Projects in Electrical & Computer Engineering 2007-2008

Cellular Over The Horizon Enforcement Network using Automatic Link Establishment

Jennifer Sullivan

Christopher Rogers

Project Advisor: Dr. McKaughan

Sponsor: TISCOM

Outline

- Background
  - Current structure
  - Significance of Project
  - Automatic Link Establishment (ALE)
  - Cellular Over the Horizon Enforcement Network (COTHEN)
- Test and Results
- Recommendations

Introduction

- Commandant has mandated a communications systems transformation (COMMSYS Transform)
- One portion is to improve HF communications
  - Holes in coverage area
  - Limited to point to point calls
  - Lack of expertise in frequency management
  - Difficulty of use

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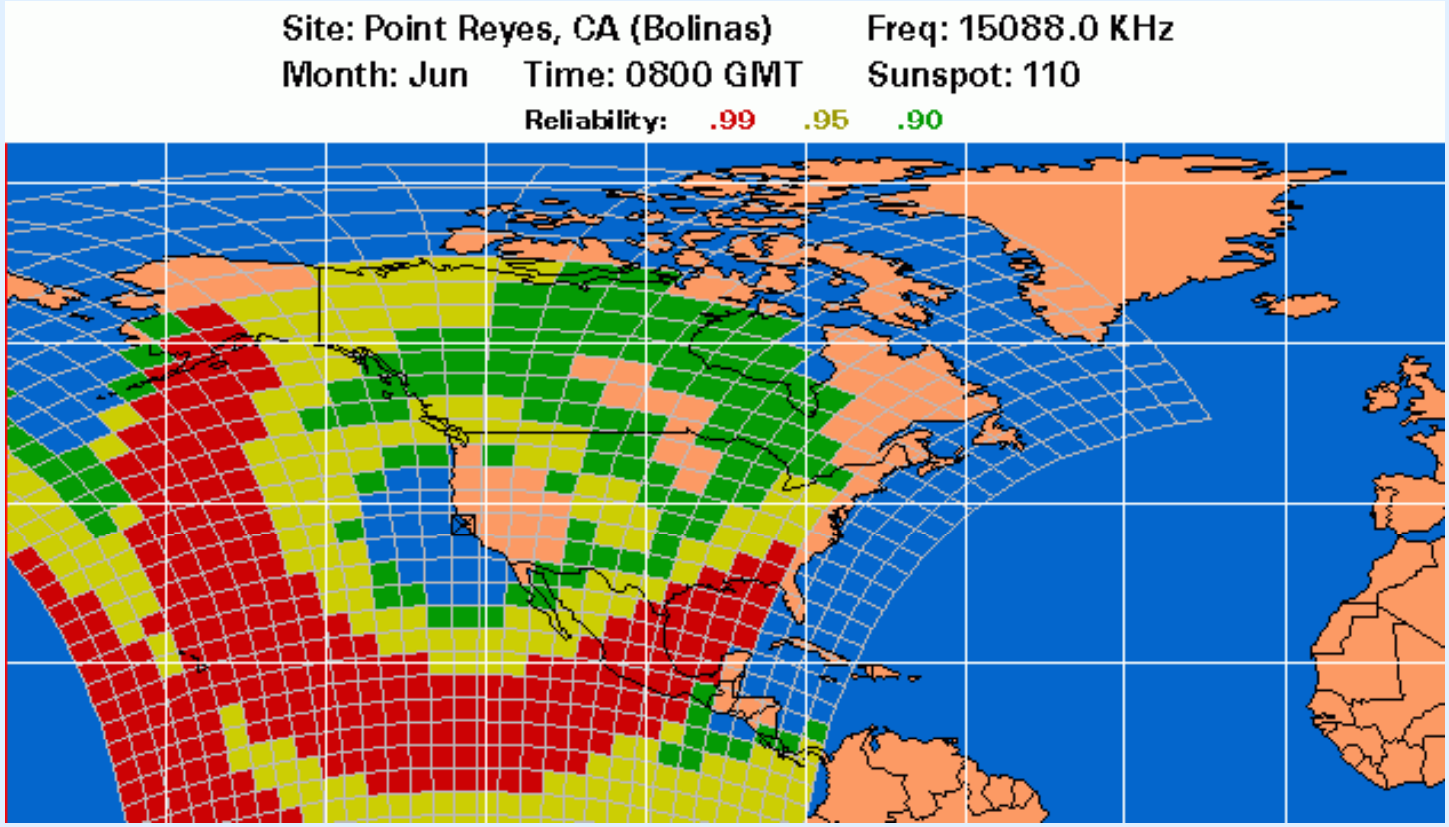
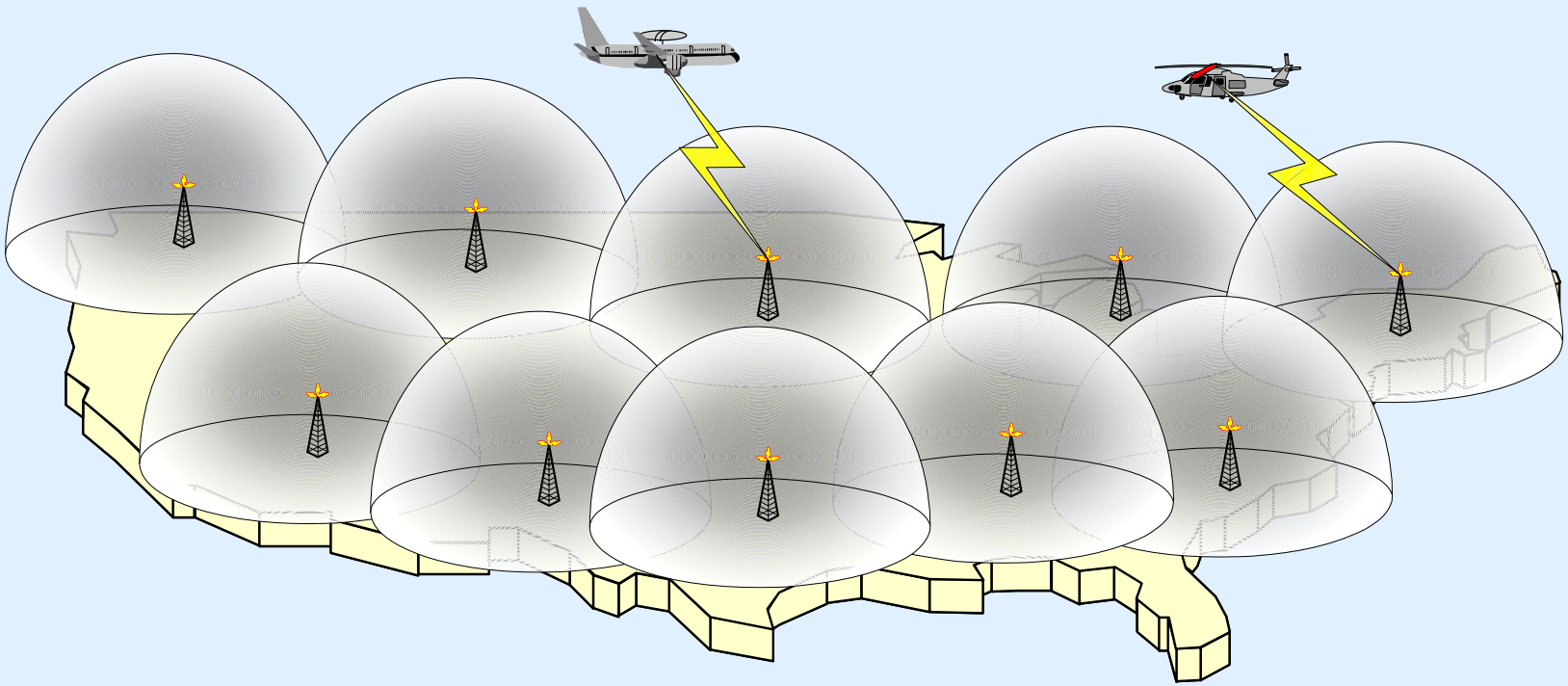
Holes in HF Propagation



