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SENDER SCHEDULING FOR MULTIMEDIA IN ADHOC P2P NETWORK

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ABSTRACT

Multi-source multimedia transmission is a popular architecture in wireless mobile peer-to-peer (P2P) networks. Most of previous work on wireless mobile P2P networks concentrates on the protocols and network structures, and consequently ignores the multiple senders scheduling problem. In this paper, a distributed algorithm for scheduling the multiple senders for multi-source transmission in wireless mobile P2P networks, which can maximize the data rate and minimize the power consumption. Specifically, we formulate the wireless mobile P2P network as a multi-armed bandit system. The optimal distributed sender scheduling policy can be found according to the Gittins indices of the senders. Here we compare different algorithms for sender scheduling algorithms for maximizing data rate and comparing multicasting algorithms for minimizing power

Keywords: Multicasting, Sender Scheduling, Gittins Index

I INTRODUCTION

Video Streaming refers to transferring video data such that it can be processed as a steady and continuous stream over the network. With streaming, the client browser or plug-in can start displaying the multimedia data before the entire file has been transmitted

1.1Protocol Issues

Designing a network protocol to support streaming media raises many issues, such as: Datagram protocols, such as the User Datagram Protocol (UDP), send the media stream as a series of small packets. This is simple and efficient; however, there is no mechanism within the protocol to guarantee delivery. It is up to the receiving application to detect loss or corruption and recover data using error correction techniques. If data is lost, the stream may suffer a dropout. The Real-time Streaming Protocol (RTSP), Real-time Transport Protocol (RTP) and the Real-time Transport Control Protocol (RTCP) were specifically designed to stream media over networks. RTSP runs over a variety of transport protocols, while the latter two are built on top of UDP. Another approach that seems to incorporate both the advantages of using a standard web protocol and the ability to be used for streaming even live content is the HTTP adaptive bitrate streaming. HTTP adaptive bitrate streaming is based on HTTP progressive download, but contrary to the previous approach, here the files are very small, so that they can be compared to the streaming of packets, much like the case of using RTSP and RTP. Reliable protocols, such as the Transmission Control Protocol (TCP), guarantee correct delivery of each bit in the media stream.

However, they accomplish this with a system of timeouts and retries, which makes them more complex to implement. It also means that when there is data loss on the network, the media stream stalls while the protocol handlers detect the loss and retransmit the missing data. Clients can minimize this effect by buffering data for display. While delay due to buffering is acceptable in video on demand scenarios, users of interactive applications such as video conferencing will experience a loss of fidelity if the delay that buffering contributes to exceeds 200 ms.Unicast protocols send a separate copy of the media stream from the server to each recipient. Unicast is the norm for most Internet connections, but does not scale well when many users want to view the same program concurrently.

Multicasting broadcasts the same copy of the multimedia over the entire network to a group of clients

1. Multicast protocols were developed to reduce the data replication (and consequent server/network loads) that occurs when many recipients receive unicast content streams independently. These protocols send a single stream from the source to a group of recipients. Depending on the network infrastructure and type, multicast transmission may or may not be feasible. One potential disadvantage of multicasting is the loss of video on demand functionality. Continuous streaming of radio or television material usually precludes the recipient's ability to control playback. However, this problem can be mitigated by elements such as caching servers, digital set-top boxes, and buffered media players.
2. IP Multicast provides a means to send a single media stream to a group of recipients on a computer network. A multicast protocol, usually Internet Group Management Protocol, is used to manage delivery of multicast streams to the groups of recipients on a LAN. One of the challenges in deploying IP multicast is that routers and firewalls between LANs must allow the passage of packets destined to multicast groups. If the organization that is serving the content has control over the network between server and recipients (i.e., educational, government, and corporate intranets), then routing protocols such as Protocol Independent Multicast can be used to deliver stream content to multiple Local Area Network segments.
3. Peer-to-peer (P2P) protocols arrange for prerecorded streams to be sent between computers. This prevents the server and its network connections from becoming a bottleneck. However, it raises technical, performance, quality, and business issues.

1.2Motivations

There are several motivations behind this work.

1) First, a fundamental characteristic of wireless networks is the time-varying and user-dependent fading channel.

