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SIMULATION AGAINST JAMMING AND SPOOFING

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BROADSIM

SOFTWARE-DEFINED GNSS SIMULATOR

CONTACT: TERBES@TALEN-X.COM

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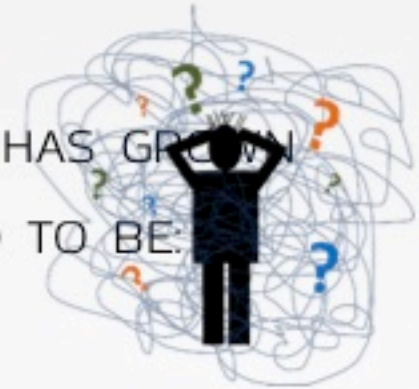
GNSS SIMULATORS HAVE STAGNATED

- THE FUNDAMENTAL WAY WE USE SIMULATORS HASN'T CHANGED FOR ~10 YEARS.
  - SIMULATOR COSTS ARE HIGH - $500,000 FOR A BASIC CONFIGURATION.
  - JAMMING IS NOT INCLUDED, YOU MUST PROVIDE THIS YOURSELF USING OTHER HARDWARE.
  - SCENARIO CREATION IS COMPLICATED AND LIMITED
- BUT THE COMPLEXITY OF THREATS AND TESTING HAS GROWN
- **PARADIGM NEEDS TO CHANGE**, SIMULATORS NEED TO BE:
  - EASY TO USE
  - AFFORDABLE
  - SUPPORT NAVWAR TESTING



SOLUTION - BROADSIM

- **GNSS SIMULATION – 1000 HZ**
  - GPS C/A, L2C, P, Y, M-CODE
  - GLONASS G1 AND G2
  - GALILEO E1, E5A, AND E5B
  - BEIDOU B1 AND B2
- **SOFTWARE-DEFINED**
  - FLEXIBLE, LOW COST, SCALABLE
  - RAPID DEVELOPMENT CYCLES
- **ADVANCED JAMMING**
  - BPSK, AWGN, BOC, CW, PULSED, SWEPT
  - 50 MHZ BANDWIDTH

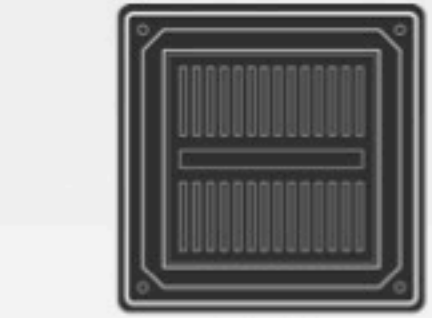
- **SYNCHRONIZATION**
  - LIVE SKY TIME SYNCHRONIZATION
  - RTK AND MULTI-VEHICLE SIMULATION
- **EXTENSIVE API**
  - FULL CONTROL THROUGH C#, C++, OR PYTHON

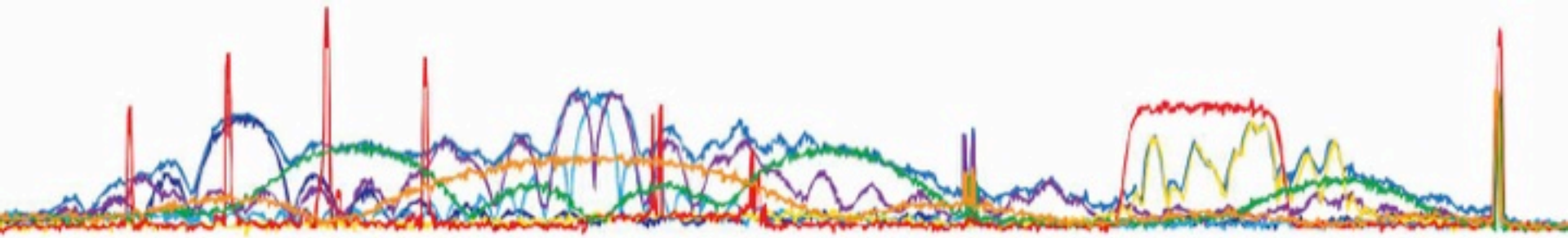
KEY FEATURES

- ADVANCED JAMMING
- EXTENSIVE API
- 6DOF TRAJECTORIES WITH HIGH DYNAMICS
- RECEIVER ANTENNA PATTERN MODELLING
- SATELLITE ANTENNA PATTERN MODELLING
- SPACE BASED MOTIONS
- PSEUDORANGE ERRORS
- DOWNLINK DATA MODIFICATIONS
- MULTI PATH
- ON-THE-FLY SCENARIO RE-CONFIGURATION
- FLEXIBLE LICENSING & IN-FIELD UPGRADABILITY

HOW IT WORKS

- GPU GENERATES THE IQ DATA STREAM
  - 10 TRILLION FLOATING-POINT OPERATIONS PER SECOND (TFLOPS)
- SOFTWARE DEFINED RADIOS CONVERT THE IQ DATA INTO RF
  - USRPS = EXCELLENT RF FRONT END
- RESULT: COST EFFECTIVE REAL-TIME AND FULL-BAND GNSS SIMULATOR





OLD METHOD OF JAMMING

- REQUIRES A SEPARATE SIGNAL GENERATOR (SG) FOR EACH JAMMER
- JAMMING SIGNALS ARE LIMITED BY THE NUMBER OF SG'S AVAILABLE
- SG'S NEED TO BE INTEGRATED INTO SOFTWARE TO RUN AUTONOMOUSLY
- JAMMING POWER DEFINED AT THE RECEIVERS FRONT END, NOT BASED ON THE JAMMERS TRANSMIT PARAMETERS (I.E. LOCATION, POWER)

NEW METHOD OF JAMMING (WITH BROADSIM)

- JAMMING SIGNALS GENERATED WITHIN BROADSIM – SOFTWARE UPGRADE ONLY
- UNLIMITED NUMBER OF JAMMING SIGNALS GENERATED ON 1 RF OUTPUT
- EACH JAMMING SIGNAL CAN HAVE DIFFERENT POWER LEVELS, MODULATIONS, AND LOCATIONS
- COMPLETE JAMMING CONTROL THROUGH THE SDX GUI AND/OR API
- OPTION TO SPECIFY THE LOCATION AND POWER OF JAMMING TRANSMITTERS - BROADSIM CALCULATES THE JAMMING POWER AT THE RECEIVER BASED ON THE LOCATION AND JAMMING PARAMETERS
- SELECT VARIOUS PROPAGATION LOSS MODELS
- ABILITY TO MODEL BLUE FORCE ELECTRONIC ATTACK (BFEA)

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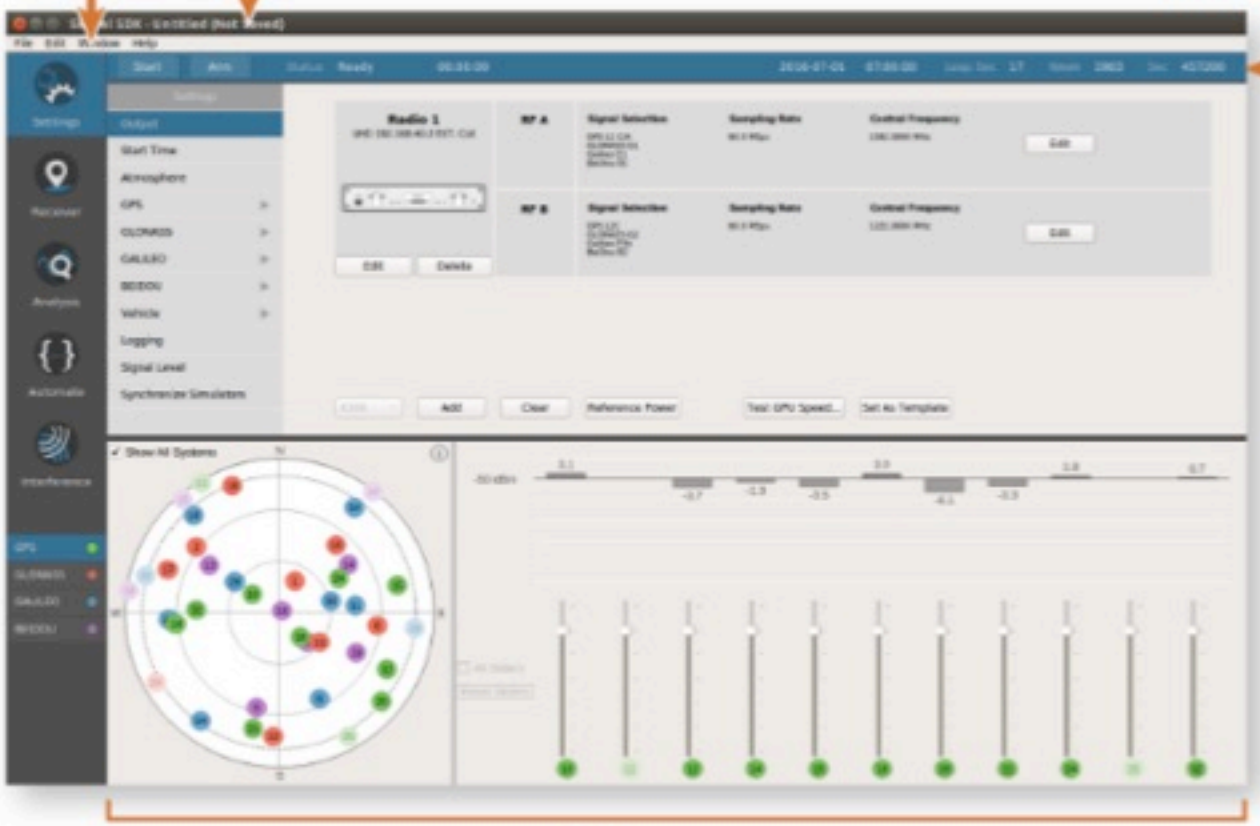
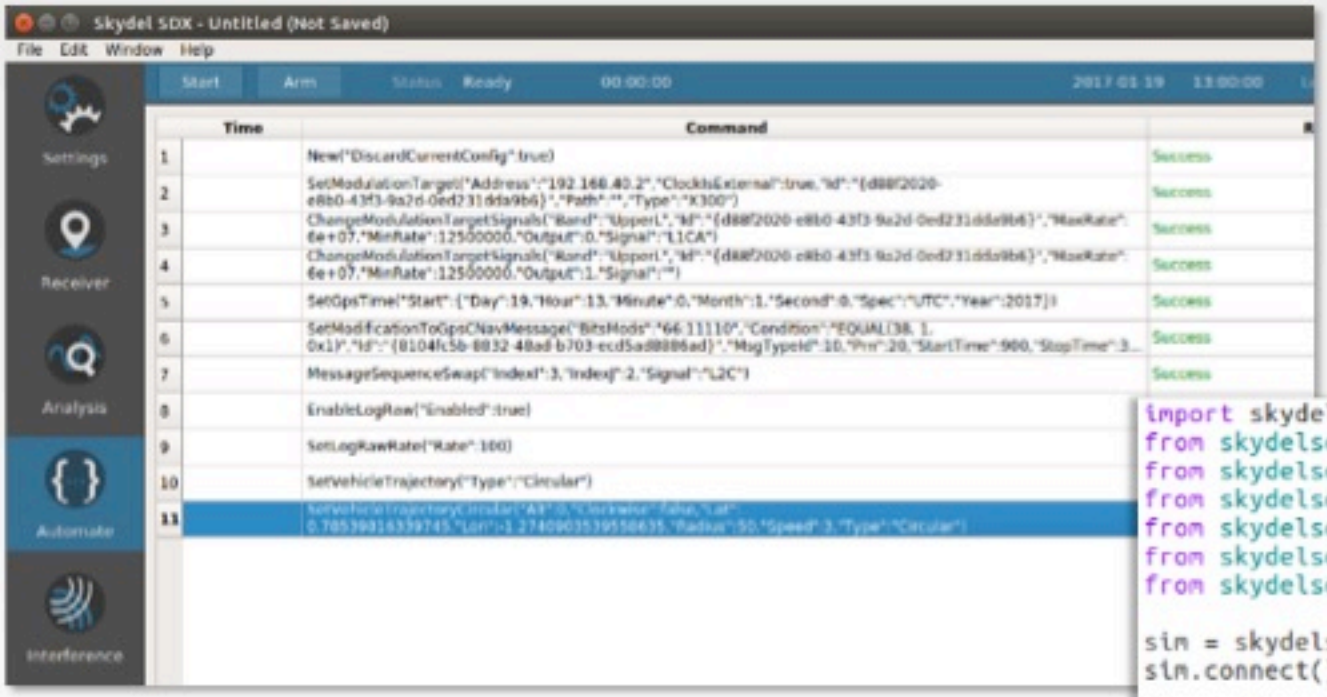
EASY TO USE



EXTENSIVE API




```
import skydelsdx
from skydelsdx.commands import SetModulatio
from skydelsdx.commands import New
from skydelsdx.commands import SetGpsTime
from skydelsdx.commands import SetGpsSatell
from skydelsdx.commands import SetModificat
from skydelsdx.commands import ChangeModula

sim = skydelsdx.RemoteSimulator(True)
sim.connect()

sim.call(New(True))
sim.call(SetModulationTarget("X300", "", "1
sim.call(ChangeModulationTargetSignals(0, 1
sim.call(ChangeModulationTargetSignals(1, 1
sim.call(SetGpsTime(datetime(2016, 7, 5, 9,
sim.call(SetModificationToGpsNavigationMess
sim.call(SetGpsSatelliteDataHealth(10, 1))

sim.disconnect()
```

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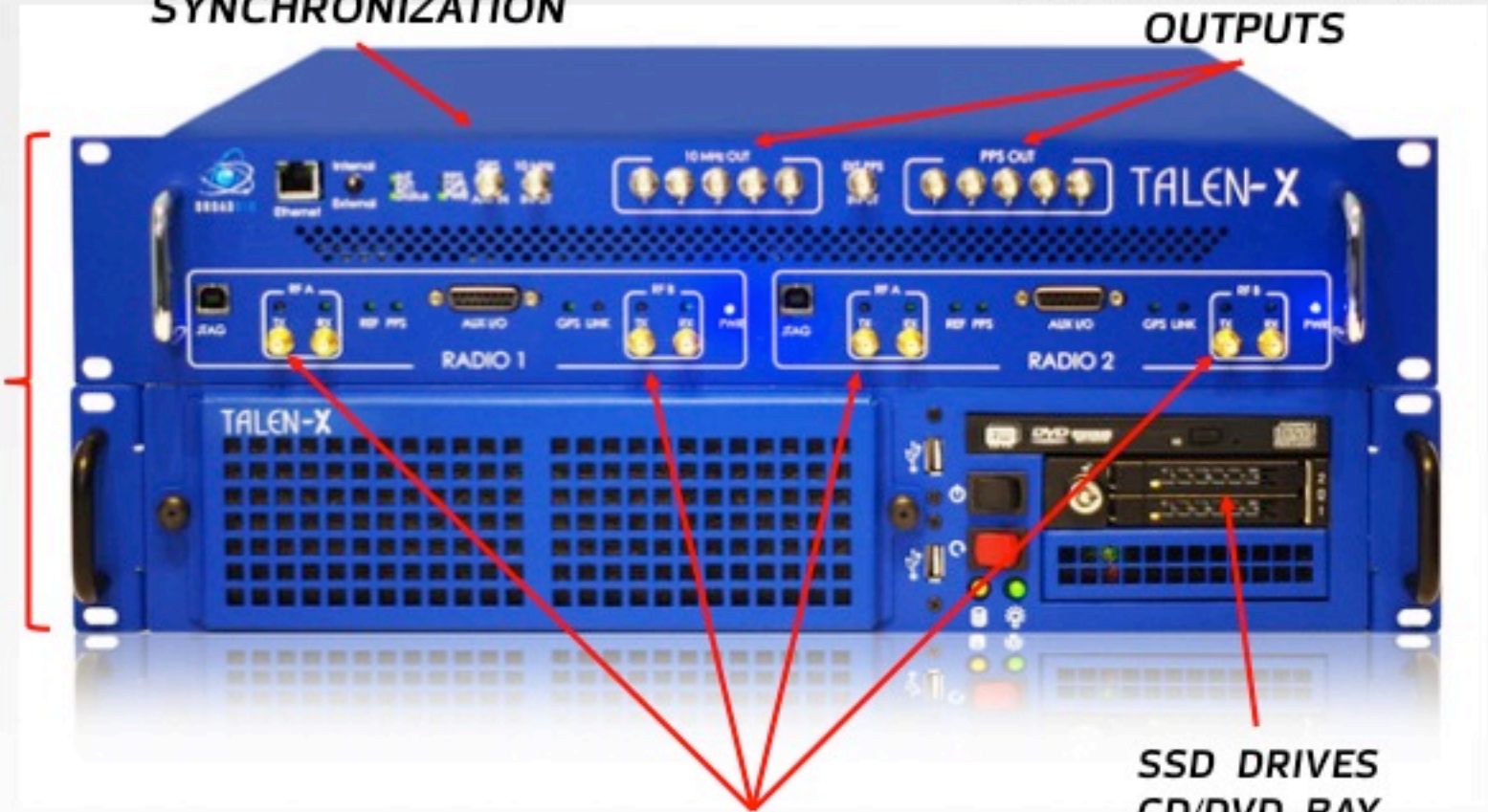
BROADSIM HARDWARE

