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# The AVIAN Flu Tracker - a Location Service Proof of Concept

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## Abstract

The bird infecting viral strain H5N1, commonly known as the Avian Flu, is a highly infectious and resilient virus that can be fatal if contracted by humans. Authorities and health services have a major responsibility to citizens to respond quickly to minimize the possibility of a localized outbreak becoming a pandemic. The Avian Flu Tracker is a dynamic Location Based Service (LBS) designed to warn citizens of their proximity to potentially infectious regions. The system tracks the location of infected zones, dynamically estimating the spread of an uncontained area over time. Users subscribed to the service receive SMS messages alerting them of the potential for danger based on their current location, and a recommended course of action. By utilizing a scalable and distributed architecture, predictive modeling and innovative zone technology to assign threat levels to spatial data, Avian Flu Tracker demonstrates that LBS can aid to stem and control the spread of the pandemic.



## Keywords

AVIAN Flu, HFN1, Location-based Services, Flu Tracker, Pandemic, Virus Outbreak, Simulator

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# The AVIAN Flu Tracker- a Location Service Proof of Concept

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ABSTRACT: The bird infecting viral strain H5N1, commonly known as the Avian Flu, is a highly infectious and resilient virus that can be fatal if contracted by humans. Authorities and health services have a major responsibility to citizens to respond quickly to minimize the possibility of a localized outbreak becoming a pandemic. The Avian Flu Tracker is a dynamic Location Based Service (LBS) designed to warn citizens of their proximity to potentially infectious regions. The system tracks the location of infected zones, dynamically estimating the spread of an uncontained area over time. Users subscribed to the service receive SMS messages alerting them of the potential for danger based on their current location, and a recommended course of action. By utilizing a scalable and distributed architecture, predictive modeling and innovative *zone technology* to assign threat levels to spatial data, Avian Flu Tracker demonstrates that LBS can aid to stem and control the spread of the pandemic.

BIOGRAPHY: Blake Stroh, Owen Berry, Adam Muhlbauer and Tim Nicholls are third year computer science and mathematics students at the University of Wollongong. They are presently completing an annual software project under the supervision of Katina Michael. Blake has studied at the University of North Carolina, Tim is currently working on an advanced mathematics dissertation, Adam is specializing in security and distributed networks, and Owen is specializing in multimedia and software design. Dr Michael is a senior lecturer in the Faculty of Informatics with interests in location-based services, security, and privacy. She has also held positions as a senior network and business planner with Nortel Networks.

## Introduction

Government readiness in relation to national security concerns is an area which is being given increasing attention, especially since the Boxing Day Tsunami and Hurricane Katrina found rescue efforts wanting. While national security today is perceived to be about how to prevent and respond to terrorism, natural disasters and biological disease outbreaks (not withstanding intentional nuclear, biological and chemical attacks) hold far greater direct risks to the community at large. Maintaining the health and well-being of citizens is increasingly being recognized as a government challenge paramount to sustaining a nation's economic interests. History has shown repeatedly the wide-reaching and devastating consequences that pandemics can have on populations. One need only consider the Spanish Influenza (1918-19) that killed an estimated 40 million people. Today, with the advent of air travel and better land and sea transportation networks, the risks to greater numbers of people (and animals) in a wider more global geographical context are evident. This paper aims to explore how information and communication technology (ICT), specifically location-based services (LBS) can be used to minimize harm to global populations by containing the spread of infectious disease through reporting, administration, and community awareness campaigns. The proof of concept (PoC) research project *Avian Flu Tracker* explores the use of LBS to help government institutions and health authorities better prepare for a H5N1 outbreak through a coordinated effort with community participation.

# Containing the Avian Flu by using location-based services

## *Lessons from SARS*

When the Severe Acute Respiratory Syndrome (SARS) epidemic began to spread in various parts of Asia, it was mobile service providers who contributed to the dissemination of important information through the Short Message Service (SMS). Sunday Communications, a Hong Kong mobile operator, and Starhub a Singaporean mobile operator, provided up-to-date information about SARS-infected buildings, giving travelers and locals the ability to reduce the risk of becoming infected. By dialing the SARS number, subscribers would request that their phones be tracked and sent a warning of the potential risk of being in a particular calling zone (Lui, 2003). In both instances the SARS-related data was taken from the country's Department of Health, and included "locations visited by suspected SARS patients and updated names of buildings within one kilometer of the subscriber's calling area in which there ha[d] been confirmed cases" (Staff, 2003). The information was then widely used to create intelligence surrounding the SARS outbreak and potential spread of new infection. Krishnamurthy (2002, p. 177) was one of the first to suggest this type of application for SMS due to its popularity and ability to do *cell broadcasts*. In fact he believed that this type of concept was useful especially in cases of "natural emergencies like tornados" (p. 181). The Multimedia Messaging Service (MMS) would also allow for the exchange of additional attachments with low investment requirements by operators (LeBodic, 2003, ch 6).

