Analytical comparison of the IP mobility protocols

Csaba Keszei

In IP networks the IP address has dual role. Firstly it identifies a node in the IP layer (identifier role). Secondly the IP address is used to locate an IP node in a general IP network topology (locater role). The locater function is effective when prefix based routing is possible which enables aggregation and helps keeping the routing tables in a moderate size.

A fundamental problem in IP level mobility is that the IP address of a mobile node cannot fulfill both roles at the same time. If it changes with node mobility, it is not an identifier. If it does not change at mobility then it looses its location significance. We can categorize the IP mobility protocols based on the way they handle this issue. In the first group of protocols the locater role is given up. This prevents route aggregation which in a general case might result in O(N) sized routing tables in all of the routers where N denotes the number of mobile nodes in the network. This group of protocols obviously cannot scale to the entire Internet. All the ad-hoc routing protocols, CIP and HAWAII are examples of this group.

In the second group the two roles are split to two actual IP addresses. One is a permanent identifier, while the second changes with movement and reflects the current location of the mobile node. The identifier address is typically routed towards a fixed point (anchor) in the Internet. From that point IP-in-IP tunelling is used towards the mobile node's actual location. Since locater role is valid, regular prefix based routing can be used in the network. Moreover, certain routers (called intermediate routers) might not be aware of IP mobility at all. Only a limited number of routers will have mobile node related entries in their routing tables. This is a scalable solution so the size of the IP mobility network is not limited by the size of routing tables. Examples are MIPv4, MIPv6 without route optimization, HMIP and BCMP.

In the third group the main goal is optimal routing. The most important difference compared to the second group is that the identifier address is never used for topologically locating (even roughly) the mobile node. Valid locater addresses are the result of database lookups. Several nodes has to maintain database entries on one mobile node in this group of protocols. Example is the MIPv6 in route optimization mode.

In this paper an analytical comparison of the three groups will be carried out. Investigated values are data path length (routing optimality), signaling overhead caused by mobility or connection setup, number of maintained states in the network (complexity in other words) and handover performance (time to bring the network into consistent state after a mobility event). Since IP mobility protocols are complex, for a fair comparison decomposition is needed. Protocol actions can be split up to parts directly dealing with core IP mobility or to - from this point of view - secondary actions such as handover management (making the handovers fast and smooth for the mobiles), context transfer or AAA actions. This paper points out that in the investigated values related to core IP mobility there are no fundamental differences between the protocols belonging to the same group. The goal is to find analytical formulas for the mentioned values in case of the three groups of protocols for a certain network topology. This enables to find the optimal solution for a given set of requirements. We believe that hierarchical combination of the protocols gives the best results when the goal is to provide a general IP mobility solution.