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September 21, 2001

David E. Hilliard
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Ms. Magalie Roman-Salas
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, DC 20554

Re: ***Ex Parte* Notification - ET Docket No. 98-153 / Ultra Wideband Proceeding**

Dear Ms. Salas:

This is to note that on September 20, 2001, Mimi W. Dawson of this firm and I on behalf of Time Domain Corporation along with Ralph Petroff, President of Time Domain, Jeffrey Ross, Time Domain's Vice-President for Development, and Phillip Inglis met with Commissioner Michael Copps and his Legal Advisor Paul Margie to discuss the ultra-wideband proceeding. We explained Time Domain's view that the NPRM's proposed limits were more than adequate for the protection of licensed radio services and urged the Commission to move forward with a decision in this proceeding. In connection with the matter of possible defense applications of UWB technology, Mr. Petroff showed the enclosed slides from a recent conference. In accordance with the Commission's Rules, an original and one copy of this letter are being filed.

Respectfully,

David E. Hilliard

David E. Hilliard
Counsel for Time Domain Corporation

cc: The Honorable Michael Copps (w/encl.)
Paul Margie, Esq. (w/ encl.)

Enclosure

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List ABCDE

Ultra Wide Band Applications and Requirements

DARPA NETEX Industry Day
McLean, VA

10 Sept 2001

Steven J. Gunderson
NFESC Port Hueneme

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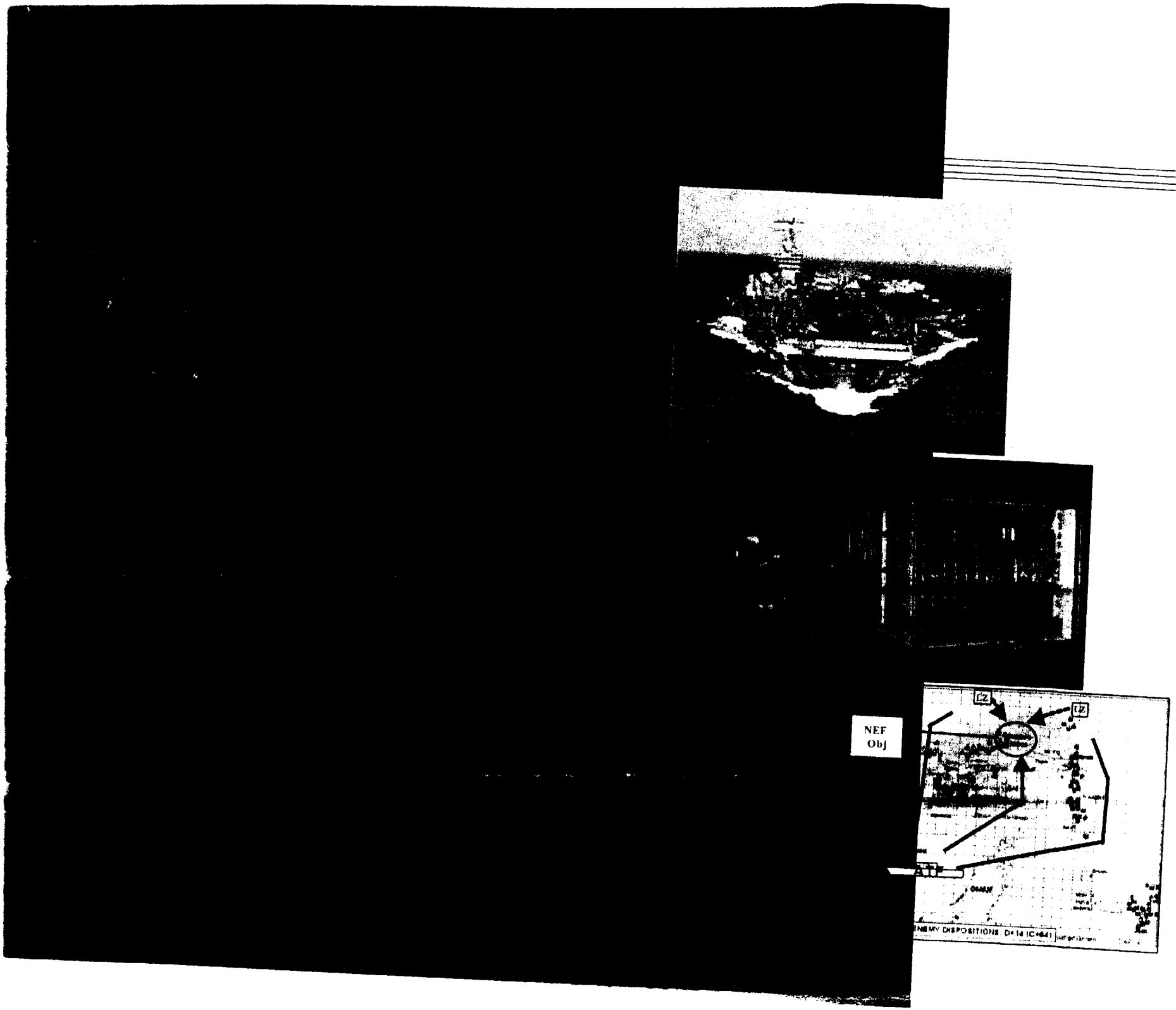
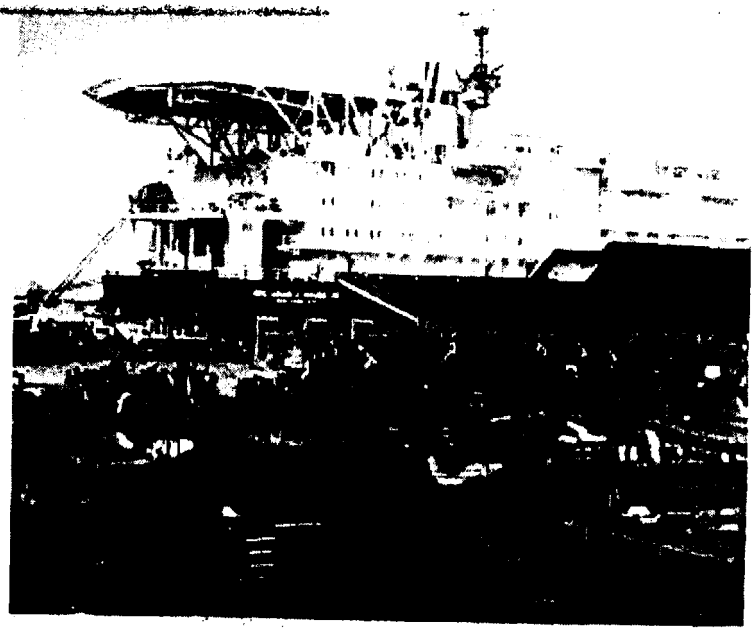