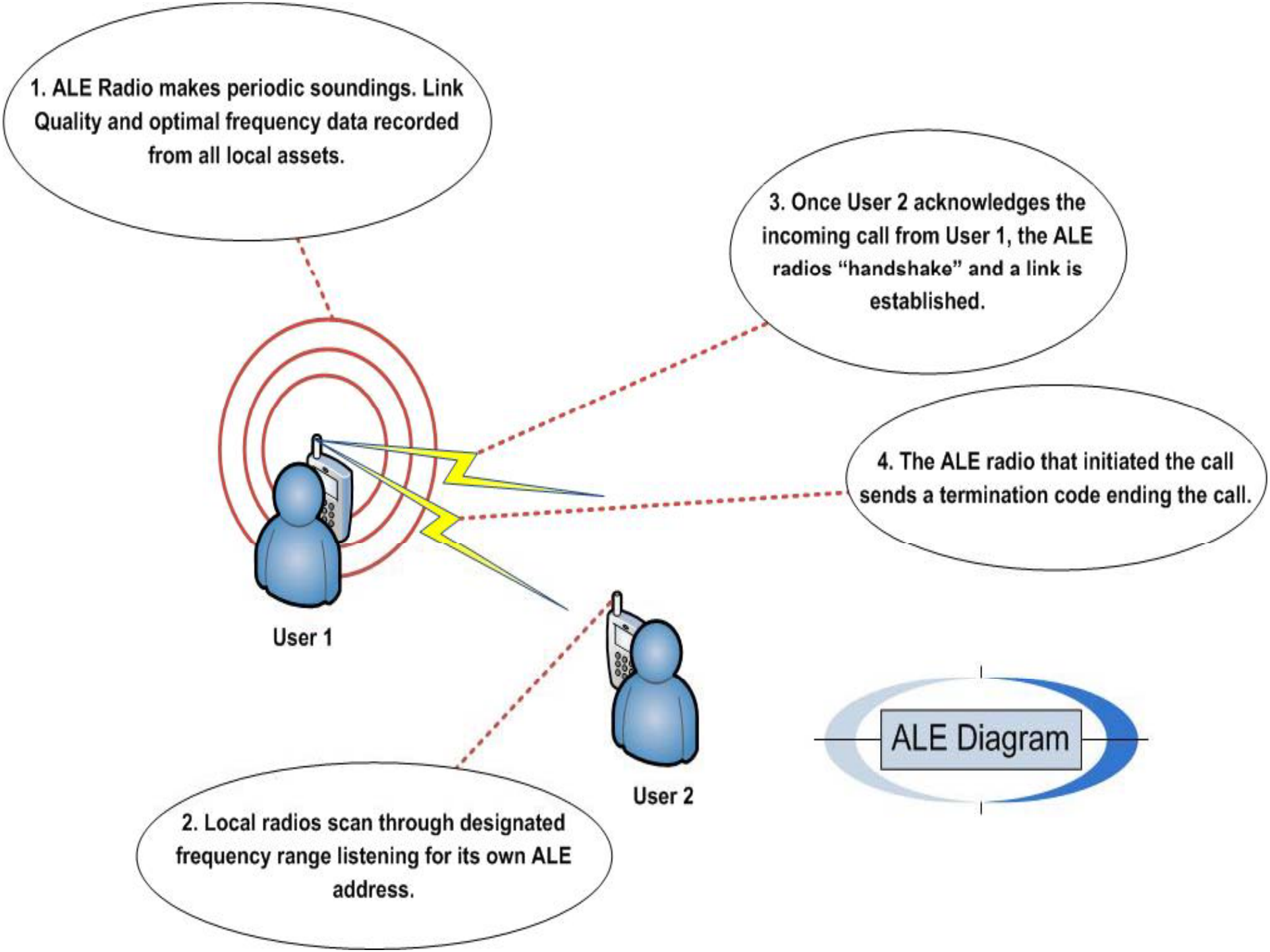
Introduction

Point to Point



Background

- Automatic Link Establishment (ALE)
- COTHEN


1. ALE Radio makes periodic soundings. Link Quality and optimal frequency data recorded from all local assets.
3. Once User 2 acknowledges the incoming call from User 1, the ALE radios "handshake" and a link is established.
4. The ALE radio that initiated the call sends a termination code ending the call.
User 1
User 2
ALE Diagram
2. Local radios scan through designated frequency range listening for its own ALE address.

Background

COTHEN

- Operated by Customs
- Employs ALE at 18 unmanned transmission sites locations
- All transmission sites are connected by phone lines creating an umbrella like coverage area.

Background

Capabilities of COTHEN

- **Proven Technology Currently in Use by the US Customs and Border Protection, and US Coast Guard Throughout the Continental United States, Puerto Rico, and the North Pacific**
- **Seamless HF Communications Coverage**
- **Best Station Linking**
- **Network Analysis at a Glance**
- **Active Platforms ICON Display**
- **Alternate Station Routing**
- **Detect and Avoid Faulted Radios**
- **No Null Areas**
- **Redundant Capacity**
- **Interoperability with other agencies**
- **Generic User Interface (HyperTerminal & Audio)**
- **Contingency Comms Capable for Emergency Response**
- **Simultaneous Calling (Collision Avoidance)**
- **Busy Channel Avoidance**
- **Intercom Call Routing**
- **Call Forwarding**

