Transmitting Video-on-Demand Effectively

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Abstract—Now-a-days internet has become a vast source of entertainment & new services are available in quick succession which provides entertainment to the users. One of this service i.e. Video-on-Demand is most hyped service in this context. Transferring the video over the network with less error is the main objective of the service providers. In this paper we present an algorithm for routing the video to the user in an effective manner along with a method that ensures less error rate than others.

Keywords- Ontology Driven Architecture; Network Coding; VoD service; Cooperative Repair of data packets;

I. INTRODUCTION

Now-a-days internet has become a vast source of entertainment & new services are available in quick succession which provides entertainment to the users. One of this service i.e. Video-on-Demand is most hyped service in this context. Transferring the video over the network with less error is the main objective of the service providers.

In order to reduce the redundancies during the VoD process and communication we put forward a radius restrained distributed breadth first search flooding algorithm (RRDBFSF) [8]. By knowing the information of neighbor node in finite scope, this algorithm does breadth first search and selects the least number of forwarding neighbor nodes to reduce redundant information in broadcasting routing information. In scenario in RRDBFSF where each node receives one of many available video streams, we propose a network coding based cooperative repair framework to improve broadcast video quality during channel losses.

The proposed methodology is as follows:
1. Generating a MODA Framework for VoD Service
2. Clustering of the nodes in the network.
3. Estimation of the available bandwidth using packet probing.
4. Transmission using RRDBFS algorithm.
5. Unstructured Network Cooperative for repairing of data packet if in case error occurs.

II. MODA FRAMEWORK

The objective of a MODA [7] is to shift the complexity from the implementation of an application to its specification. It specifies three levels of architecture:

- **Computation Independent Model (CIM)**: CIM describes the context in which the system will be used.
- **Platform Independent Model (PIM)**: It describes the system itself without any details of its use or its platform.
- **Platform Specific Model (PSM)**: At this level environment of implementation platforms or languages is known.

A. MODA Process

Figure 2 examines many of the ways translation could be used for Ontology Driven Architecture. The repeatable process of this design is that the 'System Translator Program' created in Step 1 creates a new 'System Translator Program' in Step 2 and this creates Visualization. The program is translated to a style diagram using a second stage of translation. The second 'System Translator Program' could also create a 'Model/Program', 'Meta Program' or translate to an 'External Application'.

B. MODA Framework for Video-on-Demand Service

The MODA process (CIM to PIM) allows generating from the sending communication task a SCA domain including both server and client composites. For each composite the SessionController and MediaController components are inferred. Following the general MODA process the adequate session controller as well as the media
controller implementations has been selected. XSL templates 
used to implement the mapping rules the MODA engines. 
Figure 3 illustrates this.

Cluster states: There are 6 possible states: INITIAL, 
CLUSTER HEAD, ORDINARY NODE, GATEWAY, 
CH READY, GW READY and DIST GW. 
The packet handling upon sending a packet, each node 
piggybacks cluster-related information. Upon a 
 promiscuous packet reception, each node extracts cluster-
related information of neighbors and updates neighbor information table.

a) cluster head (CH) declaration
A node in INITIAL state changes its state to CH READY 
(a candidate cluster head) when a packet arrives from 
another node that is not a cluster head. With outgoing 
packet, a CH READY node can declare as a cluster head 
(CH). This helps the connectivity because this reduces isolated clusters.

b) Becoming a member
A node becomes a member of a cluster once it has heard 
or overheard a message from any cluster head. A member 
node can serve as a gateway or an ordinary node 
 depending on the collected neighbor information. A 
member node can settle as an ordinary node only after it 
has learned enough neighbor gateways. In passive 
clustering, however, the existence of a gateway can be 
found only through overhearing a packet from that 
gateway. Thus, we define another internal state, GW 
READY, for a candidate gateway node that has not yet 
discovered enough neighbor gateways. Recall that we 
develop a gateway selection mechanism to reduce the 
total gateways in the network. The detailed mechanism 
will be shown in the next Section. A candidate gateway 
finalizes its role as a gateway upon sending a packet 
(announcing the gateway’s role). Note that a candidate 
gateway node can become an ordinary node any time 
with the detection of enough gateways.

IV. BANDWIDTH ESTIMATION BEFORE TRANSMISSION

When the service providers receive a request for a video 
from a user than a dummy packet is sent along the paths that 
lead to the requester. On receiving the destination packets 
reverts it back to the source i.e. the service provider. This 
dummy packet is responsible for the estimation of the 
characteristics of the link. At the service providers side all 
the dummy packets are analyzed and the effective bandwidth 
of the user is estimated. According to the effective 
bandwidth of the channel the original video is than 
compressed according to the channel’s bandwidth for the 
 ease of transmission. This method is known as Packet 
Probing [3].

