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High Frequency Test Facility (HFTF) and HF Network Modeling Brief (January to July 2007)

Presented By: Mr. Dan Hurd
HFTF Action Officer, JITC
19 July 2007

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STATEMENT

DISCLAIMER

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AGENDA

- ***JITC Vision and Mission***
- ***JITC Facility Locations***
- ***High Frequency Test Facility (HFTF)***
  - *HFTF Mission*
  - *HFTF History*
  - *HFTF Facilities*
  - *HFTF Test Capabilities*
  - *HFTF Certification History*

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AGENDA (continued)

- ***HFTF** (continued)*
  - *HFTF Current Test Support (CY 07)*
  - *HFTF Projected Test Support (CY 07)*
  - *Test Activity Summary (CY 07)*
  - *Certifications Issued (CY 07)*
  - *Interop Assessment Letters Issued (CY 07)*
  - *HF Test Procedures*
- ***HF Modeling and Simulation***

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JITC VISION AND MISSION

Vision: *A world-class test and evaluation organization that advances global net-centric testing in support of war-fighting capabilities*

Mission: *JITC provides a full-range of agile and cost-effective test, evaluation, and certification services to support rapid acquisition and fielding of global net-centric war-fighting capabilities*

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JITC FACILITY LOCATIONS

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HIGH FREQUENCY TEST FACILITY (HFTF)

- ***Co-Located with JITC at Fort Huachuca, Arizona***
- ***Contractor Operated and Maintained***
- ***"Split" Test Sites***
  - *Transmitter Site is Located 33 Miles Away and Connected By a Microwave Link*
  - *Receiver Site is Located 1 Mile Away and Connected By a Fiber Optic Link*

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HFTF MISSION

Established in 1989, the HFTF provides both a testing laboratory and an operational facility, supporting Conformance and Interoperability Testing

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HFTF HISTORY

- ***HF Test Support Began in 1989***
- ***Historical HF Requirements***
  - *MIL-STD 188-110A (30 Sep 1991)*
  - *MIL-STD 188-141A Notice 2 (10 Sep 1993)*
- ***Present Emphasis on HF Requirements***
  - *MIL-STD-188-203-1A (8 January 1988)*
  - *MIL-STD 188-110B (29 Mar 2000)*
  - *MIL-STD 188-141B (01 Mar 1999)*
  - *STANAG 5066 (04 Jul 2000)*

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HFTF FACILITIES

- ***Conformance and Interoperability Test Laboratory***
  - *MIL-STD and STANAG Testing*
  - *Automated and Manual Testing*
- ***Operational Facility***
  - *3 Level SCOPE Command Node*
  - *Shared Resources (SHARES) Program Participant*
  - *DICE Exercise Support*

HFTF FACILITIES (cont'd)

➢ Legends Test Network

- *14 Test Management Systems*
- *Automated Testing*
- *Central Data Management*
- *Channel Simulation (HF and Audio)*
- *Network Simulation*
  - *INTERNET*
  - *NIPRNet*
  - *SIPRNet*
- *Computer Modeling and Analysis*
  - *ICEPAC*
  - *GenetScope*

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HFTF TEST CAPABILITIES

➢ MILITARY STANDARD TEST CAPABILITIES

- *MIL-STD-188-110B*
  - *Serial Mode*
  - *39-Tone*
  - *Data Rates Above 2400 bps*
- *MIL-STD-188-141B*
  - *Basic Radio*
  - *ALE*
  - *Linking Protection*
- *MIL-STD-188-148B*
- *MIL-STD-188-203-1A*

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HFTF TEST CAPABILITIES (cont'd)

➢ STANAG TEST CAPABILITIES

- *STANAG 4203*
- *STANAG 5511*
- *STANAG 5066*
- *STANAG 4529*
- *STANAG 4285*
- *STANAG 4539*

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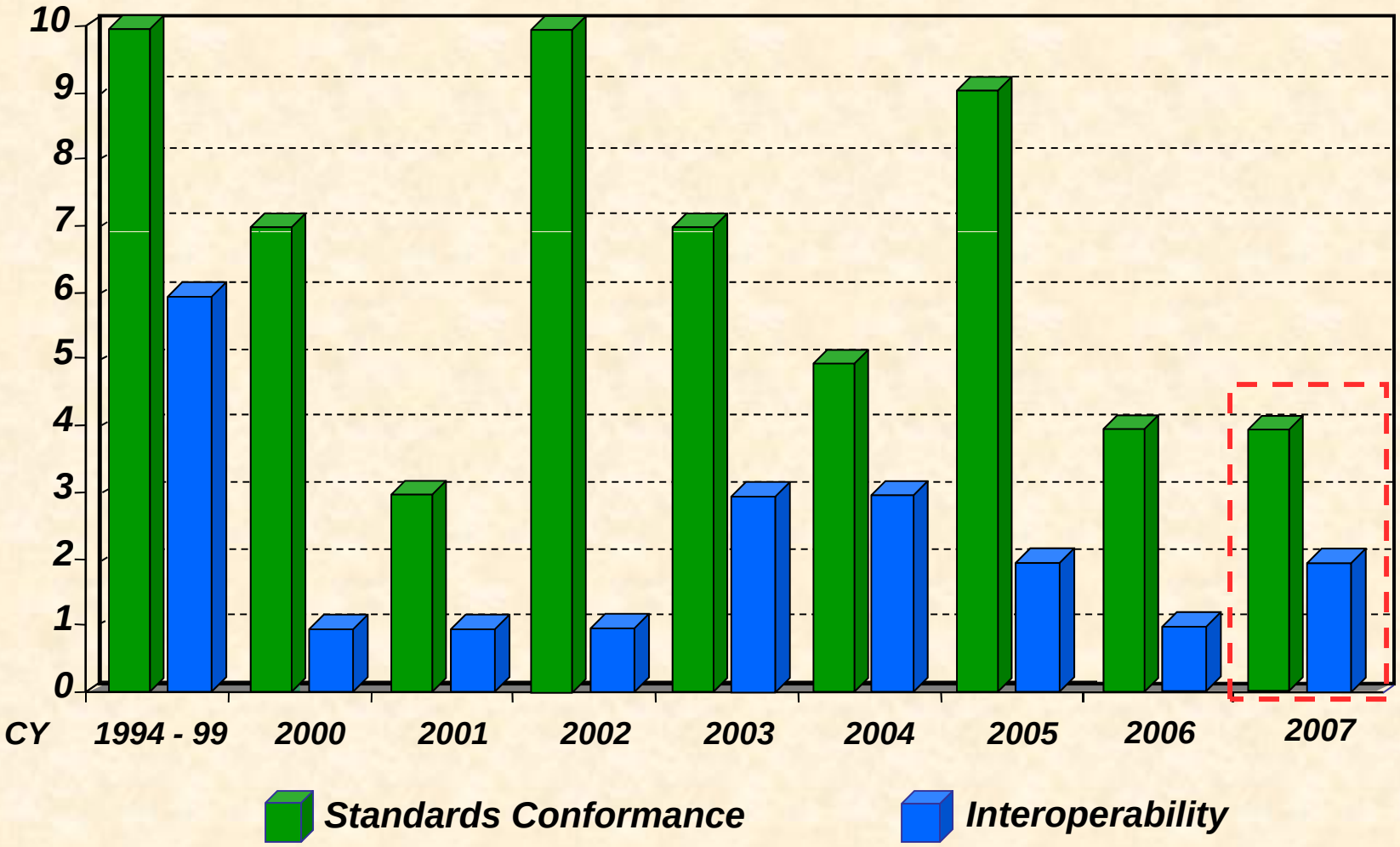
HFTF CERTIFICATION HISTORY



