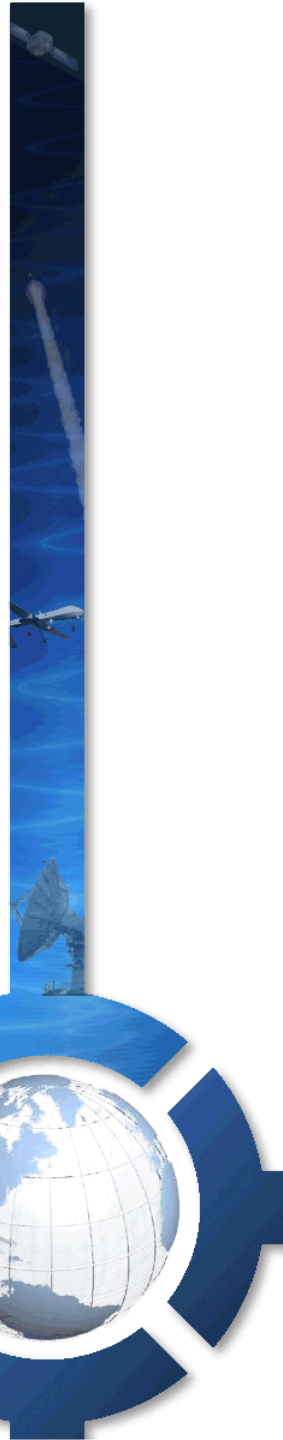
RT LOGIC
an Integral Systems Company

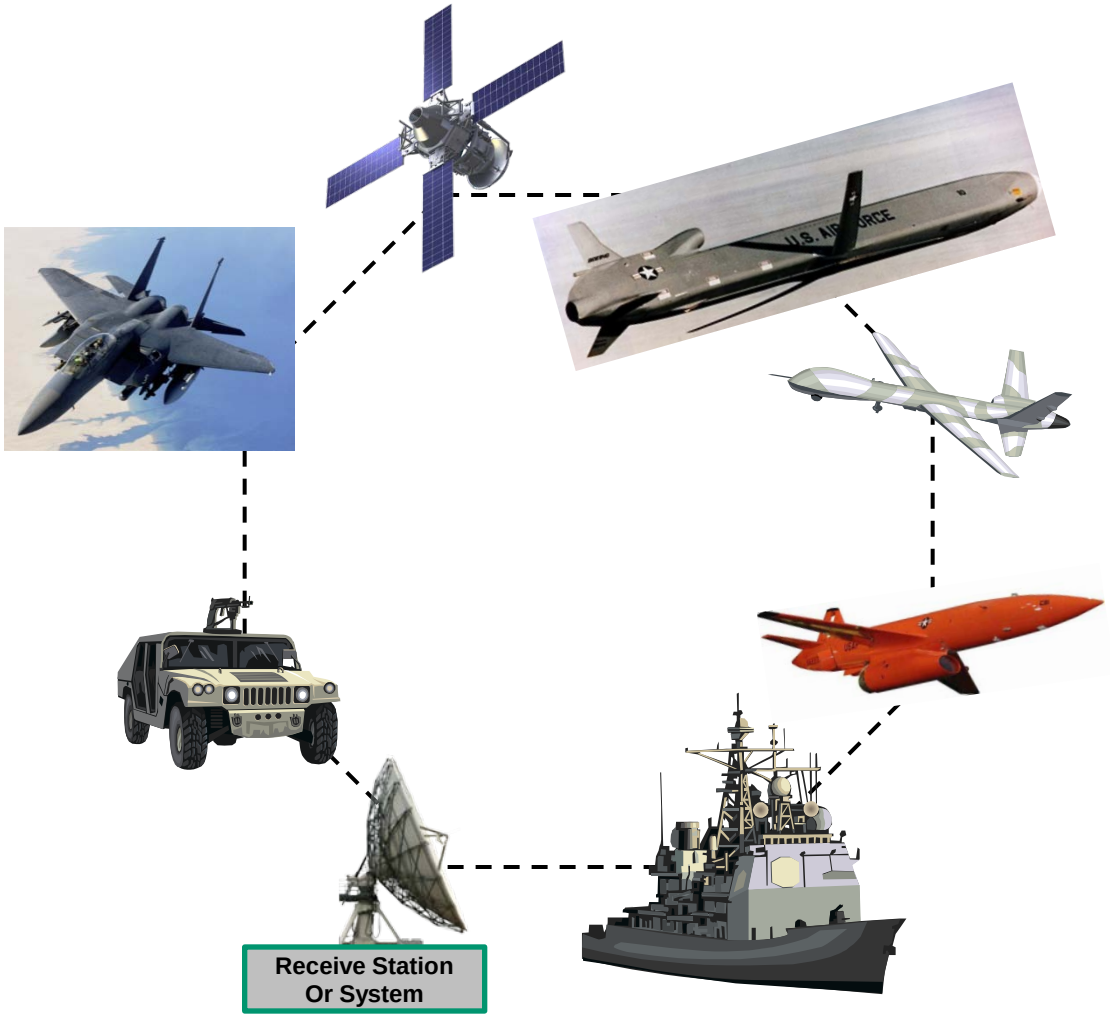
Channel Simulators to Test RF Communication Links for Targets, UAVs and Ranges

RT Logic, Steve Williams

47th Annual Targets, UAVs and Range Operations Symposium & Exhibition

22 October, 2009





Whenever transmitters and receivers are in motion with respect to each other…

- Special COMMS test needs exist…
  - Doppler shift
  - Range delay
  - Range attenuation
  - Noise
  - Interference
  - Etc.

  } Dependent on flight path and ground locations.

  } Nominal conditions
  Worst-case conditions

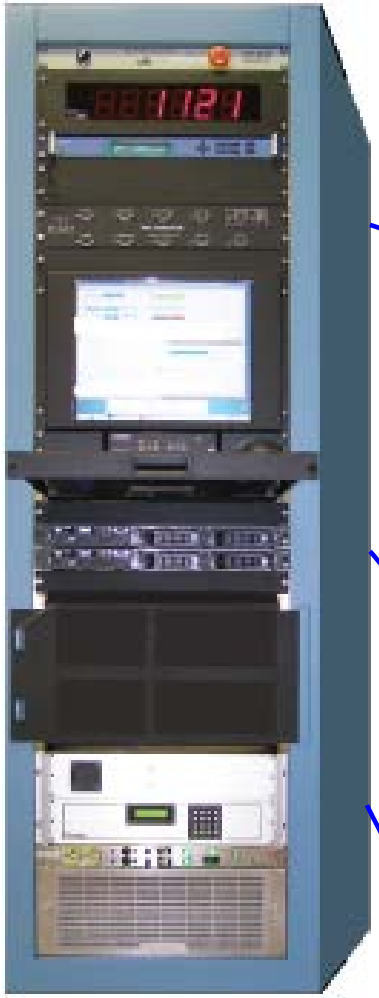
- When testing…
  - RF Hardware
  - Digital Hardware
  - Analog Hardware
  - Software
  - Firmware
  - Processes
  - Etc.

