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Emergency and Disaster Recovery System Extensions to caBIG™

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Abstract and objective

The proposed system, ca!, considers the requirement for medical resource planning as the result of a wide scale disaster. For the purposes of this scenario a Radiological Dispersal Device (RDD) explosion was considered as the event. In order to provide data for planning input for first responders and healthcare workers, combined radiation intensity, type and location (GPS) sensors need to be co-located with such service providers, providing reliable environmental data streams in the potential absence of electrical utility power and Internet, wireless or cellular connectivity. Information should be available in real time for multiple recipient organizations to perform analysis at the local and national level. This proposed low cost solution is comprised of wireless sensors and access points based upon equipment currently provisioned with the emergency services relayed to a caBIG™ style processing node on a grid computing network. Sensors are low power devices designed to run from automotive batteries.

Keywords:

disaster planning, grid computing, caBIG™, explosive agents, radiation, fault tolerant, wireless, RDD

Introduction

Subsequent to the 9/11 terrorist attack on the World Trade Center in New York, there has been an increased public and government awareness for potential terrorist attacks on U.S. soil and overseas assets [1]. Prevention or warning against such acts, are, by their very nature difficult to predict or prevent. Whilst prevention is the most desirable outcome of any counter terrorism activity [2], there has to be the distinct possibility that terrorists, domestic or foreign, will eventually succeed in any case. Therefore, systems designed for monitoring, containment and handling phases of disaster management must be available in a timely and cost effective manner [3]. Monitoring and detection systems are the initial building blocks upon which the containing and handling or treatment phases of intervention are based; the proposed system is a monitoring phase system.

Due to the large potential target list for a Radiological Dispersal Device (RDD) [4], providing an effective monitoring system with adequate geographical coverage in the same manner that one could provide, say, with airport security scanners could be an extremely expensive proposition. Additionally, RDD detonations being only effective for large conventional explosive triggers [5] will likely result in some level of disruption to both power and public wireless or cellular communications infrastructure, complicating existing monitoring device operations [2].

With the first responder, public safety and hospital clinical workers, there is a degree of health risk due to the direct and indirect contamination resulting from a Radiological Dispersal Device [6-8]. By equipping first responder vehicles and medical facility fixed assets (hospitals, morgues and clinics) with sensor devices we can obtain an informed judgment as to the likely levels and nature of exposure for critical health care workers, from both the environment and the triaged patients they come into contact with.

In this project, we propose that by the use of low cost, first responder vehicle mounted, publicly available wireless networking and computing resources, we can provide an effective sensor network for monitoring RDDs. In order to deliver captured sensor data to points of interest in a portable and understandable manner, we propose utilizing the existing caBIG™ Grid network [9-12].

Methods

The initial project is for a laboratory bench simulation providing a proof of concept. The mobile network conjoining all the sensor devices would be simulated using laptop computers, as mounted in law enforcement or first responder vehicles. The initial proof of concept and subsequent simulations will be performed using a cellular based network. Further simulations will be performed using a self-healing mesh network, as the reliability of a cellular network for sensor connectivity or data collection and filtering cannot be guaranteed. Network therefore will consist of wireless sensor devices, collection systems and a network infrastructure built upon ad-hoc wireless networks using laptop computers.

To enable distribution of the data collected by this mesh network, the network will be connected to one or more Grid computing nodes, as part of the caBIG™ computing environment. The use of the caBIG™ Grid computing network allows data to be extracted from the sensor network to a specified vocabulary and with a common data abstraction. Additionally, the data may be accessed from a variety of client nodes, at high speed, in a secure and reliable manner. The data may therefore be viewed both by local and

national government agencies, as well as by regional and distributed cancer centers, allowing for wide area participation in treatment and risk minimization planning.

Results

It is envision that the simulations will show that it is possible to build and operate a low cost, minimally invasive system for monitoring the important environmental concerns regarding a major disaster in an urban environment. Additionally, such a system can be expanded to cover a wider variety of health care relevant indicators to allow for intelligent victim to facility routing and transport. Health care facilities and emergency workers can also provide more effective decontamination site location and secondary radiation sources can be tracked in an automated fashion.