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HFTF CURRENT TEST SUPPORT (CY 07)

- ***Current Test Support***
  - *SCOPE Command*
    - *Spiral 2, Type 3*
    - *GenetScope/DEVS*
  - *Harris AN/URC-131(V) (SPAWAR)*
    - *Interoperability Assessment*

HFTF PROJECTED TEST SUPPORT (CY 07)

- ***Rockwell Collins Q9604 Modem*** *(July-Aug 07)**
  - *MIL-STD-188-110B Certification, Including Appendix C and Appendix F*
- ***Datron RT-7700 Radio*** *(June 07)**
  - *MIL-STD-188-141B Certification, Including Appendix A*
  - *Interoperability Assessment*
- ***Barrett Communications 2050 Radio*** *(Aug 07)**
  - *MIL-STD-188-141B Certification, Including Appendix A*
  - *Interoperability Assessment*

** Tentative Dates*

HFTF PROJECTED TEST SUPPORT (CY 07) (cont'd)

- ***SCOPE Command Q9604 Modem*** *(July-Aug 07)**
  - *MIL-STD-188-110B Certification, Including Appendix C*
  - *STANAG 5066*
  - *Q9604-to-S9600 Modem Functionality Testing*
- ***RapidM RM6 Modem (SUNAIR)*** *(July-Aug 07)**
  - *STANAG 5066*
- ***JTRS***
  - *HF Test Procedures Validation and Verification*

** Tentative Dates*

TEST ACTIVITY SUMMARY (CY 07)

- ***MIL-STD-188-110B***
  - *None*
- ***MIL-STD-188-141B***
  - *Rockwell Collins AN/ARC-243(V) (Appendix B)*
- ***STANAG 5066***
  - *None*

TEST ACTIVITY SUMMARY (CY 07) (cont'd)

- ***Interoperability Testing***
  - *Harris AN/URC-131(V) Assessment (SPAWAR)*
- ***Responsible Test Organization for SCOPE Command***
  - *Developing Updated NetSim Model*
  - *Simulation Model for Ship-to-Shore HF Communications (Spawar)*
  - *Test Plan Development for Spiral 2 Test*
  - *Acceptance Test Support for Spiral 2 at Andrews Air Force Base*

CERTIFICATIONS ISSUED (CY 07)

- ***MIL-STD-188-110B***
  - *RapidM RM6 Modem and ALE Controller*
- ***MIL-STD-188-141B***
  - *Rockwell Collins AN/ARC-243(V)1 and (V)2*
  - *Harris AN/URC-131(V) HF Radio Group (SPAWAR)*
- ***MIL-STD-188-203-1A***
  - *AN/ACQ-8 (MX-512PA) (Part of AN/ARC-243(V)1)*

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INTEROP ASSESSMENT LETTERS ISSUED (CY 07)

- ***Rockwell Collins AN/ARC-243(V)1 and (V)2***
  - *Non-Secure Voice*
  - *Secure Voice*
  - *Data*
  - *Link-11*
- ***Harris AN/URC-131(V) HF Radio Group***
  - *Non-Secure Voice*
  - *Secure Voice*
  - *FSK Data*
  - *Link-11*

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HFTF TEST PROCEDURES

- ***Test Procedures Under Development/Revision***
  - *MIL-STD 188-141B*
  - *MIL-STD 188-203-1A*
  - *MIL-STD 188-148B*
  - *STANAG 5066*

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HF MODELING AND SIMULATION

Presented By: Mr. Dan Hurd
HFTF Modeling and Simulation Government Action Officer
19 July 2007

MODELING AND SIMULATION

HF Radio Simulation on a Worldwide Basis

- *Background*
- *Simulation Requirements*
- *GenetScope and NETSIM2*
- *How Do You Model the World?*
- *Scenario Based Simulation*
- *Data Analysis*

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BACKGROUND

The JITC HFTF is responsible for developing the second-generation network model for the HF Global Communications System (HFGCS). JITC tasked Northrop Grumman Information Technology (NGIT) to develop NETSIM 2. Subsequently, NGIT partner, the University of Arizona, and the Arizona Center for Integrative Modeling & Simulation (ACIMS) have developed the model. Working from the original NETSIM-SC model, the ACIMS team transferred the code to JAVA and integrated it into a Discrete Event System Specification (DEVS).

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GenetScope / NETSIM 2

➢ The High Frequency Global Communications System Supports:

- *VIP Fleet - MYSTIC STAR*
- *U.S. Air Force Global HF System*
- *Defense Communications System (DCS) HF Entry*
- *Systema de Informatica y Telecommunicaciones de las Fruerzas Aereas Americanas (SITFAA) - Information and Telecommunications System of the American Air Forces*

➢ Communications Support:

- *Foreign Dignitaries*
- *State Department*
- *White House*
- *Joint Chiefs of Staff (JCS)*
- *Defense Information Systems Agency (DISA)*
- *Air Mobility Command (AMC)*
- *Air Combat Command (ACC)*
- *Air Force Space Command (AFSPC)*
- *U.S. Air Forces Europe (USAFE)*
- *Pacific Air Forces (PACAF)*
- *Air Weather Service (AWS)*
- *United States Navy*
- *North Atlantic Treaty Organization (NATO)*
- *Civil Air Patrol*
- *Department of Homeland Defense*

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GenetScope / NETSIM 2

➢ Simulation Requirements

- *The HFGCS is Offering Expanded Capabilities to Users*
  - *Voice Connection to the DISN*
  - *NIPRNET/SIPRNET E-Mail*
  - *Ground-Based in Addition to Aircraft*
- *Analysis of Coverage*
- *Analysis of Location of New Stations*
- *Analysis of Assets*
  - *Equipment*
  - *Antennas*
  - *Channels*
- *Analysis of New Capabilities*
  - *Data Protocols*
  - *MELP*
  - *Terrestrial Network*
  - *VOIP*

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GenetScope / NETSIM 2

- ***DEVS***
  - *Discrete Event System Specification*
- ***GenetScope (Generic Network Model for Systems Capable of Planned Expansion)***
  - *Architecture to Simulate Complex Radio and Protocol Systems*
- ***NETSIM 2 (Second Generation HFGCS Model)***
  - *Overlay of HFGCS on GenetScope*
  - *The Model Provides Automatic Link Establishment, Propagation, Mobile Users, and Traffic Capabilities*