  } Initial development tests
  Regression tests
  Compliance tests
  Stress tests

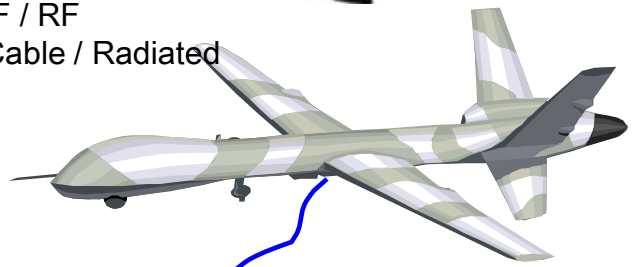
- Strong need for thorough, economic and fast testing
  - Run often to detect problems as early as possible

- Doppler shift, delay, attenuation, noise and interference generation is difficult & time-consuming
  - Must know and understand flight paths
  - Must be physics-compliant
  - Must be phase-continuous, smooth, highly interpolated
  - Must have high resolution control and output

- Channel Simulators to the rescue
  - Create Doppler shift, delay, attenuation, noise and interference on test signals



IF / RF
Cable / Radiated

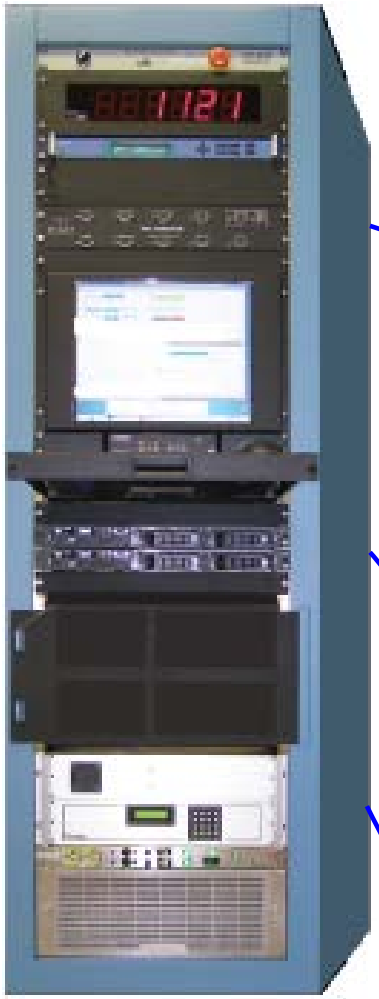


IF / RF
Cable / Radiated

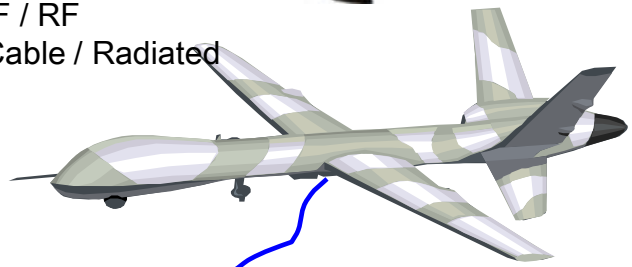
IF / RF
Cable / Radiated

TM Site

Doppler shift
Delay
Attenuation
Noise
Interference



IF / RF
Cable / Radiated

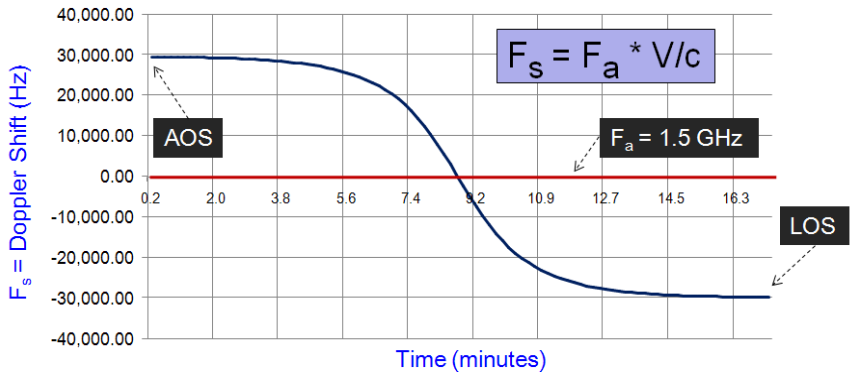


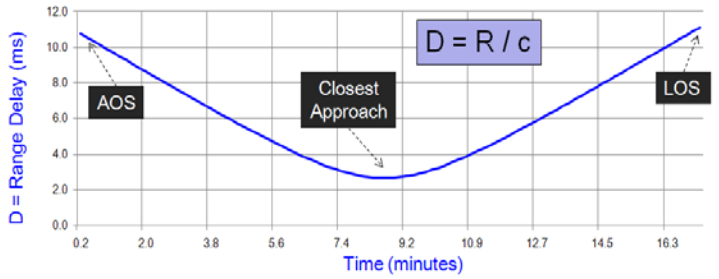
IF / RF
Cable / Radiated

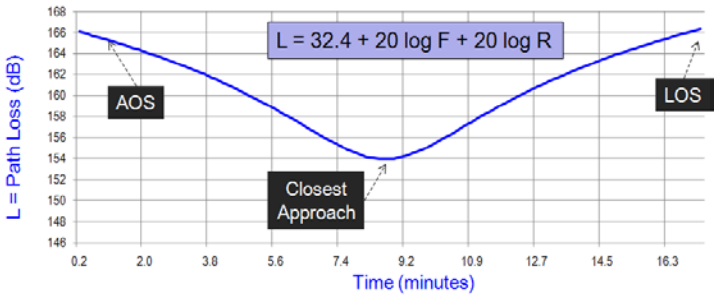
IF / RF
Cable / Radiated

TM Site

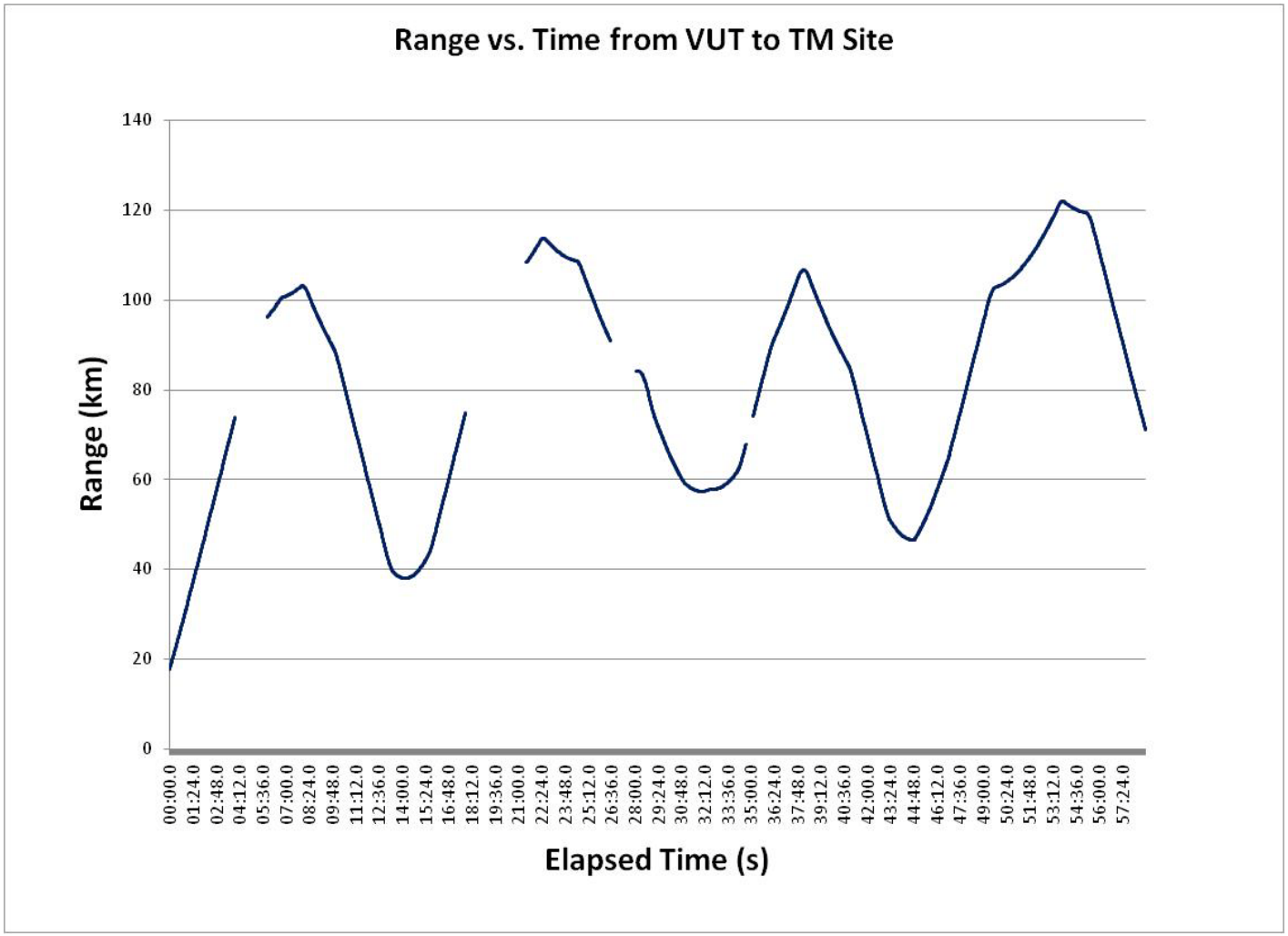
- Channel Simulator requirements are non-trivial, but relatively straight-forward for SATCOM applications.
- Much higher complexities exist with more complicated motion relationships
  - Example: Targets, UAVs and Ranges



