A Holistic Approach to Emergency Evacuation Information Support Systems

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ABSTRACT

In the USA the basic objective of local and state government's Emergency Operations Plans (EOP) is to implement mitigation measures to reduce the loss of life and property damage by the efficient mobilization and deployment of resources. The evacuation of citizens out of harms way either before an impeding disaster or after the occurrence of one is a critical component of any EOP. This document represents a summary of the Evacuation Plan designed for the City of New Orleans. Results of live field exercises conducted during the 2006 Hurricane Season and suggestions for improvement will be highlighted. The ideal Emergency Evacuation Tracking System will be designed to operate within a System of Systems framework with interfaces: to field personnel, emergency managers and logisticians operating in an Emergency Operations Center (EOC), with state and local government systems such as public information emergency hotline (311 Centers in the USA), asset tracking management systems and others.

Keywords

Emergency Evacuation System

INTRODUCTION

Emergency Evacuation Plans are designed to relocate citizens from harms way in a safe, orderly and efficient manner. Besides the obvious challenges associated with the evacuation of a population there are logistical issues to overcome such as the tagging, tracking, transporting and sheltering of citizens who have no means of evacuation, the elderly, the infirm and their pets.

The level of success of an evacuation endeavor depends on multiple factors. Careful planning and coordinated execution are critical. An all encompassing information system is a critical element in carrying out an efficient mass evacuation. This system must be capable of tracking people, pets and assets from the planning stage through registration, evacuation, sheltering and the repopulation phase. An information system of such reach will, most likely, rely on various technologies such as wireless communications, un-tethered field devices, relational databases, Geospatial Information Systems (GIS), simulation engines, asset tracking systems linked to Radio Frequency Identification (RFID) tags/readers and bar code/scanners. Such a system should operate in a system of systems framework, capable of working independently when required, and /or with interfaces to external systems to interact with interested stakeholders.

PERSPECTIVE ON HISTORICAL EVENTS

Initially as volunteers and subsequently as contractors in New Orleans, we have a unique point of view on the response, mitigation and recovery phases the City has gone through as a result of Hurricane Katrina. On August 28th of 2005, hours before Hurricane Katrina reached land in the Gulf Coast of the US, the mayor of New Orleans declared a state of emergency and ordered a mandatory evacuation. The mayor exempted from the evacuation mandate essential government and private sector personnel. It is estimated that over a million people from New Orleans and the surrounding areas fled by their own means. For multiple reasons, but mainly for lack of means, approximately 25,000 city residences did not evacuate. They gathered at the Louisiana Superdome and the Morial Convention Center to take shelter in what was expected to be a two day, albeit rough, experience. 'Two days and rough' turned out to be an understatement. With the break of the levees and the subsequent flooding, people were trapped in hideous conditions for several days in these shelters-of-last-resort.

In trying to appease the evacuated population's request to return home and to stimulate the economic recovery of the City, on September 15th of 2005 the mayor announced he would allow the return of 180,000 evacuees back to New Orleans. Then, on September 24th of 2005, Rita, a second hurricane threatened to reach the US Gulf Coast very

close to New Orleans. Since the levee systems were compromised during Katrina the concern turned to additional flooding caused by the storm surge "over-topping" the breached and patched levees. A second evacuation was required.

The second repopulation of New Orleans started in October of 2005 and continues as of this writing. As the City entered the recovery stage after Katrina and Rita it found itself depleted of employees to carry out day-to-day functions. City Hall depended on the Emergency Operations Center (EOC), staffed with agencies from other jurisdictions, volunteers, contractors, public safety and utility personnel to plan, coordinate and oversee the delivery of traditional city services.

Almost from the beginning, the EOC employed the services of a comprehensive asset management information tracking system (AMITS) to support the different functions. During the disaster response phase, Planning, Operations, Logistics, Finance & Administration (F&A) areas in the EOC all used AMITS to perform their day to day activities. The primary function of AMITS is its capability to capture, retain and report on asset and resource deployment.

The EOC leveraged AMITS' highly integrated functional modules so the different and diverse areas could stay in lock step with each other. Not an easy feat, given most of the EOC personnel never had worked with each other previously. The EOC Planning Section used AMITS as a tool to generate high level plans and dispense low level task orders to the rest of the EOC sections.

The restoration of basic infrastructure and debris removal was coordinated and tracked at the EOC on a daily basis. The restoration of City services required an enormous logistical effort. The Logistics and Operations sections of the EOC relied on AMITS to procure provisions, coordinate and track the efficient deployment of limited resources. To optimize the deployment and tracking of resources AMITS' Geospatial Information System (GIS) module was activated.

