# SOA-Based Mobile Application for Crime Control in Thailand

Jintana Khemprasit and Vatcharaporn Esichaikul

***Abstract*—**Crime is a major societal problem for most of the world's nations. Consequently, the police need to develop new methods to improve their efficiency in dealing with these ever increasing crime rates. Two of the common difficulties that the police face in crime control are crime investigation and the provision of crime information to the general public to help them protect themselves. Crime control in police operations involves the use of spatial data, crime data and the related crime data from different organizations (depending on the nature of the analysis to be made). These types of data are collected from several heterogeneous sources in different formats and from different platforms, resulting in a lack of standardization. Moreover, there is no standard framework for crime data collection, integration and dissemination through mobile devices. An investigation into the current situation in crime control was carried out to identify the needs to resolve these issues. This paper proposes and investigates the use of service oriented architecture (SOA) and the mobile spatial information service in crime control. SOA plays an important role in crime control as an appropriate way to support data exchange and model sharing from heterogeneous sources. Crime control also needs to facilitate mobile spatial information services in order to exchange, receive, share and release information based on location to mobile users anytime and anywhere.

***Keywords*—**Crime Control, Geographic Information System (GIS), Mobile GIS, Service Oriented Architecture (SOA).

## I. Introduction

CRIME is a major societal problem for most of the world's nations. It has been concluded that in order to combat crime, police forces need to consider the following five resources: first, precise and reliable information about the current situation of the emergency, existing sources and facilities. Second, how this information relates to spatial components or location. Third, reliable information and real-time spatial data from many sources should be shared and accessible to allow for better decision making. Fourth, urgency should be considered and that all aspects are time sensitive. Fifth, collecting and using spatial information on the current state of the emergency should be taken to reduce time wastage [1].

However, the police sometimes have problems with operations and are always trying to find ways to improve their efficiency. Some of the most common difficulties that they face are in crime control, crime investigation and in providing crime information to the general public to help them protect themselves [2]. Consequently, it would be easier for the police if they had tools to help them investigate and control crime, tools such as crime warning messages via mobile devices when they need to physically move through a high risk area/ environment or when they are serving an arrest warrant. The benefits for ordinary citizens would be in the form of crime warning messages if they enter a risk area and the ability to report crime information via their mobile device directly to the police. This system could also be used to access crime information from multiple sources in different formats such as: text (criminal data, property data, gang information, case information, demographic information), graphic (photographs of criminals, pictures of crime scenes), multimedia (video clips) and geographic (crime locations, details of the area, facilities). This system would also have to permit information exchange and real-time data links to and from any database on any platform among law enforcement or Government organizations. Examples of this type of information exchange are the retrieval of information from the Department of Local Administration or vehicle registration and driving license information from the Department of Land Transport. The system would of course have to interoperate any new system with the legacy systems.

According to the above stated situations, it can be seen that crime control needs to have a mechanism that supports the sharing, receiving and release of information. This mechanism also requires that there is interoperability with legacy police applications. A possible solution to achieving these objectives is Service Oriented Architecture (SOA). SOA is a methodology to design and structure information systems to support data exchange, model sharing, receiving information, information release and interoperability among heterogeneous systems through a standard protocol.

Mobile based crime control also needs to facilitate mobile spatial information services that include information technology, mobile contact technology, Internet technology and several others combined together in order to exchange, receive, share and release information based on location to mobile users anytime and anywhere.

## II. Theoretical Background and Related Work

This research is an application on mobile devices that provides data exchange (spatial and non-spatial), model sharing from multiple organizations in different formats derived from different platforms to support crime control with regards to location awareness and context awareness. Consequently, this research will be developed by covering two main research areas, namely, SOA and mobile spatial information services.

J. K. Jintana is with the Computer Science and Information Management in the Asian Institute of Technology, Pathumthani, Thailand (phone: 66 2 5245000; fax: 66 2 5162126; e-mail: jintana.khemprasit@ait.ac.th).

V.E. Vatcharaporn is with the Computer Science and Information Management in the Asian Institute of Technology, Pathumthani, Thailand ((phone: 66 2 5245000; fax: 66 2 5162126; e-mail: vatchara@ait.ac.th).

*A. Service Oriented Architecture (SOA)*

The definition of SOA can be defined from several researchers with different perspectives as the following examples show:

"SOA is an architectural paradigm and discipline that may be used to build infrastructures enabling those with needs of consumer and those with capabilities of providers to interact via services across disparate domains of technology and ownership"[3].

