6. CONCLUSION

SMS: COMMUNICATING SYSTEMS DESIGN: CONCLUDING REMARKS

In this research journey significant opportunities and methods for implementing a fail-safe closed loop compliance in disaster / safety management system by the means of public safety LTE networks are identified. When this research topic was chosen the concept was around connecting the safety compliance devices in the dedicated public safety network. This research began as early adapter of Machine to Machine communications. As the research progressed and the technology evolution continues to mature the world has become more aware about Internet of things and internet of everything, i.e. connecting people, process and things. Thus this research has become a fore father in the emerging research and application of IoT for disaster management. As stated New Zealand's public safety handbook has recommendations for electricity and gas distribution companies to follow processes similar to process safety management systems for maintaining the order of public safety. From Turk & Mishra's report on functional safety we also corroborate the need for key performance indicators for effective process safety systems. The research significantly identifies the information Meta model required for effective safety management systems and connects the spaces in the dimensions of "People", "Process" and "Things". People play an active or passive role , while Things are classified as Tags and Instruments and lastly the process is modeled with "Rules", "Verify" , "Measure" and "Simulate" procedures acting as a bridge between the people and the things.

The communication interface defined with the OR3C model suits the needs of Safety Management scenarios. The possibilities of utilizing this communication definition and realizing different use case scenarios are described in Appendix -1. In case of disaster management in oil and gas industries or specifically to chemical storage tank cases, the public safety LTE transformation would significantly re-use the existing plant design and instrumentation. Additional tag like devices may be added to provide context awareness. This significantly lowers the investments required for both the government agencies and the infrastructure organizations.

In this concluding chapter, additional use case scenarios for Public Safety are presented and the communication interface definitions are mapped.

1. USE CASE – BUILDING FIRE SAFETY

Things	Process	People	Remarks
Tag :- Fire Extinguisher PT_DATE VALIDITY MAT_TYPE PRESSURE	Verify	Safety In-charge Law Enforcement First Response	1) Periodic replacement of fire extinguishers and availability of fire extinguishers for un-towards incidents. 2) Placement of right type of extinguishers i.e. Foam based or CO2 based.
Tag :- Compliance Store CERT URI_HAZMAT MEAS_DATE URI_PROT_LVL	Measure	Business Owner Law Enforcement Occupants / Co-Tenants	Periodic inspection of safety compliance of the Facility or business house. Acceptable Risk allowance for buildings operating nearby or in the shared campus. ***In Bangalore, Garment Factory was operating on the first floor of a Paint godown in the ground floor.*** ***Hazard due to paint flame ignited the entire garment factory.*** ***Real-time inspection and approvals for Asset construction saves infrastructure and Business.***
Instrument :- Fire detectors Alarm Sounders VALUE BLK_ERROR PT_DATE TREND	Verify Simulate	Safety In-Charge First Response	1) Sensor Integrity checks for operations and Alarm capability drills. 2) In case of fire accident, real time fire TREND availability for fire growth monitoring. a. Fire Growth helps in identifying source of Fire from Short Circuits to Materials. ***Improper shutdown of Fire Alarm system i.e in Kolkata Hospital accident can be avoided.***
Instrument :- Fire Control Hose VALUE BLK_ERROR PT_DATE	Verify	Safety In-Charge Law Enforcement First Response	Control System integrity check to check operational status of pipes and levitators.
Tag :- Hazmat Identity MATERIAL LOCATION LAST_USE_DAT RISK_LEVEL	Measure	Safety In-charge Law Enforcement	Storage of chemicals and Fuels in designated places and proper update of their material location. A location change induces Alarm for change management procedure up-till law enforcement. ***Fire in Carlton towers due to wrong storage of Diesel in the eighth floor can be avoided.***

In case of fire safety which is a critical need especially in the increasing vertical growth of buildings preparedness and compliance have to be monitored to be safe rather than sorry.

