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Game-based learning using MANETs

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Abstract: Game-based learning has been widely adopted for children's learning. By playing games, children may develop fantasy, curiosity, challenge and control. Moreover, game-based learning has been adopted by several universities and lifelong learning projects. Introducing game-based learning at outdoor educational activities would benefit learning. Mobile Ad Hoc Networks (MANETs) would be used to support collaborative learning at any outdoor environment without the need for preinstalled infrastructure. Simulations are run to measure important performance and reliability factors. The results certify that MANETs can support outdoor game-based learning.

Keywords: Game-based learning, outdoor learning, MANETs, multicasting, ODMRP

1. Introduction

Game-based Learning (CBL) is the use of computer games to enhance teaching and learning. Game-based Learning enables learners to perform tasks and have experiences which would otherwise be difficult due to cost, time, safety and other reasons. The earliest games have been used to support training and learning objectives [1]. Initially, games and simulations for educational purposes have been used for war-related situations. Nowadays, educational games are adopted by most educational systems, not only in early age classes, but also in universities. Simulations have been widely employed to support specific professional and vocational training needs (e.g. military, surgical, and medical and business training).

Outdoor activities help students to absorb in a better way their lessons. For example, history lessons are easily comprehensible with a visit to an archaeological site. In this paper, we propose a new educational model by combining game-based learning and outdoor activities. We propose the use of Mobile Ad Hoc Networks (MANETs) to support these outdoor game-based learning activities. MANETs are wireless networks without the need for pre-installed infrastructure. We investigate whether MANETs can support efficiently the communications among the mobile devices used in the game-based learning by the students and teachers.

2. Game-Based Learning

Several learning systems adopt the game-based learning concept. Myzel [2] is an on-line community game. The rules of this game are created by the player themselves, during its conduct. The Monkey Wrench Conspiracy [3] videogame tutorial puts players into the role of an intergalactic secret agent dispatched to deep space to rescue the Copernicus station from alien hijackers. It is a complete tutorial for a complex technical product, designed to teach industrial engineers how to use new 3-D design. The Environmental Detectives system [4] was developed by MIT (Massachusetts Institute of Technology) and Microsoft within the Games-to-Teach project. Various examples on game-based learning supported by new technologies are provided by Prensky [5]. A detailed survey on online game-based learning [6] is provided by the UniGame project. The Unigame project was funded by the Socrates programme 'Minerva' (ODL and ICT in Education) of the European Commission and promoted game-based learning with a focus on higher education and lifelong learning. The game initiates by the teacher, who has to define the ‘Game Theme’ that provides the students with the assignments and subjects to be discussed during the game. The students join in the game’s website to participate in the game. During the navigation in the website, the students are capable of communicating or searching for information about the particular theme. The playtime of the game varies, fluctuating from several days to few weeks, depending on the difficulty of the theme and the basic skills of the students.

Educational games for learning are computer game applications destined to engage students in educational experiences for achieving specific learning goals and outcomes. Several studies show the popularity of game playing among students. A recent Mori poll of teachers and learners in the UK found that 72% of teachers never play computer games in their leisure time, while 85% of the children did play computer games at least once every two weeks [7]. Despite not playing games at home, still 36% of primary school teachers and 27% of secondary school teachers are already using games in the classroom [7]. A poll undertaken for Pew Internet and American Life [8] found that 70% of US college students had played video, computer or online games at least once, while 65% were regular or occasional players. In the same survey, 20% of those polled saw games as a social activity, and as a way to make friends, while 60% used games to fill time when friends were not available. A study found positive results for developing visual selective attention by playing video games [9]. Most studies indicate that games can effectively support learning [7], [10], [11], [12].

Other approaches of using games to support learning in schools include the leisure game *Myst*, a successful fantasy game to support literacy amongst 9-11 year old children [13]. The teacher sits in the middle of the classroom with his laptop, projecting the game through an interactive whiteboard and walking his students through the first-person ‘landscapes’ of the game, whilst narrating and setting tasks for the students.

Supercharged! is a game for teaching high-level conceptual physics [14], [15]. The game allows learners to pilot a spaceship around a three dimensional environment by using the electric charge of the spaceship and charged particles within the space. Learners plan their trajectory through each level by tracing the field lines that come from the charged objects.

Savannah is a mobile game that introduces young learners to natural history concepts. Futurelab together with the BBC National History Unit designed this game. It aims to enable young children to role play the life of lions in the open savannah. The game allows for a connection to be made between the physical space of the savannah and the virtual hub connected via PDAs over a network connection. The project uses GPS systems to map out the physical space and information is relayed back to the central hub at base camp.

