

Power Management in IEEE 802.11



Two types of power management

- **Power management in an infrastructure network.**
- **Power management in an IBSS.**



In an infrastructure network

- STAs changing Power Management mode shall inform the AP of this fact using the Power Management bits within the Frame Control field of transmitted frames.
- The STAs that currently have buffered MSDUs within the AP are identified in a *traffic indication map* (TIM), which shall be included as an element within all beacons generated by the AP.
- A STA shall determine that an MSDU is buffered for it by receiving and interpreting a TIM.



Cont.

- STAs operating in PS modes shall periodically listen for beacons, as determined by the STA's ListenInterval and ReceiveDTIMs parameters.
- If any STA in its BSS is in PS mode, the AP shall buffer all broadcast and multicast MSDUs and deliver them to all STAs immediately following the next Beacon frame containing a *delivery TIM* (DTIM) transmission.



STA Power Management modes

Active mode or AM	STA may receive frames at any time. In Active mode, a STA shall be in the Awake state. A STA on the polling list of a PCF shall be in Active mode for the duration of the CFP.
Power Save or PS	STA listens to selected beacons (based upon the ListenInterval parameter of the MLME-Associate.request primitive) and sends PS-Poll frames to the AP if the TIM element in the most recent beacon indicates a directed MSDU buffered for that STA. The AP shall transmit buffered directed MSDUs to a PS STA only in response to a PS-Poll from that STA, or during the CFP in the case of a CF-Pollable PS STA. In PS mode, a STA shall be in the Doze state and shall enter the Awake state to receive selected beacons, to receive broadcast and multicast transmissions following certain received beacons, to transmit, and to await responses to transmitted PS-Poll frames or (for CF-Pollable STAs) to receive contention-free transmissions of buffered MSDUs.

