

CUSTOMS INSPECTION AND RELEASE SYSTEM AND METHOD

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application claims priority to the Chinese Patent Application No. 201410834408.9, filed on December 26, 2014, entitled "CUSTOMS INSPECTION
5 AND RELEASE SYSTEM AND METHOD" which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure relates to customs inspection and clearance, and more particularly, to customs inspection and release systems and methods.

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BACKGROUND

In conventional customs inspection and release systems, container/vehicle inspection, site traffic management, vehicle/container recognition, radioactive substance detection, radioactive isotope recognition and the like are performed independently from one another. When a container/vehicle arrives at the site
15 entrance, it will be guided, by an operator, to pass through an X-ray container/vehicle inspection device for inspection and then into a waiting area to wait for inspection result. After an operator responsible for image review has analyzed the container/vehicle based on a scan image and other related information to reach a conclusion, the operator in the waiting area is informed of
20 the conclusion and then guides the vehicle to a manual inspection area or an exit area based on the inspection result for the vehicle. When the vehicle arrives at the exit area, an operator confirms that the inspection of the vehicle has completed before it can be released. Such inspection and release system with independent operations among the respective areas and/or the respective devices relies on
25 informing and manual guidance by the operators, and thus is inefficient and high in labor cost. In addition, the customs inspection and release system operates independently from a customs declaration system, a logistics system and the like,

and thus they cannot share information on the same subject under inspection, resulting in inefficient overall operations.

SUMMARY

According to an exemplary embodiment of the present disclosure, a customs inspection and release system is provided. The system comprises: a device layer comprising a plurality of devices for inspection and release, the plurality of devices are deployed at different types of inspection sites, at least some of the plurality of devices being configured to detect a subject and generate detection data while the subject passes through the inspection sites; an adaptor layer comprising a plurality of adaptors corresponding to the plurality of devices, respectively, each being configured to receive the detection data from its corresponding device and convert the detection data into an event in a form of a predetermined message service interface protocol; a message service layer comprising a message bus and configured to receive events from the adaptor layer and construct event messages based on the events; and a processing control layer comprising a business logic unit and configured to receive and process the event messages from the message bus, generate instructions associated with the event messages and transmit the instructions to the message service layer, wherein the business logic unit is configured to bind, to a single subject, a plurality of discrete event messages associated with the single subject, and process the bound event messages jointly, wherein the plurality of discrete event messages correspond to different events originating from different devices in the device layer while the single subject passes through the different types of the inspection sites. The message service layer constructs instruction messages based on the received instructions and transmits the instruction messages to the adaptor layer. The adaptor layer converts the instruction messages into instructions in a form suitable for the corresponding devices and transmits the instructions to the device layer. The corresponding devices in the device layer operate based on the received instructions.

In an embodiment, the processing control layer further comprises a central control unit configured to provide a user interface for monitoring operation states of the devices and a state of the subject, and in response to a user operation, generate an instruction and transmit the instruction to the message service layer.

In an embodiment, the business logic unit comprises: a binding logic module configured to bind the plurality of discrete event messages associated with the single subject to the single subject; a flow logic module configured to process the bound event messages jointly to generate an instruction corresponding to a result of the processing; a device state logic module configured to monitor states of the plurality of devices and issue a

warning upon detecting an abnormal state; and an integrated bus module coupled to the message bus, the binding logic module, the flow logic module and the device state logic module and configured to receive the event messages from the message bus, forward the received event messages to the respective logic
5 modules, receive an instruction or a warning from the respective logic modules and transmit it to the message bus.

In an embodiment, the message bus comprises: a message construction module configured to construct the event messages and the instruction messages
10 based on the received events and instructions, respectively; a message routing module configured to route the event messages to the processing control layer and the instruction messages to at least one corresponding adaptor among the plurality of adaptors in the adaptor layer; and a message queue pool comprising an event
15 message queue pool for buffering and queuing the event messages and an instruction message queue pool for buffering and queuing the instruction messages.

In an embodiment, the event messages each indicates a site where the subject is located, an identifier of the subject, a type and serial number of the
20 device for the subject, time at which the detection data is received from the device, and an event content, and the instruction messages each indicates the site where the subject is located, the type and serial number of the device for the subject, a source of the instruction and an instruction content.

25 In an embodiment, the plurality of devices comprise at least two of a container/vehicle radiophotography inspection device, a radioactive material detection device, a license plate recognition device, a container code recognition device, a digital video recording device and a traffic control device.

30 In an embodiment, the central control unit is configured to, via the user interface, performing one or more of: displaying a scan image in real time while the subject is being scanned; displaying a photo and a recognition result of a license plate of the subject; displaying a photo and a recognition result of a container code of the subject; and controlling a traffic control device in the site where the subject is

located. The recognition result of the subject is modifiable by a user via the user interface.

5 In an embodiment, the processing control layer further comprises: an image detection unit comprising an image analysis station and a re-inspection station and allowing a user to analyze a scan image of the subject at the image analysis station to determine whether the subject is suspicious or not and re-inspect the suspicious subject at the re-inspection station.

10 In an embodiment, the processing control layer further comprises: an information management unit configured to perform one or more of maintaining user information, maintaining subject information, maintaining commuter car information, information query and statistics, and configuring system parameters.

15 In an embodiment, the message service layer is further configured to receive other events from other customs business systems for processing at the processing control layer and transmit processing results to the other customs business systems. The other customs business systems comprise a customs declaration system and/or a logistics system.

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In an embodiment, the binding logic module in the processing control layer is further configured to bind discrete events among the other events that are associated with the same subject to the subject.

25 According to another exemplary embodiment of the present disclosure, a customs inspection and release method is provided. The method comprises: detecting, by at least some of a plurality of devices, a subject to generate detection data while the subject passes through different types of inspection sites, wherein the plurality of devices are deployed at the inspection sites; receiving, by each of a plurality of adaptors corresponding to the plurality of devices, respectively, the
30 detection data from its corresponding device and converting the detection data into an event in a form of a predetermined message service interface protocol; receiving, by a message bus, events from the adaptors and constructing event messages based on the events; and receiving and processing the event messages

from the message bus, generating instructions associated with the event messages and transmitting the instructions to the

message bus, wherein said processing the event messages comprises binding, to a single subject, a plurality of discrete event messages associated with the single subject, and processing the bound event messages jointly, the plurality of discrete event messages being corresponding to different events originating from different devices in the device layer while the subject passes through the different types of inspection sites, constructing, by the message bus, instruction messages based on the received instructions and transmitting the instruction messages to the respective adaptors, converting, by the respective adaptors, the instruction messages into instructions in a form suitable for the corresponding devices and transmitting the instructions to the corresponding devices, and operating, by the corresponding devices, based on the received instructions.

In an embodiment, the method further comprises: providing a user interface for monitoring operation states of the devices and a state of the subject, and in response to a user operation, generating an instruction and transmitting the instruction to the message bus.

