RECURSION SOFTWARE, Inc.

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Voyager Edge for First Responders

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Executive Summary

In a highly developed technological society that is suddenly aware of how vulnerable it can be to disruption from accidents, natural events, and terrorism, options for coping tend toward even more technological solutions. For First Responders, this means better and faster first hand knowledge, immediate access to relevant expert knowledge, and automated monitoring of people, equipment, and supplies.

Intelligent systems for emergency response will necessitate intra- and interagency coordination, cooperation, and communication and near instantaneous access to a wide array of information housed in separate databases. This article demonstrates that Voyager software is an essential tool to accomplish this goal. Voyager is a unique, multifunctional distributed programming product that can connect agencies to personnel, personnel to databases, and personnel to each other in either wired or wireless capacities and can do it with less bandwidth, in an uncertain network, filtering reams of data to return more actionable knowledge, can be stratified to appropriate “need to know” levels, and is interoperable among many platforms and hardware.

A Mind Map is used here to organize the flow of ideas. In each section an example is provided of how Voyager software can be of benefit in a First Responder situation. These small scenarios do not exhaust all the advantages of a distributed knowledge network, but they provide an insight into how such a network increases the effectiveness of emergency response and management.

Finally, in the appendices, there is a discussion of developing technologies that will be able to work with a distributed knowledge network such as Voyager for the improvement of emergency services. Some of this technology is included in the examples provided. Though some of what is written here seems futuristic, it is actually forward-looking rather than fictional, and is by no means implausible. Knowing the needs and specifications of First Responders is the starting point for creative problem solving. A fusion of skills from software architects, standards bodies, public agencies such as Homeland Security, Department of Justice, and private technology companies will collaborate to invent and evolve current capabilities to meet our country’s need for protection, access to emergency help and care, and emergency communications.

Introduction

First responders - Police, Fire, and Emergency Medical Services - are composed of a brave group of men and women who train to act quickly, and decisively at an emergency incident. They have a body of knowledge through formal learning and experience, and possess the ability to size up a situation as it unfolds in order to preserve life and mitigate further damage or destruction.

While these first responders are trained in their respective trades to be competent and efficient, they will not possess all relevant information in every case: Victims and bystanders will act of their own rational or irrational volition, weather gives little warning at times of its destructive intentions, and traffic interrupts even the most important transits. We propose that the addition of Voyager software, with Intelligent Mobile Agents, to the technical armory of the First Responder will enable a greater ability to cope with and subdue the emergent situations that he/she must face.

