ABSTRACT

The latest contribution towards teaching and learning process is the use of Internet technology to establish a Virtual Class Room (VCR). These VCRs are presently available by making use of satellite communication. These class rooms are fixed in a particular place where the equipment and the facilities are available.

The development of short-range wireless technologies provide a group of learners with the power of high transmission rate, mobility and flexibility, enabling them to interact with each other and access teaching material in an indoor or outdoor environment. A Mobile Ad Hoc Network (MANET) is a collection of mobile nodes that can communicate with each other using multi-hop wireless links without utilizing any fixed base station infrastructure and centralized management. Each mobile node in the network acts both as a host generating flows or being the destination of flows and a router forwarding flows directed to other nodes.

An attempt has been made to establish a multi-hop VCR based on MANET for a residential institution where the VCR itself can be mobile within a distance of 500m. A multi-hop VCR is a mobile ad hoc classroom that can be immediately established, and whose members can be dynamically added or removed, further the group structure of the members can be reorganized dynamically anywhere within the range at any time. The VCR can support urgent and timely learning activities. A wireless platform has been implemented to enable teachers and students to create classrooms
dynamically, whenever and wherever they want to take a lesson and enabled the students to post their queries for immediate clarification. VCR has been designed to improve the teaching process by passing Multimedia Messaging Services (MMS) comprising of audio, video, animation and text.

VCR based on MANET application has been designed and implemented using Personal Digital Assistants (PDAs) with Microsoft .NET Compact Framework. PDAs communicate wirelessly with each other using the IEEE 802.11g technology, without the use of an infrastructure. VCR based on MANET has been implemented with 30 PDA nodes. Each node in the network is assigned with a unique static IP address. The software components used for development are Microsoft Visual Studio C#.NET 2005, Windows Mobile 5.0 Pocket PC Software Development Kit (SDK), Microsoft ActiveSync Version 4.2 and Microsoft .NET Compact Framework 2005 and XML technology. The eXtended Markup Language (XML) technology has been used for providing description and representation of data and control packets.

The traditional problems faced in MANET routing are frequent node mobility, dynamic topology, diverse link capacities, limited practical bandwidth of the shared wireless channel and the battery power availability. The following efforts have been made towards finding optimal paths between source and receivers to improve the performance metrics - packet delivery ratio (PDR) and latency.

Multicasting is the transmission of datagram’s to a group of hosts identified by a single destination address and hence is intended for group-oriented computing. In MANET, multicast can efficiently support a variety of applications that are characterized by close collaborative efforts. A multicast
packet is typically delivered to all members of its destination group with the same reliability as regular unicast packets.

VCR has been implemented using Multicast Adhoc OnDemand Distance Vector (MAODV) and OnDemand Multicast Routing Protocol (ODMRP) - a standard on-demand multicast routing algorithms. The PDR and Latency metrics have been analyzed for different network traffics, areas and node speeds. For traffic up to 10 Kbytes/sec, ODMRP is slightly better, and after that point MAODV performs better. For small areas, MAODV achieves better PDR while ODMRP achieves better latency. For large areas, ODMRP achieves better PDR while MAODV achieves better latency. For different node speeds, both protocols perform well with ODMRP performing better as the speed increases.

VCR has been further executed with Multi Path Multicast Ad hoc On demand Distance Vector (MP-MAODV) and Multiple Tree Multicast Ad hoc On demand Distance Vector (MT-MAODV) – a MAODV based on demand multipath routing algorithms. When traffic increased, MT-MAODV and MP-MAODV preferably ensure the network performance and improve protocol's robustness. In MAODV, employing single path on-demand routing protocol, a route failure means that a new path discovery process needs to be initiated to find a new route. This results in a route discovery delay. The delay is minimized MP-MAODV and MT-MAODV because backup routes are identified during route discovery. MP-MAODV routing has resulted in 1% to 7% more PDR than MT-MAODV and 6% to 35% more than MAODV routing.

MP-MAODV has been extended as Power Aware MP-MAODV to provide cross-layer design between physical and network layers to monitor
received signal strength and residual battery capacity, to exploit them in routing decisions. The performance of the Power Aware Multi Path Multicast Adhoc On Demand Distance Vector (PAMPMAODV) has been compared with MP-MAODV and MAODV. The PAMPMAODV has produced 1% to 28% increase in PDR, 1% to 53% reduction Latency than MP-MAODV and MAODV.

The performance of PAMPMAODV algorithm has been analyzed under different test cases based on the network type – dense or sparse; mobility type, file types with varying size - unformatted text, formatted text, audio file and video file and different packet sent intervals-like 100msec, 200msec, 300msec, 400msec, 500msec and 1000msec respectively. For larger files, packet loss has been found to be more due to congestion at receiving end, even when the nodes are not mobile. For larger files, in a denser network, the packet delivery ratio is gradually increased from 71% to 100% for the different packet sent intervals. The packet delivery ratio reached to 100% when the packets are sent at 1000msec interval. In a sparse network, the packet delivery ratio is found to increase from 44% to 87% for the different packet sent intervals. The packet loss is minimized when they are sent at 500msec and 1000msec intervals. The congestion has been identified and handled by the receiver node to reduce the packet losses. The congestion detection scheme has resulted in the packet delivery ratio of 62% to 100% for the sparse network and 81% to 100% for the denser network.

The researcher has established and analysed the VCR based on MANET using various routing techniques. Based on the results obtained, the Power Aware Congestion Control Multipath Multicast Protocol is found to be more suitable for this proposed application.