

Wideband HF Application Example

Link-16 Messaging Reach Back with WBHF

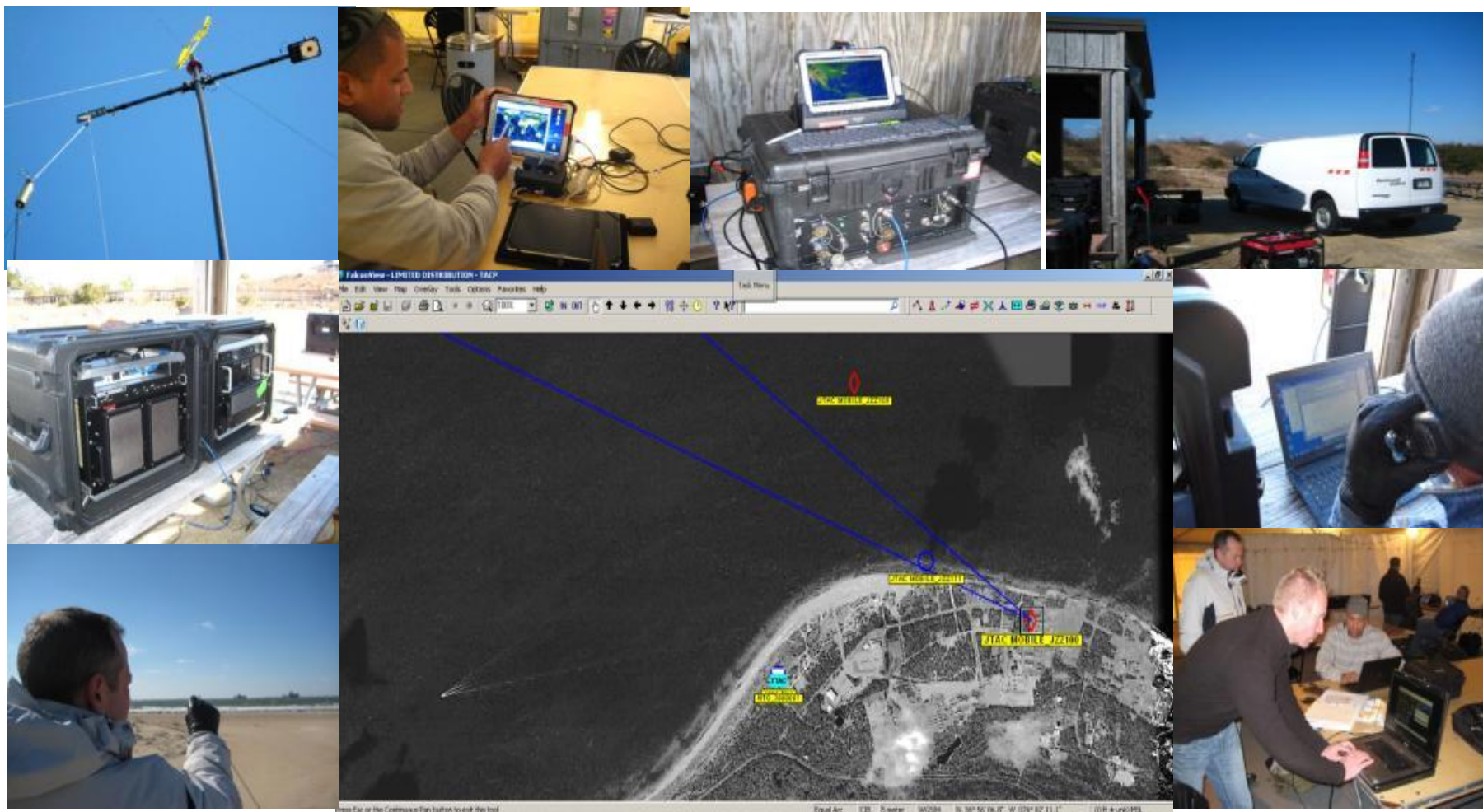
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HFIA February 12, 2015

**Rockwell
Collins**

SOCOM Technical Experiment 14-2: Link16 - WBHF Experiment, Fort Story, VA March 2014