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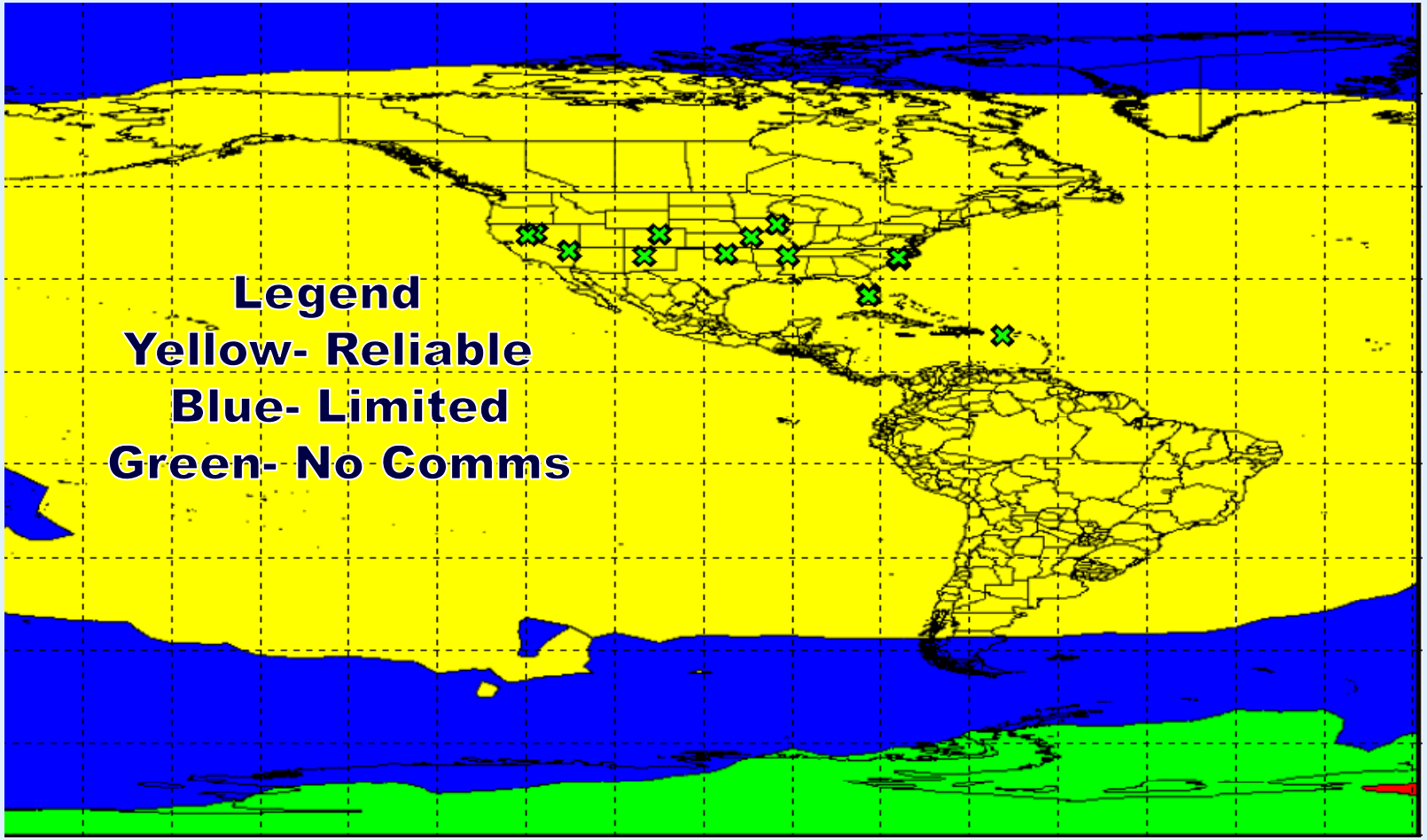
