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WIRELESS RESOURCE SCHEDULING BASED ON BACKOFF-BASED WIRELESS RESOURCE SCHEDULING IN MOBILE CLOUD COMPUTING

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Abstract:

Mobile cloud computing (MCC) can significantly improve the processing/storage capacity and standby time of mobile terminals by migrating data processing and storage to the re-mote cloud. However, due to the wireless resource limitations of access points/base stations, data streaming of MCC suffers poor quality-of-service (QoS) in multiuser multiservice scenarios, such as long buffering time and intermittent disruptions. In this paper, we propose a backoff-based wireless resource scheduling (BWRS) scheme, in which real-time services have higher priority than non-real-time services. BWRS can improve the QoS of real-time streams and the overall performance of MCC networks. We formulate an M/M/1 queueing model and propose a queueing-delay-optimal control algorithm to minimize the average queueing delay of non-real-time services.

Index Terms: Access Control, Agent, Cloud Computing, Markov Chain, Mobile Terminal (MT) & Queueing Delay.

Introduction:

Cloud computing is the trend in which resources are provided to a local client on an on-demand basis, usually by means of the . Mobile cloud computing (MCC) is simply cloud computing in which at least some of the devices involved are mobile. This paper goes over multiple techniques and methods for mobile cloud computing. It explores both general-purpose mobile cloud computing solutions and application-specific solutions. It also discusses instances of mobile cloud computing where mobile devices serve as the cloud rather than the client. MCC uses computational augmentation approaches (computations are executed remotely instead of on the device) by which resource-constraint mobile devices can utilize computational resources of varied cloud-based resources. In MCC, there are four types of cloud-based resources, namely distant immobile clouds, proximate immobile computing entities, proximate mobile computing entities, and hybrid (combination of the other three model). Giant clouds such as Amazon EC2 are in the distant immobile groups whereas or surrogates are member of proximate immobile computing entities. Smart phones, tablets, handheld devices, and wearable computing devices are part of the third group of cloud-based resources which is proximate mobile computing entities.

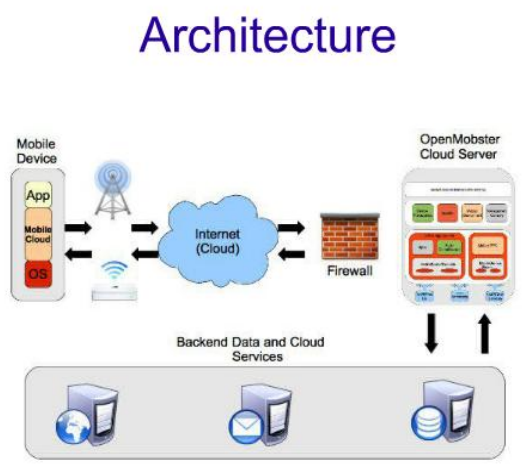

Figure 1: Architecture of Mobile cloud computing

The main contributions of this work can be summarized as follows. A backoff-based wireless resource scheduling scheme to deal with multiuser multiservice access in the MCC networks. Develop a queuing model, considering wireless re-source demand of different users with different types of services. The blocking probability of real-time and the queueing delay of non-real-time services are analyzed based on the proposed queue model. A queueing control algorithm for non-real-time services with minimized expected queueing delay using convex optimization theory. Furthermore, with the given delay constraints of non-real-time services, we propose a matching algorithm to meet individual delay constraint. The performances of BWRS scheme and the proposed algorithms are comprehensively evaluated.

Related Works:

The resource scheduling in wireless networks can be divided into two major categories, i.e., service class based and user based resource scheduling. In the user based resource scheduling, network providers allocate wireless resources to mobile users, aiming at maximizing the utilization of wireless resources. There are two approaches that have been proposed, i.e., priority based and fairness based. The former allocates the wireless resources to users considering their priorities. This scheme improves the quality of experience, but gives low channel utilization. The user fairness scheme allocates wireless resources to users fairly and dispatches data from user to services efficiently by maximizing the users utility. Correspondingly, it is more difficult for the users with higher service rate to guarantee their QoS requirements. For the service-class-based resource scheduling, limited available wireless resources must be allocated to different types of services, which are presumably operated by different ser-vice providers. Several service-class-based resource scheduling approaches were proposed in the literature. Some traditional methods tried to allocate resource using complete sharing (CS) scheme which always allows the services to access to the network when the resource is sufficient. Represented a suitable mobility model, in which new calls are blocked while handoff calls are queued. In, Fang and Zhang proposed the new call bounding scheme, which used guard channels to assign higher priority to handoff calls over new calls. The CS scheme achieves high resource utilization, whereas the QoS of a certain type of services cannot be guaranteed. Alternative approaches may use complete partitioning (CP) schemes which allocate certain resources to each type of services.

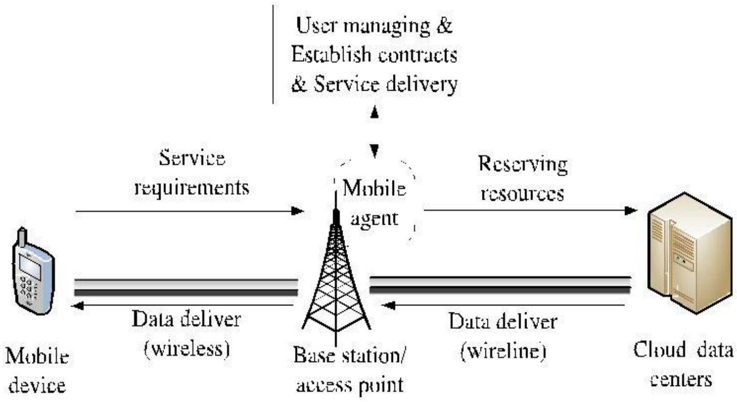

Figure 2: Service request process for agent-based MCC

Wireless Resource Scheduling and Problem Formulation:

BWRS Scheme:

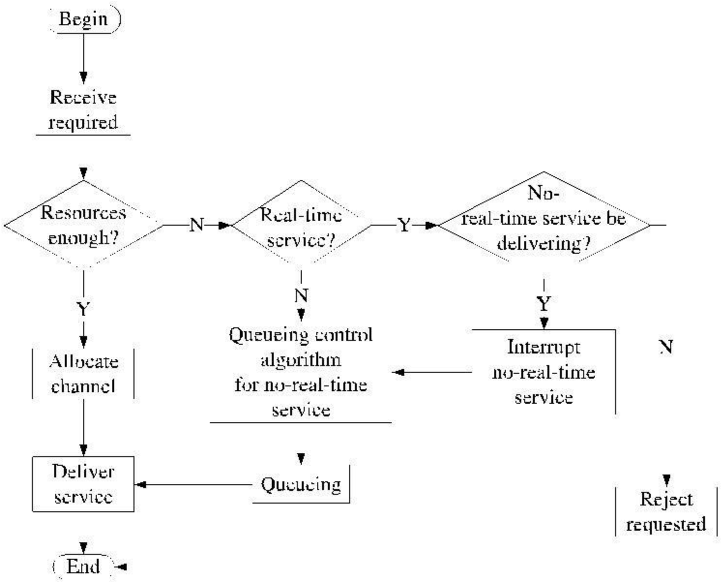

Figure 3: Flowchart of the BWRS scheme

MCC could integrate WiFi, fourth-generation (4G) Long-Term Evolution (LTE) and more cellular technology as a wireless access network. For different wireless access technique, the wireless resources, such time and frequency are scheduled with different method. In WiFi, we schedule wireless resources by transmission time's. In 4G LTE, we the wireless resources are scheduled with time slots and/or sub-carriers. In MCC, the wireless resources are scheduled with virtual channel which can be abstracted form Transmission time, time slot for sub-carrier. According to assume that the wireless bandwidth (or channel) allocation for a service (real-time or non-real-time) is normalized with respect to a basic unit. Such basic unit is referred to as a wireless channel. For simplicity, in this paper, we only considered the users are static or mobile with a low speed. The high-speed users will cause fast fading of channels, more Doppler shift and rapid change of network topology, the channel resource is different from the case of static or mobile with a low speed. In fact, the wireless resource scheduling for the high-speed users is more complicated case and beyond the scope of this article; therefore, we will dealt with it in the future work. Let N denote the total number of channels (i.e., total available radio resources) of a BS/AP. In our BWRS scheme, real-time services have higher priority than non-real-time services, which means that the real-time service requests can preempt non-real-time services channels. A mobile agent stores such non-real-time services and transfers unpunished non-real-time services.

