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Precaching of Incomplete Content and Its On Demand Completion

Bart Thomee

PRECACHING OF INCOMPLETE CONTENT AND ITS ON DEMAND COMPLETION

A content item service may provide content items (e.g., videos, songs, audiobooks, etc.) to users. For example, the content items may be streamed or otherwise provided or rendered to the users. The providing of the content item can be interrupted in response to network bandwidth issues of the user. For example, if a device of the user is currently streaming a content item from a server of the content item service and the network bandwidth of the device of the user decreases or the user device's network service is dropped or suspended, then the quality of the content item may be degraded or the content item may stop playing. Similarly, if the user is in a location that does not have network access, then the device of the user may not be able to receive content items from the content item service.

We propose a mechanism that utilizes a pre-caching of the content items before the user views content items provided by the content item service. For example, portions of a content item may be provided to a user while other portions of the content item are withheld from the user. The withheld portions of the content item may be portions of the video, portions of frames of the video, portions of audio, portions of an e-book, or any other segment of a content item. The user may download or pre-cache most of the content item, but may not be provided the withheld portions until a later time such as when the user begins streaming or playing the content item. This mechanism can thus reduce issues with network bandwidth as the device of the user can download and pre-cache most of the content item before the content item is to be streamed or provided to the device of the user. Furthermore, since the device of the user does not download the entire content item, a content owner who owns the content item may be assured that the content item in its entirety will not be easily copied. The content item service providing the content item may also optimize its own network bandwidth or traffic by providing most of the

content item to the user during times of low network demand and providing the withheld portions of the content item during times of higher network demand as the withheld portions may be smaller in size than the rest of the content item.

In an implementation, a majority of a content item may be provided to and pre-cached by a device of a user of a content item service that provides streaming of the content item and a minority of the content item may be withheld. The withheld portion of the content item can be bytes in a file, pixels in an image or video frame, sentences in a book, words in a document, scenes of a video, etc. The content item can be separated into the withheld portion and the pre-cached portion at the moment the user requests the content item from a server or the separation can be performed in advance of the user request.

Figure 1 depicts a flow diagram of a method to provide a content item to a device of a user (e.g., a smart phone, a PDA, a laptop, a personal computer, etc.) in a pre-cached portion and a withheld portion. First, at step 101, a content item may be separated into a first portion that is to be pre-cached by a device of the user and a second portion that is to be initially withheld from the device of the user. The content item may be separated into the different portions at random. Alternatively, the content item may be separated based on one or more rules that specify which portions of the content item should be initially withheld from a user. For example, if the content item is an e-book, then every third paragraph of a page of the e-book may be withheld. If the content item is a video, then a particular section of the frames of the video (e.g., the center) may be withheld. Other examples of withheld portions include, but are not limited to, dialogue spoken by a particular character, objects in the content item (e.g., cars or people being removed in a video), etc.

Next, at step 102, the first portion of the content item may be transmitted to the device of the user to be pre-cached by the device of the user. For example, the first portion of the content item may be stored in a memory of the device of the user. The first portion may be a majority or most of the content item.

Subsequently, at step 103, a request for the content item may be received from the user. For example, the user may have initiated playback of the content item for which the first portion has been pre-cached by the device of the user. At step 104, an instruction may be provided to the device of the user for playing the pre-cached portion of the content item.

Furthermore, at step 105, the second portion that was withheld from the user may be provided to the user in response to the playing of the pre-cached portion of the content item. In an implementation, the withheld portion may be identified based on an index that is provided to the user. The index may be provided to the device of the user when the first portion of the content item is also provided to the device of the user. The index may specify a listing or identify the withheld content throughout the content item and the device of the user may provide the request for the second portion that was withheld by using the index.

Furthermore, at step 106, the withheld portion may be combined with the pre-cached portion of the content item. For example, the various withheld portions may be combined into the pre-cached portion of the content item when the device of the user is playing the content item. In an implementation, the index may be used to identify the locations of the withheld or missing portions in the pre-cached portion of the content item and the withheld portions may be inserted into the locations. The combining of the withheld portion and the pre-cached portion may be performed before the content item is played for the user or may be performed as the content item is being played for the user. For example, in an implementation, the pre-cached

portion of the content item may include markers or other such identifiers within the pre-cached portion of the content item. The markers may identify the withheld portion that should be included or combined with the pre-cached portion of the content item and the location for which the withheld portion should be combined into the pre-cached portion. In such an implementation, the user's device may scan ahead of the playback of the content item to identify the next marker within the pre-cached portion so that the corresponding withheld portion may be requested and combined into the pre-cached portion at the location identified by the next marker. Thus, the withheld portion may be combined before the incomplete portion is scheduled to be played for the user.

In an implementation, if the user does not have access to the content item service via a network, then the client device of the user may synthesize or reconstruct the withheld portions of the content item. For example, a default content may be inserted into the location of the withheld portion (e.g., a default word or default image into the pre-cached portion). The default content may be specified based on a location of the withheld portion within the pre-cached portion. For example, black pixels may be inserted as default content at a first video frame and blue pixels may be inserted as a default content at a second video frame of the content item. In another implementation, the withheld content may be reconstructed or synthesized. A model may be used to reconstruct or synthesize the withheld content. For example, if the withheld portion corresponds to a particular actor's face in a video content item, then a model of the actor's face could be used to reconstruct the actor's face that has been withheld in the video content item (e.g., by using eigenvectors and eigenvalues in a computational model).

In another implementation, the withheld portions may be reconstructed by using other content (e.g., based on time, frequency, space, etc.) or a logical completion of the pre-cached

content (e.g., filling in the withheld portion based on the pre-cached portions that are adjacent). For example, if the word "scary" is withheld from a phrase "that's a scary dog," then the withheld word could be reconstructed by a speech synthesis algorithm that may generate the word "scary" in the same voice as the rest of the phrase "that's a scary dog." In such an example, the withheld portions may be separated from the pre-cached portion so that the withheld portions may not be easily reconstructed by an unauthorized entity seeking to copy the full content item.

