TPEG FOR TIMELY DISTRIBUTION OF EMERGENCY ALERTS AND WARNINGS

Teun Hendriks[1], Matthias Unbehaun[2]

Traveller Information Services Association (TISA), www.tisa.org

[1]t.hendriks@tisa.org, [2]m.unbehaun@tisa.org

Abstract

Emergency Alerts and Warnings are one of the primary duties of any public or private broadcaster or service provider alike: to warn the public of impending danger. Emergency alerts may be issued for typhoon warnings, severe thunderstorms, flooding, but also security hazards or hostile acts.

Distribution of Emergency Alert Warnings should use international standardized and widely adopted protocols to ensure compatibility with all types of devices and even reach visitors from foreign countries. This paper discusses the TPEG application 'Emergency Alerts and Warnings' (TPEG2-EAW), which is currently under development within TISA. Coming from the traffic & travel information realm, TPEG is a truly interoperable and worldwide adopted protocol, which offers significant benefits in the context of emergency alert warnings. TPEG2-EAW intends to provide a simple, but general message format for sending all kinds of hazard or emergency alerts or public warnings to different types of devices. The objective of TPEG2-EAW is the consistent dissemination of warning messages, countrywide, or by means of the embedded location referencing methods restricted to a hotspot or a geographical region.

TISA development of TPEG2-EAW targets an efficient, yet universally applicable warning application to provide a simple, extensible format for digital representation of warning messages and notifications.

Keywords: TPEG, Emergency Alerts and Warnings, Traffic and Travel Information, Location-based services.

1. EMERGENCY SITUATIONS AFFECT THE GENERAL PUBLIC AND TRAVELERS ALIKE

Friday July, 8 2016*. Super Typhoon 'Nepartak' made landfall in Taiwan early Friday, hammering the eastern coast of Taiwan with torrential rain and winds up to 149 mph. Nepartak hit Taiwan square-on. About 390,000 households were affected by power cuts, most of them in Pingtung and Taitung counties. The island's railway services were suspended, and more than 600 domestic and international flights were cancelled; another 178 flights were delayed.* (Source: redding.com, 2016)

Figure 1: Collapsed fly-over in Minqing county

(Source: South China Morning Post 2016)

Saturday July 9, 2016*. Typhoon Nepartak continued on into Southern China. Near half million people in China's Fujian province were evacuated after Typhoon Nepartak had inflicted huge damage on Saturday, making landfall and flooding. A red rainstorm alert was issued in nearby city of Putian after more than 250 mm of rain fell in about four hours early on Saturday. Many buildings collapsed and landslides were reported in rural and mountainous areas.* (South China Morning Post 2016)

Five airports in Fujian closed, resulting in the cancellation of nearly 400 flights. A total of 341 high-speed trains were cancelled, and almost 5,000 buses. Traffic was also heavily affected. Part of a flyover connecting a highway in capital city Fuzhou's Minqing county collapsed due to the typhoon (see Figure 1); at least one truck to fell into Xikou River.

As this recent typhoon occurrence clearly demonstrates, extreme weather situations affect the public and travellers alike. Evacuation orders issued by governments may force the public to become travellers, under most difficult travel conditions.

When in October 2012, hurricane Sandy – the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season – hit New York City (see Figure 2), travel conditions were very difficult. The three major NY airports were closed, as were most major automobile tunnels and bridges. All subway service and ferry service was disrupted for days.

Figure 2: Path of hurricane Sandy and ensuing flooding in NYC.

(Source: ABC)

At the height of the storm passing through the New York metro region, more than 400 safety related incident reports were live in the *Total Traffic* + *Weather Network* traffic information service (iHeartMedia, 2012). These could be broken down as follows:

- 167 road closure messages (due to flooding)
- 76 lane closure messages
- 22 traffic regulations changes
- 120 accidents
- 25 objects on the roads
- 16 fallen trees on roads
- 17 extreme weather condition messages
- 16 impassabilities and flooding messages
- 4 hazardous driving conditions
- 4 malfunctioning road-side equipment messages

In such emergency situations, accurate traffic & travel information that is consistent with general emergency-related news reports on TV and radio or the announcements of police and rescue forces becomes extremely important. This relation between public emergency notifications and safety-related traffic and travel information is of course applicable for a wide variety of emergency situations, targeting also earthquakes, volcano eruptions security threats or attacks, environmental pollution, rescue and recovery, fire hazards and many others.

