Liu and Wang *EURASIP Journal on Wireless Communications and Networking* (2019) 2019:35
https://doi.org/10.1186/s13638-019-1357-9

EURASIP Journal on Wireless Communications and Networking

RESEARCH Open Access

Investigation and analysis of the effectiveness and influencing factors of internal control in Chinese enterprise based on wireless network

Bo Liu[1*] and Pingshui Wang[2]

Abstract

The internal control system of the enterprise is an important application method to improve the operational efficiency of enterprises and reduce unnecessary cost expenditures, and there are many factors that affect its effectiveness. How to find out the key factors in many influencing factors and adopt positive improvement measures to improve the internal control system and to improve its effectiveness has become a new topic for Chinese experts and scholars. Chinese enterprises are selected as the research object, and in-depth analysis of the influencing factors of the effectiveness of the internal control of the company through questionnaire surveys and in-depth discussions on the internal control of the enterprise by making full use of the real data of corporate internal control are conducted; at the same time, the optimal strategy is put forward to the optimization of the distributed database query process in the process of research, so as to provide scientific basis for the enterprise to build a scientific and perfect internal control system.

Keywords: SQL database, Enterprise, Internal control

1 Introduction

With the rapid development of economy, the competitive environment of enterprises is becoming more intense, the development background is getting more complicated, and the corresponding risk factors are also increasing [1]. Enterprises need to avoid the risks existing in the market as far as possible to gain a foothold in a fast-growing society and achieve better economic benefits; for this, the business-related internal controls need to be done well. The effectiveness of internal control of an enterprise is not isolated in the development process of the enterprise, but is linked to the specific control objectives of the enterprise and related control processes [2]. If the internal control of an enterprise wants to be effective, the specific process of control needs to provide a reasonable and scientific guarantee for the control objective to be achieved. However, because the internal control is subject to certain restrictions in the implementation process, the guarantee is not absolute [3]. When the internal control is implemented by the enterprise, it will be influenced by many factors, such as the inaccurate operation of the control process and the dramatic changes in the environment of the enterprise [4]. Therefore, a series of specific factors need to be paid more attention in the control process to ensure the effectiveness of internal control [5]. The effectiveness of internal control mainly covers the specific design aspects and the effectiveness of the control process [6]. If the internal control is supposed to run smoothly and ultimately achieve specific control objectives, in terms of the corresponding design, it will be scientific, reasonable, and standard, so as to control the target eventually to provide a solid foundation and effective guarantee. In the specific process of internal control, it is necessary to ensure that the internal control is effective in accordance with the internal control in order to ensure the effectiveness of internal control [7].

* Correspondence: jcpnkxcu5536035@126.com
[1]School of Accounting, Anhui University of Finance and Economics, Bengbu, Anhui Province, China
Full list of author information is available at the end of the article

1.1 State of the art

In 1992, the COSO committee released the internal control—integration framework (revised in 1994) to define internal controls as follows: It is a process that is influenced by the company's board of directors, management, and other staff. It aims to provide a reasonable guarantee of business effectiveness and efficiency, reliability of financial reports, and compliance with appropriate regulations [8]. In 2004, the COSO Committee released the *Enterprise Risk Management—Integration Framework* (referred to as the ERM Framework) to shift the focus of corporate internal control to risk management [9]. At present, the empirical research on the effectiveness of internal control is limited [10]. At abroad, after the Sarbanes Oxley Act was enacted, American scholars began to focus on the financial report of the effectiveness of internal control: an empirical study. They disclose the substantive loopholes of internal control according to the requirements of SEC and of enterprises, as the criteria for evaluating the effectiveness of internal control of financial reports. At home, only some scholars have carried out relevant researches. It is believed that the effectiveness of internal control cannot be evaluated in general. It should be measured from the four objectives, compliance objectives, reporting objectives, operating objectives and strategic objectives. Based on the regulations of SEC, the internal control of compliance target, internal control of reporting target, internal control of management target, and internal control of strategic target are put forward from the objective of internal control.

