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CPU Utilization for a Multiple Video Streaming Over a Fiber Optic ATM-Network when Varying the Quality of Service

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ABSTRACT

The Asynchronous Transfer Protocol (ATM) gives the broadband services users a high quality demands with a good opportunity to operate their networks. One important feature of the ATM-Network is the Quality of Service (QoS) attribute. In this paper, we are explaining the effect of varying the QoS on the CPU usage of a workstation. This effect can be studied by getting multiple video streaming flooding over a fiber optic ATM-Network for real time usage with the variation of the frame rates per second. The Q-factor and the Q-variable are used to measure the percentage of the idle processor. Measure of the lost PDUs with the variation of Q-factor and Q-variable has been calculated.

Keywords: *ATM-Network, QoS (Quality of Service), Q-factor, Q-variable, CPU utilization of ATM*

1. INTRODUCTION

The Asynchronous Transfer Protocol (ATM) is a high-speed network standard, which is designed for multimedia communications in order to increase their throughput [1].The ATM meets the needs of the Digital Network with Broadband Integrated Services [2]. In addition, the ATM network can handle high throughput in the traditional network and the real time network for multimedia file transfer. The ATM maps the three layers of the ISO-OSI model layers, which are the physical layer, the data link layer and the network layer as shown in figure 1.

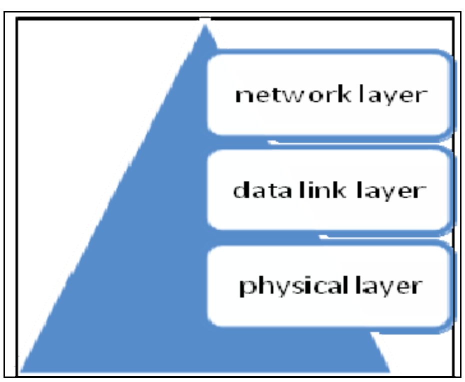

Fig 1: ATM Architecture layers

ATM has the capabilities of a packet switching and a circuit switching networking. It uses a time division multiplexing mechanism(asynchronous) with a fixed sized packets [3] ,which is different than the internet protocol and also different than the Ethernet protocol which are using a variable packet size.

The ATM uses a virtual circuit, where a fixed route is established between two end points whenever an ATM call has been created. All of the communications of the called cells (small fixed sized packets) are then following the same virtual circuit. ATM allows more than one virtual circuits between two end points. Among the features that an ATM provides is the so called Quality of service (QoS) in terms of traffic policing, traffic contract and traffic shaping [3].

Figure 2 shows an example of an ATM network.

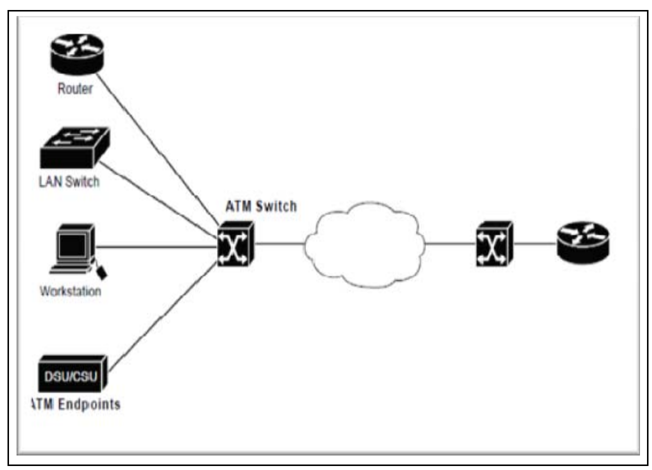

Fig 2: ATM network example

The ATM operates usually over fiber or twisted pair cables.

2. RELATED WORK

David Greave et al. [4] showed in their paper the ATM network usage for videos with the abilities of the ATM network to carry out the fixed bit rate communication channels. They showed as an example in their research how to transfer video to Home over the ATM network.

