

DATA ACQUISITION SYSTEM

This invention relates to a data acquisition system and particularly but not exclusively to a system in which data acquired by an acquisition station or unit is transmitted over a communications link, using for example a public telephone network, to a remote location.

An example of such a system is described in U.K. Patent No. 2,042,234B. Such systems are particularly useful for the monitoring of gaming machines. Data relating to the operation of the gaming machines can be conveniently transmitted to a remote location using a conventional telephone line. A central communications unit may be arranged to gather data from a plurality of data acquisition units and transmit the data over the telephone line to a data collection station.

According to the invention a data acquisition system comprises a central communications unit and a data acquisition system comprising a central communications unit and a plurality of data acquisition units each of which is assigned a poll number and is arranged to store data relating to the

operation of a coin-operated machine and to transmit said data to the central communications unit in response to receiving a data request comprising that poll number, wherein the central communications unit
5 is operable to detect the presence of a data acquisition unit having a predetermined poll number and in response thereto to assign to that unit a new poll number and thereafter to access data from the unit by sending requests comprising the new poll
10 number. The communications unit and acquisition units may collectively form a communications or acquisition station which transmits data over a communications link to a remotely located data collection station.

There is thus provided a simple means whereby new
15 acquisition units can be added to the system without interfering with the operation thereof and in such a manner that data communications with the new unit are automatically set up.

By way of example, every new acquisition unit can
20 be programmed with a poll number of, eg. zero. The communications unit can repeatedly send out requests for a response from a data acquisition unit bearing the number zero. If a reply is received, it can then transmit a new poll number which is thereafter used by
25 the new data acquisition unit. Further new acquisition units, again programmed with the poll

number zero, can be added in a similar manner.

Preferably, data transmissions to the central communications unit only take place after the data acquisition unit has received its new poll number.

5 Preferably, when a new acquisition unit is added to the system it transmits an identification number to the central communications unit. Subsequent data transmissions are enabled only if the data acquisition unit receives from the central communications unit a
10 data request comprising both the new poll number and the identification number.

Preferably, the communications station formed by the communications and data acquisition units has a first mode in which the station can communicate over a
15 remote communications link and can perform one or more operations, and a second mode in which the station can communicate over a local communications link, in which communications over the remote communications link are prevented and in which the station can preferably
20 perform at least one operation which cannot be performed in the first mode and preferably all the operations which can be carried out in the first mode.

Preferably, the communications station has a first communications port connected to the local
25 communications link and via a modem to a second communications port for communication over the remote

communications link. In both modes the station can handle data communications using the first communications port, but only in the first of the two modes can the station communicate via the first
5 communications port and the modem with the second communications port.

These preferred features of the invention are primarily intended for use in data acquisition systems in which data can be accessed from a remotely located
10 communications station using the remote communications link and the modem. In certain circumstances, however, it may be desirable to prevent access via the remote communications link, and instead to require the physical presence of an authorised engineer at the
15 communications station to enable communications therewith. This may for example be desirable as an added security feature to prevent unauthorised access during the transmission to or from the communications station of particularly important data. This may be
20 data collected at the location of the communications station and transmitted thereby, or alternatively it may be data transmitted to the communications station by way of instructions for altering the internal operation of the communications station.
25 Alternatively, it may simply be desirable to have a system in which all data communications over the

communications link can be temporarily and automatically inhibited. This may be done for example in response to discovering

that unauthorised access to the station via the communications link has taken place.

It is possible by placing the communications station in the second mode to prevent an unauthorised user from either initiating communications via the remote communications link or monitoring authorised communications. In these circumstances, an engineer can set up communications with the station using the first communications port and bypassing the remote communications link, the second communications port and the modem.

Such an arrangement simplifies construction of the system in that all communications in each of the modes are channelled through the first communications port. For example in the preferred embodiment, which is micro-processor-based, even though two different types of communication can take place there is no need to duplicate the interface hardware and the program routines used for communication.

Preferably, any operations which can be carried out by the communications station in the first mode can also be carried out in the second mode. This reduces the need for any special measures to be taken to cope with the provision of the two modes of the station, and also allows any communications which can take place over the remote communications link also to take place over the local communications link between the communications station and an on-site engineer's equipment.

