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Engineering

ENHANCED SECURITY AND ALERTING SYSTEM IN THE CONTEXT OF INTERNET OF THINGS AND CLOUD FACILITIES

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ABSTRACT:
THE PRIORITY OF LIFE AND PERSONAL ASSETS RESCUE, IN THE CONTEXT OF INTERNET OF THINGS AND CLOUD FACILITIES, OPENS NEW OPPORTUNITIES FOR EMERGENCY SYSTEMS DEVELOPMENT. THE ACTUAL ALERTING 112 EMERGENCY MECHANISM IS BASED ON CALLS MADE BY THE HOUSEHOLD OCCUPANTS TO 112. THE PAPER DEBATES THE OPPORTUNITY OF USING SENSORS TO AUTOMATICALLY DETECT FIRES, BURGLARIES AND LIFE IN DANGER SITUATIONS FOR HOUSEHOLD RESIDENTS AND TO BE SENT TO 112 AS DATA PACKAGE. LIKE ECALL SYSTEM, THE ALERTED SITUATION IS DETAILED INTO A MINIMUM SET OF DATA (MSD), CONTAINING THE TRIGGERED SENSORS, OWNER OF HOUSEHOLD, NUMBER OF RESIDENTS PRESENT IN THE BUILDING AND TIME STAMP. IT MUST BE NOTICED THAT ECALL SYSTEM IS DESIGNED FOR CAR ACCIDENTS AND IT IS OPERATIONAL STARTING WITH 2017 AND MANDATORY FOR NEW DESIGNED VEHICLES CLASS M1 AND N1 AFTER 30TH OF APRIL 2018. AFTER THE MSD IS RECEIVED BY 112, THE EMERGENCY SYSTEM WILL USE ALSO USE THE CALL BACK FUNCTION TO CHECK AND REQUEST MORE DETAILS ABOUT THE EMERGENCY EVENT. FURTHERMORE, THE MANUAL TRIGGERING BUTTON IS ALSO PROVIDED TO INITIATE MSD. THE HOUSEHOLD ALERTING SYSTEM COULD ALSO INTEGRATE, BESIDES FIRING, GAS LEAKING DETECTION AND BURGLARIES, NEW INTERNET OF THINGS DEVICES THAT MONITORIES THE HEATH OF RESIDENTS. THE FORESEEN EMERGENCY SITUATIONS, OTHERWISE IMPOSSIBLE TO BE ALERTED ARE: FIRING, GAS LEAKING AND BURGLARIES WHEN NO RESIDENT IS PRESENT AND SEVERE HEALTH ISSUES, LIKE HEART ATTACK WHEN THE RESIDENT IS UNABLE TO MAKE THE CALL TO 112.

KEY WORDS: HOUSEHOLD EMERGENCY, INTERNET OF THINGS, SENSORS, ECALL

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INTRODUCTION

The actual alerting system for emergency situations in Romania, according to 112 website[3], is by voice call, SMS (Short Message Service) and eCall for vehicles. The 112 should be alerted when life, property or environment need immediate assistance from Fire Brigade, Police or Ambulance.

From emergency type point of view, there several common situations that consist a 112 indicated calling:

- Criminality against persons (homicide, armed assault, attack, robbery) or property (fire, burglary),
- Traffic accidents (road, train, ship, aviation),
- Extreme weather accidents (landslide, fire caused by thunder, flooding),
- Personal accidents (severe medical problems, electrocution).

As information flow for voice call alerting method, the caller initiates a voice call to 112 and during the call the PSAP (Public Safety Answering Point) operator is questioning the caller, according to internal procedure, regarding the nature of emergency, caller identity, emergency location and severity. From communication point of view, the call is treated as emergency call, having priority against all other calls, using 112 discriminator flag, might using Public Switched Telephone Line (PSTN), mobile network or even Voice over IP (VoIP) call (figure 1). As disadvantages for this alerting method, it can be emphasized:

- High rate of false calls, most emergency agencies report over 50% rate of false calls[4],
- Inaccurate location of emergency, excluding calls made from PSTN where address is recorded into land phone line client database, but also confusions possible by misinterpreting the address. Furthermore, in case of mobile calls, the accuracy might vary from kilometers to tens of meters, depending on cells density. In case of Voice over IP call, the location is even more unlikely to be established,
- Impossibility of caller identification in some cases like pre-payed SIM or VoIP,
- Lack of emergency severity detection, the dispatched rescue forces are sized according to caller given information and PSAP operator interpretation.

