main window displays a grid of attenuation values (0.0 to 36.0 dB) for a 36x36 grid of cells. The grid is bounded by a blue double-headed arrow at the top and a red double-headed arrow on the left. The bottom section contains buttons for Line Fill, Area Fill, Global Fill, Undo, and Finished.

- $1^\circ \times 1^\circ$  Top and Bottom Hemisphere
- Attenuation [0-36 dB] / Phase [ 0-360 Degrees]
- Multiple Time-sequenced Patterns
- Tapestry transforms Body-to-ECEF automatically.

**ANTENNA PATTERN TYPE**   **UE-VEHICLE GAIN/LOSS PATTERN**

**DISPLAYED ANTENNA PATTERN #** 1

**ELEVATION** (horizontal axis)

**AZIMUTH** (vertical axis)

**ATTENUATION** 1.0 dB

**LINE FILL** START CELL A: 0° E: 0° **AREA FILL** AZ ELEV **GLOBAL FILL**

**ATTENUATION** 1.0 dB

**UNDO** **FINISHED**

The interface is identical to the one above, showing a grid of attenuation values and buttons for Line Fill, Area Fill, Global Fill, Undo, and Finished.

## FORM CONTROLS

[CREATE ANOTHER PATTERN](#)

TAPESTRY WILL NAME THE PATTERN FILE  
CONSISTENT WITH THE CONVENTION PRESENTED  
SUBSEQUENTLY

**NOTE:**  
ADDITIONAL PATTERNS WILL NOT BE USED UNLESS  
EXPLICITLY ASSIGNED USING

MULTI-PATTERN TIME LINE EVENT EDITOR

## MULTI-PATTERN TIME LINE EVENT EDITOR SEQUENCE ANTENNA PATTERNS IN TIME

ANTENNA PATTERN TYPE	UE-VEHICLE GAIN/LOSS PATTERN		ASSIGNED RF OUTPUT	RF 1			
DISPLAYED ANTENNA PATTERN #	1						
				APPLICABLE LINK	L1		

		FORMAT OPTIONS		
TYPE	<input checked="" type="checkbox"/> Antenna GAIN Pattern			
DELIMITER	<input checked="" type="radio"/> TAB [ \t ] YAPERTURE	<input type="radio"/> WHITE SPACE [ ]	<input type="radio"/> COMMA [ , ]	<input type="radio"/> DEC FORMAT
DESTINATION	<input checked="" type="radio"/> COPY ADD TO SCENARIO		<input type="radio"/> COPY REPLACE CURRENT	

## IMPORT ANTENNA PATTERN FILES [ TAPESTRY WILL RENAME ACCORDINLY ]

CLICK & DRAG

## FILL ALONG ROWS / COLUMNS

The screenshot shows the 'FILL' panel with four main sections:

- LINE FILL**: Contains icons for 'START CELL A' (AZ/EZ) and 'END CELL' (AZ/EZ), both with '0' values. It includes a 'DON'T WRAP' checkbox.
- AREA FILL**: Contains icons for 'START CELL' (AZ/EZ) and 'END CELL' (AZ/EZ), both with '0' values. It includes an 'AREA' button and a 'DON'T WRAP' checkbox.
- GLOBAL FILL**: Contains icons for 'TOP' and 'BOT'.
- FINISHED**: Contains a checkmark icon.

Annotations above the panel indicate:

- A black arrow points to the 'LINE FILL' section.
- A red arrow points to the 'AREA FILL' section.
- A red line with an arrow points to the 'ATTENUATION' field.
- A black arrow points to the 'UNDO' button.
- A label 'TWO LEVELS' is positioned above the 'GLOBAL FILL' and 'FINISHED' sections.

ENTER Elevation/Azimuth PRESS [ AREA ]

