Bandwidth Pooling

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ABSTRACT

Mobile data plans include a limit on data usage per billing cycle. Mobile service providers also restrict bandwidth per connection. Once data usage reaches the limit, the service provider takes actions such as disabling further data access, restricting speed of the connection, levying a higher billing rate, etc. Users of mobile data connections therefore face problems of respectively of affordability or convenience. This disclosure describes techniques that allow a user to share bandwidth and/or data with other users that participate in a bandwidth pool. For example, the other users can include other users that are interested in accessing the same online content. Members of a pool fetch individual content sections and locally share the content with other members. In this manner, both downloadable data and bandwidth, e.g., speed of connection, is effectively increased for each user of the pool without hitting limits and the resultant charges.

KEYWORDS

Resource pooling; mobile data; usage caps; remote co-offlining

BACKGROUND

Wireless service providers typically have limits on the bandwidth and/or data usage. Data usage limits depend on the plan selected by the user, and service providers impose bandwidth restrictions, e.g., for network management. On occasion a user’s connection may hit a limit, at which point the service provider usually charges at a higher rate, or downgrades service, e.g., reduce bandwidth. This causes for the user a problem of affordability or convenience or both.
DESCRIPTION

This disclosure describes techniques to pool user resources, e.g., bandwidth, data, etc., to access online content. Multiple users that wish to access a particular online content or otherwise make their connections available (e.g., to friends) communicate with other users to form a pool. This creation of this pool can be enabled or coordinated by software, e.g., by a smartphone app. Such an app has features that allow users to confirm and authenticate other users that are identified as members of the pool. The app is configurable such that pool requests are received only from users that satisfy certain criteria, e.g., known users, users that are at the same location, users that are connected via a social network, etc. Users are provided options to decline membership to pools, and are made members of a pool only upon explicit consent. Access to, or use of, personal information, e.g., user data, device identity, information about a user’s social network, location, time, etc. is utilized only upon user’s explicit consent. The extent to which such information is accessed or used is controlled at all times by the user.

Once a pool is formed, members of the pool access, e.g., download, various sections of the online content. Sections of the online media are shared amongst members of the pool, so that each member eventually has access to the entire content. A user that is a member of the pool also experiences effectively a higher bandwidth, e.g., when different sections of the same online content are simultaneously downloaded by different members of the pool. Once a section of online content is obtained by a member of the pool, it is shared amongst other members in a variety of ways.

If pool members are in close proximity to each other, user devices of the pool members locally exchange the content sections \( t \), enabling each pool member to access the content. Such local exchange of data is over short-range wireless technologies that are typically high
bandwidth and low cost, e.g., Bluetooth® or Wi-Fi®. If pool members are not in close proximity, the devices obtain other sections of the content at a next occasion when the devices are in physical proximity.

Fig. 1: Bandwidth and data pooling

Fig. 1 illustrates a network with bandwidth and data pooling, per techniques of this disclosure. Users of devices (e.g., wearable devices, smartphones, tablets, computers, etc.) 102a-c wish to access certain online content. The user devices each have an app 104 that enables the devices to form a pool, if permitted by the respective users. Membership to the pool is granted to specifically upon confirmation and authentication by existing members of the pool. Such confirmation and authentication is performed by app 104. Confirmation is two-way.

App 104 is configurable so that requests for pooling are received only from users that satisfy certain criteria, e.g., individuals on a user’s contact list or social network, users at the same location, etc. Users are provided options to decline membership to pools, and user devices participate in a pool only upon specific user consent. Online content that is identified for download is split among the member devices of the pool. Splitting may be performed based on
parameters received from each device, e.g., cost per MB, speed of connection, bandwidth, data remaining in the billing cycle, maximum amount of data and bandwidth allocable to the pool, etc. The split of content amongst members of the pool is coordinated by app 104. Each mobile device communicates with respective wireless service provider 106-108 to download the section of online content that has been assigned to it.

Connection to a service provider may be done over metered channels 110-114 using, for example, a 2G, 3G, 4G, LTE, or other wireless technology. Once a member device downloads relevant sections of online content, it is shared over local channels 116-120 content with other member devices. Channels 116-120 are, for example, local area networks that employ short-range and/or high-bandwidth connections that are unmetered, e.g., free. In this illustration, channels 116-120 represent offline exchange between member devices. For example, when member devices are unable to communicate over a local connection (e.g., when pool members aren’t in physical proximity) the exchange of respective sections of content is performed at a later time when local communication is possible (e.g., when the respective users meet).

Once a member device receives sections of online content from other member devices in the pool, it can stitch together the entire online content. However, viewing of the content can begin before stitching is completed, e.g., if permitted by the content owner. Stitching of sections of online content can be performed automatically by app 104. In order to guard against spoofing, content received by a user from a pool member for the purpose of stitching is authenticated, verified, and confirmed to be the original online content. While Fig. 1 shows a pool with multiple members each accessing a portion of the content, it is also possible for any one of the devices to act as a master hub, and designate a secondary master, e.g., in case of failure. Further, the local network over which content is exchanged between member devices of
the pool is fault-tolerant to enable the pool to function in case of one or more of the member devices fail, e.g., without the need to break and reformulate the pool.

