MAC/PHY Functional Partitioning

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Summary

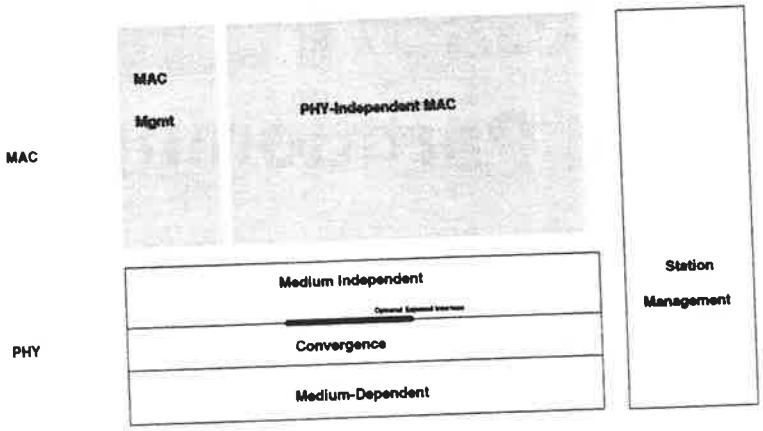
Goal: Universal MAC supporting all PHYs

But: Some PHY dependencies required within MAC

Solution: Modular MAC with a PHY-independent core and PHY-dependencies "encapsulated"

Result: Extension of existing 802.11 model, proposal for universal exposed interface

Current 802.11 Model



MAC-Level PHY Dependencies

- PHY-Control
- State Machine
- Information Exchange

PHY Control "Generic" Functions

All PHYs implement certain common functions which can be coordinated across the MAC/PHY interface:

- Bit Transmission
- Bit Reception
- Preamble Generation

In general these can be "generically" signalled across MAC/PHY interface even if they are implemented differently

PHY-Specific PHY Control

Each PHY has different parameters that need to be controlled, such as:

- Frequency channel (for RF PHYs)
- Chipping sequence (for DSSS)

These have no natural analog within the other PHYs

MAC Implementation of PHY Control

- Generic (PHY-independent) functions
- PHY-specific functions

Approach: support PHY-specific functions by means of a general command/indication interface with parameters

MAC PHY-Dependencies: State Machine

MAC may need to operate differently with different PHYs

- Retransmission scheduling in FHSS
- Use of antenna diversity
- Scanning for new access point

Approach: MAC runs a "Conditional State Machine"

MAC Conditional State Machine

PHY-Independent MAC state machine responsible for most MAC functions:

- Medium allocation
- Deferral/backoff
- Association, CRC, Addressing, Acks, ...

MAC Management Entity is "submachine" responsible for PHY-Dependent actions

MAC Management Component

- Different actions specified for each PHY
- Responsibilities (for example): scanning, hop timing, retransmission control
- *Dynamic* actions, which may occur regularly and frequently (even per-frame)
- Complete MAC = PHY-independent (common) part plus MAC Management

Scanning Example (Multi-channel)

At initialization and periodically during normal operation, station scans for access points

- Under MAC control
- May involve transmission, reception and interpretation of frames
- Operating temporarily off of current channel/hopping sequence
- Requires MAC control over tuning

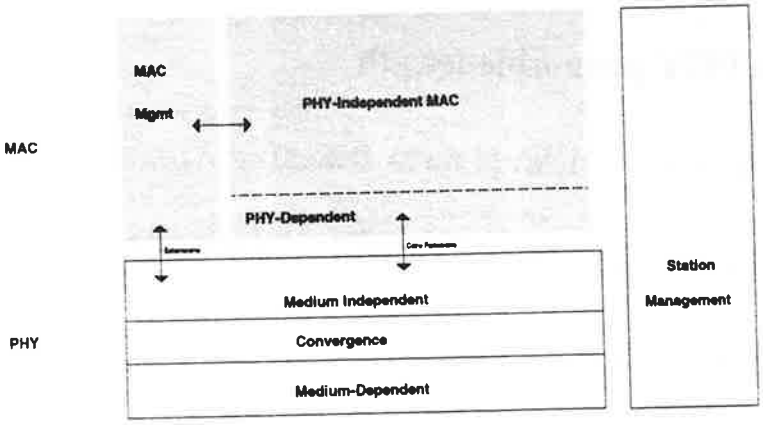
PHY-Dependent Information Exchange

- Stations need to exchange information for correct PHY operation
- Some information may be exchanged between PHYs (PHY header)
- But: some information is best handled by MAC
  - use MAC error protection and data processing facilities
  - Tx power level, channel IDs, hop times, ...

PHY-Dependent MAC Sublayer

- Lowest part of MAC
- Put all PHY-dependent fields at front of header
- Also controls interface to PHY

Extending the 802.11 Model



MAC/PHY Interface: PHY-Independent and Exposable

- PHY dependencies in MAC - but these primarily involve how bits are interpreted, not how they are passed down to PHY
- Generic (universal for all PHYs) command/indication interface
- Some specific commands and parameters for specific PHYs

Per-Frame Interface Functions (MAC)

Support variable PHY preamble length

Tx and Rx control (basic bitlevel data transfer)

Indication of status information on each frame received, such as:

- Receive signal level
- Signal Quality
- Silence/Interference Level
- Bitrate received
- Antenna diversity information

Per-Frame Interface (Continued)

Support for short training (e.g. for Acks)

Dynamic bitrate selection

Dynamic Tx power control, with associated Defer Threshhold control

Diversity option control

Other Dynamic Interface Functions (MAC)

Support for power management/sleep mode

Frequency selection (hopper control and multichannel reassociation).

Static Interface Functions (Station Management)

PHY identification

PHY initialization

PHY service specification

PHY specific statistics collection and reporting

Interface Approach

- **Bit level data signals in the transmit and receive directions, synchronous with a clock generated by the PHY.**
- **Command signals in the MAC-to-PHY direction.**
- **Status indication signals in the PHY-to-MAC direction.**

Commands and Indications: Tx

- Set Threshhold Command [Defer Threshhold]
  Sets the defer threshhold for carrier sense.

- Transmit Enable Command [Transmit Level, Bitrate, Short/Long Preamble, Retransmit]
  PHY begins transmission

- Clear-to-Send Indication

- MAC delivers frame bits

- Transmit Disable Command

Commands and Indications: Rx

- Carrier Sense Indication

- Start and End MAC Frame Indications

- Receive data bits synchronous with supplied receive clock

- Received Frame QoS Status Indication [bitrate, signal level, signal quality, SNR/Interference level, ...]

Other Commands and Indications

- Frequency Selection
- Chipping Sequence control
- Power Management control
- Get-PHY-Parameters command
  - Tx/Rx and Rx/Tx Turnaround Time
  - CS delay and sensitivity
  - Speed/symbol rate
  - Antenna information
  - Preamble length

Conclusions

- Possible for single MAC to support multiple PHYs, with parameterization
- Conditional state machine, with MAC Management component responsible for PHY-dependent actions
- PHY-dependent sublayer within MAC
- PHY-independent exposed interface between MAC and PHY
- MAC control of frequency selection (even for FHSS)