NEF
Obj
LZ
LZ
ATP
ENEMY DISPOSITIONS D+14 (C+64)

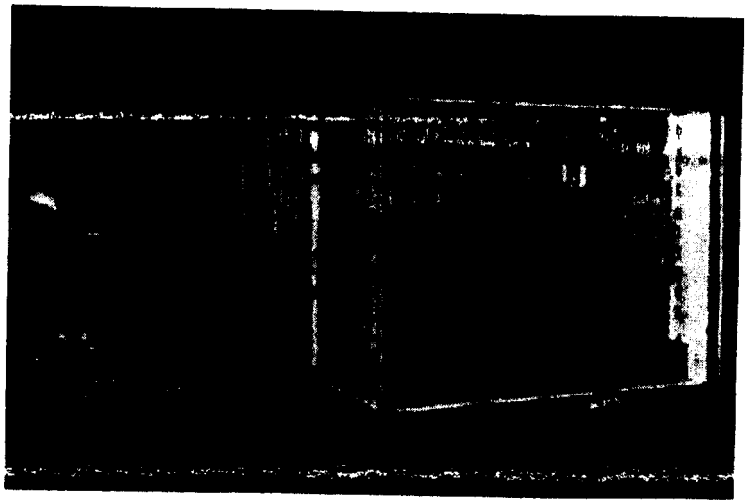
UWB Applications: Logistics

Desert Storm

- **First MRC with ISO Containers**
  - 40,000 Containers, Opened 25,000
    - » Paper Manifests Were Inaccurate and Easily Lost
  - ISO Containers Hid the Stuff
    - » Previous MRCs Used Break Bulk
  - Misplaced & Lost Stuff = $3 Billion
    - » GAO Report B-246015, Dec 1991



