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A Literature Review: Next-Generation Wireless Local Area Networks

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ABSTRACT

This phenomenal and persistent increase may be directly attributed to the emergence of the Internet of Everything (IoE) concept and the worldwide uptick in demand for Internet services. WiFi networks presently account for most of the worldwide Internet traffic because of their low cost of deployment and maintenance. In addition, projections indicate that by 2014, the number of public WiFi hotspots will have increased by a factor of seven throughout the globe [1]. As the number of densely deployed WiFi networks continues to rise, as does the amount of data that these networks must be able to support in both indoor and outdoor settings, it has become clear that the current WiFi standard must be upgraded and specifications for high efficiency wireless local area networks (HEWs) must be defined. Future situations that include dense deployments of HEWs are anticipated, and this study outlines several strategies that might be used to HEWs to attain the requisite performance. Physical layer methods, medium access control layer tactics, spatial frequency reuse schemes, and power savings mechanisms are all part of the HEW solutions under discussion. We talk about how to define simulation scenarios that represent future HEW usage models, performance metrics that reflect HEW user experience, traffic models for dominant HEW applications, and channel models for indoor and outdoor HEW deployments, all of which are necessary for an accurate evaluation of a newly proposed HEW scheme. We conclude by pointing out several areas where further study and development of HEW is needed.

Keywords: WiFI, HEW, IoT, hotpots, Wireless, Amount

I. INTRODUCTION

It is predicted that Internet traffic will expand exponentially during the next several years. Cicso forecasts that worldwide IP traffic would increase at a CAGR of 23% between 2012, reaching 2 zettabytes per year by 2013 [2]. Many causes are contributing to the anticipated increase in IP traffic. First, the proliferation of highly intelligent and capable new gadgets in the market has led to an increase in the average number of Internet connections per user. These days, it's not only computers, phones, and tablets that can connect to the web; there are also smart fridges, watches, cars, and other gadgets. The term "Internet of Everything" (IoE) is used to describe the network of all possible devices. Since several continents (e.g., Asia and Europe) have already exceeded their allotted IPv4 address spaces, the rapid adoption of IPv6 by device makers and network operators is another factor directly contributing to the formation of the IoE [2]. As Internet connection speeds have increased and more people have access to Internet-enabled devices, more and more 'data-hungry' Internet services have been adopted in homes, on the go, and at the office. For instance, between 2013 and 2014, there was an 18%, 47%, and 30% rise in the use of Internet services for domestic online video, mobile localization, and corporate videoconferencing, respectively [2]. With the advent of ultrahigh-definition TV technologies and the growing trend of people ditching their traditional TV subscriptions in favour of online video watching via the Internet, IP video services (including online video, video-on-demand, video file sharing, etc.) already make up a significant portion of global IP traffic and are expected to at least maintain that percentage in the future. The shift of certain applications from offline to online (such as gaming) and the shift of other services from broadcast to unicast (such as line TV) [2] are both developments that have the potential to significantly increase IP traffic in the future.

It is predicted that WiFi1 devices, which are part of wireless local area networks (WLANs), would contribute a significant fraction of the overall traffic in the Internet of Everything era. In 2014, WiFi traffic constituted 42% of worldwide IP traffic [2,] compared to 4% from cellular networks and the remaining 86% from wired networks. The need for affordable wireless Internet access from consumers and businesses, as well as the reliance of cellular companies on WiFi hotspots for cellular network offloading, will only increase the current reliance on WiFi technology for Internet access. Therefore, it is predicted that there will be over 340 million public WiFi hotspots globally by 2018, an increase of more than 7x from the current estimate of 48 million in 2014 [1]. Since the number and density of WiFi networks are expected to increase, as is the amount of wireless traffic that these networks should be able to handle, it is imperative that the existing WiFi standard be improved to include specifications for high efficiency WLANs (HEWs).

