A COMBINED DYNAMIC RELAY UTILIZATION AND ROUTE OPTIMIZATION PROTOCOL FOR BLUETOOTH SCATTERNET

By

SHEIKH TAHIR BAKHSH

A Thesis
Submitted to the Postgraduate Studies Programme
as a requirement for the degree of

DOCTOR OF PHILOSOPHY
INFORMATION TECHNOLOGY
UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR
PERAK, MALAYSIA

MAY 2012

ABSTRACT

The current specification of Bluetooth has described how to build a piconet, but the methods for constructing a scatternet and inter-piconet communication for routing have been left out. Critically, there still exist multiple inefficiency issues in the scatternet construction protocol and the subsequent routing protocol. These have hindered the prospect of the Bluetooth technology for wider applications and usages in the short-range communications domain. To resolve these issues and to get greater acceptance for the technology, a combined protocol of scatternet construction (by relay utilization and congestion handling) and packet routing/forwarding (by route optimization) is proposed, with the aim that a Bluetooth application can be implemented over the infrastructure with ease and efficiency. The proposed protocol is called RURO (Relay Utilization and Route Optimization) protocol, and has three protocol parts. The first part is Master-based Dynamic Relay Optimization (MDRO) protocol, and the second part, which enhances MDRO, is Dynamic Relay Utilization (RU) protocol. Both of them will be used for scatternet construction. The third part of the protocol is Route Optimization (RO) for packet routing/forwarding over the constructed Bluetooth scatternet topology.

With the scatternet construction protocol, MDRO reduces and optimizes the use of relay nodes, in which the existence of unnecessary relays may increase scheduling overhead and consume system resources. On the contrary, several links may pass through a single relay that creates a bottleneck and decreases system performance. Hence, it is important to obtain an optimum number of relays for an efficient scatternet performance, since the system is working with only limited resources. In overall, RU is aimed to optimize relay nodes, to eliminate congestion, and to obtain balanced traffic loads. For packet routing/forwarding over the scatternet topology, the Route Optimization (RO) protocol is developed to achieve an efficient inter-piconet communication, which directly enhances the RU protocol. The RO protocol considers the shortest route ahead of the source and destination nodes by utilizing the master's location information. The protocol requires location information of the nodes to

reduce hop counts between a pair of source-destination nodes by dynamically applying the role-switching operation.

For a complete process and efficient packet transmission from a sender node to a receiver node over a Bluetooth scatternet topology, a combined Dynamic Relay Utilization (RU) protocol and Route Optimization (RO) protocol is proposed. This combined protocol is now called Relay Utilization and Route Optimization (RURO).

In general, large numbers of hop counts consume more resources, and a bottleneck decreases system performance. With respect to this, through simulations, it was found that the proposed RURO has reduced the hop counts at least 20% and control overhead minimum 5% between a pair of source-destination nodes. Importantly, RURO has the ability to dynamically reconstruct the routes using only the location information of the Bluetooth nodes. The results have shown that RURO has outperformed Routing Vector Method (RVM), Relay Reduction and Disjoint Route Construction (RRDRC) and Location Aware Routing Protocol (LARP) protocols for the same issues. Subsequently, it has demonstrated an improvement in network throughput and decrease delay the Bluetooth scatternet network. Therefore, it is expected that the issue of inefficient scatternet formation and routing procedures in the Bluetooth scatternet network can be resolved by implementing the proposed RURO protocol.