International Journal of Engineering Research and Modern Education (IJERME)
ISSN (Online): 2455 - 4200
(www.rdmodernresearch.com) Volume I, Issue I, 2016

USER UTILITY IN SPECTRUM ALLOCATION

D. Nandhini* & A. Anitha**

* PG Scholar, Department of Master of Computer Applications, Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamilnadu

** Assistant Professor, Department of Master of Computer Applications, Dhanalakshmi Srinivasan Engineering College, Perambalur, Tamilnadu

Abstract:

To match wireless users' soaring traffic demand, spectrum regulators are considering allocating additional spectrum to the wireless market. There are two major directions for the spectrum allocation: licensed (e.g., 4G cellular service) and unlicensed services (e.g., Super Wi-Fi service). The 4G service provides a ubiquitous coverage, has higher spectrum efficiency, and often charges users a high service price. The Super Wi-Fi service has a limited coverage, lower spectrum efficiency, but often charges users a low service price. The spectrum regulator now simply allocates the spectrum to maximize its income, but such an income-centric allocation does not ensure the best spectrum utilization by the users. This motivates us to design a new spectrum allocation scheme which jointly considers the spectrum regulator's income and the users' aggregate utility by investigating three market tiers: the spectrum regulator, 4G and Super Wi-Fi operator coalitions, and all the wireless users. We formulate it as a three-stage game and derive the unique sub game perfect equilibrium. Compared with the traditional income centric allocation, we prove that the proposed scheme significantly improves users' aggregate utility with a limited spectrum regulator's income loss.

Key Words: Spectrum Allocation, Spectrum Regulator & Spectrum Utilization

Introduction:

Spectrum is a finite and scarce resource. The key challenge in dynamic spectrum access networks is how to maintain efficient spectrum sharing among (secondary) users. We hereby refer to secondary users as users. While maximizing spectrum utilization is the primary goal, we also need a good sharing mechanism to provide fairness across users. A user seizing spectrum without coordinating with others can cause harmful interference to its neighbors and hence reduce spectrum utilization. The problem of spectrum management can be reduced into a variant of the graph coloring problem which is NP-hard. Given a small fixed network topology, existing approaches have proposed good heuristics based on centralized systems to obtain conflict free spectrum assignments that closely approximate the global optimum. In this case, a server collects information of user demand and assigns spectrum to a limited number of users to maximize system utility. However, when network topology, user demand and available spectrum at users change, the system needs to completely recomputed spectrum assignments for all users after each change, resulting in high computational and communication overhead. This costly operation needs to be repeated frequently to maintain utilization and fairness.

Traditional wireless networks, such as 2G cellular, allocate fixed spectrum to its customers. Numerous studies have shown that this leads to spectrum wastage and causes artificial spectrum scarcity. Thus dynamic allocation of spectrum has been proposed for better utilization. In the future it is likely that the spectrum regulatory bodies such as FCC will grant wireless service providers (SP) with short term licenses so that it can purchase the exact amount of spectrum as needed to serve its customers. Motivated by these developments, we consider a centralized network consisting of a single service provider (SP) that allocates orthogonal chunks of spectrum to its customers dynamically, based on their demand. It then transmits to these users over their allocated spectrum. The user demand of spectrum depends on the received rate which is different for users due to the variations in the link gain. The SP purchases the amount of spectrum needed by its customers, from the FCC. The SP has to pay the FCC for the purchased spectrum and in turn charges the users to recover its costs. In this work we model the dynamic allocation as a SP profit maximization problem and derive the optimal values of the prices. Pricing for profit maximization has been studied under various contexts. Simple wireless settings have been considered in but the full range of relationships between spectrum prices, costs and user demands are not established. On the other hand, several works in microeconomics have considered pricing for profit maximization but for very generic user demand functions and costs. In this work, we have applied some of these principles specifically to a wireless setting and evaluated the prices and characterized the behavior of the allocation.