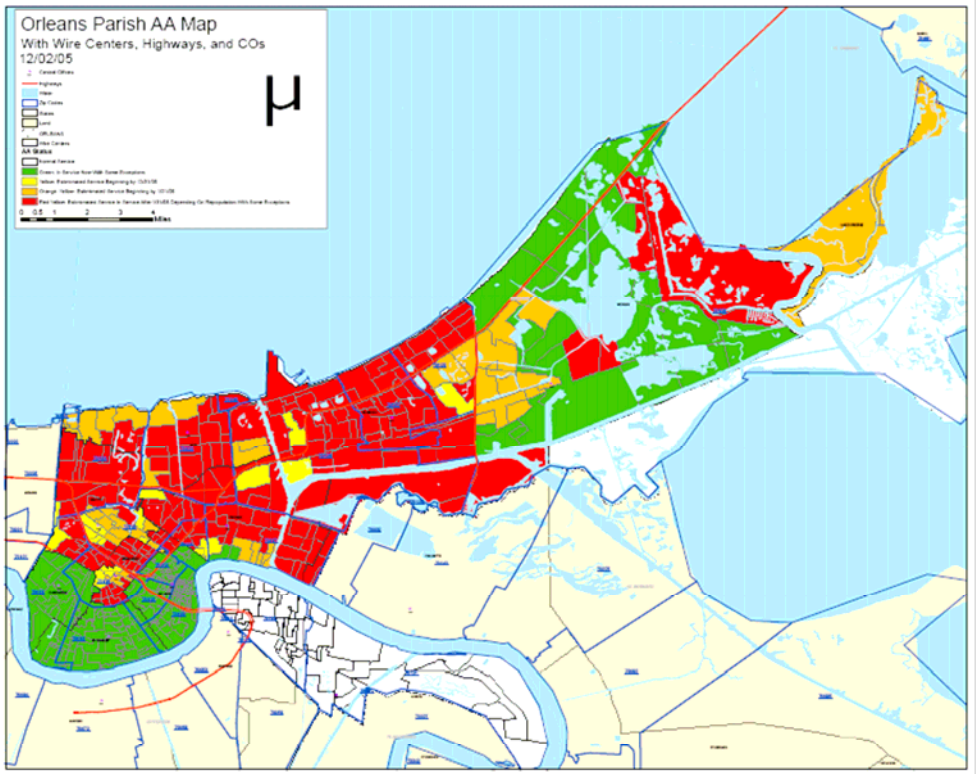
A key benefit of AMITS is its forms generation module. It automatically populates and outputs Federal Emergency Management Agency (FEMA) compliant Project Worksheets (PW) forms based on historical inputs. The submission of accurate and compliant PW is a central step for local governments to get financial reimbursement from the US Federal government for expenditures incurred during federally declared disasters. This specific feature of AMITS was extremely useful to the F&A section of the EOC.

Once a minimum level of infrastructure had been restored and deemed operational the next key task to tackle was the dissemination of meaningful and actionable information to the public.

The challenge for the City was to manage the accurate and coordinated communication given the diverse media outlets and the geographical dispersion of its target audience. City residents had been evacuated all across the US. Under the direction of the City's Public Information Office, an Emergency Public Information Hotline Call Center (employing abbreviated dialing code 3-1-1 designated within the North America Dialing Plan for non-emergency government services) was established. This inbound call center would be a primary vehicle for the City to interact with its residents, the majority of them living in exile. A structure was established to facilitate the flow of information between City Hall, the EOC and the 311 Center to ensure the timely, consistent and accurate propagation of data. A knowledge based system was implemented as a repository of data generated by City Hall and the EOC. This system became the primary 3-1-1 tool call center agents relied on it as they interacted with the calling public. Pertinent data collected by the 3-1-1 center also served as input to the knowledge system.

During the second repopulation of New Orleans the City used the EOC's GIS data to coordinate the orderly and safe return of its residents. The level of reconstitution of infrastructure services was closely tracked within the GIS. The services tracked included power, water, sewerage, telephone, cable tv, school openings, inspected buildings and others. Only those areas with cleared debris and appropriate water, power and sewerage services were open for repopulation.

The 3-1-1 center was a strategic tool at the City's disposal to communicate directly with the incoming population. The orderly repopulation was based on zip code (postal codes) defined areas. As services were restored to appropriate levels additional zip codes were open for the return of residents. The 3-1-1 center was used to communicate information indispensable to the incoming population, such as what city services were not available and what provisions were required by returning families to be self sufficient in an unfriendly environment.



Green: 75 - 100% functional. (Satisfactory)
Amber: 25 – 74% functional. (Marginal)
Red: 0 – 24% functional. (Unsatisfactory)

Figure 1. GIS Screen – Telecommunications Recovery

CITY OF NEW ORLEANS ASSISTED EVACUATION PLAN

In the Spring of 2006 the City of New Orleans initiated its effort to enhance the City Assisted Evacuation Plan (CAEP). To avoid similar tragedies, human suffering and civil unrest experienced by those stranded in New Orleans during Hurricane Katrina, the City government set out to develop an evacuation plan for the upcoming hurricane season.

