SOCIO-TECHNICAL COLLABORATIVE SECURITY SUPPORT SYSTEM(STCS^3)

Gopal R Jani[1] , Avish Puri [2] and Tushar Mehta[3]

1Human Centered Design Institute,Florida Institute of technology Melbourne FL – 32901, USA
2School of business, Florida Institute of technology Melbourne FL – 32901, USA
3Smt.Chandaben Mohanbhai Institute of Computer Applications, Charusat University, Changa, GJ, India

ABSTRACT

In this paper, we describe the structure and the methodologies incorporated with implementation and development of socio-technical collaborative security support system considering it as a life critical system. The first section provides a brief introduction followed by the section for problem statement and factors of LCS. We have also discussed about the methodologies used to implement the system. Moreover, we have also explained the comparison with currently used tools along with recommendation for the future work.

Safety and Security of a citizen is always a field of interest in current day's digital revolution, innovation and inventions. With collaborative work environment and real time information sharing, we can generate situation awareness, whereas without it, it becomes really difficult to reduce the response time of the security personals as they will have lack of reliable information and on the other hand the city structure and traffic structure is very unpredictable. This problem lay down government officials in the situation where they really want to reduce the response time but they do not have means to do it.

KEYWORDS

Life critical system, safety and security, Human Centered Design, real time, decision making, situation awareness, safety model, machine learning, collaborative situation awareness, crisis management procedure.

1. INTRODUCTION

Crime against women, child, senior citizens and unified security has been a serious problem that our country is facing since last decade or more. According to government database regarding the crime reports and analyses based on those reports, there is an exponential increase in crime rates in many cities[28]. Several methods have been proposed in order to combat this. Perhaps the most popular of these is the simplest: having helpline to assist people in need such as 108, 100, cell phone based applications etc.

Efforts of the government personals and organizations have been tremendous, but the technological infrastructure behind the security aspect comprises downsides in technological systems and support. As we discussed, without collaborative work, it is always difficult to diminish the downsides in technological advancement, situation awareness mechanisms and to support the security structure.

In this paper, we will walk you through our solution using Life Critical System principals, which will increase socio-technical advancement and can be inordinate support to security personals.

DOI : 10.5121/ijist.2016.6223

Solution can provide security forces with human machine integration and highly automated control mechanisms. The security personals with current infrastructure and methodologies will not have reliable information and on the other hand the city structure and traffic structure is very incalculable. This problem place security officials in the situation where it gets difficult for them to make crucial decisions and act on it, as they lack with the means to do it

For that purpose, by applying human centered design approach, in STCS3, we have considered the specific requirement and needs of security structure and the security personnel's involved in real-time response/request system. It also provides separate situation awareness platforms for everyone involved in incident. Its solution provides a great way of simplifying an abstract view of the current situation at end user. STCS3 is an integrated combination of different software tools which provides different features and functionality to accommodate required situation awareness, control centers and to the end users as well.

2. PROBLEM STATEMENT

Security is not a job, it is way of life. Nowadays, in this socio-technical world, security is both easy as well as difficult. We have cameras installed everywhere but do not have artificial machine learning algorithms which runs behind the cameras and identifies the situation if any suspicious activity occurs, also cameras over the internet are not reliable as it is very easy to hack into. The current infrastructure and available resources are not enough which can enable them to eliminate these problems. For example, while using existing systems and methods, it has certain restrictions which disable them to provide the security which every person deserves. The field of automation in security structure is very new but has proven on many circumstances by solving complex issues with simple solutions. In this paper we are introducing many different architectural advancements using automation which can increase situation awareness in security.

With deep consideration of Life critical system and application of Human Centered design approach, STCS3 system considers the specific requirement and needs of the human involved in a given situation and time which provides with the situation awareness information to act as accurately as possible with the help of automation and machine learning.

In later section, we discussed about overview of the system design and its artifacts

- Life critical system and its effect on socio-technical world
- Safety model to be used.
- Human error tolerance and avoidance.
- Risk matrix
- Crises management

3. SOCIO-TECHNICAL COLLABORATIVE SECURITY SUPPORT SYSTEM (STCS3)

The STCS3 has been designed considering current technological advancement and currently available infrastructure. The goal is to provide situational awareness information to the right person at right time to optimize security model in operations in order to have synchronized and cooperative working environment which provides real-time situation awareness.

