Greedy Cost Matrix for Deadline Scheduling for Multimedia Video Streaming in Wireless Networks

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Abstract - In a Context of Multimedia Video Streaming in Wireless transmission, a Greedy based scheduling is proposed, assuming that a minimum QOS is ensured for all users in a channel in Uplink transmission. The new smart mobile devices choose favored average transmission rates by balancing to video quality as well as the charge of the data broadcast. In a TDM based Greedy approach, the base station collects the information on data frames to be transmitted within the current deadline, a sorting process is proposed by putting the deadlines in a Greedy sorted array to meet the deadlines and schedules the transmission in a TDM fashion. The well design of a Greedy Cost matrix will aid to estimate the cost of all the users getting Multimedia Video frames in a channel. This algorithm will maximizes the total network utility, by satisfying the delivery deadline constraints.

Keywords: Multimedia Video, Wireless transmission, TDM, Greedy Cost Matrix

. I. INTRODUCTION

Video streaming is becoming one of the main driving forces for next generation wireless networks. Many research efforts have been devoted for adaptation of video content to reconcile the conflict between high demand of video data quality and limited resource capacity for wireless medium among users. To confirm the eminence of real-time video streaming, smart video coding as well as the adaptation methods needed to be achieved at the application layer to come across the rigorous resource constraints at lesser layers. For the right low bit rate channels, just code the video streams at the high quantization distortion levels is disagreeable to audiences. A improved elucidation is to make content-aware video coding, via summarization, which chooses a subgroup of video frames that finest exemplify the sequences, and encodes these at a sophisticated quality. Different summarization procedures have newly been described. The actual adaptation can be achieved through video summarization/Transco ding and/or bit stream extraction from scalable video.

This paper improves, examines and simulates novel joint rate control as well as the scheduling algorithm for uplinking the video streaming in CDMA enabled cellular networks. The rate control fragment of the algorithm depend on the adaptive content-aware video summarization, and exploits a pricing-based method to allocate the computational load through the network and individual mobile operators, and entirely operates the multi-user diversity to diminish users' whole distortion[16]. The scheduling part of the algorithm lets users transmit the summary frames in a time-division multiplexing (TDM) fashion, which avoids excessive mutual interferences, achieve higher rate compared with a simultaneous equal rate transmission scheme. The appraising method has been effectively used to distribute communication resources efficiently amid flexible data applications in a wireless networks[10]. We previously showed that a pricing-based approach combined with adaptive video summarization techniques can greatly improve the performance of multi-user wireless download video transmission. This paper more covers the appraising framework to the uplink streaming incident, which is extra multifaceted because of the interfering inadequate environment of the communication channel. Scheduling of numerous video consumers in CDMA networks has been well-thought-out in preceding work. Our involvement at this time is to display that a TDM-based transmission amid video consumers hints to enhanced performance related with the structure where video consumers also transmit concurrently, by evading great mutual intrusion and manipulating multi-user content variety. In earlier effort on multi-user uplink video streaming at precise low bit rate, we attempt to make the permissible rate profile by iteratively altering topmost rates amid video consumers[17]. The weakness is that convergence is not certain in overall. The algorithm projected here , though, has supposedly demonstrable and essentially precise dissolute convergence.

II.MODELLING OF THE SYSTEM

The uplink size for the WCDMA system, the third-generation (3G) wireless standard, is fractional to interloping (Tse and Viswanath, 2005). The question of providing quality of service (QoS) comes to the video users for a mixed voice and streaming video transmission, which is to be done without interrupting the transmissions of video users. This is termed as total received power constraint of video users at the base station[1].

Let us study a single CDMA cell with a set of two types, X_{voice} users ,and Y_{video} consumers. On receiving the common received P_{voice} each voice user adjusts its transmission power and the SINR target γ_{voice} at base station, thus by using a common rate R_{voice} of transmission. On achieving this, the total received power P_{video} at the base station should satisfy this following,

$$\frac{G_{voice}.W}{R_{voice}} . \frac{P_{voice}}{n_0 W + P_{video} + (x-1).P_{voice}} \geq \gamma_{voice}..........(i)$$

W $\longrightarrow$ Bandwidth of the transmission Channel

$\longrightarrow$ The Constant factor be contingent on consumer’s selection of the Modulation strategy

(G_{voice} is equal to 1 for BPSK, it is 2 for QPSK)

$n_0 \rightarrow$ Background Noise density

$$\Rightarrow \frac{\mathrm{G}_{voice}.\mathrm{W}}{\mathrm{R}_{Voice}.\gamma_{Voice}} \geq \frac{n_0.w + P_{video} + (x-1).P_{voice}}{P_{voice}}$$

$$\Rightarrow \left[\frac{\mathrm{G}_{voice}.\mathrm{W}}{\mathrm{R}_{Voice}.\gamma_{Voice}} + (1-x)\right].P_{voice} - n_0.\mathrm{w} \geq P_{video}$$

Thus the maximum value of P_{video}, denoted by P_{max},

$$P_{max} = \left[\frac{\mathrm{G}_{voice}.\mathrm{W}}{\mathrm{R}_{Voice}.\gamma_{Voice}} + (1-x)\right].P_{voice} - n_0.\mathrm{w}..................(ii)$$

This is the extreme full power acknowledged by all video consumers in the cell.

