A comprehensive survey on channel bonding techniques in wireless sensor networks and futuristic cognitive radio networks

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Abstract

Channel bonding is an authenticated approach used in wireless networks that improve data rate as well as reduces latency. Traditional networks like mobile networks, non-cellular networks, and wireless LAN and wireless sensor networks use traditionally the Channel bonding technique. To support channel bonding, effective frequencies assignment techniques are significant to use, and thus improving frequencies use. In multi-hop topologies, WSN usually generates a bunch of packets like scattered and event-driven transmission methods’ where data transmitted over many transitional hops. In this paper, we have thoroughly analyzed the various parameters affecting channel bonding as well as its application in wireless sensor networks. Finally, various challenges for channel bonding implication in futuristic cognitive radio networks are also presented.

Keywords: Channel bonding, mobile networks, non-cellular networks, wireless LAN, Channel aggregation.

I. Introduction

Channel Bonding (CB) is an approach to merge a variety of adjacent wireless channels without duplicating and set up a uniform channel of higher bandwidth. An

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approach of CB is that when a variety of adjacent frequency channels are merged without duplication and set up a uniform frequency of higher data rate, when needed, the merged channel can crack to liberate part narrow-band frequencies. The responsibility of CB is to provide a higher data rate for data transmission than different separate frequencies [I]. CB offers a fortunate possibility to convey significant parts of information (or packets burst) over a short period.

Various types of wireless networks such as mobile networks, non-cellular networks, wireless LAN, and wireless sensor networks use CB. While extensively researched, have already been done on these wireless networks. To support channel bonding, effective frequencies assignment techniques are significant to use, and thus improving frequencies use. For example, femtocells and Long-Term Evolution Advanced (LTE-A) carried out in cellular networks; which provide high data rates to their customer by the combination of both contiguous and non-contiguous channels [II]. A new standard also introduced like IEEE802.11ac by wireless computer networks that make sure compromising accessibility for both adjacent and non-adjacent channels [III].

From the perspective of non-cellular based networks. Dynamic Spectrum Access (DSA) has proved to be a prospective technique for transmission in bands in case of radio frequency congestion [IV]. This technique has formerly proved a definite consequence for energy use levels, a lifetime of the network, and member nodes interaction. DSA easily applied in WSNs as Cognitive Radio (CR) nodes can alter their operative constraints to animatedly adjust into a free channel [V]. The positive effects of CB in non-cellular networks cover a higher data rate, little difficulty, enhance channel capability for the same quantity of communication energy [VI]. But CB awake non-cellular networks also appear specific difficulties like security hazards from spiteful operator [VII]. For well-organized DSA, the number of CR nodes optimized in a particular network [VIII] sharing among a set of CR nodes and coexistence with different networks [IX].

Industrial and home automation [X] service measuring and defines applications are advancing and moving towards WSNs. In multi-hop topologies, WSN usually generates a bunch of packets like scattered and event-driven transmission methods where data transmitted over many transitional hops [XI]. Burst becomes transmitted after the transmission medium is usually underexploited. The international frequency usage calibrations [XII] also describe that wireless points usually expect discord in a minimal range whilst further parts of the spectrum stay abandoned. That creates use to assign the accessibility of the resources more effectively. Experimentally evaluations reveal that frequencies sharing (under standard energy restrictions) can provide considerable frequency reuse possibilities [XIII]. And run smoothly without generating any bad interference or congestion problems to improve the spectrum that is used by contiguous channel combinations using CB.

WSNs enhanced with the added ability of non-cellular have been directed to the development of non-cellular sensor networks [XIV]. It equips sensor nodes with DSA, both can completely handle the licensed and the unlicensed bands. Because of the potential advantages of non-cellular sensor networks, this is utilized in several assignments [XV]. Noncellular networks having high data rate prerequisites, the benefits of the CB technique are being used in wireless multimedia sensor networks.
(WMSNs) to carry out network concerns. For universal health monitoring systems, Wireless Body area networks (WBANs) are being developed as a potential technique [XVI]. Also, non-cellular sensor networks and CB plays a significant task in the application area for carrying out large data rates to a given system. CB within noncellular sensor networks also faces various problems that need to develop for broad applicability in later applications. The primary problem is neighbor channel interference amongst adjacent channels or communication energy and bonds energy [XVII].

