

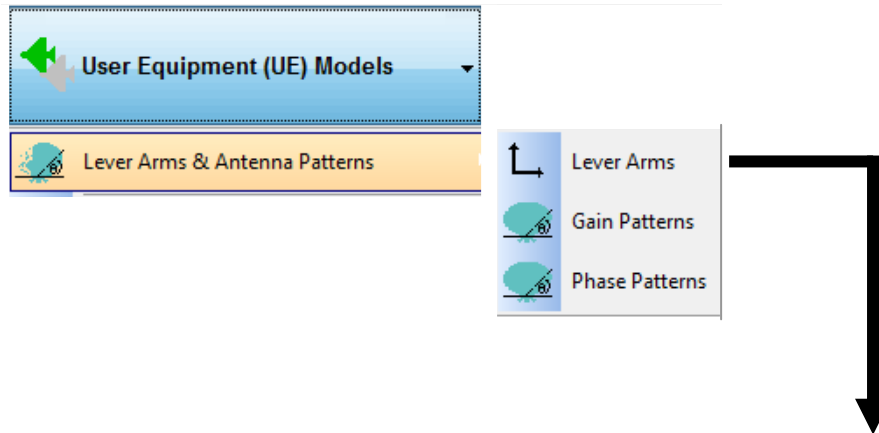


## ANTENNA MODELS

- **$1^{\circ} \times 1^{\circ}$  User Receiver Antenna Power Pattern as a function of Azimuth and Elevation**
- **$1^{\circ} \times 1^{\circ}$  User Receiver Antenna Phase-Shift Pattern as a function of Azimuth and Elevation**
- **$1^{\circ} \times 1^{\circ}$  GPS SV Broadcast Power Pattern as a function of Azimuth and Elevation.**
- **$L_1 L_2 L_5$  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

VEHICLE 1

ANTENNA 1

LI

RF 1

GAIN

ANTENNA\_GL1\_PATTERN\_RF1\_1

PHASE

ANTENNA\_PL1\_PATTERN\_RF1\_1

GPS Antenna Lever Arm

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

BORESIGHT ELEVATION

90.00

RELATIVE TO LEVEL IN VEHICLE BODY FRAME

BORESIGHT AZIMUTH

0.00

RELATIVE TO VEHICLE NOSE/VELOCITY VECTOR

CONE ANGLE

180.00

RELATIVE TO VEHICLE BORESIGHT

$\theta = 90^\circ$

$\phi = 0^\circ$

$\psi = 180^\circ$

= all-in-view patch antenna

Assignment Matrix

CANCEL

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.

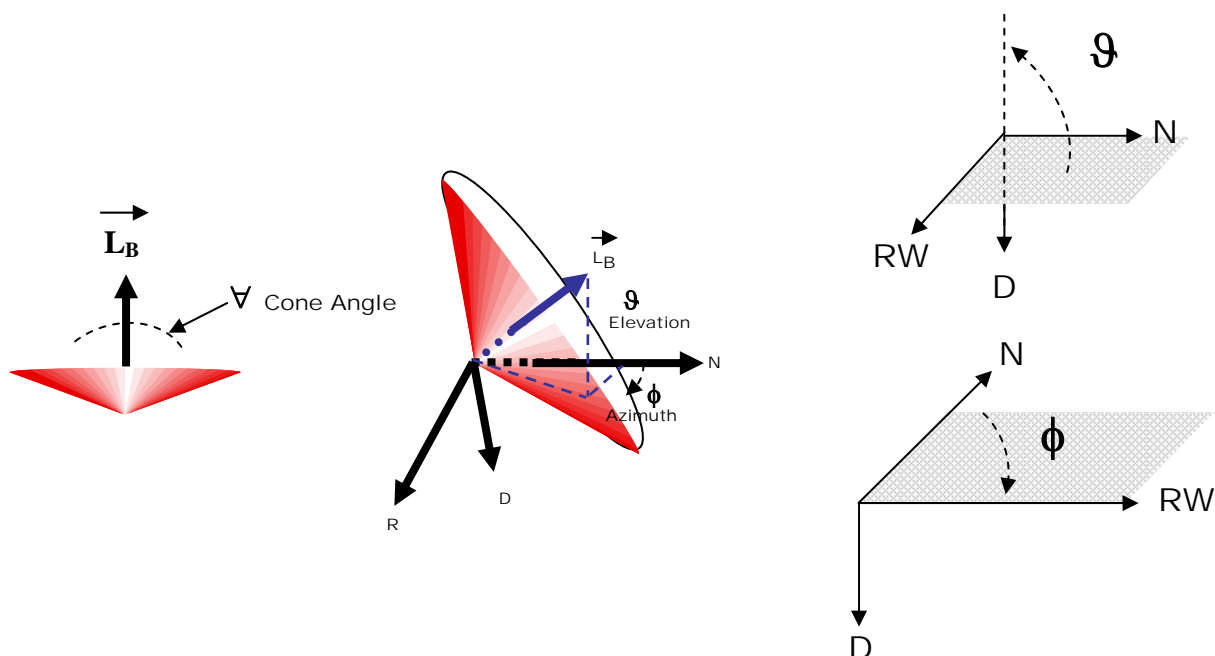
## Antenna Orientation ( bore-sight $\vartheta$ $\phi$ $\varnothing$ )

