Research Design for a Natural Disaster Management Communication System: Local Indiana Government Agency Model

Barbara Nicolai
bnicolai@calumet.purdue.edu

Katheryn Puntillo
kpuntill@calumet.purdue.edu

Brian Bilow
bbilow@calumet.purdue.edu

Computer Information Technology and Graphics
Purdue University Calumet
Hammond, Indiana 46323, USA

Abstract

In the past decade, the world has seen several large and deadly natural disasters, such as hurricanes, tsunamis, and earthquakes. These disasters, as well as man-made emergencies, such as the destruction of the World Trade Center in 2001, all have several unavoidable results in common. Disasters cause huge loss of life, enormous amounts of property damage, and long recovery times. The tool needed by emergency response personnel to mitigate some of the loss is an integrated, mobile, self-contained voice and data communications system. This paper explores a solution to facilitate and expedite the process of distributing resources when a disaster occurs by managing the aftermath more efficiently and effectively.

Keywords: disaster management system, database tracking system, communication system

1. INTRODUCTION

It is well known that when disasters such as tornadoes or hurricanes strike, localities often suffer from destruction of property, loss of life, and lengthy recovery times. Although it is impossible to avoid the costs of disasters and emergencies, human sufferings can be minimized through effective disaster management communications starting at local government levels.

It is the aim of this paper to describe a solution that was modeled for a local Indiana government agency for a disaster management communication system. The solution provides an efficient way for the local government agency model to process information and manage a client base, through day-to-day operations or under adverse conditions as experienced in a disaster.

2. BACKGROUND

In August 2005, Hurricane Katrina devastated the coasts of Louisiana, Mississippi, and Alabama, causing more than 1800 fatalities, and leaving more than 60,000 people homeless (Hurricane). In the aftermath, the American government was strongly criticized for its overall response; for mismanagement and lack of leadership, and for the deaths of citizens after the storm

from thirst, exhaustion, and lack of medical attention. Academic research conducted in the fall of 2005 produced examples of doctors and other volunteers who were not able to help because officials could not get them assigned to the relief effort. There was an instance of a North Carolina Mobile Hospital that was not able to deploy because of Louisiana officials' red tape. Research has further yielded evidence of an overall lack of preparedness in areas such as locating and rejoining family members, tracking missing and deceased persons, retrieving school matches for displaced students, locating and contacting resources and service providers, and disseminating information to victims. (Nicolai, 2007, pp. 5-7)

With a general perception of lack of planning and coordination on both federal and state levels, the question arose as to the preparedness of local government programs. Indiana Townships are part of state and local government systems which supply indigent populations with needed services. A report prepared by the Institute for Family and Social Responsibility of Indiana University indicated that, for many, Indiana's 1008 Township agencies are the first line of defense when families experience emergencies. They are responsible for providing life's basic support needs to the community's poor and indigent people from all lifestyles who find themselves in need of temporary assistance.

Unfortunately, these resources, while considerable, also have weaknesses. Academic research (Nicolai, 2007, pp. 2-3) has shown that one local system in Indiana requires a client to interface with eight different departments before general assistance may be given. It has also been shown that, at present, many systems lack an emergency plan capable of expediting meeting immediate needs such as basic shelter, food, clothing, and medical services for a large number of people in a short amount of time. It only makes sense to find ways to strengthen these existing resources.

3. PROPOSED MODEL

The proposed model is for a technological system, sustainable in adverse conditions as experienced in a disaster, to enable collaboration between cooperating agencies and effectively serve the indigent population in an efficient and timely manner. The goal has been to design and develop a flexible, scalable, highly portable, and self-supporting centralized network and modular component facility. As a web application, it is portable and self-supporting with laptops or handheld devices that can be carried into a disaster area. The components of the system could be quickly and easily transported to any disaster terrain site. Its centralized network is the internet, which connects to storage repositories for its entire client base. After deployment, the system could be operational and functional within just a few hours.

The model is flexible and scalable in the sense that it was designed with dual purposes in mind; it can be used to manage the everyday components of a township agency, or expanded to accommodate the more extensive communication operations of a disaster client base. For instance, in day-to-day operations, a single parent might seek assistance with food and clothing, or job searching because they lost their last position to outsourcing, while in an expanded disaster mode, if a mother is separated from her child in a disaster, she would be able to relay the information to agency personnel, giving descriptive and identifying data that would be stored centrally. Later, if a child was found, the child's information could be collected and queried against the system. This would enable staff to disseminate information and allow a distraught mother to see that her child was found, even if it occurred across town at another facility.

4. PROTOTYPE DESCRIPTION

The prototype is a wireless web application. This application can be utilized in a situation where there is no available power source and is capable of collecting large amounts of demographic information on an indigent population during regular every day activities and on a larger scale during a disaster. This information can then be used to allocate resources, reunite families, and provide for the basic needs that an indigent population requires.

This system is not only efficient it is also cost effective. It utilizes several open source software solutions combined with portable handheld devices to perform its basic functions. Not only can it serve one mother and her child, but also it can serve all of the victims of a disaster no matter

what their needs are such as food, shelter, transportation, medical assistance, and job placement as shown in figure 2 of the appendix. It accomplishes this arduous task by using a multitude of handheld devices, which when connected to the internet, can both send and receive client information and determine what resources are available. When there is no power source available, it can be powered by generators or batteries, which power all of the systems required during a disaster. By using handheld devices in the field with a batch processing option, data can always be collected. Another feature of the prototype is a Global Information System (GIS) module, which could be used to display geographic conditions. All of these features combined address what is severely lacking in the current system.

5. IMPLEMENTATION PLAN

To implement this system, it has been modeled off a local township agency, which already provides for an indigent population. The system not only facilitates the current processes of the township by eliminating large amount of paperwork required to receive aid, but also acts as a disaster management system. The model is designed to replace the existing paper based system with a fully paperless internet based system.

The implementation of this system starts at the township level where it simply replaces file cabinets and binders with small compact computers. In addition to computers, a repository acts as file cabinets and stores the information, which is inputted from the web application. There are also several handheld devices, which can be utilized in a disaster situation. To transition to the new system, pilot agencies would test the system with their existing client base. Once endorsed, the system would be distributed as a web application to all of the township agencies in Indiana with the repository being maintained by the Indiana Township Association.

6. DATABASE RELATIONSHIPS SYSTEM MODEL

Figure 1 in the appendix, the Data Flow Diagram, explains how a client interacts with the system during regular every day business activities. A client registers with the agency, a request is sent to the information desk upon completion of the registration process, and an ID card is generated for the client. After registration is complete, the client can then begin requesting services. A client can be denied or approved for services based on the criteria they gave during registration. Services given are in the form of printed service vouchers.

Figure 1 also explains how a client interacts with the system in an emergency. During an emergency, the business rules change to accommodate clients expediently. A client requests services, which then reference an emergency services account that contains information about what resources, are immediately available. The client is then approved or denied for the services requested and a basic account is created with whatever client information is available. If approved, the client is provided with the necessary services.

Figure 2, the Enhanced Entity Relationship Model, describes the relationships between the agency, clients, and service providers during both regular business functions as well as emergencies. A client can be an employee, an active client, (missing, or deceased in emergencies). After the client type is identified, an active client can request products or services from vendors or service providers through the agency. In regular and emergency situations, a client has a case, which lists family members, which may also require services as well as their status of missing to help locate them or deceased.

7. TECHNICAL DESIGN

The overall design of this system consists of a software/hardware solution. The software consists of a SQL Server database and user interface built on the ASP.NET framework. ASP.NET and SQL Server are utilized for this prototype because they are both extremely robust as well as inexpensive. The storage and expandability of SQL Server are nearly limitless. ASP.NET has proven its worth by being one of the leading web development communication tools. Both applications attractively have freeware versions available. The application contains modules for collecting client information necessary for immediate decision-making. Instant assessment allows for the most efficient processing of daily tasks as well as critical decision making

in a crisis environment. There are also modules, which store available resource information for services such as housing, transportation, emergency assistance, clothing, etc. Emergency modules process data on the status and location of clients and persons missing or deceased. The emergency modules would also implement the business rules, which would apply in a crisis environment and differ from day-to-day business requirements.

The networking and hardware portion of this system consists of wireless handheld devices or laptops, which can be brought to a disaster site and collect indigent demographic information. This information is then added to the SQL database through a wireless network system. The repository for the database information consists of a server with backup support. Built on an open-source Linux platform, this system can be implemented on both portable computers and workstations, which can be easily transported if necessary.