II. Channel Bonding: Basics, Benefit, Challenges, Limitations & Related Concepts

By carrying out CB in mobile networks, non-cellular networks, wireless LAN, one can assure concerns of data rate hungry intersection. CB is possibly the simple key for issues because contiguous small channels bonded together and send large amounts of data. Once the data transmission is done, then bond broke again and individual channels will be assigned to various customers. On the nature of network type, CB schemes are arranged in various categories. The aims of carrying out CB differ according to the nature of network types and need. Generally, there are multiple aims to gain which focus on the nature of network type. For example, power usage is the highest essential aim in one scheme and few more schemes may examine power to be the minimum useful standard. The selection of spectrum for CB may be certified or unrestricted or equally, which made a bond of existing adjacent available channels.

By examining a combat zone strategy, transmit the multimedia information in the network to different nodes, through a determination of multimedia sensors attached to troops; thereby producing incoherent traffic in multi-hop nodes. Assume that the shield units are designed as the Primary Radio (PR) nodes and the troop's units as CR nodes in this particular strategy. Since information having graphic data is bigger and sensors need a larger different bandwidth. To meet the frequency demand of CR nodes (infantry) CB will be a good choice that is realized that a split guard band demanded at the corner of the bond instead of when a single channel. A wider separation need for spectrum overflow generates within signal optimization and to secure the adjacent PR/CR transmission [XVII]. A larger guard band needs larger bonds when the width of the channel expends (greater bond size), and also increases leakage of frequency [XVIII]. The problem of secure band size choice is an energetic nature that is checked by channel bonding schemes. The size of the guard band is managed in such a manner to guard adjusted transmission from Adjacent Channel Interference (ACI) [XIX].

A. Benefits of Channel Bonding

CB is applied to enhance the data rate and slow rate decrease and to improve complete capacity. The algorithm for CB faces fewer difficulties to decrease the capacity energy usage of nodes. So, to get these benefits of channel bonding, a suitable robust channel sensing and a low complexity CB algorithm are needed.

1) Bandwidth Improvement: Channel width can be altered on using CB, which in response affects various network standards such as ability, energy usage, broadcast

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area, etc. Broader channels can support a significant amount of information to send [XX]. Circumstances of the sensor network such as those sensors are usually compactly given in haphazard topology. Then identical broadcast ability retains the path of a low transmission range needed. Bandwidth advancement is used for large amounts of data or bundle of packets transmission in multimedia sensors. Suppose that frequency channels CH2 and CH3 are free from any PR activity and used by any CR node, they can be combined to create a bond i.e. two channels are free from PR activity CH2 and CH3 but used by CR node then they together create a bond.

2) Delay Minimization: With intelligent CB, large bandwidth reduces transmission delays and transmission of data at a higher rate becomes available [XXI]. Assume a hospital environment in which different medical devices examine the patient and send their data to the control center or data center. i.e that network has four different frequency channels, each individual transmit data in Time T, channels CH1 and CH4 are busy, and CH2 and CH3 are free, if a sensor sense some data and ready for transmission then the sensor use CH2 and CH3 channels together to get higher bandwidth. Sensed data can easily transmit over a large bandwidth and take half time in comparison to normal transmission.