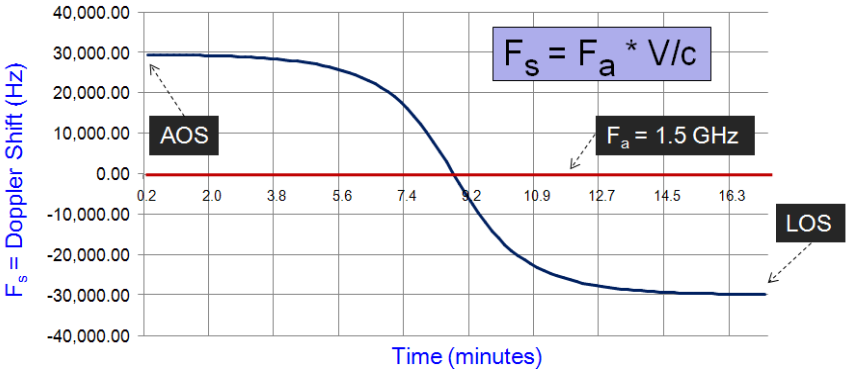


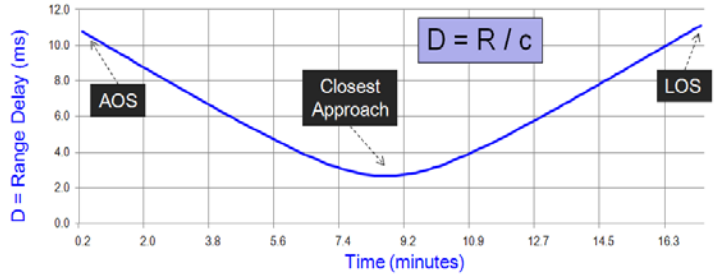


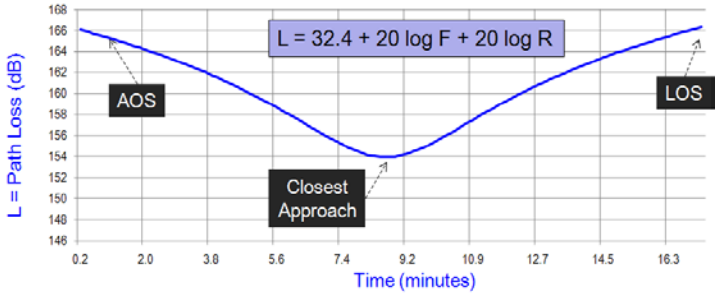
- Range vs. Time between a Vehicle Under Test (VUT) and a TM site