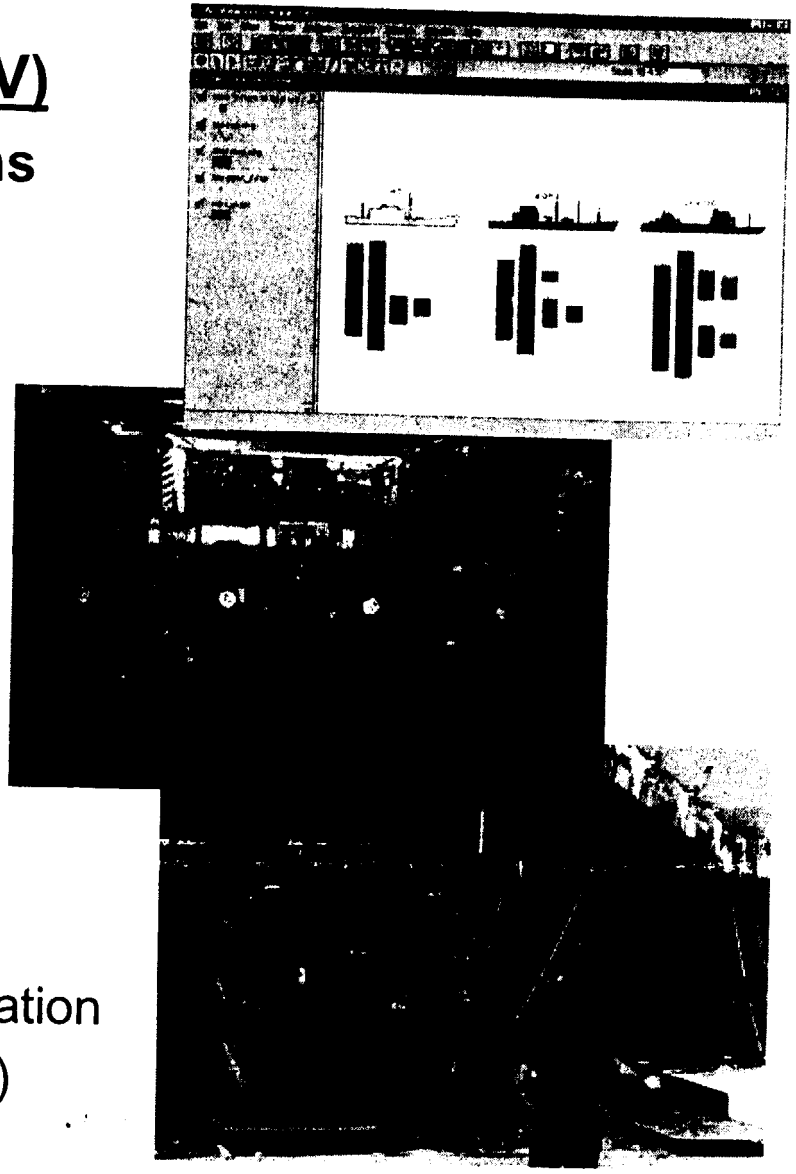
- **The BIG Questions**
  - What Do I Have?
  - Where Is My Stuff?
  - What Is In the Box?
  - What Is Its Condition/History?



UWB Applications: Logistics

Naval Total Asset Visibility (NTAV)

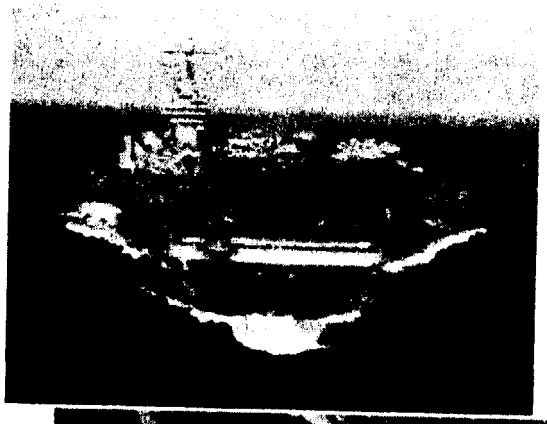
- **Tackle the Unsolved Hard Problems**
  - Precision Asset Location (PAL)
    - » Where's my Stuff?
    - » Ship Stow Plans
      - 40% Stow Error, Re-Inventory Required
  - Autonomous Manifesting (AM)
    - » What's in the Box?
    - » The "Holy Grail of Logistics"
  - Infrastructure Reduction (IR)
    - » Cost Reduction ($K's/Reader)
    - » Ship Pre-Installation and Cabling
- **Transportation is a $1T Industry**
  - DoD is Largest Purchaser of Transportation
  - US CINC Transportation (TRANSCOM)

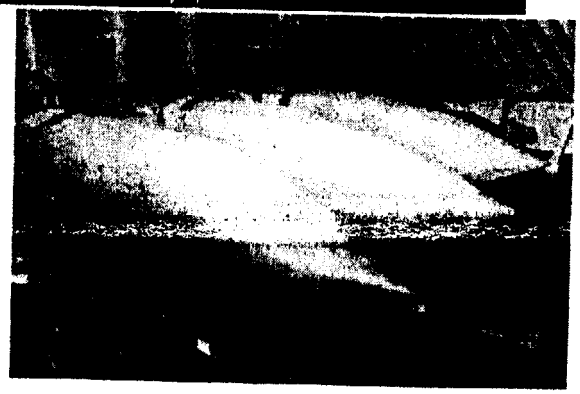


UWB Applications: Weapons

Carrier Weapons Management

- **NAVAIR / NAWC Lakehurst**
- **Problem**
  - Aircraft Leave With Partial Loads
    - » Desert Storm: Several Carriers Continuously Launched Aircraft with 2 or Less Weapons
  - Locate Weapon Components for Assembly
    - » Up to 9 hrs for Assembly: 8 Decks, 32 Mags
  - Locate Weapons in Hanger & Flight Decks
    - » Staging Areas, Main Deck, Bomb Farm
- **Hot RF Spots Throughout Carrier**
  - High Powered Radars: EMI / EMC / HERO
- **Proposed Solution**
  - UWB Precision Location of Weapon Sleds: 1 ft
- **Makes Aircraft Carriers More Lethal**

