COMMUNICATION EFFICIENCY

FIELD

[0001] The invention relates generally to improving communication efficiency in a wireless access network.

BACKGROUND

[0002] Typically wireless access networks perform better when the traffic load is small or moderate. Also when the density of the networks and terminals is small, the wireless access networks perform well. However, with a high number of users or a high traffic load, the communication efficiency may decrease. This may be, e.g., due to collisions of transmissions from different users.

BRIEF DESCRIPTION OF THE INVENTION

[0003] According to an aspect of the invention, there is provided a method as specified in claim **1**.

[0004] According to an aspect of the invention, there are provided apparatuses as specified in claims **10** and **20**.

[0005] According to an aspect of the invention, there is provided a computer program product as specified in claim **19**.

[0006] According to an aspect of the invention, there is provided a computer-readable distribution medium carrying the above-mentioned computer program product.

[0007] According to an aspect of the invention, there is provided an apparatus comprising means for performing any of the embodiments as described in the appended claims.

[0008] Embodiments of the invention are defined in the dependent claims

LIST OF THE DRAWINGS

[0009] In the following, the invention will be described in greater detail with reference to the embodiments and the accompanying drawings, in which

[0010] FIG. **1** presents a wireless access network, according to an embodiment;

[0011] FIG. **2** shows a method, according to an embodiment;

[0012] FIG. **3**A shows an example data packet, according to an embodiment;

[0013] FIG. **3**B shows an example negotiation during data transmission, according to an embodiment;

[0014] FIGS. **4**A and **4**B illustrate examples of acknowledgement frames, according to some embodiments;

[0015] FIG. **5** depicts a scenario where an access node controls transmits an indication of a maximum packet duration, according to an embodiment;

[0016] FIGS. **6**A and **6**B illustrate how a station waking up from a sleep mode may operate, according to some embodiments;

[0017] FIG. **7** shows a method, according to an embodiment; and

[0018] FIG. **8** illustrates an apparatus, according to an embodiment.

DESCRIPTION OF EMBODIMENTS

[0019] The following embodiments are exemplary. Although the specification may refer to "an", "one", or "some" embodiment(s) in several locations of the text, this does not necessarily mean that each reference is made to the same embodiment(s), or that a particular feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments.

[0020] The number of IEEE 802.11-enabled mobile devices is increasing. The IEEE 802.11 is a set of standards for implementing wireless local area network (WLAN), also known as the Wi-Fi. Such IEEE 802.11-enabled stations (STA), e.g. user terminals/equipment **102-108** in FIG. **1**, may associate and communicate with an access node/point (AP) **100**. The STAs **102-108** may comprise a mobile phone, a palm computer, a wrist computer, a laptop, a personal computer, or any device capable to access the wireless radio access network, such as the WLAN. The access node **100** may be a WLAN (IEEE 802.11) access point (e.g. Wi-Fi base stations), for example. Although in the following WLAN is used for the simplicity of the description, the embodiments may be applicable to other types of wireless access networks.

[0021] As the number of users (devices) is increasing, the requirements for communication efficiency in terms of reliability and throughput become more difficult to reach. For example, data transmission from the STA **108** may collide with the on-going data transmission between the STA **102** and the STA **106** (via the AP **100**), as shown with a reference numeral **110** in FIG. **1**. In order to avoid or at least to mitigate the problem of interference/collisions, the WLAN uses Enhanced Distributed Channel Access (EDCA) with physical carrier sensing, such as a Clear Channel Assessment (CCA), and virtual carrier sensing, such as a Network Allocation Vector (NAV). As such, when the physical and virtual carrier sensing indicate an idle channel, the STA **102-108** may reduce the value of the back-off. When the back-off is zero, the device (STA) **102-108** may obtain a transmission opportunity (TXOP) to transmit data. The physical and virtual carrier sensing try to avoid simultaneous transmissions that cause interference, e.g., collisions, to each other. The protection level thus depends on the carrier sensing mechanism applied, distance between the transmitters and the intended recipients, network topologies, antenna technology, amount of traffic, etc.

[0022] However, a power saving capable STA, such as the STA **104** may go to sleep (i.e. to a power save mode, also known as a doze mode/state). When a mobile device **104** is using the power save (e.g. is in the doze mode), the device **104** is not aware of the possibly on-going transmissions. In other words the STA **104** may rely only on the physical carrier sensing, such as the CCA. Likewise, if directive transmissions are applied, the NAV or CCA information may not be broadcasted to all devices **104**. As a consequence, when directed transmissions are being used, those devices that disturb the receiver of the directed transmission may not be aware of the on-going transmission(s) and, thus, cause interference to the transmission(s).

[0023] To improve the protection of the on-going transmissions (e.g. to avoid collisions), the devices **104** and **108** should be able to detect the on-going transmissions, such as the transmission between the STAs **102** and **106**. However, e.g. the power saving STAs **104** may not obtain the NAV information from the on-going data transmissions. This may be, e.g., due to the number of data streams, due to different modulation and coding schemes (MCS) being applied, as well as due to possible directive transmissions which may make the data frames of the on-going transmissions hard to detect by a STA **104**. It may also be noted that typically a link adaptation procedure tries to adapt the MCS to a specific