

# Presentation Outline

- Historical Overview
- Radio Fundamentals
- US Developments in PCS
- Mobile Data
- Satellite Systems
- Problems with existing schemes
- Wireless Overlay Networks
- **US Government Research Initiatives**



# Today's State-of-the-Art

*Military and civilian need for global, robust, reliable, high performance, secure Information Infrastructure, with rapid deployment and mobile operation*

- **System architecture focuses on narrow-bandwidth voice, not flex bandwidth data communications**
  - sophisticated variable bit rate voice encoders
  - channel versus packet architectures
- **No end-to-end architectures**
  - CDPD between mobile host and base station, but what gateways will exist?
- **No effective method for applications to negotiate with network for level of service**



# Technology Opportunity

- **Widespread availability of low-power, low-cost, small size digital radio technology**
- **Ubiquitous satellites ranging in power and bandwidth**
- **Emergence of highly capable, portable computing environment (PDA's)**
- **Widespread deployment of Internet, ATM, and other information infrastructure**
- **Widespread commercial availability of system components**



# Paradigm Shifts

- **Small lightweight “intelligent” digital radios**
  - “Low cost” packet radio, circa 1984: 25 lbs, 110 W, 9.3” by 6.1” by 13.4”
  - Packet radio today: AT card, < 1 lb, 1 W
  - Tomorrow: PCMCIA card, < 4 oz, 0.1 W
- **New gen radios: control “knobs” exposed to apps**
  - transmit power, channel quality, network routing, mobile assisted handoff, etc.
- **Extend technology for disconnected access to “gracefully degrading” connections**
  - CODA, Ficus
- **Extension of wireline networking infrastructure**



# Government Program Focus

- **Integrated end-to-end networking technology**
- **Wireless networking architectures/protocols**
- **Untethered node architectures**
- **Mobile robust computing techniques**



# Integrated End-to-end Networking

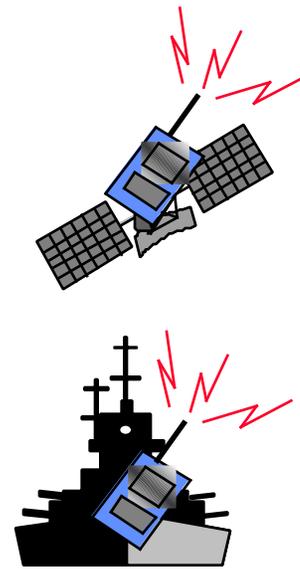
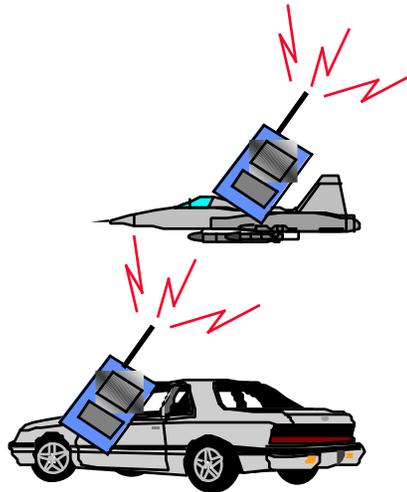
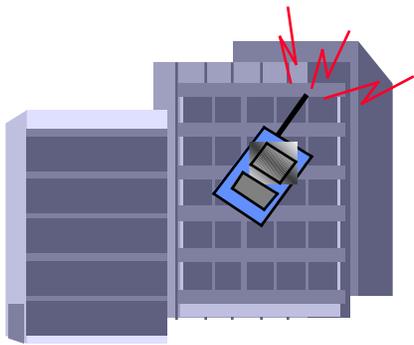


## Expected results:

- Protocols and algorithms for movement between wireless domains
- Bandwidth-adaptive end-to-end application support
- Opportunistic exploitation of communications
- Demonstrated end-to-end application



# Wireless Networking Architectures



## Expected Results:

- Support for movement within wireless domain
- New location-adaptive protocols
- Self-organizing network architecture/algorithms
- Use packet radio as initial demo
- Investigate wireless ATM, data on cellular, etc.



# Untethered Node Architectures

*Leverage Microsystems Design & Component Technology to Provide Scalable, Adaptable, Untethered Systems Building Blocks Supporting ARPA Global Mobile Goals*

<b>Applications</b>	<b>Mobile Computing</b> <b>Global Mobile Access</b>	<b>Video Conferencing</b> <b>Wireless Networking</b>	<b>TIA</b>
<b>Node Architectures</b>	<b>Mobile Computing Nodes</b>	<b>Packet Radio System Nodes</b>	<b>Miniature Modular Untethered Systems</b>
<b>Microsystems Design Components</b>	<b>Video Compression ICs</b> <b>Wireless Systems Design Environment</b>	<b>Modem ICs</b>	<b>Adaptive Signal Processing ICs</b> <b>Spread Spectrum ICs</b>



# Techniques for Mobile Robust Computing

- **Consistent, robust services in presence of**
  - Dynamically varying bandwidth
  - Changing location (addresses)
  - Sporadic connectivity
  - Loss of server nodes
- **Possible Techniques**
  - Migratable computing
  - Distributed replication of data
  - Global virtual address space (e.g., Virtual IP)
  - Softly degradable application support



# Intended Program Results

## *Broad Technology Base for Mobile Computing*

- **Nodes for Untethered Networks**
  - Rich Interfaces for Adaptive Control
  - Adaptive Behavior for Varying Environment
  - Modular
- **Architectures for Robust Wireless Networks**
  - Self-configuring
  - Effective bandwidth utilization
  - High performance services



# Program Results

## *Broad Technology Base for Mobile Computing*

- **Protocols for End-to-End Networking**
  - Mobility support within and between regions
  - End-to-end resource utilization
  - API for performance negotiation
- **Global, Mobile Computing Services**
  - API for performance negotiation-graceful degradation
  - Distributed/disconnected file service
  - Global virtual address space
  - Migratable, survivable compute services



# Government Opportunity

***Shift industrial paradigm from piecewise solutions to end-to-end information systems***

- **Develop technology for robust end-to-end information systems in a global, mobile environment.**
- **Demonstrate in realistic applications environment**



# Strategic Directions

- **Combine wireless network technology with information infrastructure architecture supporting mobility**
- **Order of magnitude improvement in end-to-end bandwidth to applications “on the move”**
- **API for developing location-dependent and situation-aware applications**
- **Support at the network protocol, file system, distributed system**
- **Integrate new electronic component technologies emerging (displays, mmic, low power) into system context**
- **Applications drawn from systems offices, NII national challenges**



# Summary

- **Demonstrate high bandwidth wireless networking infrastructure, system services, and location-dependent applications**
- **Distributed computing in untethered environment:**
  - Public safety, law enforcement, emergency medical teams, disaster response, military ops
  - Intelligent Vehicle Highway Systems, transportation, mapping, location finding
  - Smart buildings: people and item tracking, energy management
  - Where tethering is too restrictive, e.g., repair in hostile, hard to reach places