After the estimation & compression the video is 
transmitted according to RRDBFSF algorithm which is 
described in the next section.
V. RADIUS RESTRAINED DISTRIBUTED BREADTH FIRST SEARCH FLOODING ALGORITHM (RRDBFSF) FOR VIDEO ON DEMAND (VoD) SERVICE

Our algorithm is flooding in a small scope, namely, radius restrained flooding algorithm, and can reduce redundancies within a certain scope. Based on the rule that lessen the cost and time of forwarding message between nodes to the best, we choose the scope within a radius of three to flood message. So, every node need know its neighbor nodes which are connected directly with it, and need realize some information about their neighbor nodes. We call these information are nodes information within a radius of three. Thus, we suppose that v is random node in the networks.

A. Description of RRDBFSF Algorithm

1) The Rules followed in the Algorithm:

- The least cost of forwarding message time.
- Node is only concerned about the nodes flooding within a radius of three.
- When there are more than one path that message can get to the destination, we choose the shortest path.

2) Given Conditions of RRDBFSF Algorithm:

- The network is connected entirely ensuring that there is a reachable path between any two nodes.
- Any connection between nodes is bidirectional.
- Before running the flooding algorithm, the node has received its neighbor nodes information and built the neighbor nodes table NT (v).

3) Some Common Terms:

- Node Set

| Notation | Description |
|----------|-------------|
| N(x)     | The neighbor nodes set of node x. |
| RN(x)    | The relative neighbor nodes set of node x, viz. RN (x). |
| N(x)     | The set is calculated by the RRDBFSF algorithm. |
| TLen(x)  | The neighbor nodes set of node x within a radius of three. |
| RTLen(x) | The relative neighbor nodes set of node x within a radius of three, viz. RTLen (x). |
| T(x)     | The set is calculated by the RRDBFSF algorithm and message from node is forwarded for the second time to the nodes in the set. |
| T(x)     | The sum set of node x neighbor nodes, viz. the sum of neighbor nodes and the nodes within a radius of three. |
| R(x)     | The set of node x next forwarding nodes |

- Neighbor Node table

| Neighbor node ID | Its neighbor nodes within a radius of three |
|------------------|-------------------------------------------|
| b                | f, g, h, l, c                             |
| k                | e, g, a, d                                |
| i                | a, g, d, f, e, l                          |

TABLE II.  NEIGHBOR NODE SET NT(V) WHICH DEFINES

TABLE III.  NEIGHBOR NODE SET NT(V) WHICH DEFINES

Next forwarding node ID | Next forwarding nodes
-------------------------|-------------------------|
| a                       | b, c, d, i, j, k, m     |

The RRDBFSF algorithm calculates, gets RT(v), and transmits it to next forwarding neighbor nodes. So, if a forwarding node ID is i in RT(v), its next forwarding nodes set concerned with node v is RT (v, i).

Consider a sample network in figure 5. All the values are calculated considering v as reference node.

![Fig. 5 A Sample Network](image)

N (f) = \{b, k, j\}
TLen (f) = \{c, i, m, j, b, d, a\}
T (e) = \{a, b, c, d, i, j, k, m\}

VI. NETWORK BASED CODING

A. System Architecture For Video Repair System in VoD

1) CPR System Architecture: We consider the scenario where N peers are watching broadcasting video streams through their wireless mobile devices and mobile devices
are equipped with wireless local area network (WLAN) interfaces. We first assume that the media source provides a total of Sall video streams. Sall varies due to different technologies, broadcast technologies, broadcast bandwidths and operational constraints of the mobile video providers. Although Sall stream are available, not all streams will have audiences in a given ad-hoc network at a given time. Without loss of generality, we denote S*=\{s1,s2,…,ss\} as the subset of Sall streams that have audience and S=|S*|. Each peer n in the network watches one stream S(n) \in S* from the media source and conversely each stream s \in S* has a group of receiving peers μs. Peers in μs, each receiving a different subset of packets of stream s, can relay packets to others WLAN interfaces to repair lost packets. This repair process is called CPR i.e. Cooperative Peer to Peer Repair. We denote as the set of streams of which n peer has received packets: either original video packets from the media source or CPR packets from peers, i.e., streams that peer n can repair via CPR. We use flags in CPR packet header to identify the stream a packet repairs. Whenever n peer has a transmission opportunity - a moment in time when peer n is permitted by a scheduling protocol to locally broadcast a packet via WLAN, peer n selects one stream from An to construct and transmit a CPR packet.