[3] Special Telecommuncation Service, "112-Sistemul national unic pentru apeluri de urgenta.". Accessed: August 16, 2018

[4] EENA, "False Emergency Calls," 2011

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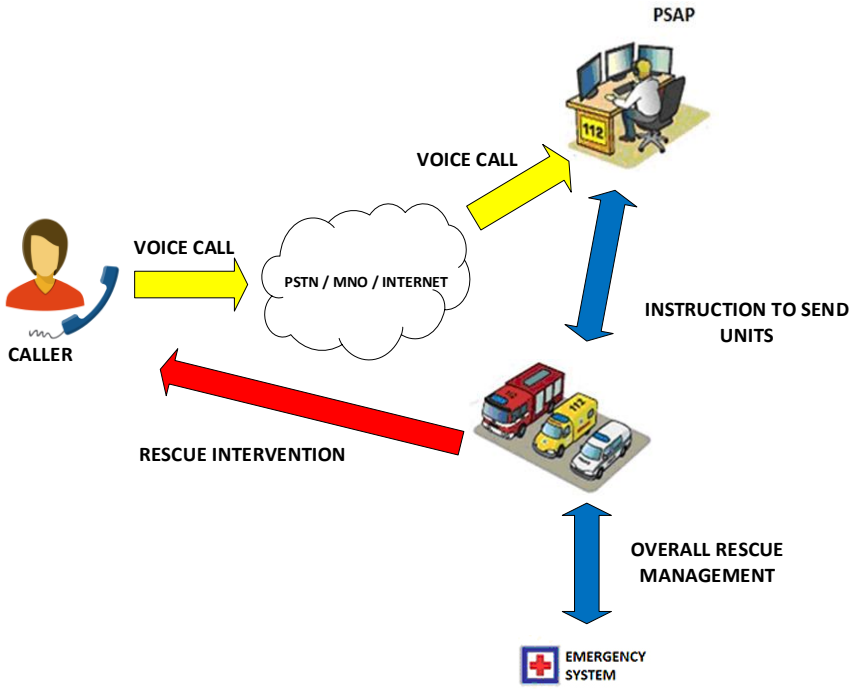

Figure 1. 112 system architecture

The second method of alerting emergency system is using 113 number to send a SMS, which mandatory should contain the nature of emergency and the address (location). The 113 SMS emergency service is operated according the Law 132/2015 for persons with hearing or speech disabilities. As a difference against previous voice call method to 112, the SMS service requires that potential user to be pre-registered to Single National Emergency Calls System (SNECS). The operational flow[3] implies that the person with disabilities initiate the call to 112 and receives a message with the text "SEND AN SMS TO 113 WITH THE EMERGENCY AND ADDRESS OF THE INCIDENT". The caller must reply to 113 with requested information, the two-way communication channel making possible further details requirement from PSAP operator.

What is important to be noticed regarding 113 SMS service is that the communication between caller and emergency agency is made using a two-way channel and the content of emergency is exclusively data. Also, the pre-registered form might be able to enhance the location accuracy.

The last alerting method presented is eCall. The eCall[5] represents a harmonized free emergency service at European level which makes possible the automatically notification of 112 in case of car accident. The implementation of eCall at PSAP level and most of operational tests

[5] "The interoperable EU-wide eCall - European Commission." Accessed: June, 26, 2017

were made under HeERO1[6] and HeERO2 projects course. The Romanian pilot site and tests are largely exhibited in[7]. In figure 2[8] is presented the operational flow of eCall service.