In practice, the value of P_{max} , could change over time to reflect the load change of voice. Here the main focus is on resource allocation during a single time segment [0,T], which corresponds to the time window in which one round of video coding and summarization takes place.

Given the constraint of P_{max} , the boosting of overall network utility is realized by the acknowledged video qualities.

The optimization techniques for network utility maximization is thus considered by $\left\{P_j(t)\right\}_{1 \le j \le y}$, which is a received power function for video user ‘j’ at any time $t \in \left[0, T\right]$.

The transmission network utility boosting problem is,

$$\max\left\{P_j(t) \geq 0\right\}_{1 \le j \le y} \sum_{j=1}^{Y} U_j \left\{ \int_0^T R_j\left[P(t)\right] dt \right\}..........................(iii)$$

$$\text{so that } \sum_{j=1}^{Y} P_j(t) \leq P_{\max}, \forall t \in [0,T] ....(iv)$$

Due to Variable Bit Rate Nature of the video streaming contents, it is likely that the optimal solution of Eqn. – (iii) entails of time changing function. Together with utility function U_j which do not have analytical forms, finding the optimal solution is quite difficult[7].

III.EFFECT OF MULTIUSER INTERFERENCE AND NOISE ON VIDEO STREAMING

If $X_{K'}$ is the transmitted symbol vector of interest and N_u denotes the multiuser interference for user K′ and N is the AWGN with double with double side spectral density $N_0/2$. Therefore the filter output for user K′,

$$y_{K'} = x_{K'} + n_u + n, ...(v)$$

the bit–energy–to-equivalent-noise spectral density ratio, E_b / N_e for each frame of Multimedia Video is given by,

$$\frac{E_b(k')}{Ne(k')} = \frac{1}{R_{K'}} . \frac{P_{K'}.\alpha_{K'}^{2}.S_{K'}}{N_0 + \beta \sum_{K \neq K'} P_K.\alpha_{K'}^{2}} ....(vi)$$

$P_{K'}$, $R_{K'}$ and $S_{K'}$ is the transferred power and the channel coding rate and the spreading factor of user K. the channel gain factor $=\alpha_{K'}$, predictable a constant for a particular frame where β constant depends on the noise type.

INFORMATION RATE EXPRESSION	**AVERAGE INFORMATION RATE**
The information rate for user $k^{/}$ is defined as, $r_{k'} = \frac{R_{K'}}{S_{K'}},$ $r_{k'} = \left(\frac{E_b(k')}{Ne(k')} \right)^{-1} . \frac{P_{K'}.\alpha_{K'}^{2}.}{N_0 + \beta \sum_{K \neq K'} P_K.\alpha_{K'}^{2}} ....(vii)$	Averaging out the channel gains described by the parameter, $E(\alpha_1^2) = \frac{\Omega}{N_U}$ and the corresponding p.d.f $f\alpha_1(\alpha) = \frac{2.N_U.\alpha}{\Omega}.e^{\frac{-Nu.\alpha^2}{\Omega}}, \alpha \succ 0....................................(viii)$ by defining $C = \left(\frac{E_b}{N_e} \right)^{-1} .P_{\max,}$ and $\lambda = \beta(N_U - 1).P_{\max,}$ the average information rate is given by, $\bar{r} = E(r) = \int_0^{\infty} r_{\max-\min}.f\alpha_1(\alpha)\partial\alpha...............................(ix)$ $= C.\frac{N_U}{\Omega.\lambda^2}.e^{\frac{Nu.N0}{\Omega.\lambda}}.(I_1 - I_2)$ where, $I_1 = \frac{\Omega.\lambda}{Nu}.e^{\frac{-Nu.N0}{\Omega.\lambda}}, I_2 = N_0.\Gamma(0, \frac{Nu.N0}{\Omega.\lambda})$ where, $\Gamma(p,z) = \int_z^{\infty} t^{p-1}.\exp(-t)\partial t$ is the Gamma function. $I_2 \prec N_0.e^{\frac{-Nu.N0}{\Omega.\lambda}} \left(\frac{Nu.N0}{\Omega.\lambda} \right)^{\frac{1}{P-1}} .(P-1)^{1-\frac{2}{P}}.P^{\frac{1}{P-1}}, \forall P \succ 1.............(x)$