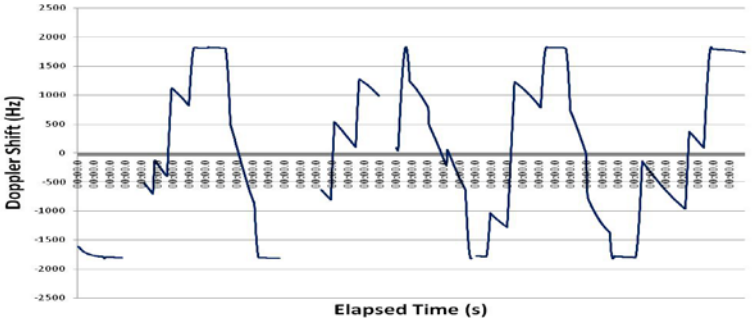
LEO Satellite Case

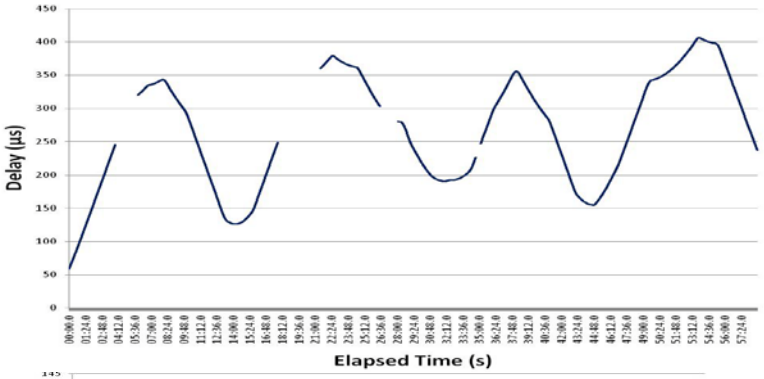


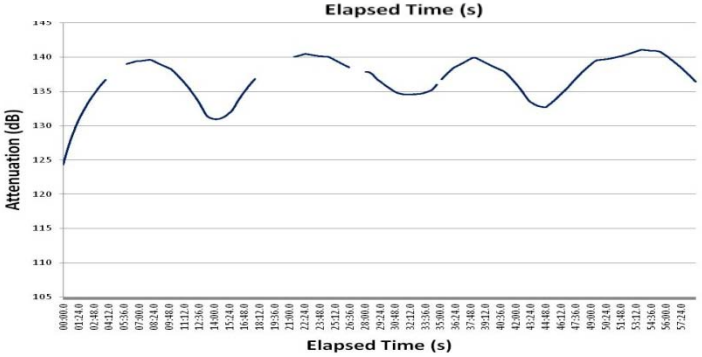




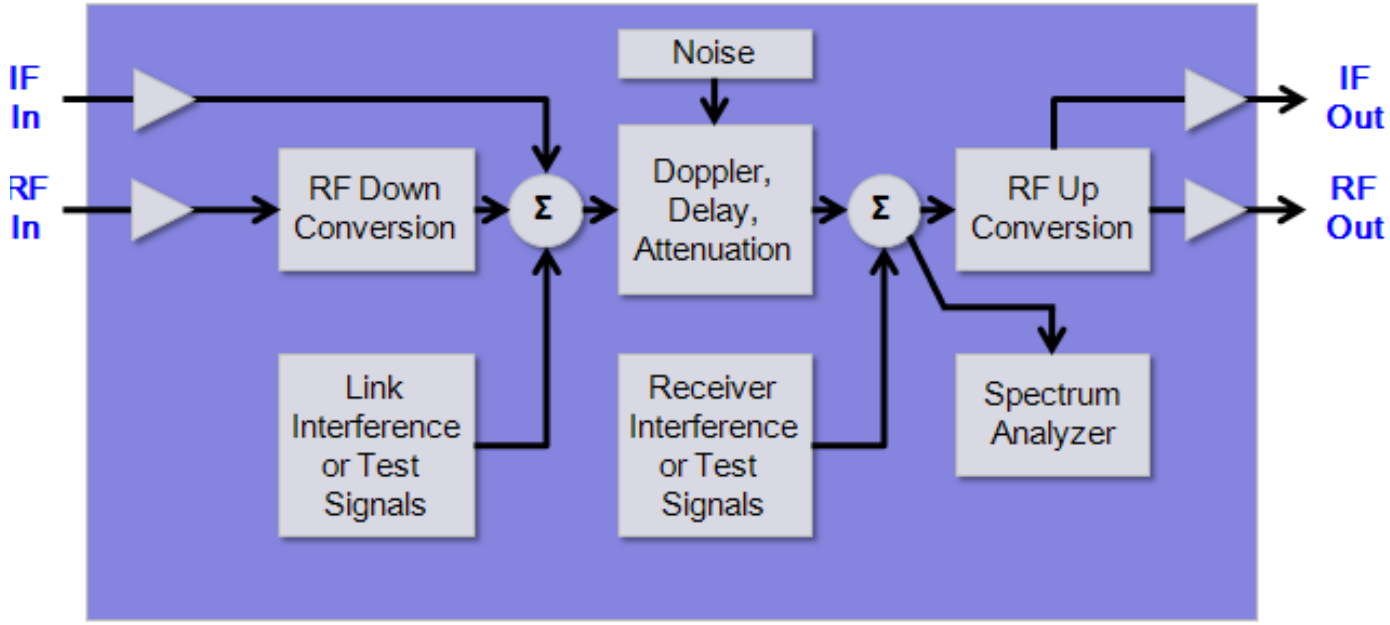
UAV/Target/Aircraft Case



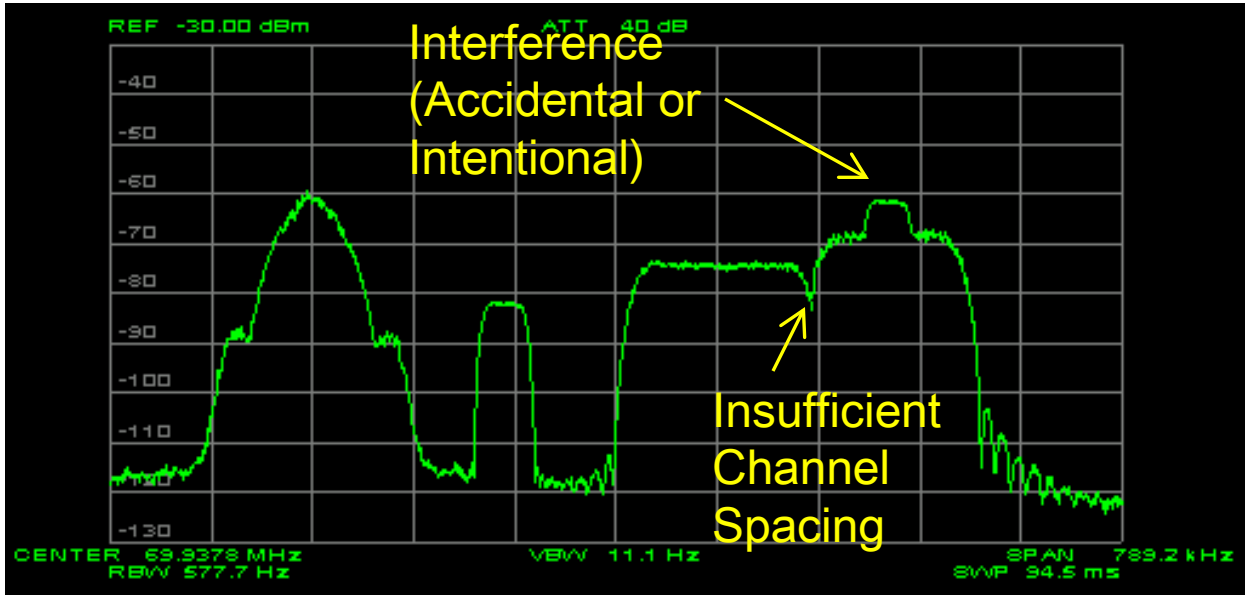




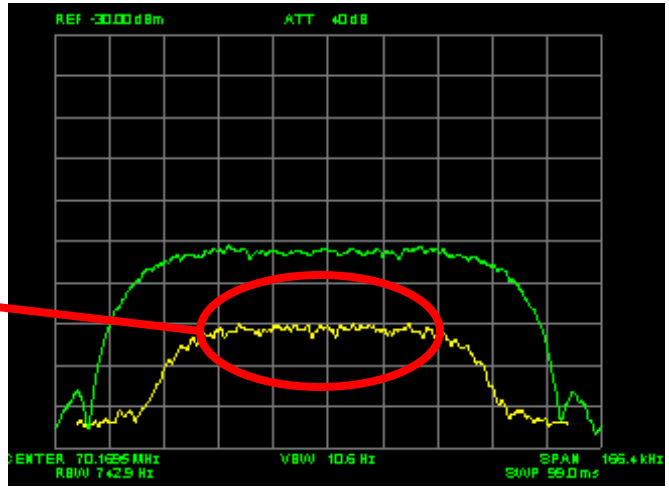
- Key Channel Simulator Capabilities
  - Specs, phase-continuous and physics-compliant
  - Modular to accommodate multiple projects and test scenarios
  - Easily reconfigurable
  - Standard inputs / output
  - IF (cable), RF (cable), RF (near-field), RF (far-field)

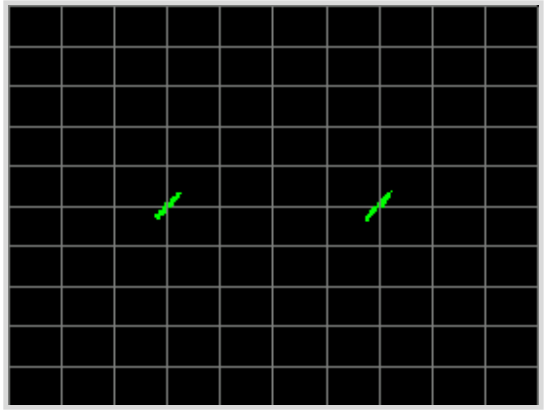


- Signal Generator Capabilities
  - Multiple independent signals
    - Modulation type
    - Data rate
    - Frequency offset
    - Amplitude
    - Etc.