An important means to cope with channel fading is the use of *multi-user diversity*. It is shown that the optimal strategy is to schedule at any time only the user with the best channel to transmit. This *opportunistic scheduling* is used in many modern wireless systems. Such as high speed downlink packet access (HSDPA)

2) Second, like those in traditional wireless networks, the channels in wireless mobile P2P networks experience time-varying and user-dependent fading. Selecting the best sender for multi-source multimedia transmission in wireless mobile P2P networks may maximize the data rate. [1]

3) Third, system resource constraints are important issues in wireless mobile devices. Some examples of the constraints include limited battery power, low-power microprocessor and small memory. In selecting the best sender, these resource constraints should be taken into account.

4) Fourth, there is no centralized control point in wireless mobile P2P networks. Therefore, the sender scheduling scheme should be distributed.

II PROPOSED WORK

We formulate the sender scheduling problem for multi-source transmission as a multi-armed bandit system [3], which has been widely studied in operations research in the context of an infinite-horizon discounted-cost stochastic control problem. This problem is studied to make the optimal decision of which arm of the multi-slot gambler machine to pull each time to maximize the total reward. The object, which is the arm in the gambler machine example, has a finite set of available states and the transition probabilities between the states. At each epoch, with the tradeoff of system studying and reward collecting, one optimal object among N is selected to be active to maximize the total discounted reward over the horizon. This is very similar to the sender scheduling problem for multi-source transmission in wireless P2P networks. Generally, we need to solve N-partially observed Markov decision process (POMDP) [16] with large computational complexity; however, it is proved to have an “index able” property that dramatically simplifies the computation and implementation of the optimal policy, which means that the optimal sender scheduling policy can be found according to the Gittins indices [12] of the senders. The Gittins index is computed based on the information state, which is the function of system state and observation.

2.1 Objective

In this paper, we take both channel state and battery energy into consideration to find out the optimal sender selection policy. The optimization objectives can be summarized as follows:

1) Maximized receiving data rate. Better channel state realization $S^{K}_{C} \varepsilon \Theta$ enables higher data rate, and consequently, higher reward in our formulation. According to the information state that contains the history of the channel observation $Y^{K}_{C} \varepsilon \Theta$ and the channel state transition probability matrix $A_c (L)$, Gittins index is computed to maximize the receiving data rate, which is one of the key issues for improving user experience.

2) Minimized power consumption. Since most mobile devices are powered by batteries in a wireless mobile P2P networks, we assume that minimizing the power consumption is equivalent to maximizing the network life time. The life time is prolonged by selecting proper potential sender L based on the residual energy $S^{K}_{E} \varepsilon \mathcal{E}$. The definition of lifetime $\mathcal{L}$ depends on the underlying network application. One of the commonly used lifetime definitions is the number of time slots until the number of dead nodes reaches a threshold $\mathcal{L}_T$. The objective is to simulate the proposed model which schedules multiple senders and consumes the power.

2.2 Constraints

1) It introduces some computational load and into system. Senders are required to compute the indices to form the index tables.

2) It also introduces communication overhead in proposed scheme mainly caused by the multicast of three types of message, ITREQ, ISIMUL, and SIMUL.

III METHODOLOGY

3.1Steps to acquire and process

1) We formulate the wireless mobile P2P network as a stochastic control problem .The optimal distributed sender scheduling policy can be found according to the Gittins indices of the senders

2) The proposed scheme can optimally select the best sender for multi-source transmission taking into account of channel conditions and resource constraints.

3) It is a fully distributed and scalable scheme. There is no need for a centralized control point to coordinate the senders.

3.2 Inputs for the Projects

The system model which following different models each is giving better for streaming over wireless network.

3.2.1) Network Model

The network layer routing protocol and the application layer P2P lookup protocol are not specified. Existing ad hoc routing protocols, such as AODV, DSR, TORA and ZRP, are all applicable. Some P2P lookup protocols, such as Chord [7] and Pastry [9], should be extended to enable the lookup result to cover multiple potential senders.

3.2.2) Channel Model

Wireless channels are not stable and only provide limited bandwidth. In this paper we consider block fading wireless channels that can be modeled using a finite-state Markov chain by dividing the continuous link state into discrete levels for simplification. Channel is characterized by a set of states C= (C1, C2, … ..C_G) where G is the number of available channel state levels. The time is divided into K slots of equal duration. The channel state $S^k c$ in time slot k where k Є 0, 1, 2…k-1.The channel state transition probability matrix of sender l is Ac (l) = [C_{gh}] where $C_{gh} =$ Pr($S^{k+1}c$ =g and $S^k c$ =h), g, h Є C. The transition probability can be approximated as

Where Γ_g and Γ_h are the SNR corresponding to the state C_g and $C_{h.}$ [Bad-bad, bad-good, good-bad, good-good] Let Θ = (Θ1, Θ2, . . . Θn ,) denote the observation vector, where each element in the vector corresponds to an element in C.

