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**APT RECOMMENDATION ON**

**SPECIFICATION OF INFORMATION AND COMMUNICATION SYSTEM USING VEHICLE DURING DISASTER**

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**No. APT/ASTAP/REC-02**

**APT RECOMMENDATION**

**on**

**SPECIFICATION OF INFORMATION AND COMMUNICATION SYSTEM**

**USING VEHICLE DURING DISASTER**

This Recommendation provides the specification of information and communication system using vehicle during disaster which is called V-HUB system. The V-HUB system has two types of interface;

- network interface for devices, and

- application interface for applications

This document also covers scenarios using vehicles to replace destroyed/broken communication infrastructure during disaster beyond Vehicle to Vehicle (V2V) communications and describes the technical requirements and the functional architecture of the V-HUB system. The specification does not cover any protocol details such as message format and message sequences in this version of the specification.

**Asia Pacific Telecommunity (APT),**

***considering***

a) that based on the lessons learned at the Great Earthquake in Eastern Japan and Tsunami attack in 2011, and Philippines storm surge in 2013, there have been major efforts to find solutions to quickly build information and communication infrastructure in disaster area;

b) that vehicles have increasing attentions in terms of;

1) Physical shelter capability (wind, rain, wild life and more),

2) Electric power source (gas, power generator (dynamo) and battery) and

3) Radio communication capability.

Information and communication infrastructure well responsive to natural disasters could also be essential to Asia Pacific maritime nations;

c) that it is important to collect use cases and bring initial concepts, architectures and requirements about disaster information and communication systems based on experiences in Asia Pacific Region;

d) that as each county has various use cases and requirements, it is important to open the discussion to Asia Pacific nations and harnessing ideas for best solutions;

***recognizing***

a) that ASTAP-24 agreed to initiate a study on “utilization of vehicles as information hubs during disasters” including: roles of vehicles in disasters situation, study of possible frequency band to be used in the case, developing streamline standard for early responder;

b) that ASTAP-25 approved a report on “Requirements ofInformation and Communication System using Vehicle during Disaster” (APT/ASTAP/REPT-21) and a new workplan on “Disaster Information and Communication System Standard Using Vehicle” based on the collected use cases in the report;

c) that ASTAP-26 received the initial draft of the specification and ASTAP-27 approved to start discussion on the specification of V-HUB in a corresponding groups (ASTAP-27/OUT-17R1);

d) that the corresponding group has developed the draft recommendation on “Information and Communication System using Vehicle during Disaster” with the participations of the experts from Philippines, Thailand, Malaysia, Papua New Guinea and Japan, are participating,

***recommends* that APT administrations**

take into account the specification on technical requirements and functional architectures detailed in Annex 1 when implementing the Information and Communication System using Vehicle during Disaster.

**ATTACHMENT**

1. ANNEX-1

Standard Specification Information and Communication System using Vehicle during Disaster

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**ANNEX-1**

**Standard Specification Information and Communication System
using Vehicle during Disaster**

**CONTENTS**

[1. Scope 5](#_Toc491346778)

[2. References 5](#_Toc491346779)

[3. Terms and definition 5](#_Toc491346780)

[3.1. V-HUB system 5](#_Toc491346781)

[3.2. Device 5](#_Toc491346782)

[3.3. Network interface 6](#_Toc491346783)

[3.4. Application interface 6](#_Toc491346784)

[3.5. Application 6](#_Toc491346785)

[4. Abbreviations 6](#_Toc491346786)

[5. Conventions 6](#_Toc491346787)

[6. Network interfaces 7](#_Toc491346788)

[6.1. WLAN 7](#_Toc491346789)

[6.1.1. Description 7](#_Toc491346790)

[6.1.2. Technical requirement 8](#_Toc491346791)

[6.1.3. Functional architecture specification 9](#_Toc491346792)

[6.2. Beacon (V2X) 9](#_Toc491346793)

[6.2.1. Description 9](#_Toc491346794)

[6.2.2. Technical requirement 10](#_Toc491346795)

[6.2.3. Functional architecture specification 10](#_Toc491346796)

[6.3. Satellite 11](#_Toc491346797)

[6.3.1. Description 11](#_Toc491346798)

[6.3.2. Technical requirement 11](#_Toc491346799)

[6.3.3. Functional architecture specification 12](#_Toc491346800)

[6.4. White space 12](#_Toc491346801)

[6.4.1. Description 12](#_Toc491346802)

[6.4.2. Technical requirement 12](#_Toc491346803)

[6.4.3. Functional architecture specification 12](#_Toc491346804)

[6.5. Cellular 12](#_Toc491346805)

[6.5.1. Description 12](#_Toc491346806)

[6.5.2. Technical requirement 12](#_Toc491346807)

[6.5.3. Functional architecture specification 12](#_Toc491346808)

[7. Application interfaces 12](#_Toc491346809)

[7.1. Messaging 12](#_Toc491346810)

[7.1.1. Description 12](#_Toc491346811)

[7.1.2. Technical requirement 13](#_Toc491346812)

[7.1.3. Functional architecture specification 14](#_Toc491346813)

[7.2. Tracking 14](#_Toc491346814)

[7.2.1. Description 15](#_Toc491346815)

[7.2.2. Technical requirement 15](#_Toc491346816)

[7.2.3. Functional architecture specification 15](#_Toc491346817)

[7.3. Streaming 15](#_Toc491346818)

[7.3.1. Description 15](#_Toc491346819)

[7.3.2. Technical requirement 15](#_Toc491346820)

[7.3.3. Functional architecture specification 16](#_Toc491346821)

[7.4. Alerting 16](#_Toc491346822)

[7.4.1. Description 16](#_Toc491346823)

[7.4.2. Technical requirement 17](#_Toc491346824)

[7.4.3. Functional architecture specification 17](#_Toc491346825)

[BIBLIOGRAPHY （Informative） 18](#_Toc491346826)

[APPENDIX (Informative) 19](#_Toc491346827)

[APPENDIX-A. Example of VSAT terminal on vehicle unit 19](#_Toc491346828)

[APPENDIX-B. Example of alerting application 20](#_Toc491346829)

[APPENDIX-C. Proactive V-HUB system 21](#_Toc491346830)

[APPENDIX-D. Example of the pre-defined SSID of WLAN AP for disaster in japan 22](#_Toc491346831)

**1. Scope**

This document defines the specification of information and communication system using vehicle during disaster in order to support the system requirements. The specification covers technical requirements and functional architectures. The specification does not cover protocol details (message format, message sequence, and etc.), conformance/interoperability testing, and operational guideline. They can be developed in the future.

**2. References**

[APT/ASTAP/REPT-21] Report APT/REPT-21(2016), “Requirements of Information and Communication System using Vehicle during Disaster”

**3. Terms and definition**

This document defines the following terms.

**3.1. V-HUB system**

V-HUB system is the entire information and communication system using vehicles\*1 during disaster. Note that it is not limited to vehicle unit. The V-HUB\*2 system has two types of interface; network interface for devices and application interface for applications. The specification covers scenarios using vehicles to replace destroyed / broken communication infrastructure during disaster beyond V2V communications.

Note \*1; The vehicle of V-HUB has engine or motor and battery, communication unit.

Note \*2; The HUB of V-HUB means information and communications infrastructure.

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**Fig. 1 The V-HUB system**

**3.2. Device**

Device is defined as a hardware that serves as a communication network node and may include consumer device, vehicle unit, and information kiosk. The consumer device is off-the-shelf such as smartphone, PC, tablet and other mobile device.

A) Smartphone, Tablet, PC The computer device used for consumer.

B) Other mobile device The mobile computer device out of A).

C) Vehicle unit The vehicle unit can be factory-installed by manufacturer and also carried-on by user.

D) Information Kiosk The information kiosk may include a stationary server at the evacuation site with internet access. The information kiosk is usually maintained by designated operators.

**3.3. Network interface**

Network interface is defined as a communication interface among devices and may include WLAN, beacon (V2X), satellite, white space and cellular.

**3.4. Application interface**

Application interface is defined as a communication interface among applications and may include messaging, tracking, streaming and alerting.

**3.5. Application**

Application is a software enabling use cases. APT Report on Requirements of Information and Communication System Using Vehicle during Disaster (APT/ASTAP/REPT-21) has a list of suggested use cases of V-HUB. Use cases can be classified by nature into four categories below:

A) SMS/Whiteboard Non-real-time text communication
ex. Short Message Service and Whiteboard for information sharing during disaster. etc.

B) Public announcement Non-real-time/Real-time text distribution
ex. Delivering information by Web news. etc.

C) Phone(E-call)/Conferencing Interactive voice/video communication
ex. Emergency Call etc.

D) Search/Rescue Non-real-time beacon communication
ex. Person Search Service. etc.

**4. Abbreviations**

AP Access Point

CRUD Create, Read, Update and Delete

E-call Emergency call

GIS Geoaphic Information System

GPS Global Positioning Syatem

IoT Internet of Things

SMS Short Message Service

SSID Service Set Identifier

STA Station terminal

V2X Vehicle to Everything

V-HUB Vehicle Hub

VSAT system Very Small Aperture Terminal system

Wi-Fi Wireless Fidelity

WLAN Wireless LAN

**5.** **Conventions**

None

**6. Network interfaces**

**6.1. WLAN**

**6.1.1. Description**

WLAN has two major connection methods; infrastructure mode and ad-hoc mode. The V-HUB system must support the infrastructure mode, because most of consumer off-the-shelf devices such as smartphones only support the infrastructure mode and the V-HUB system must offer the service to such popular devices. Alternatively the V-HUB system may additionally support ad-hoc mode for communications between vehicle units. Since this is also achieved by infrastructure mode as mentioned below, the ad-hoc mode specification has been postponed. It does not mean the ad-hoc mode remains declined. This option can also be developed in the future.

The infrastructure mode has two functions; AP and STA. One WLAN AP serves multiple connections to WLAN STAs. It is not supported to establish connection between APs or between STAs. Since the consumer devices usually operate WLAN STA as a standard setup, the vehicle unit must operate WLAN AP to connect to user devices without any operation on the user side. In addition, the inter-vehicle communication also requires the AP-STA linkage. This means that the vehicle unit must operate WLAN STA for relaying. This also benefits the vehicle unit to connect to the internet access point and information kiosk at the evacuation site. As a consequence, the vehicle unit must operate both WLAN AP and STA. There are three potential options for this as follows:

Dual interfaces

Concurrent mode

Wi-Fi Direct

With dual interfaces or concurrent mode, the vehicle unit may operate both AP and STA at the same time. The concurrent mode is to switch AP and STA periodically on the single interface to emulate (pretend) the dual interfaces. This is a kind of proprietary technology provided by many major WLAN chipset manufacturers. Though it looks the simplest setup, it is not true actually. If there are several vehicles in the same communication vicinity, multiple APs are appeared. Since there is no linkage among APs, communication network is divided among APs even in the same communication vicinity. This also induces a complication for users to choose one AP to connect. The third option Wi-Fi Direct enables the interface to be AP or STA and not both at the same time. If there is no AP, the interface gets AP. If there is AP, the interface gets STA and connects to the existing AP. If existing APs are met, one random AP gets STA and connects to the other AP. This mechanism virtually ensures a single AP in the same communication vicinity and keeps the V-HUB system away from network complication due to multiple APs that occurs in case of dual interface and concurrent mode.

In addition, it is quite opportunistic to practice inter-vehicle communication on the street. In order to increase that opportunity, it will be highly recommended that the V-HUB system support IEEE802.11ai of Fast Initial Link Setup (FILS) capability.

Note that this specification does not cover multi-hop ad-hoc routing, that is known as VANET (Vehicular Ad-hoc Network), and DTN (Delay/Disruption Tolerant Network). Both capabilities can be developed in the future.

**6.1.2. Technical requirement**

|  |  |  |
| --- | --- | --- |
| ID | Technical requirement | Use case |
| N001 | The V-HUB system shall enable the vehicle unit to have both WLAN AP and WLAN STA. | A, B, D |
| N002 | The V-HUB system shall enable the vehicle unit to deactivate WLAN AP after a random time wait, while the vehicle unit identifies the presence of WLAN AP of the other vehicle unit.Note: Wi-Fi Direct can be a solution for this. | A, B, D |
| N003 | The V-HUB system shall enable the vehicle unit to use a pre-defined SSID at WLAN AP. | A, B, D |
| N004 | The V-HUB system shall enable the vehicle unit to operate WLAN STA to automatically connect to the pre-defined SSID of WLAN AP of another vehicle unit.Note: IEEE802.11ai may apply for fast link setup. | A, B, D |
| N005 | The V-HUB system shall enable the vehicle unit to operate WLAN STA not to connect to its own WLAN AP while the same vehicle unit activate WLAN AP. | A, B, D |
| N006 | The V-HUB system shall enable the consumer device have WLAN STA. | A, B, D |
| N007 | The V-HUB system shall enable the consumer device to operate WLAN STA to manually connect to the pre-defined SSID of WLAN AP of the vehicle unit.Note: IEEE802.11ai may apply for fast link setup. | A, B, D |
| N008 | The V-HUB system shall enable the information kiosk to have WLAN AP. | A, B, D |
| N009 | The V-HUB system shall enable the information kiosk to use a pre-defined SSID at WLAN AP. | A, B, D |
| N010 | The V-HUB system shall enable the vehicle unit that operates WLAN AP to operate WLAN STA to automatically connect to the pre-defined SSID of WLAN AP of the information kiosk.Note: IEEE802.11ai may apply for fast link setup. | A, B, D |

**6.1.3. Functional architecture specification**

Vehicle Unit

WLAN

AP

Consumer device

Pre

-

defined SSID

STA

Information

Kiosk

Vehicle Unit

WLAN

AP

-

>

deactivated

STA

STA

AP

Pre

-

defined SSID

**Fig. 2 Functional architecture of wireless LAN interface**

**6.2. Beacon (V2X)**

**6.2.1. Description**

The consumer device (pedestrian device) broadcasts a rescue message using wireless beacon(s). The vehicle unit (including drone) relays the message to the information kiosk. After receiving the message at the information kiosk, the message will be used to make rescue map in the information kiosk. The rescue map shows position and priority of people who needs support. Typical wireless media for the beacon are 1) ARIB STD T109 (V2X) and 2) IoT using sub-giga band (IoT), because communication distance and stability is better than higher band. Field trial to confirm communication distance is carried out in the Philippines and it is reported to ASTAP. The report shows that the vehicle unit can work to find victims and the information kiosk can gather the victim information.

This system has three types of beacons. First beacon is an alert delivery beacon that will be sent by authorized organization. This beacon defines mode of this system and area. If the alert delivery beacon shows disaster mode and certain area, consumer devices that are in the certain area shift to disaster mode automatically. Before shifting disaster mode, the consumer devices stay in normal mode, so the pedestrian units can use the beacon system for normal V2X communication and so on.

Second beacon is a rescue request beacon, and this rescue request beacon can be sent only after shifting disaster mode. We can assume that the beacon can be sent by four cases. First case is that the consumer device sends the beacon automatically. Second case is victim sends the beacon by him/herself. Third case is other person sends the beacon in order to call rescue team for rescuing victims. Fourth case is a rescue team uses this beacon to share the information within other rescue team. The rescue request beacon includes requirement information, personal information that is needed, vital information, and METHANE information. METHANE is defined in NATO. M means Major incident happens. E means Exact location. T means Types of incident, H means kind of Hazard, A means Accessibility to the location. N means Number of casualties. E means Emergency services to rescue the casualties.

Third beacon is a rescue response beacon from rescue team to victim. This rescue response beacon includes accepting time, estimated arrival time, and so on.