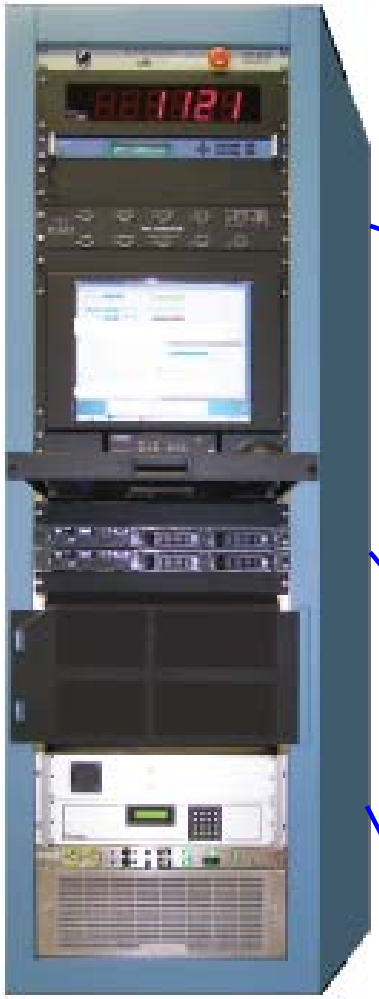


- Spectrum Analysis Capabilities
  - Spectrum, Constellation, Spectrogram
  - Modulation Analysis
  - Interference Analysis
  - Monitoring, Alarms



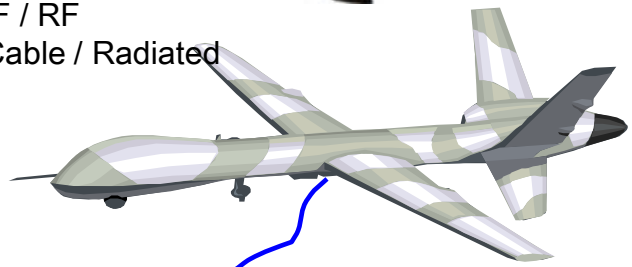


Date/Time	Modulation...	Symbol Rate(Ksps)	Center Freq(MHz)	C/No(dB/Hz)	Eb/No(dB/Hz)	BER	C/I(dB)	Carrier
2009-02-19 06:41:03	BPSK	100.000	70.168184	69.82	19.82	----	19.82	UNKNO