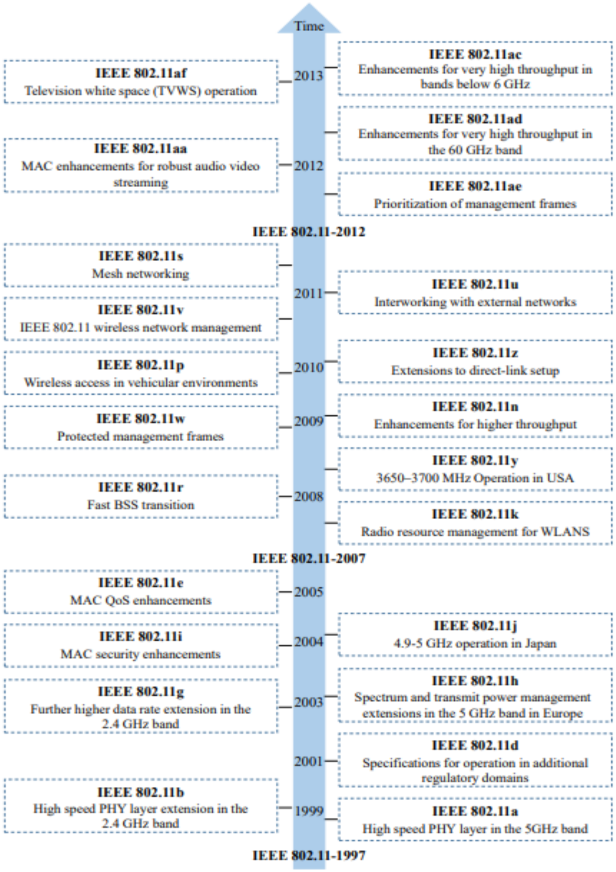

Figure No. 1:Evolution of the IEEE 802.11 standard

The older IEEE 802.11-1997 standard does not provide a method to give extensive QoS guarantees. However, the later IEEE 802.11e amendment increased QoS support with an improved distributed channel access (EDCA) method [4]-[11]. There has been a lot of effort done to improve the QoS provisioning to fulfil the QoS requirements in WiFi networks [12, 16]. The IEEE 802.11af modification was introduced in 2013 to allow for use in the empty airwaves between TV channels (known as TVWS) [17]. To achieve its long communication range, good signal penetration ability, and relatively high throughput, IEEE 802.11af operates at lower frequency bands than other WiFi amendments, for example, 54 MHz to 698 MHz in the United States and Canada [18]. This technology is commonly referred to as Super-WiFi. over instance, it has been shown that IEEE 802.11af, when using a 6 MHz TVWS channel width and a 4 W transmit power level, can achieve a throughput of 80 Mbps over a 1200 m communication range [19]. Accessing the TV White Space (TVWS) without a license.

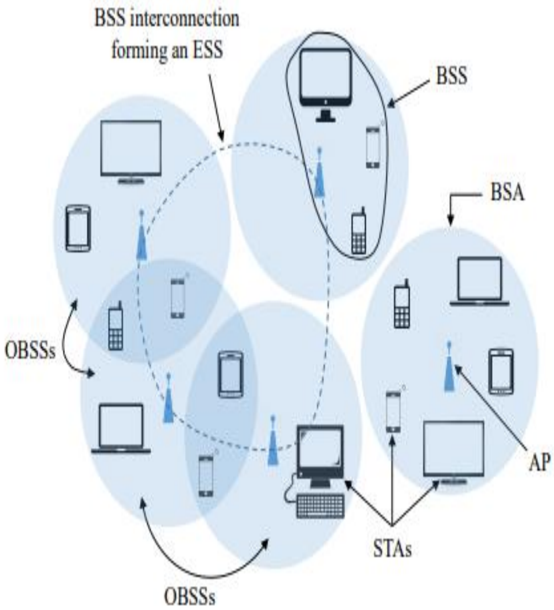

Figure No. 2: Illustration of main HEW Components

It will be difficult, if not impossible, to accomplish the goals for HEWs with only one technology. Therefore, a future HEW's requirements should include several cutting-edge technologies at once, such as cutting-edge approaches at the physical (PHY) layer, better strategies at the medium access control (MAC) layer, increased spatial frequency reuse schemes, and efficient power saving mechanisms.

It is also important to use appropriate simulation scenarios that represent realistic HEW use cases, such as scenarios with varying AP and STA densities, single and multiple management domains, and indoor/outdoor deployment, when evaluating a newly proposed technology for HEWs. In this study, we provide a comprehensive review of the methods now available for HEWs, provide the assessment process for a novel HEW approach, and highlight several outstanding questions for the field. We begin with a discussion of physical layer (PHY) strategies for increasing STA-to-STA throughput and enabling concurrent communications among several STAs in a BSS. Then, we show off state-of-the-art research at the MAC layer, which maximizes the benefit from the PHY layer's approaches by ensuring that BSS members make effective use of the channels available to them.

