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OFFICE OF THE SECRETARY

September 20, 2001

David E. Hilliard
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Ms. Magalie Roman-Salas
Secretary
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Washington, DC 20554

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McLEAN, VA 22102
PHONE 703.905.2800
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www.wrf.com

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

Dear Ms. Salas:

This is to note that on September 19, Mimi W. Dawson and Mary Jo Manning 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 Paul Margie, Legal Advisor to Commissioner Copps concerning the ultra-wideband proceeding. Except where reflected in the attached materials, the presentation covered matters previously addressed in Time Domain filings made in this proceeding. Copies of the materials provided during the meeting are enclosed. 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: Paul Margie (w/encl.)
Enclosure

No. of Copies rec'd 0+1
List A B C D E

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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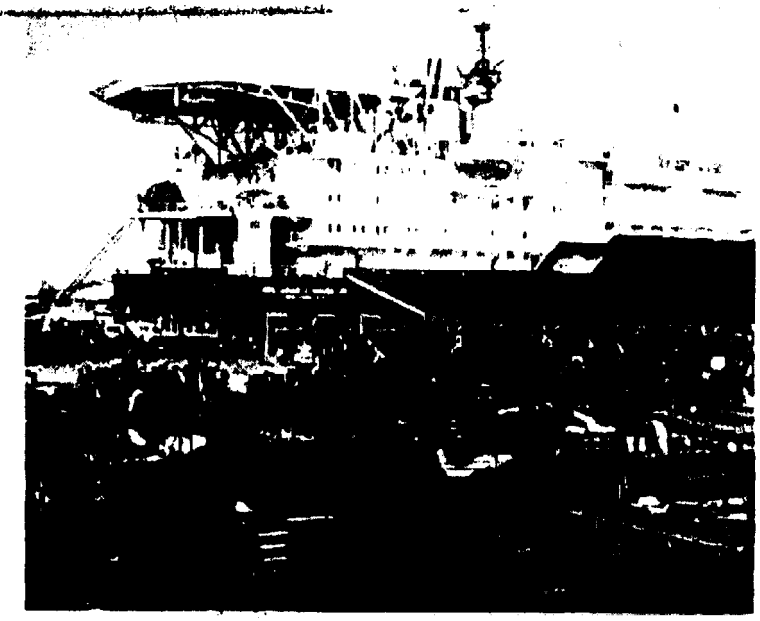
NEF
Obj
ENEMY DISPOSITIONS

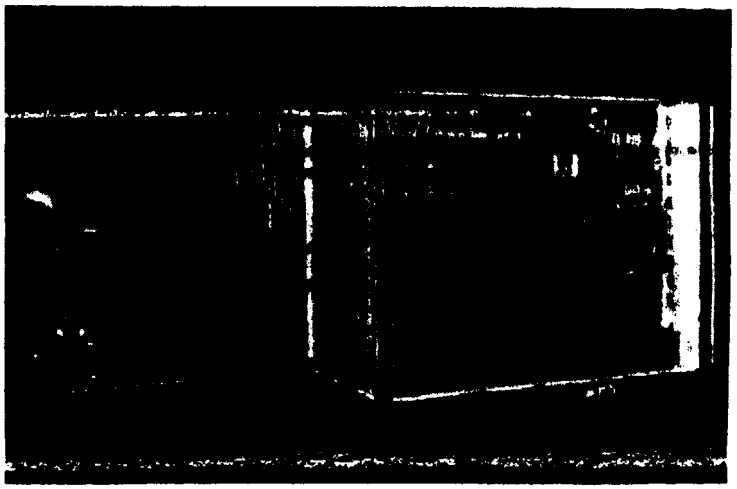
UWB Applications: Logistics

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

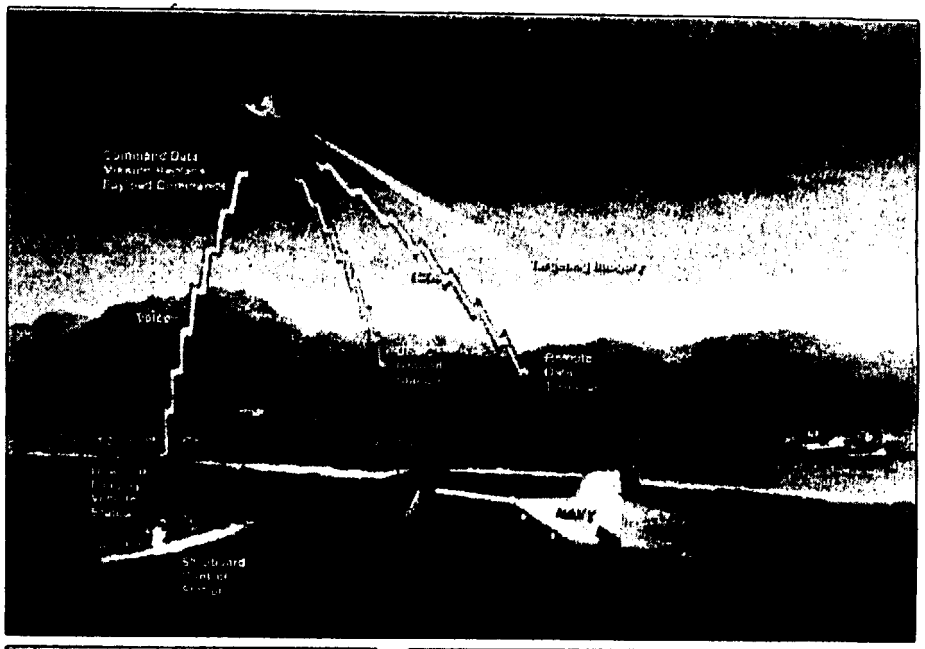
Carrier Weapons Management

- **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**

