Streaming Algorithm For Multi-path Secure Routing in Mobile Networks

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Abstract

Proposed streaming algorithm for forming a plurality of disjoint paths refers to algorithms which are based on the paths construction of the tree. Due to exception of iterate operations through different variants of path construction, this algorithm is characterized of minimal time complexity and rapid convergence.

Keywords: Mobile network Ad Hoc, Multi-path secure routing.

1. Introduction

Mobile Ad Hoc networks have a self-organizing network architecture, where a set of mobile nodes with wireless network interfaces may form a temporary network without any infrastructure. The characteristic features of Ad Hoc networks are dynamic topology, lack of infrastructure, the compounds of variable capacity, etc., which are the primary cause of many problems. One of the encountered problems, in this type of networks, is limited bandwidth, energy constraints, high cost and safety. An attack "to a denial of service» (DOS) in these networks aimed at expenditure of scarce energy resource. Using solutions such as, PKI (Public Key Infrastructures), ineffective due to resource constraints in Ad Hoc network. Routing is an important aspect in the Ad Hoc network due to its features. In this regard, the most promising approach is the utilization of secure multi-path routing. [1] To secure multi-path routing protocols are put forward two groups of requirements. Requirements define the first group forming a plurality of the safest path, as usually, disjoint.

The second group of requirements connected with necessary to ensure the low computational complexity, the rapid convergence and the minimal volumes of generated service traffic[2].

Multi-path routing algorithms are divided into combinatorial and stream algorithms. Combinatorial models based on the mathematical description of the computer network as a directed or undirected graph with the subsequent use combinatorial algorithms for searching plurality of shortest paths between the specified pairs of nodes. Streaming algorithms exclude an operation directed enumeration and, at the same time, forming the set of admissible paths[3,4].

2. The streaming algorithm for forming plurality of disjoint paths

Consider the streaming algorithm for forming plurality of disjoint paths based on the formation of a decision tree on the original computing network graph (Fig. 1). In order to decrease the time complexity of forming a plurality disjoint paths algorithm, this paper, propose to use an operation on a plurality of adjacent vertices.

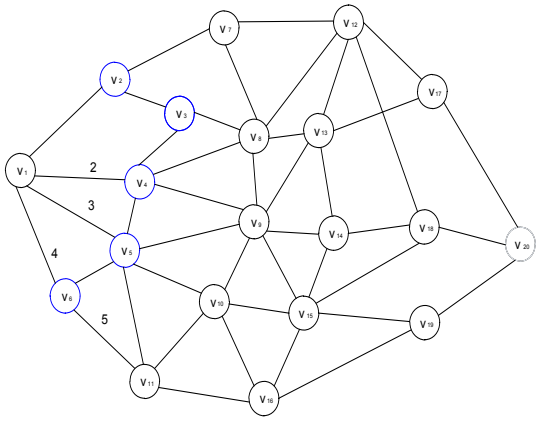

Fig.1. The initial network graph

1. Forming path between the initial vertex v_1 and a variety of $V_{cs} = \{v_2, v_4, v_5, v_6\}$ adjacent with it vertices. For the initial vertex set of vertices adjacent with it is a boundary

set $V_{cs} = V_{d1}$. Vertex set of the first path $V_{L1}=\{v_1, v_2\}$, where v_2 - final vertex of the path L_1, respectively: $V_{L2}=\{v_1, v_4\}$, $V_{L3}=\{v_1, v_5\}$, $V_{L4}=\{v_1, v_6\}$. In this case, the edges between the vertices plurality of $V_{cs} = \{v_2, v_4, v_5, v_6\}$ are removed (Fig. 2).

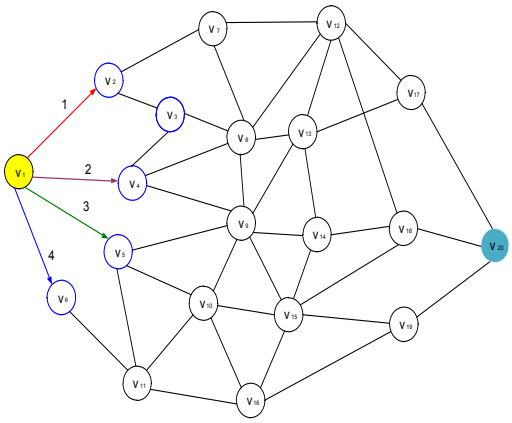

Fig. 2. Creating a path between the initial vertex and a variety of adjacent vertices

2. For a subgraph G_0 with set of vertices$V_0 = \{v_1, v_2, v_4, v_5, v_6\}$ forming next boundary set of vertices $V_{d3} = \{v_3, v_7, v_9, v_{10}, v_{11}\}$.

3. Among the vertices of the previous boundary set $V_{d2} = \{v_2, v_4, v_5, v_6\}$ select vertex $V_6 \in V_{d2}$ with the minimum number of adjacent outer vertices, in this case, it is adjacent a vertex v_{11}.

