

Disaster Warning and Alerting Integrated Systems Based on CAP profile

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Abstract— If a disaster occurs or is predicted, the Korean government and local governments will deliver disaster information to the people based on the “Disaster and Safety Management Basic Law”[1]. Disaster information transmission media currently used in Korea are classified into mobile communication networks, broadcasting networks, civil defense alerts, and disaster warning and alerting systems. This paper deals with the implementation of an integrated system of disaster warning and alerting and managing disaster information in various types of disaster warning and alerting systems operated and managed by local governments. The proposed system utilizes the Common Alerting Protocol(CAP) established by the ITU-T standard[2] to integrate and issue and manage disaster information in the existing disaster forecast and warning system. In this paper, the CAP-based profile was implemented by modifying it to consider the environment of the Korean warning and alerting system. Based on the TTA standard, this CAP profile defined the method of using the parameter defined as an option according to the characteristics of each disaster. This paper includes interworking methods and test results to directly connect with the automatic voice notification system, the village broadcasting system, and the bus information system(BIS) among the existing disaster warning and alerting systems.

Keywords—disaster information, warning and alerting system, CAP, disaster information transmission

I. INTRODUCTION

During the experience of COVID-19, the public's perception of disaster information transmitted by the central government and local governments has changed significantly. In addition, news articles related to Korea's fast and transparent disaster information delivery are coming out of domestic and abroad.

In South Korea, the media that delivers disaster information to public at the national level is not only the Cell Broadcasting Service(CBS) using the mobile communication network, TV subtitles emergency broadcasting and DMB using the broadcasting network, and radio but also automatic voice notification systems, village broadcasting systems, disaster message digital signage, and bus information systems(BIS)

operated by local governments. Figure 1 shows the status of various disaster warning and alerting systems in South Korea[3]. When a disaster situation occurred, the current local government has carried out the process of transmitting the same disaster information to a number of warning and alerting systems in the local government through individual systems. This method also has a complicated and cumbersome disadvantage when considering the urgency of distributing disaster information.

The proposed integrated warning and alerting system provides the advantage of delivering disaster information rapidly to various disaster warning and alerting systems based on the ITU-T standard protocol, CAP, and integrating and managing the transfer results.

In this paper, we analyze the current status of domestic warning and alerting systems, and based on this, we present the structure of the next-generation warning and alerting integrated system and the management plan to integrate and operate the existing warning and alerting systems. Through the proposed warning and alerting integrated systems, it is expected that disaster management and disaster information delivery can be provided quickly and efficiently in the future, ultimately contributing to reducing human and economic damages and building the “SAFE KOREA”.

II. CAP PROFILE

The CAP is a digital format for exchanging emergency alerts that allows a consistent alert message to be disseminated simultaneously over many different communications systems. FEMA worked with the Organization for the Advancement of Structured Information Standards(OASIS) to develop a standardized international technical data profile that defines a specific way of using the standard for the purposes of the Integrated Public Alert and Warning System(IPAWS) [4], [5], [6]. The CAP proposed by OASIS became the ITU-T standard in March 2014.

The CAP profile proposed in this paper is composed of customized parameters so that disaster information can be simultaneously delivered to the existed disaster warning and alerting systems with different characteristics, and the classification of the entities that transmit disaster information

is clearly rearranged. In addition, the proposed CAP profile has a structure that supports multimedia and multi-language (currently limited to English, Japanese, Chinese, and Vietnamese). The type of multi-language provided is a flexible structure that can be added and deleted as needed.

Table 1 shows the example of CAP profile for Earthquake early warning from Korea metrological administration(KMA) and the last column shows Mandatory(M) and Optional(O).