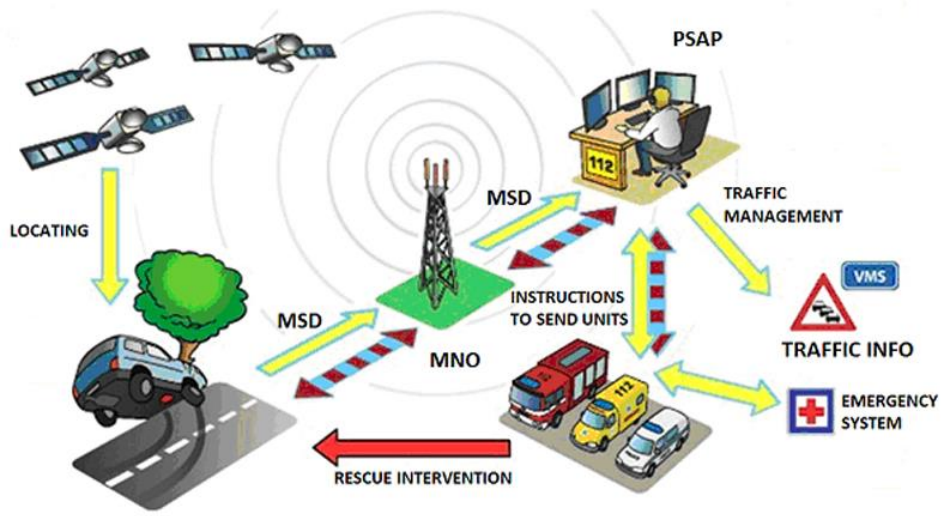

Figure 2. eCall operational flow

The emergency is automatically detected by car embedded sensors or could be triggered manually. The emergency call is started using an Minimum Set of Data (MSD), the content being standardized by CEN EN 15722[9]. However, after the MSD is sent from InVehicle System (IVS) to 112 and it is received successfully, the content of MSD is resolved and proper displayed as meaningful information to PSAP operator. The operator initiates the call back function of the system in pursuit of more detailed information regarding the emergency. Furthermore, in time of calling, the operator already posses the location, using the GNSS coordinates, the car model, by resolving Vehicle Identification Number (VIN) code into the EUCARIS database, all this information being included into MSD. The further action is seized according to call details or procedural standard rescue force are dispatched if no one can answer or is unable to give more details.

As specific to eCall alerting method, it can be underlined several aspects:

- The triggering event is automatically set, but also could be manually, increasing the range of situations that can be used. It covers the situation when driver could be temporarily incapacitated by a hearth attack or stroke when shortening the intervention time is a priority. Also, if an accident or other emergency is seen on the road, the driver could use the hands-free feature of IVS, without stopping or pay attention to phone during of call,

[6] HeERO Consortium, "HeERO - About HeERO Objectives." Accessed: July 5, 2017
[7] Dumitrescu, Dorin, Andrei Grososiu, Sorin Dumitrescu, Vioteta Rosu, Germina Ristea, and George Carutasu, "Solution for eCall implementation at national level within the HeERO project - Romania case study," (paper presented in 19th Intelligent Transport Systems World Congress, ITS 2012, 2012)
[8] EENA, "eCall," 2014. http://www.eena.org/uploads/gallery/files/pdf/2014_10_28 _3_1_5_eCall_Update_v2.0_FINAL.pdf
[9] BSI Stanards, "Intelligent transport systems. eSafety. eCall minimum set of data (MSD)," 2011

- The location is signalized into MSD, avoiding the address misinterpretation and indicating the direction of move, being very useful on highways accidents where dispatching points positioning depends on it,
- The severity of the accident might be evaluated using optional additional data field, where vehicle manufacturer or special vehicles categories are defined. Furthermore, after iHeERO project it possible to implement eCall for two-wheels vehicles, long distances buses and dangerous goods transports[10].

NEXT GENERATIONS EMERGENCY SERVICES AND SMART HOME

After detailing the alerting methods described above, it can be noticed that between today users IT&C usage and emergency services is very serious gap, in terms of type of communications channel used. Furthermore, if we are considering the way that people communicate nowadays, using social media, video calls over mobile networks or internet, sharing location etc. and the possibility of resolve those data into 112 system, reveals a technical impossibility to do so.

There are several reasons, which contributes to this fact, regarding the gap between existing technology and related emergency services:

- Lack of standardization of data format, approved to be used into 112 systems from foreign applications. For instance, in case of eCall service was necessary to implement 11 different standards[11] to normalize the communication between IVS and PSAP, starting with discriminator flag implementation, to consider the call back function, where the PSAP calls the IVS, MSD format and finishing with high level applications protocols,
- Harmonization and pan-European feature of the service, because of mobility character of the emergency for car accidents, the service should operate into the same way all Europe and to be able to treat eCalls from foreign cars situated on national territory, which was a huge task to plane the procedure around all PSAP,
- Industry effort to implement the service, beside the PSAP upgrade was necessary to implement the eCall flag discriminator by all MNO's around Europe and car manufacturers to certify and implement IVSs to new car models.