The City of New Orleans CAEP was conceptualized to relocate further inland and out of harms way, that cross section of the population, permanent or transitory, that did not have the means to evacuate on their own, in the event of an impeding hurricane threat. To mitigate loss of life and avoid the human hardship experienced in the Superdome and the Convention Center in the aftermath of Hurricane Katrina, the City decided that in the event of future hurricanes there would be no shelter of last resort within the limits of Orleans Parish. This would ensure that all efforts would be focused in evacuating the entire population and reduce any incentive for anyone to stay during a hurricane. A lesson learned from Hurricane Katrina was that many residents refused to evacuate because they didn't want to leave their pets alone. As a result the CAEP was designed so that citizens could evacuate with their pets.

The CAEP was developed by the City of New Orleans Office of Emergency Preparedness with input from City Police Department, Fire Department, Emergency Medical Services (EMS), Major's Office of Technology, The State of Louisiana Dept of Social Services, Unisys, Louisiana (LA) National Guard, LA Chapter of the American Society for the Prevention of Cruelty to Animals (ASPCA), Public Information Emergency Center, multiple NGOs and others. The main objective of the plan is to evacuate all city residents and their pets in an orderly manner before any tropical storm force winds associated with a hurricane reach land. A primary goal of the evacuation plan is to keep family units together throughout the entire evacuation process.

During the Summer of 2006, residents and special needs residents of New Orleans were urged to pre-register by calling the 3-1-1 Public Information Emergency Hotline. During pre-registration a citizens would provide personal and vital medical information. Pre-registration is intended to speed up the registration process during an actual evacuation. This was an important factor since the City relied on the work of volunteers to staff the evacuation center. These volunteers received minimum training to learn their roles during the evacuation.

If a hurricane is to form or enter the Gulf of Mexico with a forecasted threat to New Orleans the Office of Emergency Preparedness (OEP) would activate the Emergency Operation Center (EOC) within 84 hours of the hurricane reaching land. Within 60 hours of hurricane winds reaching land in the New Orleans vicinity the CAEP would be activated. The formal evacuation of citizens begins 54 hours before tropical storm force winds reach land. The City would issue a mandatory evacuation order to the general population. To aid in the effort the LA Dept of Transportation would implement a contra-flow traffic mandate in all major highways leading in and out of New Orleans. All highway lanes would be used to exit the New Orleans region and disallow any vehicular traffic from entering the City. Once activated the EOC would coordinate with the Regional Transit Authority (RTA) to deploy buses to make runs through routes with pre-determined evacuee pick up stops. At these pick up points medical technicians would make a quick health assessments of each evacuee before boarding the buses. These buses would then drop off the evacuees at a city designated exit point or evacuation centers. In parallel with the RTA effort the EOC would coordinate with EMS to pick up infirmed and elderly residents at senior centers through out the city limits. These evacuees would be taken to the train station, the designated exit point for the special needs population. Once at the evacuation centers, evacuees and their pets would be tagged with barcode and / or RFID-encoded wristbands and registered into the Evacuation Tracking System (ETS). The last steps of the city assisted plan are to direct the evacuees to state provided buses or trains. Before boarding the trains or buses evacuees' wristbands are scanned once again. This creates a human manifest within the ETS.

Once on the trains or buses the evacuees and pets are taken to shelters operated by the State of Louisiana.

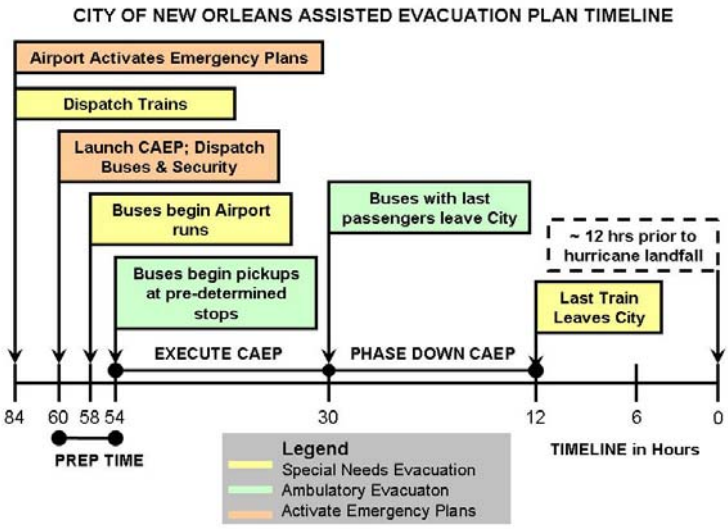


Figure 2. CAEP Time Line

CITY OF NEW ORLEANS EMERGENCY EVACUATION TRACKING SYSTEM

Unisys oversaw the overall design, testing and implementation activities of the tracking system that is to support New Orleans CAEP. This includes the specification of the front end user interfaces and backend reporting requirements, base system programming logic specifications, selection of wireless field devices/intelligent scanners, integration design of the instantaneous infrastructure equipment required to support field operations, integration of field operations to the City IT infrastructure. The system's primary goal was to support the efficient execution of the CAEP given the City's limited resources and the dependence of a volunteer workforce assumed to have low computer literacy. A key objective was to automate the registration, tagging, scanning and tracking activities and provide a friendly end user interface designed for the unsophisticated field operator.