**6.2.2. Technical requirement**

|  |  |  |
| --- | --- | --- |
| ID | Technical requirement | Use case |
| N011 | The V-HUB system shall enable the rescue message to have three types of beacon; alert delivery beacon, rescue request beacon, and rescue response beacon. | B, D |
| N012 | The V-HUB system shall use V2X such as ARIB STD T109, IEEE 802.11p and 3GPP C-V2X and/or sub-giga band wireless IoT system (IoT) that carries the rescue messages. | B, D |
| N013 | The V-HUB system shall enable the consumer device to broadcast and to receive the rescue message. | B, D |
| N014 | The V-HUB system shall enable the vehicle unit to relay (receive and re-broadcast) the rescue message. | B, D |
| N015 | The V-HUB system shall enable the information kiosk to broadcast and to receive the rescue message. | B, D |

**6.2.3. Functional architecture specification**



**Fig. 3 Functional architecture of beacon interface**

**6.3. Satellite**

**6.3.1. Description**

Satellite Network Interface is used for providing robust communication line to other networks outside the V-HUB system.

In a typical regulatory environment, high power satellite communication requires a trained and licensed person to operate the terminal. However, in a case of disaster obtaining such personal at the right site will be extremely difficult. Therefore the V-HUB system must deploy a VSAT system, which is a system that uses low power satellite communication equipment that does not require trained and licensed personal to operate the terminal.

The VSAT system is constructed by terminals with satellite antenna, satellites and satellite gateways. The terminal will be deployed on to the vehicle unit and the information kiosk. The satellite gateway is an entity that will control the remote terminal and become the gateway to connect to the internet. In order to secure robust communication a backup the satellite gateway is needed.

**6.3.2. Technical requirement**

|  |  |  |
| --- | --- | --- |
| ID | Technical requirement | Use case |
| N016 | The V-HUB system shall have the V-SAT system that consists of the information kiosks/the vehicle units, satellites, satellite gateways and the internet. | A, B, C, D |
| N017 | The V-HUB system shall have the satellite in the sky. | A, B, C, D |
| N018 | The V-HUB system shall have the satellite gateway outside the disaster area that connects to the internet. | A, B, C, D |
| N019 | The V-HUB system shall enable the satellite gateway to have back up equipment including site diversity to avoid service down time. | A, B, C, D |
| N020 | The V-HUB system shall enable the information kiosk, the vehicle unit and the satellite gateway to have a terminal with satellite antenna in order to connect to the satellite. | A, B, C, D |
| N021 | The V-HUB system shall enable the terminal to use the pre-assigned IP address. | A, B, C, D |
| N022 | The V-HUB system shall enable the VSAT system to deliver the data between the information kiosk/the vehicle unit and the internet. | A, B, C, D |
| N023 | The V-HUB system shall enable the VSAT system to maintain designated capacity. | A, B, C, D |

**6.3.3. Functional architecture specification**



**Fig. 4 Functional architecture of satellite interface**

**6.4. White space**

**6.4.1. Description**

The VHUB system may use the government specified frequency such as VHF. The VHUB system dynamically finds/utilizes the available white space typically for long-range (10-17 km) communications for isolated disaster areas. The use case may follow technical requirement of VSAT and the specification can be developed in the future.

**6.4.2. Technical requirement**

To be developed.

**6.4.3. Functional architecture specification**

To be developed.

**6.5. Cellular**

**6.5.1. Description**

The VHUB system may use mobile BTS (base transceiver station) for isolated areas. The specification can be developed in the future.

**6.5.2. Technical requirement**

To be developed.

**6.5.3. Functional architecture specification**

To be developed. It will include the utilization of DTH (Direct to Home) satellite band.

**7. Application interfaces**

**7.1. Messaging**

**7.1.1. Description**

The messaging application is a general service platform. It may be used by citizens, responders and volunteers. Note that the application is neither intended to be time sensitive nor mission critical. The messaging interface is for asynchronous transfer of data such as binary, text, voice, image and video. This interface is widely used for application such as SMS, SOS signaling, white board, public announcement, phone (E-call), conferencing and search/rescue. The V-HUB system delivers messages among users. There are following four options in which users put their messages into the vehicle unit:

Web service
The web service is the simplest fashion that does not require users to install any application - just available at the pre-installed web browser. In order to host the service, the vehicle unit must have a web server and a database. In addition, the vehicle unit must show the default web page whichever URLs users indicate.

Dedicated applications
The dedicated application is mainly for professional use. Though it requires an additional installation, it may offer optimized user interface for professional users and also for challenged users. Since the dedicated application does not limit protocol options, the vehicle unit may also use the web server for it.

Commercial applications
The commercial application should be user friendly. Users may use any social media applications. For that service, the vehicle unit must emulate these commercial services and this requires individual collaborations.

Email service
The last option of email service seems easy and friendly to users, but the fact is the opposite. It requires users to modify email client settings and that information is obtained from the web service.

The last two options are not suitable as standard specifications.

The vehicle units share messages among each other. Since there remains limited time to inter-vehicle communication, it is important to share messages efficiently using dedicated messaging daemon. The information kiosk shall have the same requirements and therefore have the same functions with the vehicle unit because the vehicle unit also acts as the information kiosk at the evacuation site in some situation.

In order to protect messages from fraud acts, the vehicle unit uses encryption or digital signature in the messages. Note that important is not concealment of information but proof of identity of message originators. Messaging interface is mainly supported by WLAN interface.

**7.1.2. Technical requirement**

|  |  |  |
| --- | --- | --- |
| ID | Technical Requirement | Use case |
| A001 | The V-HUB system shall enable the vehicle unit to have both web server and database. | A,B,D |
| A002 | The V-HUB system shall enable the consumer device to have web client accessible by users. | A,B,D |
| A003 | The V-HUB system shall enable the vehicle unit to have DNS server to let the web server respond to any host name request from the web client of the consumer device. | A,B,D |
| A004 | The V-HUB system shall enable the web server of the vehicle to have web page to receive message and message query from the web client and show message to the web client. | A,B,D |
| A005 | The V-HUB system shall enable the web page to use encryption or digital signature in the message based on information from the web client. | B |
| A006 | The V-HUB system shall enable the web page of the vehicle unit to have CRUD (create, read, update and delete) function of the message at the database. | A,B,D |
| A007 | The V-HUB system shall enable the vehicle unit to have messaging daemons CRUD function of the message at the database. | A,B,D |
| A008 | The V-HUB system shall enable the messaging daemon of the vehicle unit to have CRUD function of the message at the database. | A,B,D |
| A009 | The V-HUB system shall enable the messaging daemon of the vehicle unit to communicate with the messaging daemon of the other vehicle unit connected at the network interface. | A,B,D |
| A010 | The V-HUB system shall enable the messaging daemon of the vehicle unit to send summary of messages to messaging daemons. | A,B,D |
| A012 | The V-HUB system shall enable the information kiosk has the same requirements as the vehicle unit. | A,B,D |

**7.1.3. Functional architecture specification**

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**Fig. 5 Functional architecture of messaging interface**

**7.2. Tracking**

**7.2.1. Description**

The V-HUB system tracks victims, responders and vehicle units to locate and coordinate the rescue team. The specification can be developed in the future.

**7.2.2. Technical requirement**

To be developed.

The VHUB system shall enable the vehicle unit to track responders, vehicle units, existing sensors (fitness trackers) for rescuers, health information/ body status (activity tracker, body sensor data). Smartphone acts as intermediary. The VHUB system shall involve GIS map format, GPS (responders should have GPS), and data analytics.

**7.2.3. Functional architecture specification**

To be developed.

**7.3. Streaming**

**7.3.1. Description**

The streaming interface is for distributing video contents to users as live streaming and also sending of recorded videos. Considering it is difficult for consumer devices to deploy satellite antennas, an IP streaming method is required.

A video playout system at the satellite gateway will uplink the video content to the information kiosks and the vehicle units with satellite interface. Information kiosks and vehicle units will receive the RF signals and encode it through an IP encoder that will multicast it to the vehicle units and the web client on consumer devices and vehicle units.

Note that it has not covered the use case of phone call and video chat yet. Here it assumes the use case of the command center streams down to victims and responders. If an interactive streaming capability gets available, the command center, responders and victims can talk among each other interactively according to appropriate designated policy. Even drones can do streaming. The requirement may involve ISDB-T and DTN. This can be developed in the future.

**7.3.2. Technical requirement**

|  |  |  |
| --- | --- | --- |
| ID | Technical requirement | Use case |
| A013 | The V-HUB system shall enable the satellite gateway to have a video playout system. | C |
| A014 | The V-HUB system shall enable the vehicle unit and the information kiosk to have a decoder, an IP encoder, a database and a web server. | C |
| A015 | The V-HUB system shall enable the video playout system to encode video signals into RF signals and transmit them to the decoder. | C |
| A016 | The V-HUB system shall enable the decoder to receive the RF signals, decode them into video signals hand them to the IP encoder. | C |
| A017 | The V-HUB system shall enable the IP encoder to receive the video signals, encode them to IP video stream and store them into the database. | C |
| A018 | The V-HUB system shall enable the consumer device and the vehicle unit to have a web Client to connect to the web server. | C |
| A019 | The V-HUB system shall enable the web server to retrieve the IP video stream from the database and send it to the connected web client on demand. | C |

**7.3.3. Functional architecture specification**



**Fig. 6 Functional architecture of streaming interface**

**7.4. Alerting**

**7.4.1. Description**

The alerting interface is for delivering critical information that requires robust and immediate delivery. Here the information assumes Earthquake Early Warning Alert.

The Earthquake Early Warning Alert is an alert to provide awareness to humans and machines in minutes or seconds prior to the earthquake wave hits the location.

A typical massive earthquake accompanies large aftershock for few days or more. Hence, it is necessary to deploy a robust communication line that can deliver the Earthquake Early Warning Alert even when the terrestrial line has been damaged after the first shock.

The alert will be distributed to alert software servers from an alert management server which is located in the satellite gateway.

The alert software server, which is a software deployed in certain vehicle units or information kiosks will be responsible to distribute the alert to other vehicle units or consumer devices.

Of course, the alerting application should cover not only earthquake but also other natural disasters and even man-made ones. The application should also use other network such as Beacon (V2X). This can be developed in the future.

**7.4.2. Technical requirement**

|  |  |  |
| --- | --- | --- |
| ID | Technical requirement | Use case |
| A019 | The V-HUB system shall enable the satellite gateway to have an alert management server. | B |
| A020 | The V-HUB system shall enable the vehicle unit and the information kiosk to have an alert software server. | B |
| A021 | The V-HUB system shall enable the consumer device and the vehicle device to have an alert software client. | B |
| A022 | The V-HUB system shall enable the alert management server to distribute Earthquake Early Warning Alert to the alert software servers. | B |
| A023 | The V-HUB system shall enable the alert software server to distribute Earthquake Early Warning Alert to the alert software client. | B |

**7.4.3. Functional architecture specification**



**Fig. 7 Functional architecture of alerting interface**

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[3GPP C-V2X] 3GPP TR 22.885, “Study on LTE Support for Vehicle to Everything (V2X) Services“

**APPENDIX (Informative)**

**APPENDIX-A. Example of VSAT terminal on vehicle unit**

VSAT Terminals for information kiosk can be a typical off the shelf product. However, it is advised that VSAT terminal for vehicle unit implements certain specification such as

・Small antenna space factor

・Quick satellite acquisition process including auto track satellite antenna

・Low Electric power consumption

**APPENDIX-B. Example of alerting application**

Figure below shows arrival time of destructive quakes in the case of Tohoku-Pacific Ocean Earthquake.



**APPENDIX-C. Proactive V-HUB system**

The V-HUB system can be more proactive for forecasting next action and moves, maybe using big data infrastructure. This can be developed in the future.

**APPENDIX-D. Example of the pre-defined SSID of WLAN AP for disaster in japan**

The pre-defined SSID of WLAN AP for disaster is assigned by government or disaster organization. The Japanese government assigned “00000JAPAN” to the pre-defined SSID of WLAN AP for disaster .

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