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**

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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**

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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

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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

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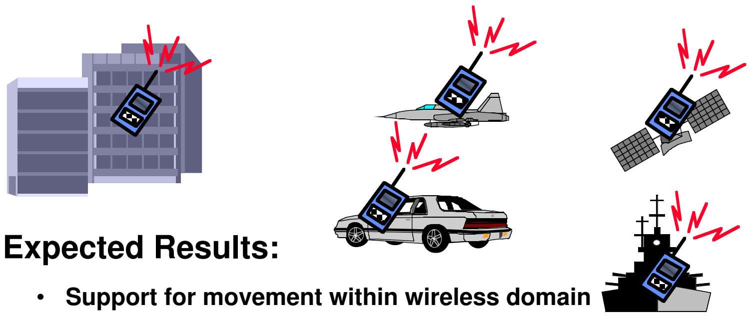
Wireless Networking Architectures



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.

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Untethered Node Architectures

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

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

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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

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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

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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**

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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**

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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**

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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**

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