GPS INPUT FOR TIME SYNCHRONIZATION

(4) 10 MHZ AND PPS OUTPUTS

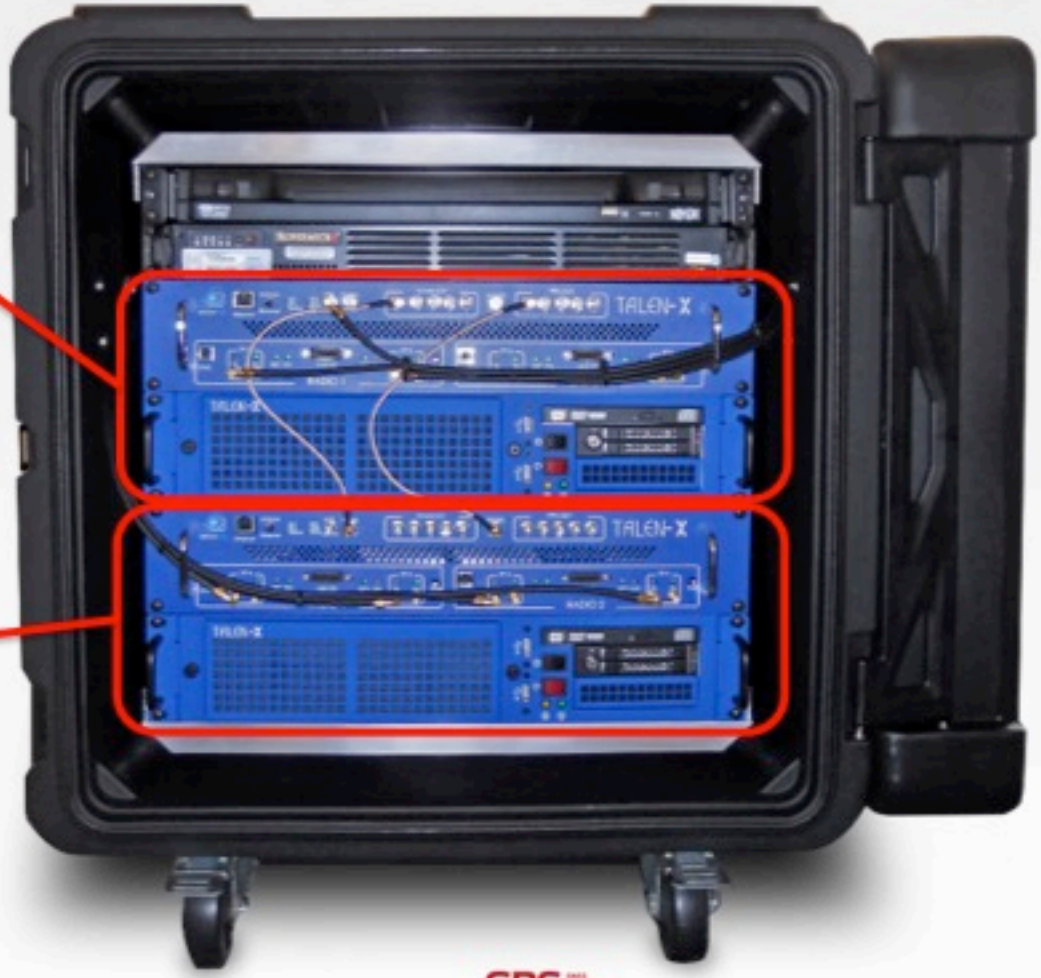


4U TALL

4 RF OUTPUTS

SSD DRIVES
CD/DVD BAY
I7 PROCESSOR

SYNCHRONIZE MULTIPLE SYSTEMS



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IURIE ILIE

CHIEF TECHNICAL OFFICER AND CO-FOUNDER
SKYDEL SOLUTIONS

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GNSS JAMMING: TEST FOR COMPLEX ENVIRONMENT

IURIE ILIE

SKYDEL SOLUTIONS

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INTRODUCTION

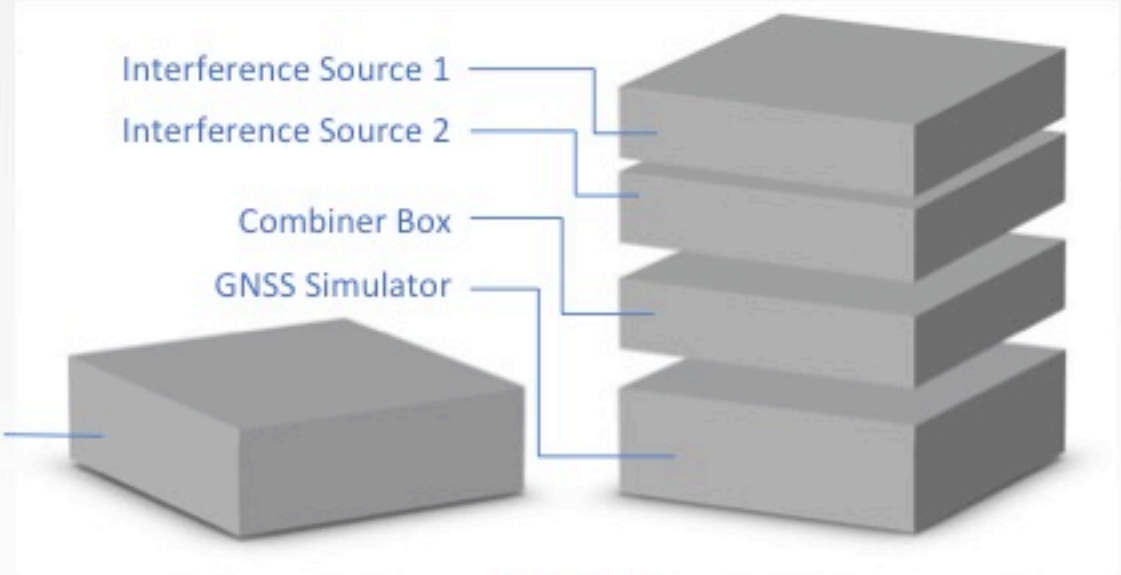
- **GNSS JAMMING IS A REAL THREAT**
  - JAMMING IS A CHEAPEST WAY TO DISRUPT A GNSS RECEPTION
  - GNSS SIGNALS FROM THE LIVE SKY ARE WEAK AND EASY TO JAM
  - COTS JAMMING DEVICES ARE ILLEGAL TO USE, BUT CAN BE LEGALLY BOUGHT ON THE MARKET
  - COMPLEX MULTIBAND JAMMERS CAN BE BUILD USING SOFTWARE-DEFINED RADIOS (SDR)
  - LOW COST SDR ARE READILY AVAILABLE, AND CAN BE COMBINED WITH OPEN-SOURCE SOFTWARE

- **THERE IS NEED FOR NEW TEST SOLUTIONS TO STRESS THE GNSS RECEIVERS FOR COMPLEX JAMMING ENVIRONMENT**

EXAMPLES OF SDRS & JAMMERS AVAILABLE TO THE PUBLIC

CONVENTIONAL WAY OF TESTING

- THE CURRENT APPROACH TO TESTING INTERFERENCE IS USING AN EXTERNAL SIGNAL GENERATOR FOR EACH INTERFERENCE SOURCE.
- LIMITED NUMBER OF INTERFERENCE SOURCES
- USE A LOT OF RACK SPACE
- EXPENSIVE
- COMPLICATED



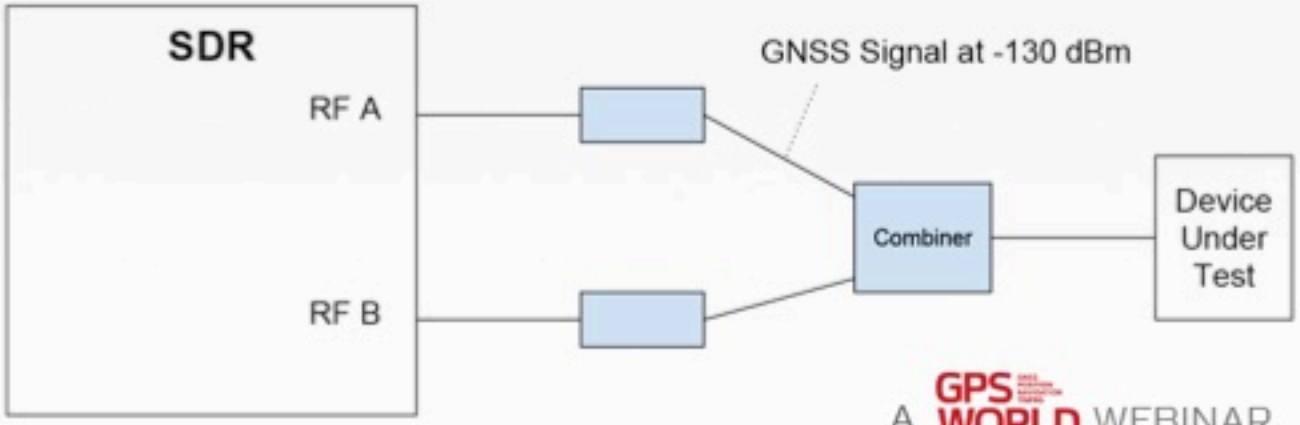
THE BETTER WAY

- SOFTWARE-DEFINED SIMULATOR USES THE COMBINATION OF BOTH GPU-ACCELERATED COMPUTING AND THE FLEXIBILITY OF SDR TO CREATE A COMPLETE INTERFERENCE TESTING PLATFORM.

- INTEGRATED
- EASY TO USE
- REUSE SAME HW
- **CUSTOM WAVEFORM**
- **100S OF JAMMERS**

SOFTWARE-DEFINED RADIO FLEXIBILITY

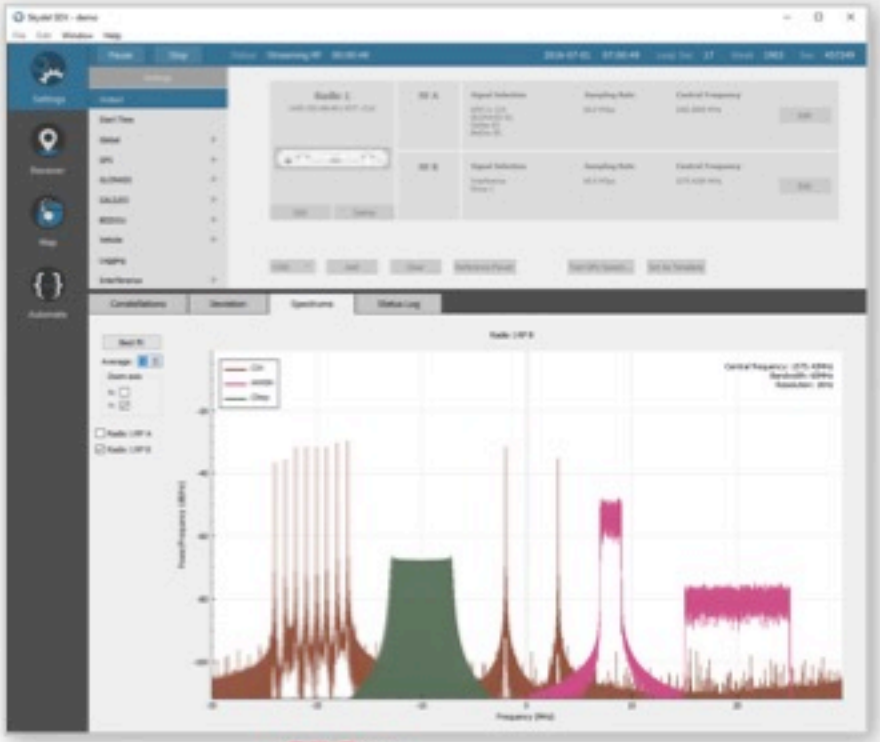
- SDR CAN BE USED TO GENERATE GNSS AS WELL AS INTERFERENCE
- NO NEED TO ADD DEDICATED OR EXPENSIVE HARDWARE JUST FOR JAMMERS
- INTERFERENCE MODULATION IS DONE IN GPU (JUST LIKE GNSS SIGNALS) WHICH ALLOWS TO SIMULATE A VAST NUMBER AND TYPE OF JAMMERS SIMULTANEOUSLY