"SOA is a particular kind of software architecture to construct a distributed, dynamic, flexible, and re-configurable service system over the Internet that can meet the information and service requirements of many different users" [4].

The definition of SOA in this paper is defined as a methodology to design and structure an information system to support data exchange, model sharing, receiving information, information release and interoperability among heterogeneous systems through a standard protocol. The basic structure of SOA is shown in Fig. 1 and consists of three roles: service provider, service requester and service broker. The service provider publishes its services to the service broker and makes the services available to the users who need them. The service requester is a consumer of services. It can be an application client that needs the services provided by the service provider. The service broker or UDDI (Universal Description, Discovery and Integration) is a service registry or a catalog of the services. In order to allow a consumer to access the service, the provider has to publish a description of the service called WSDL (Web Service Description Language), which is an XML-based language for describing services and how to access them [4,5,6,7]. The service can be exchanged between provider and consumer through a standard protocol named Simple Object Access Protocol (SOAP). This is a simple XML-based protocol to let applications exchange information over HTTP by providing a way to communicate between applications running on different operating systems, with different technologies and programming languages [7].

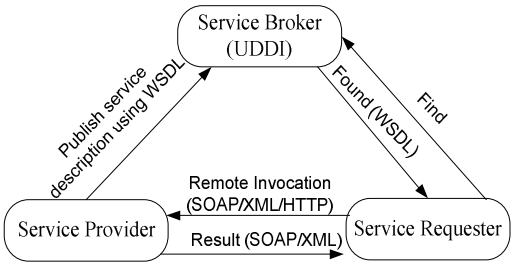


Fig. 1 Structure of Service Oriented Architecture

SOA has received lots of attention from researchers worldwide. However, most of the existing research has been focused on design and implementation for Internet based applications [8-12]. There has been little research on mobile based SOA. The relevant work in the early stages of the mobile based applications of SOA considers the application on mobile environments without any details of the SOA design, architecture or technologies involved [13]. In later phases, the transaction management of mobile clients over the wireless environment was considered [14]. The latest phase of research is focused on designing message exchange patterns based on service oriented frameworks for disseminating geospatial data, designing location and context aware for mobile services when clients are on the move, and requesting services based on the current location of the client [15,16].

SOA-based framework is structured from various perspectives in accordance with the application domain. Jorstad et al. [17] proposed a SOA-based framework for collaborative services which consists of two layers i.e. service layer and application layer. A service layer is a collection of services which is available to all the developers. Secondly, an application layer is the collection of collaborative functions which are based on the services in the service layer. Shin & Kim [18] proposed a framework for SOA-based application development. This framework was based on the SOA-based architecture of Erl [19] which consists of four layers i.e. presentation layer, service interface layer, business process layer and framework layer. RIAD & EI-GHAREEB [20] proposed SOA to integrate mobile assessment in learning management system. The proposed architecture consists of two layers i.e. interface layer and service layer. The interface layer interacts with instructors and learners via portal and also interacts with external organization via web services. The service layer consists of three sub-layers i.e. orchestration, application service and agents layer. Orchestration contains business logic required by system processes. Application service contains set of stateless services and agent layer presents the suggested required software agents to serve the overall system. Amirian & Alesheikh [16] proposed a service oriented framework for disseminating geospatial data to mobile, desktop and web clients. The proposed framework consists of three layers: a client layer, a geospatial web service layer and a data source layer. A client layer consists of three different ways to interact with geospatial web service i.e. mobile, desktop and web clients. A geospatial web service layer consists of services to support geospatial data i.e. Web Map Service and Web Feature Service. A data source layer consists of geospatial data which is stored in a spatial database.

*B. Mobile Spatial Information Service*

The mobile spatial information service involves information technology, mobile contact technology, Internet technology and others combined together in order to exchange, receive, share and release information based on location to mobile users anytime and anywhere.

The evolutionary path of mobile spatial information services from the geographic information system (GIS) has four distinct stages. The first stage, GIS has been steadily improving since the 1970s. Early GIS focused on assembling, storing, manipulating, and displaying geographically referenced information. The next stage in GIS development has been shaped by the tremendous growth of Internet technologies. Internet based technologies have been assimilated into GIS leading to a variety of Web-enabled GIS applications [21]. Internet GIS can be seen as an expansion of the ordinary GIS in the sense that the Internet is used as a

means to exchange data, perform GIS analysis and present results. The third stage in GIS development is mobile GIS. Mobile GIS integrates several technologies such as mobile devices, Global Positioning Systems (GPS), and Wireless communications for Internet GIS access. Mobile GIS focuses on the use of GIS through mobile and wireless devices. The final stage of GIS development is the mobile spatial information service. This is a complicated technical system with spatial information technology, mobile contact technology and internet technology, etc. combined together for the purpose of sending mobile information services to mobile or cable users anytime and anywhere [5]. This stage focuses on sharing spatial data among organizations, utilizing the location based service and combining GPS with various applications. According to Jun-fang et al. [5], the mobile spatial information service based on an open framework was proposed to increase the information and storage service functions of GIS used in mobile terminals. This would bring a more convenient and economical means for mobile device users to exchange information based on location.