To recover this gap, the European Emergency Number Association published a position document[12], that reveals the main features of NG 112 and also in EMYNOS project[13]:

- Extending the communication option from traditional voice call to VoIP, message text, real time messaging, pictures and video,
- Improve the interoperability between PSAP and other emergency services to facilitate the data transfer,

[10] Carutasu, George, Cristina Coculescu, and Mihai Alexandru Botezatu, "Romanian roadmap for e-call technology adoption and future developments of emergency systems," (paper presented in Annals of DAAAM and Proceedings of the International DAAAM Symposium, 2017)
[11] EENA, "eCall and open issues (2018 revision)"
[12] EENA, "Next Generation 112 Long Term Definition," 2014.
[13] Markakis, Evangelos, Asimakis Lykourgiotis, Ilias Politis, Anastasios Dagiuklas, Yacine Rebahi, and Evangelos Pallis, "EMYNOS: Next generation emergency communication," IEEE Communications Magazine, 55, 139–45 (2017)

- Moving to IPv6 architectures for all services, allowing multiple routing and identification methods to be used instead of CallerID.

As it can be seen above, the 112 is more oriented to manually initiated call rather than automatically alerted situation, the exception being given by eCall. For the main proposal of this paper, to implement and enhanced security and alerting system for households, the legacy of existing 112 system can not be ignored. Regarding the smart home concept, even is present in the literature[14] it traits mainly the energy efficiency[15] in the context of smart metering implementation. However, beyond the real-time sensors based descision systems, the smart home is a concept that use efficiently resources to sustain the indoor living environment. Related to smart home application development, in[16], the authors proposed a framework for further services, presented in figure 3.

The emergencies signalized by an automated system from smart homes should eliminate or reduce at least the disadvantages of traditional voice call. In this case, it will be emphasized as individual:

- High rate of false calls: automated identification of household will discourage the caller to initiate false calls and even so, restriction might be implemented for abusive calls,
- Inaccurate location: the data packet, like MSD will contain the GNSS coordinates of emergency location,
- Lack of emergency severity detection: the sensors triggering the call will be displayed to PSAP operator, indicating the nature of emergency and severity.

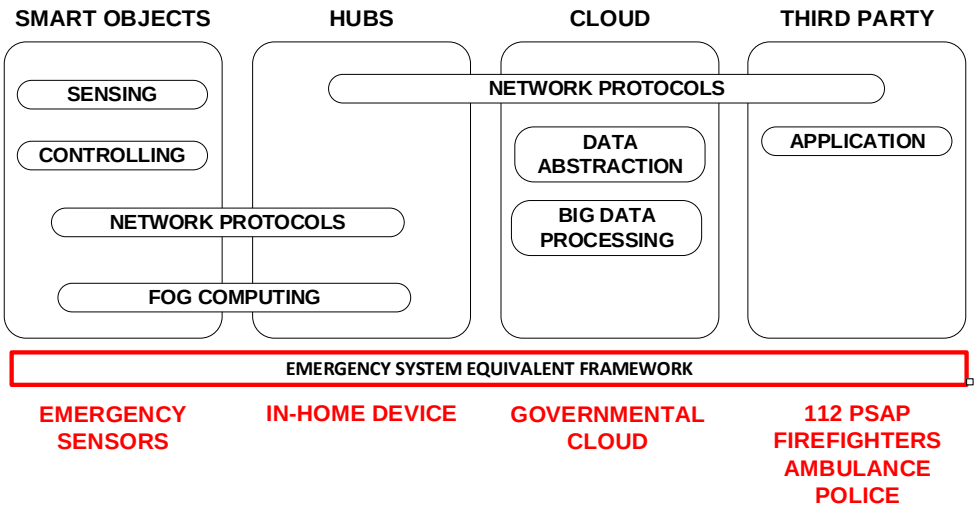

Figure 3. Emergency system architecture for IoT (adapted from[16])

[14] Alaa, Mussab, Aws Alaa Zaidan, Bilal Bahaa Zaidan, Mohammed Talal, and Laiha Mat Kiah, "A review of smart home applications based on Internet of Things," Journal of Network and Computer Applications, 97, 48-65 (2017).
[15] Carutasu, George, Alexandru Pirjan, Cristina Coculescu, and Nicoleta Luminita Carutasu, "Business opportunities for retrofit homes within smart meter implementation context," (presented in Technology and Innovation Industrial Management, 2018)
[16] Risteska Stojkoska, Biljana, and Kire V. Trivodaliev, "A review of Internet of Things for smart home: Challenges and solutions," Journal of Cleaner Production, 140, 1454–14, (2017)

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PROPOSED SOLUTION FOR SMART HOME EMERGENCY SYSTEM

As is presented in figure 3, the 112 system architecture adapted for IoT should comprise the next modules:

- Emergency sensors that detects any potential situation that might endanger the live of residents, property or environment and for this purpose are established the potential situations:
  - Criminality against persons or property (attack, burglary) and in this case the system could be used as panic alarm button and immediate alerting systems without being necessary to send all emergency details (e.g. identification, location),
  - Fire (fire condition detection, number of residents, rooms affected),
  - Personal accidents (severe medical problems).
- In-House System, presented in figure 4 with similar function with IVS, integrating home sensors, communication function using PSTN/GSM/GPRS module with GSM antenna if mobile channel is selected and GNSS localization. Unlike vehicles accidents, in case of house emergency location could be stored at initial setting of IHS. The short-term memory function is used to store sensors recorded data a small period (one hour) in 5 minutes series, very useful in establishing the severity of emergency.
- Governmental cloud, structure necessary to integrate data among all emergency agencies but also, with National Agency for Cadaster and Land Registration for building floor plans, Construction State Inspectorate for Construction Authorization details, like type building material, year of construction, type of heating systems, Police for number of residents declared as living in current household etc.
- 112 PSAP, firefighters, ambulance or police, that receive the emergency data crossed the governmental cloud and to forward it to rescue forces.

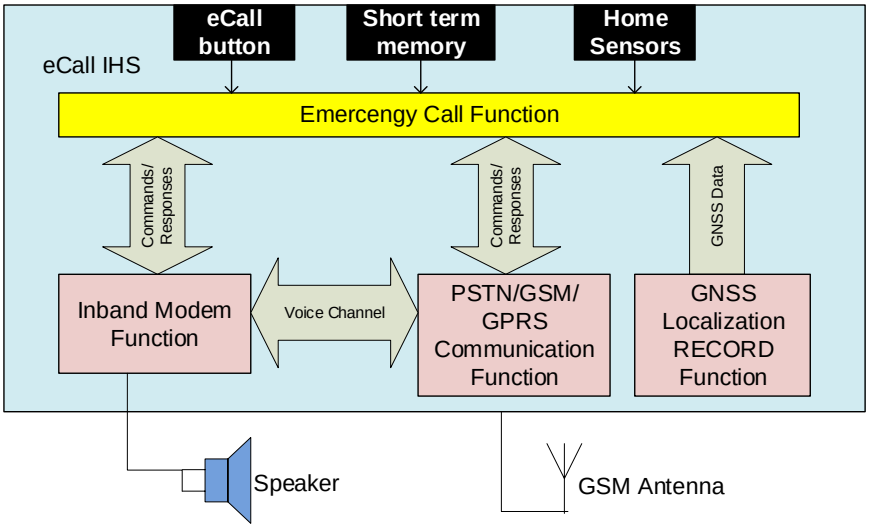

Figure 4. In-House Emergency module architecture

The operational flow (figure 5) for the enhanced security and alerting system follows the rules and procedures of eCall for vehicles. The emergency is triggered automatically or manually, sending MSD from IHS to PSAP through PSTN/MNO/Internet communication channel. The MSD is resolved by PSAP interface, displaying to PSAP operator the significant details of emergency: nature of emergency, location in GNSS coordinates and postal address (useful for multilevel households), unique residency number, which further will allow to interrogate from external agencies database for additional details, number and type of sensors triggered and might access the short-time memory of IHS as history.

After the MSD is received, the PSAP call back to IHS, in attempt of establishing the connection with eye-witness of the event and determine more accurate the severity of emergency. The collected data is sent to emergency rescue forces dispatched to intervene at emergency site.