The mechanism described herein allows a portion of a content item to be pre-cached by a device of a user so that the withheld portion of the content item may be provided to the user at a later time. Because the mechanism allows a majority of the content item to be pre-cached by the device of the user before the user attempts playback of the content item, the device of the user may download or obtain most of the content item at the user's convenience or during times of lower network bandwidth use. As a result, the device of the user may subsequently obtain the rest of the content item (e.g., the withheld portion) at a time of higher network bandwidth use. Since the device of the user is obtaining a smaller portion of the content item at such a time, the playback quality of the content item may not be significantly degraded during the times of higher network bandwidth use as the device of the user has previously pre-cached the majority of the content item.

ABSTRACT

A mechanism to separate a content item provided by a content item service into a first portion that is to be pre-cached by a device of a user and a second portion that is to be initially withheld from the device of the user. The first portion of the content item may correspond to a majority of the content item and may be transmitted to the device. Subsequently, the user may request playback of the content item. In response to the request, the device of the user may retrieve the second portion of the content item that was previously withheld from the user. The second portion may then be inserted into the first portion of the content item so that the complete content item may be played.

Keywords: caching, video, content, streaming, synthesis, reconstruction

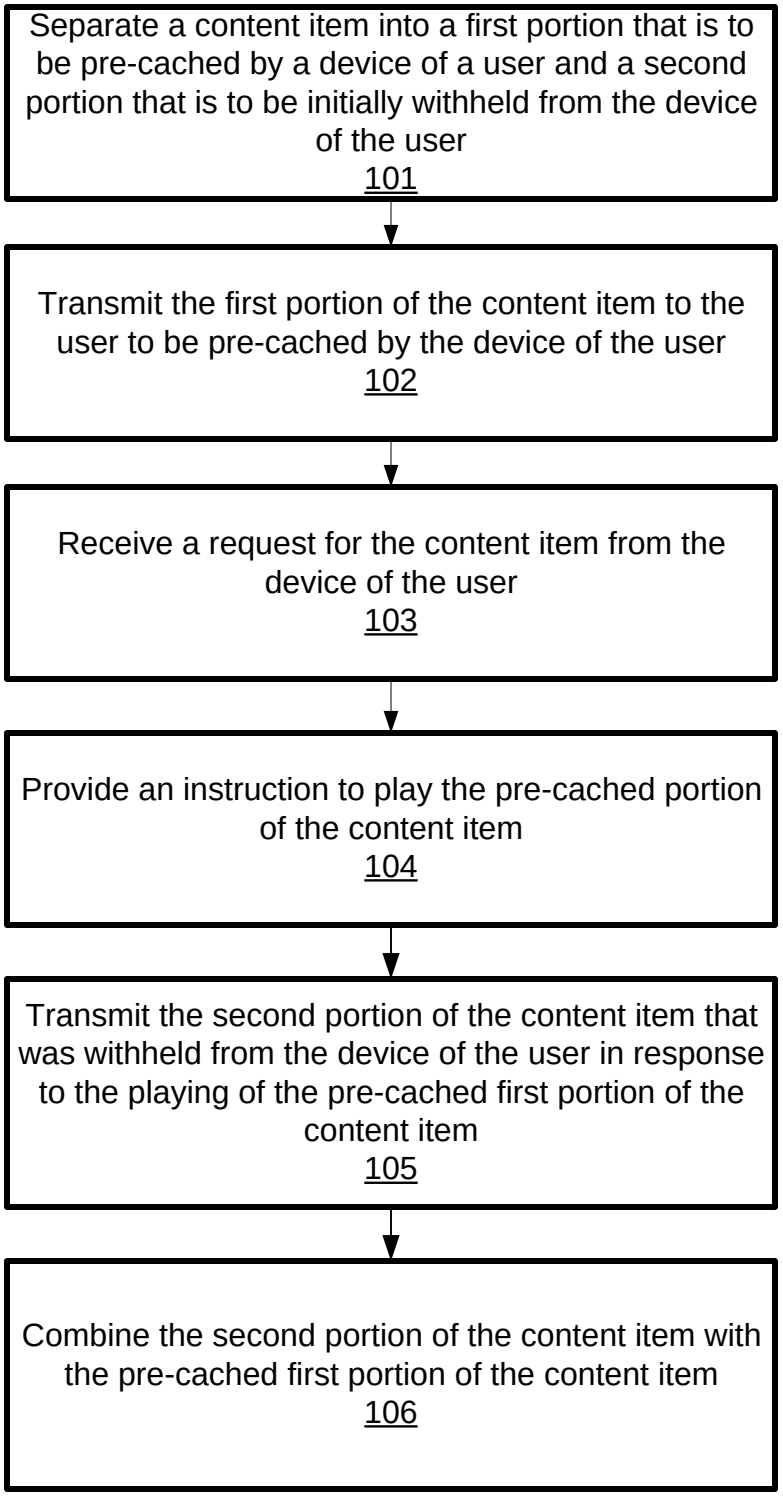
Separate a content item into a first portion that is to be pre-cached by a device of a user and a second portion that is to be initially withheld from the device of the user
101
Transmit the first portion of the content item to the user to be pre-cached by the device of the user
102
Receive a request for the content item from the device of the user
103
Provide an instruction to play the pre-cached portion of the content item
104
Transmit the second portion of the content item that was withheld from the device of the user in response to the playing of the pre-cached first portion of the content item
105
Combine the second portion of the content item with the pre-cached first portion of the content item
106

FIG. 1