



1998 International Symposium on Advanced Radio Technologies

SPEAKeasy Military Software Defined Radio

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SPEAKeasy System

- The “PC of the Communications World”
- Fully Programmable Waveform and COMSEC for Voice, Multimedia and Networking Use
- Multiband . . . continuous from 2MHz to 400MHz
- Open Modular HW Architecture
- Open SW Architecture
- Commercially Successful HW and SW
- Legacy Systems Compatibility



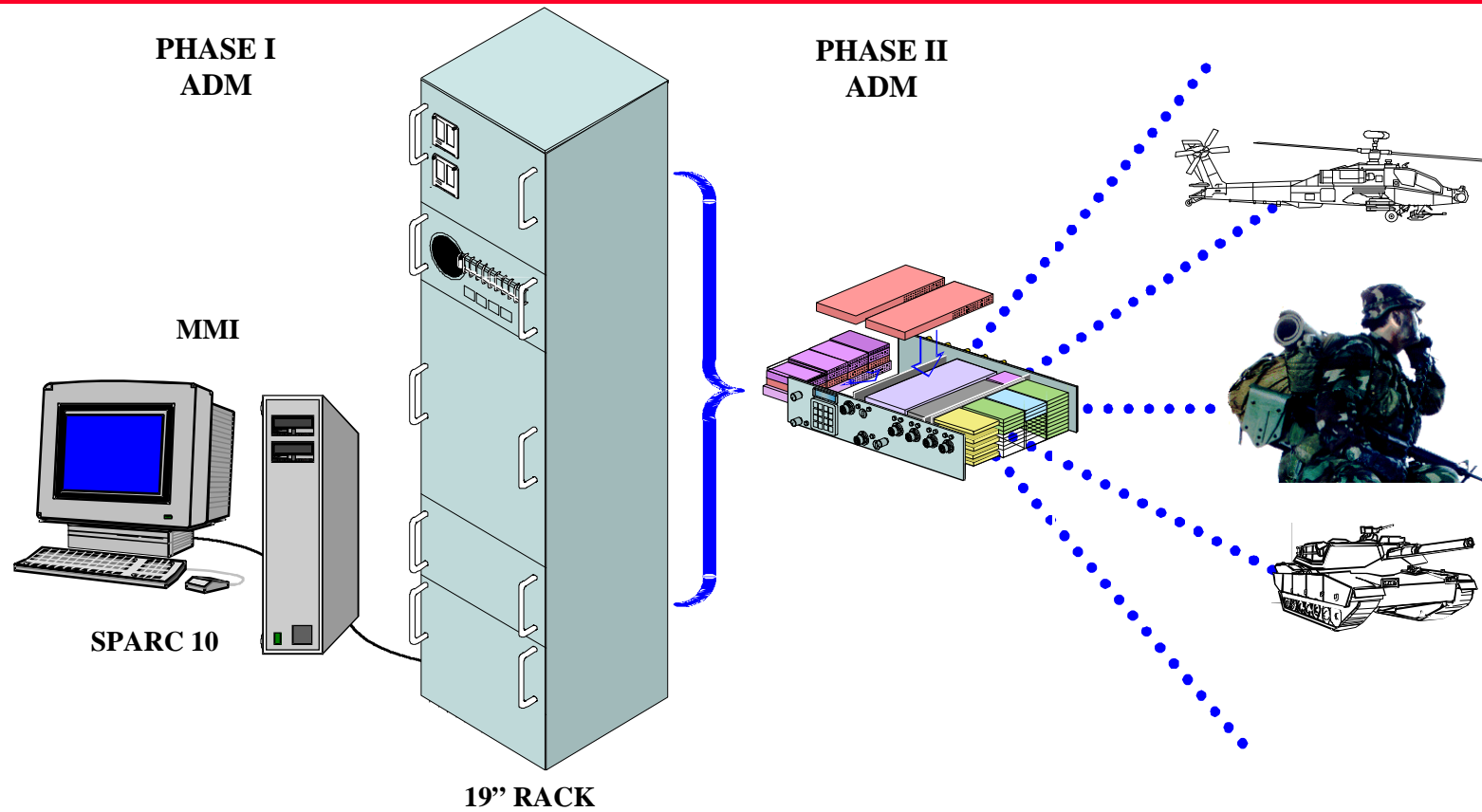


SPEAKeasy Phases

FY95

FY96 - FY99

FY00+





PARTICIPANTS

- DARPA
- AIR FORCE/AFRL
- ARMY/CECOM
- NAVY/NRaD/SPAWAR
- NSA

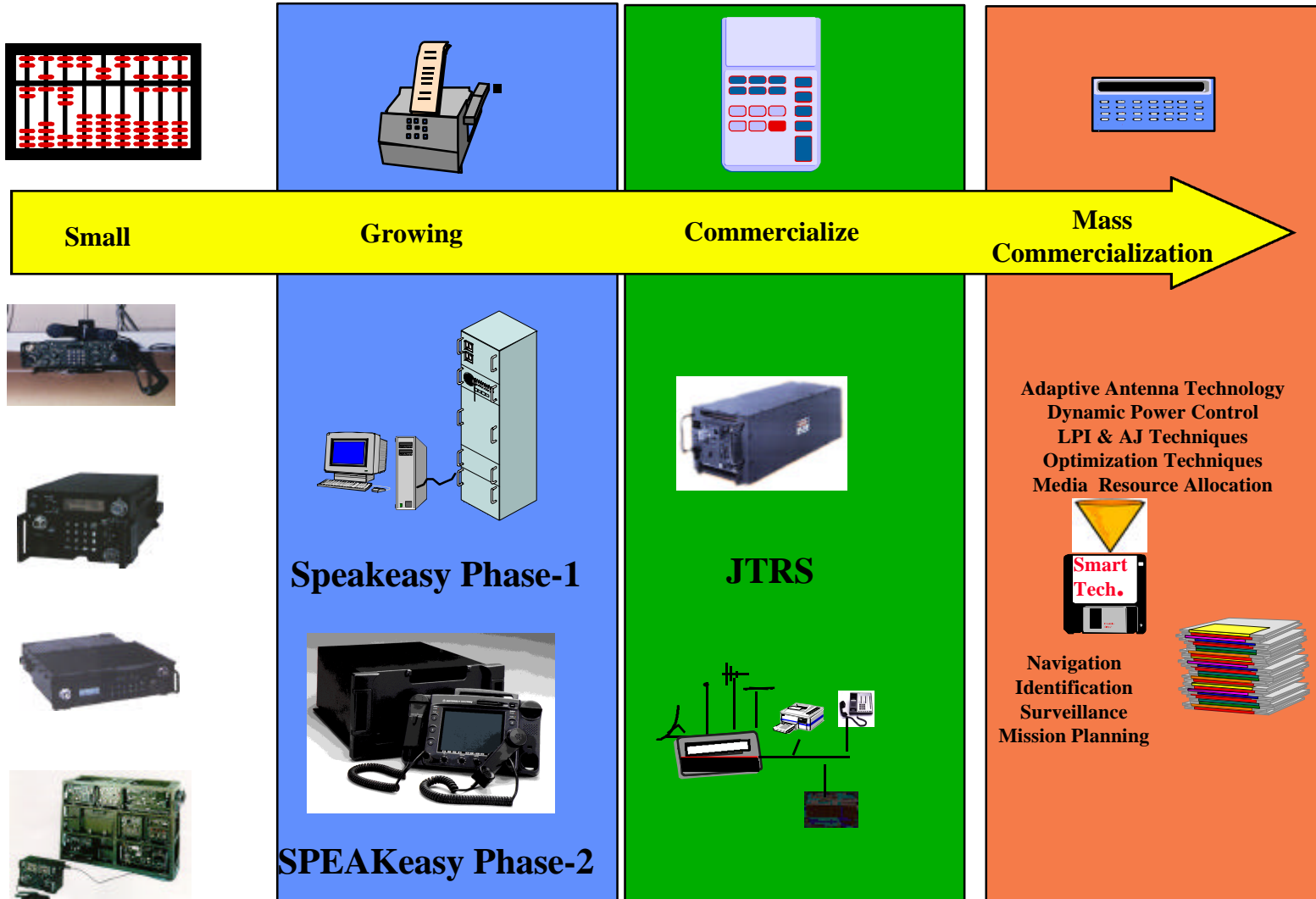


Military Benefits

- **Interoperability**
 - Emulates Legacy Systems
 - Bridges Diverse Non-interoperable Systems
 - Provides Data Gateways
- **Flexibility/Adaptability**
 - Reconfigurable, Modular, Scaleable to Platform Requirements