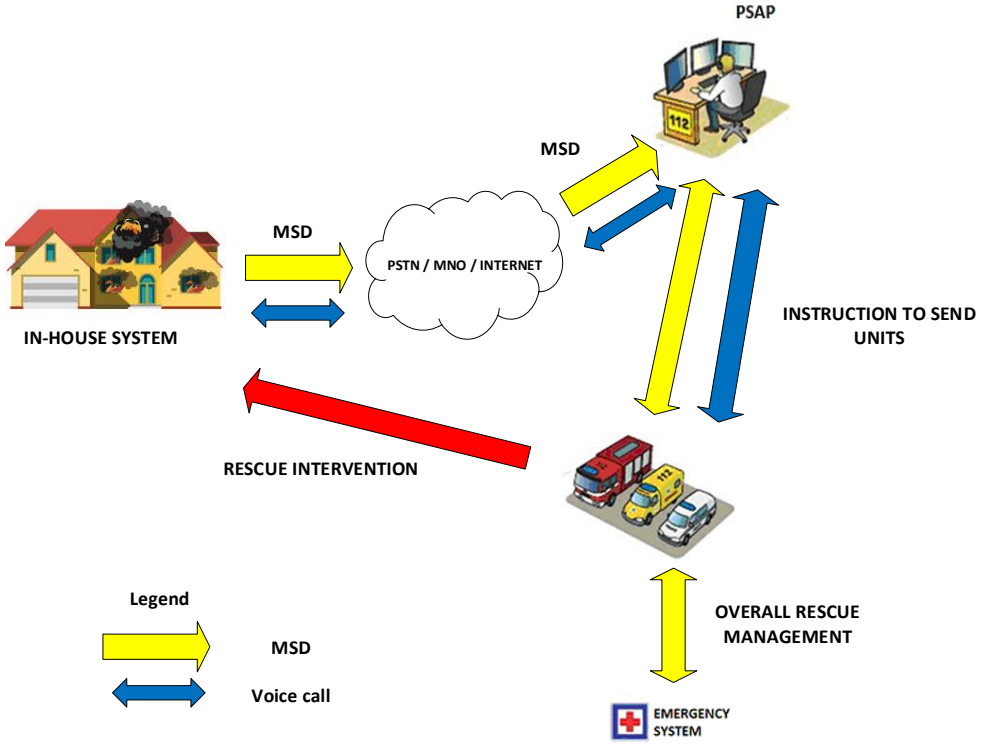

Figure 5. eCall operational flow for households

The content of MSD in case of In-Vehicle Systems is regulated by CEN EN 15722. The comparison between MSD content for vehicles and households is presented in table 1.

Table 1. Comparison between MSD content for vehicles and households

MSD for vehicles	MSD for households
Message identifier: MSD format version	Message identifier: MSD format version
Activation: Automatically / manually triggered	Activation: Automatically / manually triggered
Call type: Emergency or test call	Call type: Emergency or test call
Vehicle type: passenger Vehicle, buses and coaches, light commercial vehicles, heavy duty vehicles, motorcycles	Residential type: Single-family home (SFH), apartment blocks

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Vehicle Identification Number (EUCARIS)	Residential Identification Number (National Agency for Cadaster and Land Registration)
Vehicle propulsion storage type: Gasoline tank, Diesel tank, Compressed natural gas (CNG)	Heating systems type: natural gases, electric, pellets etc.
Time stamp: Timestamp of incident event	Time stamp: Timestamp of incident event
Vehicle location: determined by the on-board system at the time of message generation	Residential location: stored at initial setting of IHS and resolved using Residential Identification Number in related database of National Agency for Cadaster and Land Registration
Recent vehicle location (Optional): vehicle's position in (n-1) and (n-2)	Recent sensors values: Reading the recent values of sensors from short-term memory of IHS
Number of passengers (Optional): number of fastened seatbelts	Number of residents: Values obtained by resolving the Police database for determined location and reading values from occupancy sensors disposed in rooms
Optional additional data field that can be used to send additional information to PSAP	Optional additional data

CONCLUSIONS

The novelty of the paper is given by using the existing eCall technology, which now is available for automotive industry, for households. Authors contribution consists in evaluating and foreseen the changes needed to implement eCall technology for wide category, meaning households, with immediate user adoption. The results of study might be used for feature adoption of eCall or other emergency services for households. The existing emergency system features, regarding alerting methods are still behind the technology used in ordinary life by the citizen. Even further efforts were made for implementing combined voice call and data massage as communication channel between caller and PSAP, or NG 112 framework is defined, changing the paradigm from CallerID to IPv6. The very long term of implementation, eCall started in 2009 with an impact study, in 2017 PSAP reported the availability for the service and is mandatory only for new car models for class M1 and N2 after May 2018, rise a series of questions regarding the priority of rescue services into EU action plan or budget. The extension of already existent eCall technology to other type of use scenario, like boats, trains or residential building enhance the efficiency of investment for this technology. However, the presented solution is depending on eCall key elements but involves further developments. The first measure is to connect all emergency agencies and other related structures into a governmental cloud structure, able to offer a secure and integrated access for various information that might be useful during on-site emergency intervention of rescue forces. Another issue to discuss is that all residencies should have available for query from PSAP site at least several data explained into table 1, this Residencies Register is already implemented in traditional form, each property having a unique cadaster number. The type and position of sensors should be further evaluated, but a starting pull might consist in smoke detector, temperature, carbon monoxide or dioxide sensors, occupancy for each living space and security sensors for preventing unauthorized entrance on property: broken glass, door and window sensors and motion detectors.

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