GEOMETRIC MODELING OF WIRELESS SENSOR NETWORKS USING THE METHOD OF STANDARD POINTS

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Summary. **The method of modeling a wireless sensor network with a limited number of information nods (INODES) that allows you to organize tracking and analysis of the signal strength of INODES is described. The scheme of classification of WSN, which allows you to determine the best view and type of imaging technique of signal strength is proposed.**

Keywords: **Wireless Sensor Network (BRSM), information units, visualization method reference points, cluster model, chotyrytochkovyy simplex.**

Formulation of the problem. The development of information technology promotes the improvement and widespread use in virtually all areas of human WSN. Today WSN have a special place among the means of collection and processing of a large number of different information. Expanding areas requires continuous use of WSN their complexity, increase reliability, durability and performance of information security. Solving these problems contributes to the availability of effective and simple modeling techniques. Therefore, the development and approbation of new methods of modeling WSN pay special attention. It is known that WSN simulation systems allow you to develop hardware and software at a much lower cost than in the case of real devices [1]. Yes mathematical and physical models of WSN significantly different among themselves, but to successfully meet the challenges of development and improvement of hardware and software components of WSN [2-5]. To study the parameters of IP signals, including signal strength, offer to create geometric models which use methods of computational geometry, including the distance geometry [6-10], which allows the existence of correlation between the measured distances to explore the intrinsic properties of geometric shapes. This convenient in terms of the optimal number of eyeballs is the Delaunay triangulation method.

In the proposed model the distance between the mesh virtual network nodes are functions of the real power signal IP. These models are used to visualize the wormhole attack in WSN. At the heart of the proposed models is flat geometric figures that with the increasing size of their elements can not be transformed into three-dimensional geometric figures, therefore not suitable for imaging individual IP parameters which signals change.

To visualize some signal IP parameters, which change proposed cluster model WSN [11, 12]. In the simulation accept that the configuration space of two dimensions are geometrically IP signaling points (PT), and the distance between the CT forces are functions of their signals. The basis for the cluster suggested regular hexagon. It consists of a cluster of 18th century, connected by 36 functional ties (FL). Euclidean space cluster configuration covering 18 chotyrytochkovyh simplex diamond, which under certain conditions by changing the lengths of functional ties can be transformed into three-dimensional shapes.

Based on the proposed cluster model developed methods chotyrytochkovyh simplex and fictitious CT imaging signals attacks on certain IP or IP group that includes the structure of the cluster. However WSN imaging with a limited number of IP (<18) should use the standard method of signaling points (ECT).

Main part. ECT method lies in the fact that the first stage of all simplexes chotyrytochkovomu FZ determined by the same reference parameters IP. Thus, the simplex formed of five equal FZ length l and a geometric coupling length (Figure 1). Real IP, the signal is changed, placed in a position that is determined by three Federal Law, that this provision CT, which is located on a small diagonal diamond (Fig. 1, a). Three elongation FZ cause transformation in three-dimensional diamond chotyrytochkovyy simplex, which determined a triangular pyramid with the top in the ST that defines the real IP (Figure 1, b). As with the method [4], in this case the height of the pyramid will characterize the degree of change in signal parameters real IP.

The test operation of the proposed method performed on the reconstructed surface topological WSN obtained based on the actual network. This was built on WSN IP that formed on the **XBee** modules manufactured in the USA by Digi International **XBee** programming protocol stack at the program level. IP protocol functioned within **Zig Bee** accordance with the standard **IEEE 802.15.4.**

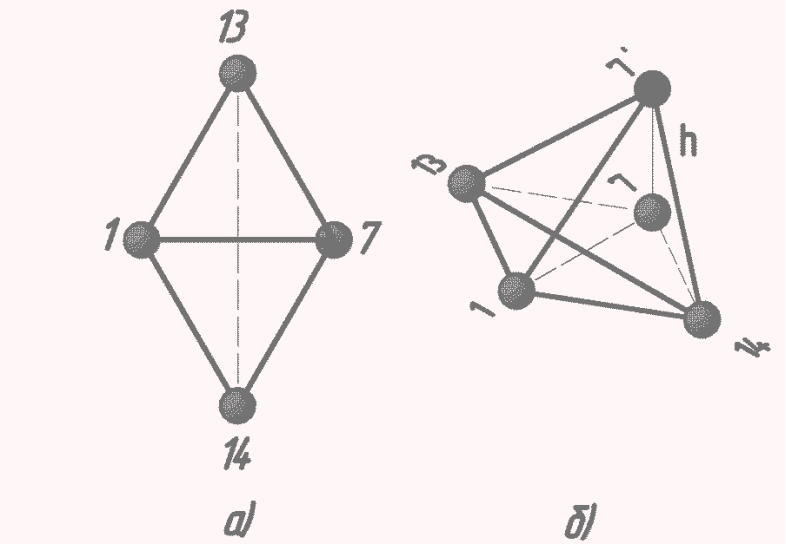

Fig. 1. Single investigated simplex.