Assume that wireless mobile devices are channel state detectors. Potential senders can only know the probability of the current channel state level. Assume that the channel state observation in time slot k to be $y^k c$ so transaction probability matrix of the observation when sender l is active is represented as B_c (l) = [σ_{gh}] Where $\sigma_{gh} =$ Pr ($y^{k+1}c$ =g and ykc =h), g, h Є C.

3.2.3) Energy Model

Most wireless mobile devices are powered by batteries with limited energy. Assume that the residual energy of each wireless mobile device remains unchanged when it's not in use Residual energy of each device can be detected locally, but the probability of false detection may not be zero. This model can be considered as special case of the Markov model in this paper. For simplification, The continuous battery residual energy can be divided into discrete levels, denoted by E = ($E1$, $E2$, . . .,EH),where H is the number of available channel state levels. Assume the energy state to be skE in time slot k, and the energy state observation to be ykE . The residual energy is also a Markov chain when sender l is active according to the results of [26]. The transition probability matrix is $AE(l) = [\ egh\ ]H\times H$, where $egh\ = Pr(sk+1\ E = g$ and $sk\ E = h\ )$, g, h , E. In some other works (e.g., [25]), the residual energy is assumed to be reduced by a fixed amount after every data transmission action. This model can be considered as special case of the Markov model in this paper. The observation vector of residual energy is $\Psi = (\psi 1,\ \psi 2, \ldots, \psi H)$, where each element in the vector corresponds to an element in E. The transition probability matrix of the observations when sender l is active is represented as $BE(l) = [vgh]H\times H$, (4)

where $vgh = Pr(yk+1\ E = g$ and $sk+1\ E = h,\ ak = l)$, $g \in \Psi$, $h \in$ E.

3.2.4) System State and Reward

In practice, the state of battery residual energy is independent on the channel state. Therefore, the state of sender l, $sk(l)$, can be modelled as $sk(l) = [sk\ C(l),\ sk\ E(l)]$. If sender l is active in time slot k, then the state $sk(l)$ evolves according to an Ul-state Markov chain with transition probability matrix:

$$A(l) = [(cij,\ eij\ )]Ul\times Ul\ ,$$

where cij and eij are defined in (1) and (3), respectively, and $Ul = G\times H$. If sender l is not an active sender in time slot k, $sk+1(l) = k(l)$. That is, the states of all other $L - 1$ passive senders do not change. The state of the active sender is observed by the detector output $yk+1(l)$ for the sender state $sk+1(l)$. Assume that there is a finite Wl observation set indexed by $w(l) = 1, 2, \ldots, Wl$. Let $Y\ k = (y1(a0), \ldots, yk(ak-1))$ denote the observation history for time slot k. Let $B(l) = (bdf\ (l))d\in Ul, f\in Wl$ denote the observation probability matrix, where each element

$bdf\ (l) = Pr(yk+1(l) = f\,|\ \ sk+1(l) = d,\ ak = l)$, in which $ak \in \{1, 2, \ldots, L\}$ means that sender l is the active sender in time slot k. The observation is derived from σij and vij.

After a potential sender is selected as the active sender within each time slot, an instantaneous reward $\beta kR(sk(l),\ l)$ is accrued, where $0 \le \beta \le 1$ is the discount factor.

3.2.5) Information State

Information state is a probability distribution over states. It is a sufficient statistic for the decision and observation history. Define the information state $xk(l)$ for each sender l to be $xk(l) = (xki\ (l))$, $i = 1, 2, \ldots, Ul$, where $xki\ (l) = Pr(sk(l) = i/Y\ k,\ ak-1 = l)$, $Y\ k$ is the observation history and $ak-1$ is the sender that is active in time slot $k-1$. Let $\chi(l)$ denote the state space of information states $xi(l)$: $\chi(l) = \{x(l) \in \Re Ul : 1'\ \ Ulx(l) = 1,$ $0 \le\ xi(l) \le\ 1$, for all $i \in 1, \ldots, Ul\}$,where $xi(l)$ is a $l - 1$ dimension simplex.