Nurul and co. [5], in their paper compared the ATM network with the Gigabit Ethernet Technology. They checked the Quality of Service features of these Networks with the results that the Gigabit Ethernet Network has a higher bandwidth, lower cost, less complex and easier to be integrated with existing Ethernet standards. They came to these conclusions after simulating the two networks based on the throughput, delay for voice, video conferencing and others.

Jiuhuai Lu and co [6], described the quality of service for the real time video delivery over the ATM-Networks. They looked for the video coding and the Network-Performance issues over ATM-Networks. They measured the cell losses and delays, the important issues for the end user of the video services with some estimates for the user's vision of the delivered video qualities. Finally they demonstrated in their work that the video quality-analysis approach could be used to get the performance-characteristics for the distribution quality of video coding-parameters over ATM-Networks.

3. THE NEED OF QUALITY OF SERVICE (QOS)

Video delivery needs to have a certain level of quality to be accepted by the end user of a network. This service level called as the quality of service (QoS).The Quality of Service is now a standard adopted for the networks to ensure the high quality networking performance for some critical network transmissions.

Technically seen that the network should have some criteria to be fulfilled, where some important things can have influence on the quality of the transmitted video like the delay of cell delivery, number of cells lost, errors in bits transmitted, which influences the quality of the transmitted video. For non-real time video transmission a bit-error rate of less than 10-5 could be accepted, which is for a real time video transmission not acceptable and causes problems in the quality of the received video.

The Asynchronous Transfer Mode (ATM) has the Quality of Service attributes delivered within its basic protocol. It doesn't need to be extra integrated into the service. The allocation of the network resources grantees and enforces the quality of service, where the allocation of the bandwidth is done at a very low level namely the hardware level. ATM has 5 categories for the quality of service, the Constant Bit Rate (CBR), the Variable Bit Rate (VBR), the Available Bit Rate (ABR), Unspecified Bit Rate (UBR) [7].

4. ATM NETWORK STRUCTURE

Different networks hardware components have been used in the ATM network structure that we have proposed for our experiment. These components as shown in figure 3 below.

