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GENERALIZED NET MODEL OF COMMON GATEWAY ARHITECTURE FOR MOBILE AD-HOC NETWORKS

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Abstract

Ad-hoc networks are created by definition on demand without any infrastructure. They are often considered as an extension of the range of Internet access points, providing multihop wireless access to them. This paper tries to examine the situation where there are exist several Internet access points in a single ad-hoc network.

We present a generalized net model proposed Common Gateway Architecture which allows to use multiple access points and send traffic using the closest access point.

Keywords: generalized nets, mobile ad-hoc networks, ad-hoc networks, AODV (Ad hoc On-Demand Distance Vector), networks.

Introduction

The current paper examines Generalized Net (GN) model [1] that present multi-hop ad-hoc routing protocols which provides extension of the range of the APs (Access Point). Nodes which are not directly covered by the APs can connect through the other nodes. Currently, if multiple gateways exist in the area of one ad-hoc network, they are independent of each other and manage different address spaces. This requires extensions to the ad-hoc nodes, since they need to decide which gateway to choose. The Common Gateway Architecture (CGA), provides a micro-mobility solution for the ad-hoc network.

In the current architectures, which provide single-hop wireless Internet access, there exist several micro-mobility solutions. If the change is very frequent standard Mobile IP does not work, since its mechanisms bring too much overhead. Micro-mobility mechanisms try to minimize signalling, handover time and avoid communication with distant servers.

There are several solutions in the area of micromobility: Cellular IP, Hawaii and Hierarchical Mobile IP [3, 4]. They all work in a scenario where a mobile node is moving and changing its point of attachment to the network. The communication with point of attachment (e.g. access point) is always direct, i.e. single-hop. A good comparison of micromobility solutions is given in [5, 6]. From the above methods, Cellular IP seems to have most in common with ad-hoc routing protocols, especially AODV [7].

About the minimize control messaging, it uses data packets to refresh host locations. AODV uses data packets to refresh host location and maintain the reverse path (if needed). Limited broadcast is also used to locate the node.

Ad-hoc routing protocols provide enough mechanisms to support micromobility, since them can already manage movement of nodes.

In ad-hoc networks can view neighbor access points like 'points of attachment', which provide access to the distant points.

Instead of using any micromobility mechanisms to support handover between multiple points of Internet access, can be used ad-hoc routing protocols directly.

Internet connection for ad-hoc networks

Initially, nodes belonging an ad-hoc network can only communicate among themselves, using multi-hop wireless transmission.

According to [2] there are two general approaches providing for Internet connectivity: with and without tunnelling. In both approaches, the mobile node needs to know the gateway address and has a route to it. Mobile nodes also need to know their network prefix and compare it with the destination address. When using the tunnel, if the destination lies outside the mobile network, mobile nodes encapsulate the packets directed to Internet and put the gateway address as a destination. When such a packet is received by the gateway, it decapsulates its contents and forwards the packet to the desired destination. Because of this encapsulation, the packets are tunnelled between the mobile node and the gateway.

In another approach, if the destination lies outside the mobile network, mobile nodes send the packet with the 'real' destination address and direct the packet to the next hop for the gateway.

Each of the nodes needs to keep a default route, as in standard Internet connectivity. The next hop for such route is the next hop to the gateway. The tunneled solution is transparent to the intermediate nodes, since it doesn't require gateway support in them. If each node can distinguish external address from internal ones the tunneled approach is not required.

Initially the following tokens enter in the generalized net:

- in place S_{cd} - α-token with characteristic "client data";
- in place S_{1A} - β'- token with characteristic "data in the Node 1";
- in place S_{3A} - β''- token with characteristic "data in the Node 2";
- in place S_{2A} - χ'- token with characteristic "data in the Access Point 1";
- in place S_{4A} - χ''- token with characteristic "data in the Access Point 2".
- in place S_{5A} - δ''- token with characteristic "data in the Gateway".

GN- model

The GN model (Fig.1) is introduced by the set of transitions:

A= { Z_1, Z_2, Z_3, Z_4, Z_5, Z_6}, where the transitions describe the following processes:

Z_1 = " Tasks are made by Node 1"
Z_2 = "Tasks are made by Access Point 1"
Z_3 = "Tasks are made by Node 2"
Z_4 = " Tasks are made by Access Point 2"
Z_5 = "Tasks are made by Gateway"
Z_6 = "Internet"

