



Improving Emergency Response Communication In Race Circuits

By

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ABSTRACT

The research discusses and evaluates a way to improve emergency response communication systems in race circuits. The traditional emergency response communication system used in race circuits depends mainly on vocal communication and surveillance cameras. As a fact, the use of communication over radio connection (walkie-talkie) makes great challenge in interpreting reports sent by responders since the noise and different accents in responders' crews, which might encounter great threat and delay in response time. Furthermore, cameras blind spots and angles might decrease the certainty of the incident scene.

In contrast, the proposed emergency response communication system deploys wireless network aside with handheld devices and all other circuit technologies to send or receive instant messages between the control unit and the responders. Depending on image and text representation, that describes the scene status and the help needed cuts out the time spent in interpreting a call and dispatching the emergency rescue crews. In addition to data transmission, the solution will collect and manage data for later investigation and use.

خلاصة

يناقش ويقيم البحث النظام المستخدم للاستجابة للطوارئ في حلبات السباق . حيث يعتمد النظام المستخدم حاليا في حلبات السباق على الاتصال الصوتي وكاميرات المراقبة والتي في الواقع تشكل تحدي كبير لمستقبل الاتصال في استيعاب واستخراج المعلومات المرسله اذا ما وضعنا عوامل مختلفة في الحسبان مثل الضوضاء واختلاف نطق الأحرف عند الطاقم المسؤول ، وهذا التحدي يشكل تهديدا بسبب التأخير الناتج والذي يطيل من مدة الإستجابة . أما بالنسبة للكاميرات فلا يخفى مصطلح النقاط العمياء لدى اجهزة تصوير الفيديو والاتجاهات والزوايا التي لا يمكن لهذه الاجهزة الوصول لها مما يجعل الحصول على معلومه واضحة عن موقع الحادثه صعبا احيانا .

على النقيض من ذلك نظام الاتصال المقترح والذي يوظف الشبكات الاسلكية مع الأجهزة الكفيه وكل التقنيات المستخدمة في حلبات السباق لإرسال واستقبال رسائل فورية بين غرفة التحكم والطاقم المسؤول عن الاستجابة للطوارئ .بالاعتماد على الرسائل النصية والصورية التي توضح موقع الحادثه وحالته ونوع المساعدة المطلوبة ، مما يقلل من الوقت المطلوب للاستجابة من طاقم الطوارئ ، بالإضافة إلى تجميع وإدارة كل المعلومات الخاصة بالحلبة خلال السباق وحفظها للتحقيق لاحقا .

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Completing this research was such a challenge to me because of the lack of resources related technically to motorsports. In addition to the fact that motorsport people really top secret every detail that might be significant to researchers. Motorsport's in the U.A.E is fresh and new everyone works by the book, but without the support of a number of people I would never reach as far as I knew to complete this research. First of all my parents who really worked hard with me in the encouragement part they kept me working hard and tried to make it easy for me, also my sisters and brothers who stood behind me. Mr. Mohammed Bin Suliem the racing icon in my country and number of his assistants who provided me with access to Race control, and guidance. I just want to deliver my thanks to them.

In the journey to accomplish this research I had to attend meetings, interviews, and even meet really interesting motorsport icons. The process was hard but it was interesting and exciting in the same time. I was able to attend motorsports events not from the audience view but from the officials view which reveals much more of what I thought before. During the research I understood many concepts in emergency response and racing environments like rules regulations and other information that I was not aware of before.

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Declaration

I declare that this thesis was composed by myself. That the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted to any other degree or professional qualification except as specified.

(Asma Muhsen Al Ameri)

Terms

The following pages contain terms and definitions used in the research and might not be clear or known.

- **Clerk of the Course and Race Director:** Based in the race control . The Clerk of the Course is responsible for the overall organization, safety and judicial decisions.
- **ER:** stands for Emergency Response.
- **SecureConnect :** the naming of the proposed system
- **Incident officer :** “responsible for the team of incident marshals and equipments. Incident officer describes the location of marshals around the track.
- **Marshals :** According to (marshal guide) Marshals can be anybody interested in being involved in motorsport event . They are trained to response to incidents in the circuit.
- **Observer :** “Senior official in charge of the post .”
- **Post :** location on the circuit where a group of marshals located to response to the incidents in this specific location and refers to the ID in the proposed solution .

- **Race control (RC)** : the head quarter in control of the racing event which handles communications with marshals' posts , emergency vehicles , scrutineers , timekeepers , judges of fact , Paddock , Assembly Area , Pits and start line .It is simply the Clerk of Course's office while the track is occupied by contestants . It is the main circuit information center. All decisions and instructions are issued from there. The SecureConnect PC part of the application is located in the race control .
- **Responders** : any actor in the emergency process like a firefighter ,medical crews , and marshals .
- **Sign on** : time where marshal arrive to the circuit to find out their location and gather their gadget , most of the time there will be a briefing from the Clerk of the course to all the marshals or the post chief. In the SecureConnect application it is the module where the PDAs IP or ID configuration is done.
- **Stewards** : ensures the safety of a running event . Stewards are responsible of submitting a report to the Motor sport association at the end of the event judging the ability of holding further events. Stewards sometimes act as an immediate court of appeal for drivers and teams against the clerk's of the course decision.

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Chapter 1

Overview

1.1 Introduction

The organization of any motorsport event requires high level of safety measures and qualified facility, moreover organizing such event needs qualification to the holding facility by the FIA federation , FIA stands for the The Fédération Internationale de l'Automobile, which is the international association, concerned with organizing and holding motorsport events. Qualification by FIA relays on strict rules, regulations and specifications, in order to ensure high level of safety and rescue resources. Consequently organizers encouraged the use of information and communication technology what changed people thoughts about participating or attending any motorsport event.

Deploying efficient communication system focusing in organizing coordination between the emergency response parties ensures more successful response to emergencies, using instant messaging reduces the time needed to report and update the headquarter knowledge about the emergency scene. Just like the technology used in fire stations where a message is sent directly to the fire fighters through computer with the incident's exact location.

the strategy used in the research to improve emergency response communication technology depends on time reduction , message clarity , response , and accordingly the quality of the decision taken , this is by reinforcing verbal communication with handheld devices carrying automated multitask solution fulfills the need of racing environment .

According to marshals' database in different places naming Europe and Middle East, marshals have different backgrounds, nationalities, languages, education and accents. This makes great challenge to call receiver, in understanding and processing a report.

The time between reporting incident , processing the incident aspects and taking any action is really valuable in case of serious accidents and running events because it can be life threatening . While using this time to enforce safety makes the racing environment safer and more attractive.

In addition to the previous fact, the proposed system keeps record of each message send or received to aid in further investigation.

1.2 Motivation

Attending different races from organizers view showed the weakness of the communication tool (walkie-talkies) used to report an incident , therefore developing a solution the improves and replaces the old communication system will cut out the time used to response to any emergency by instant messaging over a wireless network rather than vocal communication in using radios .

1.3 Research Question

The research question is the effectiveness of improving emergency response communication system used in race circuits to cutout the time used to response to an incident .

1.4 Research Objectives

The objective of this research is to propose and evaluate the use of automated instant emergency response communication system between responders and control unit that organizes the emergency response life cycle between the two parties.

1.5 Thesis Structure

This thesis is structured into five main chapters presenting the idea of the research and supporting the effectiveness of the suggested solution.

- The First chapter contains general introduction about the problem and some clarification about the motorsport environment and terms.
- The Second chapter is the literature review describing emergency response systems and the functions definitions under any emergency response systems in addition to general information about decision making while the response process involves many decision making.
- The Third Chapter is about the use of information technology in different emergency response systems and the knowledge collected about the current system in Yas Marina Circuit located in Abu Dhabi , UAE.

- The fourth section is demonstrating the proposed emergency response communication system and the advantages of such system which can be reused by other users like police and hospital crews.

Chapter 2

Literature Review

2.1 Emergency Response

2.1.1 Introduction

The definition of emergency response is the process executed to prevent damage to any valuable existence, and responders are the people, organization and crews responsible for responding to an incident call. Many emergency response association and teams deployed information and communication technologies to improve the quality of the response process, for example, the use of GPS (Global Positioning Systems) and satellites to located incidents. In such changing and important field researchers tried to evaluate and suggest the use of different information and communication technologies to help improving the emergency response process quality.

To avoid accident and nature disasters is hard, the need or crisis management and emergency response arouses. In the other hand, emergency response teams can be useless in absence of collaboration, which make information and communication technology fundamental. For example, the rescue service in metro areas using mobile command units and wireless connectivity to command counter network but as a fact the integration between those systems and other systems was limited, which makes using a solution that covers all rescue services at the same time a better idea.

2.1.2 Emergency Response in motorsports

The faster the response to an incident the better because of the fact that time is a challenge when trying to save peoples life and gain trust. At the time of the incident , the incident officer (Responder) reports the happening to the Control Unit using a walkie-talkie , after that the control unit will take action towards this incident like instructing vehicles to slow down

As a result of different meeting with marshals and race organizers it is clear that they come from different backgrounds such as Arabs , Indians , Asians , Europeans , Canadians and other nationalities that depends on English to communicate ,which make it difficult sometimes on the call receiver (Incident Chief) to understand the call from the first time . In addition to that, radio users in general complain about the common misunderstanding in vocal communication because of radio noise. For instance when a sender says fifteen it can be received as fifty as a result of the poor sound that similar ate some words.

The verbal reports sent by responders are the only description of the situation depending on the received description and the control unit experience about the field a response strategy declared achieved by the first responders. For any report received by the control unit there are further testimonials to prove and support the incident details, this is to keep record about each incident occurring at the event time.

2.1.3 Response in Real Time

Studies on emergency response technologies aimed to improve communication systems used to trigger alarms and receive commands, to increase the functionality and accountability of rescue groups. Other studies focused on time, collaboration, and designing ideas according to the casualty. Different parts of the research built upon evaluation done on some studies in the same field.

Responding to an emergency makes the responders a part of it because responders can prevent or increase the emergency level for instance a responder using wrong type of fire extinguisher will result in harmful consequences that increase the level of emergency.

The successful interaction between responders in ambiguous situation enables discovering different ways to interfere and reduce the rise of the disaster . To study emergency response and how organized between different sides, the focus must be on the group interaction in addition to the information and communication technology used by parties in this field.

2.2 Relation in Emergency Response

This section describes the relationships in Emergency response between responders, and the methodology used in dealing with a happening emergency.

The occurrence of an accident triggers a threat to people, property or environment, which leads to the start of the emergency response process in order to prevent further or probable harm to any valuable existence. Generally, (Responders) or the emergency response service providers organize the Emergency Response processes, where patterns of interaction between various responders occur to organize the emergency response. Undoubtedly, the use of mobile phones interaction compared to radio communication gives advantage as a verbal communication, but if we thought of it as a verbal and information sharing the advantage will be much higher. In other words including verbal description of the incident but with symbolic and image represented information to improve the knowledge will influence the decision makers from the head quarters . It is not about making it more complicated but to support the process in different aspects naming time, response and crews.

2.3 Researches on Information technology for Emergency Response

The Design of emergency response management systems is upon the command and control point of view. It focuses on the decision makers that certainly follow hierarchy to reach a final decision. All of this concludes that effective processing of information can

produce a picture of the common operation; which means the necessary information will always hit the appropriate decision makers to come with a correct decision to use the correct response strategy (Jungert, Hallberg & Hunstad, 2006). Other studies on fire fighter's communication systems suggested that this communication tool can be improved by supporting the hierarchical structure of the emergency response levels , as an example reporting to the person above the sender in the hierarchy. (Camp, Hudson, Keldorph, Lewis & Mynatt, 2000).

The setting of the Control Room or the Command Room and emergency responders (named actors in some studies) presents complex work structure and practice where the information technology use falls to the idea of command and control. also these studies sketches that the decisions are co-operatively build between operators as the work load on the teams is already defined (Heath & Luff , 1992 , Normark 2002 , Pettersoon , Randall , & Helgesson 2002) .

The Change on mobile technology and the wireless infrastructure changed the way of using or employing mobile to support emergency response (Stephenson & Anderson , 1997) while the connectivity between responders is more easier than before the improvement focuses in other design aspects in emergency response management systems (Turoff , 2002 , Turoff , Chumer , Van de walle & yao , 2004 ; Yuan & detlor , 2005) .

The more capable mobile technology become the more studies that specialized on the use of information technology are encouraged to support the process in different ways , not only the reporting part but also building the complete successful response operation .

2.4 Decision theories

It is a phase to implement safety measures to prevent an incident from causing further damage and to return the event to a secure status. It is about containing, solving, and preventing the problems from happening again.

Many researches and the number of interviews to come with a simple idea about the process behind the responders crews suggested that the decision making approach which depends mainly on hierarchical system or as called a distributed decision making (Brehmer, 1998) . But in the first running event while watching some minor incidents it was clear that there is no single approach used to respond to an incident. In more simple words sometimes the acts, waits for the hierarchical system to take place and sometimes it just decided without going back to any hierarchical system.

Theories like distributed decision making , naturalistic decision making (Kelin, Calderwood & Clinton-Criocco , 1998 ; Klein , 1997) and the option decision strategy (Klein , 1993) was similar when trying to think about them for the studied case because it showed that first responders or person in the scene decisions and knowledge is critical in the overall process and decisions .

During some readings about firefighter crews and theories applied to represent a picture of their Responses there was a theory called, Sense making which can be found as Karl Weick's Sense making theory (Weick , 1979,1995) this theory widely used in many studies concerned with organizations responsible for emergency response . Due to the similarity between the proposed system and the firefighter's crew problem the theory helped representing the proposed system clearly. The main aim of this paper is to improve the Emergency Response by making sense of using Information and communication technology as many studies before adopted sense making to assign information technology that improves the overall sense making activities.

In decision making it is always about what should we do? But in Sense making theory it is about a bigger question which is what is going on? The fit between what is expected and what is come upon (Weick & Meader , 1992) .

Understanding that a person or experiences of a situation made clear progressively is one of the main aspects of sense making theory (Weick, 1995). To make sense of anything an action must be taken this means there must be interaction to create meaningful facts. Sense making social context will affect the type of extracted indication and the interpretation of these indications.