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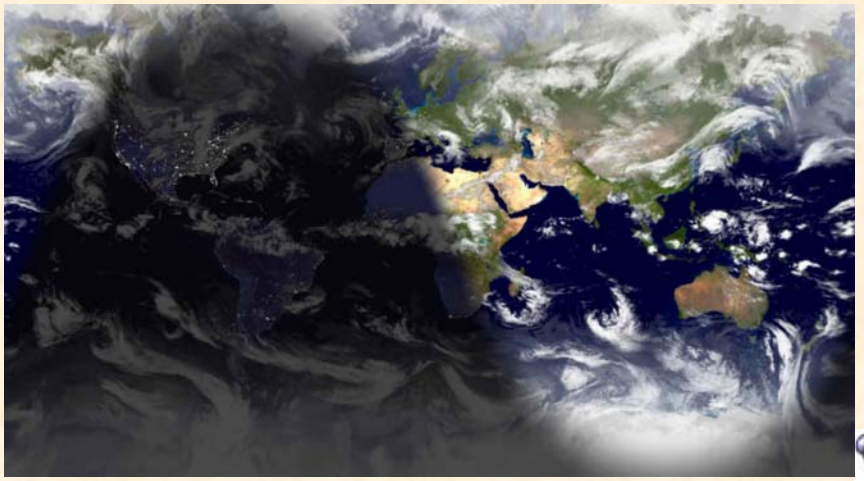
GenetScope / NETSIM 2

- ***How Do You Model the World?***
  - *Location*
  - *Equipment Specifics*
    - *Power*
    - *Antenna*
  - *Date*
  - *Time*
  - *Sunspot Number*
- ***Propagation?***
  - *Predictable Using Industry Standard Programs*

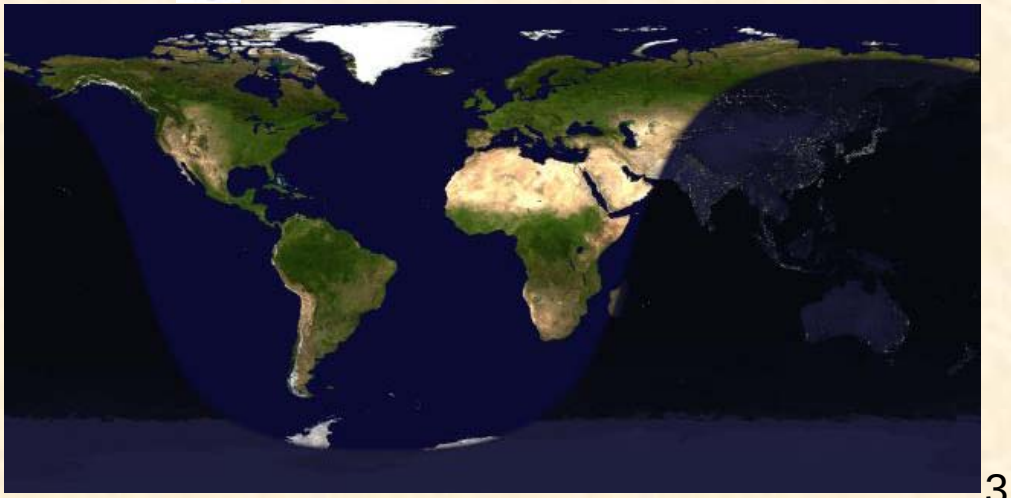
GenetScope / NETSIM 2

Factors Affecting Propagation



- *Location*
- *Date*
- *Time*
- *Solar Activity*
- *Solar Cycle*

- *Transmit Power*
- *Receive Noise*
- *Bandwidth*
- *Signal to Noise*



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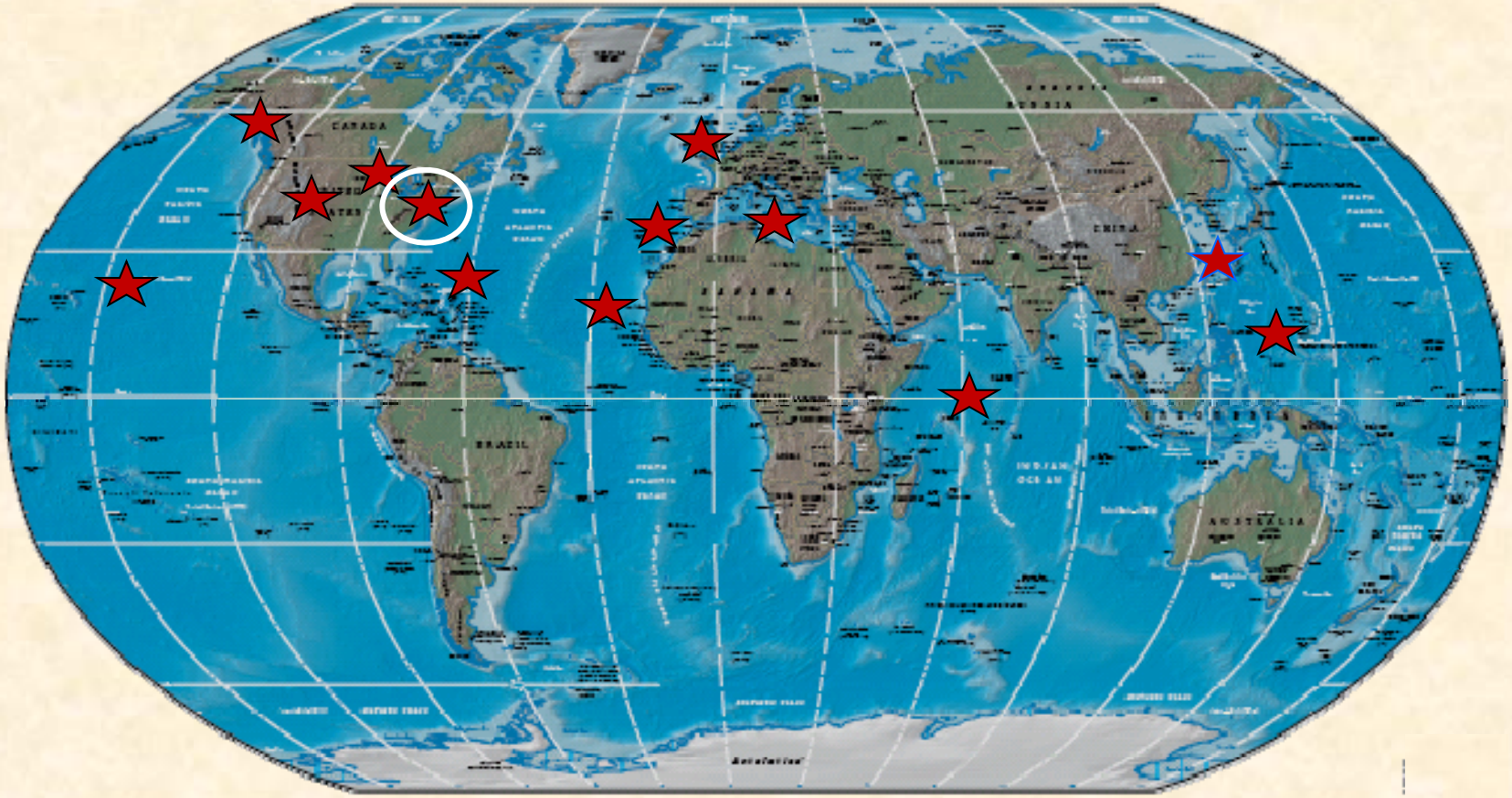
GenetScope / NETSIM 2