Related Work:

Existing wireless network architectures are characterized by a fixed spectrum assignment policy. In the authors focused on maximizing both spectrum utilization and fairness. They reduced the problem to a graph multi coloring problem, and proposed some heuristic algorithms. There are several studies on joint routing and spectrum allocation for dynamic arrival of flows. In the authors proposed a delay motivated on demand routing protocol to find a minimum delay route and channel assignment for an arriving flow. In a spectrum aware routing protocol has been proposed to find a route and channel assignment for an arriving flow that maximizes the throughput. We consider a number of embedded wireless sensor networks (WSNs) that are deployed in an aircraft cabin to detect events and transmit them to a base station to be processed. One of the most important requirements for implementing cognitive radio is that the channel assignment procedure should avoid the disruption of PU's transmission on their dedicated frequency. We adopt an approach which is based on the Received Signal Strength Indicator (RSSI) to detect vacant channels in the spectrum band. In this, we present our approach for optimizing channel allocation problem in the cognitive radio sensor network.

Our proposal is based on the design of an embedded entity named Avionic Spectrum Controller (ASC) that coordinates and manages spectrum allocation in the aircraft cabin. With ever-increasing wireless services and Qos requirements, traditional WSNs operating over the license-free spectrum, are facing unprecedented challenges to guarantee network performance. Qurans and Kim propose a throughput-aware routing algorithm to improve network throughput and decrease end-to-end delay for a large-scale clustered CRSN based on ISA100.11a. In addition, opportunistic medium access (MAC) protocol design and performance analysis of existing MAC protocols for CRSNs. OFDMA is similar to OFDM technology however designed specifically to be used in a multiuser environment. The idea is to group multiple tones into a sub channel and each user transmits data on the assigned sub channel while sending no information over the rest of the tones. Therefore, all users send data at the same time on different parts of the spectrum. We will address the synchronization restrictions of OFDMA as well as the requirement of channel state information at the transmitters and receivers with our MAC signaling.

Methodology:

Network Formation: Create the nodes using ns2 tool and form the network group. The nodes are mobile phones, pc, and laptops and, etc. then establish the connection between each nodes. The spectrum should be allocated dynamically to the entire group of the network equally.

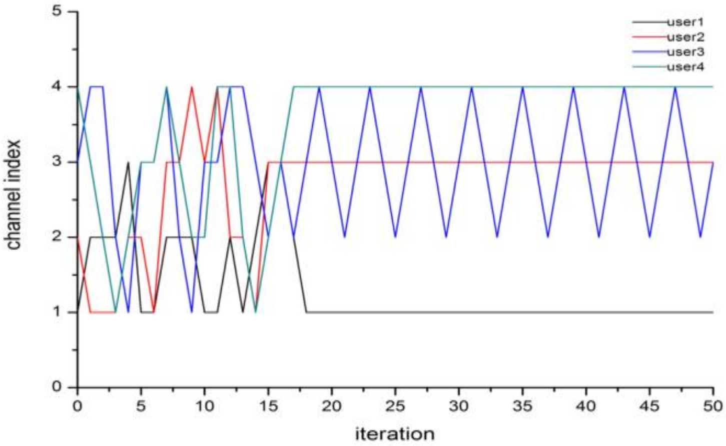

Figure 1: Network Formation

Spectrum Allocation:

The access point of the network is establishing the connection using spectrum allocation. The spectrum is a wavelength. The income of the spectrum on the access point is split into number of users on the network. The spectrum is dynamically allocated to the users. The speed of the network is equally share into the network users.

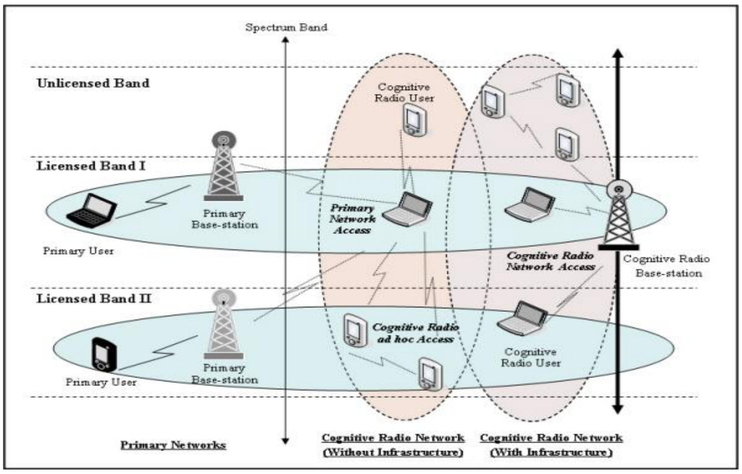

Figure 2: Spectrum Allocation

Spectrum Sharing:

The numbers of users connects into the network and allocate the spectrum. The unused spectrum is recovered into the access point. Thus the spectrum is shared into the long distance users on dynamically. The spectrum usage is differing to the all users. Thus usage of spectrum is balance the entire network users.

Performances Evolution:

The project is increase the spectrum speed into the entire network users and reduces the time delay problem. Then dynamically exchange the spectrum speed into the group of the network users. The long distance users must be access the high speed networks.

Algorithm:

Spectrum Allocation:

Initialization

Sk is the set of frequencies affected to the CH

ACL = Ø is the list of available channels

```
Curreq = Ø is the set of current requests
newreq = Ø new requests generated at each frame period
collisionj = 0 number of collisions observed on channel j
before a successful transmission
begin
1) Collect the channel assignment requests from sensor nodes, newreq
2) Add the new requests to old requests Curreq = Curreq U newreq
3) Check availability of channels in Sk using RSSI measurements and add each feasible channel to the ACL.
4) Arrange the set of requests that have the same priorities in terms of real-time constraints in a number of lists denoted as L0;L1;...;Lq-1where L0is the list of requests with the highest priority and Lqis the list of requests with the least priority.
5) for m = 0 to q-1{ while (Lm= Ø) and ACL 6= Ø do {
    a) sort Lm in a descending order according to the number of the needed transmission time slots of each request
    b) take the first element of Lm and suppose that is generated by sensor i with a duration li
    c) select a frequency , j 2 ACL according to the probability, P8j = 1/(collisionj+1)j8kj
    d) Assign j to the transmission of the request i, Lm = Lm-i
    e) set occupied Slotsj = li the number of occupied slots in the frame
    f) while (occupiedSlotsj < L) do {
        i) take the last element of the list Lm, suppose that is generated by sensor k with a requested period of lk
        ii) if ( L - occupiedSlots8j > lk) {
            A) affect j to sensor k, Lm = Lm - k,
            occupiedSlot8j = occupiedSlot8j + lk
        iii) else, break }
    g) eliminate j from ACL}}}end
```

Experiments and Results:

In order to have a comparison, we need to first build a benchmark against which the SINR and data rate values can be compared to measure the overall improvement. The two different benchmarks that will be used for simulation includes full frequency reuse and static channel allocation scheme.

A. Full Frequency Reuse and Static Channel Allocation: In full frequency reuse scheme, the entire spectrum is available for transmission across all the sectors. The main advantage of this is high spectrum utilization and ability to handle maximum number of users. But the interference level with this scheme is very high, particularly for users lying at the edge of the sectors. In order to reduce the interference levels, we can introduce an orthogonal approach for channel allocation in such a manner that no neighbors share the same channel for transmission.

B. Dynamic Channel Allocation: The adaptive nature of the system can be incorporated by two factors, automatic neighbor relation and load concentration awareness amongst the neighboring sectors. Here we introduce an algorithm which allocates channels based on the above mentioned factors. Once we have an allocation pool for each sector determined dynamically based on the load concentration in the adjacent neighbors, the base station transmits signal to the user from one of the channels available to the particular sector. We evaluate the performance of our scheme according to two parameters: the request satisfaction rate and the transmission delay. For every network topology, the simulation is repeated 10 times to ensure a confidence interval of 90%. In addition, we compare the proposed scheme to a basic channel allocation scheme where the CHs randomly select an available channel regardless the activity of primary users.