Due to the time, critically sense making focuses more on the reasonable rather than the accurate. It is facts that sense making is visible when ambiguity or surprise comes to action, this means that when people expectation conflict with what is experienced at that

point the more information the more turbulence sense without decreasing the ambiguity (Weick, 1995).

What is an ambiguous situation? A situation can expect a number of interpretation or probabilities, in such situation people start extracting their knowledge from previous experiences to create more stable situation to deal with and can accept applying on whatever they know (Weick & Meader, 1992).

From the Emergency Response point of view, the previous will mean that when responders responses to an emergency they automatically create a list of point that is used for sense making which help in reveling the crisis (Weick, 1988). The responder's actions will affect the emergency and then will affect their future actions.

Responding and interpretation are not taken individually , but it is a collective process (Weick , 1995) this means the interaction between people and the number of responders will give greater chance to team up to decrease the escalation of the crisis (Smircich & Stubbart, 1985). In other words organization surfaces from sense making, but sense making is not a result of organization (Weick, Sutcliffe & Obstfeld, 2005)

2.5 The Response Operation

2.5.1 Response Preparation

Before responding to any emergency call we need to verify the truthfulness of this emergency. Once the emergency call verified an appropriate solution from the solution (knowledge base) or the decision makers applied with strategy while keeping in mind that there is associated risk related to the proposed solution, to ensure the availability of the sufficient emergency response resources in time.(Emergency response operation figure2.1) . In other words, the response preparation process is critical it also depends on the availability of the resources and task verification, in order to reach a response solution, which is the start point in solving an emergency.

2.5.2 Emergency Response

This part of the response operation is more like coordination and collaboration, where the crews, experts and communication means described. Dispatching the right personal or crew to the right place, establishing reliable communication with them and then lunching expert group in the case of difficult and unexpected situations, are the main highlights in the Emergency response processes. As an example when an ambulance reaches a patient in a forest that requires filed operation to keep him/her living for the time needed, to reach the hands of surgeons or doctors, doctors might direct medics in a simple operation by describing it gradually using communication technology.

2.5.3 Emergency Rescue

In this process the success of the response operation depends on number of factors , such as responders role while interacting with the scene and emergency (where responders needs to provide medical care or assistants if needed) , evacuation of people affected by the emergency , controlling the emergency scene , monitoring the emergency development and finally alerting decision makers about further danger signals .

2.5.4 after incident

This is a critical process where the investigation about the causes or elements participated in the incident occurrence is held to prevent future threats. In addition to that, it spots the causes of the rise in the incident, which might be as a result from the response operation. Actually, this part is very important for further responds, where it is like a knowledgebase to go back to in case of similar emergencies.

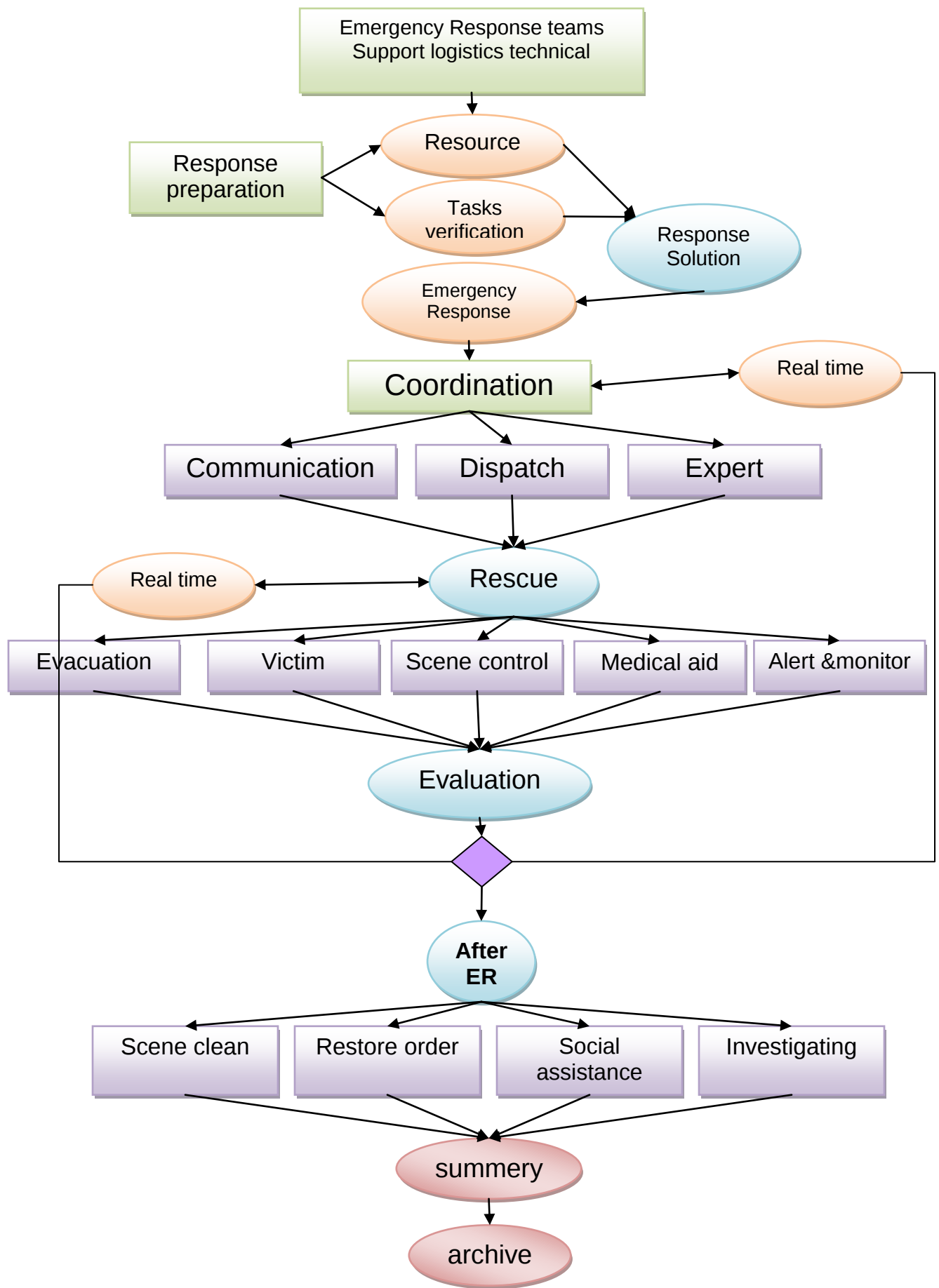


Figure 2.1 Emergency Operation

2.6 Time critical Response

Emergency response as discussed before is one of the main processes in the response operation , that is affected by different factors like responders , communication tools and time . Hence time needed to response to any call is a main factor in the successfulness or failure of any response operation, the use of information technology comes handy to support the emergency response in time reduction. For example, if an emergency responder reported an incident in need of more experts in the location by clicking on the PDA screen on specific icon that sends a message instantly carrying the location and the type of experts needed , without the effort of typing or verbally communicating with the head quarters , will definitely show how much time , effort , and even comfort to the casualty the process is , in addition to the chance to use time in providing more details that to the control unit or who ever in responsibility of supplying the scene with more effective tools , people or transportation means .

There are other points or effects that might interfere on the response time such as the time pressure on the responders that are located in this research mainly around a race track which mostly depends on their physical ability to carry or move around and communicate using specific body postures. In addition to the ambiguity of some calls or requests that may cause some trouble on the responder's lines while trying to attend an incident. Such a dynamic situation forces the responders to act fast and depending on immediate reactions towards the scene, which sometimes might lead to unwanted result. The previous problem can also be because of distributed teams working separately without communicating with each other to improve the situation.

2.7 Incident Response methodology for motorsport events

The following pages will show the incident response methodology from the motorsport organizers point of view. Processes in the response methodology divided as follows.

(Figure 2.2 seven components of incident response)

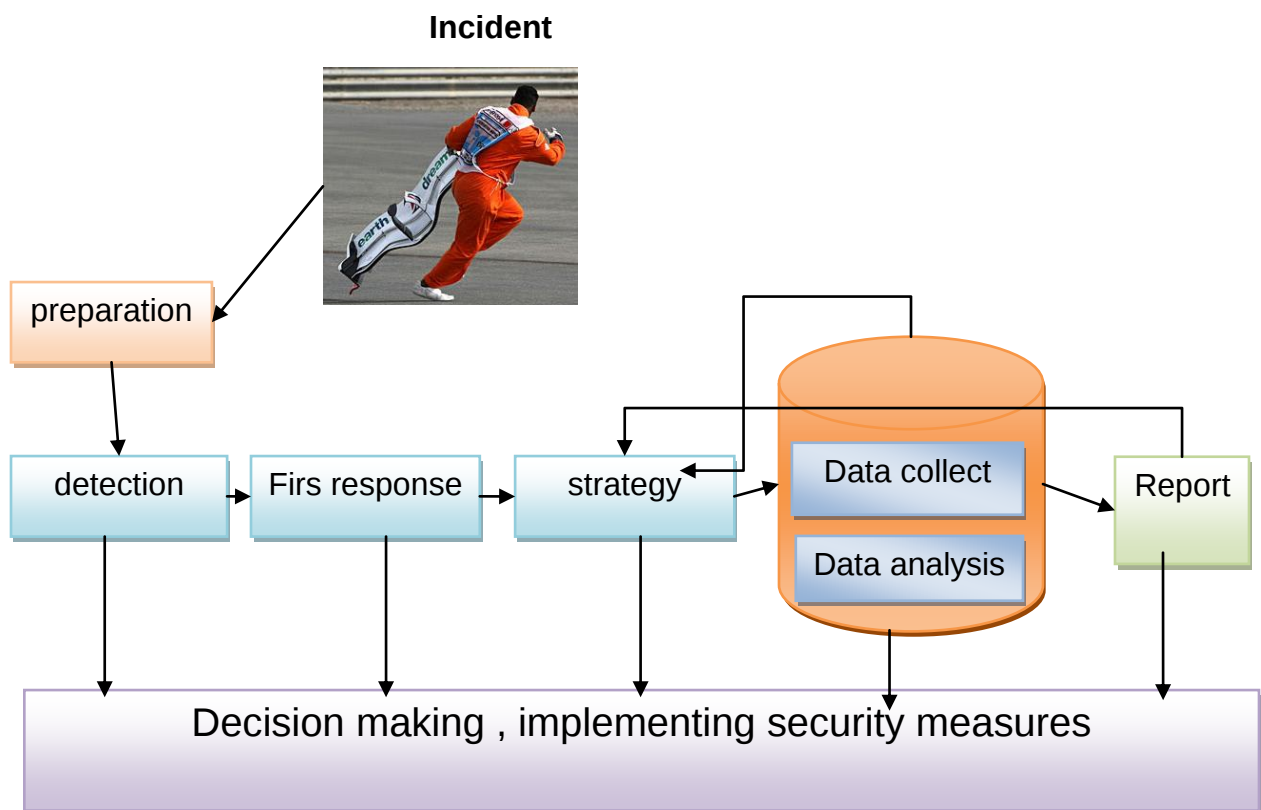


Figure 2.2 Seven Component of Incident Response

1- Preparation before incident:

The scene or post must be prepared by providing it with people and supplies to respond to any incident for instance locating ambulances and marshals around the racetrack to attend any emergency.

2- Incident detection

Predicting the incident before it happens gives advantages in responding to it for example , posts located in turns or near to a hotspot in track usually have high percentage for incident occurrence than straight lines.

3- First Response

Where marshals are the first person harrying to the incident in the race track and reporting it, it is important to record details, investigate, gather the response team, and notifying the commander or as the decision makers .

4- Response Strategy

After analyzing the situation according to the previous steps , the best response will be decided after upon the approval and support of the decision makers (in motorsport case decision makers are in the Race Control Room).

5- Incident investigation

In this step the processing of the collected data is held , to find out what happened or what causes the incident to occur to prevent further incident from happening and to be prepared for it.

6- Reports

Finalizing the findings concerned with an incident and the response operation to keep records for management use.

7- Decision:

Employ security measures and procedural changes, in addition to recording lessons learned and developing long-term fixes for any problems identified.

2.8 Response methodology for motorsport events in focus

2.8.1 Preparation

Focuses in preparing the circuit and officials to response to any incident that might take place during the event as motorsports field is not predictable and anything can happen anytime. Consequently good preparation before the occurrence of any incident gives a great chance to achieve the best possible response. The preparation phase is not only to prepare the circuit with tools and technology but it also includes preparing marshals , officials and responding crews with training to act fast and effectively towards any incident . Preparation phase in circuit includes providing tools for different crews (medics, marshals, fire fighters, towing team) and providing Race control with the latest technology to monitor the facility. In addition to training all involved personal (training in different fields , Rules and Regulations , first aid , fire fighting , .. etc) to be able to

handle any incidents inside the track . Furthermore, the track inspection to which makes sure that it is safe to hold the coming event.

2.8.2 Incident Detection

If an incident can not be detected then there will never be a good or proper response. The incident detection is one of the most effective components of an incident response if it was fully employed it will give responders full control of the situation. This will lead directly to the question how can we detect an incident? there are many ways to detect incident that might differ from a field to another , for example when a car speeds towards a sharp turn to compete with another car , the team in that turn get informed to be ready expecting a crash or at least a drifting car , so obviously it can start from the team doing nothing when a driver's car drift and continue the race to a deadly smash to a wall The teams will hurry to save the racers life and remove any obstacles from the track to ensure other racers safety . Because the team was informed about the speeding cars the teams were ready to run for help. So the medics and other crews will be ready and close to support the marshal team.

2.8.3 First Response

It is simply obtaining information to determine appropriate response by team , collecting as much as information about the incident scene , determining the incident type , reporting to the Race Control and assessing the incident impact which all are important to be covered by the response strategy . These steps are also important to document

everything during a response. The first response phase records the incident and a detailed idea about that incident including (incident type, impact, and other information) to give advantage to decision makers to come with a correct and safe decision to handle that incident.