Doppler shift
Delay
Attenuation
Noise
Interference

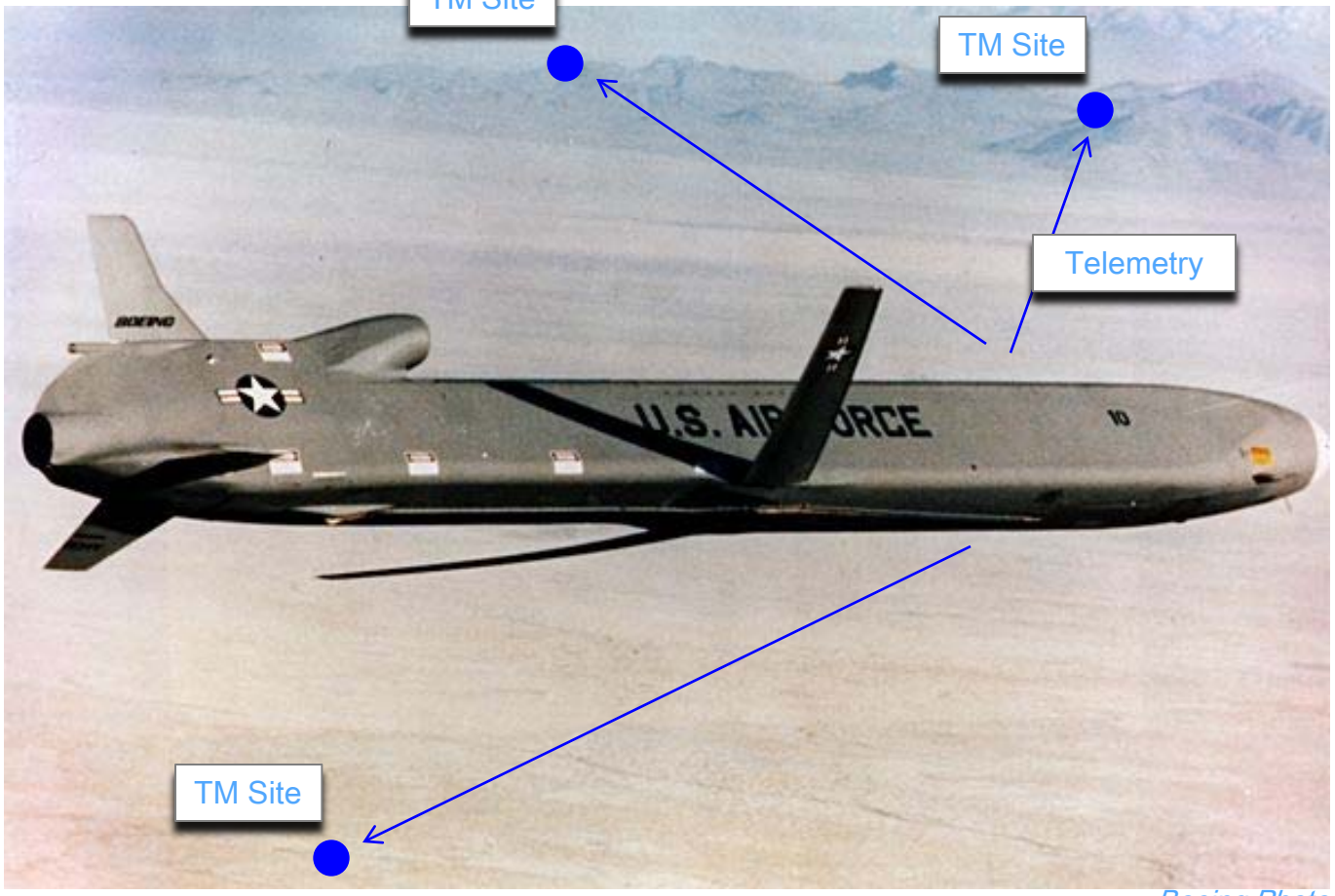
IF / RF
Cable / Radiated



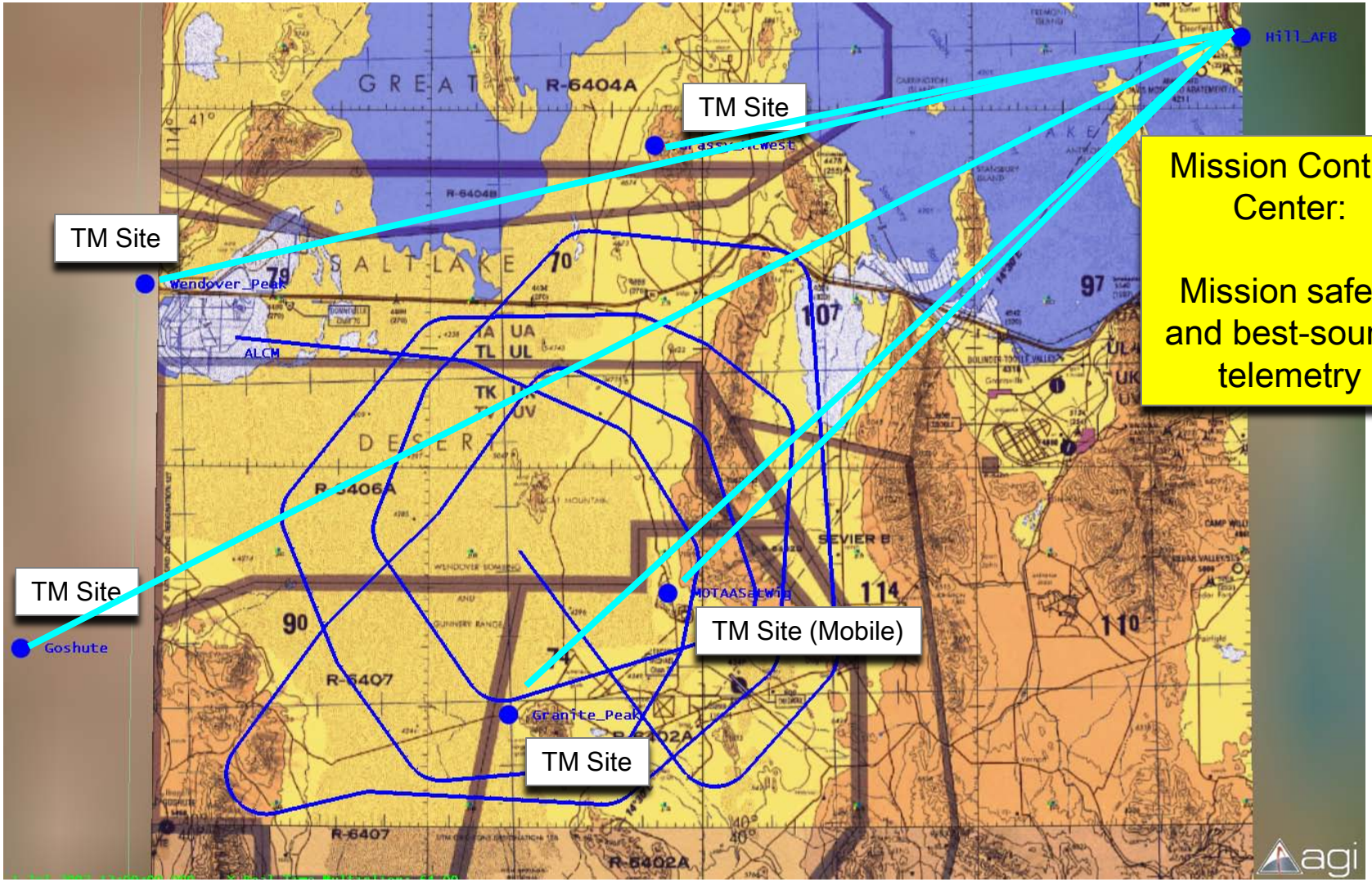
IF / RF
Cable / Radiated

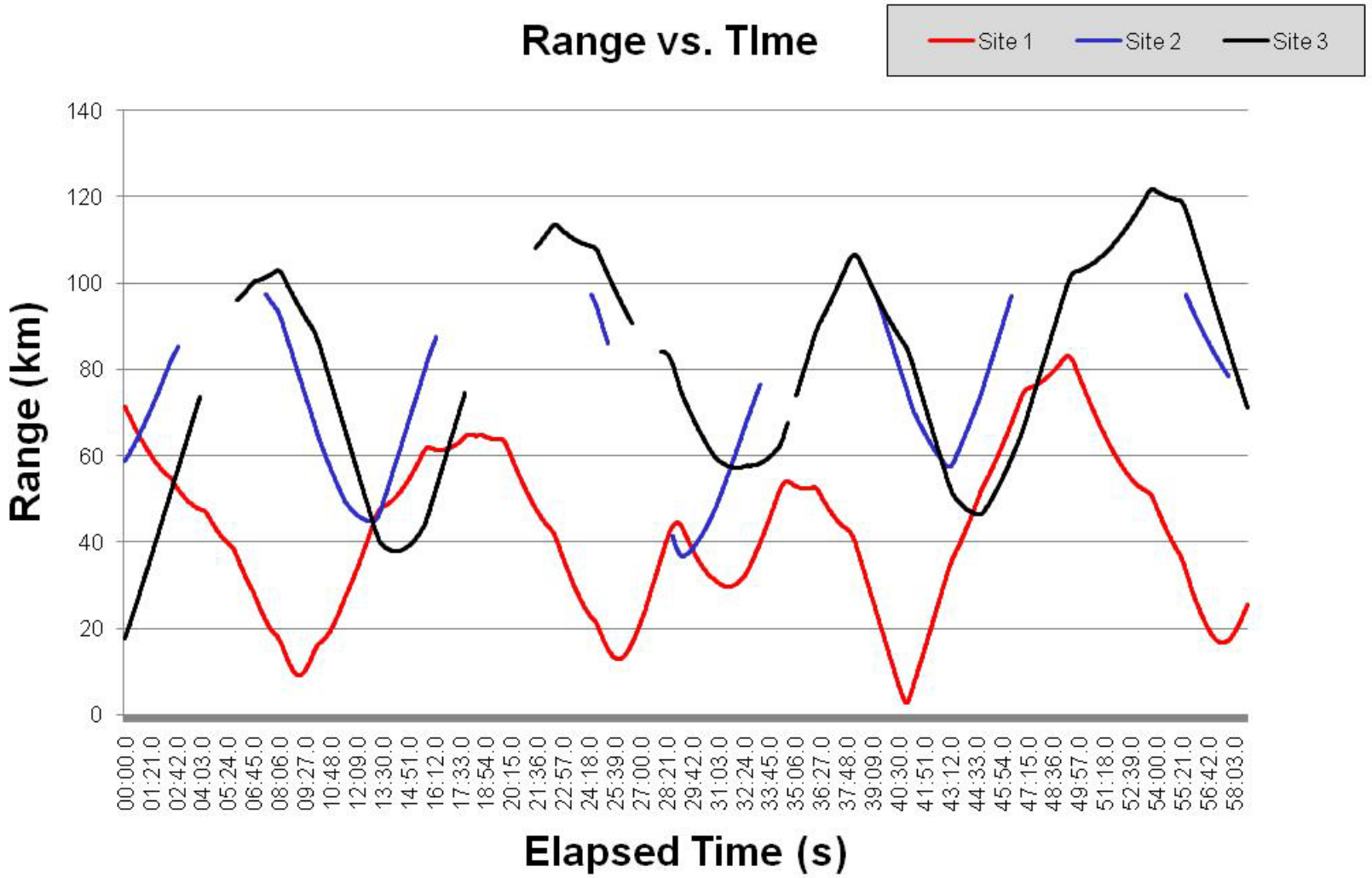
IF / RF
Cable / Radiated

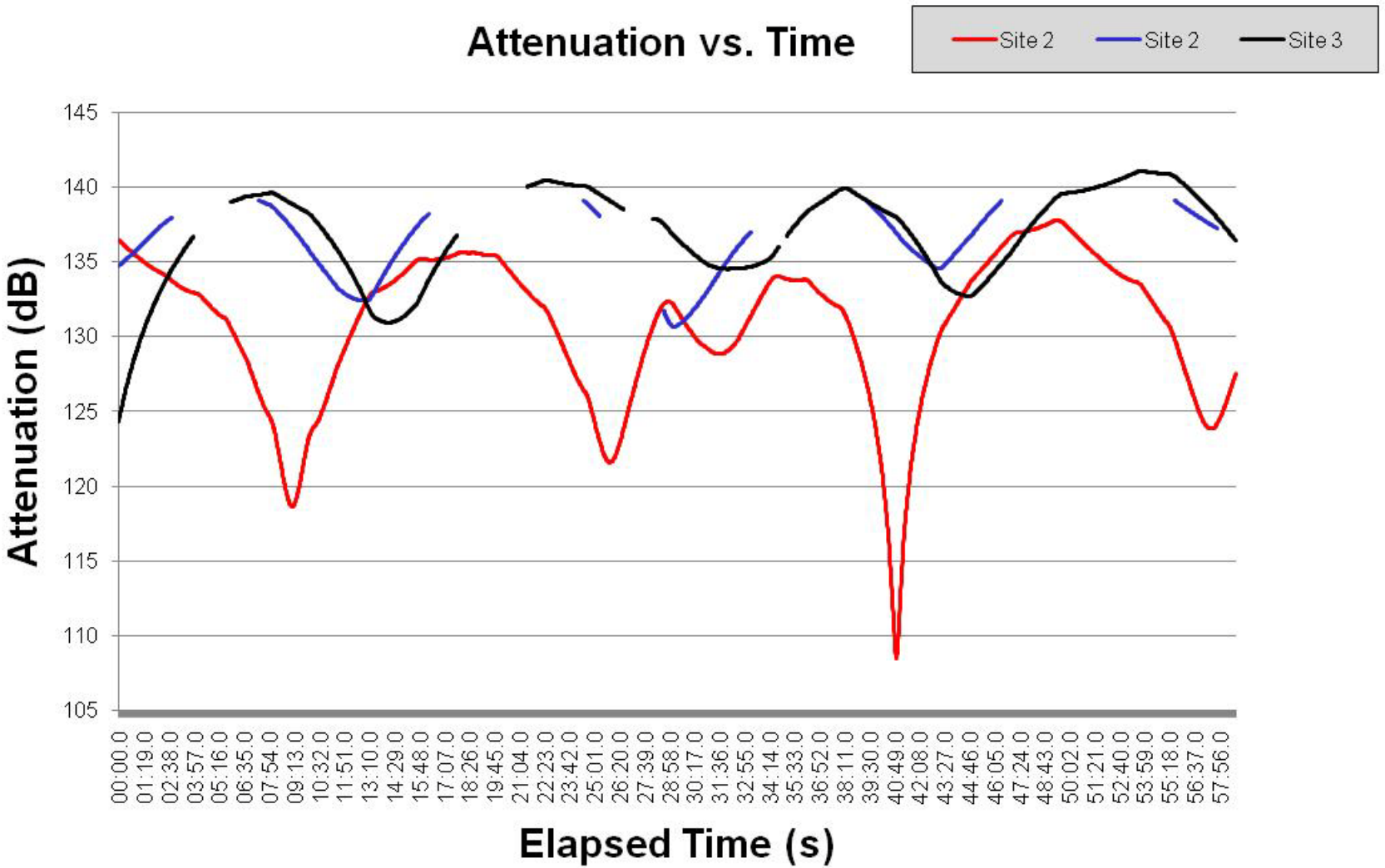
TM Site

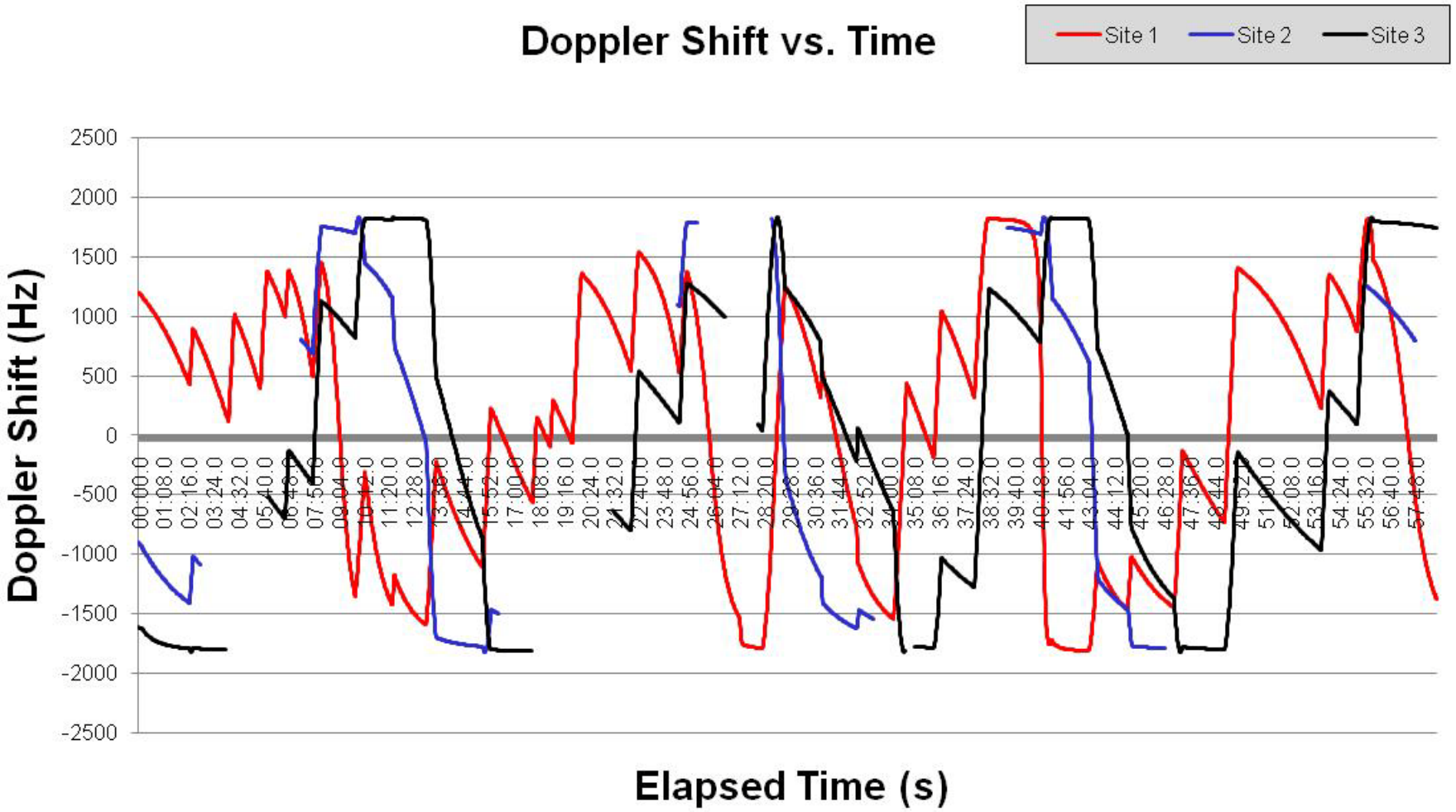


Boeing Photo


TM Site
TM Site
TM Site
TM Site (Mobile)
TM Site
Mission Control Center:
Mission safety and best-source telemetry
Hill_AFB
Wendover_Peak
Goshute
Granite_Peak
R-6404A
R-6404B
R-6406A
R-6407
R-6402A
SALT LAKE
DESERT
ALCM
SEVIER B


Range vs. Tlme
Site 1
Site 2
Site 3
Range (km)
140
120
100
80
60
40
20
0
00:00.0
01:21.0
02:42.0
04:03.0
05:24.0
06:45.0
08:06.0
09:27.0
10:48.0
12:09.0
13:30.0
