MANET-based outdoor collaborative learning

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Abstract— **Traditional teaching methods fall behind in many factors such as collaborative learning creativity etc. In this paper we analyze the benefits of collaborative learning. Furthermore we analyze an educational trip to an archaeological site, and propose a new approach to these outdoor activities, using collaborative learning. For the implementation of our scenario we use Mobile Ad Hoc Networks technology. We simulate our proposal in order to see if MANET is suitable to our scenario.**

Index Terms—**Collaborative Education, Collaborative Learning, Mobile Learning, , Multicasting, MANET, Mobile Ad Hoc Networks**

I. INTRODUCTION

There has always been a question about traditional teaching methods and their efficiency in the 21th century. Typical teacher centered or lecture-centered milieu in college classrooms seems to be the standard educational method.

This model was first implemented when means for other more advanced modes of teaching were not available. These traditional teaching methods fall behind on factors such as collaboration, creativity, responsibility, trustworthiness, dependability etc. On the other hand, computer technology is gaining wide acceptance in education. As students have great familiarity with electronic devices such as personal computers, handheld devices, PDAs (Personal Digital Assistants), mobile phones, new innovative teaching methods have been proposed, which would reduce traditional teaching methods' drawbacks. The integration of mobile devices, wireless communication and network technologies in campus environment may provide further opportunities to teachers and students [1]. Mobile computing can potentially enable students to share information, coordinate their tasks and more broadly, function effectively in collaborative settings [2].

Collaborative learning seems to be a new educational approach where students have an active role in the learning activity. Involvement, cooperation and team works are the most crucial benefits from the use of collaboration in the educational system. Cooperative learning is a form of collaborative learning and is defined as "the instructional use of small groups so that student's work together to maximize their own and each other's learning" [3].Cooperative learning is based on the social interdependence theories of Kurt Lewin and Morton Deutsch.

Successful projects in this direction include the Class Talk project for improving classroom feedback [4], and the MUSEX [5] system for using games as educational tools. Optical readers, handheld devices and an annotation tool support the exchange and discovery of key ideas among students [6].

In another project [7], each child is given a wirelessly (WiFi) interconnected Pocket PC. The network layer uses the TCP/IP and UDP protocols working over a wireless WiFi network (IEEE 802.11b). The network is configured in peer-to-peer (P2P) mode (ad hoc network) and has no access either to the Internet or a local network. It supports asynchronous message sending and allows synchronous conversation to be held between machines in the form of successive messages. The network also permits the transmission of files.

In the WiTEC [8], a teacher can implement teaching activities supported by an e-whiteboard, and each student can use a mobile learning device to learn individually or interact with other classmates and teachers. It helps the teacher to monitor, easily, each student's learning status for further guidance, engages students in learning activities, facilitates students' group collaboration and empowers the teacher and students to apply technologies to a variety of traditional and innovative learning and teaching activities seamlessly.

Porta-bile project [9] focuses on the technological aspects of mobile learning, and on their integration with e-Learning systems, and more generally, with the information systems of the academic institutions. In the Palm Education Pioneers (PEP) project [10], students use probes to collect and analyze data in real time and compare it instantaneously with data from different locations—often by shouting out their readings to others.

Results from collaborative learning projects showed the benefits that the students took ,working in groups, together in a common goal. Students with handhelds achieve better access to information, increased engagement in learning-related activities in diverse physical locations, enhanced communication among themselves, and support for group work on projects [11][12]

Students at four different Michigan schools most often use portable devices as tools to aid in research, alternatives to paper-based tasks, group collaboration activities [13] . Handhelds support collaborative activities and increase student-to student interaction. Students are able to divide group projects and then beam their individual work to their classmates, allowing the entire group to benefit from individual students' expertise.

Students spend more time in working on an education activity that integrates handhelds than a traditional one [14].

