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The Role of Informal Communications in C2 Decision Making

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Abstract

The paper introduces the concept of informal communication networks that operate in parallel with the formal organisational networks, and illustrates how greatly increased operational effectiveness in decision making can result from combining both forms of networks.

The paper is based on a series of projects conducted into the operations of the state-wide County Fire Authority (CFA) in the State of Victoria, Australia. This Authority was selected as a representative emergency service that encountered operational problems of a severe nature on a day-to-day basis, particularly during the summer season. The characteristics of these problems were seen to have close parallels to those under consideration by DSTO, so that modelling the CFA operations could give a rich source of scenarios that could be evaluated on a continuous basis.

The emphasis of the projects was on the communication links between the organisational components of the CFA, and between the CFA and associated emergency services such as the Police, and the State Emergency Service (SES).

The initial objective of modelling these communication links was to determine the effects of introducing new technologies such as Unmanned Aerial Vehicles (UAV), and personal GPS moving map devices, allied to mobile and satellite phone technologies such as GSM. The scenarios and simulation models that were derived during the series of projects showed that there were a significant number of instances in which the new technologies enabled a more effective approach to fire fighting, such as dealing with spot fires quickly before they developed.

However the simulation models also illustrated the shortcomings of the formal, and essentially hierarchical, communications networks. The shortcomings were primarily in the quality and timeliness of information flowing through to the actual fire fighting teams. A specific example was found to be in the provision of highly critical information on major shifts in the wind direction, shifts that are by far the most dangerous operational scenario for the fire fighters.

The simulation models were used on actual historical cases of severe fires to determine the effect of receiving information that was correct and timely, at the fire front. The effect of such information was dramatic, as it enabled fire teams to move to safe locations without being caught by a wind change in every case that was investigated, which had not been the case in the actual situations, regrettably.

It was also noted that the experienced teams were often alerted by other CFA members that were positioned further west, and could give actual information as to the wind change passage time, change in wind direction, and strength. This information was both accurate and timely, and its usage confirmed the simulation results.
It is this information that represented the informal communications since it was not formally checked and distributed by the organisational network. This raised issues of

operational control within the CFA since, in essence, teams were operating without control from the hierarchy when they moved out of harm's way.

This is an example of the role of informal communications in a C2 environment, one that illustrates the effectiveness and necessity of such an informal network, but one that raises problems for an organization's C2 operations. A solution considered in the paper, and one that has been simulated, is the concept of an awareness space, or bubble, for each asset within which they make their own operational decisions.

This solution fits the CFA situation extremely well and is described in the paper, illustrating how the informal communications can be blended with the formal communications to maximise the total communications utility.

The Role of Informal Communications In C2 Decision Making

1. Introduction

The paper introduces the concept of informal communication networks that operate in parallel with the formal organisational networks, and illustrates how greatly increased operational effectiveness in decision making can result from combining both forms of networks. In this context the formal communication networks are those sanctioned by an organization and through which the flow of information is both controlled and validated.

In contrast the informal networks are those established by individuals through interpersonal links between members of the organization, links that can often relate to non-work related interrelationships such as sports activities.

These networks are an intrinsic component of what are termed *Organisational Architectures* and *Social Architectures*, Reference 1. This reference focuses on the design of a Headquarters starting from the social aspects, rather than from a formal organisational approach, whilst this paper focuses on the detail of the communications.

The work reported on in this paper examines the effect on operational C2 situations of utilising the informal communication links as well as the official links, and demonstrates that such a combination is significantly more effective than only using the official links.

The issue of handling the informal flows without changing their essential characteristics is also analysed, and an approach outlined that can be accepted by the organizational bureaucracy

2, The Communications Model

The underlying project was within the ambit of the Defence Scientific and Technology Organization (DSTO) in Australia, as a part of the organizations ongoing research program into communications for C2 applications. As with previous research the project was translated into an equivalent emergency services regime that mirrored the most important characteristics of the original DSTO project, but was unclassified.

The emergency service that was selected as the exemplar was the Country Fire Authority of Victoria, Australia (CFA). The CFA is always in action fighting bush fires so that almost immediate feedback can be gained on the effect of operational changes in real situations.