Reconstructing the topological surface WSN performed by calculating the virtual position using CT into the FZ length 1m. This amount equal investigated simplex 0. After muting signal determine the real value of its IP transformation by measuring the received signal power of neighboring IP. So for the muted power of the received signal determines that the distance between the studied ST simplex increased to 2,85 m, and transformed simplex volume reached 0.38 m^3.

If a change of signal parameters IP cluster creates a complete transformation of the region, it is advisable simplex parameters of each test from this area with such a standard IP. In this case, you can create research clusters that consist of two, four, eight, sixteen simplex, each of which is defined by three PTs that are at rest. Fourth PT will give each simplex attacks on IP characteristics (Fig. 2, 3).

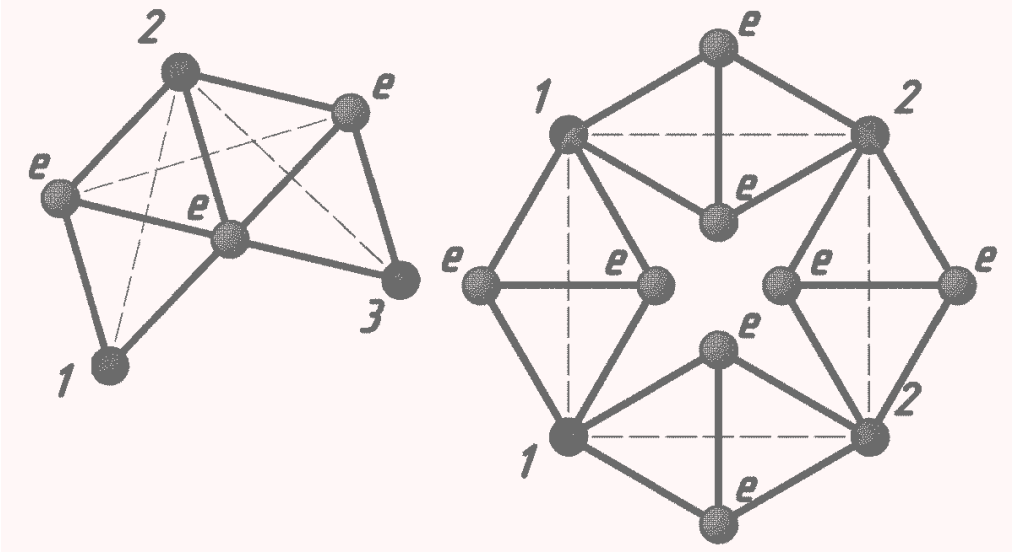

Fig. 2. Research clusters of two or four simplex.