14:51.0
16:12.0
17:33.0
18:54.0
20:15.0
21:36.0
22:57.0
24:18.0
25:39.0
27:00.0
28:21.0
29:42.0
31:03.0
32:24.0
33:45.0
35:06.0
36:27.0
37:48.0
39:09.0
40:30.0
41:51.0
43:12.0
44:33.0
45:54.0
47:15.0
48:36.0
49:57.0
51:18.0
52:39.0
54:00.0
55:21.0
56:42.0
58:03.0
Elapsed Time (s)


Attenuation vs. Time
Site 2
Site 2
Site 3
Attenuation (dB)
145
140
135
130
125
120
115
110
105
00:00.0
01:19.0
02:38.0
03:57.0
05:16.0
06:35.0
07:54.0
09:13.0
10:32.0
11:51.0
13:10.0
14:29.0
15:48.0
17:07.0
18:26.0
19:45.0
21:04.0
22:23.0
23:42.0
25:01.0
26:20.0
27:39.0
28:58.0
30:17.0
31:36.0
32:55.0
34:14.0
35:33.0
36:52.0
38:11.0
39:30.0
40:49.0
42:08.0
43:27.0
44:46.0
46:05.0
47:24.0
48:43.0
50:02.0
51:21.0
52:40.0
53:59.0
55:18.0
56:37.0
57:56.0
Elapsed Time (s)