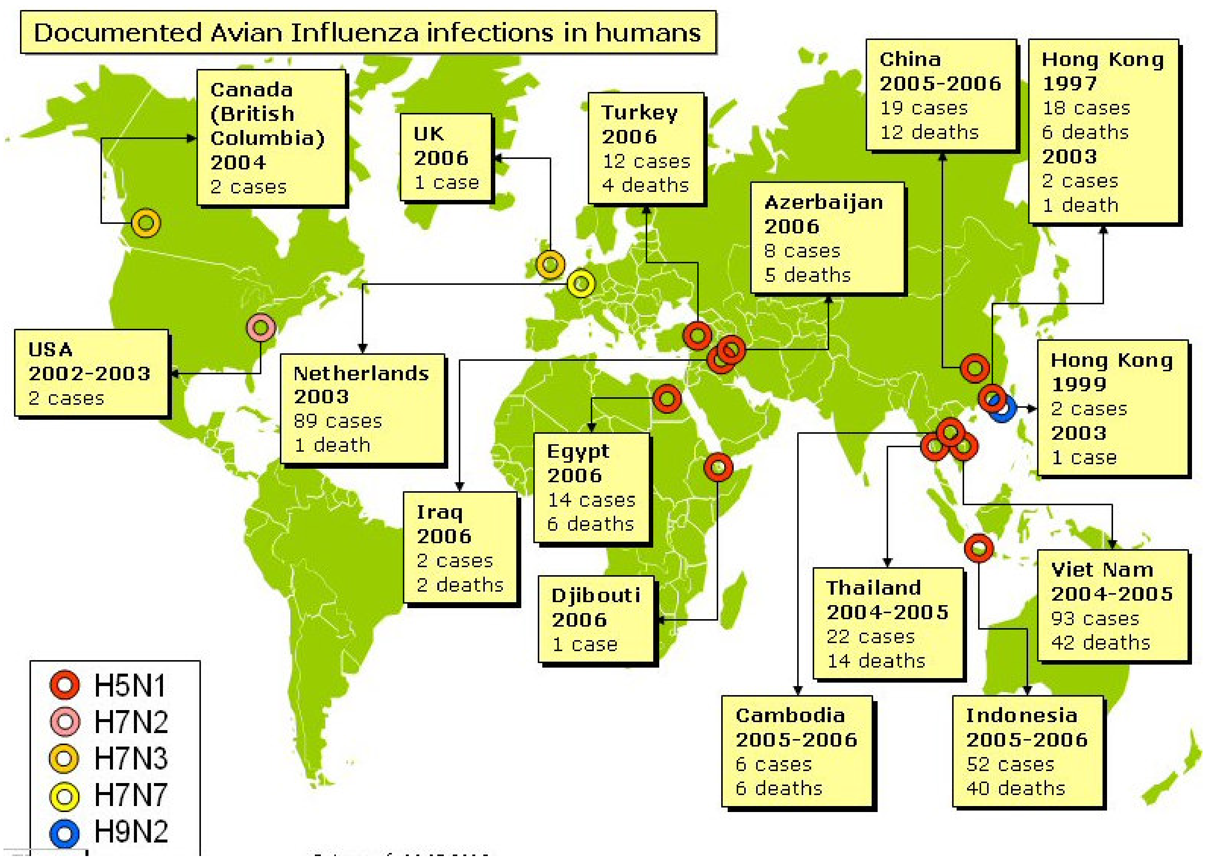
## *The Bird Flu and Location Intelligence*

In comparing SARS to the Avian Influenza, health experts have placed the influenza on a far greater scale in terms of its potential effect on society. The Bird Flu is a contagious viral infection and is classified as a Highly Pathogenic Avian Influenza (HPAI) strain. It was first documented in 1997 in Hong Kong. The quick actions and strict control measures in the Hong Kong poultry industry allowed the outbreak to be halted promptly preventing further spread of the virus. In 2003 a number of countries in Asia began to report a strain of H5N1 that differed slightly from the 1997 virus (map 1). This has since emerged in many parts of the world but not in Australia. The major international body presently monitoring the Avian Flu is the World Health Organization (WHO). WHO stores details of all confirmed cases in humans and animals worldwide and have set strategies and plans in place should an outbreak occur. Along with WHO, each country has a major responsibility in controlling any possible outbreaks. In Australia, the Government Department of Health and Ageing is charged with this task.