The *Racing Academy* game is a racing car physics simulation based upon advanced mathematical techniques. It has been developed by Lateral Visions with Futurelab to support learning communities in the field of engineering and science. The game has been used by GCSE students [16] and undergraduate mechanical engineering students [17].

3. Outdoor activities and Mobile Ad Hoc Networks (MANETs)

As students have great familiarity with electronic devices such as personal computers, handheld devices, PDAs (Personal Digital Assistants), mobile phones, new innovative teaching methods use them trying to reduce the drawbacks of the traditional teaching methods. Outdoor activities help teaching and learning to take place in more natural environments than in classrooms. For example, history classes would be more effective if they were taken place at archaeological or historical sites. Moreover, playing an educational game in a museum would help students to understand and absorb easier their lesson. Outdoor activities can be used in many other courses (e.g. agriculture, natural history, geology, geography, gymnastics). So, we promote the idea of combining outdoor activities and games that help learning. A major problem at various outdoor places is the lack of communication infrastructure. Mobiles devices would be used by the students and teachers in order to communicate among themselves.

However, they would visit only places where pre-installed networking infrastructure could support their communications. In our model, we propose the use of MANETs that do not need pre-installed infrastructure (either networking or power or other). MANETs can be deployed anywhere. So, they provide freedom to the teacher to decide where to realise the outdoor activity without thinking about pre-installed infrastructures.

4. Simulation

In MANETs every node acts as a sender, as a receiver, and as a router. During the outdoor activities, the students and the teachers may continuously move and communicate among themselves. So, the network topology may change rapidly. Thus, intelligent routing algorithms should continuously find the best routes.

In our model, we consider that most communications will be instructions, comments and lectures from the teacher to the students, or discussions among many people. So, we use multicast in order to reduce the traffic into the network. We employ the ODMRP protocol, a well discussed multicast protocol [18], [19], [20]. We simulate several cases of different traffic and number of participants (Table 1). We try to find out whether MANET can deploy a credible network.

Table 1: Simulation parameters

Protocol	ODMRP
Nodes/multicast team	5 or 10 or 15 or 20 or 25
Traffic (Kbytes/sec)	CBR (Constant Bit Rate) 1 or 2 or 4 or 8 or 10 Kbytes/sec
Simulation time	900 sec
Simulation area	500m * 500m
Speed	1m/sec
Network	802.11b

Multimedia applications 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. Wireless technology can give us up to 108 Mbits/sec (Wi-Max). In order to be complied to all past networks (802.11a , 802.11b , b02.11g etc) we simulate our network with 802.11b standard. If our results are satisfactory in 802.11b then we will have same and better results in all the other standards.

The students may move, communicate and be connected anywhere and anytime using wireless networks. The bandwidth requirements needed for audio communication range are 1 Kbyte/sec (telephone quality), 4 Kbytes/sec (AM quality), The bandwidth requirements for video communication range are 2 Kbytes/sec (videophone quality).

During the simulation, we measure two parameters: i) PDR (Packet Delivery Ratio), and ii) Latency.

PDR is the percentage of the packets delivered at the destination from those sent by the origin. 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.

In our experiments we used the NS-2 simulator with the implementation of the monarch project [21], an open-source software. Many papers validate the accuracy of NS-2 [22]. The main drawback about using simulations is that we do not get back any feedback from any user.

