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Power Management

The importance of Power Management provisions in the MAC

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Wireless Network Applications

* Mobile computing
  - Battery operated Notebooks and Notepads.
  - Need desktop like LAN speed connectivity.
  - File transfer, Data-Base access, and Email.
  - Major NOS support.

* Messaging/Transaction Systems
  - Small Extreme Low Power devices.
  - PDA's, scanners, personal communicators.
  - Little traffic, Short (voice) messages and Mail.
  - Do not need all Network services, but need an infrastructure.

* Current (wired) LAN applications
  - Wireless to provide high flexibility.

Power Requirements.

* Notebooks / Notepads.
  - Running on rechargeable batteries.
  - Battery life from 2-4 Hrs now, 4-8 Hrs future.
  - Power consumption 500-1500 mAh.
  - Impact Connectivity function < 20 % Battery life.

This allows for 50-100 mAh for the connectivity function.

Power Requirements.

* Extreme Low Power Devices.
  - Running on few small AA or AAA cells (2000/250 mAh)
  - Battery life for weeks to months.
  - Assume 8 weeks @ 8 hrs/business day.
  - Assume Impact Continuous Connectivity function < 50 % Battery life.

This allows for .4 - 3 mA for the connectivity function.

Transceiver Power Consumption

* Transmit Power consumption:
  - Relate to Tx-Level.
  - Very low duty cycle < 1% of Power budget.
    (assuming 1MByte File/15 minutes and 25% Power efficiency)
  - Tx-Level Control is for medium efficiency only.
  - Peak current is other limitation.
* Rx Power consumption:
  - Relate to bandwidth, linearity and complexity.
  - Idle situation dominates Power Consumption.
  - Idle consumption same order as Rx Power.
  - Assume 150 mA as practical example.

Power Management methodology

* Turn transceiver on only when needed.
  - Already the case in Transmitter.
  - Should also be done in the receiver.
* Put transceiver in sleep mode most of the time.
  - Without loss of service.
  - Use only minimum power in "Doze" state.
  - With adequate throughput / Response time.

Problem: Current Networks require the receiver to be active continuously.
Solution must be independent of any application knowledge.

Sleep duty cycles needed

* Notebooks/Notepads:
  - Need Moderate sleep duty cycle in order of 10-20%
* Extreme Low Power devices:
  - Need extreme low duty cycle of few ms/sec.
  - Transceiver can only turn on once per tens of seconds.
  - This does not combine with LLC-2 timers, so no LLC-2 protocol support possible.
  - Possibly no Broadcast possible.

MAC Provisions needed:

* MAC transmitter need to buffer packets when receiver is in sleep mode.

* Transmitter and receiver needs to be synchronized.
  - Transmitter needs to know when Rx is Awake.
  - Rx needs to be Awake when relevant data is expected.
  - Accurate synchronization needed to allow extreme low Power operation.

Related Issue's

* Network Operating System sensitivities
  - "Connection Alive" monitoring.
  - Out-of-range consequences.

* Network Operating Systems need to reduce their sensitivity levels for such conditions to make them more robust for service disruptions that are not uncommon within a (mobile) Wireless environment.

* Interaction of MAC Power Management with Device Power Management.

Conclusions:

1 - Power (consumption) Management is a crucial function for the 802.11 MAC.

2 - Transmit power consumption has a very insignificant effect on battery life. Therefore Transmit Power Control is not done for power conservation, but its function is to optimize medium re-use.

3 - The idle traffic situation is the most dominant factor for power consumption.

4 - Different Power Management levels are needed to support a large range of applications.

5 - Stations must be able to turn off their receivers for most of the time to meet the power requirements of most power critical devices.

6 - Power Management scheme should be independent of any application knowledge.

7 - Provisions in the MAC are needed to support sleeping stations without loss of service.

- Temporary buffering of packets for sleeping stations.
- Synchronization between transmitter and receiver.

8 - Different Power Management levels have impact on the MAC services supported.

9 - Extreme Low Power Devices can only use LLC-1 services, without Broadcast.

10 - Network Operating Systems show different sensitivity for service interruptions.