Our Ref.: 1019.P001

APPLICATION FOR REPUBLIC OF SINGAPORE LETTERS PATENT

FOR

A SYSTEM FOR MINIMIZING CONGESTION AT BUS STATION

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A SYSTEM FOR MINIMIZING CONGESTION AT BUS STATION

FIELD OF THE INVENTION

The present invention is a system for minimizing congestion at bus station. In particular, the present invention relieves congestion at bus station by maximizing commuter clearance from bus station, improving bus mobility at bus station, and by regulating bus movement adaptively.

BACKGROUND OF THE INVENTION

The management of modern public transport systems faces the challenges of providing good services to commuters with shorter waiting time, extensive route coverage, and reliable schedule. It is difficult for prior art transportation systems to meet these requirements because bus schedules are constantly affected by factors beyond management's control such as traffic condition, road works, accidents, bus breakdown, inclement weather and customer loading. Moreover, it is difficult to achieve these objectives for services plying along major thoroughfares, as they are more subject to erratic traffic conditions caused by heavy traffic congestion and high commuter loading.

Buses queuing up to serve commuters slowly at busy bus stations are common because most bus stations accommodate two buses at a time. The reduced mobility results in inefficient use of public transport resources and wastage of commuter time. Bus moving slowly and stopping too often also causes higher fuel consumption, worsening air pollution and severe engine wear and tear. In order to increase frequencies of services, more buses are put on road thus exasperating the congestion problems.

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SUMMARY OF THE INVENTION

The present invention is a system for minimizing congestion at bus station. The present invention requires each bus station to be extended to include a plurality of bus bays and each bay is sited next to each other along roadside where buses move. Each bay is to accommodate at least one oncoming bus whose service is displayed at the bay by a visual device. Commuters are guided to the respective bays to wait for buses by visual device showing the order of bus arrival and the service at each individual bus bay. Meanwhile the system informs the bus drivers to halt their buses at the respective bays for commuters to board the buses. Upon departure of these buses, services of next group of oncoming buses are displayed. In this way, commuter clearance is maximized.

The system also minimizes commuter inconvenience at bus station with a data capture and display process applicable to every bay of the bus station for guiding commuters to wait for their buses at respective bays and to board the buses upon arrival. The data capture and display system displays the identity of each of the buses at the respective bus bays.

To regulate bus movement in real-time, the data capture and display system also captures the vehicle identity of each bus arriving at the bus stop and compares the bus arrival time with the desired schedule. The system instructs the driver of a bus to slow or to hasten which the bus deviates from the desired schedule. Such minor movement adjustment to each bus prevents cumulative deviation from the desired bus schedule.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A shows a multiple-bay bus station of the present invention featuring a data capture and display system including a remote bay assigning unit (BAU) and a display of services by bay visual devices and equipment layout.

Figure 1B shows in detail an embodiment of a visual display system used at each bay of a bus station according to Figure 1A.

Figure 2 shows a multiple-bay bus station of the present invention featuring a data capture and display system including a centralized bay assigning unit and equipment layout.

Figure 3 illustrates the architecture of a data capture and display system according to two alternate embodiments of the present invention.

Figure 4 shows a schematic of an in-bus unit (IBU) according to Figure 3 of the present invention.

Figure 5 shows a schematic of a BAU according to Figure 3 of the present invention.

Figure 6 shows a schematic of a display cum sensing unit (DSU) according to Figure 3 of the present invention.

Figure 7 shows a schematic of a service display controller (SDC) according to Figure 3 of the present invention.

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DESCRIPTION OF THE EMBODIMENTS OF THE INVENTION

General System Configuration

The multiple-bay configuration of bus station is commonly employed at major transportation terminals and central bus depots where buses are not expected to move within a short period of time. On the other hand, bus stations between major terminals have single or, at best, double bays to serve commuters. The conventional bus station layout contributes significantly to the increasing traffic congestion as commuters are not served efficiently while the long queue of buses in the vicinity of bus stations are at time the cause of traffic bottlenecks. The present invention describes a bus station configuration which integrates a data capture and display system in order to not only maximize commuter clearance at bus station but also minimize commuter inconvenience at bus station.

