Rapidly Deployable Radio Network

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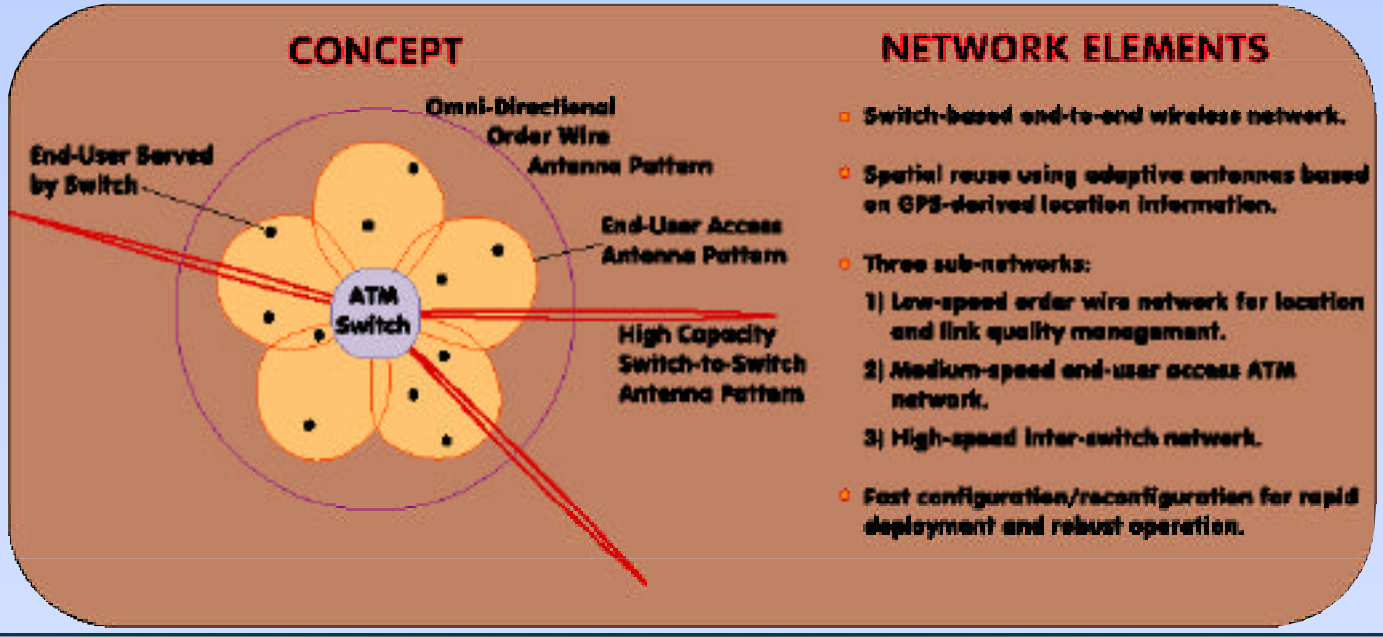
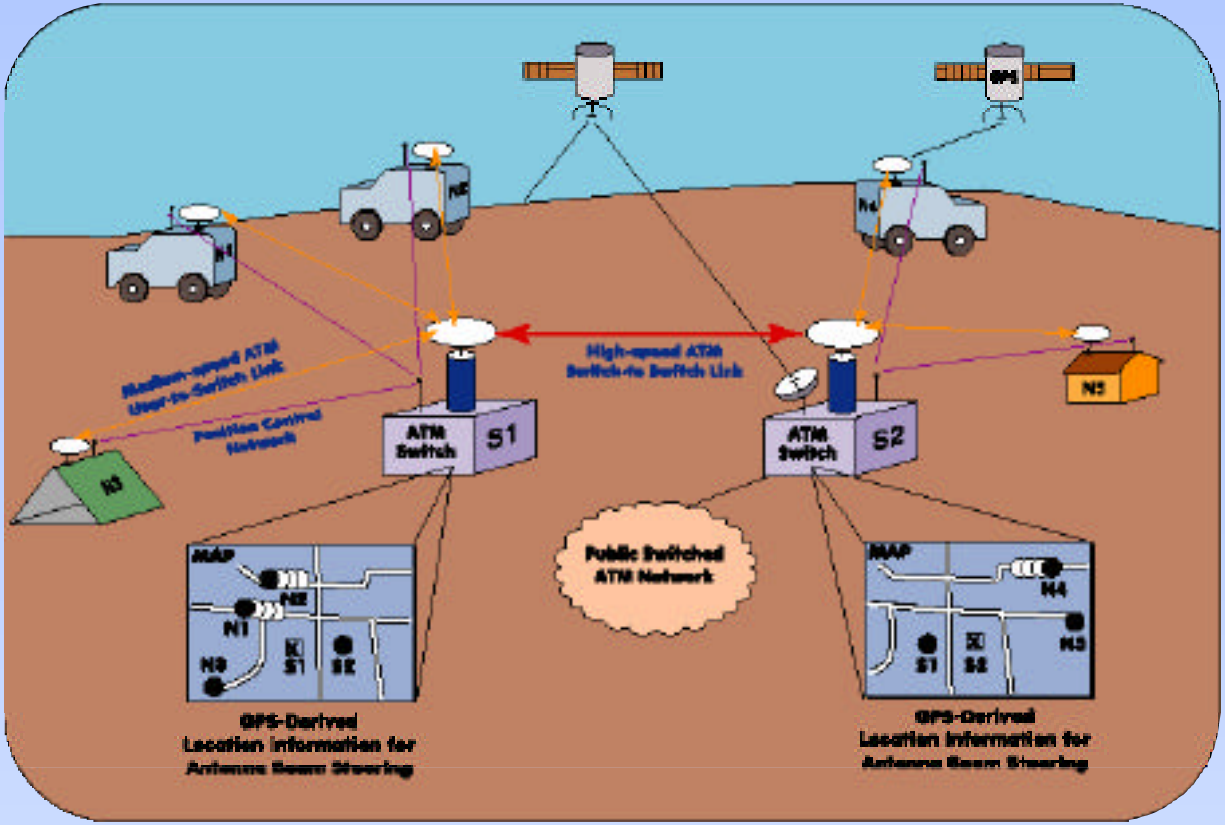