However, collaborative mobile learning has not been investigated by previous research. In this paper, we propose a new novel educational model which can give the opportunity for out-of-class activities. We propose using mobile ad hoc networks (MANETs) to support the communication and collaboration among students and teachers during outdoor educational trips to places such as wilderness, national parks, archaeological sites, etc. All of the projects that were described above have a serious drawback. In order to work they need a pre-installed infrastructure. A true mobile system will be the one that can be easily deployed in any place. This is the main advantage of using MANETs. There is no need for pre-installed infrastructure. Every person becomes a mobile node and a router in the network. This means that we can easily deploy a new MANET everywhere. Then, we propose the use of multicasting for efficient collaboration among the teacher and the students of a class. In order to investigate the applicability and feasibility of the proposed method, we investigate via simulation the reliability and the delay of the collaboration activities. We simulate the collaboration activities among the teacher and the students during an archaeological site visit. We find out that the achieved reliability and delay of the collaboration are acceptable for efficient collaborative learning.

II. Archeological site scenario

Using wireless technology in museums is not a pioneer idea. The Electronic Guidebook research project began in 1998 at The Exploratorium, in partnership with researchers at Hewlett-Packard Labs and The Concord Consortium. [15].This project aims are to understand how the introduction of wireless Technologies changes and augments user experiences at the Exploratorium, an interactive science museum.[16]Visitors are given a handheld device , and after a 15 minute of training from Explainers (high school students , volunteers etc) the visitor could see the exhibits , find particular online resources , even see information about the exhibit as they come close to it. A lot of the in formations are using sound, so headsets are important .As this use of technology seems to offer great advantages in addition to a classical visit to a museum, isolation phenomenon was observed to most of the users. There were no interaction with other visitors and the use of headset makes the handheld device the primary exhibit. No collaboration was succeeded in any point. Our scenario except from the structure in depended networking, promote the collaboration between the students, making wireless technology the mean for an alternative education.

Another project that seems to use the collaboration learning in a museum visit is the Mystery of the Museum [17]. In this project kids learn the exhibits by playing group games. Main disadvantage of this project is that the games that students play are created from the museum administrators, and not from the teachers that escort the students. This means that students can find the games boring and stop playing. Even more class interests could different from the exhibits that the game shows. Furthermore, class may want to take electronic notes, videos or sound examples etc, but they cannot because the handheld equipment belongs to the museum. Answer to all the above is the use of MANET where devices belong to the collaboration teams and teachers could prepare the visit by the needs of the class. This is the first time, as we know, that MANET is used for educational visits.

Analytically our scenario is implemented by a high school class, which schedules a visit to an archaeological site. In a common educational visit, student can only see the exhibitions and listen what the teacher or the guide is saying. There is no participation from the students in the learning process. Moreover, students probably will get bored and try to leave the area, making the visit less productive and minimizing the knowledge that should be won from the visit. In addition, using multimedia in the educational activities supports the knowledge building. Even if a student shows great interest about the exhibitions, the small friction with this knowledge will make it easy for the kid to forget them. Our proposal seems to be a very good solution to all the above. Using MANETs the students have the opportunity to use multimedia applications, access databases, play online games for understanding better the knowledge, etc. Analytically, we propose a flexible network with the use of very common devices as laptops, PDAs, smart phones, and any device with a wireless connectivity. Students and teachers can easily communicate to each other. The teacher can send multimedia packets to students describing th

e exhibitions. The students can easily access a remote database for finding more information about the exhibitions, and take a quiz game at the end of the visit so they can indulge with the knowledge they gain. In this paper we will try to find out if MANET can deploy an efficient network in order to use it in an archaeological visit. We didn't concentrate in creating new software or a new GUI. After ensuring reliability in our network and understanding the factors that have a bad influence in our network (traffic speed etc), then a future work could be the development of a software especially for archaeological visits or out-door visits. In our experiments we used the NS-2 simulator with the implementation of the monarch project [18], an open-source software.

There are many papers about the accuracy of NS-2[19] .The main drawback about using simulations is that you don't get back any feedback from any user.

III. MANET

To establish the network connection we have to use wireless connectivity. We propose MANETs because these networks do not need fixed infrastructure and can be deployed in every place. Even if an archaeological site has an installed wireless infrastructure, so simple Wi-Fi networks can be implemented, we are not sure if all possible outdoor sites provide this infrastructure. Moreover, we propose multicast MANETs because multicast between the teacher and the students or between the students that belong into the same group will reduce the network traffic. In MANETs every node acts as a sender, as a receiver, and as a router. Because the network topology changes rapidly, clever algorithms have to find always the best routes. In our experiments, we simulate an efficient multicast algorithm for various parameters such as traffic per student, speed of a student, etc. We are interested in discovering whether MANETs can support efficient collaborative mobile learning.