DESIGN COMPLEX INTERFERENCE WAVEFORM

EACH TRANSMITTER CAN OUTPUT A COMPLEX WAVEFORM MADE OF MULTIPLE SIMPLER WAVEFORMS

- CW
- CHIRP
- PULSE
- BPSK
- BOC
- AWGN
- CUSTOMER-DEFINED



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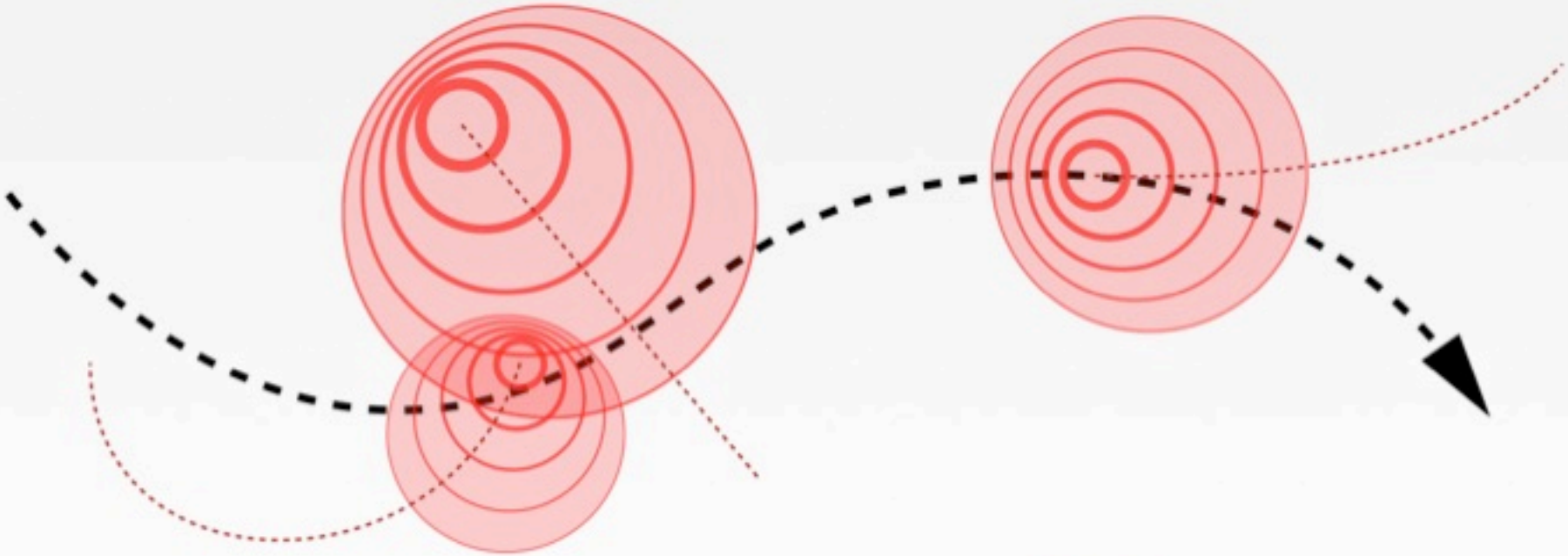
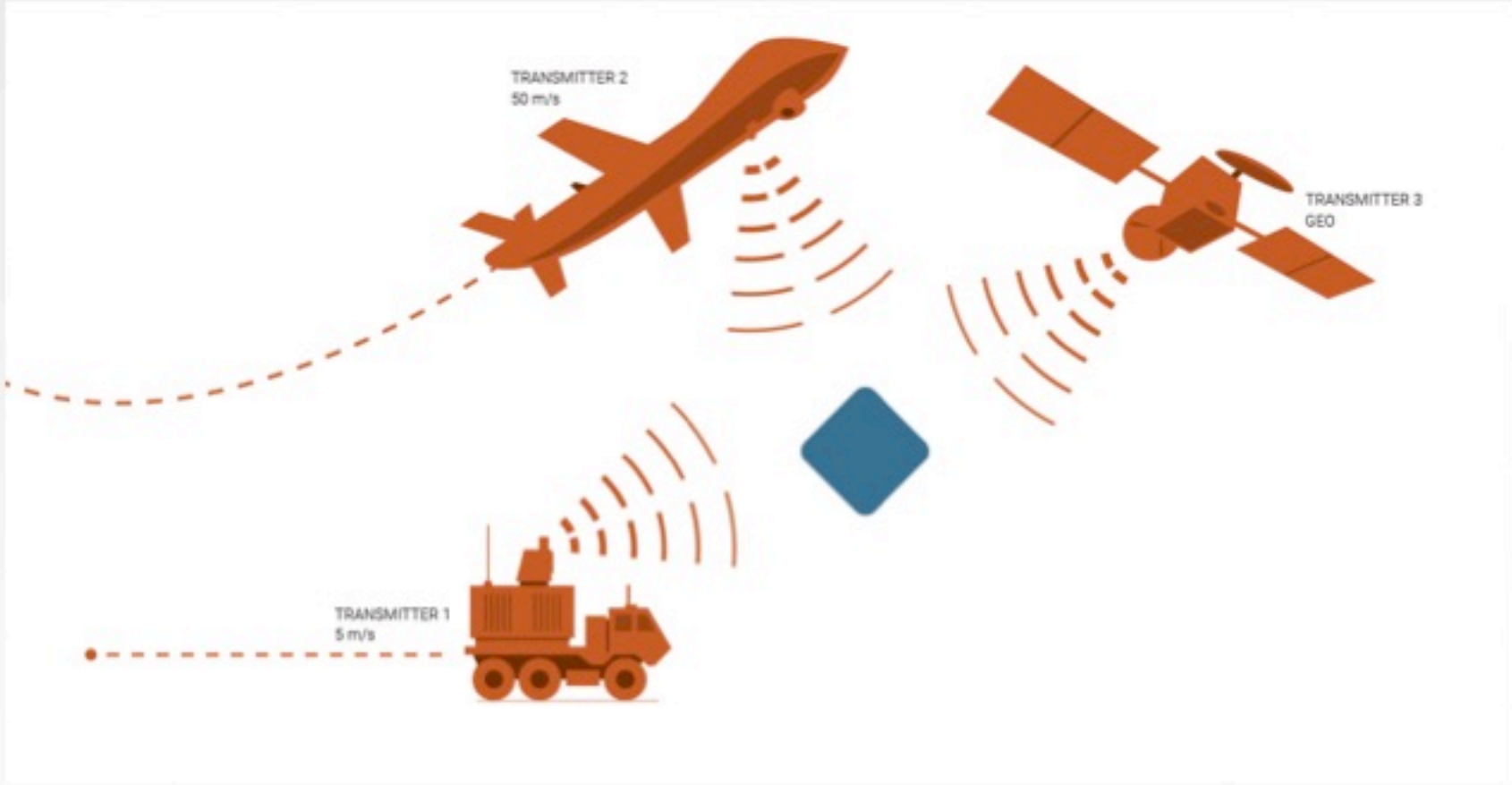
DYNAMIC SCENARIO EXAMPLE

- A RECEIVER MOVING IN AN ENVIRONMENT WITH MULTIPLE INTERFERENCE SOURCES. EACH SOURCE CAN MOVE & TRANSMIT DIFFERENT WAVEFORMS WITH DIFFERENT POWER LEVEL.



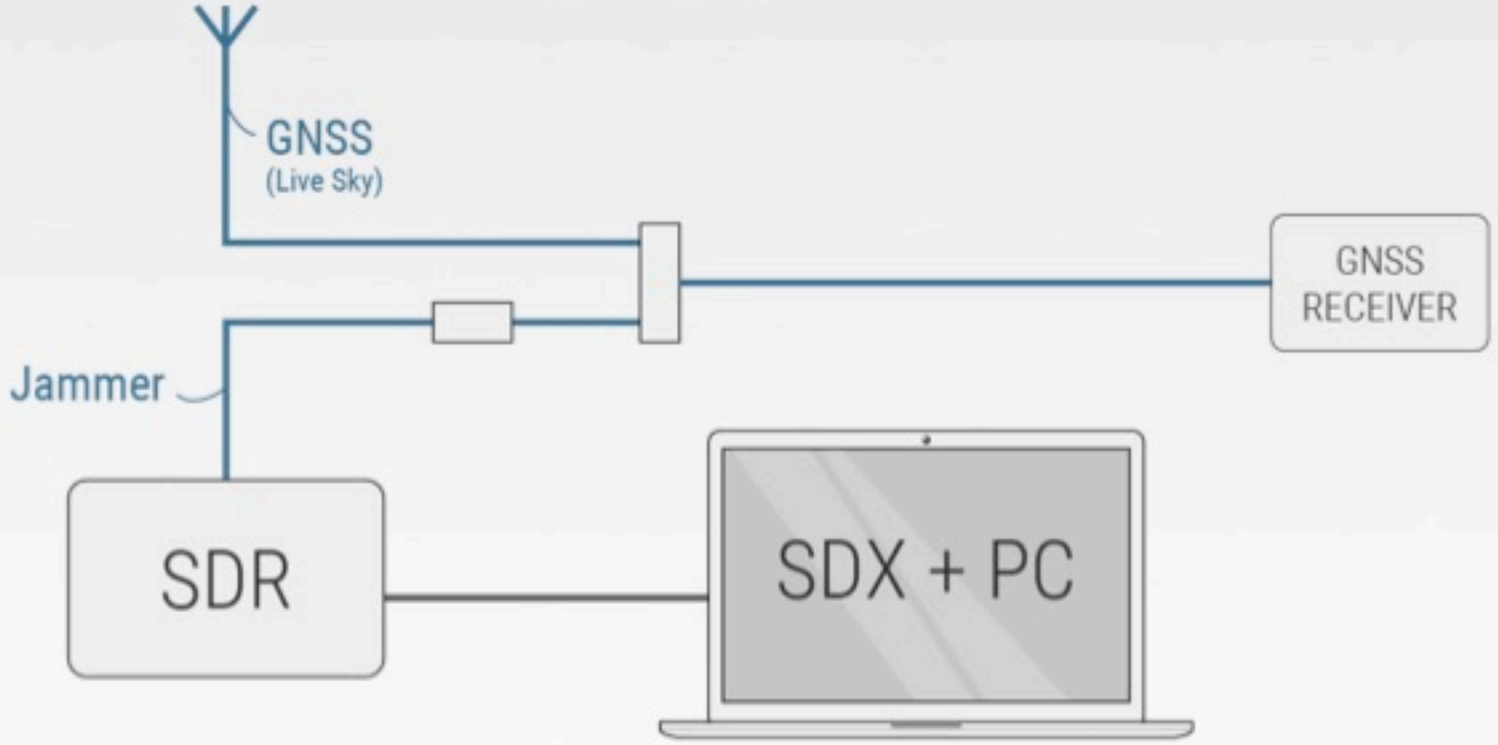
DYNAMIC SCENARIO EXAMPLE



SOURCE CAN BE AN AIRCRAFT, A SATELLITE OR A GROUND BASED TRANSMITTER. EACH TRANSMITTER FOLLOW ITS OWN TRAJECTORY. TRAJECTORIES CAN BE PREDEFINED OR DYNAMICALLY CONTROLLED.

EXAMPLE SETUP

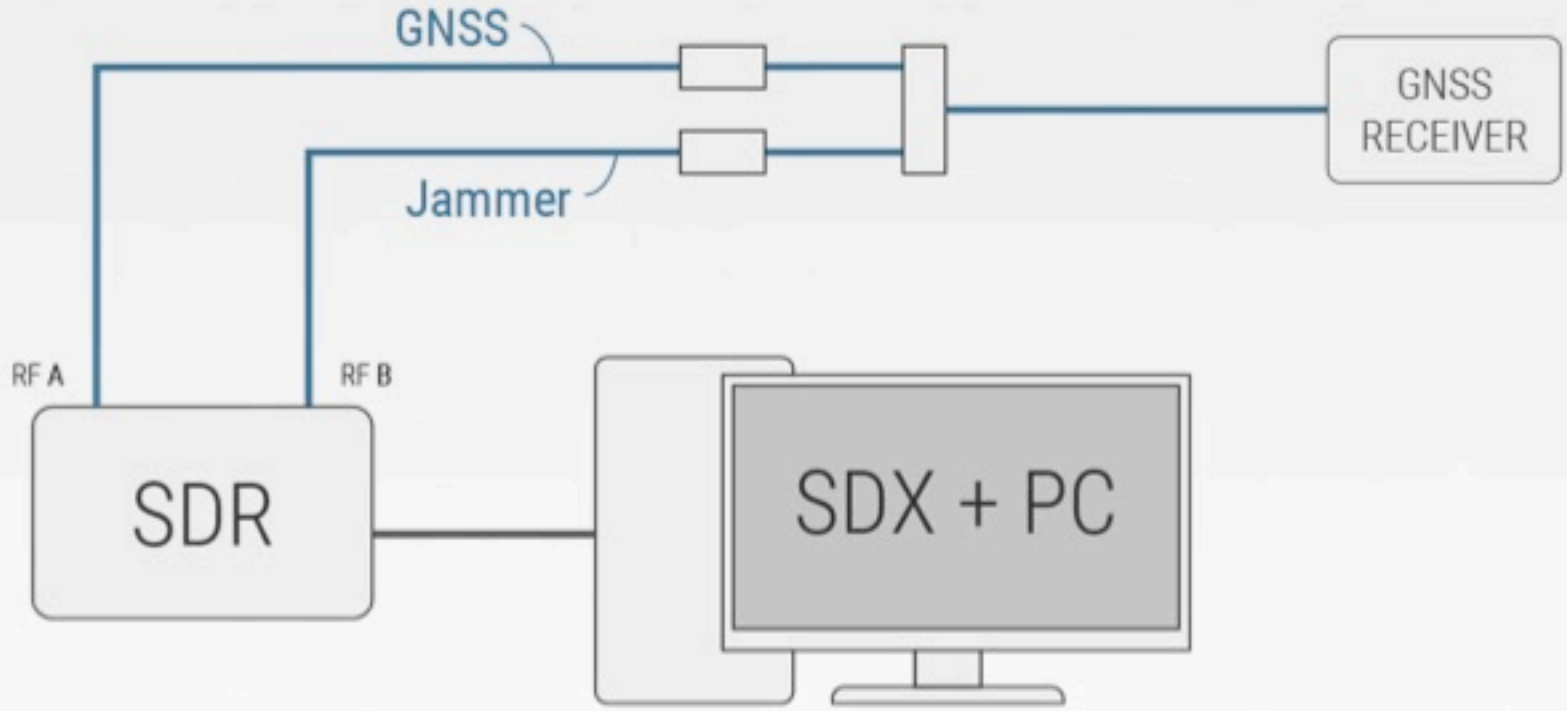
JAMMER + GNSS LIVE



- ✓ COST EFFICIENT SETUP
- ✓ TEST ROBUSTNESS WITH REAL SIGNALS IN CONTROLLED ENVIRONMENT
- ✓ HARDWARE REUSE

EXAMPLE SETUP

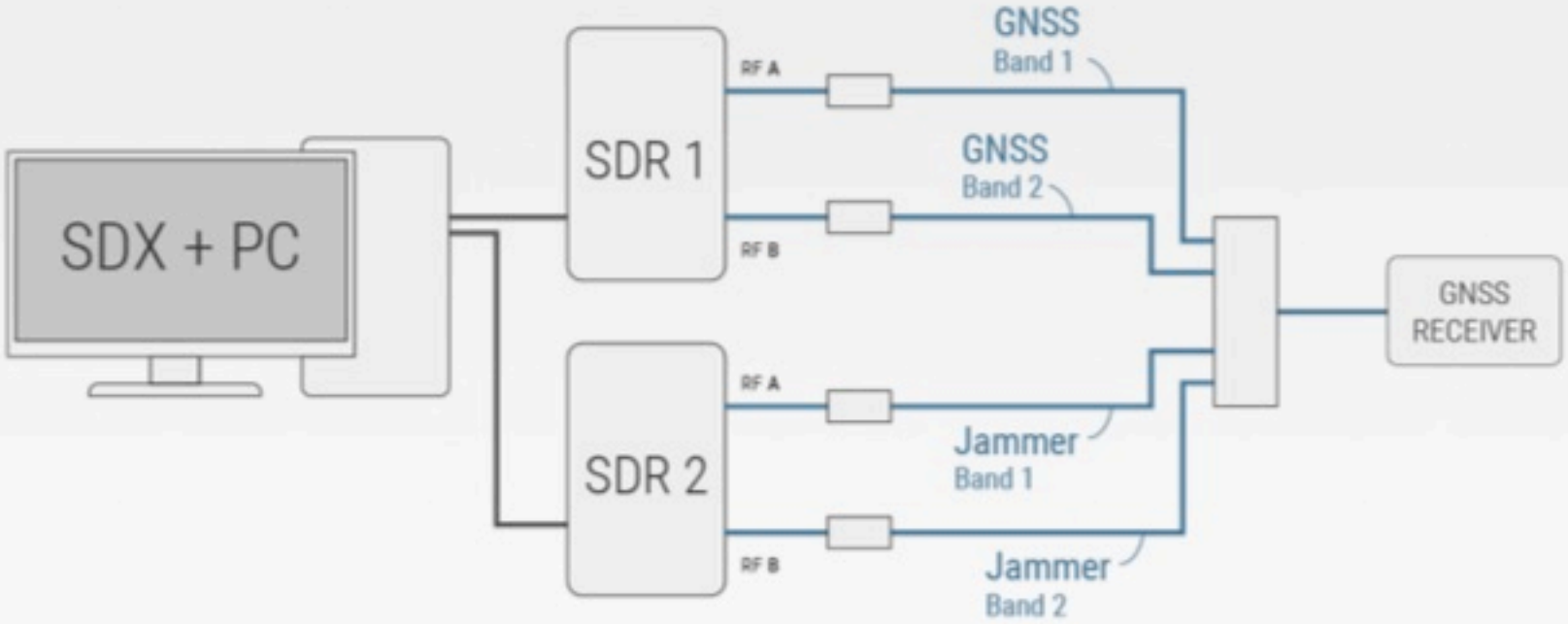
JAMMER + MULTI-CONSTELLATION



- ✓ GNSS AND JAMMERS ON THE SAME RADIO
- ✓ UP TO 120 DB OF J/S RATIO
- ✓ MULTI-CONSTELLATIONS

EXAMPLE SETUP

MULTI-BAND JAMMING



- ✓ SCALABLE TO COVER UPPER AND LOWER GNSS BAND
- ✓ UP TO 100MHZ OF BANDWIDTH FOR JAMMING SIGNALS
- ✓ EXTEND TO MULTIPLE RADIOS

CONCLUSION

TESTING JAMMING – BEFORE & AFTER

THE CURRENT WAY

- NEED TO ATTACH A SIGNAL GENERATOR (H/W) PER INTERFERENCE
- NUMBER OF INTERFERENCE SOURCES LIMITED BY # OF SIGNAL GENERATORS
- SIGNAL GENERATORS REQUIRE INTEGRATION OR OPERATION IN REAL TIME
- POWER LEVELS ARE STATIC; SIGNAL LEVEL IS SET ONCE AND TRANSMITTED AT RECEIVER FRONT-END, W/O SIMULATION CONTEXT.

NEW APPROACH USING SKYDEL SDX

- UNLIMITED NUMBER OF INTERFERENCE SIGNALS AND MULTI-BANDS WITH A SINGLE SDR
- SAME SDR CAN BE A GNSS SIMULATOR OR JAMMERS SIMULATOR
- GRANULAR CONTROL OVER EACH INTERFERENCE POWER, MODULATION, AND DYNAMICS
- JAMMING CAN BE TURNED AT WILL, ON-THE-FLY, WITH THE GUI OR API
- POWER LEVEL IS CALCULATED BASED ON DYNAMICS OF THE INTERFERENCE (LOCATION, SPEED, DISTANCE): FULL INTEGRATION WITH GNSS SIMULATION.