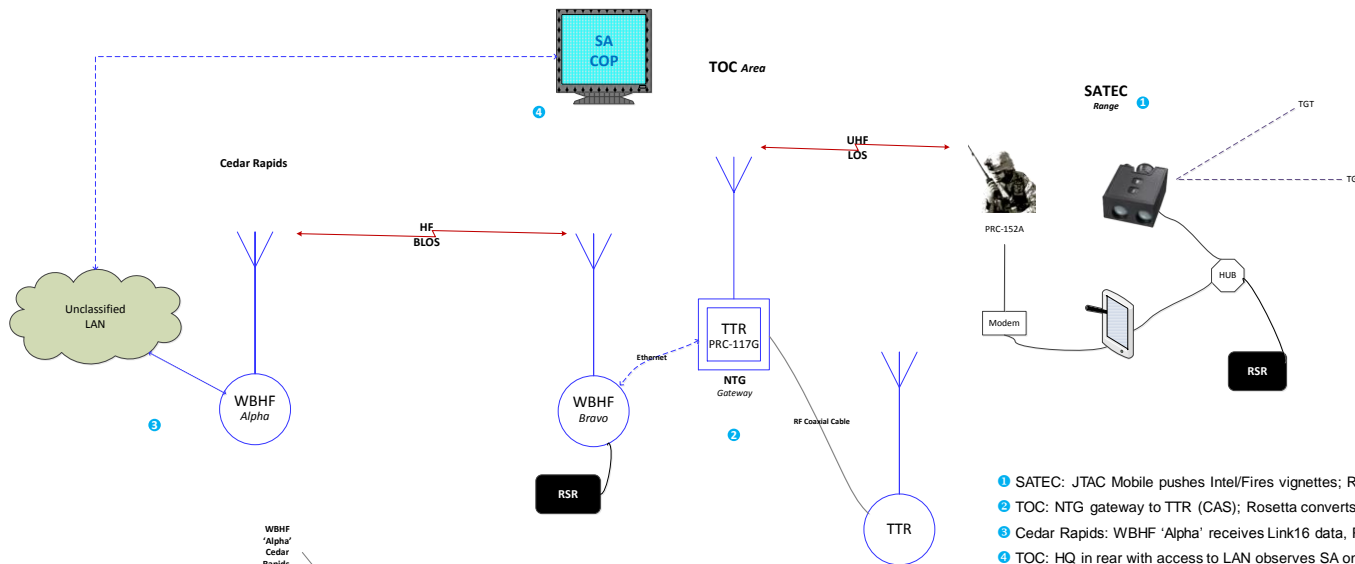
WBHF Experimentation – Objectives

- Perform a series of experiments underscoring how Wideband HF (WBHF) is a viable BLOS communications alternative for mitigating A2AD challenges:
 - WBHF transceiver: transportable WBHF system for OTA experimentation examining full motion video, chat, file transfer, whiteboard collaboration.
 - Conduct joint fires vignette using Joint Terminal Attack Controller (JTAC) Mobile, TacNet Tactical Radio (TTR) supported by Rosetta for generating TADIL J messages focusing upon Link-16 (JREAP-C) interoperability utilizing WBHF as a Beyond-Line-Of-Sight (BLOS) reach back medium
 - Establish 905 mile HF TCP-IP link between Fort Story, VA and Cedar Rapids, IA to demonstrate situational awareness reach back to command and control.

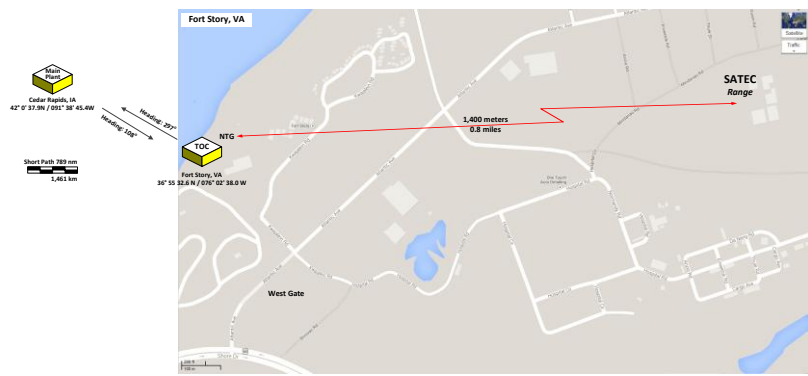
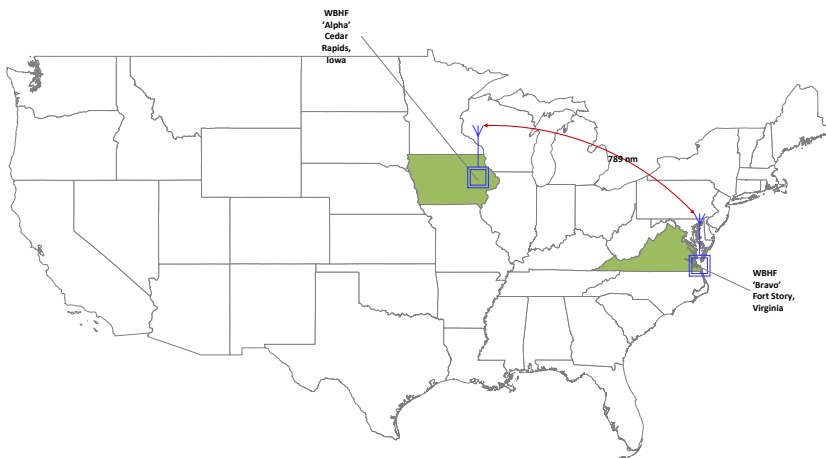
Link 16 over WBHF Experiment – CONOP

