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Delay Tolerant Spatial Distribution of Content Replication in Wireless Networks for Efficient Video Streaming

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Abstract: The growth of information technology has introduced various functionalities and services to support video streaming like video streaming and live streaming. There are many approaches has been discussed to support content delivery in wireless networks, but suffers with the problem of latency and quality of streaming which takes more time and the frequency of retransmission is high. To solve these problems, we propose a delay tolerant approach with spatial distribution of video contents to support efficient video streaming. The proposed method maintains numbere of replicas of video content in different locations of wireless networks. The method selects the location of the video content or the node which has the requested data according to the delay present in the network and the user location. Also the number of replicas maintained is performed according to the spatial request factor which represents the number of request being received from different user from a specific spatial region and the delay present in the network towards a video content. The proposed method reduces the overall latency present in the network and increases the efficiency of content delivery which supports multimedia data transfer. Also the proposed method reduces the overall time complexity and reduces the overhead introduced by data transfer.

Key words: Replication · Spatial Distribution · Video Streaming · Wireless Networks

INTRODUCTION

Wireless networks is the collection of wireless nodes where the nodes of wireless network can be classified according to the service provided or the data it posses. Some of them has data nodes which stores various information which can be accessed by the other nodes of the network. Some of them provides set of wireless services which can be accessed by the other nodes of the network. The wireless network has no fixed topology and can be of any form. The application of wireless networks has no limit and can be applied for video streaming.

Video streaming is the process of transferring video content to the client who requested the video. The video is nothing but a collection of scenes where each scene has number of frames or snapshots. Each frame has fixed size according to the quality of the video and each video sccene has number of frames according to the video quality. Because of the wireless nodes and their mobility of nodes, accessing video files from geographically longer distance introduce more traffic in the network and increases latency in the network which reduces the quality of service of the network.

To avoid streaming data from longer routes, there are options where the data files are stored in distributed manner. The files are stored geographically distributed which helps uses to fetch the requested files from the nearby nodes. What happens when distributing the data files in more nodes where there is no necessary, it reduces the resource utilization of the wireless nodes, because the wireless nodes are limited with the storage and cannot store more amount of data. In order to increase the resource utilization, the data files has to be stored in optimal manner and the selection of the nodes has to performed in efficient manner.

Replica are the copy of data file which is placed in various locations of the network according to various requirements and other factors. Generally the replicas are

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placed in the network to reduce the overload in server side where there are numerous request being received and to reduce the traffic at that point the replica of the service being generated in different nodes of the network. In our case the problem is video streaming and the video file has to be replicated according to different conditions of the network. How this is going to be achieved is the challenge here and we discuss and propose a novel approach to achieve the quality of service of the network and increase the resource utilization of the overall network.

Related Works: There are many approaches has been discussed for the development of quality of service of the wireless networks and increase the quality of video streaming. We discuss few of them here in this paper in detail in this section.

A combined approach for Qos Guaranteed and low power video decoding [1], proposes a power management technique for video playback in mobile multimedia devices, which combines low-power video decoding and QoS-guaranteed algorithms: ILI (Interval-based Linear Interpolation) and QLB (QoS-guaranteed and Low-power Buffering). First, the proposed ILI algorithm precisely estimates the decoding time of video frames through interval-based linear interpolation. Second, the QLB algorithm has two modes of operation and dynamically switches between the modes based on feedback of decoding statistics of recent frames. The combinations ILI and QLB algorithms allow the CPU voltage and clock frequency to be adjusted to the optimal setting.

Delay controlled wireless video playout system [2-5], propose a new adaptive media playout (AMP) system that makes the most effective use of a packet-delay prediction algorithm. Here, as the prediction method makes decisions based on the delay interdependency of the adjacent packets the differential auto-regression delay prediction model is used for working out the estimation. The proposed algorithm also adopts more refinement changing steps in the adjustment process and takes into accounts any packet losses with deadline constraint. The simulation results show that the proposed method outperforms the AMP-live method in reducing the average buffer delays as well as enhancing package loss rates for both overflow and underflow.