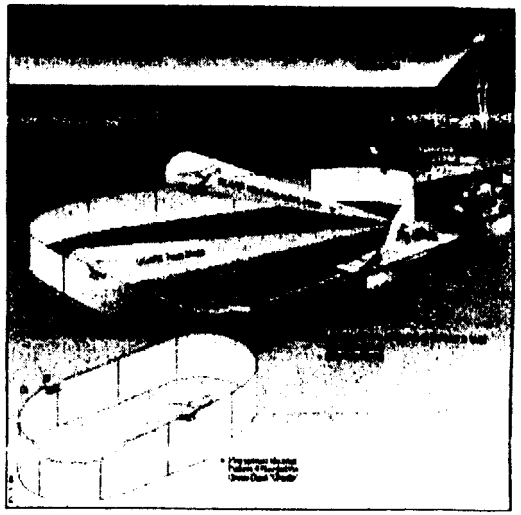
UWB Applications: Geolocation

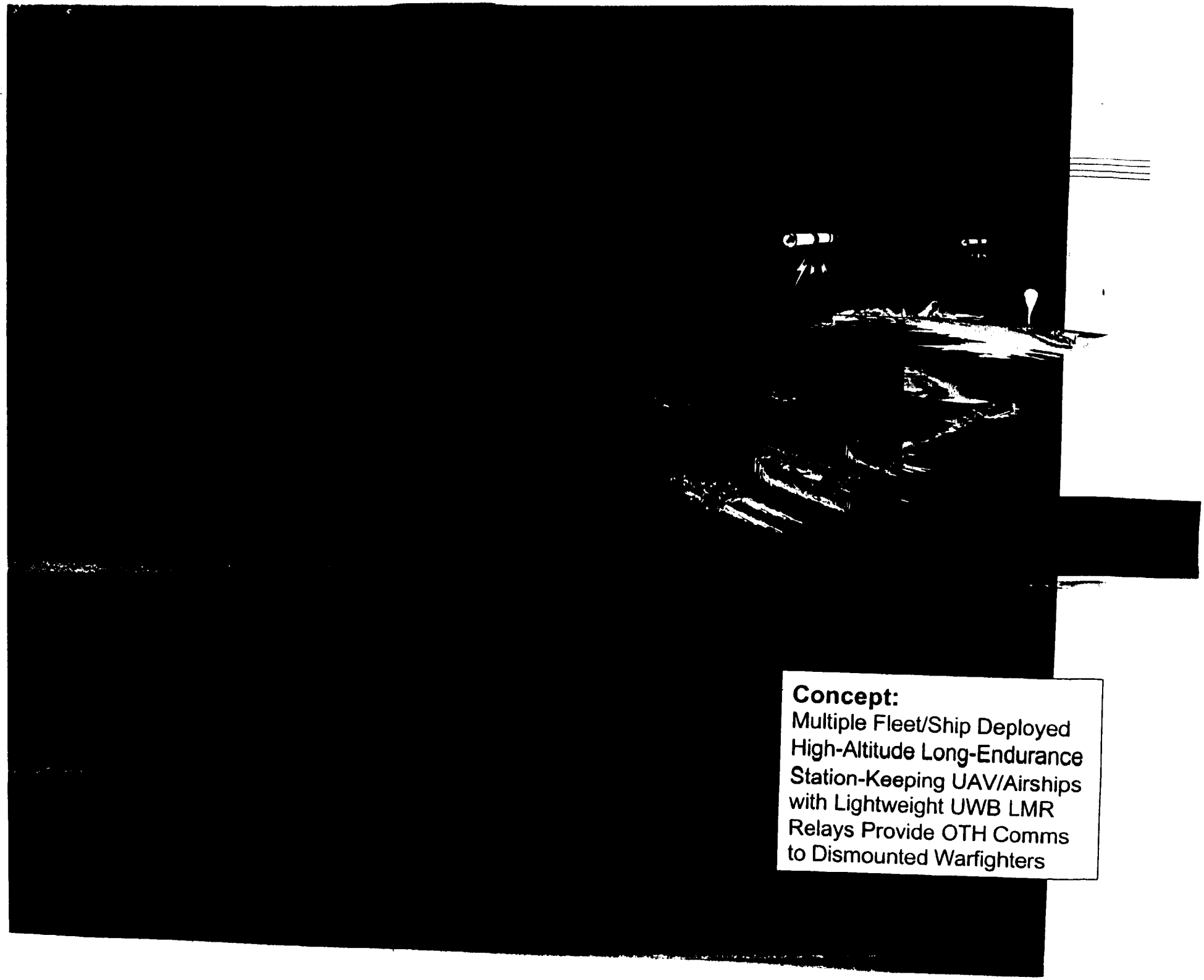
UAV Landing System

- **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.