HFGCS Worldwide Network



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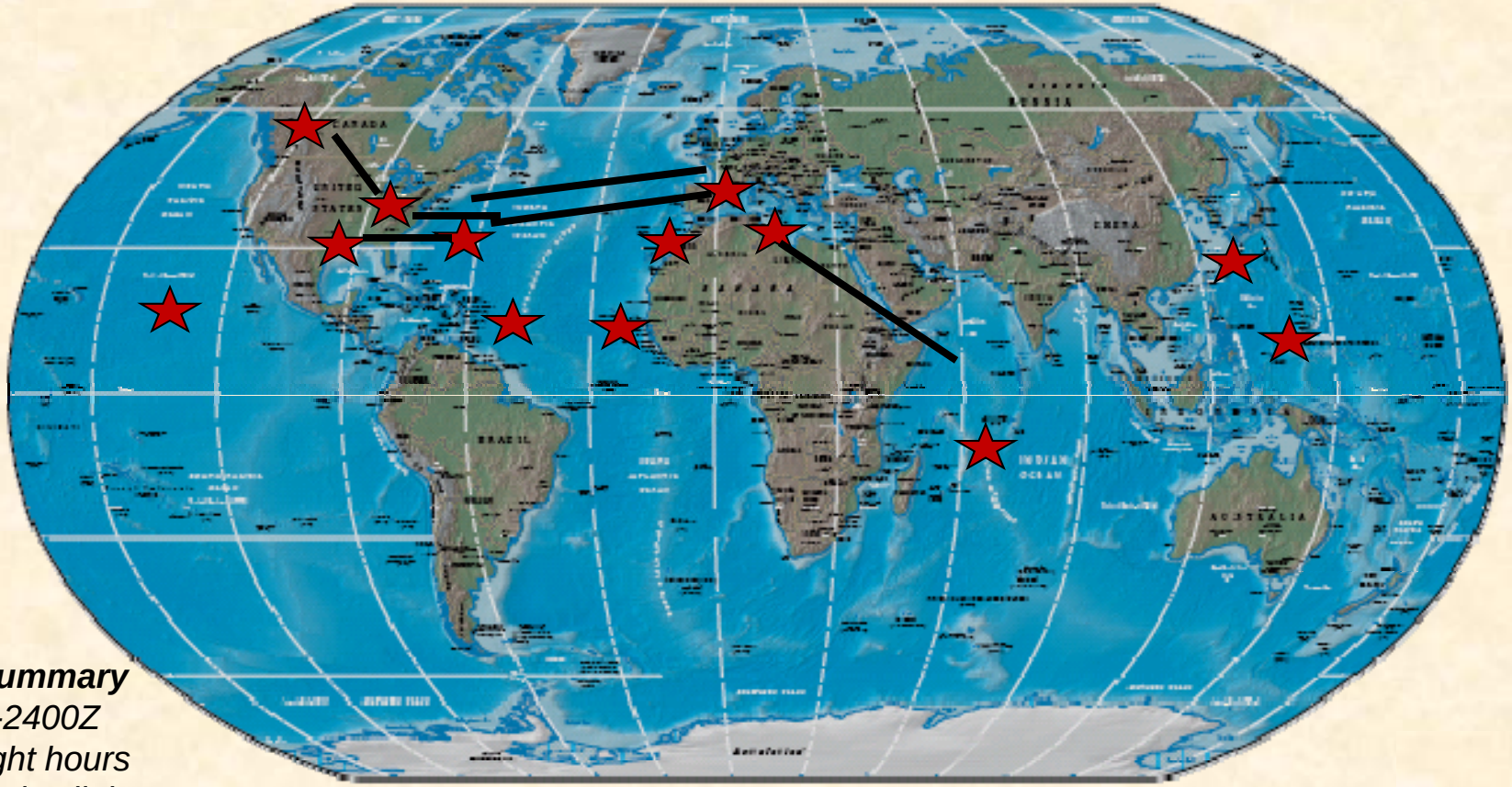
GenetScope / NETSIM 2