As indicated above, however, the communications station can preferably carry out one or more operations only in the second mode so that unauthorised access to the system via the remote communications link is prevented so far as these operations are concerned. For example, the communications station may only respond to an instruction received via the first communications port to clear data storage locations if the station is in the second mode.

It will be appreciated that the invention is particularly useful for systems in which data acquisition can take place via the remote link, but in which there is also provided an interrogation unit for on-site data acquisition (e.g. in the event of a remote communications link breakdown). This is not, however, absolutely essential, as the on-site equipment used while the station is in the second mode may simply be used for controlling the operation of the station, rather than for data acquisition.

In a particularly convenient arrangement, data communications between the remote communications link and the first communications port are prevented in the second mode of operation of the communications station by arranging for the communications station to operate at a data transmission rate which is different from that used in the first mode. The transmission rate used in the

second mode is such that data transmissions cannot be handled by the modem, and is preferably determined by the program of a processor-controlled station so as to prevent unauthorised alteration thereof by tampering with the hardware of the station. It would be possible to use a modem which can be switched for operation at different data transmission rates, and to arrange for the data transmission rate of the communications system in the second mode to be unsuitable for the modem setting. However, it is more desirable for the purposes of security to arrange for the system to use a transmission rate in the second mode which the modem is totally incapable of handling, for example because the response time of the circuitry is insufficiently great.

As an alternative to switching the data transmission speeds, other means can be used to inhibit communication between the remote communications link and the first communications port during the second mode of operation of the communications station; for example means can be provided for switching off the modem or for altering its transmission rate setting so that it is unsuitable for the rate used by the communications station. However, these are less desirable than the preferred arrangement described in the preceding paragraph, because they are more susceptible to misuse by tampering with the hardware.

An arrangement embodying the invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic representation of a data acquisition system in accordance with an embodiment of the invention;

Figure 2 is a schematic block diagram of a communications unit of the system; and

Figure 3 is a flow chart illustrating the operation of the communications unit.

Referring to Figure 1, a data acquisition system of the invention comprises a data collection station 2 and a remotely located data acquisition station 4 connectable to the collection station 2 via a public telephone network indicated schematically at 6.

The data collection station 2 comprises a main system controller and data collection unit 8 formed by an appropriately-programmed general purpose computer. This is coupled to the telephone network via a modem 10 which can dial telephone numbers in accordance with instructions from the computer 8.

The telephone line at the data acquisition station 4 is connected in parallel to a communications unit 12 and to a standard telephone receiver 14.

The data acquisition station 4 is at a location, such as a public house or an amusement arcade, where

there is a plurality of housings 16 each containing a gaming machine 18, a coin handling unit 20 and a data acquisition unit 22.

Each coin handling unit 20 may be an Integrated Coin Handling System, available from Mars Electronics, Money Systems Division, Eskdale Road, Winnersh, Nr. Reading, Berkshire, RG11 5AQ, England and is capable of validating and storing inserted coins and in response thereto providing to the gaming machine 18 signals for enabling it to be operated by a user. Each data acquisition unit 22 is coupled both to the respective gaming machine 18 and the respective coin handling unit 20, and receives data concerning the operation of the gaming machine, the amount of money inserted, servicing data such as the times at which access doors to the housing 16 and a cashbox of the coin handling unit 20 were opened, and any other desired data. Appropriate sensors (not shown) may be coupled to the acquisition unit 22 for detecting opening and closing of access doors.

Each data acquisition unit 22 is connected to a power line 24 from the data communications unit 12. Each data acquisition unit 22 is also coupled to the communications unit 12 via a data path 26.

The gaming machine 18, coin handling unit 20, and data acquisition unit 22 in each housing 16 receives power from a local source. However, as the source may be

interrupted in order to switch off power to the gaming machine 18, the acquisition unit 22 is arranged to receive, in these circumstances, power from the collection unit 12 via the supply line 24, so that
5 communications with the data units 22 can still take place even if the gaming machines 18 are shut down.