The designers aligned system performance with the City's key directive of maintaining the family units together during the evacuation process. The database schema was designed around the concept of Head of Household. All registered evacuees and pets were documented by a record within the ETS. All database records contain a head of household field. In the unfortunate event where an evacuee or pet is separated from the rest of the family unit the system could be used to quickly re-unite the lost member by tracking the Head of Household at its current location. Each evacuation activity requiring a system touch point (registration, scanning and tracking/reporting) has a unique end user screen. All end user screens can be accessed via a standard web browser resident on a multitude of computing devices. The benefit is the afforded flexibility in selecting the most appropriate device for the operations to be performed. For example the registration activity could lend itself to using a low cost PC or laptop while the scanning can be performed by a wireless PDA or tethered scanner. The system can supports multiple scanning modes, such as scanning the barcode of an evacuee during the registration process or scanning the same barcode at the train or bus boarding point with the intention of creating the human manifest of the vehicle as it departs to a shelter.

LIVE FIELD EXERCISE "HURRICANE ALICIA" - AN OPPORTUNITY TO TEST THE CAEP AND THE ETS

In May 23, 2006 the US Department of Homeland Security in conjunction with the State of LA and the City of New Orleans conducted a two day live field exercise coined "Hurricane Alicia". The exercise started by simulating the current time to be 60 hours before winds from category 3 Hurricane Alicia would reach coastal LA. The City of New Orleans EOC has been activated for 24 hours. During this time the EOC has been tracking the activities of transportation authorities deploying railcars and buses, law enforcement and public safety agencies preparing for the eminent mass evacuation of the entire city of New Orleans. The airport had activated its emergency hurricane plan, airline carriers had arranged for the routing of additional planes to aid in the evacuation of tourist and hotel guests.

At '60 hours out', the CAEP is activated and the bus authority begins to make trips between different hotels and the airport. At 54 hours out, EMS arranges for the pickup of special needs evacuees at senior centers. At the same time the bus authority begins to pick up evacuees at pre-determined bus stops. The convention center and the train station are the designated evacuation centers. Special needs evacuees will be transported to the train station. The rest of the evacuees will be taken to the convention center. The evacuation of New Orleans residents will continue for the next 42 hours.

The ambulatory evacuees will be tagged with barcode and /or RFID wristbands and registered into the ETS in a two step process; first, their wristbands will be scanned and second, the evacuee's personal data and scanned information will be entered into the ETS. If the evacuee(s) bring their pets, the whole family will be directed to a special tagging station where both people and pets will be registered. The pet registration process consists of placing the animal in a State and/or LA SPCA provided animal carrier that has been pre-tagged on the outside. The scanned tag data and the pet's information will be entered into the ETS. The family unit, both people and pets, will be directed to a bus boarding station. Family unit members and pet carrier are scanned as they are boarded on the same bus. Once the bus is full the encoded tag on the bus is scanned. A manifest will be created from the data captured at the boarding station of people, pets and bus. This information will be helpful in the future for tracking and reporting purposes. The state operated bus will transport the evacuees to a state operated shelter further inland. The City has only 24 hours to evacuate the ambulatory population. These evacuees are being transported out of New Orleans by bus. The roads these buses traverse will be congested by vehicle traffic of the evacuation of the general population.

The special needs evacuees will be tagged with encoded wristbands and registered into the ETS at the senior centers before being transported to the train station. Once at the train stations the evacuees will be taken to a boarding station. The identical procedure will be followed at this boarding station as the one described for the convention center. Once the railcars are full the train will transport the evacuees to a state provided shelter. The City has allocated 28 hours for the evacuation of the special needs residents.

The CAEP is limited to gathering evacuees, transporting them to the evacuation centers, registering them into the ETS and boarding them on state buses or trains. The data capture during the process will be forwarded to the state of LA Dept of Social Services. Once these tasks are performed CAEP's responsibilities will haven been satisfied.

During Hurricane Alicia Exercise the City was able to recruit approximately 100 volunteers to pose as evacuees. These volunteers were recycled through the different evacuation stations multiple time to simulate a larger evacuee count. This allowed planners to assess the execution of the Evacuation Plan and the performance of the ETS with a higher volume of people than available at the exercise.

While the number of volunteers at the exercise did not come close to the 20,000 evacuees projected to be processed in a real hurricane evacuation, the simulated load was enough to exercise the plan and system for over an hour. During the exercise the planners were able to observe, record and gauge the efficacy of the plan and the performance of the systems and its subcomponents deployed at the different processing stations. Results were extrapolated to assess if in fact 24 hour and 38 hour periods were adequate to process the ambulatory evacuees and special needs evacuees, respectively. The exercise planners concluded that the CAEP and ETS can handle the volume of 20,000 evacuees in a 24 hour period as long as the appropriate staffing of volunteers at evacuation stations is available to aid the City.