In October 2005, Kevin Coleman, wrote a paper in *Location Intelligence*, titled: "The Bird Flu- A Homeland Security Planning Scenario" where he called for the development and implementation of a global mapping system that would aid in the tracking of the spread of the virus. Coleman described a web-based system which would "include attachments that provide specific scientific data defining what strain of the virus is present, the number infected (human and animal), the number of deaths (human and animal) and the specific geographic location of all points of infection. Additional information would include the virus verifying agency and contact information, agency in charge of outbreak control, and a point of contact there" (Coleman, 2005, p. 2). The proposed system would have the capability to drill-down to a single event of an individual infection. What Coleman did not discuss however, was the element of mobility that would make his proposed system manifold times more powerful, especially in the case of virus mutation. While *location* is paramount and web-based systems are accessible by the masses, a mobile service based on a citizen's position (especially one who is visiting in a given geographic region for the first time) would aid awareness "just-in-time".

Location-based services (LBS) are the ability for an information system to denote the position of a user based on a device they are carrying or their position in a given context (Gartner & Uhlirz, 2005, p. 159). Three ways a position can be determined include: a GPS chip built into the phone, *trilateration* which uses the phones signal from two or more reference points, or *radiolocation* which measures signal-strength from a single phone tower giving a location with a radius of inaccuracy. LBS are gaining popularity in a wide range of applications within the ICT sector including in inventory management and the tracking of children for safety. Many researchers in the field have stated that LBS could be used in response to national security issues, especially for first responders (Michael & Masters, 2005). Dependent on the proximity of persons to target locations, various levels of alarms could be raised (Wang, 2004, p. 24).

As in the case of SARS, citizens who wished to “opt-in” to particular location-based content could, the AVIAN Flu Tracker would not only allow for an alert service but use the traffic data gathered to conduct a level of scenario planning and outbreak management previously unavailable. Consider IntelliOne Technologies who have just developed a system that can track commuter’s cell phones and provide them with up to the second traffic reports accurate to three miles per hour. The service “takes advantage of the fact that wireless devices in motion communicate constantly with multiple cell towers” (Than, 2006). If a subscriber “opts-in” to the service, they are effectively saying that they want the LBS system to know where they are and who they are. Similarly the Avian Flu Tracker ideally would be able to provide this type of capability and much more. These kinds of ICT systems are a part of what Laxminarayan and Kun (2004, p. 27) call *passive measures* to national security, such as “rapid warning and evacuation, quarantining, mitigating through vaccines, health, fire, and police intervention”. ScoringAg (2005) believe these types of systems can “minimize or even eliminate the large loss of life that is often associated with the usual inaccurate, inadequate, and late response experienced when an emergency response system is not in place and ready to be used by those most needed…”




*Map 1. Documented Avian Influenza Infections in Humans (European Commission, 2006)*

## Methodology

The proof of concept followed a conventional approach to development. Just as Coleman (2005) reflected on the fifteen national security scenarios given by the Department of Homeland Security (DHS) in the United States, so did the BOAT Software group consider a comparative Australian scenario. The DHS placed a "biological disease outbreak: flu pandemic" as the third item on its list of fifteen serious national security considerations. Coleman took this item and expanded on the flu pandemic scenario. He wrote: "[t]he scenario involves an influenza pandemic that begins in south China and spreads within months to four major cities in the U.S. The scenario estimates 87,000 dead and 300,000 hospitalized in the U.S. alone. The economic impact is estimated at being between $70 and $160 billion." The scenario formulation by BOAT Software was based on a document review to qualify and verify the special characteristics of the AVIAN Flu. An interview with a prominent expert researcher working in the area was also conducted (Media, 2006). It is important to note that a system such as the proposed Avian Flu Tracker needs to act to minimize public panic and aid in the management of a potential outbreak, rather than working in a counteractive manner to cause mass hysteria in the community. In the 2003 SARS outbreak, the Hong Kong government had to send millions of mobile text messages to residents to "debunk a hoax that led many to believe that the city was soon to be formally declared *an infected place*, causing mass panic and buying binges throughout the region" (Jardin, 2003). The problem was put down to the "terse" nature of SMS texting which can lead to misinformation by not revealing the whole story. MMS could overcome some of the SMS limitations but careful deployment of the service would be required with strict procedures and controls.

## Hypothetical scenario

The following scenario is set in the state of New South Wales and was used as a basis for developing the functional capabilities of the Avian Flu Tracker software. The document titled: "National Strategy for Pandemic Influenza" written by the Homeland Security Council (2005) was also consulted. Avian Flu Tracker aims to address the strategic needs stipulated in pillar three of *response and containment* of a pandemic. These are "[a]ctions to limit the spread of the outbreak and to mitigate the health, social and economic impacts of a pandemic" (Homeland Security Council, 2005, p. 3). The key to eradicating potential pandemics are early warning systems and an ability to closely track the initial spread of the virus, before it crosses borders, whether they be local, regional, or transnational.

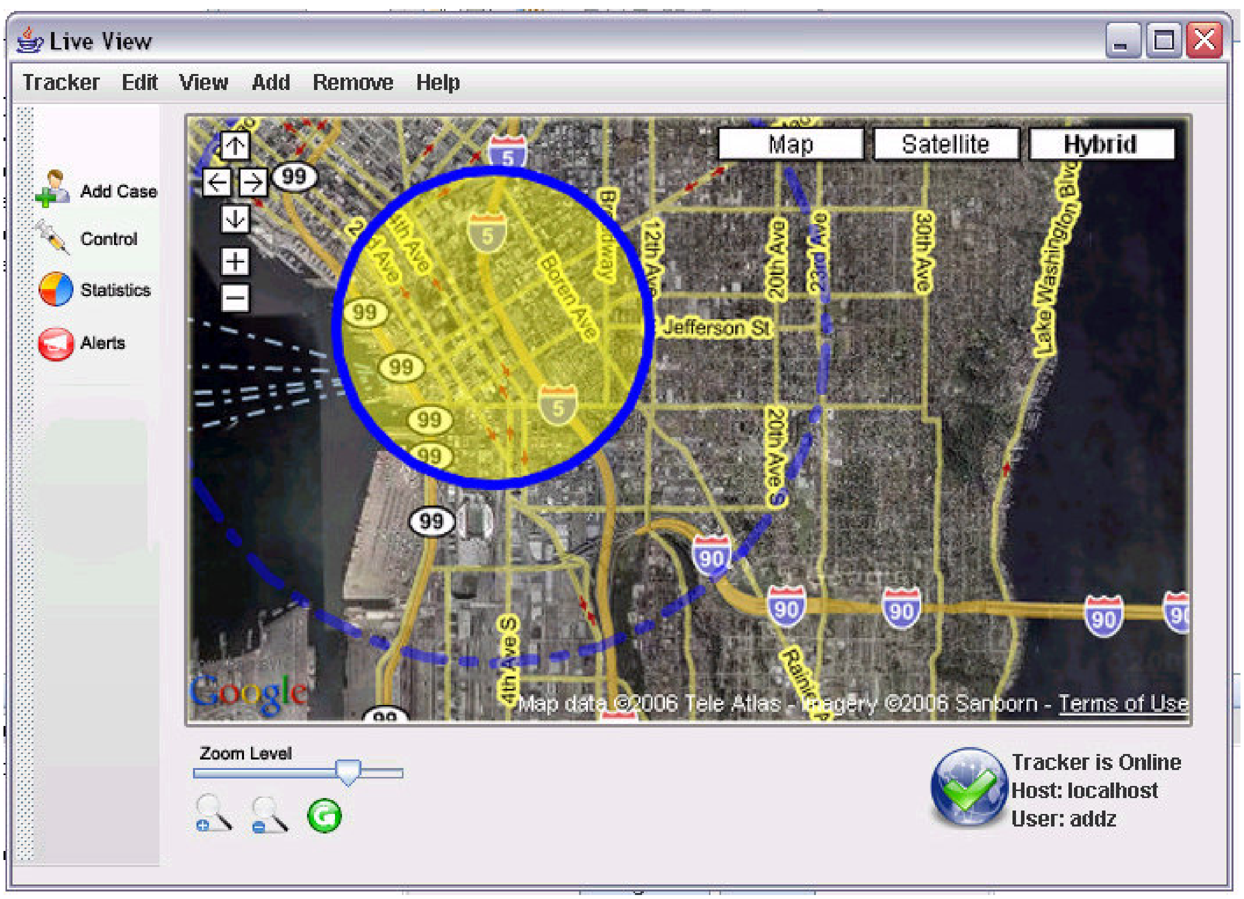
*Internal Memo:* A number of confirmed cases of Avian Flu have been identified in Sydney, NSW. As feared the infected persons contracted the virus from other human contact. The government needs to act immediately to control the possibility of a widespread outbreak. In conjunction with relevant health authorities, the government needs to know what action to take, where and within what timeframe. Widespread quarantine is impossible due to both the cost and potential magnitude of the problem but insufficient action may lead to a pandemic.

### *Confirmed case of Avian Flu in North Bligh, Sydney, NSW*

*Scenario*: You have been contracted to work for the NSW Health Department, alongside health professionals to respond and contain the Avian Flu outbreak. The government has recently invested resources and capital in the development of an Avian Flu Tracker to help them make more informed decisions in the event of an outbreak. Since the alert service was made available to the public, approximately 80,000 people subscribed in the first day, and this figure has rapidly increased with each successive day, as the mass media broadcasts reports on new confirmed

cases. The profile of adopters is predominantly adults with families. Subscribers are given access to the latest Avian Flu government updates and are alerted when approaching hotspots.

*Stage 1:* Since the first confirmed case, health authorities have been entering confirmed cases into the system. *Stage 2:* At an emergency meeting of the Federal Health Department, a group of important government officials meet to assess the situation. The Committee log into the Avian Flu Tracker system at the Pandemic Control Centre using the government task force access mode to conduct a situational awareness (dialogue 1). *Stage 3:* It becomes immediately apparent that the problem area is in North Bligh, Sydney, and has yet to spread to other parts of Sydney. The government decides to take immediate action, by quarantining North Bligh and evacuating people from surrounding suburbs. This information is entered into the system as quarantine and evacuation zones. *Stage 4:* In addition to newsflash television and radio broadcasts, messages are sent to all subscribed Avian Flu Tracker users currently in the Bligh zone, notifying them that the area is in quarantine and to remain in their homes. Strict constraints are placed on serving hospitals in the area, including on North Street, East Bligh. Messages are also sent to all subscribed users within a 50km buffer zone of Bligh, alerting them to keep away from the area. *Stage 5:* As more infections take place, the infection zone grows in surface area, and spawns new colliding infection zones in surrounding suburbs, such as Coogee. But government officials are not unaware. The Avian simulator uses confirmed cases to show the most susceptible surrounding areas, and allows officials to take appropriate actions toward containment. *Stage 6:* After further quarantine zone cases emerge, the infection zones begin to shrink as the virus is contained, and though 45 people have fallen victim to the Bird Flu, the government has stopped the virus from spreading rampantly throughout Sydney and elsewhere.




*Dialogue 1. Inspecting an Individual Confirmed Case of Avian Flu (Government Access Mode)*

# The AVIAN Flu Tracker

## *Purpose and functionality*

BOAT Software have created a prototype dynamic information system that can demonstrate the provision of useful information for a variety of stakeholders, including government authorities, health organizations, and citizens during pandemic outbreaks like the Avian Flu. Citizens with mobile phones are able to subscribe to the system so that when they approach a potential Avian hotspot, an SMS message is created and sent warning them of their proximity to possible dangers at that location. Other information regarding possible courses of action can be determined and communicated to the user such as the location of hospitals, evacuation points or the location of emergency service teams in the field. Health authorities can also visually see the location of predicted hotspots within a given locale, and add the location of the confirmed origin of an outbreak in order to increase the accuracy of the predictive model. This view can be used to administer information in the system, as well as see where subscribed users are in relation to potential Avian Flu infected areas. Some of the more important features include the location-based user alert system which notifies users in precarious locations to be contacted first rather then just flooding the whole subscriber base with a blanket broadcast.

The basis of the research is using LBS technology together with a customizable Avian Flu simulator to monitor potentially dangerous areas. This allows for the predictive spread of the virus through various population parameters including, the speed at which the hazardous area is increasing or decreasing over time. The system will implement a distributed architectural design to allow maximum performance, as processing can be spread to many computers working in parallel. All the web-based interfaces are designed to meet detailed design principles with various analysis and reporting tools available in drop-down menus. Security is also of great importance allowing for a limited number of authorized users to access the system ensuring data integrity and confidentiality.

## *User profiles*

The Avian Flu Tracker application has a number of different users that interact with the system. This user base divides logically into direct users who interact directly with the system to enter data (health authorities) or use the system to aid them in making decisions to control the spread of the Avian virus (government officials), and indirect users who only receive alerts from the system (subscribers). The direct users of the system are the authorized health service personnel, authorized government personnel, and the system administrators. The tasks that each group performs can be summarized in the use case diagram (diagram 1). These include adding confirmed cases, adding quarantine and evacuation zones, viewing and generating reports, editing and sending alerts (i.e. messages) to subscribed citizens, viewing subscriber movements, and managing users.

## *High-level design*

The Avian Flu Tracker has a highly distributed architecture, with each main component running in an independent Java virtual machine, and communicating via a network connection. The main purpose behind this approach is to create an extremely scalable platform for future real-world operations. Initially, the application can be hosted on a single computer. However, as operations increase or as the range of the area tracked is expanded, additional computers running core components can be added to an existing Avian Tracker system with no downtime. This also allows for greater load balancing as demand for the service increases during a time of heightened alert. Currently, checking prescribed users proximity to potential hot zones, and simulating the spread of the virus within a community are relatively simple tasks. However, if these tasks

become more complex, such as the addition of more advanced spread simulation or data mining and inference operations in deciding whom to send warnings to, the system would require more powerful hardware.

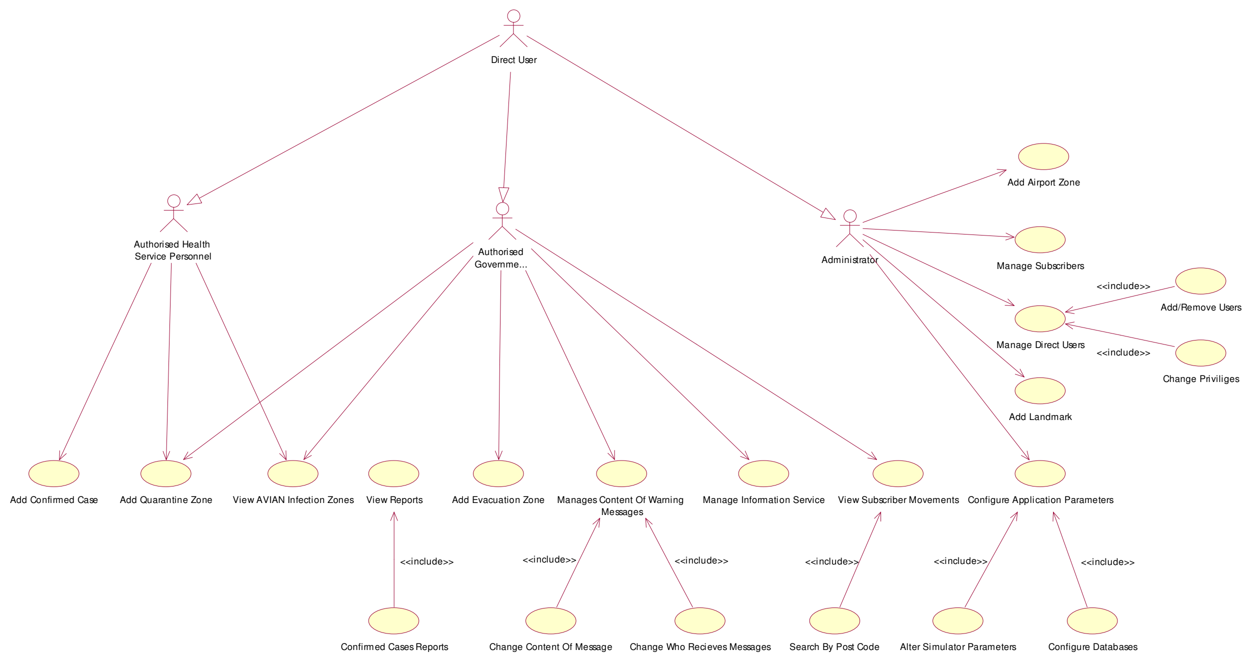



*Diagram 1. Use-Case Diagram of the Avian Flu Tracker*

**TrackerApp**

The TrackerApp is the central hub of the Avian Flu Tracking system. This component retrieves the latest locations of infectious zones from the Avian Simulator(s), and checks a subscribed user's proximity obtained in real-time from the LBS subsystem. Each infectious region is represented as a 'zone', a circle with a defined origin and non-fixed radius that varies over time in accordance with the spread or containment of the virus within an area. Each user themselves is surrounded by another 'buffer' zone, which dynamically changes depending on characteristics such as the users speed of movement. When these zones overlap, a collision occurs and the user is warned of their proximity to danger (see diagram 2). Furthermore, the level of threat to an indirect user can be determined by the extent of overlapping zones. Depending which range the threat level is in determines the type of information sent to the subscriber (i.e. 'emergency' versus 'be aware').

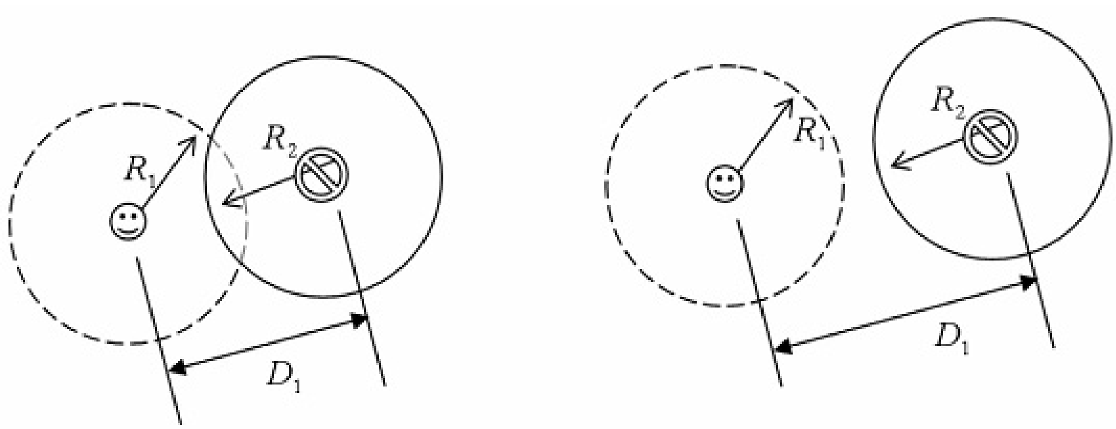



*Diagram 2. Overlapping Zones Mean that a Subscriber Needs to Receive an Alert Message*

