

PROXIMITY MONITORING SYSTEM AND METHOD

FIELD OF THE INVENTION

[001] The present invention relates to a proximity alarm monitoring system and method for monitoring a plurality of articles.

BACKGROUND OF THE INVENTION

[002] The use of monitoring devices for articles of value is known in the prior art. Such devices are utilized for both personal and commercial use. For example, companies that provide delivery services for their products will be required to ensure that an article picked up by a delivery personnel will be delivered to the intended addressee. Monitoring devices enable the company and sender of the article to track the whereabouts of the article from the time the article leaves the sender's premises to the intended address. Manual processes may also be established within the company to ensure that the delivery personnel guarantees the delivery of the article and that it is delivered in a timely manner.

[003] However, there may be occurrences where the delivery personnel inadvertently misplaces the article on the way to the intended destination. One way of misplacing the article may be when the article is delivered on foot to the intended destination by the delivery personnel. Another way of misplacing the article could be when an article is misplaced from a vehicle unit, whether advertently or inadvertently, while the delivery personnel is away on a delivery assignment. In some cases, such loss of the article by the delivery personnel can lead to financial loss by either the sender or the receiver of the intended article.

[004] Currently, there are monitoring devices, processes and systems in place to ensure the whereabouts, timely and accurate delivery of a company's products to the intended

addressee. However, monitoring devices, processes and systems do not mitigate the occurrence of loss of the article by the delivery personnel enroute to the intended addressee. These monitoring devices, processes and systems also do not allow for the delivery personnel to retrieve the lost article.

[005] In addition, the work flow of delivery of articles by delivery personnel presents some challenges in meeting the desired timeframes of customers. Some customers expect articles to be delivered within a certain timeframe due to the sensitivity of the documents. For instance, delivery personnel may be held up at a certain designated delivery location due to unavailability of personnel to receive the article or a delivery personnel may be held up due to a breakdown of the vehicle delivering the articles. Current work flow and systems may not be sufficient to mitigate against these occurrences.

[006] Any discussion of documents, devices, acts or knowledge in this specification is included to explain the context of the invention. It should not be taken as an admission that any of the material forms a part of the state of the art or the common general knowledge in the relevant art in Singapore or elsewhere on or before the priority date of the disclosure and claims herein. All statements as to the date or representation as to the contents of these documents is based on the information available to the applicant and does not constitute any admission as to the correctness of the date or contents of these documents.

OBJECT OF THE INVENTION

[007] It is an object of the present invention to overcome, or at least substantially ameliorate, the disadvantages and shortcomings of the problems discussed above.

[008] Other objects and advantages of the present invention will become apparent from the following description, taken in connection with the accompanying drawings, wherein, by way of illustration and example, an embodiment of the present invention is disclosed.

SUMMARY OF THE INVENTION

[009] According to a first aspect of the invention, a proximity monitoring alarm system for monitoring a plurality of articles is disclosed comprising a plurality of article tags wherein each of the article tags is in an activated condition and capable of attaching to each of the plurality of articles located within a vehicle unit and each of the article tags is configured to transmit an article tag validation signal in a predetermined time interval. It also includes a handheld unit configured to receive a monitoring unit, the monitoring unit operatively communicating with each article tag by receiving the article tag validation signal so that an alarm will be triggered on the handheld unit when the monitoring unit fails to receive the article tag validation signals from any one of the plurality of article tags; a vehicle tag for attaching to the vehicle unit, the vehicle tag operatively communicating with the monitoring unit and transmitting a vehicle tag validation signal in a predetermined time interval to be received by the monitoring unit; a deactivating module for selection on the handheld unit by a user for deactivating the plurality of article tags within a predetermined distance from the handheld unit so that the plurality of article tags are in a deactivated condition, wherein when the deactivating module is selected, and when the monitoring unit subsequently detects the vehicle tag validation signals less than a first predetermined vehicle tag RSSI value, a portion of the plurality of article tags within the predetermined distance from the handheld unit will reactivate to be in an activated condition and the remaining portion of the plurality of article tags within the vehicle unit will remain in the deactivated condition.

[010] Preferably, the proximity monitoring alarm system further comprises a reconciliation module activatable when the monitoring unit detects the vehicle tag validation signals above a second predetermined vehicle tag RSSI value, wherein the monitoring unit matches article tag identifier information received from each of the plurality of article tags in the deactivated condition within the vehicle unit with the article tag identifier information of the article tags stored in the handheld unit.

[011] Preferably, the proximity monitoring alarm system further comprises a leave module for selection on the handheld unit by the user when one of the plurality of articles for delivery at a delivery point is unable to be received by a receiving personnel, whereby when the leave module is activated, the one of the plurality of article remains in an activated condition.

[012] Preferably, the proximity monitoring alarm system further comprises a leave module for selection on the handheld unit by the user when a second article for collection at a delivery point is unavailable for collection.

[013] Preferably, when the leave module is activated, the handheld unit prompts the user to select a predefined list of reasons.

[014] Preferably, the article tag identifier information of the one of the plurality of articles unable to be received by a receiving personnel and the selected predefined list of reasons are sent via the communications network to notify the administrative manager interface.

[015] Preferably, the system further comprises a first job re-assignment module for selection by a user at the administrative manager interface for assigning a job assignment list from a handover delivery personnel to a takeover delivery personnel.

[016] Preferably, when the first job re-assignment module is activated, the user at the administrative manager interface notifies the handover delivery personnel and the takeover delivery personnel of a designated location for handover and take over of the plurality of articles.

[017] Preferably, system further comprises a second job re-assignment module for selection by the takeover delivery personnel on the second handheld unit to take over the job assignment list and the plurality of articles from the handover delivery personnel at a designated location.

[018] Preferably, the predetermined distance from the handheld unit is approximately 0.5 meters.

[019] Preferably, the first predetermined vehicle tag RSSI value is less than 130 units.

[020] Preferably, the second predetermined vehicle tag RSSI value is more than 160 units.

[021] According to a second aspect of the invention, there is provided a method of monitoring a plurality of articles, each of the plurality of articles tagged with an article tag, comprising the steps of: a) activating the article tags to be in an activated condition with a handheld unit, each of the article tags transmitting an article tag validation signal in a predetermined time interval, and operatively communicating with a monitoring unit adapted to be received by the handheld unit, so that an alarm will be triggered on the handheld unit when the monitoring unit fails to receive the article tag validation signals from any one of the article tags; b) assigning a vehicle unit for delivery of the plurality of articles, the vehicle unit including a vehicle tag adapted for operatively communicating with the monitoring unit and transmitting a vehicle tag validation signal in a predetermined time interval adapted to be received by the monitoring unit; c) selecting a deactivating module on the handheld unit by a user for deactivating the plurality of article tags located within a predetermined distance from the handheld unit so that they are in a deactivated condition; d) reactivating a portion of the plurality of article tags within the predetermined distance from the handheld unit when the monitoring unit detects a vehicle tag validation signal less than a first predetermined vehicle tag RSSI value while the remaining portion of the plurality of article tags within the vehicle unit remain in the deactivated condition.

[022] Preferably, the method further comprises the step of: e) reconciling article tag identifier information received from each of the plurality of article tags in the deactivated condition within the vehicle unit with the article tag identifier information of the article tags stored in the handheld unit when the monitoring unit detects the vehicle tag validation signals above a second predetermined vehicle tag RSSI value.

[023] Preferably, the method further comprises the step of: f) activating a leave module for selection on the handheld unit by the user when one of the plurality of articles for delivery at a delivery point is unable to be received by a receiving personnel, whereby

when the leave module is activated, the one of the plurality of article remains in an activated condition.

[024] Preferably, the method further comprises the step of: f) activating a leave module for selection on the handheld unit by the user when a second article for collection at a delivery point is unable to be collected.

[025] Preferably, the predetermined distance from the handheld unit is approximately 0.5 meters.

[026] Preferably, the first predetermined vehicle tag RSSI value is less than 130 units.

[027] Preferably, the second predetermined vehicle tag RSSI value is more than 160 units.

DRAWINGS

[028] In order that the invention may be better understood and put into practical effect, the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[029] Figure 1 is a diagrammatic view of a proximity monitoring alarm system according to the present invention;

[030] Figure 2 is a flow chart of an article collection process according to the present invention;

[031] Figure 3 is a flow chart of a monitoring process according to the present invention;

[032] Figure 4 is a flow chart of an article tag dropped process according to the present invention;

[033] Figure 5 shows the process flow when an article tag is in an in-range list according to the present invention;

[034] Figure 6 is a flowchart of the relationship between the administrative manager interface, database and report generation module according to the present invention;

[035] Figure 7 is a RFID tag status indicator diagram according to the present invention;

[036] Figure 8 is a flowchart of the process when an article is delivered according to the present invention;

[037] Figure 9 is a flowchart of an article recovery process according to the present invention;

[038] Figure 10 is a flowchart of a further article recovery process according to the present invention;

[039] Figure 11 is a continuation flowchart of Figure 10;

[040] Figure 12 is a flow chart of a process for deactivating tagged articles;

[041] Figure 13 is a flow chart of a process for reactivating tagged articles;

[042] Figure 14 is a flow chart of a process for a delivery point check;

[043] Figure 15 is a process flow for a deactivating module and a reconciliation module;

[044] Figure 16 is a process flow for a leave module; and

[045] Figure 17 is a process flow for a job re-assignment module.

DETAILED DESCRIPTION OF INVENTION

[046] The present invention will now be described in detail in connection with preferred embodiments with reference to the accompanying drawings. The present invention detects an article tagged with a Radio Frequency Identification (RFID) tag which is not within monitoring distance of a monitoring unit while in transit from point A to point B. Should the system detect a breach in the monitoring distance while in transit from the pickup point to the intended destination, the present invention also provides a method for recovering the article.

[047] Figure 1 illustrates a proximity monitoring alarm system 10 for monitoring tagged articles. The system 10 comprises a portable handheld unit 20 which operatively communicates with a central server 30 via a communications network 40. Each of the articles being monitored is tagged with a Radio Frequency Identification (RFID) article tag (not shown), each article tag having a unique identification code. The portable handheld unit 20 is configured to receive a monitoring unit 50 at the base of the handheld unit 20. The monitoring unit 50 has a male or female portion to enable attachment with the respective female or male portion of the portable handheld unit 20. The monitoring unit 50 is a receiver configured to receive article tag validation signals from each of the article tags on the articles. The article tag validation signal may be in the form of radio frequencies that is received by the monitoring unit. The article tag validation signals from each article tag are transmitted periodically, over a predetermined time interval, which could range from between 1.5 seconds to 3 seconds. In the event the monitoring unit 50 does not receive an article tag validation signal from any one of the article tags, an alarm will be activated on the handheld unit 20, alerting a delivery personnel of the loss of the article. The alarm provides an audible, visual or tactile signal to alert the delivery personnel. The alarm may be in the form of a buzzer 21, speaker, light or sound source on the handheld unit 20. At the

same time, an alert message will be transmitted to the central server 30 to notify a user at the administrative manager interface 34 of the loss of the article.

[048] The handheld unit 20 includes a microprocessor (not shown) for executing instructions and applications installed on it and memory (not shown) for storing data. The handheld unit 20 is capable of transmitting and receiving information from the monitoring unit 50. The information may be in the form of tag identifier information, which will be further explained. The handheld unit 20 also includes a module manager interface 23 which controls the functions and activities of the handheld unit 20, the monitoring unit 50 and the article tag. The handheld unit also includes a deactivating module, a reconciliation module, a leave module and a job re-assignment module. The module manager interface 23 includes a distance adjusting module 24 which allows a user to predetermine or select a monitoring distance of the monitoring unit 50 to the article tag or to a plurality of article tags. The monitoring distance of the monitoring unit 50 is the distance or the radius around the monitoring unit from which it can receive article tag validation signals from the RFID tag. Given a predetermined monitoring distance that the monitoring unit 50 can receive the article tag validation signal, an alarm will be activated when no article tag validation signal is received from the article tag located further than the predetermined monitoring distance, or where the article tag validation signal is not able to reach. The monitoring distance may be adjusted from a distance of 0.5 meters to 10 meters, or more if the specification of the monitoring unit 50 allows.

[049] The handheld unit 20 also includes a time interval adjusting module. As mentioned previously, article tag validation signals transmitted by the article tag at periodic time intervals are received by the monitoring unit 50. The time interval adjusting module has an option of allowing a user to select the time interval at which article tag validation signals are transmitted from the article tag when necessary. Preferably, the time interval at which article tag validation signals are transmitted from the article tag are automatically

preselected at the handheld unit 20 and the time interval is instead controlled at the central server 30 which will be explained in further detail below.

[050] The module manager interface 23 of the handheld unit 20 also includes a tag tracking module 25, an article recovery module, a Global Positioning Satellite (GPS) module, a time synchronization module 26, a status monitor module 27, a report generation module 38, each of which will be explained in further detail.

[051] The central server 30 includes a database 36 for storing the article tag identifier information of each article tag. The article tag identifier information of each article tag includes a unique identification code and an article identifier information unique to the article the article tag is attached to. The central server 30 is configured to communicate with the handheld unit 20 and the article tag over the communications network 40. It will be appreciated to a skilled person that the communications network 40 can be any form of network that allows for wireless or non-wireless transmission of data. The central server 30 includes a RFID adapter 32, which may be integrated with or separated from the central server 30, for transmission of data to or from the central server 30 to the handheld unit 20. When an alarm is activated on the handheld unit 20, an alert message is correspondingly sent to the central server 30 to inform of the loss of an article. The alert message can be sent to the workstation or portable communication devices in the form of a Short-Message-Service (SMS) or an email. The alert message may include information such as the details of the handheld unit 20, the delivery personnel information, geographical location details of the handheld unit 20 or operational information required to perform an article recovery.

[052] The system 10 also includes workstations or other portable communication devices which can access the central server 30 via the communications network 40 to control or utilize the functions of the central server 30. The central server 30 further includes an administrative manager interface 34 for controlling the functions and activities of the

database 36, the portable handheld unit 20 and article tags. The administrative manager interface 34 can be an application installed on workstations or other portable communication devices. On the administrative manager interface 34 are other program modules which can be installed. The program modules include those that may be included on the handheld unit 20 such as a distance adjusting module 24, a tag tracking module 25, an article recovery module, a Global Positioning Satellite (GPS) module, a time synchronization module 26, a status monitor module 27, a report generation module, a job re-assignment module, etc.. The administrative manager interface 34 also includes a time interval adjuster which allows adjustment to the predetermined time interval for transmission of article tag validation signals from the article tag. However, while the modules on the handheld unit 20 are specific to the article tags that are being tracked by the specific handheld unit 20, the program modules on the administrative manager interface 34 controls a plurality of handheld units 20, each of which controls a plurality of article tags.

[053] Figure 2 describes an article collection process 100 from a specified location for delivery to an intended destination. A delivery personnel begins the day by collecting a handheld unit 20 from headquarters. The delivery personnel will authenticate on the handheld unit 20 by supplying a user or employee identification and a password to confirm the identity of the delivery personnel. Upon authentication, the handheld unit 20 will synchronize the clock time on the handheld unit 20 with the clock time on the server 30. The handheld unit 20 also downloads a job assignment list from the central server 30, the job assignment list containing the delivery routes indicating the locations of each of the articles to be collected and delivered. At step 102, the delivery personnel will make his way to the intended pick up point to pick up the articles. Alternatively, the articles which have been tagged with article tags can be collected at the headquarters to be delivered at various locations. At the pick up point, the delivery personnel will require to physically add an article tag to the article to be delivered. Once this is done, the article will next be authenticated to ensure that the details of the article are correct. The authentication can be

done by the client representative or the delivery personnel. The handheld unit 20 will next communicate with the article tag at step 104 by either scanning the article tag with the handheld unit 20 or configuring the handheld unit 20 to automatically receive an article tag validation signal from the article tag. As mentioned above, the article tag identifier information includes the unique identifier code of the tag and article identifier information which identifies the article. The article tag identifier information is subsequently received by the handheld unit 20 into a monitoring list. Step 106 confirms if the article tag identifier information has been added to the monitoring list. Once the handheld unit 20 confirms receipt of the article tag identifier information in the monitoring list, this information is also transmitted to the central server 30 at step 108 into a global tag tracking monitoring list, indicating that the tagged article is now being monitored by both the handheld unit 20 and the central server 30. However, if at step 110, the handheld unit 20 does not receive the article tag identifier information in its monitoring list, it will also notify the central server 30 that no article tag identifier information was received by the handheld unit 20 and the central server 30 will subsequently alert the handheld unit 20 that the article tag identifier information has not been entered at step 114. At step 110, the handheld unit 20 will attempt to directly communicate with the article tag once again till the article tag identifier information is in the monitoring list. The process is configured in a manner where if the article tag identifier information is not in the monitoring list, the information is in an in-range tag list, details of which will be explained below. Once the article tag identifier information has been confirmed that it is in the monitoring list, the article tag identifier information will be removed subsequently from the in-range tag list.

[054] Once the delivery personnel reaches the intended destination, the article will be authenticated by the recipient to confirm receipt of the article. The authentication may be in the form of a user identification, password or digital signature to ensure that the recipient is authorized to receive the article. Once this is done, the handheld unit 20 will de-tag the article by removing the tag identifier information from the monitoring list. The central

server 30 will be notified of the de-tagged article tag and similarly remove the article tag identifier information from the global monitoring list within the administrative manager interface 34.

[055] Figure 3 describes the monitoring process 200, which occurs once the delivery personnel leaves the sender's premises with the tagged articles enroute to the intended destination. Upon confirmation that the article tag identifier information is in the monitoring list at step 202, the delivery personnel will proceed with the delivery to the intended destination. Once in the tag tracking module 25 mode, the monitoring unit 50 will be activated to receive the article tag validation signals transmitted from the article tags. If the article tags are within the preset monitoring distance, the monitoring unit 50 will receive the article tag validation signals and the article tags will remain in the monitoring list of the handheld unit 20. The transmission of article tag validation signals from the article tags may be measured in terms of tag signal strength or RSSI (Received Signal Strength Indication) values which are configurable on the tag tracking module 25. The tag signal strength or RSSI value is measured by the monitoring unit 50 when it receives an article tag validation signal. A stronger tag signal strength indicates that the article tag is within close proximity to the monitoring unit 50. If the article tag signal strength is above a predetermined article tag signal strength in step 204, the article tag will remain in the monitoring list, indicating that the article is within monitoring distance. If the article tag signal strength falls below the predetermined article tag signal strength in step 204, this indicates that the article is not within the monitoring distance. To confirm that the article tag is not within the monitoring distance of the monitoring unit 50, a series of consecutive article tag validation signals from each article tag and its corresponding RSSI values will be taken and compared with the predetermined article tag RSSI value over a predetermined number of cycles, each cycle corresponding to the predetermined time interval of the article tag validation signal. For example, 7 consecutive RSSI values are taken over 7 cycles, and if any of the RSSI values does not meet the specified criteria, the article tag validation

signal will be considered a false positive and disregarded. The article tag validation signals will be verified again until the RSSI values meet the specified criteria. At the same time, an article tag age counter within the article tag is activated in step 206 to indicate the time lapse when beyond the monitoring distance. The article tag age can be predetermined by the central server 30 or handheld unit 20 and a threshold predetermined by the central server 30 or handheld unit 20. If below the threshold, the handheld unit 20 will continue to monitor the article tag signal strength to determine if the article tag signal strength is above or below the predetermined article tag signal strength. Once the article tag age reaches a threshold in step 208, indicating that a certain amount of time has lapsed, a 'tag dropped' event will be activated at step 210. The 'tag dropped' event will trigger the alarm within the handheld unit 20. The article tag identifier information will be removed from the monitoring list at step 212 and transferred to an in-range list at step 214. Once the article tag identifier information is in the in-range list at step 214, the central server 30 will be notified accordingly at step 216 and similarly transfer the article tag identifier information from the global monitoring list to the global in-range list.

[056] Figure 4 describes an alert notification process 300 when an article tag dropped event has been raised. The event will be received by the administrative manager interface 34 at step 302. An alert message will be sent at step 306 via the administrative manager interface 34 to notify the workstations and portable devices connected thereto of the loss of the article. The event will also be stored in the database 36 at step 304.

[057] Figure 5 illustrates a process flow when the article tag is in the in-range list. As mentioned previously, the article tag identifier information is either in the monitoring list or in the in-range list. When the article tag identifier information is in the in-range list at step 400, communication between the monitoring unit 50 and the article tag has been broken, and the monitoring unit 50 cannot receive article tag validation signals from the article tag. The monitoring unit 50 will be automatically activated to detect the article tag signal

strength in step 402. This will monitor the article tag so that article tag validation signals from the misplaced article tag can be received by the monitoring unit 50. By doing so, an article tag signal strength measured in terms of RSSI (Received Signal Strength Indication) values will be returned to the monitoring unit 50, indicating the estimated distance of the article tag from the monitoring unit 50. As mentioned above, the monitoring distance of the monitoring unit 50 is approximately between 8 to 10 meters, or to a maximum monitoring distance that the configuration of the monitoring unit 50. At step 404, an article tag-in-range event will be raised regardless of whether the article tag is within monitoring distance.

[058] Figure 6 illustrates the relationship within the central server 30 between the administrative manager interface 34, the database 36 and a report generation module 38. All the data relating to the administrative manager interface 34 including that of the individual program modules stored within will be saved in the database 36 for retrieval. A report generation module 38 can be activated by a user whenever it is necessary. A report may be generated showing the status of the article tags in the monitoring list, in-range list, geographical location details or details of the handheld unit 20.

[059] Figure 7 illustrates the various status indicators that an article tag may experience from the pickup location to the intended destination of the tagged article. A new article tag status 500 indicates that the article tag is inactive. This could be prior to attaching the article tag to the article. A tracked article tag status 502 indicates that the article tag is attached to an article and is in an activated condition to be actively being monitored by the monitoring unit 50. An article tag removed status 504 indicates that the article tag has been de-tagged or is no longer being monitored. The tagged article could have reached its intended destination and is therefore de-tagged. Alternatively, the article tag is now inactive because it could not be located after being misplaced after a predetermined time

period. An article tag lost status 506 indicates that the article tag is active but is not within monitoring distance of the monitoring unit 50.

[060] Figure 8 illustrates a method of recovering an article once the system 10 has detected that an article tag is no longer within the monitoring distance of the monitoring unit 50. As mentioned previously, the monitoring unit 50 will be activated by default to receive article tag validation signals or article tag RSSI values from the article tag when the system 10 detects that an article tag is no longer within the monitoring distance. The article tag sends article tag validation signals to the monitoring unit 50 which receives the article tag validation signals if the article tag is within monitoring distance of the monitoring unit 50. If the article tag is within monitoring distance at step 604, the article is in a safe position and this process recurs. However, if the monitoring unit 50 no longer receives a article tag validation signal from the article tag, the system 10 will trigger an alarm at step 606, which could be by sound, visual or tactile mode. Once the alarm is triggered, a time clock will be triggered indicating the start of time T. A visual inspection will be conducted by the delivery personnel at step 607 in an attempt to locate the article within his vicinity. The system 10 will send a signal to the handheld unit 20 and at the same time an alert message to the central server 30 to notify a user at the administrative manager interface 34. In addition, at the same time, the central server 30 will activate a business process notification module which alerts relevant personnel of the loss of the article. The relevant personnel may be a representative or management of the sending company of the article, if the article was sent out by a company, or an individual sender of the article. In some cases, the relevant personnel may be a representative or management of the intended addressee of the article, or the individual addressee of the article. The contacts, email addresses of these relevant personnel are stored in the central server 30 and retrieved when the business process notification module is activated. The alerts may be sent out by the system via SMS or email. Alternatively, a user who is at the administrative manager interface 34 may also notify the relevant personnel via telephone. The business process notification module is a

module available on the administrative manager interface 34 or it may be a separate program to be activated whenever an alert message is activated. By alerting the representative or management of the sender or the intended addressee of the article, steps can be taken by the relevant personnel to mitigate the loss of the article, particularly where the article is susceptible to misuse or unauthorized use. At the time the alarm is triggered, the article tag identifier information will be removed from the monitoring list and transferred to the in-range list. If no article tag validation signal is received after a predetermined time interval ($T + x$) at step 612, the article will be deemed to be lost and a first article recovery module will be activated at step 700. If an article tag validation signal is received, the alarm will be cancelled at step 614 and central server 30 will be notified of the retrieval. The article tag identifier information will be transferred from the in-range list to the monitoring list once the article tag is within the extended monitoring distance.

[061] Upon activation of the first article recovery module, a recovery procedure level 1 will be generated at step 702 for the delivery personnel to aid him in attempting the recovery of the article. The recovery procedures may be in the form of back tracing to his previous position or monitoring the article tag validation signals. The delivery personnel will execute the recovery procedure as indicated. If the article is located at step 704, the user at the administrative manager interface 34 will be notified through the central server 30 at step 706. The process will begin from the start point at step 600. If however, the article is not located after a certain time interval, for example, 3 minutes from the triggering of the alarm at step 708, a second article recovery module will be activated at step 800.

[062] Upon activation of the second article recovery module, a recovery team will be activated by the administrative manager interface 34 at step 802. This could be done by sending out alert messages to the recovery team personnel via SMS or email. Within a predetermined time interval, the recovery team will arrive at the location at step 804. The

recovery team will set up the recovery equipment at step 806, which includes equipment that is capable of receiving article tag validation signals from the lost article tag at an extended monitoring distance. The extended monitoring distance could be at a range of 60 meters. At this point, a second recovery procedure list will be generated for the recovery team to be executed at step 810 which will aid the team in locating the lost article. If the article is located at step 812, the user at the administrative manager interface 34 will be notified through the central server 30 at step 814. The recovery team will also return to base at step to report its finding. There is a possibility that after a certain prescribed time interval, for example, after ten minutes, that the article still has not been located. In this case, the recovery team will report the recovery as unsuccessful to the user at the administrative manager 34 and at step 822. The recovery team will subsequently return to base. However, if it is still within the prescribed time interval, the recovery team will continue to execute the procedures in the second recovery procedure list again in step 820.

[063] The handheld unit 20 may also include a distance proximity indicator which provides the delivery personnel a visual indication on the display interface of the handheld unit 20 the approximate distance the tagged article is from the monitoring unit 50. This distance proximity indicator may be provided in the form of a module on the administrative manager interface 34. Should the delivery personnel discover that the article has been misplaced or the alarm has been activated, this distance proximity indicator can be selected to indicate the approximate distance the tagged article is from the monitoring unit 50.

[064] Figure 12 illustrates a flow chart of a process for deactivating tagged articles in an activated condition. Each delivery personnel is assigned a vehicle unit to deliver an assigned number of a plurality of tagged articles. The plurality of tagged articles may be placed separately into various bags, each bag assigned a delivery location and holding a number of tagged articles. As mentioned above, during the article collection process at step 100 in Figure 2, the delivery personnel will be issued with a handheld unit 20 containing a

job list which includes all the information required for the delivery personnel to make the delivery. The job list is downloaded into the handheld unit 20 by the administrative manager interface 34 and includes the article tag identifier information of the article tags assigned for delivery, a vehicle tag identifier information corresponding to a vehicle tag attached to the vehicle unit, and the delivery routes. The vehicle tag is a RFID tag and has similar characteristics to the article tag. The registration process at step 830 occurs at the same time as when the handheld unit 20 is issued to the delivery personnel. Upon authentication, the handheld unit 20 would register the vehicle tag identifier information into the handheld unit 20 and the delivery personnel will collect the assigned bags containing the plurality of tagged articles. The plurality of tagged articles will be activated to be in an activated condition to trigger the alarm should the monitoring unit 50 fail to receive article tag validation signals from any one of the article tags. When the delivery personnel approaches a vehicle unit, the handheld unit 20 he has on hand will verify that the vehicle tag on the vehicle unit matches with the vehicle tag identifier information on the handheld unit 20 at step 832. The handheld unit 20 will receive the vehicle tag validation signals from the vehicle tag once the handheld unit 20 is within monitoring distance. The handheld unit 20 will then match the vehicle identifier information stored within the handheld unit 20 with the vehicle tag detected. He will then place the tagged articles in the activated condition into the vehicle unit at step 834.

[065] At a delivery point (step 836), if the delivery personnel walks away from his vehicle unit to deliver one of the bags containing a plurality of tagged articles, the alarm would be activated as the tagged articles remaining within the vehicle unit are in the activated condition and will breach the monitoring distance of the handheld unit 20. To prevent triggering the alarm unnecessarily in this situation, the delivery personnel would require to scan the plurality of tagged articles he is intending to deliver with the handheld unit 20 before leaving his vehicle unit. Once this is done, the handheld unit 20 would attempt to detect the vehicle tag. If the vehicle tag detected is more than the predetermined

vehicle tag RSSI value, this would mean that the delivery personnel is in close proximity to the vehicle unit and a 'deactivate' function in the form of a button (step 840) would appear on the screen of the handheld unit 20, prompting the delivery personnel to select if he would like to deactivate the remaining bags containing the plurality of tagged articles in the activated condition within the vehicle unit. Once the 'deactivate' function is selected, the status of the remaining tagged articles in the vehicle unit will be changed from the activated condition to a deactivated condition and the alarm would not be triggered once the handheld unit 20 is beyond the monitoring distance of the remaining tagged articles in the vehicle unit. The remaining tagged articles would however still remain in the monitoring list. In the event that the handheld unit 20 remains within monitoring distance of the vehicle tag after a predetermined time interval once the 'deactivate' button has been selected, i.e., the delivery personnel is within close proximity of the vehicle unit, the handheld unit 20 will cause the remaining tagged articles in the deactivated condition to revert back to the activated condition and to revert to step 838 again. If the handheld unit 20 is not able to receive vehicle tag validation signals from the vehicle tag or if the vehicle tag validation signals can be received and the RSSI value is less than the predetermined vehicle tag RSSI value, the handheld unit 20 will proceed to verify that the RSSI value detected is less than the predetermined vehicle tag RSSI value in step 842. The verification process is similar to the 'false positive' test as described above which verifies the vehicle tag validation signals received for a predetermined number of cycles before it confirms the verification. Should the process satisfy the preset parameters, eg, if out of seven predetermined cycles, at least one of the RSSI values is less than the predetermined vehicle tag RSSI value, the 'deactivate' function will not be prompted on the handheld unit 20 (step 844) and simply return to step 838. In the case where the RSSI value is verified to be less than the predetermined vehicle tag RSSI value in step 844, the 'deactivate' function will not be prompted on the handheld unit 20 and the alarm will be activated accordingly to alert the delivery personnel to return to the vehicle unit. If it cannot be verified that the RSSI value is less than the predetermined vehicle tag RSSI value, the handheld unit 20 will

revert to step 838 to detect the vehicle tag again. Once the scanned tagged articles have been delivered at the delivery point at step 848, the delivery personnel returns to his vehicle unit at step 850.

[066] Figure 13 illustrates the flow chart of a process for re-activating the plurality of tagged articles in the deactivated condition. When the delivery personnel returns to the vehicle unit to proceed to the next delivery point at step 852, the handheld unit 20 will receive vehicle tag validation signals from the vehicle tag once it is within monitoring distance. If the vehicle tag is detected and the RSSI value of the vehicle tag validation signal is more than the predetermined vehicle tag RSSI value, indicating that the handheld unit 20 is within close proximity of the vehicle unit, the 'reactivate' function will be prompted on the handheld unit 20 at step 854. The 'reactivate' function will only be prompted if the monitoring unit 50 detects the presence of tagged articles in the deactivated condition. Once the 'reactivate' function is selected, the handheld unit 20 will change the status of the plurality of tagged articles in the deactivated condition to a reactivated condition at step 856. In the reactivated condition, the plurality of tagged articles in the remaining bags can now trigger the alarm should the monitoring distance be breached. In the event where the handheld unit 20 is detects the vehicle tag and the RSSI value is less than the predetermined vehicle tag RSSI value, a verification process will be done at step 858. As above, the verification process will validate that the RSSI values are less than the predetermined vehicle tag RSSI value after a predetermined number of cycles. In either case, the 'reactivate' function will not be prompted on the handheld unit 20 and the process will revert back to step 852 again. In all cases above, the predetermined vehicle tag RSSI value is in the range of 230-250.

[067] Figure 14 shows a flow chart of a process for conducting a delivery point check. This check (Step E in Figure 12) is done after the delivery personnel has selected the 'deactivate' function to deliver the tagged articles. In the event that the delivery personnel

is on the way to deliver the tagged articles in an activated condition, but takes another tagged article in a deactivated condition by accident, the alarm would not be triggered if the tagged article in the deactivated condition were to breach the monitoring distance of the handheld unit 20. Should the delivery personnel misplace the tagged article in the deactivated condition enroute to making the delivery, the delivery personnel will not be alerted. To prevent this situation, the handheld unit 20 will activate a delivery point check. The delivery point check ensures that the handheld unit 20 will detect any tagged articles in the deactivated condition within monitoring distance of the handheld unit 20. At step 860, the handheld unit 20 detects tagged articles in a deactivated condition with RSSI values above a predetermined article tag RSSI value. This indicates that the tagged article in the deactivated condition is in close proximity of the handheld unit 20. If no tagged articles in a deactivated condition is detected, the delivery point check ends. If a tagged article in a deactivated condition is detected and the article tag validation signal has an RSSI value more than the predetermined article tag RSSI value, the handheld unit 20 will verify the article tag RSSI values. This verification process at step 862 will determine that the RSSI values of the article tag validation signals obtained will be more than the predetermined article tag RSSI values over a predetermined number of cycles. Should one or more RSSI value be less than the predetermined article tag RSSI value, the process will revert to step 860 again. Should all the RSSI values be more than the predetermined article tag RSSI value over the predetermined number of cycles, the handheld unit 20 will automatically 'activate' the tagged article in the deactivated condition at step 864. In the event that the delivery personnel misplaces the activated tagged article, the alarm will be activated accordingly. The delivery point check therefore detects any tagged articles in the deactivated condition, and the handheld unit 20 will automatically change the status of the tagged article in the deactivated condition to the activated condition. The predetermined article tag RSSI value is in the range of 220-240.

[068] Where the remaining deactivated article tags in the vehicle unit are left unattended while the delivery personnel is away on an assignment, a situation may arise when the delivery personnel returns to the vehicle unit on completion of his assignment and one or more of the articles with deactivated articles tags have been misplaced or stolen. In this situation, it is likely that the delivery personnel would not be aware of the misplaced or stolen articles. This is because the handheld unit would simply reactivate all the article tags in the deactivated condition, on activation of the reactivate function by the delivery personnel when the handheld unit detects the vehicle tag signal above the predetermined RSSI value of the vehicle tag as described above. Any misplaced articles in its deactivated condition would not be detected by the handheld unit upon reactivation. To prevent the occurrence of misplaced articles which have been left unattended, the handheld unit will perform a reconciliation procedure to reconcile all the remaining articles with deactivated article tags in the vehicle unit with the article tags in the monitoring list, details of which will be explained hereinafter.

[069] Figure 15 shows a process flow of a deactivating module and a reconciliation module in action. At step 870, the delivery personnel is at the designated delivery point. At this point, he will pick up the article or articles for delivery, if any, and decide if there will be any remaining articles which will be left unattended in his vehicle unit while he is performing the delivery. In the affirmative, the delivery personnel will select a deactivating module or an 'AWAY' module located on the display interface of the handheld unit. As mentioned previously, all the article tags in the vehicle unit are activated or 'armed' throughout the journey to the delivery point to ensure there is no loss of articles enroute to the delivery point. Once the deactivating module is activated at step 874, the monitoring unit in the handheld unit will proceed to deactivate all the article tags, including the article tags scheduled for delivery at the delivery point. In order to deactivate the article tags in the vehicle unit, the handheld unit must stay within a predetermined range from the article tags. Once all the article tags have been deactivated, the handheld unit will notify the delivery

personnel that the deactivation process is complete and he can proceed to walk away from the vehicle unit. If he continues to remain within the predetermined range upon notification by the handheld unit, after a predetermined time interval, the deactivating process will be aborted and the article tags will not be deactivated. For example, the predetermined range from the handheld unit to the article tags is approximately 0.5m. Once the deactivation of the article tags is complete, at step 876, the delivery personnel will then pick up the articles for delivery, if any, and walk away from the vehicle unit. Once the delivery personnel is at a predetermined distance from the vehicle unit or the monitoring unit detects a vehicle tag validation signal above a predetermined vehicle tag RSSI value, at step 878, the handheld unit will prompt the monitoring unit to reactivate or 're-arm' the article tags the delivery personnel is holding. For example, the predetermined distance from the vehicle unit is approximately 1.5m-2m or the predetermined vehicle tag RSSI value is less than 130 units. Where no remaining articles are left unattended in the vehicle unit, the delivery personnel will simply walk away from the vehicle unit and perform the delivery at the delivery point.

[070] Once the article or articles have been delivered at the delivery point or collection of articles at the delivery point have been made at step 880, the delivery personnel will return to the vehicle unit at step 882. If there were no unattended articles in the vehicle unit, the delivery personnel will simply return to his vehicle unit and proceed to the next designated delivery point. If there were unattended articles in the vehicle unit at step 884, at step 886, the monitoring unit will detect the vehicle tag validation signals as the delivery personnel approaches the vehicle unit. At a certain range of distance, for example, 0.5m-2m away from the vehicle unit, or once the monitoring unit detects the vehicle tag validation signals more than a predetermined vehicle tag RSSI value of 160 units, the monitoring unit will be automatically activated to receive all the article tag validation signals left in the vehicle unit in order to detect if any articles are missing (at step 888). The predetermined vehicle tag RSSI value for the reconciliation module and the deactivating module are not identical. This is because the monitoring unit will not be able to discern whether it is deactivating or

reconciling if the same predetermined vehicle tag RSSI values are used. Each article tag validation signal on each article tag includes an article tag identifier information unique to each article tag. The monitoring unit sends the received article tag identifier information to the handheld unit. The article tag identifier information of the article tags are then compared to the article tag identifier information of the article tags in the monitoring list specific to the job assignment issued to the delivery personnel stored in the handheld unit. If the article tag identifier information of the articles left in the vehicle unit matches with the article tag identifier information of the article tags in the monitoring list stored in the handheld unit, this indicates a successful reconciliation of the article tags and no further action needs to be taken. If however, the reconciliation of the articles tags was not successful, the handheld unit will inform the delivery personnel of the mismatch or reconciliation failure. Specifically, the delivery personnel will be notified of the article tag which is missing from the monitoring list. Particulars such as the client identifier, address of client, of the missing article tag will be displayed on the display screen of the handheld unit. At the same time, at step 890, this will trigger an alert similar to the alert for a missing article both on the handheld unit and the server and the article recovery module will be activated.

[071] A delivery personnel faces time pressure in the course of delivering or collecting tagged articles at designated delivery locations. For instance, a receiving personnel who is not available to acknowledge receipt of the article at the designated delivery location promptly or documents that are not yet available for release may lead to delays in the delivery of the subsequent tagged articles. To prevent such cascading delays, the handheld unit provides a "leave" module for the delivery personnel to activate in the event the designated receiving personnel at the designated delivery location be unavailable after a predetermined time interval. The predetermined time interval is determined by protocols in place which can be determined by the client or delivery company. For example, the predetermined time interval can be 5-10 minutes. Figure 16 shows a process flow when the

“leave” module is activated. At step 900, the delivery personnel arrives at the designated delivery location or the client office with the designated article to be delivered or to collect a designated tagged article for delivery. At step 910, the delivery personnel will next confirm that the client location is correct. This can be done, for instance, by a card identifier which the delivery personnel can scan with the handheld unit to ensure that the client location on the card identifier matches with the client location in the job list of the handheld unit. At step 920, the delivery personnel will now have to ensure that the article to be delivered is safely received by the receiving personnel or to ensure that the article he is collecting for delivery is available. If the receiving personnel is available, the receiving personnel will simply acknowledge receipt of the article. The article tag is deactivated upon receipt of the article and the job assignment is completed. In the case of an article for collection for subsequent delivery, the delivery personnel will activate the article tag on the article and complete the job assignment. If the receiving personnel is not available or the article is not ready for collection, a “leave” module is provided as an option for the delivery personnel to select on the user interface of the handheld unit. At step 940, when the “leave” module is activated or selected by the delivery personnel, the article tag on the article to be delivered which is in an activated condition prior to the receipt of the article by a receiving personnel, would remain in an activated condition. The handheld unit will prompt the delivery personnel to select one of a predefined list of reasons for the non-delivery of the article. Some reasons could be “The receiving personnel is not available” or “The document is not ready for collection”. At step 960, the reason together with the article identifier information of the article, whether to be delivered or for collection, would be transmitted back to the server in a remote location and at step 970, the administrative manager interface would be prompted on the non-performance of the job assignment. The article would remain in the monitoring list and the status of the article would remain undelivered or uncollected. The delivery personnel would leave the client location with the activated article, if any, and return to the vehicle unit.

[072] There may be times when a live job assignment must be re-assigned in order to maintain work flow efficiency or to prevent delays in completing the job assignment. For example, a delivery personnel enroute to a delivery location may encounter a vehicle unit breakdown or an accident. In such cases, and as shown in Figure 17, step 980, the affected delivery personnel will inform Command Centre of the situation. The Command Centre can also be the user manning the administrative manager interface at the server. Once the user at the administrative manager interface has been informed of the need for a job re-assignment, at step 982, the user will activate a job re-assignment module on the display screen of the administrative manager interface. The job re-assignment module allows the user to re-assign the affected job assignment list to a suitable delivery personnel. Once the job assignment list has been re-assigned, the user will notify the handover delivery personnel and takeover delivery personnel of the change in job assignment. The mode of notification can be via telephone or a mobile communication unit. If the articles for delivery has been collected, at step 986, the takeover delivery personnel and the handover delivery personnel must meet in order to handover the articles to be delivered. At the meeting point, at step 988, the takeover delivery personnel initiates the handover by selecting a job-re-assignment module on his handheld unit. When activated, the job re-assignment module will proceed to instruct the takeover delivery personnel to commence the takeover. The job assignment list containing details of the article tags, client identifiers, locations, etc. will be downloaded wirelessly into the takeover delivery personnel's handheld unit from the server. This synchronizes the job assignment list in his handheld unit. At step 990, on instruction by the job re-assignment module on the handheld unit, the takeover delivery personnel will then scan the articles for taking over from the handover delivery personnel. The article tag identifier information on the article tags will be matched with the article tag identifier information contained in the job assignment. At the same time, the handheld unit of the takeover delivery personnel will notify the administrative manager interface of the successful takeover of the articles and synchronization of the job assignment list via the communications network. Once all the articles have been handed

over to the takeover delivery personnel, at step 992, the handover delivery personnel will select the job re-assignment module on his handheld unit to synchronize his job assignment list. This synchronization involves the removal of the article tags on the monitoring list stored in his handheld unit and removal of the job assignment list from his handheld unit. The synchronization will only be successful if the takeover of the articles and the synchronization of the takeover delivery personnel are successful.

[073] Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures can be made within the scope of the invention, which is not to be limited to the details described herein but is to be accorded the full scope of the appended claims so as to embrace any and all equivalent devices and apparatus.