2.8.4 Response Strategy

Many strategies are there to response to incident according to it is type, impact and even time which was previously recorded in the first response. The strategy decides the resources needed to response to an incident . Likewise there are factors that help in decision making for example how dangerous is the incident (the threat it presents to the surroundings) , the location of that incident (any object in the track is high level danger) , the impact of that incident (dose it threaten lives ? and is it going to create more damage ?) and the team preparation .

Incident can vary naming a drift ,car malfunction, tire explosion, crash to a pole, crashing with another car , and cars on flames which is one of the most serious accidents that can threaten not only the racers life but also officials and public lives.

Details obtained during the first response can be critical when choosing the strategy. For instance assume that a car stopped in dirt making it not possible to drive to track again, marshals can attend the car and return it to the track without the need of medic crews be available around the post , but in this case a tow car can be present to help in moving the car. In summery it is all about deciding who will be running where and calling the right person at the right time in the right place.(Table 2.1)

Incident	Response strategy	Outcome
Car drifts to dirt	Marshal and tow car release car from dirt.	Race continue, racer come back to compete, audience satisfied, event continues.
Car catches fire	Fire fighters and medics crews to post , marshals carrying fire extinguisher runs to vehicle , flag to be raised if car in track , remove racer if needed , remove car from track if can not continue race ,if small fire racer continue race .	Make sure racer safe, race continues without losing lives, incident will never ruin an event. Audience satisfied and feeling safe.
Table 2.1 Possible response : the outcome of some responses.		

In response strategy in motorsports there are some things called actions , actions are judgment needed to be taken against racers , teams , marshals and sometime public that can interfere in the event safety . For example, some racers competing to occupy the first place can include dangerous behaviors like those that overtaking in an area that overtaking not allowed, accordingly then the Race Control might decide to take an action against the racer like slowing down his car or disqualifying him/her from the competition.

2.8.5 Incident investigation

After and during the incident depending on the initial data send by marshals incident investigation process is started to determine the causes of that incident determining what was damaged and by what or how ? Investigation is divided to two phases, collecting data and analysis of the data relevant to resolve incident and build a response strategy.

Example of questions to investigate an incident

Incident : car crash

What caused the crash?

- 1. competitor**
- 2. speed and overtaking**
- 3. object on track (hard object , or oil)**
- 4. environmental (rain , or other weather condition)**
- 5. Car malfunction.**

If other involved who caused it?

And how it affected the situation?

Does it need action against the person?

Data collection is a collection of facts and clues. If the data collected is not enough, it will be difficult to find the reason behind the incident. This is why data collection logically done before investigating anything (while investigation needs something to relay on to come to conclusions that will help out the process and will add to the knowledge of all the members to avoid further harm by similar incident).

2.8.6 Reporting

It is a key phase while conclusions and organized facts with testimonials of marshals and officials are included according to the incident. This phase mainly describes the incident in deep details giving information about:

- 1- What happened?
- 2- How it happened?
- 3- Where it happened?
- 4- How the crew reacted and thought of the incident?

5- What was the Race Control or the Decision maker's decision?

6- Sometimes it includes image representation of the incident.

Marshals and crews are required to fill reports containing all the previous information about any incident they responded to, in order to keep record of everything. But these reports are done after the race which might encourage the chance of losing some details and being confused with other incident details as a result of a long and full day of work

In conclusion many researches showed the importance of the communication factor between emergency response parties to improve the response quality , furthermore collecting and keeping record about incidents to make the decision making process easier depending on previous knowledge . As well as the importance of the first responders knowledge about the response achieved to reach a high level of understanding and confidence in dealing with the situation in hand .

Chapter 3

Everyday Response in motorsport environment

3. Everyday Response in motorsport environment

3.1 Background on motorsport

Motorsport is one of the most important sports that attract audience from everywhere, like formula one race. In the past, the idea of attending a motorsport event was life threatening while races held in open streets that was not safe for people, teams or emergency crews. In addition, the recent incidents happened in different racetracks resulting on marshals, racers, and public death spread the doubt that motorsport will stay on of the top entertaining sports in the world. But now with circuit like YAS Marina Circuit in Abu Dhabi , UAE equipped with safety measure and luxurious visions for audience the attraction to motorsport event increased to reach high levels to encourage the use of further information technologies that competes to make events safer and full of competition.

Since motorsport involves high risk, emergency response and management systems must be presented on circuit just like any organization responsible of attending incidents like floods, traffic accidents, earth quakes, pollution hazards, and everyday's emergencies like fire, and hospitals.

This chapter will present a general idea about everyday work practice of officials (marshals, officials and other crews) involved in the motorsport event. It will describe some of the tasks, tools, training and information technology support. Information

presented in the following pages are acquired from experts in YAS Marina in Abu Dhabi ,UAE Circuit and the motorsport organization by interviewing, providing documentation and observation during real events from officials point of view.

As this research concentrates in improving the communication system used in YAS Marina in Abu Dhabi , UAE , the data collected will be organized according to the following main points

- 1- Response preparation
- 2- Communication parties
- 3- Communication tools
- 4- Reports types

3.2 Response Preparation:

Prior to any motorsport event there are meetings , conferences , training sessions and advertisement to cover all the event needs from the financial support to finding participants to work as marshals in the event . Meeting are held with officials to be informed about the event schedule. After that, the training sessions held to give marshals an opportunity to know each other, get familiar with the equipment, and know their roles, their teams and locations. According to the marshals experience some of them signed to special training sessions to hold positions that are more critical.

3.2.1 The Event Day:

In the beginning of the day all marshals meet with the officials encouraging them with a small talk then they sign on. All officials must sign-on and check back with the senior

officials regarding their locations and roles. Every signed – on official is in duty until relieved. Sign-on is important to cover some shortage that might happen because the absence of some marshals. After that the teams gather and receive their Radios and test it to replace headsets or handsets if not working. Then they double-check the tools, water, and food they need for such a long day.

After that Marshal Head to their locations confirming to the Race Control that everything is running smoothly and no problems to attended. Then the Clerk of the Course starts the track inspection , which is checking the race track for any faults obstacles and objects that might threaten the safety of the event. All of the inspection done while the Race Control monitors the track, marshals and crews in their posts.

3.3 Communication parties?

Race circuit include many people from big circuits .Like Yas Marina Circuit in Abu Dhabi , UAE , there are thousands of people in such a place in one time , but talking about who work there or who will be in the circuit in meaning the people involved in responding to an incident .

- 1- Officials (Clerk of the course, Stewards, motorsport managements, technicians)
- 2- Marshals
- 3- Fire fighters crews
- 4- Medic crews

In this research the concentration mostly on marshals and officials, it is true that marshals calls other crews like medics and firefighters But the first responders to any incidents are marshal.

Marshals are not like fire fighters or medics, they are not employed nor paid for their services in motorsports events, and some of them participate for the first time in their life. Marshalling encourages motorsport fans to be a part of an event they used to watch from audience views, to be more close to the action of this sport that make participating in such dangerous place the most attractive unpaid service in all sports. marshals attend some training sessions to be prepared to use the tools and understand the motorsport rules and regulations which encourage them to care about their own safety in such dangerous environment where marshals are exposed to many dangers like drifting vehicles, flying objects, fire explosions and other dangers that can occur while trying to respond to an incident.

Marshals are the first group of people with the officials to be present in the circuit , in order to find out there location which is called in motorsport (POSTS) and make sure they are all well and fully equipped according to the FIA (Fédération Internationale de l'Automobile) . Marshals are asked to wear comfortable clothes made from natural fabrics, and are not allowed to wear any manmade fabrics, also over their clothes they have to wear an overall protective suite usually orange (to make sure it does not interfere with the flag known colors).

To develop a system for such field it is necessary to understand more about it, the following pages will describe many terms, rules, regulations and facts to support the research. These facts and rules were recorded according to the interviews and filed work accomplished in Yas Marina Circuit in Abu Dhabi , UAE.

3.3.1 Firstly, who organizes the event?

The event organizers are very important because they put the rules regulations and communication hierarchy. As well as the organizers are the ones who provide training and all facilities needed to response to any emergency.

- **Promoter** : the organization responsible for the commercial and technical aspects of the event.
- **Organizer**: who is responsible for the circuit activity at the Grand Prix?
- **Federation Internationale de l'Automobile (FIA)**: controlling body for motorsports around the world.
- **Formula One Management (FOM)**: is the body through which the Formula One constructors Association (FOCA) conduct it's administration of Grand Prix. It is the commercial units of the FORMULA 1™.
- **National Sporting Authority**: association responsible for the control and administration of motorsports in the area, approved by FIA.

- **Race organizing Committee:** clerk of the course, secretary of the meeting and representatives from different associations interested in the current event, which hold complete responsibility of the event.

3.3.2 Secondly, who are the responders?

Normally every post will have a Post Chief, Incident Officer, Flag Marshals and Track Marshals. The following page will discuss the role of every one of them in brief.

- **Post Chief:** the responsible member for the Marshals safety and directions, every Post Chief must brief marshals at the start of the day, ensuring the checking of the equipment, the availability of the tools and to report anything to the Race Control. He must verbally inform Race Control of incidents within their section, supporting this call with a written report to be handled to the Clerk of the Course.
- **Incident Officer:** Generally, he is the Clerk of the Course eyes during the race, incident officer reports incidents by radio in the first instance and continue updating the Race Control of the incident situation.
- **Recovery Vehicles:** tow trucks, mobile cranes, tilt tray units, 4WDs with recovery roles allocated by Race Control.

- **Safety Car** : it is used during the race if a problem occurs which requires the control of the cars to slow down or to be stopped , the race will continue after the Safety car exits the track
- **Race Control** : the head quarter or the main heart that controls the race which handles communications with marshals' posts , emergency vehicles , scrutineers , timekeepers , judges of fact , the Paddock , Assembly Area , Pits and start line .it is simply the Clerk of Course's office while the track is occupied by contestants . It is the main circuit information center, all decisions and instructions are issued from there.
- **The Race Administration Office:** located next to the Race Control it is the sporting Radios connecting these units, responding to initial directions from Race Control.
- **Equipment Team Vehicles:** service or utilities to deliver drinks, food, equipments.
- **Course Car** - Positioned in the Pit Lane or approved position by the Race Director. The course car closes the track with a red light showing before each session or race on the track, checking that the track is completely ready for

competition at the same time. It opens the track with a green light. It also can be used on an open track to collect report forms from around the track.

- **The Secretary of the meeting** is the senior administrative race official and who is responsible for the sporting organization of the meeting, and for all announcements required. In other words the Secretary of the Meeting is responsible for planning and organizing the event, but the Clerk of the Course is responsible for conducting the activities.
- **The Emergency Coordinator:** assessing the Clerk of the Course in responding to incidents and other emergencies on the track, works in cooperation with the Chief Medical Officer who is the senior Scrutineer.
- **FIA Medical Rescue Coordinator** who is responsible for on-the-ground responses to incidents. The Race Director shall work in permanent consultation with the Clerk of the Course.
- **Clerk of the Course:** must be a national and have authority in a number of issues about the conduct of the FORMULA 1 event, including starting and stopping of activity on the track, the use of the Safety Car, scheduling the activities and discipline of the FORMULA 1 contestants and drivers. Senior local official he is responsible of controlling all race activities, and other activities where circuit safety and functioning may be involved , in accord with the regulations and

scheduling drawn up for the event. All other The Clerk of the Course has a Deputies and a number of Assistants carry out some of his duties.

- **Medical Centre:** is the medical facility for treating injuries and providing all medical services in the circuit, located next to the Race Control.
- **Chief Incident Officer:** responsible for all Incident officers and controls the overall incident handling track marshals and other crews.
- **Chief Flag Marshal :** responsible for the flagging signals shown to racers.
- **Race Control officials** – controls the race control radio channels and sending messages from and to the Clerk of the Course.
- **Timekeepers:** above the Race Control in the tower the time keepers overlook the start and finish line, they record the time taken for every lap for every contestant during all the qualifying sessions, in order to produce a printed result of each session.

3.4 Communication Tools

The circuit is equipped with different emergency response tools but in posts there are medical teams close to response to incident, fire fighter, and other crews just to ensure safety. Marshal's teams are equipped with different tools also, like fire extinguisher,

flags, water and radios. All the tools must be available and usable by checking it's expiry date. The following pages will present some information about some tools and equipments used in the circuit.

1- Race Control :

The Race Control is equipped with Screens showing the position of the Dig Flag panels (will be explained later) and flagging area in each position. The system will automatically perform some actions according to the flags chosen for example showing a Yellow Flag in a Post with a Mirror, the same flag will be automatically shown at the mirror point. Also the system can maintain a record of all flag operation and who decided the operation. the Closed Circuit TV (CCTV) which is a system controls cameras around the track enabling officials to focus and see all areas , this system give the officials a bigger opportunity to support response people and decide the best way to act towards an incident .

2- Marshals :

There are different types of equipments used by the marshals

- **Walkie-talkies** : radio communication to report incidents and receive commands which will be explained in more details as the core communication tool.
- **Flagging system** : which are the flags used to announce a message to racers , race control or other posts . this communication tool is very important as it will be explained in details later on this chapter .

- **Dig flag** : electronic flagging system .the Marshals must mirror the flag presented in the Dig flag system. Dig flags are controlled from the marshal posts but the Race Control has the privileges to override the system
- **The Digital Panel:** at each flag post also the start and finish line a Digital panel is mounted. It consists of LEDs on a panel to be lit on both sides and is able to be rotated. In the start and finish line there are some special panels representing the three black flags?
- **-The Marshals Control box:** it gives the Marshal the ability to pick the flag exhibited at their post. It also shows what flags are shown in the previous and following post.

3.4.1 Radios

Radio communication systems and other systems used in the Race control available to help in running the event smoothly and to response to incidents. Marshals and officials are equipped with radio handsets to communicate with the race control. In case of observing an emergency the incident officer will report the incident to the race control and will provide the Race Control with details to help in deciding the next step. Marshals will work according to their roles to help in the incident.

Tools like the Closed Circuit TV, makes it easier for Race Control to monitor everything happening and supporting their decision with postures and images sent by the marshals.

The Radio distribution among marshals is in a way that no marshal is farther than 50 meters from a senior marshal with radio contact with the Race Control, by this the Race Control

ensures that all marshals can be notified and commanded in short time, also the marshals sent warnings and some information to the Race Control with this distance the senior marshal can send this information in seconds.

The Radio channels used in the circuits connects a number of officials, so it needs rules in using it because of the fact its on- at – a – time calling system. Also the calls between officials and marshals must be arranged by the Race Control, these calls are only to transmit important information to keep the event running. Once the transmit button was pressed the system is occupied by the official pressing the button, no interruption can happen. In some situations when attending an incident the button is pressed unintentionally this will disturb the entire network.



Figure 3.1 Walkie-Talkie And Marshals

3.4.1.1 Steps to use a Radio

First the marshal will collect the fact needs to be transmitted, marshal will listen to the channel if it is clear then the transmit button is hit and make the call. During a call marshals are encouraged to use clear voice and phrases already known and agreed on by the Race Control. To show the clarity of the transmission marshals use the phrase “Reading you five by five “

1- Calling In

When transmitting callers must identify themselves by the official title or call-sign for example Medic 1 , or by telling the location which is according to the maps distributed to them after identifying themselves the caller must identify the intended recipient almost at all times the Race Control . Then the caller must wait for acknowledgement to send the message and make sure that the recipient was alerted at the end the call is over.

Press transmission button

Identify your self and location

Identify your recipient

Wait for acknowledgment

Proceed with the message

Alert is done

End the call

2- Radio Message

Messages must be clear to the recipients no personal abbreviation or other phrases are accepted while transmitting a message. If the message was not clear to the recipient a repeat might be asked to make sure of the delivered message especially if the message transmitted was dangerous in the matter of event or personal lose. All senders must be calm and brief to the point no conversations are made during the transmission of a message.

3- Sending Incident message:

First of all the incident status description must be given clear and exact keeping in mind that the Race Control will make the correct decision according to the information transmitted by the Incident Officer . To make the message clear Incident Officer must describe the incident location accurately according to the circuit sectoring, after that he must recommend the type of service maybe needed like Medical or fire fighter, and Ambulances. Then the Race Control must be informed about the progress of the emergency responses and activity.

- **Terms and Letter pronunciation used in Radio**

To make the message clearer and to cut out the time used in transmitting any message special wording and letter pronunciation used to communicate between the senders and receivers. as any call needs terms to begin and end the Radio Terms table below shows number of terms used in Radio Communication between marshals and Race Control .Alphabets and numbers are great challenge in radio transmission while it can be wrongly

understood, so there is a pronunciation used to address a wanted letter, for example Alpha means A look at the Letter pronunciation table for more information.

Term	Meaning
Affirmative	Yes , positive
Negative	No
Understood	Understand your message.
Acknowledge	Understand your message
Relevant	Used to break into a communication when you have information relevant to what is being said.
Go Ahead	Permission granted to speak (usually preceded by a call sign).
Send or Pass Your Message	Permission to pass on message
Go Again, Repeat	Repeat message
Over	I have finished what I have to say, but you may want to come back to me.
Out.	This conversation is ended
PRIOR ITY	potential or a Life or death situation

Table 3.1 Radio Terms

Letter	Pronunciation
A	Alpha
B	Bravo
C	Charlie
D	Delta
E	Echo
F	Foxtrot
G	Gulf
H	Hotel
I	India
J	Juliet
K	Kilo
L	Lima
M	Mike
N	November
O	Oscar
P	Papa
Q	Quebec
R	Romeo
S	Sierra
T	Tango
U	Uniform
V	Victor
W	Whiskey
X	X-Ray
Y	Yankee
Z	Zulu
Table 2 :Letter pronunciation table	

Table 3.2 Letter pronunciation

Example of a Call:

The following pages are to set an example of how communication is now like in the circuit.

- **Incident Facts**

Vehicle number 6 hit vehicle 8 when closing to the entry point of turn 5 vehicle 8 spins and stops but vehicle 6 left track and hits barriers , flames was spotted .

- **Communication**

Post 4

“Base, this is Papa four”.

Base

“Go ahead Papa four”.

Post 4

“Cars 6 and 8 have collided; car 6 has hit the barrier and is on fire. We require a fire unit on drivers’ left at Turn 5 – driver is not moving, can I have a Medic car on stand-by”.

Base

“Papa four, confirm you require Fire Unit at Turn 5 on driver’s left”.

Post 4

“Affirmative, Fire Unit required”.

Base

“Papa four, do you require medical assistance (Race Control dispatches a Fire Unit, and places an intervention vehicle on standby”.)

Post 4

“Base this is Papa four”.

Base

“Go ahead Papa four”.

Post 4

“Driver is out of the car and appears Kilo one-nine, Medical response not required”.

Base

“Fire unit is on the way, please provide update. “Thank you, Papa four, please report location of vehicles relevant to track, that requires recovery assistance.”

Post 4

“Base, this is Papa four”.

Base

“Go ahead Papa four. Fire unit has arrived. Fire is out. Car 6 is off the track, and will require a full lift. Car 8 is close to track but considered in a safe location. Car 8 requires a straight tow”.

Post 4

“Base, this is Papa four”.

Base

“Go ahead Papa four”.

Post 4

“Fire unit has left Turn 5 and is behind barriers. All marshals are clear and in a place of safety”.

Base

“Thank you, Papa four - please advise if Medical is required to collect drivers following the session”.

3.4.2 Flagging system

According to the flag raised somewhere in the circuit the marshal motion and the vehicles motion will differ, the flagging system is ruling the activity inside the circuit. There are many types of flags with different meanings that warn marshals, racers, and personal involved in the action. The following page will describe some flags and the meaning of them.

1- Red Flag

This flag to be waved at all the posts if the practice/qualifying session is stopped because of some emergency or of a technical issue. No overtaking is allowed when this flag is waved.

Flag marshals have to wave this flag if have seen it at the previous post, or have seen the red circuit light, or from direct instruction from the Race Control.



Figure 3.2 Red Flag

2- Yellow Flag

This flag if it was waved a single wave will instruct the racers to slow down and not to overtake; it instructs them to the probability of following an unusual time because of the hazard that might be present on track.

In the case of waving the Yellow Flag double waved this will instruct the racers to slow down not to overtake and to be prepared to change their direction because the track is partially blocked or wholly blocked. Once the object or obstacles is removed the posts will show a green flag confirming that the track is clear.



Figure 3.3 Yellow Flag

3- Blue Flag

Blue flag is difficult to understand sometimes but it relays on the flag marshal , during practice/qualifying the blue flag send a message to the driver that they are being caught or about to being passed . But during the race it is displayed to a car about to be lapped and should give a way as early as possible.

The blue flag and blue lights are shown also in the Pit lane exit when a car exits the pits and a speeding car is closing in the track. In many races the blue flag is not waved, and sometimes the Race Control calls for it.



Figure 3.4 Blue Flag

4- White Flag

This flag is waved to notify racers that a slow moving competitor or a course care (sometime a rescue vehicle) is ahead. Flag marshal should wave the flag when the vehicle in his sector which is the area between his post and the next flag post.



Figure 3.5 White Flag

5- Green Flag

Green Flag is waved after the end of the Yellow Flag and to indicate the start of a session on the track.



Figure 3.6 Green Flag

6- Red and Yellow Striped Flag

This flag indicates that there is a slippery surface , some marshal will call it the “ oil flag “ competitors be attention to this flag while it can be used also to indicate gravel , dirt , oil and water .



Figure 3.7 Red and Yellow Striped

7- Black and White diagonal Flag

Used with the car number to notify the racer that his driving standards are under observation and can be accused of unsportsmanlike conduct in trying to advance.

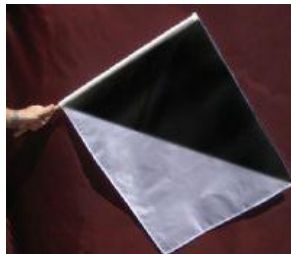


Figure 3.8 Black and White diagonal Flag

8- Black Flag with an Orange disc

This flag is also displayed with the car number; it indicates mechanical problems that the racer is not aware of for instance losing some bodywork, open doors, hatchbacks and petrol leaks.



Figure 3.9 Black Flag with on orange disk

9- Black Flag

This flag is shown with the car number to instruct the racer to pull in to the pits and the end of the next lap; this might be because of the racer not behaving well or if he has incurred a stop/go penalty for overtaking.



Figure 3.10 Black Flag

10-Chequered Flag

This flag is shown to announce the end of the practice session or the end of the race.



Figure 3.11 Chequered Flag

3.5. Reports

After an incident takes place on track there are reports that must be filled by the Post Chief to be handled to the course car between sessions. Sometimes a personal called

Boundary Rider who is responsible for roving around the circuit according to the Race Control instructions can collect this report before the session is over.

Each report is logged and numbered according to the incident number. Using the same report form other off track incident might be recorded by officials. These reports must be written using the same communication strategy previously mentioned in the Radio communication section this means with the minimum number of words and recording facts only. In the case that risks remained present even after attending the incident this must be reported in the incident report.

All written reports must be recorded after the verbal report .writing the report to be filled because of the occurrence of the following hazards:

- Two cars collide
- Car crashes to barrier
- Car – person contact.
- Injured person
- Rule breaking
- Race Control Request
- Any report must include the following
- Incident time
- Sketch if possible
- Actions taken (flags for example)
- More details

3.5. 1 Report Types

According to the authorized side the report comes from there will be different reports accordingly the following reports are the most common reports recorded by officials:

- 1- Incident Report:** reports a detailed information about any reportable issue rises in the sector. If the incident evolves any injury a Medical report is needed then it will be attached to the incident report to be sent to the Race Control.
- 2- Trackside Marshals:** Marshals reports incident and technical error. Then transmit the report by Boundary Rider or Course Car to the Race Control after that the report is logged and numbered according to the incident. In case of reports identifying potential risk will be logged for different processing. Some reports needs follow up or judicial actions which are discussed by Clerk of the Course and the action taken will be reported.
- 3- Medical Reports:** are reports written by a medical officer then forwarded to the Race Control. If there are reports with no injury then it will be kept separately in a different file then passed to the Secretary of the meeting. Medical reports form contains three page carbon copy forms one delivered to the patient or ambulance, a second one to the secretary of the meeting, and the third to the circuit owner.
- 4- Engineering Reports:** senior marshals generate engineering reports and the problems with the facility. Some engineering reports are urgent which are collected by the Boundary Riders during the event to be transmitted to the

Administration office of the Secretary also another copy is delivered to the circuit maintenance team. The Circuit maintenance log the report and classify it according to the priority then discussed with the Engineers to find a solution. In case there is no solution, then it will be attended after the event.

5- Critical Incident : incident are classified critical if involves fatality or potential fatality , at that time the Race Control will initiate number of actions to preserve evidence of the incident . At that time an Incident Controller will be sent to be responsible of the response and to preserve evidence. Following the Incident Controller an Incident coordinator will be appointed to coordinate the response routine. Sometimes these officials will be the Clerk of the Course and the Secretary of the meeting.

Chapter 4

The proposed SecureConnect system

4 . The proposed SecureConnect system

4.1 Introduction

Rapid development in the information technology field especially in mobile systems and networks give users and organization a wide range of choices to apply application and solutions to serve their business goals and services. Many organizations are now heading towards building systems that can reduce the time and effort of their employees and clients because of the wide understanding of the time concept.

According to the fact that people are getting more familiar with using complex technologies in everyday life . For example, volunteers or marshals are more used to use smart phones than using and tuning a Radio handset; this is what it will make it better if we replaced this technology with a new one that is used every day.

This chapter will discuss the proposed system employed to control and manage many aspects in the circuit. This system is all about supporting the need of more advanced systems, in the way communication held in circuits. As the data from the previous chapter stated a real problem in communication tools used and the fact that there are many signs, postures and words to interpret before triggering any alarm. The proposed system will encourage replacing the old or Radio communication handsets with new Smart phones or PDAs . All the information that is verbally transmitted replaced by icons when pressed instantly sends a message to the required receiver , in order to cut out the time needed to understand a call in a very noisy environment like the circuit or the Race Control and to reduce the vocal dialog across the radios .

4.2 The Use of iconic and short messaging

From the early days of our existence humans tried to represent their thoughts and facts using iconic representation of what they see, feel, or need. Icons are the arts of building vocabularies in a simple visual representation. Moreover everyday's experience encourages the use of figures or short terms to refer to a long piece of information for instance figure 4.1 below it is understandable that it says "Biohazard danger" without the need of reading it means the same in all languages. As well as the yellow triangle on every sign means danger. but if we wrote down the sentence " Biohazard danger " rather than this sign it will be known only for people that reads and can read English . From that fact and as shown in the previous chapter the proposed system deploys the idea of developing iconic and short messages representation of the commands and needs of circuit to make it easier and faster to give more time to response to incident rather than trying to transmit the facts verbally . Any work place creates a dictionary of terms abbreviated to describe a situation or a process and sometimes a position in order to facilitate fast communication, even In motorsport they already have a huge database of gestures , signs , flags , code words and many other ways to reach a faster communication .



Figure 4.1 Biohazard Danger

4.3 The proposed system architecture

The system focuses in solving the communication problem between the response communication parties to ensure cutting out the time used to deliver the message and responding to the incident. The overall architecture is described in the figure 4.2 below, showing that the main parties in the communication process are the race control, marshals or officials and the crews located in different parts.