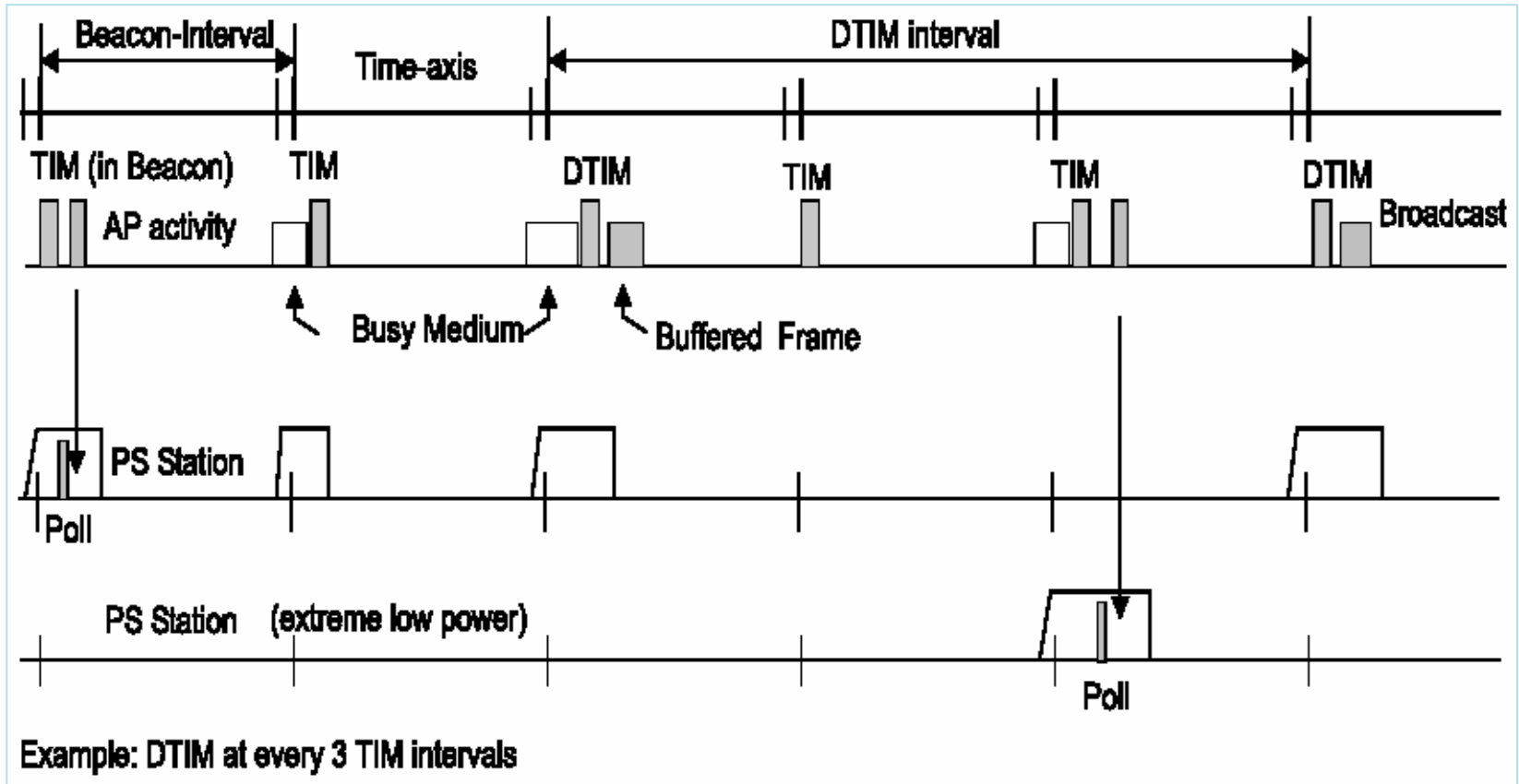


AP TIM transmissions

- The TIM shall identify the STAs for which traffic is pending and buffered in the AP.
- Every STA is assigned an Association ID code (AID) by the AP as part of the association process.
- AID 0 (zero) is reserved to indicate the presence of buffered broadcast/multicast MSDUs.



Infrastructure power management operation (no PCF operating)





AP aging function

- The AP shall have an aging function to delete buffered traffic when it has been buffered for an excessive period of time.
- The AP aging function shall not cause the buffered traffic to be discarded after any period that is shorter than the ListenInterval of the STA for which the traffic is buffered.
- The exact specification of the aging function is beyond the scope of this standard.