TIM ERBES

CHIEF TECHNOLOGY OFFICER

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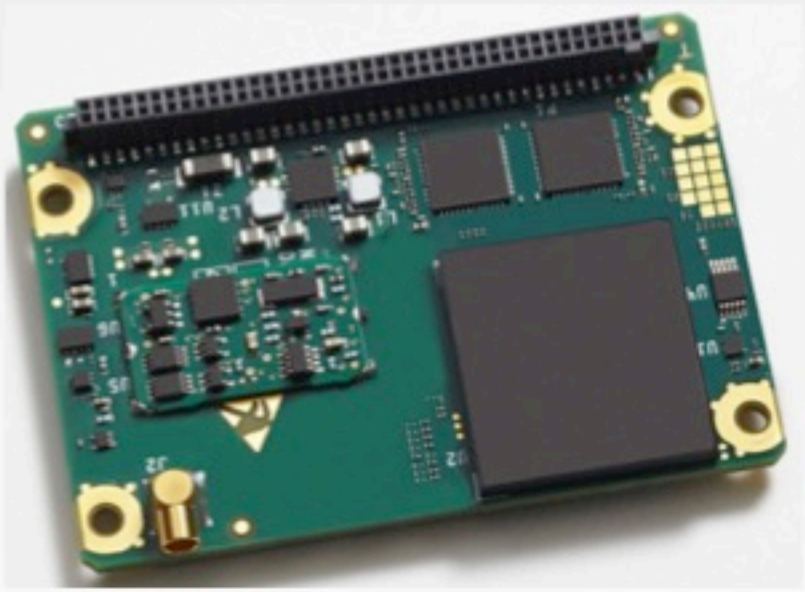
SPOOFING TESTING – WHAT IS THE OBJECTIVE?

QUANTIFY THE PERFORMANCE OF GPS RECEIVERS IN THREAT ENVIRONMENTS.

DOMAINS THAT REQUIRE SPOOFING TESTING:

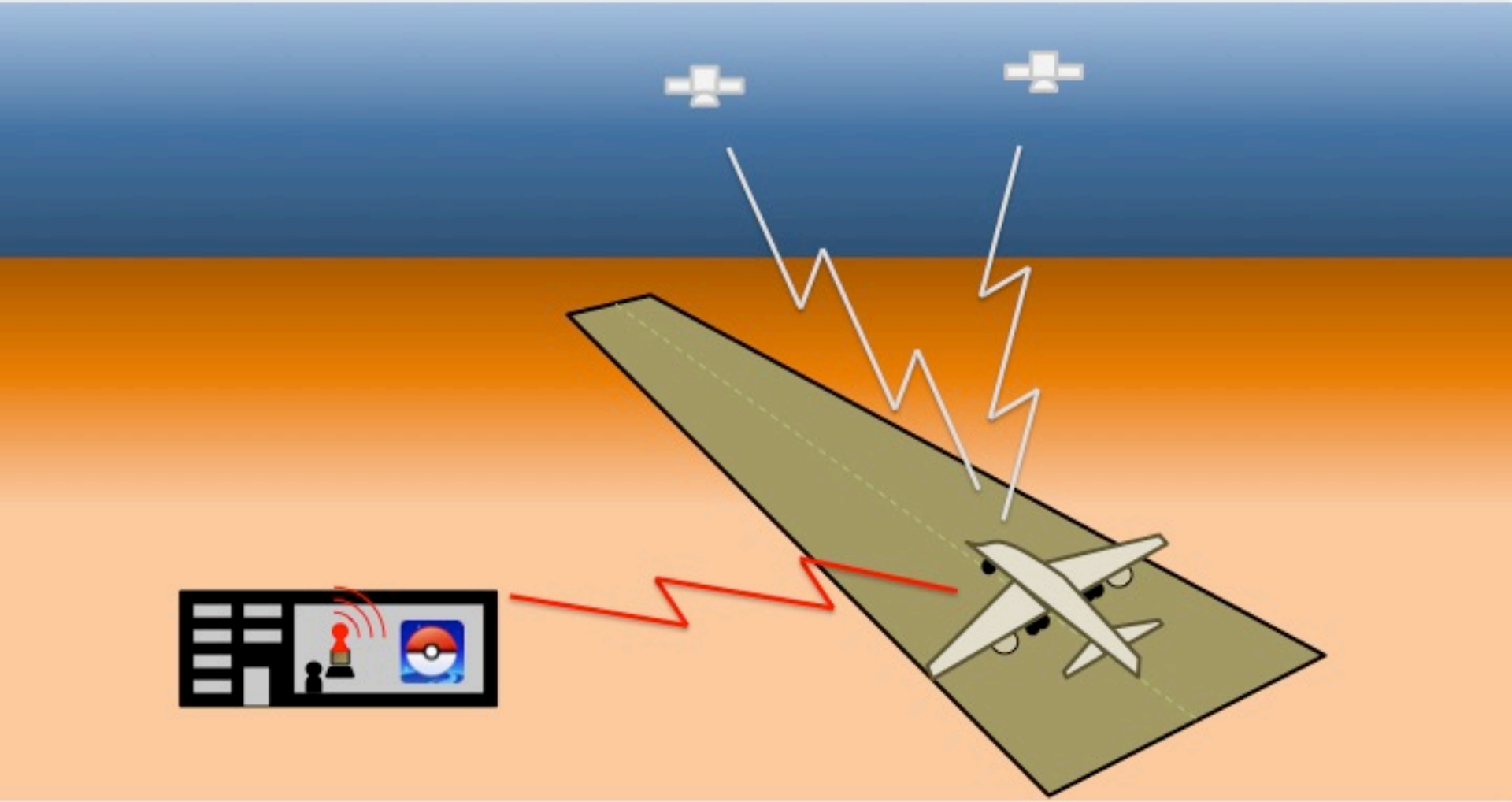
- RESILIENCY
- ASSURED PNT
- ANTI-SPOOFING



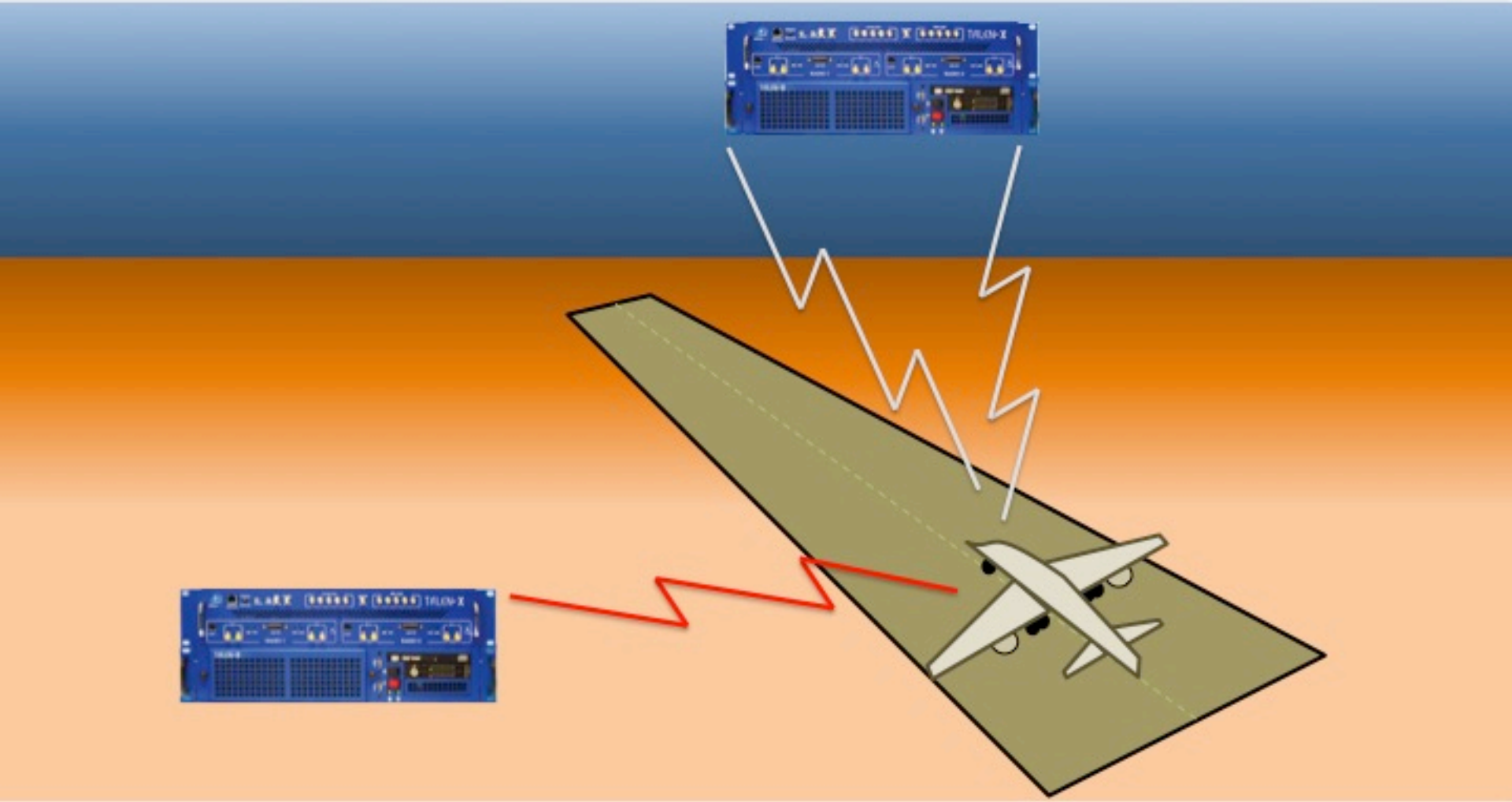
REAL WORLD SCENARIO – CHEATING AT POKÉMON GO