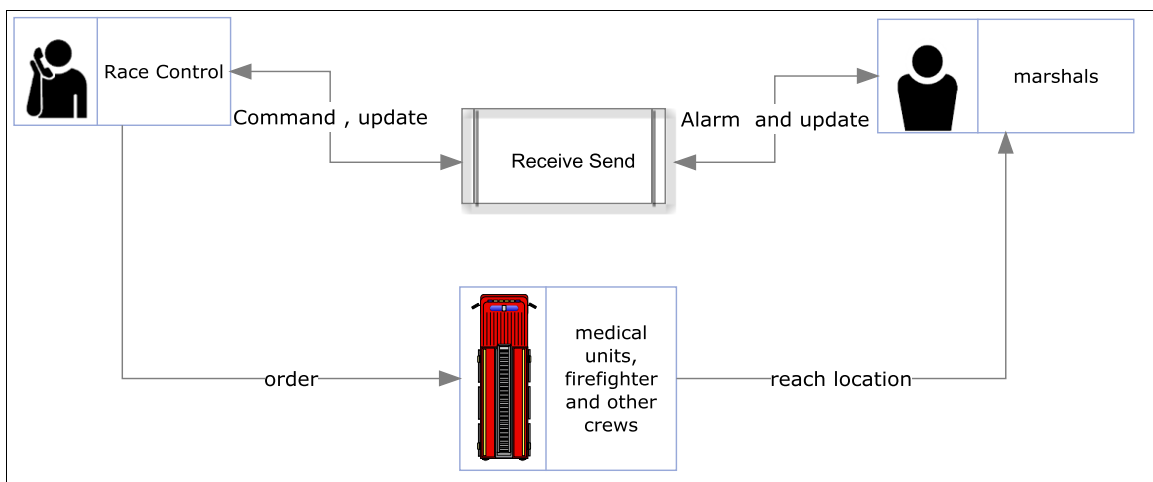


Figure 4.2 Communication architecture

when an emergency icon clicked it alerts the Race Control immediately by transmitting all the emergency data required by the Race Control for example location , type , time , needed help and the sender , which will give the Race Control time to response with a better decision accordingly , and all teams related to the emergency will start working .

when an emergency icon clicked it alerts the Race Control immediately by transmitting all the emergency data required by the Race Control for example location , type , time , needed help and the sender , which will give the Race Control time to response with a better decision accordingly , and all teams related to the emergency will start working .

Correct actions taken immediately and knowing the situation from distance will help to avoid other incidents caused by flames or flying objects over the track. While being able to send notification specifically to people it can be easier to send warning or notification without the need to drag a marshal or an official to the Race Control to straighten a behavior, just like instant messaging.

The communication between marshals and Race Control can vary according to the happening and the location, while marshals are responsible of track safety decisions and the Race Control triggers unit dispatch, the previous fact states a fact of a hierarchical system in responding to an incident. Marshals according to motorsport rules are the first responders to some types of emergency that are controllable by them and minor, but in case of major incidents and violations, the decision goes back to the Race Control.

4.4 SecureConnect Analysis

The figures below shows types of emergencies that can occur in any motorsport event, (figure 4.2 Incidents Type). The analysis of the system accomplished while acquiring the knowledge, whenever new information presented there was a negative side that needs justification or replacement. The Analysis concentrated in different parts, User analysis and Task Analysis.

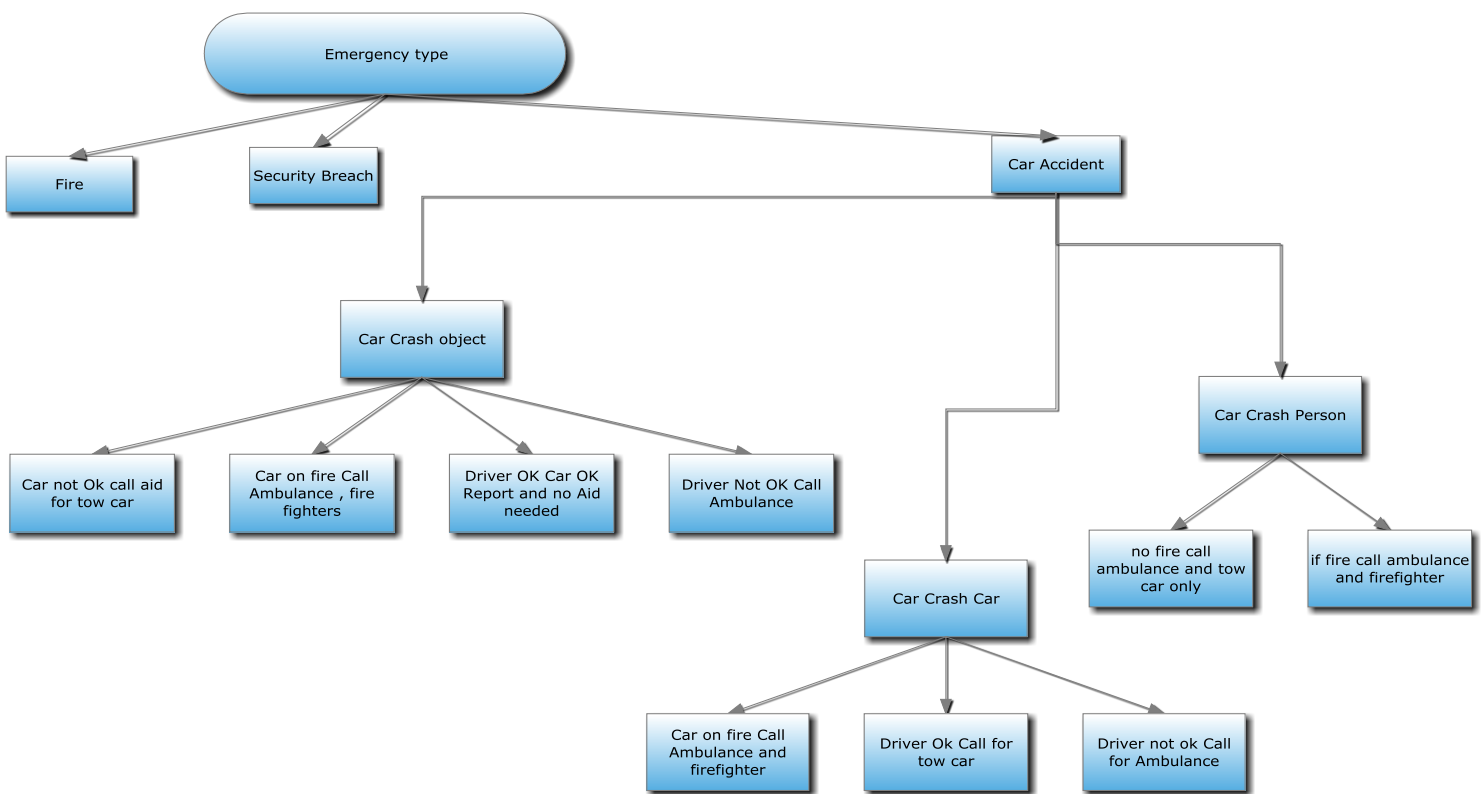


Figure 4.3 Incident Type

4.4.1 User Analysis

In the user Analysis different interviews and observations stated different difficulties and malfunctioning to the traditional communication system which is walkie-talkies. The

following paragraphs will show the different difficulties according to the users interviewed.

- New marshal :

Freshmen or new marshals stated that they volunteered to the marshaling experience because of their interest in motorsports events and the fact that they can get closer to the action and help their favorite racers in case of emergencies but the fact that they are new to the field holds a great pressure on their physiological and psychological skills. Some of the main points are:

- 1- How to communicate with the Race Control with clarity and without delay in case of major accidents.
- 2- The lack of experience in signs and codes to communicate
- 3- Taking the best decision and responding correctly to an incident.

- Senior marshals :

Well experienced marshals that really enjoy the marshalling experience but they also have some complains that once solved they stated that being a marshal will be much easier and less dangerous. Because of their experience they developed a knowledge base about how to response to incidents but they stated many points to be improved like:

- 1- Walkie-talkies malfunctions, the speakers are not clear or the microphone is not working which is a major problem in the middle of a race session.
- 2- The one line access of the Walkie-talkies which means one person at a time can't hold and can't take another message.

- 3- The Time spent in Dialog between marshals and Race Control to report an incident, which means more time spent before units can response to the incident.

- Race Control :

The Race Control where the officials and the communication expert receive calls and triggers alarms to dispatch units and to send orders to be followed by officials and racers. In a very restricted area with a big dashboard the communication expert stated different difficulties when receiving a call :

- 1- Sound clarity
- 2- Different marshal accents because of the fact that the marshals volunteers from different nationalities and backgrounds as mentioned before .
- 3- The lack of communication skills in some marshals and not knowing the correct abbreviation and language used to raise a call to the race control.

4.4.2 Task Analysis

Analyzing the task currently held by marshals and officials, also finding the difficulties to propose a solution for them to effectively use time and effort in any sporting event. As tasks mentioned in the knowledge acquisition part which is mainly holding communication to dispatch help and report incidents.

Informing the Race Control of a happening, Reporting in the traditional system is possible but sometimes challenging and needs more time and effort. But once proposing a

symbolic communication a big deal of time will be cut down. Also the fact that marshals are on alert during the race session experiencing a huge deal of noise, it is hard to keep the Walkie-talkies sound clear and to be alert that the calling button is not pressed by mistake.

4.5 SecureConnect Design

According to the analysis and the type of emergencies described in the previous figures the solution design is generally described in the following figure (system Design figure)

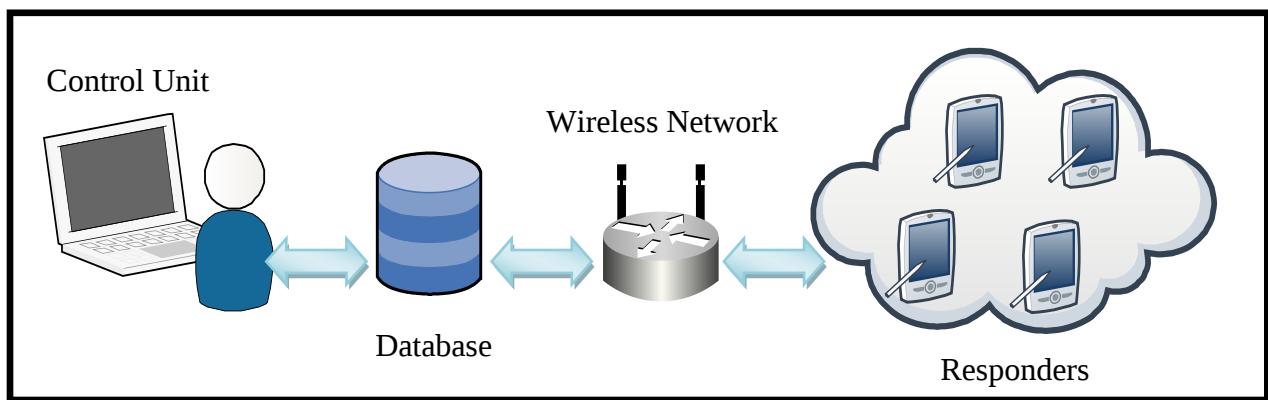


Figure 4.4 System Design

From the figure the marshals and the rescue units PDAs are connected to a wireless network where each PDA will have a unique ID that will define the location , type and specify the person holding the PDA .

The Alert will be sent as instant messages to the Database that pops up the alert immediately in the Race Controls screen waiting for an answer. The following pages will go through the design of the proposed system.

4.5.1 Who will use the system?

To know the crews that will use the PDA system is the most important point to start designing an application that can present interfaces and privileges according to the users authorities. Race circuit include many people , for big circuits like Yas Marina Circuit in Abu Dhabi , UAE it can be thousands of people at the same time , but the people that are concerned with using the emergency system to respond or report an incident are divided to four main categories

- 1- **Officials** (Clerk of the course , Stewards , motorsport managements , Technicians)
- 2- **Marshals**
- 3- **Fire Fighter Crews**
- 4- **Medic Crews**

But the main concentration will be on the marshals and officials in designing and implementing the solution because of the fact that decision making and first responses comes mainly from these two groups.

Marshals are distributed along the circuit in organized posts or locations, posts can be either marshal control post which is a storage area for everything might be needed in rescue operations which is lead by the post chief and can be marshal post (track marshal or medical post) . The difference between the two post is that in the marshal post no flag to be shown .

Marshal can be:

- 1- **Post chief** (leads and reports anything to the Race Control , responsible of informing the race control about incidents and writes reports about these incident after the race session ends)
- 2- **Incident officer** (keeps the race control updated about the incidents reported)
- 3- **Recovery Vehicles** (crews helps in moving marshals and vehicles)
- 4- **Safety Car.**

Race Control:

The head quarter of the event that handles communication and decision making connected directly to the race administration office which is connecting units to help for fast respond to initial direction from the Race Control.

4.5.2 Modules

The following are the main modules to be included in the mobile marshaling communication system, only the Incident report module was implemented in the system that evaluates the practicability of the suggested system .

1. Login
2. Incident Report Module
3. Safety Breaches Module
4. Racing Rules Violation Module
5. Medical Reports Module
6. Tips and Rules Module

7. Current Networked Device Module
8. Flag Module

4.5.2.1 Login Module:

The login module is build designed according to the following concepts

Post configuration: this part of the login module is done by the race director and technicians or the crew responsible of handling the devices to the marshals; it is done initially once during a racing event since the marshal post will never be changes until the end of the racing event or session. at this part an ID is assigned to the PDA , which will be used to connect , send , receive information from the PDA and to the race control the figure below shows how the communication is suppose to happen and the PDA operation accordingly .

According to the number of post in each race circuit the allocated ID will facilitate describing the exact location to refer immediately to the location with the correct response. The figure below shows Yas Marina Circuit in Abu Dhabi , UAErrr track and the posts around the track (Yas Marina Track Figure 17), and how the ID will be configured according to the location . And for the other crews other class of IDs will be used as described in the table below the (Figure 4.5).

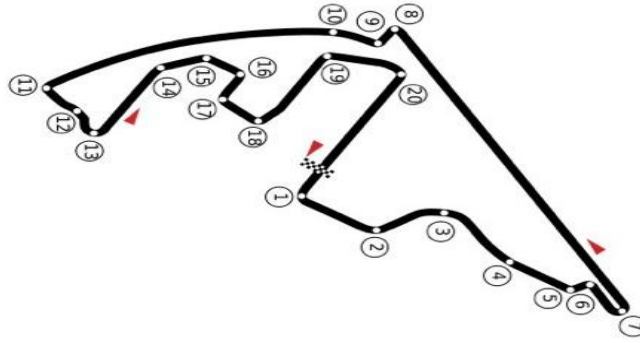


Figure 4.5 Yas Marina Track

Unit	ID
Post marshals (post Chief)	Post#Turn#
	Post10Turn1
Medical Units	Medic#
Firefighters	Fire#

Table 4.1 Sample Of ID representations

The login module asks the user for the name and the post to verify that the user is holding the correct PDA also to append the users name in each report that will be filled after the event about incidents and violations that might take place in the event .