Transitions with the following description:

$$Z_1 = \langle \{S_{cd}, S_{33}, S_{23}, S_{1A}\}, \{S_{11}, S_{12}, S_{13}, S_{A1}\}, R_1, M_1, \vee(S_{cd}, S_{23}, S_{33}, S_{1A}) \rangle$$

$$
R_1 = \begin{array}{c|cccc}
 & S_{11} & S_{12} & S_{13} & S_{1A} \\
\hline
S_{cd} & false & false & false & true \\
S_{33} & false & false & false & true \\
S_{23} & false & false & false & true \\
S_{1A} & W_{1A,11} & W_{1A,12} & W_{1A,13} & true
\end{array}
$$

where:

$W_{1A,11}$ = "It is impossible to establish the connection"
$W_{1A,12}$ = "There is a request for Access Point 1"
$W_{1A,13}$ = "There is a request for Node 2"

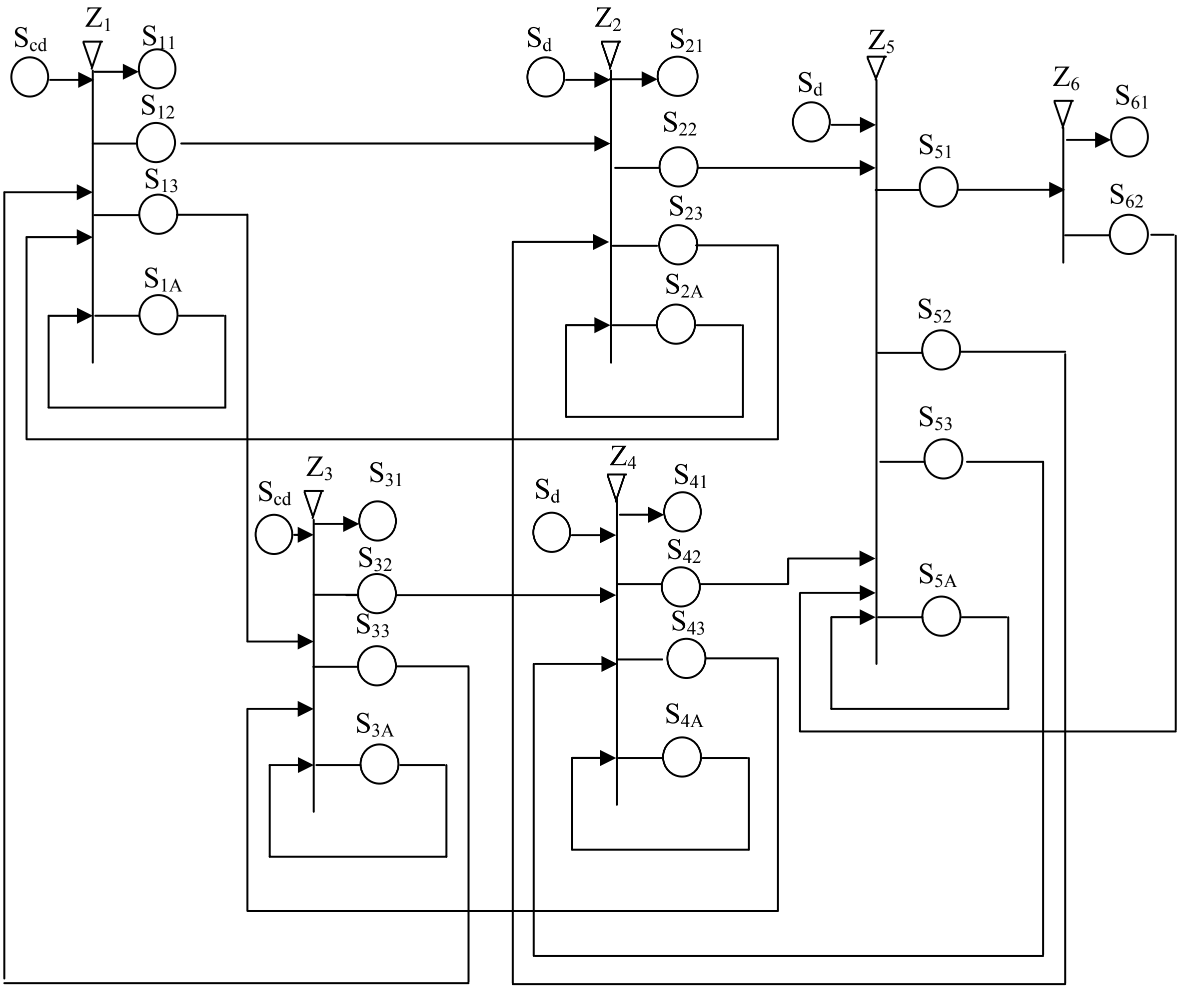

Fig.1

The token that enters place S_{12} obtains the characteristic "request for establish the connection to the Gateway trough the Access Point 1". The token that enters place S_{13} obtains the characteristic "request for establish the connection to the Gateway trough the Node 2".