3) Throughput Maximization: A bonded channel is offering higher data rates and lower transmission. A higher data rate assumes a higher amount of binary to transmit per unit time. CB offers a higher data rate and further data is to transmit under a specific time. When the bandwidth increases then reduce the entire communication delay, so the responsibility can reduce cause conflict to other nodes. CB is used to transmit a large amount of data over the channel which needs to increase bandwidth so the following systems will convey a higher communication rate and enhanced efficiency [XXII]. To increase bandwidth on demand, users can dynamically adjust the bond size when the benefits of adjustable bandwidth and adjustable data rate [XXIII] are attained. To focus on system limitations the user maximized the throughput of the communication system and decreased end to end delay.

B. Limitations of Channel Bonding

The importance of high bandwidth, CB schemes facing fewer difficulties, and issues need both hardware and software changes at the sender and receiver. CB is applicable at the physical layer so that multiple channels need a single MAC Protocol Data Unit (MPDU) for transmission but each channel bonding which together it needs a separate modulator. All channels have a single bit interleave, having combined a higher bandwidth instead of an individual channel. But the throughput may badly reduce in the situation of the major difference of signal interference as well as noise ratio that is present among the channels [XXIV].

When applying CB to multiple proportional channels, the protector bands are needed to minimize ACI and to protect neighboring PR/CR communications. The function of the guard band is a type of separation that holds two bonded (Or unbonded) blocks at a safe distance to each other to avoid ACI. Guard bands add to the barrier of effective spectrum assignment and use. Channel bonding schemes must consider the issue of guard band when assigning channels to CR users. To avoid wasting resources, reuse

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of the guard band is a better approach, in this way, two adjacent channels use a single guard band [XVII].

Security is the key point for every network. CB scheme is vulnerable in terms of security. [XVIII] performed experiments on LTE-A and HSPA+ networks which shows that the throughput and orthogonality losses among the bonded channels are abused by hackers to create a disturbance. So, it is needed for CB schemes to find out a better solution for such types of limitations and provide a sure way of achieving the advantages of the CB scheme.

### C. Wireless Sensor Networks

A wireless sensor network (WSN) is a suite of several independent tiny computing nodes (called mote) that are installed in a specific area or region. These tiny motes are capable of performing a great variety of applications in our daily life like for example, indoor monitoring, industrial-scale monitoring, forest fire detector, remote surveillance, and weather information accessing as shown in figure 1. Hence, each of these applications uses a different scenario and may depend on the requirements of user needs. Some applications of WSN need a low delay, higher data rate, network reliability and robustness, quick access among nodes. Important issues of WSNs are discussed below:

**Bandwidth:** Bandwidth is the ability of data-carrying in a link for data transmission between nodes and transceiver, nowadays WSN requires more bandwidth due to the wider application of WSNs and also depends on the size of networks. Each network has the capability of assigning spectrum band and density of the node which need to be managed in such a way that it cannot exceed the given bandwidth.

**Latency:** Latency is the delay between endpoints, the transmission time is well known to the devices and measurable in the field of digital networks, so some protocols can send data fast which can reduce latency in a network.

**Robustness:** WSNs need to be deployed in such a way that it can operate continuously without any error or failure, this property knows as robustness, it has further two qualities:

1. Reliability is the continuous operation of a network without any compromises
2. Resilience is the ability of operation under complex environments like failure or catastrophe.

So, WSNs can be designed with these qualities as compared to a wired one, WSNs need to manage itself and adopt for a long period.

**Energy consumption:** energy consumption is an important issue in WSNs and optimization is needed to operate longer as it possible for node because in some situation like volcano monitoring of underwater sensors are deployed once and there is no management for battery replacement or charge it, so energy optimization in need in such way that node can use at energy at the minimum point to operate long as possible for node.

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Congestion: WSNs use a burst type traffic because of improper implementation of node and each node knows the adjacent nodes and the remaining nodes are unknown to that node, in which packets scattered in every direction which may cause congestion in a result of late data delivery, sometimes packets lost, etc. such protocol is needed to avoid congestion and send data in a meaningful time and also can send data fast, accurate and secure to destination.

![Various Applications of WSNs](image)

**Fig. 1:** Various Applications of WSNs.

### III. Channel Bonding Schemes in Wireless Sensor Networks

In general, the PR activity is not considered by the WSNs, the accessible channels are at the same priority at all the nodes. In such cases, when the traffic is low, channel bandwidth can be increased by CB [XIX]. But if the traffic is high, CB can cause interference due to the low number of frequencies and various nodes being shared. Contrarily, the multi-channel technique is capable to tackle huge traffic used by multiple nodes. Such a type of network, have limited channel or frequency widths, encounter a brute choice between power consumption and transmitter range. In WSNs, the limitation is faced due to the power consumption at every node where batteries are installed. By increasing the power of transmitters can increase the range of communication but on the other hand, it reduces the working life of a node as well. To cope with such issues, a possible way to overcome this constraint is using CB, which adjusts the width of the channel dynamically. Channels are bonded when high data transmission is required and these bonds are broken when the transmission is over. In [VIII] an adaptive technique for the allocation of the channel in IEEE802.11b/g is shown, which can be used for WSNs keeping in mind the issues related to WSNs. [XX] shows another CB dynamic technique that targets wireless
networks with multicarrier. The scheme proposed in WSNs can act well and drive a pivotal role in decreasing contention in spectrum efficiency and getting high-frequency allocation agreement. However, assessing the performance of any technique, certain metrics are taken which depend on the requirement and type of specific protocol. A comprehensive summary of channel bonding schemes has been presented in Table I.

Bonding and selecting channels in WSNs can be assessed by using various metrics that are being defined in the observations. It is why the CB is defined to enhance the throughput of a network which will become the basic indicator if bandwidth is increasing and it is being accessed by a user for sending more data or else.

Other metrics are also used in the abstracts other than throughput. Frequency utilization is another widely used metric while delaying, end to end delivery ratio (DR), network capacity (NC), convergence time (CT) and load balancing (LB) are rarely used metrics. All these metrics are purposed to collectively assess the network performance and dynamically increase the channel bandwidth. These metrics are discussed in detail: In research, throughput is a widely used metric for performance analysis. It explains the idea of CB to increase the data rate in WSNs.

**Table I: Summary of Channel Bonding Schemes for Different Wireless Networks**

| Work  | Network | Year | Description |
|-------|---------|------|-------------|
| [XXIV] | WSNs    | 2009 | This paper is focused on providing QoS for multi-channel Ad-Hoc networks using CB |
| [XIII] |         | 2005 | This paper presents CB as a bandwidth sharing approach for improved utilization of licensed spectrum |
| [XXXIV] |         | 2007 | This paper discusses CB to maximize throughput for multi-radio mesh networks |
| [XXXVII] |         | 2008 | This paper discusses CB as load aware technique for WLANs |
| [XIV]  |         | 2009 | This paper is based on a joint channel assignment scheme and routing protocol for IEEE 802.11 networks |
| [XXVIII] |         | 2009 | This paper discusses QoS aware CB scheme for multi-radio Ad-Hoc networks |
| [XXIX] |         | 2010 | This paper characterizes the link quality of the 802.11n network when CB is applied for high data rates |
| [X]    |         | 2008 | This paper discusses the objective of interference avoidance and control for CB based methods |
| [XXVII] |         | 2011 | This paper discusses the impact of CB schemes on IEEE 802.11n network management |

In [VIII] a comparison is shown, which says that over the width of a channel the throughput increases but the distance and number of users among the nodes and it plays an important role to find the throughput. The combination of the number of nodes, throughput, and nodes distance are collectively termed as load balancing. The

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under-utilized frequencies in a cellular network can efficiently be used by sensor nodes in such wireless networks [XII] taking an approach like DSA and CB technique, which enhance nodes throughput. [XXXVII] has figured out the issues faced in static channel allocation, in which the spectrum is not effectively utilized. On the other hand, dynamic spectrum assignment can allocate the free frequency slots to the CR which utilizes it more efficiently by using the CB scheme. [XIX] suggested (VERITAS), a channel auction technique that satisfies that channel can be utilized effectively and allocated to such users who are authorized to attain these channels. A delay is a basic parameter in a network for evaluating its performance. Inserting CB technique in the network can have an important impact over delay propagation. In a network with more PR traffic, the delay is experienced by a user [XIII], but in a less PR traffic, the CB technique can minimize such delays in propagation. In [XIV], it is revealed that in channels that are non-overlapping and can be utilized together which will decrease delays end to end and increase throughput.