4.5.2.2 Incident Report module:

The incident report module is the module that carries the most important process in the marshalling experience, it reports the happening of any incident varies from life threatening to simple or none serious incident rather the fact that race officials takes every incident seriously because of the aggressivity of the racing environment and how it can change in matter of seconds. This module is the main reason behind suggesting such system to raise the safety level in such full of fans and competitors circuit.

The incident report module will be using simple icons touched in the screen to trigger a message to the race control to take action like dispatching help or to inform the race control for violations. According to the traditional way of sending messages to the race control the most important things about the message are as follows:

- 1- Clarity and who is sending the message and from where
- 2- Describing the situation
- 3- Locating the incident location
- 4- Recommendation (help needed , decision needed)

So the incident report module will help to append almost 3/4 of the information automatically , where the sender , location , part of the description and further information will be assigned according to the PDA assigned and the button pressed .

For example let's assume that the incident officer (Ahmed) is in post 15 Turn 5 and a car crashed to the wall just after his post the PDA process will be as follows.

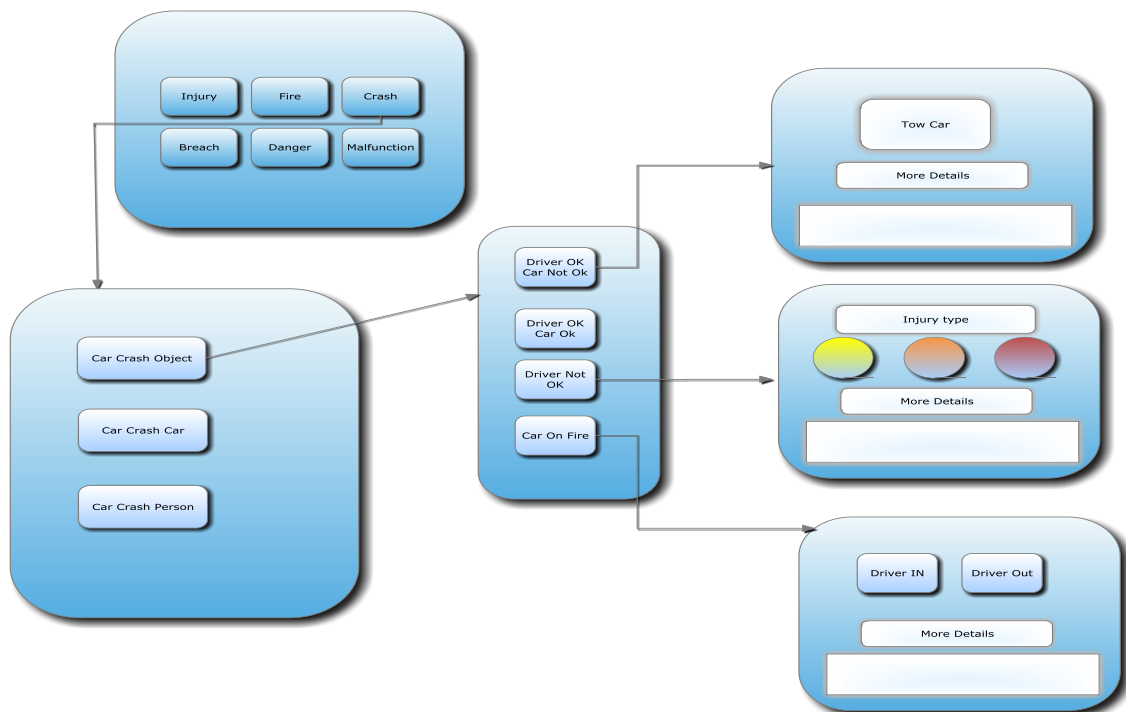


Figure 4.6 Car Crash process

After sending the incident report and all the required information the screen will show list of possible decisions that the Race Control might take in such incidents according to the previous actions, the according to the real response from the Race Control the incident officer will receive an alarm message carrying the action that might be taken, then will inform the other marshals about it. Also in the time the incident officer selects recommendation the closest crews will be at standby according to a similar message send to them but will dispatch after the race control send a request to dispatch for the incident location reported, this message will be sent to the closest units to the post and if more than one incident at a time along will appear to the crews.

This mainly cuts out the traditional call by 3/4 the time needed to report and response to an incident while the traditional call will need a long conversation to achieve a dispatch for any unit or to take a decision according to the reported facts from the marshals.

4.5.2.3 Safety Breach module

This module concerned about reporting any safety breaches done by anyone inside or around the race track or the race control . This module is to help officials respond to this type of breaches because some security breaches might end or stop the race and sometimes might cause life threatening incidents .Race track is a very dangerous place where some fans , reporters and freshmen marshals don't take it seriously and might endanger their selves and others .

This module will have different types of security breaches

- 1- Racers
- 2- Teams

- 3- Officials (changing location or being in dangerous location)
- 4- Fans (being next to danger , entering secured zones , throwing objects).

Each security breach will contain list of icons and short description with the ability to add more details about the situation.

4.5.2.4 Racing Rules violation module

The module name describes it's job , this module is created to spot and report rule violation to the Race Control , where in the motorsport there are rules participants , officials and teams must follow to minimize the possibility of accidents . for example if a racer overtake another racer when it is not allowed to overtake in the going session the responsible marshal will send immediate message to the Race Control by the car number and the action to take decision or penalty .

Some violation can lead to legal questioning where racing events are highly dangerous and any violation can cause serious accidents.

4.5.2.5 Medical Reports module

The medical reports module is a form to be filled from the medical units attending a racer , official , or others to keep the Race Control updated about what happened and if the racer is physically capable of continuing a race effectively , or might need medical attendance from outside of the circuit . It is also to keep report for the Circuit medical archive.

4.5.2.6 Tips and Rules Module

The tips and rules module is something like a help document or simulation of problem and possible solution for the problem , this module is not communicating nor receiving information it is just to refresh the officials knowledge about motorsport rules and events . this module not to be used in sessions , it is only for break time , training or after a session. It will not be active during a session .

4.5.2.7 Current Networked Device module

This module shows the networked device and locations of these devices , showing also the status of each post , for example

- If an incident occurred in post number 10 (it will be labeled in Red)
- If a violation report triggered from post number 5 (it will be labeled in Blue)
- If a flag raised by post 12 (the shape of the flag will be shown)
- Else the post will be in black .

4.5.2.8 Flag Module

In this module the marshal will send a request to carry a specific flag according to what is happening in the race track , this module is active for the flag marshals , the Race Control will confirm that and then the flag will be raised , in some situation the flag marshall will show a flag according to the post before , or to send immediate warning message to the racers to be caution about the track for specific dangers .

This module will allow sending messages to raise specific flag to the next post because of situations that the next post might not see the flag raised.

4.6 Implementation

This section will discuss a simple implemented application that only cover a small part of the designed solution while building the complete solution will need more effort, time , and money . The implementation part is just a suggestion to how the solution might look like and tools that might help in implementing such solution. Also it is build to evaluate the solution.

4.6.1 Tools and requirements:

First of all the tools used to build this part of the solution varies from hardware, software and knowledge that is needed to accomplish the task.

Hardware

Hardware requirements was a challenge, because of the fact that some PDAs can reach high prices like 10,000 DHS when it comes to heavy duty PDAs . Below is a list of hardware used in the process of building the solution.

1- PDA

The system was implemented on a device called Symbol (figure 4.7) it runs Windows CE which an old system but luckily the most stable and supported windows mobile system. It was easy to find framework and other needed tools to be installed to run the

mobile application created. Also this PDA is small, light and rugged which facilitates the PDA

to be used in environments that requires high performance and really harsh situations . this rugged design can stand falling to concrete also sand and temperature .It is also facilitated to capture data fast. The simple finger touch and stylus touch to use the PDA makes the experience when using it just like using any PC at home , fast simple and similar . The PDA also supports wireless connectivity in real time data exchange, also it can connect to range of devices at the same time.



Figure 4.7 PDA Symbol

2- Computer

Computer is needed in the Race Control to Respond to the Alert messages sent by the marshals and to Send alert and dispatch messages to the different crews . with a wireless connectivity .

Software

The software list below shows the software needed to implement and run the SecureConnect solution:

PC Side Software

- 1- Windows XP, Vista , 7 installed
- 2- Visual Studio (the application coded in Vb.net)
- 3- SQL server 2008
- 4- Windows Sync Framework
- 5- .Net Framework, and IIS.

Mobile Side Software

- 1- Windows CE installed
- 2- .Net Compact Framework.
- 3- SQL Mobile

4.6.2 The Database

Database used in the application is SQL database, it was created using the SQL management studio , the script that been used to create the database and the structured tables is attached among with the source code in the(Appendix). Tables designed to keep record of messages and responses to these messages and saved in the main computer in order to generate reports about any of these messages at any time after the event. The structure of the database as follows:

Message Table:

MESSAGE			
Column Name	Condensed Type	Nullable	
MESSAGE_ID	int	Yes	
MESSAGE	varchar(4000)	Yes	
SOURCE	varchar(50)	Yes	
STATUS	varchar(50)	Yes	
DATE_TIME	datetime	Yes	

Message_From_Device Table :

MESSAGE_FROM_DEVICE			
Column Name	Condensed Type	Nullable	
MESSAGE_ID	int	No	
MESSAGE	varchar(4000)	Yes	
SOURCE	varchar(50)	Yes	
STATUS	varchar(50)	Yes	
DATE_TIME	datetime	Yes	

Message_To_Device Table :

MESSAGE_TO_DEVICE			
Column Name	Condensed Type	Nullable	
MESSAGE	varchar(4000)	Yes	
DEVICE_IP	varchar(25)	Yes	
DATE_TIME	nvarchar(50)	Yes	
MESSAGE_ID	int	No	

4.6.3 Coding

Implementing the solution is divided into three main parts, the PC part application, the web service and the Mobile part application. The following pages will show some parts of the code .

1- Mobile Part application :

The mobile part application is built using VB the SecureConnect.vb calls all the classes like the figure below:

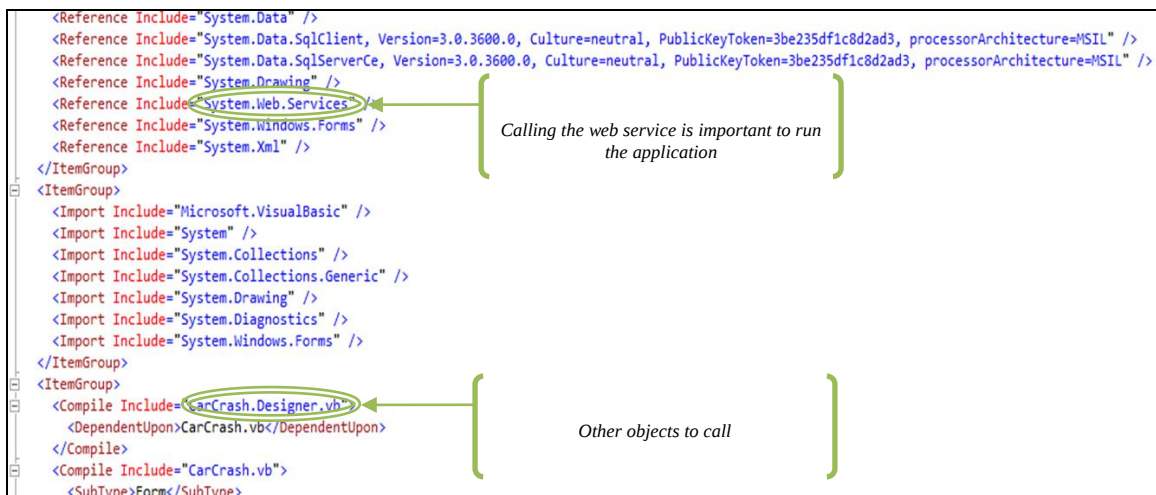


Figure 4.8 Mobile Part Code 1

The Common.vb part of the application holds all the definition used in the different modules as shown in the figure below :