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

Tapestry uses **Bore sight** as:

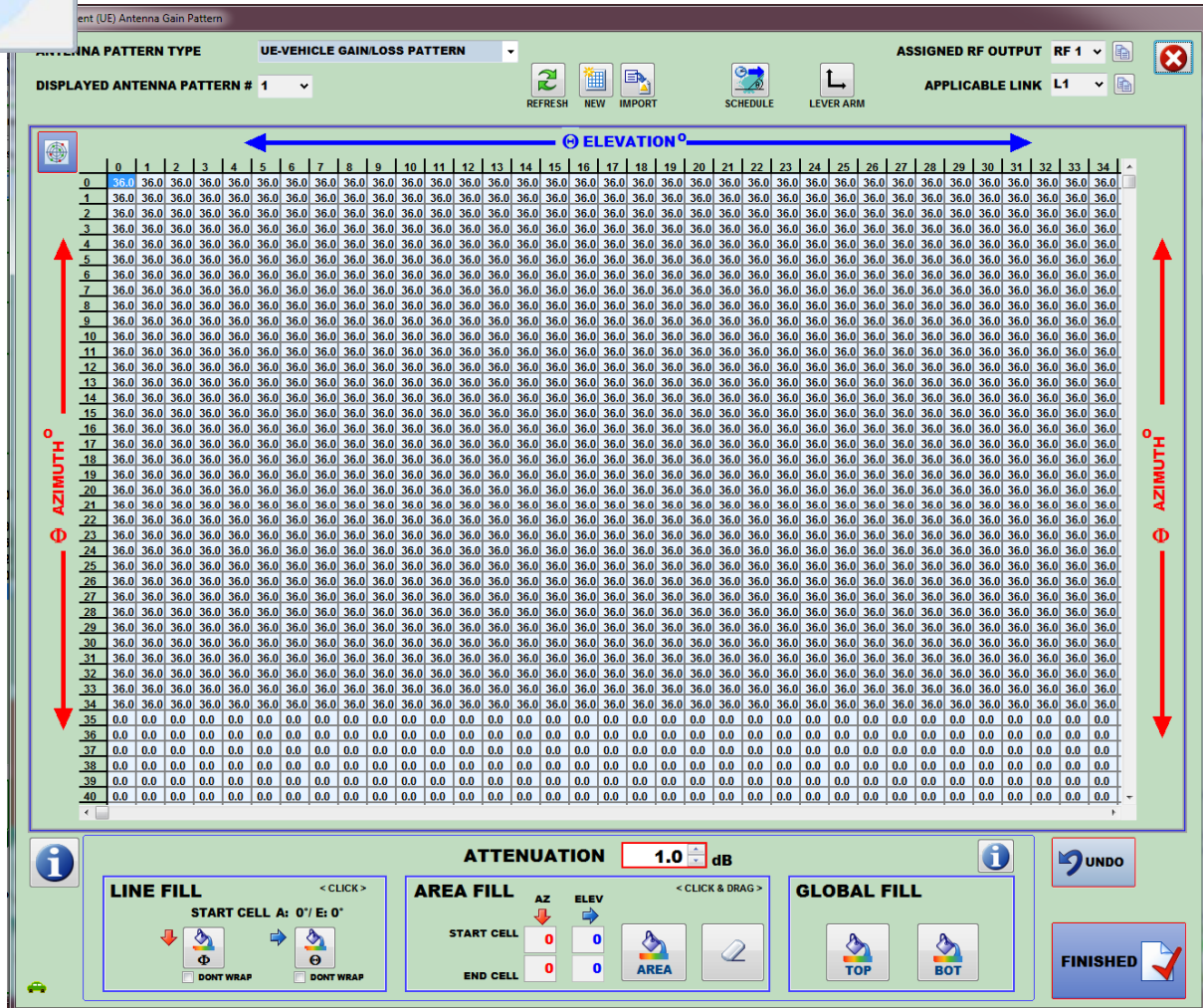
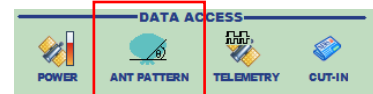
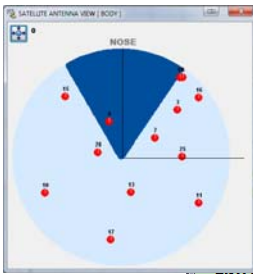
→  
 $L_B$  = *The vector pointing outwards (+) along the geometric centerline of the antenna in Vehicle BODY Frame.*

