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Reducing carrier and code interference in wireless communication systems

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Abstract

The interference has a major detrimental effect on wireless network performance. Today's globe is rapidly focusing on the issue of reducing interference in wireless networks due to the ongoing deployment of larger and more advanced networks. In this research we will discuss the reducing carrier and code interference in wireless communication systems. This paper showed that the critical factor in wireless communication is the carrier-to-interference ratio (CIR). Network operators may improve their systems to provide their customers with high quality telecommunication services by knowing their importance and uses. Requirements for reliable communications will increase along with the development of wireless technology, making proper CIR control more urgent. Furthermore, the signal-to-interference ratio (SIR) is a basic metric in wireless communication systems that evaluate signal quality when interference is present. Better signal quality is indicated by a higher SIR value, while more susceptibility to interference is indicated by a lower value. The effects of SIR on wireless communications are evident in a number of areas, including data speed, bit error rate (BER), and overall quality of service (QoS).

Key words: Interference Reduction, Wireless Networks, Carrier-to-Interference Ratio (CIR), Signal-to-Interference Ratio (SIR)

1. Introduction

The quality of the signal is critical in the field of wireless communication. The need for dependable communication grows along with technology advances, thus it becomes increasingly important to comprehend the elements that influence signal quality. One such element is the Carrier-to-Interference Ratio (CIR), a metric that is important in figuring out how well wireless communication networks operate. The goal of this page is to provide readers a thorough grasp of CIR, its significance, and its uses in wireless communication (Dong et al., 2023). Unsettling issues with interference have an impact on how well wireless communication systems operate. Wireless signal transmission is more prone to interference, which might impact neighboring consumer and electrical device functionality (Oyedepo et al., 2010).

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A lot of the most modern wireless multimedia apps prefer high data rates. Due to the receiver complexity and the multipath impact of the wireless channel, traditional single carrier modulation schemes can only achieve restricted data rates. Orthogonal frequency division multiplexing (OFDM) is a leading contender to meet the needs of wireless communication systems of the present and the future. The main obstacles to adopting an OFDM system, however, are Peak-to-Average Ratio (PAPR), Inter-symbol Interference (ISI), and Inter-carrier Interference (ICI) (Slimane, 2020). A multicarrier modulation technology called orthogonal frequency-division multiplexing (OFDM) has been used for several high-speed wireline and wireless applications. In fact, OFDM's orthogonal subcarrier characteristics result in great spectral efficiency and a superior capacity to handle multipath fading environments (Smida, 2017). There is a requirement for a precise frequency-synchronization approach since the subcarriers' spectra overlap. Oscillator problems and imperfect transmitter/receiver synchronization lead to an easy breakdown of the orthogonal characteristics, which in turn causes frequency offset errors. Inter-carrier interference (ICI) and a reduction in the usable signal strength are well-known effects of carrier frequency offset (CFO) (Sathananthan & Tellambura, 2001).

One of the main challenges of wireless communication is interference. Systems for wireless communication might cause interference or be the victim of it. An interference-immune wireless communication system is achieved using a variety of interference reduction strategies. Regretfully, because this field of study is still in its infancy, many theories have been put out by researchers regarding how to determine a universal proxy for network interference (Oyedepo et al., 2010). Therefore, this research will focus on interference in wireless communication systems and some mitigation techniques.

2. Interference in Wireless Communication Systems

In wireless communication systems, air serves as the medium for signal transmission. Since transmitters share the air, devices using the same frequencies may be mutually accessible, which might interfere with one another's ability to function? Interference occurs when additional wireless signals cause a disruption or weakening of the wireless communication signals. Electromagnetic signal emitters are all susceptible to interference (Ramachandran et al., 2006). Interference is defined as a coherent emission with a relatively narrow spectral content that prevents the intended recipient from receiving the desired signal. Examples of this type of emission include radio emissions from other transmitters at roughly the same frequency or with a harmonic frequency that is roughly the same as another emission that the recipient finds interesting. Informally, if a node u accidentally overlaps a node v in its interference range, u may interfere with v. As a result, the quantity of interference generated by nodes whose transmission range includes node v equals the

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quantity of interference that node v experiences. Reducing interference creates fewer channels in frequency division multiplexing cellular networks, which can be used to boost bandwidth per frequency channel (Couture et al., 2007). Coding overhead is reduced in systems that use code division multiplexing by relatively minimal interference. There is another reason to minimize interference in the context of ad hoc and sensor networks. Energy is usually scarce in these battery-powered networks, therefore judicious use of it is essential to extending system lifetime and network operability. Reducing interference can not only increase throughput but also lessen node energy dissipation by lowering the number of collisions (or the energy used trying to avoid them) and retransmissions on the media (Hassan & Chickadel, 2011).