For a user defined number of users N_u and the noise power ‘P’, the best value for the real parameter ‘P’ diverges over the range of noise powers ,different values of $N_{u.,}$

since $I_2 \geq 0$, the $\bar{r}$ having the following the upper bound,

$$\bar{r} \leq C.\frac{N_U}{\Omega\lambda}.e^{\frac{Nu.N0}{\Omega\lambda}}.I_1 \leq \frac{C}{\lambda} \text{ ....(xii)}$$

and finally we get, $$\bar{r} \leq \frac{\left(\frac{E_b}{N_e}\right)^{-1}.t}{\beta.\left(N_U-1\right)} \text{...............}(xiii)$$

IV.TDM BASED GREEDY SCHEDULING

Ensuring satisfactory reception of the video streaming application, each video summary frame has to be delivered to the receiver before a certain deadline. The “optimal” averaged rate allocation sends the video frames to the receiver but without considering the deadlines of video summary frames. The Greedy Scheduling algorithm meets the deadline requirements.

The deliver deadline of each summary frame is determined by three parameters; the initial delay $Fi_{.position}$, and the total length of the current time segment T. In this case the delay of sending the frames is arranged as a Frame delay array.

0 1 2 3 4 …. n-3 n-2

F initial	**F1**	**F2**		**…….**	**Fk**	**…..**	**Fn-2**	**Fn-1**

Figure 1: Frame Delay array

For these first frames $F_{initial}$, their deadline is the initial delay, the value of $Fi_{.position}$ for these frames are zero.
For additional frames cases, the delay is considered as ,

F i, position = (i-1)/ total sampling rate of frames in seconds.

Finally the entire summary frames need to be delivered within the current time segment T. Thus deadline of packet i is,

$$T^i = \min\left(Fini + F_{i.position}.T\right) \text{...................}(xiv)$$

Greedy Algorithm works as follows. The BS’s first sort the frames in increasing orger of delivery deadline and lets the frame to be transmitted one-at-a-time, Thus the very frame array,

0 1 2 3 4 …. n-2 n-1

F initial	**F1**	**F2**	**F3**	**…………….**	**Fi**	**…..**	**Fn-2**	**Fn-1**

is sorted in arising order of the deadlines,

0 1 2 3 …. n-2 n-1

D initial	**D1**	**D2**	**D3**	**…….**	**Di**	**…..**	**Dn-2**	**Dn-1**

Figure 2 : Sorted Deadlin e array

D initial < D1< D2<D3<D4<D5<……..<Dn-2<Dn-1,

Now in case of any fresh adding of frame, it is to be injected in the array by means of insertion sort process.

V.GREEDY COST MATRIX

Let us consider a model considering two square matrices of order 2x2 to find out the cost for sending the Multimedia video frame in a Wireless Network, the cost matrices are

$$\begin{array}{c} \begin{matrix} d1 & d2 \end{matrix} \\ \begin{bmatrix} C1 & C2 \\ C3 & C4 \end{bmatrix} \end{array} \; \frac{n}{e}$$

Matrix for User1,d1 and d2 are deadlines for frames f1 and f2.

The multiplication of the Cost matrices will give the total cost for sending the two frames to two users existing in the channel likewise for N users in the channel the resultant of n matrices multiplication will give the total cost for all the users in the channel. This systems considers that for sending Multimedia data frames to every user, the number of data frames are the same with different deadlines.

GREEDY algorithm is simple and optimal among all TDM-based algorithms:

5.1 Proposition 1 : If any TDM-based scheduling algorithm can meet the deadlines of all video frame, the GREEDY scheduling algorithm also can. Proposition 1 can be proved as follows : pick any TDM-based scheduling algorithm where all deadlines are met and one or more packets are transmitted out of the deadline order. Then by rearranging the corresponding out of the order packets by the deadline as in the GREEDY algorithm, all the deadline constraints are still satisfied.

It can be shown that if no TDM-based scheduling algorithm can meet all deadline constraints, then the GREEDY algorithm incurs the least deadline violation. To correctly predict the outcome, let us describe

$$\Delta^{\Pi} = \max{}_i \left(T^i{}_{\Pi} - T^i \right) \text{..............................}(xiv)$$

as the maximum delay violation under TDM-based scheduling policy Π, where $T^i{}_{\Pi}$ denotes the actual delivery time of the jth packet under TDM-based algorithm Π. If $\Delta^{\Pi} \leq 0$, then all deadline constraints are met.