1. Employing JTAC Mobile to engage numerous offshore vessels (out to 2900 meters) using PLRF15C Laser Range Finder, plotted on a Panasonic tablet using Rosetta software.
2. Positioning, Navigation, Timing (PNT) data to be automatically transmitted via PRC-152A hand-held VHF/UHF radio from the beach location to Network Tactical Gateway (NTG), positioned 200 meters inland where data is received on a PRC-117G man pack radio.
3. The NTG converts the Variable Message Format (VMF) messages into Link 16 tracks, then routed to a TTR Link 16 terminal that passes the TADIL J messages to a second TTR Link 16 terminal (notional ground to air link).
4. Simultaneously, Rosetta converted the same targeting data to IP packets (JREAP-C), routed to the collocated WBHF fly-a-way kit, which relayed the data over a 905 mile BLOS link between Fort Story and WBHF station located in Cedar Rapids, Iowa.

LINK16 over WBHF Experiment



- 1 SATEC: JTAC Mobile pushes Intel/Fires vignettes; RSR injects SAASM PNT.
- 2 TOC: NTG gateway to TTR (CAS); Rosetta converts to IP (JREAP-C) to WBHF 'Bravo'.
- 3 Cedar Rapids: WBHF 'Alpha' receives Link16 data, Rosetta routes to LAN.
- 4 TOC: HQ in rear with access to LAN observes SA on COP display.



WBHF Experimentation – Equipment (Fort Story)

JTAC Mobile

- Equipment:
 - AN/PRC-152A HH Radio 220-512MHz; operating frequency: 337.5 MHz
 - Panasonic Tablet (Rosetta)
 - PLRF15C Laser Range Finder
- Location:
 - 200 meters NW of NTG, TTR, WBHF 'Bravo' Experiment Site

NTG

- Equipment:
 - TTR (2 radios)
 - AN/PRC-117G
 - CF-19 Toughbook
 - DAGR (GPS)
- Location:
 - 50 meters NW of TOC