The CFA fights some 600 major bush fires each year, of which some 70% are started by human activity, Reference 2. The organization consists of 1000 employees and over 60000 volunteers, grouped into 1200 individual brigades, so it is a significant organization in terms of geographical spread, ongoing activity and size of organization.

The operation of the CFA is very flexible, with the basic structure shown in Figure 1. The basic strategy for fighting fires is that of controlled response, so that additional resources are applied as needed, up to calls for resources from other States such as New South Wales. In other words the communication structure needs to be capable of rapid expansion if a fire escalates to the status of a wild fire.

The original intention of this CFA project was to generate and validate a simulation model of communications, using data from actual fires, and then model the effect of introducing new technology, such as Unmanned Aerial Vehicles (UAV), to both monitor weather and fire conditions and to act as communication platforms.

The paper is also based on a series of earlier projects conducted into the operations of the State-wide County Fire Authority. These projects were initially based on work done for DSTO in the generation of a secure form of GSM cellular telephone technology. The emphasis of the projects was on the communication links between the organisational components of the CFA, and between the CFA and associated emergency services such as the Police, and the State Emergency Service (SES). However the secure form of GSM took advantage of GPS signals, so the potential for mapping applications was also investigated.

The initial objective of modelling these communication links was to determine the effects of introducing new technologies such as personal GPS moving map devices, allied to mobile and satellite phone technologies such as GSM. The scenarios and simulation models that were derived during the series of projects showed that there were a significant number of instances in which the new technologies enabled a more effective approach to fire fighting, such as dealing with spot fires quickly before they developed into a significant fire.

The simulation model described in this paper concentrated purely on the communication links, with all devices included, such as the GSM phones, and the UAV deployment, with a simplified approach to the actual dynamics of the fires. The additional components that were incorporated in the simulation model are shown in Figure 2.

A further critical item was the incorporation of the informal network of CFA volunteers, with information on aspects such as critical wind changes being relayed to strike teams by volunteers well to the west of the fire, the direction from which the weather changes.

2. The Simulation Model

The intention when building the simulation model was to allow the simple incorporation of different forms of communication platforms, so a tool set was constructed termed the Communication Simulation Tool Set (COSTS) Reference 3. A number of different approaches to the design of such a model were investigated, and a final design chosen that included

. A design approach using UML as the design language, Reference 4

. A production rules based open source system termed drools, Reference 5

. An independent-blackboard communication architecture Reference 6

. Integration with a Java environment

. A time-step monitor used to control the progress of the simulation.

The primary reason for introducing individual blackboards for all simulation model components such as trucks and people was to ensure that their actions were not reliant on some form of omniscient model knowledge, but only on communications received, and their own direct perceptions. This in turn lead to the concept of an ‘awareness bubble’ for each component within which they could make their own decisions, based on their own direct perceptions, such as a changed rate of fire front speed.

Once the simulation model was established it became obvious that one of the most important scenarios that needed modelling was that of a major wind shift, a common and sustained occurrence in Victoria, as shown in Figure 3. The critical aspect of this shift is due to the positioning of fire fighting assets on the eastern side of the original fire both to pinch the fire front, and to tidy up any smaller areas that remain burning. With the wind shifting from a northerly to a south-westerly direction these assets have to be moved clear before the fire front starts moving east.

The forecasting of the timing of such shifts is very difficult, and the timing is often in error by over an hour, and the shift goes through in 10 to 60 minutes Reference 7. One of the fires used to validate the model was the Linton fire, Reference 7, which had a tragic outcome primarily as a consequence of an incorrect forecast.

The simplified graphic model used to display the simulation model results is shown in Figure 4. This shows a wind from the north, a typical initial scenario for fires, with fire trucks being the primary means of fighting the fire.

In the case of Linton the wind shift arrived over 40 minutes earlier than forecast, and this meant that trucks on the eastern side of the fire did not have time to get clear. The forecast in this case represents the officially validated information that was available through the formal communication channels.

The model was then modified to examine the effects on this outcome of earlier warnings, either through a UAV, or through the informal communications from un-engaged volunteers to the west of the overall fire region.

