















							person can perform necessary activity.
Rules	Ack	Certificates	INF	CERT	Uri	GET PUT POST	Certificates are updated from latest 3 <sup>rd</sup> party / agency certifications.
		Expected remaining Life	INF	LIFE	Float32	GET	Used by ops. Person for knowing the remaining life of the product.
Verify	Ack	Last Date of Maintenance	INF	MAINT	Date-time	GET PUT POST	Used by ops. Person to update the maintenance and usage status.
		Last date of Use	INF	USE_DATE	Date-time	GET PUT POST	For remote monitoring it is desired to use Caching POST interface than on demand GET interface.
		Operational State	ALL	MODE	Mode	GET PUT	A status parameter as enumeration indicating different states in which the entire block can function. OUT_OF_SERVICE MAINTENANCE MANUAL NORMAL CONFIG_ERROR

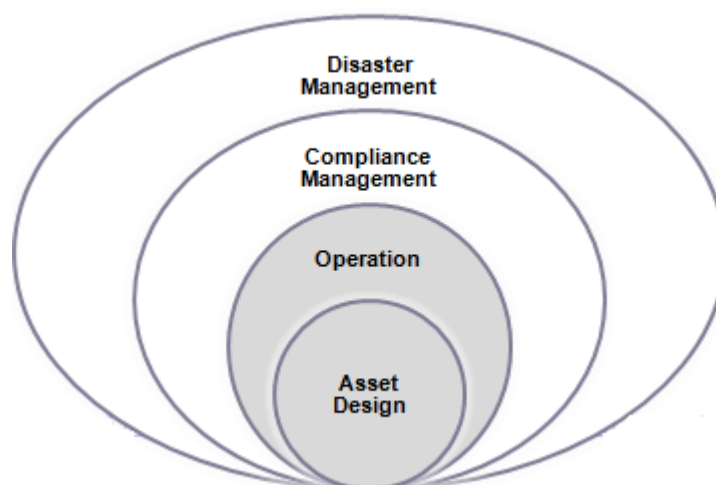


Figure 5: Layers of Protection Safety Management Structure

Table 7: Emergency Management Scenario

Title	Description	Protocol Usage	Coverage Bodies	Coverage %	
<b>Records Management</b>	Availability of Onsite Plans, Jurisdiction, Compliance Adherence Information – <i>OBSERVE</i> 1) Tank Size 2) Stored Chemical Identifier 3) Tank NDT – Proof Testing Information 4) Mandatory regulatory Health Check Records	Possible to GET values from Smart-Tags INF Blocks. All requests disperse as  GET coap: //<DeviceID >// OR3C	LE	Source	100 %
			EMS	Covered	
			FR	Covered	
			ECC	Covered	
<b>Rapid Assessment</b>	Situational Assessment, typically available from the first crew to investigate damages, typically the First Responder – Initiator - <i>ORIENT</i> 1) Identification of Gas Leak or Chemical Spill 2) Estimated number of People / Life under threat 3) Best Muster Zone	1) Covered by the Smart-Instrument to respond with stored chemical details and the quantity just before the disaster. 2) Need support from ECC and Jurisdiction to share people data. – Not covered. 3) Annunciate Mustering area through Alarm systems. Communication to Alarm systems can be carried out traditionally. - Smart Annunciator can be a variant product.	LE	Not Required	66%
			EMS	Covered	
			FR	Covered	
			ECC	Source. <i>Sharing of people occupancy information has to be investigated further.</i>	
<b>Hazard Assessment</b>	Typical Assessment of Hazard and potential cause. – <i>ORIENT</i> – <i>OBSERVE</i>	1) & 2) are carried out traditionally. Both these require strong Voice over LTE capabilities and other	LE	Not Required	33%
			EMS	Covered	
			FR	Covered	