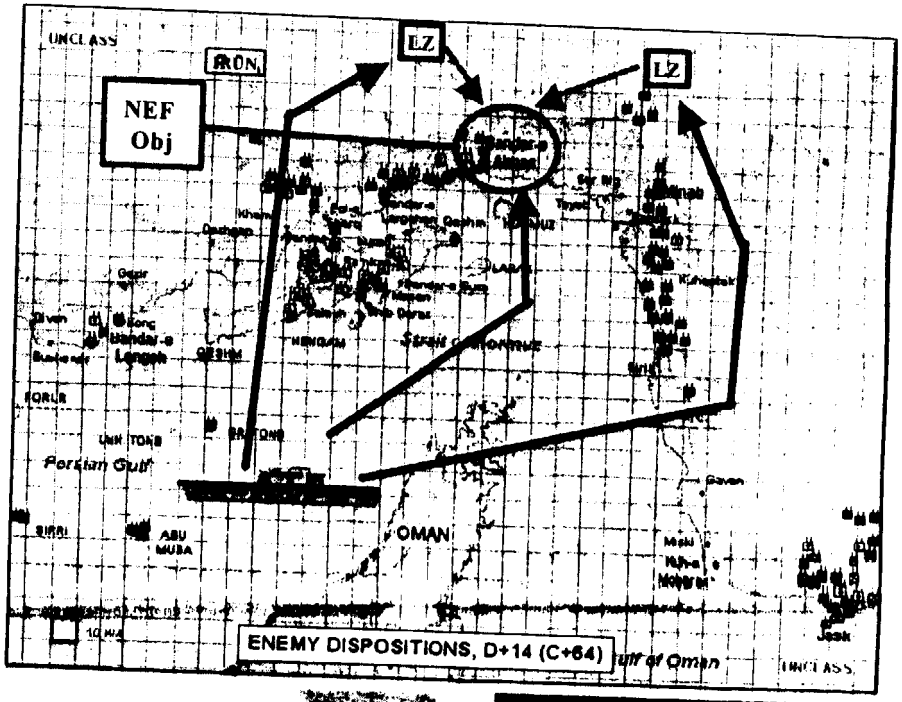


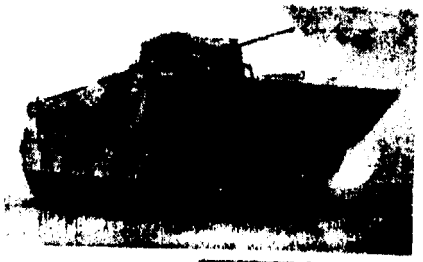
Concept:
Multiple Fleet/Ship Deployed High-Altitude Long-Endurance Station-Keeping UAV/Airships with Lightweight UWB LMR Relays Provide OTH Comms to Dismounted Warfighters