5. Simulation results

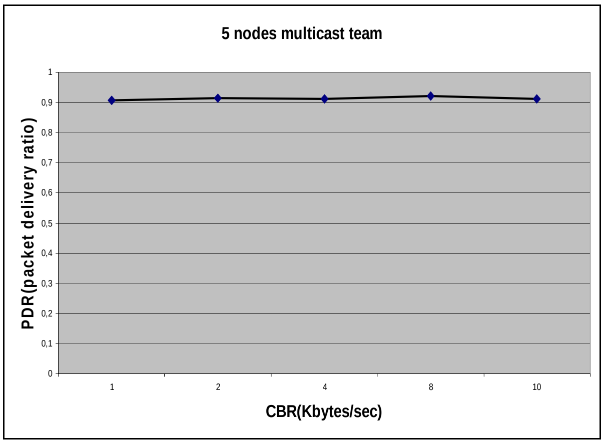

Figure 1: PDR versus traffic for 5 nodes multicast team

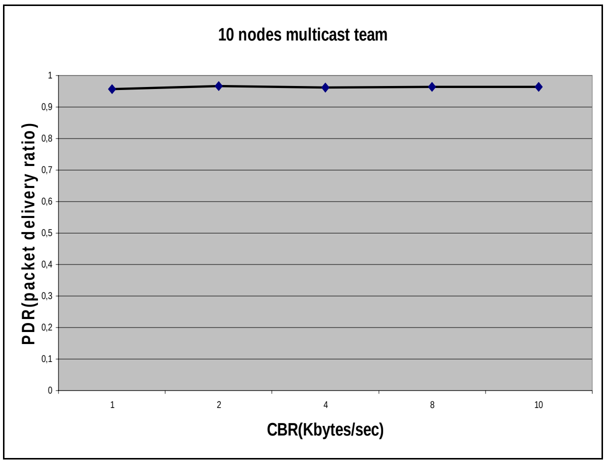

Figure 2: PDR versus traffic for 10 nodes multicast team

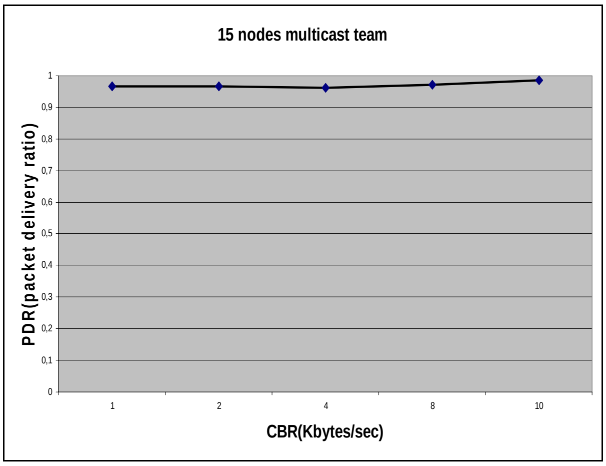

Figure 3: PDR versus traffic for 15 nodes multicast team

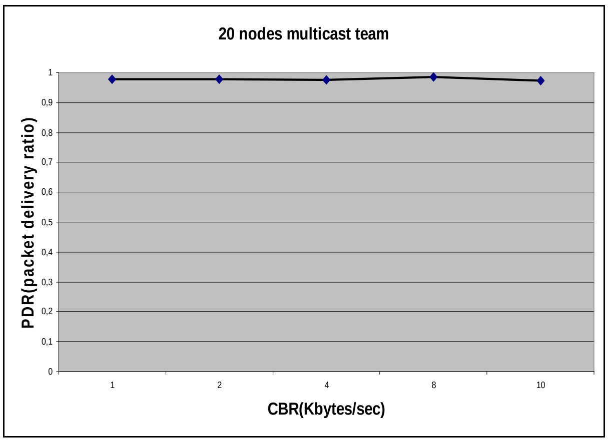

Figure 4: PDR versus traffic for 20 nodes multicast team

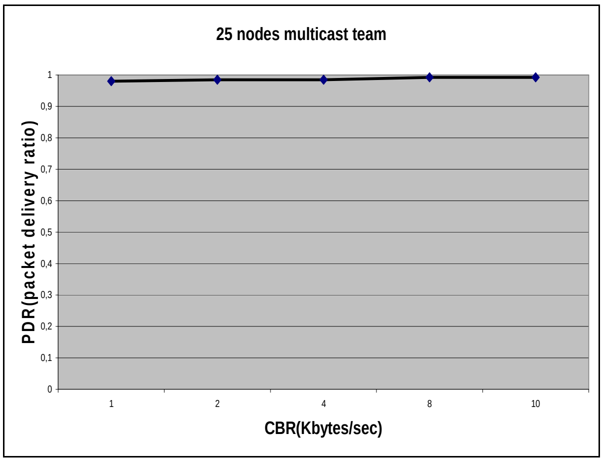

Figure 5: PDR versus traffic for 25 nodes multicast team

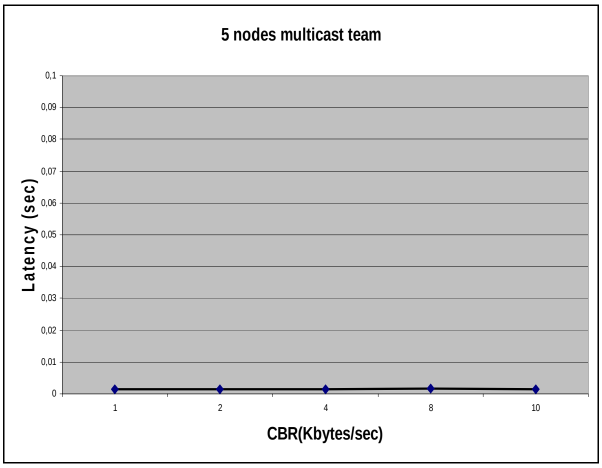

Figure 6: Latency versus traffic for 5 nodes multicast team

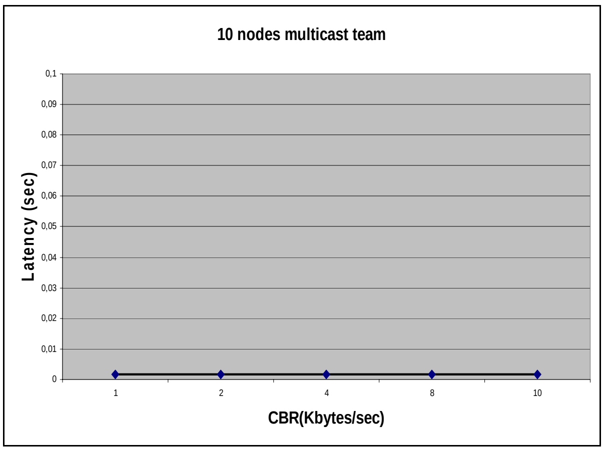