The proposed scheme performs the resource scheduling as soon as a service arrives at an associated BS or AP, After a new service request arrives, the mobile agent checks whether there are channels satisfying the request. If there are enough idle channels, the mobile agent initializes the remote computing modules of a server in the cloud data center. Then, this mobile service starts running. If the channel resource is not enough to serve the new request, the mobile agent should decide whether this new service request is a real-time service. If required service is a non-real-time service, then it puts this service in channel queues according to a queuing algorithm (as proposed in the following section). If the new service request is real-time service, then the mobile agent will further decide whether it is serving non-real-time service. If it is not delivering non-real-time service at this moment, then the mobile agent rejects this service request. If the mobile agent is delivering non-real-time services, then it interrupts a non-real-time service and accepts this new real-time service request, the mobile agent will schedule the resource when a service arrives.

Symbol	Description
ξ_1^i / ξ_0^i	The expectation of arrival / leave rate for real-time service in channel i
λ_{n-i}	The expectation of arrival for non-real-time service packets of ith user
λ_n / λ_r	The total arrival rate of non-real-time / real-time services
μ_n^i	The exponential of service time for non-real-time service pack -ets in channel i
$E[T^i]$	The expected queueing delay of non-real-time services at chan -nel i
$E[T]$	The expected queueing delay of the non-real-time services ove -r N channels
P_0/P_1	The steady-state probability of channel at the state ON / OFF
ρ^i	The real-time services intensity of user i
$\vec{\lambda}$	The predetermined vector of non-real-time services
$\vec{\lambda}^*$	The optimal predetermined vector of non-real-time services
Q^j	The queue if channel j
$E[T^i]$	The expected queueing delay of non-real-time services at chan -nel i
$E[T]$	The expected queueing delay of non-real-time services over N channels

Table 1: Notations in the BWRS Scheme

Problem Analysis and Formulation:

For the convenience of presentation, the notations used in the following discussion are listed in Table I. To simplify our analysis, let us consider a multiuser multiservice scenario, where N mobile users are connected to a BS or AP. There are N channels between the mobile users and BS (i.e., each mobile user has a dedicated channel). Assume that the mobile agent can deliver real-time services to users on its dedicated channels, while delivering the non-real-time services in any channel j's queue Q^j to minimize its average queueing delay.

Queueing-Delay-Optimal Control Algorithm:

For channel i, we use a Markov ON/OFF channel model to analyze the expected queueing delay $E[T^i]$, where the state ON in denotes that the real-time service is absent in channel i, and the state OFF denotes the real-time service is present in channel i. Let the arrivals of real-time services obey a Poisson process with its intensity ξ_1^i, and let leave of real-time services obey an exponential distribution with its intensity ξ_0^i. Then, the channel at the state ON tends to jump to the state OFF with ξ_1^i, and the reverse happens with ξ_0^i. We further assume that the service time of non-real-time service packets in channel i follows an exponential distribution with its rate μ^i_n.

Algorithm 1 QDOC Algorithm.