Figures 1A illustrates a bus station configuration according to an embodiment of the present invention featuring a data capture and display system having a remote bay assigning unit (BAU) and a bay service display equipment layout. A multiple-bay bus station 10 includes a plurality of bays 12, 14, 16, 18 and 20 for accommodating up to five buses at any one time is shown to serve commuters. Each bay is sited next to each other along roadside where buses 22, 24, 26 and 28 move, and each bay is preferably wide enough to accommodate just one bus with provision of minimum head space for a bus to bypass the front bus, if necessary. Although five bays are illustrated in the accompanying figures, it should be understood by one skilled in the art that by multiple-bay, the present invention has in mind a plurality of bays greater than two. The present invention envisages that most of the bus stations between major bus terminals to have multiple-bay configuration as they can

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accommodate multiple buses at any one time. While the real estate taken up a multiple-bay bus station is more than that of a conventional bus station, it is believed that the advantages of better commuter clearance and lesser traffic congestion far outweigh the perceived disadvantages. The present invention also envisages bus stations employing the multiple-bay configuration on more than one side of the road.

The data capture and display system 30 of the present invention comprises at least one in-bus unit (IBU) 32, at least one bay assigning unit (BAU) 34, a plurality of display cum sensing unit (DSU) 36, at least one service display controller (SDU) 38, and a plurality of visual displays 40. The detailed schematics and interconnections of the IBU, BAU, DSU, and SDU shall be elaborated in connection with the description of Figures 3 - 7 respectively. Referring to Figure 1A, each bay is provided with at least one visual display 40 (not shown in Figure 1A but in Figure 1B) for displaying commuters services of the oncoming buses. Figure 1B shows in detail an embodiment of an enlarged display 46 at central bay 16 (also designated as bay C) being used at the multiple-bay bus station 10 according to Figure 1A. The enlarged display 46 comprises further of an upper portion 45 for displaying service for bay C and the lower portion 47 for displaying services for other bays. In other words, the central visual display 46 at bay 16 informs commuters through the upper service display 45 that bus 26 (designated service code 190) will next disembark at that bay. For commuters who are not taking bus having service code 190, they are shown on the lower portion 47 buses having service codes 70, 16 and 33 respectively. The purpose of having multiple-tier displays 45 and 47 within the central bay display 46 is to assemble commuters in the central portion of the bus station, and to minimize commuter movement to adjacent bus bays when there is a change in bus service. The other reason for

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having the central display 46 is to cater for buses which do not belong to the system. In other words, buses which do not belong to the system stop at the central bay. As such, this maximizes clearance for commuters who board buses which belong to the system. At the same time, the data capture and display system 30 also minimizes commuter inconvenience at bus station 10 because the next available buses are displayed in advance on the visual displays.

Figure 2 shows a multiple-bay bus station 50 of the present invention featuring a second embodiment of a data capture and display system having a centralized bay assigning unit for multiple bus stations and data display equipment layout for each said bus station. Here, the BAU 84 monitors the position of the buses in bus convoy 72 - 78 continueously. It also allocates bay code to each approaching buses once the bus passes a predetermined distance from the bus station 50. With the exception of the BAU 84, the centralized bay assigning unit and data capture equipment layout of Figure 2 is substantially similar to the bay assigning unit and data display system of Figure 1A. By centralized bay assigning unit, the present invention envisages a BAU 84 that maintains a communication link with each service display unit SDC. The position of each of the buses within the predetermined distance of the bus station is generated by IBU from the received reference signals transmitted from signal generators (not shown) installed at predesignated locations or from the satellites of a global positioning system. As shall be elaborated further below, the description of the present invention incorporates the centralized BAU and data capture and display system features as embodied in Figures 3 to 7.

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As mentioned briefly above, Figure 3 illustrates an architecture of a data capture and display system of the present invention. Buses fitted with IBUs are each identified by a vehicle code 104, services of buses are each represented by a service code 105, each bay is assigned a bay code 108, and each bus station is assigned a bus station code 112. These codes consist part of the system parameters of the data capture and display system. The data capture and display system 30 of the present invention comprises at least one in-bus unit (IBU) 32 on each bus 100 and 102 plying the route featuring the present invention. The IBU 32 stores vital information about the buses including vehicle code 104, service code 105, key data 106, operation data 110, and bus station codes 112 included on the service route. The IBU communicates with bay assigning unit (BAU) 34 and display cum sensing unit (DSU) 36.

Referring to Figure 3, at least one BAU 34 is installed at or in the vicinity of each bus station for assigning bay code 108, sending operation data 110 and bus station code 112 to buses passing by its position. The BAU 34 also receives vital information from the buses and transmits onwards to SDC 38 of the bus station.

In Figures 1A and 3, at least one DSU 36 is installed at each bus bay 12, 14, 16, 18 and 20 respectively to display services to commuters. The services are represented by service code 105. The DSU 36 also senses the existence or absence of an IBU at bus bay by receiving vehicle code 104 therefrom. Finally, the DSU 36 transmits bay code 108 and operation data 110 to IBU 32 for storing in the latter's memory. Interposed between the BAU 34 and the DSU 36 is at least one SDC 38 which is installed at each bus station for controlling the service display in each DSU 36 and to transmit data to or receive data from each DSU.

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At least one Event Data Analyzer (EDA) (not shown in Figure 1A) is installed at bus terminal for retrieving data from and storing new system parameters in the data storage device of each IBU. EDA generates management information reports and produces faulty equipment alarm to alert repair crew to attend to equipment fault, if any.

Operation of the Data Capture and Display System

Prior to the arrival of a bus 100 or 102 at the BAU position, BAU 34 transmits a polling signal 114 to SDC 38 at fixed interval to request bay status data 116 therefrom. The bay status data 116 corresponds to the momentary status of every bay 12, 14, 16, 18 and 20 at the bus station 10 in Figure 1A. BAU 34 receives the bay status data 116 in order to assign bay codes to oncoming buses. In Figure 1A, the convoy of buses 22 - 28 has already passed the position of BAU. Concurrently, BAU 34 transmits bus station code 112 regularly to interrogate IBU 32 in its vicinity. Once the bus arrives at BAU position, IBU 32 receives the bus station code 112 and verifies that it is included in its service route. IBU 32 then transmits vehicle code 104 and service code 105 to BAU 34. When BAU 34 receives the two codes, it assigns and transmits a bay code 108 to IBU 32. Thereafter, BAU 34 transmits the assigned bay code 108 together with the received vehicle code 104 and service code 105 to SDC 38.

When the assigned bay is available at the bus station 10, SDC 38 transmits the vehicle code 104, the service code 105 and bay code 108 to DSU 36 at central bay or bay C in Figure 1A. Simultaneously, the vehicle code 104 and service code 105 are also transmitted to the assigned bay. DSU 36 stores the

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vehicle code 104 for verifying the existence of the bus at the assigned bay; it displays the service code simultaneously on the visual display of the central bay and that of the assigned bay. Thereafter, SDC 38 updates the bay status data and transmits it to BAU 34 which again uses these data to assign bay codes to other oncoming buses.

In Figures 1A and 3, all DSUs 36 at the bus station 10 transmit respective bay code 108 regularly to poll IBU 32. When the bus arrives at the bus station 10, IBU 32 returns vehicle code 104 upon receipt of the bay code 108 from a DSU. DSU 36 transmits the received vehicle code 104 to SDC 38 to indicate the detection of a bus. Thereafter, DSU 36 continues to transmit bay code 108 regularly to request vehicle code 104 from IBU 32 to monitor the existence of a bus. SDC 38 verifies the identity of a bus at the assigned bay by counter-checking the vehicle code received from BAU with that from DSU. SDC also compares the received vehicle code and the arrival time with that of a predetermined schedule. While the bus is serving commuters, SDC 38 transmits a signal to IBU to inform the driver to hasten or slow the bus movement if the arrival time deviates from the predetermined schedule. SDC 38 also transmits operation data 110 for earlier buses movement, if any, through DSU 36 to IBU 32 for storing in its memory. When the bus leaves, DSU 36 receives no vehicle code from IBU 32 and in turn informs SDC 38. SDC 38 then updates the bay status data, generates operation data 110 to record this instance, and transmits vehicle code 104 and service code 105 of the next bus assigned to this bay, if any, to the DSU and DSU at bay C.

In-bus Unit (IBU)

Figure 4 is a schematic of an in-bus unit according to Figure 3 of the present invention. IBU 32 comprises at least two main modules: one is preferably

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installed at the front of a bus and further comprises a microprocessor 122, a communication link 126, an input device 128, an in-vehicle visual display device 132, a memory 134 and a software 136; the other is an optional transceiver 124 and preferably installed at the rear of a bus for communicating with other IBUs. The microprocessor is coupled to all the other components of the IBU and controls the same. The communication link 126 is preferably a wireless modem for transmitting and receiving vital information between the BAU 34, the DSU 36 or the transceiver 124 of a bus in front of the present bus. It should be understood by one skilled in the art that the wireless modem 126 communicates with the microprocessor over a input/output port 125 of the microprocessor. The input device 128 is preferably coupled to a predetermined set of functions keys for activating a plurality of functions. In the preferred embodiment of the present invention, there are eight functions for activating key status bytes 130 such as missing bay code, faulty DSU display, bus breakdown etc. The in-vehicle visual device 132 displays bay codes, bus station codes and operation data from either the DSU or the BAU. The memory 134 is preferably a random access memory for storing a list of bus station and other codes. Finally, the firmware is a repository of the software program which controls the IBU.

The IBU 32 receives bus station code 112 over the wireless modem 126 from the BAU 34 when the IBU comes within the effective range of the BAU. The microprocessor 122 checks whether the received bus station code 112 is in the list of bus station codes in memory 134 for a current service route. IBU 32 ignores the bus station if the bus station code is not on the current list. Otherwise, the IBU transmits over the wireless modem 126 its vehicle code 104 and service code 105 to the BAU 34. The IBU also transmits the number of buses behind it. This is accomplished with the transceiver 124 receiving the

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vehicle codes and service codes from the IBU behind it in a daisy chain fashion. As mentioned briefly above and shall be elaborated further below, BAU 34 then assigns a bay code to the bus by transmits it to the IBU over the wireless modem 126 the assigned bay code 108 and operation data 110 to the IBU.

Again in Figures 3 and 4, the IBU 32 receives respective bay code 108 from each DSU 36 and transmits its vehicle code 104 thereto upon arriving at the bus station 10. If the bus halts at the assigned bay, the IBU 32 receives from the DSU 36 a real time for updating the time and operation data 110 for other buses to be stored in the memory 134. When the bus leaves the assigned bay, the IBU 32 clears the assigned bay code 108 stored previously in its memory 134 by virtue of the fact that the IBU no longer receives bay code from the DSU 36.

Bay Assigning Unit (BAU)

Figure 5 shows a schematic of a BAU 34 according to Figure 3 of the present invention. The BAU 34 comprises a microprocessor 138, at least two modems 140 and 142, a memory 144, and a firmware 146. The microprocessor 138 is coupled to each of the other components of the BAU 34 for controlling the operations thereof. The modem 140 has a communication link with IBU 32, while the modem 142 establishes another communication link with SDC 38. In one embodiment of the present invention, the modems 140 and 142 are wireless modem. In the centralized BAU embodiment, the communication links with SDC are hard wired. Not shown in Figure 5 but should be understood by one skilled in the art, at least one transceiver in IBU 32 and SDC 38 transmits and receives data via the modems 140 and 142 into and from the I/O ports 139 and 141 respectively. The memory 144 is preferably a

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random access memory RAM for storing operation data such as system parameters. The data in memory 144 may be altered via I/O ports 139 and 141. Although the firmware 146 is illustrated as a distinct component from the microprocessor 138, it should be understood by one skilled in the art that it may not be necessarily so. The firmware 146 stores the operating software for controlling the BAU 34.

Referring again to Figure 1A, BAU 34 is installed at the multiple-bay bus station 10 or in the vicinity thereof. The present invention also envisages other modes of communication between the BAU and the SDC. For example, the communication between the BAU and SDC can adopt transmission techniques such as line communication, radio communication, infra red, satellite or ultrasonic.

The communication link between BAU 34 and IBU 32 is preferably focused narrowly to detect different IBUs in a defined zone. Referring again to Figure 3, BAU 34 transmits bus station code 112 at a predetermined interval via the modem 140 to poll for any IBU 32 moving into the effective range of BAU.

BAU 34 utilizes a bay code assignment byte (BCAB) and a pointer (both not shown in the Figures) for assigning unique bay code 108 to buses within the effective range of BAU automatically. The first bit (i.e., the least significant bit) of the BCAB is linked to the bay code corresponding to bay 12 in Figure 1A, the second bit to bay 14 and so on. The pointer always points to '0' bit in the BCAB. In response to receiving bay status data 116 from SDC 38, the contents and pointer of the BCAB is updated automatically. The BAU assigns the bay code linked to the bit of BCAB pointed by the pointer to a bus.

