METHOD AND APPARATUS FOR DATA LOGGING

This invention relates to a method and apparatus for data logging.

BACKGROUND

Data logging in this specification is the process of collecting data from mobile devices performed in order to obtain business information relating to how the mobile devices operate. For example, position, location and speed of a vehicle over time is useful log data for use in insurance liability calculations for that vehicle. In another example, signal strength of a mobile communication system over both time and position is useful log data to enable a telecommunication company to plan its transmitter locations. Such data is collected by a mobile embedded system using positional information and signal strength information from sources including the network itself (e.g. GSM) and global positioning satellites (GPS). Log data is stored in the mobile embedded system for later transmission to the central system. Transmission is by mobile phone network or other wireless technology.

Transmission of the data log may be performed on demand, when the device is ready it requests control of the transmission channel. Such a system is described in US Patent Publication 6263268 which discloses a mobile automotive telemetry system for installation on-board a vehicle. It includes a diagnostic structure for monitoring operational functions of a vehicle and a server which communicates with the diagnostic structure to receive operational information. The operational information is uploaded to the server when the information is ready.

Another download on demand system, International Patent Publication 02/03350, discloses a method and system for monitoring cellular communication. The method continuously extracts traffic load and speed on roads within the coverage area of a cellular network from a mobile device in a vehicle. The data is extracted directly from the higher level of communication in a cellular network so there is no scheduled or negotiated download of data from the mobile device.

One problem with downloading log data on demand is that it can lead to a conflict situation when several devices are requesting control of a single download channel and attempting to download at the same time. Only one request per channel will be successful at any one time and the other requests fail. The failed requests use download resource so that more

resource is used for non-ordered requests than for ordered requests. One way to order the downloads is to schedule them to come in at a certain times.

US Patent publication 0028313 discloses a distributed telemetry method and system affected by co-ordinating the taking of readings of a parameter by mobile phone users, the parameter readings being sent to a service system together with location information on the users. It is the task of a query scheduler to, amongst other things, organise when the reading of interest are to be taken. The reading is sent to the service system immediately or triggered by, for example, a scheduled time.

The problem with scheduled remote data logging is that simultaneous and multiple device upload of data can create overload on a server that collects such log data when the bandwidth is different from that predicted.

SUMMARY OF THE INVENTIONS

According to a first aspect of the present invention there is provided a data logging method for transferring log data to a server over a wireless network from a plurality of remote devices, said server for receiving data from the plurality of said devices, said method comprising the following steps:

scheduling a transfer period for transferring log data from a device to the server taking into account the wireless network signal strength of the device for the scheduled transfer period whereby the scheduled transfer period does not overlap a time when the estimated wireless network strength is too low to transfer the log data; and

transferring data determined by its respective transfer period in the schedule.

The scheduling step above advantageously comprises the following steps:

selecting a device from the plurality of devices;

providing a transfer size for data to be transferred from the selected device;

calculating, for the selected device, a transfer period including a start time and an end time to transfer the log data to the server, the calculation using the selected device's transfer size and using transfer periods of other devices if known;

estimating, for the selected device, wireless network signal strength data for the calculated transfer period;

performing, for the selected device, the calculating and estimating steps again if the transfer period overlaps a period of time where the estimated wireless network strength is below a predetermined threshold; and

storing the transfer period in a schedule.

The method advantageously further comprising:

acquiring the actual transfer size for a device before transferring the data;

re-calculating the transfer period for the first device; and

re-calculating transfer periods of other devices if the re-calculated transfer period of the first device affects the transfer periods of the other devices.

Suitably, when calculating the transfer period, the server transfer capacity is taken into account.

More suitably, an estimate is made using historical server transfer capacity data from a similar time period.

Preferably, for a particular device, more than one transfer period is calculated so that the data may be downloaded. Such a device is one existing in variable signal strength conditions.

More preferably the device alerts the server to the actual transfer size when or before transfer takes place. If the actual transfer size is significantly different to the predicted transfer size then the server recalculates the schedule.

Advantageously, the server stores wireless network signal strength for each client with respect to time.

More advantageously, the server makes an estimate of future wireless network signal strength for a particular client based on the signal strength at a previous time, for instance, the same time of day a week before. If the signal strength is acceptable for all or most of the scheduled transfer then the server can assume a low chance of interruption. Conversely if there is an interruption in this previous transfer, the server can assume a high chance of interruption.

Suitably, the server stores wireless position data for each client with respect to time and makes an estimate of future wireless network signal strength by estimating future position based on the present position, direction of travel, and speed of travel.