HTTP://WWW.RTL-SDR.COM/CHEATING-AT-POKEMON-GO-WITH-A-HACKRF-AND-GPS-SPOOFING/

REAL WORLD SCENARIO – CHEATING AT POKÉMON GO



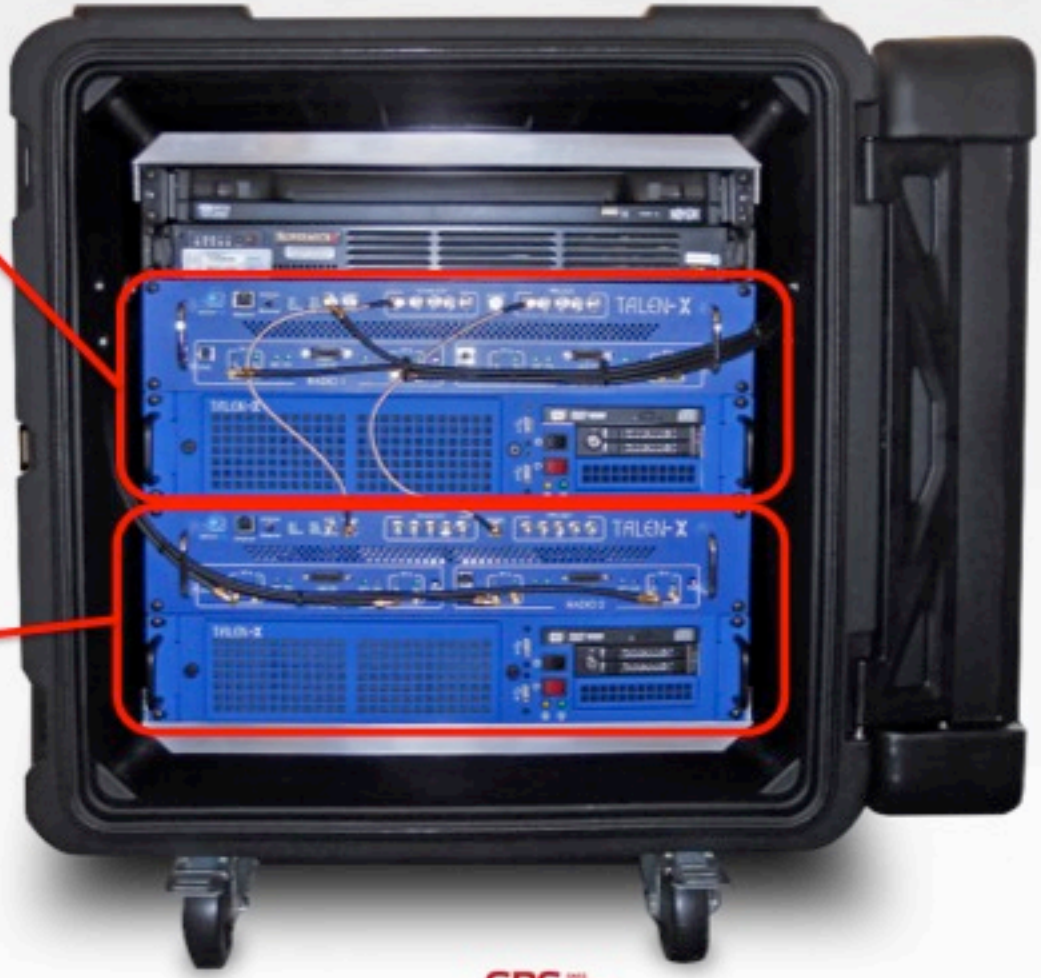
SIMULATION MIMICS REALITY



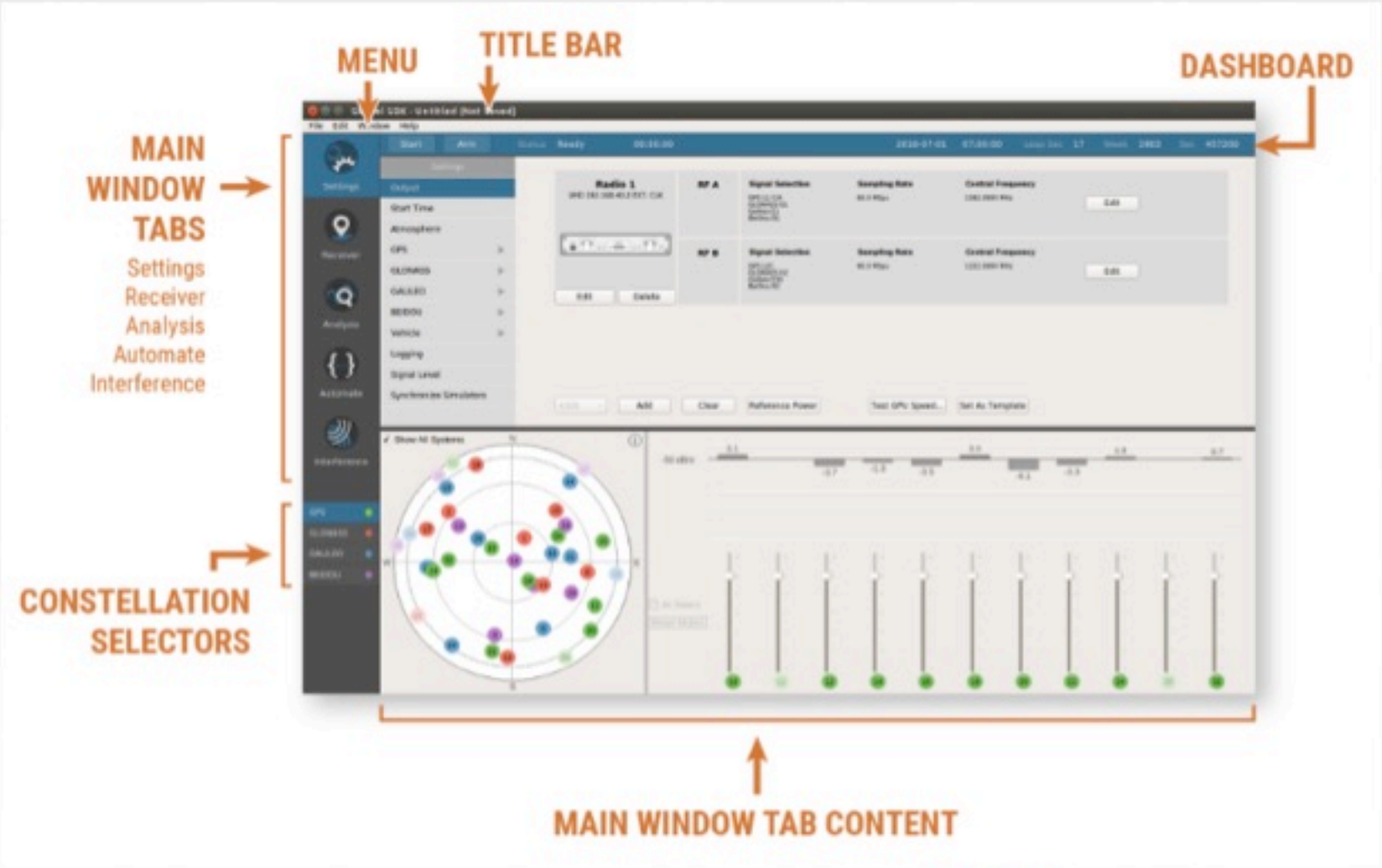
SIMULATION

TRUTH

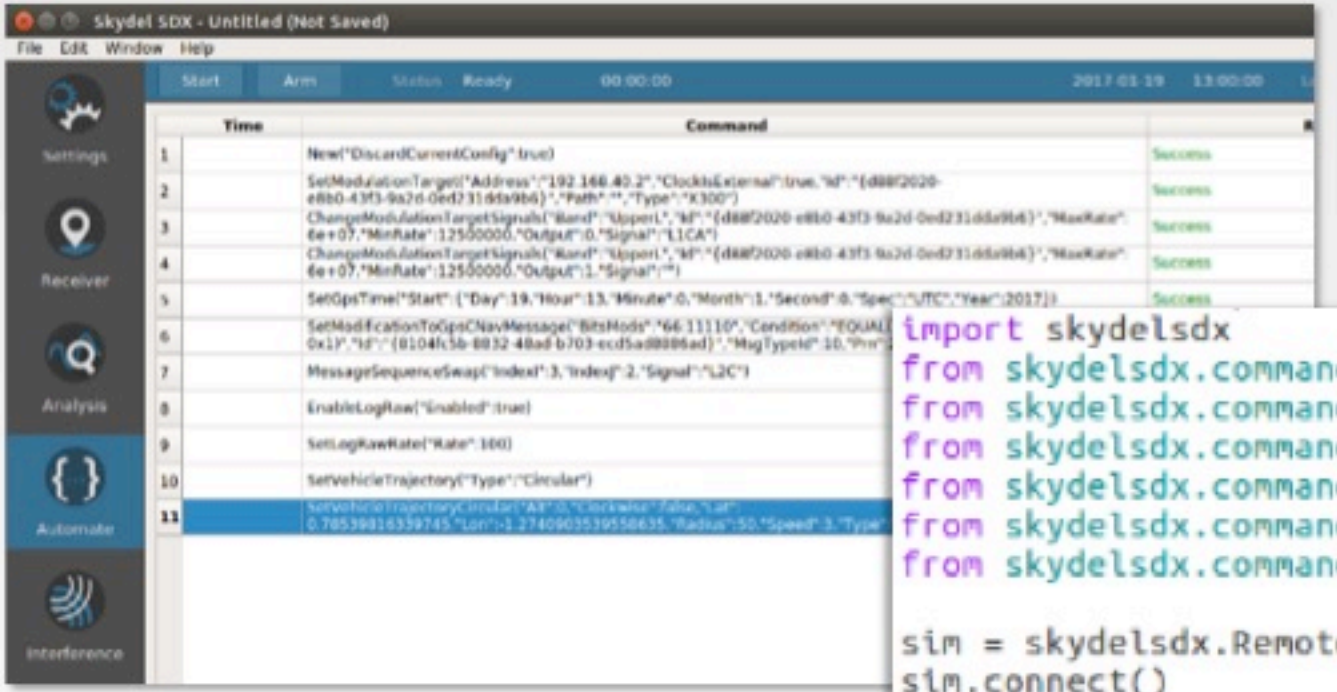
SPOOFER



WE COULD USE THE GUI



API CAN BE FASTER




```
import skydelsdx
from skydelsdx.commands import SetModulatio
from skydelsdx.commands import New
from skydelsdx.commands import SetGpsTime
from skydelsdx.commands import SetGpsSatell
from skydelsdx.commands import SetModificat
from skydelsdx.commands import ChangeModula

sim = skydelsdx.RemoteSimulator(True)
sim.connect()

sim.call(New(True))
sim.call(SetModulationTarget("X300", "", "1
sim.call(ChangeModulationTargetSignals(0, 1
sim.call(ChangeModulationTargetSignals(1, 1
sim.call(SetGpsTime(datetime(2016, 7, 5, 9,
sim.call(SetModificationToGpsNavigationMess
sim.call(SetGpsSatelliteDataHealth(10, 1))

sim.disconnect()
```

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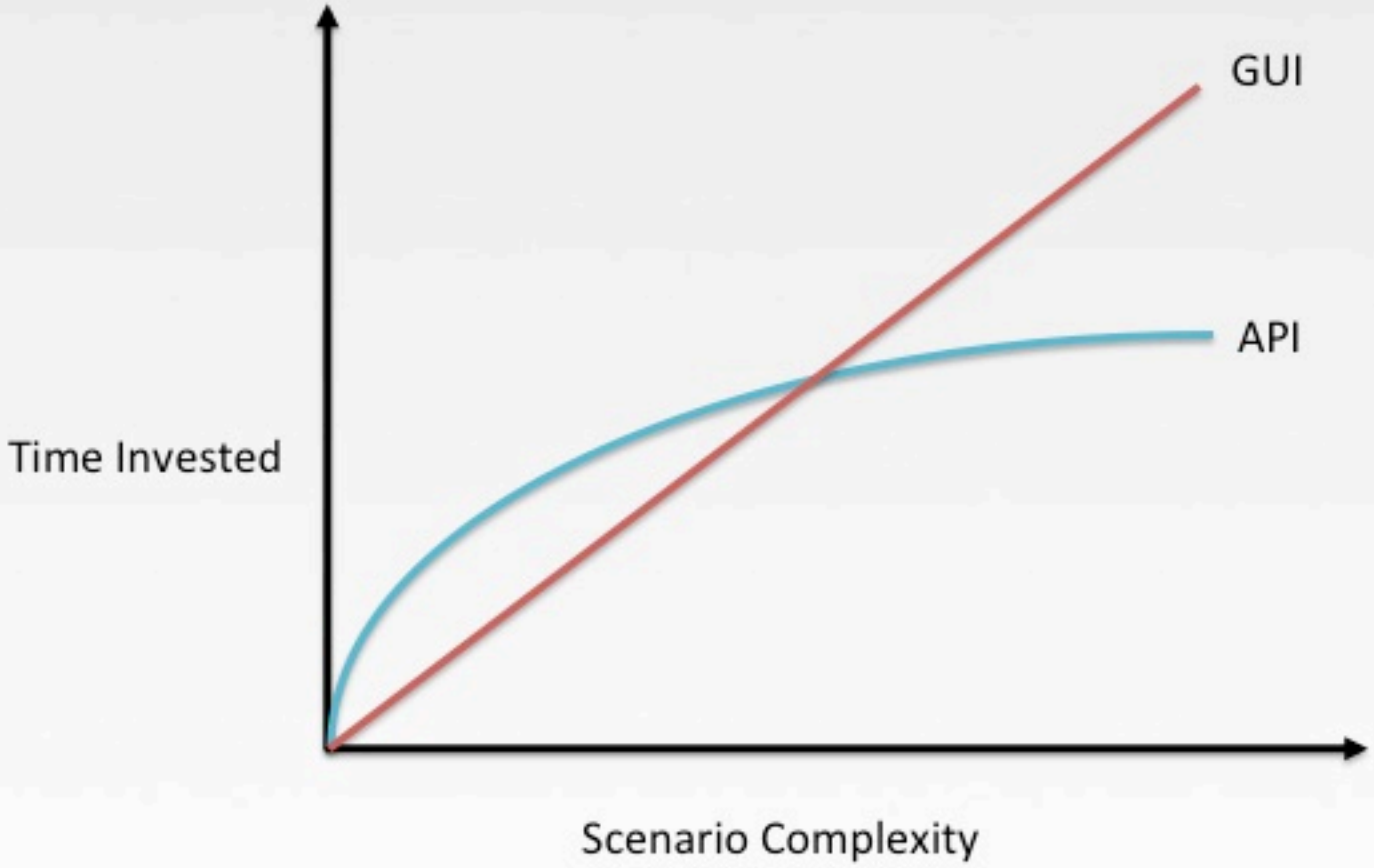
GUI VS API



CODE - WHOLE CLASS

```
1   using System;
2   using Sdx;
3   using Sdx.Cmd;
4
5   namespace BroadSimSpoofingExample
6   {
7       class BroadSimInterface
8       {
9
10          public void Run()...
36
37          public void SetupTruth(RemoteSimulator sim, Lla truthLla)...
51
52          public void SetupSpoofer(RemoteSimulator sim, Lla spooferLla)...
80
81          public void SetupJammer(RemoteSimulator sim, Lla spooferLla)...
110
111         private void Connect(RemoteSimulator sim, string host, int instance)...
121
122         private void SetupOutput(RemoteSimulator sim, string radioIpAddress)...
129
130         static double ToRadian(double degree)...
134
135     }
136 }
137
```

CODE – RUN()

```
public void Run()
{
    Lla truthLla = new Lla(ToRadian(43.8791), ToRadian(-103.4591), 1750);
    Enu offset = new Enu(1000, 0, 0);
    Lla spooferLla = truthLla.AddEnu(offset);

    RemoteSimulator sim1 = new RemoteSimulator();
    RemoteSimulator sim2 = new RemoteSimulator();

    Connect(sim1, "192.168.10.1", 0);
    Connect(sim2, "192.168.10.1", 1);

    SetupOutput(sim1, "192.168.101.2");
    SetupOutput(sim2, "192.168.102.2");

    SetupTruth(sim1, truthLla);
    SetupSpoofer(sim2, spooferLla);
    SetupJammer(sim2, spooferLla);

    Console.WriteLine("Starting");
    sim1.Start();

    Console.WriteLine("Sending Post Commands");
    sim2.Post(new EnableIntTx(true, "Jammer"), 120); // spoofer turns on @ 2 mins
    sim2.Post(new EnableSignal(0, "L1CA", true), 120);
    sim2.Post(new SetIntTxRefPower(-20 /*dbm*/, "Jammer"), 122);
}
```

CODE – HELPER FUNCTIONS

```
private void Connect(RemoteSimulator sim, string host, int instance)
{
    Console.WriteLine("Connecting to BroadSim");
    sim.IsVerbose = false;
    sim.Connect(host, instance);
    sim.Stop();

    Console.WriteLine("Create New Configuration");
    sim.Call(new New(true));
}

private void SetupOutput(RemoteSimulator sim, string radioIpAddress)
{
    Console.WriteLine("Output Settings");
    sim.Call(new SetModulationTarget("X300", "", radioIpAddress, true, "Radio1"));
    sim.Call(new ChangeModulationTargetSignals(0, 50000000, 50000000, "UpperL", "L1CA", "Radio1"));
    sim.Call(new ChangeModulationTargetInterference(1, 50000000, 50000000, 1, 1575420000, "Radio1"));
}

static double ToRadian(double degree)
{
    return (Math.PI / 180) * degree;
}
```

CODE – SETUPTRUTH()

```
public void SetupTruth(RemoteSimulator sim, Lla truthLla)
{
    Console.WriteLine("Setting up truth");

    sim.Call(new EnableMasterPps(true));

    sim.Call(new SetGpsTime(new DateTime(2017, /*year*/ 7, /*month*/ 2, /*day*/
        0, /*hour*/ 0, /*min*/ 0 /*sec*/)));

    sim.Call(new ImportRinex("/opt/broadsim/rinex/2017-182.txt"));

    sim.Call(new SetVehicleTrajectoryFix("Fix",
        truthLla.Lat, truthLla.Lon, truthLla.Alt, 0, 0, 0));
}
```

CODE - SETUPSPOOFER

```
public void SetupSpoofer(RemoteSimulator sim, Lla spooferLla)
{
    Console.WriteLine("Setting up spoofer");

    sim.Call(new EnableSlavePps(true));

    sim.Call(new SetGpsTime(new DateTime(2017, /*year*/ 7, /*month*/ 2, /*day*/
        0, /*hour*/ 0, /*min*/ 2 /*sec*/)));

    sim.Call(new ImportRinex("/opt/broadsim/rinex/2017-182.txt"));

    sim.Call(new SetVehicleTrajectoryFix("Fix",
        spooferLla.Lat, spooferLla.Lon, spooferLla.Alt, 0, 0, 0));

    // spoofer is off at start, signals are 20db stronger than truth
    sim.Call(new SetPowerGlobalOffset(10 /*db*/));
    sim.Call(new SetPowerGpsCaOffset(10 /*db*/));
    sim.Call(new EnableSignal(0, "L1CA", false));

    sim.Call(new SetPseudorangeRamp("GPS",
        0, // prn (0=all)
        1000.0, // offset (meters)
        0, // time of ramp up
        0, // time of ramp up complete
        640800, // time of ramp down
        640800, // time of ramp down complete
        "Geometric Delay"));
}
```

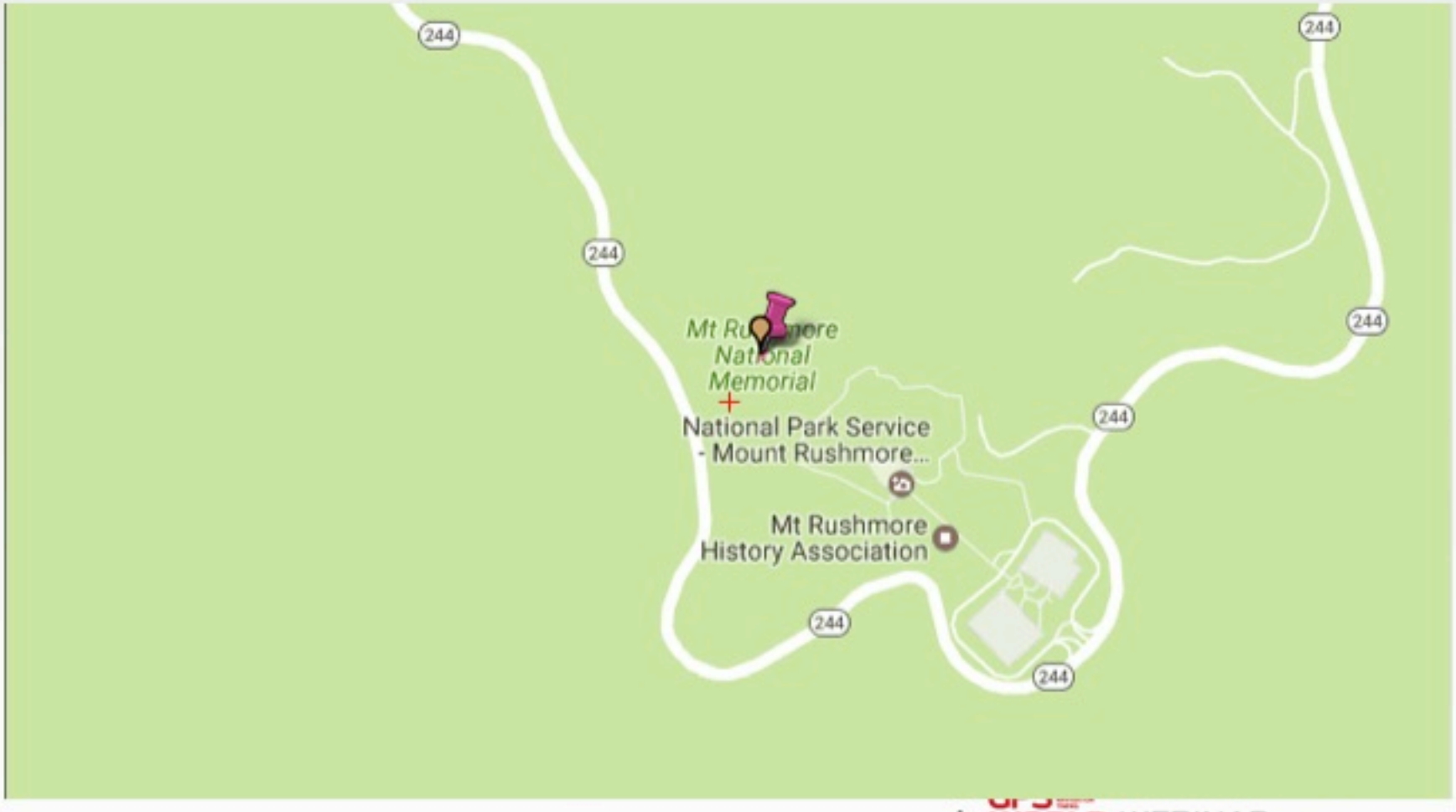
CODE – SETUPJAMMER()

```
public void SetupJammer(RemoteSimulator sim, Lla spooferLla)
{
    Console.WriteLine("Setting up jamming");

    // dynamic jammer for spoofer
    sim.Call(new AddIntTx("Jammer", false, 1, "Jammer"));
    sim.Call(new EnableIntTxDynamicMode(true, "Jammer"));
    sim.Call(new SetIntTxRefPower(0 /*dbm*/, "Jammer"));
    sim.Call(new SetIntTxFix(spooferLla.Lat, spooferLla.Lon, spooferLla.Alt, 0, 0, 0, "Jammer"));
    sim.Call(new SetAWGNToIntTx(
        true, // enabled
        1575420000, // center freq (hz),
        0, // relative power (db),
        2000000, // bandwidth (hz)
        "Jammer", // jammer name
        "AWGN_2mhz")); // waveform name

    // simple jammer for noise floor
    sim.Call(new AddIntTx("NoiseFloor", true, 1, "NoiseFloor"));
    sim.Call(new EnableIntTxDynamicMode(false, "NoiseFloor"));
    sim.Call(new SetIntTxRefPower(-50 /*dbm*/, "NoiseFloor"));
    sim.Call(new SetAWGNToIntTx(
        true, // enabled
        1575420000, // center freq (hz),
        0, // relative power (db),
        20000000, // bandwidth (hz)
        "NoiseFloor", // jammer name
        "AWGN_20mhz")); // waveform name
}
```