CLEAR AREA



## ANTENNA PATTERN FILE CONVENTIONS

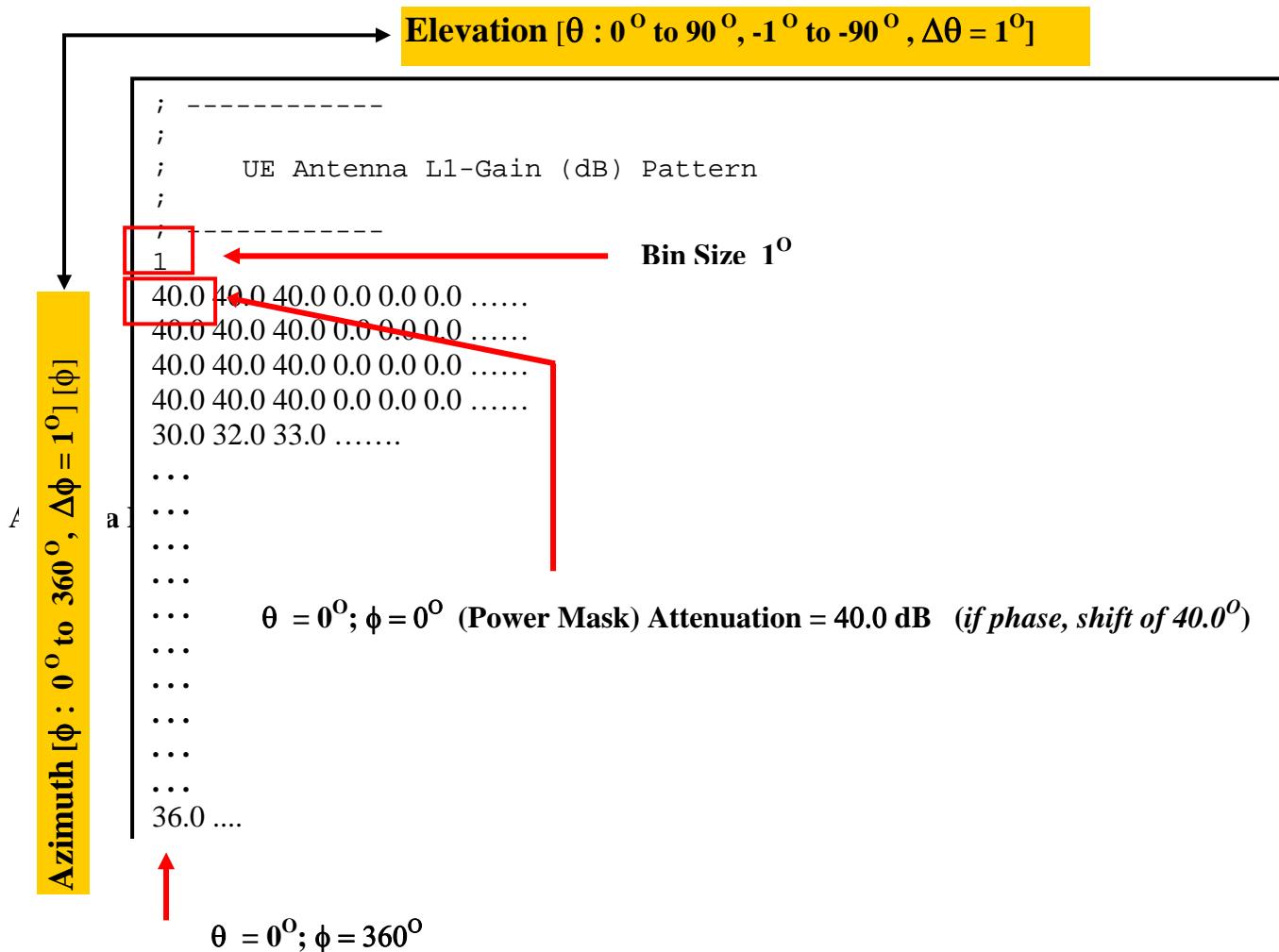
Tapestry provides Antenna Patterns as follows (in sets of 3  $L_1$ ,  $L_2$ , and  $L_5$ )

- Two sets for the User Equipment (UE) Antenna providing power and phase effects,
- One sets, one for each GPS-SV -modeling power effects from beam shape.

Patterns are specified in Vehicle Body (B) Coordinates (and GPS-SV Body). **BUILD SCENARIO** computes the GPS line-of-sight measurements in ECEF transforming them into the Body Frame. Using the Pattern Azimuth and Elevation bins, the Power and or Phase effects are "looked up" and applied.

The Antenna Pattern files associated with the above models are ASCII and defined as follows:

[only  $1^\circ \times 1^\circ$  supported ]





## FILE NAMING CONVENTION

Tapestry uses the following naming convention. If you import Antenna files, you must follow this conventions.