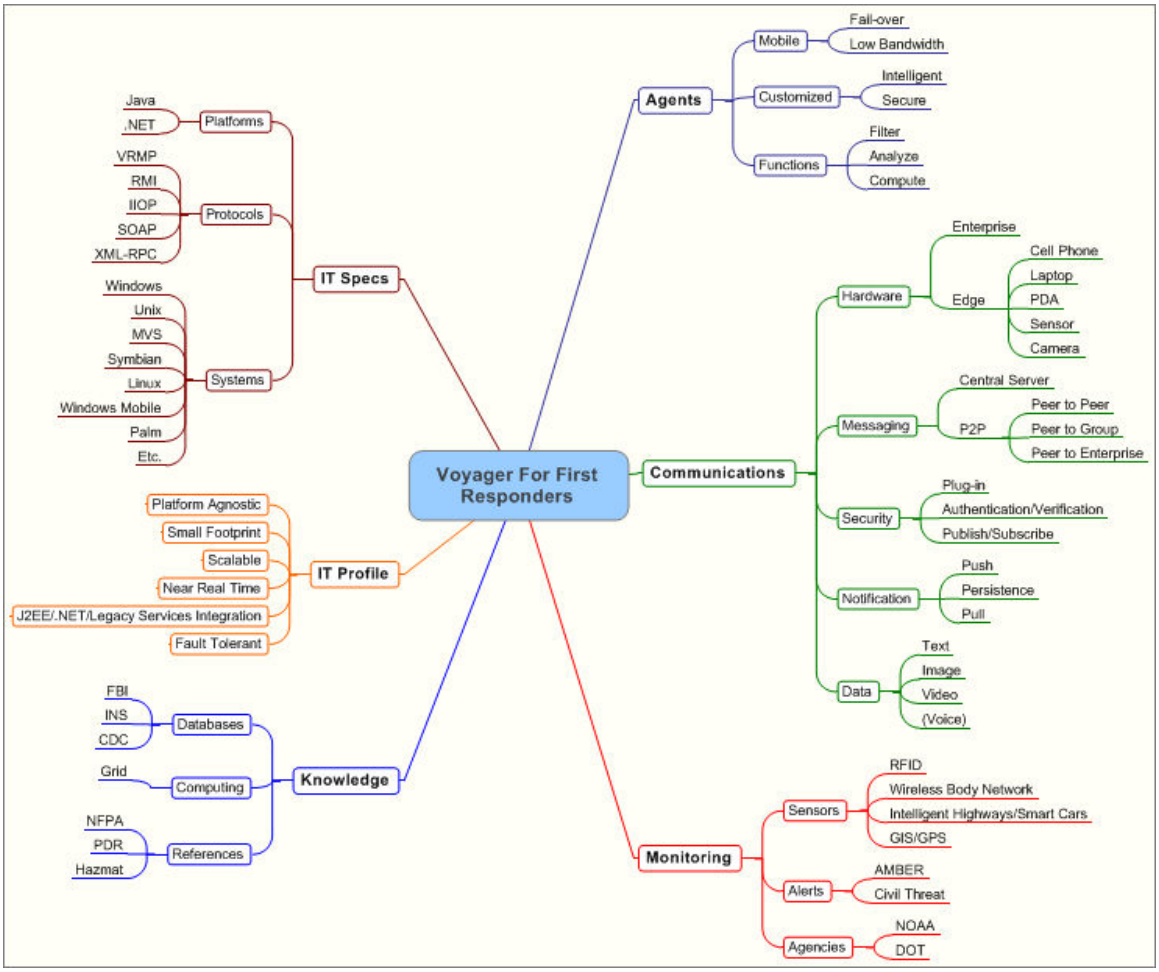

Figure 1. Mind Map of Voyager Edge for First Responders. To read the map, start at the 1 o'clock position.

Voyager is a powerful intelligent distributed computing platform for building communications. It is stable, mature software that has seen use in a wide variety of industries: IT, defense, finance, etc. Part of Voyager was segmented into Voyager Edge and further developed to perform distributed computing and mobile agent technology with a light footprint for use in smaller peripheral, or edge, devices, i.e., laptops, PDA's, cell phones, etc. Smart phones and many sensors will be included in this list by the end of 2008.

Voyager Edge is multifaceted software that is best understood in parts. A Mind Map is provided to guide and clarify the discussion (see Figure 1).

Software Agents

Intelligent Mobile Agents (IMAs) are bits of software coding that can travel across wired or wireless networks carrying with them a predefined ability. Abilities that might be included are: finding information or computing a calculation and returning the answers, or notification of a change in status. Because they are small packets of information, and they return specific knowledge rather than raw data, they travel using less bandwidth than regular communications. The IMA can be taught to adapt itself to the user, learning the user's habits and preferences, or can be configured based on role assignment. It has the ability to persist in a task despite network failures, and will seek a way around a failed node and/or resume where it left off after a network is restored. The user has the option of knowing the status of the agent, or can 'send and forget' until the agent returns with the task complete.

Communications

At present, Recursion Software's Voyager Edge uses IMAs on devices ranging in size from enterprise server to laptops and PDAs. The advantage of the smaller devices is that each First Responder can carry them with his/her other equipment.