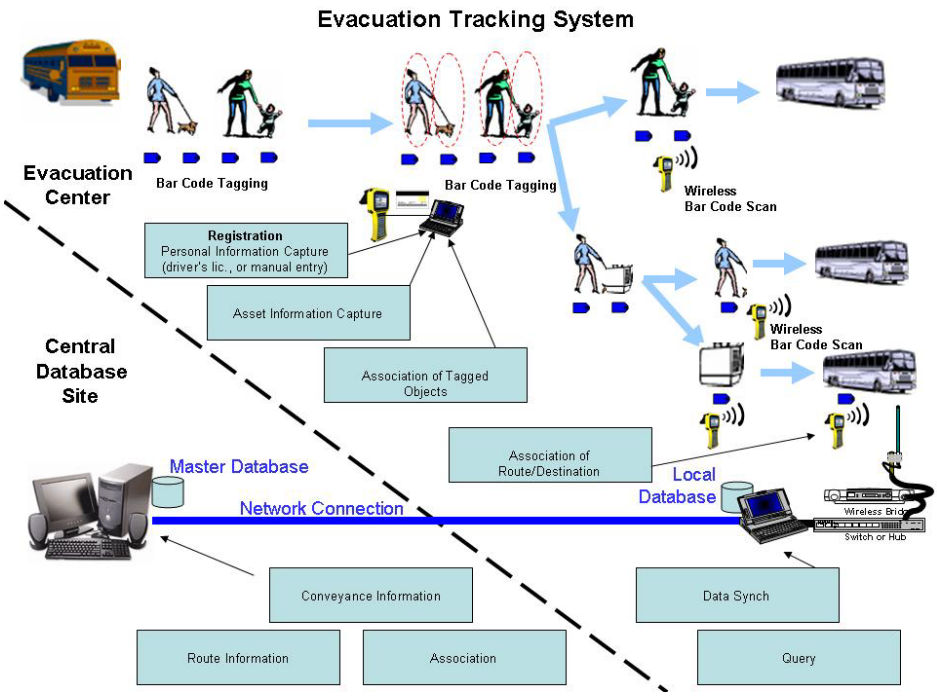


Figure 3. City of New Orleans Evacuation System

APPLYING LESSONS LEARNED TO IMPROVE THE EFFECTIVENESS OF THE EMERGENCY EVACUATION SYSTEM

After having some time to step back and reflect on the New Orleans experience one question we continue to ask ourselves is 'What would we change'? One staggering statistic that continues to weigh heavily is the estimated 1600 to 1800 lives lost as a result of Hurricane Katrina. It has been said that a good number of these deaths happened in the days after Hurricane Katrina moved away from the Gulf Coast. The loss of human life could have been avoided if the entire population had been evacuated out of harm's way.

If the City of New Orleans is ever threatened again with a category 3 or higher hurricane we strongly recommend that a mandatory evacuation order is issued at least 2 day before hurricane force winds make landfall and for emergency management practitioners to have at their disposal a comprehensive Emergency Evacuation System to support the evacuation.

We propose that a comprehensive and integrated Emergency Evacuation Information Support System (EEISS) will increase the efficiency of the evacuation process by allowing for a better planning phase and optimizing the actual evacuation. An evacuation plan should be executed as part of a larger mitigation and/or response plan orchestrated by the EOC command structure. In an early section of this article, we introduced the concept of asset tracking information management system (ATIMS). Just as the Planning, Logistics, Operations and F&A sections relied on the integrated nature of ATIMS to be part of an efficient operating National Incident System (NIMS) compliant EOC in New Orleans, so, too, should evacuation planners.

The New Orleans CAEP can be improved upon by more closely integrating the ETS to the ATIMS, enhancing some very specific functionality to the ETS and increasing the interoperability of the ATIMS/ETS systems with state operations. This would transform the ETS to a comprehensive end to end information support system or EEISS. One of the biggest gaps in the City of New Orleans CAEP was its weak link with the State of Louisiana evacuation and sheltering system. At the time of this writing the only potential input to the ETS from the state resource tracking system were the buses. Even this specific input had to be modified in the ETS to be able to distinguish the 8:00AM pickup of bus number 5 from the 3:00PM pickup of the same bus. Other than running reports manually or uploading files of captured data, state systems had no link to ETS. This is a wasted opportunity to optimize the deployment and operation of state run shelters. An integrated/interoperable state and city system would allow for the optimization of resource deployment. Shelter operators would use the integrated system to assess hours before evacuees arrive on buses and trains, the exact number of evacuees, number and types of pets, number of family units, medical needs, etc. Equipped with this information shelter operators could better prepare for the proper amount and type of: provisions, beds and cribs, sanitary and medical facilities, security resources, power generation, water, telecommunications, ventilation, waste disposal and sewerage facilities. The integrated EEISS can be used by the state once the shelters are operational. If and when family units are moved between shelters or out of the shelter system the EEISS can be used to track these activities.