HFGCS Worldwide Network

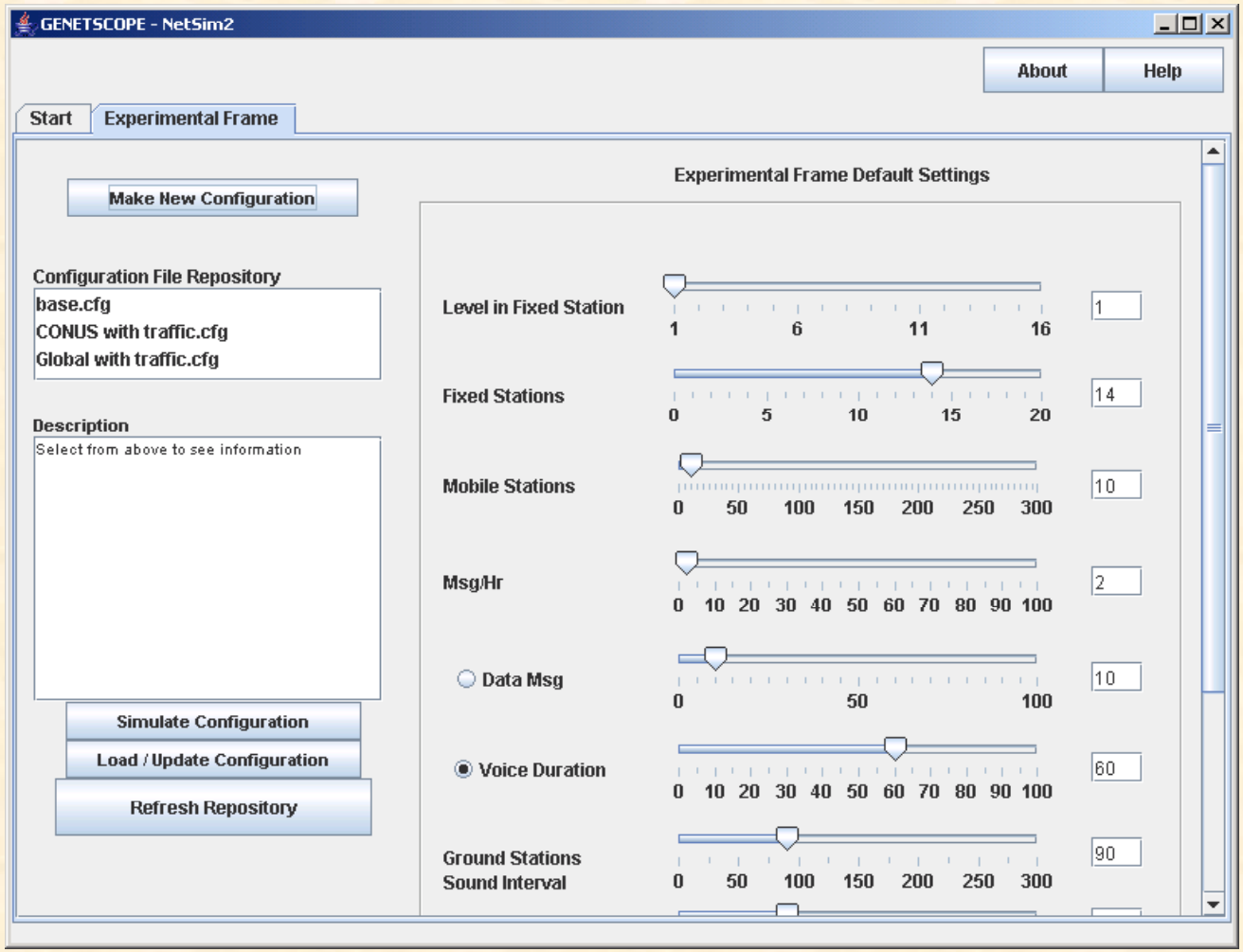


Summary

1600-2400Z
33 flight hours
151 voice links
76 links on first attempt
10 of 14 stations used
6 of 9 channels