Examples of switched off systems and improper hazardous material storage and identities have caused accidents in the past and a closed loop 3rd party agency monitoring system would alleviate the problem of compliance and increase rigor.

Real time monitoring of fire growth patterns would help in identifying the cause of fire with reported data analysis. Emergency response teams can then be aware of treatment and containment procedures.

2. USE CASE – EMERGENCY MEDICAL RESPONSE

Things	Process	People	Remarks
Instrument :- Traffic Signal Light PT_DATE VALIDITY VALUE CONTROL	Verify	Safety In-charge Law Enforcement First Response	Light Control Check and traffic control operations 1) Control of light switches and periodic proof testing monitored at remote control rooms 2) Simulate Traffic flow and Mock drills for sections of Traffic post.
Tag :- Compliance Store CERT MEAS_DATE URI_PROT_LVL	Measure	Hospital Law Enforcement CAD	Periodic inspection of safety compliance of emergency vehicle.
Instrument :- Different Medical Instruments VALUE BLK_ERROR PT_DATE TREND	Verify Simulate	Paramedic First Response	Sensors integrity check and real time vitals monitoring to remote Emergency response team at hospitals.
Tag :- Patient Identity UHID LOCATION LAST_USE_DAT RISK_LEVEL FIRST OBSERV	Verify	Patient / User Paramedic	Identification of Patient details including Red Tag entries for mass emergency response. Includes first observations tagged in the field by paramedics

Traffic control and ambulance routing is a static problem in the current situation. Predominant problems again arise due to malfunctioning of traffic signals. Periodic compliance and proof testing helps the traffic signals to work in desired control paths.

The second problem that this co-operative communication system addresses is real time information sharing of patient vitals and enables red-tagging of patients in mass causalities.

The third problem solved by the availability of this parametric communications for compliance of emergency vehicles. There is no unique way of managing the certifications of these vehicles and this communication method again enables governance to monitor the compliance of these vehicles and manage scale-up issues.

3. USE CASE – PIPE LINE MONITORING: - GAS DISTRIBUTION

Things	Process	People	Remarks
Instrument :- Leak Detector , Flow Meters , Pressure Transmitters PT_DATE VALIDITY VALUE CALIB_DATE	Measure	Safety In-charge Law Enforcement First Response	Light Control Check units and traffic control operations
Tag :- Compliance Store CERT MATERIAL MEAS_DATE URI_PROT_LVL	Verify	Safety In-charge Law Enforcement	Compliance Report store of Pipeline Segments
Instrument :- Different Inspection Instruments VALUE BLK_ERROR ALARM PT_DATE TREND	Verify Simulate	3rd party Audit Agency Law Enforcement Safety In-Charge	Sensor integrity check and instant audit report sharing with Agencies and Government

Pipe line monitoring has been an important need from both the business and government priorities. Recent accident in GAIL Pipeline near Vizag is a sheer example of accidental human errors and lack of attention for early warning signals. Different solutions are proposed for pipe-

line monitoring, but existing instrumentation can be effectively used and closed loop communications can alleviate the present problems. Simple rule based algorithms and parametric communications reusing available instrumentation helps to identify and monitor real time progress of pipe lines. Instant report sharing by agencies and accountable people identifies near misses more reliably than screening by the concerned operators.

With this generalization of capabilities of the designed model we submit that a parametric communications with significant re-use or extension of existing instrumentation can provide co-operative communications between different cyber physical systems.

In Appendix -2, a summary on the LTE communications is presented and details of recommendations for Safety Grid LTE implementations are presented. The following recommendations are observed.

I. ***Utilize Channel access scheme Physical Random Access Channel (PRACH) to transmit additional bytes of Alert data from Fixed Safety Related instruments data.***
II. ***Utilize Paging Control Channel (PCCH) channels to transmit Alarms to concerned devices and people using a Multicast mechanism.***
III. ***Develop schemes for Static Resource Allocation for Battery powered devices.***

In recommendation III, for having a static schedule device communications feature, a detailed study and prototyping shall be required.