3.2.6) Gittins Index

For each sender, there is a function $\gamma k(l,\ xk(l))$ called Gittins index [12], which is the function of sender l and its information state $xk(l)$. That is, the policy has an index rule: The sender with the largest Gittins index in time slot k acts as the active sender, i.e.,Activate sender q, where $q = \arg\max\ l\in\ 1,\ldots,L\ \gamma(l,\ xk(l))$. Thus, to solve the sender scheduling problem, computing the Gittins indices is the key step, which is described in the following. The Gittins index for each sender l is off-line computed and independent on the other $L-1$ senders. The computation can be solved with dynamic programming formulation. For each sender l, let a positive real number $M(l)$ for each potential sender l denote a positive real number:

$$0 \leq M(l) \leq \bar{M}(l),\ \ \bar{M}(l) = \max_{i \in U_l} \frac{R(s^k(l) = i, a^k = l)}{1 - \beta}.$$

For simplification, we omit the l in $M(l)$ and $\bar{M}(l)$ and the superscript k in $xk(l)$. Thus the Gittins index of sender l with information state $x(l)$ can be written as $\gamma(l, x(l)) = \min\{M : V\ l(x(l), M) = M\}$, where $V\ l(x(l), M)$ is the value function for sender l. Let $\gamma K(l, x(l))$ denote the approximate Gittins index, $\gamma K(l, x(l)) = \min\{M : V\ l,K\ (x(l), M) = M\}$.

3.2.7) Steps to Carry out Project Work

Optimal Sender Scheduling: The proposed distributed optimal sender scheduling algorithm is practical in real wireless mobile peer-to-peer networks. The physical, MAC and network layer protocols are not specified, thus the proposed scheme could be used for various technologies based peer-to-peer networks *A*.

Scheduling Process*:* The optimal sender scheduling for providing the maximized receiving bit rate and network life time. The *L* potential senders found by P2P lookup protocol cooperate with each other in a distributed manner, without additional computational complexity of the receiver. The requested multimedia file is divided into fragments. The time period of the multimedia transmission is also divided into time slots. Each time slot corresponds to one file fragment. We formulate the problem of dynamically choosing which sender among the potential senders should be active as a multi-armed bandit problem. Sender l calculates its Gittins index $\gamma^K(l, x^k(l))$ in time slot *K*, and then shares $\gamma^K(l, x^{k+1}(l))$ with the other $L-1$ potential senders by a multicast algorithm, in each time slot, only the sender who has the largest index is scheduled to transmit the file fragment corresponding to the time slot *K* to the receiver.

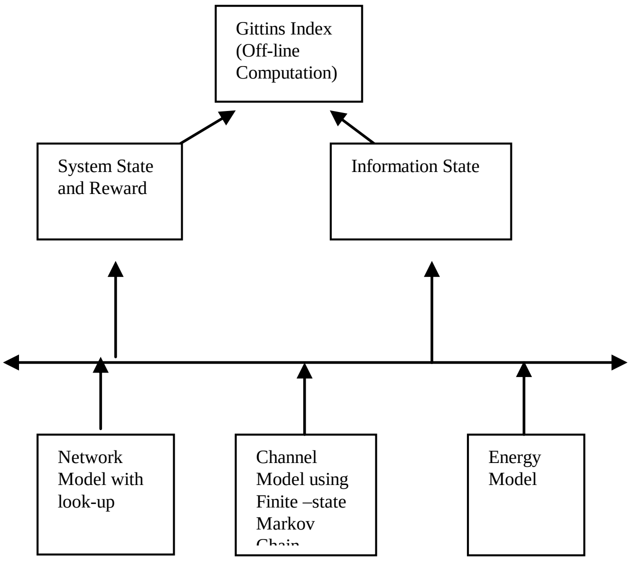
To gather the necessary information for providing observations, the receiver multicasts a message to all *L* potential senders before the sender selection process in each time slot, so that the potential senders can obtain y_C^k between the receiver and themselves. y_E^k Can be observed by reading local devices. We also use the DMEM algorithm for multicasting.

The process for the multimedia transmission in the wireless mobile P2P network includes off-line computation and realtime scheduling.

1) Off-line Computation of Gittins Index

1) For each sender $l = 1, 2, \ldots, L$, **input:** $A(l)$ {Transition probability matrix}, $B(l)$ {Observation probability matrix}, $R(l)$ {Reward vector}, $x^0(l)$ {A priori state estimate at time 0}, *K* {Horizon length}, and β{Discount factor}, then off-line compute a finite set of vectors $\Lambda^N(l)$ and have the vectors stored in the index tables.

2) At time *K* = 0, compute $\gamma^K(l, x^0(l))$.