To understand it more deeply, let's start answering a question "what is life critical system?" Life critical system (LCS) can be any system which potentially affects human. for example,

Considering, the normal day to day switch and the electric control system, lite fuse, a car, motorcycle, airplane, sport equipment like hatches used in tracking, etc. The life critical system also includes the safety critical system as LCS is a broader category. There are many sophisticated life critical systems in many different domains such as robotic surgery machine in health care, autopilot in airplane, the space craft technologies etc. However, depending on the domain, the life critical system may have different aspects and consideration.

Increasing knowledge of technology, new and innovative field of computer science and information technology with approaches of safety system, life critical system, and the emergent property of advancement in different domain allows us to get a broader idea to make LCS more effective. Ultimate goal of a life critical system can be driven in three dimensions, safety, efficiency and comfort[16]. The experience of a person can also show us a different prospective for a regular system to life critical system. One of the best examples of system being LCS is losing a cell phone can become a crucial issue while in emergency and how it can be a life critical system.

After extensive research, we can observe that a life critical system should be reliable, resilient, redundant, socio-cognitively stable, as well as controllable and observable, and it should also provide mechanism for tolerant or resistant to human error and system failure.

While designing security support system of collaborative situation awareness in real-time, for STSC3, a life critical system, we took on the sensitive issue of safety and security in India. After deep consideration of life critical system and its approaches, Fig. 1 below illustrates operational architecture of STSC3. Based on highly automated systems with machine learning and decision making capabilities through which solving safety and security issues will be easier, effective, and efficient as compared to existing systems and operational structure. Operational architecture of STSC3 consists of three broader categories, Technology, Organization and People. According to TOP model [2], let's discuss about technology, organization and people aspects of STSC3 life critical system.

Before going into the further details, Let us give readers an example of how this model works, using real life scenario. Imagine an emergency situation where you are in need of help, whether it is medical emergency, fire, or police or anything else which can be considered as crises at the victims end. All you do is just press a button and within 15 minutes or less, you will have rescue team there to get you out of the situation. Doesn't matter what time of the day it is or what day of the year or where you are. An automated security support system which after initiating distress signal by victim, operates collaboratively with human interaction methodologies and a control center (human contact), which provides fastest and expeditious way to get you help.

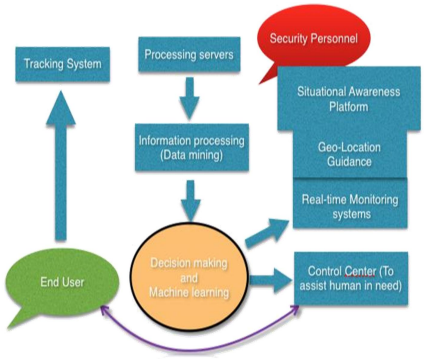

Fig 1. Operational architecture of STSC3

To generate this type of distress signal and gather every information about users surrounding, we have used geo-location chips in a device which provides very accurate and reliable geo-data to be used for decision making mechanism which we will discuss later in this paper.

3.1 Tracking Device

Geo-Location positioning services has been increasingly improving and constantly crossing the barriers of accuracy. After taking advantage of these existing technology and probabilistic calculation algorithms, we were able to design a tracking device. This device can be very small in size with powerful battery backup which makes it very reliable and accurate. The tracking device can have many designs such as, jewelry clip on, in the form of watch, distress signal belt, or in any form which is feasible and required. The processing capability and real time response and tracking provides accurate geo location calculation and makes it possible for processing server to generate the request immediately. Following are the basic features, but not limited to, which can be accommodated in the device.

- A wearable device of the size of a regular watch or clip on device.
- State of the art Geo location algorithms with accuracy of approximately 1 feet.
- Operates on Global Positioning System (GPS), satellite navigation system that provides location and time information in all weather conditions.
- Communication mechanism using Global System for Mobile (GSM) and GPRS
- Geo-fence mechanism for the location based tracking and monitoring
- The generated distress signal immediately gets to the processing server from where automation begins.