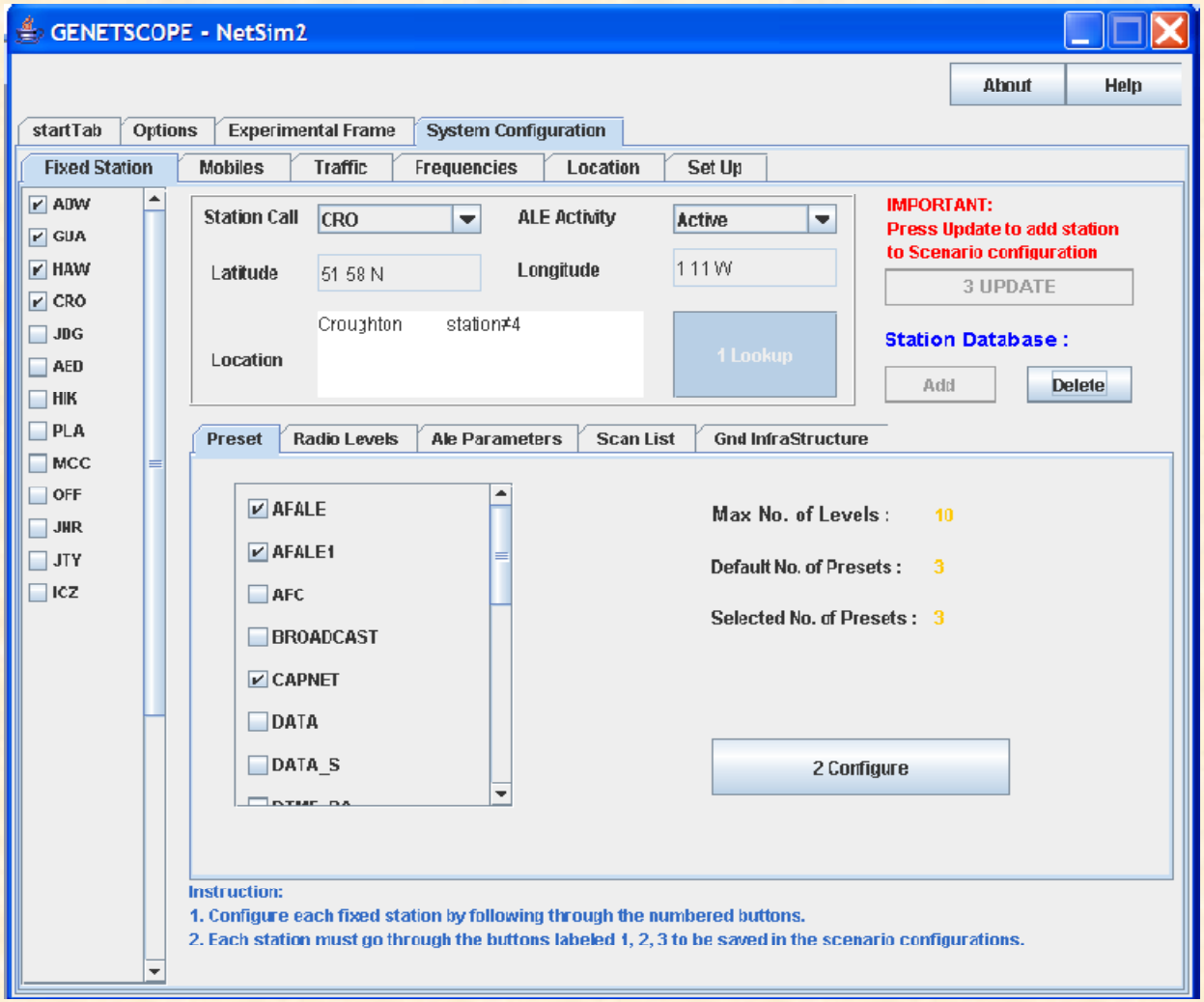
GenetScope / NETSIM 2

Experimental Frame - Scenario Plan



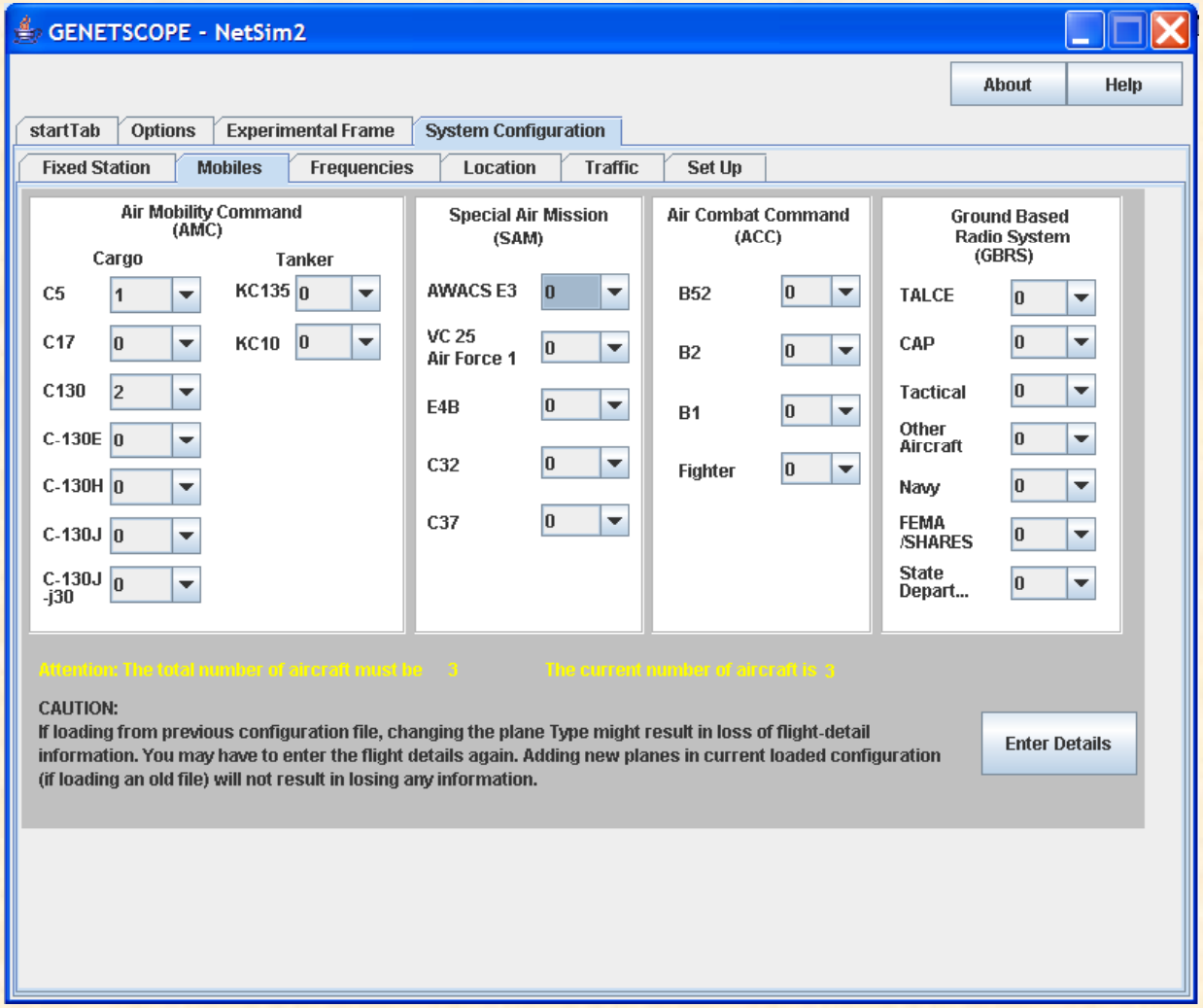
GenetScope / NETSIM 2

Fixed Station Configuration Pane



GenetScope / NETSIM 2

Mobile Station Selection Pane



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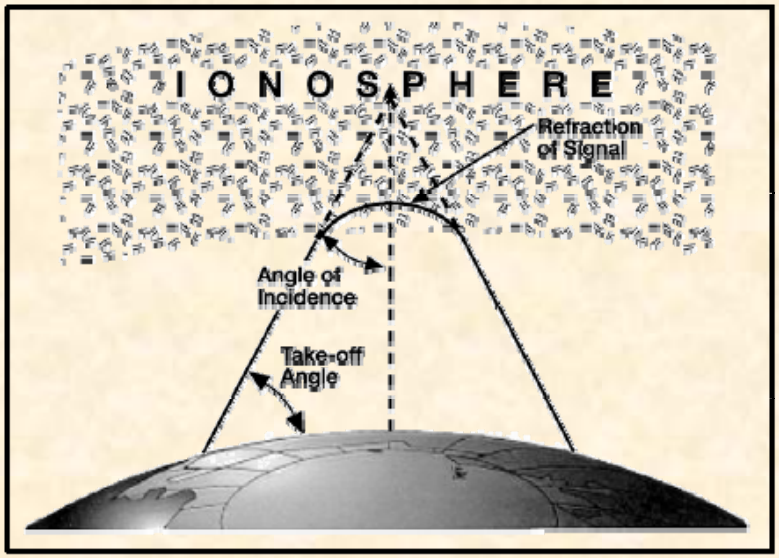
GenetScope / NETSIM 2

- *Automated Scenario Management*
- *Traffic Generation*
- *Movement of Mobiles Between Waypoints*
- *Propagation for Any Communications Requirement Anywhere in the World*
- *Just Like the Old Days*



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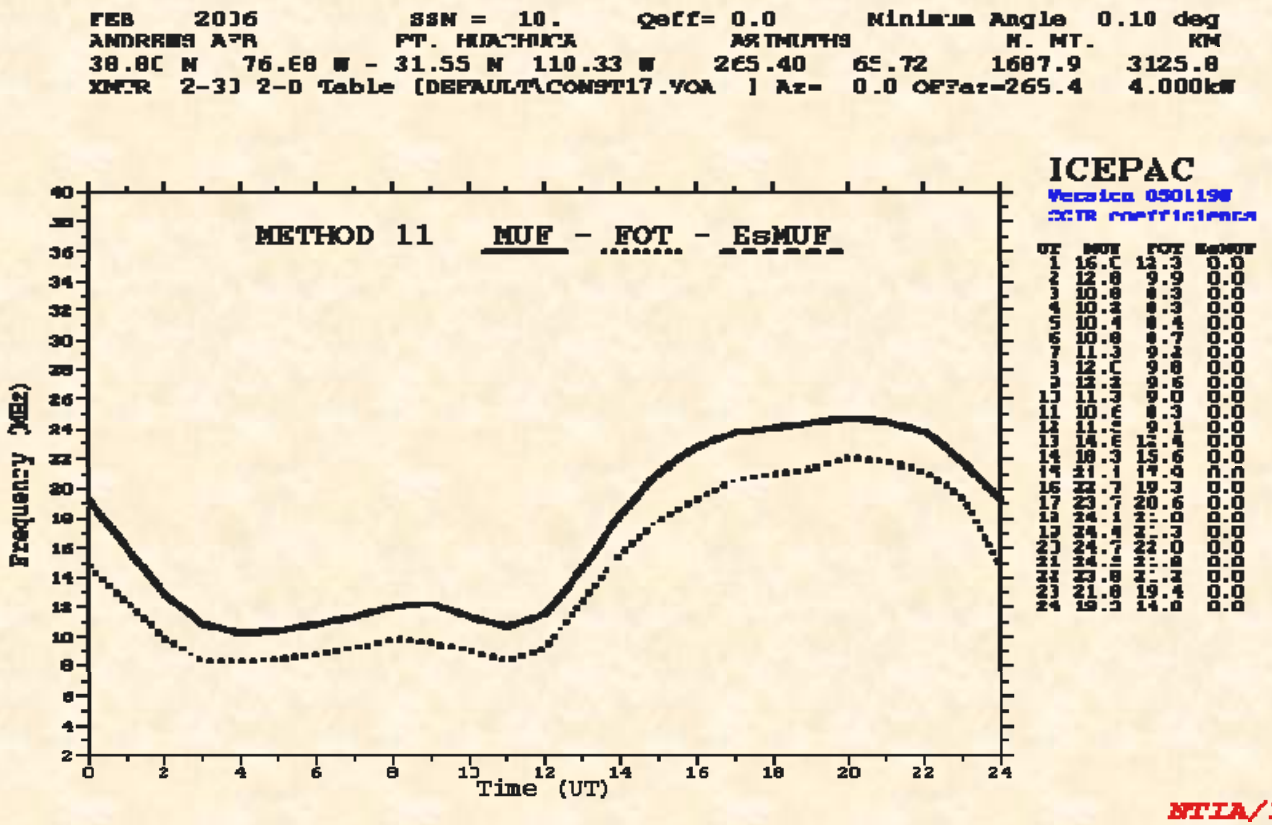
GenetScope / NETSIM 2