The aim of TISA with the development of the TPEG application ‘Emergency Alerts and Warnings’ (TPEG2-EAW) is to ensure a consistent dissemination of warning messages – countrywide, or restricted to a hotspot or a geographical region by means of the embedded location referencing methods.

2. THE NEED FOR INTERNATIONAL STANDARDS FOR EMERGENCY ALERTS AND WARNINGS

To reach the largest possible audience, encoding of emergency warnings should be standardized, ideally on a global scale. Only then, it is assured that all types of receivers – even foreign devices carried by tourists or business travellers – can decode the potentially life-saving information. Scalability is another important requirement, such that simple receives with limited capabilities (e.g. only a text display) can extract and show at least the core information (e.g. *‘Tsunami approaching XYZ city at 08:00am pacific time from east’*), while high-end receivers with graphic display and built-in GPS can provide comprehensive situation-and-forecast maps with detailed instructions how to reach shelter or circumnavigate the danger zone.

On the content side, the Common Alerting Protocol (CAP) is emerging as a global standard. CAP is an XML-based data format for exchanging public warnings and emergencies between alerting technologies (OASIS, 2012). CAP has defined a standard for what information is included in a warning message, regardless of the type of emergency or its location. The information provided is readable by humans and can be decoded/interpreted by machines. It allows consistent dissemination of information across various communication channels. CAP is an International Telecommunication Union (ITU) recommendation (X.1303) and it is endorsed by the World Meteorological Organisation (WMO). CAP is adopted in countries and regions such as USA, Australia, Canada, EU, Japan, Sri Lanka and Taiwan. The WMO maintains a register of official alerting authorities and their CAP feed, if present (WMO, 2016).

For consistent dissemination of emergency warning and alerts to end-users, the authors propose TPEG as base technology and its extension Emergency Alert & Warning (EAW), because TPEG technology is deployed on a global scale, it is scalable and location-aware. Being an ISO standard, TPEG is accessible and can be integrated by any organization into their services or products with a maximum degree of interoperability between implementations. Embedded in millions of devices, it is a mature technology. Many service providers around the globe know how to properly implement and operate TPEG services (see Figure 3). Originating from the traffic and traveller information realm, where cars and passengers roam between different countries and services provides, interoperability is an intrinsic and proven feature of TPEG.

Figure 3: TPEG services worldwide

(Source: http://tisa.org/technologies/tpegtm-services-map/)

Following are descriptions of some of the core functionalities of TPEG that, from the authors' viewpoint, make it very well suited for emergency warnings.

2.1 Bearer Independence

TPEG comes in a bandwidth-efficient binary format as well as in XML encoding that is easy to parse and interpret with standard technology. Both formats can easily be transcoded. TPEG can therefore be distributed via narrowband systems, such as GPRS, DRM or HD-Radio, or via wideband systems, such as 3G/UMTS, 4G, WiFi or DAB/DMB. Being a unidirectional data protocol, TPEG can be distributed via many different broadcast systems. Currently, adaptations for DAB and HD-Radio exist, whereas a DRM adaptation is currently being prepared by TISA. For distribution via mobile internet, a general-purpose IP adaptation is available, which also features bi-directional communication. The HTTP uplink channel may be used, but is not required.

In case of a major emergency, service providers can therefore engage an *'all channels available'* regime, where TPEG-EAW is distributed through every accessible channel, maximizing reach and impact of the emergency alert.

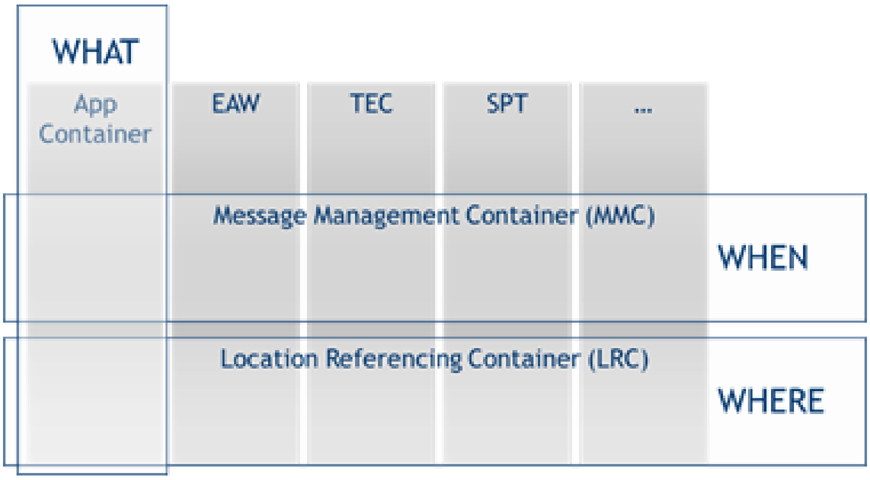
2.2 Built-in Location Referencing

Emergencies do not necessarily always have a nationwide impact, but can instead be limited to a geographic region or a certain location (hotspot). For such cases, several built-in location-referencing schemes can be employed, which support polygon shapes or accurate point references, including a navigation map matching e.g. for pinpointing a chemical spill from a truck that has been involved in a road accident.

2.3 Language Independence

The encoding of information in TPEG, both binary and XML, is language independent. Translations of event codes exist for many languages and new translations are continuously being added. The device applies the translation tables according to the language preferences set by the user. It is possible to carry Unicode text via TPEG as well, but this feature should only be used for distribution of supplementary information.

Figure 4: TPEG modular design principle



(Source: TISA)

2.4 Extensibility

Due to its modular design (see Figure 4) and the top-down construction of TPEG, where the binary and XML encoding is derived from an UML model (Booch 2005), extensions can be easily added to existing TPEG applications. Older receivers would simply skip the unknown XML tags or byte fields, moving on to the next piece of information. Thus, the device may miss one or the other advanced feature, but still be able decode the core information and properly inform its user.

2.5 Service Linking

TPEG provides a range of applications, addressing different modes of traveling. With proper configuration by the service providers, emergency warnings and the resulting advice can be tailored to the different transportation modes. The general public can be alerted via EAW, whereas car drivers can receive more specific information via Traffic Event Compact (TEC) or the Weather application (WEA), causing their navigation system to re-route the journey away from a hazardous area. Likewise, passengers in public transport systems can be advised via the Shared Passenger Transport (SPT) application, e.g. to not exit the train at a certain stop in case of overcrowding of the station or the platforms due to a close-by emergency.

Due to the language independence of TPEG, such information would also be comprehensible to tourists, who may not be able to understand spoken announcements on trains or station platforms.

3. TISA PROCESS TO DEVELOP TPEG STANDARDS

The Traveller Information Services Association (TISA) maintains the TPEG specifications and collaborates closely with ISO TC204 during the subsequent standardization and publication process. Besides, TISA distributes supplementary technical documents and position papers via its website. With its global membership of 100+ organizations, covering different industry sectors and including a number of public authorities, it is inherently ensured that i) concerns from different countries and regional specificities are considered, and that ii) the requirements of the entire value chain, ranging from content production over service providers to device manufacturers and end user representatives, are involved when a TPEG specification is created.

TISA has well-defined processes in place: Ideas for new standards have to be submitted as Use Case Proposals (UCP) and are scrutinized by a Business Analysis Working Group (BAWG) regarding their business prospects and their benefits for the society at large. Only after approval by the BAWG and a 4-week review window involving the entire TISA membership, technical development work will commence, which is carried out by the TPEG Application Working Group (TAWG) and its various task forces.

The overall TPEG framework is mature. Development processes are stable (cf. following Section 4) to such a degree that oftentimes, implementation of products and rollout of services start before the ISO standardization process is finished. Industry heavyweights such as Garmin, TomTom, Audi, BMW, Hyundai, Mercedes

Benz, Bosch, Continental, LG Electronics or Mitsubishi incorporate TPEG technology into their products and services.

4. DEVELOPING TPEG2-EAW

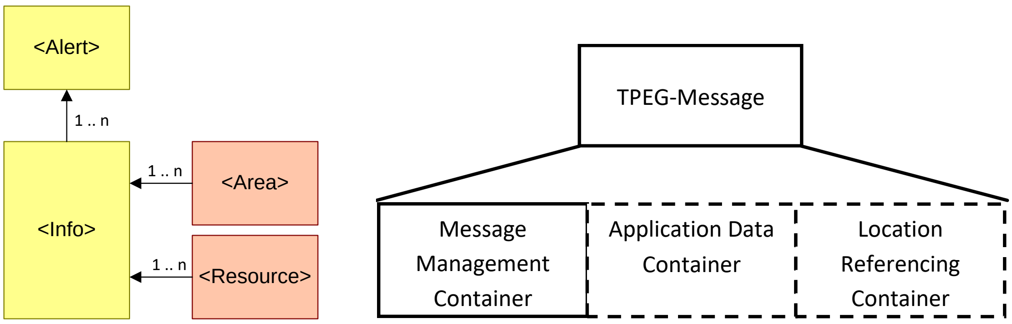
Technical development of new TPEG applications within in TISA is undertaken by its TPEG Applications Working Group (TAWG). Typically, a dedicated task force is set-up to work on a new specification development. This task force undertakes the technical work to transform the BAWG brief into a new TPEG application specification.

4.1 TPEG Framework, UML Modelling, and Modelling Challenges for TPEG2-EAW

The technical development starts with defining an UML model, respecting a set of TPEG UML modelling rules (ISO/TS 21219-2, 2014). This UML model is to capture the intent, structure, data elements, and composition of a TPEG application in a way that is independent from the actual deployment protocol (binary or XML).

The TPEG framework defines a standard message structure (see Figure 5, right), in which the message management container and location referencing container are generic constructs that are re-used in every TPEG application (cf. Section 2 and Figure 4).

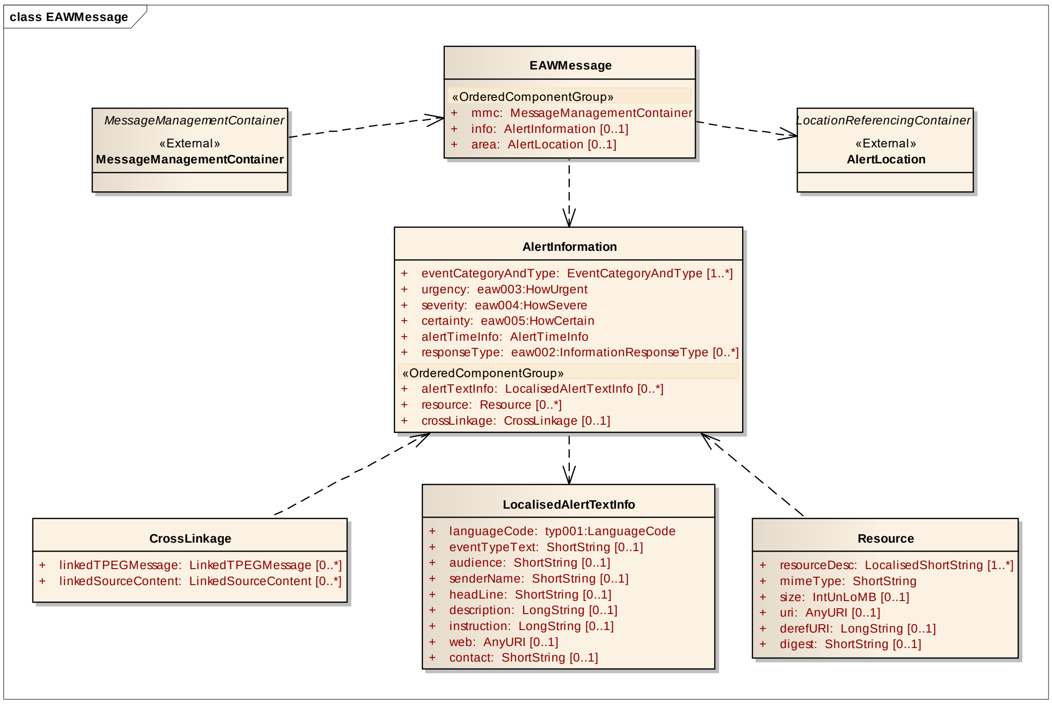
Figure 5: CAP message structure (left) versus TPEG message structure (right)



For the TPEG2-EAW development, this poses a challenge how to harmonize both protocol management and location management with the way these are defined in the Common Alerting Protocol (OASIS 2010). The Common Alerting Protocol (see Figure 5, left) “hides” the (Alert) message management information in the top-level <alert> container, and has delegated the <area> location reference information as a sub element of the <info> element. This <info> element can be roughly compared with the TPEG Application Data Container. Each CAP <alert> segment may contain one or more (language-specific) <info> segments, each of which may include one or more <area> and/or <resource> segments.

Thus, a simple one-to-one mapping of CAP to TPEG2-EAW protocol elements is not feasible. Tackling this issue, the current TPEG2-EAW draft UML model, representing the task force status of development of July 2016 is shown in Figure 6.

Figure 6: Draft TPEG2-EAW model (status July 2016)



In this Figure 6, clearly recognizable is the top-level TPEG message structure from Figure 5. Underneath this top level TPEG2-EAW message container, the AlertInformation is the principle data container for information about a specific event). The AlertInformation component itself holds language-independent information in one place, and may include one or more language-dependent, i.e. localized, text information blocks (LocalisedAlertTextInfo) for presentation in the end-user's language of choice.

The principle design choices underlying this model are the following:

- Fit with the TPEG framework and message structure.
- General location-aware messaging, i.e. a single message for a single area.

- Language-independence, i.e. benefit for use by the general public and travelers, even when none of the language specific text blocks can be understood.
- Bandwidth conscious design and structure, avoiding repetition of language-indepent information in language-dependent segments.

For the design of TPEG2-EAW, CAP's <info> segments are taken as starting point for the application data container. In TPEG, a single <info> segment shall be associated with a single (*Area*) location. If a CAP message would have multiple <area> segments, then in TPEG these would be converted into two (linked) TPEG messages.

Recognizing that the CAP top-level <alert> segment is in fact a composition of message management and cross-linking information, message management in TPEG2-EAW is delegated to the Message Management Container. The cross-linkage information is added to the (EAW application-specific) AlertInformation component.

Further, the general language-independent information in the TPEG2-EAW AlertInformation component is separated from the language-specific information (LocalisedAlertTextInfo). A principle objective of the TPEG2-EAW design is that the message should also be useful/comprehensible to some degree even without understanding the language-specific texts. Hence, the main AlertInformation component is designed to provide language-independent information in one place.

4.2 TPEG derivation of byte-binary and XML-formats for TPEG2-EAW

Given a complete and agreed TPEG2-EAW UML model, protocol formats can be automatically derived from this UML model based on the TPEG general framework (ISO/TS 21219-5) and conversion rules to a binary TPEG format and for on-air use (ISO/TS 21219-3) and equivalent conversion rules towards a XML-based TPEG format (ISO/TS 21219-4).

TISA has a *TPEGUMLconverter* tool in place that embodies all TPEG modelling and conversion rules and facilitates the automatic generation of both binary and XML TPEG specifications. This tool has been a major step for TISA towards increasing the speed and effectiveness of generating specifications. In addition, the tool has provided a large quality boost to the resulting specifications as the protocol formats are now automatically generated to form the skeleton of the final specification.

The *TPEGUMLconverter* tool supports the task force also in examining binary and XML formats as they proceed in the modelling and specification work. The following Figure 7 shows an example of the TPEG binary format for the Resource component in the UML model (cf. Figure 6). Note that the format and text is completely automatically generated from the UML model with no manual post-processing or editing.

Figure 7: Byte-binary format for the Resource component

<Resource(5)>:=	
<IntUnTi>(5),	: id of this component
<IntUnLoMB>(lengthComp),	: number of bytes in component, excluding the id and lengthComp indicator
<IntUnLoMB>(lengthAttr),	: number of bytes in attributes
<IntUnLoMB>(n),	
n *<LocalisedShortString>(resourceDesc),	: Langugage specific human-readable text describing the type and content, such as “map”; or “photo”, of the resource file.
<ShortString>(mimeType),	: MIME content type and sub-type as described in IETF RFC 2046.
BitArray(selector),	
if (bit 0 of selector is set)	
<IntUnLoMB>(size),	: Approximate size of the resource file in bytes.
if (bit 1 of selector is set)	
<AnyURI>(uri),	: A full absolute URI, typically a Uniform Resource Locator that can be used to retrieve the resource over the Internet OR a relative URI to name the content of a <derefURI>; attribute if one is present in this resource block.
if (bit 2 of selector is set)	
<LongString>(derefURI),	: The base-64 encoded data content of the resource file.

	Clients intended for use with one-way data links MUST support this element. This attribute MUST NOT be used unless the sender is certain that all direct clients are capable of processing it.
if (bit 3 of selector is set)	
<ShortString>(digest);	: Digest value calculated using the Secure Hash Algorithm (SHA-1), see FIPS 180-2.

Figure 8: XML schema for the AlertInformation information component

```
<xs:complexType name="AlertInformation">
 <xs:sequence>
 <xs:element name="eventCategoryAndType" type="EventCategoryAndType" maxOccurs="unbounded"/>
 <xs:element name="urgency" type="eaw003_HowUrgent"/>
 <xs:element name="severity" type="eaw004_HowSevere"/>
 <xs:element name="certainty" type="eaw005_HowCertain"/>
 <xs:element name="alertTimeInfo" type="AlertTimeInfo"/>
 <xs:element name="responseType" type="eaw002_InformationResponseType" minOccurs="0" maxOccurs="unbounded"/>
 <xs:element name="alertTextInfo" type="LocalisedAlertTextInfo" minOccurs="0" maxOccurs="unbounded"/>
 <xs:element name="resource" type="Resource" minOccurs="0" maxOccurs="unbounded"/>
 <xs:element name="crossLinkage" type="CrossLinkage" minOccurs="0"/>
 </xs:sequence>
</xs:complexType>
```

Figure 8 shows an example of the TPEG XML format for the AlertInformation component in the UML model of Figure 6. Again, this format and text is completely automatically generated from the UML model without any manual post-processing or editing.

Table 1 Enumerated type for Urgency eaw003:HowUrgent

Code	Reference-English 'word'	Comment	Example
0	unknown	Urgency not known	
1	immediate	Responsive action SHOULD be taken immediately	
2	expected	Responsive action SHOULD be taken soon (within next hour)	
3	future	Responsive action SHOULD be taken in the near future	
4	past	Responsive action is no longer required	
255	undefined	Undefined urgency	

Finally, Table 1 shows an example for the creation of TPEG specification tables – here for an Enumerated type. Such tables form the core of the TPEG approach to language independence. For the provisioning of a TPEG service, only the codes are transmitted (e.g. code '1' when the urgency is *immediate*). TPEG client devices then reference internal tables with translations for each supported language. Hence, the User Interface of a client device can present the information in the language of choice according to the user's preferences, even when the service does not provide texts in that language.

Language independence is of great importance to tourists or business travellers, who cannot be expected to be fluent in all languages of the countries they are traveling to. Hence, language independent protocol specification has always a cornerstone of TPEG technology and TISA.

4.3 Status of Development of TPEG2-EAW

TPEG2-EAW development is underway. The structure of the application has been shaped, but further discussions and work are ongoing. Extending the current language independence capabilities and tables is still a principle work item for the task force.

One of the major tasks is to create a language-independent taxonomy of all kinds of alerts, which is applicable on a global scale. This means that, apart from the main category codes in CAP (e.g. *Fire*, *Safety*, *Security*, *Rescue*, *Health* etc.), also a finer level of codes is needed. Much like the SAME codes in use in the USA (NOAA, 2016), codes for events such as *Tornadoes*, *Hurricanes*, and equivalently for Asia-Pacific *Typhoons* need to be defined. In this work, the hierarchical code definition principle of TPEG2-TEC (ISO/TS 21219-15) can be reused as blueprint. Following this approach, category-specific event codes can be defined.