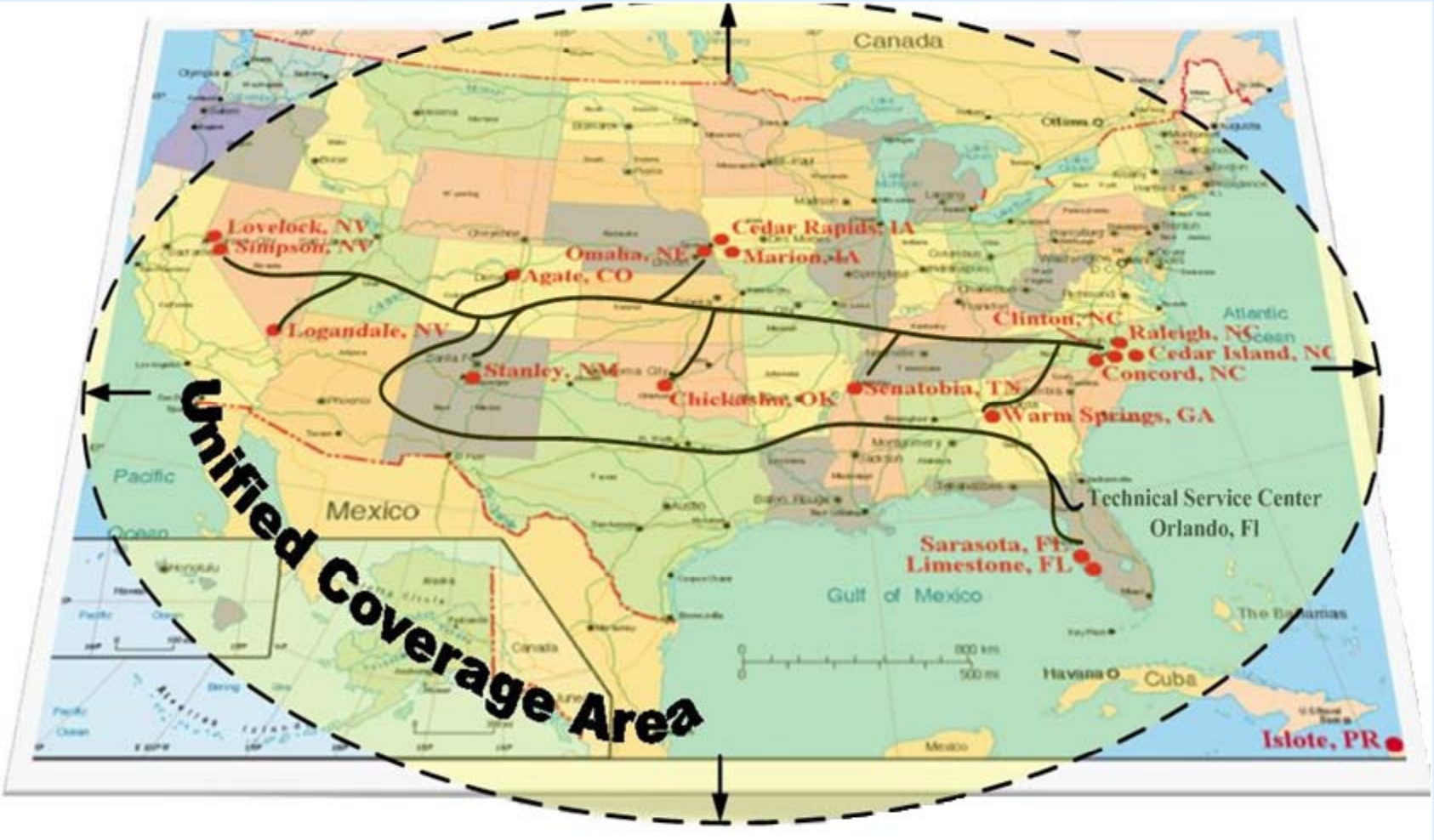
Propagation Map of COTHEN