Our concept of a holistic approach to emergency evacuation systems is one where the EEISS operates in a framework as a component system of a broader set of emergency systems. In this particular example the ATIMS is the overarching framework and EEISS is but one of the systems in the multitude of EOC systems under ATIMS. EEISS would be highly integrated with the other ATIMS systems supporting Planning, Logistics, Operations and F&S sections of the EOC.

In the event that an evacuation order is issued, the EOC will be activated. Most immediately, the EOC will activate the CAEP and delegate duties to Operations. Logistics will work closely with Operations to identify, locate and deploy required resources to execute the evacuation.

Planning personnel will logon to ATIMS' planning module to review CAEP activation procedures, punch list and notification list. Planners will access the ATIMS simulation module to run different scenarios and gauge how, the number of available volunteers, weather conditions, available vehicles, traffic conditions, highway construction and Real Estate Convention attendees at a local hotel might affect the evacuation. The most likely scenario is selected for planning purposes.

Planning scenario and pertinent data will be forwarded to Operations. Operations personnel will get an ATIMS notification alerting them the CAEP has been activated and Operations will oversee the execution of the evacuation. Operations personnel review the evacuation scenario and develop a tactical plan. Using ATIMS Operations personnel distribute the tactical plan to the utility group, transportation authorities, EMS, law enforcement, airport highlighting roles and responsibilities. AMITS will alert Logistics with a notification of the tactical evacuation plan. Logisticians review the evacuation plan to identify the types of provisions, resources and equipment required. To optimize limited resources on hand, Logistics uses the simulation module to determine the appropriate type and amount of provisions and supplies needed given the expected volume of evacuee and timeline.

Logistics personnel access the AMITS GIS module to identify the current location of the provisions, supplies, equipment and resources and develop a detailed deployment plan. Logistics reconcile the resources on hand with those identified by the simulation module. It is determined that procurement of additional provisions and resources are required. Using AMITS Logistics notifies F&A of the type and amount of provisions required and request expedited delivery.

F&A is alerted of an expedited request in queue. F&A personnel access AMITS and review Logistics request. F&A immediately access the vendor management module, review existing procurement agreements and submits purchase orders electronically.

Once the evacuation is under way Operations will oversee and monitor the progress as evacuees are being processed at the evacuation centers' registration and boarding stations. Data captured by wireless scanners is being transmitted in real time to the EOC. Buses and trains depart the evacuation centers en route to state run shelters with their live cargo. Operations personnel monitor the movement of the evacuation vehicles as well as traffic, road and weather condition. With the use of on board GPS devices, the GIS module displays evacuation vehicle locations in real time. Since the general population is also evacuating in their own vehicles, evacuation buses are starting to encounter heavy traffic. In addition, a minor vehicle accident has amplified traffic congestion. This has a down stream effect

creating a bottleneck at the evacuation centers. Evacuee processing rate at the centers is diminished due to loaded buses not able to depart because of highway on-ramp traffic congestion. EOC personnel in coordination with state police, the department of transportation and the bus authority attempt to alleviate traffic congestion by reducing the influx of evacuees to the centers and modifying counter-flow highway routing. The bus authority directs its intra-city bus drivers to wait 30 minutes before dropping off riders at the evacuation centers. In addition, two check points are established. The first one is setup at the highway on-ramp and the second check point is positioned further north. At the checkpoints the state police with the help of the department of transportation create a buses only lane. Within twenty minutes bus flow and processing rates at the evacuation centers improve. Valuable time has been lost due to this unforeseen event. Additional volunteers are dispatched to registration stations in an attempt to increase processing rates at evacuation centers. Shelter operators have been monitoring the evacuation to better prepare for the incoming population. Data captured by wireless scanners at the point of bus and train boarding is transmitted in real time to the EEISS. Human manifests are immediately created and made available electronically in the AMITS. Shelter operators can fine tune their logistics to a just in time operations with the use of the human manifest and the GIS modules. Once the city is stabilized after a disaster and it's deem safe to have evacuees return, the EEISS can be used once more as a system of systems in the repopulation effort. In the past the City Hall was forced to take a reactive approach to the repopulation effort. It set up the 3-1-1 but had to wait for both local and displaced residents to call in for the most accurate and up to date information regarding availability of basic infrastructure services. With the data captured during the evacuation and maintenance actuated on that data during the sheltering period, City Hall in partnership with the state can take an extremely pro-active approach on the repopulation of the city. With the use of ATIMS, EEISS, GIS and other modules the capability to data mine is very powerful. All things being equal, areas that are home to the largest numbers of evacuees can be targeted as the highest priority for reconstitution of basic infrastructure and city services. Data mining the EEISS will facilitate for a more orderly and optimized repopulation and allow the City and State to better control the process. Economic recovery efforts cans be approached in the same manner with the data captured during the repopulation phase.

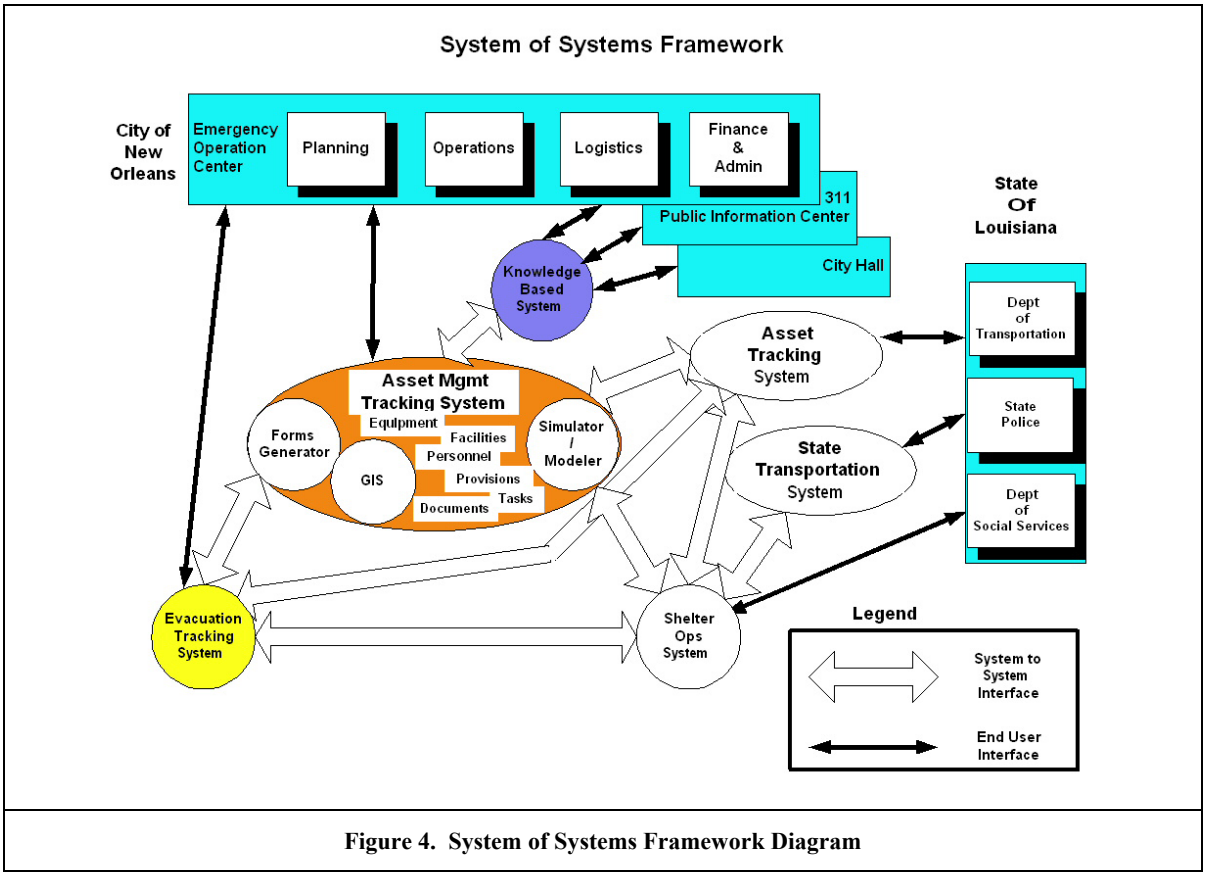


Figure 4. System of Systems Framework Diagram

OTHER ENTITIES EMBRACING THE SYSTEM OF SYSTEMS APPROACH

The system of system concept being proposed in this article is an emerging discipline. This paper proposes that a system of systems approach is a way to achieve a certain level of integration between separate and disparate systems.

SAFECOM is a communications program of the Department of Homeland Security's Office for Interoperability and Compatibility. Its raison d'être is to improve emergency response through effective and efficient interoperable wireless communications. One of its primary strategies is to promote a system of systems approach through the use of standards-based communications equipment [1]. Its long-term goal is to achieve a system-of-systems environment supported by communications standards, tools and best practices [2]. Within this system of systems emergency responders from different agencies and/or jurisdiction would be able to communicate and share information when and where it is needed in a mode or form that allows the practitioners to effectively use it. The communications mode may be voice, data, image, video, or multimedia that includes multiple forms of information [2].

The premise of this concept is that different agencies/jurisdictions responder systems are capable of interfacing with the system of systems networking framework. This overarching framework acts as a bridge between the individual responders' systems, hence the system of system concept.