The task force will report regularly to the TPEG Applications Working Group (TAWG) according to the following process: once the Task Force finished the draft specification, this will undergo a two-week review by the TAWG. Comments are discussed and the draft-specification is adjusted. In the next step, a four-week TISA wide review is launched, ensuring the greatest-possible transparency and feedback from the entire TISA membership. Again, comments are resolved on a consensus principle before the specification is approved and published by TISA.

With the TISA approved specification in hand, service providers and client device manufacturers can start developing their services and realizing their client implementations. In parallel, TISA will submit the specification into the ISO standardization process to become part of the growing set op TPEG ISO technical specifications in the ISO TS 21219 series.

5. TPEG2-EAW BENEFITS

TPEG is designed as a generic framework, where application containers carry specific content. This makes it easy for service providers to extend their TPEG service with a new application, such as TPEG2-EAW, and address a variety of client devices with different user interface styles, yet deriving content from the same protocol.

TPEG client manufacturers equally are in a position to re-use much of their core and common TPEG implementation for realizing the EAW specific client software and EAW user interface, be their device a map-based navigation system with weather map, or a simple location-aware digital radio without a map (see Figure 9). Moreover, the TPEG bearer-independence allows service providers to reach a wide variety of clients over different communication technologies. The language independence of TPEG allows multi-language audiences to be addressed effectively and efficiently, and the TPEG location referencing approach support both.

With the EAW application in place, TPEG technology will offer a coherent and cross-referenced dissemination of alert messages together traffic and travel reports related to the emergency. This will provide the most complete and consistent information to the public and travellers alike.

Figure 9: Two possible client user interfaces for TPEG-EAW: simple (left) and map-based (right)

6. OUTLOOK

TPEG is a modern, flexible, future proof technology. Coming from the traffic information & navigation business, where TPEG is now a proven technology with a global footprint, the scope is now widening towards general location based services, such as Emergency Alerts and Warnings (EAW), multimodal travel services with an increased interest from e.g. rail operators in TPEG technology, all the way to new modes of mobility, like car sharing or autonomous vehicles. TISA expressly invites all interested parties to join and together with us shape the future.

7. REFERENCES

Booch, G. (2005). *The unified modeling language user guide*. Pearson Education India.

iHeartMedia, (2012), *TPEG archive of the Total Traffic Network TPEG service contents for October 30th, 2012*.

ISO/TS 21219-2 (2014) *Intelligent transport systems -- Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) -- Part 2: UML modelling rules.*

ISO/TS 21219-3 (2015) *Intelligent transport systems - Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) -- Part 3: UML to binary conversion rules*

ISO/TS 21219-4 (2015*) Intelligent transport systems -- Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) -- Part 4: UML to XML conversion rules*

ISO/TS 21219-5 (2015*) Intelligent transport systems - Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) -- Part 5: Service framework (TPEG2-SFW)*

ISO/TS 21219-15 (2016*) Intelligent transport systems -- Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) -- Part 15: Traffic event compact (TPEG2-TEC)*

NOAA (2016), *NWR Specific Area Message Encoding (SAME),* at http://www.nws.noaa.gov/nwr/info/nwrsame.html [Accessed July 20, 2016]

OASIS, (2010), *Common Alerting Protocol Version 1.2*, at http://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.html, [Accessed July 20, 2016]

Redding.com (2016), *Powerful typhoon slams into Taiwan; killing 2, injuring 66*, at redding.com: Powerful-typhoon-slams-into-Taiwan-killing-2-injuring-66 [accessed July 20, 2016]

South China Morning Post (2016), *Typhoon Nepartak brings chaos to eastern China*, at SCMP: typhoon-nepartak-brings-chaos-eastern-china [Accessed July 20, 2016]

TISA – Traveller Information Services Association, www.tisa.org [accessed May 23, 2016]

Wikipedia (2016), *Effects of Hurricane Sandy in New Yo*rk ,at wikipedia: Effects_of_Hurricane_Sandy_in_New_York [Accessed July 20, 2016]

WMO (2016), *WMO registry of Alerting authorities by WMO Member or Organization*, at http://alerting.worldweather.org/ [Accessed July 20, 2016]