### Simulators

The Avian Simulator represents the spread of the flu over time. This component stores parameters for each region of a map that would affect the spread of a pandemic. New zones are added to the simulator and their growth and decay are dynamically adjusted as time progresses. One benefit of the distributed design of the Avian Tracker is that multiple Simulators can be run on multiple computers, each responsible for a different region. This enhances the scalability and expansion of the system as a pandemic spreads uncontained.

### Graphical user interfaces and access control lists

For management and administration, there are two interfaces- the 'TrackerUI' component which is a standalone client program and the web-based interface implemented using an industry standard server-side platform. Both interfaces are designed for ease of use, transparent to the other components of the system. A structured access model utilizing access control lists (ACLs) and group-based policies define what tasks users can perform.

### LBS compliance to the Mobile Location Protocol (MLP)

Avian Tracker has been designed to be independent of any specific Mobile Location Centre (MLC) or LBS provisioning platform. However communication from the TrackerApp to the 'Black Box' component has been designed to conform to version 3 of the Mobile Location Protocol (MLP) open standard set by the Open Mobile Alliance (OMA) (L.I.F., 2002). This is done to ensure support with any hardware platform supporting the communication standard. The Black Box component is designed to provide a software-only simulation of an MLC hardware platform, and is a bridge to the Population Simulator, which models the movement of a mobile phone carrying populous about a region. Theses two components provide a software alternative to time-consuming testing with expensive proprietary equipment. The Population Simulator itself is designed to be reactive. As simulated individuals move towards an infectious zone, an SMS message is passed to them via the black box.

# Low-level design

The Avian Flu Tracker was implemented using Java. Java provides built-in support for networking, database and the graphical user interface which allows for greater ease of development. This is important considering the proof of concept nature of the work, and the timeframe in which the prototype is to be completed. Using Java gives greater portability of any of the programs used within the Avian Flu Tracker to be run on any operating system platform preferred by the user. It also provides configurations using a crossover of different operating systems which allows for server style programs to be run using only the command line on a UNIX system for greater stability and up-time, while the main application and interface for using the program can be run on Windows or MacOS.

## *Avian Simulator*

The Avian Simulator is a program designed to simulate the spread of the Avian pandemic. It works using a formula which calculates the spread of the disease, based on research gathered on dominant variables which affect the transmission of Avian (Li et al, 2004; Liu et al., 2005). Some of these variables include the density of population, the efficiency of human-to-human and bird-to-human infection, and even the lifetime of the virus in humans and birds. The Avian Simulator works in both a confirmed and predictive manner. Confirmed cases are entered into the simulator that are then used to predict the spread of the disease, creating an infected zone which spreads from the point of origin, i.e., the location of the confirmed case. Confirmed cases are entered into the simulator through input from the main application, the TrackerApp.

For the purpose of predictive management, the simulator may create more confirmed cases thus continuing the spread of the virus through more zones. This could be used to aid in making either further containment plans, or to simulate the spread of the pandemic from scratch for planning for different starting outbreak conditions. It may also be used to prioritize vaccine delivery to potential hotspots in preparation for further containment. Each infected zone is essentially a point of origin, along with a radius of the infected area. The rate at which this zone spreads is based on the variables mentioned above, and the zone's proximity to other surrounding zones. While in some zones the pandemic may spread quickly, in others it may decrease due to a variety of reasons. The pandemic may also spread into areas which have different conditions, which should affect the rate of spread. For the purpose of the Avian Flu Tracker, the spread of these zones will remain the same, which will reduce the accuracy of the program. However, if the pandemic has entered a highly contagious zone, there will likely be a new confirmed case reported providing yet more accurate infected zone information.

### *Population Simulator*

The Population Simulator is to simulate the movement of subscribers within a mobile phone network which have subscribed to receive warnings when they have moved too close to an infected area. The Population Simulator behaves like an individual person moving around, acting upon information which is known by that person. Given that not all people know the same information, a *memory* will be kept for each person in the system. The number of people to be simulated can be set within the simulator, and an output display can be shown of the messages received by each person. Each person will only react to the messages which have been sent to them, which corresponds to their knowledge of the situation. For example, a person being simulated will proceed to move around as normal but may then receive a notification that they are too close to an infected area. In this case they would react by moving away from the direction indicated by the message and would likely proceed to a home address, or another location which they consider a safe area.