Figure 7: Latency versus traffic for 10 nodes multicast team

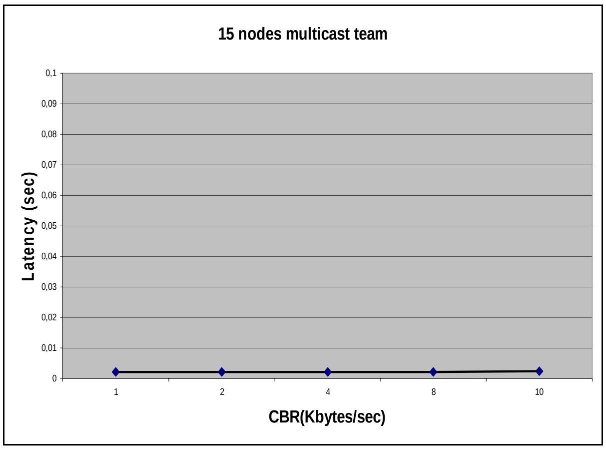

Figure 8: Latency versus traffic for 15 nodes multicast team

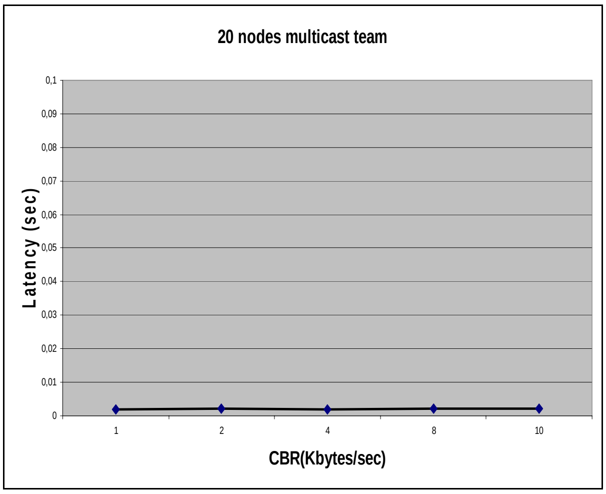

Figure 9: Latency versus traffic for 20 nodes multicast team

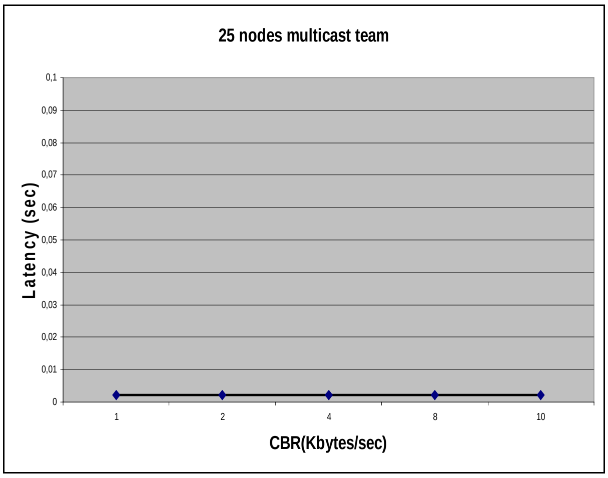

Figure 6: Latency versus traffic for 25 nodes multicast team

Figures 1 to 5 are related to PDR and describe the reliability of the network. No matter how many nodes represent a multicast team, the PDR values are very high. So, the reliability of the network is marginally affected from the traffic and the number of nodes per multicast team.

