Power-Aware Replacement Algorithm to Deliver Dynamic Mobile Contents

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Abstract. As more and more users are using wireless network to access Web contents, the power awareness issue becomes one of the most important concerns for Mobile contents delivery networks (MCDN). Unnecessary power dissipation always brings the disconnection and delay during the time of wireless access. Replacement algorithm is looked upon as one solution to resolve this problem. However, most of the current replacement algorithms have not been taken the power-awareness into consideration. Therefore, in this paper we design a new method where a novel power-aware algorithm is proposed. Both theory analysis and simulations improve that our proposal can outperform other conventional methods.

Keywords: Mobile Contents, Contents Processing, Network Architecture, Power Aware, Replacement Algorithm.

1 Introduction

Mobile contents delivery network (MCDN) has emerged as a promising alternation to the conventional client-server based networks, by distributing the replicas of mobile contents onto a group of mobile nodes geographically. However, with the recent progress of mobile technology, more and more dynamic contents are being delivered by mobile users and need to be controlled [3]-[10].

For example, with posting the dynamically changing contents such as online auction or advertisements, because these contents are updated frequently on their original servers, how to replace the old version of these replicas on different mobile nodes becomes very important. If the unused contents can not be replaced with other new contents on time, it will cause a waste of power capacity since these contents may not be requested by users.

The above problem is called mobile contents replacement and plays an important role in the performance of the MCND. But the conventional replacement methods are almost for the wired network and can not be directly applied into the mobile environment.
Therefore, this paper proposes a novel replacement algorithm for the MCDN. Note that this proposal is not designed for the consistency control to update the contents, while this paper is to decide which replica in a given mobile node should be removed completely from the mobile node to make room for the newly coming contents. We firstly make a theoretical analysis of the distribution of mobile contents. Then, based on the result of analysis, we present the proposed algorithm for replacement. Finally, we test the proposal by simulation experiments. The results show that our proposal can outperform other conventional method, where the capacity resource can be used more efficiently.

2 Theory Analysis

2.1 Parameters Definition

For each mobile node \( i \) (\( i = 1, \ldots, I \)) in a MCDN, \( O_i \) is defined as its capacity and \( \lambda_i \) (bytes/second) denotes an aggregate request rate from the clients to this node. The total number of contents delivered in the MCDN is \( J \). For each content \( j \) (\( j = 1, \ldots, J \)), let \( h_j \) define the request probability that this content is requested by clients. Its data size is defined as \( b_j \).

The Request Routing (RR) function is available in each node in the mobile networks, where this RR function keeps the residence time value \( x_{q,i} \) of each client \( q \) (\( q = 1, \ldots, Q \)) in node \( i \)'s zone. The local data provided by the RR function can be described by

\[
X = \begin{bmatrix}
    x_{1,1} & \cdots & x_{1,J} \\
    \vdots & \ddots & \vdots \\
    x_{Q,1} & \cdots & x_{Q,J}
\end{bmatrix}
\]

(1)

A matrix \( G \) represents the placement pattern of different contents on different nodes by:

\[
G = \begin{bmatrix}
    g_{1,1} & \cdots & g_{1,J} \\
    \vdots & \ddots & \vdots \\
    g_{I,1} & \cdots & g_{I,J}
\end{bmatrix}
\]

(2)

where \( g_{i,j} \) in the above matrix takes a binary value as follows.

\[ g_{i,j} = 1 \text{ (if the replica of content } j \text{ is available in node } i) \]

\[ g_{i,j} = 0 \text{ (otherwise)} \]

(3)

Assume that the exhausted power to fetch the content \( j \) from its original sever is \( C \), in the case that content \( j \) is not available in the node \( i \), which it is requested by client \( q \). Then we can get the total exhausted power to be: