DESIGN OF THE SERVICE-BASED ARCHITECTURAL FRAMEWORK FOR THE SOUTH AFRICAN NATIONAL PARK SYSTEM

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DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any degree or diploma at any University or other institute of higher learning, except where due acknowledgement has been made in the text.

Themba Cyril Khumalo

DEDICATION

To my mother,

Nomsa Alice Khumalo

1959 – 1999

Acknowledgement

Firstly, I would like to acknowledge the rich blessings that God has bestowed upon me. Secondly, I want to thank my supervisor, Prof. M. O Adigun for guidance and encouragement through my two-year program of study. It is not often that one finds a supervisor that always finds the time to listen to the little problems and roadblocks that unavoidably crop up in the course of performing research. His technical and editorial advice was essential to the completion of this dissertation; and it has taught me innumerable lessons and insights on the workings of academic research in general. The same goes to Dr. S. S. Xulu, G. Ojong, B Dlodlo, M. W. Nkambule, H. P. Kunene, P. D. Biyela, J. Okharedia and all postgraduate students in the Department. I would also like to thank Mcebo and Masina, for the development of the prototype. Lastly, let me thank my best friend Ntokozo, whose without her love and support I would not have completed the write up of this dissertation.

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Abstract

A typical response to the challenge of rendering competitive services to the customers of the South African National Parks led to the development of architectural mechanisms for providing services by taking advantage of the dynamic web protocol standards and frameworks. This was done in three steps: (1). The evaluation of existing IT-level support in providing nature conservation information and marketing of National Park services; (2). Investigation of mobile commerce services to create customer values that promote customer loyalty based on enterprise values; and (3). The development of a distributed service-based architectural framework for the South African National Park system based on service-oriented architectural model. The building blocks (publishing, registration, personalization of services, etc) of the architecture serve as the basis of designing system services for disseminating nature conservation information and marketing the services of the national parks. A prototype of the information service system was used to prove the usability of the architectural framework developed. The architecture proposed in this work is a guide and should provide the basis for an ICT infrastructure that responds to the quest for modernising the national parks information system.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Overview

A national parks infrastructure plays a pivotal role in today's society. Each park has to address the challenge of making services available to its customers. A typical response to the challenge is to develop channels and mechanisms of providing services that take advantage of the current web protocol standards and electronic commerce business model. Therefore, it is necessary to either extend the current ICT infrastructure, or develop new ones. Mobile information service is a new candidate answer to this problem due to the fact that it takes an advantage of the capabilities of mobile devices. Mobile commerce creates entirely new opportunities both for mobile devices and services. The number of users of mobile devices is continuously increasing. People on the move need services, information and entertainment that move with them. M-Commerce differs partially from e-commerce due to special characteristics and constraints posed by mobile devices and wireless networks.

The extensive headway of mobile networks and their expected convergence with the Internet has been driven by the demand for wireless connectivity in support of terminal mobility and the need for novel services that can satisfy the requirements of mobile users. The evolution of network infrastructure with increased bandwidth and coverage is to promote the primary objective of the network operators [1]. The challenge is how to deploy a variety of new services

that meet the needs of mobile users, utilising the provided bandwidth to satisfy these needs. Personalised and flexible content dissemination has been recognized as a valuable service in the environments which support mobility [2]. Such services enable users to receive the relevant information while mobile, and to define the type and customise the content delivered to their terminals. This discussion is followed by how the South African National Park's business model can be impacted.

The South African national parks system currently consists of 20 national parks, namely, Kruger, Cape Peninsula, Marakele, Golden Gate, Vaalbos, Mountain Zebra, Addo Elephant, Tsitsikamma, Knysna, Wilderness, Bontebok, Agulhas, West Coast, Karoo, Namaqua, Richtersveld, Augrabies, Kgalagadi, Vhembe Dongola and Tankwa Karoo. With domestic and international acclaim, as well as access to large scale government funding in its kitty, SANPARK now finds itself seeking new roles to justify and secure its future as an enterprise. It is envisaged that South African national parks has the potential to evolve into a knowledge-based resource for various purposes, such as: Tourist destination, custodian of conservation data, knowledge archive for researchers in disciplines like Botany, Zoology, Nature conservation, Anthropology to name a few. Traditionally, the mission of national parks system is to preserve history and the natural beauty of a nation for the enjoyment of all citizens and international visitors. The parks being places for recreation, education and reflection, they need to be taken care of in a way that they are preserved for posterity. This can only be realized through a well defined business process framework.

1.2 Statement of the problem

It has been established in a survey that South African National Park (SANPARK) is striving towards enabling communities to benefit from its activities [33]. For SANPARK to become a vibrant and dynamic organization, it needs to create mechanisms to disseminate information to local as well as international tourists. An information system is required that allows sharing of information between and among all the stakeholders in the tourism industry. Therefore, the most promising direction to go is e-commerce.

E-commerce has been a revolution for the marketplace and has greatly influenced and changed the way goods are exchanged in terms of space and time. Wide area networks, namely the Internet, have made possible the creation of a global market place largely independent of the physical location of users and goods [3] [4] [5]. Mobility has added a new dimension to this picture. Portable devices, notably cellular phones, and wireless networks have made this global market virtually accessible to millions of consumers. This, besides extending the e-commerce reality to a much larger number of users, has also motivated the creation of a large set of value-added services specifically targeted to mobile consumers. The reality is that the static web pages that are designed to inform the public about services or products provided by our National Parks are not up to the task of increasing the targeted market. This raises the need to find the web-based infrastructure that will meet the needs of various users of the South African national park system.

Therefore an architectural framework is to be formulated that adds value to both the game park business in a customer-oriented manner. What is needed is a modern SANPARK information system with features that first adds value to the customers and also makes the SANPARK business more competitive and profitable. A preliminary investigation was carried out that looks beyond tourist customers, but aims at marketing SANPARK as destinations that earn customer loyalty. In addition, a new look is required that will enable it fulfill a more comprehensive role of providing rich conservation information to users. The system envisaged uses a single distributed architecture to connect all national parks over the Internet infrastructure providing new services to both desktop and mobile users. The proposed model is a service-oriented architecture and is presented in this dissertation as having three distinctive features:

i. Posses a common interface that is device-independent;

ii. Uses pervasive computing style and

iii. Employs web service technologies.

1.3 Motivation for the study

Information and notification services for communicating time-sensitive data have proved their usability in the Internet domain [10]. The huge success of the Short Message Service technology encourages further efforts to implement and deploy information dissemination services in mobile environments. The contribution of this research is the successful design of a service-oriented architectural (SOA) framework that delivers a mobile information service

facility. Relying on the wide variety of content that is already available with the national parks system, this framework should meet the needs of different users with varying tastes. The following are the justifications for a system that will keep users coming back:

i. The system will take advantage of the robustness, scalability and user friendliness of the web service framework;

ii. Service-oriented architecting will be employed to connect national parks into the single system and

iii. Higher revenue and stronger competitiveness are expected to be the economic rationale of the system.

1.4 Goal and objectives

The main goal of this research is to design an architectural framework that will connect all South African National Parks on a single distributed infrastructure based on the service-oriented architectural model. The following are the objectives that have been set to achieve our goal:

i. Formulate a service-oriented architecture (SOA) with own service access model;

ii. Design and implement a demonstration prototype of the architecture using web service infrastructure and

iii. Make recommendations on using web services to improve the use of ICTs in National Park Domain.

1.5 Research design and methodology

The research design and methodology intend to:

i. Evaluate existing IT-level support in National facility with respect to Nature Conservation information and its marketing and support in South African Nature conservation as part of information gathering, resulting in the model which is currently being used in Nature Conservation;

ii. Investigate mobile commerce services to create customer values that promote customer loyalty based on the enterprise values. This will be achieved through identifying the services that add customer value and promote customer loyalty in the same process;

iii. Design a distributed web-based architectural framework for the South African national park system that seeks to consolidate the linkages and partnership between the national parks and other stakeholders in the promotional and marketing of services and

iv. Use the service-oriented architecture model as depicted in figure 1.1 for our approach based on web service technology. This is for the interaction between service providers and service requesters.

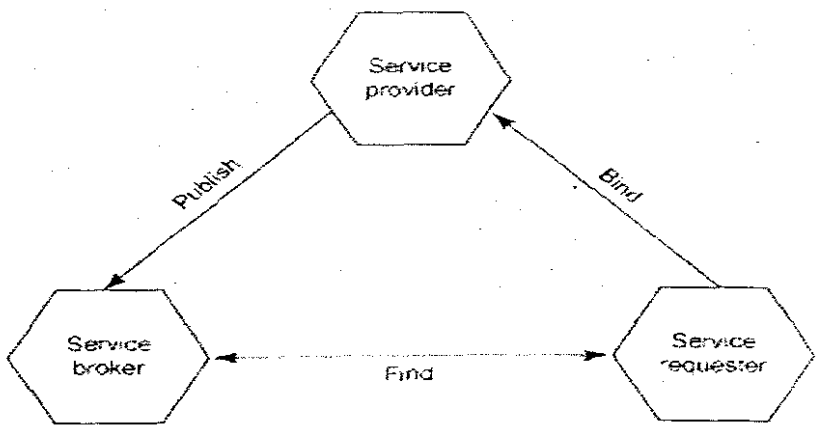


Figure 1.1: Basic service-oriented architectural model

1.6 Arrangement of the Rest of Dissertation

Basic concepts, such as service-oriented architectures and its enabling technologies are covered in chapter two. The chapter also justifies the decision to adopt Service-Oriented Architecture (SOA) in the development of our framework. In Chapter three, the development of the service-based architectural framework for the national park system is covered. The chapter also discusses the National Park system architecture needed for the implementation of the distributed National Park information service system. The service-based national park information service system is the subject of discussion in Chapter four. The system prototype that proves the usability of the proposed solution framework is covered in detail. The chapter also presents how the IBM UDDI test registry has been used to demonstrate the process of publishing business services in the service registry. Finally, the conclusion is the subject matter of Chapter five. This chapter also discusses the limitation and future work in the information service system.

CHAPTER TWO

2.0 SERVICE-ORIENTED ARCHITECTURES AND ENABLING TECHNOLOGIES

2.1 Introduction

This chapter summarizes the concepts of SOA and web services technology. The service oriented architecture and its enabling technologies are presented for a clearer understanding of what they are and their advantages. Section 2.2 presents the SOA concept in relation to what the national parks system needs. Section 2.5 proposes a service-oriented information system model. Section 2.6 compares the web service technology with other distributed system enabling technologies. Scalable and efficient dissemination of information to users residing in wide area networks has been an area of active research for many years [32]. Service like electronic mail is an established application used for communication and exchange of content in everyday life. Recently, push/pull and publish/subscribe systems have been introduced to provide active information dissemination with increased information customization through user subscriptions [11]. The listed systems have mainly been designed for stationary environments. However, the development of higher bandwidth mobile networks promotes the deployment of information dissemination services in mobile environments. What follows is an overview of the service oriented architecture concept and its enabling technology which informs how the national parks process can be reengineered.

2.2 Service Oriented Architecture

Service oriented architecture is a conceptual architecture for implementing dynamic e-business [15]. It is the logical evolution of object-oriented analysis and design, and the logical evolution of components geared towards the architecture, design, implementation, and deployment of e-business solutions [15]. Both approaches have been proven in dealing with the complexity of large systems. As in object-oriented systems, some of the fundamental concepts in service-oriented model are encapsulation, message passing, dynamic binding, and service description and querying. Fundamental to Web Services, then, is the notion that everything is a service, publishing an API for use by other services on the network and encapsulating implementation details. It is a way of designing a software system to provide services to end-user applications or other services through published and discoverable interfaces.

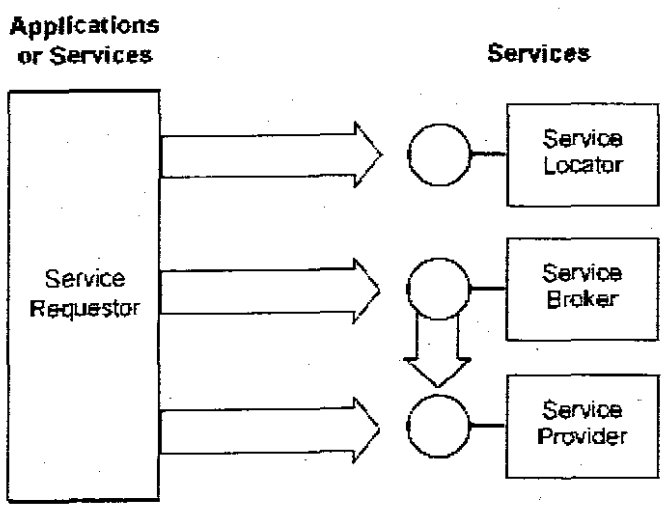


Figure 2.1: General SOA environment

Services provide a better way to expose discrete business functions and, therefore, an excellent way to develop applications that support business

processes. There are three participants, service providers, service brokers and service requesters as shown in figure 2.2 that interact using three basic operations: *publish, find* and *bind.* Service providers publish services to a service broker. Service requesters find required services using a service broker and bind to them. This is due to the fact that in any service-oriented environment, several essential activities need to happen: A web service needs to be created, and interfaces and invocation methods must be defined. A web service needs to be published to one or more Internet repositories for potential users to locate and invoke. Figure 2.1 depicts the general SOA environment.