3.2 Processing server and Information processing (Data mining)

After receiving the signal at Processing server (Integration server) which we will use to facilitate interaction between diverse devices, operating systems and applications across internal and external networked computer systems. The additional processing capabilities and real time request response mechanism is design considering following aspects.

- Distance based distress call allocation algorithms.
- Ticketing system assistance with real-time monitoring and tracking.
- control center call processing

As soon as the distress signal reaches to the processing server, it provides data to mining algorithm to generate necessary meaning full information. It quickly processes it and converts in to automated supporting mechanism throughout the time:

It starts providing information to the authorities and having a quick safe record of the incidence which in terms increases traceability. It also provides the geolocation information to the nearest six different security personals. After receiving immediate information about the incidence, security person will accept the incidence case. As soon as the case has been accepted, security person gets a predefined path and procedure which has been calculated and designed by decision making and machine learning mechanism.

3.3 Decision making and Machine learning

Decision making and machine learning module, processes information through two different algorithms and two different decision making process to select appropriate rescue procedure simultaneously as shown in the Fig. 2.

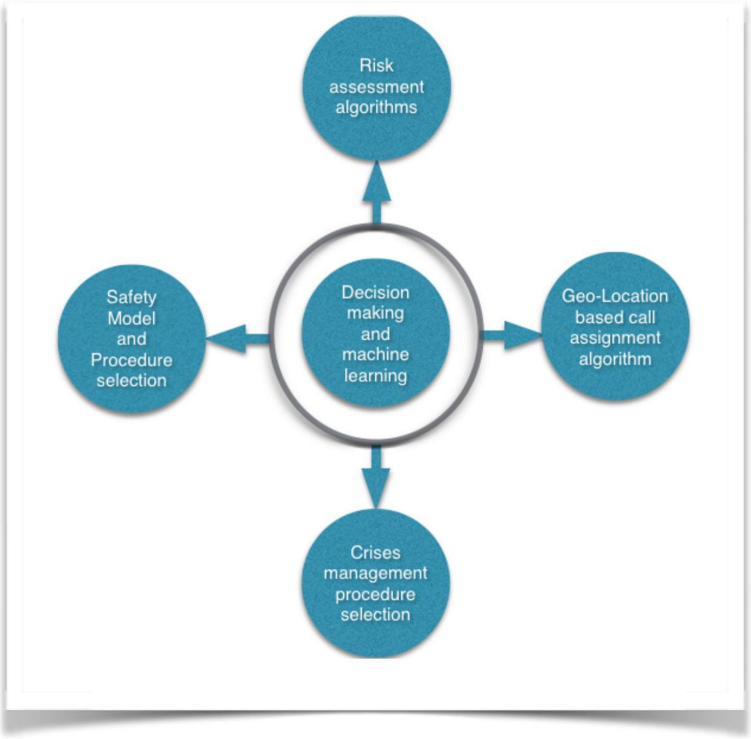

Fig 2. Decision making and machine learning module

Risk assessment algorithm

Risk assessment is one of the crucial factor while handling a situation of emergency. With current infrastructure and limitations, it becomes very hard to identify the risk involved in particular incidence. But the fusion between machine learning and risk assessment with the help of automation opens up a different horizon. Alternatives and choices which are explained through

the notion of liability and insurance. Risk is not always as it has been defined in dictionary, it sometimes include only few factors which are not under control of the human. By using logical inference forms, we can make hypotheses and prove it by inference. The main question is to identify that where the risk is situated. Depending upon risk, law and freedom we can further categorize nature of risk and allowance of risk. Depending on risk and responsibility, it calculates difference between individual risk and collaborative risk. Once the learning and assessment process gets completed, it automatically selects the safety model and procedures to be followed.