II. PHY TECHNIQUES

The IEEE 802.11ax standard for HEWs necessitates an enhanced PHY layer to accommodate the increased requirements.Due to significant multipath delay spread, substantial Doppler shift, and rapid channel fluctuations, conventional WLAN PHY layers are not well-suited for use in outdoor settings.In addition, efficient PHY/MAC cross-layer design and interference cancelation/management methods are needed to fulfil the stringent QoS requirements of HEW applications in a dense HEW deployment scenario. Here, we discuss some of the possible improvements to the physical layer that are presently being discussed by the IEEE 802.11ax work group. Some examples of these upgrades include the usage of orthogonal frequency division multiple access (OFDMA) and the introduction of technologies like MU-MIMO and inband full-duplex (IBFD) communications. Table III summarises the PHY layer methods that have been addressed here.

2.1: OFDMA

Most current WLANs use orthogonal frequency division multiplexing (OFDM) for their physical layer. By using closely spaced (in frequency) and orthogonal sub-carrier signals, OFDM is a multi-carrier modulation technique for transmitting data. Current WLAN protocols, such as IEEE 802.11n/ac, use OFDM for downlink and uplink communications (transmissions from an AP to a non-AP STA and vice versa) due to the various benefits of OFDM, including the efficient OFDM implementation based on Fast Fourier Transform (FFT) algorithms. In contrast to orthogonal frequency division multiplexing (OFDM), in which a single STA always transmits and receives signals over all the OFDM sub-carriers, OFDMA allocates different subsets of sub-carriers for different STAs at a given time, allowing for simultaneous uplink transmissions from multiple STAs to an AP and simultaneous downlink transmissions from an AP to multiple STAs, as shown in Fig. 2. Subsection IV-B explains how a dense HEW deployment scenario might benefit from the interference control made possible by OFDMA for HEWs via fractional frequency reuse (FFR) [8].

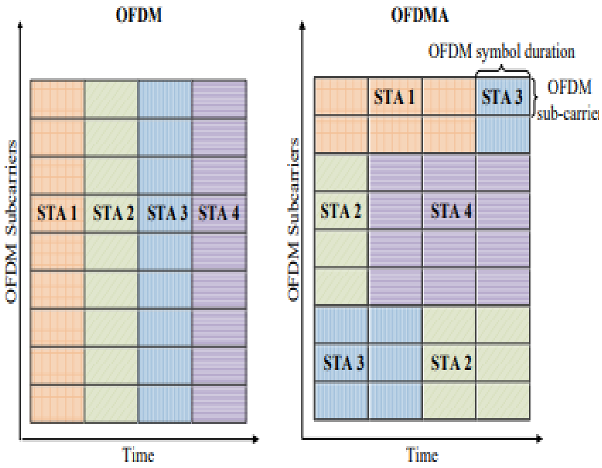

Figure No. 3 :An example of uplink sub-carrier allocation for STAsin OFDM and OFDMA

As was previously noted, separate subcarriers need be allotted to various STA members of a BSS to implement OFDMA in HEWs. In this situation, a high throughput for the BSS is necessary, hence an efficient sub-carrier allocation mechanism is needed. Specifically, because to a narrow channel coherence bandwidth, the channel gain between two STAs might vary greatly depending on the subcarrier used. In addition, the multipath signal transmission between each STA and the AP results in variable channel gains for each sub-carrier. Frequency diversity refers to the variation in channel gain between two STAs using different sub-carriers, whereas multiuser diversity refers to the variation in channel gain between one access point and many STAs using the same sub-carrier. To maximize the throughput gained over each sub-carrier, sub-carriers may be effectively distributed to STAs by making use of frequency and multiuser diversities [59], [80]. That instance, if one STA's channel gain is low between the AP and the STA over a given sub-carrier, the AP may reallocate that sub-carrier to another STA with a better channel gain. This adaptability is a benefit of OFDMA over OFDM, where many sub-carriers may go unused owing to poor channel circumstances, for example when a water-filling method is employed for OFDM sub-carrier power distribution.