Joint energy-distortion aware algorithms for cooperative video streaming over LTE networks [6, 7], proposed approach,mobiles are grouped into collaborative clusters using a low-complexity clustering algorithm. In each cluster, collaboration is implemented by having a cluster head send the content to other cluster members using a short-range wireless communications technology. The cluster heads receive the data on the long-range LTE links, either via unicasting or multicasting. LTE scheduling is taken into account on the long range transmissions. Videos with single description coding(SDC), multiple description coding(MDC) and scalable video coding(SVC) are considered. Results show that the proposed approach leads to significant energy savings and enhanced QoS compared to the non-collaborative scenario. Furthermore, MDC is shown to outperform SDC in terms of QoS,at the cost of a slight increase in energy consumption. The same conclusions were reached with respect to SVC compared to single layer coding.

Cooperative power allocation for broadcast/ multicast services in cellular OFDM systems [8] Energy consumption is not considered explicitly, but is affected by the video distribution delay. Broadcast/multicast services in multi cell orthogonal frequency multiple access (OFDMA) systems are investigated. Sce- narios with and without BS collaboration are studied. BS collaboration consists of sending the video streams simul- taneously in a synchronized way over the same subchan- nels so that the signals can add-up constructively at the mobile terminals without leading to intercell interference.

Multiple description coding-based optimal resource allocation for OFDMA multicast service [9], weighted sum-rate maximization over OFDMA multicast systems with MDC is investigated. The problem is formulated as an optimization problem and solved using dual Lagrangian techniques. Users are assigned to multi- cast groups and a subset of the subchannels is dedicated to each multicast group.

The above discussed approaches has produced less quality video streaming with more latency and requires more frequency of retransmission. To solve this issue, we propose a noval approach to enhance the video streaming with less latency which will be discussed in the next section.

The above discussed approaches has various problem in performing video streaming.

- The approaches produced more latency in video streaming which is introduced by location selection.
- The methods maintains resource in different locations which are not optimal according to the network conditions and the requirement.
- The methods produces poor streaming quality by introducing breakages in streaming.

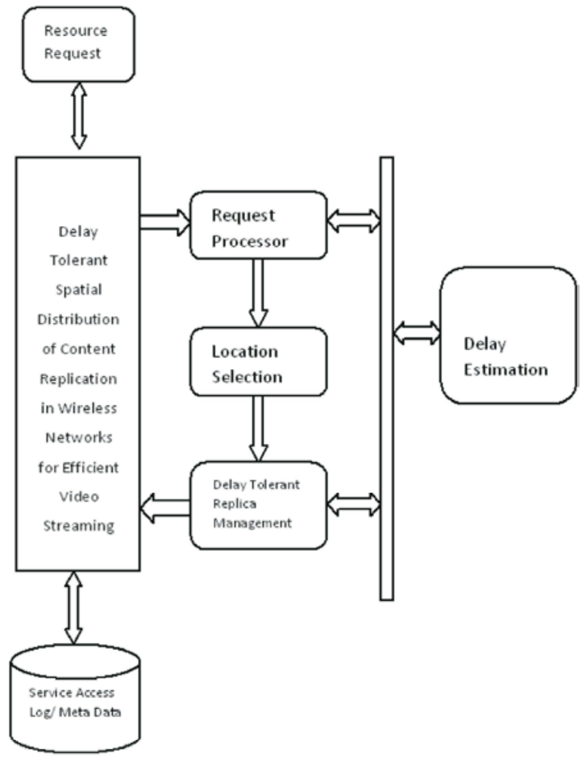


Fig. 1: Proposed System Architecture

With the above identified problems we are motivated to rise some efficient sophisticated approaches to perform video streaming. We are motivated to design a solution for video streaming which generates content replication according to the network conditions and the delay tolerant approaches. The method produces dynamic replicas according to the resource popularity.

Basic Model and Approaches

Delay Tolerant Spatial Distribution Based Content Replication: The delay tolerant spatial content distribution is performed according to the delay factor exists in streaming the content from different locations of the network. The method computes the delay factor for the requested resource from the available locations and the number of request being produced by different users for any of the resource available in the network. Based on the delay factor the location for the current request has been identified and selected to fulfil the request which redues the latency of the network. The approach is not upto this but generates the replication or the copy of the file being requested in different location according to the service rate and the delay factor, so that the latency could be reduced further and performance can be increased further.

There are various stages present in the proposed method and they are named as Delay Tolerant Replica Management, Location Selection, Request Processor. We discuss each of the functional component in detail in this section.

The Figure 1, shows the architecture of delay tolerant spatial distribution approach and it shows the functional components of the proposed method.