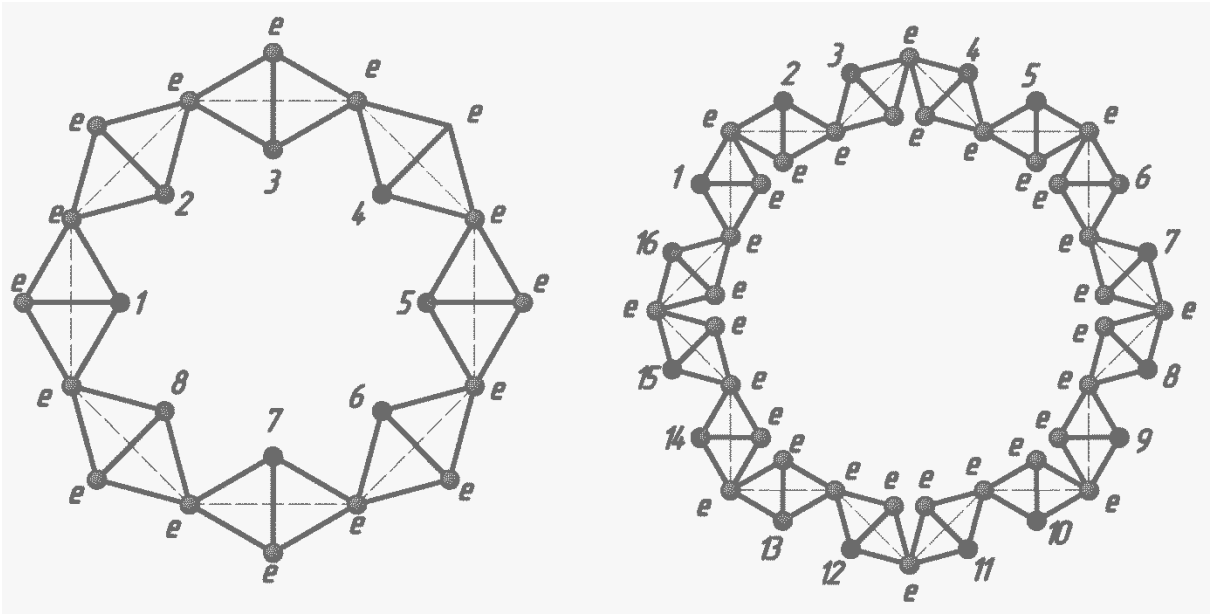

Fig. 3. Research clusters of eight and sixteen Simplex.

The possible combinations of clusters of more simplex (Fig. 4).

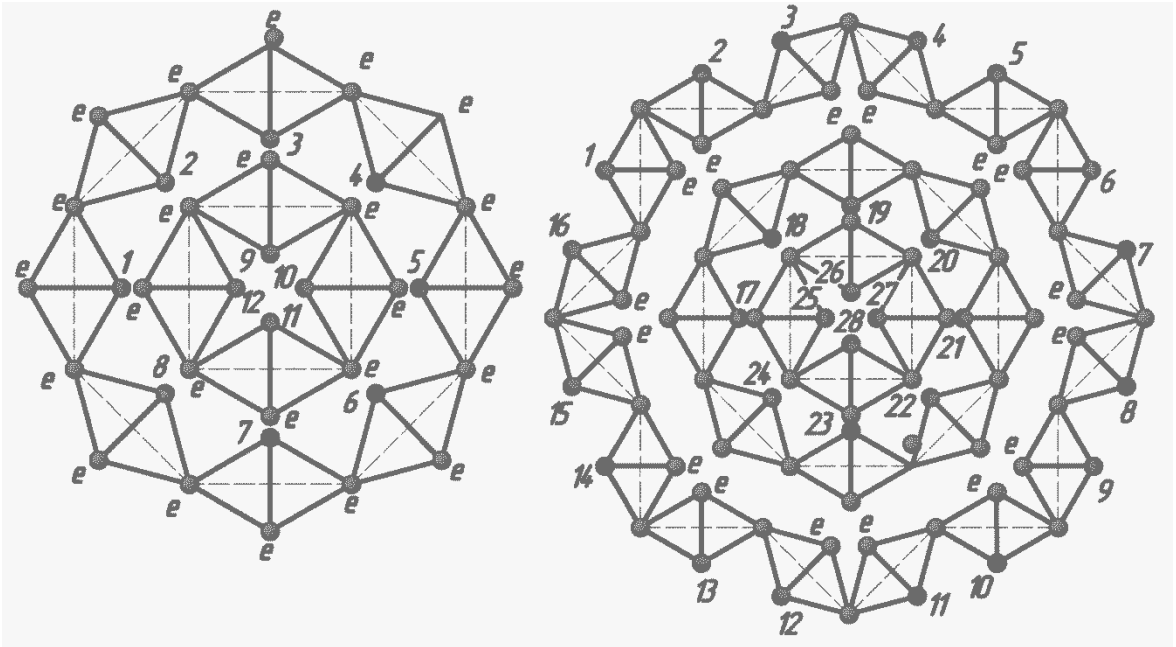

Fig. 4. Combined research clusters.

In the above clusters studied one shocked IP accounted for two standard IP. Therefore, to reduce the number of standard ICs, it is possible to create other types of clusters, which in addition to the formation of triangular pyramids having other dimensional simplex as a bent side of the joint of two triangles. It is clear that the volume of such three-dimensional simplex zero. Determination of geometric simplex communication leads to their deployment in a flat rectangle. Sketch. 5 shows two research clusters that consist of seven (Fig. 5 a) and six (Fig. 5, b) ST. The three studied 1B

in the first case and two IP investigated in the second case, accounts for four reference IP.