2) Real-time Sender Scheduling over Horizon K

Three types of message are introduced in the real-time scheduling process.

INITIAL-TRANSMISSION-REQUEST (ITREQ) message is sent at the beginning of the process from the receiver to all the potential senders for indicating the sender addresses. The length of this message is 4*L* bytes that contain *L* IP addresses.

INITIAL-SENDER-INDICES-MULTICAST (ISIMUL) message is sent at the beginning of the process among the *L* senders to make sure each sender has the knowledge of the indices of the others. The length of this message is 8 bytes that contain an eight-byte length index fields.

SENDER-INDEX-MULTICAST (SIMUL) messages are sent at the beginning of the time slots from the active sender in the former time slot if its state changed. The length of this message is 8 bytes that contain one eight byte length index field.

With the three types of the new message, the on-line sender scheduling is described in below.

Multicasting and Scheduling

1) The receiver executes a P2P lookup protocol to find the desired file, and then the address list of the *L* potential senders is sent to the receiver. According to the length of the multimedia file, the receiver calculates the number of file fragments.

2) At *K* = 0, the receiver multicasts the ITREQ message as the request of the first fragment to all □ potential senders using a multicast algorithm. The address list of all potential senders is included in the request. Each sender $l = 1, 2, . . ., L$ decides $\gamma^K(l, x^0(l))$ according to its index table, and multicasts the index in the ISIMUL message to the others senders, using the multicast algorithm.

3) Each sender stores the *L*-dimensional vector (a^k, γ), where a^k is the active sender and γ is the vector of Gittins indices of the *L* senders, arranged in descending order, i.e. $\gamma = (\gamma(1, x^k(1)), \gamma(2, x^k(2)), \ldots, \gamma(L, x^k(L))),$ where $\gamma(1, x^k(1))$ is the sender that has the largest Gittins index.

4) Sender 1 transmits the requested fragment to the receiver as the active sender.

5) At the beginning of the next time slot, sender 1 obtains the observation $y^{k+1}(1)$ from the detector, updates the state estimation, and then looks up the index table to decide its $\gamma^K(1, x^{k+1}(1))$.

6) Keep the Gittins indices unchanged for the other senders $q = 2, 3, \ldots, L$.

7) If $\gamma^K(1, x^{k+1}(1)) \quad \geq \quad \gamma^K(1, x^k(1))$, ender 1 will continue to be active. Else, if $\gamma^K(1, x^{k+1}(1))$ $<\gamma^K(1, x^k(1))$, sender 1 will multicast $\gamma^K(l, x^{k+1}(1))$ in the SIMUL message to other potential senders and become a passive sender.

8) Go to Step 3 to rearrange the vector in each potential sender, until the last fragment is successfully transmitted.

Multicasting

The multicast algorithm used is not restricted to any special one. All network layer multicast algorithms for ad-hoc networks can be used. In order to send any kind of the word "Multicast" is typically used to refer to *IP Multicast*, which is a protocol for efficiently datagram in Java, be it unicast, broadcast or multicast, one needs a *java.net.DatagramSocket* :*DatagramSocket socket = new DatagramSocket();*sending to multiple receivers at the same time on TCP/IP networks, by use of a multicast address.

IV EXPERIMENTAL SETUP

Maximum 4 nodes in wireless ad-hoc network, using wireless ad-hoc network. One node requesting for the multimedia file. All nodes are potential senders sharing their index value. Following flow explains the whole process:

4.1 Testing

We show the Gittins Indices of the two senders in the simulation examples. There are two channel states: bad and good. The residual energy has two states as well: low and high. Thus, there are four states for each sender: low energy with bad channel (b0c0), low energy with good channel (b0c1), high energy with bad channel (b1c0), and high energy with good channel (b1c1). For the senders of Type I, the transition probability matrix of the residual energy is $A_E(1)$ and the transition probability matrix of the channel is $A_C(1)$.

Four observations are available corresponding to the four states. However, the observation is not accurate. We assume there're 10% chance to have a false observation for each variable. The lowest receiving data rate of 100 Kbits/s can be obtained when the sender is in state b0c0, and the highest receiving data rate of 500 Kbits/s is obtained when in state b1c1. The reward matrices of Type I and Type II senders when active are: $R(1) = R(2) = (\ 100 \quad 300 \quad 400 \quad 500\ )'$. Set the discount $\beta = 0.8$. The matrices $\overline{A}(1), \overline{A}(2), \overline{B}(1), \overline{B}(2), \overline{R}(1)$ and $\overline{R}(2)$ can be calculated.