Table 1. The example of CAP profile for Earthquake

Column_name	Value(including example)	Description	M/O
identifier	<identifier>KR.T10402-2019100440_EEW_1</identifier>	Country EventID_eventCode_number	M
sender	<sender>Disaster Warning and Alerting Integrated Systems@Korea Government</sender>	Notification issuing entity	M
sent	<sent>2019-04-05T15:54:09.00</sent>	Notification Send Time(RFC-3339 format)	M
status	<status>Actual</status>	The code of notification issuance status (Actual/Exercise/Test)	M
msgType	<msgType>Alert</msgType>	Notification classification code(Alert/Update/Cancel)	O
source	<source>KMA@Korea Government</source>	Provider of alert issuance	O
scope	<scope>Public</scope>	Propagation target	M
code	<code>C-MPFI-D</code> <code>C-LAS1-D</code> <code>C-BC1-D</code>	Message processing interface information	M
note		Additional elements to express the purpose of the message	O
language	<language>ko-KR</language>	If not used, it is regarded as ko-KR	O
category	<category>Geo</category>	Disaster type classification code(Geo/Met/Env/Fire)	M
event	<event>Earthquake</event>	Normally Disaster name	M
urgency	<urgency>Immediate</urgency>	Immediate/Unknown	M
severity	<severity>Unknown</severity>	Event damage scale	M
certainty	<certainty>Likely</certainty>	The probability of a disaster(Likely/Observed)	M
eventCode	<eventCode> <valueName>KR.eventCode</valueName> <value>EEW</value> </eventCode>	Disaster classification code(pre-define 3 characters code for example Earthquake Early Warning : EEW)	M
senderName	<senderName>Ministry of the Interior and Safety</senderName>	Event sending organization name	M
headline	<headline>Earthquake Early Warning</headline>	News headline(Notification name)	M
description	<description>2019-04-05 12:25:06 5.8 earthquake occurred in an area 5km northwest of Buk-gu, Pohang-si, Gyeongbuk</description>	Summary of article content	O
instruction	<instruction>Indoors, you must enter under a sturdy table, block gas and electric lights, open the door to secure an exit, and use stairs to evacuate outside, and outside, evacuate to a large space without falling objects or far away from buildings or walls</instruction>	Response method (including references and requests)	O
web	<web>http://www.report/report.do?identifier=KR.T10402-2019100440_EEW_1</web>	Earthquake information web site URL	O

Table 1 and 2 shows CAP profile based warning message content include EventTime, Magnitude, Location, Depth, AreaPredictedURI, etc. in consideration of earthquake characteristics as like magnitude, earthquake latitude and longitude, and depth. Other disasters were also configured according to the characteristics required for each disaster.

This paper describes earthquakes among CAP profiles for each disaster, and uses them to constitute the results of conducting a linkage test with an existing disaster warning and alerting system.

The biggest feature of the proposed CAP Profile is that it supports multiple languages and automatically provides different disaster broadcast texts at the same time in consideration of the characteristics of each media. In the CAP profile provided by the proposed disaster warning and alerting integrated system, disaster information can be prepared to fit the characteristics of each media(40 and 80 characters for Disaster Text Display Board and BIS, 180 and 315 characters for CBS, the longer characters for TV broadcasting service and portal, SNS, and Separate disaster description text for voice) so that it can be integrated and issued to cell broadcasting service by mobile communication, UHD broadcasting, and existing warning and alerting systems. Furthermore, for rapid disaster information transmission, the proposed system provides the basic disaster editorial. We developed the basic requirements and contents for the CAP protocol and profile in compliance with the TTA standard TTA.KO-06.0498.[7]