RDRN Project Overview



K. Sam Shanmugan, Gary Minden, Joseph Evans, Glenn Prescott, Victor Frost, David Petr, Jim Roberts, Richard Plumb

Goals and Objectives

- **Design, implement, and evaluate:**
  - **A network architecture for a Rapidly Deployable Radio Network**
  - **A Network Control Protocol to support RDRN and mobile users**
  - **A wireless ATM protocol**
  - **A software radio with digital beamforming**
  - **Prototype sub-system components**
- **Demonstrate multimedia applications over wireless/wired ATM networks**

RDRN Technical Challenges

- **Rapid Deployment and Mobility imply —**
  - **Limited a priori RF, topology, and deployment specific engineering**
  - **Adaptive techniques at link and network to achieve tasks at hand**
  - **Development of control and management techniques based on location information to meet performance goals**
- **Automatic network configuration and soft handoffs based on location and timing (GPS) information**
- **Adaptive communications based on channel estimation**
- **Baseband digital beamforming**
- **Conformal antenna arrays (analysis and design)**
- **Seamless integration of wireless/fiber/satellite networks**

Accomplishments

- Implemented a network topology constructor that minimizes the maximum S/I for a set of nodes at known locations
- Implemented a Network Control Protocol that monitors node location and re-configures network connections at the ATM and link levels as needed
- Implemented a protocol for wireless ATM with minimal overhead and suitable forward error correction
- Implemented a software based ATM switch
- Implemented a software radio with digital baseband beamforming on trasmitter end
- Built two prototype nodes