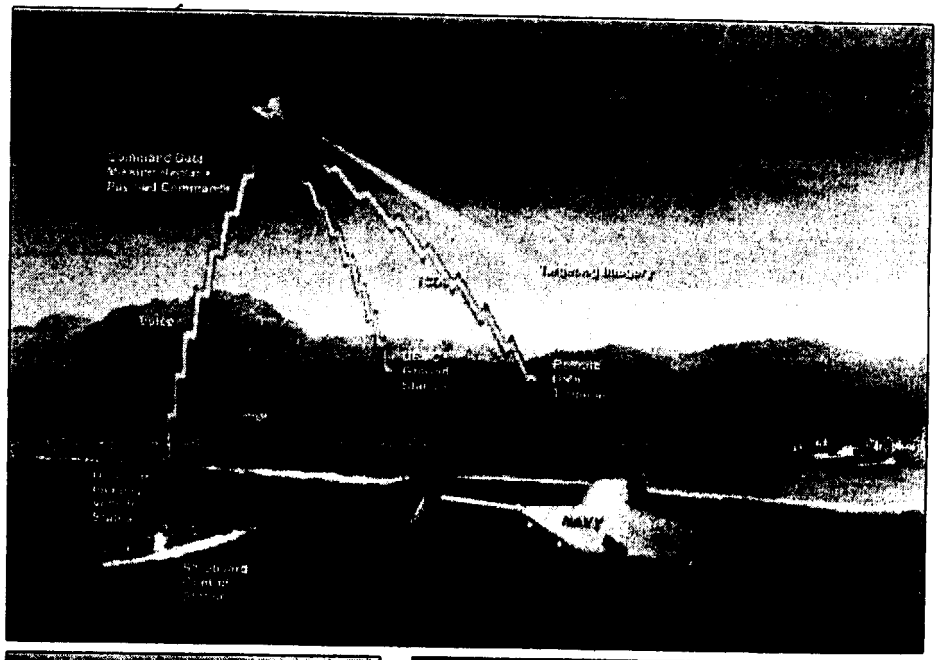


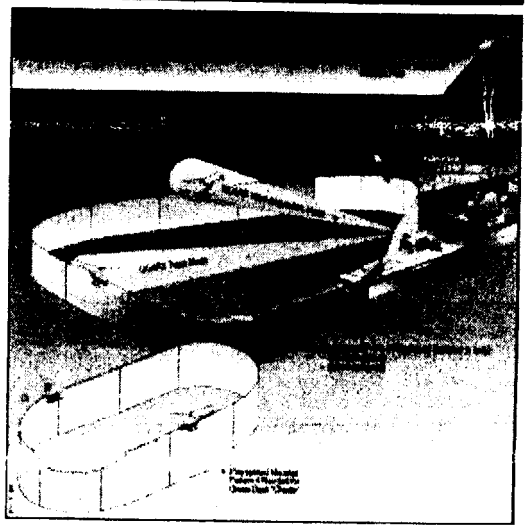


UWB Applications: Geolocation

UAV Landing System

- **UAV Common Automatic Recovery System (UCARS)**
  - Pioneer UAV
  - Microwave: 3 ft Accuracy
  - 6 ft Landing Grid
    - » Pitch / Roll / Stability
    - » Ship Under Way
- **RQ-8 Vertical Takeoff UAV**
  - 3 hrs 150 nmi, 12 hrs Total
  - Payload Capacity = 300 lbs
  - Comms Payloads
    - » (3) ARC-210 (Aircraft Radio)
    - » TCDL: 14-15 GHz, 10 Mbps
    - » SINCGARS to Ground MEUs