**Fig. 2: Bandwidth pooling between multiple devices**

Fig. 2 shows the communications interchange that occurs during pool formation, and download and local exchange of online content by pool members. Devices belonging to Alice (202), Bob (204) and Charlie (206) form a pool to download online content from a server (208). Alice sends a request (210) to Bob and Charlie to form a pool to download the online content. Bob and Charlie each accept (212) the request to form a pool. In this example, requests to potential pool members are accepted; however, a user is presented options so that they can
accept or decline such requests. Upon acceptance, the devices of Alice, Bob and Charlie form the pool (214). Once the pool is formed, different sections of online content (216) are accessed by each respective from the server. The server responds (218) by sending each pool member the respective requested section. Member devices then exchange (220) individual sections with other devices of the pool. Individual devices then stitch sections together to assemble the entire online content (222).

Examples of use

Example 1. Streaming on poor networks: Alice wants to stream a video but is on a relatively low-bandwidth connection, e.g., a 2G connection. She is near other users, each with their own connectivity to wireless service providers. She requests these other users to join her bandwidth pool. Those users that consent to her request jointly download sections of the video along with her, and transfer (e.g., stream) their sections to her over a fast local-area network. In this example, different packets of the data stream that comprises the video are offlined to different devices that contribute to the pool such that they can be stitched together at Alice’s device. Continuous playback is possible without interruption, if the respective connections of pool-members to their wireless service providers remain somewhat uniform. Thus, Alice experiences a high-bandwidth connection based on multiple low bandwidth connections.

Example 2. Data usage management: Alice and Bob both want to download a video from a video-sharing website. The video is 14 MB in size; however, Alice and Bob each have only 10 MB left in their respective data plans for the current billing cycle. With mutual consent, they form a pool for the purpose of downloading the video. Through mechanisms of the pool, e.g., through a smartphone app that coordinates pooling, Bob and Alice indicate the amount of data they are willing to respectively contribute to the pool. Alice indicates that she can contribute up
to 8 MB and Bob indicates that he can contribute unto 6 MB. The video is partitioned into two sections, one of size 8 MB and the other 6 MB, and is respectively downloaded by Alice’s and Bob’s devices. Once sections of the video are downloaded, these are locally exchanged between Alice and Bob through fast, unmetered local connections, swapping of memory cards, etc. At each of Alice’s and Bob’s devices, sections are stitched together, so that Alice and Bob now both have the entire 14 MB video. Each user thus gains access to the entire 14 MB video without hitting respective data-usage limits. Viewing of sections of the video can be done even prior to stitching of the sections of the video, or even prior to complete download of just a single section of the video, if permitted by DRM policies for the just-downloaded video.

Example 3. Remote Co-offlining: Alice and Bob are both on a relatively low-bandwidth network, e.g., a 2G network, and are not in physical proximity to each other. With mutual consent, they form a pool for the purpose of downloading a certain online video, and grant each other permission to share sections of the video. Once they are done downloading their sections of the video, they could view their just-downloaded sections, provided such viewing is consistent with and permitted by the DRM policies associated with the video. When they meet the next time in person, they share each other's sections such that they can each access a complete, stitched video.

In situations in which certain implementations discussed herein may collect or use personal information about users (e.g., user data, information about a user’s social network, user's location and time at the location, user's biometric information, user's activities and demographic information), users are provided with one or more opportunities to control whether information is collected, whether the personal information is stored, whether the personal information is used, and how the information is collected about the user, stored and
used. That is, the systems and methods discussed herein collect, store and/or use user personal information specifically upon receiving explicit authorization from the relevant users to do so. For example, a user is provided with control over whether programs or features collect user information about that particular user or other users relevant to the program or feature. Each user for which personal information is to be collected is presented with one or more options to allow control over the information collection relevant to that user, to provide permission or authorization as to whether the information is collected and as to which portions of the information are to be collected. For example, users can be provided with one or more such control options over a communication network. In addition, certain data may be treated in one or more ways before it is stored or used so that personally identifiable information is removed. As one example, a user’s identity may be treated so that no personally identifiable information can be determined. As another example, a user’s geographic location may be generalized to a larger region so that the user's particular location cannot be determined.

CONCLUSION

Techniques of this disclosure enable the pooling of metered data connections. By pooling connections to wireless service providers, members of a pool can access large online content while conserving data and/or bandwidth on their metered connections. Pooling is accomplished by partitioning the content amongst member devices content, having each member device download her assigned partition, and by local exchange of partitioned content between member devices. Each device stitches together partitioned content to obtain the entire content. Membership to a pool is subject to a two-way confirmation, e.g., by existing members of the pool and by the new entrant to the pool. The pool is formed with consenting devices and content access is managed using a software application, e.g., a smartphone app.