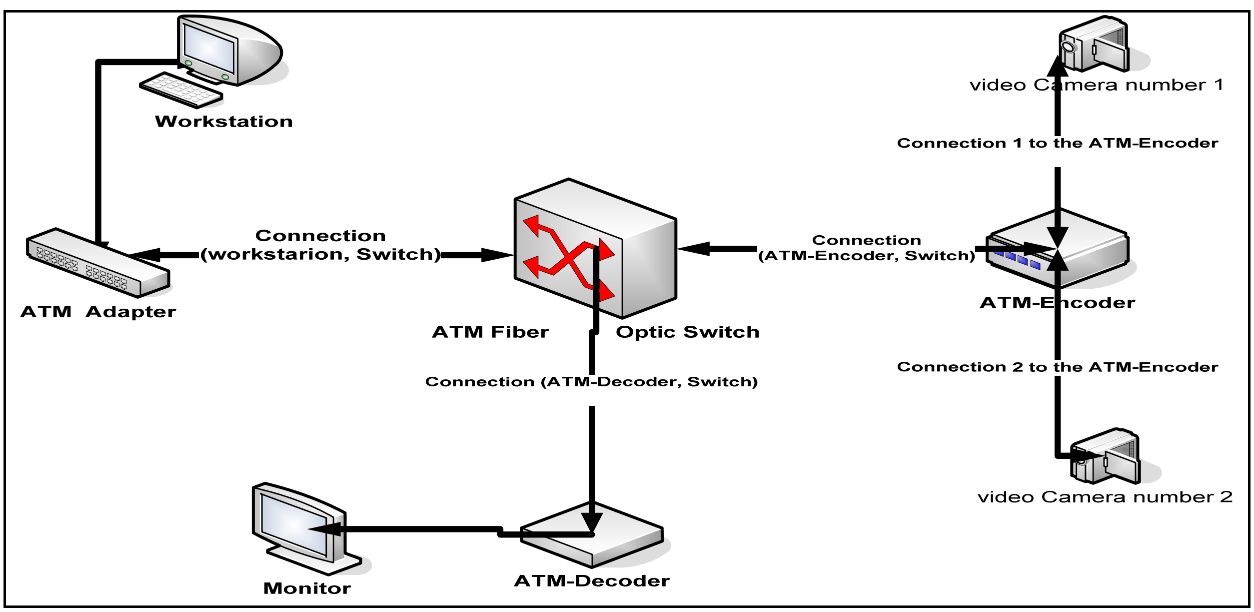

Fig 3: Experiment ATM Network

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The following is a brief description of the different network components:

- The ATM fiber optic switch that is used to link the ATM network.
- Tow cameras distributed on a certain distain to load the network with video streaming.
- ATM Encoder that convert the electrical signal of the cameras to optical signals in order to send it to the ATM monitor via the fiber switch.
- Monitor system is used to display the video streaming received from the cameras after decode the optical signal to electronic signal in the ATM decoder.
- And a Sun workstation that is connected to the ATM network through ATM SBUS Adapter to receive the video of the two cameras.

5. EXPERIMENT RESULTS AND DISCUSSIONS

Figure 4 shows the working model for the experiment that has been built, where an interlacing mechanism is used to combine the two video streams, a conversion into a fiber optic signal is then done. A transmission over an ATM switch is followed. At the receiver side a decoding process is done, and then a selection of the choice video is followed. Finally after that the selected the video is displayed.

A device used in wavelength-division multiplexing systems for multiplexing and routing different channels of light into or out of a single mode fiber (SMF).

The control of quality of service attributes is followed at different stages of the model, namely at fiber optic multiplexing level, at ATM switch level, at Fiber optic De-multiplexing level and at the receiver selection level.