IBM defines the objects in the general service-oriented architecture environment as: A **service** is a logical entity, whose contract is defined by one or more published interfaces. It is an application that exposes its functionality through the application programming interface (API) and the interface hides the inner workings of the application. A client application doesn't need to understand how the service actually performs its work. All it needs to understand is how to use the interface. A **service provider** is a network node that provides a service interface for a software asset that manages a specific set of tasks. A service provider node can represent the services of a business entity or it can simply represent the service interface for a reusable subsystem. A service provider creates a Web Service and its service definition and then publishes the service with a service registry based on a standard called the Universal Description, Discovery, and Integration (UDDI) specification.

A **service requester** is a network node that discovers and invokes other software services to provide a business solution. Service requester nodes often represent business application components that perform remote procedure calls to distributed objects, or service providers. Provider nodes may reside locally within an intranet or remotely over the internet. The conceptual nature of web service scheme leaves the networking, transport protocol, and security details to the specific implementation. Traditionally, this is termed a **client**; however, a service requester can also be an end-user application or another service. Once a Web Service is published, a service requester may find the service via the UDDI interface. The UDDI registry provides the service requester with a WSDL service description and a URL (uniform resource locator) pointing to the service itself. The service requester may then use this information to directly bind to the service and invoke it.

A **service locator** is a specific kind of service provider that acts as a registry and allows for the lookup of service provider interfaces and service locations. A **service broker** is a network node that acts as a repository, yellow pages, or clearing house for software interfaces that are published by service providers. A business entity or an independent operator can represent a service broker. We have a situation in which multiple organizations are requesting information from multiple Web Service providers. A broker is a central medium that makes the information transfer happen: It is a common gateway/address for client applications to access a wide variety of services. It is a standard method for transforming applications into Web Services. These Web Services may

require a broker to interact with only one server application or multiple server applications. Brokers perform the following functions:

i. Receive SOAP requests in XML format from client applications;

ii. Authenticate the request and check for authorization and

iii. Publish all the services offered, or cancel the Web Service as service provider request

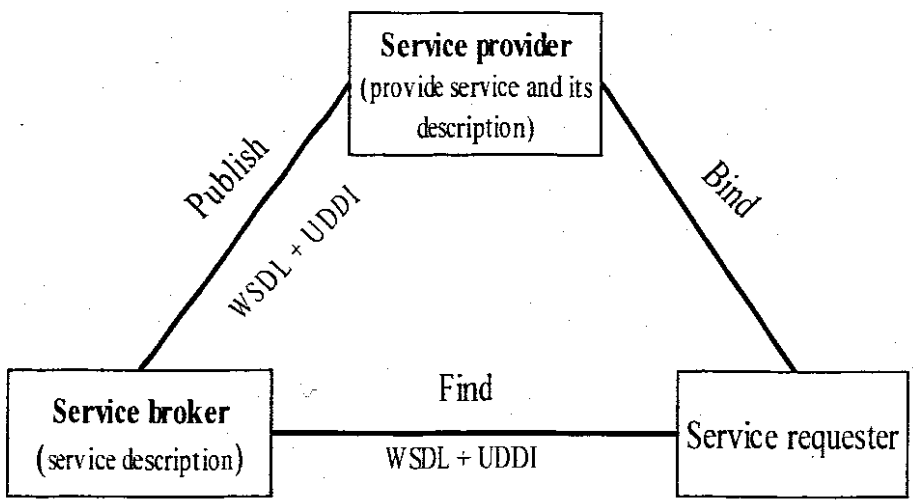


Figure 2.2: Service-oriented architecture

The service request operation consists of the following three actions:

i. Publish: A service provider creates a web service and its service definition and then publishes the service with a service registry based on the standard called the Universal Description, Discovery, and Integration (UDDI) specification;

ii. Find: Once a web service is published, a service requester may find the service via the portal (UDDI) and

iii. Bind: The service requester may then use this information to directly bind to the service and invoke it.

A Web Service is a software application identified by an URI, whose interfaces and bindings are capable of being defined, described, and discovered as XML artifacts. A Web Service supports direct interactions with other software agents using XML-based messages exchanged via internet-based protocols [12]. Expressed in a simple way, a Web Service is something that one can call over the web from a program. Many organisations and companies (such as Microsoft, IBM, Sun etc) specify the interoperability interfaces that enable software vendors to deliver services in the Internet's open, standards-based environment. For national parks application, this will make publishing, discovery, access and use of information much easier and less expensive. Web Services use XML to provide an application implementation of distributed application services and information based on multi-platforms and multi-languages. What this means is that applications and people can use the data and services of an application running on a remote computer regardless of differences between the application server technology running on the remote and local machines. Web Services make it possible for diverse applications to discover each other and exchange data seamlessly via the Internet. While it is perfectly feasible for a person to use a browser to take advantage of a Web Service running on a remote computer, the real potential of Web Services lies in its ability to allow applications to work with other applications without the need for any human intervention.

2.2.1 SOA enabling technologies:

i. **XML**: The Extensible Markup Language 1.0 standard is a text-based markup language specification from the World Wide Web Consortium (W3C). Unlike HTML, which uses tags for describing presentation and data, XML is strictly for the definition of portable structured data. It can be used as a language for defining data descriptive languages, such as markup grammars or vocabularies and interchange formats and messaging protocols;

ii. **SOAP**: Simple Object Access Protocol is a lightweight XML-based protocol for the exchange of information in a distributed environment via HTTP. SOAP defines a messaging protocol between requester and provider objects, such that the requesting objects can perform a remote method invocation on the providing objects in an object-oriented programming fashion. SOAP forms the basis for distributed object communication in most vendor implementations of service oriented architecture. With a SOAP framework, a client sends a request in XML over HTTP to the web service; in return, the web service sends a response to client in XML as well;

iii. **WSDL**: The Web Services Description Language is an XML vocabulary that provides a standard way of describing service Interface Definition Languages. It provides a simple way for service providers to describe the format of requests and response messages for remote method invocations (RMI). WSDL addresses this topic of service IDLs independent of the underlying protocol and encoding requirements. In general, WSDL provides an abstract language for defining the published

operations of a service with their respective parameters and data types. The language also addresses the definition of the location and binding details of the service;

iv. **UDDI**: The Universal Description, Discovery, and Integration specification provides a common set of SOAP APIs that enable the implementation of a service broker. The UDDI specification was outlined by IBM, Microsoft to help facilitate the creation, description, discovery, and integration of Web-based services and

v. **Wireless communication**: In fact, for a web application, the XML/SOAP, UDDI and WSDL are enough for a web application implementation. But if there is a need to use this kind of Service oriented architecture for mobile application, a wireless communication protocol is needed for connecting web application with mobile devices. Currently, there are several wireless communication protocols available, such like WAP (wireless application protocol).

WAP has a relative closer relationship with W3C. WAP protocol is the leading standard for information services on wireless terminals like digital mobile phones. WML is used to create pages that can be displayed in a WAP browser. By using WAP and WML, it enables the conversion of HTML pages to pocket format, so that the information can be accessed from devices like mobile WAP Phones.

2.3 Web services programming stack

We now look at how the layers of the web services programming stack facilitate the use of SOA to provide web services. Figure 2.3 shows the web service programming stack as a collection of standardised protocols and application programming interfaces (APIs) that lets individuals and applications locate and utilise Web services. Prominent at each layer in the stack is the standardization of simple, open protocols and APIs. This standardisation is the key to the ubiquitous deployment of service oriented architectures, and the ubiquitous deployment of the infrastructure is the key to

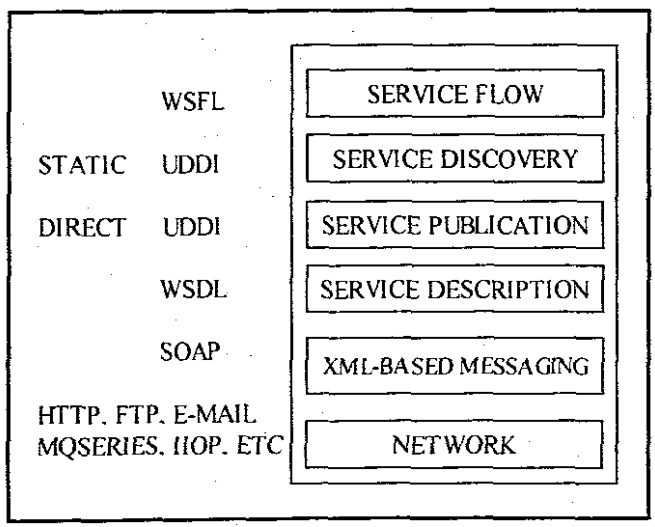


Figure 2.3: Web service programming stack

the network effect of Web services adoption. The network is the foundation layer for the Web services programming stack. All Web services must be available over some network. The network is often based on an HTTP protocol, but other kinds of network protocols, such as the Internet Inter-ORB Protocol (IIOP) or the IBM MQSeries, FTP are also used [16].

On top of the networking layer is an XML-based messaging layer that facilitates communications between Web services and their clients. The messaging layer is based on SOAP. SOAP is an XML protocol that facilitates *publish, find, bind,* and invoke operations described previously [17]. WSDL is a specification that describes available Web services to clients. These descriptions take the form of XML documents for the programming interface and location of Web services [18]. The three layers described thus far are required in order to have interoperable Web services. These layers also create a low-cost entry for leveraging Web services by allowing these services to be deployed over the Internet. The remaining layers in the programming stack are used as business needs require them [13].

Publication of a service is basically any action by the service provider that makes the WSDL document available to a potential service requester. Sending the WSDL (or a URL pointer to the WSDL) as an e-mail to a developer is considered to be publishing. Publishing is also advertising the WSDL in a UDDI registry for many developers or executing services to find [19]. Likewise, the discovery of a service is any action that gives the service requester access to the WSDL for a service. The action may be as simple as accessing a file or URL containing the WSDL or as complex as querying a UDDI registry and using the WSDL file(s) to select one of many potential services. The service flow layer of the stack facilitates the composition of Web services into workflows and the representation of this aggregation of Web services as a higher-level Web service. The standardization activity at this level is ongoing, but IBM has produced the Web Services Flow Language (WSFL) as its input to the

standardisation process [20]. In order for a Web services application to meet the stringent demands of today's e-businesses, enterprise-class infrastructure must be supplied, including security, management, and quality-of-service management. [14].

2.5 The proposed system model

This research proposes a layered architectural framework for the South African national park system developed using both service-oriented architecture and web service technology as foundation. The proposed architectural framework is designed with the national park system domain in mind. The main aim is to *create an architectural framework for use in developing distributed system*, which ensures access to information in the national parks system by means of web services. Two principal components (namely, User profile management and Information retrieval management) have been selected to demonstrate how services are encapsulated in the architectural framework.

2.6 Justification for adopting web service technology

The challenges facing the national park system can indeed be overcome through the use of web service technology. Any web service can be accessed *by any other application regardless of either's language or platform*. Web services communicate using XML and web protocols, which are pervasive, work both internally and across the Internet, and support heterogeneous interoperability. The growing effect of these technologies is the fundamental change in how we now think about distributed computing [30]. Prior to SOAP,

doing distributed computing interaction meant choosing from other technologies apart from web services such as JINI, CORBA or DCOM, which enable communication between distributed software to take place and can in principle be used for the implementation of services. While these technologies are still in wide spread use today, their primary drawback is that they limit the potential reach of the enterprises to the network nodes that share the same infrastructure [30]. With SOAP, however, the potential space of interconnection is the entire web itself. Most of the other technologies as mentioned were not explicitly developed for web communication whilst web services are based on standardized web protocols and enable communication generally via HTTP.

JINI is based on the JAVA programming language, which is platform independent. However, its language dependency constitutes its major drawback because each object that wants to use JINI service must be implemented in JAVA.

CORBA relies on a protocol called the Internet Inter-ORB Protocol **(IIOP)** for remoting objects. Everything in the CORBA architecture depends on an Object Request Broker **(ORB)**. The ORB acts as a central Object Bus over which each CORBA object interacts transparently with other CORBA objects located either locally or remotely. Each CORBA server object has an interface and exposes a set of methods. To request a service, a CORBA client acquires an object reference to a CORBA server object. The client can now make method calls on the object reference as if the CORBA server object resided in the client's

address space. The ORB is responsible for finding a CORBA object's implementation, preparing it to receive requests, communicate requests to it and carry the reply back to the client. Problems relating to the communication of services may arise with CORBA at run-time. If at some point the ORB is not available for use then communication cannot take place. In contrast, web services communicate either directly with each other or applications communicate with web services [28].

DCOM is an extension of "Component Object Model", **COM**. It supports remoting objects by running on a protocol called Object Remote Procedure Call, ORPC. This ORPC layer is built on top of Distributed Component Environment's RPC and interacts with COM's run-time services. Objects that want to communicate via DCOM have to fulfill a certain binary format that is specified by COM. All programming languages that support that binary format can be used to implement components and applications (e.g. VB, Visual C++ or J++) [28]. However, that format is not supported by all programming languages. Web services are, on the other hand, not dependent on the programming language used.