2 Methodology

2.1 Distributed database data allocation algorithm

Distributed database refers to the connection of multiple data storage units that are physically scattered by high-speed computer network to form a unified database. The basic idea of a distributed database is to store the data in the original centralized database to a plurality of data storage nodes connected through a network to obtain a larger storage capacity and a higher concurrent access volume. In recent years, with the rapid growth of data volume, distributed database technology has been developed rapidly, and traditional relational databases have started to develop from centralized model to distributed architecture. On the one hand, the relational based distributed database has retained the data model and the basic characteristics of the traditional database and has been moved from centralized storage to distributed storage and from centralized computing to distribute computing. On the other hand, with the increasing amount of data, relational databases have begun to expose some insurmountable shortcomings. The non-relational databases represented by NoSQL have enjoyed rapid development due to their advantages such as high scalability and high concurrency. Suddenly, many key-value storage systems, document-type databases, and other NoSQL database products appeared in the market. Data distribution is a key step in a distributed database. The mathematical description of data distribution can be defined as follows: Set the data site included in the system as S, then $S = (S_1, S_2, \ldots, S_m)$, the sites are connected to each other over the network. Program transaction set running on this network is set as T, $T = (T_1, T_2, \ldots, T_n)$. As the basis for running a program transaction, set the data collection on the network as D, then $D = (D_1, D_2, \ldots, D_p)$. The data allocation algorithm needs to be transformed into a problem: design an algorithm to properly place the copies of D_i in different sites S, so that the overall performance of the entire system is the highest and the total cost is the lowest, and mark this program as $C(D_i, S_j, T_k)$. The distribution of data units to different cluster phases is more superior than direct distribution to the site. It can effectively improve the communication efficiency between sites and reduce the cost of communication. After completing the cluster operation, there is a need to define the communication cost between different clusters and the communication cost of each cluster. A single cluster C_i contains multiple sites S; its internal average communication cost can be defined as:

$$ArgC_i = \frac{\sum_{i=1}^{n}\sum_{j=1\wedge\neq j}^{n} CC(S_i, S_j)}{n^*(n-1)} \tag{1}$$

The communication cost between different clusters can be defined by formula (2):

$$ArgCC(C_i, C_j) = \frac{\sum_{i=1}^{m}\sum_{j=1\wedge\neq j}^{n} CC(S_i, S_j)}{m^*n} \tag{2}$$

The total communication cost for all clusters in the system can be defined as Eq. (3):

$$AllACC = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} ACC(C_i, C_j)}{n^*n} \tag{3}$$

The above definition and analysis of intra-cluster communication costs and communication costs between clusters are the basis for the next step in the optimization of data allocation based on genetic algorithms. For the principle research and application of genetic algorithm, it is discussed in detail in many related reference materials. Due to limited space, it is not discussed in detail there; just the processing process of genetic algorithm is improved based on the application characteristics of data distribution algorithm (Fig. 1).