Researchers have taken metrics used for the performance of a network that includes network capacity (NC), load balancing (LB), delivery ratio (DR), convergence time (CT), and Quality of Service (QoS). A comparison of various techniques in terms of these parameters is expressed in table II.

IV. Guidelines on Using CB for Futuristic Cognitive Radio Sensor Networks

When a network has a small number of PR nodes and large combined channels are available then CB is important but in case of user exceeding which may result in a small number of channels accessible for other struggling CR nodes. To take the full channel advantage, a dynamic MAC protocol is necessary which can change the bond volume according to the availability of channels number and struggling CR nodes. CB initiates particular challenges and difficulties, which is necessary to point out to take full advantage when implementing WSNs. Important challenges and difficulties are discussed below:

A. The Separation Distance between Adjacent Channels

To avoid the adjacent channel interface also called spectrum leaks, it is needed to abandon guard bands on both sides of bonded channels. The Bonded channel’s guard band needs to keep the half bandwidth of a separate channel [I]. In this way, some bandwidth can be avoided at the expense of leaving idle.

| References | LB | NC | QoS | Throughput | CT | Spectrum Utilization | Delay | DR |
|------------|----|----|-----|------------|----|---------------------|-------|----|
| [X]        | √  |    |     |            |    |                     |       |    |
| [XIV]      |    |    |     |            |    |                     |       |    |
| [XV]       |    |    |     |            |    |                     |       |    |
| [XIII]     |    |    |     |            |    |                     |       |    |
| [XXI]      |    |    |     |            |    |                     |       |    |
| [XXV]      |    |    |     |            |    |                     |       |    |
| [XVIII]    |    |    |     |            |    |                     |       |    |

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This loss of bandwidth can be avoided by adopting a capable approach than existing ones. There is a tradeoff between guard band size to avoid interference and bandwidth usage. As in the battlefield scenario, this is possible when the infantry finds free channels to bond. The coming neighboring channel was being used by armored units. Interference is avoiding due to us between these two transmissions, so a lot of the guard band is needed. This issue of guard band size has not yet been examined for WSNs and therefore may be considered as a correction issue for CB in WSNs. Various techniques like screening, energy monitoring, and antenna engineering can also reduce ACI in standard networks. Since separate requirements for WSN which can face, these designs need to be examined to find the solution to ACI in WSNs. Ad-hoc networks offering QoS Capabilities available for a static width and dynamic width [XXIV]. The examination is required for capabilities under the importance of WSNs.

B. Energy Conservation Problems:

Power usage is higher when the bonded channel has a higher data rate [I]. Remember QoS and power interruptions. Ideal stability between power usage and the size of bonded channels is needed to be examined. It can be seen here that several nodes have different power usage. Certain powerful nodes use more energy as compared to other nodes. These nodes also perform the function of cluster head or gateway nodes. Hence bonded channel data rate is related to the power of these nodes. CB performing network layer protocols know every node power consumption, when communication between cluster head nodes occur then a few frequencies power together able to communicate. For the transmission of high data, the rate is needed to increase the size of the bond. i-e food security scenario, CB is likely performed by CR node than other sensor nodes in the container, that is why these nodes deployed with high energy than others, channel width are kept according to the node energy, to save energy the bond size can be reduced in case of CR node facing low power. In the fixed-width systems, these functionality is not available [VIII]. To minimize node power and avoidance interference, an intelligence scheme split wide-band interferes friendly technology (SWIFT) is used in narrow-band devices with co-exorbitance and CR nodes [XI].
C. How to use A Channel for Bursty Traffic?