CHAPTER THREE

3.0 ARCHITECTURAL FRAMEWORK ANALYSIS AND DESIGN

3.1 Introduction

A framework is a set of prefabricated software building blocks that programmers can use, extend, or customize to suit their application [21]. It is an object oriented reuse mechanism that allows the developer to decompose an application into a set of interacting objects. The framework describes the interfaces implemented by the framework components, the flow of control between these components, and the contracts between the components and the system. In this way the framework is a reusable design. The standard interfaces and interactions make it possible to mix and match existing components and create a wide variety of systems from a core set of components. With frameworks, developers do not have to start from scratch each time they build an application. The inherent flexibility enables the rapid creation and deployment of software solutions in a constantly evolving business environment.

A common framework identifies specific functions that need to be addressed in order to achieve decentralised interoperability. It does not determine the particular technologies used to fulfill the functions but rather divides the problem space into sub-problems with specified relationships. Thus functional decomposition allows differing solutions to sub-problems without overlaps, conflicts or omitted functionality. This is not to say that all applications must

offer the same facilities, rather that when a feature is offered it should fit into a common framework and preferably have a standard expression.

Conversely, without a common framework and coordinated development of each component, one almost certainly produces overlaps, which are likely to make implementations more complex and decrease the probability of achieving interoperability. The lack a common framework also forces developers to guess how various components work in concert. This guessing leads to poor interoperability and fragility. The framework also allows the development and adoption of the individual components to happen in parallel and asynchronously. This has the added benefit of enabling critical pieces to be completed sooner than others, thereby allowing implementations to proceed. As new components or modules are completed, they can be applied later, as desired. It is crucial that these mechanisms remain orthogonal so they can evolve without having to change the whole system. Finally, a framework supports selections of subsets of components to provide specific levels of service that scenarios require. It has been mentioned already that the SOA model featuring the concept of subscribe and unsubscribe services will be adopted. Several tasks in the design and implementation process, using UML-based pattern [34], have been identified which include:

i. Identification of the specific domain to which the framework will apply;

ii. Determining the key use cases the framework will support;

iii. Identification of known set of actors associated with the framework and

iv. Design the key interfaces and components of the framework, mapping roles and actors into interfaces

The preceding tasks for designing and implementing the framework produce artifacts to consider when packaging a framework as shown in the next section. Section 3.2 presents the national park system requirements based on current technology. Section 3.3 describes the specific domain to which our framework will apply. The key uses cases that will be supported by the framework are the subject of discussion in section 3.5.

3.2 National Parks Requirements

In order to increase the local and international tourists visiting the parks and also to forge strong linkages with stakeholders in the tourism industry, SANPARK need to develop channels and mechanism of providing tourism information relevant to the needs of all the stakeholders.

Tourists' awareness is a key strategy to raising the number of tourist visits to a destination as well as satisfying tourists' visits by providing various choices. The national parks should develop information systems that can create awareness and disseminate information regarding the quality of their services and destinations' attractions. The national parks should take advantage of the potential of Information and Communication Technologies (ICTs), such as the Internet, websites and Intranet to provide responsive content of tourism information.

The Internet provides unprecedented advantages over the other media. It provides the cheapest means of reaching a big number of audiences, and covers wide geographical area (Bahta 2002). It enables companies of different sizes to compete on equal terms. Unlike media advertising, promotion of tourist destination on the Internet does not depend so much on the amount spent as the other media do. But people want access to service anytime and anywhere which the current infrastructure can not do. It should also be taken into consideration that other people can not perfectly use the websites to locate services they need in a speed of light. National parks users' behavior is changing with technology advances. People are looking for easy and portable terminals for access to an on-line system capable of offering information relevant to user' preferences in a user friendly way. SANPARK need a system that will allow the service suppliers to make known the services they are providing to all prospective customers and an ICT infrastructure that will make it possible for customers to quickly discover those services. This means that the system will need to allow customers to use their mobile devices to locate and access services in a cost-effective manner and very simply.

SANPARK, therefore, need a mobile information service system that will allow researchers/tourists to quickly discover services of their interest. For an example, the system should allow the botanist to quickly find a park that conserves the plant of his interest for research purposes using a mobile device and furthermore give the botanist the location of that particular park. SANPARK need an ICT infrastructure that will let all national parks to render services in a common fashion. The mobile information service system requirements are to be

realized subject to quality attributes grouped under Performance, Revision and Transition as described next:

Performance

This addresses the overall performance of the system.

i. **Correctness** – Identifies the degree to which the system should meet its specification and fulfils user requirements;

ii. **Reliability** – Identifies the degree to which the system should execute its intended functions with accuracy;

iii. **Usability** – Identifies the ease of learning and the use of the system to enter input, process and generate output;

iv. **Integrity** – Identifies the degree to which access to the system or data, by unauthorised persons, and security controls, can be managed and

v. **Efficiency** – Identifies the amount of computing resources and programming code that is required to implement the system.

Revision

This addresses changeability, which identifies the system's ability to change its functionality.

i. **Maintainability** – Identifies the ease with which errors can be located and corrected in a program or system. This also extends to errors that may be encountered during environmental changes and enhancements that may arise from changes in user requirements;

ii. **Flexibility** – Identifies the ease with which modifications can take place to the system, through the adding or adjustments made to system functions;

iii. **Testability** – Identifies the ease with which a program or the system may be tested in order to determine whether it will perform its intended *functions and*

iv. **Scalability** - the ease with which a system or component can be modified to fit the problem area

Transition

This addresses the system's adaptability to new environments.

i. **Reusability** – Identifies the degree to which the system components may be used in other systems and

ii. **Interoperability** – Identifies the ease with which the system may interface with another system.

3.3 Domain analysis

The reuse of software components has received considerable attention as a method to improve quality and development productivity. But there is growing consensus that providing a library of source code is insufficient to support reuse [22, 23, 24]. The key to successful reuse lies more in understanding and defining the application domain for a collection of components [22, 25]. Recognizing the importance of domain knowledge to development process, domain analysis techniques have been designed to systematically identify objects and relationships of a class of systems [26, 27]. The central issue is

identifying what constitutes the domain – what should and should not be included in the domain.

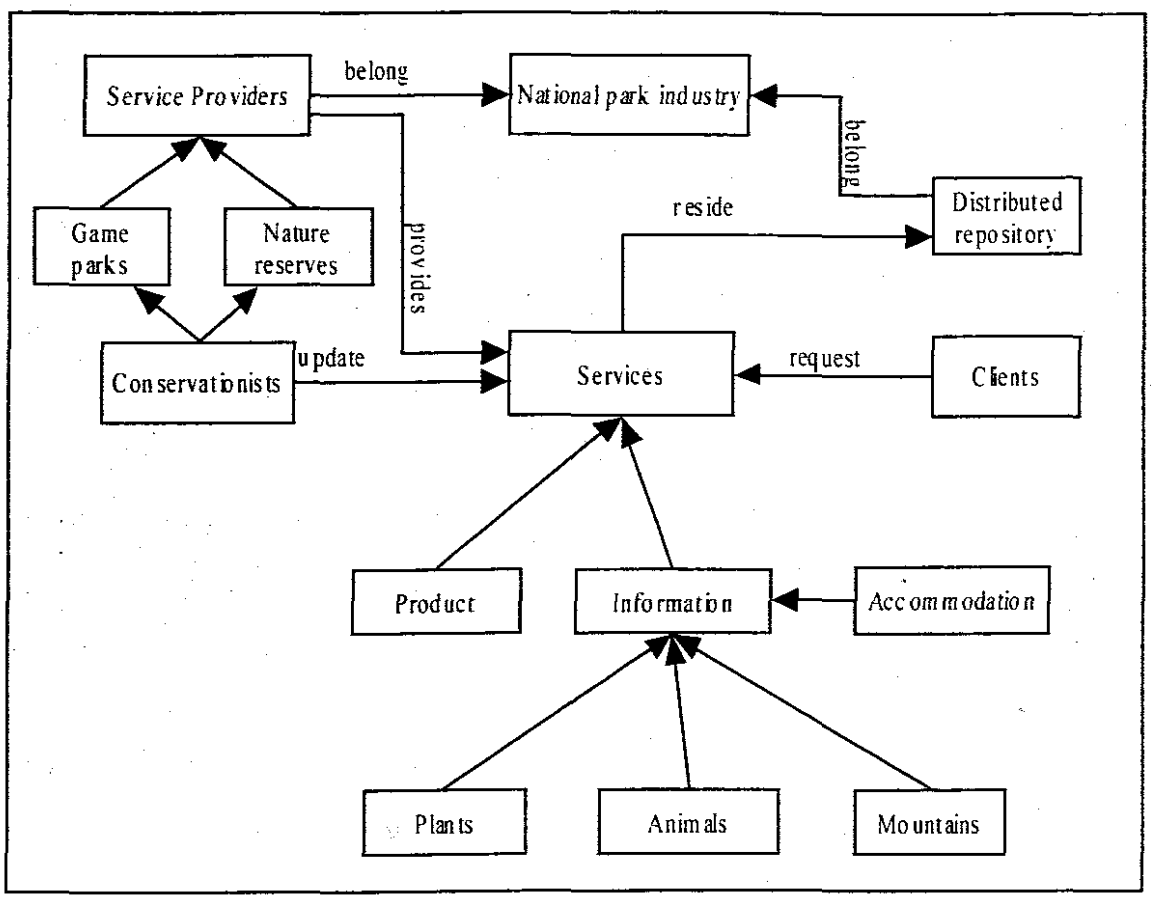


Figure 3.1: National park service-based conceptual model

Figure 3.1 depicts the national park conceptual model which gives an understanding of the national park domain. This conceptual model is as a result of the study we conducted to investigate the provision of national park's information via Information and Communication Technologies in KwaZulu-Natal province. The study targeted tourists who visited the Royal Natal National Park between the 5th and 13th of April 2004. It was necessary to carry out the study during this period because it was during Easter Holidays and many tourists

from various parts of the world were expected to visit the park. The study targeted 51 tourists and 5 key informants who are staff working at the Royal Natal national Park and KwaZulu-Natal Wildlife Department.

A survey method was employed to conduct the study. A self-completed questionnaire was used to solicit information from tourists, while an interview schedule was utilized collect data from the key informants. The two main data collection instruments were supplemented by observations and document review. This park's business is focusing on plants, animals (though not dangerous animals), mountains (especially for hikers) and has camps as accommodation facilities for visitors. But, most importantly, these business services are not known to the public.

The respondents were asked to state the measures that could be taken to improve the provision of information and services in national parks in South Africa. This question received varied views but with the help of the content analysis method, the views were grouped according to similar phrases and summarized. The following summarizes the envisaged national park system with regards to national park system analysis:

i. More aggressive marketing and partnership among the national parks;
ii. More linkage and collaboration between the national parks, hotel industry and tour agents and
iii. Make information about national parks more accessible through networks, websites and other media;

The influences mentioned above are the corner stones of the development of national park service-based architecture, but all these require a relevant concept so that they can be a reality which suggested a conceptual modeling. Since this section deals with conceptual modeling, essential concepts and constraints are identified, analyzed and described using a modeling language. We used the Unified Modeling language in developing our conceptual model. The elements in the model (boxes) represent the objects identified in the national park domain as most of national parks provide related or similar services. Relationships between objects have been described to capture the relations between them. Clients represent both researchers and tourists who need services. This conceptual model also gives an idea of what kind of services are at the center of national park business. These services need well-defined business model to be known and accessed anytime and anywhere. Service-orientation provides an answer to this challenge.

3.4 Design of services

A service-based architectural framework is founded on a component based architectural concept. Services widen the scope of the components and can be characterised as follows:

i. They are registered in the service registry. This entails telling the network how services can be located and what kind of functions they can offer and

ii. They support loosely coupled connections. By registering various services in the service registry, it is possible to start several services

with the same function. Therefore, scaling can be significantly increased because the burden has been distributed among services which are similar to each other.

In contrast to components where the connections required have to be determined during planning stages, services, have to be technically capable of not only looking for and connecting with other services, but also be able to use the functions which are on offer when they go into operation [28]. This requires a more detailed description of interfaces and the order in which the services will be combined. There are two components that encapsulate the national park system services, namely:

(i). *Customer Profile Component* – which stores and manages user profiles and enables the user to define his preferences and

(ii). *Information Retrieval Component* – which manages the information to be requested by the service requesters (e.g. plant information, animal information, mountain information and national park names).

We show the component interaction using the Unified Modeling language sequence diagrams in the next section.

3.5 Standard service use cases

In this section we outline the three key use cases adopted from the service-oriented architecture to implement our architectural framework. A use case is a textual description of a sequence of interactions between an actor (roughly corresponding to an external agent or class of users) and the

system we are designing. Use cases were first described by Ivar Jacobson in his book "Object Oriented Software Engineering, A Use Case Driven Approach." Jacobson, however, made the keen observation that use cases can be treated as refineable, extensible and even reusable specifications of system requirements [31]. Use cases are a considerably powerful modeling concept, if one has knowledge of how to effectively build them. What sounds good in theory needs to be practically applied within a basic system development framework.

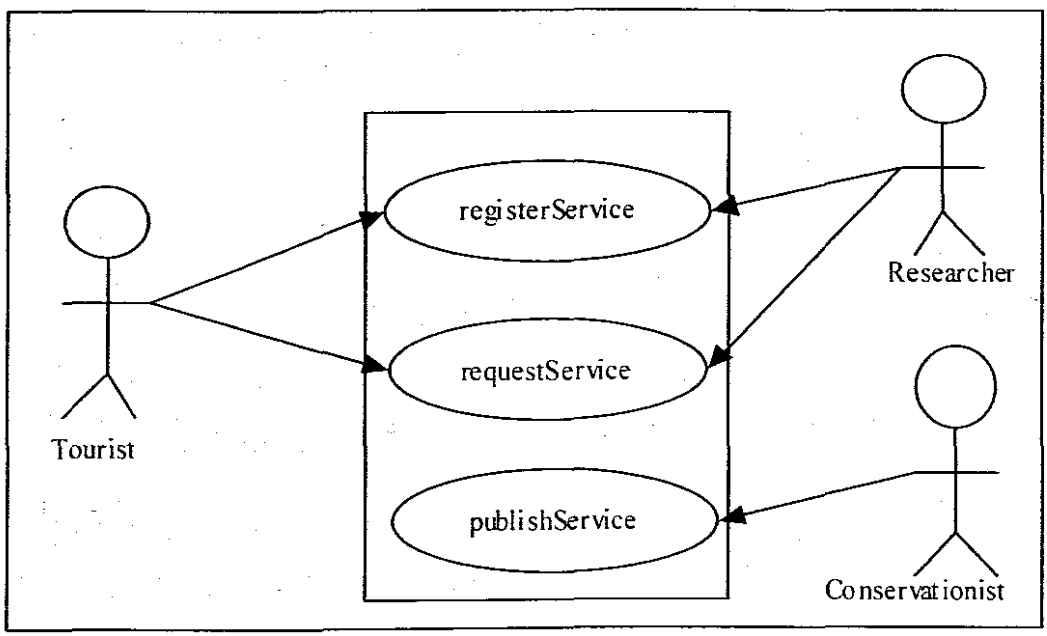


Figure 3.2: General national parks service use cases

The description of the use cases is merely done to determine the scope of the application. The use cases and the actors interacting in the framework are presented in the form of a use case diagram as shown if figure 3.2.

The use case diagram above encapsulate the key actors namely, the conservationist who is representing the national park as a service provider and Thus both the researcher and tourist represent the service requesters. The following section looks at the use case scenarios as suggested by the above use case diagram which abstract the behavior of the web service based national park system the developers must take into cognisance when using this framework. From these key use cases, we have identified use cases associated with them necessary to design the national park system as presented below:

(i). Publish service – associated with Add New Service and Update Service;

(ii). Register service – associated with Subscribe, Set Profile, Sign In and

(iii). Request service – associated with Retrieve Plant Information, Retrieve Animal Information, Retrieve Mountain Information, Get Park Names.

3.5.1 Publishing a national park service

UDDI allows the service providers (conservationists) to register and publish the services they are providing in a specific national park. Services provided in the national park range from providing information on among other things: plants and animals conserved and also mountains available in certain parks. Publishing the plants information service is necessary for researchers like botanists who are interested in that information for academic and research purposes, whereas the mountain information service would be merely provided for an example, tourists who have an interest in hiking. The UDDI as introduced in chapter two, provides data structures which are a business entity,

a business service, a binding template, a publisher assertion and a technical model.

In the *business entity* section, the service provider (conservationist) gives information about a specific national park (name) and description of their business.

In the *business service* section, the conservationist gives a categorized set of services provided by that specific national park. When it comes to the binding template, the conservationist provides a technical description of a service e.g. access point for the park that provides the service in the form of a URL, phone numbers, email address etc.

In the *technical model* section, the conservationist should provide specific information about how to interact with the service. It consists of a name and URL elements point to a location where information can be found about a particular model. And lastly in the publisher assertion, the conservationist provides information about the relationship with other services.

3.5.2 Registering a Service

This operation pertains to the process of registering a new user (Subscriber) in the system. The Subscriber represents both researchers and tourists who use the system for the first time. The Subscriber uses the graphical user interface provided in the national park system to define his /her profile. In the process of defining the user profile, the Subscriber provides his personal details (name, cell number, e-mail address etc) and preferences (plants, animals, mountains etc) so the system can be in a position to identify and authenticate him/her

when needing to access services. For cell phone users, the system should use the cell number as the username and allow the subscriber to create his/her own password. The subscription and provision of preferences make it easier for the system to present the user with relevant interfaces for easy access to services of their interest. Figure 3.2 presents the process in the form of a sequence diagram.

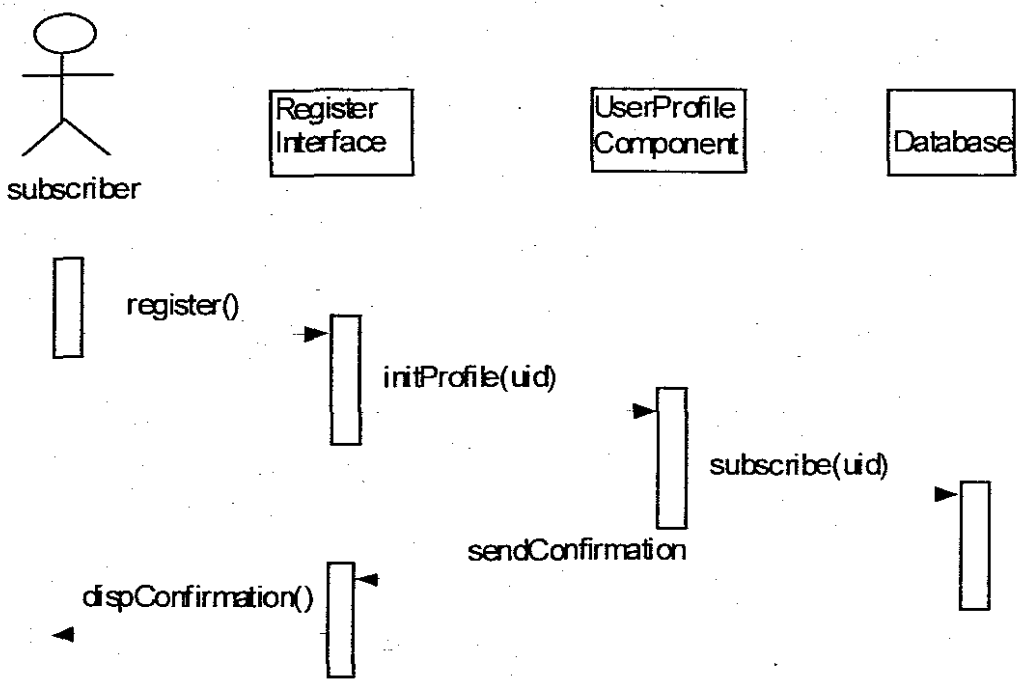


Figure 3.3: Register service use case

3.5.3 Requesting a Service

The user (Researcher or Tourist) uses the national park system URL to activate or access the information service. The system must then firstly authenticate the user to verify whether he is subscribed or unsubscribed so that the system can present him/her with the relevant service interface. If the user is subscribed, the system should present to him/her the service interface

relevant to his/her area of interest e.g. a subscribed botanist should be provided with a plant service interface. The system then gives him/her an option to enter the name of the plant he/she is looking for and after the system has processed the request operation, it should then present the specific national parks URLs where that particular plant is conserved. Figure 3.4 depicts the process in the form of a sequence diagram.

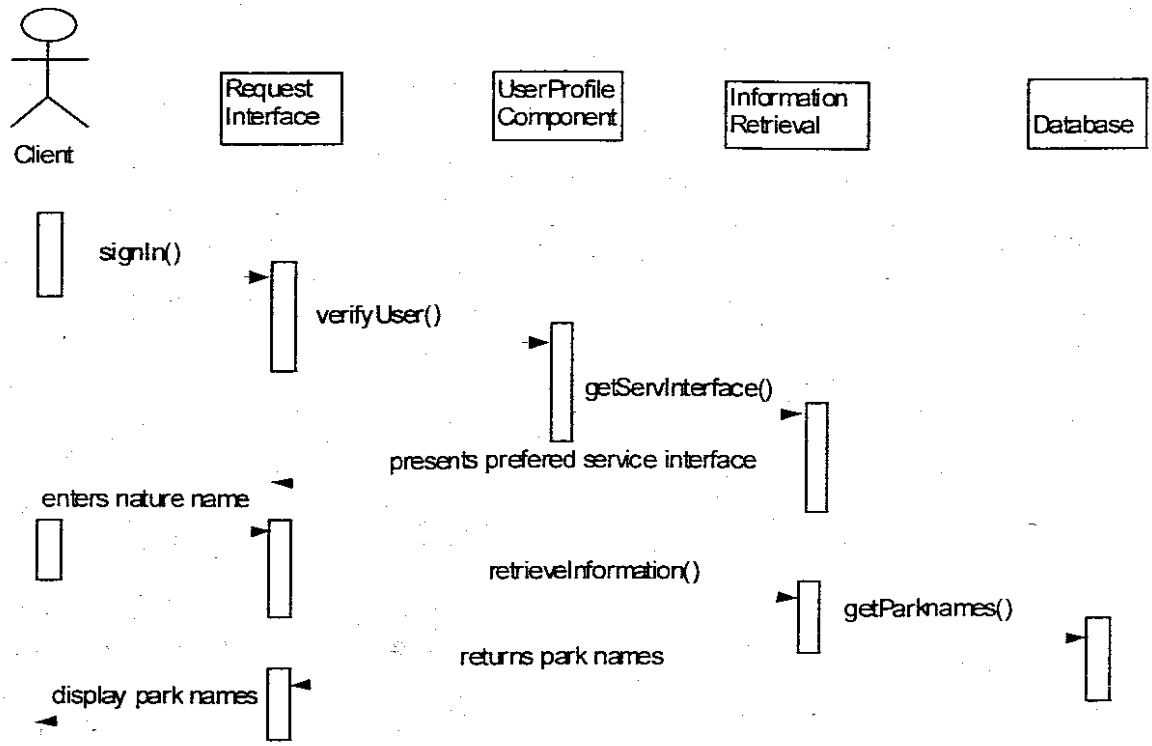


Figure 3.4: Request service use case

The two sequence diagrams presented above informed the use of the service access model developed from [6] depicted in figure 3.5 which diagrammatically illustrates the service access process undertaken by the service requester in order to access the service.

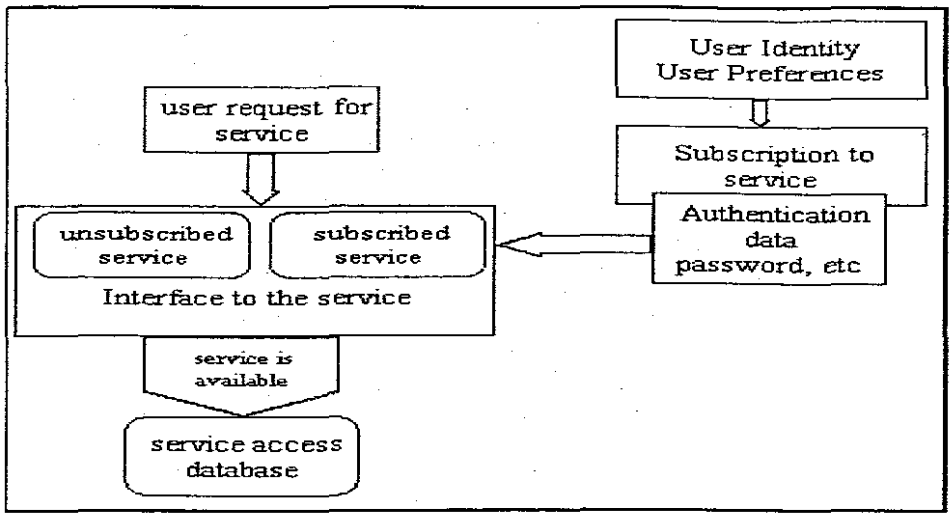


Figure 3.5: Service access model

To create a working environment which consists of various services, clearly defined guidelines on access are required in order to protect data from being tampered with or information sent to unauthorized destinations. The user may first examine the offered service(s), possibly by directing a request for a limited amount of additional information to the vendor, then defining the service details and checking the availability of the desired service. These steps can be performed without any identification of the user, since they are only "informative". Registration is useful to perform a preliminary user profiling (so that the interaction during the service access is limited) and/or limit the access of users that are not really interested in the service. The interface must be designed in a personal and flexible manner so that the user interfaces of certain services can be combined and presented according to personal preferences. The user can then start using the system according to own preferences and needs.

3.6 System design

A system is an organized set of communicating parts designed for a specific purpose. Parts of a system can in turn be considered as simpler systems called subsystems. Many systems are made of numerous subsystems interconnected in a complicated way, often so complex that no single developer can manage its entirety. Modeling is a means for dealing with this complexity as it has been demonstrated already in figure 3.1. The final goal is to provide a product tailored to the individual user's needs. Resulting from the above expectation, the national park system architecture decides on certain services which can be deemed necessary in a distributed national park service-oriented system. The system design deals more specifically with information retrieval component as presented in the next subsection.

3.6.1 Subsystem design

We have used the Mediator pattern for defining an interface for communication between objects and Façade pattern to provide a unified interface to a set of interfaces in a subsystem. In figure 3.6, Information Retrieval Management system acts as a Façade which glues together classes that implement retrieval functionality. The subsystem contains classes such as retrieve plants information, retrieve animals' information, retrieve mountains information and accommodation information. Looking at the envisaged national park business service, one can identify services which are provided by a system. Figure 3.6 models the structure of the system with objects showing attributes and operations specifically for retrieving information. The model specifies that a

researcher needs to subscribe to be known in the system through the creation of his/her profile and the information retrieval component providing services through interfaces.