Typically, communication travels from a network user to a central server then on to another network user. Voyager Edge is able to communicate in ad hoc networks. Users can be added to the network, or drop out without shutting down communication with others. Communication is also facilitated during intermittent connectivity, where an IMA can travel on active nodes to reach its destination in a round about way, rather than being stuck at a dead node until the network is fully functional again. The ad hoc network means that a central server is not necessary to process information – each peripheral device acts as both client and server. If one or more nodes drop off, the network continues to function. This is markedly different from a system requiring a central server that processes all software traffic, which is destined to be, no matter how frequent or rare, a single point of failure.

Security features in Voyager Edge include innate permissions (no one gets on the network unless they have asked to be on it) and authentication/verification/role based security (users are proven to be who they say they are) and receive information in accordance with their role, whether interagency (police or firefighter) or intra-agency (firefighter or chief). Information can be selectively available through the use of authorization and verification so that those who genuinely need it and are cleared to receive it will do so, and those not cleared will have no access. There is also a plug-in

feature, so that heterogeneous security applications of choice can be used to ensure system integrity.

Messages to emergency personnel can be pushed or pulled, and persisted. Pushing means that the First Responder receives the message whether he/she is signed onto a network or not. Pulling is logging into an email account to read mail. Persistence is the repetition of the message until it is verified to have been received. It is the difference between a weather radio alarm of severe weather and tuning into a local TV station to get the weather report. Additionally, changes in information are automatically updated without the system shutting down, or the user needing to log off and then back in.

Communication transmissions can be text, image, or video. Streaming video and Voice Over Internet Protocol (VOIP) are possible additions to the software suite in the future, depending upon demand.

Example 1: An aerosolized anthrax scare has been determined to have some validity. Notification must go out to all hospitals and the Medical Reserve Corps to set up medication dispensing centers to treat the entire population of the county within 3 days.

Voyager or Voyager Edge at the central emergency command (a hospital our example) can push a message to the volunteers who have Voyager Edge on their phones and/or laptops and notify them of the urgency to report to their stations before the general public is aware. Messages are persisted until each person receives notification; they are secure allowing emergency services a short period of time to get into place before general radio and TV announcements lead to the subsequent traffic and crowding at treatment facilities. Peer-to-peer messaging allows staff at each center to communicate to each other without going through a centralized computer, if there is one, and the person in charge can communicate with all of the staff simultaneously as needed.

Historically, there has been little or no funding for technology advances to volunteers such as the Medical Reserve Corps, volunteer firemen, and CERT trainees. But with Voyager Edge and the ubiquitous nature of cell phones and PDAs, volunteers can be mobilized for an emergency more quickly and discretely than through a general announcement. Deploying manpower to a widespread incident quickly with instantly and automatically updated relevant information greatly amplifies an emergency responder's capabilities with little to no additional expense.

Example 2: California wildfires

During the recent fires in California, reverse 911 was used for notification of civilians. Landlines that had been interrupted or overwhelmed by phone traffic prevented the messages from reaching all the intended contacts. If Voyager Edge resided on cell phones and other mobile devices, the alert could have been propagated in a peer-to-peer fashion to cell phones in near proximity, even if cell towers were down. The messages could be persisted until everyone had finally received them.

Monitoring

Not all messages have to come from live entities. Voyager Edge is able to receive information transmitted from sensors, whether embedded and stationary, or loosely attached and mobile, and every stage in between. It is able to automatically update information if a sensor indicates a change in value for whatever it is measuring, i.e., temperature, position, traffic congestion, etc. and with programmed decisions rules, could act upon a change that exceeded important parameters. See Appendix A for information on some developing technologies that combined with IMAs may one day benefit First Responders.

An alert can be pushed to everybody, such as an AMBER alert, or pushed just to those who are expected to be involved, as in a civil threat (bomb threat, riot, etc.) that might involve the addition of off-duty police or auxiliary staff for fire or EMS.