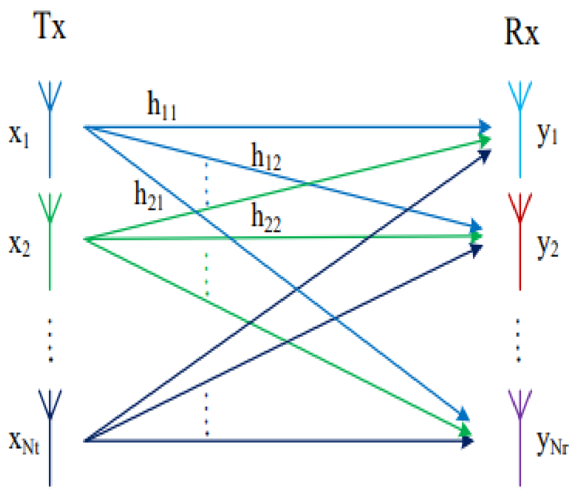

Figure No. 4:MIMO channel model with N^ttransmit antennas, Nrreceive antennas, and channel gain h_{ij} between the I^{th}transmit antenna and the j^{th} receive antenna

In addition to being compatible with older IEEE 802.11 updates based on OFDM, such as IEEE 802.11n/ac, the effective use of frequency resources is another benefit of adopting OFDMA for HEWs. If the available bandwidth is 80 MHz, for instance, an IEEE 802.11n AP can only use 40 MHz of it, but an IEEE 802.11ac or HEW AP may use the whole 80 MHz [6]. A set of sub-carriers in the frequency spectrum enabled by the prior IEEE 802.11 amendment may be assigned to a STA when it joins a HEW. An IEEE 802.11n STA, for instance, will receive sub-carriers in a 40 MHz contiguous bandwidth from a HEW AP. When a HEW STA (supporting OFDMA) associates with an AP that employs an earlier IEEE 802.11 amendment (supporting OFDM), the STA behaves as if it has been assigned all the sub-carriers in the frequency channel over which the AP is operating. In addition, each communicating STA may support a separate standard for modulation orders over sub-carriers [6]. Therefore, clients using IEEE 802.11n and IEEE 802.11ac may talk to a HEW AP using the maximum supported modulation order of 64-quadrature amplitude modulation (QAM) and 256-QAM, respectively. However, as we saw in Section VII-A, there are still many open questions that need to be explored before we can successfully adapt OFDMA for HEWs, particularly regarding uplink communications.

2.2: MU-MIMO

Thus, compared to single-input single-output (SISO) where just one antenna is used at each end, the data rate will rise by a factor of Ns. However, to reap the benefits of MIMO, more sophisticated signal processing and channel state information (CSI) must be implemented at the source and/or destination nodes. To decode the sent vector x from the received vector y, the receiver in an open-loop MIMO system requires the CSI (i.e., the H matrix), which is not accessible at the transmitter. In contrast, the CSI is accessible at the transmitter (through feedback from the receiver) and pre-codes the broadcast symbols in a closed-loop MIMO system. In [1], the authors compare the capacity increases of open-loop and closed-loop MIMO systems.

There is just one sender and one receiver in a single-user MIMO (SU-MIMO) system, but each uses several antennas for sending and receiving data. In contrast, a multi-user multiple-input multiple-output (MU-MIMO) system uses the available antennas across several nodes.

When the number of STAs is high and the number of antennas at the AP is more than the number of antennas at each STA, MU-MIMO may be used to obtain a spatial multiple access gain by taking advantage of the users' dispersed positions.When compared to SU-MIMO, MU-MIMO is less affected by signal propagation difficulties including antenna correlations and channel rank loss. Broadcast channels (MIMO-BC) and multiple access channels (MIMO-MAC) are two types of MU-MIMO. When talking about spatial multiplexing, MIMOBC refers to transmissions made from a single AP to multiple STAs over the downlink, whereas MIMO-MAC refers to transmissions made from multiple STAs over the uplink. Most MIMOBC methods, in contrast to SU-MIMO systems, need the presence of CSI at the transmitter AP.

Due to the need for feedback signals from the receiver, obtaining CSI on the transmitter side is typically more expensive. In contrast to MIMO BC, which requires CSI at both the transmitting and receiving access points, MIMO-MAC only needs it at the receiving access point. There has been a lot of research on the efficiency of MU-MIMO systems [6], and that includes MIMO-BC and MIMO-MAC.

2.3: IBFD Communication

It is possible to (theoretically) increase the spectral efficiency of a communication system by using IBFD communications, a technique that enables a transceiver to send and receive signals on the same frequency band [9]. Realizing IBFD communications is complicated by the fact that the transceiver's own sent signal is substantially stronger (up to 109x [11]) than the required signal being received at the same time. As can be seen in Fig. 6, SIC can be accomplished either in the digital domain, following the analog-to-digital conversion (ADC) of the received signal at the receiver, or in the analogue domain, prior to the ADC's processing of the signal by positioning and orienting the antennas appropriately. The IBFD solution shown in [70] uses both analogue and digital SIC methods to produce 73 dB of SIC for a 10 MHz bandwidth WiFi signal. For an IEEE 802.15.4 system running on a 2 MHz channel bandwidth and using less transmit power than WiFi, this design provides an advance on the IBFD approach in [7] that reaches 60 dB of SIC.