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In the preferred embodiment of the present invention, BAU 34 transmits a polling signal 114 at a predetermined interval to SDC 38 when no bus is passing through BAU's position. The bay status data 116 comprises at least two bytes: (1) the Fault-status byte for indicating faulty or unavailable bay, and (2) the Free-status byte for indicating free bay for accepting new bus service (both bytes are not shown). Just as the BCAB of BAU, the first bits (the least significant bits) of the bay status data are associated with bay code corresponding to bay 12 in Figure 1A, the second bits to bay 14 and so on. When a bay is faulty or unavailable, the linked bits in bay status data are set (i.e., to '1'). When a bay is engaged (i.e., DSU of the bay displays a service code) the linked bit in Free-status byte is set. If the bay is available to accept new service code, all the linked bits in bay status data are cleared (i.e., '0'). As mentioned briefly in the preceding paragraph, BAU 34 receives a bay status data 116 from SDC. The bay status data is used to update the BCAB and its pointer automatically. BAU 34 uses the Fault-status byte to replace the contents of the BCAB such that the faulty or unavailable bays linked to '1' bits in the BCAB will not be assigned to IBU. BAU further sets the pointer of BCAB according to contents of the Free-status byte, the number of oncoming buses in a convoy, and the size of the buses (single or double-cabin bus). Other factors taken into consideration are the expected waiting time of the services currently occupying the bays, and the expected travel time for the bus to travel from the moment the bay code is assigned to the moment the bus moves to the assigned bay. Thereafter, the pointer increments sequentially by either a single (for single-cabin bus) or double (for double-cabin bus) step to the next higher significant '0' bit of BCAB and returns to the first bit. When the BAU 34 completes the bay assignment process, it transmits the vehicle code 104, service code 105, and the assigned bay code 108 to SDC 38.

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Display Cum Sensing Unit (DSU)

Figure 6 shows a schematic of a display cum sensing (DSU) unit 36 according to Figure 3 of the present invention. The DSU 36 comprises a microprocessor 148, at least two modems 150 and 152, a display device 154, a display memory 156, a memory 158, and a firmware 160. The microprocessor 148 is coupled to each of the other components of the DSU 36 for controlling the operations thereof. The modem 150 has a communication link with IBU 32, while the modem 152 maintains another communication link with SDC 38. In the preferred embodiment of the present invention, the modem 150 is wireless and modem 152 is either line or wireless. The memory 158 is preferably a random access memory RAM for storing system parameters such as bay code 108 and operation data 110. The data in memory 158 may be altered via I/O ports 149 and 151. The display device 154 and the associated display memory 156 provide up-to-date information for the commuters waiting at the bus station. An example of the display device 154 is shown in Figures 1B. Preferably the display device 154 are equipment with a tone generator for alerting the commuter of certain status of oncoming buses such as a fully loaded bus. Although the firmware 160 is illustrated as a distinct component from the processor 148, it should be understood by one skilled in the art that it may not be necessarily be so. The firmware 160 stores the operating software for controlling the DSU 36.

Referring again to Figure 3, DSU 36 transmits bay code 108 at a predetermined interval to poll IBU 32 for oncoming buses. Upon receiving bay code 108, IBU 32 on bus 100 transmits vehicle code 104 to DSU 36. Upon receiving vehicle code 104 from IBU 32 on bus 100, DSU 36 switches to a monitoring mode and transmits sensor data 120 to SDC 38. In monitoring mode, DSU 36 transmits bay code at another predetermined interval to IBUs to

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poll for vehicle code 104. When bus 100 leaves the bay, DSU receives no vehicle code 104 from IBU 32 on bus 100. DSU clears its display memory 156 and transmits bay status 118 to SDC 38. If DSU 36 receives no response from SDC 38, it means that SDC 38 is faulty. Otherwise, it receives from SDC 38 vehicle code 104 and service code 105 of the next bus assigned to the bay.

Service Display Controller (SDC)

Figure 7 shows a schematic of a service display controller SDC 38 according to Figure 3 of the present invention. The SDC 38 comprises a microprocessor 162, at least one modems 164 and a plurality of modems 166 to 168, a clock 170, a memory 172, and a firmware 174. The microprocessor 162 is coupled to each of the other components of the SDC 38 for controlling the operations thereof. The modem 164 has a communication link with BAU 34, while the modem 166 to 168 maintains communication links with corresponding DSU 36. In the preferred embodiment of the present invention, the modems 164, 166 and 168 can either be line or wireless modem. The clock 170 generate real time clock for the system. The memory 172 is preferably a random access memory RAM for storing system parameters and operation data. Although the firmware 174 is illustrated as a distinct component from the microprocessor 162, it should be understood by one skilled in the art that it may not be necessarily be so. The firmware 174 stores the operating software for controlling the SDC 38.