4. Forming path L_4 of the set of vertices $V_{L4}=\{v_1, v_6, v_{11}\}$.

5. Next vertex $V_2 \in V_{d2}$ with two external adjacent vertices v_7, v_3.

6. Forming path L_1 of a vertices set $V_{L1}=\{v_1, v_2, v_7\}$.

7. Next vertex $V_5 \in V_{d2}$ with two external adjacent vertices v_9, v_{10}.

8. Forming path L_3 of the vertices set $V_{L3}=\{v_1, v_5, v_{10}\}$.

9. Last vertex $V_4 \in V_{d2}$ with three external adjacent vertices v_3, v_8, v_9.

10. Forming L_2 path from the set of vertices $V_{L2}=\{v_1, v_4, v_9\}$.

11. Remove the connection between the vertices of the set $V_{d3} = \{v_3, v_7, v_8, v_9, v_{10}, v_{11}\}$ (Fig. 3).

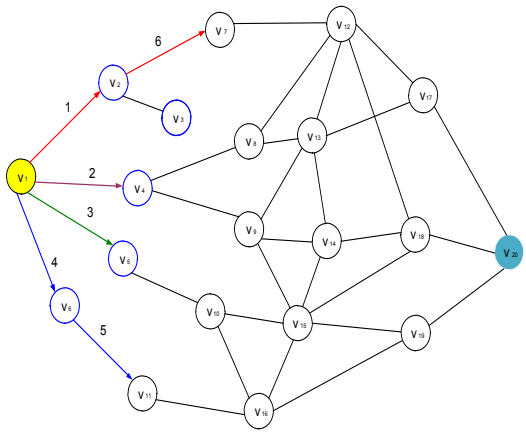

Fig. 3. Second step of forming a path from the initial vertex

12. Forming next boundary vertex set $V_{d4} = \{v_{12}, v_{13}, v_{14}, v_{15}, v_{16}\}$.

13. Among the vertices of the previous boundary set $V_{d3} = \{v_3, v_7, v_8, v_9, v_{10}, v_{11}\}$ choose the vertex $V_{11} \in V_{d3}$ with a minimum of external adjacent vertices, in this case, it is adjacent to a vertex v_{16}.

14. Forming path L_4 of the set of vertices $V_{L4}=\{v_1, v_6, v_{11}, v_{16}\}$.

15. The next vertex $V_7 \in V_{d3}$ with one external adjacent vertex v_{12}.

16. Forming path L_1 of a vertices set $V_{L1}=\{v_1, v_2, v_7, v_{12}\}$.

17. The next vertex $V_{10} \in V_{d3}$ with two external adjacent vertices v_{15}, v_{16}. Vertex $V_{16} \in L_4$ don't used for any other way, we choose v_{15}.

18. Forming path L_3 of the vertices set $V_{L3}=\{v_1, v_5, v_{10}, v_{15}\}$.

19. The next vertex $V_9 \in V_{d3}$ with three external adjacent vertices v_{13}, v_{14}, v_{15}. Vertex $V_{15} \in L_4$ don't used for any other way. Four way are formed. Vertex v_{13} is not used.

20. Forming L_2 path from the set of vertices $V_{L2}=\{v_1, v_4, v_{9,} v_{14}\}$.

21. Forming the next boundary vertex set $V_{d5} = \{v_{17}, v_{18}, v_{19}\}$.These vertices adjacent to a destination vertex.

22. Vertex $V_{14} \in V_{d4}$ with one external adjacent vertex v_{18}.

23. Forming L_2 path from the set of vertices $V_{L2}=\{v_1, v_4, v_{9,} v_{14,} v_{18,} v_{20}\}$.

24. The next vertex $V_{16} \in V_{d4}$ with one external adjacent vertex v_{19}

25. Forming path L_4 of the vertices set $V_{L4}=\{v_1, v_6, v_{11}, v_{16,} v_{19}, v_{20}\}$.

26. The next vertex $V_{12} \in V_{d4}$ with two external adjacent vertices $v_{17,} v_{18}$. Vertex $V_{18} \in L_2$ don't used for any other way, chooses v_{17} .

27. Forming path L_1 of a vertices set $V_{L1}=\{v_1, v_2, v_7, v_{12}, v_{17}, v_{20}\}$.

28. The path L_3, consisting of $v_1, v_5, v_{10,} v_{15}$ can not be extended because v_{15} has two adjacent vertices, that aren't included in the current tier - $\{v_{10,} v_{19}\}$, but, at the same time , $V_{18} \in L_2$, $V_{19} \in L_4$.

As a result, next paths are formed (Fig. 4): $V_{L1}=\{v_1, v_2, v_7, v_{12,} v_{17,} v_{20}\}$; $V_{L2}=\{v_1, v_4, v_{9,} v_{14,} v_{18,} v_{20}\}$; $V_{L4}=\{v_1, v_6, v_{11}, v_{16,} v_{19,} v_{20}\}$.

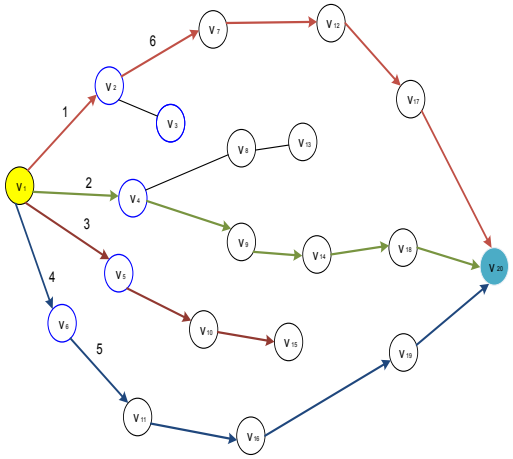

Fig. 4. A plurality of independent path between the initial and final vertex

3. Conclusions

Proposed algorithm for forming plurality of disjoint paths refers to streaming algorithms, based on the construction of the tree paths. Due to exception of operation trying different path of constructing the algorithm is characterized by the minimal time complexity and fast convergence.

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