

BLUETOOTH SCATTERNET FORMATION ALGORITHMS

Sain Saginbekov,
Suleyman Demirel University

Abstract

Short range, low power wireless technology, called Bluetooth, is an emerging Wireless Personal Area Network standard. In the specification of Bluetooth, the way how the network, called piconet, is formed of less than or equal to eight devices is given. Also, it is given that if the number of Bluetooth devices is more than 8, then a larger network, called scatternet, can be formed. However, the scatternet formation algorithm is not given in the specification. So, scatternet formation algorithm is an open issue. In this paper, we discuss several scatternet formation algorithms existing in the literature.

Introduction

Bluetooth[1] is one of the short-range, low power wireless technologies. It is originally designed as a cable replacement between personal devices such as PDA, headset, cell phone, printer, etc. But it is also used in different kinds of industrial applications. It uses license- free ISM (Industrial, Scientific, Medical) frequency band 2.4 GHz. It uses Frequency Hopping Spread Spectrum. The given spectrum is divided into 79 channels each having 1MHz bandwidth. Further, each channel is divided into time slots each having 625 μ s interval. Bluetooth packets hop 1600 per second[2].

The smallest network that can be formed by Bluetooth devices, so called *piconet*, can have at most eight active devices. One of them will be a *master* and the other seven devices will be slaves. Slaves can communicate only through the master. Overlapping piconets by time and by space will form a larger network called *scatternet* by one of the nodes called *bridge*. Figure 1 is an example of piconet and scatternet. Any device can be a bridge. Bridges can be a slave in one piconet and a master of another piconet. Or it can also be a slave of each piconet. It cannot be master of two piconets at the same time.

There are three different Bluetooth device classes. Each class has a different transmit power, hence a different transmission range:

1. *Class 1 device*: The communication range is 100 meters and transmit power is 100 mW
2. *Class 2 device*: The communication range is 50 meters and transmit power is 2.5 mW
3. *Class 3 device*: The communication range is 10 meters and transmit power is 1 mW

There are four different power saving modes in Bluetooth. They are Active, Sniff, Hold and Park modes. If the node is not active, or if it is not communicating, it can take any of power saving modes to consume less energy.

Although there is information about scatternets in Bluetooth specification, there is no information about the formation of scatternets. The formation of scatternet is open question. However, in the literature there are a lot of works about the formation algorithms of Bluetooth scatternets. And each of these algorithms is developed for different purposes. If the one is aimed to form a bandwidth efficient scatternet, the other one is to form delay efficient scatternet, etc. [3, 4]. In the next section, the scatternet formation algorithms are described

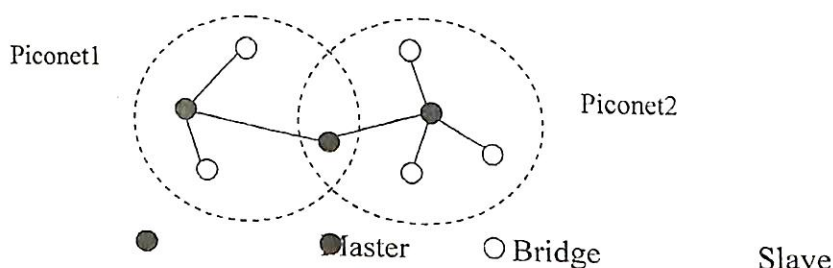


Fig.1. Piconets and scatternet

Scatternet Formation Algorithms

There are several works done about the scatternet formation algorithms. In this section, we discuss some of the works proposed in the literature.

In [5], the scatternet formation algorithm called, Tree Scatternet Formation, is described. The algorithm is decentralized and self-healing. It forms scatternet according to three rules. Here, the root nodes can only connect to root nodes. Free nodes can only connect to free nodes and non-root nodes. And, non root nodes do not attempt to form a scatternet with free nodes.

In [5], Bluetooth devices are partitioned into components. Each component can have one or more devices. Only component leader node can combine other components. At the beginning each node is a leader node. When it tries to connect other devices and connects, it takes the role of master and at the same time it will be a leader node. This way, all components will be combined into one large network called scatternet.

In [4], the tree-shaped scatternet, called Bluetree, is formed using a special node called Blueroot. Blueroot takes a role of master and tries to connect other free nodes. After connecting, these free nodes will be the slaves of blueroot. Then, these nodes will take the role of master and try to connect other free nodes. This procedure is repeated until all nodes will be connected.

In [3], two-phase algorithm called BTCP (Bluetooth Topology Construction Protocol) is mentioned. In phase one, nodes try to connect to other nodes. According to the rule, a node becomes a winner and takes the loser node information. The one who wins all nodes, in the second phase, using the collected information forms a centralized scatternet.

In [6], three-phase algorithm called BlueStar is described. In phase one, each node discovers the neighboring nodes. In phase two, piconets called BlueStars are formed according to gathered information in phase one. In third phase, the bridge node is selected to merge BlueStars into scatternet.