The effect of an pre wind shift warning was surprisingly time sensitive, something of the order of ten minutes warning would have been sufficient to get clear in the Linton example. This result led to an investigation of the representative delays in decision making through the current formal channels.

The results were

Location of Decision	Type of Decision	Decision Time (mins)
Front Line	All Decisions	2-3

Head Office	Escalating Decisions	5-10
Head Office	Restructuring Decisions	60

These results match those noted for front line personnel, as in Reference 9, and indicate that the timeliness for communicating critical information is very marginal when using the formal channels.

On the other hand the informal information in such cases was both timely and accurate, and it was observed that experienced crews made full use of such information to make decisions as to the safety of their teams.

Another scenario that was explored through the model was that of spot fires, as shown in Figure 4. In this scenario a fire starts to develop down wind of the fire front, with the potential for trapping a team between the main fire front and the developing spot fire.

Once again the correctness and timeliness of the informal communications made a most significant contribution to the safety of the teams, allowing movements to be made to places of safety in good time.

3. Informal Communications

There is certainly more to the concept of informal communication networks and their effectiveness than the previous discussion indicates. Another example in the C2 area is that of air-traffic control, where weather plays as important a role as it does for the fire scenarios.

A typical scenario for charter aircraft is shown in Figure 5, with aircraft in transit across Bass Strait in southern Australia from Melbourne to Hobart, having obtained a legal forecast that does not contain indications of icing conditions en route.

However the aircraft at position 3 encounters icing and diverts, but the aircraft at position 2 is not permitted to divert immediately on the basis of the overheard in-flight report from the pilot of aircraft 3, since that pilot is not considered to be an official weather observer at that stage of the flight. An immediate diversion in this instance from position 2 is actually illegal, and can result in the pilot having their licence suspended.

At first sight this scenario would appear to be an ideal candidate for utilising the informal network of communication between pilots. However there is a major difference between the two communities, fire fighters and charter pilots.

This difference if that the fire fighters wish to cooperate, as they are all involved in protecting their properties and their friends. The charter pilots are competitors in a very marginal industry, and it is not unknown for pilots to try and spook others to gain a commercial advantage. In other words, the fire fighters form a trusted community of interest. The charter pilots do not.

Another viewpoint on the role of informal communications is in the political and commercial arena, from the perspective of the senior governance group, such as at Cabinet or Board level. Any such group needs a strong flow of informal information if only to ensure political survival, but such information cannot be seen in any official way, the politics of ‘plausible denial’ Reference 10.

This highlights one of the main issues coming from this research project, how to meld the apparent conflict between the official information flows and the informal flows in a manner that is both effective, and is acceptable to the specific organization.

An example of this potential conflict is seen in the use of UAVs, as illustrated in Figure 2. The UAV is shown communicating information concerning a spot fire in two modes, a secure satellite link back to Head Office, and a local broadcast. The Head Office link represents the formal link while the broadcast is both timely and accurate and so represents the informal form of communication.

One major issue that has been under discussion is whether or not this broadcast mode should be enabled, clearly highlighting the potential loss of control issues faced by Head Office. These issues include serious legal considerations if a course of action is not successful, which is why such a tight hold is kept on the validation of weather forecasts.

The approach currently taken to resolve this issue is based on the awareness bubble concept introduced earlier in the context of the simulation model. This is a common approach, and has been applied to real time targeting situations with Australian F18s in Iraq for example. The principle is that of a group making operational decisions based on their own sensors, or on sensors that are available to them and are trusted.

With this principle the use of the UAV broadcasts, and phone calls from colleagues to the west of a Victorian fire, certainly qualify under this definition of ‘local’ sensors, without modifying the overall C2 structure, an acceptable outcome.

4. Organisational Architectures

The primary focus of this paper is on the design and implementation of a tool set for modelling communication flows in an emergency services environment. The initial results from running, validating and extending the simulation models indicated some tentative conclusions related to the organisational structures as articulated in Reference 1, particularly the social architectures.

Three forms of social architecture have been noted in the previous section

. A trusted community of interest within in the CFA volunteers

. The community of charter pilots operating within the Air Traffic Control system that are constrained by legal restrictions as to information flows, based on a lack of trust endangered by commercial pressures.