The details of the collection and storage of data by the acquisition units 22 will not be described as various ways in which this can be accomplished are well known.
10 For example, the procedures described in GB 2129173A may be used, suitable modifications being applied to deal with the fact that the data from the acquisition unit is transmitted over a path 26 instead of being loaded into a module.

15 Generally, as will be explained, the communications unit 12 repeatedly polls the data acquisition units 22 to check for their presence, and to determine whether any new units have been added. The unit 12 also checks to determine whether any of the access doors of the housing
20 16 have been opened and, if so, requests data from the associated acquisition unit 22 and produces a print-out of this data.

In addition, at a predetermined time, the unit 12 will enter a state in which it is enabled to receive
25 calls from the data collection station 2. If a call is received, the unit 12 can be instructed by the station 2

to access the data in any one or more of the acquisition units 22 and to send the data to the collection station 2.

5 The communications unit 12 is shown in more detail in Figure 2. A central processor 30 is one of a family named MCS-51 available from Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA. 95051, U.S.A. The processor carries ROM and RAM memories 32 and 34, respectively. It is also connected to a non-volatile RAM
10 36 which is provided to store data (such as the "appointment" times to be discussed later) which should not be lost in the event of power failures.

 The collection unit 12 has a modem 38 connected between first and second communications ports or
15 terminals 40 and 42 of the communications unit 12. The terminal 40 is a data input/output terminal of the processor 30. The terminal 42 is connected to the telephone network 6. The terminal 40 is also connected to an input/output coupling shown schematically at 44 for
20 communication with an interrogator unit, as will be described below. The coupling 44 may for example be a socket for an interrogator unit plug, or an infra-red receiver/transmitter.

 The processor 30 can enable and disable the modem 38
25 by generating signals on a line 45. In the interval between communications with the collection station 2, the

modem 38 of the communications unit 12 is disabled by the processor 30 providing an appropriate signal on the line 45. Disabling can be achieved by interrupting the power supply to the modem and/or by applying a signal to a
5 "data terminal ready" (DTR) terminal which is commonly present in commercially-available modems.

At a pre-arranged time, the modem is enabled. Any call received during the enabled period of the modem 38 is answered quickly, before the telephone receiver 14 has
10 time to ring, so as to establish communication between the data collection station and the terminal 40 of the processor 30. This can be accomplished in a well known manner, for example using techniques employed in conventional telephone answering machines which often
15 can be adjusted to answer an incoming call before a telephone attached to the line rings. (References herein to a telephone "ringing" are intended to cover any means which may be employed to indicate to a user that there is an incoming call to be answered).

20 Communications can then take place at the data transmission rate of 300 baud (or 1200 baud may be preferred). The processor 30 itself handles the conversion of serial data received at the terminal 40 to data which is stored in the RAM 34, and the conversion of
25 data in the RAM 34 to serial data to be transmitted via the terminal 40, in accordance with a program routine

stored in the ROM 32. Appropriate routines for achieving this are very well known. Alternatively, this conversion could be achieved by a standard UART (Universal Asynchronous Receiver/Transmitter); however, this is not
5 the preferred arrangement.

At the end of the communication with the collection station 2, or after a predetermined time if no call from the station 2 is received, the modem 38 is disabled.

A portable interrogator unit (not shown) can be
10 connected to the communications unit 12, e.g. via a standard RS232 connector coupled to a socket formed by the coupling 44. Thereafter, the interrogator unit can send signals to the terminal 40 which are treated by the processor 30 as if they had been received from the
15 collection station 2. Indeed, so far as the processor 30 is concerned, it is not possible to determine whether an exchange of data via the terminal 40 is taking place between the communications unit 12 and the collection station 2 or between the communications unit 12 and a
20 portable interrogator unit.

The processor 30 is operable to respond to an instruction formed by particular data received via the terminal 40 by using a modified program routine for handling the communications so that subsequent communi-
25 cation takes place at 9600 baud. If at that time communications are taking place between the interrogator

unit and the processor 30, this causes no problems because the interrogator unit can handle this transmission rate. However, communication via the modem 38, the terminal 42 and the telephone network 6 is precluded because the modem 38 has been selected to be incapable of handling such high transmission rates. Thus, unauthorised access to the processor 30 by the telephone network can be prevented while the higher data transmission rate of 9600 baud is being used.