8. BEST STATE SCENARIO

The proposed solution is to use a database application created for a local government agency to support an indigent population, which would meet the current needs of multiple agencies and include assistance for natural or man-made disasters. The database application would be developed with open-source and freeware products to keep development and user costs low. It would be modular to be customizable to fit individual agency requirements with a menu-driven interface for ease of use. As a distributed web application, it would not be dependent on the functionality of specific processing units.

Initial setup would include resource modules which would be used to enter information on local resources, such as potential housing, food sources, and medical providers for both large and small scale demands. Online modules would be available to local resources for registration and updates. Prior to implementation, active client information would be inputted into the information system. New clients could apply for services through a self-service web option and active clients could access and update information as needed. Update requests would automatically be sent out at appropriate intervals, with agency alerts for clients and organizations that have not been updated within a defined period. Another component, a geographical information system (GIS) module, would be included for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

It is logical that the data center be maintained by the Indiana Township Association, which is a statewide, nonprofit organization established to unite and support the Trustees and Assessors in Indiana. Its mission is to "secure for township officers and office holders full recognition and enjoyment of their rights to administer their responsibilities in a just and professional manner; to secure the tools necessary for them to fulfill their obligations as public servants; and to strengthen and extend Township government in such a way as to provide to the citizens the services they are entitled." (ITA, 2008)

A wireless solution proposes a highly portable, highly available high-speed voice and data communications network. It would be flexible and scalable to meet the needs of disaster workers in a variety of situations. The network would utilize current technologies to provide wireless communications solutions to all levels of the emergency response community, from the first responder up through executive level administrative personnel.

9. CONCLUSIONS

There is no present way of preventing a disaster. However, by managing the aftermath of a disaster more efficiently and effectively the intensity of human suffering and recovery time can be drastically reduced. It is vitally important for time-critical decisions to be made quickly and precisely as to avoid the personal distress of a prolonged indigent state. A solution now exists based on a local Indiana government agency that provides an efficient paperless method to process information and manages a disaster client base.

Disaster systems are currently not installed as a consistent solution across the nation. A consistent method of communication is necessary to handle not only state but also

national network solutions. The ideas within this paper offer a concrete solution to give hope and promise to those whom fall victim to a disaster or emergency.

10. REFERENCES

Hurricane Katrina Timeline. Brookings institution. Retrieved August 2, 2007, from http://www.brook.edu/fp/projects/homeland/katrinatimeline.pdf

Indiana Township Association (ITA). Retrieved April 4, 2008, from http://indianatownshipassoc.org/content/view/13/38/

Institute for Family and Social Responsibility of Indiana University (2005). September report. Retrieved August 2, 2007, from http://www.spea.indiana.edu/fasr/

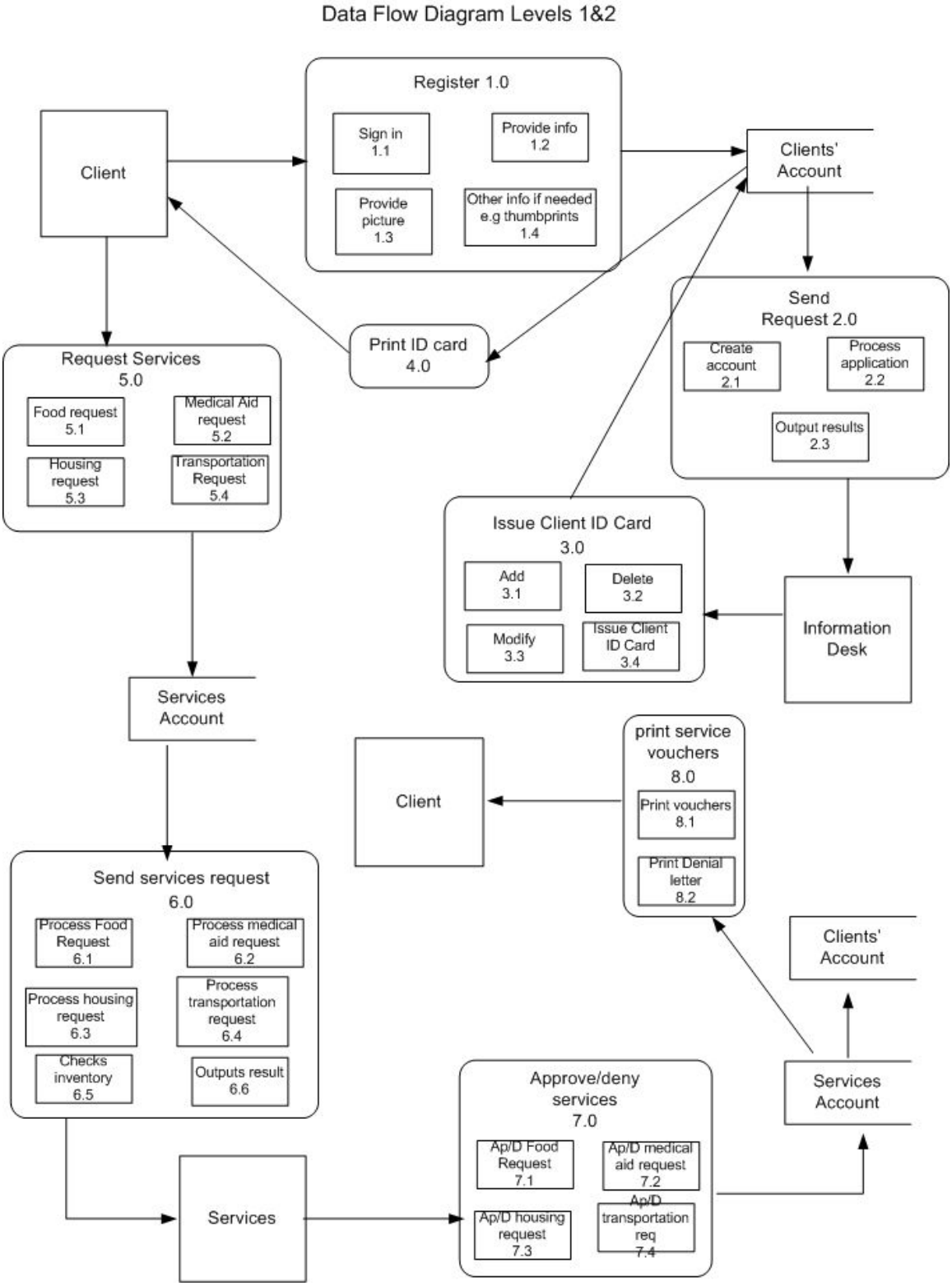
Nicolai, B. (2007). Teaching Relational Database Modeling Using A Case Study: Indigent Population Database Project. Can our existing government agencies provide life support to our indigent population and survive a national disaster?, *Proceedings from ATINER 2007 International Conference.* Athens, Greece.

Purdue University Calumet ITS 364 Research Team. (2007). [Graph Figures 1-3 May 2007] Retrieved May 29, 2007, from Purdue University Calumet Intranet.

Van Heerden, I. & Bryan, M. (2006). The storm: What went wrong and why during hurricane Katrina – The inside story from one Louisiana scientist. New York, New York: Penguin Group.

Appendix

Figure 1



(Figure 1 continued)

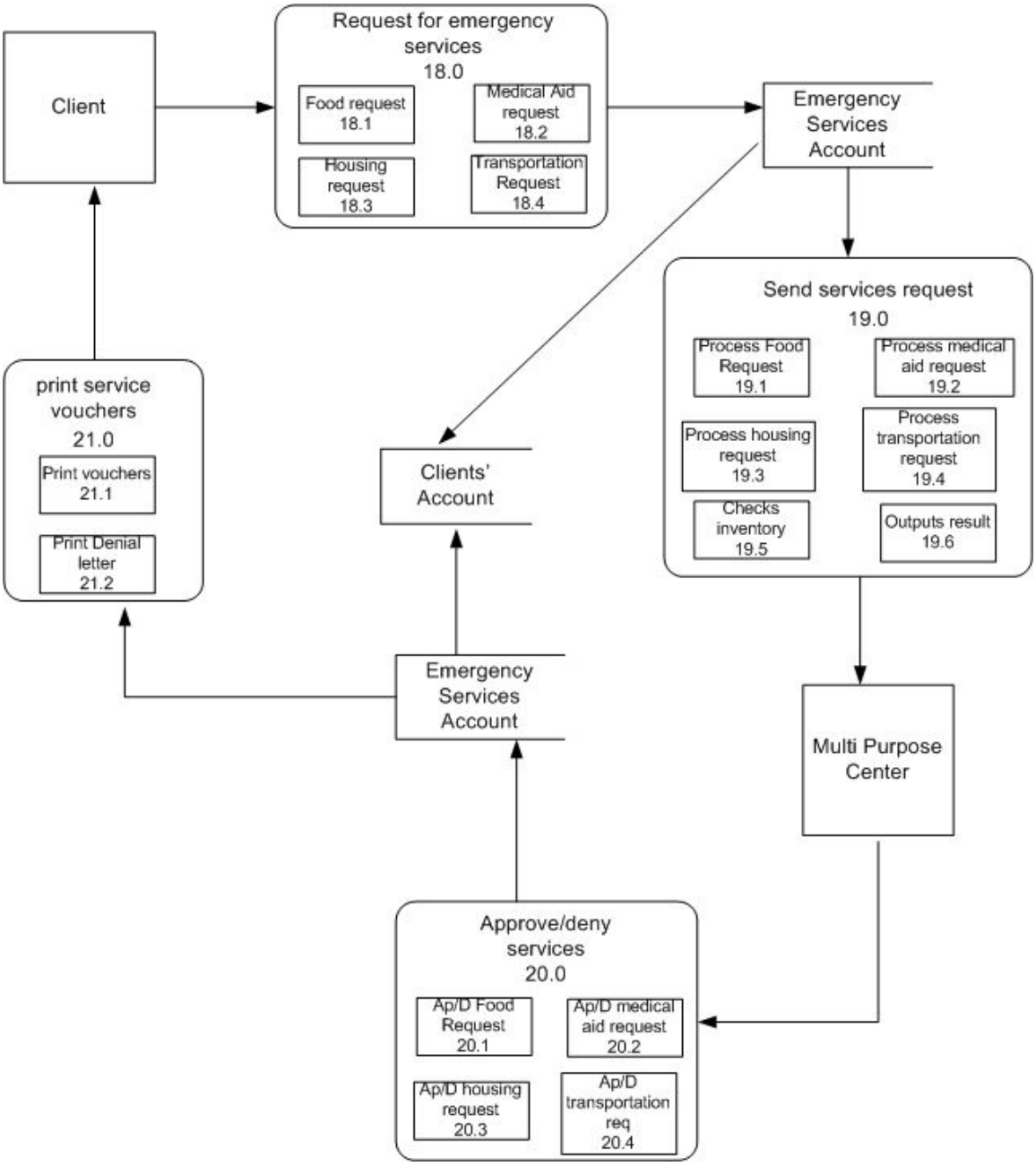
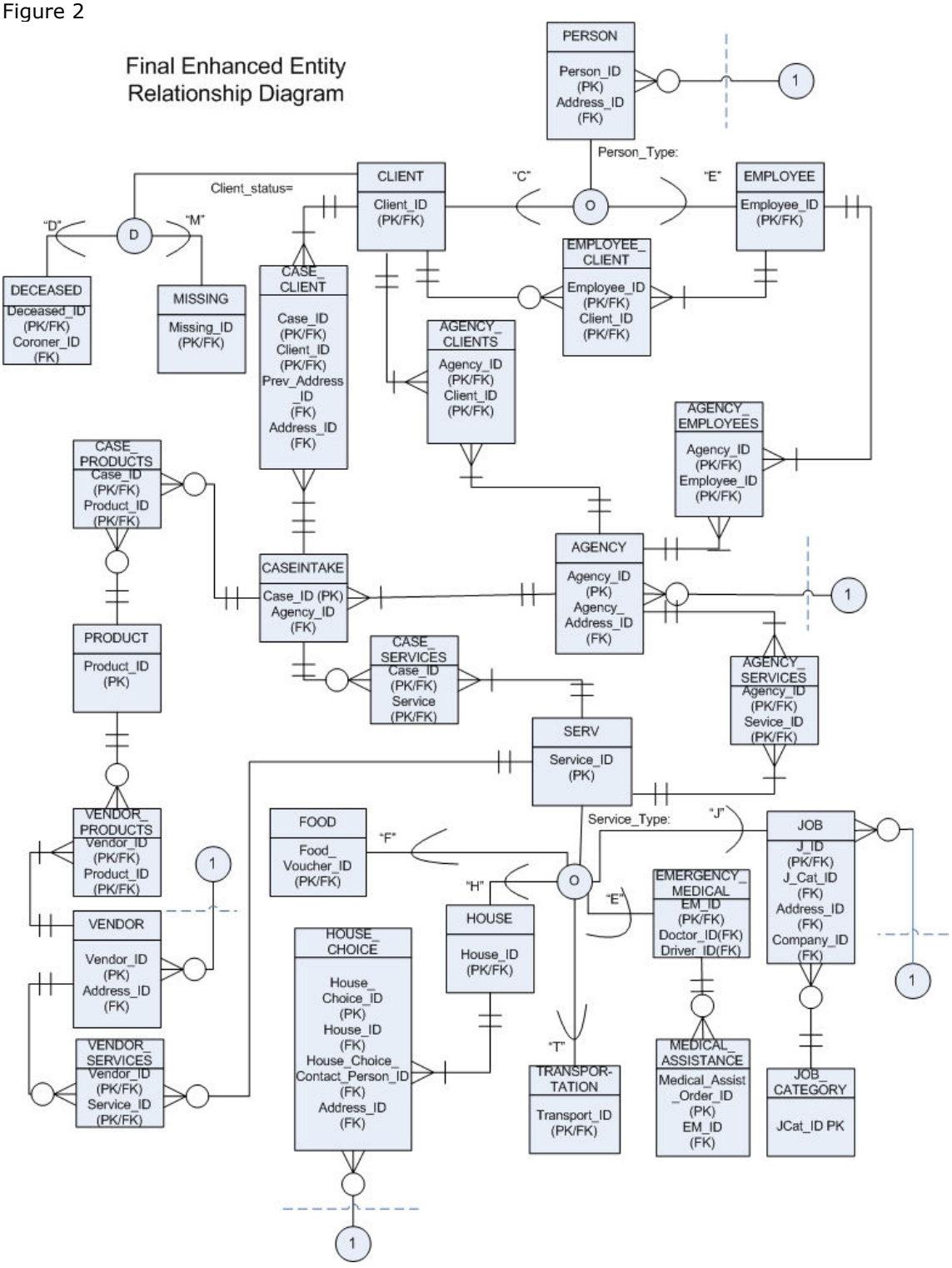