Safety Model and Procedure selection

In emergency operations it is important to build a perfect safety model which includes both the human and machine which will help in avoidance, recovery and crises management phases. In STCS3, Safety models and procedures associated to incidents gets converted into predefined procedures according to constitutional laws and security officials with help of Life critical system fundamentals. Risk and reliability is a crucial aspect of any system which can be categorized as life critical system. For example, nuclear power plant design, systems in aircraft cockpit, search and rescue operations, etc. by evaluating involved risk, STCS3 calculates the risk and reliability factors, once having the information about all scenarios, it implements an ideal safety model for the system. Based on that safety model, it selects the available procedures and distributes among involved people in an incident

The STCS3 operates in three phases of safety model; prevention, recover and mitigation. It can identify from known and expected situation during the recovery phase. And when it cannot come out of the situation in recovery phase, it would get to mitigation information collection which will enable security personnel's to assess the consequences and causes of the safety issue at users end. As discussed in the paper by Jean Christophe Le Coze and Kenneth Pettersen, "Is resilience engineering realist or constructivist?" STCS3 establishes right amount of barrier within the phases. The paper[] also discusses about the resilience engineering with perspective of finding out whether it is realistic or constructivist. There many questions which have been raised by scientists such as human factor in safety model, socio-technology, social actions by people towards system etc.

Crises management procedure selection

Crisis is the event that leads to or is expected to produce some unstable situation in future or propose things in dangerous situations which might affect any individual, group, community or whole society. Crisis depends on the Quality of decision made. To achieve it in STCS3 we have included following parameters:

- **Information:** Available information, reliable information, some certainties and some uncertainties it depends upon, while the level of ignorance of the information which might not be relevant.
- **Spatial-temporal Complexity:** A database that contains space and time information for the past events and decisions.
- **Multi-Agent Decision Making Process:** Quality and complexity of all interactions, conflicting objectives such as legal and technical aspects of the domain and site and lastly the trade-offs for the same.
- **Decision making culture:** It includes the variation in the decisions based on the different types of views for the crisis and individual analyses of the decision.

The crisis Management procedures gets constructed based on many different parameters such as past accidents, disaster, Emergency, Logistics, Regulations, Risk involved and social aspects STCS3 crises management procedures analyses crises in 3 stages:

- **Pre-crisis:** Crisis prevention measurement starts looking for procedures for preventing the crisis on a long term.
- **Live:** Maximizing mitigation efforts, Maximum mobilization, making a chance that leads to easiness of the crisis management.
- **Post-Crisis:** Mitigation efforts pursued traceability and liability. STCS3 traces the parameters that caused the crisis and necessary data such as time of crisis, duration of crisis, and actions taken gets produced.

Geo-Location based call assignment algorithm

While processing information, STCS3 executes geo-location based algorithms to perform following functions:

- **Distance based notifications and case assignments:** It calculates the real-time coordinates of the user and pin point it up to 2 feet of accuracy. Once pin pointed, if calculates distance of six nearest security officers or vehicle of the officers and assigns them according to their distance. Nearest being highest priority of 1, it assigns the same case to six different security authorities with assigned priority.
- Integrated with processing server, decision making and control center automatic case assignment system. It provides real-time updates of each and every process and situation to control center including real-time geo-location tracking information.
- Collaborative working environment: real-time updates to every individual involved in incident. Collaborative situation awareness platform

Real time monitoring is a vital requirement for most collaborative situation awareness. To provide that platform, we considered having a smartphone application for security personnel's. This is due to the fact that it is just not possible to undertake meaningful IT service management through periodic reports. For speed of service as well as efficiency, STCS3 security personnel have real time monitoring of application.

Collaborative situation awareness application will also act as a hub and recording each and every activity of end user with Accuracy based on satellite triangulation, speed of traveling, direction of traveling, longitude, latitude and real time point to point location tracking.
The process of Monitoring and measuring environmental developments with technology and communications systems that provide time-relevant information to the officials in an easily understood format such as maps, ticketing system at control centre and smartphone application.

Control center

24/7 control center can be a physical place where distress and other calls will be handled, high level of computer automation and training based on the structured operational processes. Typically, it will have the ability to handle a considerable volume of calls at the same time, to screen calls and provides information to the security personals to handle the emergency situations with accuracy. The control center can be considered as main point of situation awareness link between users data and security personnel.