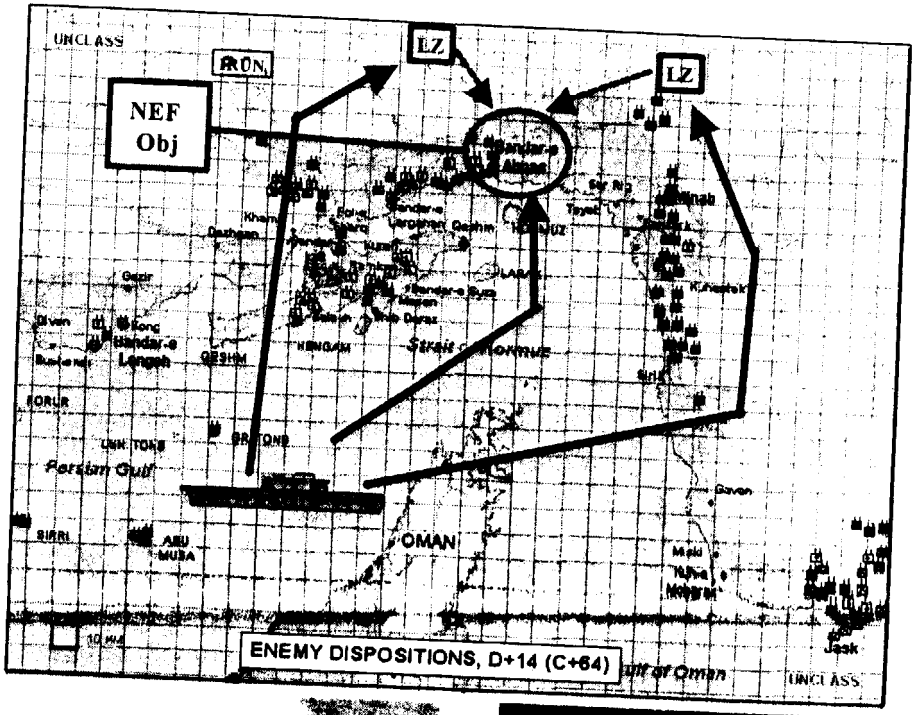
UCARS Ldg. Sys.

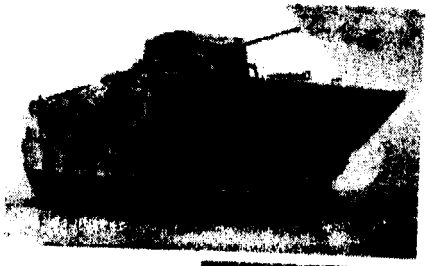
Concept:
Multiple Fleet/Ship Deployed High-Altitude Long-Endurance Station-Keeping UAV/Airships with Lightweight UWB LMR Relays Provide OTH Comms to Dismounted Warfighters

UWB Applications: Comms

Marine Corps OMFTS/STOM

- **High Capacity LOS Comms**
  - Replace MRC-142
    - » 576 Kb Ship-to-Shore, 25 nm
    - » Losing 1350-1850 MHz Band
- **Command Post on the Move**
  - Secure Wireless LAN
    - » Connect Servers Within CP
- **Convoys on the Move**
  - Inter-Vehicle Comms
- **Combat ID**
  - Geolocation
  - Surface Management
    - » Ship-to-Shore Movement: AAAV & LCAC
- **Asset Visibility**





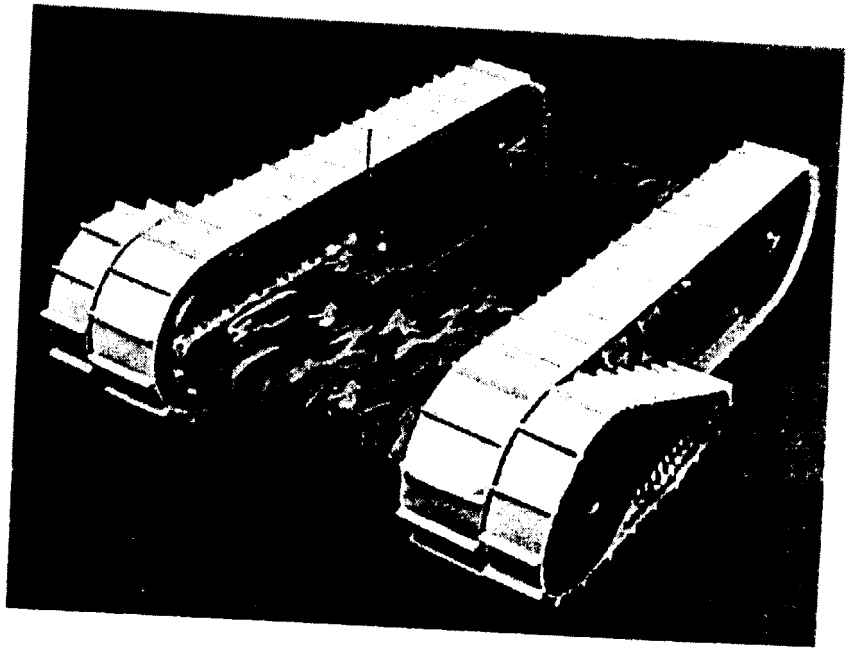
UWB Applications: Comms

Urban Warfare

- **MOUT ACTD / USA / USMC**
  - Frustrated Requirements: **C4I**
    - » R1: Identification of Friendly, Enemy, Noncombatants (IFF)
    - » R3: Hands-Free Non-Line of Sight (NLOS) Communications
    - » R7: Thru-Wall Sensing
    - » R41: Position/Location Inside Buildings
  - Military/Com'l Comms Inadequate
    - » Marine Corps Inter-Squad Radios (ISR)
      - ICOM UHF Radios: Non-Secure - 16,000 Units
    - » Need Secure Radio, 1-5 Km Range
      - PRC-126 Size, Light Weight (Micro-UAV)
      - C2 for Unmanned Ground Vehicles & Video
  - Transition to Proposed Vanguard ATD '03
  - Transition to SBCCOM Objective Force Warrior Program