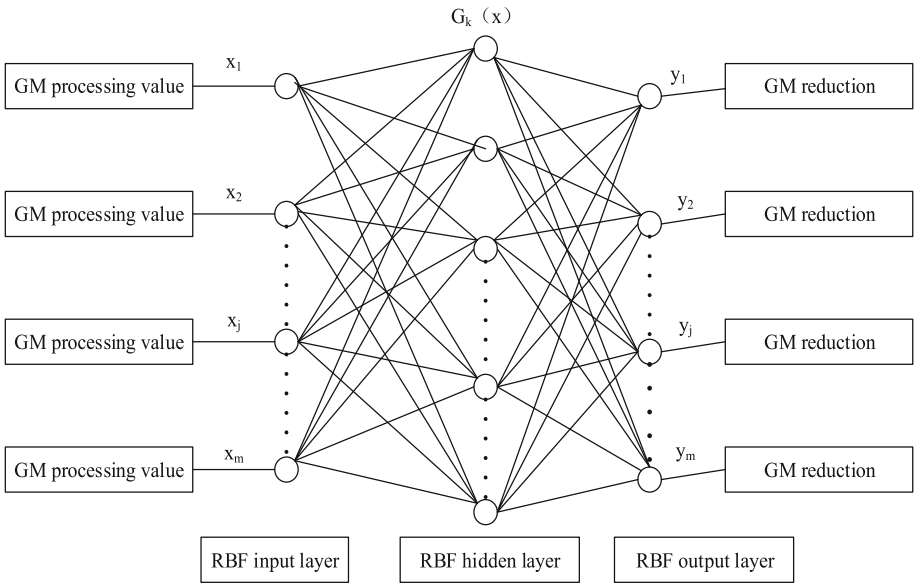

Fig. 1 The processing of genetic algorithm

According to the generation of chromosome clusters, the use of random numbers in the traditional mode has certain limitations and blindness. In this paper, the average distribution method is used to cover the initial population as much as possible to improve the probability of finding the optimal solution. The strategy of chromosome selection is improved, and the optimal selection algorithm is added. The traditional genetic algorithm is based on roulette, which may cause some loss of excellent chromosomes, and the optimal selection algorithm is added to solve this problem. Dynamically changing the probability of crossover and mutation ensures the generation speed of new chromosomes, ensures the diversity of chromosomes, and ensures excellent chromosomes are not destroyed; algorithm is not easy to fall into local optimum. The determination of dynamic probability is related to changes in fitness. The definition of the chromosome definition and fitness function of the genetic algorithm is elaborated below.

2.2 Wireless sensor network broadcast authentication

Network security technology has always been an important part of network technology. Wireless sensor networks are more vulnerable to security threats than traditional networks due to the openness of their deployment environment and the limited resources. Many applications demand on the security of wireless sensor networks. Authentication is a basic aspect of network security services. Its purpose is to prove the identity of nodes and the origin of messages. It is the basis of other security services. The following is an in-depth analysis of one of the basic security services in the sensorless network broadcast authentication and various basic cryptographic algorithms for broadcast authentication. A novel broadcast authentication scheme is proposed on this basis. Due to the “one-to-many” communication mode used in wireless sensor networks, broadcasting is the main communication method that can save energy in wireless sensor networks. The main research achievement of the wireless sensor network security broadcast is the TESLA broadcast authentication protocol, which is part of the SPINS protocol. Based on the TESLA agreement, Liu et al. lately proposed a multi-layer and broadcast authentication protocol suitable for multiple senders. The TESLA protocol uses hash key chain and delayed publishing key technology, at the expense of a certain authentication delay. The broadcast process is authenticated with only symmetric cipher algorithm, and it has high authentication efficiency. The working mechanism of the μ TESLA protocol is shown in Fig. 2.

μ TESLA protocol greatly reduces the computational strength of broadcast authentication and improves the speed of broadcast authentication. But its disadvantage is that it requires the node to store the message before the authentication key is published, causing storage problems and easily causing DoS attacks; during the initialization of the protocol, the base station sends the protocol initial information to the sensor node in a single broadcast mode. In addition, long network life cycles require long key chains. In order to reduce the cost of the key chain length and the initial information of the distribution protocol, Liu et al. proposed the layered μTESLA protocol. When layering μTESLA, the network life cycle is first divided into high-level time intervals,

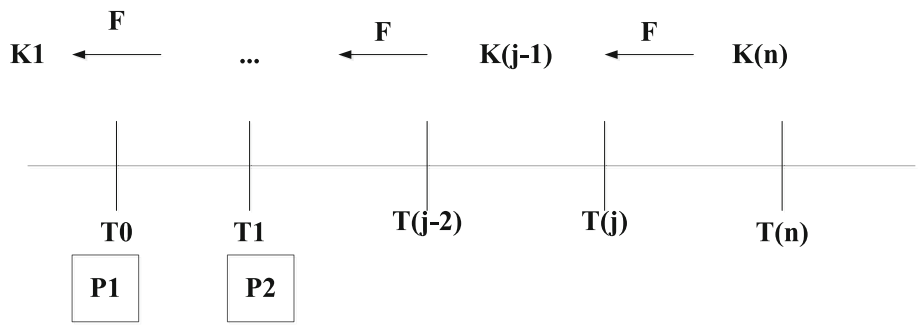

Fig. 2 μTESLA protocol working mechanism

and then each high-level time interval is divided into low-level time intervals. Each interval generates a key chain of a corresponding length. The higher level key chain authenticates the initial information of the lower level key chain; the lower level key chain authenticates the broadcast data packet.

3 Result analysis and discussion

The distribution algorithm and query algorithm for distributed database data are improved in the above, and then the efficiency of data distribution is effectively improved, the time for data query is shortened, and good results are obtained in the actual application process. To verify the effectiveness of the algorithm, test it by contrast. First, the data allocation optimization algorithm is tested. In the process of testing, different numbers of data records are generated by the simulation software. The database management system and the distributed database management system studied by the project are carried out in the centralized database management system, and the storage time is compared. The results are shown in Fig. 3.