Conclusion:

In this project propose a novel spectrum allocation scheme that enables the FCC to take into account both the income and the users' utility. We model the wireless market interactions as a 3-stage game, which involves the FCC, the Wi-Fi and the 4G operators, and all wireless users. We use backward induction to first calculate users' subscription choice in final stage, then derive the equilibrium prices of both Wi-Fi and 4G services in middle stage, and finally obtain the equilibrium spectrum allocation for the FCC to maximize the weighted sum of the income and the users' aggregate utility in first stage. Comparing with the income-centric benchmark, it show that the consideration of users' aggregate utility will make FCC balance the spectrum allocation between two operators. Further characterize the lower-bound of the income loss ratio of the proposed spectrum allocation to the income-centric benchmark, and provide detailed discussions regarding the impacts of weighted Wi-Fi spectrum efficiency and Wi-Fi network coverage on the spectrum allocation, service prices, and user subscription.

References:

1. M.A. McHenry, P.A. Tenhula, D. McCloskey, D. A. Roberson, and C.S. Hood. Chicago spectrum occupancy measurements & analysis and a long-term studies proposal. In Proceedings of the ¯rst international workshop on Technology and policy for accessing spectrum. ACM New York, NY, USA, 2006.
2. R. Chandra, R. Mahajan, T. Moscibroda, R. Raghavendra, and P. Bahl. A case for adapting channel width in wireless networks. ACM Sigcomm2008
3. C. Cordeiro, K. Challapali, and M. Ghosh. Cognitive PHY and MAC layers for dynamic spectrum accessand sharing of TV bands. In Proceedings of the –rst international workshop on Technology and policy for accessing spectrum. ACM New York, NY, USA, 2006.
4. R. B. Myerson, Game Theory: Analysis of Conflict. Cambridge, MA: Harvard University Press, 2002.
5. E. Koutsoupias and C. Papadimitriou, "Worst-case equilibrium," in Proceedings of the 16th Annual Symposium on Theoretical Aspects of Computer Science, 1999, pp. 404–413.
6. R. Bohn, H.-W. Braun, K. Claffy, and **S.** Wolff, "Mitigating the coming Internet crunch: Multiple service levels via precedence," Tech. Rep., UCSD, San Diego Super computer Center, and NSF, 1993.
7. R. Braden, D. Clark, and S. Shenker, "Integrated services in the Internet architecture: an overview," Tech. Rep., IETF. RFC 1633, 1994.
8. J. Buchanan, "An economic theory of clubs,'' Economica, 32, 1-14,1965
9. R. Comes and T. Sandler, The Theory of Externalities, Public Goods, and Club Goods**.** Cambridge, MA: Cambridge University Press, 1986.
10. N. Economides, "Critical mass and network size," New York University Stern School of Business, New York, Tech. Rep., 1994.
11. G. Hardin, 'The tragedy of the commons," Sci., pp. 1243-1247, 1968.
12. M. Katz and C. Shapiro, "Network externalities, competition and compatibility," American Economic Rev., vol. 75, pp. 424440, 1985

13. J. K. MacKie-Mason, and H. Varian, “Some economics of the Internet,” Univ. Michigan, Tech. Rep., 1993.
14. J. Jia, Q. Zhang, Q. Zhang, and M. Liu, “Revenue generation for truthful spectrum auction in dynamic spectrum access,” in ACM, Mobihoc 2009.
15. B. L. Wei WAng and B. Li, “Designing truthful spectrum double auctions with local markets,” Mobile Computing, IEEE Transactions on.
16. M. Dong, G. Sun, X. Wang, and Q. Zhang, “Combinatorial auction with time-frequency flexibility in cognitive radio networks,” in IEEE, INFOCOM 2012.
17. Y. Zhu, B. Li, and Z. Li, “Truthful spectrum auction design for secondary networks,” in IEEE, INFOCOM 2012.
18. H. Kim, J. Choi, and K. Shin, “Wi-fi 2.0: Price and quality competitions of duopoly cognitive radio wireless service providers with time-varying spectrum availability,” in IEEE, INFOCOM 2011.
19. L. Duan, J. Huang, and B. Shou, “Duopoly competition in dynamic spectrum leasing and pricing,” IEEE Transactions on Mobile Computing, no. 99, pp. 1–1, 2011.
20. H. Zhou, R. Berry, M. Honig, and R.Vohra, “Investment and competition in unlicensed spectrum,” CISS 2012.