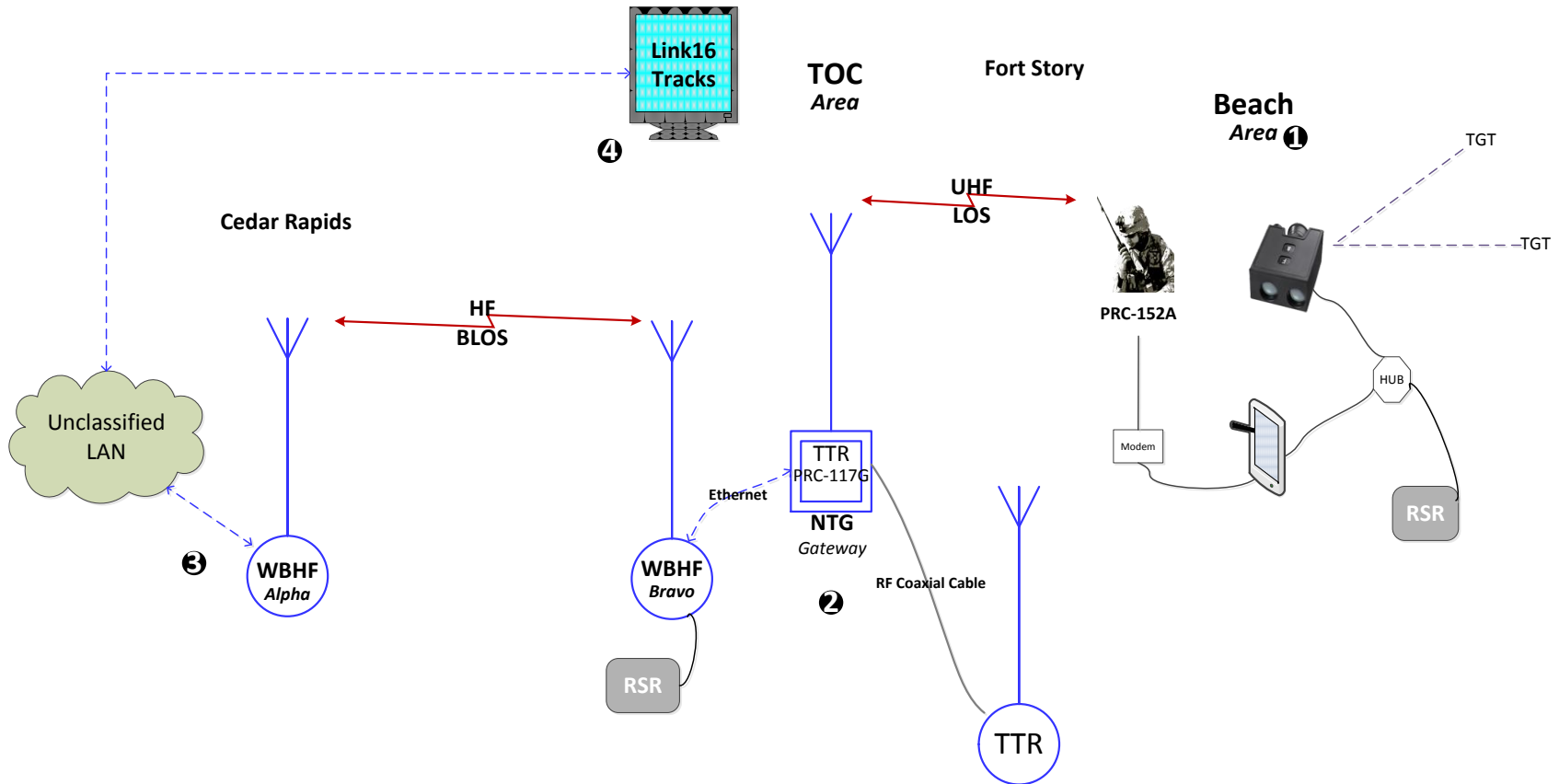
WBHF Node (Cedar Rapids)

- Equipment:
 - WBHF Receiver/Exciter: 1.5-30 MHz; 4G ALE, Modem; operating frequency: 14.965 MHz
 - SubNet Relay IP Network Layer Link
 - Power Source: Generator
 - Power Amplifier: ~400 watts average
 - Antenna: Tactical Sloping Vee
- Location:
 - 50 meters NW of TOC

Tactical Operations Center

- Equipment:
 - PC Laptop with WiFi (2)
- Location:
 - 50 meters SE of WBHF / NTG