In a sensor network, when the need for communication occurs then it transmits a junk of packets across the network, so a fixed-width approach is not a satisfied solution in this model. The only possibilities are that it remains to hibernate after transmitting junk of packets or it will transmit continuously for a random amount of time. In the railway track selection process, when the train is coming then every junction node can communicate, and also in health monitoring modules when sensor sense changes in the body then it transmits junk of packets over the network. To control error occurrence, an effective approach like strategic channel assignment is the need to ensure reliability and prevent packet losses. Split wide-band interfere friendly technology (SWIFT) effectively implemented for wide-band junk of packets like traffic-utilizing TCP in 802.11a without disturbing the narrowband users [XI]. In some situations, it can be expanded to a wide-band channel for WSNs. To use UDP protocol a technique was proposed [VIII] which presents that when both modulation rate and channel width increasing then the throughput will also increase.

D. Impact of Pr Activity Type

The performance of PR nodes in the network establishes PR activity. That is why PR activity pattern is believed to be a significant block in any CR based network. If the pattern suitably estimates the activity of nodes which can create an application of effective channel. In CR capacity with smart grids, the effect of PR activity is very high in the process of channel selection because different geographic locations have different values [LIII]. PR activity patterns get the result that can easily decide the channel selection scheme that is why an appropriate PR activity pattern will assign to an area in which the collision of the PR node with the CR node is avoided. PR activities can classify into four different categories, which are High PR activity, Low PR activity, Long term PR activity, and Intermittent PR activity. best fit channel selection (BFC) [23] is a non-selfish scheme for non-cellular networks, during CR transmission time it performs effectively. To deliver the capabilities of WSN made the scheme intelligent.

E. How to Check Accuracy?

It is essential to find out the performance measuring of a system that precisely how it is working. Accuracy term is to check the certainty or accurateness of result in availability of spectrum or up to what extent the activity of PR was examined. In terms of accuracy, the model of activity of PR can be found out in different ways like interference between CR and PR nodes. Detecting energy is the easiest way to find out PR activity, wherever it can turn into collision. There are two stages involved in IEEE 802.22 frequency sensing procedure XXXVII i-e fast sensing and fine sensing. The exponential model of Markov is less memory and has an imperfect high degree of detections when CR nodes store a record of bad spectrum decision selection, it can help to examine the network and performance is improved [LII]. I-e in food security, when a CR node transmits data and some collision is sensed with another PR node, it will identify the corresponding channel as a bad channel for sending data. Profiling in such a technique will help CR node to opt such channels which are limitedly selected by PR nodes.

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F. Size of the Network

Network size is important for monitoring the PR nodes actively in network operation. Increased PR nodes in a network will make it difficult to monitor PR activity. For an ideal size network, research can be carried out. Clusters can be made for a large size network, which is difficult in handling. In such cases, the head lifetime (CHs) will decrease because of more coordination and calculations of information with the other CHs. An appropriate clustering technique is taken for nodes CH designation periodically, to keep the lifetime of node equal. There will be an increase needed for the CHs energy resources to perform for a longer time when a task is assigned. When CR nodes are high in a network, then the CR nodes are high in a network, then the CR technique is not able to perform due to scarcity of frequency by the competing CR nodes. As in general, if many contenders are there for a free channel in a limited resource, then it is difficult for CR node to find a free spectrum. Where if less number of CR nodes are present in a scenario, then the CB scheme can be more promising to get wideband demands [XXVII].

G. Spectrum Profiling for CB

For a better knowledge of frequency availability, analysis of time series and CB logged over time in instances can be performed. For example, the suitable spectrum/ frequency can be added or bonded together by a CR node which observes the spectrum activities. This is considered interesting for further analysis that came across other several fields like decision analysis and machine learning.