Input: $\vec{\xi} = \{\xi_l^i | 1 \le i \le N, l = 0 \text{ or } 1\}$, $\vec{\mu}_n = \{\mu_n^i | 1 \le i \le N\}$, $\vec{\lambda}_n = \{\lambda_{n-i} | 1 \le i \le N\}$
Output: $\vec{\lambda}^* = \{\lambda^{*(1)}, \lambda^{*(2)}, \ldots, \lambda^{*(i^*)}\}$
Initialization: $i^* = 1$, $\lambda_n = 0$;
for (int $i = 1; i \le N; i++$) **do**
  Compute $\bar{\mu}_n^i = \mu_n^i P_0$, $\gamma^i = \frac{\xi_0^i + \xi_0^i + \mu_n^i P_1}{\xi_0^i + \xi_0^i}$, $\lambda_n = \lambda_n + \lambda_{n-i}$;
  Compute $q^i = \frac{\gamma^i}{\bar{\mu}_n^i}$;
end for
$q_j = q^i$ and sort $q_1 \le q_2 \cdots \le q_N$;
for (int $i^* = 1; i^* \le N; i^*++$) **do**
  Compute $\alpha^* = \left(\frac{\sum_{i=1}^{i^*} \gamma^i \bar{\mu}_n^i}{\sum_{i=1}^{i^*} \bar{\mu}_n^i - \lambda_n}\right)^2$
  if $q_{i^*} < \alpha^* \le q_{i^*+1}$ **then**
    Return i^* and α^*;
  end if
end for
for (int $i = 1; i \le i^*; i++$) **do**
  Compute $\lambda^{*(i)} = \bar{\mu}_n^i - (\sqrt{\gamma^i \bar{\mu}_n^i} / \sqrt{\alpha^*})$;
end for

Simulation Results:

The performance of the proposed scheme and algorithms through MATLAB simulations. We also com-pare proposed scheme with the prioritized bandwidth adaptive (PBA) scheme and the dual threshold bandwidth reservation (DTBR) scheme. To make the comparison more convenient, we adopt mobile games and mobile multimedia applications to represent real-time or non-real-time, respectively. The MCC system for the simulation is composed of a cloud date center and mobile internet. Let us consider MCC system support users by a base station with eleven channels. The services that are offered by the cloud data center need to allocate the wireless channels to the mobile users. The MCC system executes the wireless channels scheduling to users when the users subscribe services on the cloud.

Evoluation of BWRS Scheme:

Let us consider an eleven-channel system with following traffic parameters. For real-time service traffic, $\xi_1^1 = \xi_1^2 = \cdots = \xi_1^{11} = 0.05$, $\xi_0^1 = 0.1466$, $\xi_0^2 = 0.1416$, $\xi_0^3 = 0.1366$, $\xi_0^4 = 0.1316$, $\xi_0^5 = 0.1266$, $\xi_0^6 = 0.1216$, $\xi_0^7 = 0.1166$, $\xi_0^8 = 0.1116$, $\xi_0^9 = 0.1066$, $\xi_0^{10} = 0.1016$, and $\xi_0^{11} = 0.0966$. For non-real-time service traffic, we assume that non-real-time service arrival rates of all mobile users are the same. Moreover, the coefficients of queueing delay are $A = 3.2$ and $\tau_0 = 3.5$. Assume that serving rate of every channel for non-real-time services is the same and equal to 0.2. We vary the total non-real-time service arrival rate λ_n from 0.001 to 0.4. Fig. 5 shows each channel is assigned to non-real-time service, as a function of λ_n, where the channel index denotes the channel occupation rate by real-time services in an ascending order of $\gamma/\bar{\mu}_n$. We can see that a part of channels are not assigned to non-real-time services when λ_n is lower than 0.23, which is due to the fact that QDOC prefers to select better channels for minimizing the queueing delay. For example, when λ_n =0.06, the optimal λ is (0.0083, 0.0068, 0.0053, 0.0036, 0.0019, 0.0001, 0, 0, 0, 0, 0), which means that only six channels 1, 2, 3, 4, 5, and 6 are assigned to non-real-time services. This is consistent with Lemma 3. Moreover, as λ_n increases, non-real-time services tend to select more other channels to transmit data to balance the traffic loads in different channels and to reduce the queueing delay. Furthermore, with a λ_n, the number of channels assigned to non-real-time services reduces steadily with the increase of $\gamma/\bar{\mu}_n$, which varies the average queueing delay.

Conclusion:

In this paper, we have proposed a new channel scheduling method for its applications in multiuser multiservice scenarios in MCC networks. This new scheme employs a backoff mechanism and QDOC algotithm used to integrate real-time services with non-real-time services in the same channel. Simulation results showed that our proposed scheme can improves network performance signficantly in terms of blocking probability and queueing delay, and it also offers greater channel utilization. In the future, we will implement our proposed scheme on an MCC testbed.

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