MAP - BEFORE


244
244
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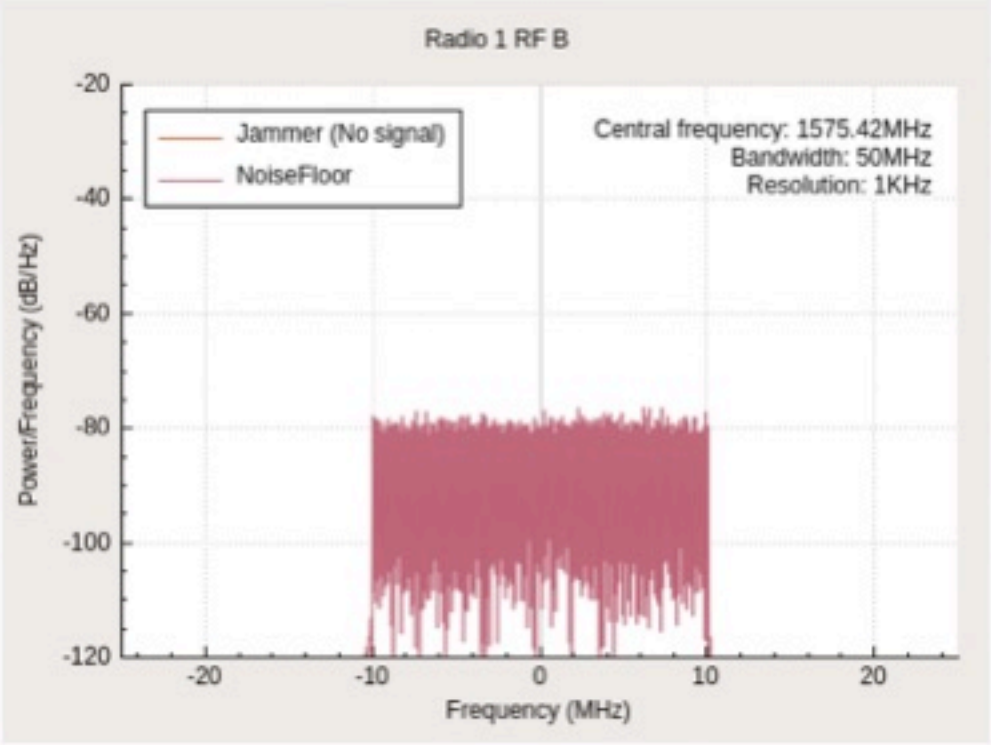
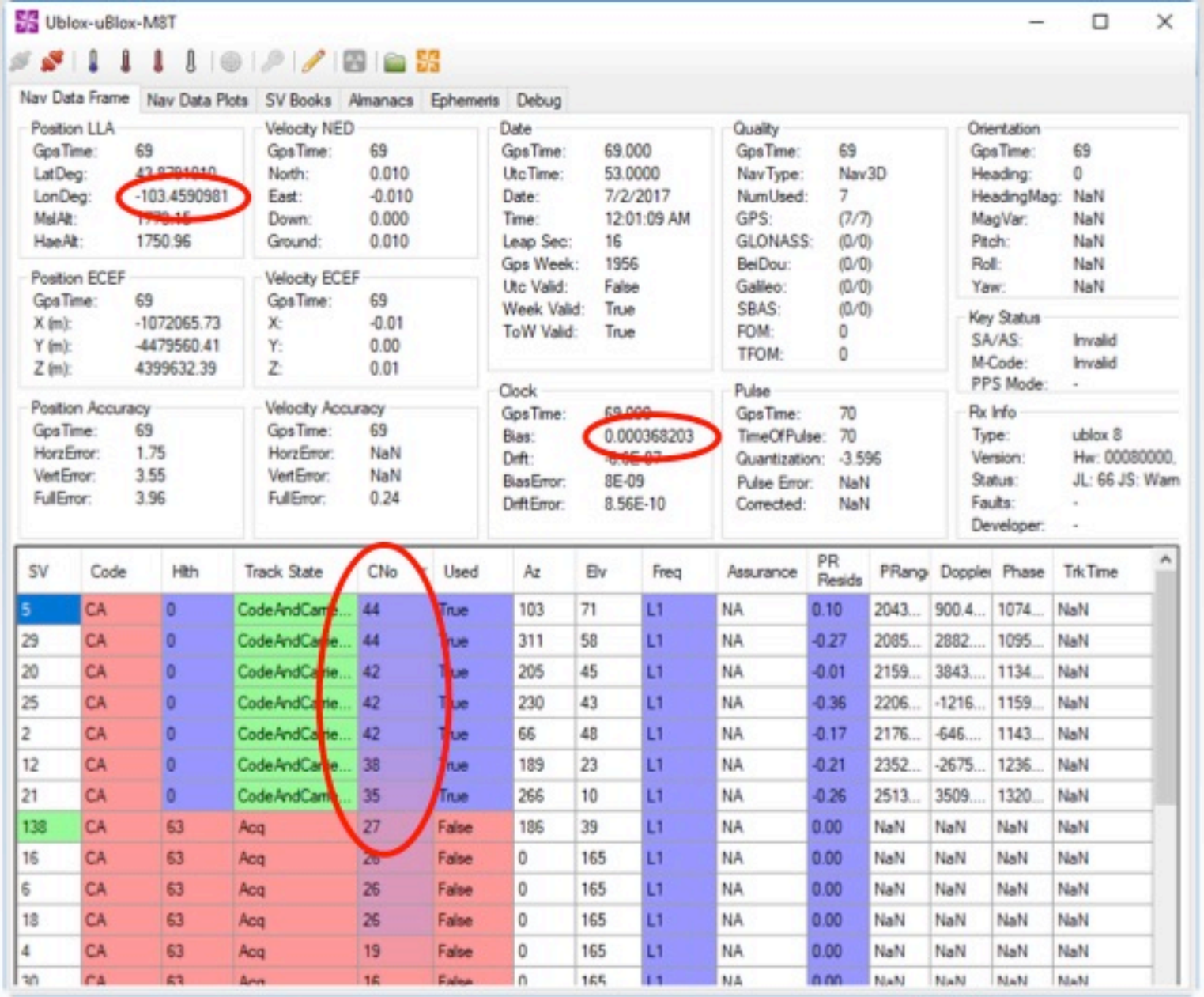
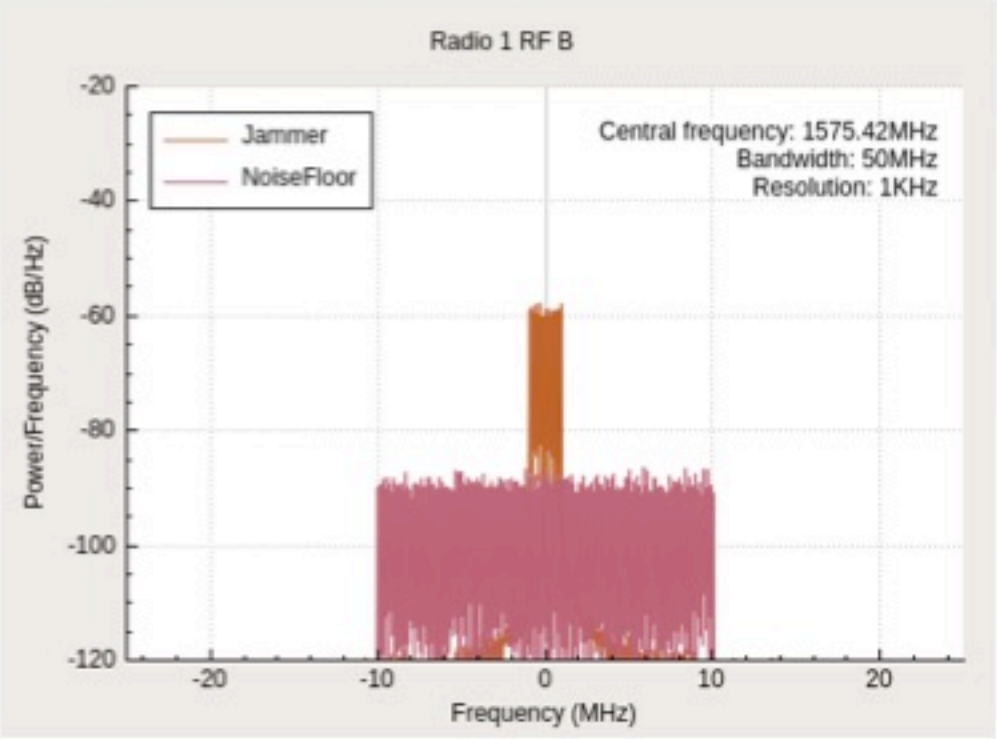
244
244
244
Mt Rushmore
National
Memorial
National Park Service
- Mount Rushmore...
Mt Rushmore
History Association

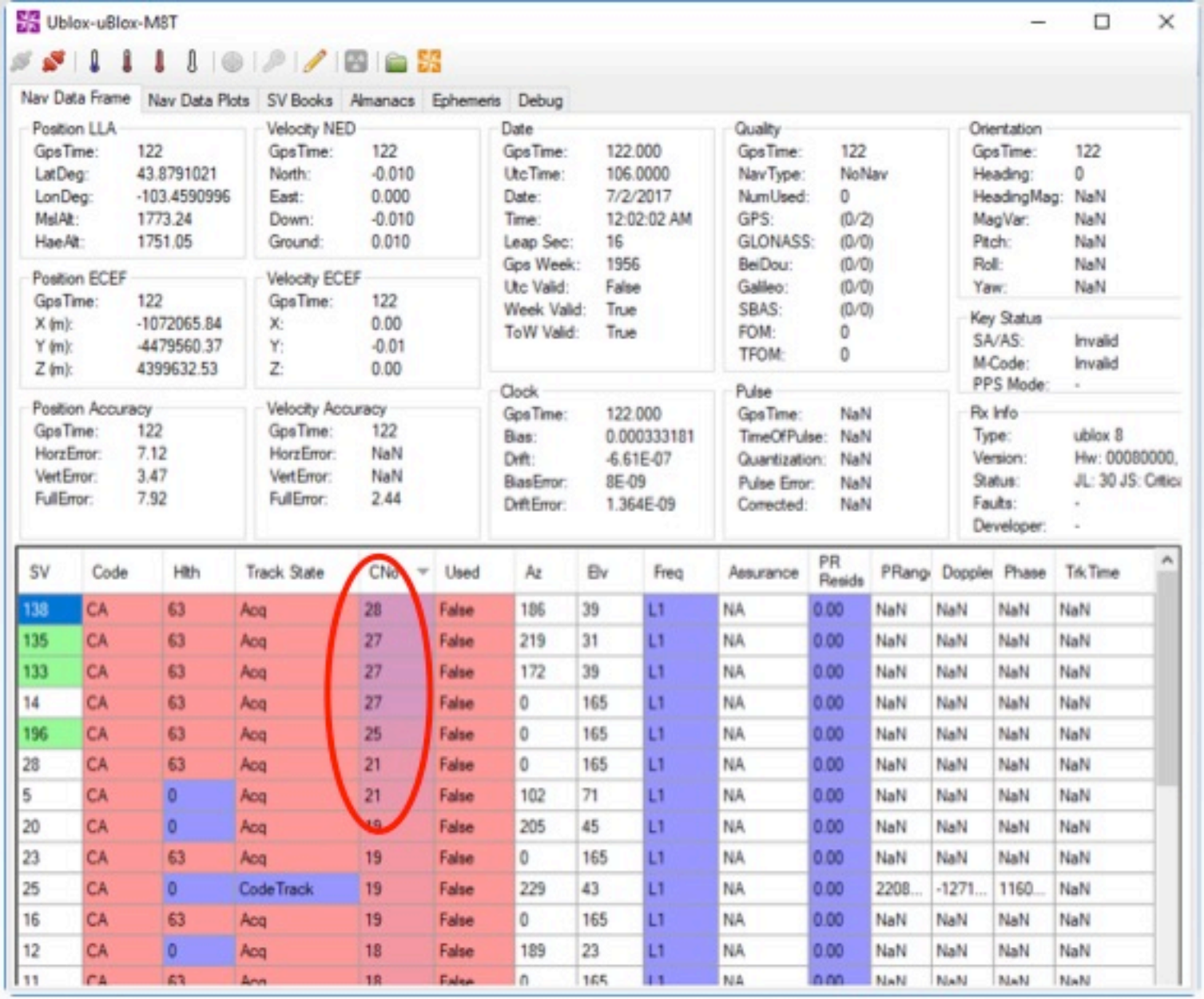
NOISE


Radio 1 RF B
Jammer (No signal)
NoiseFloor
Central frequency: 1575.42MHz
Bandwidth: 50MHz
Resolution: 1KHz
Power/Frequency (dB/Hz)
-20
-40
-60
-80
-100
-120
-20
-10
0
10
20
Frequency (MHz)



