

# Mobile Monitoring System: A Convenient Solution for Reducing Cost of Producing Crude Oil

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## Abstract

Mobile computing technology is arguably one of the most significant technological developments of this century. All over the world, there is a growing demand for mobility, which has brought significant change to how businesses are being run. Everybody wants access to information resources and services of a company wherever they are and whenever they want. It is against this background that this research was carried out to develop a mobile monitoring system using mobile computing technology to boost crude oil production in Nigeria by reducing the cost of production. This work places equipment failure reports on the lap of all the parties involved. It is no more necessary for servicing companies to visit rig or “company man’s” office before they can get the reports. Mobile phone can be used to access the database from anywhere. Since report is readily available, planning is made easy. The system was implemented using Wireless Markup Language (WML) on ColdFusion 4.5 as Common Gateway Interface (CGI). The testing was done using ccWAP phone emulator. The modular approach of programming which is a prominent feature of the modern system of programming was applied in the system design.

**Key words:** WML, WAP, Mobile Data, Mobile Phone, Rig, Oil Well

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## 1. INTRODUCTION

There is a constant drive to improve the quality of oil well operations by stakeholders in the oil and gas sector. The approach differs from one petroleum company to the other but the aim is the same – trying to reduce the cost of producing crude oil or the cost of delivering an oil well thereby increasing profit margin. The cost of drilling is calculated in dollars. A single well cost millions of dollars to drill. That’s why petroleum companies always welcome any idea that will ensure continuous performance improvement of well operations and early completion of drilling operations.

Crude oil exports account for far over 80% of our national revenue. The quantity of crude oil produced is a function of numbers of oil wells available and running. Drilling operations are contracted out to oil servicing companies who make use of various equipment and technology to ensure early completion of oil well drilling. The expected time of completion of drilling operations are often time exceeded due to equipment failure and other activities referred to as non-productive time. Whenever the time is exceeded, it increases the cost of delivery thereby increasing the cost of production.

Oil well drilling involves a set of operations that are allotted a maximum expected time of completion based on the experience from previously completed (delivered) oil wells. There is always a need to capture the actual time taken to drill the oil well so as to know whether they were able to beat the planned time or not. All these are stored in database for future learning. In

well drilling operations, equipment failures account for more than 80% of the down or lost time (Ureigho, et al., 2007). Monitoring equipment failures therefore is used as a kind of measure of performance with the aim of avoiding re-occurrence and focusing key people to the area of deficiencies (Irobiko, 1999).

Since the introduction of GSM a couple of years ago, Nigerians have accepted it with open arms despite the cost of usage and poverty level, in some circles, it seems as though everyone has a mobile phone, including children. According to Anderson (2000), most of the mobile phone users in United States said they wanted to use mobile phone for mobile data instead of a computer or some other devices. The Nigeria experience is not different because those that don't know anything about computer own a mobile phone and will be glad to use it to do all that can be done on computer.

This study makes the process of reporting, investigation and close-out simple and easy by using mobile computing technology where mobile phone or PDA can be used to access equipment failures database from any location. This enhances quick dissemination of the learning points needed for the planning of future wells.

## **2. SYSTEM MODELING**

The Unified Modeling Language (UML) was used to capture and model some of the functionalities in the system. There are two main types of diagrams in UML: structure diagrams and behavioural diagrams. Structure diagrams are used, for example, to describe the relationship between classes. They include class diagrams, object diagrams, component diagrams, and deployment diagrams. Behavioural diagrams, on the other hand can be used to describe the interaction between people (actors) and the thing we refer to as a use case. The behavioural diagrams include use case diagrams, sequence diagrams, collaboration diagrams, state-chart diagrams, and activity diagrams (Kendall, et al., 2002). In this study, we used two types of behavioural diagrams: use case and sequence diagrams. The use case diagram shows the standard flow of events within the system thereby describing the system behaviour.

There are two types of users of this system: the service provider or servicing company comprising of the various contractors involve in the drilling operations and the "company man" referring to the petroleum company representatives in charge of the drilling operations. Base on business rule, the service provider can only view list of oil fields (rigs) so as to select a particular rig and then view list of wells within the selected rig to pick a specific well of interest. The service provider can now check the equipment failure report that involves his/her company. The "company man" can view equipment failure report of all service providers, list of all service provider, and equipment. This scenario is captured in figure 1.

The sequence diagram; a derivative of the use case analysis illustrates the processing described in the use case scenario. It shows the interactions, relationships and methods of the objects in the application. The user (service provider or "company man") initiates the application via mobile phone. The request is sent in the form of wireless markup language (WML) over WAP transaction protocol (WTP) to the WAP gateway which convert the WAP request to Web request. The WAP gateway then forwards the request to the Web server. The Web server then connects the database server through the ColdFusion server. The ColdFusion server serves as the Common Gateway Interface (CGI) processing data received from Web server and return data in dynamic web pages (Danesh, et al., 2001). The WAP gateway receives the output data from the Web server and converts it into WAP response which is displayed on the mobile phone of the user. Figure 2 is used to represent this scenario.

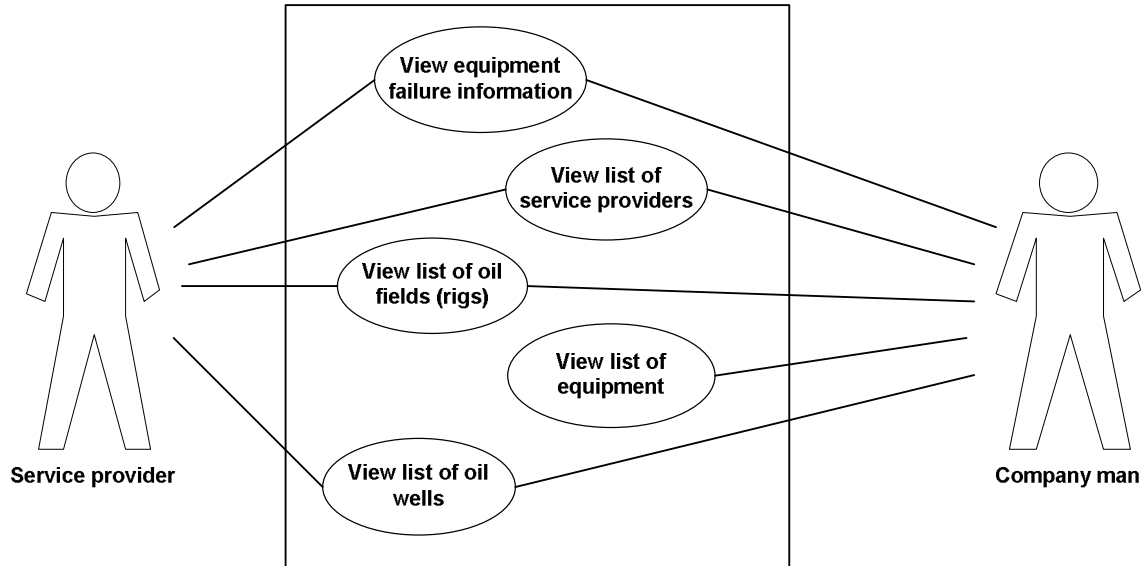


FIGURE 1: Mobile Monitoring System Use Case Model Diagram

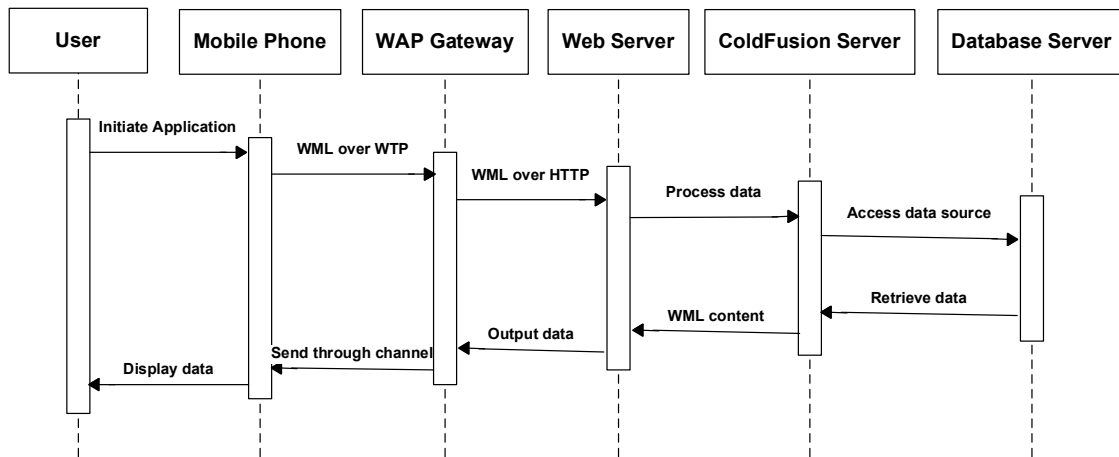


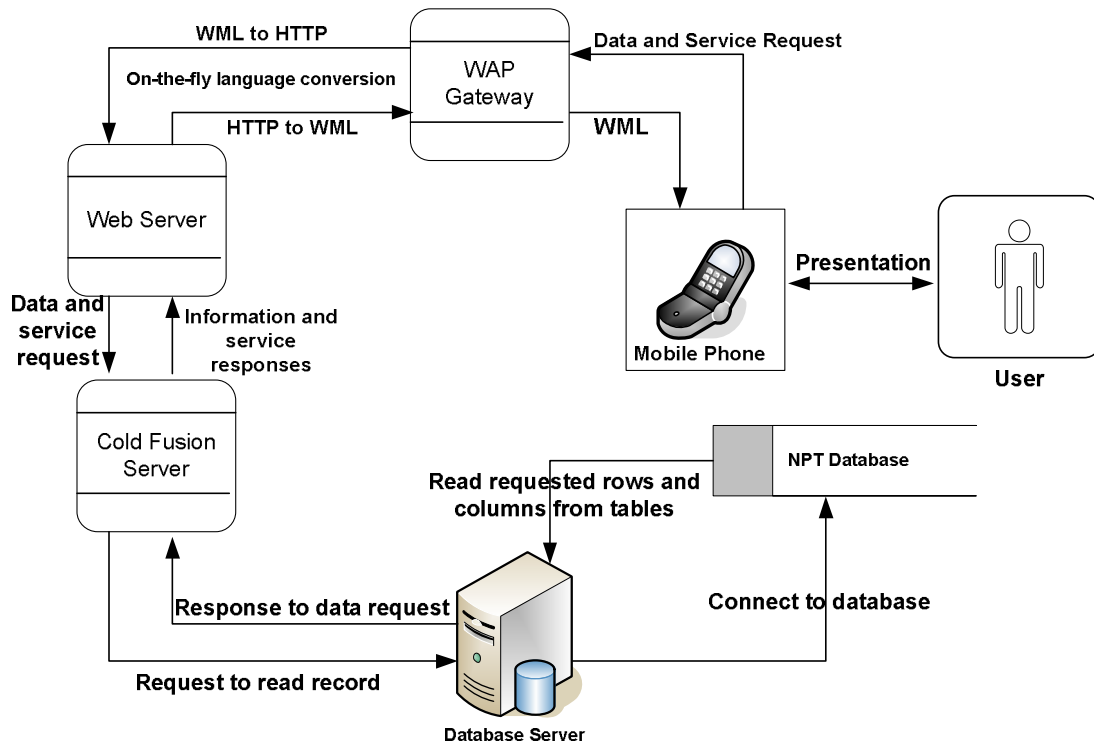
FIGURE 2: Sequence diagram for the Mobile Monitoring System