More suitably the method further comprising:

acquiring the actual wireless network signal strength before transferring log data; and

rescheduling the transfer period if actual wireless network strength is below a predetermined threshold.

Preferably, the method is performed on devised in a defined priority.

More preferably a device's priority is defined by its wireless network signal strength.

Advantageously a device's priority is defined by the quantity of data to transfer.

More advantageously, there is provided a reserve channel for service information. If a device finds that it has not been serviced but now has a need to transfer data. The device can proactively contact the server to request a higher priority of servicing. This request and data transfer needs to use an alternative channel of communication into the server and ensures that other lower priority tasks do not block its request.

Suitably, some devices do not have a scheduled download but download on demand. This allows for the benefits of an on-demand download as well

as that from adaptive scheduling. Some devices may be deactivated, hence to not need to be included into the scheduling and planning system while in this state. They are treated as non-scheduled devices and data log download is on-demand and when available.

DESCRIPTION OF THE DRAWINGS

In order to promote a fuller understanding of this and other aspects of the present invention, an embodiment of the invention will now be described, by means of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of the present embodiment of the invention;

Figure 2 is a schematic diagram of a profile data structure stored by the present embodiment of the invention;

Figure 3 is a schematic diagram of a plan data structure stored by the present embodiment of the invention; and

Figure 4 is a method according to a first embodiment of the present invention

DESCRIPTION OF THE EMBODIMENTS

Referring to Figure 1, a data logging system comprises: a server 300 connected over a mobile network to a plurality of remote client devices 100A...N. The first device is 100A, second device is 100B and so on up to 100N where N is of order a million devices. Each device 100A...N comprises: profile data 102; a device profiler 104; a data log 106; a device controller 108; and a data exchange 110. The server 300 comprises: profile data 301; a device profiler 302; a scheduler 304; a plan 306; an updater component 308; data exchange 310; a bandwidth forecast component 311; and an upload component 312. Log data is stored in a datastore 400.

Device profiler 302 maintains each device profile 102 collected from the client devices.

A device profile 102 includes characteristics relating to the device but not the download data itself. Referring to Figure 2, device profile 102 comprises two profiles for each device in the preferred embodiment:

firstly a connectivity profile 103A; and secondly a download profile 103B.

The connectively profile 103A includes GSM radio reception power over time and comprises a data structure having a date and time field and GSM signal field. In a further embodiment the geographical position of the device will be included in the connectivity profile where it is derived from global positioning system (GPS) data or trigonmetric data from the GSM receivers. The status of a device is recorded over a week as this is mostly likely to show a pattern. However, in other embodiments, a longer period may be used instead of or as well as. A day of data is normally regarded as the minimum, although theoretically it could be smaller, and three weeks of data gives better averages. More than four weeks of data puts pressure on the storage resource of the device profiler 302.

The quantity of data previously collected allows for at least an estimate to be made of the next quantity of data downloaded. The device profiler 302 provides information to the device scheduler 304 to enable it to establish an estimate for connection time. It also provides information relating to GSM power levels so that unsuitable connection times can be estimated.

The download profile 103B, stores, for each device, a record of each download of data and comprises the time of download and the quantity of data collected in the download.

The scheduler 304 builds the plan 306 by allocating time periods to each specific device based initially on the amount of data that each device is expected to transfer. Device scheduler 304 receives the actual network usage from the data exchange 310 and bandwidth forecast information from component 311. If the scheduler 304 sees that current network usage exceeds or is much less than that used to build the plan 306 then the scheduler 304 updates the plan 306. The device scheduler 304 works to substantially 80% full capacity so that overruns can be catered for and rescheduling work does not continuously replan.

The plan 306 (see Figure 3) is a data structure that stores a download schedule for each device. Each download for a device is a record in the database having four fields: 1) transfer period (start time and end time); 2) the device identification; and 3) the transfer size.

The updater component 308 keeps a device updated as to its scheduled time by passing messages with the current schedule details and also when relevant changes are made to the plan 306. It keeps track of a device that is off-line and informs the off-line device as soon as it becomes on-line through the data exchange 310.

The update component 308 negotiates with the scheduler 304 in case the device has run out of memory or has not downloaded for an excessive period of time. The scheduler 304 identifies change in the plan 306 and informs the updater component 308 and updates the plan 306 with confirmation from the devices 100A...N.