Figure 2


Final Enhanced Entity Relationship Diagram
PERSON
Person_ID (PK)
Address_ID (FK)
Person_Type:
"C"
"E"
CLIENT
Client_ID (PK/FK)
EMPLOYEE
Employee_ID (PK/FK)
Client_status=
"D"
"M"
D
DECEASED
Deceased_ID (PK/FK)
Coroner_ID (FK)
MISSING
Missing_ID (PK/FK)
CASE_ CLIENT
Case_ID (PK/FK)
Client_ID (PK/FK)
Prev_Address _ID (FK)
Address_ID (FK)
EMPLOYEE_ CLIENT
Employee_ID (PK/FK)
Client_ID (PK/FK)
AGENCY_ CLIENTS
Agency_ID (PK/FK)
Client_ID (PK/FK)
AGENCY_ EMPLOYEES
Agency_ID (PK/FK)
Employee_ID (PK/FK)
CASE_ PRODUCTS
Case_ID (PK/FK)
Product_ID (PK/FK)
AGENCY
Agency_ID (PK)
Agency_ Address_ID (FK)
CASEINTAKE
Case_ID (PK)
Agency_ID (FK)
PRODUCT
Product_ID (PK)
CASE_ SERVICES
Case_ID (PK/FK)
Service (PK/FK)
AGENCY_ SERVICES
Agency_ID (PK/FK)
Sevice_ID (PK/FK)
SERV
Service_ID (PK)
Service_Type:
"J"
VENDOR_ PRODUCTS
Vendor_ID (PK/FK)
Product_ID (PK/FK)
FOOD
Food_ Voucher_ID (PK/FK)
"F"
"H"
"E"
EMERGENCY_ MEDICAL
EM_ID (PK/FK)
Doctor_ID(FK)
Driver_ID(FK)
JOB
J_ID (PK/FK)
J_Cat_ID (FK)
Address_ID (FK)
Company_ID (FK)
VENDOR
Vendor_ID (PK)
Address_ID (FK)
HOUSE_ CHOICE
House_ Choice_ID (PK)
House_ID (FK)
House_Choice_ Contact_Person_ID (FK)
Address_ID (FK)
HOUSE
House_ID (PK/FK)
"T"
TRANSPOR- TATION
Transport_ID (PK/FK)
MEDICAL_ ASSISTANCE
Medical_Assist _Order_ID (PK)
EM_ID (FK)
JOB_ CATEGORY
JCat_ID PK
VENDOR_ SERVICES
Vendor_ID (PK/FK)
Service_ID (PK/FK)
1