3.4 Information distribution mechanism

Information distribution Mechanism provides information to all the humans involved in the system, when the information corresponds to criteria individually selected by the algorithms, and then provides restricted and role based information to the operators. Encrypted information packages (IP's) will be provided at operator's site, via high and/or low density bandwidth by

broadcast transmission. The IP's allocated to operator are decrypted and displayed for viewing by the operator which will provide them with all the details they require for the rescue operation. The IP's are periodically reported by server links to the system's central processing algorithms which issues encryption keys. The encryption keys, used to decrypt the IP's, are changed periodically and distributed to operator stations.

The Information distribution mechanism takes in to the account of workload measurement techniques which vary with respect to certain properties that determine the utility of a technique for individual applications. Two particularly critical properties which are being considered are the sensitivity and intrusiveness of a technique.

- Workload assistance and efficiency improvement distribution methodology.
- Use of behavior shaping constraints to prevent errors.
- Mitigation of the effects of errors after they are made.

Security structure and operation organizational layout

Currently available man power and resources with security officials is more than enough to control any given situation and scenario related to citizen's security if used with the support of automations and procedural methods.

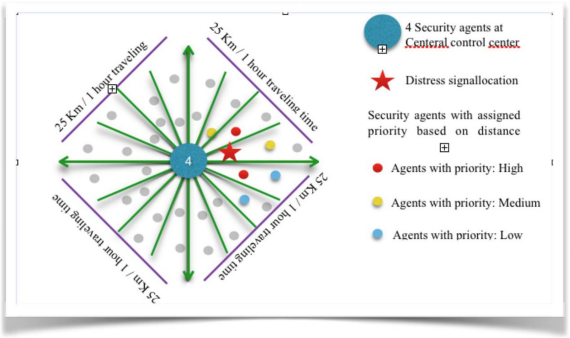

Fig 3. security city layout in STSC3

By using the organizational structure for the security in a particular city, and the back end support for the collaborative work, the STCS3 can reduce the response time approximately up to 15 min anywhere in the city.

Lets assume that the incidence happening at location from where x = 4 and y = 6, distance d will be

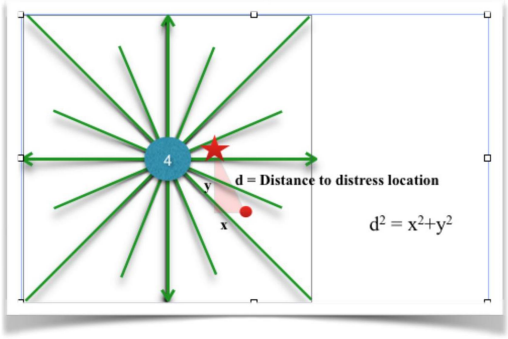

Fig 4. example time and distance calculation between user and security person using security city layout in STSC3

$$d^2 = (2)^2+(5)^2 = 4 + 25\ d^2 = 29$$
$$d = 5.38 \text{ km}$$

Distance from security person to the user's location is 5.38 km, not from assumption that a person can cover at least 25km in 60 minutes at any given time of the day considering traffic and busy work hour rush. So to travel 1km, it requires 2.4 minutes.
So to travel total distance from point A to point B as
shown in the figure is Total time required to reach

Distressed user = 5.38km * 2.4= 12.91 minutes.

City as big as 25 km square km can be handled only with the help of 36 officials. Four in control center and remaining distributed across the city in team of two according to the 16 different segments. So that from any given point there are 2 security personal with highest priority because they will end up having nearest distance to the desired location. Neighboring other 4 security persons are assigned medium and low priority. The control center will also be involved with 4 people as a backup support. This mechanism can provide 10 different officials working collaboratively to resolve issue at users end with automated decision making and procedure selection algorithms. Ultimately, the rescue time get decreased to less than 15 minutes irrespective of the situations and scenarios at end user and city infrastructure. and in addition to security structure of city, STCS3 provides real time situation awareness information to every individual involved through different platforms.

As we discussed, Ultimate goal of STCS3, a life critical system is driven in three dimensions, safety, efficiency and comfort to accommodate best interest focused on Technology, Organization and People. The experience of a person can also show us a different prospective for a regular system to life critical system and it is a life critical system which is reliable, resilient, redundant, socio-cognitively stable, as well as controllable and observable, and it also provide s mechanism for tolerant or resistant to human error and system failure.