5.1 Supposed Model

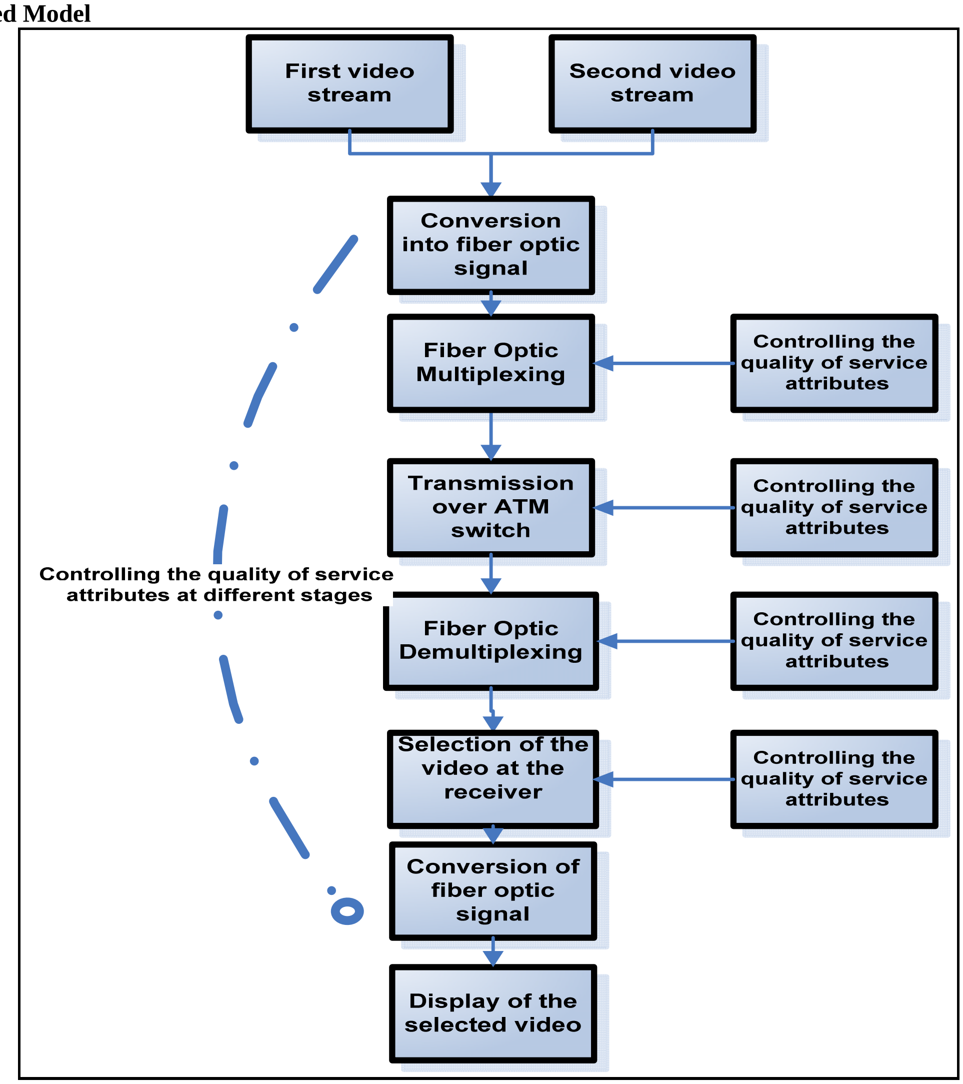

Fig 4: experiment's model

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5.2 Running the Experiment

In this part we are presenting the load tables of the workstation's processor. The variation of frame rate and the Q-factor (Quality factor) parameters or the Q-variables (Quality variables) are taken and then the mean of the unused processor performance (the processor idle state) and the lost PDUs (Protocol Data Unit) are measured.

The following table gives the results when we have the video cameras connected to the ATM network and the Real Time Display program is displaying the video stream on the workstation (table 1).

Table 1: result of the CPU usage and lost PDUs for different Q-factors with different fame rates

Frame rate(frame/s)	**1**	**2**	**5**	**12.5**	**25**	
Q-factor	**idle%**	**idle%**	**idle%**	**idle%**	**idle%**	**lost PDU**
20[High Quality]	90	81	61	12	0	14
32	90	81	61	12	0	13
64	90	81	61	16	0	7
128	90	81	62	16.5	0	10
200	90	82	62	17	0	10
156	90	82	62	16.5	0	16
512	90	82	62	17	0	7
1024[Low Quality]	90	82	62	17	0	5

Table 2: result of the CPU usage and lost PDUs for different Q-variables with different fame rates

Frame rate(frame/s)	**1**	**2**	**5**	**12.5**	**25**	
Q-variable	**idle%**	**idle%**	**idle%**	**idle%**	**idle%**	**lost PDU**
[1-4][low Quality]	90	82	62	17	0	6
[5-9]	90	82	62	17	0	9
[10-14]	90	82	62	17	0	7
[15-19]	90	82	62	16	0	12
[20-24]	90	82	62	17	0	11
[25-29]	90	82	62	15	0	9
[30-34]	90	81	62	13	0	12
[35-40][High Quality]	90	81	62	12	0	14