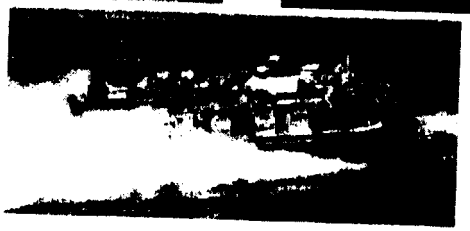
UWB Applications: Comms

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**



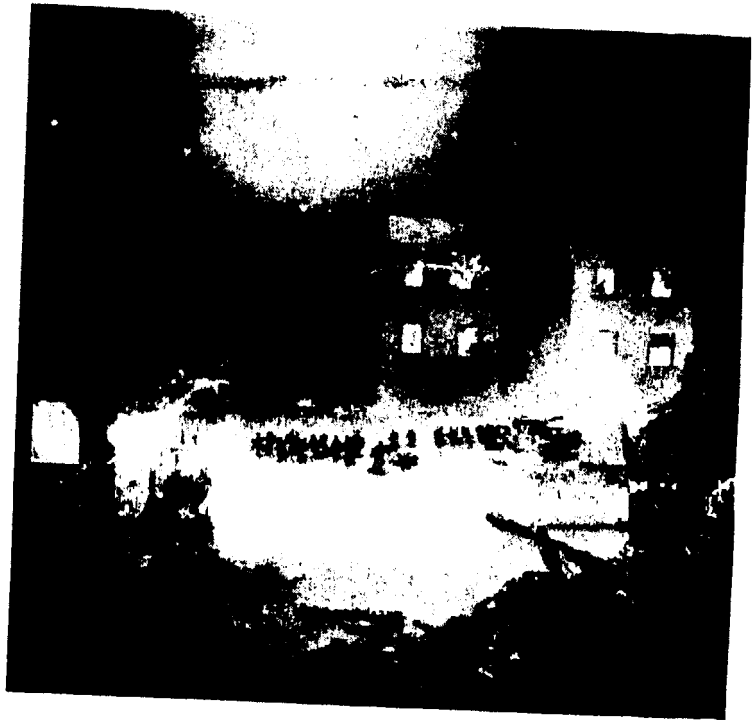




UWB Applications: Comms

Urban Warfare

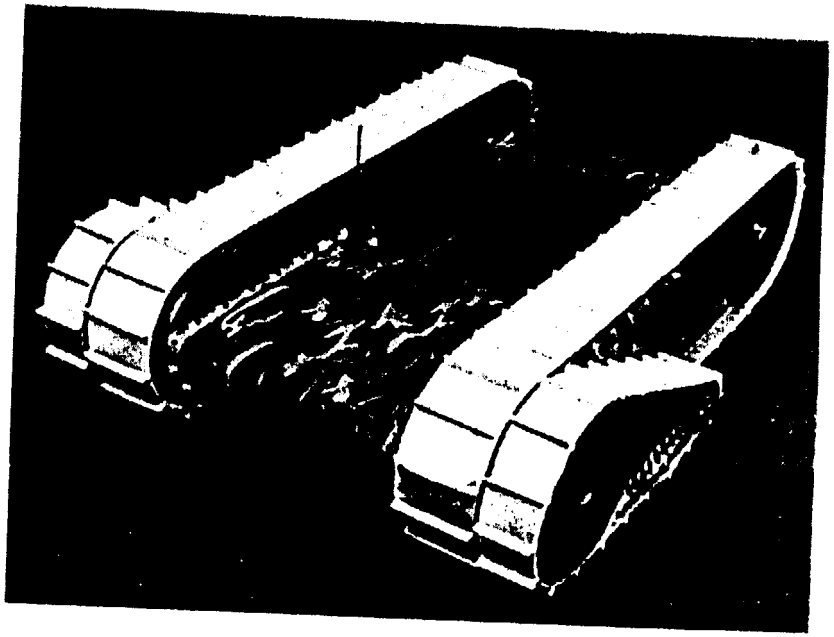
- **MOUT ACTD / USA / USMC**
  - Frustrated Requirements: **C4I**
    - » R1: Identification of Friendly, Enemy, Noncombatants (IFF)
    - » R3: Hands-Free Non-Line of Sight (NLOS) Communications
    - » R7: Thru-Wall Sensing
    - » R41: Position/Location Inside Buildings
  - Military/Com'l Comms Inadequate
    - » 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)

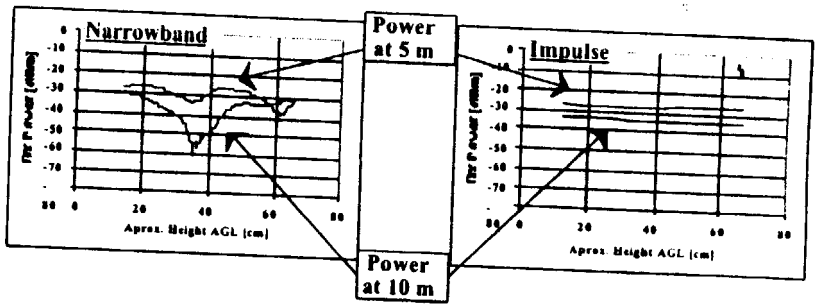
- **Imperatives**
  - Tele-Operation
    - » C2, Audio and Video
    - » Robots Talk to Each Other
  - Geolocation / Navigation
    - » Robots Find Each Other
  - Autonomously Reestablish Comms
- **Requirements**
  - Bandwidth
    - » C2 & Audio (low latency) 25 Kbps
    - » Video (B&W, fuzzy, min) 100 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)

GOVERNMENT AND DEFENSE PROJECTS

TIME DOMAIN GOVERNMENT PROJECTS

National Institute of Standards and Technology Advanced Technology Program

- Internal communications and tracking system for medical equipment

NASA Johnson Space Center

- Astronaut / Space Station Extra Vehicular Activity communications and position location and tracking for space walks: Phase II Small Business Innovation Research contract
-

National Science Foundation

- Universal Home Networking: Phase I Small Business Innovation Research contract

Department of Commerce

- Firefighter locator: Phase I Small Business Innovation Research contract

NASA Glenn Research Center

- Phased Array and SAR Radar: Phase I Small Business Innovation Research contract