## III. The Current Situation of Crime Control

The current state of crime control was investigated to determine the problem of crime control in Thailand. These investigations were carried out by conducting interviews and observations of work processes in crime control. To this end, two police departments were interviewed. Police departments generally have several types of police officers, depending on their duties, e.g. administrator, detective, investigative case officer, patrol police, traffic police and suppression police.

The interviews focused on attempting to understand the type of police, the information and the work process in police operations for controlling crime.

The police administrators, detectives, patrol police and the investigative case officers from two departments were interviewed. Semi-structured interviews were used with pre-determined interview questions, aimed at discovering the problems and the needs of police operations in crime control. The interview questions covered the information used in crime control, how they accessed information from internal and external organizations, how they disseminated information to the public, how the public informed cases to the police and what operations they felt needed to be improved.

The interviews results are collected and summarized in the following five problem areas:

*1) Data exchange*

*Current situations:* Investigative case officers and detectives often need to search through information about suspects, victims and crimes from various data sources that are in different formats. For example, a typical crime case requires them to search at least four different systems, i.e. criminal database, civil registration, vehicle registration and passport registration in order to collect information with which to analyze the case correctly. Moreover, the police always need to exchange data with the Ministry of Justice, e.g. stolen car information and crime information. The data sources used in crime control from internal organizations (criminal database, immigration registration) and external organizations (civil registration, vehicle registration, driving license registration, gun registration).

*Problems:* Data from multiple sources are in different formats and from different platforms.

*2) Model Sharing*

*Current situations:* When patrol police receive commands from the emergency call center, they sometimes need to request additional information from the call center, e.g. the location of the event, the best route to take to the event and the nearest actual event, this information can be processed using the suggested model.

*Problems:* The emergency call center has a greater work load because there are lots of emergency calls per day because the police always use the same model e.g. finding the best path to get to a specific destination, finding a risk area or finding the nearest neighbor with a different data set of different environments. Therefore, the work load of the emergency call center would decrease if the police have a tool to help them share these models, hence, having no need to make further requests to the call center.

*3) Information Accessing in Anytime and Anywhere*

*Current situations:* When patrol police or detectives are working in a given area, they often have to access arrest warrant information or lost/stolen car information. For example, while patrolling they may find a suspect or a stolen car, they then need to access detailed information on that suspect or stolen car immediately.

*Problems:* The police use radio communication to access detailed information that is sometimes not reliable or understood fully because of radio interference in the communication between the senders and the patrols. There is also the problem of using paper based information that may or may not be up to date.

*4) Information Disseminating*

*Current situations:* When police move through an area, they sometimes need to know what degree of risk there is or whether this area has any open arrest warrants.

*Problems:* None of the currently used tools can provide warning information (crime risk, arrest warrants) to the police when they are physically moving through a high risk area/ environment or when they are serving an arrest warrant.

*5) Crime Informing*

*Current situation:* The public reports emergencies by calling to the emergency call system, following this, the call center will send the case to the patrol police via radio communication. Then, the patrol police will go to the crime scene.

*Problems:* Command messages are sometimes not received or understood fully because of radio interference in the communication between commanders and the patrols. The patrol police sometimes also need to request additional command messages from the commander. For instance, following the initial command message, the patrol may request the location of the event, the best route to take to get to the event and information on where the nearest event is.

## IV. SOA for Crime Control and SOA-Based Framework

As discussed earlier, the current state of crime control needs to have a mechanism that can support data exchange, model sharing, accessing information and disseminating information.

The concept and the benefits of SOA would appear to be an appropriate solution to achieve the needs of crime control. The SOA solutions in crime control are shown in Table I.