Less transmission power can be used by nodes to reduce interference. There will be fewer nodes in the region that the shorter transmission range covers, which will reduce interference. Nonetheless, lowering the broadcast range results in the loss of communication linkages, still, there's undoubtedly a limit to how low the transmission power can go. Due to the difficulty of reducing interference in arbitrary networks, several more basic topologies have been studied, including hexagonal topologies (Khanna & Kumaran, 1998), unit disk graphs (Couture et al., 2007), multi-hop wireless mesh network layouts (Ramachandran et al., 2006) , triangular lattice topologies (McDiarmid & Reed, 2000), hexagonal topologies, and other more general topologies (Battiti et al., 1999). Other important aspects of the interference problem in wireless networks include whether or not a proposed solution is artificial in a centralized or distributed setting, whether or not nodes in a given solution are selfaware of their location, and whether or not algorithmic solutions need to take the minimum separation distance between nodes into account.

When unwanted wireless signals are introduced into the original signal, it can cause short-term wireless signal loss, poor receiver performance, or poor output quality from electronic devices. Network slowness, which is less noticeable in low capacity data transmission but a significant issue in large capacity data transfer, can occasionally is caused by interference. The majority of wireless communication technologies have the potential to cause interference to adjacent electronic equipment. Wireless communication systems can also be interfered with by electronic equipment including microwave ovens, Bluetooth gadgets, cordless phones, and wireless video cameras. Among the other factors that can interfere with wireless communication systems are (Dong et al., 2023):

- Multiple communication systems that share the bandwidth on one channel
- Hidden nodes in wireless networks generate numerous cyclic redundancy check code errors
- Broad radiofrequency emissions from bad electrical connections
- Radiofrequency jamming

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- Channel interferences

Co-channel and neighboring channel interferences are two types of channel interferences that can affect how well wireless communication systems operate. These kinds of interference in wireless communication systems are introduced in the next section. Based on the spacing between desired and interfering signals, there are two kinds of interference (Oyedepo et al., 2010):

- Co-channel interference - Interference in wireless systems that transmit signals at the same frequency is called co-channel interference.
- Adjacent channel interference - Interference in wireless systems caused by adjacent frequency signals.
- Based on the type of signal interfering, the interference in wireless communications can be classified into:
- Electromagnetic interference - The electromagnetic signals emitted by various systems and devices interfere with the desired signals of wireless communication systems.
- Sound interference - There can be constructive as well as destructive interference caused by sound waves in speakers and other sound-producing devices.
- Light interference - Light waves can interfere with communication systems transmitting signals through other mediums.

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- Multicarrier systems utilizing orthogonal frequency-division multiplexing (OFDM) techniques experience the following two interference types (Dong et al., 2023):
- InterCarrier interference - In telecommunications, the OFDM subcarriers lose orthogonality and cause interference called intercarrier interference (ICI).
- InterSymbol interference - The time delay in OFDM symbols traveling from the transmitting end to the receiving end results in the spreading out of OFDM symbols and they interfere with consecutive OFDM symbols.

Moreover, there are many techniques and algorithms put into wireless communication systems to mitigate interference

Reduce the power level: The reduction in radio frequency power of wireless signals is an effective method of interference mitigation.

Filtering and equalizers: In communication channels whose characteristics are known, filters can be incorporated for interference mitigation. If the channel characteristics are unknown, equalizers are an alternative to filters.