2) Source Model: We use H.264 codec for video source encoding because of its excellent rate-distortion performance. For improved error resilience, we assume the media source first performs reference frame selection for each group of picture (GOP) in each stream separately during H.264 encoding. In brief assumes each GOP is composed of a starting I-frame followed by P-frames. Each P-frame can choose among a set of previous frames for motion compensation, where each choice results in a different encoding rate and different dependency structure. If we then assume that a frame is correctly decoded only if it is correctly received and the frame it referenced is correctly decoded probability. Figure 6 illustrates the use of DAG Model for reference frame selection.

![DAG source model for H.264/AVC video with reference frame selection](image)

After the media source performs reference frame selection for each HOP of each stream, we can model Mk frames in GOP of a stream sk, Fk=\{F1k,…,Fmk\}, as nodes in a directed acyclic graph (DAG) in fig 4. Each frame Fik has an associated dik, the resulting distortion reduction if Fik is correctly decoded. Each frame Fik points to the frame in the same GOP that it uses for motion compensation. Frame Fik, referencing frame Fjk is packetized into real-time transport protocol (RTP) packets according to the frame size and maximum transport unit (MTU) of the delivery network. A frame Fik is correctly received only if all packets within Fik are correctly received. We assume that the media source delivers each GOP of Mk frames of stream sk in time duration Yk. Yk is also the repair epoch for sk, which is the duration in which CPR completes its repair on the previous GOP, i.e peers exchange CPR packets for previous GOP of stream sk during the current epoch.

3) CPR-Unstructured Network Coding (UNC): We denote the traditional random NC scheme as UNC. First, suppose n peer has a transmission opportunity and n selects stream s from An for transmission. Suppose there are M original (native) frames F=\{F1,…,FM\} in a GOP of stream s to be repaired among peers in μs. Each frame Fi is divided into multiple packets Pi=\{p1i,…,pni\} of size W bits each. Here Bi is the number of packets frame Fi is divided into. A peer adds padding bits to each packet so that each has constant size W bits; this is performed for NC purposes. We denote P as the set of all packets in a GOP, i.e P=\{P1,…,PM\}. There are a total of |P|=\sum_{i=1}^{M} Bi packets to be disseminated among peers in μs.

We denote Gi as the set of native packets of stream S(n) peer ‘n’ received from media source. Denote Qn as the set of NC packets of stream ‘s’ peer ‘n’ received from other peers through CPR. If the stream selected for transmission is the same as the stream peer ‘n’ currently watches, i.e. s=S(n) then the NC packet qn generated by peer n is represented as:

\[ q = \sum_{p_{lj} \in Q_n} a_{lj} p_{lj} + \sum_{q_{mj} \in Q_m} b_{mj} q_{mj} = \sum_{p_{lj} \in P^*} c_{lj} p_{lj} \]  

where a_{lj}s and b_{mj}s, random numbers in , are coefficients for the original packets and the received encoded NC packets, respectively. Because each received NC packet qn is itself a linear combination of native and NC packets, we can rewrite qn as a linear combination of native packets with native coefficients c_{lj} s. If the stream selected for transmission s ≠ S(n), then the NC packet is simply a linear combination of all NC packets of stream s received through CPR from other peers so far as follows:

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\[ q_n = \sum_{q_m} b_m q_m = \sum_{p_{lj} \in P} c_{lj} p_{lj} \]  

(2)

For UNC, all packets of stream ‘s’, both native packets (if any) and received NC packets, are used for NC encoding, and a peer in \( \mu \) can reconstruct all native packets of stream when innovative native or NC packets of stream ‘s’ are received, and hence all frames can be recovered.

VII. RESULTS

Methodology has been simulated on a network with 10 soft switch nodes, 50 soft switch nodes, or 100 soft switch nodes.

- Fig. 7 Average Receive Repeated Message
- Fig. 8 Average Transfer Delay of Message

Network Scale

- flooding with clustering
- flooding with out clustering
- ordinary clustering

VIII. CONCLUSION AND FUTURE WORK

This paper presents a framework for the VoD. A cluster of the network is created & based on the estimation by packet probing method the data i.e. the video is sent to the destination using Radius Restraint Breadth First Search which decreases the redundant information in the network & stream the video data effectively to the destination node. To avoid any error or to ensure reliable data delivery a repair mechanism for the VoD service has been given.

The future work includes designing a more efficient algorithm which will route the video data efficiently & securely over the network. The other area of research is designing a framework for packet repairing which incurs less overhead on the basis of time & cost. Next steps in MODA framework aim at generating dynamic user interfaces for final users (to drive the deployment process) and enhancing deployment specifications produced by MODA in order to be used for self-configuring the communication system.

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