Z_2= < { S_{12}, S_{32}, S_{52}, S_{2A} }, {S_{21}, S_{22}, S_{23}, S_{2A}}, R_2, M_2, $\vee$ (S_{12}, S_{32}, S_{52}, S_{2A}) >

$$R_2 = \begin{array}{c|cccc} & S_{21} & S_{22} & S_{23} & S_{2A} \\ \hline S_{12} & false & false & false & true \\ S_{32} & false & false & false & true \\ S_{52} & false & false & false & true \\ S_{2A} & W_{2A,21} & W_{2A,22} & W_{2A,23} & true \end{array}$$

where:

$W_{2A,21}$= "$W_{1A,11}$";
$W_{2A,22}$= "There is an information about Gateway";
$W_{2A,23}$= "There is a confirmation about Node 1";

The token that enters place S_{22} obtains the characteristic "information about connections with Gateway". The token that enters place S_{23} obtains the characteristic "confirmation of Node 1".

Z_3= < { S_{13}, S_{43}, S_{3A} }, {S_{31}, S_{32}, S_{33}, S_{3A}}, R_3, M_3, $\vee$ (S_{13}, S_{43}, S_{3A}) >

$$R_3 = \begin{array}{c|cccc} & S_{31} & S_{32} & S_{33} & S_{A3} \\ \hline S_{13} & false & false & false & true \\ S_{43} & false & false & false & true \\ S_{3A} & W_{3A,31} & W_{3A,32} & W_{3A,33} & true \end{array}$$

where:

$W_{3A,31}$= "$W_{1A,11}$";
$W_{3A,32}$= "There is a request for Access Point 2"
$W_{3A,33}$= "There is a confirmation about Node 1";

The token that enters places S_{32} obtains the characteristic "request for establish the connection to the Gateway trough the Access Point 2 through Node2". The token that enters place S_{33} obtains the characteristic "confirmation of Node 1".

Z_4= < { S_{33}, S_{53}, S_{4A} }, {S_{41}, S_{42}, S_{43}, S_{4A}}, R_4, M_4, $\vee$ (S_{33}, S_{53}, S_{4A}) >

$$R_4 = \begin{array}{c|cccc} & S_{41} & S_{42} & S_{43} & S_{4A} \\ \hline S_{33} & false & false & false & true \\ S_{53} & false & false & false & true \\ S_{4A} & W_{4A,41} & W_{4A,42} & W_{4A,43} & true \end{array}$$

where:

$W_{4A,31}$= "$W_{1A,11}$";
$W_{4A,42}$= "There is an information about Gateway";
$W_{4A,43}$= "There is a confirmation about Node2"

The token that enters place S_{42} obtains the characteristic "data for connections with Gateway". The token that enters place S_{43} obtains the characteristic "confirmation to the Node2 ".

Z_5= < { S_{22}, S_{42}, S_{62}, S_{5A} }, {S_{51}, S_{52}, S_{53}, S_{5A}}, R_5, M_5, ∨ (S_{22}, S_{42}, S_{62}, S_{5A}) >

$$R_5 = \begin{array}{c|cccc} & S_{51} & S_{52} & S_{53} & S_{5A} \\ \hline S_{22} & false & false & false & true \\ S_{42} & false & false & false & true \\ S_{62} & false & false & false & true \\ S_{5A} & W_{5A,51} & W_{5A,52} & W_{5A,53} & true \end{array}$$

where:

$W_{5A,51}$= "There is a data for Internet";
$W_{5A,52}$= "There is a data for Access Point 1";
$W_{5A,53}$= "There is a data for Access Point 2".

The token that enters place S_{51} obtains the characteristic "data for Internet". The token that enters place S_{52} obtains the characteristic "data to Access Point 1". The token that enters place S_{53} obtains the characteristic "data to Access Point 2".

Z_6= < { S_{51}}, {S_{61}, S_{62}}, R_6, M_6, ∨ (S_{51}) >

$$R_6 = \begin{array}{c|cc} & S_{61} & S_{62} \\ \hline S_{51} & W_{51,61} & W_{51,62} \end{array}$$

where:

$W_{51,61}$= " $W_{1A,11}$";
$W_{51,62}$= "There is a data for the Gateway".

The token that enters place S_{62} obtains the characteristic "data for Gateway".

Conclusion

Ad-hoc networks are created by definition on demand without any infrastructure. The current paper presents a Generalized Net Model using Common Gateway Architecture, which allows the use of multiple access points and send traffic using the closest access point. The model allows simulation and optimization of the behavior of this architecture of Ad-hoc network.

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