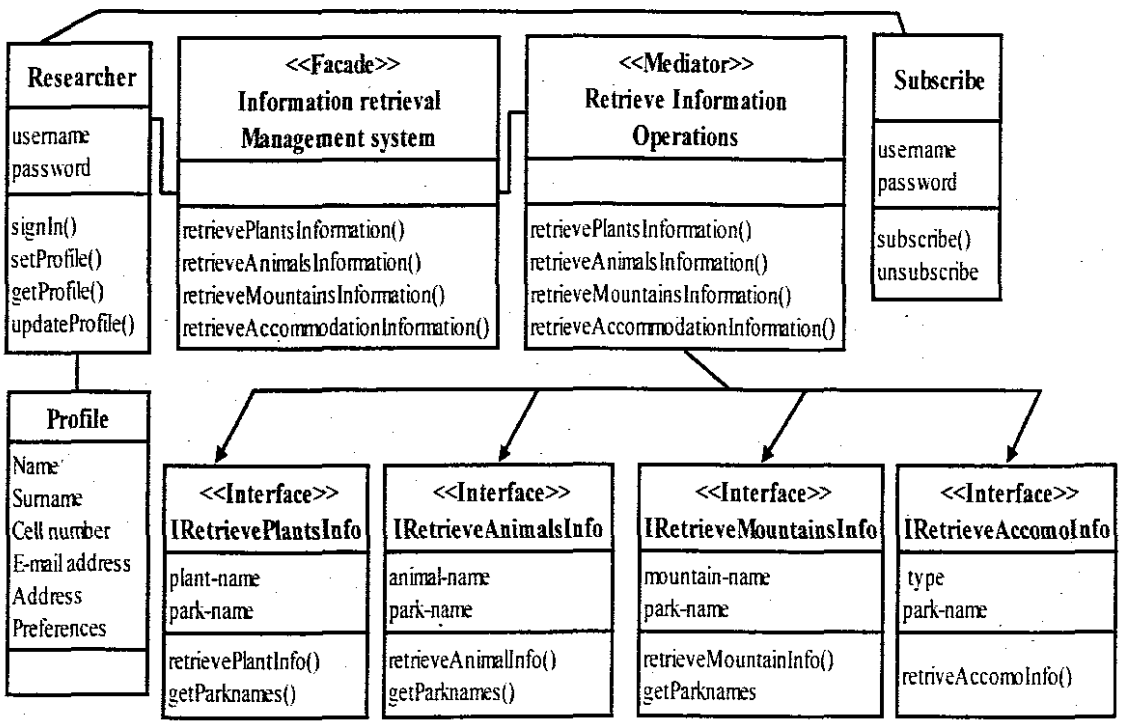


Figure 3.6: National Park Framework class diagram

The object "Researcher" in figure 3.6 represents both the Researcher and the Tourist whose usernames and passwords must be known in the system. The object "Subscribe" encapsulates subscribe service as an method necessary for profiling a Researcher, whereas the object "Profile" defines the mandatory attributes for profiling the Researcher. The mentioned objects constitute the User Profile Component through their methods. The method signIn must be performed after the researcher has fulfilled the requirements of becoming a

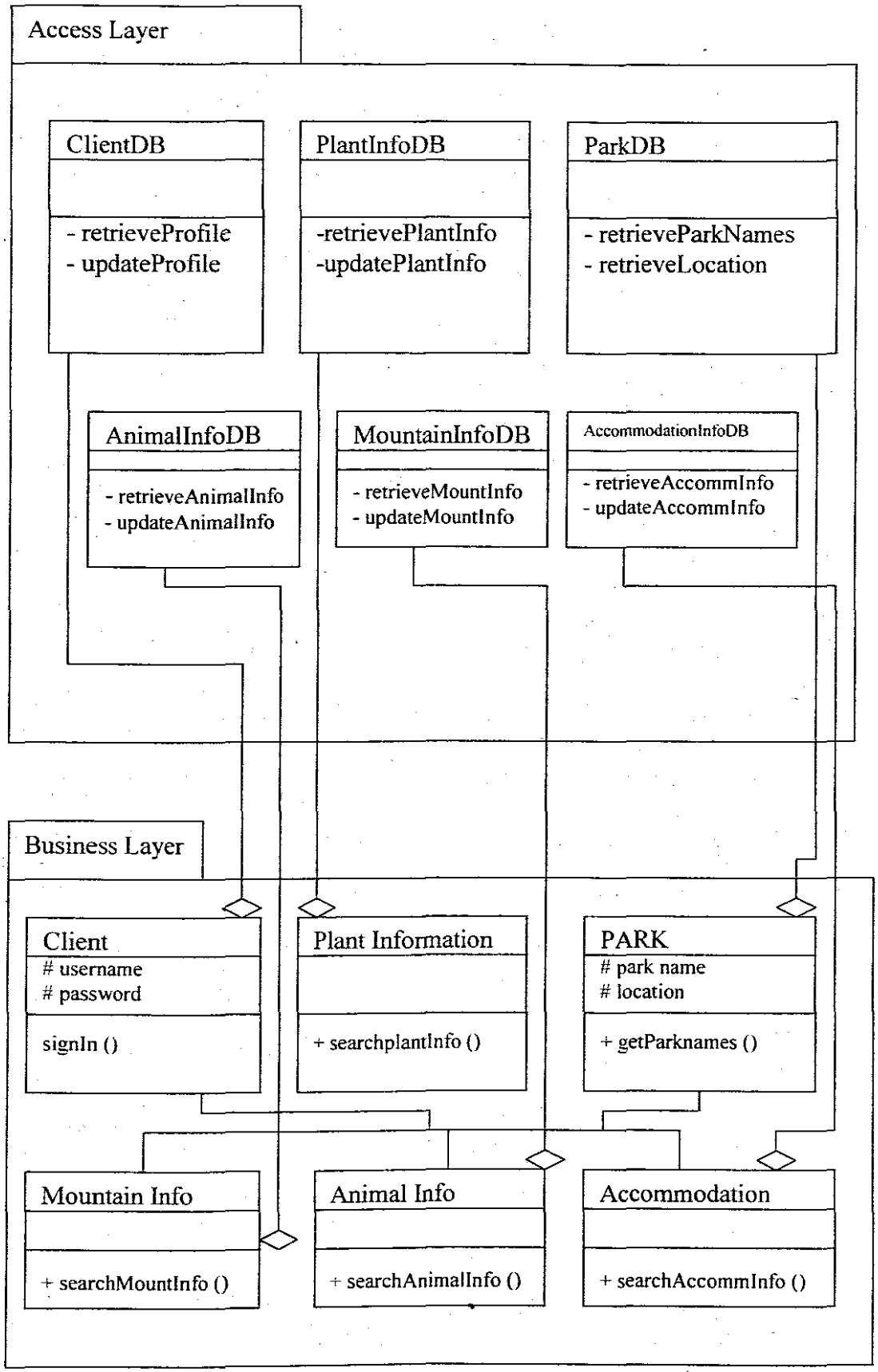
user of the system so he/she can be presented with relevant service interface from the Information Retrieval Management System.

The information retrieval management system is a component encapsulating service interfaces to be used to retrieve information about specific "nature" conserved in specific national parks. The information is to be retrieved using methods in each service interface. For an example, IRetrievePlantInfo must perform retrievePlantInformation and getParkNames as methods to identify specific national parks as service providers that conserve a particular plant defined in the query. The next section describes how the business Layer relates to access layer in the form of a data access model.

3.6.2 Data Access Model

Figure 3.7 conceptual describes how data-related requests are translated by the access layer from the business layer into appropriate protocol for data access. This allows the creation of set of classes that know how to communicate with the data source. This model outlines how the objects in figure 3.6 interacts and shows the relationships of the new access classes (e.g. ClientDB) with the Client business class. For an example, using the SQL, the *retrieveProfile* should return the attributes of the Client and *updateProfile* method changes attributes such as password, firstName or preferences. Figure 3.8 presents this in the form of architecture, because the business layer objects and presentation (view) layer objects should not directly access the database [36].

Figure 3.7: National Park System Data access Model



3.7 Service-based Architecture

The methods in figure 3.6 indicate most important aspects the developers must have in mind when developing national park information services using this framework. Figure 3.8 presents the web service-based national park architecture needed for implementation of a distributed national park information service system. This is due to the fact that a large number of clients who represents researchers and tourists in the architecture are expected to be looking for national park services. The adoption of service-oriented architecture is also spurred on by the benefits they bring to the developers. XML and the related tools and technologies used to create Web services help developers create small, task-specific applications with software "modules" that can be used and re-used [27]. This makes it easier for developers to develop efficient applications with the functionalities that address the needs of end-users.

The architecture in figure 3.5 is translated into three layers to illustrate the implementation of national park services with the aid of web services. The following sections look at what each layer contributes in the overall architecture, starting from the top layer, *presentation layer,* and describe each layer until the last layer at the bottom.

Presentation layer

This layer presents the integral part of national park services where the clients interact directly with the system through the specific browser based graphical user interface via a HTTP.

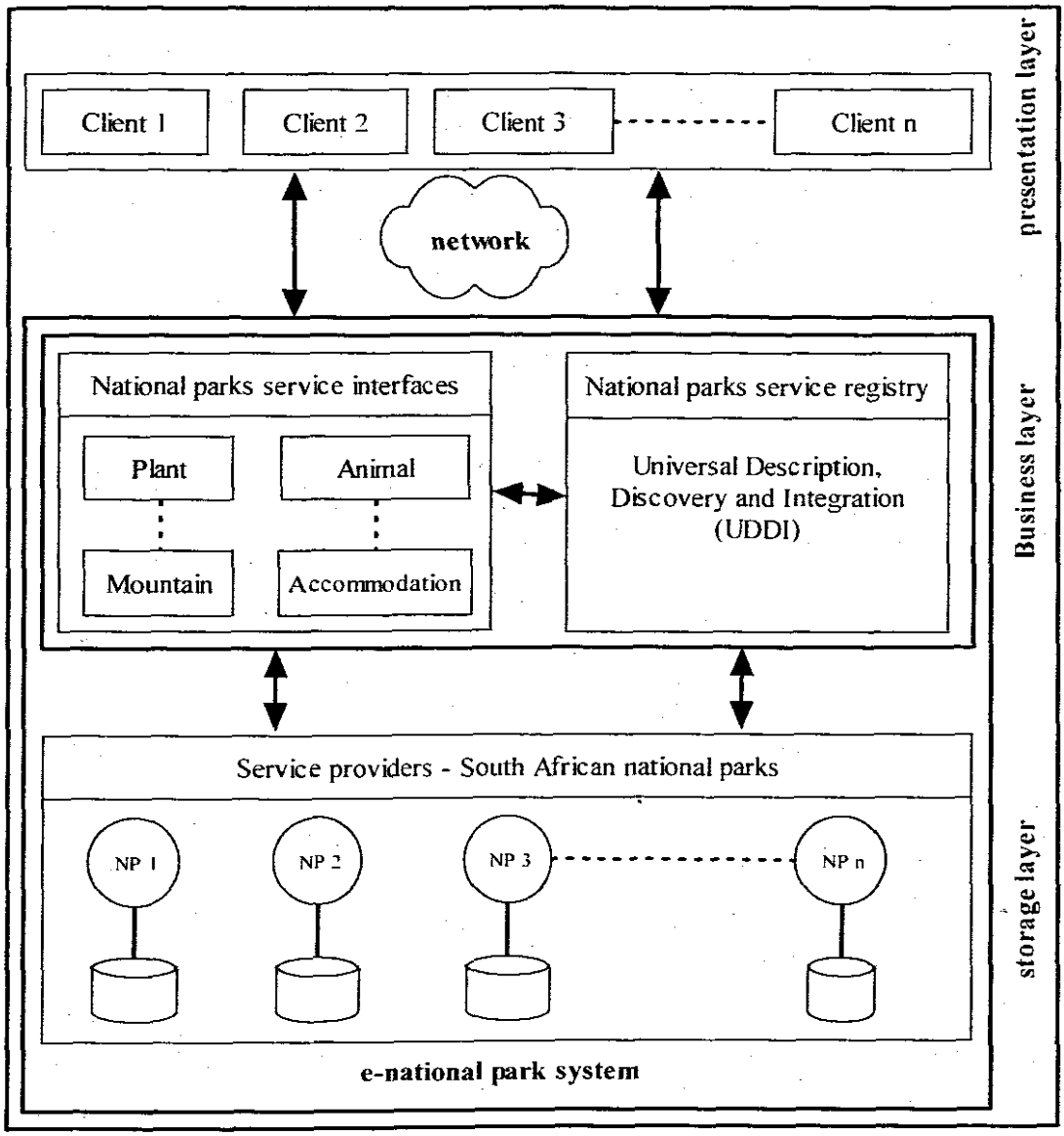


Figure 3.8: Web service-based national park system architecture

The layer presents the way interfaces define access to encapsulated system functions without giving an idea of how they are implemented. It accommodates both pc users and mobile device users to ensure equal access to services. The authentication and authorization of clients is encapsulated at

this layer through suitable XML elements in the SOAP messages that are exchanged between web services.

Business layer

This layer presents the national park service interfaces found /registered in the UDDI registry that are clearly defined in the WSDL document, other than web service such as user profiling, customer relationship management, user authentication, etc. The layer encapsulates among other things, processes such as described previously in section 3.5.1. UDDI registry can be replicated with the other to ensure availability of the registry at all times because the other will act as a back-up. The web services in the business layer communicate through SOAP to ensure secured application logic.

Storage layer

This layer presents the service providers (national parks) and local database that is based on their current ICT infrastructure. The information contained in these legacy systems should be made available to national parks web services. This means that a central database has to be accessed via a JDBC/ODBC as required. This can be done through implementing the legacy systems as new web services as mentioned in chapter one.

CHAPTER FOUR

4.0 IMPLEMENTATION OF THE NATIONAL PARK INFORMATION SERVICE SYSTEM

4.1 Introduction

This chapter presents the service-based national park information service system as a prototype built to prove the usability of the framework developed in chapter three. In software development, a prototype is a rudimentary working model of a product or information system, usually built for demonstration purposes or as part of the development process [29]. A national park information service system was developed as a prototype to prove that our framework described in chapter three can work for the South African national park system. This prototype does not incorporate most of the services provided in the national parks, but it demonstrate how the national parks users can request services and access information through services published by the providers that is relevant to their area of interest. This prototype was developed recognizing that the service-oriented architectural model does not limit the developer's specific usage of language/tools in the development process. Figure 4.1 depicts the developer's view of the web services, which played a major role in the decision made during the implementation of this prototype.

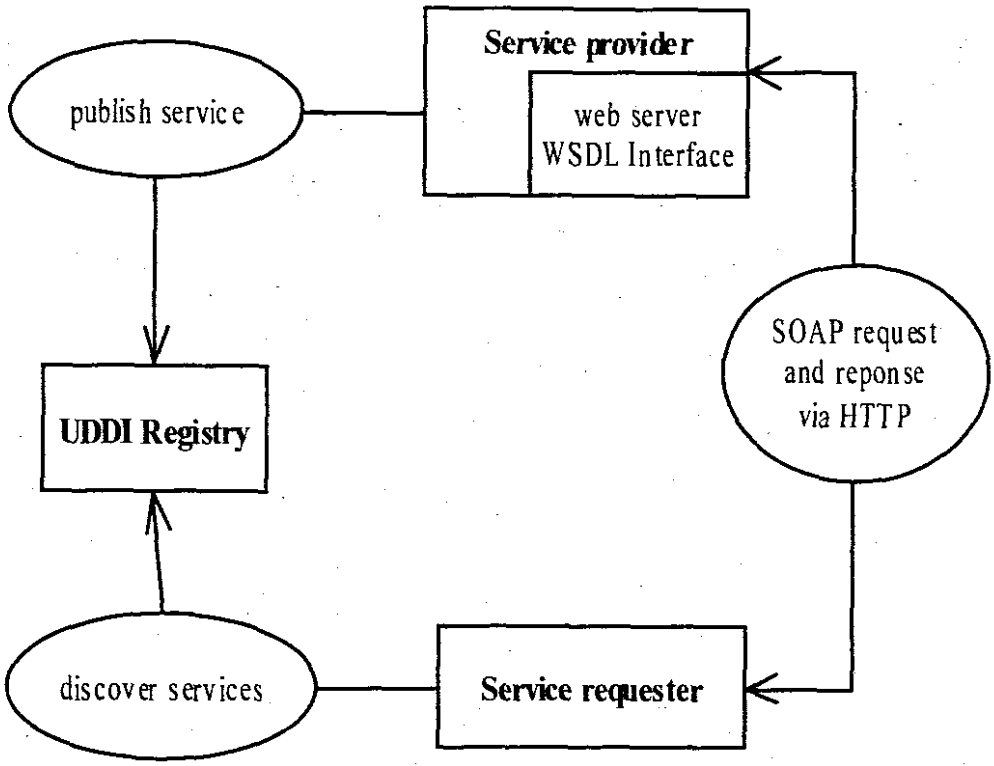


Figure 4.1: Developer's view to web service system

The next section outlines the reason why the JAVA servlets and Tomcat were adopted.

4.2 Implementation decisions

What are servlets? – Servlets can be compared to CGI programs which can also be written in Java, but Java servlets add additional functionality including security, dynamic loading from remote servers, and the ability to add the functionality to the web server. Unlike CGI programs, servlets are loaded once and then stay resident. Therefore, future calls to the servlets are faster since the servlets is already in memory. They have an advantage in that they are

able to maintain state information between service calls and servlets API are supported by most major web servers.

Servlets are server-side java programs that are loaded and run within the framework of a web server. They are often compared to Applets, which are client-side java programs that are loaded and run within the framework of a web browser. The servlets life-cycle is described below.

There are three phases of the servlet life-cycle which made it easy to implement this prototype, which are:

i. Initialization: accepts the configuration and initializes the state;

ii. Service: processes zero or more user requests and returns output, and

iii. Destruction: final preparations for shutdown and release of memory resources.

4.3 Implementation details

System implementation is the fourth phase of the systems development life cycle, in which the information system is programmed, tested, installed, and supported (web definition). The amount of services shown here is not by any means complete, but should be seen as a basic structure of the national park system with minimal functions. The system can be expanded with extra services to implement additional functions when necessary.

To implement the system prototype, the following was taken into major considerations:

i. System interoperability – meaning that the system can access and process data from multiple resources and

ii. Personalisation capability – which means that users will be able to define the way they want to obtain data and information that exactly match their own needs.

The next sections present how to access and retrieve information using this system. The publishing part of the services is dealt with later in this chapter. This is despite the fact that it has been assumed that the services have already been published in the UDDI registry.

4.3.1 User profile component

Figure 4.2 depicts the form used to profile each subscriber (Tourist or Researcher) who wants to use the national park information service system. The subscriber must also select his/her preference (Plant, Animal or Mountain) as a service that falls in his/her area of interest. The information entered is then saved to the central database and the user gets confirmation of the successful registration.

4.3.2 *Information retrieval component*

The researcher uses his/her mobile device to interact with the system. In that process, the system through the user login interface as depicted in figure 4.3, authenticates the researcher so he/she can be presented with the relevant service interface based on his/her preferences (e.g. plants).

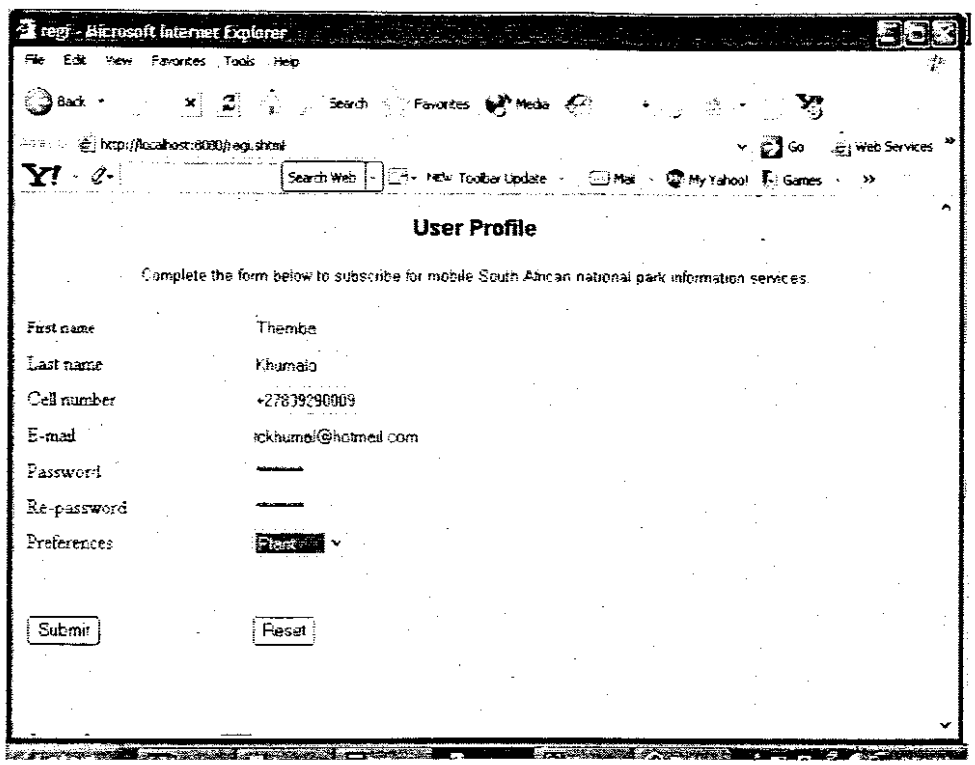


Figure 4.2: User Profiling Interface

This authentication service is the centre of all other services in the system in that it has to check if the user has a right to access or not. Having used java servlets, the system performs the method which authenticates the researcher and gives him/her the relevant service interface, which might be a plant service interface (if profile has plant service as a preference otherwise other service interface will be presented to the researcher). See appendix for the method.

The system then prompts the researcher to enter the name of the plant. Having entered the name of the plant, the system performs a query method to identify all the national parks that conserve that kind of a plant and presents them

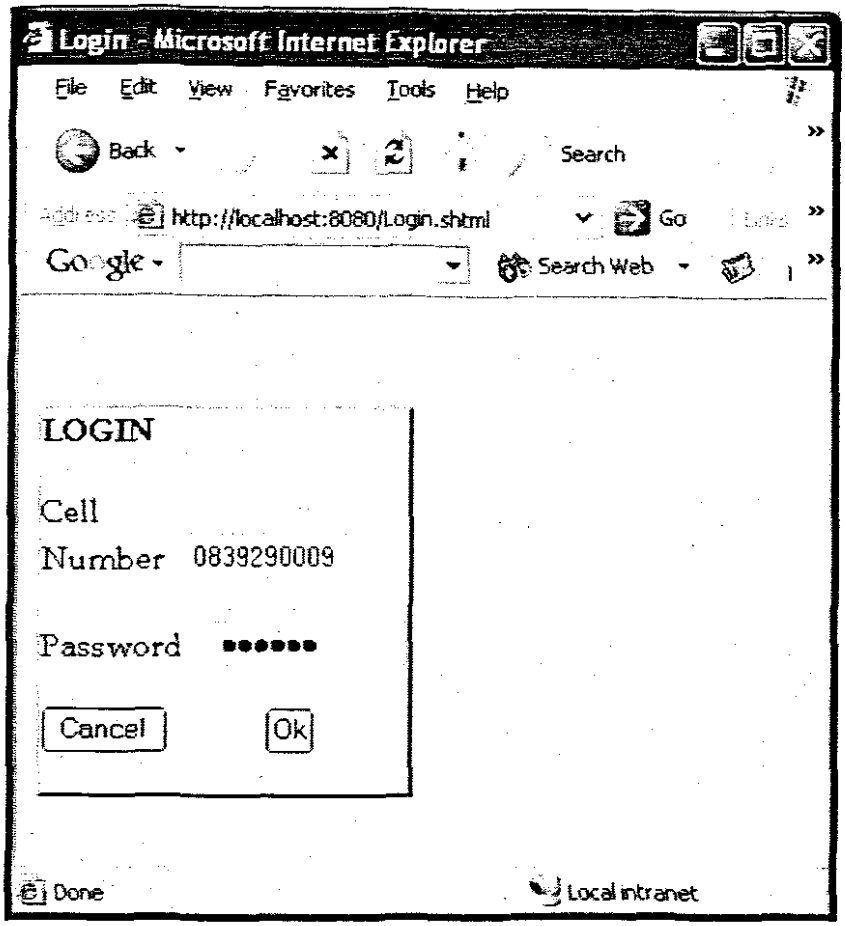


Figure 4.3: User Login Interface

as a response to the researcher in a form of URLs, so that the researcher can view more information (e.g. number of those plants in the park and park's location), the method in Appendix illustrates the query method which checks the parks conserving the plant. As demonstrated in figure 4.6, due to limitations posed by the size of mobile device screens, the system provides the location of the park and number of plants in that park as a text of not more than 160 characters. A central national park database was developed, which is accessed via JDBC/ODBC for storing and retrieval of data.