Automatic monitoring from NOAA for weather can give immediate updates on wind speed and direction changes that become important in a fire or a HAZMAT incident. Monitoring traffic information from the DOT might facilitate arriving at an incident more quickly.

Example 3: Wireless Body Networks for Firefighters

Should a firefighter have difficulty once inside of a blazing building, a Wireless Body Network would alert his colleagues of any abnormal vitals signs, such as hypo- or hyperventilation, and even issue a call for help. If he was having difficulty finding his way out of the building because of fallen debris or smoke, his PDA could be used to pinpoint his own GPS location relative to the nearest exit plotted on the building blueprint supplied by E-Plan, or, alternatively, if there is not a PDA available to him, his colleagues could view his location on a laptop and give him verbal instructions. The firefighter is automatically connected to the peer-to-peer network via Voyager.

Monitoring the status of fire department personnel in responding to an emergency allows for quick intervention if the responder is in trouble but unable to call for help. A mobile agent could automatically send an emergency call for help to the local firefighters in the peer-to-peer network, as well as simultaneously notifying the central station (if one is used) indicating what the abnormal or critical value is.

Example 4: During a winter storm, a call comes in to 911 concerning an elderly couple found unresponsive in their home.

Automobile sensors in the intelligent vehicle systems of newer cars transmit local road conditions anonymously to DOT. Highway sensors detect traffic slowdowns. That data, which is continuously and spontaneously updated, is available to EMS, who queries the traffic system with the addresses of their starting and ending points. The mobile agents gather any available road knowledge for only potential routes between the two points (i.e., not all of the road and traffic conditions). Knowing the local road conditions on a moment by moment basis allows EMS to choose the quickest route to the scene without going over hazardous frozen bridges or waiting for solid, unmoving traffic to clear a path.

Knowledge

An IMA can be sent off to perform calculations on another computer or grid of computers and return the answer to the device that had launched it. An IMA can be deployed to search out all relevant information from an assortment of databases and return only actionable knowledge rather than reams of data that must be analyzed. Consider that many database or Internet searches return thousands or millions of hits. First responders have to continue to fine-tune their queries until a specific solution is found, possibly requiring time away from addressing the event at hand. For First Responders, IMAs allow them to receive just-in-time information over their handheld devices culled from multiple sources while in the midst of a developing event.

With the assent of the involved agencies, software adaptations can be written to allow a one-way passage of information from an agency's databases to a First Responder or other emergency agency, such as an Emergency Operations Center. This could include NFPA databases available to firefighters, FBI and INS records available to police, and CDC information available to EMS. Again, access is limited to those with the need to know and can have "Read Only" restrictions to ensure that there is no possibility of changing the information that resides inside the agency databases.

Information housed in these separate databases is very likely accessed through software systems that employ different computer languages and protocols. Voyager can interact between diverse protocols such as RMI, IIOP, CORBA, XML-RPC, etc., and can be programmed in Java and .NET enabling interoperability between these two languages. It also utilizes database APIs that are suggested by all of the most common relational databases. In addition, C++ is scheduled to be added to the Voyager stack in 2008.

While it could be argued that this information is already available to those with authorization, what is actually available is a vast volume of data, probably in separate searches through each database. An IMA could glean information on a subject across several databases and coalesce the information into a single report. Because the agent is intelligent, it can be taught to delete duplicate references, highlight key words, or otherwise filter the information into a more useable and accessible format.

Example 5: A fire alarm system alerts dispatch that there is a fire at a local gas station.