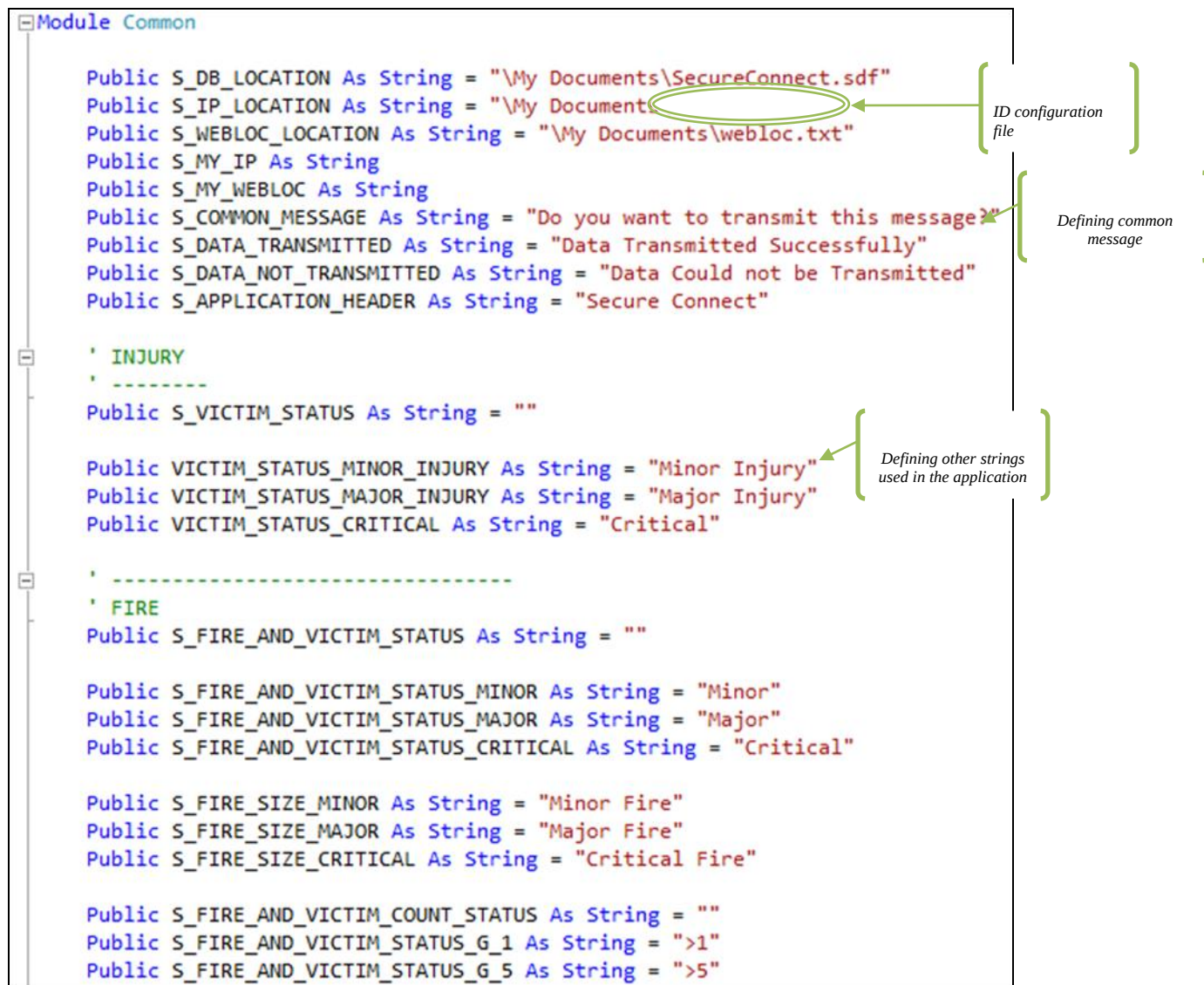


Figure 4.9 Mobile Part Code 2

Another part of the application is the main.vb which holds all the buttons and what each button means. The figure below shows a part of the main code.

```

Public Class Main

#Region " Data Members "
Private mDataAccess As New DataAccess
Private moSOCWebSer As New SECUREWS.Service
#End Region

#Region " Event Handlers "
--> Load
--> Button Click
--> Timer Tick
--> Menu Item Click
#End Region

Private Sub Button_FireAndVictimsYellow_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button_FireAndVictimsYellow.Click
    S_FIRE_AND_VICTIM_STATUS = S_FIRE_AND_VICTIM_STATUS_MINOR
    Label_FireAndVictimsStatus.Text = "Minor"
    Panel_FireAndVictimsDetails.BringToFront()
    Panel_FireAndVictimsDetails.Show()
End Sub

Private Sub Button_FireAndVictimsOrange_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button_FireAndVictimsOrange.Click
    S_FIRE_AND_VICTIM_STATUS = S_FIRE_AND_VICTIM_STATUS_MAJOR
    Label_FireAndVictimsStatus.Text = "Major"
    Panel_FireAndVictimsDetails.BringToFront()
    Panel_FireAndVictimsDetails.Show()
End Sub

```

Meaning of one of the icons which will be sent to the database

Figure 4.10 Mobile Part Code 3

The Main.Designer.Vb contains all the buttons and GUI interface components added in the login module, part of the code is shown in the figure below

```

'Panel_Login
Me.Panel_Login.Controls.Add(Me.TextBox_UserId)
Me.Panel_Login.Controls.Add(Me.Label3)
Me.Panel_Login.Controls.Add(Me.PictureBox_LoginCancel)
Me.Panel_Login.Controls.Add(Me.PictureBox_LoginOk)
Me.Panel_Login.Controls.Add(Me.TextBox_Password)
Me.Panel_Login.Controls.Add(Me.Label6)
Me.Panel_Login.Controls.Add(Me.Label4)
Me.Panel_Login.Controls.Add(Me.Label2)
Me.Panel_Login.Controls.Add(Me.PictureBox_Login)
Me.Panel_Login.Controls.Add(Me.Label1)
Me.Panel_Login.Location = New System.Drawing.Point(3, 3)
Me.Panel_Login.Name = "Panel_Login"
Me.Panel_Login.Size = New System.Drawing.Size(327, 270)

'TextBox_UserId
Me.TextBox_UserId.BackColor = System.Drawing.Color.LemonChiffon
Me.TextBox_UserId.Location = New System.Drawing.Point(86, 152)
Me.TextBox_UserId.Name = "TextBox_UserId"
Me.TextBox_UserId.Size = New System.Drawing.Size(143, 23)
Me.TextBox_UserId.TabIndex = 20

'Label3
Me.Label3.Location = New System.Drawing.Point(10, 153)
Me.Label3.Name = "Label3"
Me.Label3.Size = New System.Drawing.Size(100, 20)
Me.Label3.Text = "User Id"

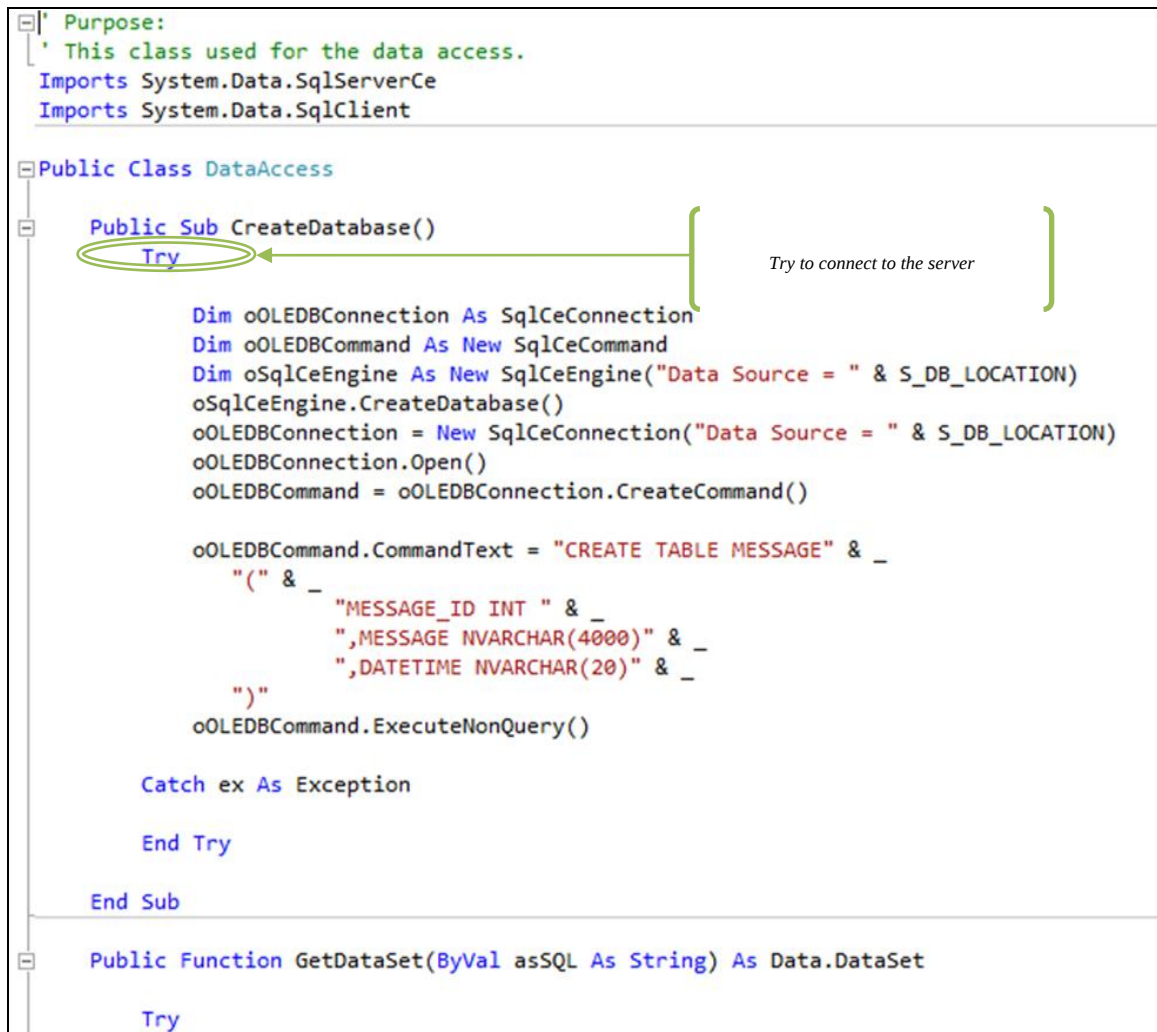
'PictureBox_LoginCancel
Me.PictureBox_LoginCancel.Image = CType(resources.GetObject("PictureBox_LoginCancel.Image"), System.Drawing.Image)

```

The textbox used for the entering the user id

Figure 4.11 Mobile Part Code 4

The DataAccess.vb is used to access the data by importing the sqlserverce and the sql client as the figure below :



```

' Purpose:
' This class used for the data access.
Imports System.Data.SqlServerCe
Imports System.Data.SqlClient

Public Class DataAccess

    Public Sub CreateDatabase()
        Try
            Dim oOLEDBConnection As SqlCeConnection
            Dim oOLEDBCommand As New SqlCeCommand
            Dim oSqlCeEngine As New SqlCeEngine("Data Source = " & S_DB_LOCATION)
            oSqlCeEngine.CreateDatabase()
            oOLEDBConnection = New SqlCeConnection("Data Source = " & S_DB_LOCATION)
            oOLEDBConnection.Open()
            oOLEDBCommand = oOLEDBConnection.CreateCommand()

            oOLEDBCommand.CommandText = "CREATE TABLE MESSAGE" & _
                "(" & _
                "MESSAGE_ID INT " & _
                ",MESSAGE NVARCHAR(4000)" & _
                ",DATETIME NVARCHAR(20)" & _
                ")"
            oOLEDBCommand.ExecuteNonQuery()

            Catch ex As Exception

            End Try

        End Sub

        Public Function GetDataSet(ByVal asSQL As String) As Data.DataSet

            Try

```

Figure 4.12 Mobile Part Code 5

The carcrash.vb which is one of the emergencies carrying all the definitions and actions required to send a message to the control unit about a car crash according to some details. The figure below shows simple part of the code.

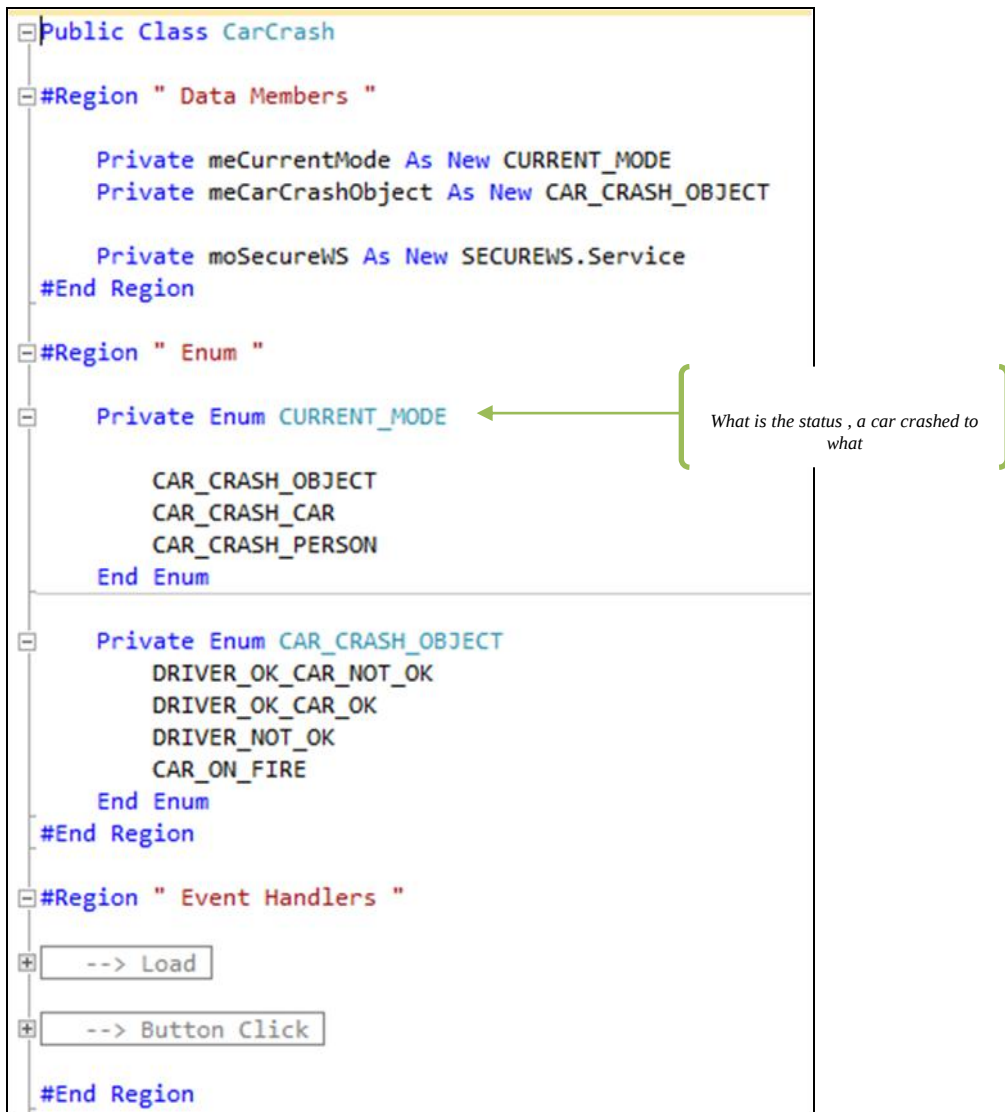


Figure 4.13 Mobile Part Code 6

2- PC part application :

To configure the web service that will be called to facilitate the connection between the PC part and the Mobile part of the solution

	Name	Type	Scope	Value
	SecureConnect...	(Web Servic...	Application	http://localhost/SecureConnectWebservice/Service.asmx
*				

The main form in the PC part is concerned with showing the sent messages and sending back the response to these messages the figure below shows part of the code and the figure after showing the application form .

```
Imports System.IO

Public Class Form_Main
    Data Members

    Private Sub Form_Main_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
        Timer1.Enabled = True
        Timer1.Interval = 5000

        Dim oStreamReader As StreamReader

        If Not System.IO.File.Exists(Application.StartupPath & "\webloc.txt") Then
            MessageBox.Show("Settings Not Found", "Secure Connect")
            Exit Sub
        Else
            oStreamReader = New StreamReader(Application.StartupPath & "\webloc.txt")
            msURL = oStreamReader.ReadLine()
        End If
    End Sub

    Private Sub Button_Send_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles Button_Send.Click
        moSecureWS = New SecureWS.Service
        moSecureWS.Url = msURL
        If Not moSecureWS.TransmitMessage(ComboBox_Message.Text, ComboBox_IP.Text) Then
            MessageBox.Show("Could not transmit the message", "Secure Connect")
        End If
    End Sub
End Class
```

Figure 4.14 PC Part Code 1

The screenshot shows a Windows application window titled "Secure Connect". It features a "Mobile IP" dropdown menu with "POST2" selected, a "Message" dropdown menu, and a "Send" button. Below these is a table with columns "Message", "Source", and "Date Time". Annotations with orange boxes and arrows point to specific elements: "Post or Unit" points to the "Mobile IP" dropdown; "Response Message" points to the "Message" dropdown; and "Messages or alert sent by marshals" points to the table area.