Transmission at multiple frequencies, locations, and times: If wireless communication systems operating in the same region are using separate frequencies, they can communicate simultaneously. This method of minimizing interference is used by mobile communication, radio stations,

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local television stations, and other wireless communication systems. In wireless communication systems, interference can be minimized by staying away from the locally utilized frequencies. Only when they are separated may wireless signals that are transmitted at the same frequency at the same time be used without experiencing interference. Interference cannot occur if the signals are within permitted power limits and the transmission geographic zones are far apart. If the transmission periods of wireless communication systems differ, they can send signals across the same region at the same frequency without interference. Interference reduction in wireless communication systems also involves channel splitting of the radio spectrum using methods like frequency division, time division, and code division (Oyedepo et al., 2010).

3. Carrier-to-Interference Ratio (CIR)

In a wireless communication system, the carrier-to-interference ratio, or CIR, is a dimensionless number that shows the ratio of the strength of the desired signal (carrier) to the power of the undesirable signals (interference). To put it another way, it's a measurement of the strength difference between the desirable and undesired signals. Better signal quality is indicated by a higher CIR, while worse signal quality is implied by a lower CIR. CIR, which is commonly measured in decibels (dB), is a crucial metric for evaluating the effectiveness of wireless communication

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systems, including satellite communication, cellular networks, and wireless local area networks (WLANs) (Dong et al., 2023).

It is impossible to exaggerate the significance of CIR in wireless communication. Interference between signals is more likely to occur when wireless devices and users continue to rise in number. A number of things, including as physical barriers, meteorological conditions, and other wireless devices using the same frequency band, might produce interference. Interference can cause a signal's quality to deteriorate, which can impair communication, cause conversations to disconnect, because data speeds to lag, and lower the capacity of the network. Network operators may make sure that their users receive high-quality communication services by keeping an ideal CIR under observation and up to date. Cellular network design and optimization is one of the main uses of CIR in wireless communication (Smida, 2017). Multiple base stations, often referred to as cell sites, are set up in cellular networks in order to cover a big geographic region. Within its coverage region, each base station sends and receives signals to and from mobile devices. Nonetheless, there is a chance that the signals from nearby base stations will interfere with one another because they frequently use the same frequency ranges. Network operators utilize a variety of strategies, including power regulation, cell sectorization, and frequency reuse, to reduce this interference and maintain a high CIR (Slimane, 2020).

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Satellite communication systems are one area where CIR is also used. Signals are sent and received in these systems between Earth-orbiting satellites and ground stations. Due to the great distances involved, a variety of sources, including other satellite systems, terrestrial microwave connections, and even natural occurrences like solar flares, can interfere with satellite transmissions. Satellite operators need to carefully control the CIR in order to guarantee dependable communication. They may do this by use directional antennas to reduce interference, choosing suitable frequencies, and utilizing sophisticated modulation and coding systems. Additionally, CIR plays a critical role in the architecture and functionality of wireless local area networks (WLANs), such Wi-Fi networks. Radio transmissions are used in a WLAN to facilitate communication between several devices and a central access point. Interference becomes more likely as the number of devices and access points rises. WLAN operators can employ strategies including dynamic channel selection, adaptive transmit power regulation, and interference mitigation algorithms to maintain a high CIR and guarantee dependable connectivity (Dong et al., 2023).

4. Signal-to-Interference Ratio (SIR)

A crucial parameter in wireless communication systems, the signal-to-interference ratio (SIR), sometimes called the carrier-to-interference ratio (CIR), measures the quality of a received signal in the presence of interference. In the modern world, when wireless communication is a need for day-to-day activities, comprehending the idea of SIR and how it affects wireless system performance is vital. The power ratio of a desired signal to the total power of all interfering signals is known as SIR. It may be computed using the following formula and is commonly represented in decibels (dB): SIR (dB) is equal to 10 * log10 (Interference Power / Signal Power). Better signal quality is indicated by a higher SIR value, whereas increased interference susceptibility is indicated by a lower value (Qi et al., 2023).

Interference can arise when numerous signals are delivered concurrently over the same frequency range in wireless communication networks. Numerous things, including the existence of other wireless devices, physical barriers, and ambient conditions, might create this interference. This might result in a major deterioration of the received signal quality, which can impair communication and lower data rates. The effects of SIR on wireless communication are evident in a number of areas, including data speed, bit error rate (BER), and overall quality of service (QoS). Bit mistakes are more likely to occur when the SIR is low, which raises the BER. Retransmissions increase as a result, potentially leading to a drop in data flow and deterioration in the quality of service. Keeping a high SIR in the face of interference is one of the key problems of wireless communication. Many methods, including adaptive modulation and coding, power management, and interference cancellation, have been devised to do this. In order to provide dependable communication, these strategies seek to optimize the transmission characteristics, such as the

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modulation scheme, coding rate, and transmit power, depending on the current SIR level (Smida, 2017).