10 The unit 12 has a power supply unit 46 arranged to receive mains power along the line 48. The power supply unit 46 delivers power to various parts of the unit 12 and to the supply line 24 leading to the data acquisition units 22.

15 Power failures are detected by a circuit 50 which responds by enabling a battery unit 52 so as to maintain power supply to a real time clock 54. Failures can be sensed and recorded by the processor 30.

20 The processor 30 is also connected to a printer unit 56 and, via a standard UART 58 and line driver 60 to the data path 26 leading to the data acquisition units 22.

25 Two switches 62 and 64 are connected via an interface 66 to the processor 30. The switch 62 is used to instruct the processor 30 to order the printer unit 56 to feed out paper for retrieval by a user, and the switch 64 to control various operations of the unit 12, some of which will be described below.

It should be noted that Figure 2 is a schematic block diagram of the communications unit 12, and that the actual circuitry may vary considerably from that illustrated. The terminal 40 is preferably a standard RS232 port. The various other connections to the processor 30 are shown as independent, and indeed may be formed by respective input/output lines; however, instead the various blocks shown in Figure 2 may be coupled to a common data bus leading to the processor 30.

10 An overall description of the sequence in which operations are carried out by the communications unit 12 will now be given with reference to Figure 3.

Following power-up in step 300, an initialisation procedure takes place at step 302. Here, the time at which the modem 38 is to be enabled for receiving telephone calls is set to a standard call time of, e.g. midnight.

Then, at step 304, the current poll number (I) is set to one.

20 At step 306, the processor 30 sends along the data path 26 a request for a data acquisition unit bearing the current poll number I to transmit back a response. The request contains both the poll number I and a serial number which is associated with the data acquisition unit and which was previously communicated to the processor 30 (as will be explained below). The processor then, at

step 308, determines whether or not a reply has been received. If not, then at step 310 the processor 30 records the fact that a data acquisition unit 22 is no longer associated with poll number I; otherwise, at step
5 312 the processor 30 determines whether any action needs to be taken in respect of the acquisition unit bearing the poll number I. If for example the response from the data acquisition unit indicated that an access door associated therewith had recently been opened, the
10 processor 30 enters a routine whereby further data is requested from the acquisition unit 22 and is then printed out using the printer unit 56.

At step 314, the poll number I is incremented, and then at step 316 it is determined whether the new poll
15 number has exceeded the maximum that can be handled by the system. If not, the procedures at steps 306 to 314 are repeated for the next poll number.

After all the poll numbers from one to the maximum have been checked, the processor proceeds to step 318, at
20 which it issues a request for a data acquisition unit bearing the poll number zero to respond. Any new data acquisition unit 22 coupled to the lines 24 and 26 will bear the poll number zero and will therefore respond. This will be determined at step 320, whereupon the
25 processor proceeds to step 322. Here, the new data acquisition unit is requested to send its serial or

identification number (which is stored in a permanent fashion in the memory of the data acquisition unit 22) to the processor 30. This number is recorded by the processor 30, using the non-volatile RAM 36, and used in subsequent data requests to the new acquisition unit. The processor then enters a routine whereby an engineer is requested (e.g. using the printer unit 56) to indicate whether the new data acquisition unit should be allocated a completely new poll number which is greater than the maximum number presently being used, or whether the minimum free poll number should be used. The latter may be appropriate if for example a data acquisition unit bearing a relatively low poll number has been previously disconnected so that poll number is no longer being used. The engineer is able to signify one response by pressing the switch 64 within a predetermined interval, and a different response by not pressing the switch 64 at all. In accordance with the response, the processor 30 then stores the appropriate non-zero poll number in the RAM 36 in association with the previously-received serial number.

The processor then enters step 324 (which is entered directly from step 320 if no new data acquisition unit has been coupled to the system). At step 324, the processor determines whether the time for enabling the modem has been reached, and if not the program loops back

to step 304 so that polling of the data acquisition units can be recommenced.