NASA Goddard Space Flight Center

- Interspacecraft Communication: Phase I Small Business Innovative Research contract

NASA Marshall Space Flight Center

- Terahertz waveform Cooperative Research and Development Agreement (CRADA)

TIME DOMAIN DEFENSE PROJECTS

DoD Military Operations in Urban Terrain Advanced Concept Technology Demonstration

- Through wall radar for military operations in urban terrain to clear buildings by detecting human presence through walls

Office of Naval Research

- Location and status tracking system for environmental conditions history and shelf life of ammunition in storage depots to circumvent the need for destructive testing and lot sampling

Office of the Assistant Secretary of the Navy for Safety and Survivability

- Personal, Position, Location, and Tracking System to locate sailors aboard ships during life-threatening situations

Army Missile and Aviation Command Advanced Concept Office

- Over-the-horizon communications link using unmanned aerial vehicles: Phase II Small Business Innovation Research contract

Army Missile and Aviation Command Weapons Sciences Directorate

- Blue Laser research: Phase II Small Business Technical Transfer Research contract

Army Tank Automotive and Armaments Command Tank Automotive RDE Center

- Terrain mapping radar system to provide ground truthing for Grizzly mine-breaching program: Phase II Small Business Innovation Research contract

As of 19July 2001

Army Simulation Training and Instrumentation Command

- Advanced Tactical Engagement Simulation Program for the Objective Infantry Combat Weapon to detect hits on non line-of-sight targets during military exercises: Phase II Small Business Innovation Research contract

Army Simulation Training and Instrumentation Command

- Cooperative Research and Development Agreement to introduce time modulated ultra wideband technology into military training

National Security Agency

- Technology license for Army Research Laboratory to study how and where time modulated ultra wideband communications should be implemented for the Army

Marine Corps

- Personnel Identification System: Phase I Small Business Innovative contract

Defense Threat Reduction Agency

- Evaluation of UWB for airborne surveillance and ground penetrating radar

Land Warrior Program

- Evaluation of UWB for Land Warrior Program

Army STRICOM

- Development of Mobile ad hoc networking BAA with military and commercial dual-use capability

Army STRICOM

- Aim-point determination and geometric pairing solution for OICW weapon system: Phase II Small Business Innovative Research contract

DoD Office of Science and Technology

- OST IDIQ Program

Navy Sea Systems Command (NAVSEA)

- UWB engineering expertise for technology insertion into Naval Applications

Navy Research Lab (NRL)

- To provide precise timing via wireless

COMPLETED PROJECTS

Defense Advanced Research Projects Agency Advanced Technology Office

- Self-Healing Minefield program that causes mines to autonomously fill in minefield breaches

Army Corps of Engineers

- Cooperative Research and Development Agreement to mark locations of unexploded ordnance on training ranges, for subsequent munitions clearing

Army Space and Missile Defense Command Battle Lab

- Wireless communications for Future Operations Center local area network, the next generation tactical operations center

Army Simulation Training and Instrumentation Command

- Lightweight Personnel Detection Device to track soldiers during military training exercises

L3 Communications

- Provision of 3 full duplex evaluation PulsON radios with propagation software.

Navy Training Command

- Demonstration of Time Domain's PulsON® radio to track weapons on a training range: Phase 1 Small Business Innovation Research contract

Army Material Command

- Proposal to support intelligent mines with PulsON® radar sensor and PLT

National Telecommunication & Information Agency

- Utilization of the PulsON® pulsers to facilitate interference testing in support of the FCC NPRM

National Telecommunication & Information Agency

- Utilization of PulsON® pulsers to facilitate interference testing in support of the FCC NPRM

Johnson Space Center

- Astronaut / Space Station Extra Vehicular Activity communications and position location and tracking for space walks: Phase I Small Business Innovation Research contract

