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FORTIFIED 802.11

Proposal for formation of a study group to evaluate hardening a subset of 802.11

Presented at

IEEE 802 Committee Meeting

March 10-13, 1997

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- Built on the completed work of 802.11
- Extension of 802.11 for adverse environments
  - Multipath
  - Time, Synchrony management
  - Station Fast Mobility
  - Transmission Security
  - Membership drop-in, drop-out, signal shadows
- Propose a Study Group pursuant to a PAR, to keep our development under the 802.11 configuration

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WLAN Users: examples

- Class 1: traditional LAN
  - Hospital communications
  - office building
- Class 2: industrial, mobile LAN
  - factory, foundry, refinery
  - urban construction, highway construction
  - fleet control (taxi, delivery)
  - military users of commercial equipment
  - police, fire, emergency

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Meeting The Needs

- Proposed 802.11 addresses the needs of Class 1 users, very well.
- Our concern is with the second class of user. After some effort to directly apply 802.11, we find several limitations and several candidate enhancements, and want to bring these to review.

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Problem environments and uses

- Exposure to strong multipath interference
- Mobility at vehicular speeds
- Intermittent connectivity as members pass through signal “shadows”
- Members dispersed out to a kilometer or more
- Multimedia applications: voice, data, video

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A Proposed Investigation for 802.11 “Class 2” Performance Predictions

- Evaluate network performance of 802.11 in Class 2 environments
- Use broadly-accepted modeling tool (OPNET) for simulations
- Construct models using predefined 802.11 state machine descriptions
- Simulate exemplar environments:
  - Team dispersal within 1-km radius
  - fleet movement along a highway
  - Multipath campus environment

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802.11 Station Models

- Construct both AP and non-AP ("ad hoc") station models
- Non-AP station model looks like the following slide:

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An *ad hoc* Station Model

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Simulation Objectives

- Average message output rate *vs*. average message input rate
- Message completion rate *vs*. average message input rate
- Average 1-way intranet delay *vs*. average message input rate
- Average channel loading *vs*. average message input rate

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Typical Output Graphs from Prior OPNET runs

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Ruggedized 802.11

- PROPOSED: study group to evaluate an extension to 802.11 with enhancements for operations in adverse environments
- Near-Term Tasks:
  - Establish goals
  - Define Schedule
  - Who will staff it?
  - Provide examples of technical extensions
  - Write PAR and present it

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Multipath Defenses: candidates

- Increase the chip rate of the spreading code
  - Reduces each chip's exposure to interfering reflected rays
  - Strengthens DSSS resistance to Broadband CDMA interference and narrowband interference
- Use different spreading codes on consecutive data bits
  - minimizes intersymbol interference from reflected rays with delays > 1 bit period

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Adaptive Power Management - Candidates

- Manage transmitters to use only enough power to maintain link S/N
  - mitigates cosite interference
  - extends battery life

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Range extensions: candidates

- Protocol encapsulation to support intranet relay capability
  - Eliminate the need for an all-connected net
  - Support “hidden terminal” communication
- Introduce distributed routing tables as a MAC station service option
  - Supports intranet relay operation
  - Less vulnerable to single-point failure, vs. centralized routing
- Power management, to reach “remote” member
- Bandwidth management, with redundant retransmit for longer range

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Transmission Security: Candidates

- Lowers probability of interception
- Eliminates MAC addresses as a source of intelligence to a competitor or adversary

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Multimedia Extension: candidate

- Modify MAC protocol to ignore dropped packets during video transfers
- E.g., use MIB variables to set retrys at value zero for these frames
  - Reduces bandwidth utilization by not retransmitting “lost” video packets
  - “Lost” packets can be ignored during frame reconstruction

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Shall We Authorize a Study Group for the Question of Extending the Capabilities of 802.11 for Robust Operation?

- TASKS:
  - Quantify 3-5 defined challenge scenarios
  - Summarize available RF data on such scenarios
  - Using OPNET, do network modeling of 802.11
  - Derive candidate extensions and additions to 802.11
  - Do network modeling of candidate extensions in the challenge scenario, to quantify effectiveness
  - Write a PAR, if practicable and justified

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Initial Study Group Members

- Oliver Edwards, Image Systems Inc.
- Robert Radkey, Syoptek
- Terry Charbonneau, ITT
- Bill Rogers, ITT
- Ken Clements, Innovation On Demand
- Others, as care about adverse environments, and can pitch in

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