- **Responsiveness**
 - Reprogrammable - In-situ and Over-The-Air
 - Enables P3I
- **Mobility & Sustainability**
 - Reduces Logistics - SWAP - Spares
 - Reduces # of Terminals and Ancillary Boxes
- **Reductions in Cost**
 - Initial Production is Competitive
 - LCC Savings: Common Equip, Volume Buy, COTS



Communications Revolution





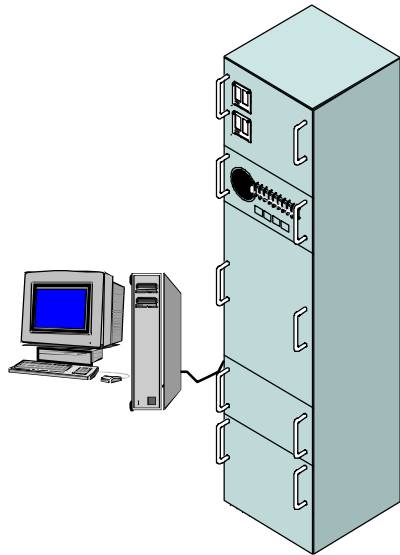
Speakeasy Phase-1

Objective:

- Demonstrate the feasibility of a Multiband, Multimode Radio
- Develop technologies that facilitate programmability and implementation of MBMMR

Accomplishments:

- Demonstrate multiband, multimode operation at JWID95
- Operation of HF, SINCGARS, Have Quick
- Bridging between voice networks



Phase-1 Equipment Rack

Lessons Learned:

- INFOSEC is paramount to acceptable architecture
- All areas (HW/SW, subassemblies) need open system
- Beware of growing requirements
- Requires cutting-edge technology