The fire departments in all 50 states have at least some access to E-Plan, an online information source developed by the EPA that details what chemicals and hazardous materials are housed in individual industries. Sometimes the blueprint of the affected building is available as well. This tells the crew what they may find once on scene, and helps them to prepare. If a mobile agent query is included in this arsenal of information, it might be possible to overlay the GPS maps available in laptop computers or handheld devices and see the location of any nearby hazardous materials not part of the effected industry, such as surrounding liquid gas pipelines, or the placement of important structures such as a med-evac helicopter pad or an elementary school that may need to be evacuated. Further detail can be garnered from local databases regarding local population clusters from census data, and wind direction information from NOAA. The level of detail can be tailored depending upon need – those planning the rescue need

more detail, those performing the rescue would probably only want the building blueprint and to see his/her own location on the blueprint in relation to the hazardous materials.

Advantages of Using Voyager Edge

Voyager is a superior method of communication when there are possible network outages, failure at a central server, or the need to immediately notify but partition the information relayed depending upon clearance or responsibility. Voyager also has a track record with other large industries – it is robustly scalable, faster than RMI at high volumes, functions at near real time, and has a small footprint to support handheld devices.

Interoperability is a great need for emergency response communications. Voyager Edge is platform agnostic, working with Java and .NET languages, over multiple protocols, and on many different systems. Voyager Edge can run on hardware that ranges from servers to handhelds, to sensors.

The use of Intelligent Mobile Agents allows First Responders to accomplish multiple tasks at one time. The agents perform the database and reference searches once they are specified, maintain an alert system should important variables change, and persist in delivering messages if they do not go through immediately or the system goes down. This frees up the First Responder to focus attention on the incident at hand. Additionally, since Voyager Edge runs on smaller devices, the Responder has access to changing information wherever he/she must go. While other software might be cobbled together to yield similar capabilities, Voyager Edge has them all in one cohesive package.

For further information on Voyager Edge software specifications, go to http://www.recursionsw.com/Products/voyager.html.

Example 6: Going up a level of the hierarchy above the first responders, to the Division Chiefs in Incident Command (logistics, planning, operations, and finance), or the city Emergency Operations Center, tracking personnel and materials in a near real-time, graphic way alleviates some reporting needs with their attendant delays and possible miscommunications. Between RFID devices for physical supplies to small hardware devices to monitor both the presence and the physiological status of emergency personnel, in an ad hoc network, the chiefs can know what qualified personnel are present and what materials are at hand.

Conclusion

Intelligent Mobile Agents present an extremely flexible and multifaceted solution for the First Responder. Using Voyager Edge, Intelligent Mobile Agents can be easily and rapidly coded by in-house Emergency Services IT engineers or alternatively, Recursion Software can write the code in collaboration with them. Recursion can provide either generic agents that can be modified by the customer at a future date, or deliver specific agents with all their attendant authorization and security features.

For further information, please contact Recursion Software, Inc. at 1.800.727.8674 to speak with our Chief Technical Officer.

Appendix A

Developing Technologies that can work with Intelligent Mobile Agents and First Responders

Intelligent Transport Systems: Intelligent Highways & Smart Cars

In 1991 the US federal government initiated and funded a long-term development program called the Intelligent Transport System to research and develop improved surface transportation. These initiatives include augmented highway traffic and road surface conditions information, fed to the Department of Transportation from sensors built into the roads and newer model vehicles. Sensors in the wheel wells forward road information such as temperature, wetness, and iciness at specific points along a route. This is anonymous data and not information gathering about a driver or specific vehicle.

We are already familiar with traffic cameras, but what if those cameras could estimate the number of vehicles waiting in any direction at traffic lights, could run an algorithm for the most efficient processing of that traffic, and then coordinate the light system for itself and several predetermined traffic signals in the near vicinity, with or without human input from the DOT? Each car would send an anonymous “Hello World” and be counted as one of x number of cars or trucks on the road.

Several cities are testing the efficiency of allowing emergency vehicles to change the traffic lights in their pathway to become green, facilitating quicker access to emergency scenes, a procedure known as Emergency Vehicle Pre-emption.