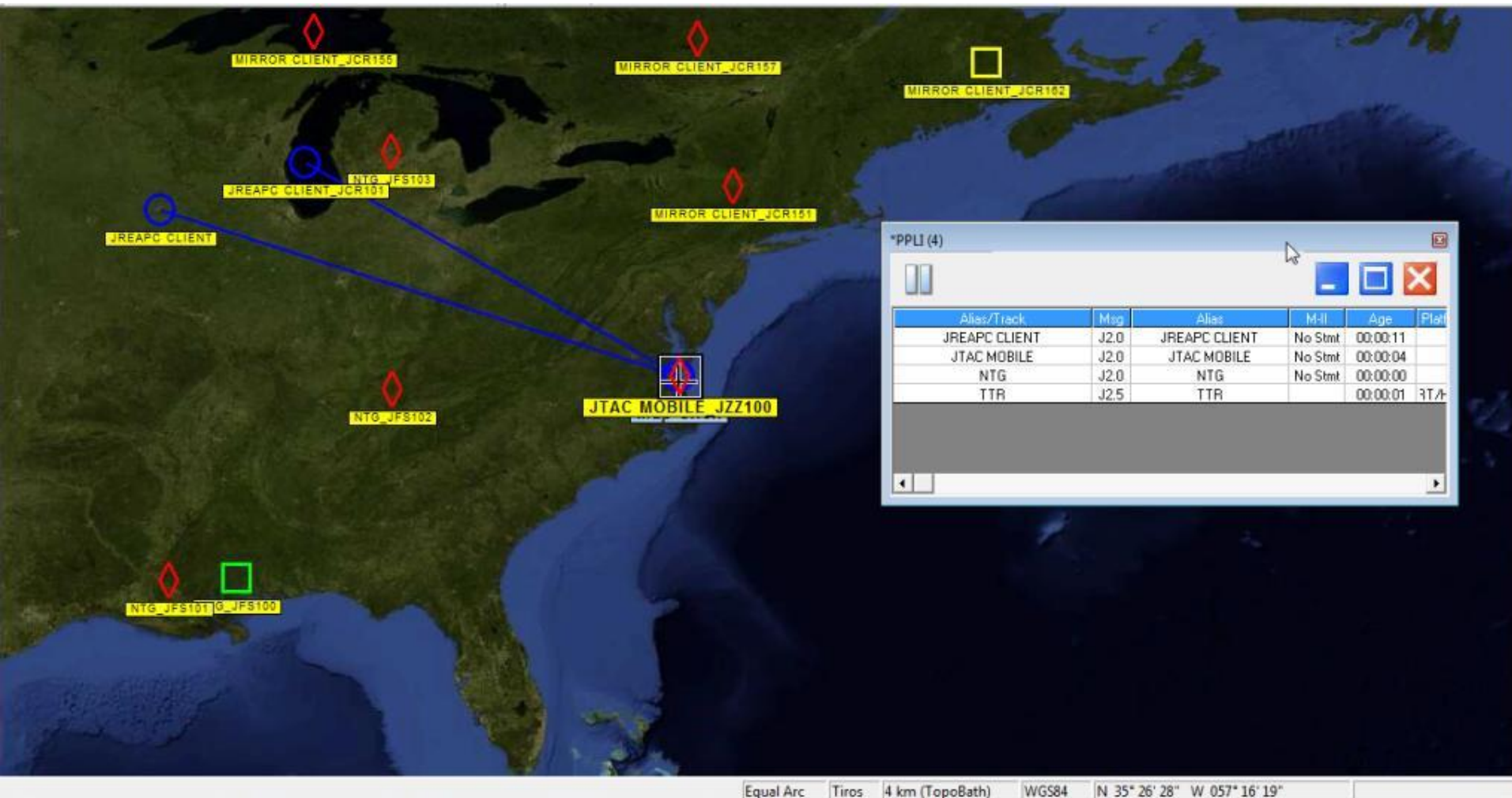
SOCOM Link 16 over WBHF Experiment



- ① JTAC Mobile initiates Joint Fires vignette; lazes off shore vessels from beach area, a distance of 200m west of NTG gateway; transmits VMF position messages to NTG via PRC-152 to PRC 117G UHF LOS radio network.
- ② NTG manages translation of JTAC's VMF messages, routes TADIL J messages to TTR (CAS) LOS radios; and simultaneously, performs JREAP-C, delivers to WBHF BLOS radio (Ft Story).
- ③ WBHF BLOS radio (Cedar Rapids receives TADIL J traffic and routes to Rosetta PC laptop.
- ④ RC Team in TOC (Ft Story) remotely logs into Rosetta PC laptop in CR via TOC WiFi; observes Link 16 Tracks, captures screen shots, and conducts two-way free text 'chat' session bridging internet, WBHF, and Link 16 networks.

LINK 16 JREAP-C via WBHF

- Rosetta Networked Joint Fires Common Operating Picture



Screen Capture of Link 16 Tracks at Cedar Rapids WBHF Node 'Alpha'.

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Quantitative/Qualitative Results

- Bandwidth:
 - Started experiment at 48 kHz bandwidth transmitting full motion video
 - Re-established more conservative ALE link to 30 kHz band for majority of the experiment to avoid detected periodic interferers and ~3 dB gain in SNR
- Throughput:
 - SNC-2050 Subnet Relay TDMA Node Controller (per STANAG 4691) utilized for establishing point-to-point IP link between WBHF nodes
 - Data rate 32 kbps (4-PSK) with 120 msec interleaver
 - Effective net data throughput: 22.4 kbps (TDMA & TCP/IP overhead ~30 %)
 - Conservative data rates were selected to prevent IP network link loss and to minimize errors (packet retransmissions).