Table 2. The example of CAP profile parameters for Earthquake

Column_name	Value(including example)	Description	M/O
language	<language>ko-KR</language>	If not used, it is regarded as ko-KR	O
category	<category>Geo</category>	Disaster type classification code(Geo/Met/Env/Fire)	M
event	<event>Earthquake</event>	Normally Disaster name	M
urgency	<urgency>Immediate</urgency>	Immediate/Unknown	M
severity	<severity>Unknown</severity>	Event damage scale	M
certainty	<certainty>Likely</certainty>	The probability of a disaster(Likely/Observed)	M
eventCode	<eventCode> <valueName>KR.eventCode</valueName> <value>EEW</value> </eventCode>	Disaster classification code(pre-define 3 characters code for example Earthquake Early Warning : EEW)	M
senderName	<senderName>Ministry of the Interior and Safety</senderName>	Event sending organization name	M
headline	<headline>Earthquake Early Warning</headline>	News headline(Notification name)	M
description	<description>2019-04-05 12:25:06 5.8 earthquake occurred in an area 5km northwest of Buk-gu, Pohang-si, Gyeongbuk</description>	Summary of article content	O
instruction	<instruction>Indoors, you must enter under a sturdy table, block gas and electric lights, open the door to secure an exit, and use stairs to evacuate outside, and outside, evacuate to a large space without falling objects or far away from buildings or walls</instruction>	Response method (including references and requests)	O
web	<web>http://www.report/report.do?identifier=KR.T10402-2019100440_EEW_1</web>	Earthquake information web site URL	O
parameter	EventID <parameter> <valueName>EventID</valueName> <value>T10402-2019100440</value> </parameter>	Event ID	M
parameter	Sequence <parameter> <valueName>Sequence</valueName> <value>1</value> </parameter>	Event sequence	M
parameter	ReportTime <parameter> <valueName>ReportTime</valueName> <value>201904051551</value> </parameter>	Report time(YYYYMMDDHHMM)	M
parameter	EventTime <parameter> <valueName>EventTime</valueName> <value>20190405122506</value> </parameter>	Event time(YYYYMMDDHHMMSS)	M
parameter	Magnitude <parameter> <valueName>Magnitude</valueName> <value>5.8</value> </parameter>	Magnitude(M)	M
parameter	Latitude <parameter> <valueName>Latitude</valueName> <value>36.08</value> </parameter>	Latitude(Percentile)	M
parameter	Longitude <parameter> <valueName>Longitude</valueName> <value>129.33</value> </parameter>	Longitude(Percentile)	M
parameter	Location <parameter> <valueName>Location</valueName> <value>강북 포항시 북구 북쪽 5km 지역</value> </parameter>	Event location	M
parameter	Depth <parameter> <valueName>Depth</valueName> <value>12</value> </parameter>	Event depth(km)	O
parameter	Seafall <parameter> <valueName>Seafall</valueName> <value>0</value> </parameter>	1 sea, 0 land	O
parameter	NKflag <parameter> <valueName>NKflag</valueName> <value>0</value> </parameter>	North Korea(Y/N)	O
parameter	AreaPredictedDesc <parameter> <valueName>AreaPredictedDesc</valueName> <value>강북 포항시 북구 북쪽 5km 지역</value> </parameter>	Observation information by region Region name, maximum progress	O
parameter	AreaPredictedURI <parameter> <valueName>AreaPredictedURI</valueName> <value>http://www.kma.go.kr/2019/04/05/122506/5.8-earthquake-occurred-in-an-area-5km-northwest-of-buk-gu-pohang-si-gyeongbuk</value> </parameter>	URL of observation information by region Administrative area code, maximum acceleration, maximum progress By city and province, by city or district	O
parameter	AreaShelterURI <parameter> <valueName>AreaShelterURI</valueName> <value>http://www.kma.go.kr/2019/04/05/122506/5.8-earthquake-occurred-in-an-area-5km-northwest-of-buk-gu-pohang-si-gyeongbuk</value> </parameter>	URL of shelter information by region Administrative area code, name of evacuation site, number of people available for evacuation, contact information, address	O
parameter	Text40-ko-KR <parameter> <valueName>Text40-ko-KR</valueName> <value>강북 포항시 북구 북쪽 5km 지역 발생</value> </parameter>	Disaster Broadcasting Text (Disaster Text Display for Korean)	O
parameter	Text80-ko-KR <parameter> <valueName>Text80-ko-KR</valueName> <value>[강북] 강북 포항시 북구 북쪽 5km 지역 발생</value> </parameter>	Disaster Broadcasting Text (DS Cell Broadcasting Service for Korean)	O
parameter	Text180-ko-KR <parameter> <valueName>Text180-ko-KR</valueName> <value>[강북] 14시 25분 강북 포항시 북구 북쪽 6km 지역에서 규모 5.8 지진 발생</value> </parameter>	Disaster Broadcasting Text (HS Cell Broadcasting Service and Bus Information System for Korean)	O
parameter	Text315-ko-KR <parameter> <valueName>Text315-ko-KR</valueName> <value>[강북] 14시 25분 강북 포항시 북구 북쪽 6km 지역에서 규모 5.8 지진 발생</value> </parameter>	Disaster Broadcasting Text (DS Cell Broadcasting Service, portal and SNS for Korean)	O
parameter	BroadcastText-ko-KR <parameter> <valueName>BroadcastText-ko-KR</valueName> <value>[강북] 14시 25분 강북 포항시 북구 북쪽 6km 지역에서 규모 5.8 지진 발생</value> </parameter>	Disaster broadcasting online system and UHD for Korean	O
parameter	BroadcastText-US <parameter> <valueName>BroadcastText-US</valueName> <value>[Earthquake information] 2019-04-05 12:25:06(MST), 5.8, 5km NW of Pohang-si/Buk-gu, Gyeongbuk</value> </parameter>	Disaster Broadcasting Text (Disaster broadcasting online system and UHD for English)	O
parameter	BroadcastText-jp <parameter> <valueName>BroadcastText-jp</valueName> <value>[地震情報] 2019-04-05 12:25:06(KST), 震度 3.6, 韓国 江津市 浦上 地区 NW 5km (区域)</value> </parameter>	Disaster Broadcasting Text (Disaster broadcasting online system and UHD for Japanese)	O
parameter	BroadcastText-zh-chi <parameter> <valueName>BroadcastText-zh-chi</valueName> <value>[地震情報] 2019-04-05 12:25:06(KST), 震度 3.6, 韓國 江津市 浦上 地区 NW 5km (區域)</value> </parameter>	Disaster Broadcasting Text (Disaster broadcasting online system and UHD for Chinese)	O
parameter	BroadcastText-vn <parameter> <valueName>BroadcastText-vn</valueName> <value>[地震情報] 2019-04-05 12:25:06(KST), 震度 3.6, 韓國 江津市 浦上 地区 NW 5km (區域)</value> </parameter>	Disaster Broadcasting Text (Disaster broadcasting online system and UHD for Vietnamese)	O
parameter	VoiceText-ko-KR <parameter> <valueName>VoiceText-ko-KR</valueName> <value>[강북] 14시 25분 강북 포항시 북구 북쪽 5km 지역 규모 5.8 지진 정보를 알립니다. 여진 등 안전에 주의하십시오.</value> </parameter>	Voice announcement text (Village broadcasting system, automatic voice notification system and radio for Korean)	O
parameter	VoiceText-en-US <parameter> <valueName>VoiceText-en-US</valueName> <value>[강북] 14시 25분 강북 포항시 북구 북쪽 5km 지역 규모 5.8 지진 정보를 알립니다. 여진 등 안전에 주의하십시오.</value> </parameter>	Voice announcement text (Village broadcasting system, automatic voice notification system and radio for English)	O
parameter	DeviceType <parameter> <valueName>DeviceType</valueName> <value>ALL</value> </parameter>	Identify the types of receivers that need to receive alerts. ALL : All BIS : Disaster Text Display Board CBS : Disaster Text Display Board VNS : Village Broadcasting System	O
parameter	Broadcastflag <parameter> <valueName>Broadcastflag</valueName> <value>1</value> </parameter>	Broadcasting classification (0: subtitle, 1: subtitle duty, 2: data service, 3: data service duty, 9: full duty)	O
parameter	Priority <parameter> <valueName>Priority</valueName> <value>4</value> </parameter>	Priority(4: serious, 3: alert, 2: caution, 1: interest, 0: Test or management signal message)	O
resourceDesc	<resourceDesc>Map image</resourceDesc>	Description	O
mimeType	<mimeType>image/png</mimeType>	Type	O
uri	<uri>http://www.kma.go.kr/2019/04/05/122506/5.8-earthquake-occurred-in-an-area-5km-northwest-of-buk-gu-pohang-si-gyeongbuk</uri>	URL	O
areaDesc	<areaDesc>5km northwest of Buk-gu, Pohang-si, Gyeongbuk</areaDesc>	Areas affected by warning message/special report areas	M
circle	<circle>36.08,129.33,50.0</circle>	Expressing the zone of influence of the warning message in radius (km)	O
geocode	<geocode>K000000000.000000000.000000000.000000000</geocode>	Area code (administrative area code of the CBS issuance area)	O

III. THE PROPOSED DISASTER WARNING AND ALERTING INTEGRATED SYSTEMS

This chapter describes the role and function of the proposed warning and alerting integrated system. The left side of Figure 1 shows the organizations that issue the warning and alerting system in the event of a disaster, and the right side shows the connection to the media through which the emergency information is delivered. The proposed system can send the disaster information through not only tradition media TV(DMB, UDMS), 2G, 3G, and 5G mobile network CBS, and existed local disaster warning and alerting system(Automatic voice notification system, village broadcasting system, Bus Information System) but also, current interest media for example Internet portal, SNS, etc.

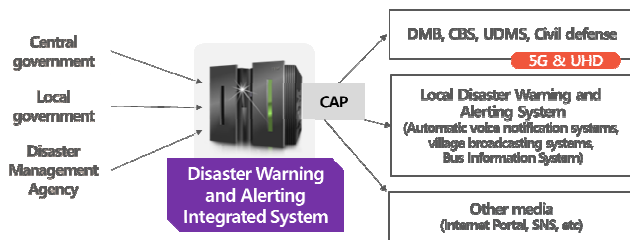


Figure 1. Linkage between the proposed warning and alerting integrated system and the existing warning and alerting systems

The proposed system is divided into the 3 main functions of extracting disaster information, automatically generating disaster content(including multimedia contents), and transmitting multi-media disaster information when disaster information comes in as shown in Figure 2. The proposed disaster warning and alerting integrated system is using to send disaster information by standard CAP profile format. The proposed system is an integrated system in which disaster information that fits the characteristics of each media is processed at the same time when the relevant government department selects all required media at once and transmits the disaster information.

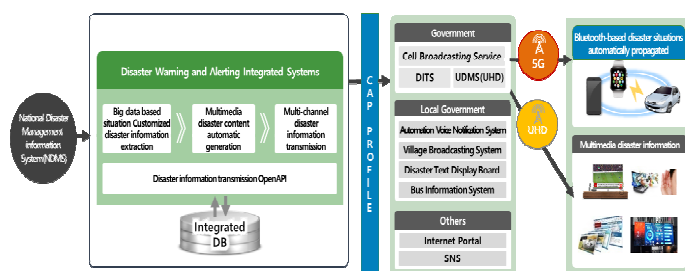


Figure 2. The Structure of proposed system

IV. THE RESULTS OF INTERCONNECTION TEST

We explain the results of interconnection testing with the existing warning and alerting systems in operation. Figure 3 is the configuration for interconnection test of the function of

transmitting disaster information between the existing warning and alerting systems and the proposed system[8].

As shown in Figure 3, warning and alerting integrated system for executing integrated announcements is installed in Seoul, and is connected to the existing disaster warning and alerting systems in Cheongju-si, Chungbuk, South Korea by connecting to a web service. Among the various existing warning and alerting systems, three types (automatic voice notification system, village broadcasting system, and bus information system) were interconnected to directly issue disaster information. As shown in Figure 4, the warning and alerting integrated system can select and issue media and regions to deliver disaster information through a web-based GUI, and issue and deliver disaster information based on a standard CAP profile. The proposed system has the advantage of being able to be used simultaneously by the government and local governments, and has the feature of sharing the results of disaster information delivery in real time.

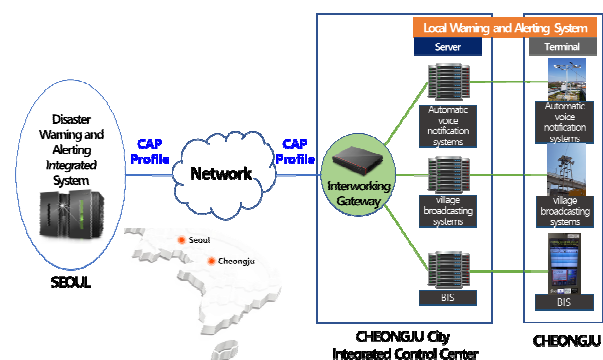


Figure 3. The configuration of interconnection test for disaster information integrated announcements

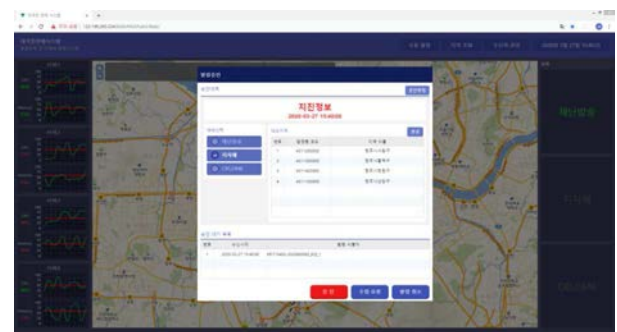


Figure 4. The GUI of proposed warning and alerting integrated system for sending earthquake disaster information

Disaster information issued by the warning and alerting integrated system is generated and transmitted as a CAP profile, converted according to the characteristics of each media through the interworking gateway. As shown in Figure 5, disaster information is displayed on the top of the screen at red box in the bus information system(BIS). Also, Figure 6 show that disaster information is broadcast through the speaker in the automatic voice communication system and the village broadcasting system in test area Cheongju-si.



Figure 5. The BIS at Cheongju-si displays earthquake information in Korean



Figure 6. The Automatic voice notification system(left) and village broadcasting system(right) at Cheongju-si plays voice earthquake information

Figure 7 is a log screen showing the contents received from the proposed warning and alerting integrated system by the interworking gateway and the results transmitted to the existing warning and alerting systems successfully.

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[전] 정보 수신 : message identifier - KR.T20505-20200900024_FDW_1
[전] 정보 수신 : KR.T20505-20200900024_FDW_1, 송신대상목록, Actual, Alert, Public, ko-KR, Env, 국제안전
[전] 정보 수신 : message identifier - KR.T20505-20200900024_FDW_1
[전] 정보 수신 : message identifier - KR.T20505-20200900024_FDW_1, 결과 : 200 - OK
[전] 정보 수신 : message identifier - KR.T20505-20200900027_FDW_1
[전] 정보 수신 : KR.T20505-20200900027_FDW_1, 송신대상목록, Actual, Alert, Public, ko-KR, Env, 국제안전
[전] 정보 수신 : message identifier - KR.T20505-20200900027_FDW_1
[전] 정보 수신 : message identifier - KR.T20505-20200900027_FDW_1, 결과 : 200 - OK
[전] 정보 수신 : message identifier - KR.T10402-2019000380_EQ1_1
[전] 정보 수신 : KR.T10402-2019000380_EQ1_1, 송신대상목록, Actual, Alert, Public, ko-KR, Geo, 지진
[전] 정보 수신 : message identifier - KR.T10402-2019000380_EQ1_1
[전] 정보 수신 : message identifier - KR.T10402-2019000380_EQ1_1, 결과 : 200 - OK
  
```

Figure 7. The log information between interconnection GW and existing warning & alerting systems at cheongju-si

By using the CAP profile for the earthquake described in Chapter II, it can be confirmed that the earthquake disaster information was successfully transmitted from the warning and alerting integrated system in Seoul, to 3 existing warning and alerting systems in Cheongju-si. Through this system, we confirmed the establishment of a system that can handle disaster information that was previously delivered individually for each existing warning and alerting system. Disaster information can be delivered quickly and efficiently using the proposed system.

V. CONCLUSIONS AND FUTURE WORKS

In this paper, we propose warning and alerting integrated system and the Korean-CAP profile for it, which can be linked

to the existing local warning and alerting systems in South Korea environment, and to deliver disaster information to various media including 5G mobile network, UHD TV broadcast, Internet portal simultaneously by the government and local governments.

We present the results of the interconnection test by linking the proposed warning and alerting integrated system with the automatic voice notification system, village broadcasting system, and bus information system currently operating in Cheongju-si, Chungbuk, South Korea.

In the future, it is preparing for interworking with other local governments, and it is planning to conduct expansion development and testing to link with Internet portals and SNS, which are private media. In addition, we will continue to conduct research on how to effectively include multimedia so that more useful content can be included in the disaster information to be delivered and the CAP profile for this. Through the proposed system, it is expected that faster and more useful disaster information can be delivered to the public, thereby reducing damage.

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