It can be seen from the above test results that when the amount of data needed is less, the storage time of the centralized database is less than the distributed database storage time using the optimized data allocation algorithm, which is due to the time required for the optimization of the calculation (Fig. 4). When the amount of data is small, there is little difference between centralized and distributed database. However, when the amount of data increases continuously, the time spent on the distributed database based on the optimization algorithm is significantly less than the time spent on the centralized database. Experiment shows that when the amount of incoming data is large, the efficiency of distributed database storage using the data distribution optimization algorithm is significantly improved. In terms of data distribution, the traditional centralized database management system saves all data on the same database server, resulting in inefficient data storage and slow data operations. At the same time, for the data operation applications of each client in a distributed system, concurrent operations often occur, and a single data source often fails to efficiently process concurrent operations. After the distributed database data optimization allocation algorithm is adopted, according to the actual situation of the data and the application of the distributed database system, the data are allocated to different nodes for storage and processing reasonably. The actual application shows that the average speed of data processing is significantly improved after the optimized allocation algorithm is adopted. In terms of data query, the data in the same distributed database is processed, and a general distributed database query method and a distributed

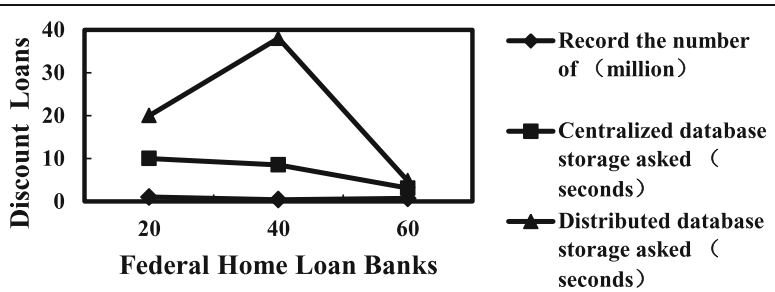

Fig. 3 Distributed database data distribution optimization algorithm contrast implementation

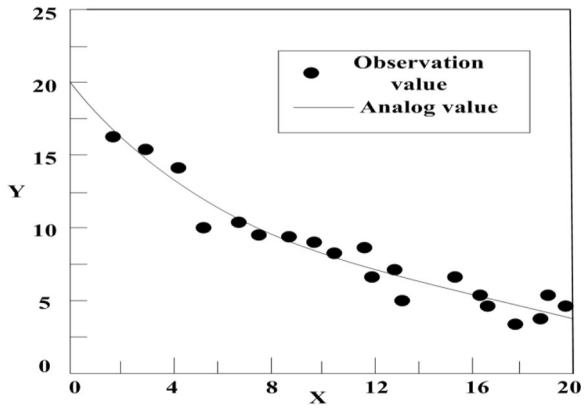

Fig. 4 Fitting curve of parameter identification

database query method using an optimization algorithm are respectively adopted for processing. The results are shown in Fig. 5.

It can be seen from the figure above that the optimized distributed database query method based on genetic algorithm is superior to the general distributed database query and requires less time. In the aspect of data query, traditional centralized database is based on SQL language for data query operation, but in distributed database, the query operation needs to consider several factors; the performance of query algorithms varies greatly between different scenarios. The data query optimization algorithm is based on genetic algorithm which is proposed and researched in this paper. Considering the related factors, the optimal solution is larger. Practical application shows that based on the optimization algorithm, the query time of distributed database can be reduced significantly.

In order to test the correctness and efficiency of adaptive and mutation operators, it is necessary to compare the performance of the algorithm under different crossover and mutation probabilities. Comparing the above probabilistic coefficients through experiments, and using the method of sorting and selecting operators, the following results are obtained by assigning different values of the probability coefficients a and b: the result of taking different values of probability coefficients. It is found by figure that when $a = 0.9$, evolution is faster, but it will soon enter precocity and fall into local optimum; when $a = 0.7$, evolution is too slow to achieve efficient search; when $b = 0.2$, there is less variation and easy to fall into the local area; and when $b = 0.4$, there are too many mutations that prevent many excellent chromosomes from being effectively preserved, but they are eliminated, which affects the speed of evolution. Only when $a = 0.8$ and $b = 0.3$, evolution has a high speed, and it is not easy to enter "precocity" and search for high efficiency and stability. Among them, $f_{\max}$ is the maximum value of the population fitness function, and $f_{\min}$ is the minimum value of the population fitness function, f is the fitness function value of adjacent individuals after individual fitness values are sorted, and k is the number of individuals in the population. When the fitness tends to be consistent, we can achieve the effect of "genetic catastrophe" through the change of b.