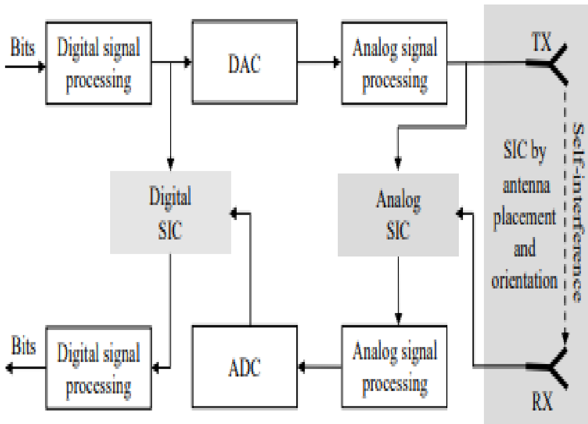

Figure No. 5:A generic block diagram of an IBFD transceivershowing the SIC in the digital, analog, and signalpropagation domains.

The SIC achieved in [2], where the transmit and receive antennas are linked by a low loss wire, is predicted to grow by roughly 40 dB if the antennas are separated physically. This would bring the SIC to a grand total of 113 dB. Antennas may reach a high SIC [6] if they are suitably separated and oriented, and a mobile device (like a laptop) is present between them. IBFD designs may achieve 80 dB of SIC for a narrowband signal with a bandwidth of 625 KHz [3] and a median of 85 dB of SIC for an OFDM signal with a bandwidth of 20 MHz [4] by utilizing antenna separation in conjunction with analogue and digital SIC. Furthermore, utilizing just one antenna and a circulator to concurrently broadcast and receive signals, a 110 dB of SIC may be realized for an 80 MHZ WiFi signal (the highest WiFi channel bandwidth as established by the IEEE 802.11ac amendment) [5].

As predicted by IBFD communications, the substantial SIC of 110 dB leads to a nearly twofold increase in throughput. For IBFD communications, directional antennas are introduced [2] utilizing the same analogue and digital SIC approaches as described in [1], even though most current IFBD systems are based on omni-directional antennas. Table IV provides a brief overview of the four most prominent IBFD designs now under consideration by the IEEE 802.11ax work group [8]. Additional IBFD methods may be found in [9].

III. MAC STRATEGIES

It is possible that a significant number of STAs will coexist near one another in many HEW deployment situations, such as in a stadium, airport, or concert hall, leading to the establishment of a BSS with numerous STAs connected to the same AP. When there are many users in a BSS, channel contention among the AP and its connected STAs can become intense, leading to significant delays in accessing the channel and an increased likelihood of collisions during transmission. This can have a devastating effect on the HEW's performance. Therefore, it is important to design a MAC scheme that can effectively decrease the probability of a transmission collision among different STAs, permit simultaneous transmissions in the same BSS, and shorten the channel time for transmission of control information to improve channel utilization and the BSS throughput.

Many researchers are working towards these goals by studying MAC for HEWs from three different angles. Primarily supported by the distributed coordination function (DCF) [3], the IEEE 802.11 standard MAC approaches are the initial area of study. The second trend involves the development of novel MAC techniques for concurrent multiuser transmission, such as OFDMA or MU-MIMO (addressed in Sections II-A and II-B, respectively). Third, based on what was covered in Section II-C, we're working on MAC schemes that can function atop an IBFD communication PHY layer.

'Multiuser MAC' and 'IBFD MAC' refer to the final two types of MAC schemes discussed here. In what follows, we'll break down the progress made in each of those three areas of study, and Table V will categorise the many MAC approaches we'll be talking about.