Request Processor: The request processor is the process of receiving the request from the client or the user and upon receiving such request the process is to select a service point from where the requested video has to be streamed. The method maintains various data files at different wireless nodes and maintains the details of those information. Whenever the request has been received by the service provider, it performs look up about the requested resource. From identified resource location, the method performs the location selection and replica management to choose a location fromm where the client should get the stream [10-13].

Algorithm

Input: User Request UR, Resource Data Rd.

Output:Stream Point Sp.

Step1: start

Step2: Identify set of locations where the resource available.

$$Rl = \sum_{i=1}^{size(Rd)} Rd(i).Loc \in UR.source$$

Step3: Perform Location Selection Loc.

Step4: Estabslish Connection and give it to user.

Step5: stop.

The above discussed algorithm idenitifies the set of locations where the requested resources are available and selects an optimal location according to the multi attribute data factor to fulfill the request.

Location Selection Approach: The location selection approach is performed based on various factors of the service orient architecture. The method identifies the number of request received per second and the number of locations where the requested resource is available, the number of hops the resource is away from the requested node and so on. Based on the above said factors, we compute the resource availability factor which represent the probability of service completion. If the resource availability factor is less than the threshold then and delay tolerant replica will be requested to generate a new replica of resource to service the user.

Algorithm

Input: Requested Resource Res, Service Records SR.

Output: Optimal Location OL.

Step1: start

Step2: for each resource Res_i compute time orient service arrival rate.

Tosar = $\sum_{i=1}^{size(RES)} \sum_{t=1}^{N} Res \in SR$

End

Step3: for each resource Res_i Number of hops

Noh = $\sum_{r=1}^{size(RES)} \sum Hops$

End

Step4: for each resource Res_i

Compute resource availability Rav = $\frac{Tosar \times Noh}{size(Res)}$

End

Step5: if Rav<RTh then

Perform Delay tolerant Replica Generation.

End

Step6: stop.

The above discussed alogirthm, computes the time orient service arrival rate for each of the service and for each source the method computes the number of hops present between the source and requester. Then the method computes the resource availability using the above computed measures and choose the location for servicing and if the resource availability value is greater than the threshold maintained then the process of replica generation is performed.

Delay Tolerant Replica Generation: The delay tolerant replica generation is performed based on various factors like the number of locations the service is available, the number of request rise from a region and the request demand and so on. Based on the above said factors and the location from where the user is requesting the service the method choose a location where the service has more demand and close to the requesting users. Finally a single location will be choose based on the above discussed factors and the copy of the resource will be deployed in the selected location to fulfill the user requirement.

Algorithm

Input: User Request UR, Service Log Sl.

Output: Optimal Location Ol and Replica R.

Step1: start

Step2: Identify the location where the resource is available

Rl = $\sum_{i=1}^{size(Rd)} \sum Rd(i).Loc \in UR.Resource$

Step3: for each location L from the RL

Compute number of request been received Nor = $\sum_{i=1}^{size(Rl)} \sum Req \in Sl$

End

Step4: compute resource demand rd = $Rl \times Nor$

Step5: if Rd > RTh then //RTh request threshold
Nh =Compute number of hops between the user and near by resource host.
Nsh=Compute number of service port near requesting host.
If Nsh< $\frac{1}{8}Nh$ Then
Ol =Choose a node with most dense request.
R=Create replica in the selected host.
End.
End
Step6: stop.

The delay tolerant replica generation algorithm identifies the set of locations L where the resource is available and for each of the location the method computes the number of request has been arrived. Using above computed values, the method computes resource demand and if the demand is greater than the resource threshold then choose a location according to the number of requesters present around any location. The replica generation is performed on selected location to improve the quality of service of the network.

RESULTS AND DISCUSSION

The proposed delay tolerant approach has been implemented and tested for its effectiveness and efficiency. The proposed method has produced efficient results in all the factors of quality of service in video streaming. Also the proposed method has produced efficient resource utilization and has produced less time complexity.

The Table 1, shows the details of simulation parameters being used to evaluate the efficiency of proposed method.

Table 1: Simulation Parameters

Parameter	Value
Simulation Area	1000X1000 meters
Number of nodes of network	500
Number of data location	75
Number of users	50

The Figure 2, shows the snapshot which details the network configuration being set to evaluate the proposed metod.

Figure 3, shows the list of request has been received and the target has been selected to perform the specific task. The Figure 3, shows the snapshot of request details which contains information about the request being received and target node selected to process the request by the resource manager.