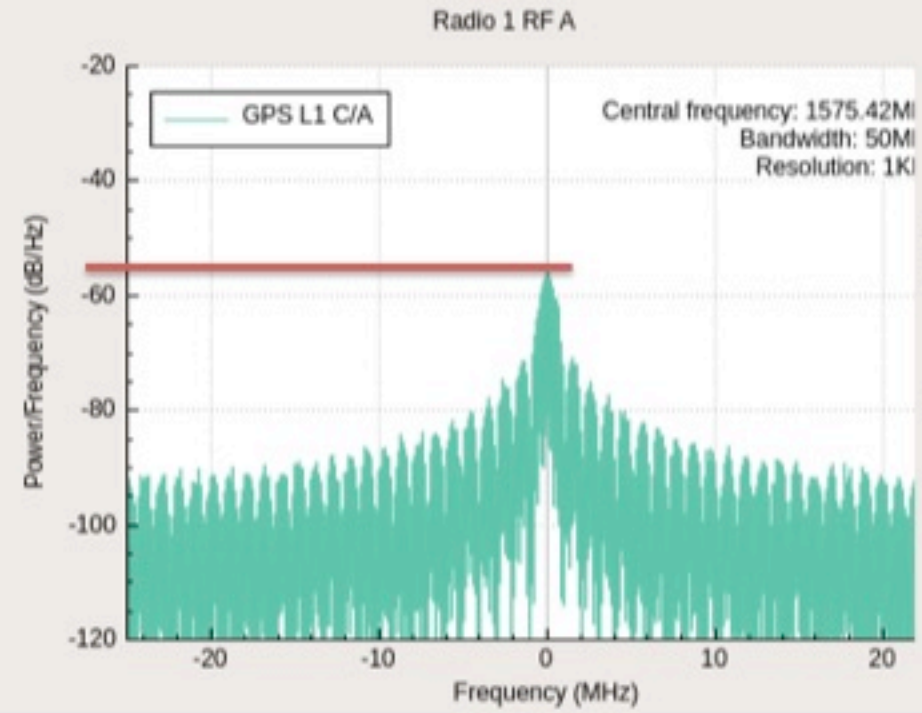
NOISE + JAMMER



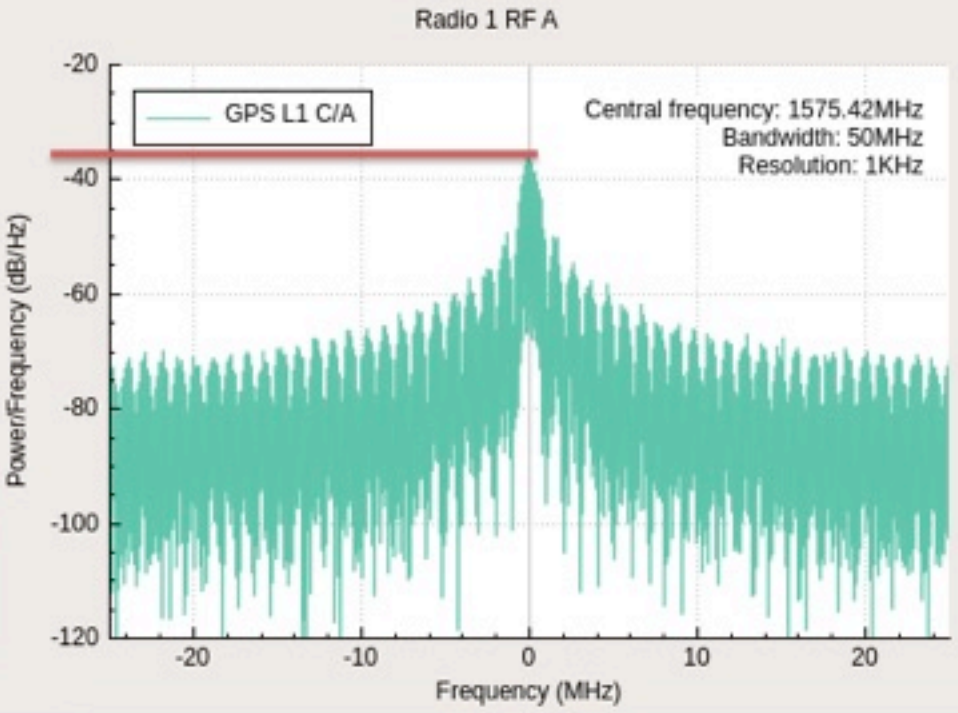


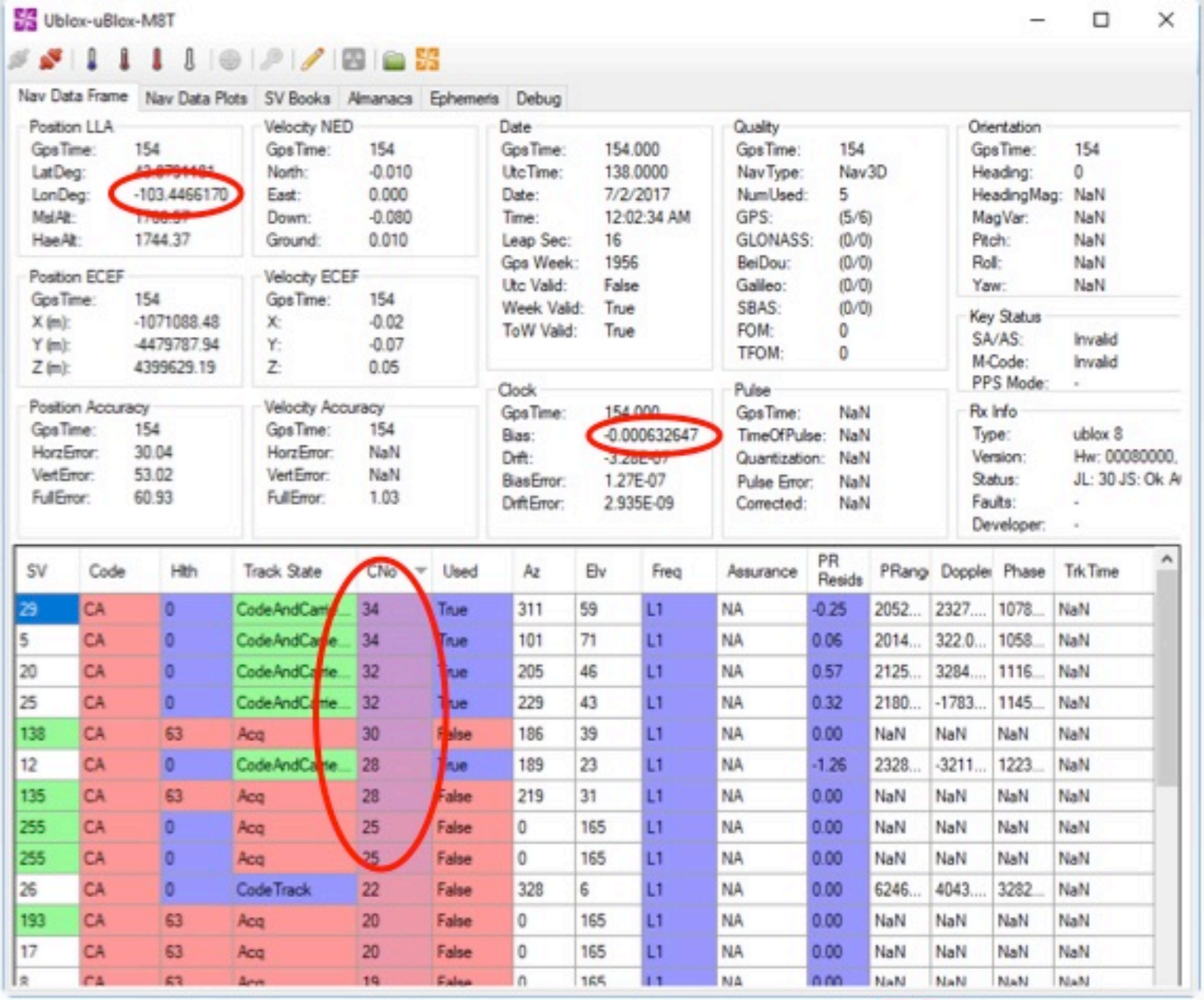
C/A CODE POWER

TRUTH



SPOOFER

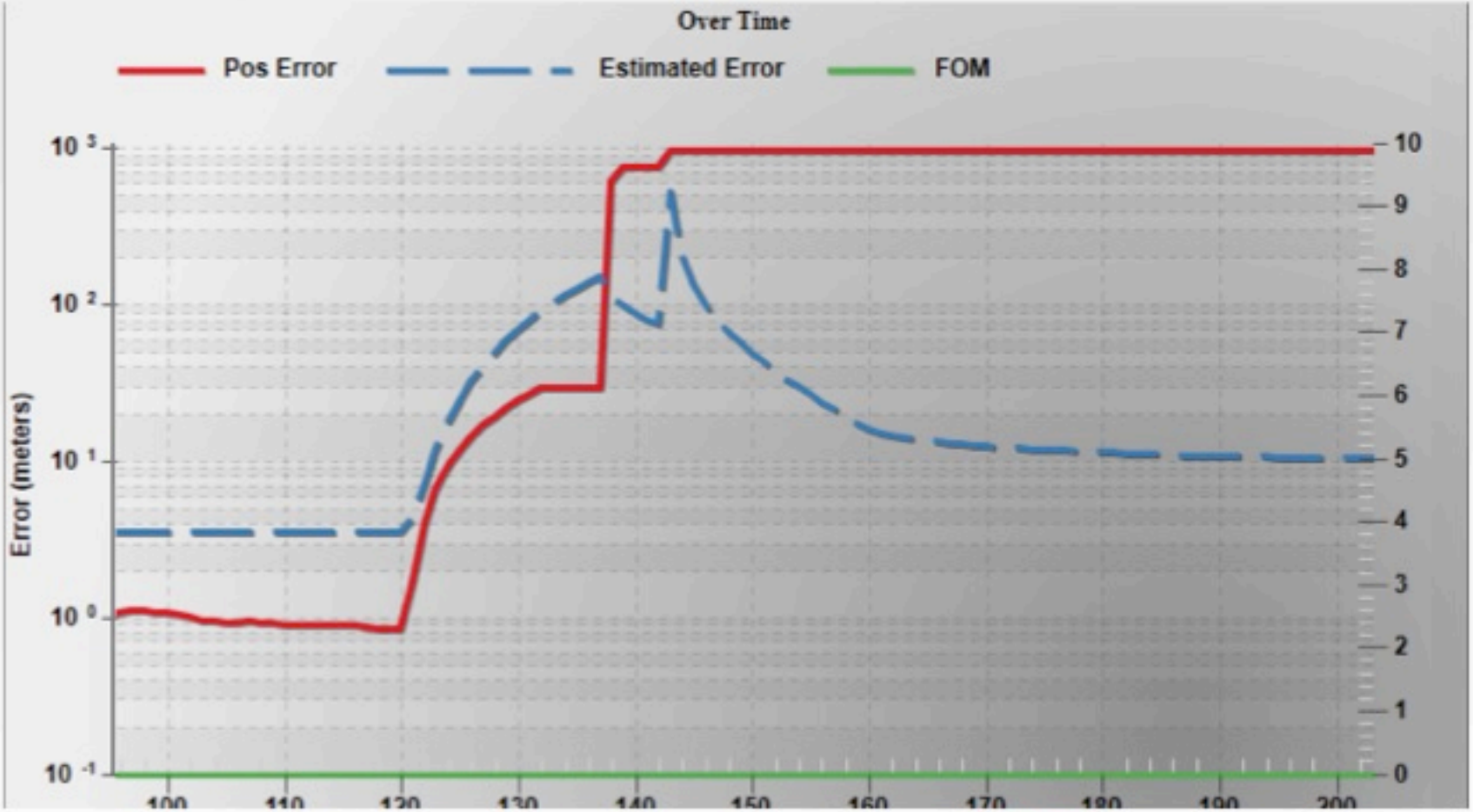




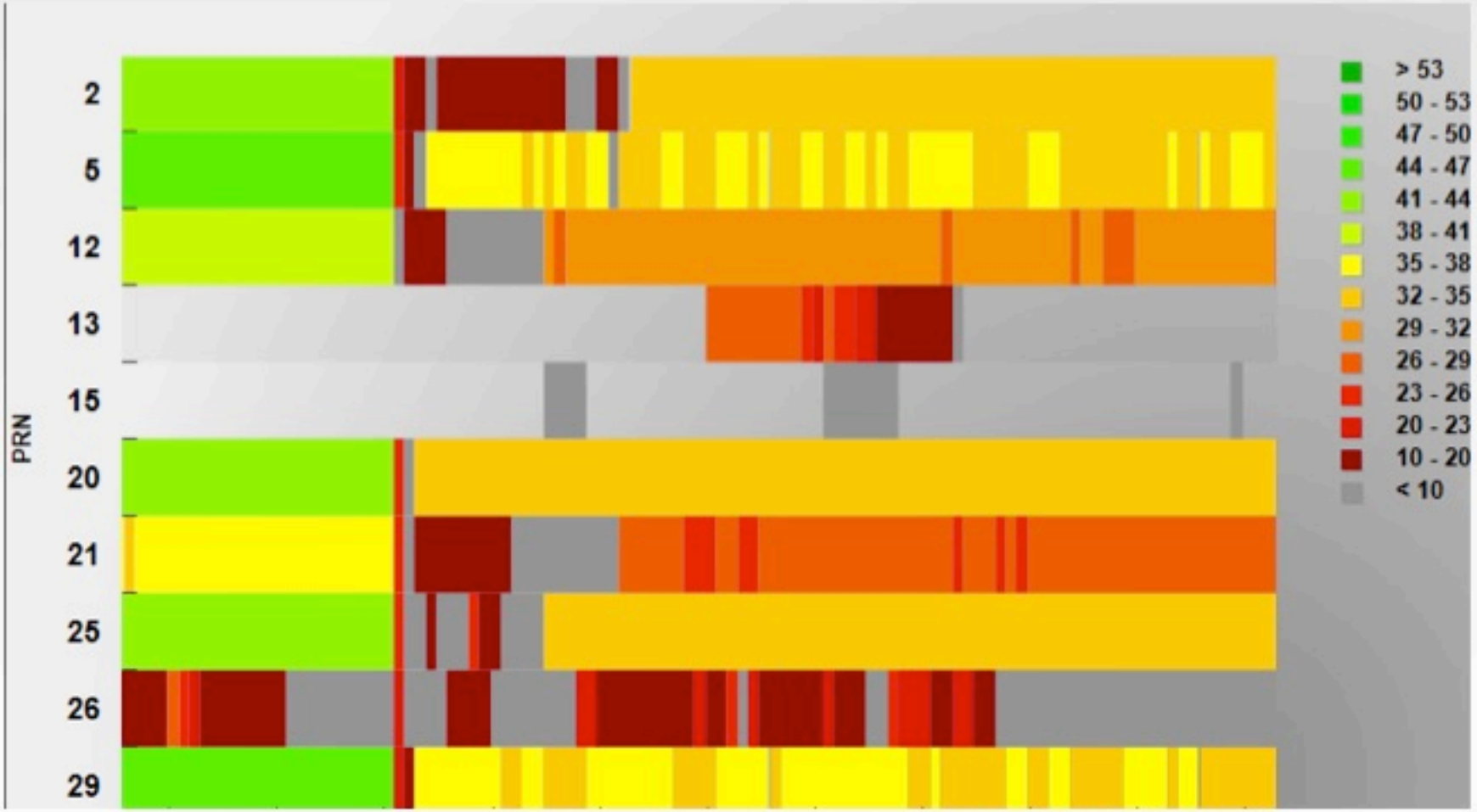
MAP - AFTER


244
244
244
244
244
Mt Rushmore
National
Memorial
National Park Service
- Mount Rushmore...
Mt Rushmore
History Association

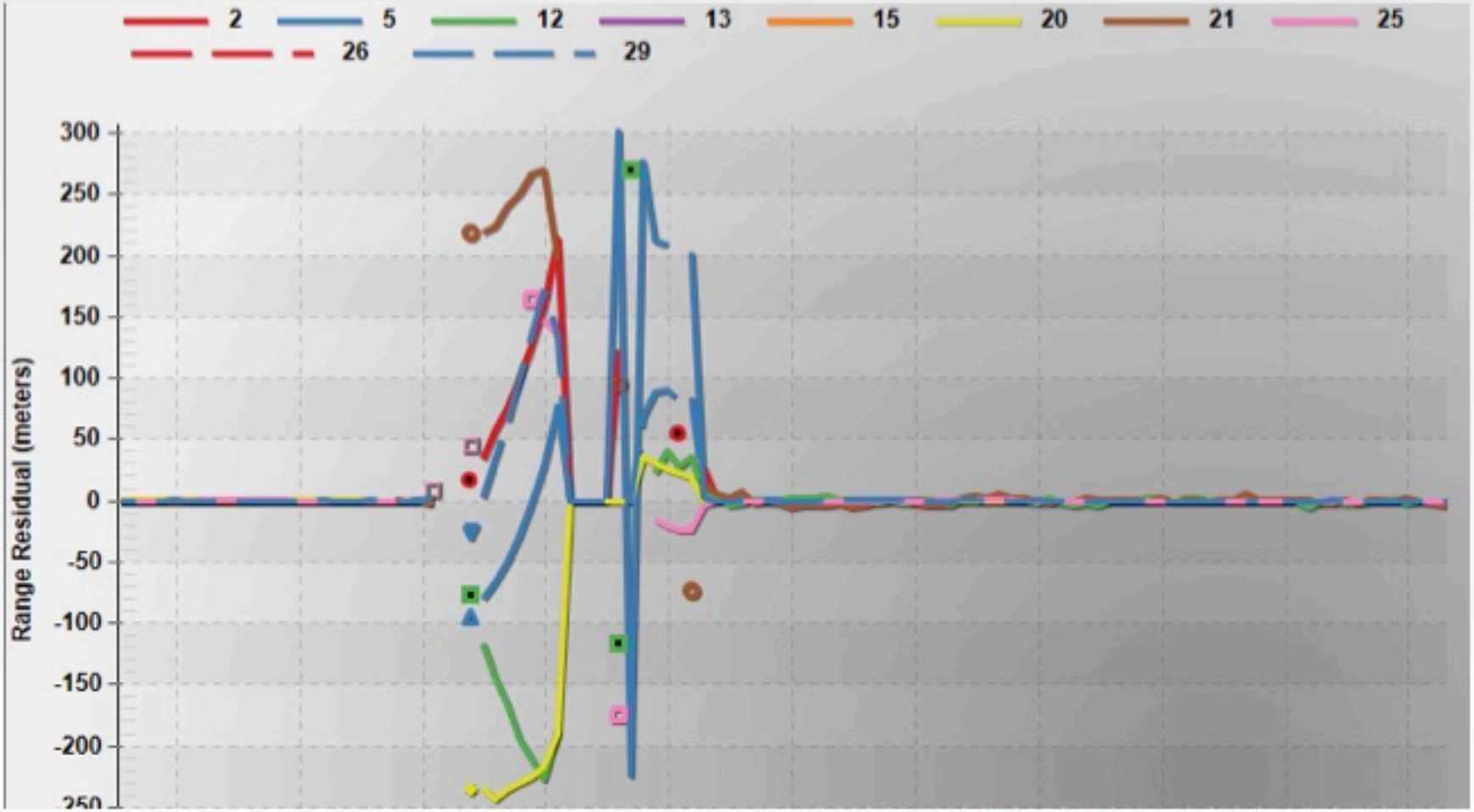
UBLOX RESULTS – POSITION ERROR W/ ESTIMATE