. A classic major company organization including the Board that needs informal but confidential information flows for early warning of issues that might affect individuals on the Board, or the Board itself. This example is one that has been reflected in many of the governance problems being faced by major organizations worlds wide.

Of these three forms of social architecture the only one that is seen to be effective in an operational sense is the first one, that of a trusted community of interest.

This tentative result has obvious implications for any emergency service, including defence, and some positive results have been observed in the cases where multiple emergency services are involved, such as when a major crash occurs on a highway.

In Victoria a major issue that had to be resolved was that of the service to be actually in charge of the site, and once this was settled the various services could start to build a regime of trust over an extended period. This outcome of building a trusted community of interest can be mapped against the experiences in East Timor, and Iraq to explain any differences noted in operational effectiveness in these different environments.

5. Summary

The paper describes the development of a simulation tools set for modelling the communication aspects within an emergency services environment, the Country Fire Authority of Victoria. This tool set has been used to model the communication aspects of fire fighting. In addition the model was extended to include new technologies, and the inputs of informal information into the real scenarios.

An unexpected result from these models has been the critical nature of the informal communications, significantly increasing the overall operational effectiveness for the teams, specifically in the avoidance of hazardous situations.

The use of informal channels raises the prospect of conflict with the organizational hierarchy of formal communications. However a relatively minor extension to the accepted concept of a team's awareness bubble of perception is a possible solution to this apparent conflict issue.

Finally, some comments are made as to the nature of different forms of social organization, and the effect of these forms on operational C2 effectiveness.

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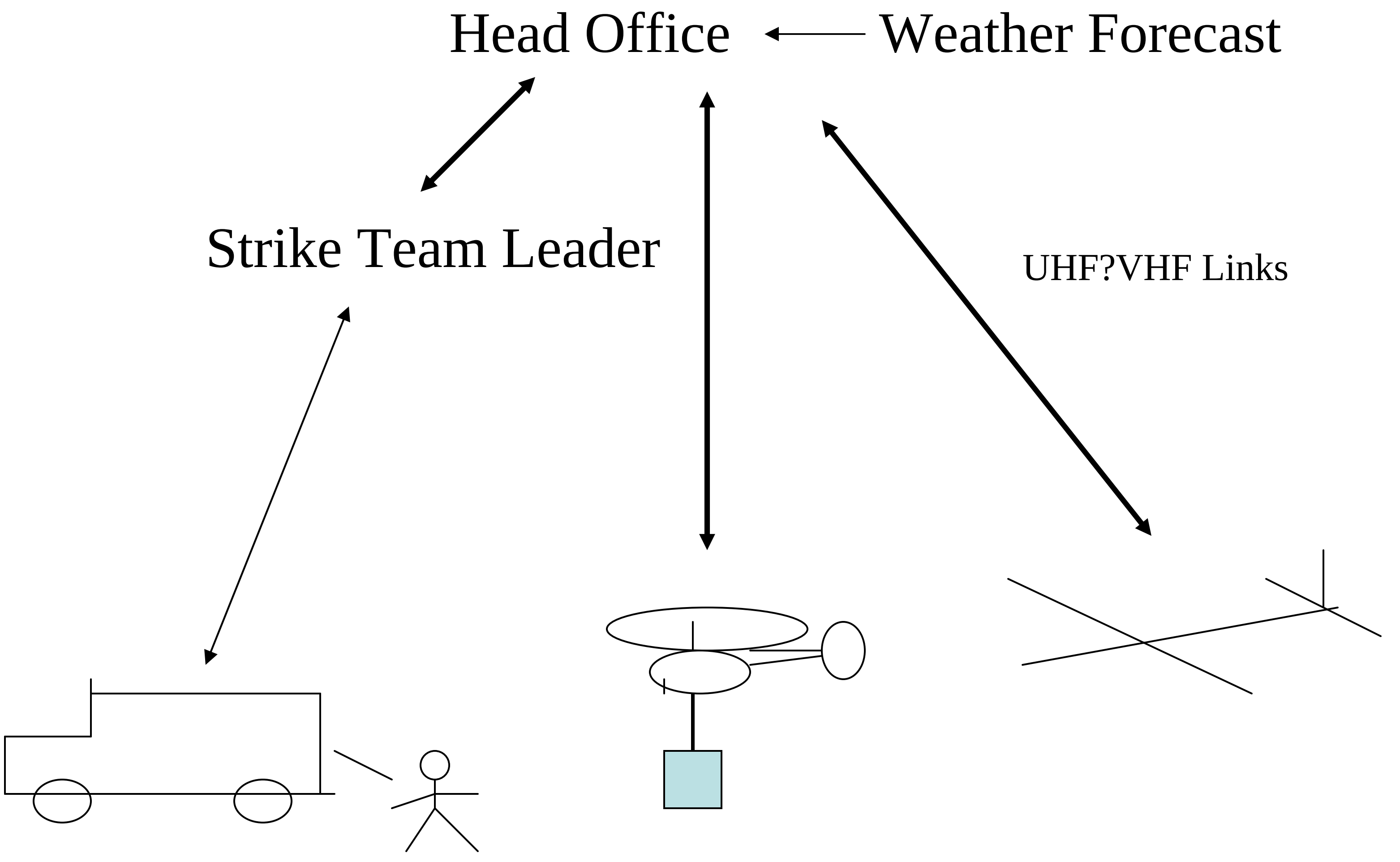