UWB Applications: Comms

Tactical Mobile Robots (TMR)

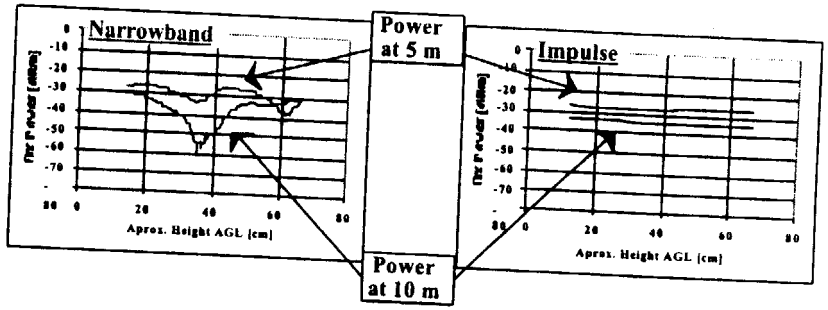


- **Imperatives**
  - Tele-Operation
    - » C2, Audio and Video
    - » Robots Talk to Each Other
  - Geolocation / Navigation
    - » Robots Find Each Other
  - Autonomously Reestablish Comms
- **Requirements**
  - Bandwidth
    - » C2 & Audio (low latency) 25 Kbps
    - » Video (B&W, fuzzy, min) 100 Kbps
    - » Color Video (160x120) 1-2 Mbps
    - » High Res Video (320x240) 3 Mbps
  - Range
    - » 500m min (LAN Block Conv), 1-2 Km
  - Weight & Power: 1-2 lb, 2-5 W
  - Geolocation: 1 cm
    - » Navigation/Mapping/Marsupial
  - Environment
    - » Urban: Streets, Buildings, Sewers, Tunnels
    - » High EMI: DC Motors

UWB Requirements

Advantages

- **Multi-Path**
  - Minimize Nulls in Urban Environments
  - $1/r^2$ -- $1/r^4$ -- $1/r^6$ Losses
    - » 1 - 2 Orders Better than Narrow Band
      - Extra Transmitter Power Not Needed: 10-100X



- **Co-Interference**
  - FHSS: SINCGARS -- >2.5 Radios Co-located
  - DSSS: Near-Far Power Management -- Qualcomm 1 dB Match Required
  - UWB: 40-50 dB Rejection
- **Land Mobil Radio (LMR) / Cellular**
  - Greater Agility: No Critically Tuned Tanks / Combiners / Splitters
  - No Dedicated Reservation Channel
- **Interceptibility**
  - Inherent LPI/LPD/LPE/AJ
- **Geolocation**
  - High Inherent Accuracy: Short Pulse Length ~1 ns = 1 ft
- **Dual Capability: Communications and Geolocation Simultaneously**

UWB Requirements

Architectures

- **Voice**
  - Inter Squad Radio (ISR)
  - Land Mobile Radio (LMR)
- **Data**
  - Burst Store & Forward
  - TCP-IP / Packet
  - Ad-Hoc Peer-to-Peer Networks
- **Video**
  - High Data Rate 1-3 Mbps
- **Geolocation**
  - Intra-Squad
  - Urban: Bldgs, Streets, Sewers
  - Alternate GPS