The Figure 4 shows the snapshot of replica detail generated by the proposed method and it shows the details of replica being generated.

The Graph1 shows the resource utilization of different methods and it shows clearly that the proposed method has produced efficient utilization than others.

The Graph 2, shows the comparison of scheduling efficiency produced by different methods and it shows clearly that the proposed method has produced efficient scheduling than others.

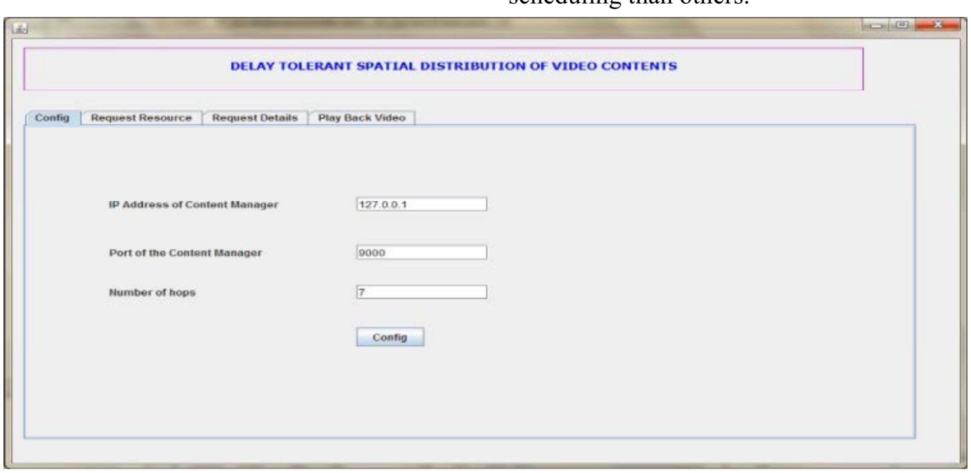


Fig. 2: Snapshot of details of configuration

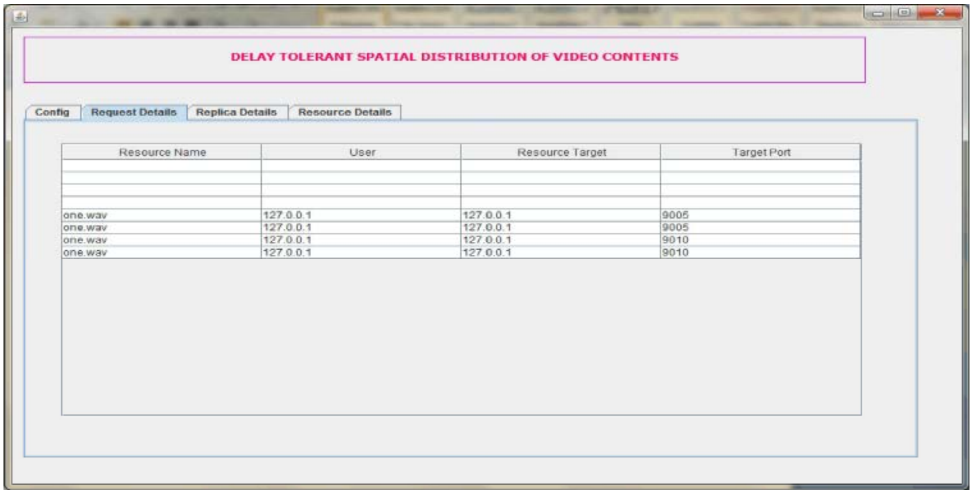


Fig. 3: Details of request received and target selected

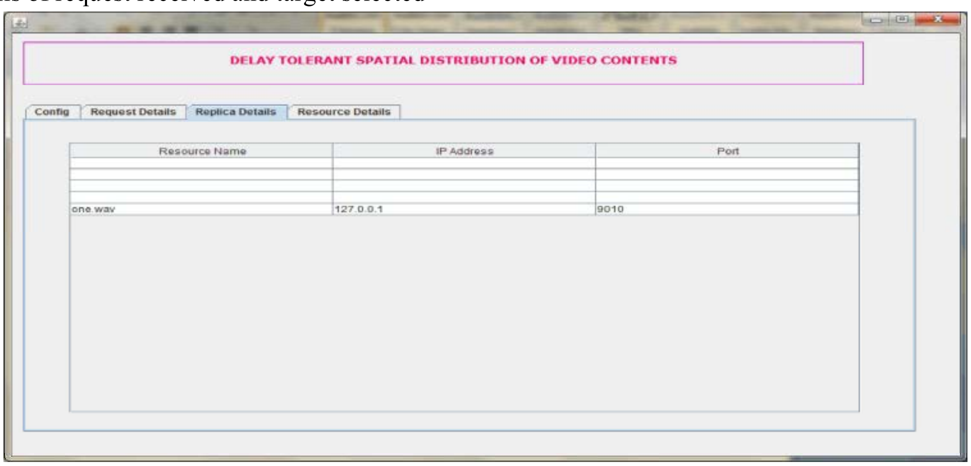
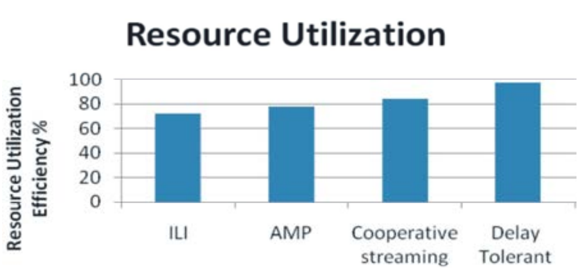
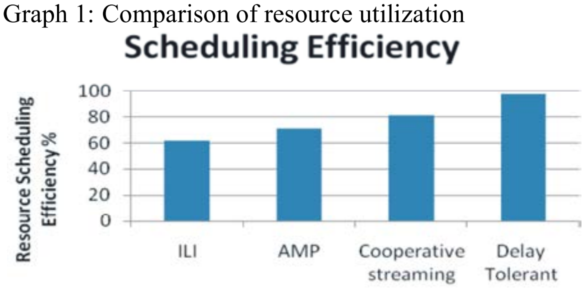


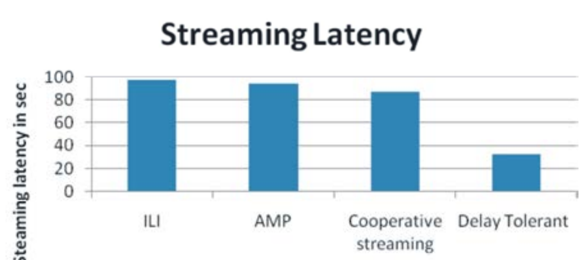
Fig. 4: Snapshot of replica generated



Graph 1: Comparison of resource utilization



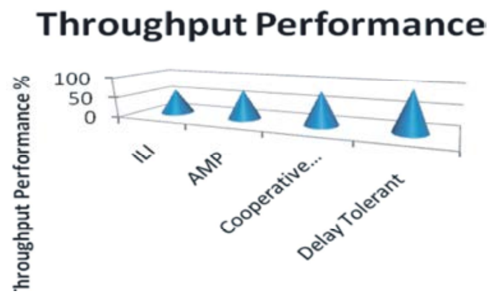
Graph 2: Comparison of scheduling efficiency of different methods



Graph 3: Comparison of scheduling latency of different methods

The Graph 3, shows the comparison of scheduling latency produced by different methods and it shows clearly that the proposed method has produced less latency than other methods.

The Graph 4, shows the comparative result on throughput performance achieved by different methods and it shows clearly that the proposed method has produced more throughput performance than other earlier



Graph 4: Comparative result on throughput performance

Table 2: Comparative analysis of QoS parameters

No of Locations	Streaming Efficiency %	Latency in seconds	Throughput Ratio%
100	97.6	21	98.4
300	98.7	17	99.2
500	99.6	12	99.7

methods. The streaming efficiency of the proposed method has been evaluated using different conditions and listed below:

The Table 2 shows the result of comparative analysis performed on different parameters of quality of service and it shows clearly that the proposed method has produced efficient results. To measure of efficiency of video streaming produced by the proposed method, number of test cases has been carried out with varying number of data locations and different number of users. In all the test cases the method has produced efficient result in video streaming with less time complexity and latency which improves the streaming efficiency also.

CONCLUSION

We proposed a noval delay tolerant approach for video streaming where the number of users are huge in size and the timing delivery is essential in video streaming. The proposed method performs the location selection approach to select the resource location from where the video can be streamed. Also when there are more traffic and delay present in the network then a delay tolerant replica generation approach is performed to generate a replica of the resource requested in any of the node. The proposed method has produced effficnent results in resource utilization and time complexity.

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