Technology International Incorporated of Virginia

429 West Airline Highway
Suite S
LaPlace, LA 70068-3817
www.tii-va.com

Point of Contact

Sabri, Zeinab
(985) 652-1127
dr_sabri@rtconline.com

Title

Connectivity Technologies for the Warfighter Network

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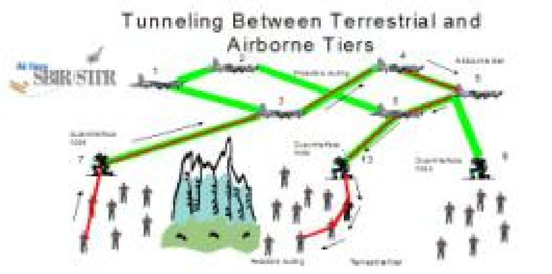
Summary Report Type

Phase II Interim



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High-Level, Multi-Tier, Multi-Protocol Architecture for Ad-Hoc Communication

Summation

This project is aimed at development, design, prototyping, and demonstration of multi-tier mobile ad hoc wireless networking protocols. Our multi-tier protocol design allows a set of airborne nodes to form a virtual backbone that enables long-range, multi-hop communication between groups of terrestrial nodes, without extensive fixed infrastructure. The various tiers employ different ad hoc routing schemes and support is provided in the airborne tier for very high-speed nodes (e.g., jet fighter planes) that may participate in the network for only short periods of time.

Our prototype is a hybrid scheme that integrates proactive and reactive routing techniques, combined with mechanisms for handling high-speed nodes. The design fuses Optimized Link State Routing (OLSR), a proactive routing protocol, with Dynamic Source Routing (DSR), a reactive routing protocol. Airborne nodes are routed proactively with OLSR, with high-speed airborne nodes being temporary members of the airborne tier. In the terrestrial tier, nodes are routed reactively on a local (cluster) basis, with the airborne tier providing a backbone to connect the terrestrial clusters. In our current design, communication between nodes in distinct terrestrial clusters uses a tunneling scheme to tunnel DSR packets between the clusters. Distinguished nodes with dual wireless interfaces (one interface for terrestrial-to-airborne and one interface for cluster-local communication) provide connectivity between terrestrial and airborne tiers and are responsible for tunneling and de-tunneling operations.

We are investigating several hierarchical naming schemes for terrestrial nodes that allow multiple dual-interface nodes per cluster and tolerate movement of terrestrial nodes between clusters. Our candidate naming schemes involve assignment of first class names to airborne nodes and to the dual-interface, terrestrial nodes. Terrestrial nodes are located either through a distributed registration process (similar to handoff in cellular networks) or via cluster-local “hello” messages that introduce terrestrial nodes to nearby distinguished nodes. Both of these schemes will require that multiple dual-interface nodes in a single terrestrial cluster cooperate so that communication is maintained seamlessly if one or more of the dual-interface nodes fail. Our requirements are that the naming scheme be scalable, fault-tolerant, and minimize overhead.

Our Phase I work defined wireless networking architectures and initial designs that provide high bandwidth, energy efficient, communication links between disparate wireless ac hoc networks and identified the most appropriate routing algorithms. Extensive modeling and simulation led to a preliminary design that enables energy efficient, ad-hoc networking amongst heterogeneous devices in the IP-AN.

Phase II is the expansion of this work to develop and demonstrate a prototype system. This includes development of dual-interface wireless node models in the OPNET simulator, identifying IP-AN connectivity challenges, refinement of the architecture, testing of a store and forward system for the airborne tier, and modeling and simulating our architecture in OPNET. Development of the dual interface node models in OPNET is crucial, because otherwise OPNET cannot be used to simulate our architecture (or any other multi-tier, multi-protocol ad hoc architecture). These dual-interface nodes have ability to participate in and route traffic between both proactively and reactively routed tiers, tunneling control and data traffic as needed.

Anticipated Benefits

The innovative applications of networking technologies in our work serve to effectively increase the digital bandwidth to wirelessly connected users and enable energy efficient ad-hoc networking amongst heterogeneous and geographically diverse devices, including JTRS compliant devices. The connectivity technologies for the warfighter network will exploit the dense concentrations of wireless users to support high bandwidth, bursty applications such as VoIP and image and video transfers. Improved networking technologies for the IP Airborne Network will benefit both the DoD's objectives for the JTRS program and have extensive applications to homeland defense initiatives for network interoperability and increased information throughput.

The ad hoc connectivity technology can be leveraged into air traffic and sea navigation expeditions; large scale events such as disaster relief or rescue efforts in a natural disaster area struck by earthquake or hurricane; community networks in dense residential areas and large scale, long-range networks.