At least one SDC 38 is installed at each bus station and is linked to BAU 34 for the same station. In its default mode, SDC 38 receives data from BAU 34 and DSU 36 respectively. Although not shown in Figures 3 and 7, SDC 38 maintains a bank of send-frequency counters which are individually linked to each operation data in the memory 172 for ensuring each operation data is

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sent to a predetermined number of IBUs 32. Each of the IBUs is on different bus. Again in Figure 3, SDC 38 transmits a bay status data 116 to BAU 34 in response to receiving a request code or vehicle code, service code and bay code therefrom. BAU 34 transmits the codes to SDC 38 after a bus (for example bus 102) has been assigned a bay code 108. Upon receiving the codes from BAU, SDC 38 stores them in its memory 172. SDC re-transmits the vehicle code 104, service code 105 and bay code 108 to the assigned DSU 36 as well as the DSU 36 at the central bay 16 in Figure 1A.

The process of making SDC 38 to return bay status data upon receiving data from BAU 34 at fixed interval establishes a link between BAU and SDC for monitoring each other's functionality. Any fault found is recorded and transmitted to IBU by the functioning SDC or BAU, where BAU transmits directly but SDC transmits through a DSU. The bus driver can also activate function keys provided in IBU to record any malfunctions of BAUs or DSUs, e.g. no bay code received from BAU after passing by the BAU position, no display of service on visual displays of the assigned DSU.

Operation Data Handling

While buses ply along service routes, each IBU receives operation data from DSUs or BAUs and also records data generated from activation of function keys by bus driver. These operation data are stored in the data storage device of IBU which is brought to bus terminal for transferring the stored data to event data analyzer (EDA) for generating management information reports and producing alarms on faulty equipment. In addition, the data storage device also stores the new system parameters or the revised bus schedules generated by EDA, these data are to be transmitted through IBU to BAU or

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DSUs for changing system parameters or schedules stored in BAUs, SDCs and DSUs.

EDA derives equipment faults from the collected operation data as follows:

a. faulty BAU is confirmed by the operation data generated by SDC after observing no receipt of polling signal from BAU within a fixed duration or few consecutive cases of buses arriving at bus stop without being assigned bay code by BAU, and is further confirmed by the operation data generated by bus drivers through activation of proper function key to record the case of no bay code being assigned after passing by the BAU position;

b. faulty DSU is confirmed by the opreation data generated by SDC after observing few consecutive cases that all DSUs are able to detect IBUs except the faulty DSU, and is further confirmed by the opreation data generated by bus drivers through activation of proper function key to record the case of no service or wrong service being displayed by the visual displays linked to the faulty DSU;

c. faulty SDC is confirmed by the operation data generated by BAU after polling SDC a fixed number of times without receiving bay status data from SDC or with the receipt of invalid bay status data from SDC; and

d. faulty IBU is confirmed from the operation data generated by the only bus driver of the faulty IBU through activation of proper function key to record the case of no bay code being displayed after passing by BAU position or, in the case of no reception of operation data for the IBU or no reception of operation data or reception of wrong operation data from the faulty IBU by EDA.

EDA also derives abnormal bus movement from the collected operation data as follows:

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a. a bus assigned with a bay code by BAU is declared as missing (could be due to bus breakdown or accident) if the buses behind the mission bus but not the said bus are detected by DSUs at bus station; and

b. a bus assigned with a bay code by BAU is declared as not halting at the assigned bay if the duration between the arrival time and departure time of the bus recorded by the DSU at the assigned bay is less than a reasonable value.

Although, the present invention has been described particularly with reference to Figures. 1 to 7, it should be understood that the figures are for illustration only and should not be taken as limitations on the invention. It is also contemplated that many changes and modifications may be made by one of ordinary skill in the art without departing from the spirit and the scope of the invention as described.

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CLAIMS

1. A system for minimizing congestion at bus stations including a plurality of bus bays for each bus station, each bay being provided optionally with barrier for confining commuters in at least one queue for each bus bay and being sited adjacent to each other along roadside, at least one bay accommodating at least one bus at a time while providing minimum head space for a bus to bypass bus in front of it, said system comprising:

at least one in-bus unit (IBU) being installed on each bus for communicating with bus stations and buses within a predetermined range, said IBU having at least one receiving means for receiving information from said system, at least an input means for interacting with said system, at least one data storage means for storing data, at least one in-vehicle querying means for querying and communicating with IBUs within communication range;

at least one display and sensing unit (DSU) being installed at each bus station for displaying services at respective bus bays and for guiding commuters thereto, said DSU having a first communication link with IBU for receiving vehicle codes therefrom, said DSU transmitting bay codes and operation data over said first communication link to said IBU, said DSU further having at least one visual display at said bus station for displaying services available at respective adjacent bays;

at least one service display controller (SDC) being installed at each bus station for controlling service display on said DSU, said SDC having a first communication link with DSU for transmitting vehicle codes, service codes, bay codes, and operation data thereto, said SDC controlling data