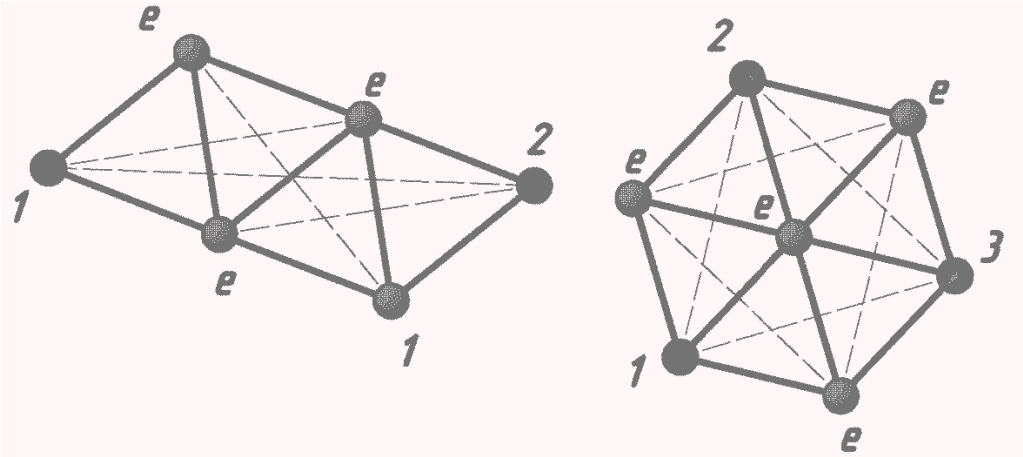

Fig. 5. investigated clusters of four or six reference information nodes.

Cluster type b (Fig. 5) enables the cluster to form more complex structures in which there is a significant reduction in the number of reference points IP. Sketch. 6 shows the cluster structure for the study of four (Fig. 6 a) and eight (Fig. 6, b) IP.

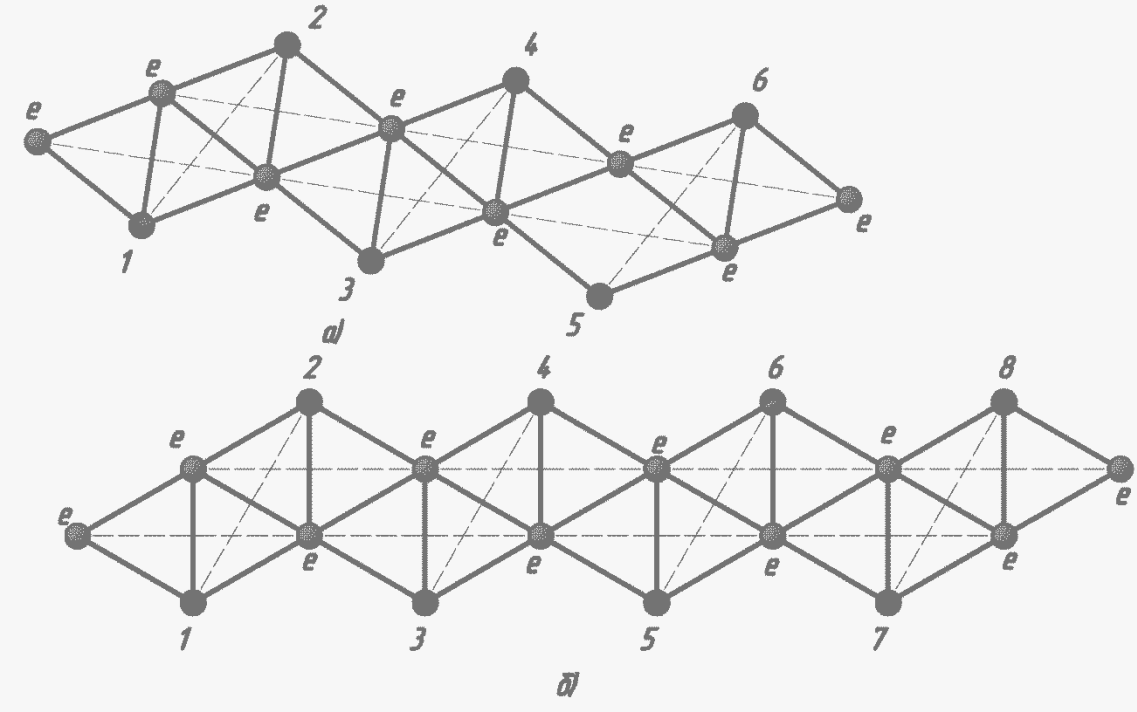

Fig. 6. Cluster structure more complex types.

For these structures are characterized by a decrease in the number of standard IP One study IP. Sequence relationships standard IP number to the number of investigated IP has the form:

$$\frac{4}{2}=2;\ \frac{6}{4}=1{,}5;\ \frac{8}{6}\approx 1{,}33;\ \frac{10}{8}=1{,}25;\ \ldots$$

Conclusion. It is proved the feasibility of using the method of reference signal points for simulation of wireless sensor networks with a limited number of information nodes. Powered schemes investigated clusters for different number of real IP. The dependence between the real and the reference number of IP in the studied clusters.

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