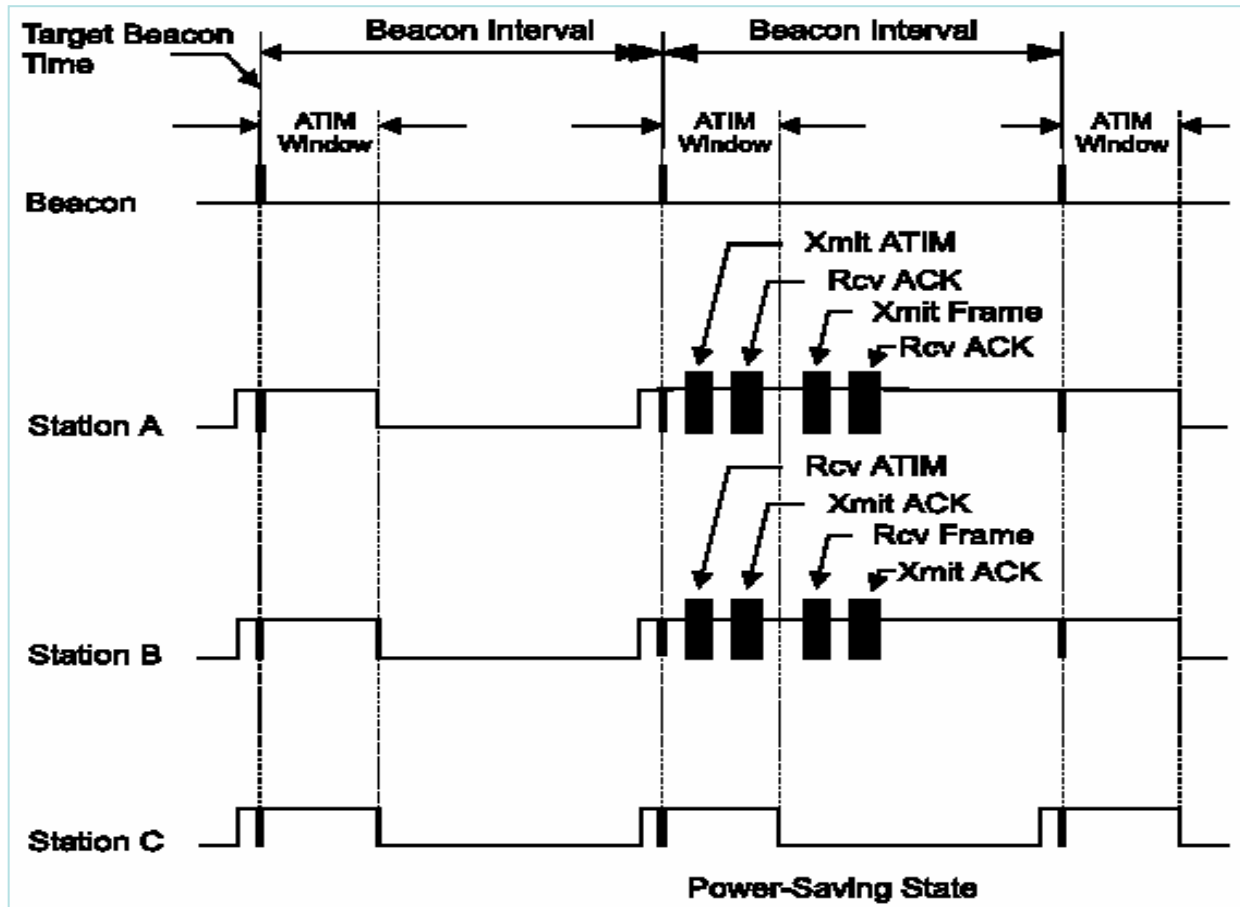


Power management in an IBSS

- The MSDUs that are to be transmitted to a power-conserving STA are first announced during a period when all STAs are awake.
- The announcement is done via an ad hoc traffic indication message (ATIM).
- A STA in the PS mode shall listen for these announcements to determine if it needs to remain in the awake state.



Power management in an IBSS—Basic operation





Initialization of power management within an IBSS

- A STA joining an existing IBSS shall update its ATIM Window with the value contained in the ATIM Window field of the IBSS Parameter Set element within the Beacon or Probe Response management frame received during the scan procedure.
- A STA creating a new IBSS shall set the value of the ATIM Window field of the IBSS Parameter Set element within the Beacon management frames transmitted to the value of its ATIM Window.



Cont.

- The start of the ATIM Window shall be the TBTT, defined in 11.1.2.2. The end of the ATIM Window shall be defined as $\text{TSF timer MOD BeaconInterval} = \text{ATIMWindow}$.
- The ATIM Window period shall be static during the lifetime of the IBSS.
- An ATIM Window value of zero shall indicate that power management is not in use within the IBSS.



STA power state transitions

- If a STA is operating in PS mode, it shall enter the Awake state prior to each TBTT.
- If a STA receives a directed ATIM management frame containing its individual address, or a multicast ATIM management frame during the ATIM Window it shall remain in the Awake state until the end of the next ATIM Window.



Cont.

- If a STA transmits a Beacon or an ATIM management frame, it shall remain in the Awake state until the end of the next ATIM Window regardless of whether an acknowledgment is received for the ATIM.
 - If the STA has not transmitted an ATIM and does not receive either a directed ATIM management frame containing its individual address, or a multicast ATIM management frame during the ATIM Window, it may return to the Doze state following the end of the current ATIM Window.
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Problem statement – multi-hop

- Clock synchronization
- Neighbor discovery
- Network partitioning