Figure 6 shows that if the b changes in the consistency of the fitness, the search will jump out of the "premature" state test. Make the search wider, which can search for better results. It is necessary to compare the two algorithms to know which algorithm is better for the niche operator and the sorting operator. In the comparison of the two, we found that the simulated small habitat

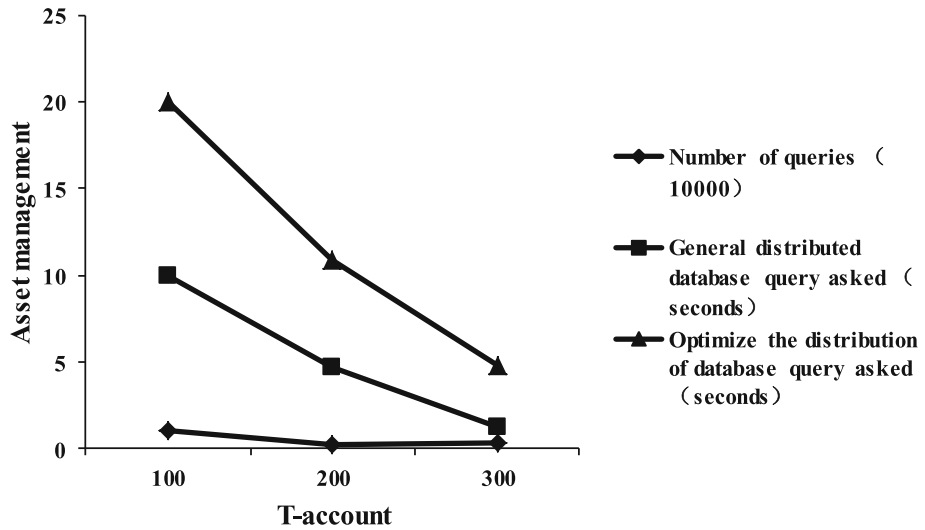

Fig. 5 Distributed database optimization query method comparison experiment

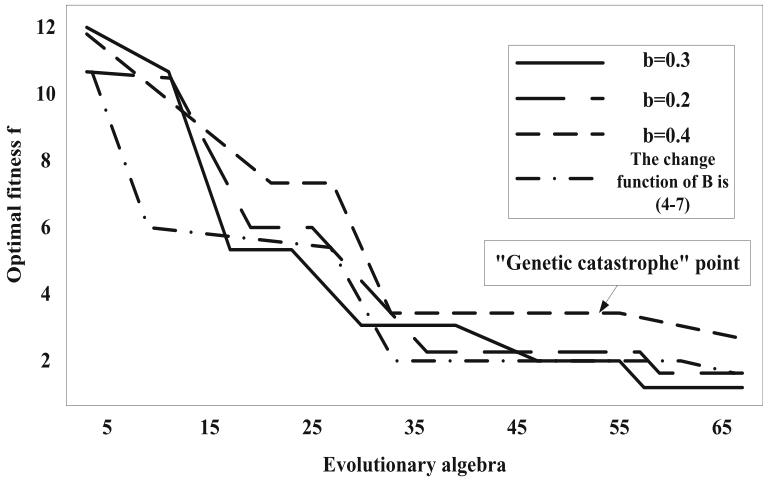

Fig. 6 Diagram of the relationship between evolutionary algebra and optimal fitness

selection operator can improve the diversity of the population more than the sorting operator, and it also occupies a great advantage in eliminating homogeneity of chromosomes.