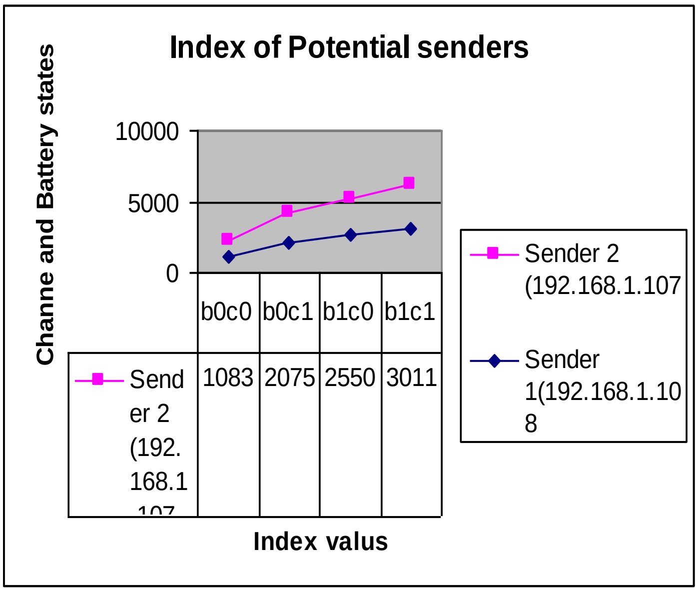
4.2 Results

With the computed Gittins Indices, an optimal series of actions (policy) can be obtained. We simulate a 40-time slot process for the system. We can see the states, observations and Gittins indices of the two senders. In addition, we simulate the system no. of times and calculate the expected receiving bit rate (reward) of each step.

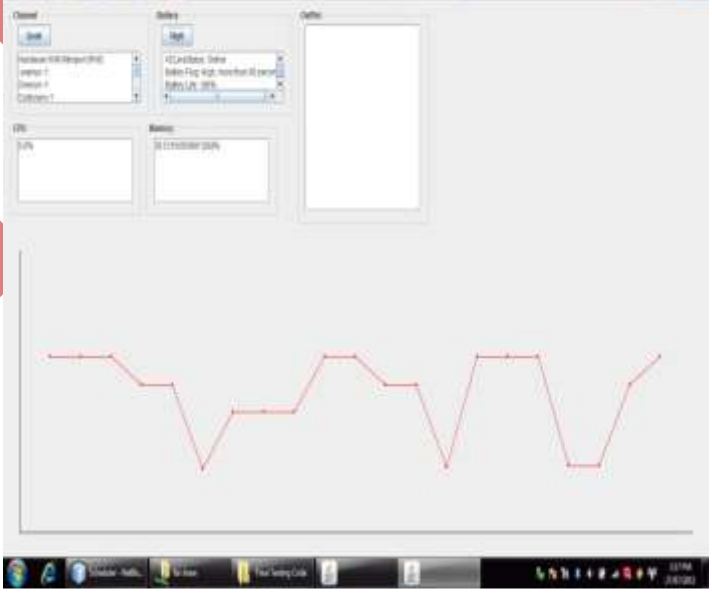
In addition, we compare the bit rate in each time slot in the proposed scheme with that in the existing selection scheme of potential senders for 50 time slots, with R(1) = (100 300 200 500) and

In our simulation, we consider two other sender selection schemes. The first one is called "Always-Select-the-Best" scheme, in which the sender that could obtain the highest reward in last time slot is selected as the active sender in the current time slot. The second one is simply selecting one sender in a random fashion at the beginning of each time slot.

As soon as file is requested by the receiver (requester) all senders trying to get index value of that sender, compare the index value with each other and sender will be selected having largest index. The following graph compares the index value of 2 sendes.



Index of sender sending data to receiver: Graph of Index value of sender by changing the battery and channel states manuaaly



V CONCLUSION AND FUTURE WORK

In wireless mobile P2P networks, with the optimization goal of maximizing the receiving bit rate of the multimedia receiver, and the life time of the network, we have studied the multiple potential sender scheduling problems. This problem was formulated as a multi-armed bandit system. The proposed optimal algorithm to decide which sender should be active in the given time slot, so that the optimization goal can be achieved. The entire process of the transmission was also discussed. Simulation results demonstrated that the Gittins index based optimal policy enables the receiving bit rate and the life time of the network to be increased significantly.

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