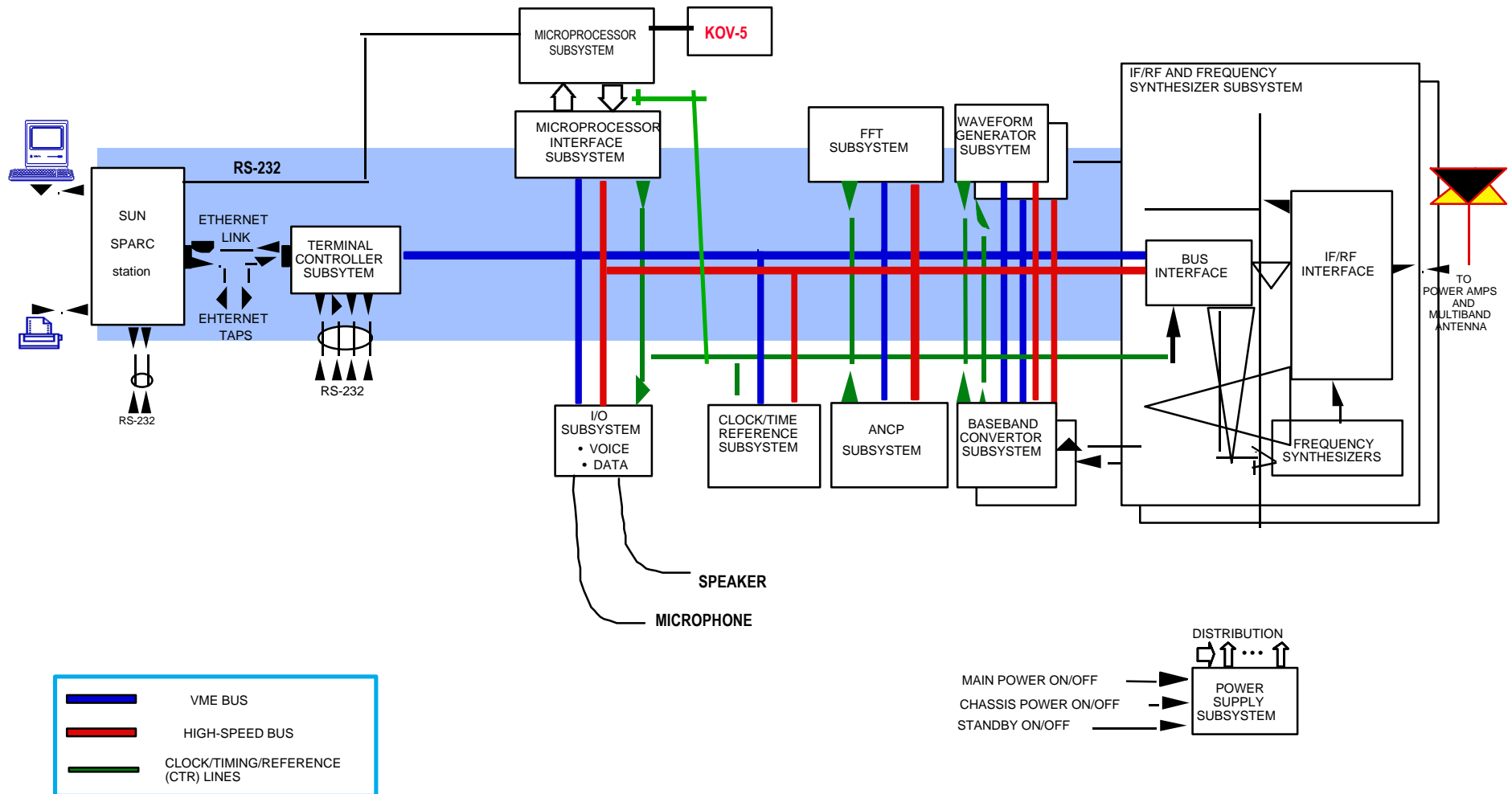


SPEAKeasy Phase 1

- A proof of concept, research and development program
- Awarded in 1990 to Hazeltine, TRW, Lockheed-Martin, Motorola, and Rockwell-Collins
- 2 programmable channels
 - VME bus architecture
 - Texas Instrument quad-TMS320C40 multi-chip module for digital signal processing
 - SUN Sparc 10 workstation as man-machine interface.