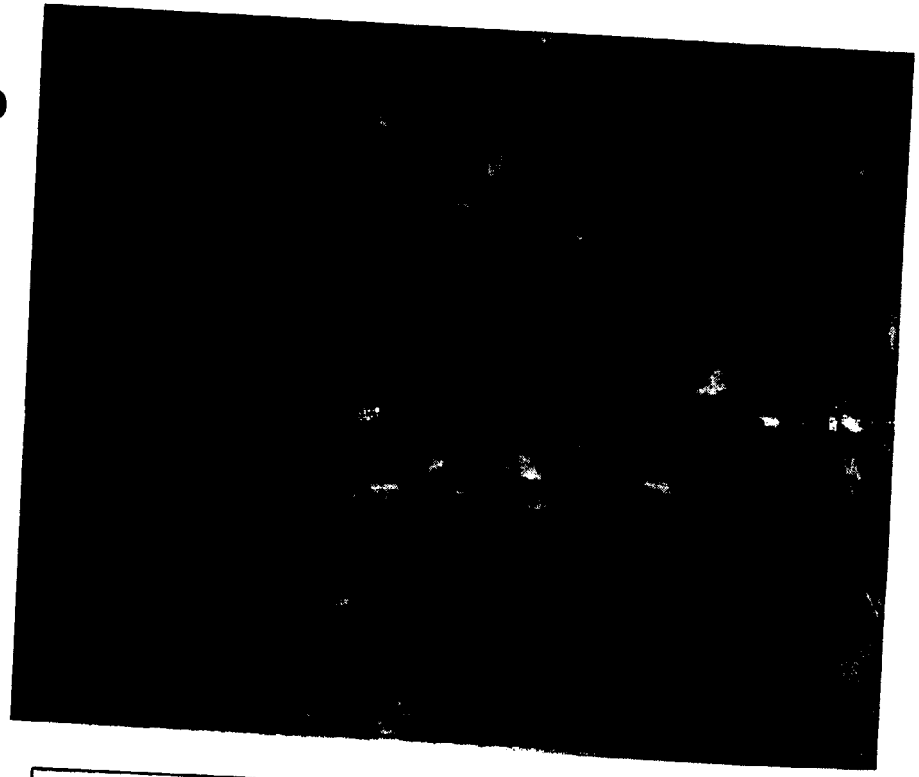
Warfighter Requirements

- **Works Anywhere**
  - Urban
  - Triple Canopy
  - Mountain Terrain
  - No Terrestrial Infrastructure
- **Quality**
  - Fast Enough
  - Secure: LPI/LPD/LPE/AJ
  - 20 - 30 dB More Link Margin
- **Logistics**
  - Small
  - Light
  - Cheap

Conclusion

Hunter Warrior AWE

- **Marine Corps Warfighting Lab**
  - First AWE, 1997 All Data
  - RMA: Asymmetrical Warfare
- **DARPA Provided Technology**
  - Land Mobil Radio (LMR)
  - Internet Node In the Sky (INITS)
  - Shared Net: *Content Centric*
  - ADOCS / LeatherNet (M&S)
  - Surrogates, But They Worked
- **Burst Store & Forward**
  - LMR: Serial, 2.7 Kbps
    - » Short Message: OTH Gold & VMF
    - » 3 Sec on Air, Hard to Locate
  - INITS: TCP-IP, 300 Kbps Total



"In This World Where We're Carrying **Mobile Handsets**, I'm Afraid the Communications of the World's Most Advanced Military Are Operating at Levels that are 40 Years Out of Date."

Adm. Owens (ret)

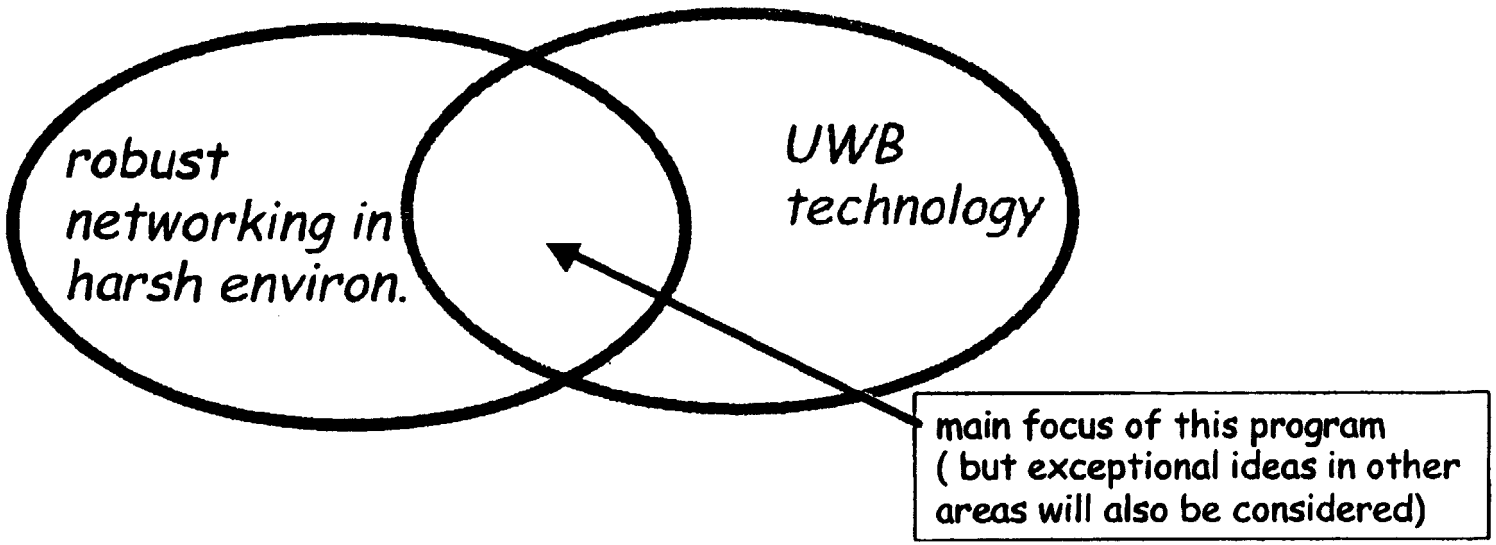
Networking In the Extreme (NETEX) Program

Industry Day
Sept 10, 2001

Mari Maeda
Program Manager
Information Technology Office
DARPA

Program Goal

Robust and rapid wireless networking in complex, hostile environments *using UWB technology*



- robust - immunity to fading/outages
- complex - harsh settings, urban, indoor
- hostile - low probability of jam/detect
- rapid - on-the-fly networks, no spectrum assignment

Why Harsh Environments

- Dense urban terrain represents the single most hazardous setting for engagement
- Casualty rate extremely high
- Increasing shift of world population to cities
  85% of world population by 2024
- GPS often ineffective
- Need to protect our forces, remove personnel from areas of high threat, deploy sensors & robots

- Other harsh settings: on ships, inside cargo containers, close to the ground...