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communication between DSU and IBU over said first communication link with DSU; and

at least one bay assigning unit (BAU) within a second predetermined communication range of SDC. said BAU having a first communication link with SDC for querying said SDC for the status of bus bays at said bus station, said SDC transmitting bay status data to said BAU over said second communication link with BAU, said BAU further having a second communication link with IBUs in an approaching convoy for querying whether the bus station is included in IBU's service route, said BAU receiving vehicle codes from the IBU over the second communication link if the service route verification is affirmative, said BAU reconciling the number of buses in said convoy with the status of the bus bays and transmitting a bay code via said second communication link to IBU, said BAU transmitting the assigned bay code with the corresponding vehicle code and service code to said SDC over said first communication link with SDC, said BAU repeating this process for all buses in said convoy,

whereby the assignment of bus bays to buses in an approaching convoy is executed optimally and automatically in order to minimize commuter movement at said bus station according to the number of approaching buses to the bus station.

2. The system for minimizing congestion at bus stations as in claim 1 wherein the plurality of bus bays are sited adjacent along at least one roadside.

3. The system for minimizing congestion at bus stations as in claim 1 wherein said barrier is a physical barrier.

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4. The system for minimizing congestion at bus stations as in claim 1 wherein said barrier is an imaginary barrier.

5. The system for minimizing congestion at bus stations as in claim 1 wherein said first communication link of DSU with IBU is controlled by at least one processor.

6. The system for minimizing congestion at bus stations as in claim 1 wherein said in-vehicle querying means of said IBU identifies the codes of successive buses in a convoy by querying and receiving from IBU the vehicle codes of successive buses in a daisy chain manner.

7. The system for minimizing congestion at bus stations as in claim 1 wherein said in-vehicle querying means of said IBU comprises a transceiver and a receiver, said transceiver and said receiver being further controlled by at least one processor.

8. The system for minimizing congestion at bus stations as in claim 1 wherein said first communication link of BAU with SDC and said second communication link of BAU with said IBU are controlled by at least one processor.

9. The system for minimizing congestion at bus stations as in claim 8 wherein said first communication link of SDC with DSU comprises at least one hardwire.

10. The system for minimizing congestion at bus stations as in claim 8 wherein said first communication link of SDC with DSU comprises at least one wireless modem.

11. The system for minimizing congestion at bus stations as in claim 1 wherein said first communication link of BAU with SDC comprises at least one wireless modem.

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12. The system for minimizing congestion at bus stations as in claim 1 wherein said second communication link of BAU with IBU comprises at least one wireless modem.

13. A system for minimizing congestion at bus stations including a plurality of bus bays for each bus station, each bay being provided optionally with barrier for confining commuters in at least one queue and being further sited adjacent to each other along roadside, at least one bay accommodating at least one bus at a time while providing minimum head space for a bus to bypass bus in front of it, a method for maximizing commuter clearance and for minimizing commuter movement at bus station, said method comprising:

capturing information for plurality of bus bays and buses respectively, said bus bays being represented by bay codes, said buses being represented by vehicle codes and service codes;

translating and transmitting within a first communication range between BAU and SDC, said information representing bus bays and buses to a plurality of physical addresses in said system, said physical addresses representing a plurality of mutually exclusive relationship between available bus bay and an approaching bus in a convoy, each bus in said convoy being detectable by said system once it is within a second communication range between IBU and BAU;

matching and ushering the buses in said approaching bus convoy into available bus bays, said matching being maximized to correspond to the number of available bus bays and as close to a position of commuter concentration at said bus station as the availability of bus bays allows; and

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displaying the service code of the approaching bus to commuters after the mutually exclusive relationship between available bus bay and approaching bus is established,

whereby the assignment of bus bays to buses in an approaching convoy is executed optimally and automatically in guiding commuters to available bus bays for boarding said buses simultaneously and thus obviating the commuters to identify and match the approaching bus with the designated bus bay.

14. The method for minimizing congestion at bus stations as in claim 13 wherein said matching is determined by the number of available bus bays, number of buses at the bus station, number of buses approaching said bus station, and the historical bus traffic pattern at said bus station.