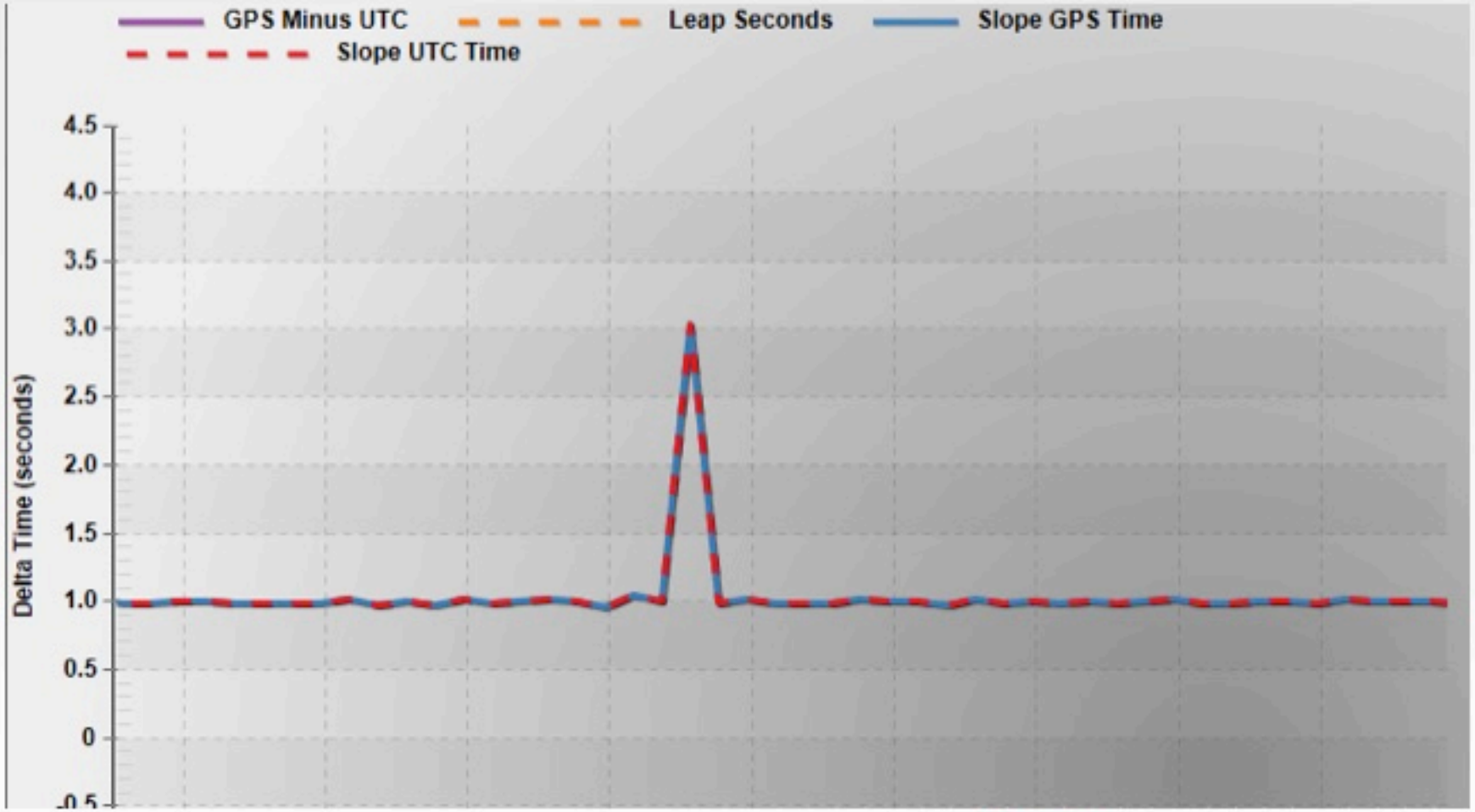
UBLOX RESULTS – C/NO



UBLOX RESULTS – RANGE RESIDUALS



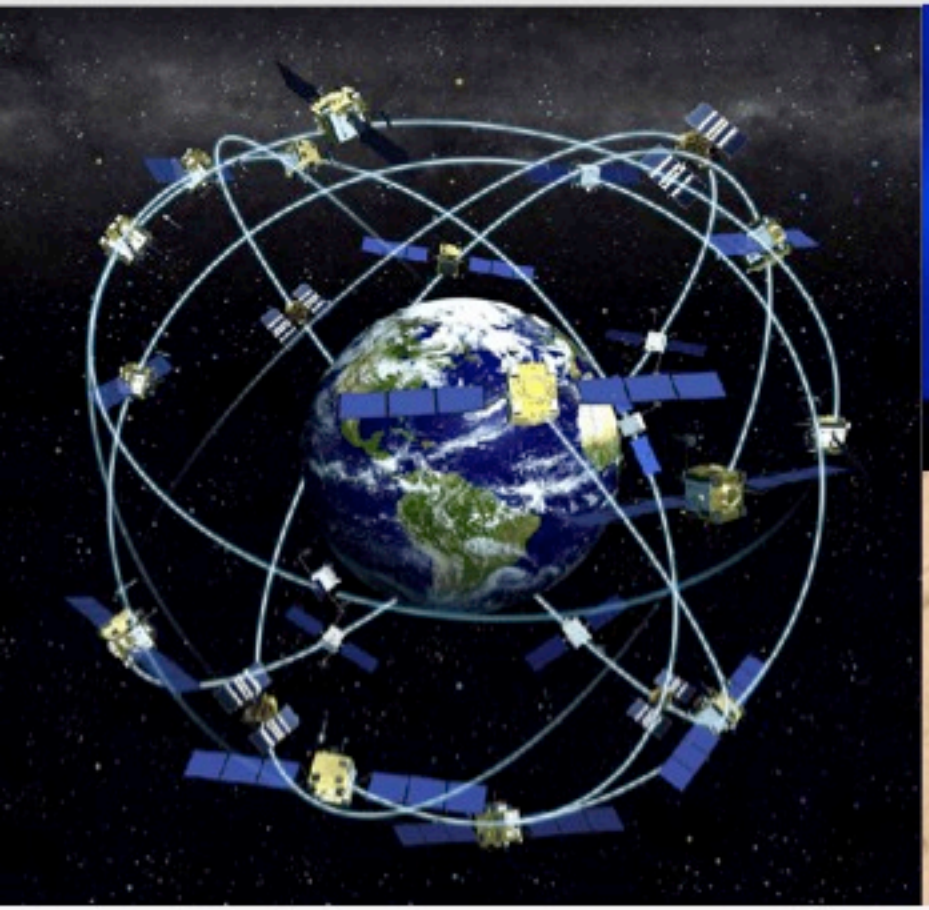
UBLOX RESULTS – TIME JUMP

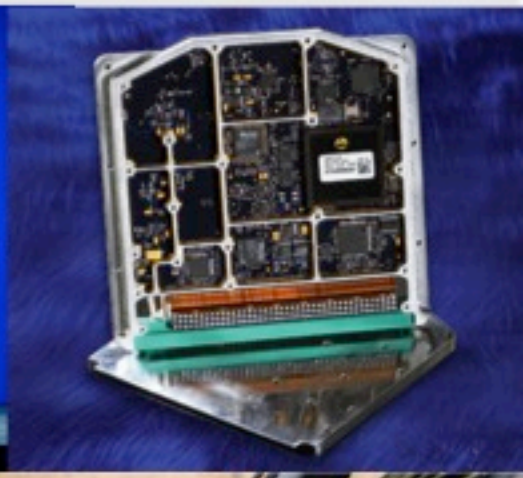


JOHN WEGER

ENGINEER

ROCKWELL COLLINS





PREPARE FOR TOMORROW, FIND VULNERABILITIES TODAY

SIMULATION AGAINST JAMMING AND SPOOFING

DATE 20 JULY, 2017

PRESENTED BY JOHN WEGER

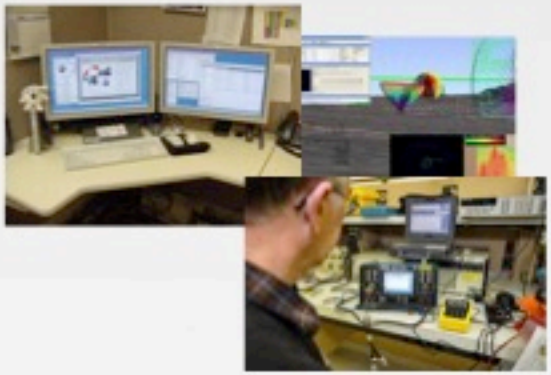
A GPS WORLD WEBINAR, BROUGHT TO YOU BY: TALEN-X

DRIVERS FOR SYSTEM TEST COMPLEXITY

- THREATS
  - THREAT TYPES: COMPLEXITY, AGILITY, POWER
  - LAYDOWNS: LOCATIONS, COMBINATIONS
  - TACTICS: ACTIONS AND EFFECTS
- SYSTEM PERFORMANCE
  - TACTICAL SYSTEMS PROVIDING STATE OF THE ART PERFORMANCE
  - DIFFICULT FOR TEST, EVALUATION, AND TRAINING SYSTEMS TO KEEP PACE
- SYSTEM COMPLEXITY
  - COMPLEMENTARY NAVIGATION SENSORS
  - NAVIGATION FUSION ALGORITHMS
  - DIFFICULTY IN TRACING LOW-LEVEL EFFECTS TO SYSTEM-LEVEL IMPACTS

TEST AND EVALUATION

COMPONENT



- CODE
- COMPONENTS
- MODULES
- SUBASSEMBLIES
- TEST SOCKET
- OFFLINE SIMULATION

UNIT/SUBSYSTEM

- TARGET-BASED SOFTWARE CHECKS
- EMI / ENVIRONMENTAL
- RF SIMULATORS
- ANECHOIC CHAMBER
- LIVE SKY / SURROGATE VEHICLES

SYSTEM

- INTEGRATED SYSTEMS
- REALISTIC ENVIRONMENTS
- COOPERATIVE OPERATIONS
- REALISTIC THREATS

INCREASING COST

THREAT COMPLEXITY

- TRADITIONALLY SIMULATED IN SIMPLE FASHION AS RF INTERFERENCE POWER COUPLED INTO THE RECEIVER FRPA FEED
- SYSTEMS SUCH AS THE WRIGHT PATTERSON WAVEFRONT SIMULATOR ALLOW CONSIDERABLY GREATER FIDELITY FOR GPS/INS SYSTEMS
  - MULTIPLE INDEPENDENT THREATS & TYPES
  - PROPAGATION AND ANTENNA MANIFOLD EFFECTS
- HIGHER-LEVEL SYSTEMS (AIRCRAFT, VEHICLES) RELY ON LIVE-SKY THREAT TESTING
  - LOGISTICS
  - BROADCAST CLEARANCE
- SOME CASES ARE SIMPLY UN-TESTABLE IN THE REAL WORLD
  - SATELLITE FAULTS & OUTAGES
  - SYSTEM-WIDE FAILURES (MONITOR & CONTROL)
  - INTERDEPENDENT SYSTEMS

SYSTEM PERFORMANCE

- NEW CAPABILITIES ARE DEPLOYED INTO OPERATIONAL SYSTEMS AT THE SAME SPEED AT WHICH TEST CAPABILITIES ARE DEVELOPED
  - REAL-TIME KINEMATIC / PRECISION CARRIER PHASE DIFFERENTIAL
  - GLOBAL DIFFERENTIAL GPS
  - CRPA ELECTRONICS
- THE ABILITY TO MAINTAIN AN INDEPENDENT "GOLD STANDARD" FOR RESULTS COMPARISON IS BECOMING INCREASINGLY DIFFICULT
  - SYSTEMS UNDER TEST OFTEN EXCEED OUR ABILITY TO MEASURE THEM IN A LABORATORY ENVIRONMENT
  - COMMERCIAL TECHNOLOGY PACING THE ABILITY TO MAINTAIN 10X MEASUREMENT
  - RF SYNTHESIS PROVIDES TRUTH (FOR NOW) FOR PERFORMANCE ANALYSIS
- NEXT GENERATION SYSTEMS WILL LIKELY RIVAL WHAT CAN BE ACHIEVED WITH METROLOGY, CREATING AMBIGUITY IN "TRUTH" VS MEASURED PERFORMANCE

AS THE ART OF THE POSSIBLE BECOMES AN AFFORDABLE REALITY, WE NEED TO CHANGE OUR APPROACH TO TESTING

SYSTEM COMPLEXITY

- STANDALONE RECEIVERS ACTING AS ONE OF SEVERAL NAVIGATION AIDS.
- OPERATOR ACTION TO SELECT / DE-SELECT.
- MINIMAL CONNECTION TO AUTOMATED SYSTEMS.
- REQUIRE RELATIVELY SIMPLE RF SIMULATION CAPABILITIES.

- COUPLED GPS NAVIGATION SENSORS: INERTIAL, DOPPLER, VISION, MAG, WHEEL SPEED, CRPA
- REQUIRE HIGH LEVELS OF TEST EQUIPMENT SYNCHRONIZATION AND EXQUISITE SIMULATION CAPABILITIES
- OPERATIONAL SYSTEMS OFTEN EXCEED LIMITS OF TEST EQUIPMENT

- ASSURED PNT: REAL-TIME INTEGRATION OF ALL-SOURCE NAVIGATION INFORMATION
- SOLUTION-SEPARATION AND REAL-TIME INTEGRITY
- THREAT SENSE AND REJECT/DEFEAT
- ATTRITABLE NAVIGATION AIDS (PSEDUOLITE, STOIC)

APPROACH TO NEXT-GENERATION TEST CAPABILITIES

- THE APPROACH FOR SIMULATION AND TEST OF NEXT-GENERATION SYSTEMS WILL ULTIMATELY FOLLOW THE SAME HIGH-LEVEL PRINCIPLES BEING APPLIED TO SYSTEM-UNDER-TEST DEVELOPMENT
  - MODULARITY
  - OPEN STANDARDS
  - SOFTWARE-DEFINED TEST ENVIRONMENTS
  - HIGHLY AUTOMATED
- CHALLENGES
  - PRECISION: THE STANDARDS AND INTEGRATION METHODS MUST SUPPORT SYNCHRONIZATION OF SIMULATION HARDWARE COMPONENTS TO SATISFY MULTI-SOURCE PNT TEST NEEDS
  - INTELLECTUAL PROPERTY: THE ABILITY TO OPENLY SHARE AND BUILD ON CURRENT STATE-OF-THE-ART IN A BUSINESS OF CONSIDERABLE WORTH AND COMPETITION
  - PACE: STAYING CURRENT WITH MULTI-SOURCE NAVIGATION, FREQUENCY AGILITY, ADVANCED WAVEFORMS, AND IMPROVED COUPLING METHODS

QUESTIONS?

A GPS WORLD WEBINAR, BROUGHT TO YOU BY: TALEN-X

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