Army Missile and Aviation Command Advanced Concept Office

- Over-the-horizon communications link using unmanned aerial vehicles: Phase I Small Business Innovation Research contract

Air Force Rome Labs

- UWB SAR Research: Phase I Small Business Innovation Research contract

Army Missile and Aviation Command Weapons Sciences Directorate

- Photonics Research Support: Phase I Small Business Innovation Research contract

Army Missile and Aviation Command Advanced Concept Office

- Over-the-horizon communications link using unmanned aerial vehicles: Phase I Small Business Innovation Research contract

Army Tank Automotive and Armaments Command Tank Automotive RDE Center

- Terrain mapping radar system to provide ground truthing for Grizzly mine-breaching program: Phase I Small Business Innovation Research contract

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AVIATION DAILY
Daily Business Intelligence for the Commercial Aviation Industry since 1937

Wednesday, August 29, 2001

Study Reports GPS VulnerableTo Several Types Of Jamming

An as-yet-unreleased study on the vulnerability of GPS (Global Positioning System) shows that satellite networks are vulnerable to disruptions from several causes, including intentional jamming and atmospheric effects. The study, by the Volpe National Transportation Center, makes several recommendations to lessen the impact of such events on the national transportation infrastructure. It appears to pour cold water on FAA's plan to use GPS as a sole-means system, recommending instead the development of affordable backup systems.

DOT and the Defense Department had sponsored the Volpe study after questions were raised in the U.S. and abroad on the wisdom of relying solely on GPS signals when evidence existed that the signals were vulnerable to unintentional and intentional disruptions.

FAA nevertheless forged ahead with a policy that GPS be a sole means system. That appears likely to change, according to a draft press release from the DOT and obtained by The DAILY due to be released next week. First, DOT wants to brief its modal agencies, the White House and congressional committees. The report is scheduled to be discussed at a Sept. 10 Salt Lake City conference, which will include representation by the Volpe Center's Jim Carroll and a DOT response by DOT's Bart Blue.

Although subject to change, the draft press release quotes DOT Secretary Norman Mineta as saying that "this report provides a road-map to addressing possible vulnerabilities in GPS so that we can maintain the highest standards of transportation safety. This department is committed to developing and carrying out a plan based on these recommendations, so that GPS will fulfill its potential as a key element of the nation's transportation infrastructure." Sources said that both U.S. and international interests hope the actual report will spell out the vulnerability problems and what it intends to do about them. An earlier draft report was sent back to Volpe to review the vulnerability aspects, but sources said Volpe refused to water down the implications. According to the draft press release, GPS is susceptible to unintentional disruption from such causes as atmospheric effects, blockage by building and communications equipment, and by intentional disruption.

The report contains a number of recommendations, including continuing the GPS program with higher broadcast power and with the eventual availability of three civil frequencies. Another is to make users aware of the need to mitigate degradation or loss of signal through unintended inferences by communications sources. It also recommends implementing systems to monitor, report and locate unintentional interference, to assess the applicability of military anti-jamming technology and to work with industry to make the technology available for civil uses. The report encourages the development of "affordable systems as backups to GPS."

By Jim Baumgarner,
james_baumgarner@aviationnow.com

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.