Voyager can facilitate all of these tasks using Intelligent Mobile Agents. Parameters are chosen and fixed before any agents are deployed; algorithms are based upon the expert knowledge of the departments responsible for them, whether the DOT or engineering experts. Agents used this way can make near real time changes to the system without requiring a central server, intensive DOT personnel involvement, or using large broadband transmissions.

Wireless Body Network

Monitoring equipment that is small enough to be attached unobtrusively to clothing, attached to a person's skin, or even embedded into muscle tissue can be used to wirelessly track the behavior or health status of a First Responder dealing with a crisis.

Connecting very small hardware devices, such as Telos' Moteiv, or a Gumstix, to a ZigBee, Bluetooth or WiFi enabled wireless network will allow physiological data to be sent to a mobile device (cell phone, laptop) or a central server. This data can be filtered by using intelligent mobile agents to signal "normal" when vital signs are with normal limits, rather than transmitting each data point. A change in status would be immediately transmitted, so that if the pulse rate escalated to 110, that rate would be reported, but no other variables need to be reported as long as they remain within normal ranges.

Appendix B

Glossary of Acronyms

AMBER Alert	America's Missing: Broadcast Emergency Response Alert System
CDC	Center for Disease Control
CERT	Community Emergency Response Team
DOT	Department of Transportation
EOC	Emergency Operations Center
EMS	Emergency Medical Service
FBI	Federal Bureau of Investigation
GIS/GPS	Global Information System/Global Positioning System
HAZMAT	Hazardous Materials
IIOP	Internet Inter-Orb Protocol
IMA	Intelligent Mobile Agent
INS	Immigration and Naturalization Service
J2EE	Java 2 Enterprise Edition
JMS	Java Messaging Service
MSMQ	Microsoft Messaging Service
MVS	Multiple Virtual Storage
NFPA	National Fire Protection Association
NOAA	National Oceanographic and Atmospheric Administration
OTC PDR	Over the Counter Physician's Desk Reference
PDR	Physician's Desk Reference
RFID	Radio Frequency Identification

RMI	Remote Method Invocation
SOAP	Simple Object Access Protocol
VOIP	Voice Over Internet Protocol
VRMP	Voyager Remote Messaging Protocol
XML-RPC	eXtensible Markup Language – Remote Procedure Call

About the Author

Teresa Lipari earned a degree has a Physician Assistant from the University of Texas Southwestern Allied Health Center. She has a 10-year background as an Emergency Department Physician Assistant, during which time she also earned a Master Degree of Healthcare Administration at the School of Public Health, University of North Carolina, Chapel Hill. Since becoming a co-owner of Recursion Software, Inc., she has also earned a certificate in Emergency Management and Preparedness at the University of Texas at Dallas. Currently, Teresa fills the position of Business Continuity Planner at Recursion Software, Inc. She is a member of the local Medical Reserve Corps, the Dallas-Ft. Worth World Affairs Council, and the International Association of Emergency Managers.

She lives in Frisco, Texas with her exceptional husband and above-average Lhasa.

About Recursion Software, Inc.

Recursion Software is an innovative provider of intelligent middleware and distributed computing solutions based on Service Oriented Architecture (SOA) principles and interoperability standards between multiple languages and platforms. Recursion products help enterprises to extend their current application architecture while providing the tools developers need to build the next-generation of intelligent, mobile, applications. The company is a small, privately held corporation, located in the Dallas-Fort Worth area with a large customer base of government and commercial clients across the world. Since 1993, our products have enabled complex, performance-oriented software development solutions for mission-critical applications and systems. The majority of clients are in the defense, financial, energy, computer technology, and telecommunications industries.

Recursion Software is regarded for its Voyager Edge platform, a powerful agent-based interoperable platform that supports a total range of edge devices, including handheld devices, PDAs, sensors and cameras. The company remains the leading proponent and preferred platform for intelligent mobile agent and agent space technology and has been issued more than 18 patents related to distributed computing, with 30 patents in various states of pending and filing.

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