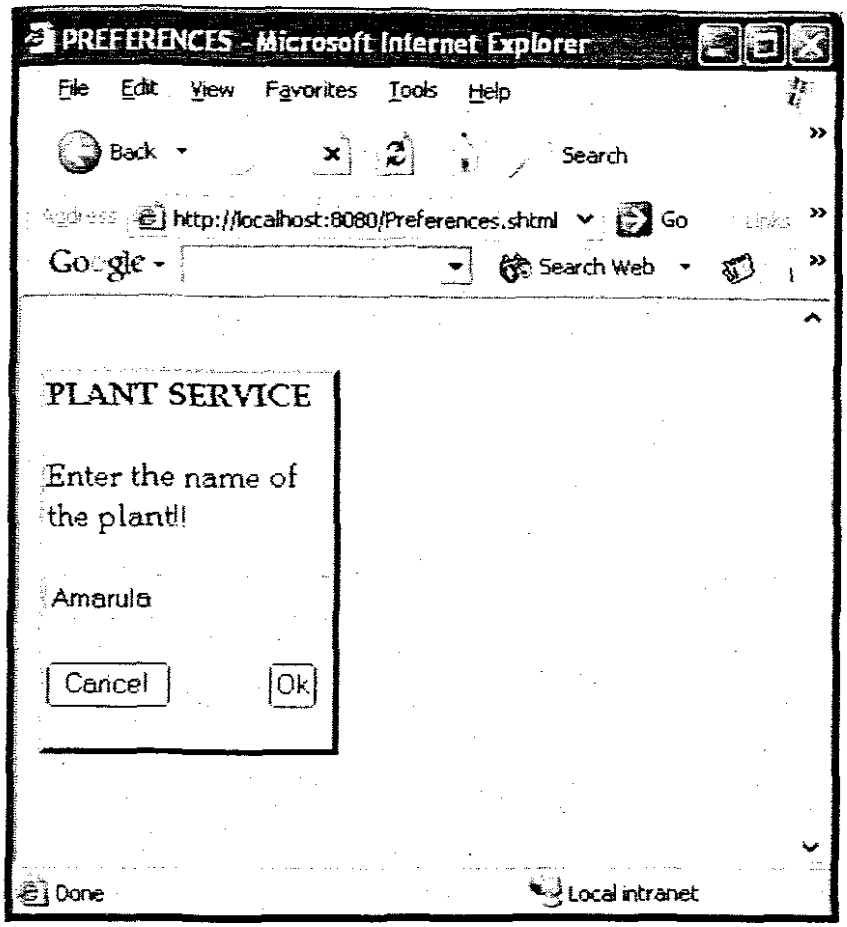


Figure 4.4: National park plant service interface

Figure 4.4 depicts the event where the researcher enters the name of the plant to be searched in the central database. The system performs an operation which identifies all the national parks that conserve the plant "Amarula" (see Appendix for the method).

Figure 4.5 presents the researcher with the national parks as service providers that conserve that particular plant. The researcher then has an option to choose from presented links for more details on plant "Amarula"

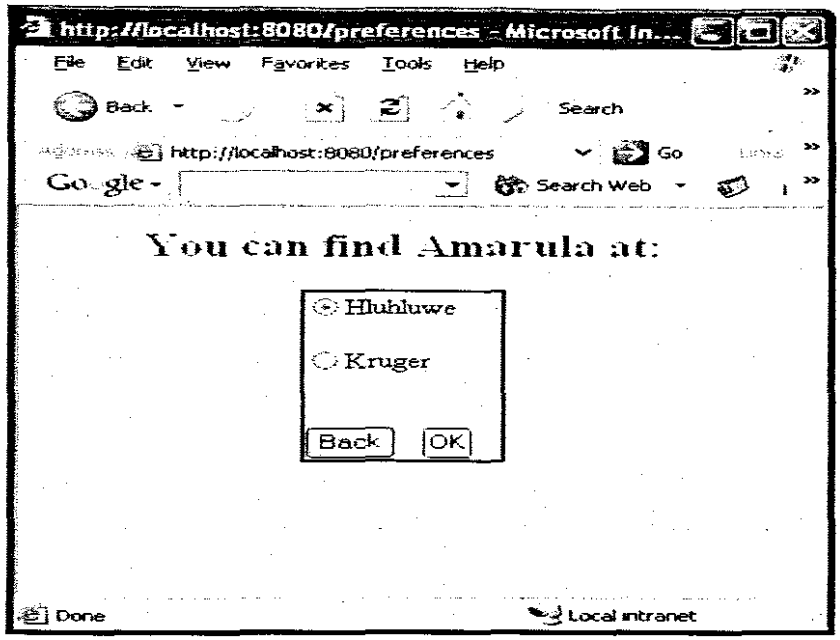


Figure 4.5: Plant service providers

If Hluhluwe is selected, then the system responds with the detailed information about the park and the specific plant which was searched as depicted in figure 4.6. This information will be able assist the researcher to plan his/her research trip because of the assurance of the availability of the plant he/she is interested in, which may involve third party services such as accommodation reservation systems.

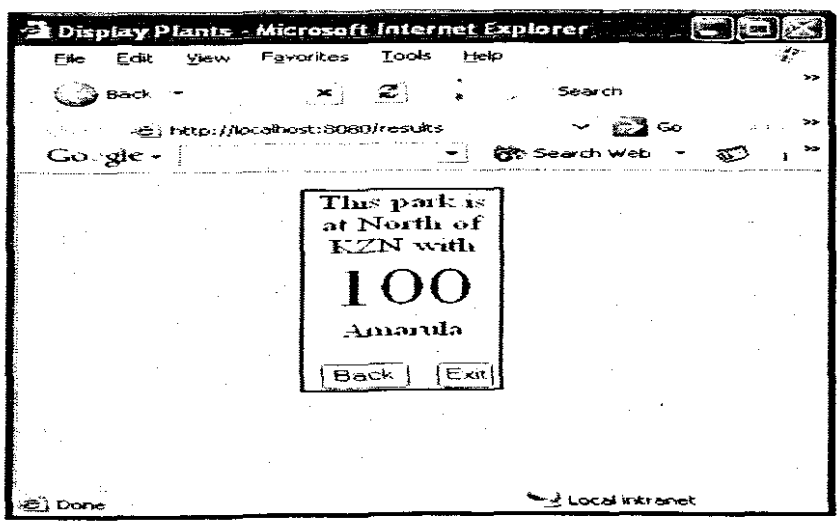


Figure 4.6: Park's detailed information

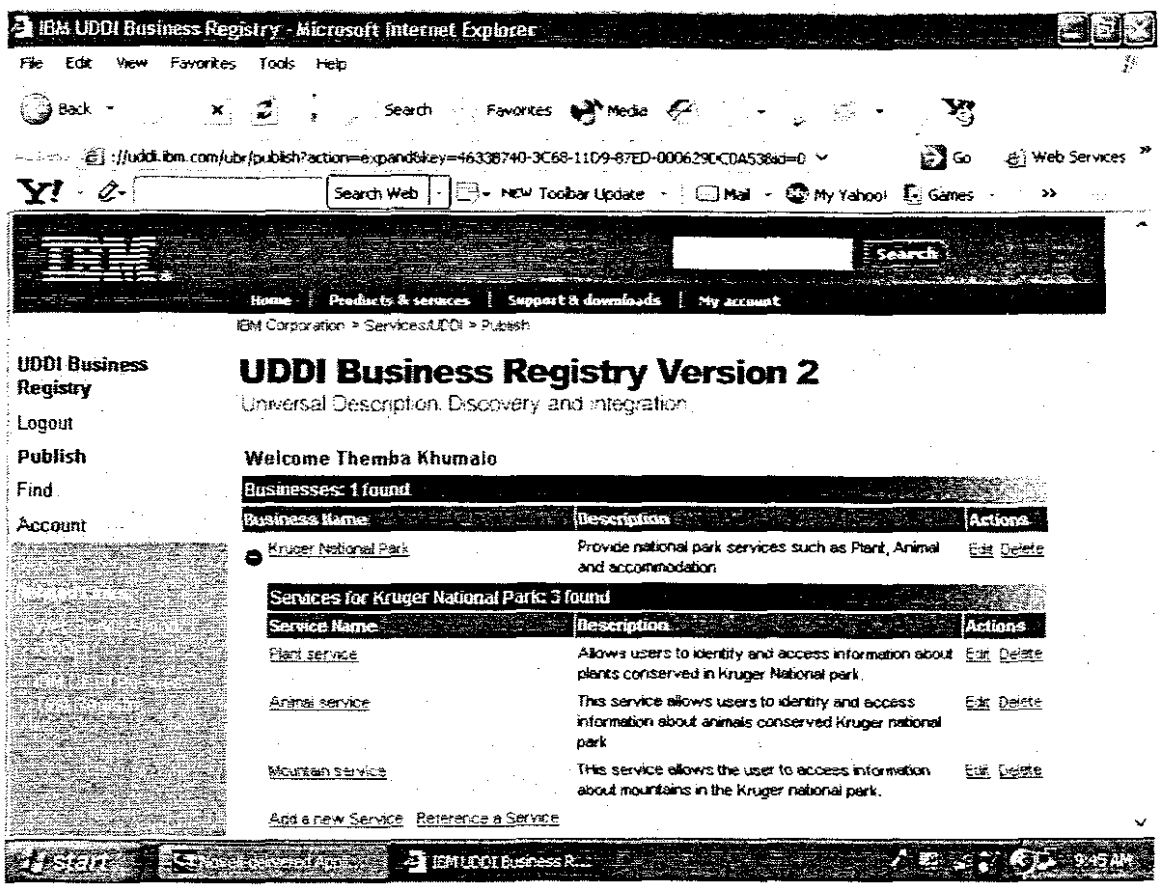


Figure 4.7: Published business and services

4.3.2 Publishing national park services

IBM UDDI test registry was used to prototype the process of publishing and finding business and services. This registry allows the service providers (Conservationist) to provide cataloged information about business, the services being offered, communication standards and interfaces they use to conduct the transactions. The business services were published in this test registry which maintained the pointers to the services description and to the services as shown in figure 4.7. The figure depicts the information about Kruger National Park as a business and presents the link to services (plant service, animal service, etc) plus their descriptions.

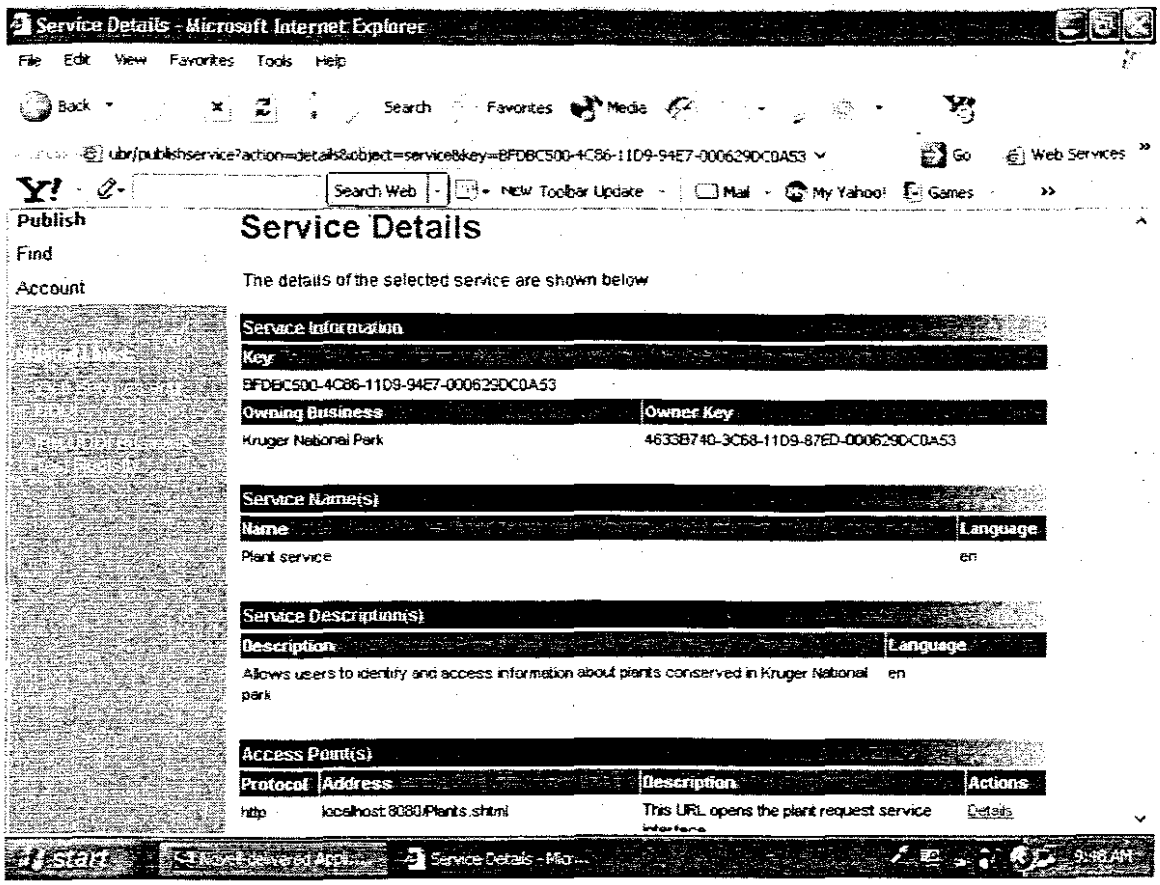


Figure 4.8: Plant service details

This registry allows clients to search the registry, find the intended services and retrieve its details as shown in figure 4.8. The details include the service invocation point as well as information help to identify the service and its functionality as discussed in chapter three. Figure 4.8 presents the details of the plant service (owner of the service, service description and access point in the form of a URL to be used when wanting to use the service).

CHAPTER FIVE

5.0 CONCLUSION

In this work, a study of the South African National Park system was carried out using a survey research method, comprising self-completed questionnaires and scheduled interviews. The investigation resulted in relevant data on national parks ability to provide nature conservation information and other services. Both data collection instruments were supplemented by observations and documents review. The information gathered suggested that the national park system needs a new ICT infrastructure to provide and market services to customers.

In order to achieve the first objective, a service-based architecture that depicts how elements in the national park system should interact in a service-oriented environment was formulated. The formulation was preceded by identifying national park services, corresponding role players and then the architectural framework was developed.