Requirements

- **Communications between aircraft and shore stations need to be made every 15/30 minutes 95% of the time**
- **One standard Coast Guard wide HF communications protocol**
- **Operational commanders do all the flight following, reducing the load at CAMS**
- **Increase HF expertise in the Coast Guard**

COTHEN Design



COTHEN Design

- 2 antennas: directional and omni-directional
- 1 KW of power
- 56 k bit phone lines
- Rockwell Collins RT 2200 radios (data and voice transceiver)
- Remote Command Consoles (RCC)

COTHEN Design

Technical Service Center

- Full time watch standers
- Monitor all calls within the network
- Provide real time on-air assistance
- Ensure best link
- Simultaneous calling

Test Plan

- Analyze HF communications logs from CAMS to provide quantitative data about COTHEN and HF use.
- Use HF data log to gather qualitative data for both pre and post COTHEN at CAMSLANT
- Analyze data from TSC/COTHEN to outline strengths and weaknesses of system

Test Plan

HF Data Log

DATE	UNIT	CLEAR	BROKEN	NO JOY / LOST COMMS	GUARD KEPT W/ OTHER UNIT / WHO?

Results

CAMSLANT HF Communications Logs

Total Number of Calls Through CAMSLANT

	COTHEN				HF			
Date	Rotary Calls	Rotary < 20min	Fixed Calls	Fixed < 35min	Rotary Calls	Rotary < 20min	Fixed Calls	Fixed < 35min
3-Mar	71	63	29	27	0	0	21	21
10-Mar	92	89	45	43	0	0	27	25
13-Mar	86	85	31	30	0	0	57	57
14-Mar	140	115	32	31	0	0	39	37
16-Mar	35	35	3	3	0	0	25	22
17-Mar	55	52	13	13	0	0	75	70
18-Mar	62	57	37	35	2	2	50	44
19-Mar	112	110	17	13	10	10	43	39
20-Mar	122	114	34	33	0	0	43	42
21-Mar	35	33	26	25	0	0	47	46
22-Mar	22	20	26	25	21	19	11	11
23-Mar	16	16	13	13	0	0	22	20
24-Mar	82	74	31	27	4	4	55	50
25-Mar	93	84	57	53	0	0	43	41
Total	**1023**	**947**	**394**	**371**	**37**	**35**	**558**	**525**

