Proposal for a Wireless Personal Area Network Medium Access Control and Physical Layer

Pat Kinney
Intermec Technologies Corporation
550 Second St S.E., Cedar Rapids, IA
Phone: (319) 369-3593
Fax: (319) 369-3299
e-Mail: kinneypw@norand.com

Introduction

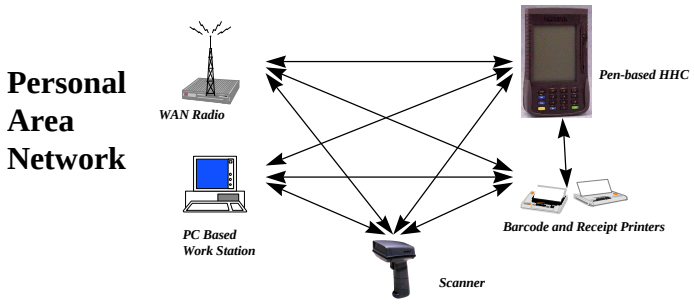
Typical applications such as the mobile worker and Physiological Monitoring involve short messages and short distances between devices. Key attributes for these devices include:

- low cost
- small size
- low current drain
- minimal operator intervention

Features

- Dynamic addressing: allows the network to be intiated and maintained with minimal operator intervention
- Temporary network: allows a device to temporarily split from its PAN, attach to a non-PAN device, detach from that device and resume participation in the original PAN

Sample Configuration



Cost

- One of the major drivers behind WPAN is the lowest possible cost. Cost is typically driven by complexity and high performance requirements. The design philosophy behind this proposal is a system design with relaxed requirements on hardware cost drivers and which leverages existing technology and componentry where possible for the lowest recurring costs.

Cost

- MAC greatly simplifies requirements on RF design
  - SIFS/DIFS/PIFS are greatly relaxed, etc.
- Low MAC S/W overhead (estimate 25% of 802.11)
- Low MAC/PHY gate count (estimate 10% 802.11)
- Single conversion receiver
- Direct launch VCO

Power Consumption

- Minimal MAC complexity allows:
  - reduced ASIC current drain
  - reduced microprocessor on time
- Minimal transceiver performance requirements allow:
  - reduced active componentry
- Above results in less than 6 mA current drain @ 3.3V for connection maintaince

Coexistence

- It's essential that these devices operate satisfactorily in congested spectral environments. The proposal is for CSMA/CA protocol, Frequency Hopping, with a high speed aggregate data rate to aid in Coexistence with:
  - 20 other co-located PAN networks
  - WLAN FH networks

Range

- The majority of requirements for PANs are met with a maximum range of 10 meters. Intermec Technolgies' implementation of this proposal has a demonstrated range of greater than 10 meters as verified in a cubicle environment and in shipping and receiving areas.

Regulatory

- Worldwide
  - US: Part 15.249
  - Europe: ETS 300 328
  - Japan: RCR 33

Hardware

- 2.4 GHz operation
  - world wide regulatory
  - reduced non-desired emissions from host device
  - wide bandwidths allow simple high speed modulation/demodulation methods
  - low cost componentry from PCS and WLAN products

Hardware

- Frequency Hopping
  - world wide regulatory as spread spectrum
  - low cost, low current drain, spread spectrum technique
  - interference immunity from narrow band sources
  - allows a simplified strategy of coexistence in a congested area

Hardware

- Low transmit power: <1 mW
  - low current drain
  - complimentary to an effective coexistence strategy
  - allows submission under FCC 15.249 (no hop sequence constraints)
  - low device count
  - reduced consumer concerns about safety

Hardware

- 1 Mb/s aggregate data rate
  - more effective coexistence strategy due to reduced transmit durations
  - reduced average current drain
  - reduced response times yield reduced host current drain

Protocol Requirements

- Support Functional Requirements in CFP (except only 10 stations)
- Support Power Management
- Support Auto Configuration
- Support Temporarily Split Networks

Basic Protocols

- Initialization
- Normal Operation
- Termination

Initialization Protocol

- One Station is “coordinator”
- Others “join”
- Coordinator broadcasts inits
- Others unicast attaches
- Coordinator accepts or declines
- When all expected stations attach, coordinator starts normal operations

Normal Operation Protocol

- Coordinator periodically broadcast synchronization information (beacons)
- After beacons, stations transmit to powered down stations by requesting other stations to leave receiver on, and after a short interval sending to that station
- Stations transmit to powered up stations at any time