	1) Identifying Safe resorts and Musters 2) PPE Identification and call for specialists 3) Identifying known and unknown chemicals.	technologies. 2) Smart Instruments provide different chemical composition data and shared via POST messages with Block ID, chemical Type and measured concentration / quantity.	ECC	Covered – Common End point for all the 3 agencies <i>Requirement 1&amp;2 require human cognition to seek specialties and schedule the resources through interaction.</i>	
<b>Resource Management</b>	Deployment Planning of Trained Resources, PPE, Hospital Management – <i>DECIDE</i>	Status of used /in-use devices or people are measured using GET interface.	LE EMS FR ECC	Source Source Source Source	100 %
<b>Tasking</b>	Execution Strategy and real-time availability of information - <i>ACT</i>	Public Safety personnel and Para med's are scheduled and tasked using PUT services in respective PEOPLE blocks or Muster Zones block.  PEOPLE – Operating Mode – Transition from <b>Normal to Occupied</b>  Each people block has Personal Protection Parameters like Short Term Exposure, Long Term Exposure, SCBA Status etc.	LE EMS FR ECC	Covered – Generally not required but for Accident Investigation and Post Incident Analysis the LE People are used. Covered Covered Covered	100 %
<b>Legend</b>					
<b>EMS- Emergency medical Services</b> <b>LE – Law Enforcement</b> <b>FR - First Responders</b> <b>ECC – Emergency Command Center</b>	<i>Items in italic are not satisfactorily answered by the systems / communications design and would need further investigation / research.</i>				

## 6. Conclusion & Future work

A cohesive function block architectural model was developed with CoAP as the basic means of transport for Smart Things (Instruments and Tags). The new enhancement of options field was CoAP protocol was developed to satisfy the communication needs and cohesively verify that the information needs in Asset Design & Construction, compliance management and public safety audits is covered by the design enhancement. Most of the disaster management needs are covered by the protocol scheme. Some aspects in emergency management require further investigation i.e. estimating number of people affected by the disaster and establishing human organizational chain to utilize competent people to task for disaster containment. Different solutions exist to select specialists and also track/associate PPE today. These do not conform to the common communications requirement and may require stronger standardization initiatives. These Information model & API definitions provide a means for the Emergency command center and law enforcement to fuse and operate this larger set of data.

This work considers LTE as a medium for establishing communications. The presented work considers the devices and people connect in a typical M2M network as LTE UE (user equipment) nodes. In the public safety LTE work by 3GPP, the focus is on enabling TETRA replacements with LTE systems. This research in the future would focus on specific optimizations in the LTE network for a SafetyM2M network deployment.

## References

[1] C. K. N. S. S B Aanandh, "A Review of Functional Safety Models for Public Safety Management Systems," Journal Of System Safety, pp. 20-31, 2014.

[2] D. S. Mannan, "Environment and Public Works," Mary Kay O'Connor Process Safety Center Texas A&M Engineering Experiment Station, 27 June 2013. [Online]. Available: [http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore\\_id=12b33b05-57d8-474a-a5d2-ded91814b20c](http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=12b33b05-57d8-474a-a5d2-ded91814b20c). [Accessed 29 June 2013].

[3] "Public Safety Architecture Framework Volume I, II, III," 2006.

[4] Gas Association of New Zealand, SMS for Public Safety – Handbook for ESI & GSI Companies, New Zealand: Electricity Engineers Association, New Zealand, July 2011.

[5] V. Vyatkin, IEC 61499 function blocks for embedded and distributed control systems design, ISA-Instrumentation, Systems, and Automation Society, 2007.

[6] S. Lehnhoff, W. Mahnke, S. Rohjans and M. Uslar, "IEC 61850 based OPC UA Communication-The Future of Smart Grid Automation," in 17th Power Systems Computation Conference (PSCC 2011), Stockholm, 2011.

[7] U. Hunkeler, H. L. Truong and A. Stanford-Clark, "MQTT-S—A publish/subscribe protocol for Wireless Sensor Networks," in Communication Systems Software and Middleware and Workshops, 2008. COMSWARE 2008. 3rd International Conference on, 2008.

[8] Z. Shelby, K. Hartke, C. Bormann and B. Frank, "Constrained Application Protocol (CoAP), draft-ietf-core-coap-13," Orlando: The Internet Engineering Task Force--IETF, Dec, 2012.

