Part 2

In my last article I gave a brief introduction to my work in developing a prototype computerised control system for Breathing Apparatus. I would now like to conclude my article by making the reader aware of the current state of play regarding BA/Incident Command and Control and the possibilities offered using existing technology.

Consider the following:
Most emergency services use operational command and control procedures that were originally developed by UK fire brigades. These command and control procedures have been refined over many years and until recently offered an effective command and control system. Foreign brigades not actually using UK systems often use procedures based on the UK systems. While current procedures have served us well they rely on pretty basic technology, currently most fire-ground command and control is still accomplished using dry wipe boards. Until recently this technology seemed to be adequate but the events of 911 revealed some fundamental flaws that urgently need to be addressed.

Purely out of interest I have recently undertaken some research regarding the use of technology in BA/Incident Command and Control, for logistical reasons I have confined my research to the United Sates, the United Kingdom, and Australia.

For obvious reasons I am unable to be too specific but here are the results of my research.

United States.
There seems to be a limited uptake on the use of Mobile Data Computers for dispatch and some accountability functions (basically a computerised list of who is on what apparatus what radios they are assigned etc). Dispatch is able to identify who is communicating via what radio ID. The primary tool for accountability is a plastic tag system (passport with the apparatus designation and tags for each member assigned) the tag is retained by the supervisor. Most command and control functions are still handled using white boards. The US do not use a dedicated BA controller, individuals are responsible for monitoring their own air supply although the supervisor is expected to get readings every 10 minutes. Some BA equipment incorporates a "head up display" consisting of coloured LED's indicating 100, 75, 50 and 25% of cylinder capacity (no telemetry). I read that Tulsa, Oklahoma fire department undertook testing of the Motorola computerised accountability system, but I have not been able to establish the results of this test.

United Kingdom.
Currently use dry wipe boards for both BA and other fireground incident command information systems. There are a number of electronic systems in use with London Fire Brigade they are only available on the command units (sent to 4 pump fires and above) and only gives stored information about command – no live feeds from the incident ground. Inputs are fed live to remote command suites but this is no more than messages, appliance locations, etc. London Fire Brigade has bought Drager Bodyguards for all of its BA sets and Merlin has been looked at for EDBA but I don't believe any commitment has yet been made to purchase in significant numbers.

Australia.
Basically Australia is still dependant on dry wipe board technology. A number of Pelican cased dry wipe board versions are around but still the basic technology remains unchanged. I worked with a company based in Australia that was developing a computer-based system for command and control but I have no idea as to if and when it will become a commercial reality.

An incident requiring the attendance of the emergency services can be as simple as a house fire or as complex as the twin towers, involving a single fire appliance with 4 firefighters up to many appliances with hundreds of firefighters distributed over a very wide area. Controlling a single appliance with 4 firefighters does not pose a major problem

for existing command and control systems, but controlling a multitude of fire appliances and personnel with a dry wipe based system becomes increasingly more difficult the more resources there are to control. This problem is further complicated if Breathing Apparatus is required (as is commonplace even at small house fire).

Currently wearers of Breathing Apparatus (BA) rely on a simple pressure gauge and some basic calculations (based on the capacity of the air cylinder the starting pressure of the air in the cylinder and a standard consumption rate of 40 liters/minute plus a 10-minute reserve). The pressure gauge also has a whistle attached that will sound when the air pressure reaches a low level, this audible indication of low air cylinder pressure is useful but of course being air driven it adds to the depletion of air that is already at a low level. The BA equipped firefighter must also wear an Distress Signaling Unit (DSU) that monitors movement and gives an automatic alarm (audible and visual) if the wearer becomes immobile for a predetermined period (usually 30 seconds). BA wearers are controlled on the fire-ground by a dedicated BA control officer whose duty is to record the time the firefighter starts up his BA and keep tack of the time until the firefighter is safely out of the area that requires the use of BA. Ideally the BA control officer will be in frequent radio contact with his team but of course there are times when radio contact will not be possible. The 40 liters per minute air usage is as based on a set of tables compiled used by Navy Divers in the 1940's and unfortunately does not represent the actual air usage of a firefighter who is running on pure adrenalin and may be involved in strenuous physical activity. Fortunately the 10-minute reserve has covered this additional air usage, but recent developments in air storage have resulted in higher-pressure composite cylinders almost doubling the available airtime, unfortunately the 10-minute safety margin is now proving inadequate.

As previously mentioned an incident can have many appliances and personnel present, there may also be other services present (police and ambulance) and can often involve airborne resources as well as members of the press. It is at these larger incidents that existing command and control systems start to reveal their shortcomings.

The Current Status.

Dry wipe boards remain the norm as regards incident command and control, although dry wipe boards having inbuilt digital clocks and even computerised systems are now being used to control BA wearers. Basic telemetry has started to appear on BA equipment from some manufacturers but is limited by slow data rates, short range and incompatibility with other manufacturer's equipment. We are also starting to see sophisticated command and control systems but due to their complex nature these are currently best suited for training purposes or managing major incidents.

If we are not careful the fire ground will have a number of computer-based systems designed to replace or enhance current systems that do not have any form of interoperability or compatibility. Whilst these systems will undoubtedly improve overall command and control do we really want a number of stand alone solutions when we could have a complete command and control system capable of handling all the resources and personnel present at an emergency incident? Having been involved with the development of hardware and software for use by the emergency services for over 15 years I believe that a totally scalable and integrated command and control system is long overdue.

Consider the hardware.

Each command and control requirement on the fire ground could be met using ruggedised laptop computers. Ruggedised laptops would have to be used due to the nature of the environment, as equipment could be subject to water splashes and would have to be able to survive rough handling. Having a number of ruggedised laptop at an incident would be no use unless they could share information, in order to share information the computers would have to be networked and since hard wiring would not be an option a reliable radio network would be required. Unfortunately most existing radio networking technology is designed for fixed installations and operates on a client server basis, sending and receiving

data using a radio link through a central radio hub. Clients need to be configured to use the correct server and the server needs to have a list of the clients. This type of radio network is not suitable for a dynamic environment; fortunately recent developments in radio networking have produced a system that is ideally suited for use on the fire ground. This new technology uses a Mesh infrastructure and was designed to overcome the weakness associated with existing radio networks. Mesh radio networking technology is totally self-configuring and self-healing, able to handle constantly changing network infrastructure. Due to the high data throughput Mesh networks can handle simple telemetry, voice over IP and even real-time video simultaneously. Fortunately Mesh radio networking offers a number of levels of security ensuring that any data sent over the radio link is secure.

What about the software.

Unfortunately there are no off the shelf solutions currently available, therefore it would need to be written. I am aware of at least one company that is developing a system and I hope the product meets expectations. Potential developers should remember that any software they intend to produce for the fireground has to be simple and intuitive to use and should wherever possible be designed to offer a user interface that resembles the manual interface that firefighters currently use. It would also be advantageous to offer touch screen operation using oversize buttons that can be operated by a firefighter wearing gloves. Fortunately once the core of the system is developed the user interface becomes a simple matter of providing the user with what they require. A system once developed could have huge market potential particularly if there are numerous user interface options.

Scalability

Due to the volatile nature of a fire incident any command and control system would have to be able to handle every size of incident from a simple house fire to a major disaster.

A scalable system would have to handle simple tasks such as BA control but would also be capable of managing the complex requirements of a major incident. It is not difficult to envisage a small scale incident escalating to become a major incident, so a workable system would have to be totally dynamic allowing additional resources to be handled and duties delegated, theoretically as the incident escalates then key individuals will become responsible for specific duties. Imagine arriving on the fireground and starting up a ruggedised laptop to be presented by an overview of the whole incident, who is controlling what sector, who is committed to BA and where. This feature would save valuable radio traffic and allow a suitably trained incident controller to rapidly take charge of the incident.

This concept is better demonstrated by giving an example:

Consider a house fire on the edge of an industrial complex, the initial fire appliance turns up, and as persons have been reported trapped in the house a BA team prepares for action, the BA controller opens the ruggedised laptop and as the BA teams startup their equipment initial pressure readings are transferred to the laptop and the calculations are automatically made regarding the air cylinder contents "time to whistle" etc. The BA wearers can then get on with their job knowing that detailed information relating to their air cylinder contents and environmental conditions are being sent to BA control and that not only is the BA controller checking their status but the artificial intelligence built into the system is also looking out for them.

Due to unforeseen circumstances the incident spreads to an adjacent commercial property, so additional resources are required. More firefighting equipment is required so requests are made to fire control; the requests could be done using conventional radio calls or could be done by the control station over the radio link. If the request is undertaken by the control station the time of the request is recorded. Once the additional resources arrive on scene the time is noted, due to the escalating size of the incident the existing controller is prompted to hand over incident control to the incident controller who has now arrived on

the scene. The incident controller on starting up his laptop is asked if he wants to assume control of the incident, after selecting yes all information relating to the current incident status is downloaded to his screen, and the initial controller reverts to his original BA control duties. The control system should be totally dynamic allowing command and control to expand and contract in line with the scale of the incident.

Ideally the software would be intuitive and would support automatic arrival and departure of resources using either RFID technology or the inbuilt features of Mesh Technology.

If there is to be a total command and control system it has to be based on standards that would allow any manufacturer the option to produce hardware and software that is compatible with the system, thereby enabling integration with other hardware and software such as ALOHA (Area Locations of Hazardous Atmospheres) and the HAZCHEM data base.

As the radio based networking is a key component in a command and control system I would like to elaborate a little on Mesh technology.
As previously mentioned most current radio networks operate on a client server basis and send and receive data using a radio link through a central radio hub. Clients need to be configured to use the correct server and the server needs to have a list of the clients. This technology is fine for fixed installations but does not cope at all well with multiple clients, particularly if clients are constantly changing. Mesh technology was developed to overcome this weakness and can be considered as a totally self-configuring and self-healing network. It was originally designed for the United States Military by ITT at a significant cost, and is so robust that it can handle hundreds of connections and is able to provide reliable data exchange between fixed units and mobile units traveling at up to 240Km/hr. Being self forming and self healing no configuration is required and Mesh enabled devices can come and go without impacting on the integrity of the network. One of the other advantages of Mesh technology is the fact that connections are always being optimised by the network itself so that the most reliable and fastest link is always used to send and receive data. Mesh devices can also use other Mesh devices as repeaters so that the normal range of operation is effectively increased by a factor of 10 (currently up to 10 hops can be achieved). Mesh technology also supports very accurate geo-location (using some very complex time of flight algorithms). This geo-location capability would certainly be useful on the fireground and could be used to track the location of resources.

Mesh technology was brought to my attention a couple of years ago by a colleague in the IT industry. Based on my initial research it appeared to offer and ideal solution to fire-ground telemetry requirement. Following a trip to the USA to see the product in use I have become a firm advocate of this technology. The demonstration involved a trip in a mini-van that was equipped with a laptop computer. Once aboard the mini-van we were driven around downtown Maitland. The demonstration started with the viewing of a movie that was being streamed from the server at Mesh headquarters, then an internet session was started (the streaming video was still running) so we could surf the net whilst on the move, next a voice over IP call was made to a location in Miami, (still able to watch the video and surf the net) and finally a screen was activated showing a representation of our moving mini-van overlaid on a high resolution aerial image of the local area. At no time during the demonstration did any loss of data occur.

Tests of the geo-location accuracy revealed the ability to accurately track and locate a subject within 2-3 meters of their calculated position. 3D location is possible but there is still a great deal of work to do in this area.

Since commercial products have been available, Mesh is rapidly becoming the technology to watch. Several US pilot schemes have now become permanent installations and more are expected to follow shortly (there is even a pilot scheme running in the UK). A small number of companies have signed up to become developers and as a result some pretty exciting products are being developed, one of these product that I find interesting is the

Mesh Communicator, this product could eventually be the replacement for conventional hand held radios on the fire-ground offering voice communications and a host of other possibilities.

One thing that really shatters public confidence is when response agencies are seen to lose control and communications, and with the current trends in accountability our emergency services should be supplied with the best systems that we can give them. The lines between fire, disaster response, civil defense and terrorist response are all starting to dissolve and for this reason alone surely it has to be worth providing a command and control solution that can integrate with other agencies systems or a neighboring municipality.

Just for those few diehards who consider that current technology is adequate I recently hear of a major fire where all incident command and control was lost due to a sudden heavy downpour of rain totally obliterating all the data on the dry wipe board. This is not at all uncommon in that this is the second time in the last two years that I have heard of weather related breakdown of command and control. Whilst a breakdown of command and control may be a simple inconvenience at a small incident if the same thing happens at a major incident then lives can be lost.

This article is simply my impression of what I believe is required and is long overdue. All the technology required other than the software is available off the shelf. Sure we take a risk on becoming dependant on technology but if a system is designed correctly failsafes can be incorporated.

Recent developments
Motorola purchased mesh Networks last year.

I would appreciate feedback on this article.

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