Figure 1 Current Communication Links

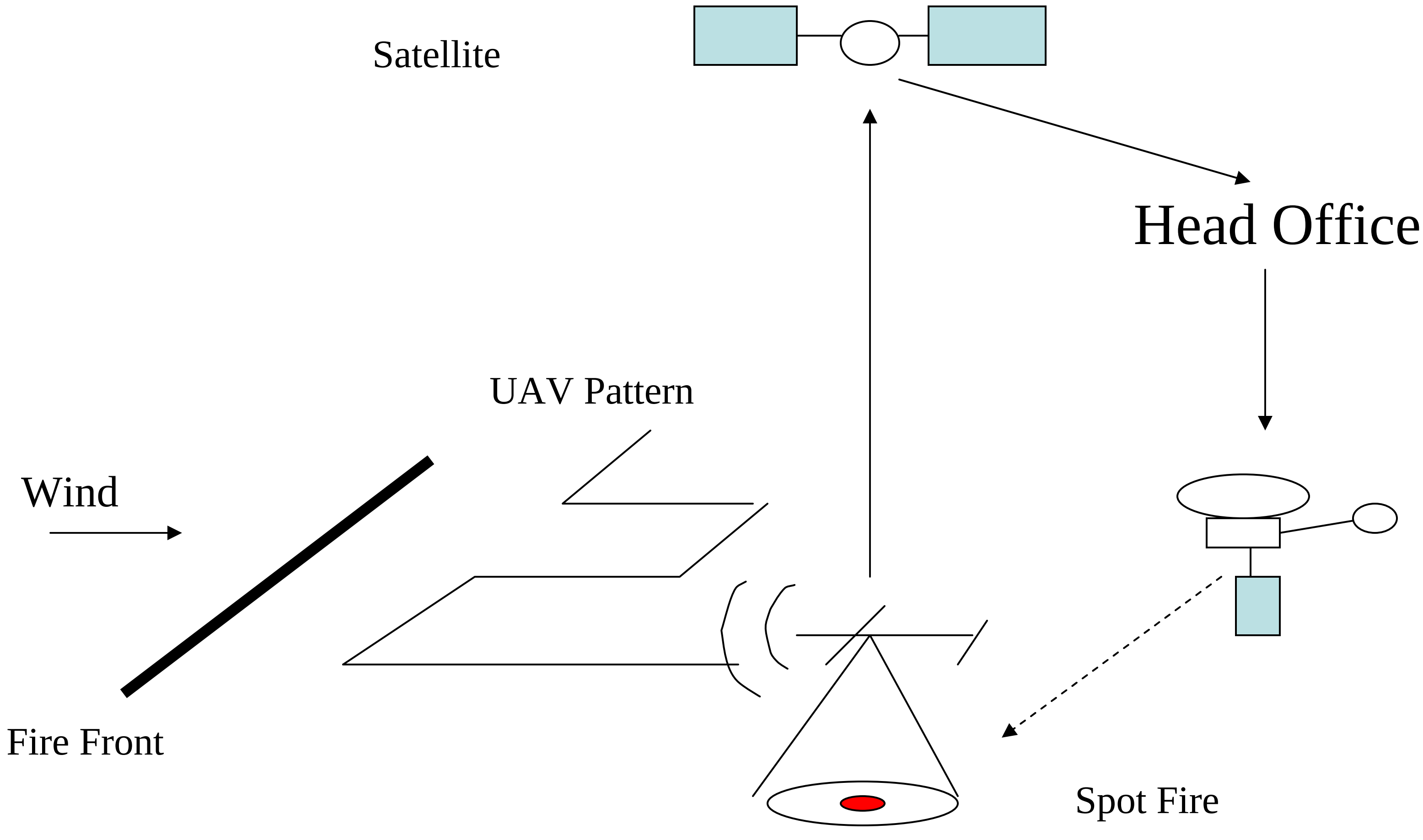