The development of the architectural framework posed the challenge of recognizing business processes as revolutionized by service-oriented architectures, On the other hand, the choice of web services resulted in using standard-based interfaces to software functionality. This means that national parks may publish information about their services in a service registry, where

prospective end-users can look up those services they need and retrieve information accordingly.

The architecture proposed in this work is a guide and should provide the basis for an ICT infrastructure that responds to the quest for modernizing the national parks information system. There are several advantages in seeking to use a guide like this one. Firstly, each national park does not need to develop its own system but can team up with others and adopt their existing applications as web services. Secondly, being based on web services, modernizing their system will not require them to change existing technology as long as it is web-enabled.

This kind of framework is attractive because it is implemented as a new layer that integrates with existing systems in the industry. SOAP has become the emerging standard for integrating web services with client services; allowing programs written in different languages to communicate even on different platforms. It also works with other service oriented architecture enabling technologies so that services can be published, located and invoked after being discovered in the UDDI registry.

The limitation of the framework is such that the prototype is not strong enough to serve as forerunner of typical SANPARK information system. The following are the aspects of the implementation that will require attention in the near future:

i. Personalisation should adopt a typical portal technology or style;

ii. The user interface should provide support for data mining;

iii. The restructuring of data should be revised along ontological lines and

iv. XML registry style will be more useful than UDDI for obvious reasons.

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Appendix A: Methods

Method – Connect to Database

```
Public void connectToDB(String DRIVER, String url, Connection con)
{
 try {
    Class.forName( DRIVER );
    con = DriverManager.getConnection( url );
    System.out.println( "Database connected" );
}
catch (Exception e )
 {
  System.out.println( "Could not connect to database" );
  System.out.println( "Error" + e );
  }
}
```

Method – Verify user

```
String query = "SELECT * FROM Subscribing
        WHERE CellNumber = '"+username+"' and
                Password = '"+password+"'";

       rs = stmt.executeQuery(query);

   if (rs.next())
    {
      area = rs.getString( "AreaOfInterest" );
      if( area.equalsIgnoreCase( "Animals" ) )
       response.sendRedirect("http://localhost:8080/Preferences1.shtml");

      else if( area.equalsIgnoreCase( "Mountains" ) )
       response.sendRedirect("http://localhost:8080/Preferences2.shtml");

      else if( area.equalsIgnoreCase( "Plants" ) )
       response.sendRedirect("http://localhost:8080/Preferences.shtml");
   }
      else
      {
         out.println("Please enter your details correctly");
      }
 }
```

Method – Retrieve Plant Information

```
    if(plantType.length() != 0){
            rs = st.executeQuery("SELECT Park_Name FROM
    Plants WHERE Plant_Type = '"+plantType+"'");
            boolean found = rs.next();

        if(found)
        {
        out.println( "<form action = /results method = post>" );
        out.println("<center><h2><font color=red>You can
    find\t"+plantType+"\tat:</font></h2></center>");
        out.println(" <center><table border=\"2\" cellpadding=\"0\"
    cellspacing=\"0\" style=\"border-collapse: collapse\"
    bordercolor=\"#111111\" width=\"28%\">");
        out.println("<tr>");
        out.println("<td>");
          keep = rs.getString(1);
          out.println("<p><input type = radio name = park value = " +
    keep + ">"
                        + keep + "</p>");
         while(rs.next()){
          keep = rs.getString(1);
          out.println("<p><input type = radio name = park value = " +
    keep + ">"
                        + keep + "</p>");
        }
        } // close if found
        else if(!found)
        {
          out.println("Requested plant type is not avaliable");
        }
    }
    else{
      out.println("Please input plant type");
      }
}
```

Method – Get Park's Details

```
String query = "Select * From Parks where Park_Name = '" + park + "'";
 String query2 = "Select * From Plants where Park_Name = '" + park + "'
    AND Plant_Type = '" + p.plantType + "'";
       stmt = con.createStatement();
       rs = st.executeQuery(query);
       result = stmt.executeQuery( query2 );

       if (rs.next() && result.next() ){
         String part = rs.getString("Location");
         int quantity = result.getInt( "Quantinty" );
         out.println("<center><font size = 4>This park is at </font>"+ "<font size =
4>"+part +"</font>"+ "<font size = 4> with </font>" + "<font size = 12>"+quantity +
"</font> " +"<font size = 4>"+ p.plantType + "</font></center>");
        }
       else if(!rs.next()){
         out.println("Please select Park name");
      }
}
```

Appendix B: Questionnaires

Research Instruments for SANPARK
Questionnaire to Tourists

Dear Friend.

We are postgraduate students at the University of Zululand and conducting a study to investigate the use of Information and Communication Technologies (ITCs) in the provision of tourism information among the South African National Parks. The findings of this study are expected to indicate the level of access and utilization of tourism information by stakeholders in the tourism industry. This information will be useful in the designation of a distributed information system for the South African National Parks.

We are, therefore, kindly requesting you to spare some 10 minutes from your busy schedule and respond, as best as you can, to items in the questionnaire. Most questions require you to tick the answers, while a few require short answers based on your views. The information you give will be treated with utmost confidentiality and will be used only for purposes of the study.

Thank you very much for your cooperation and participation.

Yours faithfully,

Joseph Kiplangat and Themba Khumalo

Section One: Personal data

1. State your gender
   [ ] male
   [ ] female

2. Age
   [ ] 20-29 years
   [ ] 30-39 years
   [ ] 40-49 years
   [ ] 50-59 years
   [ ] over 60 years

3. Highest qualifications
   [ ] Certificate
   [ ] Diploma
   [ ] Bachelors degree
   [ ] Masters Degree
   [ ] Doctoral Degree

4. Kindly state your country/region of origin
   [ ] Western Europe
   [ ] Eastern Europe
   [ ] Australia/ New Zealand
   [ ] North America
   [ ] Latin America
   [ ] Africa
   Others, please specify .....

5. What is the purpose of the visit (you may tick more than one)?
   [ ] Work
   [ ] Vacation /holiday
   [ ] Visit friend and relatives
   [ ] Others (please specify) .....

6. How many times have you visited the Royal Natal national Park?
   [ ] First time
   [ ] Second time
   [ ] Three or more times

Section Two: Provision of tourist information

7. While searching for information on South African National Parks which of the following sources/materials did you consult? (You may tick more than one)

[ ] Tour/travel agents
[ ] In-flight magazines
[ ] Brochures
[ ] Leaflets
[ ] Websites
[ ] Documentary videos
[ ] Local and International media (TV. news paper, magazines)
[ ] South African Embassies abroad
[ ] Radio program for local tourists
[ ] Television programmes/advert
[ ] Friends
[ ] Others (please specify).....
.....

8. How do you rate the adequacy of the information provided on the South African National Parks in the sources/materials you consulted?
[ ] Very adequate
[ ] Adequate
[ ] Fairly adequate
[ ] Not adequate

9. If you consulted any South African National Parks websites on the Internet, how helpful was the information you obtained?
[ ] Very Helpful
[ ] Helpful
[ ] Fairly Helpful
[ ] Not Helpful

10. While searching for the information on South African National Parks on the internet and websites did you experience any of the following problems? (You can tick more than one)
[ ] Inadequate information
[ ] Absence of online reservation forms
[ ] The information is not easily searchable
[ ] Poor links on the websites
[ ] Absence of contact information
[ ] Others (please specify).....
.....

11. Generally, is the promotional information provided through various sources abundant enough to let people know about the South African National Parks and game reserves?
    [ ] Very abundant
    [ ] abundant
    [ ] Not abundant
    [ ] Almost non-existing

Section Three: Tourists satisfaction or dissatisfaction

12. How do you rate the natural elements available at the Royal Natal National Park in terms of attractiveness/conduciveness?

Natural elements	Very attractive	attractive	Not Very attractive	Least attractive
Temperature				
Vegetation and Landscape				
Scenery and natural beauty				
Birds and animals				
Snorkeling				
Others(specify)				

13. Are the services and tourist attractions at the Royal natal national Park the same as promised or expressed by the various information sources?
    [ ] Same as promised/expressed
    [ ] Fairly representative of what was promised/expressed
    [ ] Poor than promised/expressed
    [ ] Worse than promised/expressed

14. Which hotel/lodge are you staying in? .....

15. How satisfied are you with the following services in the hotel/lodge?

Services	Very satisfied	Quite satisfied	Fairly satisfied	Not satisfied
Food Variety				
Cleanliness of rooms				
Air conditioning system in rooms				
Hotel Service Quality				
Price relative to service quality				

Others (please indicate).....

16. What should be done (if any) to improve the services of the hotel?

.....

.....

17. Which other National Park are you planning to visit or have visited?

.....

.....

18. How do you rate the overall satisfaction of your holiday?

[ ] Very Satisfied
[ ] Satisfied
[ ] Fairly Satisfied
[ ] Not Satisfied

19. What measures should be taken to improve the provision of tourism information and services in the national parks of South Africa?

.....

.....

.....

.....

Thank you very much for your participation.

Research Instruments for SANPARK
Questionnaire to Personnel of the Royal Natal National Park

Dear Friend.

We are postgraduate students at the University of Zululand and conducting a study to investigate the use of Information and Communication Technologies (ITCs) in the provision of tourism information among the South African National Parks. The findings of this study are expected to indicate the level of access and utilization of tourism information by stakeholders in the tourism industry. This information will be useful in the designation of a distributed information system for the South African National Parks.

In view of your knowledge, involvement and status in tourism activities/industry, you have been identified to participate in the study. We are, therefore, kindly requesting you to spare some 15 minutes from your busy schedule and respond, as best as you can, to items in the questionnaire. Most questions require you to tick the answers, while a few require short answers based on your views. The information you give will be treated with utmost confidentiality and will be used only for purposes of the study.

Thank you very much for your cooperation and participation.

Yours faithfully.

Joseph Kiplangat and Themba Khumalo

Section One: Demographic Data

1. What is your status/position?.....

2. Outline tourist attraction/services available at the Royal Natal National Park.

   .....
   .....
   .....

3. How many tourist resorts/hotels are in the Royal Natal national Park?
   .....

4. What was the average number of tourists who visited the Royal Natal national Park in the year 2003?
   [ ] January – March 2003
   [ ] April – June 2003
   [ ] July – September 2003
   [ ] October – December 2003

Section Two: Provision of Tourist Information

5. How much is the promotion budget for the current fiscal year?
   .....

6. What types of promotional material does the Royal Natal National Park produce for disseminating tourist information?
   [ ] In-flight magazines
   [ ] Brochures
   [ ] Leaflets
   [ ] Websites
   [ ] Documentary videos
   [ ] Others. specify.....

7. Through which channels or media does the Royal Natal National Park use to disseminate the above tourist information to reach the target market?
   [ ] Travel agents
   [ ] Local & International media (TV. newspaper. magazines)
   [ ] Foreign travel agencies
   [ ] South African Embassies abroad.
   [ ] Websites and Internet sites of target country
   [ ] Radio programmes for local tourists
   [ ] Television
   [ ] Others (please specify).....

8. How does the Royal Natal National Park assess whether the information distributed is easily accessible to tourists?
   [ ] By conducting surveys
   [ ] Forging linkages with stakeholders and tourists agencies
   [ ] Evaluating effectiveness of each channel/media
   [ ] Others, please specify.....
   .....

9. Which countries does the Royal Natal National Park target in promotional programmes?
   [ ] Western Europe
   [ ] Eastern Europe
   [ ] North America
   [ ] South America
   [ ] Africa
   [ ] New Zealand/Australia

10. How does the Royal Natal National Park collaborate with other stakeholders such as South African National Parks and KZN Tourist Authority in promotion, marketing and advertising tourist information and services?
   .....
   .....
   .....
   .....

11. What customer loyalty programmes has the Royal Natal National Park designed to attract both local and international tourists?
   .....
   .....
   .....

Section Three: Use of ICTs in dissemination of tourism information.

12. How frequently/often does the Royal Natal National Park use the following ICTs in disseminating tourism information?

ICT tools & services	Always	Often	Sometimes	Never
Internet websites				
Email				
Electronic journals				
CD-ROM databases				
Desktop publishing				
Mobile phones				
Television				
Radio				
Video				

Others, please specify.....

13. Which of these ICTs do you consider in disseminating tourism information?

ICT tools & services	Very effective	Effective	Sometimes effective	Never effective
Internet websites				
Email				
Electronic journals				
CD-ROM databases				
Desktop publishing				
Mobile phones				
Television				
Radio				
Video				

Others, please specify.....

Section Four: Perceptions of ICTs use

14. To what extent have ICTs helped in promoting tourist information and raising the number of tourists visiting the Royal Natal National Park?
    [ ] Greater extent
    [ ] Some extent
    [ ] Less extent
    [ ] Insignificant

15. In your opinion, what limitations (constraints) affect the use of ICTs in dissemination of tourism information to stakeholders?
    [ ] High costs
    [ ] Poor infrastructure
    [ ] Lack of skills
    [ ] Lack of enabling environment
    [ ] Lack of comprehensive government ICT policy
    [ ] Lack of comprehensive ICT policy in the tourism sector

    Other, please specify.....
    .....

16. What measures should be taken into account to improve the application and use of ICTs in dissemination of tourism information at the Royal Natal National Park?
    .....
    .....
    .....
    .....

Thank you very much for participation.