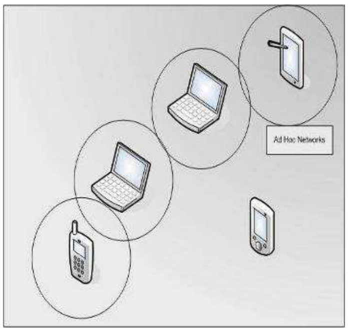

Figure 1. Ad Hoc networks

IV. SIMULATION

This scenario is related to visiting an archaeological site. For example, the second grade of a high school is visiting an archaeological site. Three classes have entered for this visit. Every class has a responsible teacher and twenty students. So, there are 3 groups. Every group includes 1 teacher and 20 students. All the students and the teachers are moving randomly.

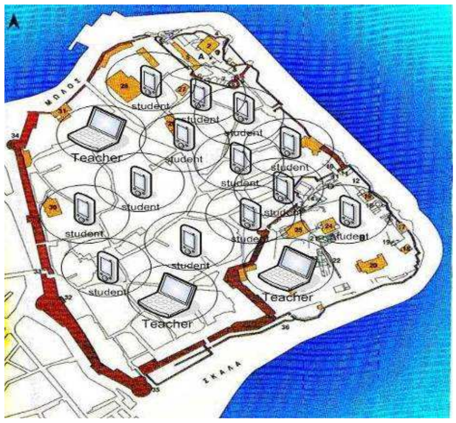

Figure2 . Manet in an archaeological site

We examine two different speeds, as speed factor plays important role in MANET.

- 1m/sec which is the average speed of a walking person
- 10m/sec which is the average speed of a slow vehicle

Every class, which represents a multicast group, is accepting multicast packets only by the responsible teacher. This means that there are one sender and twenty receivers. The teacher sends video streaming packets to the students resembling the exhibits they see. Using multimedia applications they load the network with increased traffic (packets per second). This ascertainment leads us to the conclusion that in this experiment traffic is the most challenging factor.

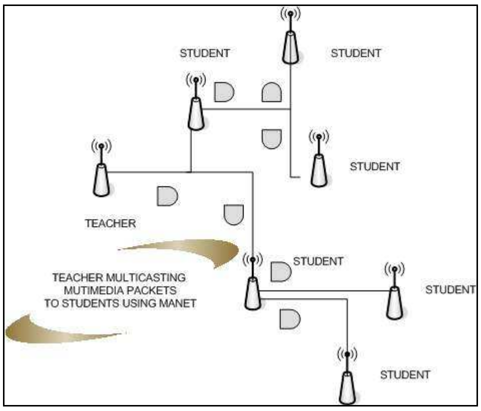

Figure3. Multicasting packets

Except from video streaming packets, this network may occasionally transmit voice, or exchange information from databases in order to play an educational game. In these experiments we use the ODMRP multicasting protocol [20], one of the most efficient protocols in very heavy traffic MANETs.[21] , [22]. The packet size is either 256 Bytes or 512 Bytes. We alter the packet size, and observe how this influences the network. Our purpose is to try to simulate this scenario altering all the crucial factors (speed, traffic, packet size), so our conclusions can be used as a reference in most cases for an out-of-class activity.

We investigate the feasibility of collaborative learning over MANETs using multicasting. We are interesting in exploring the reliability and delay of exchanging information among the teacher and the students. During the simulation, we measure two parameters:

i the PDR (Packet Delivery Ratio), and
ii) the Latency.

- PDR is the percentage from the send messages that was actually delivered. It represents how much reliable the communication is.
- Latency is the average time that a packet takes to traverse the network. It is the amount of time between sending a packet from the originating node and receiving it at its destination node. This factor is very crucial in video streaming applications. If the delay is too high then the quality of video or audio transmission would be low.