4 Conclusion

The application of distributed database system in various industries of social production is the foundation of data processing application. Based on the wireless network, the use of distributed database technology is proposed to build the basic data platform of the internal control system for the problems of large amount of data redundancy and low query efficiency in the internal control management of cross-regional grouped enterprises. Utilizing the characteristics of high reliability and high operating efficiency of distributed databases, it solves the problem of building a basic database for cross-regional enterprise internal control. The application of improving the effectiveness of internal control is further studied, and the construction of distributed database is realized by using My SQL database management system. The function and performance of the system are analyzed; the function architecture, logic architecture, physical deployment architecture and other models of internal management and control of the enterprise are established (Table 1); and the design of the system's data architecture is focused on. The Java language is used to implement the main functional blocks of the system in the development environment, focus on the realization of data through major functions, discuss the support functions of the system for improving the effectiveness of internal control, and avoid influencing factors. Finally, the test cases are used to verify that the system's functions and performance indicators can meet actual usage requirements.

Table 1 Prediction error of different models

Error	Linear regression model	Model 1	Model 2	Model 3
Maximum relative error absolute value Emac/%	41.6	38.8	26.2	13.3
Average relative error Eave/%	5.1	13.3	5.8	3.7
Root mean square error RMSE (10^4)	8.9	8.0	7.3	4.1

Abbreviations

COSO: The Committee of Sponsoring Organizations of the Treadway Commission; Dos: Disk operate system; ERM: Enterprise Rights Management; NoSQL: Not Only SQL; SEC: Securities and Exchange Commission; SPIN: Sensor protocol for information via negotiation; TESLA: Torrify Ethical Software License Agreement

Funding

No Funding.

Authors' contributions

BL has made great contributions to the direction of the internal control survey of Chinese enterprises in wireless network. PW has done a lot of work on the effectiveness and influencing factors of internal control in Chinese enterprises and has paid a lot of efforts. Both authors read and approved the final manuscript.

Authors' information

Bo Liu, Doctor of Management, Associate professor. Graduated from Sichuan University in 2011. Worked in Anhui University of Finance and Economics. His research interests include Audit and Internal Control.
Pingshui Wang, Doctor of Engineering, professor. Graduated from Nanjing University of Aeronautics and Astronautics in 2013. Worked in Anhui University of Finance and Economics. His research interests include information technology and information security.

Competing interests

The authors declare that they have no competing interests.

Publisher's Note

Author details
[1]School of Accounting, Anhui University of Finance and Economics, Bengbu, Anhui Province, China. [2]School of Management Science and Engineering, Anhui University of Finance and Economics, Bengbu, Anhui Province, China.

Received: 21 October 2018 Accepted: 23 January 2019
Published online: 12 February 2019

References

1. N. Lu, N. Cheng, N. Zhang, et al., Wi-fi hotspot at signalized intersection: Cost-effectiveness for vehicular internet access. IEEE Trans. Veh. Technol. **65**(5), 3506–3518 (2016)
2. A. Länsiluoto, A. Jokipii, T. Eklund, Internal control effectiveness – a clustering approach. Manag. Audit. J. **31**(1), 5–34 (2016)
3. M. Shams, Effective architecture for greenhouse controlling and monitoring using Wi-Fi peer to peer direct protocol. Indian. J. Sci. Technol. **9**(17), 57–93 (2016)
4. H. Ning, M. Zhang, Relationship between structure and internal control effectiveness in sports brand companies. China Leather **46**(3), 99–162 (2016)
5. Hua C, Ye C, Guan X. Empirical Study on the Correlation between the Internal Control and Enterprise Value -- Based on the Information System[J]. Journal of Computers **7**(7), 1387–1396 (2012)
6. Y. Guo, Internal control effectiveness and stability of capital structure an empirical test based on GEM listed companies. Journal of Henan Polytechnic University **46**(1), 4–72 (2018)
7. W. Zeng, Z. Liu, Z. Zhang, et al., Research on media coverage, effectiveness of internal control and performance volatility. J. Cent. South Univ. **56**(3), 487–572 (2016)
8. S. He, S.H.G. Chan, Wi-fi fingerprint-based indoor positioning: recent advances and comparisons. IEEE Commun. Surv. Tutorials **18**(1), 466–490 (2017)
9. G. Wang, Y. Zou, Z. Zhou, et al., We can hear you with Wi-fi! IEEE Trans. Mob. Comput. **15**(11), 2907–2920 (2016)
10. Y. Li, F. Baccelli, J.G. Andrews, et al., Modeling and analyzing the coexistence of Wi-fi and LTE in unlicensed Spectrum. IEEE Trans. Wirel. Commun. **15**(9), 6310–6326 (2016)