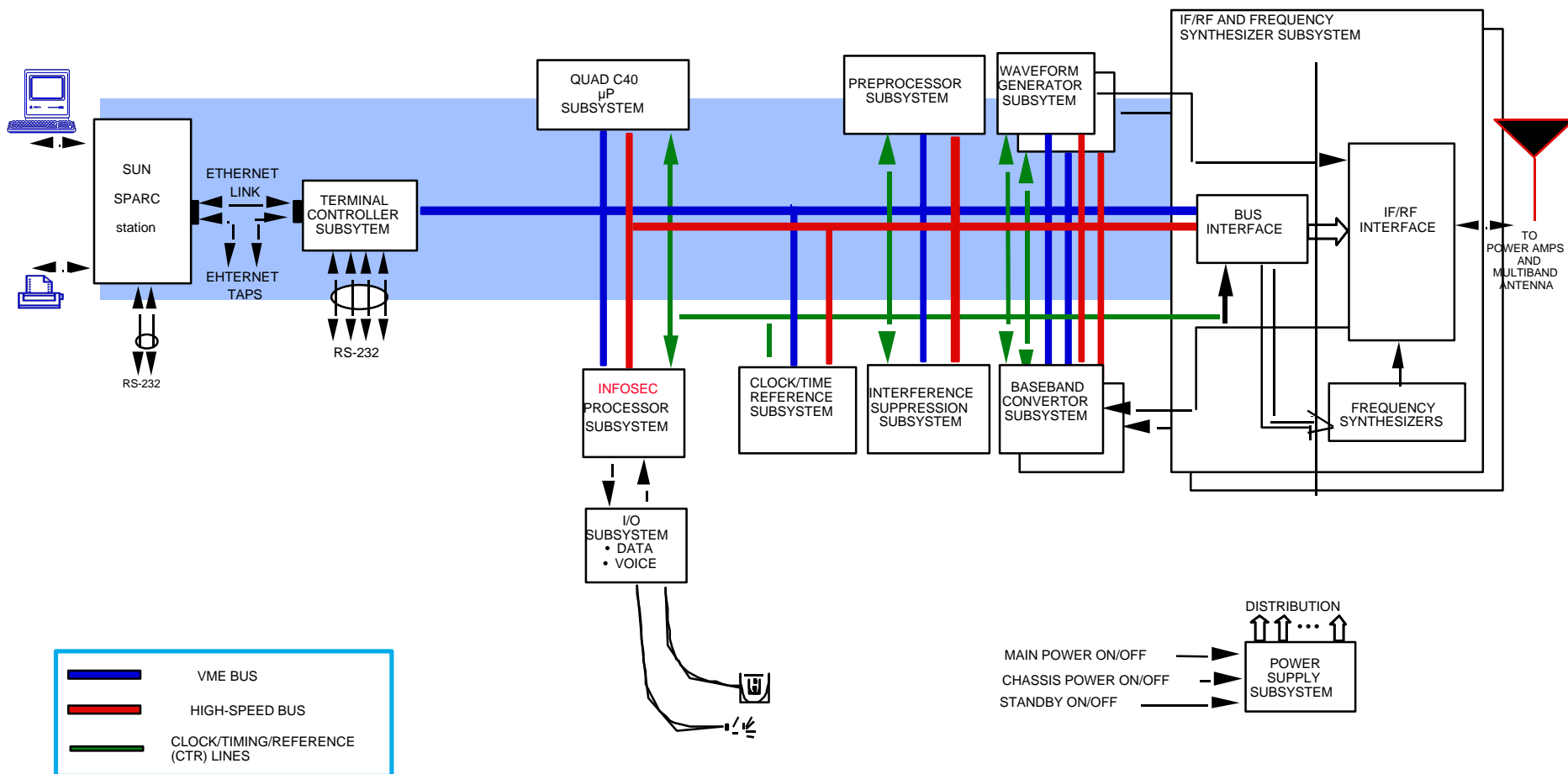


Initial SPEAKeasy Phase 1 Architecture





Revised SPEAKeasy Phase 1 Architecture





SPEAKeasy Phase 1

Lessons Learned

- OVER DESIGNED
- PERFORMANCE/COST TRADE-OFFS
- SECURITY AT CORE
- OPENNESS IN ALL AREAS
- REQUIREMENTS CREEP



SPEAKeasy EVOLUTION TOWARDS MBMMR

PHASE 1

PHASE 2

	PHASE 1	PHASE 2
DEVELOPMENT EMPHASIS ARCHITECTURE	MODEM ONLY	ENTIRE RADIO
WAVEFORMS	MODULAR BY FUNCTION FOR MODEM	MODULAR BY FUNCTION FOR RADIO (PUBLISH "OPEN" INTERFACE STANDARDS)
RESULT	EMPHASIS WAVEFORM CAPABILITY FOR LAB	WIDEBAND & NARROWBAND, NETWORKS & BRIDGES
FORM FACTOR	PACKAGED FOR LAB USE	TEST AND DEMONSTRATION



Speakeasy Phase-2

Objective:

- Develop and Demonstrate
 - Open Architecture
 - Software Reprogrammability
 - Package in near "field ready" enclosure

Accomplishments:

- Successful demo at TF-XXI AWE Ft. Irwin, March 97
- Interoperation with HF, VHF, UHF
- Bridging between any diverse radios
- In-Field Reprogramming
- In-Field Repair w/ COTS Components