3.1: IBFD MAC

The most recent development in IBFD technology challenges a major tenet of the IEEE 802.11 MAC's initial design: that a STA may only broadcast or receive on the same frequency band at any given time instant. According to the research in [7], both indoor and outdoor settings may benefit greatly from the increased throughput that IBFD communications can provide to HEWs. However, various MAC difficulties need to be addressed before using IBFD technology for HEWs, in order to achieve the anticipated increase in the total throughput of a BSS [8]. Here we assume that the two frames being exchanged between the Access Point (AP) and the STA (x) in an IBFD conversation have different durations, as illustrated in Fig. 7a. It's feasible that a collision will occur between the broadcasts of STAs x and y at the AP if the surrounding STA y gains access to the channel when it perceives the channel to be idle following the AP transmission. It is impossible for the standard RTS/CTS exchange to prevent this transmission collision from occurring because the AP does not know the length of the frame that STA x needs to transmit (if any) at the time it sends the RTS frame (which should include the duration that the channel has to be reserved to exchange the data and ACK frames). This leaves the surrounding STAs, which have received the RTS frame, in the dark as to how long they should wait before re-entering the channel. Even if both frames sent and received between the AP and STA x have the same length, this problem persists if the frames' transmissions begin at different times.

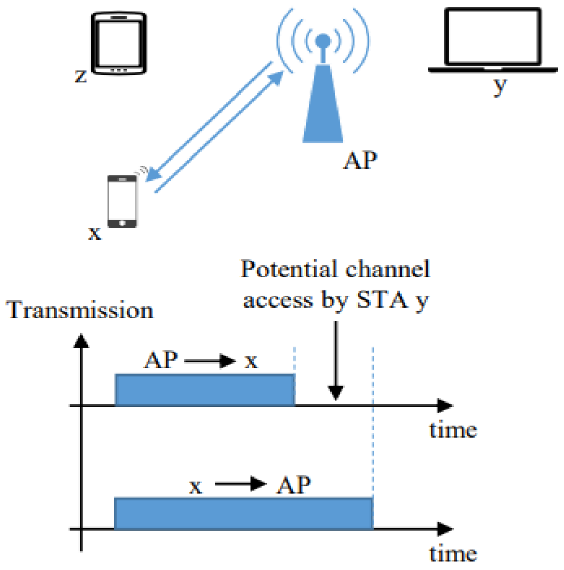

Figure No. 6:Potential transmission collision caused by surrounding STAs

Even if both frames sent and received between the AP and STA x have the same length, this problem persists if the frames' transmissions begin at different times. A system for deciding when and how the AP and STA x will exchange the ACK frames at the conclusion of the IBFD transmission of data frames is also required. Another difficulty is that because of the simultaneous broadcasts from the AP and STA x, any STAs within the communication range of both the AP and STA x, including STA z, would get a corrupted frame. To comply with the IEEE 802.11 standard, STA z will wait much longer to transmit after the IBFD data exchange between the AP and STA x is complete (equal to the value of extended inter-frame spacing (EIFS) instead of the DCF inter-frame spacing (DIFS) [3]) than the other STAs that can successfully decode either of the two frames transmitted by the AP and STA x.As a result, the possibility for injustice brought on by IBFD communications has to be minimized. It is also conceivable for STA z's broadcast to interfere with the AP's transmission to STA x, as seen in Fig. 7b, if the AP uses IBFD to interact with both STAs, x and z, instead of just one.Therefore, an appropriate technique should be used to kick off these non-pairwise IBFD communications5 without producing interference among the many STAs involved.

IV. RESULTS

4.1 : PHY

As was discussed in Section II-A, OFDM is the basis of the PHY layer of contemporary WLAN standards. A longer cyclic prefix (CP) duration12 is recommended for HEWs when OFDM is used outdoors, where multipath signal propagation with a large delay spread (due to reflection from obstacles located over a large area) is present, to facilitate robust communications, combating long delay spreads [238]. However, since the CP does not contain any data, increasing its length decreases STA goodput. The maximum CP allowed by IEEE 802.11n/ac standards is 1.6 s, but the maximum duration of an effective OFDM symbol is 3.2 s [11]. Therefore, increasing the length of the usable component of the OFDM symbol is necessary to improve the STA goodput in HEWs. By decreasing the sub-channel bandwidth, or the frequency difference between two consecutive sub-carriers, more sub-carriers may be used to transmit each OFDM symbol, which in turn increases the symbol duration [8]. The FFT size, however, should be set such that the sub-channel bandwidth is like that of the earlier IEEE 802.11 amendments based on OFDM, such as 312.5 KHz for the IEEE 802.11n/ac amendments, to maintain compatibility with older WLAN standards. Therefore, HEWs employing OFDM with a high FFT size will need to use novel signal processing algorithms for modulating/demodulating OFDM signals with varying subchannel bandwidths.