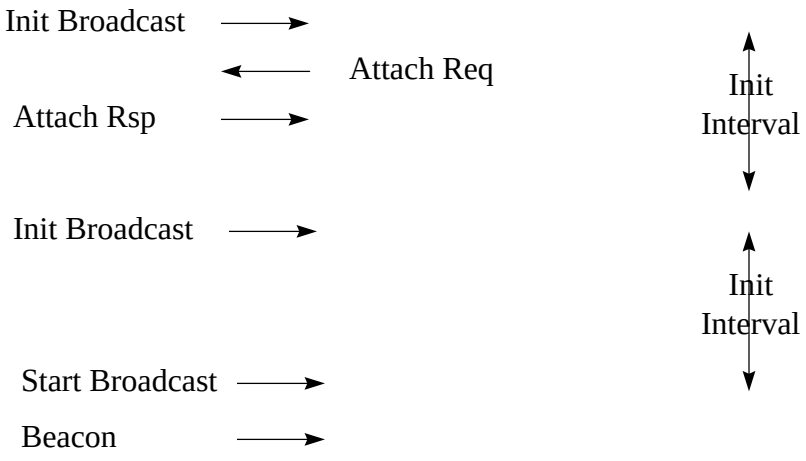
Termination Protocol

- Coordinator broadcast (after beacons) termination notification
- This is repeated several times

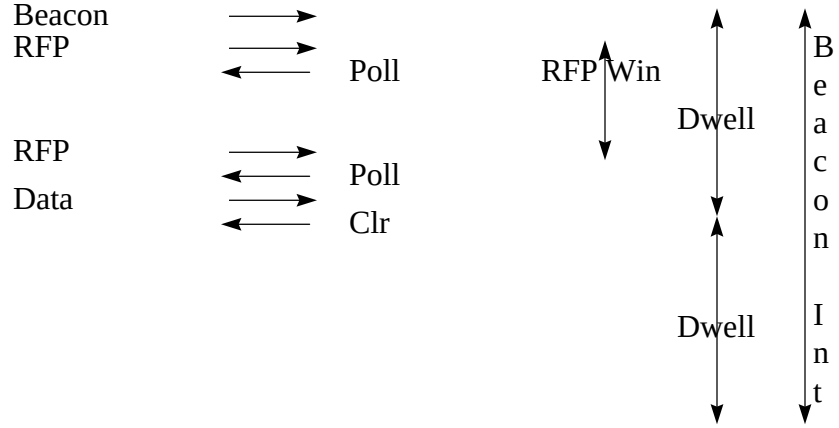
Medium Access Control (MAC)

- CSMA/CA
- P-persistent with reservations (the reservation is similar to that in 802.11)
- Unicast frames all have an immediate response from recipient

Frame Sequences: Initiation



Frame Seq's:Normal Op
Send to Powered Down Sta



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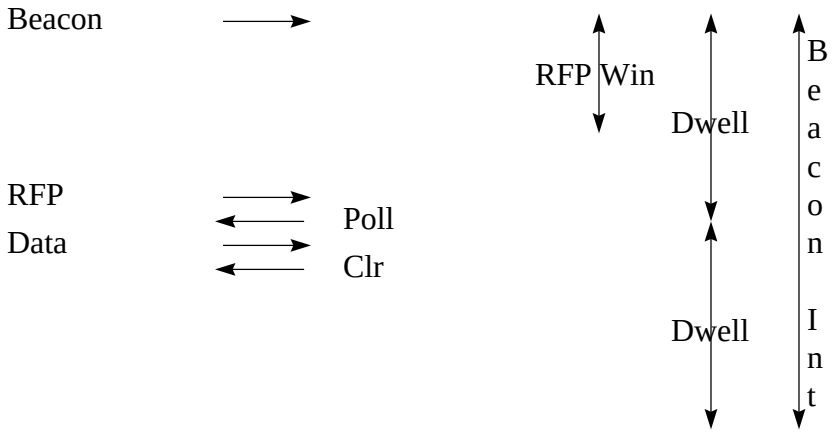

Differences from CFP

- 10 vs 16 nodes per network
  - this number is arbitrary
- Currently at 1.5 cubic inches
  - shape factor dictated by host device

Summary

- Dynamic: self initiating, self contained network
- Cost: minimal cost, low relative to host
- Power Consumption: less than 20 mW for connection maintenance
- Coexistence: both WLAN networks and PAN networks
- Range: greater than 10 meters in cubicle environment