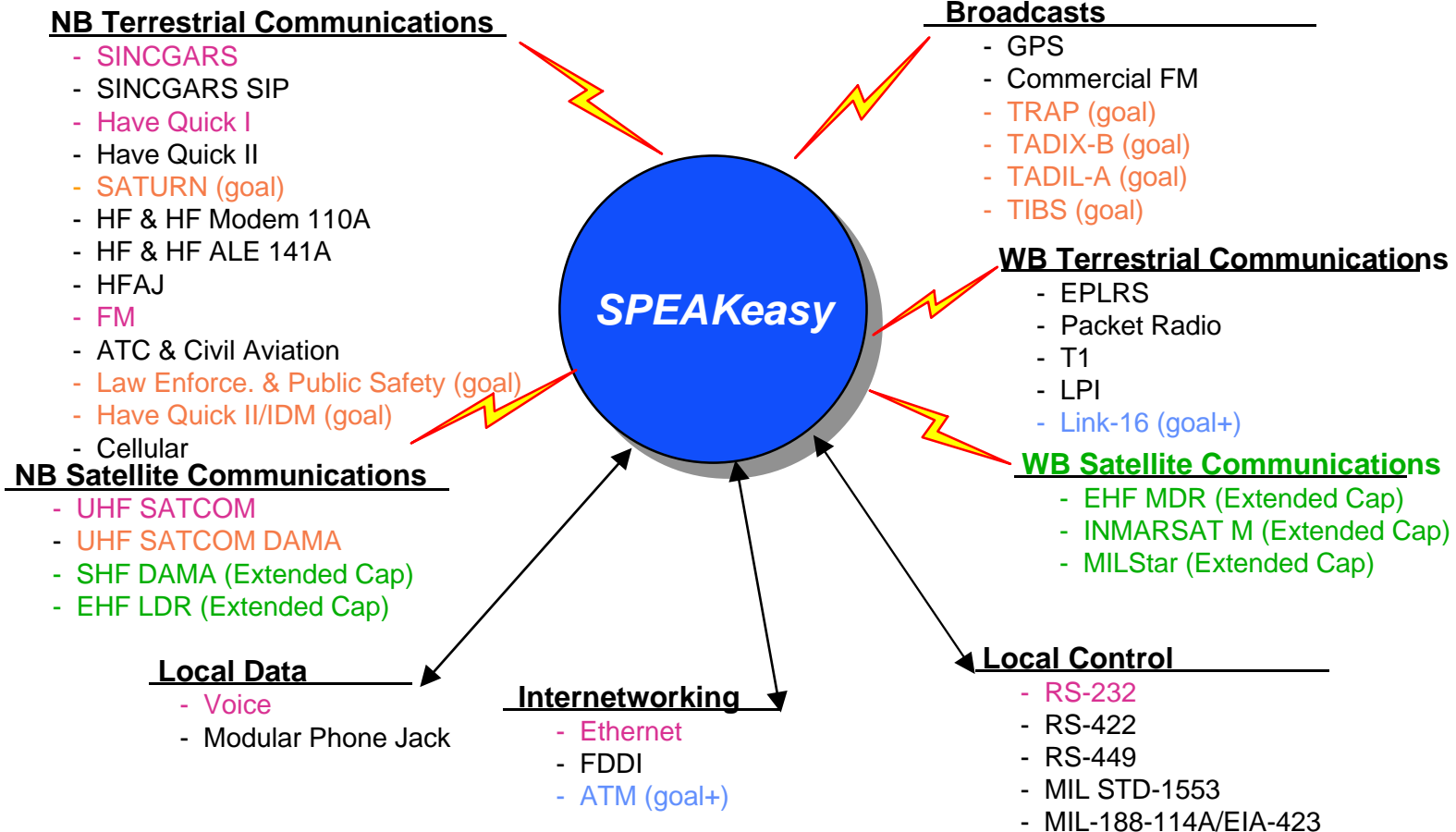
Phase-2 TF-XXI Model

Lessons Learned:

- Composing Lessons Learned Report
 - RF
 - INFOSEC
 - Control
 - Software
 - Modem
 - Man-Machine Interface
 - Internetworking
 - General Comments



SPEAKeasy Objective Interconnectivity



(Goal) = By Addition of Software (Only)

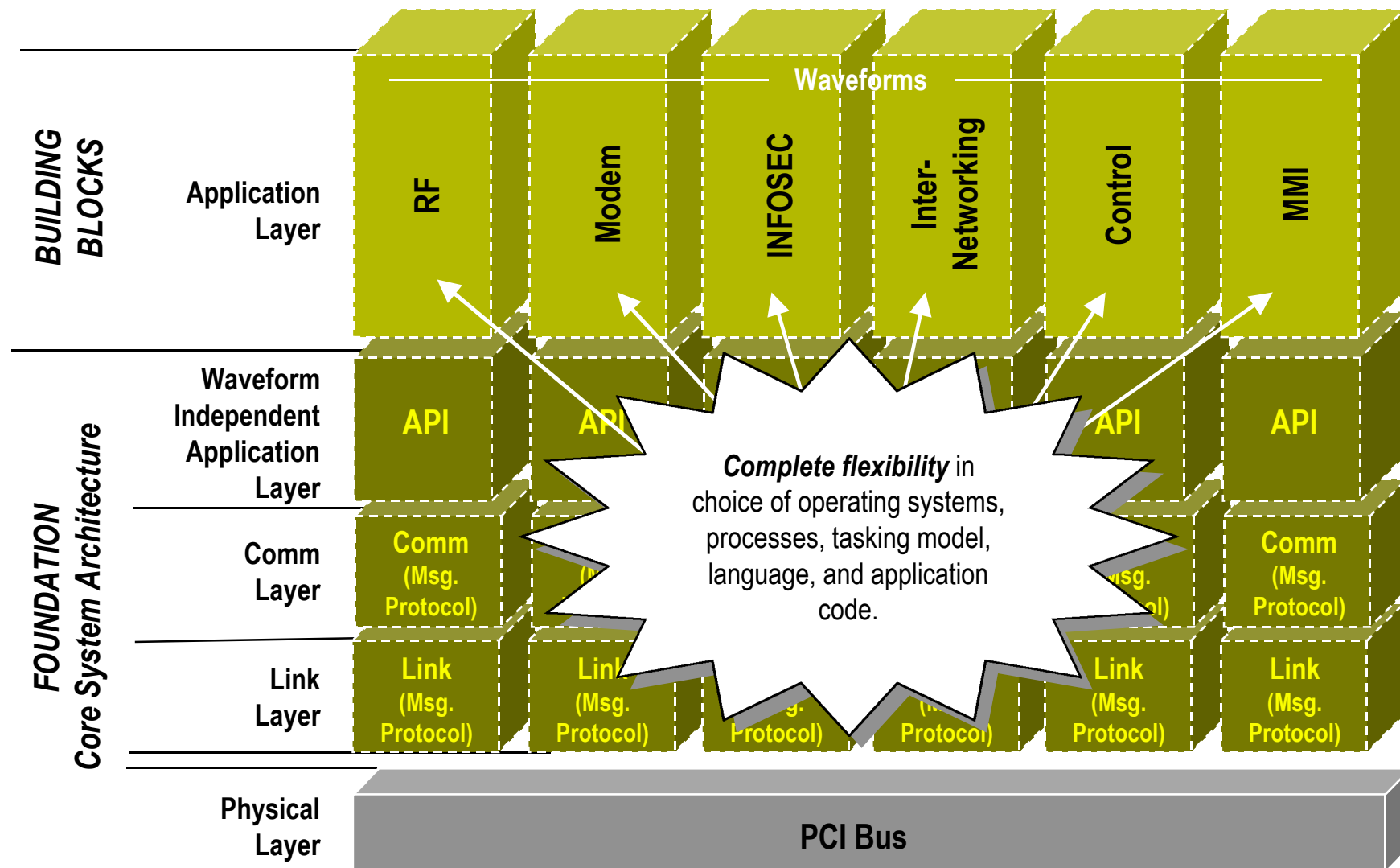
(Goal+) = By addition of Software; possibly some HW