Quantitative/Qualitative Results

- Link 16 over WBHF Experiment
 - Date: 26 March 2014
 - Time frame: 2 hours, 14:30-16:30 EDT
- Both 4G ALE /Subnet Relay sustained and maintained an uninterrupted physical layer and higher layer IP-based network (TCP/IP) hosting the Rosetta JREAP-C application for 2 hours.
- Noted Errors:
 - During the 2 hours relaying / transmitting JREAP-C tracking data, the system detected only 1 packet error recognized by the SubNet Relay TCP protocol, noted on the WBHF node 'Alpha' (Cedar Rapids)
 - No errors noted during Link 16 over WBHF over-the-air experiment on WBHF node 'Bravo' (Fort Story); only error originated from Bravo side of link.

SOCOM WBHF Experimentation – Results

- Time of receipt for Link 16 data (end-to-end)
 - Calculated from moment target was lazed, transmitted over the entire communications system, and realized on digital map display at distant end (Cedar Rapids): **~5 seconds**.
 - Post experiment analysis concluded additional two seconds could be shaved from total transport time to “command and control”
 - Fort Story TOC remotely logged in to Rosetta PC connected to WBHF link at distant end (Cedar Rapids) to view Link 16 tracks and conducted two-way chat sessions through entire system.
- Truly digital CAS scenario, as JTAC and acting Ops/Intel personnel were the only human factors in the loop. Equally important, BLOS communications accomplished without SATCOM.

JTAC Mobile Lazes Offshore Vessel – JZZ105

Sym	Age	Src	Ref	Alias
←	00:00:14	55	JZZ106	
←	00:00:40	55	JZZ105	
←	00:01:04	55	JZZ103	
←	00:00:29	55	JZZ102	
←	00:00:07	55	JZZ101	
←	00:00:25	55	JZZ100	
◇	00:00:22	602	JFS103	
◇	00:00:54	602	JFS102	
◇	00:00:07	602	JFS101	
◇	00:00:17	602	JFS100	