The technology known as adaptive modulation and coding modifies the coding rate and modulation scheme based on the current SIR level. Higher data rates can be attained when the SIR is high by using a lower coding rate and a higher-order modulation technique. On the other hand, a lower-order modulation scheme and a greater coding rate can be used to increase the signal's resistance to interference when the SIR is low. Another method for keeping a high SIR in wireless communication systems is power control (Lin et al., 2023). The system may reduce interference from other users while maintaining the required signal strength by allowing each user to modify their broadcast power. Increased system capacity and better communication performance may result from this. An increasingly sophisticated method called interference cancellation estimates and subtracts the interfering signals from the received signal in an effort to lessen the effects of interference. Many techniques, including sequential interference cancellation (SIC) and parallel interference cancellation (PIC), can be used to accomplish this. These methods have the potential to greatly raise the SIR and improve system performance as a whole (Mahbub & Shubair, 2023).

The dynamic algorithm, BFS-CA [1], is one of the best algorithms used for ever-changing wireless network architectures. It is the most ready to implement compared to other graph coloring algorithms. BFS-CA has

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also been shown to have a significant improvement in static channel allocation (Ramachandran et al., 2006). The weighted Hminmax and Hsum algorithms, despite resorting to greedy implementations, achieved an average of more than 40% reduction in interference over a single “fresh” method (Mishra et al., 2005). McDiarmid and Reed (2000) bandwidth-dependent weighted algorithms bring together many new ideas, but ultimately seem difficult to implement (Hassan & Chickadel, 2011).

5. Related works

The research has suggested two primary strategies to lessen the ICI issue brought on by the CFO. Estimating and eliminating the frequency offset is one method (Luise et al., 2002). The frequency-offset estimation in this method is often done in two steps: fine frequency-offset estimation guesses the remaining portion of the offset, and coarse frequency-offset estimation predicts the partial frequency offset that is a multiple of the subcarrier spacing. Numerous CFO estimate methods are available, including as training-based approaches (Li et al., 2007) and semi-blind or blind methods (Tureli et al., 2000). Utilizing coding1 is an additional strategy to lessen the OFDM system's susceptibility to frequency offsets (Singh Sahu, 2015). Since the coding method is often used after coarse CFO has been removed, fine residual CFO is assumed. In recent years, wide varieties of coding techniques have been created and may be categorized as follows (Smida, 2017):

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• Self-cancellation: Zhao and Haggman presented a straightforward and successful technique in and later expanded upon in (Zhao & Haggman, 2001), dubbed the ICI self-cancelation scheme, which uses polynomial coding in the frequency domain to lessen the impact of frequency offset. This technique uses specified weights to modulate duplicates of the same data symbol on r neighboring sub-carriers. At the cost of a factor r decrease in transmission rate, this approach can lessen the ICI. Numerous researches suggested more effective mapping (optimal weighting coefficients) for the redundant data symbol modulated over adjacent or non-adjacent subcarriers in order to further enhance the ICI self-cancellation effectiveness (Liu et al., 2015). The weights are engineered in a way that when a frequency offset is present, the ICI at each subcarrier is decreased at the receiver. The important concept was initially put out in (Sathananthan & Tellambura, 2002). Take note that ICI self-cancellation approaches can be thought of as a coding scheme, where only the codewords with low ICI are employed.

• Windowing: It was demonstrated by Seyedi and Saulnier (2005) that windowing in the time domain is comparable to employing polynomial coding in the frequency domain, which is what ICI self-cancellation systems employ. Therefore, in order to generalize and enhance self-cancellation techniques, they employed windowing at both the transmitter and the receiver. Recently, windowing at the transmitter only has been adopted by Real and Almenar (2008), allowing a decrease in receiver complexity without sacrificing performance. Although the windowing

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techniques greatly reduce ICI sensitivity, they also decrease transmission rate and add complexity to the transceiver.