In an embodiment, the step of processing the event messages further comprises: processing the bound events to generate an instruction corresponding to a result of the processing.

In an embodiment, the method further comprises: receiving, by the message bus, other events from other customs business systems for processing, and transmitting processing results to the other customs business systems. The other customs business systems comprise a customs declaration system and/or a logistics system.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and advantages will become more apparent with reference to the following description taken in conjunction with the figures where similar reference numerals denote the same elements, in which:

Fig. 1 is a block diagram showing a customs inspection and release system according to an exemplary embodiment of the present disclosure;

Fig. 2 is a block diagram showing a customs inspection and release system according to another exemplary embodiment of the present disclosure;

Fig. 3 is a block diagram showing a structure of a business logic unit in a customs inspection and release system according to an exemplary embodiment of the present disclosure;

Fig. 4 is a block diagram showing a structure of a message bus in a customs inspection and release system according to an exemplary embodiment of the present disclosure;

Figs. 5a and 5b show exemplary formats of an event message and an instruction message used in a customs inspection and release system according to an exemplary embodiment of the present disclosure;

Fig. 6 is a schematic diagram showing an adaptor layer and a device layer in a customs inspection and release system according to an exemplary embodiment of the present disclosure;

Fig. 7 is a flowchart illustrating a customs inspection and release method according to an exemplary embodiment of the present disclosure;

Fig. 8 is an inspection site where a customs inspection and release system and method according to an exemplary embodiment of the present disclosure can be applied; and

Fig. 9 is an inspection flow where a customs inspection and release system and method according to an exemplary embodiment of the present disclosure can be applied.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The specific embodiments of the present disclosure will be described in detail below. It should be noted that the embodiments herein are used for illustration only, without limiting the present disclosure. In the description below, a number of

specific details are explained to provide better understanding of the present disclosure. However, it is apparent to those skilled in the art that the present disclosure can be implemented without these specific details. In other instances, well known circuits, materials or methods are not described specifically so as not to obscure the present disclosure.

Throughout the specification, the reference to "one embodiment," "an embodiment," "one example" or "an example" means that the specific features, structures or properties described in conjunction with the embodiment or example are included in at least one embodiment of the present disclosure. Therefore, the phrases "in one embodiment," "in an embodiment," "in one example" or "in an example" occurred in various positions throughout the specification may not necessarily refer to the same embodiment or example. Furthermore, specific features, structures or properties may be combined into one or more embodiments or examples in any appropriate combination and/or sub-combination. Moreover, it should be understood by those skilled in the art that the term "and/or" used herein means any and all combinations of one or more listed items.

In the following, the exemplary embodiments of the present disclosure will be described with reference to the figures. Fig. 1 is a block diagram showing a customs inspection and release system according to an exemplary embodiment of the present disclosure. As shown, the customs inspection and release system 1 can include a device layer 10, an adaptor layer 12, a message service layer 14 and a processing control layer 16. The device layer 10 can include a plurality of devices for inspection and release. At least some of the plurality of devices are configured to detect a subject and generate detection data. For example, the plurality of devices may include at least two of a container/vehicle radiophotography inspection device, a radioactive material detection device, a license plate recognition device, a container code recognition device, a digital video recording device and a traffic control device. The adaptor layer 12 can include a plurality of adaptors corresponding to the plurality of devices, respectively, each configured to receive the detection data from its corresponding device and convert the detection data into an event in a form of a predetermined message service interface protocol. The message service layer 14 can include a message bus 40 configured to receive

events from the adaptor layer and construct event messages based on the events. The processing control layer 16 can include a business logic unit 30 configured to receive and process the event messages from the message bus, generate instructions associated with the event messages and transmit the instructions to the message service layer 14. The message service layer 14 constructs instruction messages based on the received instructions and transmits the instruction messages to the adaptor layer 12. The adaptor layer 12 converts the instruction messages into instructions in a form suitable for the corresponding devices and transmits the instructions to the device layer 10. The corresponding devices in the device layer 10 operate based on the received instructions. The structures and functions of the respective layers will be described in detail below.

Fig. 2 is a block diagram showing a customs inspection and release system 1' according to another exemplary embodiment of the present disclosure. The customs inspection and release system 1' in Fig. 2 differs from the customs inspection and release system 1 in Fig. 1 in that the processing control layer 16 further includes a central control unit 20 configured to provide a user interface for monitoring operation states of the devices and a state of the subject, and in response to a user operation, generate an instruction and transmit the instruction to the message service layer 14. In an example, the central control unit 20 is configured to perform one or more of the following via the user interface (e.g., including input/output devices such as a display, a touch screen, a keyboard and a mouse): displaying a scan image in real time while the subject is being scanned; displaying a photo and a recognition result of a license plate of the subject; displaying a photo and a recognition result of a container code of the subject; and controlling a traffic control device in the site where the subject is located. The user can perform various user operations via the user interface, such as modifying the recognition result of the subject or performing control operations and issue control instructions.

The customs inspection and release systems 1 and 1' as shown in Fig. 1 and Fig. 2, respectively, are exemplary only. A customs inspection and release system according to the present disclosure may include additional components. For example, the processing control layer 16 can further include: an image detection

unit including an image analysis station and a re-inspection station and allowing a user to analyze a scan image of the subject at the image analysis station to determine whether the subject is suspicious or not and re-inspect the suspicious subject at the re-inspection station. In an example, the processing control layer 16
5 can further include an information management unit configured to maintain user information, maintain subject information, maintain commuter car information, inquire and statistically process information, and/or configure system parameters. As an example, the information management unit may include a database for storing and managing various information, and provide a user interface which
10 allows the user to perform information query and statistics and/or system parameter configuration.

In the illustrated customs inspection and release system, the adaptor layer and the message service layer are provided between the device layer and the processing control layer. The adaptor layer converts data collected by the devices
15 using different interface protocols into a form of predetermined, uniform message service interface protocol, and transmits the converted data to the message service layer in form of events. The message service layer encapsulates the received events into event messages suitable to be received and processed at the processing control layer. Further, the message service layer encapsulates the
20 instructions from the processing control layer into instruction messages suitable to be received and processed at the adaptor layer. Then, the adaptor layer converts the instruction messages into forms suitable to be received and executed by the corresponding devices. In this way, a uniform interface, message construction and transmission mechanism is provided in the above customs inspection and release
25 system, such that the information obtained by the respective devices in the device layer can be gathered together while the respective devices are operating independently from each other, and the respective device and the subject can be monitored and controlled remotely through a uniform platform, thereby achieving efficient, intelligent inspection and release and minimizing the labor cost. Further,
30 with an event-driven scheme, the data generated by the devices can be collected to form site events, which are bound into flow events to be processed by the flow logic unit to generate site instructions for controlling the devices. In this way, it is possible to ensure a real-time system response and a centralized data

management. Further, the system design can be divided into modules on a basis of tasks, such that the development and maintenance of each module can be made only in consideration of its task. Hence, the processing control layer is not required to consider removal and/or addition of the devices. As a result, the devices can
5 be added and/or removed dynamically with almost no change in the processing control layer.

According to an exemplary embodiment of the present disclosure, the message service layer 14 is further configured to receive other events from other customs business systems for processing at the processing control layer 16 and
10 transmit processing results to the other customs business systems. Here the other customs business systems may include e.g., a customs declaration system and/or a logistics system. In this way, not only all the devices in the inspection and release system can be correlated, but also the system can be integrated with the other customs business systems via the message service layer. In this way, all the
15 devices and all the related systems in the entire customs region can be integrated, arranged and coordinated to improve the overall operation efficiency.

Fig. 3 is a block diagram showing a structure of a business logic unit 30 in a customs inspection and release system according to an exemplary embodiment of the present disclosure. The business logic unit 30 can include a binding logic
20 module 302, a flow logic module 304, a device state logic module 306 and an integrated bus module 308.

The binding logic module 302 is configured to bind a plurality of discrete events associated with the same subject to this subject. The inspection flow is subject-oriented, and the subject under inspection passes through the plurality of
25 devices as described above and a plurality of sites. For example, an inspection site is generally divided into five sites related to the inspection flow and a commuter car access. The five sites include a Local Inspection Site (LIS), a Vehicle Waiting Site (VWS), a Secondary Inspection Site (SIS), a Central Control Site (CCS) and an Exit Verification Site (EVS). Different devices are deployed in the respective sites,
30 and various signals collected and events generated by these devices are discrete and need to be bound together based on their correlation. For example, an

identifier (ID) of the subject (e.g., a license plate number of a vehicle or a container code) can be included in an event message and the events having the same subject ID can be bound to the identified subject. The binding process allows the respective events associated with the same subject to be considered jointly, and
5 prepares for subsequent, comprehensive and accurate processing and control.

In the case where the other customs business systems have been integrated via the message service layer 14, the binding logic module 302 in the processing control layer 16 can be further configured to bind discrete events from the other systems that are associated with the same subject to this subject, such that the
10 information on the subject can be shared among the systems and the operation efficiency can be further improved.

The flow logic module 304 is configured to process the bound events to generate an instruction corresponding to the processing result. For example, the flow logic module 304 can include a plurality of application modules for a plurality of
15 data collection or detection devices. Each of the application module may be configured to process events from a corresponding device and generate a processing result. The processing results for the same subject can be considered jointly for generating instructions for the respective devices.

The device state logic module 306 is configured to monitor states of the plurality of devices and issue a warning upon detecting an abnormal state. For
20 example, based on the received state data for each device, the device state logic module 306 can detect whether the device has failed and issue a warning upon determining the presence of such failure, so as to inform an operator to maintain the device.

The integrated bus module 308 can be coupled to the message bus 40, the binding logic module 302, the flow logic module 304 and the device state logic module 306, and configured to receive the event messages from the message bus
25 40, forward the received event messages to the respective logic modules 302, 304 and 306, receive an instruction or a warning from the respective logic modules 302, 304 and 306, and transmit it to the message bus 40. For example, upon receiving
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an event message for a detection event associated with the subject, the integrated bus module 308 can forward the event message to the binding logic module 302 or the flow logic module 304 for processing. Upon receiving an event message related to a device state, the integrated bus module 308 can forward the event message to device state logic module 306 for processing. The integrated bus module 308 can provide configurable message transmitting, receiving and forwarding mechanisms, such that the development and maintenance of each logic module 302, 304 or 306 can focus on the tasks of the module, while the simple and general message transmitting, receiving and forwarding operations can be configured and carried out by the integrated bus module 308.

The structure and function of the business logic unit 30 as shown in Fig. 3 are illustrative only, and can be modified, increased or decreased without departing from the teaching of the present disclosure, as can be appreciated by those skilled in the art. The development and configuration of the business logic unit 30 and the respective modules can be performed by utilizing e.g., programmable processors and servers.

Fig. 4 is a block diagram showing a structure of a message bus 40 in a customs inspection and release system according to an exemplary embodiment of the present disclosure. The message bus 40 can include a message construction module 402, a message routing module 404 and a message queue pool 406.

The message construction module 402 can be configured to construct the event messages and the instruction messages based on the received events and instructions, respectively. The formats of the event messages and the instruction messages can be predetermined and/or user configurable. Figs. 5a and 5b show exemplary formats of an event message and an instruction message used in a customs inspection and release system according to an exemplary embodiment of the present disclosure. As shown, the event message may include a number of fields, indicating a site where the subject is located, an identifier of the subject, a type and serial number of the device for the subject, a time at which the detection data is received from the device, and an event content, respectively. The instruction message may also include a number of fields, indicating the site where the subject

is located, the type and serial number of the device for the subject, a source of the instruction and an instruction content, respectively. An event or instruction can be described in a message of a {key, value} pair type, where the key and the value are both character strings. The message formats shown in Figs. 5a and 5b are illustrative only and any appropriate message format can be designed depending on design requirements by those skilled in the art.

The message routing module 404 is configured to route the event messages to the processing control layer 16 and the instruction messages to at least one corresponding adaptor among the plurality of adaptors in the adaptor layer 12. In an example, based on the content of an event message, the message routing module 404 can route the event message to one or more of the business logic unit, the central control unit, the image detection unit and the information management unit. Further, based on an identifier of a device in an instruction device, the message routing module 404 can route the instruction message to an adaptor corresponding to the identified device.

The message queue pool 406 can include an event message queue pool for buffering and queuing the event messages and an instruction message queue pool for buffering and queuing the instruction messages. In an example, when a number of event messages are received from a number of sites or a number of devices, these event messages can be sorted based on the sites and/or device identifier and/or event contents carried in the messages and placed into a queue for transmission. In an example, when instruction messages from the business logic unit and the central control unit are received, these instruction messages can be sorted based on the sites and/or device identifier and/or message sources and/or instruction contents carried in the messages and placed into a queue for transmission. The sorting rules as used here can be predetermined or configured by the user.

Fig. 6 is a schematic diagram showing an adaptor layer 12 and a device layer 10 in a customs inspection and release system according to an exemplary embodiment of the present disclosure. Fig. 6 shows a plurality of devices and their corresponding adaptors.

A container/vehicle radiophotography inspection device (or Non-Intrusive Inspection, NII) can scan the subject (e.g., a container or a vehicle) to form a perspective image for an inspector to inspect whether items inside the container are eligible without opening the container. In an example, an NII interface module
5 can be added as an NII adaptor. In another example, the container/vehicle radiophotography inspection device can include an NII device and an algorithm workstation which provide information to the outside via different interfaces. In order to interface with the entire system, the NII interface module as well as a Programmable Logic Circuit (PLC) and a PLC interface module can be added as
10 adaptors. In this way, scan results by the container/vehicle radiophotography inspection device, real-time thumbnails and device states can be transferred to the processing control layer via a uniform message interface.

A radioactive material (RM) detection device can include a detection device and a database. In order for the RM device to interface with the entire system, an
15 RM collection module can be added as an adaptor for transferring real-time conditions, such as an operation state of the RM device and a detection state, to the processing control layer via a uniform message interface.

A License Plate Recognition (LPR) device can automatically take a picture of a license plate and recognize its content, thereby providing a discriminable feature of
20 a vehicle. An LPR adaptor can be added for transferring the license plate information to the processing control layer via a uniform message interface.

A Container code Recognition (CCR) device can automatically recognize the number of a container carried by a vehicle, such that the system can retrieve declaration information from the customs based on the number for reference by an
25 image inspector in image inspection. A CCR adaptor can transfer the container code to the processing control layer via a uniform message interface.

A Digital Video Recording (DVR) device can provide a video segment of a vehicle when it is being scanned. The DVR device records video continuously. A DVR adaptor module can retrieve a video of a specified time period from the DVR
30 device in response to an instruction conveyed from the processing control layer. In

an example, the retrieved video segment can be transcoded and posted onto a streaming media service station.

5 A traffic control device may include a stop lever, a traffic light, a Light Emitting Diode (LED) or the like, for restricting and guiding vehicles in the site. In an example, the stop lever and the traffic light can provide an electrical connection point to be controlled and collected by a PLC adaptor. The LED can be a network device controlled by the processing control layer directly via messaging.

10 The devices and adaptors listed above are illustrative only and it can be appreciated by those skilled in the art that more or less devices can be provided as desired.

Next, a customs inspection and release method according to an exemplary embodiment of the present disclosure will be described with reference to the figure. In the flowchart of Fig. 7 illustrating a customs inspection and release method, at step 700, at least some of a plurality of devices detect a subject to generate
15 detection data. At step 702, each of a plurality of adaptors corresponding to the plurality of devices, respectively, detects the detection data from its corresponding device and converts the detection data into an event in a form of a predetermined message service interface protocol. At step 704, a message bus receives events from the adaptors and constructs event messages based on the events. At step
20 706, the event messages from the message bus are received and processed, and instructions associated with the event messages are generated and transmitted to the message bus. At step 708, the message bus constructs instruction messages based on the received instructions and transmits the instruction messages to the respective adaptors. At step 710, the respective adaptors convert the instruction
25 messages into instructions in a form suitable for the corresponding devices and transmit the instructions to the corresponding devices. At step 712, the corresponding devices operate based on the received instructions.

In an embodiment, the customs inspection and release method further includes: providing a user interface for monitoring operation states of the devices

and a state of the subject, and in response to a user operation, generating an instruction and transmitting the instruction to the message bus.

5 In an embodiment, the step of receiving and processing the event messages from the message bus, generating instructions associated with the event messages and transmitting the instructions to the message bus includes receiving event messages from the message bus; binding a plurality of discrete events associated with the same subject to the subject based on the event messages; processing the bound events to generate an instruction corresponding to a result of the processing; and transmitting the generated instruction to the message bus.

10 In an embodiment, the customs inspection and release method further includes: receiving, by the message bus, other events from other customs business systems for processing, and transmitting processing results to the other customs business systems.

15 The customs inspection and release system and method according to the exemplary embodiments of the present disclosure have been described above and will be further explained with reference to specific examples.

Fig. 8 is an inspection site where a customs inspection and release system and method according to an exemplary embodiment of the present disclosure can be applied. The inspection site can be divided into five sites related to the inspection flow, including a Local Inspection Site (LIS), a Vehicle Waiting Site (VWS), a Secondary Inspection Site (SIS), a Central Control Site (CCS) and an Exit Verification Site (EVS), as well as a Commuter Car Access (CCA). The CCS is a site where the processing control layer is deployed. In the following, the data is transmitted to the CCS, i.e., to the processing control layer for processing and control. The operation of each of the sites will be described below, assuming that the subject is a vehicle carrying a container.

Local Inspection Site (LIS)

The vehicle enters the LIS.

An intercom and/or closed circuit television device, for example, can be provided for an operator to guide the vehicle at any time.

The license plate is recognized and the recognized data is transmitted to the CCS.

- 5 The traffic control device receives an instruction transmitted from the processing control layer of the CCS and guides the vehicle to enter the LIS.

RM detection is performed and the detected information is transmitted to the CCS.

- 10 The container code is recognized and the recognized data is transmitted to the CCS.

A scan device performs X-ray scan and transmits the obtained information to the CCS.

The vehicle leaves the LIS.

Vehicle Waiting Site (VWS)

- 15 The vehicle enters the waiting site.

The license plate is recognized and the recognized data is transmitted to the CCS.

For example, an intercom and/or closed circuit television device can be provided for an operator to guide the vehicle at any time.

- 20 Based on a radioactive material detection result or an image detection result of the vehicle, the driver is prompted to go to the SIS or the EVS with a LED.

The vehicle leaves the VWS.

Secondary Inspection Site (SIS)

The vehicle enters the SIS.

The corresponding license plate is displayed with a LED.

For example, an intercom and/or closed circuit television device can be
5 provided for an operator to guide the vehicle at any time.

An image inspection station displays the corresponding image and information.

If there is excessive radiation, a radioactive material detection is performed
first and a radioactive conclusion is given.

The container is inspected to generate a secondary inspection conclusion.

10 The vehicle leaves the SIS.

Central Control Site (CCS)

An instruction is transmitted to the traffic control device in the CCS to guide the
vehicle to enter the site.

A recognized data for license plate is received from the CCS and stored in a
15 database.

RM detection information is received from the RM device, bound to the license
plate data and stored in the database.

A recognized data for the container code is received from the CCS, bound to
the license plate data and stored in the database.

20 The container/vehicle radiophotography inspection device is informed to get
ready for scanning.

A scan data is received from the container/vehicle radiophotography inspection device, bound to the license plate data and stored in the database.

An image inspector analyzes the scan image and gives an inspection conclusion.

5 The inspection conclusion is transmitted to a LED display for the corresponding lane in the VWS.

If the subject is suspicious, the license plate information is transmitted to a LED display in the SIS.

10 A recognized data for license plate is received from the EVS, and the database is inquired to determine whether the vehicle can leave the site or not.

A control instruction is transmitted to the traffic control device of the EVS.

Exit Verification Site (EVS)

The vehicle enters the EVS.

15 The license plate is recognized and the recognized data is transmitted to the CCS.

For example, an intercom and/or closed circuit television device can be provided for an operator to guide the vehicle at any time.

The traffic control device receives the control instruction transmitted from the CCS.

20 The vehicle leaves the EVS.

Commuter Car Access (CCA)

The vehicle enters the CCA.

The license plate is recognized and the recognized data is transmitted to the CCS.

For example, an intercom and/or closed circuit television device can be provided for an operator to guide the vehicle at any time.

- 5 The traffic control device receives the control instruction transmitted from the CCS.

The vehicle enters or exits from the CCA.

- With reference to the site shown in Fig. 8, Fig. 9 is an inspection flow where a customs inspection and release system and method according to an exemplary
10 embodiment of the present disclosure can be applied. When a vehicle arrives at the site entrance, a ground sensor triggers license plate recognition and then a stop lever is lifted automatically. Then, the vehicle enters the LIS for RM detection, container code recognition and NII scan. Next, the vehicle moves to the VIS for license plate recognition. A LED displays the vehicle state: release (qualified),
15 secondary inspection (suspicious) or wait (for image inspection which has not been completed). If the vehicle is suspicious, it enters the SIS for container-opening re-inspection and a conclusion will be made with reference to the NII image. A LED displays the vehicle that requires re-inspection and its inspection state. Then, the vehicle arrives at the EVS for license plate recognition. If the vehicle is qualified,
20 the stop lever will be lifted automatically and the vehicle will be released; otherwise the stop lever will not be lifted and a warning box will be popped up in the CCS and the image inspection station to inform that the vehicle is not qualified.

- For a commuter car, when a registered car arrives at the CCA, the stop lever will be lifted automatically and the car will be released. For an unregistered car, it is
25 required to request via intercom for the stop lever to be lifted manually.

In the following, exemplary abnormal flows and countermeasures in the customs inspection and release system and method according to an exemplary embodiment of the present disclosure will be described.

For example, when a vehicle arrives at the site entrance and presses the ground sensor twice, it triggers two consecutive license plate recognitions which may have different results. In this case, the vehicle cannot be detected and bound correctly. Hence, the container/vehicle radiophotography inspection device can provide a number of photoelectric switches arranged along a lane for the binding logic module in the business logic unit to determine whether the vehicle is moving forward and backward. The binding logic module can make this determination by quickly checking the states of the photoelectric switches. When it determines that the vehicle that pressed the ground sensor previously did not enter the inspection lane, it ignores the result of the first recognition.

If the vehicle enters the LIS lane and then travel backward to get out of the lane, there could be two possible situations. First, the vehicle moves out of the ground sensor area and travels back and thus presses the ground sensor again. This will cause the license plate to be recognized again and the recognition would fail. Hence, if it is detected by the photoelectric switches along the lane that the vehicle does not enter the lane, this recognition failure event can be ignored. Second, the vehicle travels back before it leaves the ground sensor area, which will not cause the license plate to be recognized again. The binding logic module can determine that the vehicle does not enter the lane by quickly checking the states of the photoelectric switches. When the vehicle triggers license plate recognition again, the previous recognition result will be ignored.

If the license plate recognition fails, the CCS will be notified to designate a license plate number manually for binding. In particular, if the license plate recognition at the entrance fails, the vehicle can move on for inspection and move to the VWS. A serial number can be assigned to the vehicle as its unique identifier and the photo of the license plate can be stored for reference in the subsequent operation for designating the license plate. For example, if the vehicle is stuck in the VWS since the operator in the CCS does not designate a license plate number timely, the operator in the CCS needs to designate a license plate number immediately. If the license plate recognition fails while the vehicle is in the VWS or EVS, the vehicle would be stopped and the operator in the CCS needs to designate a license plate number immediately.

If the container code recognition goes wrong or fails, an operator in the CCS will be notified to designate a container code manually. The failure in the container code recognition does not prevent the vehicle from moving for inspection and to the VWS. The photo obtained in the container code recognition can be recorded and, during the image inspection in the image inspection station, the container code can be designated manually and the declaration information can be retrieved. If the container code recognition has not been triggered, the container code recognition device will report this event and a reminder dialog box will be popped up in the CCS.

10 In the case where the vehicle enters the LIS lane immediately followed by another vehicle, the user interface of the CCS informs an operator, such that the operator can find the other vehicle from a video segment and guide it to move out of the inspection site for re-inspection.

15 There could be several situations of device failures while the vehicle is moving into the site.

If the license plate recognition device fails, the binding logic module has not received the license plate recognition information after a defined period has lapsed since a signal indicating that the RM has entered an inspection mode is received. In this case, the CCS can be notified that the license plate recognition device may fail and an operator can designate a license plate number for the current vehicle manually and avoid any further vehicles from entering the site, so as to fix the device.

25 If the RM detection device fails, e.g., if the system finds out that the connection to the RM has lost, or a RM failure signal is received, an operator in the CCS is notified. The operator can select to guide the current vehicle to move out of the site for re-inspection or to ignore its RM information.

If the container code recognition device fails, e.g., if the system finds out that the connection to the container code recognition device has lost, an operator in the CCS is notified. The operator can designate a license plate number for the current

vehicle manually and avoid any further vehicles from entering the site, so as to fix the device.

If the container/vehicle radiophotography inspection device fails, e.g., if the system finds out that the connection to the container/vehicle radiophotography inspection device has lost, or a container/vehicle radiophotography inspection device failure signal is received, an operator in the CCS is notified. The operator guides it to move out of the inspection site for re-inspection and avoid any further vehicles from entering the site, so as to fix the device.

The foregoing detailed description has set forth various embodiments of the method and apparatus for marking a suspected object in a security inspection CT system via the use of diagrams, flowcharts, and/or examples. In a case that such diagrams, flowcharts, and/or examples contain one or more functions and/or operations, it will be understood by those skilled in the art that each function and/or operation within such diagrams, flowcharts or examples may be implemented, individually and/or collectively, by a wide range of structures, hardware, software, firmware, or virtually any combination thereof. In one embodiment, several portions of the subject matter described in the embodiments of the present disclosure may be implemented via Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), Digital Signal Processors (DSPs), or other integrated formats. However, those skilled in the art will recognize that some aspects of the embodiments disclosed herein, in whole or in part, may be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and/or firmware would be well within the skill of those skilled in the art in ray of this disclosure. In addition, those skilled in the art will appreciate that the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to

actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive, a Compact Disc (CD), a Digital Versatile Disk (DVD), a digital tape, a computer memory, etc.; and a transmission type medium such as a digital
5 and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communications link, a wireless communication link, etc.).

While the present disclosure has been described with reference to several typical embodiments, it is apparent to those skilled in the art that the terms are used for illustration and explanation purpose and not for limitation. The present
10 disclosure may be practiced in various forms without departing from the spirit or essence of the present disclosure. It should be understood that the embodiments are not limited to any of the foregoing details, and shall be interpreted broadly within the spirit and scope as defined by the following claims. Therefore, all of modifications and alternatives falling within the scope of the claims or equivalents
15 thereof are to be encompassed by the claims as attached.

What is claimed is:

1. A customs inspection and release system, comprising:

a device layer comprising a plurality of devices for inspection and release, the
5 plurality of devices are deployed at different types of inspection sites, at least some
of the plurality of devices being configured to detect a subject and generate
detection data while the subject passes through the inspection sites;

an adaptor layer comprising a plurality of adaptors corresponding to the
plurality of devices, respectively, each being configured to receive the detection
10 data from its corresponding device and convert the detection data into an event in a
form of a predetermined message service interface protocol;

a message service layer comprising a message bus and configured to receive
events from the adaptor layer and construct event messages based on the events;
and

15 a processing control layer comprising a business logic unit and configured to
receive and process the event messages from the message bus, generate
instructions associated with the event messages and transmit the instructions to
the message service layer, wherein the business logic unit is configured to bind, to
a single subject, a plurality of discrete event messages associated with the single
20 subject, and process the bound event messages jointly, wherein the plurality of
discrete event messages correspond to different events originating from different
devices in the device layer while the single subject passes through the different
types of the inspection sites;

wherein the message service layer constructs instruction messages based on
25 the received instructions and transmits the instruction messages to the adaptor
layer,

the adaptor layer converts the instruction messages into instructions in a form
suitable for the corresponding devices and transmits the instructions to the device
layer, and

30 the corresponding devices in the device layer operate based on the received
instructions.

2. The system of claim 1, wherein the processing control layer further comprises a central control unit configured to provide a user interface for monitoring operation states of the devices and a state of the subject, and in response to a user operation, generate an instruction and transmit the instruction to
5 the message service layer.

3. The system of claim 1 or 2, wherein the business logic unit comprises:

a binding logic module configured to bind the plurality of discrete event messages associated with the single subject to the single subject;

a flow logic module configured to process the bound event messages jointly
5 and generate an instruction corresponding to a result of the processing;

a device state logic module configured to monitor states of the plurality of devices and issue a warning upon detecting an abnormal state; and

an integrated bus module coupled to the message bus, the binding logic module, the flow logic module and the device state logic module and configured to
10 receive the event messages from the message bus, forward the received event messages to the respective logic modules, receive an instruction or a warning from the respective logic modules and transmit it to the message bus.

4. The system of claim 1 or 2, wherein the message bus comprises:

15 a message construction module configured to construct the event messages and the instruction messages based on the received events and instructions, respectively;

a message routing module configured to route the event messages to the processing control layer and the instruction messages to at least one
20 corresponding adaptor among the plurality of adaptors in the adaptor layer; and

a message queue pool comprising an event message queue pool for buffering and queuing the event messages and an instruction message queue pool for buffering and queuing the instruction messages.

25 5. The system of claim 1 or 2, wherein the event messages each indicates a site where the subject is located, an identifier of the subject, a type and serial number of the device for the subject, a time at which the detection data is received from the device, and an event content, and

the instruction messages each indicates the site where the subject is located,
30 the type and serial number of the device for the subject, a source of the instruction and an instruction content.

6. The system of claim 2, wherein the plurality of devices comprise at least two of a container/vehicle radiophotography inspection device, a radioactive material

detection device, a license plate recognition device, a container code recognition device, a digital video recording device and a traffic control device.

5 7. The system of claim 6, wherein the central control unit is configured to, via the user interface, perform one or more of:

displaying a scan image in real time while the subject is being scanned;
displaying a photo and a recognition result of a license plate of the subject;
displaying a photo and a recognition result of a container code of the subject;
and

10 controlling a traffic control device in the site where the subject is located, and wherein the recognition result of the subject is modifiable by a user via the user interface.

15 8. The system of claim 1 or 2, wherein the processing control layer further comprises: an image detection unit comprising an image analysis station and a re-inspection station and allowing a user to analyze a scan image of the subject at the image analysis station to determine whether the subject is suspicious or not and re-inspect the suspicious subject at the re-inspection station.

20 9. The system of claim 1 or 2, wherein the processing control layer further comprises: an information management unit configured to perform one or more of:
maintaining user information,
maintaining subject information,
maintaining commuter car information,
25 information query and statistics, and
configuring system parameters.

10. The system of claim 1 or 2, wherein the message service layer is further configured to receive other events from other customs business systems for
30 processing at the processing control layer and transmit processing results to the other customs business systems, and

wherein the other customs business systems comprise a customs declaration system and/or a logistics system.

11. The system of claim 10, wherein the binding logic module in the processing control layer is further configured to bind discrete events among the other events that are associated with the same subject to the subject.

5 12. A customs inspection and release method, comprising:

detecting, by at least some of a plurality of devices, a subject to generate detection data while the subject passes through different types of inspection sites, wherein the plurality of devices are deployed at the inspection sites;

10 receiving, by each of a plurality of adaptors corresponding to the plurality of devices, respectively, the detection data from its corresponding device and converting the detection data into an event in a form of a predetermined message service interface protocol;

receiving, by a message bus, events from the adaptors and constructing event messages based on the events; and

15 receiving and processing the event messages from the message bus, generating instructions associated with the event messages and transmitting the instructions to the message bus, wherein said processing the event messages comprises binding, to a single subject, a plurality of discrete event messages associated with the single subject, and processing the bound event messages
20 jointly, the plurality of discrete event messages being corresponding to different events originating from different devices in the device layer while the subject passes through the different types of inspection sites;

25 constructing, by the message bus, instruction messages based on the received instructions and transmitting the instruction messages to the respective adaptors;

converting, by the respective adaptors, the instruction messages into instructions in a form suitable for the corresponding devices and transmitting the instructions to the corresponding devices; and

operating, by the corresponding devices, based on the received instructions.

30

13. The method of claim 12, further comprising: providing a user interface for monitoring operation states of the devices and a state of the subject, and in response to a user operation, generating an instruction and transmitting the instruction to the message bus.

14. The method of claim 12 or 13, wherein said processing the event messages further comprises:

processing the bound events to generate an instruction corresponding to a result of the processing.

5 15. The method of claim 12 or 13, further comprising:

receiving, by the message bus, other events from other customs business systems for processing, and transmitting processing results to the other customs business systems, and

10 wherein the other customs business systems comprise a customs declaration system and/or a logistics system.

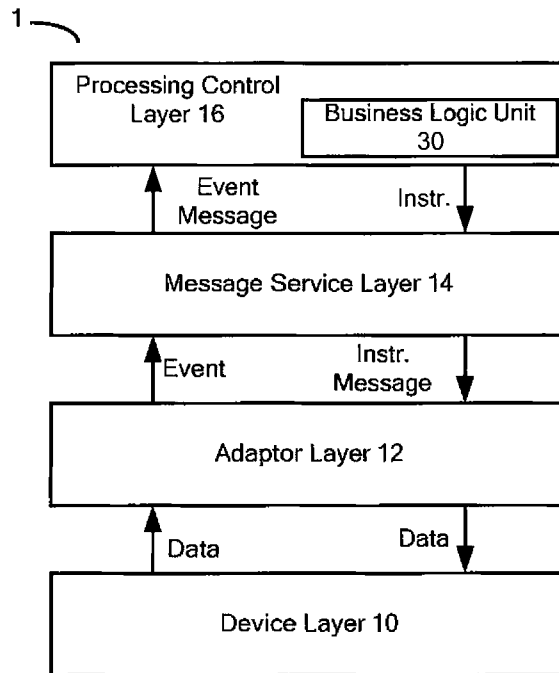


Fig. 1

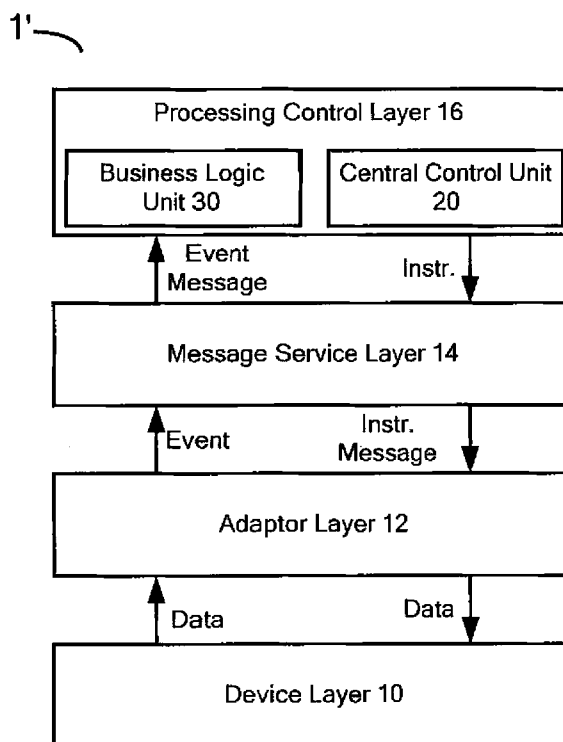


Fig. 2

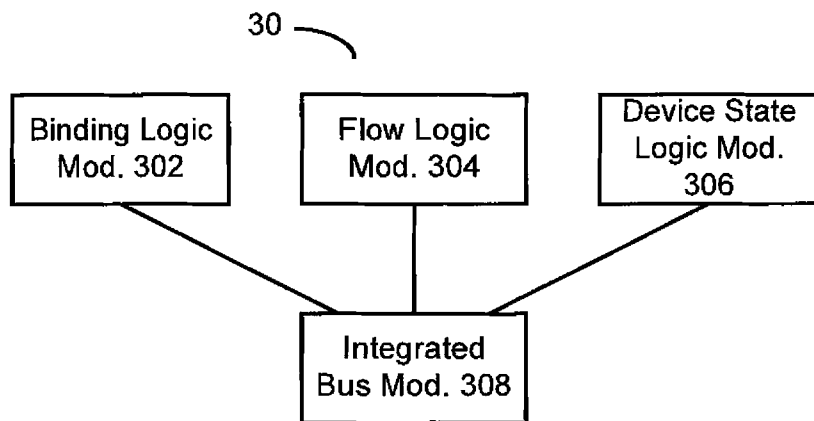


Fig. 3

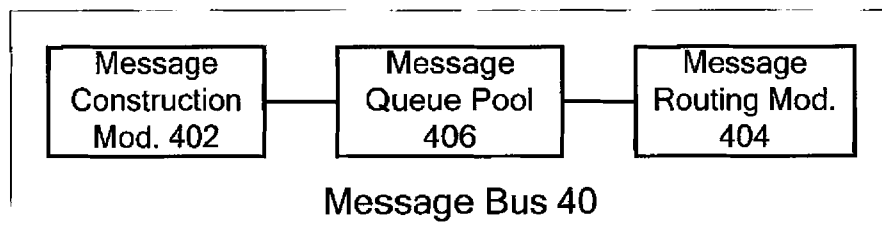


Fig. 4

Example of Event Message Format

Site	Subject ID	Device Type	Device No.	Reception Time	Event Content
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Fig. 5a

Example of Instruction Message Format

Site	Device Type	Device No.	Instr. Source	Instr. Content
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Fig. 5b

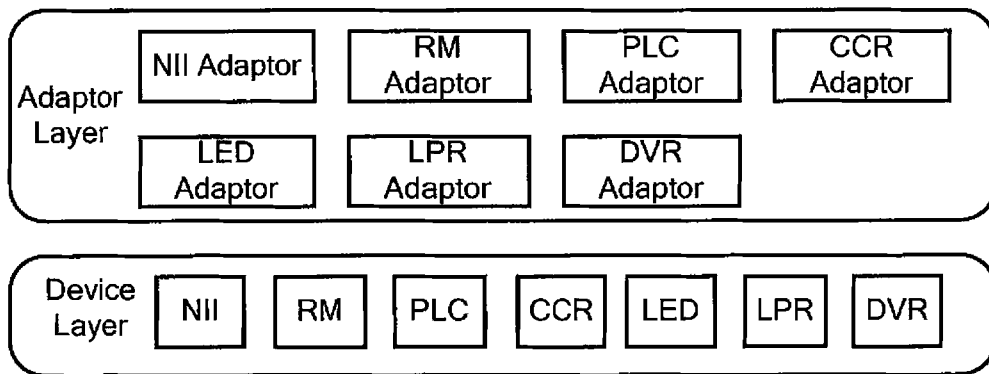


Fig. 6

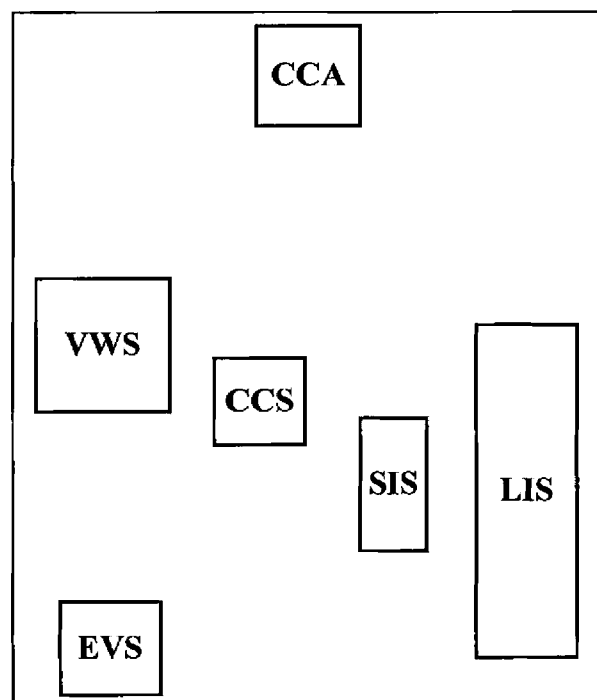


Fig. 8

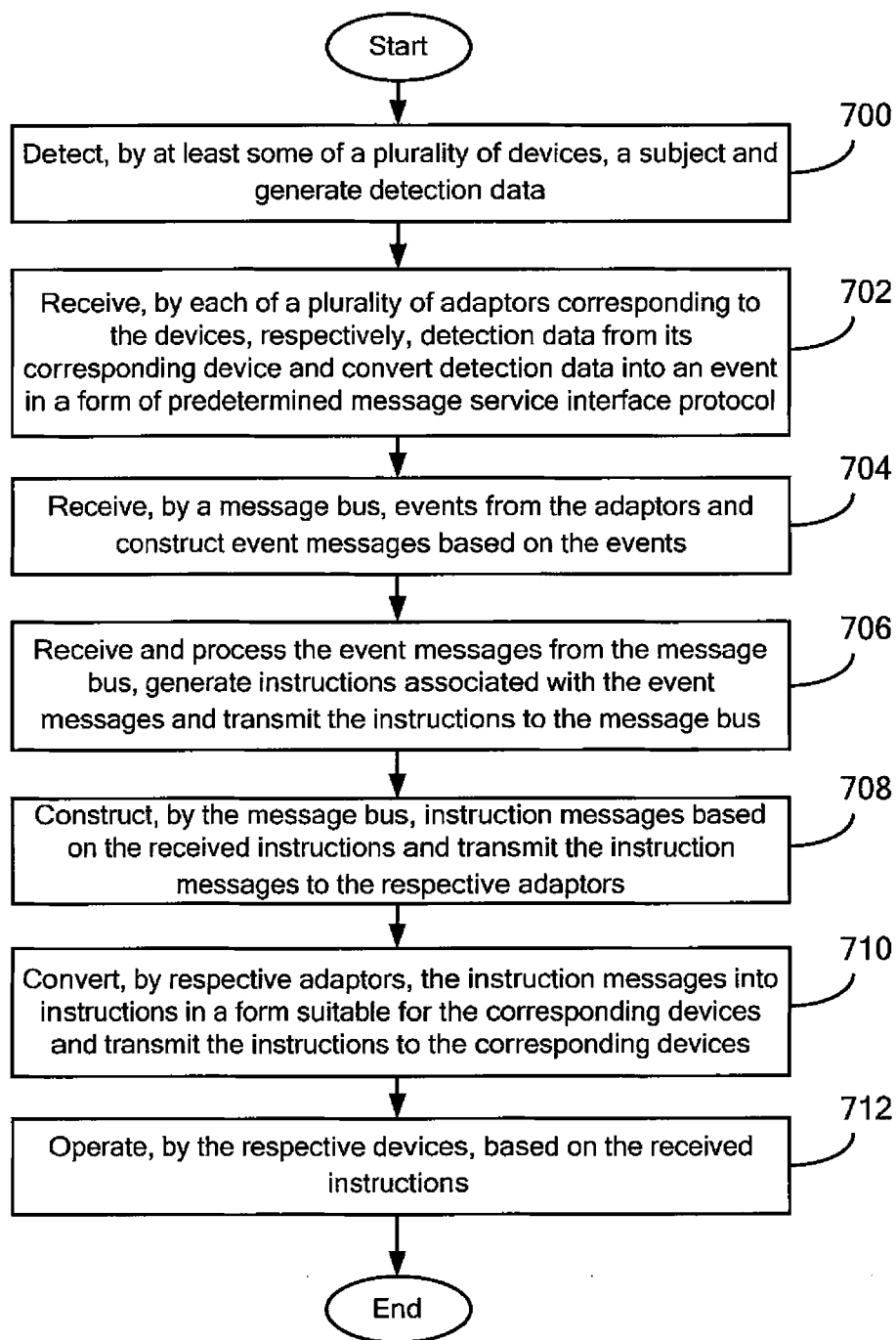


Fig. 7

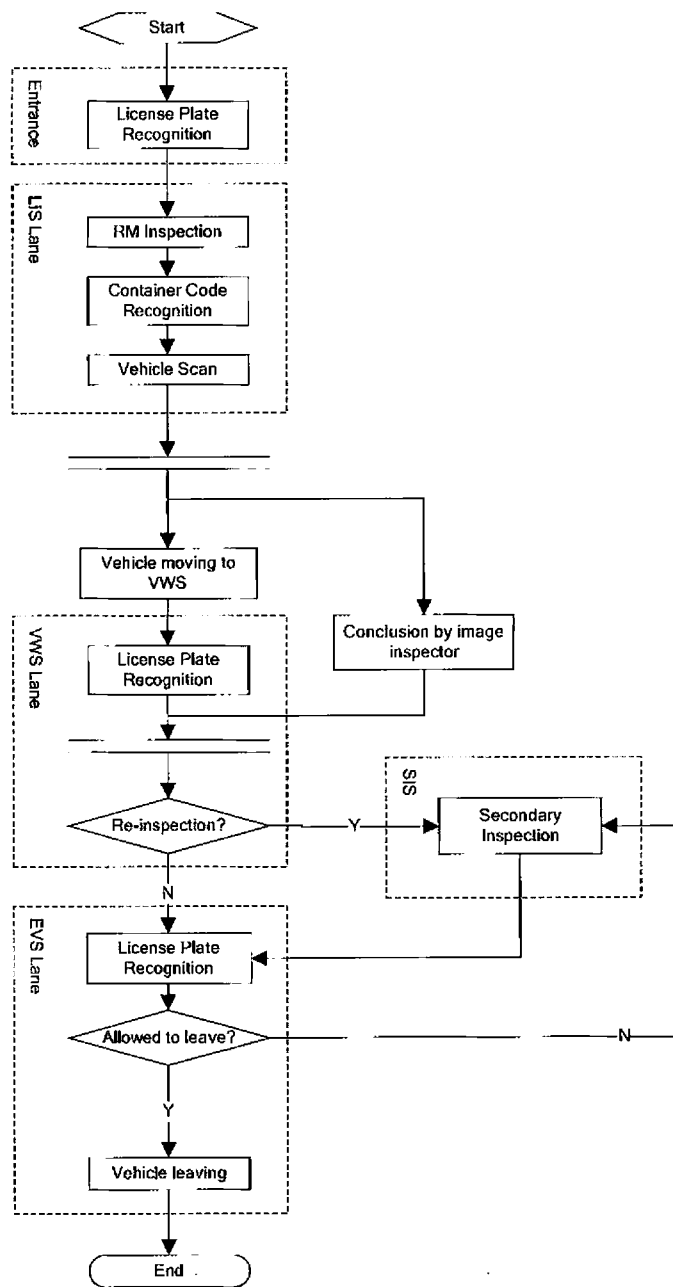


Fig. 9