(Extended Cap) - requires additional HW & SW

Accomplished



STANDARDS BASED SPEAKeasy SOFTWARE Open Architecture



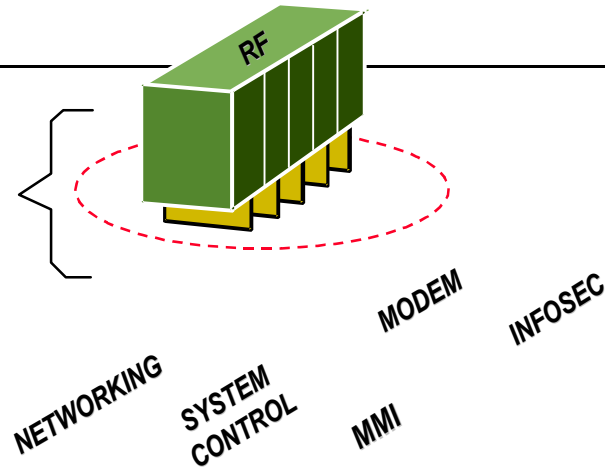


STANDARDS BASED SPEAKeasy Open Systems

BUILDING BLOCKS

Open Module Interface

- PUBLISHED -



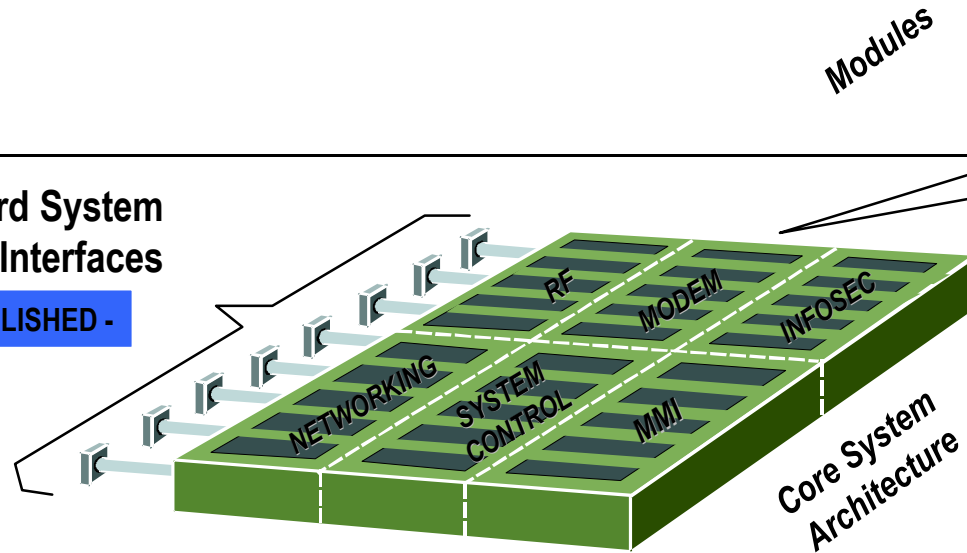
ENABLES :

- Alternate Suppliers of Modules
- Upgradeable via Commercial Technology
- Customizable System Configurations
- Lower Maintenance and Life Cycle Costs

FOUNDATION

Standard System Interfaces

- PUBLISHED -

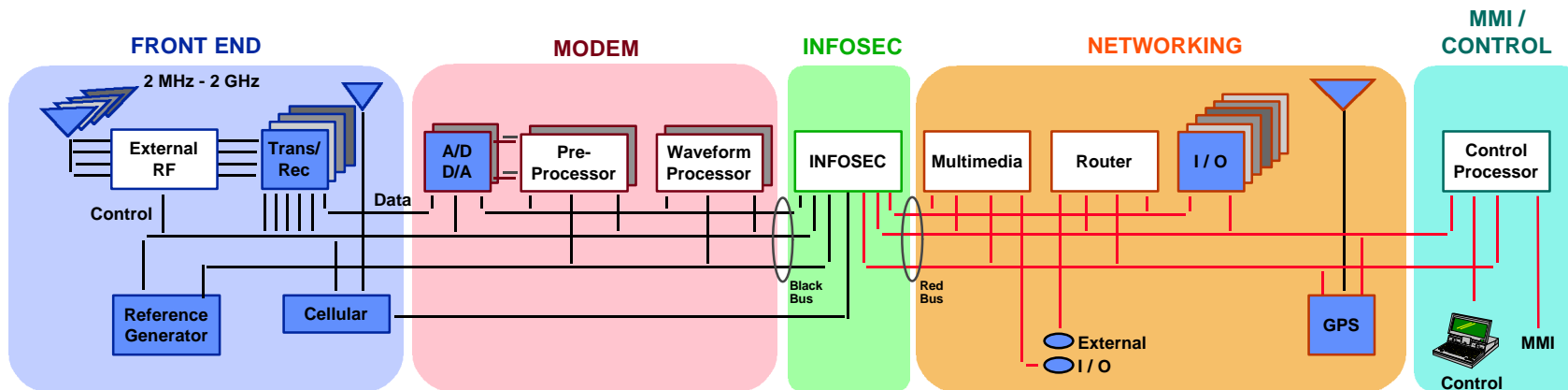


Open Architecture with Standard Module Interfaces

- PUBLISHED -



SPEAKeasy Phase 2 Modular-by-Function Architecture



SPEAKEASY MULTIBAND, MULTIMODE COMMUNICATIONS TERMINAL

Capabilities at a Glance

- Frequency Range: 2 MHz - 2 GHz Initial Capability, Extendable Through 45.5 GHz
- Data Rate: 75 bps - 10 Mbps
- Initial Capability Includes 22 Programmable Waveforms, Plus GPS and Cellular
- Four Simultaneous, Programmable Channels, Plus GPS and Cellular (Available PCI Bus Margin Can Support Additional Simultaneous Channels)