• Two-path transmission: This approach, which is comparable to ICI self-cancellation techniques in, reduces the spectral efficiency in half. The two-path transmission method, in contrast to the ICI self-cancellation approach, sends the data copies in two concatenated OFDM blocks. The conventional OFDM signal is represented by the first path, and its conjugate, the second path, is created (Yeh et al., 2007). This method was further upon by including space-time coding and phase rotation (Smida, 2017).

• Correlative coding: This strategy does not lower the data rate, in contrast to all other coding strategies that do so at the expense of sensitivity to CFO being reduced (Zhang & Li, 2003). The frequency-domain Partial-Response Coding (PRC) is the foundation of this technique. The initial purpose of PRC was to lessen the susceptibility of single-carrier systems to time offset in the temporal domain. The PRC requires a maximum-likelihood sequence estimator (MLSE), which raises the receiver complexity without sacrificing spectral efficiency. In (Yun et al., 2007), an intriguing fusion of self-cancellation and correlative coding was put forth. The total of several separate signals that have been modulated onto subchannels with identical bandwidths is an OFDM signal. The inverse discrete Fourier transform (IDFT) operation is used by the OFDM transmitter to broadcast the symbol sequence to the radio

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frequency chain. The real portion of the complex envelope may be represented as the transmitted signal at time t (Smida, 2017).

In (2005), Arunesh Mishra et al. provide strategies for utilizing innovative channel assignment algorithms among interfering Access Points (APs) to enhance the use of wireless spectrum in the context of wireless local area networks (WLANs). They discover novel approaches to channel re-use grounded in practical interference circumstances found in WLAN networks. In this research, they describe channel assignment in WLANs as a weighted vertex coloring issue, including both the effects of real-world channel interference on wireless users and the interference itself that is seen in wireless settings. In comparison to the most advanced Least Congested Channel Search (LCCS), they introduced two distributed algorithms that are efficient, scalable, and fault tolerant. Through simulations, they demonstrated that with three non-overlapping channels, the two approaches may reduce interference by up to 45.5% and 56%, respectively, for sparse and dense topologies. Additionally, they demonstrate how the methods efficiently make advantage of partially overlapping channels to reduce costs by an average of 42% more for networks of a moderate size. Using tests on a fully functional in-building wireless testbed network with 20 APs, they verified these findings and used partially overlapping channels to obtain a 40% decrease. Handling concurrent 802.11b/g APs in the same coverage region is a simple expansion of this work. In such cases, when the interference effects grow asymmetric (affecting 802.11g APs more than 802.11b), the overlap graph takes on a directed character.

The unequal effect of the interference from one AP's BSS to another would be reflected in the weights on the edges. Such expansions are left for further research. In the end, they demonstrate the NPhardness of the weighted graph coloring issue and provide scalable distributed algorithms that outperform current methods for channel assignment. First location oblivious distributed unit disk graph coloring technique with a proven performance ratio of three is presented by Mathieu Couture et al. in (2006) (i.e. the number of colors employed by the algorithm is at most three times the chromatic number of the graph). This is an improvement over the conventional sequential coloring approach since the worst-case performance ratio has a new lower constraint of 10/3 for the worst-case performance ratio of the sequential coloring algorithm.

Prior to this, 5/2 was the biggest lower constraint on the sequential coloring algorithm's performance ratio. Simulation findings, however, indicated that this technique is not much better than the one that colors the nodes in an arbitrary sequence sequentially. The results of the simulation also demonstrated that, on average, the suggested method is outperformed by largest-first, which is also distributed and location oblivious. As with lexicographic coloring, it also outperforms it with a worst-case performance ratio of no more than three. Nobody has, however, demonstrated whether largest-first outperforms five in worst-case scenarios. Whether coloring the nodes of a unit disk graph in any

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sequence may, in theory, take fewer than five colors or more than 10/3 times the minimal number of colors required is really also up for debate (Hassan & Chickadel, 2011).

6. Conclusion

In conclusion, a crucial factor in the field of wireless communication is the Carrier-to-Interference Ratio (CIR). Network operators may improve their systems to provide their consumers with high-quality communication services by knowing its significance and uses. The requirement for dependable communication will only increase along with wireless technology's evolution, making proper CIR control even more imperative.