In[7], authors take into account Bluetooth's energy saving modes. If there is no need between master and slaves, master parks all its slaves. And these slaves can invite other nodes to join or can join to another piconet.

In [8], the two phase algorithm called BlueRing is proposed. The algorithm is scalable and fault tolerant. In the first phase, the leader node is selected among the nodes according to the information they have collected. In the second phase, according to the desired ring topology the leader node selects master nodes.

In [9], algorithm forms a scatternet using three phases. In phase one, original piconets, piconets which are formed first by a Bluetooth piconets, are formed. After first phase some of the nodes may remain isolated. In second phase, the isolated nodes are connected to original nodes as a master node. In third phase, the original piconets are connected to form a scatternet.

In[10], the authors try to form a tree like scatternet using Dijkstra's algorithm. They first try to connect nodes with shorter distance and then solve the degree problem of each node.

In[11], the scatternet with a clustering approach. It has also two phases: set-up phase and steady state phase. In the set-up phase each node learns its neighbor nodes. In a steady phase, the neighbor nodes are used to be a bridge node.

The last two algorithms are proposed to use in wireless sensor networks, where the energy is the most important resource.

Conclusion

Bluetooth is the emerging Wireless Personal Area Network. The scatternet formation algorithm is not given in the specification of Bluetooth, thus making it an open issue. There are several proposed scatternet formation algorithms in the literature. And each have different parameters. In this paper, we mentioned several of these algorithms. Future work can be a detailed explanation of all existing in the literature scatternet formation algorithms with their performance analyses.

References

- [1] Bluetooth Special Interest Group. *Specification of the Bluetooth System v1.1*, December 2000.
- [2] B. A. Miller and C. Bisdikian, "Bluetooth Revealed: The Insider's Guide to an Open Specification for Global Wireless Communications," Prentice Hall, 2001.
- [3] T. Solonidis, P. Bhagwat, L. Tassiulas, and R. LaMaire, "Distributed topology construction of Bluetooth personal area networks," Proceedings Twentieth Annual Joint Conference of the IEEE Computer Communication Societies, IEEE INFOCOM 2001, Apr.2001
- [4] G.V. Zaruba, S. Basagni, and I. Chlamatic, "Bluetrees-scatternet formation to enable Bluetooth-based ad hoc networks," In Proceeding of IEEE International Conference in Communications, June 2001.
- [5] G. Tan, A. Miu, J. Guttag, and H. Balakrishnan, "Forming scatternets from bluetooth personal area networks," MIT Technical Report, MIT-LCS-TR-826, Cambridge, MA, 2001.
- [6] C. Law, A. K. Mehta, and K. Y. Siu, "Bluetooth: performance of a new Bluetooth scatternet formation protocol," in Proceedings of ACM International Symposium on Mobile Ad Hoc Networking and Computing, 2001, pp. 183-192.
- [7] C. Petrioli, S. Basagni, and M. Chlamtac, "Configuring BlueStars: multihop scatternet formation for bluetooth networks," IEEE Transactions on Computers, Vol. 52, 2003, pp. 779-790.
- [8] R. Chang and M. Chou, "Blueline: A distributed Bluetooth Scatternet Formation and Routing Algorithm," Journal of Information Science and Engineering, 2005
- [9] T. Y. Lin, Y. C. Tseng, and K. M. Chang, "Formation, routing, and maintenance protocols for the bluering scatternet of bluetooths," Wireless Communications and Mobile Computing, Vol. 3, 2003, pp. 517-537.
- [10] Z. Wang, R. J. Thomas, and Z. Haas, "Bluenet - a new scatternet formation scheme", in Proceedings of the 35th Hawaii International Conference on System Science (HICSS-35), Big Island, Hawaii, January 7-10 2002
- [11] S. Saginbekov and I. Korpeoglu, "An Energy efficient scatternet formation algorithm for bluetooth-based sensor networks," In Proceedings of the Second European Workshop on Wireless Sensor Networks, 2005.
- [12] H. Mathias, D. Jan, and T. Dirk, "Energy Efficient data collection for Bluetooth-based sensor networks," IEEE Instrumentation and Measurement Technology Conference, May 2004.

Резюме

В этой статье рассмотрены несколько scatternet алгоритмов формирования, существующих в литературе и сеть, названная risonet, работающая в восьми устройствах.

Түйін

Бұл мақалада scatternet алгоритмінің әдебиетте және жүйеде құрылуы сонымен қатар risonet атауының сегіздік жүйеде жұмыс істеуі қарастырылады.

Özet

Şu makalede scatternet olgoritmasının yapısı ele alınmaktadır.

Тіл әрбір адамға қымбат болса, әрине, ұлт үшін де қымбат. Тілсіз ұлт, тілінен айырылған ұлт болып жасай алмақ емес. Осындай ұлт тілі кеми бастауы ұлттың құри бастағанын көрсетеді. Ұлтқа тілінен қымбат нәрсе болмауы тиіс.

Мағжан Жұмабаев