When the enabling time for the modem 38 has been reached, as determined by the output of the real time
5 clock 54, the processor proceeds to step 326. Here, signals are generated along the line 45 to enable the modem 38. The processor then enters a loop, comprising steps 328 and 330, where it repeatedly checks whether a
10 call has been received (i.e. whether appropriate data has arrived at terminal 40) and whether a predetermined time period starting with the enabling of the modem 38 has expired. Assuming that no call is received within this time period, the processor proceeds to step 332. Here, the processor increments a count representing the number
15 of times it has failed to receive a communication from the collection station 2. At step 334, it is determined whether this number is greater than a predetermined number, e.g. three. If so, the processor proceeds to step 336, where the modem enabling time is set to the
20 standard time of midnight (if it is not already so set). As explained below, the enabling time can vary. It is possible that faults may occur such that the collection station 2 will not know the current enabling time for the acquisition station 4. Step 336 is carried out to ensure
25 that the enabling time is set to a standard if no call is received over the course of a predetermined number of

days, so that the collection station 2 will know the time at which to attempt to communicate with the acquisition station 4.

After step 334, and if appropriate step 336, the
5 program then reaches step 338 where the modem is disabled. The program then proceeds back to step 304 to recommence polling of the data acquisition units 22.

Assuming that a call is received during a modem enabling period, the program proceeds from step 328 to
10 step 340. Here, the processor 30 determines whether the data received at terminal 40 contains an appropriate password. If not, the processor proceeds to step 338 where the modem is disabled.

If the correct password is received, then at step
15 342 the processor stores in the RAM 36 data received from the terminal 40 and representing the next "appointment" or time at which the modem 38 is to be enabled. Preferably also the processor stores received data determining the period for which the modem is to be enabled at
20 that time.

The processor then proceeds to step 344, where it determines whether the data received at terminal 40 represents a request for information relating to one or more of the gaming machines 18. If so, the appropriate
25 data is requested by the processor 30 at step 346 (by sending to the appropriate data acquisition units 22 both

the poll number and the serial number associated there-with). The data is then transmitted by the processor 30 via the terminal 40.

5 If no request for data is received, or all requests have been dealt with, the processor proceeds to step 348 at which it is determined whether the data at terminal 40 represents a request for a change in the data transmission rate. Normally, as mentioned above, the transmission rate is set to 300 baud, but the processor can be
10 shifted into a second mode at which the data transmission rate is set at 9600 baud. This is done at step 350 if the appropriate request is received.

At step 352, the baud rate is checked, and only if it is equal to the higher baud rate (i.e. only if the
15 processor is in its second mode) the processor proceeds to a program routine including steps 354 to 360.

At step 354 the processor determines whether a request has been received at terminal 40 to clear various stored parameters within the communications unit 12.
20 This will probably be done only on very rare occasions, such as on initial installation of the communications unit or replacement thereof. The information concerning the poll numbers and serial numbers of the various data boxes is included in the data which is cleared. If the
25 appropriate request is received the clearing takes place at step 356.

At step 358, the processor determines whether a request has been received to clear the data in a specified one of the data acquisition units 22. If so, this is done at step 360 by an appropriate message being sent to the unit along the data path 26. This also will be done only on rare occasions, such as on replacement of a gaming machine 18.

It will be appreciated that as steps 354 to 360 are entered only if the baud rate has been set to 9600 baud, then the memory-clearing operations, which can have very damaging results if not carried out at the correct time, can only be performed on instructions received via the coupling 44, and cannot be instructed by signals received via the modem 38.

At step 362, the processor determines whether a request to terminate communications has been received by terminal 40. If not, the processor proceeds again to step 344. Otherwise, the processor proceeds to step 364, where it is ensured that the baud rate is set to 300, and to step 338 where the modem is disabled.

In the system described above, each time a call is made to a collection unit 12, the unit 12 is programmed with a time at which it is to expect a subsequent call. The modem is then enabled daily for a predetermined duration at the preset time. If no calls are received for several days, a standard time is used in place of the

previously set time. Various modifications are possible. For example, the collection station 2 can send data representing not only a time but also a day to the communications station 4, so that the modem is no longer enabled on a daily basis. Instead of sending a single appointment each time a call is made, the collection station 2 can send a series of appointments during one call so as to set up the times at which a plurality of subsequent calls are to be made.