In this research, we investigated the reduction of carrier and token interference in wireless communication systems. The idea is to take a code that performs well in BER and rotate each code coordinate by a specified phase-shift so that the maximum PICR over all code words is as small as possible. The code's ability to rectify errors is unaffected by this update. Furthermore, following the backrotation of the received signals, we may employ the conventional decoding procedure of the original code. According to the findings of the simulation, a 7 dB decrease is readily achievable. We also provide an approximated lower bound of the PICR in order to examine the basic limit of the suggested approach. The bound is applied to the following codes: Reed-Muller codes, BCH codes, and non-redundant binary codes. Our phase-shift designs are shown to approach our bound. Moreover, the Signal-to-Interference Ratio (SIR) is an essential measurement in wireless communication systems that assess a signal's quality when interference is present. Better signal quality is indicated by a higher SIR value, whereas more interference susceptibility is indicated by a lower value. The effects of SIR on wireless communication are evident in a number of areas, including data speed, bit error rate (BER), and overall quality of service (QoS). Adaptive modulation and coding, power control, interference cancellation, and other methods have all been developed to maintain a high SIR and guarantee dependable communication. These methods are essential for improving user experience and wireless communication system performance optimization.

One of the greatest algorithms for usage in the dynamic wireless network topologies of today is the dynamic BFS-CA algorithm. Among the several graph coloring techniques, this one is the most ready for implementation. Additionally, it was demonstrated that BFS-CA significantly outperformed static channel assignment. Despite using greedy implementations, the weighted Hminmax and Hsum algorithms have reduced interference by over 40% on average when compared to a single "state-of-the-art" technique. While the McDiarmid and Reed bandwidth-based weighted algorithms [9] include a number of innovative concepts, their eventual implementation appears to be challenging. We have also concluded that an undesired wireless signal that is mixed in with the original signal might cause the electronic equipment to temporarily lose its wireless signal, operate poorly as a receiver, or provide output that is of low quality. Co-channel and neighboring channel interference are two types of channel interference that can affect how well wireless communication systems operate. One efficient way to mitigate interference from wireless communications is to lower their radio frequency power.

Reference

Barbeau, P. Bose, P. Carmi, M. Couture. E. Kranakis, (2006) “Location Oblivious Distributed Unit Disk Graph Coloring” School of Computer Science Carleton University pp. 1- 20

Battiti, R., Bertossi, A. A., & Bonuccelli, M. A. (1999). Assigning codes in wireless networks: Bounds and scaling properties. *Wireless networks*, *5*, 195-209.

Couture, M., Barbeau, M., Bose, P., Carmi, P., & Kranakis, E. (2007, June). Location oblivious distributed unit disk graph coloring. In *International Colloquium on Structural Information and Communication Complexity* (pp. 222-233). Berlin, Heidelberg: Springer Berlin Heidelberg

Dong, Z., Yi, L., Qin, P., Zhou, Y., Zhang, C., & Liu, K. (2023). Quantification and Analysis of Carrier-to-Interference Ratio in High-Throughput Satellite Systems. Electronics, 12(16), 3443.

Hassan, M. A., & Chickadel, A. (2011). A review of interference reduction in wireless networks using graph coloring methods. *arXiv preprint arXiv:1103.5791*.

Khanna, S., & Kumaran, K. (1998). On wireless spectrum estimation and generalized graph coloring. In *Proceedings. IEEE INFOCOM'98, the Conference on Computer Communications. Seventeenth Annual Joint Conference of the IEEE Computer and Communications Societies. Gateway to the 21st Century (Cat. No. 98* (Vol. 3, pp. 1273-1283). IEEE..

Li, Y., Minn, H., Al-Dhahir, N., & Calderbank, A. R. (2007). Pilot designs for consistent frequency-offset estimation in OFDM systems. *IEEE transactions on communications*, *55*(5), 864-877.

Lin, M., Luo, Y., Zhu, X., Tu, G., & Lu, Z. (2023). Optimal GPS Acquisition Algorithm in Severe Ionospheric Scintillation Scene. *Electronics*, *12*(6), 1343.