- ***Pick Two Locations***
- ***Select Date, Time, Sun Spot Number***



NTIA/ITS

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GenetScope / NETSIM 2

- ***What if You Have 14 Fixed Stations and Several Dozen Aircraft Worldwide?***
- ***Repeat the Process Over and Over***
- ***The IONCAP Prediction Program is 30 Years Old***

IONCAP

(30 years ago)

DEVSJAVA

```
public void InsertSelfEvent(EventStruct theEvent_) {
    EventStruct theEvent = NewEvent().clone(theEvent_);
    theEvent = theEvent_;
    int entity = theEvent.EventEntity;
    double eventTime = doubleFormat.niceDouble(theEvent.EventTime);
    theEvent.srcEntity = entity; //by saurabh
    arrived.put(new doubleEnt(eventTime), theEvent);

    holdUntilNextJob();
```

(Today)

GenetScope / NETSIM 2

Propagation Program Output for Each Communications Attempt

- FEB 2006 SSN = 10. Qeff= 0.0 Minimum Angle 0.10 deg
- ANDREWS AFB FT. HUACHUCA AZIMUTHS N. MI. KM
- 38.80 N 76.88 W - 31.55 N 110.33 W 265.40 65.72 1687.9 3125.8
- XMTR 2-30 2-D Table [DEFAULT\CONST17.VOA] Az= 0.0 OFFaz=265.4 4.000kW
- RCVR 2-30 2-D Table [DEFAULT\SWWHIP.VOA] Az= 0.0 OFFaz= 65.7
- 3 MHZ NOISE = -114.0 DBW REQ. REL = .90 REQ. SNR = 25.0 DB
- MULTIPATH POWER TOLERANCE = 3.0 DB MULTIPATH DELAY TOLERANCE = 0.100 MS
-
- 1.0 16.0 6.1 7.2 9.7 11.9 13.7 15.4 17.7 21.6 25.9 0.0 0.0 FREQ
- 1F2 2F2 2F2 2F2 1F2 1F2 1F2 1F2 1F2 1F2 - - MODE
- 4.1 12.7 13.1 14.1 1.8 2.3 3.1 4.1 4.1 4.1 - - ANGLE
- 10.9 11.1 11.1 11.1 10.7 10.8 10.8 10.9 10.9 10.9 - - DELAY
- -101 -87 -87 -90 -103 -102 -99 -111 -150 -214 - - S DBW
- -139 -127 -129 -133 -135 -137 -138 -140 -143 -145 - - N DBW
- 38 40 42 43 32 35 40 29 -8 -70 - - SNR
- 14 -2 -2 5 10 13 12 23 60 121 - - RPWRG
- 0.74 0.92 0.93 0.84 0.70 0.71 0.76 0.58 0.05 0.00 - - REL
- 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 - - MPROB

GenetScope / NETSIM 2

Scenario Based Simulation (Small)

- ***A Small Scenario***
  - *6 Stations*
  - *2 Aircraft*
  - *9 Channels*
  - *1 Hour*
- ***Results***
  - *217 ALE Activities (Sound, Listen, Call)*
  - *54 Transmissions (Sound, Link)*
  - *723 Calls to the Propagation Program*
  - *2 ALE Links*
- ***2 Hours to Run***

GenetScope / NETSIM 2

Scenario Based Simulation (Large)

- ***A Large Scenario***
  - *14 Stations*
  - *100+ Aircraft*
  - *9 Channels*
  - *24 Hours*
- ***Results***
  - *10,000+ ALE Activities (Sound, Listen, Call)*
  - *5,000 Transmissions (Sound, Link)*
  - *100,000 Calls to the Propagation Program*
  - *500 ALE Links*
- ***72 + Hours to Run***

GenetScope / NETSIM 2

Fixed Stations and Mobiles

Fixed Station

```
F ADW    38.817   -76.867  -114     A        Andrews
ALE1
RT 1
PA 1
ANT1
Bcast
#T 0     2        60       10       V        ~2 msg/hr to gnd ~1.0 minutes ea
C  2     4        8        10       11       14       17       AFALE
```

Mobile

```
M  150   35.466   -97.533  S        C5       455684
T  0     3        60       10       V
T  0     1        20       250      D
L  ADW   OFF      MCC      HIK      AED
W   0.1  35.466   -97.533  A        CITY   OK  USA  TINKER AFB  USAF
W  4     39.166   -75.533  S        DOVER  DE  USA  DOVER AFB   USAF
C  2     4        8        10       11       14       17       AFALE
```