TABLE 1. SIMULATION PARAMETERS FOR THE ARCHAEOLOGICAL SITE SCENARIO

Parameter	Value
Nodes	60
Groups	3
Nodes /group	20
Senders	1
Movement	random
Bit rate	10KBytes/sec, or 20KBytes/sec, or 50KBytes/sec
Area	1200m * 400m
Speed	1m/sec or 5m/sec or 10m/sec
Simulation time	180sec
Packet size	256Bytes or 512 Bytes
Protocol	ODMRP

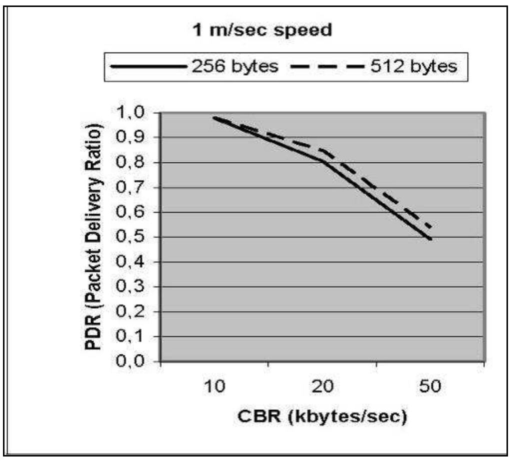

Figure 4. PDR versus traffic with speed 1m/sec and different packet sizes

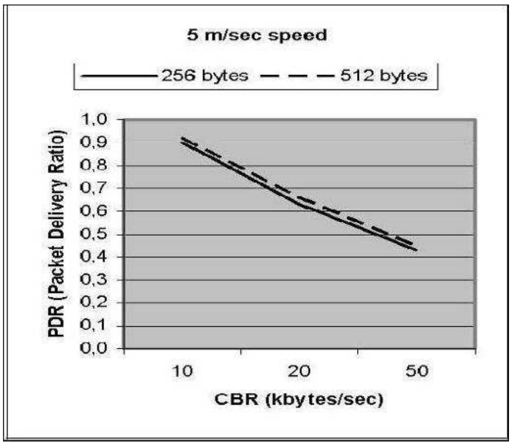

Figure 5. PDR versus traffic with speed 5m/sec and different packet sizes

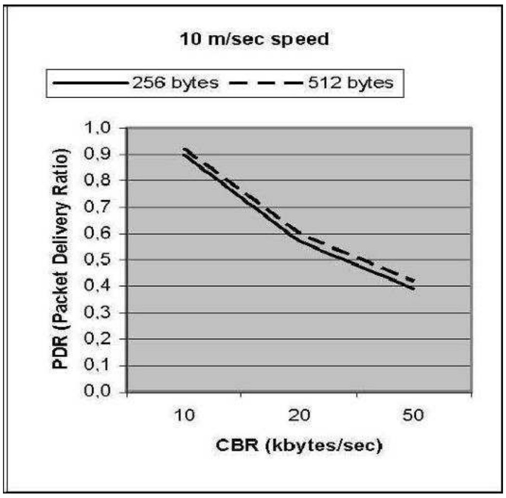

Figure 6. PDR versus traffic with speed 10m/sec and different packet sizes

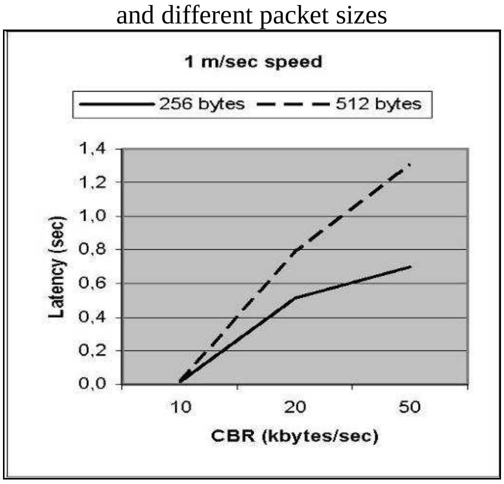

Figure7. Latency versus traffic with speed 1m/sec and different packet

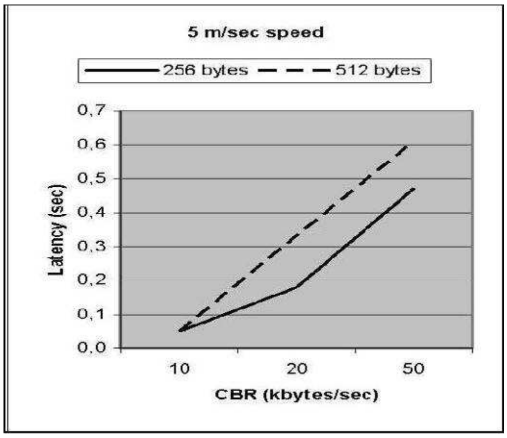

Figure 8. Latency versus traffic with speed 5m/sec and different packet sizes

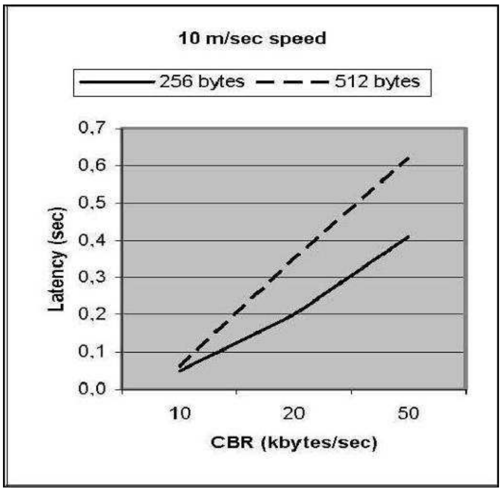

Figure 9. Latency versus traffic with speed 10m/sec and different packet sizes

V.DISCUSSION OF RESULTS AND CONCLUSIONS

After analyzing extensive the simulation results we conclude:

A. Reliability of the network (PDR)

- As traffic increase, PDR values fall. These results are logical because increasing the traffic, collisions and packet drops increase too. In most experiments, traffic of 50kbytes/sec produce an unstable network, 20 Kbytes/sec produce reliable network only when speed is low, and 10kbytes/sec produce always a reliable network.
- Both packet sizes show very similar results, with 512 bytes packet size slightly better. (4% better PDR values) This can easily be explained because double sizing the packet size will need half of the packets to be transmitted for

succeeding the same CBR values. Fewer packets mean better PDR values.

- Speed factor influence negative the network especially when traffic increase too. Higher speed means that network topology changes more often, causing more packets to drop.

TABLE 2 . INFLUENCE OF THE SPEED FACTOR TO PDR

Speed Increase	Influence in PDR (%)
From 1m/sec to 5m/sec	Average -10%
From 5m/sec to 10m/sec	Average -3.5%

The most crucial factor in our experiments was the traffic factor. Due to the existence of multimedia applications in our scenario, we used heavy traffic to our simulations.