Open Architecture “Wireless Communications PC”

- Modular by Function - “Library of Common Modules”
- Bus/Form Factor Independent Design Provides Multimission/Multiplatform Utility
- Minimizes Technological Obsolescence; Allows Periodic Insertion of State-of-the-Art Technology

Programmable Waveforms and INFOSEC

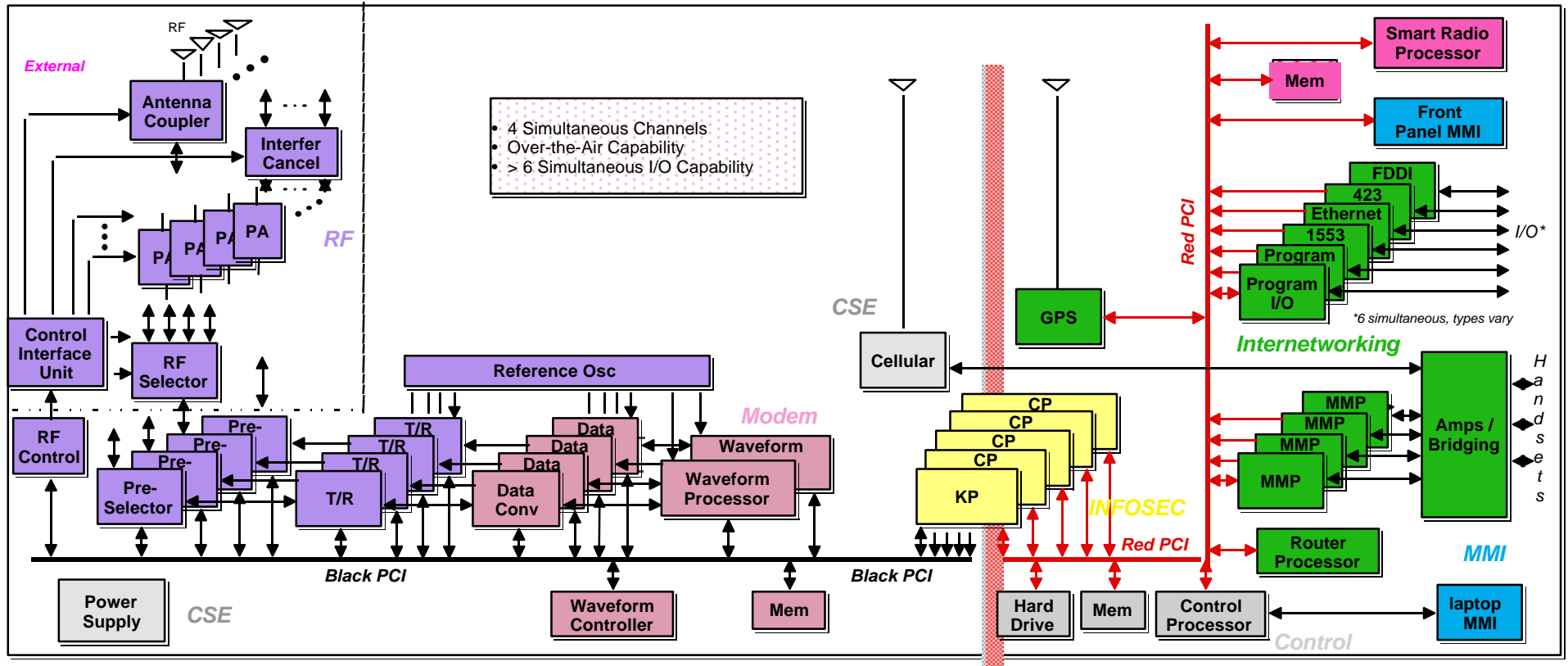
- Update/Add New Capability Without Hardware Modifications
- Reprogrammed via Over-the-Air Download

Networking

- Voice/Data Bridging Between Disparate Networks
- Tactical Internetworking (MIL-STD-188-220)



SPEAKeasy Phase 2 Hardware Architecture



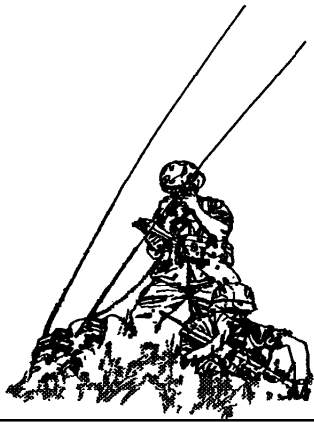


Voice Bridges Demonstrated

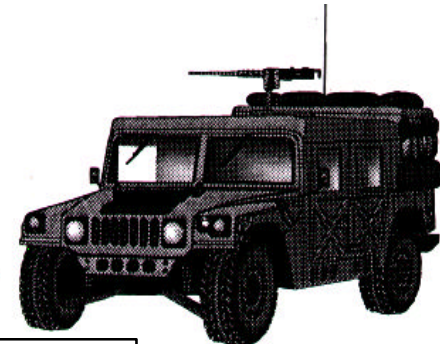


HAVE QUICK

**SPEAKEASY
INTEROPERABILITY
GATEWAY**



VHF/AM



- **Established a SPEAKeasy Voice “Bridge” at Brigade Tactical Operations Center That Allowed Air Force Tactical Air Control Party (TACP) Personnel, Using a VHF/AM Radio to Communicate With an F-16 Operating on a UHF Radio**



SPEAKeasy

Accomplishments at TF-XXI-AWE

Integrated SPEAKeasy into Army tactical vehicles (HMMWVs with SICPS shelters).