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14-Mar	140	115	32	31	0	0	39	37
16-Mar	35	35	3	3	0	0	25	22
17-Mar	55	52	13	13	0	0	75	70
18-Mar	62	57	37	35	2	2	50	44
19-Mar	112	110	17	13	10	10	43	39
20-Mar	122	114	34	33	0	0	43	42
21-Mar	35	33	26	25	0	0	47	46
22-Mar	22	20	26	25	21	19	11	11
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Results

CAMSLANT HF Communications Logs

Type	COTHEN		HF	
Platform	Rotary	Fixed	Rotary	Fixed
Total Calls Made	1023	394	37	558
Percentage of Successful Calls	92.57%	94.16%	94.59%	94.09%

Results

CAMSLANT Qualitative Data Analysis

COTHEN		HF	
% Calls Made	59.2%	% Calls Made	40.8%
Broken	6.4%	Broken	10.5%
Dropped	0.8%	Dropped	5.8%

Results

TSC/COTHEN Data

Station	Feb 14-20	Feb 21-27	Mar6-12	Mar13-19	Mar20-26	Mar27-Apr2	Apr3-9	Total LQA >30	% of calls w/ LQA >30
Total Links	1467	1501	1845	1435	1771	1804	1637	11460	
>30 LQA									
VGS	50	154	74	113	103	88	108	690	6.020942408
SS1 XMT	0	0						0	0
SS1 RCV	193	233						426	3.717277487
SEA	428	503	396	387	433	376	300	2823	24.63350785
SAR	129	205	127	134	162	132	146	1035	9.031413613
RSH	194	274	159	188	252	171	176	1414	12.33856894
RNO	23	91	25	24	33	47	45	288	2.513089005
PR1	165	257	173	191	214	192	128	1320	11.51832461
OKO	146	210	167	127	177	194	143	1164	10.15706806
OKD	93	122	80	62	127	105	91	680	5.933682373
MEM	165	246	178	155	212	199	150	1305	11.38743455
LUV	69	133	57	50	95	87	87	578	5.043630017
KCM	136	230	135	135	193	186	132	1147	10.008726
FTM	162	254	125	137	188	134	151	1151	10.04363002
DEN	23	87	46	37	51	80	73	397	3.464223386
CR8_330	57	77	61	76	79	109	83	542	4.729493892
CR7_270	48	100	69	56	84	92	104	553	4.82547993
CR6_210	87	136	96	85	140	151	129	824	7.190226876
CR5_150	109	196	178	175	226	242	169	1295	11.30017452
CR4_90	96	163	138	152	192	199	147	1087	9.485165794
CR3_30	84	81	81	64	96	121	99	626	5.462478185
CR2_NW	140	208	184	163	195	205	154	1249	10.89877836
CDI	196	257	158	208	251	180	176	1426	12.44328098
ATL	153	230	147	148	177	196	139	1190	10.38394415
ABQ	37		34	9	46	67	54	247	2.155322862
CR1_NE			104	75	124	119	83	505	4.406631763
CDR			150	144	231	203	139	867	7.565445026

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99.9%

Recommendations

- Coast Guard join COTHEN
- Test would be more robust if run for a whole year and in several locations
- Provide all sectors and air stations with RCC's
- Integrate Coast Guard transmission sites and frequencies to expand the network
- Have at least 3 mini-RCC's available in the Coast Guard to provide to other agencies in the event of joint missions or emergencies

Conclusions

- The Commandant has mandated a Communications System Transformation
- COTHEN is a good solution to CG HF communications short comings
- A more robust test will provide in-depth results about the performance of COTHEN in Coast Guard operations

Questions