UWB Claims

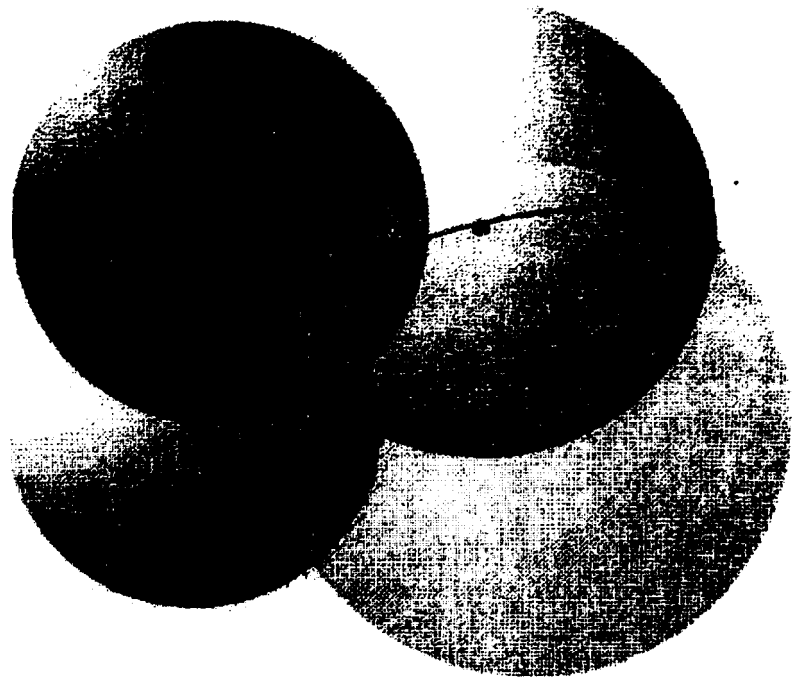
- No fading from destructive interference (coherent effects are less)
- Potential for single chip, all digital (cost savings)
- Lower power dissipation (few analog components)
- Built-in LPI/LPD/LPJ
- No need to get spectral allocation (uwb signal is buried in the noise)
- Penetration capability - walls, ground (enabled by low frequency component)
- High precision ranging (enabled by high frequency component)

- Focus on the real advantages of UWB
- Design and implement next-generation UWB hardware and software for ad-hoc networking in extreme environments.
- Develop uwb network-based geolocalization system
- Demonstrate key DOD applications in appropriately harsh, environments

Technical Areas

<u>Precision Geo-Localization</u>

- 3-D multi-lateration
- scalable and power-efficient geolocalization techniques
- in-depth tradeoff analysis
  (accuracy vs.
  power, number of nodes ..)
- mobility support



Ultrawideband (Impulse Radio) Communications Technical Challenges

NETEX Industry Day

10 September 01

Dr. James A. Freebersyser
Program Manager, DARPA/ATO
(703) 696-2296
jfree@darpa.mil

Potential Advantages of UWB

- Ultrawideband Operation (> 1 GHz)
  - Better multipath fading performance (like any wideband signal would)
  - Large processing gain (> 40 dB) improves Anti-Jam (AJ) properties
  - Covert operation (Low Probability of Intercept/Detection (LPI/D))
  - Position location on the order of a few centimeters
- Greatly Reduced Power Consumption
  - Single chip (CMOS) implementation without mixed signal processing
  - Low duty cycle operation
  - Higher energy efficiency due to pulsed battery operation
- More Efficient Use of the Spectrum
  - More users per unit of bandwidth
  - Unregulated (FCC Part 15) operation
  - Reduced near-far interference resulting from low duty cycle operation
  - Full-duplex operation in the same frequency band

The Potential of UWB Impulse Radio Has Not Been Realized

Summary/Conclusion

- Ultrawideband - What's Old Is New Again!
  - Wireless could have gone straight to UWB if DSP had been available ☺
- A Cornucopia of Commercial and Military Applications
  - Communications, radar, geolocation, automation, measurement, etc.
- UWB Has The Potential for Revolutionary Change
  - Regulatory changes (FCC Part 15?) are needed
- UWB Research Has Only Just Begun
  - Propagation, antennas, circuits, devices, waveforms, signal processing, radio architectures, MAC/network protocols, etc.