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  $90^\circ$  and Azimuth ( $\phi$ )  $0^\circ$  and Cone Angle ( $\varnothing$ )  $180^\circ$  relative to the vehicle body coordinate frame.

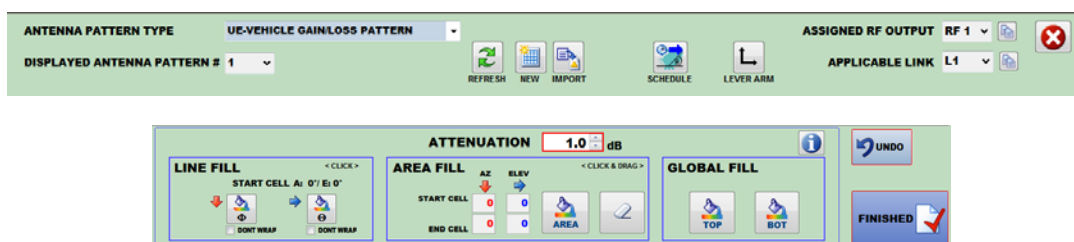


## ANTENNA GAIN PATTERNS

ANTENNA VIEW



- 1° x 1° 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

REFRESH

NEW

IMPORT

SCHEDULE

LEVER ARM

ASSIGNED RF OUTPUT

RF 1

APPLICABLE LINK

L1

## 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.

IMPORT ANTENNA PATTERN FILES  
[ TAPESTRY WILL RENAME ACCORDINGLY ]

[illegible]

CLICK & DRAG

FILL ALONG ROWS / COLUMNS  
ELEVATION (Row) AZIMUTH (Column)

## TWO LEVELS

The diagram illustrates the software interface for the 'LINE FILL' and 'AREA FILL' sections. The 'LINE FILL' section includes a 'START CELL A: 0°/E: 0°' and 'DONT WRAP' checkboxes. The 'AREA FILL' section includes a table for 'AZ' and 'ELEV' values, and 'AREA' and 'GLOBAL FILL' buttons. The 'GLOBAL FILL' section includes 'TOP' and 'BOT' buttons. An 'ATTENUATION' slider is set to 1.0 dB. An 'UNDO' button is visible on the right.

ENTER Elevation/Azimuth PRESS [ AREA ]