The bandwidth forecast component 311 monitors current download activity from actual data transfers going through the data exchange 310. From this information the present download bandwidth can be monitored and stored for future planning reference. This data is then used to provide a forecast of network capacity for the scheduler 304, which then in turn may choose to throttle back the data transfer by moving devices, or move devices up to take advantage of available bandwidth. In another embodiment the bandwidth component acquires forecast information from a network supplier.

The uploader 312 determines when to update client devices with new software. It takes as input plan 306 to provide an indication of other traffic that may make use of the data communications lines 210,206. The plan 306 will have an impact on deciding when to upload software to the client devices as each download will reduce the 'effective' communications bandwidth for data upload.

The client device 100A will now be described. Client devices 100B..N have the same components and configuration but different identification. Each device 100A...N comprises: profile data 102; a device profiler 104; a data log 106; a device controller 108; and a data exchange 110.

The profile data 102, maintained by the device profile component 104, maintains a profile of the device's connectivity and data volumetrics. It is the profile data 102 that is sent to the server 300 to be used in planning and prioritization by the scheduler 304.

The data log 106 contains the log data for transfer to the server 300, it also may contain any specific data used by the device controller

108. The key objective is to transfer log data 106 from the client to the datastore 400 via the server 300.

Device controller 108 is responsible for ensuring co-ordination of the log data 106 and controls the download of data to the server 300 and the communication of data volumes. It is the device controller 108 that initiates the data connection and bulk transfer based on the scheduled time received from the server 300. The device controller 108 receives the schedule information from plan 306 via the update component 308. Before the downloading of the log data the device controller 108 establishes communication with the scheduler 304 through update component 308 and the data exchange mechanism 310/110 to check for final adjustments. Ideally each client 100A...N would be controlled by the same version of device controller 108 but it may be that some devices have been updated by uploader 312 and others are using an older version. Software updates can be transferred between the server 300 and the clients 100A...N along the same communication lines as the data is transferred.

Method 400 of the embodiment is described with respect to Figure 4. The scheduler 304 selects, step 402, a first client device from the available devices in the profile data 301. Each device has previously contacted the server and registered itself as available in the profile data 301. Each device sends information relating to its expected future download size and this is stored in a download profile 103B. The device profiler 302 creates new profile data structures for each new registered device and stores the contact details of the device in the device profile. Any future download size is stored in the related download profile data structure.

The scheduler 304 acquires, step 404, the transfer size for log data from the download profiles.

The scheduler 304 calculates, step 406, the future transfer period of device based on the availability of the download bandwidth of the server 300 and the transfer size of the log data estimated in step 404. The calculation excludes certain periods that have been eliminated at step 410 due to a weak signal strength.

The scheduler 304 estimates, step 408, the signal strength by looking up the connectivity profile of the device. The simplest embodiment uses the signal strength of a week previous but another embodiment averages the signal strength from the last two or three weeks.

The scheduler 304 compares, step 410, the estimated signal with a threshold. If the estimated signal strength is below the threshold then the signal strength will be too low for reliable transmission of data and the method branches back to step 406 and a new transfer period will be calculated.

The scheduler 304 stores, step 412, the transfer period in the plan 306. At this point the updater 308 sends the transfer period to the device in question.

The scheduler 304 then performs, step 413, for each device 100A..N the steps 402 to 412 so that the plan 306 has a scheduled time and a scheduled download size for each device 100A..N.

The plan 306 selects, step 414, a device having an imminent transfer period.

The scheduler 304 acquires, step 415, an actual transfer size by communicating with the device controller 108 through data exchange 110/310. The device controller queries the log data 106 and returns the value.

The scheduler 304 recalculates, step 416, the transfer period at this later stage.

The scheduler 304 acquires, step 418, the actual signal strength before transmission.

The scheduler 304 checks, step 420 if the acquired signal strength is below a threshold. A typical threshold would be 20% of maximum power but this value would depend on the working conditions of the implementation. If the acquired signal strength is below 20% then the present transfer is aborted. A new transfer period is needed and the method goes back to step 406. If the acquired signal strength is 20% or above then the method proceeds to step 422.

Once the signal strength is confirmed then the log data is transferred, step 422, through the data exchange mechanism 310/110. In the preferred embodiment the device controller 108 initiates the communication and log data transfer at the scheduled time. In another embodiment the scheduler 304 initiates the download communication when it checks the signal strength.

The scheduler 304 then performs, step 423, for each entry in the plan 306 the steps 414 to 422 so that each device transfers its log data when the signal strength is acceptable.

Although the embodiments have been described in terms of a single server it is possible to scale the solution up to two or more servers.