### UE L1 Antenna Gain Pattern

	ANTENNA_GL1_PATTERN_RF1_1.SCN ANTENNA_GL1_PATTERN_RF1_N.SCN	[RF #1 [1st Pattern]] [RF #1 [N <sup>th</sup> Pattern]]
	ANTENNA_GL1_PATTERN_RF2_1.SCN ANTENNA_GL1_PATTERN_RF2_N.SCN	RF #2 [1st Pattern] [RF #2 [N <sup>th</sup> Pattern]]

### UE L1 Antenna Phase Pattern

ANTENNA_PL1_PATTERN_RF1_1.SCN ANTENNA_PL1_PATTERN_RF2_N.SCN	[RF #1 [1st Pattern...]] [RF #2 [N <sup>th</sup> Pattern...]]
--	--

Similarly,

### UE L2 Antenna Gain and Phase Pattern

ANTENNA_GL2_PATTERN_RF1_1.SCN ANTENNA_PL2_PATTERN_RF2_1.SCN	[RF #1 [1st Pattern ... etc.]] [RF #2 [1st Pattern ... etc.]]
--	--

### UE L5 Antenna Gain and Phase Pattern

ANTENNA_GL5_PATTERN_RF1_N.SCN ANTENNA_PL5_PATTERN_RF2_1.SCN	[RF #1 [N <sup>th</sup> Pattern]] [RF #2 [1st Pattern]]
--	--

### GPS SV Antenna Gain Pattern

TRANSMITTER\_GL1\_PATTERN.SCN [no RF dependency]

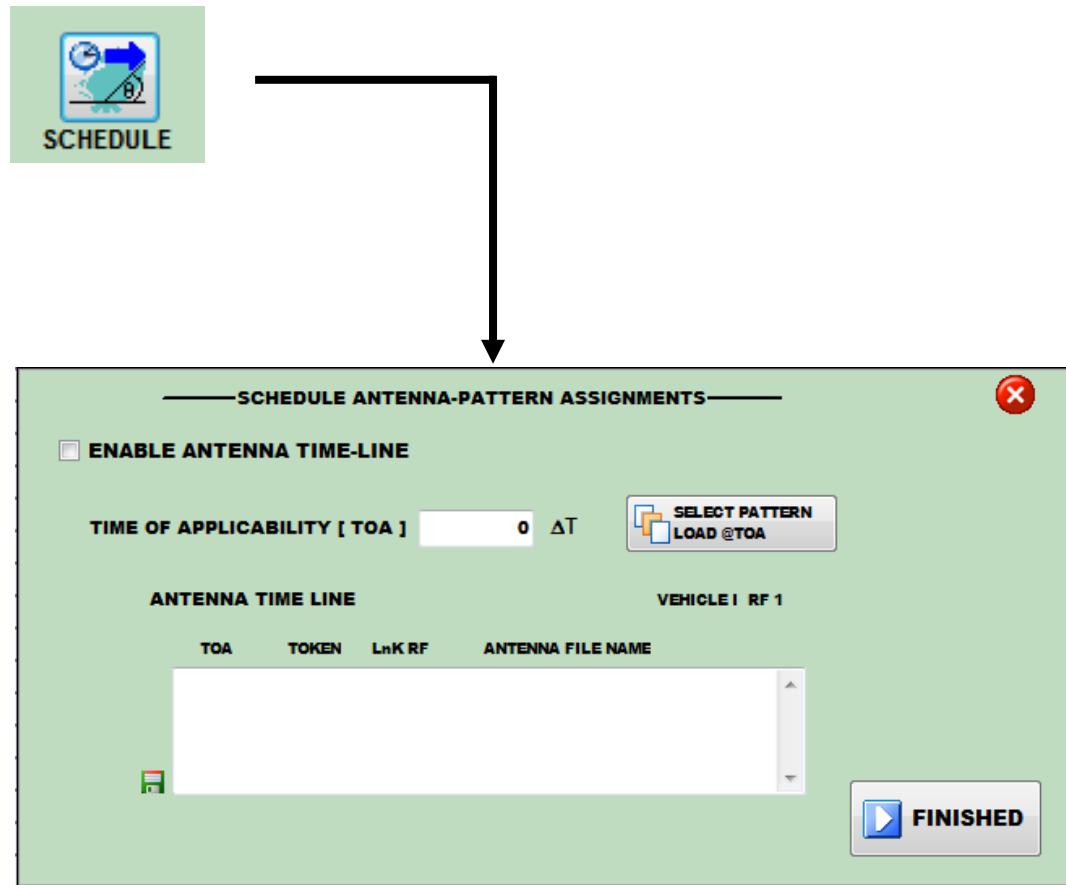
Similarly,

TRANSMITTER\_GL2\_PATTERN.SCN  
TRANSMITTER\_GL5\_PATTERN.SCN

There is no phase shift modeling for the GPS-SV.