CLEAR AREA

## ANTENNA PATTERN FILE CONVENTIONS

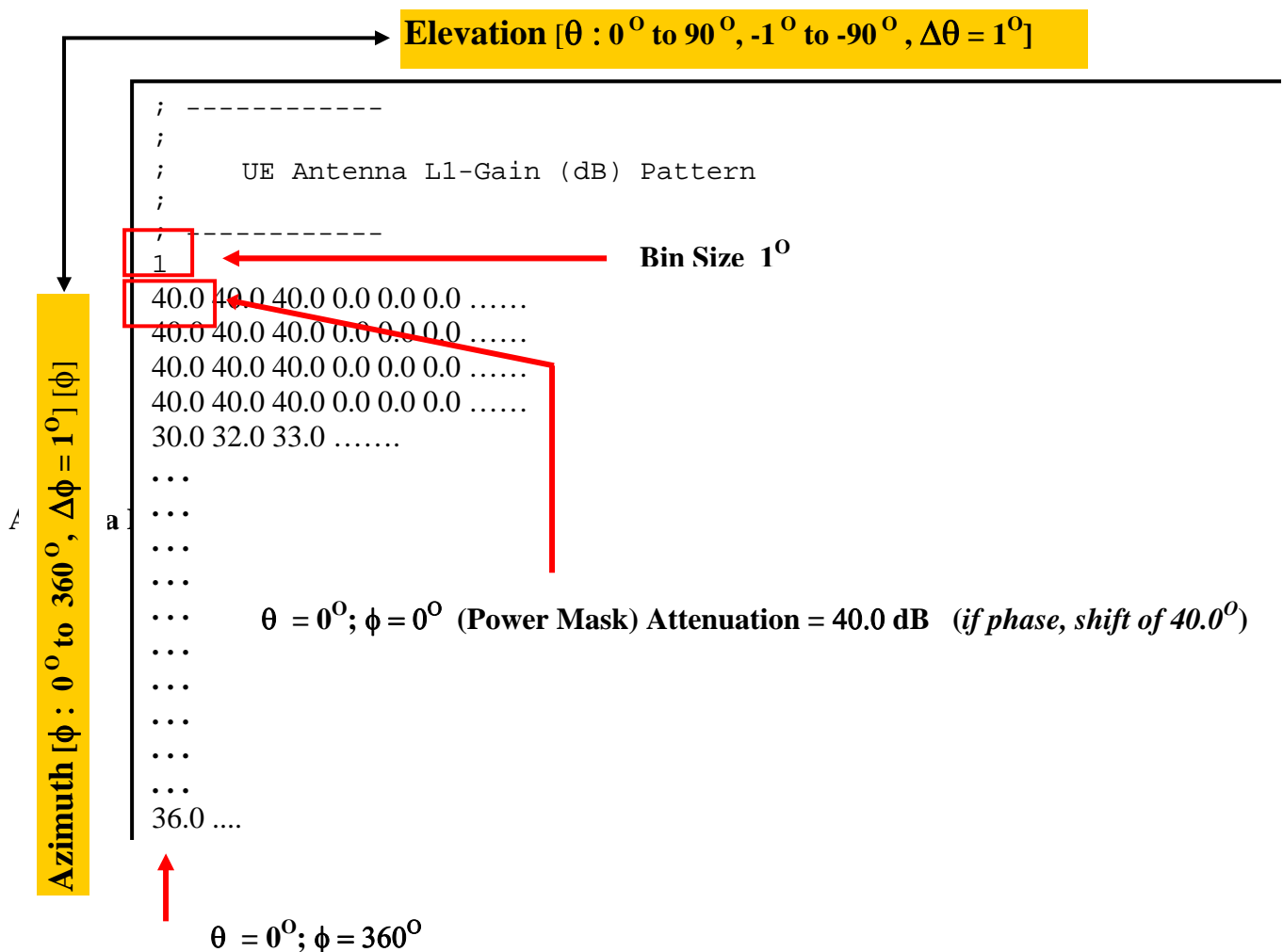
Tapestry provides Antenna Patterns as follows (in sets of 3  $L_1$ ,  $L_2$ , and  $L_5$ )

- 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 important Antenna files, you must follow this conventions.

### UE L1 Antenna Gain Pattern

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

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

### UE L1 Antenna Phase Pattern

<b>ANTENNA_PL1_PATTERN_RF 1_1.SCN</b>	<b>[RF #1 [1st Pattern...]]</b>
<b>ANTENNA_PL1_PATTERN_RF2_N.SCN</b>	<b>[RF #2 [N<sup>th</sup> Pattern...]]</b>

Similarly,

### UE L2 Antenna Gain and Phase Pattern

<b>ANTENNA_GL2_PATTERN_RF1_1.SCN</b>	<b>[RF #1 [1st Pattern ... etc.]]</b>
<b>ANTENNA_PL2_PATTERN_RF 2_1.SCN</b>	<b>[RF #2 [1st Pattern ... etc.]]</b>