[9] B. C. Villaverde, D. Pesch, R. De Paz Alberola, S. Fedor and M. Boubekeur, "Constrained application protocol for low power embedded networks: a survey," in Innovative Mobile and Internet Services in

- Ubiquitous Computing (IMIS), 2012 Sixth International Conference on, 2012.
- [10] M. Becker, K. Kuladinithi and T. Ptsch, Transport of CoAP over SMS and GPRS, 2011.
- [11] APCO International, "Unified CAD Project," 2013. [Online]. Available: [https://www.apcointl.org/component/docman/doc\\_download/375-high-priority-info-sharing-needs-for-emerg-comm-and-first-responders-final-pdf.html?Itemid=725](https://www.apcointl.org/component/docman/doc_download/375-high-priority-info-sharing-needs-for-emerg-comm-and-first-responders-final-pdf.html?Itemid=725).
- [12] Dept. of Homeland Security, "Public Safety Architecture Framework Volume I, II, III," Department of Homeland Security, 2006.
- [13] 3G Partnership Program, "3GPP Public Safety," July 2013. [Online]. Available: [www.3gpp.org/public-safety](http://www.3gpp.org/public-safety).
- [14] "Capsnet Strategic Plan," California Technology Agency, 03 03 2011. [Online]. Available: [http://www.caloes.ca.gov/PSC/Documents/PDF/CAPS\\_NET\\_Strategic\\_Plan\\_03-03-2011.pdf](http://www.caloes.ca.gov/PSC/Documents/PDF/CAPS_NET_Strategic_Plan_03-03-2011.pdf). [Accessed 10 10 2012].
- [15] J. Boyd, "Organic design for command and control," A discourse on winning and losing, 1987.
- [16] N.-T. Dinh and Y. Kim, "RESTful Architecture of Wireless Sensor Network for Building Management System.," KSII Transactions on Internet & Information Systems, vol. 6, 2012.

Mundus Fellowship from European Commission and High-Value Ph.D. Fellowship from IIT, Kharagpur. He is a reviewer of journals such as 'IEEE Transaction on Industrial Electronics', 'Mechanical Systems and Signal processing', and 'Journal of Sound and Vibration' and 'Journal of Vibration and Control'. He has chaired sessions at International conference of CM/MFPT 2013 held at Poland.



**Dr. Nihal Siddiqui** did his post graduation in Environmental Science and Doctorate in Environmental Biology. Dr Siddiqui specializes in the area of Environmental Pollution, Env. Monitoring & control techniques and Disaster Management. He is currently associated with University of Petroleum & Energy Studies, Dehradun as the head of health safety & environmental engineering department. Dr. Siddiqui was also associated with Health, Safety & Environment dept of ICEM college, Muscat, Oman University of Central Lancashire, UK. He has more than 65 Research papers to his credit and has participated in several National and International conferences. Dr. Siddiqui has authored 2 books viz. Natural Resources & Environmental Management & Handbook on Fire & safety. Dr. Siddiqui has guided more than 50 M.Tech and 7 PhD theses.

## Author Profile



**S B Aanandh** completed his bachelor's in electronics and communication engineering from Thiagarajar College of Engineering, Madurai. He is a Certified Functional Safety Engineer for HW & SW Engineering from TUV Rhineland and is pursuing a PhD in Public Safety Communication Systems Design with University of Petroleum and Energy Studies Dehradun. Aanandh is currently employed with Honeywell Technology Solutions as a product engineering leader with Honeywell Life Safety, where he leads the initiatives on relevant core architectures, architectural evaluations and systematic design for reuse. Aanandh has authored nearly 25 invention disclosures in the areas of Life Safety, Critical Infrastructure Protection and Situational Awareness. Aanandh has published 3 conference / journal papers in Chaotic Cryptography, and Measurement Instrumentation for Yarn Quality Testing. In his current PhD work he has published his review of Safety Models and concept of Safety Grid in International Journal of System Safety and presented in international conferences. Aanandh is also the recipient of Honeywell's Global Technical Excellence Award. He is reviewer of journals of systems engineering, INCOSE.



**Dr. Chinmaya Kar** completed bachelors in mechanical engineering, masters in Industrial engineering and management and Ph.D. in mechanical engineering. He has 11 years of research experience at various organizations such as Honeywell ACS Advanced Technology Lab, General Electric Global Research, INSA (Lyon, France), Crompton Greaves Limited and IIT Kharagpur. He has also 7 years teaching experience. His interests include reliability analysis and condition monitoring, data analytics (such as decision support system, signal processing, statistics etc.), and internet of everything. Currently, he is a Honeywell Fellow at Honeywell Technology Solutions, where he is leading initiatives of 'Condition Monitoring' and 'Internet of Everything'. He is leading global projects such as WiBRATE (under European Commission's FP7 grant) and Idler Monitoring under these initiatives. Chinmaya has authored nearly 20 publications in various journals and conferences, 13 patents, 2 provisional patents, 3 trade secrets and nearly 36 disclosures (reports). He is a recipient of Erasmus