15. The method for minimizing congestion at bus stations as in claim 13 wherein said plurality of bays in each bus station is greater than two.

16. A system for minimizing congestion at bus stations including a plurality of bus bays for each bus station, each bay being provided optionally with barrier for confining commuters in at least one queue and being sited adjacent to each other along roadside, at least one bay accommodating at least one bus at a time while providing minimum head space for a bus to bypass bus in front of it, a method for minimizing commuter inconvenience at bus station, and for maximizing commuter clearance from bus station, said method comprising:

installing at least one in-bus unit (IBU) on each bus to facilitate the communication between bus stations and buses with a first predetermined communication range, said IBU having at least one receiving means for receiving information from said system, at least one input means to interact with said system,

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at least one data storage means for storing data, at least one in-vehicle querying means for querying and communicating with IBUs within communication range;

installing at least one display and sensing unit (DSU) at each bus station for displaying services at respective bays and for guiding commuters thereto, said DSU having a first communication link with IBU for receiving vehicle codes therefrom, said DSU transmitting bay codes and operation data over said first communication link to said IBU, said DSU further having at least one visual display at said bus station for displaying services available at respective adjacent bays;

installing at least one service display controller (SDC) at each bus station for controlling service display on said DSU, said SDC having a first communication link with DSU for transmitting vehicle codes, srevice codes, bay codes and operation data thereto, said SDC controlling data communication between DSU and IBU over said first communication link with DSU; and

having at least one bay assigning unit (BAU) within a second predetermined communication range of SDC, said BAU having a first communication link with SDC for querying said SDC for the status of bus bays at said bus station, said SDC transmitting bay status data to said BAU over said second communication link with BAU, said BAU further having a second communication link with IBUs in an approaching convoy for querying whether the bus station is included in IBU's service route, said BAU receiving vehicle codes from the IBU over the second communication link if the service route

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verification is affirmative, said BAU reconciling the number of buses in said convoy with the status of the bus bays and transmitting a bay code via said second communication link to IBU, said BAU transmitting the assigned bay code with the corresponding vehicle code and service code to said SDC over said first communication link with SDC, said BAU repeating this process for all buses in said convoy,

whereby the assignment of bus bays to buses in an approaching convoy is executed optimally and automatically according to the number of approaching buses to the bus station.

17. The method for minimizing congestion at bus stations as in claim 16 wherein the plurality of bus bays are sited adjacent along at least one roadside.

18. The method for minimizing congestion at bus stations as in claim 16 wherein the plurality of bus bays is greater than two.

19. The method for minimizing congestion at bus stations as in claim 16 wherein said barrier is a physical barrier.

20. The method for minimizing congestion at bus stations as in claim 16 wherein said barrier is an imaginary barrier.

21. The method for minimizing congestion at bus stations as in claim 16 wherein said first communication link of DSU with IBU is controlled by a processor.

22. The method for minimizing congestion at bus stations as in claim 16 wherein said in-vehicle querying means of said IBU identifies the codes of successive buses in a convoy by querying and receiving from IBU the vehicle codes of successive buses in a daisy chain manner.

23. The method for minimizing congestion at bus stations as in claim 16 wherein said in-vehicle querying means of said IBU comprises a

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transceiver and a receiver, said transceiver and said receiver being further controlled by at least one processor.

24. The method for minimizing congestion at bus stations as in claim 16 wherein said first communication link of SDC with DSU is controlled by at least one processor.

25. The method for minimizing congestion at bus stations as in claim 16 wherein said first communication link of SDC with DSU comprises at least one hardwire.

26. The method for minimizing congestion at bus stations as in claim 16 wherein said first communication link of SDC with DSU comprises at least one wireless modem.

27. The method for minimizing congestion at bus stations as in claim 16 wherein said first communication link of BAU with SDC comprises at least one wireless modem.

28. The method for minimizing congestion at bus stations as in claim 16 wherein said second communication link of BAU with IBU comprises at least one wireless modem.

29. The method for minimizing congestion at bus stations as in claim 16 wherein said operation data are down loaded in an off-line manner at predetermined points along said bus route for further analysis.

30. The method for minimizing congestion at bus stations as in claim 16 wherein said operation data are down loaded in an on-line manner at predetermined points along said bus route for further analysis.

31. The method for minimizing congestion at bus stations as in claim 29 or 30 wherein said arrival times of buses are analyzed for deviation from a plurality of pre-stored schedule, the deviation are corrected such that cumulative errors are minimized in said system.

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