## SEQUENCING [ SCHEDULE ] MULTIPLE ANTENNA PATTERNS



To sequence your multiple Antenna Patterns, an EVENT file has to be created. The Event file (ASCII) contains the Time (seconds into Simulation), the Type of Event, and any Event arguments. The Antenna Event File name is:

**EVENTVEHICLE`SCN - VEHICLE I**

**EVENTVEHICLE2.SCN - VEHICLE II**

For example, assume there are 3 L<sub>1</sub> Antenna Gain Patterns in the scenario folder. Create the Event File as follows:

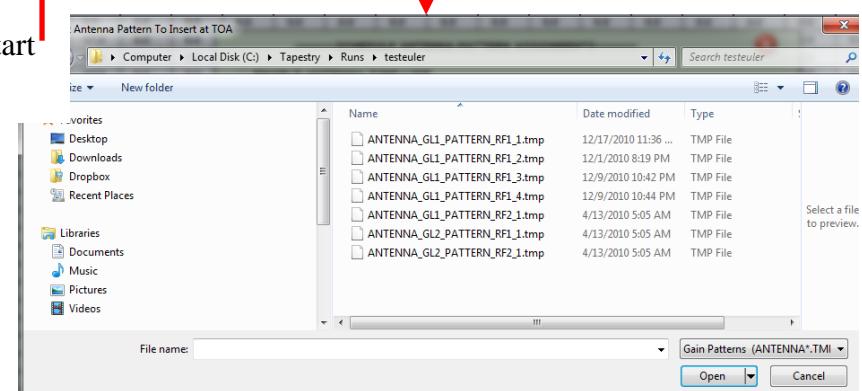




**ENABLE ANTENNA TIME-LINE**

**TIME OF APPLICABILITY [ TOA ]**   $\Delta T$  **SELECT PATTERN LOAD @TOA**

Enter 30 Seconds into Simulation. This is Event Start Time



Tapestry Enters the record into the  
EVENT FILE  
**LOAD PATTERN 1 VEH 0 RF 1**

**ANTENNA TIME LINE** **VEHICLE 1 RF 1**

TOA	TOKEN	LnK RF	ANTENNA FILE NAME
\$00030	ANTG_START	0 1	ANTENNA_GL1_PATTERN_RF1_1.tmp

An entry at 40 seconds  
**LOAD PATTERN 2 VEH 0 RF 1**

**SCHEDULE ANTENNA-PATTERN ASSIGNMENTS**

**ENABLE ANTENNA TIME-LINE**

**TIME OF APPLICABILITY [ TOA ]**   $\Delta T$  **SELECT PATTERN LOAD @TOA**

**ANTENNA TIME LINE** **VEHICLE 1 RF 1**

TOA	TOKEN	LnK RF	ANTENNA FILE NAME
\$00030	ANTG_START	0 1	ANTENNA_GL1_PATTERN_RF1_1.tmp
\$00040	ANTG_START	0 1	ANTENNA_GL1_PATTERN_RF1_2.tmp