CLAIMS

1. A data logging method for transferring log data to a server over a wireless network from a plurality of remote devices, said server for receiving data from the plurality of said devices, said method comprising the following steps:

scheduling a transfer period for transferring log data from a device to the server taking into account the wireless network signal strength of the device for the scheduled transfer period whereby the scheduled transfer period does not overlap a time when the estimated wireless network strength is too low to transfer the log data; and

transferring data determined by its respective transfer period in the schedule.

2. A method as in claim 1 wherein the scheduling step comprises the following steps:

selecting a device from the plurality of devices;

providing a transfer size for data to be transferred from the selected device;

calculating, for the selected device, a transfer period including a start time and an end time to transfer the log data to the server, the calculation using the selected device's transfer size and using transfer periods of other devices if known;

estimating, for the selected device, wireless network signal strength data for the calculated transfer period;

performing, for the selected device, the calculating and estimating steps again if the transfer period overlaps a period of time where the estimated wireless network strength is below a predetermined threshold; and

storing the transfer period in a schedule.

3. A method as in claim 2 further comprising:
acquiring the actual transfer size for a device before transferring the data;

recalculating the transfer period for the first device; and

recalculating transfer periods of other devices if the recalculated transfer period of the first device effects the transfer periods of the other devices.

4. A method as in claim 2 or 3, wherein, when calculating the transfer period, the server transfer capacity is taken into account.

5. A method as in claim 2, 3 or 4 wherein, an estimate is made using historical server transfer capacity data from a similar time period.

6. A method as in any of claims 2 to 4 wherein, for a particular device, more than one transfer period is calculated so that the data may be downloaded.

7. A method as in any of claims 2 to 6 wherein, the device alerts the server to the actual transfer size when or before transfer takes place.

8. A method as in any of claims 2 to 7 wherein, the server stores wireless network signal strength for each client with respect to time.

9. A method as in any of claims 2 to 8 wherein, the server makes an estimate of future wireless network signal strength for a particular client based on the signal strength at a previous time.

10. A method as in any of claims 2 to 9 wherein, the server stores wireless position data for each client with respect to time and makes an estimate of future wireless network signal strength by estimating future position based on the present position, direction of travel, and speed of travel.

11. A method as in any of claims 2 to 10 further comprising:

acquiring the actual wireless network signal strength before transferring log data; and

rescheduling the transfer period if actual wireless network strength is below a predetermined threshold.

12. A method as in any of claims 2 to 11 wherein the method is performed on devices in a defined priority.

13. A method as in claim 12 wherein the priority is defined by the wireless network signal strength of each device.

14. A method as in claim 12 or 13 wherein the priority is defined by the quantity of data to transfer of each device.

15. A method as in claim 2, wherein there is provided a reserve channel for service information.

16. A data logging system for transferring log data to a server over a wireless network from a plurality of remote devices, said server for receiving data from the plurality of said devices, said system comprising:

means for scheduling a transfer period for transferring log data from a device to the server taking into account the wireless network signal strength of the device for the scheduled transfer period whereby the scheduled transfer period does not overlap a time when the estimated wireless network strength is too low to transfer the log data; and

means for transferring data determined by its respective transfer period in the schedule.

17. A computer program product for transferring log data from a plurality of remote devices to a server over a wireless network, said computer program product comprising computer program instructions stored on a computer-readable storage medium for, when loaded into a computer and executed, causing a computer to carry out the steps of:

scheduling a transfer period for transferring log data from a device to the server taking into account the wireless network signal strength of the device for the scheduled transfer period whereby the scheduled transfer period does not overlap a time when the estimated wireless network strength is too low to transfer the log data; and

transferring data determined by its respective transfer period in the schedule.

18. A service for consolidating log data from a plurality of remote devices to a server over a wireless network and supplying said consolidated log data on demand to a service requester, said service performing a method comprising the steps of:

scheduling a transfer period for transferring log data from a device to the server taking into account the wireless network signal strength of the device for the scheduled transfer period whereby the scheduled transfer period does not overlap a time when the estimated wireless network strength is too low to transfer the log data; and

transferring data determined by its respective transfer period in the schedule.

19. A service requester for receiving consolidated log data collected by a web service from a plurality of remote devices over a wireless network, said service performing a method comprising the steps of:

scheduling a transfer period for transferring log data from a device to the server taking into account the wireless network signal strength of the device for the scheduled transfer period whereby the scheduled transfer period does not overlap a time when the estimated wireless network strength is too low to transfer the log data; and

transferring data determined by its respective transfer period in the schedule.