4.2: MAC

Improvements to the IEEE 802.11 DCF scheme could boost average BSS throughput and improve short-term fairness among BSS members, but a multiuser channel access and IBFD communication breakthrough is more likely to be necessary for HEWs. As a result, rather than focusing on making small gains in DCF performance, researchers should instead work to enhance the HEW MAC layer's ability to support multiple users and IBFD. While MU-MIMO-based downlink multiuser channel access is incorporated in the IEEE 802.11ac standard, realizing uplink multiuser channel access is a more difficult issue, as discussed in Section III-B.

Several MAC layer research issues must be resolved before uplink multiuser channel access can be implemented, including: a) which STAs should be selected for multiuser transmission (i.e., AP-initiated or STA-initiated) [12], b) how to transmit an ACK frame from the AP to each sending STA [13], and d) how to avoid the hidden terminal problem for each STA involved in uplink multiuser transmission, especially in When using IBFD communications at the PHY layer, the underlying MAC scheme must take into account the transmission collisions brought about by pairwise and non-pairwise IBFD communications, as well as the transmission of the ACK frame and the possibility of unfairness, as discussed in Section III-C. Existing IBFD MAC research on these topics should be supplemented by investigation into the performance assessment of the suggested IBFD MAC schemes in dense HEW deployment situations with OBSSs, using both modelling and extensive experimental testing. In addition, to the best of our knowledge, no study has been done in the prospective MAC research path of merging both IBFD communication and multiuser channel access technologies.

4.3. Reusing Frequencies in Space

A fairness issue may occur, leading to HEW STAs having better throughput relative to legacy STAs, even if upgraded CCA schemes may greatly increase the spatial frequency reuse by allowing for more concurrent transmissions (Subsection IV-A). Consider a situation in which HEWs with a higher CCA level coexist densely with other IEEE 802.11 WLANs. In such a scenario, a HEW STA may have a considerably better chance of transmission than a conventional STA. A HEW STA is permitted to transmit at all received power levels above its CCA but below those at which a legacy STA is prohibited from doing so. Because of this inequality, the throughput of a traditional STA may be as low as 2 Kbps, whereas that of a HEW STA can be as high as 14 Mbps [4].

Throughput rises by 36% for a HEW STA and decreases by 48% for a legacy STA when the CCA level is changed from -82 dBm to -62 dBm in a residential situation [3]. The inequity between HEW and legacy STAs has two root causes. To begin, the transmission of the following legacy STA will be postponed until the conclusion of the transmission of the HEW STA [4] if the transmission of the HEW STA occurs simultaneously with the transmission of the heritage STA (without any transmission collision). A broadcast from a HEW STA may render nearby legacy STAs inaudible, but the converse is not true. One way to mitigate this impact is to restrict HEW channel access to the period left until the end of the channel access granted to the legacy STA [13]. Second, as was mentioned before, a transmission collision at a receiving legacy STA can result in a high-power consumption (required for retransmission) and reduced throughput because a legacy STA transmission (being a data frame or an RTS/CTS control frame) may not silence all the surrounding HEW STAs. Controlling the gearbox power at HEW STAs is one solution to this problem [10]. To guarantee adequate performance of existing IEEE 802.11 WLANs in the presence of HEWs, extensive research is necessary before deploying a CCA-enhanced approach.

For two reasons, modern WLANs are often noise-limited systems, where the noise effect at a receiver STA predominates over the interference impact. First, current WLANs have effective co-channel interference management since BSSs are deployed sparingly and appropriate channel selection algorithms are in place. Second, the conventional IEEE 802.11 CCA system uses low CCA levels, therefore the maximum power that might disrupt a STA's reception is very low (Table VIII). But in HEWs, things are different. Co-channel interference in OBSSs is largely unavoidable due to the widespread and unchecked deployment of HEWs. It's also possible that the CCA levels of HEW STAs using upgraded CCA schemes will be greater, leading to a bump in interference power.

V. CONCLUSION

There will likely be a large increase in the deployment of dense WiFi networks soon due to the rising reliance on WiFi technology for Internet access. New solutions for HEWs must be developed to provide an adequate degree of QoS provisioning for a wide range of HEW user applications in both indoor and outdoor settings, to support the anticipated growth in WiFi network size and density. The adoption of cutting-edge PHY layer technology by HEW STAs is expected to represent a watershed moment in the evolution of HEW.Enhancements to the PHY layer may make use of methods like OFDM and MU-MIMO that are already present in today's WLANs, or they may make use of newer methods like OFDMA and IBFD communications. Toutilize OFDMA for uplink transmission through efficient STA selection, synchronization, and sub-carrier allocation, and to implement OFDM with a bigger FFT size (while keeping backward compatibility), further study is needed.