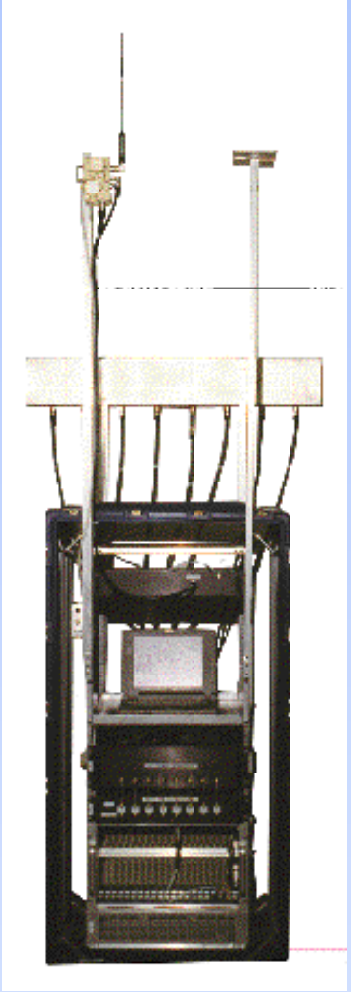
Uniqueness of RDRN

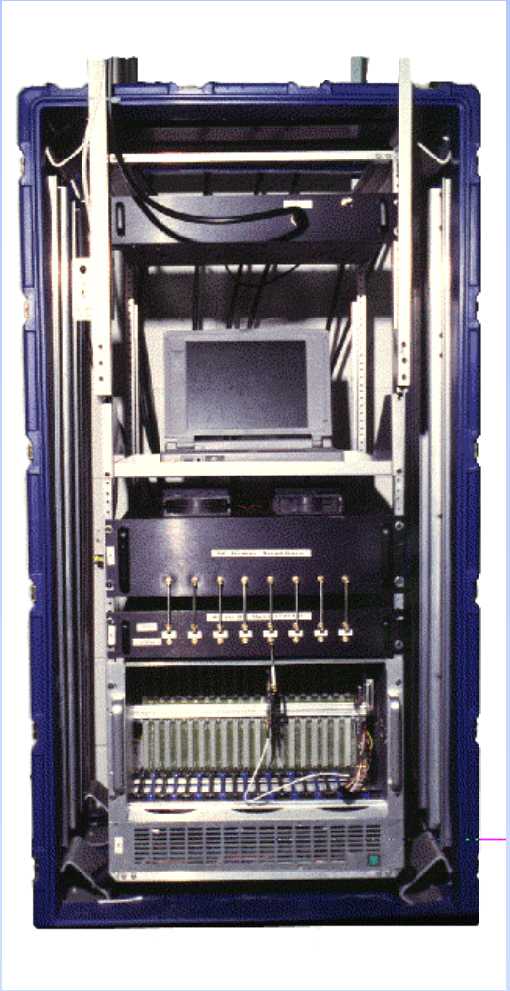
- Emphasis on system level issues
  - Digital beamforming antennas
  - Software Based Tx/Rx
  - Integration with end-to-end ATM/IP wireless/wired networks
- Channel estimation and link level Adaptation
- Integration of location information
  - Automatic initial system configuration
  - Anticipatory re-configuration and handoff
  - Adaptive beam forming

System Parameters

- Frequency: 1.27 GHz
- Symbol Rate: 1MBaud on each beam
- Radiated Power: <5W
- Range: 10 KM
- Tx Antenna: 8 element linear array
- Maximum number of beams: 4
- Independent modulation per beam (BPSK or QPSK)
- Rx Antenna: Omni
- Receiver sensitivity: ~-110 dBm
- Receiver dynamic range: ~100 dB
- 19.2 kbps packet radio for network control

RDRN Prototype Node





Proof of Concept System

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Current Status

- Low speed packet radio and GPS receivers for network control completed
- Radio hardware
  - Two nodes built and integrated
  - Initial testing started
  - Long distance loopback, antenna beam patterns, end-to-end communication testing next
- Network Control Software completed and tested
- Hardware/Software integration just started
- Integration, test, and reports to be completed by 9/97

Plans and Milestones for Remainder of Project

- 1Q97 — Test and Integration
  - Loopback in lab
  - Distance tests (5 KM, 10 KM, 20KM)
  - Beamforming measurements
  - ATM Signaling
  - Software/Hardware Integration
- 2Q97 — End-to-End Network Performance Tests
  - Multi-media over RF link
  - Demonstrate end-to-end wireless/wired ATM
  - Characterize system performance
- 3Q97 — Project Wrap-up
  - Final performance measurements
  - Final Report

Future Plans

- Adaptive communications at the link level
  - New algorithms
  - Design and implement beamforming with cylindrical and hemispheric microstrip antennas
- Improve software radio
  - Miniaturization
  - Implement adaptive algorithms
  - Beamforming on transmit and receive
- Adaptive MAC Protocols
  - Evaluate wireless ATM, IP, and ATM/IP protocols for highly mobile RDRN
- Scalability
  - Larger testbed
  - Large system performance evaluation