**FINISHED**

An entry at 60 seconds  
**LOAD PATTERN 3 VEH 0 RF 1**

**SCHEDULE ANTENNA-PATTERN ASSIGNMENTS**

**ENABLE ANTENNA TIME-LINE**

**TIME OF APPLICABILITY [ TOA ]**   $\Delta T$  **SELECT PATTERN LOAD @TOA**

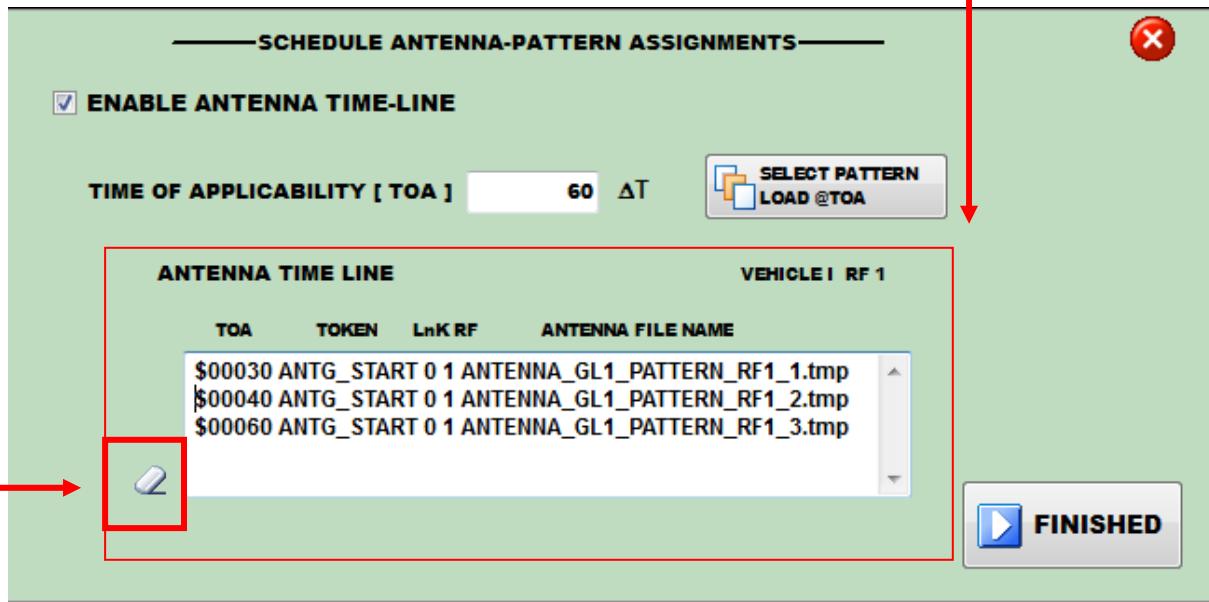
**ANTENNA TIME LINE** **VEHICLE 1 RF 1**

TOA	TOKEN	LnK RF	ANTENNA FILE NAME
\$00030	ANTG_START	0 1	ANTENNA_GL1_PATTERN_RF1_1.tmp
\$00040	ANTG_START	0 1	ANTENNA_GL1_PATTERN_RF1_2.tmp
\$00060	ANTG_START	0 1	ANTENNA_GL1_PATTERN_RF1_3.tmp

**FINISHED**



You may create the Event File by typing into this control



CLEAR EVENT LIST

Using Notepad, you may view the EVENTVEHICLE1.SCN/TMP file. It contains the following entries:

#### EVENTVEHICLE1.SCN

**TOA** = Time of Applicability  
**\$** = valid event line (column 1)  
**0010** = Event Start Time (Seconds into Simulation)

**FILE NAME** to load.  
**Must** be in Scenario Folder

```
$00000 ANTG_START 0 1 ANTENNA_GL1_PATTERN_RF1_1.tmp
$00010 ANTG_START 0 1 ANTENNA_GL1_PATTERN_RF1_2.tmp
$00027 ANTG_START 0 1 ANTENNA_GL1_PATTERN_RF1_3.tmp
$00030 ANTG_START 0 1 ANTENNA_GL1_PATTERN_RF1_4.tmp
```

Event Token

**ANTG\_START** = Load Antenna GAIN Pattern  
**ANTG\_STOP** = UNLoad Antenna GAIN Pattern

**ANTP\_START** = Load Antenna PHASE Pattern  
**ANTP\_STOP** = UNLoad Antenna PHASE Pattern

VEHICLE # 0/1

RF # 1,2,3,4

If you CREATE  
Must be in the  
well as all the

## SINGLE CELL ENTRY

- SELECT CELL
- USE CELL CONTROL
- DOES NOT SET VALUE

	0	5	10	15	20	25	30	35
0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
5	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
10	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
15	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
20	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
25	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
30	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
35	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



## MULTIPLE CELL FILL

## &lt; L-CLICK &amp; DRAG &gt;

- SELECT MULTIPLE AREA
- USE AREA/FILL CONTROL
- SETS FILL VALUE

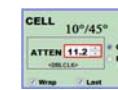
0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
5	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
10	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
15	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
20	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
25	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
30	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
35	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



## POINT &amp; SHOOT CELL ENTRY

- SELECT CELL
- USE CELL CONTROL
- SETS CELL VALUE

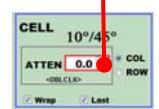
0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
5	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
10	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
15	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
20	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
25	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
30	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
35	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



## &lt; CLICK &gt; SELECT CELL ..... &lt; CLICK &gt; SET FOCUS

- SELECT CELL
- USE CELL CONTROL
- SETS CELL VALUE ( WHEN ENTER KEY PRESSED )

40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0



40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

## MOVE TO NEXT COLUMN [ELEV]

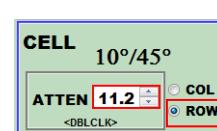
- MOVE FROM ONE ELEVATION CELL TO THE NEXT
- USE CELL CONTROL



40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

## MOVE TO NEXT ROW [AZIMUTH]

- MOVE FROM ONE AZIMUTH CELL TO THE NEXT
- USE CELL CONTROL



40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0