### UE L5 Antenna Gain and Phase Pattern

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

### GPS SV Antenna Gain Pattern

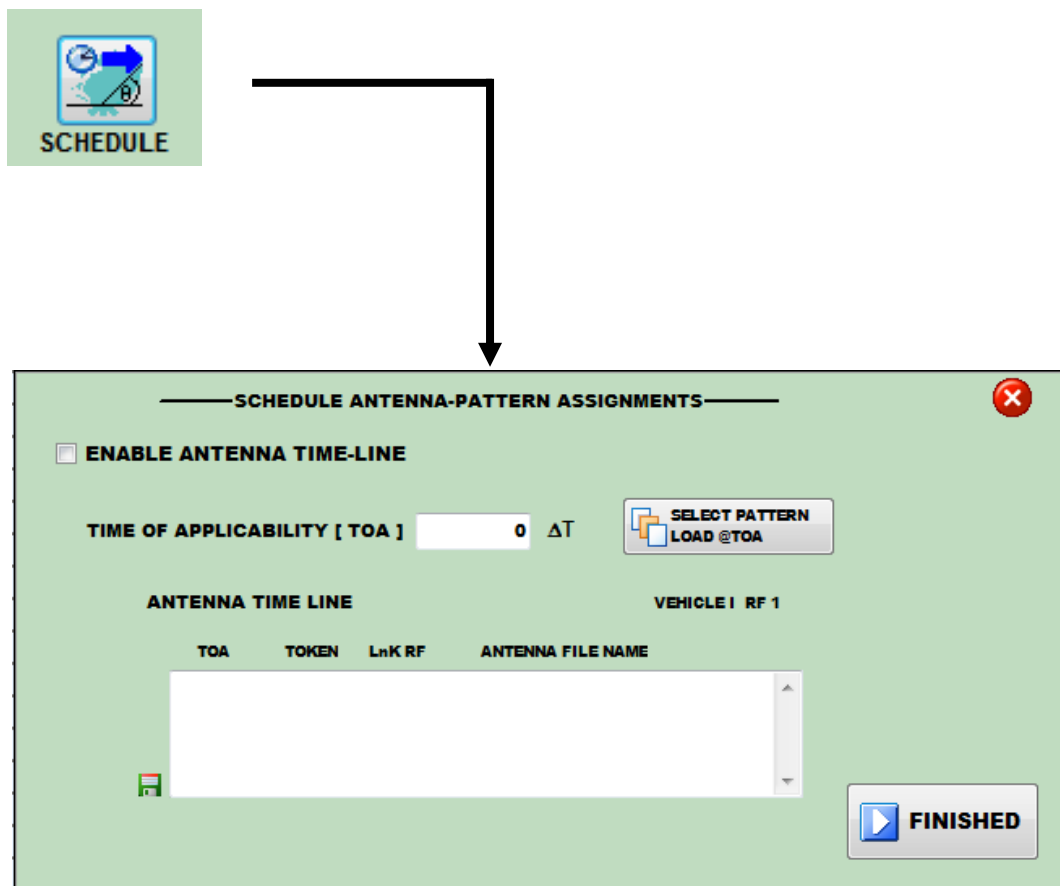
**TRANSMITTER\_GL1\_PATTERN.SCN [no RF dependency]**

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**

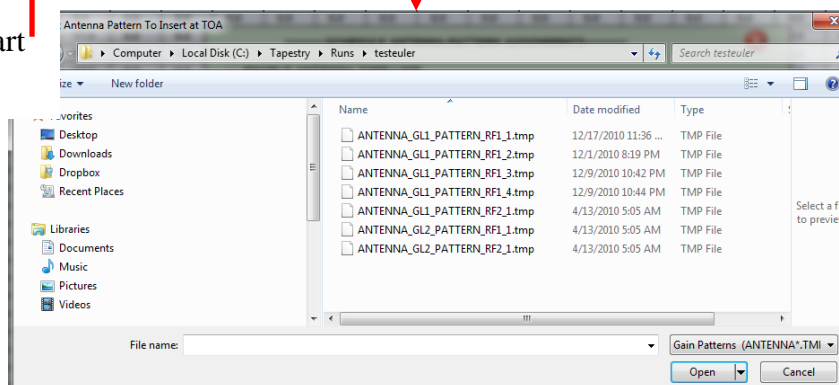
For example, assume there are 3 L<sub>1</sub> Antenna Gain Patterns in the scenario folder. Create the Event File as follows:



☒ **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 | 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 | 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**