10 In this embodiment, the computer 8 of the collection station 2 calculates the appointments. This is done in consideration of a number of factors, including the desired frequency at which data is to be accessed, the number of acquisition stations 4 with which it is to communicate, the time period during which calls are to be made (which should be confined to times at which it is unlikely that associated telephones 14 are being used), etc. It may be desirable for data to be collected in batches from groups of acquisition stations 4 all owned by the same distributor and variations in the numbers of the stations within each group may affect the time required to collect the information for each group and thus, perhaps, the times at which the collections are to be made. The computer 8 may also take into account 25 factors which are less predictable, such as variations in the difficulty in establishing communication with

stations in different areas. It may, for example, be found over a substantial period that it regularly takes longer to establish contact with one group of stations than with another. To compensate for this the enabling
5 times of the stations within a particular group may be staggered to a greater or lesser extent. In addition to these long-term factors, the computer 8 may take into account short-term problems. It may for example be found that unusually long delays are being encountered in
10 retrieving information from various acquisition stations, and as a result the computer 8 may start making appointments which are later than they otherwise would be so as to allow sufficient time to complete data acquisition from all its acquisition stations before
15 retrieving the next amount of data from each station.

**CLAIMS:**

1. A data acquisition system comprising a central communications unit and a plurality of data acquisition units each of which is assigned a poll number and is arranged to store data relating to the operation of a coin-operated machine and to transmit said data to the central communications unit in response to receiving a data request comprising that poll number, wherein the central communications unit is operable to detect the presence of a data acquisition unit having a predetermined poll number and in response thereto to assign to that unit a new poll number and thereafter to access data from the unit by sending requests comprising the new poll number.

2. A system as claimed in claim 1, wherein each data acquisition unit is operable to transmit data to the central communications unit in response to receiving a data request comprising both the poll number assigned to the acquisition unit and an identification number of the acquisition unit, and wherein the central communications unit is responsive to detecting the presence of a data acquisition unit having said predetermined poll number to obtain from that unit the



identification number thereof and thereafter to access data from that unit by sending requests comprising both the new poll number assigned to the unit and the identification number thereof.

- 5 3. A system as claimed in claim 1 or 2, wherein the communications unit is arranged to communicate with the data acquisition units sequentially in order of said poll numbers, said predetermined poll number forming part of the sequence.
- 10 4. A system as claimed in any preceding claim, wherein the communications unit and data acquisition units collectively form a communications station, the system further including a data collection station remotely located with respect to the communications
15 station and operable to obtain data therefrom via a remote communications link.
- 20 5. A system as claimed in claim 4, wherein the communications station is operable in a first mode in which it can communicate over said remote
communications link and can perform one or more
operations, and a second mode in which it can
communicate over a local communications link, in which
communications over the remote communications link are



prevented and in which the communications station can perform at least one operation which cannot be performed in the first mode.

5 6. A system as claimed in claim 4, wherein the communications station has a first communications port connected via a modem to a second communications port for remote communication over said communications link, the communications station being operable to adopt first and second modes, in both of which the
10 station can handle data communications using the first communications port, but in only the first of which the station is operable to communicate via the first communications port and the modem with the second communications port.

15 7. A system as claimed in claim 6, wherein the communications station is arranged to handle communications at a first data rate compatible with the modem when in its first mode, and at a second data rate which is unsuitable for the modem when in its
20 second mode.

8. A system as claimed in claim 7, wherein the communications station includes a programmed processor, the program being such as to define the



data transmission rates which can be handled by the communications station.

9. A system as claimed in any one of claims 6 to 8, wherein the communications station is operable to
5 carry out a plurality of operations in the second mode, and is inhibited from carrying out at least one of said operations when in the first mode.

10. A system as claimed in any one of claims 6 to 9, including equipment operable to establish
10 communication with said communications station via the first communications port and without using the modem and the second communications port.

11. A system as claimed in any one of claims 4 to 10 wherein the remote communications link is a telephone
15 network.

12. A system as claimed in claim 11, including a telephone which shares a telephone line with the communications station.

13. A data acquisition system substantially as herein
20 described with reference to the accompanying drawings.