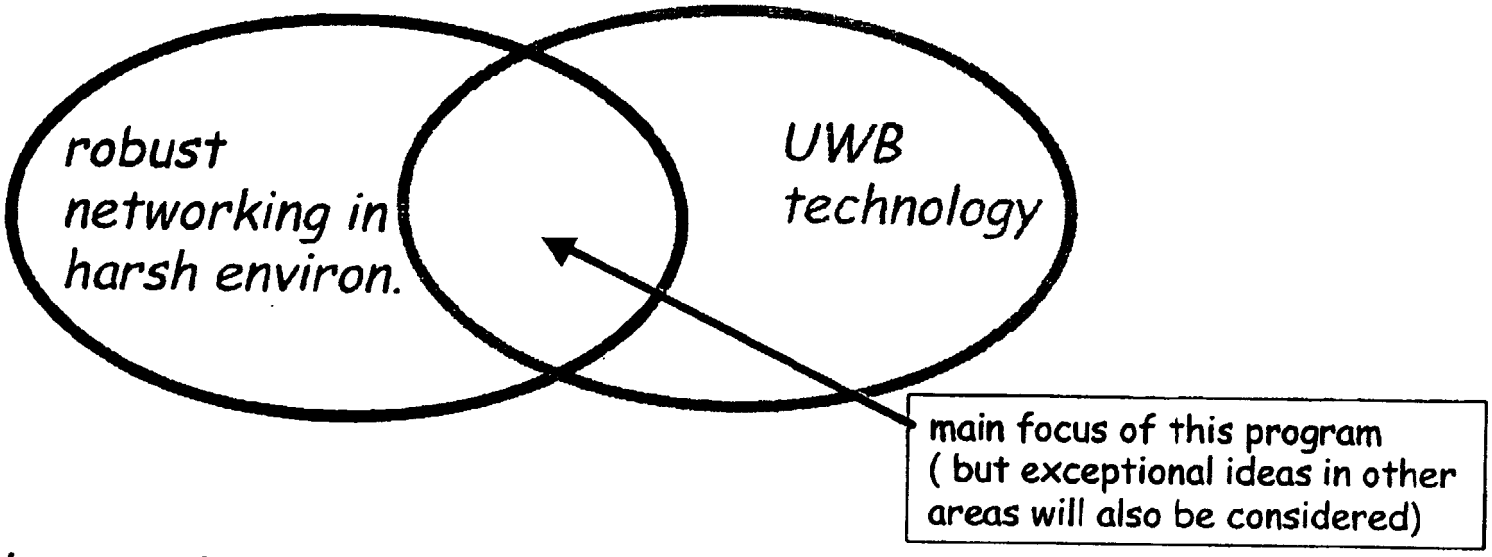
Networking In the Extreme (NETEX) Program

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

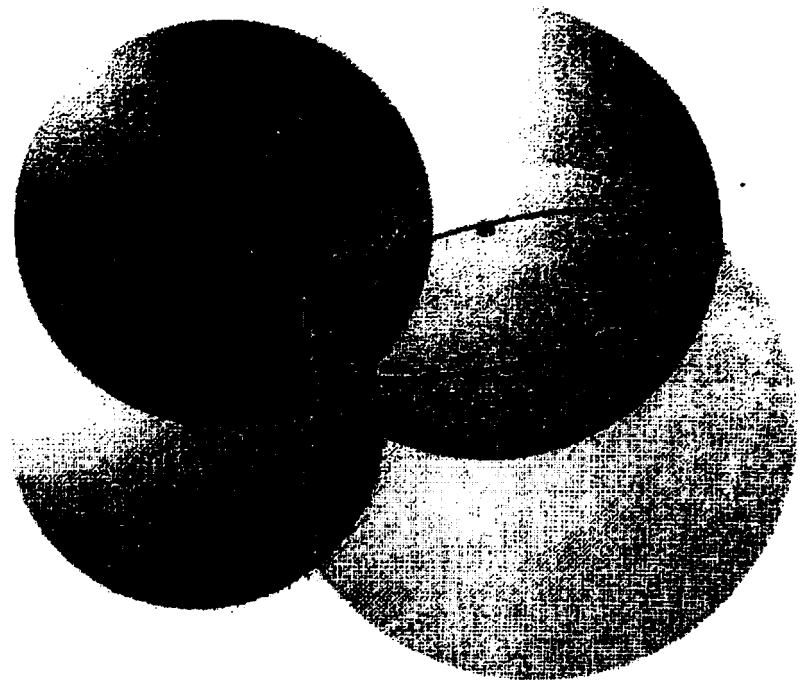
- Other harsh settings: on ships, inside cargo containers, close to the ground...

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 <u>next-generation</u> 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