Deployed and operated SPEAKeasy in the Ft. Irwin National Training Center's field environment.

Repaired SPEAKeasy on-site using parts from a commercial computer (an IBM-clone).

Demonstrated single channel operation of: **HF/SSB, VHF/AM, VHF/FM, VHF/FM-SINCGARS, UHF/FM, UHF/AM** and UHF/AM Have Quick **hopping**.

While deployed at Ft. Irwin: **received & installed software upgrades and new waveform** capabilities for SPEAKeasy; using laptop computer and commercial phone line.

Controlled A-10 and F-16 aircraft, performing close air support (CAS) mission, using a standard military UHF radio waveform.

Colocated SPEAKeasy and existing TACP communications suite (GRC-206) at Division Tactical (TAC) for comparative evaluation.



SPEAKeasy ACCOMPLISHMENTS

- Developed an Open, Modular, COTS-based Architecture
- Model-1 Demonstrated TF-XXI
 - Modular Repair w/COTS
 - Software Re-programmability
 - HF, VHF, UHF (Voice/ECCM) Waveforms
 - Voice Bridging
 - Secure Voice (CYPRIS Crypto) 1998
- Provided Baseline Documents to the Programmable Modular Comm System IPT and the Joint Tactical Radio System's Joint Program Office (JTRS-JPO)
- **Future Multiband Multiwaveform Modular Tactical Radio (FM3TR)**
 - **Allied (4 Power) ECCM waveform created**
 - **Software Radio Interoperability Demo Planning**
 - **SPEAKeasy Phase-1 used in US/UK Demo June 98**
- **Facilitated Formation of Modular Multifunction Information Transfer System (MMITS) Industry/Government Forum**
 - **International Participation (>35 members)**
 - **Service Providers, Component Mfgs, System Integrators & Regulators**
 - **Publications: Architecture/APIs/Download**
- R&D Not Completed Under SPEAKeasy
 - Advanced INFOSEC (Context Sw)
 - Data Modes
 - Wideband Waveforms
 - Data-Gateways

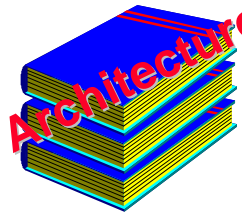


Summary of Benefits

- **Open Architecture**
 - **Eliminates Stovepipe Solutions**
 - **Reduces Cost (Purchase and Life-Cycle)**
 - **Allows for Keeping Pace with the Technology Revolution**
- **Reprogrammability**
 - **Provides a Flexibility to Support Doctrinal and Mission Changes**
 - **Modifications and Upgrades in the Field**
 - **Gracefully Degrades**
- **Simultaneity**
 - **Multiband, Multimode Operation**
 - **Enables a Broadcast Mode**
- **Internetworking and Bridging**
 - **Seamless Connection - Interconnects Diverse Radios**
 - **Enables Incremental Fielding Benefit**



SPEAKeasy Transition to JTRS



Architecture
Modular Functionally-Partitioned System
COTS-based Hardware Interfaces
Application Programming Interfaces
Message-passing Protocols



Multiband Operation
Linear RF (HF/VHF/UHF)
ECCM Capability
Military Radio Compatibility
Voice Bridging Of Diverse Legacy Systems



Digital HW
COTS-based DSP Modem
Programmable, CYPRIS-based:
TRANSEC & COMSEC



Software
Re-programmability:
Field Addition of New Waveform

WINDOWS-based Radio Control





Smart Networked Radio

- Develop Wideband Waveforms [LPI, ECCM, High Capacity, Packet-Switched]
- Adaptive Radio Control
 - Power
 - Data Rate
 - Coding
 - Bandwidth
 - AJ/LPI
 - ACE/BER
- Develop Adaptive Antennas
 - Receive Interference Cancellation
 - Tracking
 - Power Control
 - Bandwidth
 - Tuning
 - Enemy Emitter Location
 - Automatic Dynamic Matching



Smart Networked Radio (cont.)

- Media Resource Control
 - Routing/Switching
 - Packet control
 - Multiplexing
 - Priority/Preemption
 - Media/Channel selection
- Information Warfare
 - Info Gathering Analysis
 - Active ECM



Smart Networked Radio

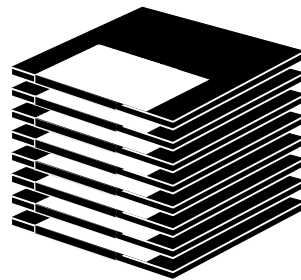
Adaptive Antenna Technology
Dynamic Power Control
LPI & AJ Techniques
Optimization Techniques
Media Resource Allocation

TRAP
TIBS
TADIX-B

Have Quick
SINGARS
JTIDS



Navigation
Identification
Surveillance
Mission Planning



A Software Defined System
IS what you make it!