### *The integrated management system*

The zones are made up of a point of longitude and latitude, a radius of the zone and a record of the type of zone. This relatively simple system allows for information about zones to easily be utilized, requiring only basic computation to analyze the proximity of zones and the expansion and relation between zones and other zones, and between zones and people. The TrackerApp is where all this information is brought together. It is the main application which controls the simulators and correlates the information received from each simulator. The TrackerApp will receive information about infected zones, and can enter new confirmed cases into the Avian Simulator. The TrackerApp also creates warning notifications, and provides updates to users in the Population Simulator. It also requests positions of people from the population simulator, tracking where people are, to decide when to notify them if certain conditions arise. The TrackerApp provides the integrated management of the whole system. It is where the current status of the pandemic can be seen and acted upon by the user(s) of the system. In this sense it is a hub for all necessary information to come together to help people make decisions regarding the spread and containment of an Avian Flu pandemic outbreak. The government may decide to make some parts of this integrated management system, publicly available via the web as well.

## Future technical developments

There are a number of future developments in this research project. Purely from an computer science pedagogical learning perspective, the first step would be to ensure an active mobile location centre (MLC) and real mobile phone hardware rather than simulating the movement of

people and the sending and receiving of SMS/MMS. Building a more complex Avian Flu simulator with more complex models and formulae would also be beneficial. According to Liu et al. (2005, p. 7463), "it is very significant and important to study the transmission dynamics using quantitative mathematical models and consequently predict and control the contagious diseases in time." Due to the layered system design, it would be possible to run more than one Avian Flu simulator that models the spread of the virus over time. Potentially, each different simulator could model a different country. The interfaces could be adapted to handle multiple simulators, and hence multiple countries studied at once. Integral to the system would be additional IS systems and databases to provide messages to users that contain more detailed and explicit courses of action. This would involve a set of data mining procedures but requires additional data available on a given study area. It also assumes the integrated web management system is fully functional and that the Department of Health in each country is liaising with service providers who can operate the LBS. Building more functionality into the user interface for a greater variety of stakeholders including global agencies like WHO and EC would also be advantageous as would improving the GUI by providing a graphical web-based interface for users to see where potential infectious zones are complete with high resolution geographic information vectors, possibly using a technology such as Java servlets. Implementing functionality to store information about subscribers such as family relationships and disabilities and to act on this information is also plausible for use in crisis management.

From a research perspective dealing with privacy and security issues is a significant project on its own, especially given the nature of wireless communications which are insecure. Such questions as: Who owns the information? Who has access to what type of service? Who has the ability to enter confirmed cases? Who can see predictive models of the pandemic spread? Under what circumstances is the system switched off? What are the procedures and policies that affect the system? How often is data uploaded? What information is made public and what remains private? Research projects could even investigate the typical architectural plans for such a system- i.e., how many location centers would be required? How would they be distributed? And what would typically cater for the needs of the Australian public so that congestion would not cripple the live service? A comparative study could then be done with a dense urban landscape and findings analyzed.

Most commercial pieces of mobile location hardware have constraints on the number of polling requests they can make before a system becomes congested. However, very accurate situational awareness requires continuous position reporting. In the ideal case, every person would immediately report a change in their position but this kind of reporting "would lead to significant overburdening of the positioning server and the communication channel" (Bušić, 2005, p. 1). However, setting too small a Position Reporting Frequency (PRF) interval may have undesired and even fatal consequences. PRF is influenced by the "[n]umber of services users, available bandwidth, need for real-time position reporting, service initiation, user dynamics and rate of situation awareness change, business model" (Bušić 2005, p. 3). There is a great deal of complexity that one could study to enhance such a prospective service, but it is interesting to note how quickly a simple system can be introduced as well, as was the case with SARS in Hong Kong and Singapore.

## Conclusion

The Avian Flu Tracker research project has demonstrated, at least theoretically, that ICT (along with a coordinated effort by government and health organizations with clearly defined processes and procedures) has a place in the containment of a pandemic. The proposed system has the benefits of tracking confirmed cases of the Avian Flu, the ability to rapidly share information with subscribers in the infected zone, the ability to prioritize the administration of vaccinations to infected zones in quarantine and other zones based on predictive models, help protect unaffected

populations and therefore encourage an environment of public stability and awareness. Above all, this kind of system allows government decision-makers and health authorities to take immediate actions to contain a potentially catastrophic pandemic. The investment in the construction of such a system (for the sake of preparedness), seems miniscule when compared to the potential costs of a fully-fledged pandemic outbreak.

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