Figure 4.15 PC Part form

3- Web service

Using SOAP stands for Simple Object Access Protocol which is a protocol to allow communication between applications without depending on the platform or the language; also it makes working without worrying about firewalls possible. SOAP is based on XML. SOAP depends on communication over HTTP which is supported by all browsers.

The following figure shows part of the web service code .

```
Imports System.Web
Imports System.Web.Services
Imports System.Web.Services.Protocols
Imports System.Data

' To allow this Web Service to be called from script, using ASP.NET AJAX, uncomment the following line.
' <System.Web.Script.Services.ScriptService()> _
<WebService(Namespace:="http://tempuri.org/")> _
<WebServiceBinding(ConformsTo:=WsiProfiles.BasicProfile1_1)> _
<Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> _
Public Class Service
    Inherits System.Web.Services.WebService

    'The Path in which Web Service is running (PC Path)
    'In this UDL (Universal Data Location) we need to specify the Data Base Location (The DataBase to which we need to transfer the data from HMD)
    Const ConnStr = "File Name = C:\inetpub\wwwroot\SecureConnectWebService\DB\conn.udl"

    <WebMethod()> _
    Public Function HelloWorld() As String
        Return "Hello World"
    End Function

    <WebMethod()> _
    Public Function TestOLEDB1() As Boolean
        Dim conn As New OleDb.OleDbConnection
        Dim connsts As String
        ' ConnStr = "Provider=Microsoft.Jet.Odbc.4.0;Data Source=C:\mydatabase.mdb;User Id=admin;Password="
        conn.ConnectionString = ConnStr
        conn.Open()
        connsts = 1
        conn.Dispose()
        If connsts = "1" Then
            Return True
        Else
            Return False
        End If
    End Function
End Class
```

Figure 4.16 web service

Running the solution :

The solution will run according to the following list of actions:

- 1- Install SQL in the PDA with the .Net compact framework
- 2- Install the application to the PDA with the file called IPCONFIG carrying the ID it suppose to be called by (for example POST10)

- 3- The PDA must be connected to the wireless network .
- 4- Run the web service link as shown in the properties of the application (for example <http://vip/secureconnectwebservice/service.asmx>)
- 5- Run the SecureConnect PC part application
- 6- Run the SecureConnect Mobile Part application
- 7- Start sending alarms.

If we go throw sending a message using the PDA the following screen will be shown after the login screen:

- 1- The Main screen: after logging in the system the mobile will ask what type of actions the user needs to do?
 - a. Send message means sending alert about incident
 - b. Check Message : to check the feedback from the Race Control
 - c. Configuration: to configure the IP or what is called the Sender ID .

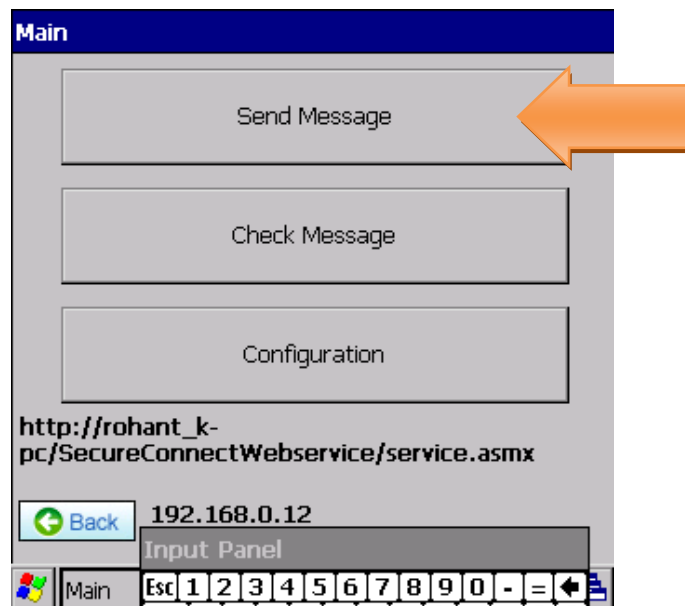


Figure 4.17 Main Screen

2- The Menu Screen : after clicking on Send Message , the menu appears showing a list of possible alarms to trigger :

- a. Injury : if an official or other people was injured
- b. Fire : if there is a fire for any reason but not as a result of a car crash
- c. Car Crash: any event involving car crash.

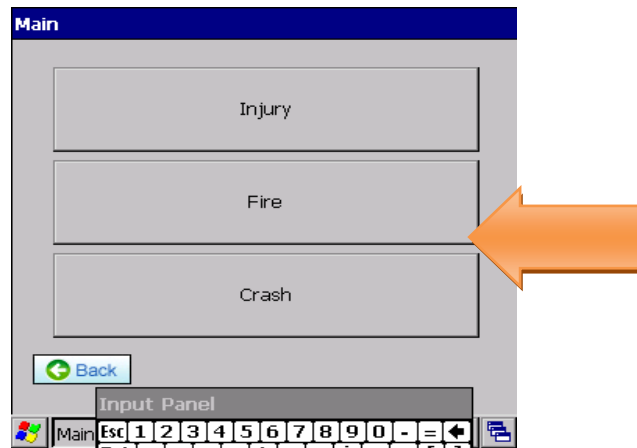


Figure 4.18 Main Messages Menu

3- The Fire Button will go to another module that will ask for the following :

- a. Fire Size
- b. Victims

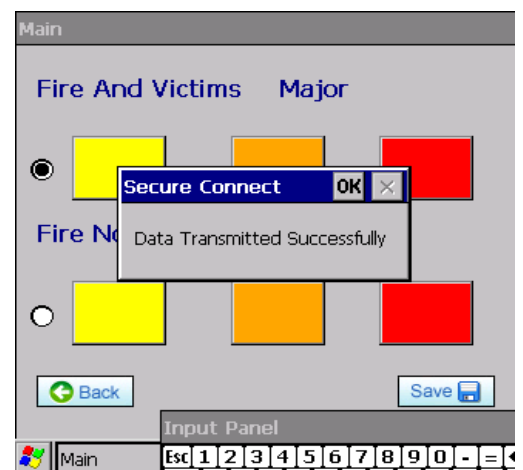
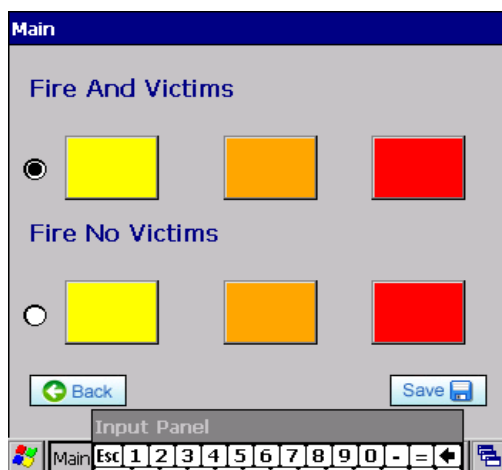


Figure 4.19 Screen Shot fire alarm

- 4- Check messages button takes the marshal to the screen that will show the list of messages sent and the Race Control answer to these messages.



Figure 4.20 Message Screen

- 5- From the PC side of the application Race control will be able to see the messages and the list of posts sending these messages also the PC will send back messages to the PDA .

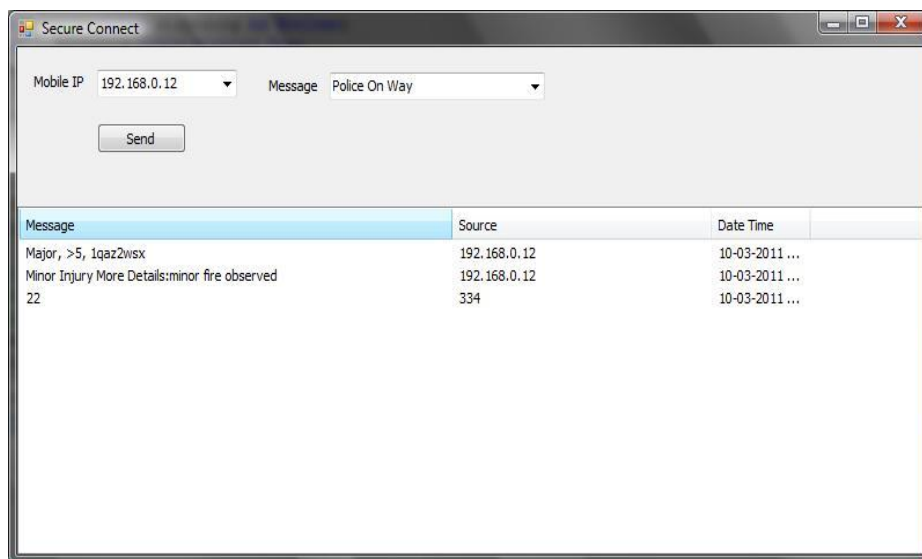


Figure 4.21 PC application

4.7 Evaluating the system

Such solution must be evaluated in similar situation like the motorsport event but because of the fact that it was not possible to carry such a test any time soon another testing method was applied. A wireless network gateway was configured to run in a closed area with one main PC working as a control Unit and three PDAs in different locations with two cars waiting for dispatch and the same test was done using the traditional system and the proposed system but without the surveillance cameras . The following table will show the result of the test.

Scenario	Number of participants	The Traditional System Time in Seconds to Act		The SecureConnect Time in Seconds To Act	
		Sending Message	Dispatch	Sending Message	Dispatch
1	10	30 – 35 s	40 – 60 s	10 s	15 s
2	10	43 s	70 s	11 s	16 s
3	10	36 s	45 s	8 s	16 s

Table 3.2 Evaluation Table

Is It saving Time?

All of the scenarios show a cut out of time in the new solution with not less than 40 seconds in different scenarios, this amount of time is critical in a place that can be dangerous in matter of seconds. The previous table answered the question about the efficiency of the proposed system according to the time spent to respond to an incident.

Is it easy to use?

From the interface used and shown in the design part all the users were happy using the system. According to their experience it is reachable and direct, but some users complained about the fact that they are not familiar with PDAs keyboard in case of more details to add and the fact that the chosen hardware's keyboard is not friendly.

Is it saving Money?

Time is money and peaceful entertaining motorsport events are more attractive than tragic ones, so once response time is less the higher money and attraction the Circuit will have. This was from the fans side, but from the competitor's side they will be more comfortable showing their skills in a high tech circuit than other circuits that lack technology.

Is it implemented in a widely used software and device?

As one of the leading corporations in developing and supporting systems, Microsoft is a powerful yet famous operating system that is widely used. This is what makes the solution compatible with any windows mobile and can read from any windows PC connected through the service.

In addition to that the device is supported by one of the leading companies in handheld devices and communication solution for big corporations.

Chapter 5

Conclusion and Future Work

5.1 Future Work

In field like emergency response there is always future plans and future work to do according to the new technologies and facilities that every single day in our technological era brings along. In regards to the solution, there will be always ideas to make it more practically usable . Some of the ideas that can be added to such a system is the integration with the CCTV cameras to catch the angles and the dangers that are surrounding a marshal post for example, also the idea of building a circuit system full of sensors that will send feeds to the marshals to urge them respond to some incidents or to run out of coming danger.

The fact that PDAs are usable by many people , some would like to use the application in their own mobiles , so studying how to make the Solution more compatible with different mobiles will be a good plan for future study .

As all the cases and the responses in any emergency system depends on previous knowledge or experiencing similar cases , supporting the Race Control with intelligent system that will hold all the cases and reasons to the correct decision according to the input , the dependency on one person decision will be over and taking the correct decision will be easier and with support from previous knowledge .

5.2 Conclusion

Emergency response system develops fast to reach a high level of satisfaction on preventing further tragic events from happening according to the incidents on hand but even that high level of satisfaction needs more technological solutions and more theories to reach a zero level of missing or mistake, this is because of the great value of a single person in the eyes of humanity.

The traditional Circuit system used everywhere is fine and fast to attend incidents but sometimes it is a matter of seconds before saving someone's life from a car explosion or other serious dangers in a race track , this is what makes a system similar to the proposed one a better option for Race Circuit to cover all the incidents anywhere in less time .

Improvement facilitated by many technologies can take the racing experience to a better level where less tragic events can be associated with the rescue crews mistakes and delays. As a conclusion improving information and communication system used in race circuit is very effective in terms of saving lives.

At the end of this research, it is clear that many forces from different parts of the world trying to reach the best solution for rescue groups communication, not only in ambulances and fire fighters but also in entertainment and sports events as people safety and life is a priority to all of us .

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