Liu, T. L., Chung, W. H., Yuan, S. Y., & Kuo, S. Y. (2015). ICI self-cancellation with cosine windowing in OFDM transmitters over fast time-varying channels. IEEE Transactions on Wireless Communications, 14(7), 3559-3570.

Multi-Knowledge Electronic Comprehensive Journal For Education And Science Publications(MECSJ)
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Luise, M., Marselli, M., & Reggiannini, R. (2002). Low-complexity blind carrier frequency recovery for OFDM signals over frequency-selective radio channels. *IEEE transactions on communications*, *50*(7), 1182-1188.

Mahbub, M., & Shubair, R. M. (2023). Signal-to-Interference Ratio Coverage-Aware Multi-Access Edge Computing in Intelligent Reflecting Surfaces-Assisted Multi-Tier 6G Networks. *SN Computer Science*, *4*(5), 603.

McDiarmid, C., & Reed, B. (2000). Channel assignment and weighted coloring. *Networks: An International Journal*, *36*(2), 114-117.

Mishra, A., Banerjee, S., & Arbaugh, W. (2005). Weighted coloring based channel assignment for WLANs. *ACM SIGMOBILE Mobile Computing and Communications Review*, *9*(3), 19-31.

Oyedepo, J. A., Salihu, Y. O., & Folaponmile, A. (2010). Interference mitigation techniques in wireless communications systems. *Journal of Research in National Development*, *8*(2).

Qi, Y., Dang, J., Zhang, Z., Wu, L., & Wu, Y. (2023). Efficient Channel Equalization and Performance Analysis for Uplink FBMC/OQAM-Based Massive MIMO Systems. *IEEE Transactions on Vehicular Technology*.

Ramachandran, K. N., Belding-Royer, E. M., Almeroth, K. C., & Buddhikot, M. M. (2006). Interference-Aware Channel Assignment in Multi-Radio Wireless Mesh Networks. In *Infocom* (Vol. 6, pp. 1-12).

Real, V Almenar, (2008), IEEE International Conference on Wireless and Mobile Computing, Networking and Communications. OFDM ICI Self-Cancellation Scheme Based on Five Weights pp. 360–364.

Sathananthan, K., & Tellambura, C. (2001). Probability of error calculation of OFDM systems with frequency offset. *IEEE Transactions on communications*, *49*(11), 1884-1888.

Sathananthan, K., & Tellambura, C. (2002). Partial transmit sequence arid selected mapping schemes to reduce ICI in OFDM systems. IEEE Communications Letters, 6(8), 313-315.

Seyedi, A., & Saulnier, G. J. (2005). General ICI self-cancellation scheme for OFDM systems. IEEE Transactions on Vehicular Technology, 54(1), 198-210.

Singh, OP Sahu, (2015). IEEE International Conference on Computational Intelligence & Communication Technology. An overview of ICI self cancellation techniques in OFDM systems (2015). pp. 299–302.

Slimane, (2020). PAPR Reduction Techniques For VLC-OFDM System (Master thesis). University of Hamma Lakhdar El-Oued Faculty of Science and Technology. Algeria

Smida, B. (2017). Coding to reduce the interference to carrier ratio of OFDM signals. *EURASIP Journal on Wireless Communications and Networking*, *2017*(1), 1-11.

Tureli, U., Liu, H., & Zoltowski, M. D. (2000). OFDM blind carrier offset estimation: ESPRIT. *IEEE Transactions on communications*, *48*(9), 1459-1461.

Yeh, H. G., Chang, Y. K., & Hassibi, B. (2007). A scheme for cancelling intercarrier interference using conjugate transmission in multicarrier communication systems. *IEEE transactions on wireless communications*, *6*(1), 3-7.

Yun, J. Y., Chung, S. Y., & Lee, Y. H. (2007). Design of ICI canceling codes for OFDM systems based on capacity maximization. *IEEE Signal processing letters*, *14*(3), 169-172.

Zhang, H., & Li, Y. (2003, May). Optimum frequency-domain partial response encoding in OFDM system. In *IEEE International Conference on Communications, 2003. ICC'03.* (Vol. 3, pp. 2025-2029). IEEE.

Zhao, Y., & Haggman, S. G. (2001). Intercarrier interference self-cancellation scheme for OFDM mobile communication systems. IEEE transactions on Communications, 49(7), 1185-1191.