B. Delay of the network (Latency)

- Using packet size 512bytes, latency increases. This can be easily explained by the thought that when a packet is dropped it is retransmitted. Bigger packets mean that the retransmission of these packets causes extra delay to the network.
- In all experiments with CBR 10kbytes/sec we have latency below 0,05 sec which is significant low After that point latency increase significant
- As the traffic increases, latency increases too. If more packets exist, more collisions and packet retransmit ions occur.
- Using 512 bytes packet size, latency increases to an average of 50%
- . Speed seems to influence in a positive way latency values, but not in a describable way.

In these experiments we used CBR (constant bit rate) traffic which means that the teacher and students exchange information continuously at the same rate (packets/sec). We use this kind of traffic in order to simulate the heaviest traffic case. In reality, the teacher and the students exchange VBR (variable bit rate) traffic, so the network traffic is usually less. Even if every person sends 50kbytes/sec (where communication seems to become unstable) this could happen just for a moment and not continuously. Moreover, the 50Kbytes/sec traffic is high even for multimedia applications. Compression algorithms reduce the traffic much below 50Kbytes/sec with no effect on the quality of the picture. We even used 11mbps wireless network for our experiments, in order to be compatible with all network technologies. Now day's wireless networks have a bandwidth of 55mbps which is 5 times bigger than our simulation network. Our purpose was to investigate if our proposal can be established in the hardest circumstances. Our conclusions are that our scenario can be implemented in most of the cases. Forasmuch as no other work has ever done in the field of Collaborative Mobile learning using MANET , there are no other results to compare. Since Mobile Collaborative learning is a pioneer promising teaching method, and MANET a new developing technology, we propose scientists from both fields to collaborate in order to design new teaching techniques using MANET.

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