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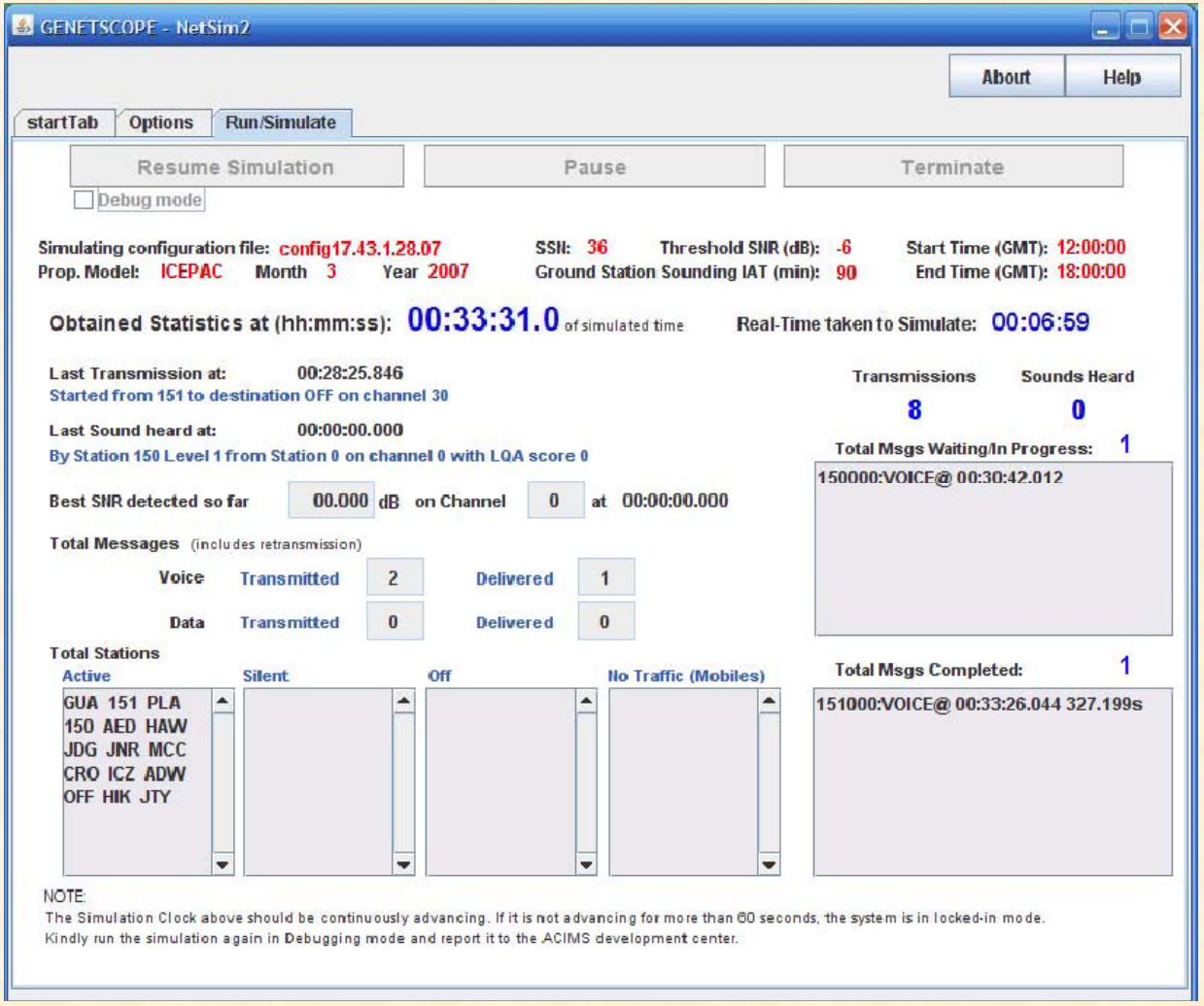
GenetScope / NETSIM 2

Real-Time Simulation Visualization Pane



GenetScope / NETSIM 2

Data Analysis

- *5 User Logs*
- *Importable into Excel*

ALE Log

```
Sta Level  At Time          on      Sta       Status
1   1     00:00:33.133     Ch:6    to:0     Listening
1   1     00:00:35.332     Ch:6    to:0     Sounding
150 1     00:00:36.283     Ch:6    to:0     Reading Snd   SNR (dB): 19.0  Score: 36
11  1     00:00:36.783     Ch:6    to:0     Reading Snd   SNR (dB): 23.0  Score: 44
10  1     00:00:39.783     Ch:6    to:0     Reading Snd   SNR (dB): 28.0  Score: 50
150 1     00:00:41.067     Ch:6    to:0     Reading Snd   SNR (dB): 19.0  Score: 36
11  1     00:00:41.567     Ch:6    to:0     Reading Snd   SNR (dB): 23.0
```

GenetScope / NETSIM 2

Channel Log

Chnl	Start time	End time	Src	Dest	Power
6	00:00:35.332	00:00:41.793	1	0	36.0
9	00:01:24.418	00:01:30.879	6	0	36.0
4	00:02:24.845	00:02:31.306	11	0	36.0
6	00:03:57.252	00:04:03.713	11	0	36.0
3	00:05:21.99	00:05:28.45	10	0	36.0
9	00:07:31.685	00:07:38.146	7	0	36.0
5	00:07:41.791	00:07:48.252	150	0	26.0

Linking Log

Src	Dest	Chnl	Qual	Start Time	End Time	Time taken
150	10	4	50	00:26:00.20	00:26:13.191	12.99
150	10	4	48	00:46:00.199	00:46:13.19	12.99

GenetScope / NETSIM 2

LQA Log

(Link Quality Analysis – Used for Channel Selection)

```
LQA Table from ALE 190 level 1  at station 150 at hour1
Sta  Ch  1,  2,  3,  4,  5,  6,  7,  8,  9,
---------------------------------------
  ADW    0,  0,  0,  33,  0,  26,  0,  0,  0,
  AED    0,  0,  0,  0,  0,  0,  0,  0,  0,
  HIK    0,  0,  0,  0,  0,  0,  0,  0,  0,
  MCC    0,  0,  0,  0,  0,  25,  0,  0,  0,
  OFF    0,  45,  41,  46,  0,  0,  0,  0,  0,
  JNR    0,  0,  0,  0,  0,  0,  0,  0,  0,
=========================================================================
   =
 LQA Table from ALE 182 level 1  at station JNR at hour1
Sta  Ch   1,  2,  3,  4,  5,  6,  7,  8,  9,
---------------------------------------
  ADW      ,   ,   , 29,    , 33,    ,   ,   ,
  AED      ,   ,   ,   ,   ,   ,   ,   ,   ,
  HIK      ,   ,   ,   ,   ,   ,   ,   ,   ,
  MCC      ,   ,   ,   ,   ,   ,   ,   ,   ,
  OFF      ,   ,   ,   ,   ,   ,   ,   ,   ,
-------------------------------------------------------------------------
```

GenetScope / NETSIM 2

Message Log

Msg ID	Dest	Src	Pri	Len(s)	Time Req	Established	Done at	If Failed(Reason)
150000	10	150	10	60	00:26:00.098	00:26:13.289	00:27:13.486	VOICE
150001	10	150	10	60	00:46:00.099	00:46:13.289	00:47:13.487	VOICE

Propagation Log

(Used for Propagation Validation)

Listening at station: ADW to: 152 at: 00:00:35.499
Running PropString: DynPropString: 16 4 2006 32114 ADW 38.81N 76.86W 152 47.61N 117.3W
4.7 5.7 6.7 9.0 11.2 13.2 15.0 18.0 23.3 0.0 0.0 FREQ
-96 -58 -28 -2 2 -10 -1 -37 - - SNR
Frequency 15.04 MHz index: 6 SNR value for Freq[6]= -10.0

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GenetScope / NETSIM 2

- **GenetScope / NETSIM2**
  - *Completed Phase 1 of Development 16 April 2006*
  - *Beta Provided to the Air Force for Review*
- **Phase II (Delivered March 2007)**
  - *Modeling of Entire Station*
    - *Up to 16 Radios*
    - *Different Antennas*
    - *Connection to DISN*
  - *Multiple Missions*
  - *Traffic Generation*
  - *E-Mail and Data Protocols*
- **Phase III**
  - *Distributed Processing*

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HFGCS SIMULATION POC

For Additional Information on HFGCS Modeling and Simulation, Contact:

Mr. Jeff Blosser

Test Director, HFGCS

547th Aircraft Sustainment Squadron

Tinker Air Force Base, OK 73145-9042

DSN: (312) 884-0062

Commercial: (405) 734-0062

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CONCLUSION

- *Closing Comments*
- *Questions*
- *Points of Contact*

JITC POC and Web Page Information

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