In real, due to the limitation of memory, the CB history can be infinitely grown and it should be cut short for saving memory. This takes us to another question that which portion of data is of little use and can be neglected. For example, if time is under consideration then we can truncate the old entries first. If spectrum utilization is important, then the least used channels can be compromised. In smart grids, when sensor requires sending the data to the grid or controlling station, they will only pick the suitable channel for them. In such a scenario, the earlier entries are discarded by the nodes as the recent most entries will provide the necessary updates about the condition channels.

H. Defining the Goal for Channel Selection

The specific goal for channel selection should be made very clear. The WSNs have appeared due to complex nature purpose and there is no single objection which can be enhanced perfectly. The group of objectives may compromise efficient spectrum utilization, maximum power conservation, reliable data dissemination, load balancing, and the least possible interference [XIX]. This group should not be measured comprehensively by any resource that is just provided as an example. Depending upon nature if the network these objectives may differ for which it has been applied and interchange can be found between critical ones. For example, one network needs higher throughput at low-cost security while other networks may ask for secure communication highly dependable without higher data rate importance.

Among all the required objectives the best tradeoff should be achieved by a mature scheme. As CB in WSNs least interference and data dissemination can be an
appropriate goal for enhancement because an effective bond can be made only when the required data may be distributed to the node which can be multi-hop from the transmitter without any damaging interference to the other users of the network in health care monitoring. In a multi-hop, the patient data is required to be sent to the physician. The transmitted data should reach accurately to the required destination so the least interference and data dissemination are the main goals to implement CB in WSNs.

I. Channel Suitability for Bonding

Based on the requirement of a network and the required set of goals, a dynamic CB technique will assign channel weights depending on their sufficient level being used by CR nodes. The most relevant or suitable channel will get the maximum relevant weight. Whenever the parameters of the network change, so the weights would be recalculated, as the nodes are said to be in motion and their location is changing, hence dynamics of the network will also change in WSNs.

It is necessary to examine the exact interval of time for weights update. An additional control head will be required for the recalculation frequently and a lengthy interval between the two recalculations can take it to entries expired in the database and PR-CR collision ultimately. For example, the scenario of the battlefield when the contenders are moving, the condition of the channel also changes, and hence the weights calculation id required at regular intervals. This is an area of investigation, where periods are updated and recalculated in such a scenario.

J. False Alarm and Missed Detection

If any incorrect calculation is prominent towards a collision or underutilization of bandwidth, a reason for its false alarm or missed detection should be examined. These problems are lethal for any kind of scenario like railway track, selection, health care monitoring, forest fire finding, battlefield, etc. no PR node was active in case of a false alarm at any exact instant of time and the channel sensing algorithm send the PR activity due to some inevitable reasons, the result is, the channel is not used by CR node hence causing the consumptions of resources. While failed detection of PR is termed as missed detection and leads to a collision of CR and PR nodes. When such a decisive mistake occurs due to the reason mentioned above, new measures are important for their remedy. Either every parameter is recalculated in the database or an intelligent technique should be used to overcome such a decision. During assigning the channel and prioritizing them for CR communication, missed detection and false alarm problems can occur. When the priorities of recalculations are carried out due to their extensive intervals, such problems are caused in the network.

V. Conclusion

In this paper, we provided a detailed survey on CB schemes for mobile networks, non-cellular networks, wireless LAN, and WSNs. CB scheme is classified into many categories according to the nature of the network and provides a brief discussion on each network according to performance metrics. We noticed from the literature review that significant work has been carried out on channel bonding.
schemes for cellular networks, WLANs, WSNs, and CRNs. In this sense, several survey papers are provided in the literature which points out specific problems related to channel bonding, however, a detailed survey on CB schemes was missed in the literature. This survey ensures a brief discussion of the problems and challenges related to the existing CB schemes and finds out the potential application areas for CB schemes belonging to cognitive radio sensor networks.

Conflict of Interest:

There was no relevant conflict of interest regarding this article.

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