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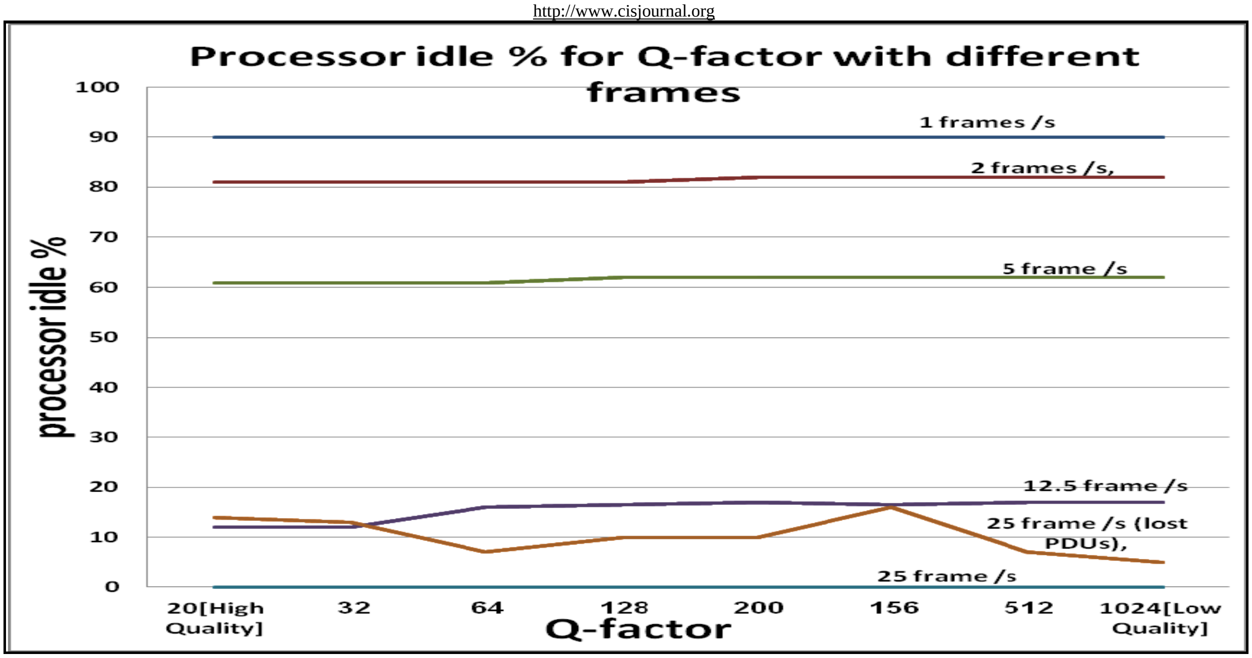

Fig 4: result of the CPU usage and lost PDUs for different Q-factors with different fame rates.

As we can see from figure 4 that if we use the frame rate of 1 frame per second then the processor idle percentage is by 90% and is unchanged with the variation of the Q-factor from 20 (high quality) up to 1024(low quality). For the frame rate of 2 frames per second the processor idle percentage is about 80% and is unchanged with the variation of the Q-factor from 20 (high quality) up to 128, but it increases with minimal values after that up to 1024(low quality). For the frame rate of 5 frames per second the processor idle percentage is about 60% and is unchanged with the variation of the Q-factor from 20 (high quality) up to 64, but it increases with minimal values after that up to 1024(low quality). For the frame rate of 12.5 frames per second the processor idle percentage is about 15% with some variations about this value with the variation of the Q-factor from 20 (high quality) up to 1024(low quality). For the frame rate of 25 frames per second the processor idle percentage is about 0% and is unchanged with the variation of the Q-factor from 20 (high quality) up to 1024(low quality). The lost PDU's is 14 for the Q-factor 20(high quality) which the decreases linearly to 5 lost PDU's for the Q-factor 1024(low quality).