TABLE I
THE SOA SOLUTIONS IN CRIME CONTROL

| Problems | SOA Solutions |
|---|---|
| 1. Data from multiple sources are in different formats and from different platforms | SOA supports data exchange from multiple sources in different formats and from different platforms |
| 2. An increasing work load for the emergency call center in receiving calls from the public and in supporting additional command message requests from the patrols | SOA supports the sharing and publishing of models among organizations, regardless of their modeling environments |
| 3. None of the currently used tools can provide all of the information required by the police while they are working in a given area. | SOA supports access to information by multiple organizations in anytime and anywhere |
| 4. No tools can provide warnings to the police or the public when they are physically moving through a high risk area | SOA supports the features to publish the distributed information and disseminate this information to the police or the public |
| 5. Command messages are sometimes not received or understood fully because of radio interference in the communication between commanders and the patrols | SOA supports access to additional information and to request the model to make in-field decisions for emergency operations. |

After establishing the needs of crime control and the appropriate solution to achieve the needs of crime control, the SOA-based framework structure is derived as depicted in Fig. 2. The proposed SOA-based framework is composed of four layers i.e. an application layer, a process layer, a service layer and a resource layer. These layers are designed to cover most of the collected requirements and are also based on SOA.

The application layer is a collection of crime control functions to achieve this objective. The process layer is a collection of business process functions from the application layer.

The service layer is a fundamental component in SOA. This layer provides services that can be used across heterogeneous systems. The service layer contains core services that encapsulates business logic specific to a task or business process. The services will be modeled by the service modeling process to classify service types. The generic business services in this study are the authentication service, the mobile service, the GIS service, the geo-location service, the data exchange service and the transaction service.The authentication service provides the security features for the system by authenticating user identity and user roles during log in. The mobile service provides mobile functions such as sending SMS (Short Message Service). The GIS service provides the geographic functions such as a point of interest (POI) function to find the nearest or a specific place, a route function to determine the path of vehicle from one point to another point with the shortest distance or fastest travel time and a map viewing function to display the geographic information on a Mobile device. The geo-location service determines a geographic position with the process of assigning geographic coordinates (latitude, longitude) called the Geocoding process. The data exchange service provides the services for exchanging information among heterogeneous organizations in different formats and different platforms. The transaction service provides services for transaction management such as insert, update, delete or search functions.

The resource layer is a collection of spatial or non-spatial databases and models from the heterogeneous and legacy systems from any platform. It was for this reason that the study proposed the mobile application for crime control that considers data exchange and model sharing from heterogeneous systems and also to interoperate with the legacy systems from any platform. Consequently, the resource layer is an important layer that has been added to this study.

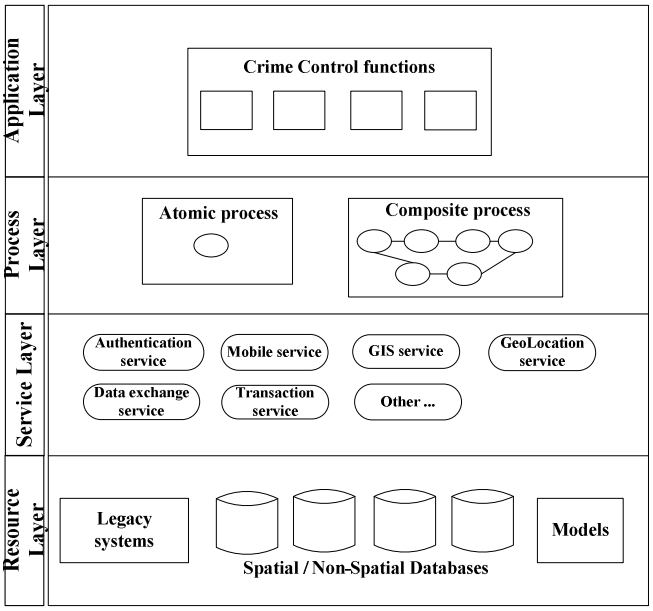


Fig. 2 SOA-based Framework Structure of Mobile Application for Crime Control

## V. Conclusion and Future Work

The current state of crime control was investigated in this paper and as a result certain problems and needs within crime control were discovered i.e. data exchange from multiple sources in different format and from different platforms, using the same model with a different data set from different environments, information access anytime and anywhere, information dissemination and crime notification. SOA was proposed as an appropriate way to resolve these problems and achieve the needs of crime control for several reasons, mainly to support data exchange, model sharing, information access

and information dissemination from heterogeneous sources in different formats and from different platforms. The SOA-based framework was proposed to provide the conceptual design of the layering framework and the functionality of each layer.

For future work, a detailed design and the implementation of mobile based crime control based on the proposed SOA-based framework will be carried out. Finally, the efficiency measurement will be used to measure, how the proposed SOA-based framework can enhance the efficiency of police operations.

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