The system will enable improved interpretation of bio-hazard risk for first responders, as well as providing applications to process sensor information in a distributed and tiered manner for clinical and law enforcement purposes. Further analysis by applications developed for regional and federal agencies, especially for the scenario of handling multiple simultaneous events, is a straightforward extension due to the underlying caGRID architecture. Using existing a low cost and proven infrastructure at all application tiers should reduce barriers to entry for public agencies, from both cost and risk perspectives.

Discussion

Our goal is to demonstrate the feasibility of constructing an effective sensor information network for use in public emergencies such as an RDD detonation event. Such a system will be shown to be effective by considering aspects of availability, data coverage, spatial resolution and temporal granularity. For the future, achievement of the specific aims specified here will enable us to work towards delivering a working prototype of the overall system, covering sensor detection, data acquisition and analysis and a hierarchical medically useful set system of analysis applications.

Sensor data as received by an analysis application can be viewed as raw sensor data or aggregated and filtered data, each with a variety of temporal parameters. All sensor data, aggregation and filter services, as well as temporal parameters are represented by metadata within the caBIG™ Cancer Data Standards Repository (caDSR) [13].

Conclusion

Core to the system will be a universal data model allowing for rapid low cost applications software development. In order to provide aggregated sensor data to a distributed set of analysis applications, there must be an abstraction of the acquired sensor data via an agreed protocol and messaging format, tied to a vocabulary. Additionally, provision of a reliable and secure networking framework is assumed, as well as generated application programming interface (API) in order to provide rapid development of low cost analysis application services. The use of the caBIG™ Grid assists in these development goals.

References

[1] Radiological Dispersal Devices: An Initial Study to Identify Radioactive Materials of Greatest Concern and Approaches to their Tracking, Tagging and Disposition. Available at www.ead.anl.gov/pub/doc/rdd.pdf

[2] The United Nations Global Counter-Terrorism Strategy. Available at http://daccessdds.un.org/doc/UNDOC/GEN/N05/504/88/PDF/N0550488.pdf?OpenElement

[3] The Effectiveness of Counter-Terrorism Strategies, a Campbell Systematic Review. Available at http://www.campbellcollaboration.org/doc-pdf/Lum_Terrorism_Review.pdf

[4] Fact Sheet: Dirty Bombs. Available at htttp://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dirty-bombs.pdf

[5] Dirty Bombs, Fact Sheet. Available at http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dirty-bombs.pdf

[6] Textbook of Military Medicine. Available at http://www.afrri.usuhs.mil/www/outreach/pdf/chapter10/chapter10.pdf

[7] Radiation Basics. Available at http://hps.org/publicinformation/ate/faqs/radiation.html

[8] Mental Health All-Hazards Planning Guidance. Available at http://download.ncadi.samhsa.gov/ken/pdf/SMA03-3829/All-HazGuide.pdf

[9] Fenstermacher D, Street C, McSherry T, Nayak V, Overby C, Feldman M. The Cancer Biomedical Informatics Grid (caBIG^{TM}). Conference proceedings l2005;1: 743-6.

[10] Gao Q, Zhang YL, Xie ZY, Zhang QP, Hu ZZ. [caCORE: core architecture of bioinformation on cancer research in America]. Beijing da xue xue bao. Yi xue ban = Journal of Peking University l2006;38: 218-21.

[11] Phillips J, Chilukuri R, Fragoso G, Warzel D, Covitz PA. The caCORE Software Development Kit: streamlining construction of interoperable biomedical information services. BMC medical informatics and decision making l2006;6: 2.

[12] Saltz J, Oster S, Hastings S, Langella S, Kurc T, Sanchez W, Kher M, Manisundaram A, Shanbhag K, Covitz P. caGrid: design and implementation of the core architecture of the cancer biomedical informatics grid. Bioinformatics (Oxford, England) l2006;22: 1910-6.

[13] Cancer Data Standards Repository (caDSR). Available at http://ncicb.nci.nih.gov/NCICB/infrastructure/cacore_overview/cadsr