5.2 Proposition 2

Among all TDM-based scheduling algorithms, the GREEDY algorithm yields the smallest value of Δ^{Π}.Indeed, proposition 1 is just a distinct circumstance of the proposition 2, and the identical proof procedure can be indiscriminate to ascertain the latter.
In the case of $\Delta^{\text{GREEDY}} > 0$, the base station must increase price so that video users request less rate. One mode of modifying value is by the next

$$\lambda^{i+1} = \max\left\{0, \lambda^i + \beta \max\left[\Delta^{\text{GREEDY}}\left(\lambda^i\right), 0\right]\right\} \text{...................}(xv)$$

where β is a small step-size. In other words, the price increased until the resulting frame sequences are schedulable (i.e. all deadline constraints can be met under GREEDY algorithm). There lies a trade-off among the value β as ell as convergence speed. If β is large, then the schedulability can be achieved by a few adjustments; however, a significant portion of the time segment [0,T] might be wasted. If β is small, then it takes longer to achieve schedulability, and the resource utilization will be higher. In either case, since users' average transmission rates decrease with λ, the price adjustment process in Eq. (xv) always converges.

VI.RESULTS

Given the summarization results, the GREEDY algorithm performs scheduling based on sorted packet deadlines. The agreeing acknowledged power functions of users , are planned in the Fig.(3) whereas the agreeing delivery deadlines are , planned in Fig. (4). under an early delay of 30 frames (1second), the GREEDY algorithm efficaciously communicates all packets within 3second and come across all deadline necessities.

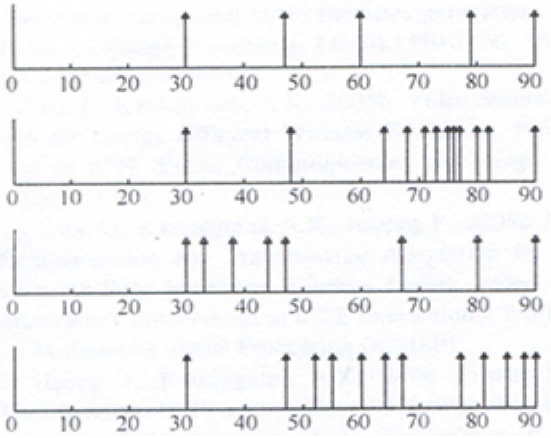

Figure 3 : Acknowledged powers at the ba.se station video users under Greedy array algorithm (power in mW)

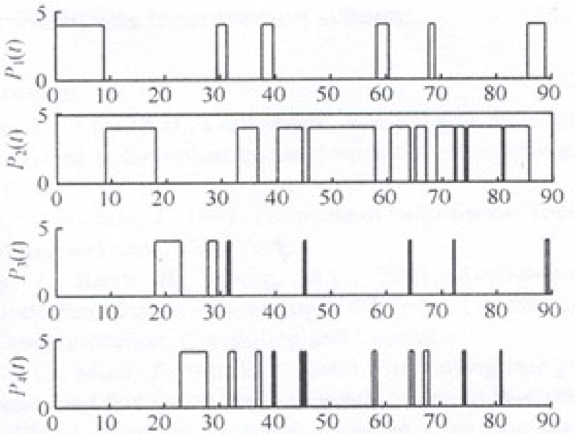

Figure 4 : Frame -delivery deadlines in Greedy -Scheduling

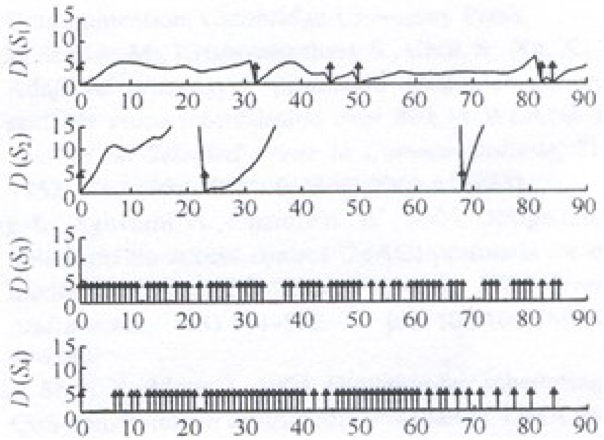

Figure 5 : Distortion under Greedy- scheduling

VII. CONCLUSION AND NOTES

A useful cross-layer strategy, for up linking the video streaming in a single CDMA cell has been depicted by this paper. We propose a resource allocation scheme, which is a TDM-based GREEDY scheduling algorithm In other words, the operations in the application layer (Video coding and summarization) and transport layer (rate control) are coupled only through a single price signal. In the data-link layer, the base station achieves TDM-based GREEDY scheduling founded on the deadlines the summary frames, amends the worth if it is not schedulable. Simulation outcomes disclosed significant improvements in the network utility related to constant rate transmission scheme.

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