Doppler Shift vs. Time
Site 1
Site 2
Site 3
Doppler Shift (Hz)
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
00:00.0
01:08.0
02:16.0
03:24.0
04:32.0
05:40.0
06:48.0
07:56.0
09:04.0
10:12.0
11:20.0
12:28.0
13:36.0
14:44.0
15:52.0
17:00.0
18:08.0
19:16.0
20:24.0
21:32.0
22:40.0
23:48.0
24:56.0
26:04.0
27:12.0
28:20.0
29:28.0
30:36.0
31:44.0
32:52.0
34:00.0
35:08.0
36:16.0
37:24.0
38:32.0
39:40.0
40:48.0
41:56.0
43:04.0
44:12.0
45:20.0
46:28.0
47:36.0
48:44.0
49:52.0
51:00.0
52:08.0
53:16.0
54:24.0
55:32.0
56:40.0
57:48.0
Elapsed Time (s)

Doppler shift
Delay
Attenuation
Noise
Interference

Test Signal Source

PRN Data

Replay Archived Data

Other

TM Site #1

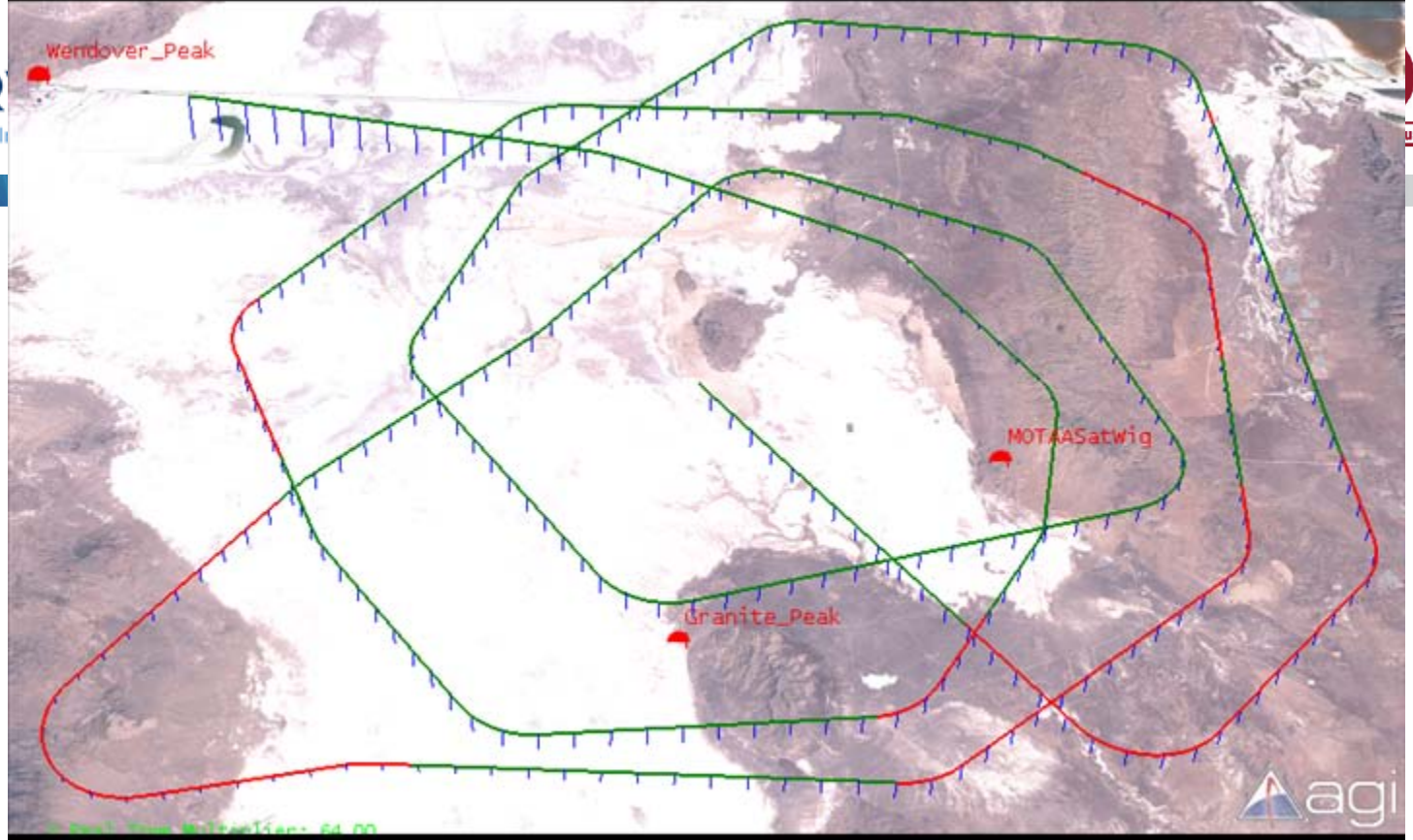
IF / RF
Cable / Radiated

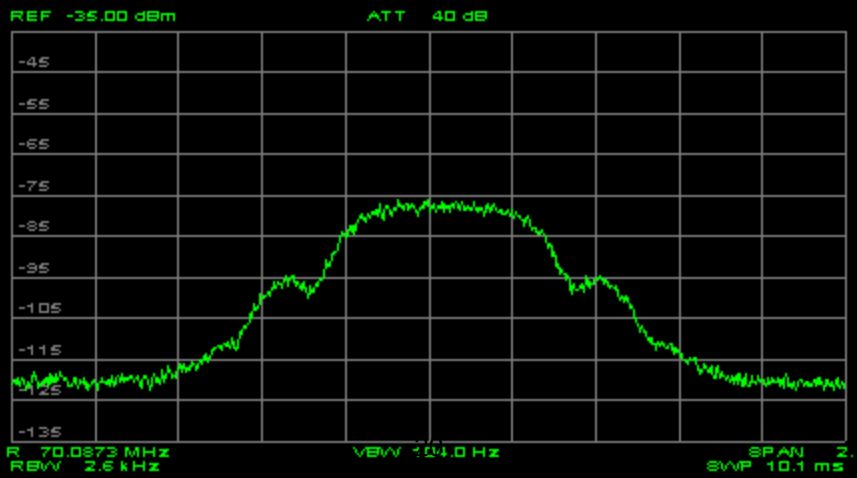
TM Site #2

IF / RF
Cable / Radiated

TM Site #3

IF / RF
Cable / Radiated


Wendover_Peak
MOTAASatWig
Granite_Peak


REF -35.00 dBm
ATT 40 dB
-45
-55
-65
-75
-85
-95
-105
-115
-125
-135
R 70.0873 MHz
RBW 2.6 kHz
SPAN 2.
SWP 10.1 ms

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- Summary
  - Thorough and realistic tests, nominal and worst-case
    - Flight COMMS systems
    - Ground COMMS systems
    - Ranges

    RF Hardware
    Digital Hardware
    Analog Hardware
    Software
    Firmware
    Processes
  - Key Values
    - Drives in quality
    - Improves system and mission assurance
    - Save time, saves cost, prevents over-design and under-design
  - Additional Information
    - Steve Williams, RT Logic, swilliams@rtlogic.com, 719-598-2801
    - RT Logic Booth #05