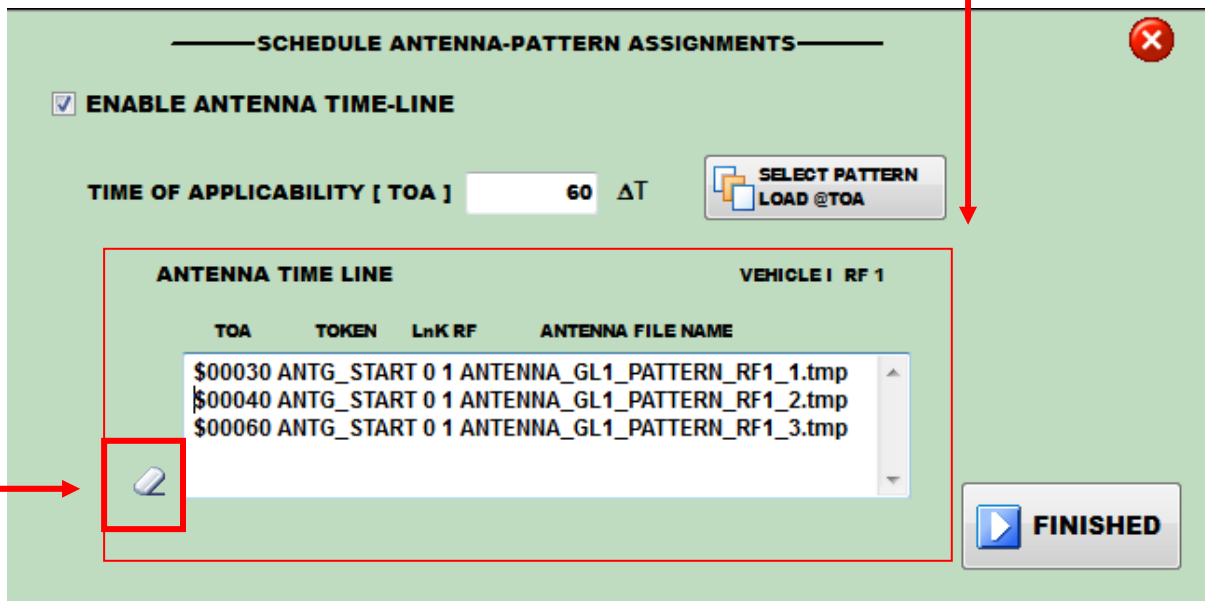
**TIME OF APPLICABILITY [ TOA ]**   $\Delta T$  **SELECT PATTERN LOAD @TOA**

**ANTENNA TIME LINE** **VEHICLE | 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



**SCHEDULE ANTENNA-PATTERN ASSIGNMENTS**

☒ **ENABLE ANTENNA TIME-LINE**

**TIME OF APPLICABILITY [ TOA ]**  **ΔT** **SELECT PATTERN LOAD @TOA**

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

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

**CLEAR EVENT LIST** **FINISHED**

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

< L-CLICK >

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

	0	5	10	15	20
0	36.0	36.0	36.0	36.0	36.0
10	36.0	36.0	36.0	36.0	36.0
20	36.0	36.0	36.0	36.0	36.0
30	36.0	36.0	36.0	36.0	36.0
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0

CELL 10°/45°

ATTEN 10.0

<DBLCLK>

Wrap Last

CELL 10°/45°

ATTEN 0.0

<DBLCLK>

Wrap Last

## MULTIPLE CELL FILL

< L-CLICK & DRAG >

- SELECT MULTIPLE AREA
- **USE AREA/FILL CONTROL**
- SETS FILL 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
10	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
30	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
50	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
70	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
90	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

AREA

10 25

45 100

ATTEN 36.0 dB

<CLK DRAG>

LINE

Wrap

## POINT & SHOOT CELL ENTRY

< L-DBL-CLICK >

- SELECT CELL
- **USE CELL CONTROL**
- SETS CELL VALUE

	0	5	10	15	20
0	36.0	36.0	36.0	36.0	36.0
10	36.0	36.0	36.0	36.0	36.0
20	36.0	36.0	36.0	36.0	36.0
30	36.0	36.0	36.0	36.0	36.0
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0
60	0.0	0.0	0.0	0.0	0.0
70	0.0	0.0	0.0	0.0	0.0

CELL 10°/45°

ATTEN 11.2

<DBLCLK>

Wrap Last

< CLICK > SELECT CELL ..... < CLICK > SET FOCUS

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

	0	5	10	15	20
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0

CELL 10°/45°

ATTEN 0.0

<DBLCLK>

Wrap Last

< ENTER >

CELL 10°/45°

ATTEN 11.2

<DBLCLK>

Wrap Last

	0	5	10	15	20
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	11.2	0.0	0.0

< ENTER >

CELL 10°/45°

ATTEN 11.2

<DBLCLK>

Wrap Last

	0	5	10	15	20
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	11.2	11.2	0.0

## MOVE TO NEXT COLUMN [ELEV]

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

CELL 10°/45°

ATTEN 11.2

<DBLCLK>

Wrap Last

	0	5	10	15	20
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	11.2	11.2	0.0

## MOVE TO NEXT ROW [AZIMUTH]

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

CELL 10°/45°

ATTEN 11.2

<DBLCLK>

Wrap Last

	0	5	10	15	20
40	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	11.2	0.0	0.0