4. RELATED WORK

Over the time Life critical systems has impacted many different domains in following three broader categories.

4.1 Safety

There have been many discussions in papers about safety in life critical system considering many domains ranging from aviation to medicine. As shown in figure below, Amalberti's risk exposure scale has a descriptive view of different domains considering risk involved in the domain.

As in the figure, a view of an ultra-safe systems which has very lower rate of having catastrophic accident or failure with the exposure rate of 10-6 (one death per million). On the other hand, very unsafe domains, high risk cardiac

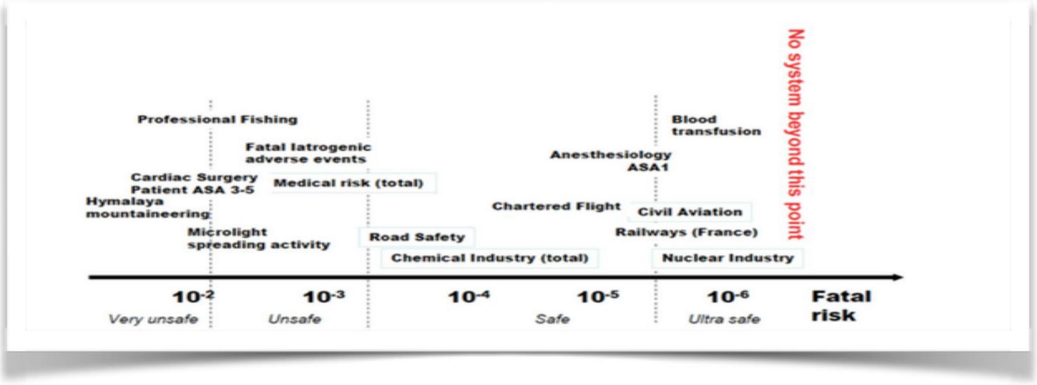

Fig.5 Safety matrix in different domain

surgery or mountaineering activity where the risk awareness is very high. As we can observe, more the system is safe, people tend to lose the risk awareness. Everything works perfectly without any errors but when a person loses the risk awareness they depend on the system more resulting in fatal failures. Human errors are unavoidable and learning from human error or previous error has been always bit advancement in the future systems. There might be many emergent cognitive functions which require us to have human centered design.

4.2 Efficiency

To have efficient life critical systems, key factors to consider are availability, maturity, effectiveness, sustainability, and ease of recovery. System availability can be represented by many models, but the basic concept is to find out the probabilistic idea about the system being available for use at any given time. It is also related to reliability of the system. There are many tools and techniques to find out reliability of the system.

Redundancy can be a very crucial aspect in life critical system. Life critical system should be up and available in normal state even after the failure of the system. LCS should also have mechanism for fail-passive, fail-safe and it should also be fault tolerant.

Any live critical system should be designed by considering maturity of technology and maturity of the practice. In fact, any system designed by human centered design approach should have technology maturity and maturity of the practice. There might not be a scale to identify the maturity of practice but we can identify if the system is being accepted or rejected by people. Acceptance and rejection of a system is always dependent on the usability and usefulness. The LCS should also provide layered approach to make it more efficient using prevention, recovery and mitigation approach.

4.3 Comfort

Comfort can be directly related to the four models created after tremendous research by many people. There have been many direct and indirect models for comfort and consideration done in the comfort. Generally, the concept of comfort can be model with respect to four disciplines, Physiology, psychology, sociology, and technology.

Physiology defines comfort as degree of pain and suffering. Psychology defines it as state of enjoyment, boredom, feeling of freedom from worry, etc. Sociology defines it as conformity to community as large and Technology defines it as technical and functional aspect of a system. The bases of comfort can be education, experience, history and conditions surrounding us.