In 2003 Purdue University College of Engineering created 9 signature areas (multi-disciplinary initiatives) to address national priorities and explore opportunities for field-defining research. System of Systems (SoS) is one of the nine signature areas. This emerging system-of-systems concept describes the large scale integration of many independent, self-contained systems in order to satisfy a global need. At the SoS in Purdue multi-disciplinary research projects are underway to assess the interdependencies of traditionally perceived isolated, large complex systems.

In the corporate environment Enterprise Resource Planning (ERP) systems integrate (or attempt to integrate) all data and processes of an organization into a unified system. A typical ERP system will use multiple components of computer software and hardware to achieve the integration [3]. The level of integration achieved by ERP systems is due to the use of a unified database which different modules access. Another contributing factor to the integration is the typical single software vendor environment.

The systems we rely upon in our daily lives are multi-disciplinary, disparate and sourced by multiple vendors. It would be safe to assume that achieving any level of integration amongst these systems will be a considerable challenge.

I propose that a standards based system of systems framework could achieve a degree of integration for the ETS in the midst of a multi-agency, multi-vendor systems environment. It appears that SAFECOM and Purdue University College of Engineering also perceive the benefits of a system of systems approach to the integration of disparate systems.

At its core the ETS is comparable to most other asset tracking systems. The most notably difference is that the ETS tracks human beings and their pets. These systems are deployed to track assets across space and time. When these tracking systems interact in a cohesive manner with other external systems and modules additional value added benefits are achieved. Doctors John Boardman and Brian Sauser from Stevens Institute of Technology assert that "a System of Systems (SoS) is much more because its parts, acting as autonomous systems, forming their own connections and rejoicing in their diversity, lead to enhanced emergence, something that fulfills capability demands that set a SoS apart" [4].

This concept is displayed in a master's thesis project that designed a system to track expensive and highly mobile equipment at a major hospital. Used by general service, it made it difficult to locate the equipment prior to repair or preventive maintenance. In addition, this equipment was often misplaced or stolen. The asset tracking module which incorporated the use of RFID tags, readers, sensors and wireless handheld devices communicated indirectly with the Computerized Maintenance Management System (CMMS). A web-based application was designed to interface to the asset tracking and CMMS to locate equipment requiring maintenance. The asset tracking system delivered financial benefits in the form of capital expenditure cost avoidance and increased staff productivity [5].

CONCLUSION

It is estimated that 1723 people died as a consequence of Hurricane Katrina. The most shocking statistic is the estimated 1,242 deaths that took places in days and weeks following the hurricane.

After the President made his Declarations of Emergency throughout the Gulf region the National Search and Rescue Response System (US&R) was activated. Under the Stafford Act US&R operational activities include locating, extricating and providing on-site medical treatment to victims trapped in collapsed structures. FEMA deployed over 25 Urban Search and Rescue teams (USART), comprised of over 1,000 personnel, to the devastated area of the Gulf Coast immediately after Hurricane Katrina. The Coast Guard also conducted search and rescue missions working alongside local officials. These search and rescue activities are responsible for saving nearly 6,600 lives in those first few days after Hurricane Katrina made landfall.

If a Government Assisted Evacuation Plan had been in place and executed in August of 2005 with the efficiency afforded by an AMITS many residents of limited means could possibly have been removed from harms way. Many of the 1,723 casualties might have been prevented, the primary goal of any Emergency Operation Plan. Many of the USART life saving deployments could potentially have been avoided.

While it is difficult to assign costs to these deployments the opportunity cost of redirecting these valuable resources to other pending tasks during the most devastating natural disaster in the US history is, without a doubt, very significant.

We estimate over 250,000 man-hours were expended in live saving response efforts just by the USART deployments. This calculation assumes USARTs were deployed on 12 hour shifts for the three weeks following Hurricane Katrina and just before Hurricane Rita made landfall on September 24th 2005. Local law enforcement personnel conducting search and rescue missions could have been reassigned to maintaining order and mitigating the civil unrest experienced in New Orleans at the time.

As of this writing New Orleans is still struggling with its economic re-development seventeen months after Hurricane Katrina. New Orleans current population is but half of its pre-Katrina level. This is a key factor contributing to the slow economical recovery. The direct consequence is a highly eroded tax base and a shortage in the local labor force. Businesses inside the city struggle to fill open employment positions.

One has to wonder how many of the residents that were sheltered in the Superdome and Morial Convention Center in late August of 2005 decided not to return due to their horrific experience.

Evacuation efforts executed before or in the aftermath of a disaster are essential mitigation and/or response initiatives aligned with the objective of reducing loss of life. The use of emergency evacuation systems to support evacuations is a very helpful tool. If the emergency evacuation system is enhanced with capabilities beyond the tracking of individuals and deployed in an integrated manner with other emergency systems within a framework of systems then it takes the function of a management information support system. Its value proposition increases exponentially when deployed in a highly interoperable environment and used by trained personnel. The end result is not only the reduction of loss lives but also the efficient execution of processes optimizing available resources throughout the evacuation, sheltering and repopulation phases of a disaster management life cycle.

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