METHOD AND APPARATUS FOR DATA TRANSMISSION IN A WIRELESS NETWORK

~~CROSS-REFERENCE TO RELATED APPLICATION~~

~~**[0001]** This application claims priority of US provisional application No. 13/866,504, filed April 19, 2013 and titled "Method and Apparatus for Data Transmission in a Wireless Network," which claims priority of US provisional application No. 61/636,136, filed April 20, 2012 and titled "System and Method for Downlink Scheduling in a Wireless Network," both of which are incorporated herein by reference in its entirety.~~

BACKGROUND

[0002] A wireless local area network (WLAN) typically includes an Access Point (AP) and one or more stations (STAs). Each station may be a device such as a notebook computer, a personal digital assistant (PDA), a wireless VoIP telephone or the like that transmits radio signals to and receives radio signals from other STAs in the local area network via the AP. In a downlink traffic transmission scheme according to the Institute of Electrical and Electronics Engineers (IEEE) 802.11 protocol, the AP periodically sends a beacon frame to the stations. Each beacon frame contains a traffic indication map (TIM) that has data indicating whether there is a downlink data packet buffered at the AP for each of the stations. After a station reads the TIM and finds out that there is a downlink data packet for it buffered at the AP, the station sends out a power save poll (PS-Poll) frame indicating that the station is available and ready to receive the downlink data packet. After receiving the PS-Poll frame, the AP either sends the downlink data packet to the station directly, or sends an acknowledgement (ACK) frame in response to the PS-Poll frame if the AP is not ready to send out the downlink data packet. After sending the ACK frame, the AP will send the downlink data packet soon.

[0003] For wireless stations, power consumption is an important consideration. In order to save power, a station may want to go to sleep unless it has to be awake for sending or receiving

CLAIMS

What is claimed is:

1. An access point for a wireless local area network (WLAN), comprising:

a processing device;

a transceiver; and

a memory having a plurality of instructions stored thereon which, when executed by the processing device, cause the processing device to cause the transceiver to:

broadcast a beacon frame including information which defines a poll period during which a group of stations are allowed to send power save poll (PS-Poll) frames;

receive during the poll period a PS-poll frame from a station of the group of stations for which the access point has a data packet buffered thereon;

send in the poll period an acknowledgement (ACK) frame to the station in response to the PS-Poll frame;

after the poll period, send a downlink schedule frame to the station, the downlink scheduling frame comprising information indicating a wakeup time for the station; and

send the data packet to the station at or after the wakeup time.

2. The access point according to claim 1, wherein the polling period is protected by a Network Allocation Vector (NAV) set by the access point.

3. The access point according to claim 1, wherein the beacon frame further comprises information that defines a data delivery period allocated after the poll period, and the transceiver sends the downlink schedule frame to the station at the beginning of the data delivery period.

~~4. The access point according to claim 1, wherein the downlink schedule frame is a management frame defined by one of Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards.~~

54. The access point according to claim 1, wherein the ACK frame includes the wakeup time.

~~6. The access point according to claim 1, wherein the transceiver multicasts the downlink schedule frame to the station.~~

75. The access point according to claim 1, wherein the transceiver sends the data packet to the station via a multi-user multiple-input multiple-output (MU-MIMO) transmission.

86. A method for data transmission in a wireless local area network (WLAN), comprising:

broadcasting, by an access point (AP), a beacon frame comprising information that defines a poll period during which a group of stations are allowed to send power save poll (PS-Poll) frames;

in the poll period, receiving, by the AP, a PS-Poll frame from a station of the group of stations for which the AP has a data packet buffered thereon;

in the poll period, sending, by the AP, an acknowledgement (ACK) frame to the station in response to the PS-Poll frame;

after the polling period, sending, by the AP, a downlink schedule frame comprising information indicating a wakeup time for the station to the station; and

sending, by the AP, the data packet to the station not earlier than the wakeup time.

97. The method according to claim 86, comprising:

protecting, by the AP, the polling period by setting a Network Allocation Vector (NAV).

108. The method according to claim 86, wherein the beacon frame further comprises information defining a data delivery period allocated after the polling, and the AP sends the downlink schedule frame at the beginning of the data delivery period.

~~11. The method according to claim 8, wherein the downlink schedule frame is a management frame defined by of one of Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards.~~

~~12. The method according to claim 8, wherein the ACK frame comprises the wakeup time.~~

~~13~~9. The method according to claim 86, wherein the AP multicasts the downlink schedule frame to the station.

~~14~~10. The method according to claim 8, comprising:

indicating, by the AP, to the station a time for sending the PS-Poll frame, wherein the time for sending the PS-Poll frame is defined as a function of a position of the station in a traffic information map (TIM) in the beacon frame.

~~15~~11. The method according to claim 86, wherein the sending the data packet to the station comprises:

sending, by the AP, the data packet to the station via a multi-user multiple-input multiple-output (MU-MIMO) transmission, at or after the wakeup time.

~~16~~12. A station for a wireless local area network (WLAN), comprising:

a processing device; and

a memory having a plurality of instructions stored thereon which, when executed by the processing device, cause the processing device to implement operations comprising:

receiving from an access point (AP) a beacon frame comprising information that defines a polling period during which the station is allowed to send a power save poll (PS-Poll) frame;

after determining that the AP has a data packet buffered for the station, sending the PS-Poll frame to the AP in the polling period;

receiving from the AP an acknowledgement (ACK) frame responsive to the PS-Poll frame in the polling period;

after the polling period, receiving from the AP a downlink schedule frame comprising information indicating a wakeup time for the station; and

being awake at the wakeup time, and receiving the data packet sent from the AP.

~~17~~13. The station according to claim ~~16~~12, wherein the sending the PS-Poll frame comprises:

sending the PS-Poll frame at a time defined as a function of a position of the station in a traffic indication map (TIM) included in the beacon frame.

~~18~~14. The station according to claim ~~17~~13, wherein the operations further comprise:

after receiving the beacon frame, going into a sleep state until the time of sending the PS-Poll frame.

~~19~~15. The station according to claim ~~16~~12, wherein the beacon frame comprises information defining a data delivery period allocated after the polling period, and the receiving the downlink schedule frame from the AP comprises:

receiving the downlink schedule frame at the beginning of the data delivery period.

~~20. The station according to claim 16, wherein the ACK frame includes the wakeup time.~~