Figures 6 to 10 are related to the average delay in the network. Since most of the applications used in game-based learning are multimedia applications the latency of the network is a crucial factor. Again, the latency is very low. So, MANETs prove to be suitable for multimedia applications

6. Conclusions

First, we described several studies on game-based learning and the benefits that it provides to the students. We also discussed the usefulness of outdoor activities in the education. Then, we promoted the idea of combining the outdoor activities and game-based learning. In order to support the communications among students and teachers, we proposed the use of multicast MANETs. We run several simulations trying to see if MANETs can deploy efficiently the necessary communications among the participants. Observing the results we came to the following conclusions.

The PDR values in all experiments are very high (91% – 99%). So, our network is very reliable to all circumstances that were simulated.

The Latency values are extremely low (1msec – 2 msec). So, our network is capable of transmitting multimedia applications without any significant delay.

Concluding, MANETs can deploy a reliable network in order for game-based learning to be taken place at outdoor school activities.

References

[1] Coleman, J. Learning through games. In E. Avedon and B. Sutton-Smith (Eds). *The study of games*. New York and London. John Wiley, 1971, pp. 322-329.

[2] *Myzel: Online community game.* Institut für Gestaltungs und Wirkungsforschung Technische Univeristät Wien, 2002, http://www.myzel.org,

[3] Monkey Wrench Conspiracy. *The Monkey Wrench Conspiracy (how to get engineers to learn and to like it)*, 1999.

[4] MIT and Microsoft. *Environmental Detectives (by MIT and Microsoft)*, 2002, http://cms.mit.edu/games/education/Handheld/Intro.htm

[5] Prensky, M. *Digital Game-based Learning*. McGraw-Hill, 2001.

[6] Dondi, C. and Moretti, M. Survey on online game-based learning. "*UniGame: Social Skills and Knowledge Training*", Minerva project. Deliverable 1.1, 2003.

[7] Sandford, R., Ulicsak, M., Facer, K. and Rudd, T. Teaching with Games: Using commercial off the- shelf computer games in formal education. Bristol, Futurelab, 2006.

[8] Jones, S. Let the Games Begin: Gaming Technology and Entertainment Among College Students. *Pew Internet and American Life report*, 2003.

[9] Green, C.S. and Bavelier, D. Action video game modifies visual selective attention. *Nature*, 423 (6939), pp. 534-537, 2003.

[10] Francis, R. Revolution: Learning about history through situated role play in a virtual environment. *American Educational Research Association Conference*, San Francisco, 2006.

[11] Squire, K. From content to context: digital games as designed experiences. *Educational Researcher*, 2006.

[12] Freitas, D.E., Savill-Smith, C. and Attewell, J. Educational games and simulations: Case Studies from Adult Learning Practice. *Learning and Skills Research Centre*, London, 2006.

[13] www.timrylands.com.

[14] Barnett, M., Squire, K., Higgenbotham, T. and Grant, J. Electromagnetism Supercharged! *Proceedings of the 2004 International Conference of the Learning Sciences.* Los Angeles, UCAL Press, 2004.

[15] Jenkins, H., Squire, K. and Tan, P. You can't bring that game to school! Designing Supercharged*!* In B. Laurel (Ed.) *Design research.* Cambridge, Massachusetts. MIT Press, 2004.

[16] Sandford, R. and Williamson, B. Racing Academy: Learning Research Report. Bristol: Nesta Futurelab, 2004.

[17] Turner, J., Gavin, C. and Owen, M. Racing Academy. *Physics Education*, 39(5), 2004, pp. 429-433.

[18] Lee, S.-J., Gerla, M. and Chiang, C.-C. On-demand multicast routing protocol. *Proceedings of IEEE WCNC*, 1999, pp. 1298- 1302.

[19] Kunz, Th. and Cheng, Ed. Multicasting in Ad-Hoc Networks: Comparing MAODV and ODMRP, *Proceedings of the Workshop on Ad hoc Communications,* Bonn, Germany, September 2001.

[20] Vasiliou, A. and Economides, A.A. Evaluation of multicasting algorithms in MANETs, *Proceedings 3rd World Enformatika Conference (WEC'05)- International Conference on Telecommunications and Electronic Commerce (TEC 2005)*, 2005.

[21] The Rice University Monarch Project: http://monarch.cs.cmu.edu/

[22] Kunz, Th. "Reliable Multicasting in MANETs", *Contractor Report, Communications Research Centre*, Ottawa, Canada, July 2003.