[074] The drawings and discussion above are intended to provide a brief, general description of a suitable computing environment in which the present invention may be implemented. Although not required, the present invention is described in the general context of computer-executable instructions, such as program modules, being executed by a computer such as a personal computer, laptop computer, notebook computer, tablet computer, PDA and the like. Generally, program modules include routines, programs, characters, components, data structures that perform particular tasks or implement particular abstract data types. It will be appreciated to those skilled in the art that the invention may be practiced with other computer system configurations, including handheld devices, multiprocessor systems, microprocessor based or programmable consumer electronics, network PCs, minicomputers, mainframe computers, and the like.

[075] 'Comprises/comprising' when used in this specification is taken to specify the presence of stated features, integers, steps or components but does not preclude the

presence or addition of one or more other features, integers, steps, components or groups thereof.

CLAIMS

1. A proximity monitoring alarm system for monitoring a plurality of articles, comprising:

a plurality of article tags wherein each of the article tags is in an activated condition and capable of attaching to each of the plurality of articles located within a vehicle unit and each of the article tags is configured to transmit an article tag validation signal in a predetermined time interval;

a handheld unit configured to receive a monitoring unit, the monitoring unit operatively communicating with each article tag by receiving the article tag validation signal so that an alarm will be triggered on the handheld unit when the monitoring unit fails to receive the article tag validation signals from any one of the plurality of article tags;

a vehicle tag for attaching to the vehicle unit, the vehicle tag operatively communicating with the monitoring unit and transmitting a vehicle tag validation signal in a predetermined time interval to be received by the monitoring unit;

a deactivating module for selection on the handheld unit by a user for deactivating the plurality of article tags within a predetermined distance from the handheld unit so that the plurality of article tags are in a deactivated condition,

wherein when the deactivating module is selected, and when the monitoring unit subsequently detects the vehicle tag validation signals less than a first predetermined vehicle tag RSSI value, a portion of the plurality of article tags within the predetermined distance from the handheld unit will reactivate to be in an activated condition and the remaining portion of the plurality of article tags within the vehicle unit will remain in the deactivated condition.

2. The proximity monitoring alarm system according to claim 1, further comprising a reconciliation module activatable when the monitoring unit detects the vehicle tag validation signals above a second predetermined vehicle tag RSSI value, wherein the

monitoring unit matches article tag identifier information received from each of the plurality of article tags in the deactivated condition within the vehicle unit with the article tag identifier information of the article tags stored in the handheld unit.

3. The proximity monitoring alarm system according to claims 1 or 2, further comprising a leave module for selection on the handheld unit by the user when one of the plurality of articles for delivery at a delivery point is unable to be received by a receiving personnel, whereby when the leave module is activated, the one of the plurality of article remains in an activated condition.

4. The proximity monitoring alarm system according to claims 1 or 2, further comprising a leave module for selection on the handheld unit by the user when a second article for collection at a delivery point is unavailable for collection.

5. The proximity monitoring alarm system according to claim 3, wherein when the leave module is activated, the handheld unit prompts the user to select a predefined list of reasons.

6. The proximity monitoring alarm system according to claim 5, wherein the article tag identifier information of the one of the plurality of articles unable to be received by a receiving personnel and the selected predefined list of reasons are sent via the communications network to notify the administrative manager interface.

7. The proximity monitoring alarm system according to claim 1, further comprising a first job re-assignment module for selection by a user at the administrative manager interface for assigning a job assignment list from a handover delivery personnel to a takeover delivery personnel.

8. The proximity monitoring alarm system according to claim 7, wherein when the first job re-assignment module is activated, the user at the administrative manager interface notifies the handover delivery personnel and the takeover delivery personnel of a designated location for handover and take over of the plurality of articles.

9. The proximity monitoring alarm system according to claim 8, further comprising a second job re-assignment module for selection by the takeover delivery personnel on the second handheld unit to take over the job assignment list and the plurality of articles from the handover delivery personnel at a designated location.

10. The proximity monitoring alarm system according to claim 1, wherein the predetermined distance from the handheld unit is approximately 0.5 meters.

11. The proximity monitoring alarm system according to claim 1, wherein the first predetermined vehicle tag RSSI value is less than 130 units.

12. The proximity monitoring alarm system according to claim 2, wherein the second predetermined vehicle tag RSSI value is more than 160 units.

13. A method of monitoring a plurality of articles, each of the plurality of articles tagged with an article tag, comprising the steps of:

a) activating the article tags to be in an activated condition with a handheld unit, each of the article tags transmitting an article tag validation signal in a predetermined time interval, and operatively communicating with a monitoring unit adapted to be received by the handheld unit, so that an alarm will be triggered on the handheld unit when the monitoring unit fails to receive the article tag validation signals from any one of the article tags;

b) assigning a vehicle unit for delivery of the plurality of articles, the vehicle unit including a vehicle tag adapted for operatively communicating with the monitoring unit and transmitting a vehicle tag validation signal in a predetermined time interval adapted to be received by the monitoring unit;

c) selecting a deactivating module on the handheld unit by a user for deactivating the plurality of article tags located within a predetermined distance from the handheld unit so that they are in a deactivated condition;

d) reactivating a portion of the plurality of article tags within the predetermined distance from the handheld unit when the monitoring unit detects a vehicle tag validation signal less than a first predetermined vehicle tag RSSI value while the remaining portion of the plurality of article tags within the vehicle unit remain in the deactivated condition.

14. The method of monitoring a plurality of articles according to claim 13, further comprising the step of:

e) reconciling article tag identifier information received from each of the plurality of article tags in the deactivated condition within the vehicle unit with the article tag identifier information of the article tags stored in the handheld unit when the monitoring unit detects the vehicle tag validation signals above a second predetermined vehicle tag RSSI value.

15. The method according to claims 13 or 14, further comprising the step of:

f) activating a leave module for selection on the handheld unit by the user when one of the plurality of articles for delivery at a delivery point is unable to be received by a receiving personnel, whereby when the leave module is activated, the one of the plurality of article remains in an activated condition.

16. The method according to claim 13 or 14, further comprising the step of:

f) activating a leave module for selection on the handheld unit by the user when a second article for collection at a delivery point is unable to be collected.

17. The method according to claim 13, wherein the predetermined distance from the handheld unit is approximately 0.5 meters.

18. The method according to claim 13, wherein the first predetermined vehicle tag RSSI value is less than 130 units.

19. The method according to claim 14, wherein the second predetermined vehicle tag RSSI value is more than 160 units.