5. RECOMMENDATION AND FUTURE WORK

There are many different areas and aspects which could be further developed in a number of ways to improve the efficiency of the system. Considering human cantered design in mind, there can be many improvement which can be done in Life critical system design such as,

- Human machine integration for assistance purpose.
- Authority sharing between human and machine for critical decision making.
- Error tolerance and resistance.
- Complexity and risk involved in LCS.
- Workload assessment
- Take over mechanism between human and machine

6. CONCLUSION

The aim of the research was to develop and demonstrate a feasible and practical methodology of security model which can be used to control a very complex and chaotic behavior of human and nature. Through machine learning and automation, we can improve upon existing methodologies. A life critical system like STCS3 can result in reduction in crime rate and can offer very efficient and reliable security solution. Such system will make security forces stronger and efficient as collaborative situational awareness can provide mean to the security officials in order to create procedural environment, automation to support security personnel's.

While designing a life critical system with human centered design, creativity and experience plays an important role. Scenario based design, iterative design process and keeping human in the loop during simulation of the system are key factors to be considered in human centered design of life critical system. To achieve the research aim, a research methodology of automation and organizational restructuring in operations was implemented, which can have significant improvements and make us ready for the security structure of the future using STCS3 which consist,

Situation awareness platform

- Geo-location positioning
- App for police for real-time tracking
- Real-time monitoring system with tracking

Control center

- 24/7 help line support via call
- Ticketing system with geo-location tracking
- Automation and digital support for decision making and predefined procedure selection according.
- Designs of operational "Procedures" based on law, freedom and expert devices from related field.

Automation

- Decision making and machine learning
- Processing server
- Information distribution mechanism

Security structure and operation organizational layout

REFERENCES

[1] Boy, G.A. (2013). Orchestrating Human-Centered Design. Springer, U.K. ISBN 978-1-4471-4338-3. -- INCOSE review by Lawrence Pohlmann.
[2] Boy, G.A. (2011). (Ed.) Handbook of Human-Machine Interaction: A Human-Centered Design Approach. Ashgate, UK. ISBN: 978-0-7546-7580-8.
[3] Boy, G.A. (1998). Cognitive Function Analysis. Greenwood/Ablex, CT, USA. ISBN 1567503764.
[4] "GPS Cycle Computer v3". Axivo Inc. 7 September 2008. Retrieved 22 April 2014.
[5] "Free Eriadne.org tracking system". Retrieved 2010-03-12.
[6] "Open-gpstracker A GPS tracking Android App: Build to be extensible and Free". Retrieved 2009-10-11.
[7] "Traccar Client - free open source Android tracker". Retrieved2012-08-15.
[8] "State budget committee rejects GPS monitoring expansion".Wisconsin State Journal. Retrieved 14 Jan 2014.
[9] "Wisconsin Legislature 165.94". Wisconsin Legislature. Retrieved 14 Jan 2014.
[10] "GPS Tracking and the Law". Salgado Investigations. Retrieved29 November 2014.
[11] Tovia Smith (August 29, 2006). "Technology Lets Parents Track Kids' Every Move". NPR. Retrieved 2011-04-25.
[12] Apt Online - Evaluation Of Vaginal Implant Transmitters In Elk (Cervus Elaphus Nelsoni)
[13] NCRB, Crime against women, Chapter 5, Annual NRCB Report, Government of India (2013)National Crime Records Bureau, http://ncrb.nic.in
[14] http://timesofindia.indiatimes.com/
[15] www.dnaindia.com
[16] "GPS Cycle Computer v3". Axivo Inc. 7 September 2008. Retrieved 22 April 2014.
[17] "Free Eriadne.org tracking system". Retrieved 2010-03-12.
[18] "open-gpstracker A GPS tracking Android App: Build to be extensible and Free". Retrieved 2009-10-11.
[19] "Traccar Client - free open source Android tracker". Retrieved2012-08-15.
[20] "State budget committee rejects GPS monitoring expansion".Wisconsin State Journal. Retrieved 14 Jan 2014.
[21] "Wisconsin Legislature 165.94". Wisconsin Legislature. Retrieved 14 Jan 2014.
[22] "GPS Tracking and the Law". Salgado Investigations. Retrieved29 November 2014.
[23] Tovia Smith (August 29, 2006). "Technology Lets Parents Track Kids' Every Move". NPR. Retrieved 2011-04-25.
[24] Apt Online - Evaluation Of Vaginal Implant Transmitters In Elk (Cervus Elaphus Nelsoni)
[25] National Crime Records Bureau, http://ncrb.nic.in