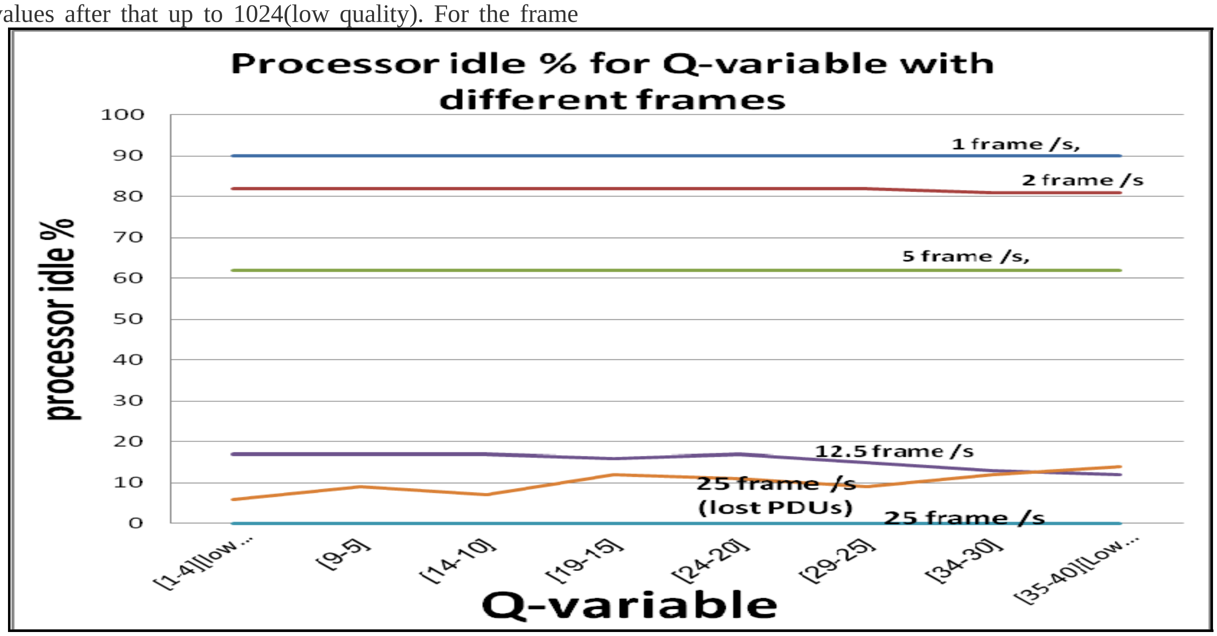

Fig 5: result of the CPU usage and lost PDUs for different Q-factors with different fame rates.

From figure 5 we can see that if we use the frame rate of 1 frame per second then the processor idle percentage is by 90% and is unchanged with the variation of the Q-variable for the range of [1-4] (low quality) up to the range [35-40](high quality). For the frame rate of 2 frames per second the processor idle percentage is about 82% and is unchanged with the variation of the Q-variable for the range of [1-4] (low quality) up to the range [35-40](high quality). For the frame rate of 5 frames per second the processor idle percentage is about 62% and is unchanged with the variation of the Q-variable for the range of [1-4] (low quality) up to the range [35-40](high quality). For the frame rate of 12.5 frames per second the processor idle percentage is about 17% and is unchanged with the variation of the Q-variable for the range of [1-4] (low quality) up to the range [20-24], but it is decreasing to 12% for the Q-variable [35-40] . For the frame rate of 25 frames per second the processor idle percentage is 0% and is unchanged with the variation of the Q-variable for the range of [1-4] (low quality) up to the range [35-40](high quality). The lost PDU's is 6 for the Q-variable for the range of [1-4] (low quality) and increases linearly to 14 for the range [35-40](high quality).

6. CONCLUSION AND FUTURE WORK

In this paper we described how multiple video streaming over an ATM-Network for real time usage with the variation of the frame rates per second, the Q-factor and the Q-variable to measure the percentage the processor is idle. As first result of this work we can see that the percentage the processor idle is dramatically decreasing when we increase the frame rate for the variation of both the Q-factor and the Q-variable. Second, we can see that percentage the processor idle mostly remains unchanged with the variation of the Q-factor or the Q-variable. The lost PDUs increase when the Q-factor moves from low quality into high quality. The lost PDUs increase also when the Q-variable moves from low quality into high quality but still within tolerated ranges.

For future work the ATM-Network should be extended to include more real time traffic on it and to see what happens with quality measurement values and the traffic conjunction issues.

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