Figure 2 New Technologies

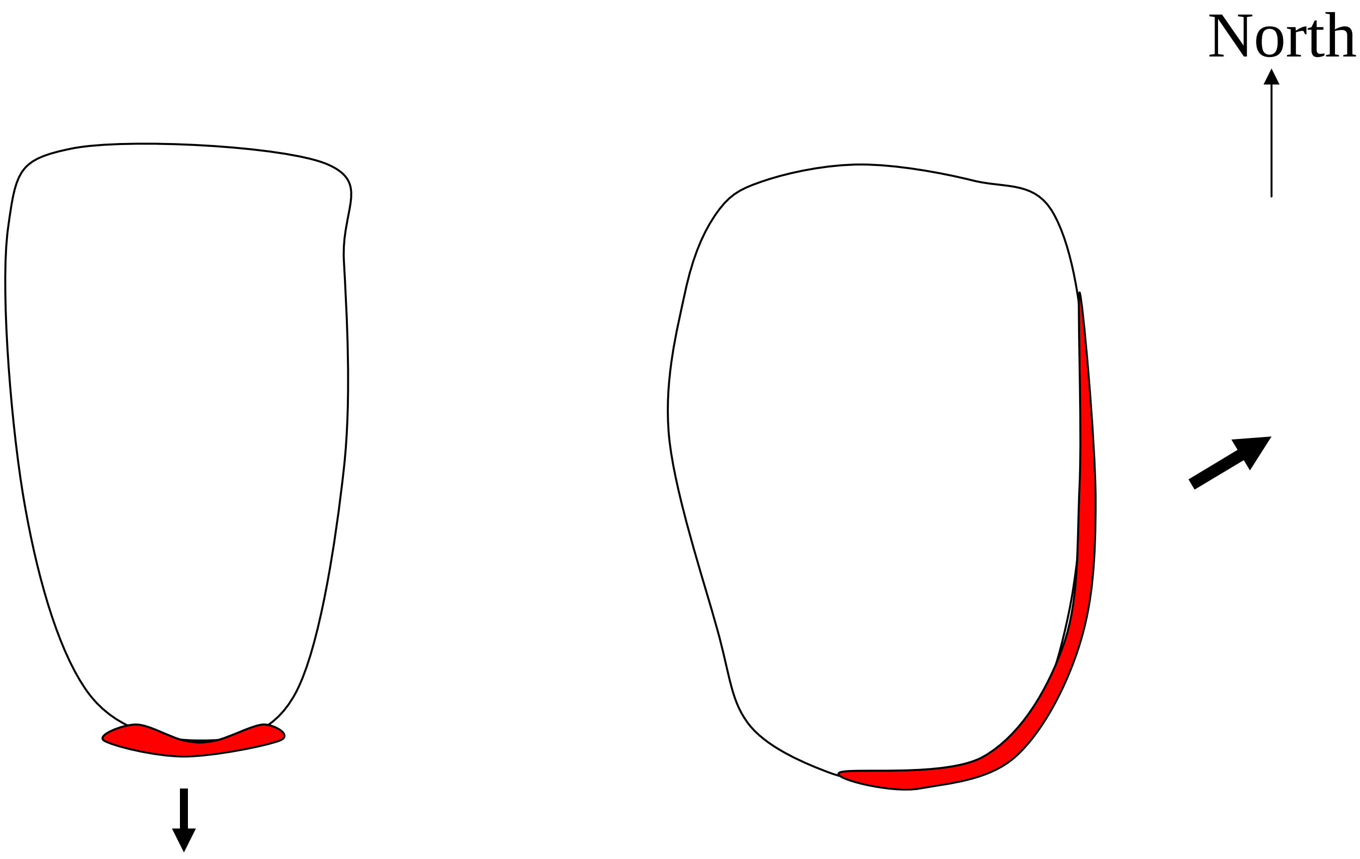

Figure 3 Fire Front with Wind Change

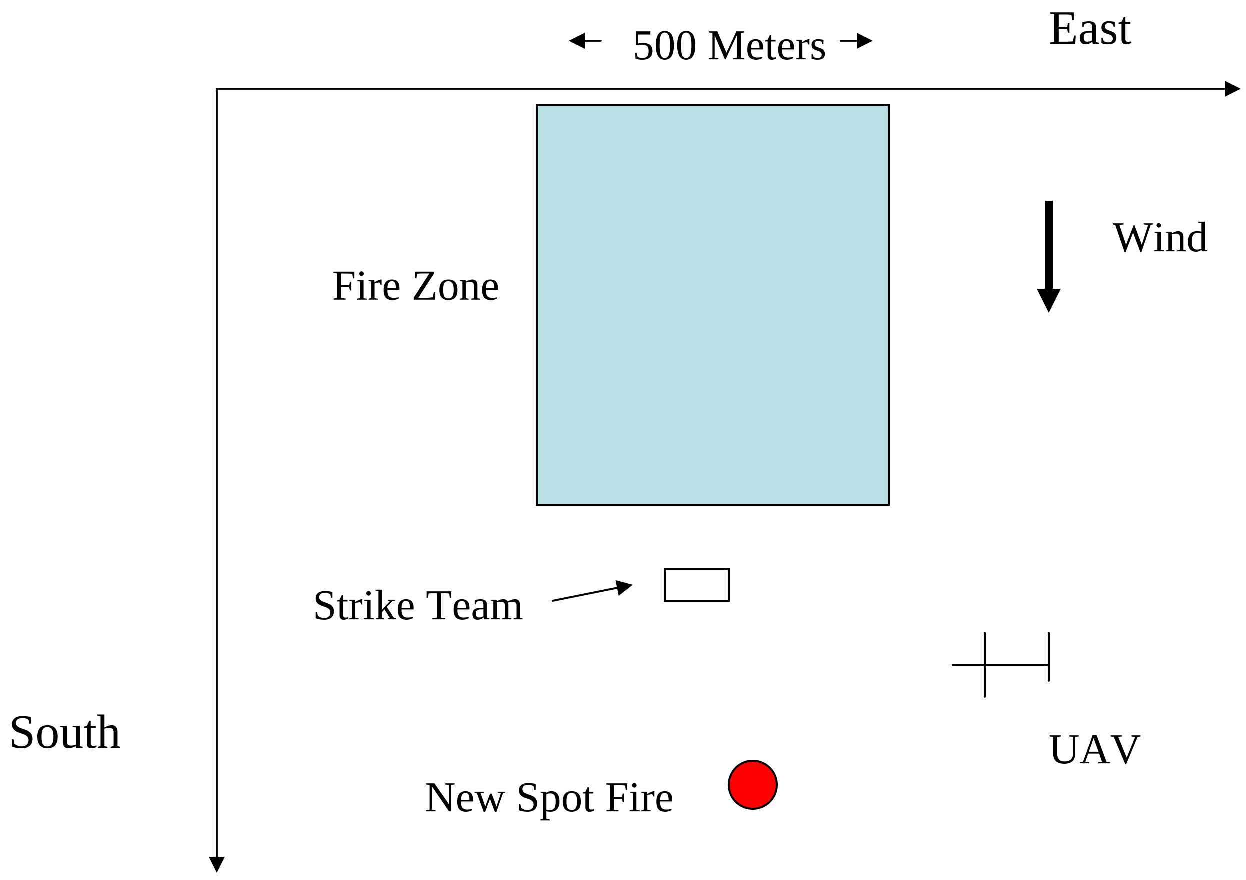

Figure 4 Screen Layout Simulation Model

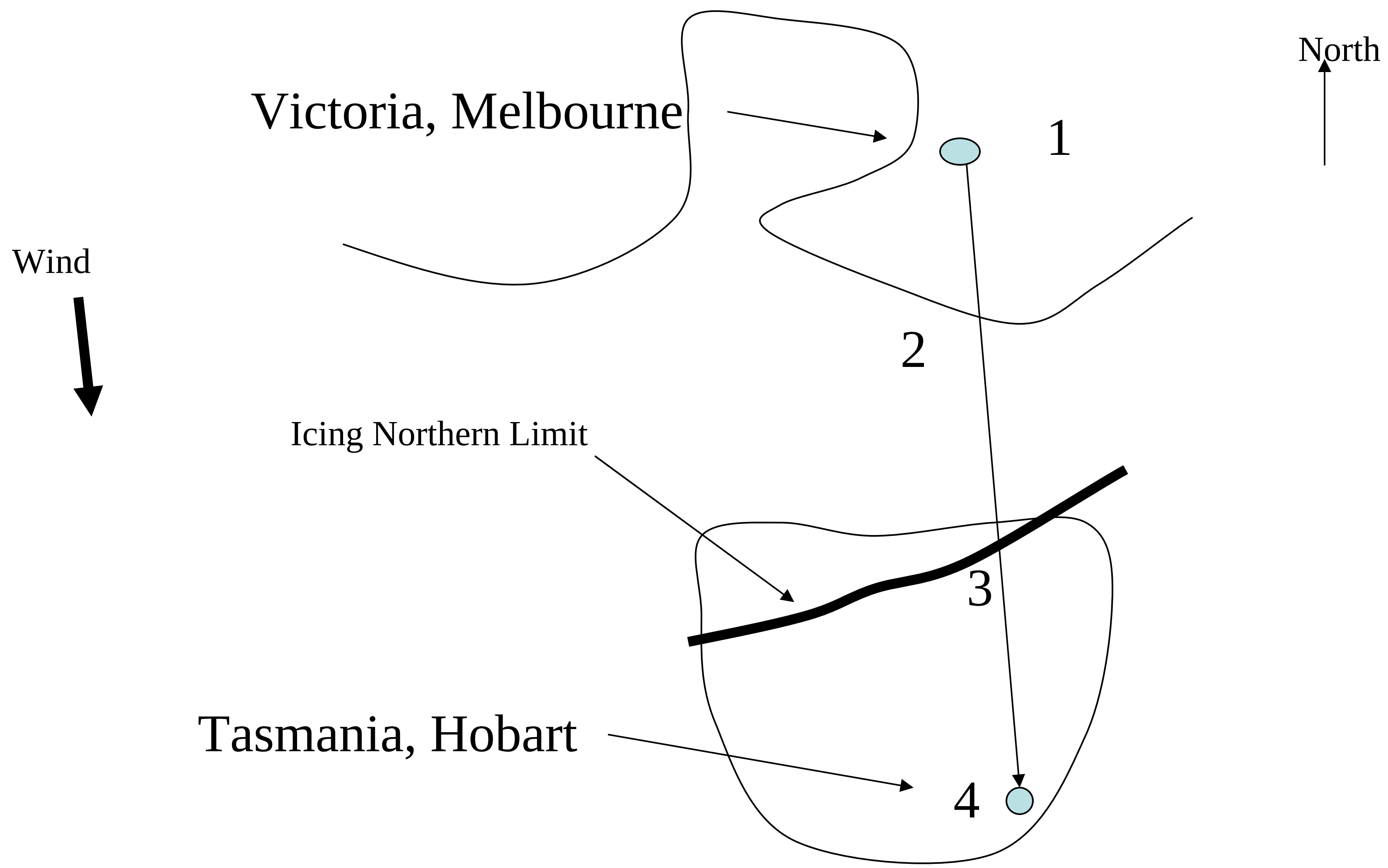

Figure 5 Air Traffic Control Example