Redesigning the MAC layer at the BSS level is necessary to get the most throughput improvement from a better PHY layer technology. Multiuser channel access and IBFD communications between BSS member STAs are two of the most significant goals of MAC layer research, besides improving the IEEE 802.11 standard DCF (through improved back-off algorithms, RTS/CTS exchange, etc.). While IBFD MAC is responsible for preventing new sorts of transmission collisions and any short-term unfairness generated by IBFD communications, multiuser MAC is responsible for solving uplink multiuser transmission difficulties in a BSS.

REFERENCE

[1]. Cisco, The zettabyte era: trends and analysis. Cisco White paper,2015.
[2]. "IEEE standard for information technology–telecommunications andinformation exchange between systems local and metropolitan areanetworks–specific requirements part 11: Wireless LAN medium accesscontrol (MAC) and physical layer (PHY) specifications," pp. 1–2793,Mar. 2012
[3]. IEEE standard for information technology–local and metropolitan areanetworks–specific requirements–part 11: Wireless LAN medium accesscontrol (MAC) and physical layer (PHY) specifications – amendment8: Medium access control (MAC) quality of service enhancements,"pp. 1–212, 2005
[4]. Y. Gao, X. Sun, and L. Dai, "IEEE 802.11e EDCA networks: Modeling,differentiation and optimization," IEEE Trans. Wireless Communications, vol. 13, no. 7, pp. 3863–3879, 2014
[5]. Q. Zhao, D. Tsang, and T. Sakurai, "A scalable and accurate nonsaturatedieee 802.11e edca model for an arbitrary buffer size," IEEE Trans.Mobile Computing, vol. 12, no. 12, pp. 2455–2469, 2013.
[6]. A. Banchs, P. Serrano, and L. Vollero, "Providing service guarantees.in 802.11e EDCA WLANs with legacy stations," IEEE Trans. MobileComputing, vol. 9, no. 8, pp. 1057–1071, 2010.
[7]. L. Zhao, L. Cong, H. Zhang, W. Ding, and J. Zhang, "Game-theoreticEDCA in IEEE 802.11e WLANs," in Proc. IEEE VTC, 2008, pp. 1–5.
[8]. Z. Wang and X. Guo, "Priority-based parameter performance optimization for EDCA," in Proc. IEEE ICCSNT, 2013, pp. 685–688
[9]. E. Charfi, L. Chaari, and L. Kamoun, "PHY/MAC enhancements andQoS mechanisms for very high throughput WLANs: A survey," IEEECommunications Surveys Tutorials, vol. 15, no. 4, pp. 1714–1735,2013.
[10]. H. Lee, S. Byeon, B. Kim, K. B. Lee, and S. Choi, "Enhancing voice.over WLAN via rate adaptation and retry scheduling," IEEE Trans.Mobile Computing, vol. 13, no. 12, pp. 2791–2805, 2014.
[11]. M. Santos, J. Villalon, and L. Orozco-Barbosa, "A novel QoE-awaremulticast mechanism for video communications over IEEE 802.11WLANs," IEEE Journal on Selected Areas in Communications, vol. 30,no. 7, pp. 1205–1214, August 2012.
[12]. M. Hegde, P. Kumar, K. Vasudev, N. Sowmya, S. Anand, A. Kumar,and J. Kuri, "Experiences with a centralized scheduling approach forperformance management of IEEE 802.11 wireless LANs," IEEE/ACMTrans. Networking, vol. 21, no. 2, pp. 648–662, 2013.
[13]. A. B. Flores, R. E. Guerra, E. W. Knightly, P. Ecclesine, and S. Pandey,"IEEE 802.11 af: a standard for TV white space spectrum sharing,"IEEE Communications Magazine, vol. 51, no. 10, pp. 92–100, 2013.
[14]. S. Deb, V. Srinivasan, and R. Maheshwari, "Dynamic spectrum accessin DTV whitespaces: design rules, architecture and algorithms," inProc. ACM MobiCom, 2009, pp. 1–12.
[15]. X. Wang, M. Derakhshani, and T. Le-Ngoc, "Self-organizing channelassignment for high density 802.11 WLANs," in IEEE PIMRC, 2014,pp. 1637–1641.