Video of JTAC pointing to JZZ105 Target (2000m) on display of Panasonic Tablet

JTAC Mobile (Chet Treloar) Lazes Offshore Vessel – JZZ105

TOC

NTG

JTAC MOBILE_JZZ105

JTAC MOBILE_JZZ100

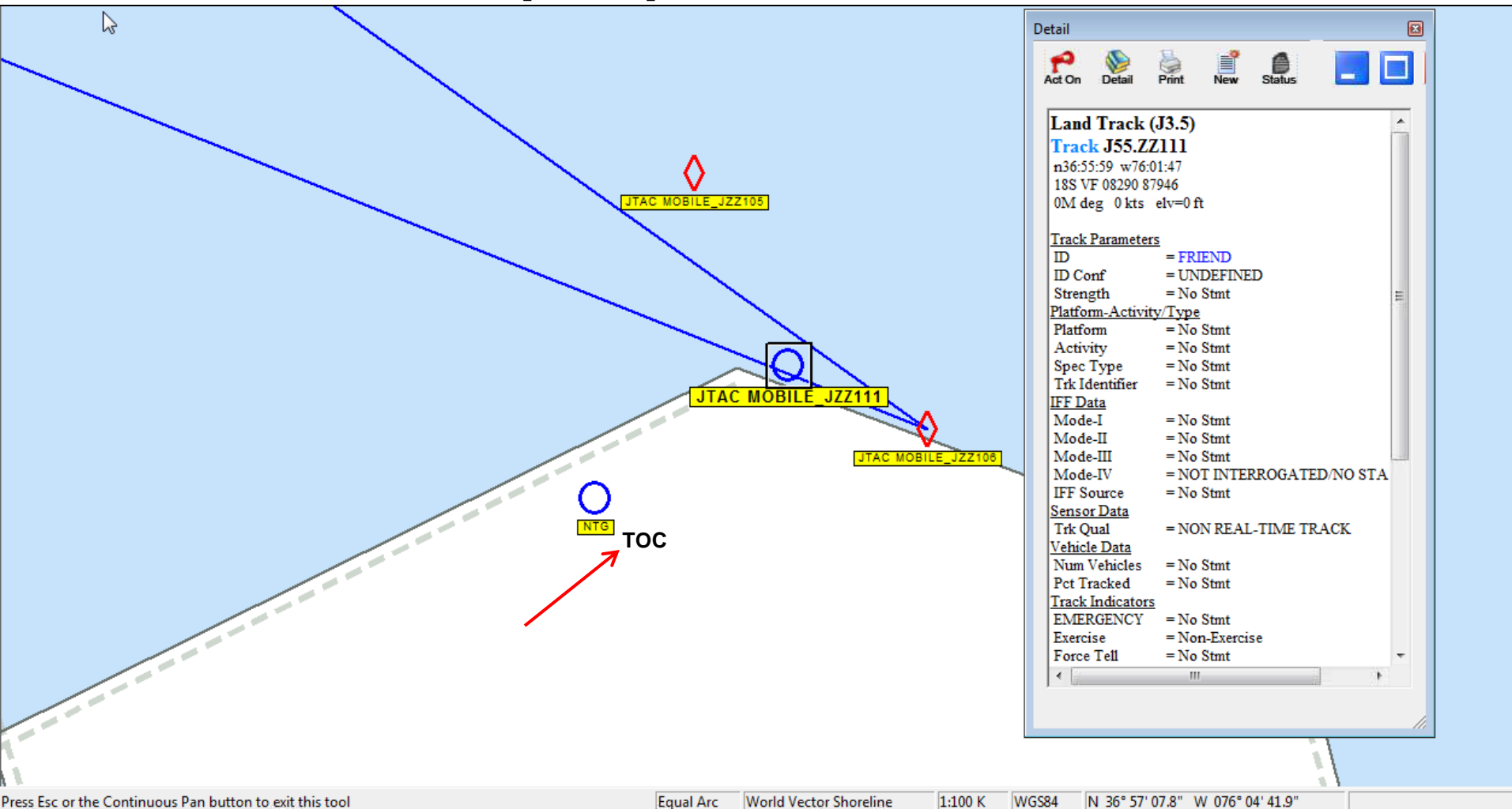
Click and drag to add range / bearing object. Equal Arc World Vector Shoreline 1:100 K WGS84 N 36° 59' 15.2" W 076° 01' 35.6"

Screen capture from PC laptop connected to WBHF node 'Alpha' located in Cedar Rapids, Iowa. Accessed remotely by RC Team situated within TE 14-2 TOC Fort Story, Virginia.

SOCOM WBHF Experimentation – Results

- Truly digital Close Air Support (CAS), as JTAC and acting Ops/Intel personnel were the only human factors in the loop. Equally important, BLOS was accomplished without SATCOM.
- Demonstrated subnet relay TCP-IP point-to-point link over medium haul HF skywave connection
- Demonstrated prototype wideband ALE protocol's spectrum sensing and bandwidth adaptation capabilities

Link 16 Free Text (Chat) Session via WBHF



Screen shot of JZZ105 and other tracks captured from PC running Rosetta and FalconView applications via Ethernet connection with WBHF node 'Alpha' located in Cedar Rapids, Iowa

Transportable Equipment used in Experiment



Transportable Fire Storm System



JTAC Mobile System



Transportable WBHF system



Tactical Sloping-V HF Antenna



"Shack" for WBHF & Fire Storm Systems



Rosetta Mapping SW

Rockwell Collins Team Members for Experiment

- Ed Clark
- Cecil Hammonds
- William Croghan
- Chet Treloar
- Ronnie Hoebeck
- Brad Buitkofer
- Joe Lahart
- David Church
- Randy Nelson

Special thanks to the transportable systems team who endured the harsh weather conditions at Virginia Beach

ACRONYMS

- **ALE**: Automatic Link Establishment
- **BLOS**: Beyond Line of Sight
- **CAS**: Close Air Support
- **JREAP**: Joint Range Extension Application Protocol
- **JTAC**: Joint Terminal Attack Controller
- **NTG**: Network Tactical Gateway
- **PNT**: Positioning, Navigation, Timing
- **TADIL**: Tactical Digital Information Link
- **TOC**: Tactical Operations Center
- **TTR**: TacNet Tactical Radio (small form factor Link 16 radio)
- **VMF**: Variable Message Format
- **WBHF**: Wideband HF



Questions?