### 3. SYSTEM DESIGN

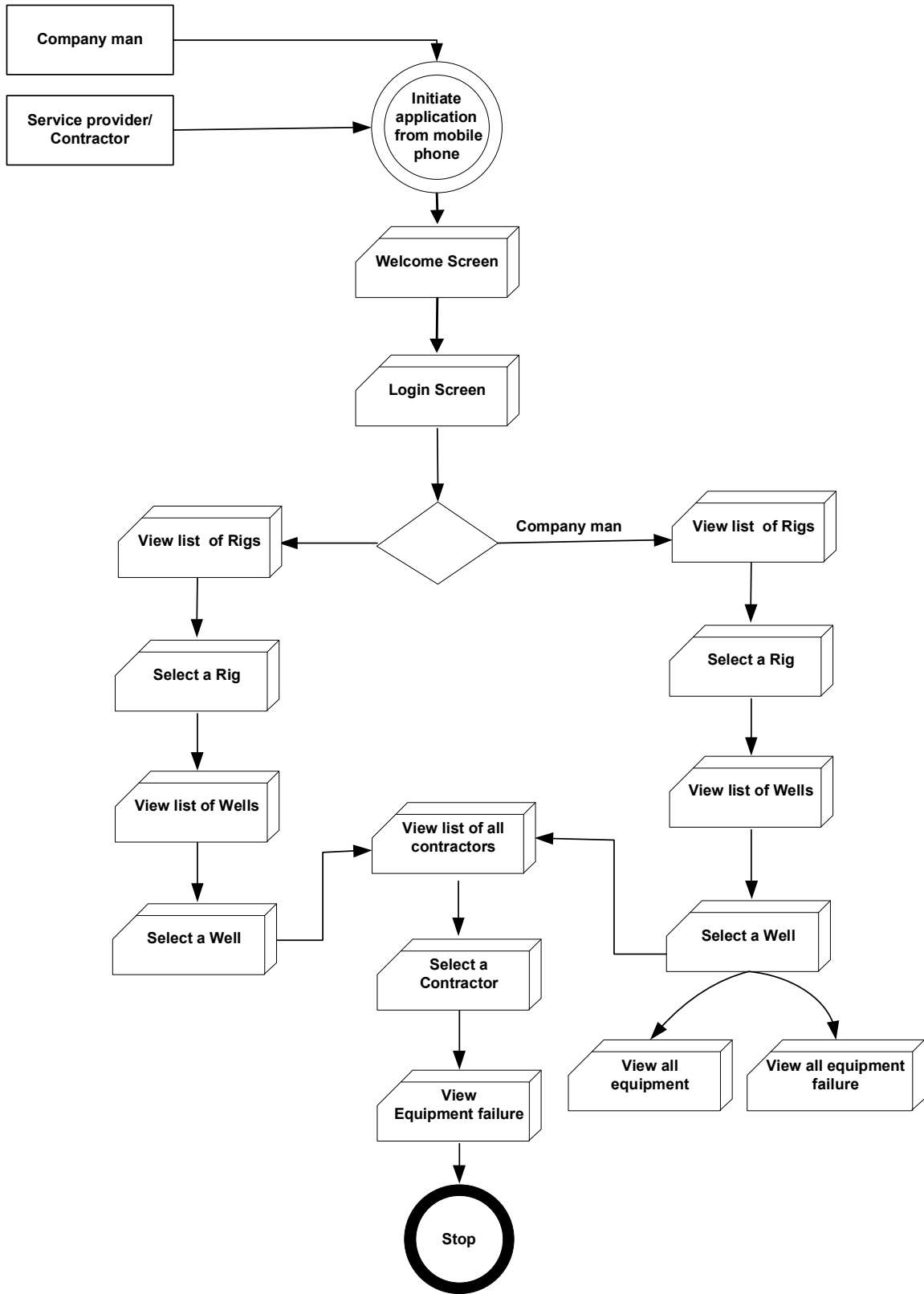
The “mobile monitoring system” was designed in such a way as to allow authorized users to search for up-to-date and prompt information on equipment performance and other well drilling events that caused delay in oil well delivery.

In order to achieve this goal, a relational database tagged “NPT” (Non Productive Time) was created to capture lost or down time. The relational database, which is to contain up-to-date records of equipment failure and other related incidents during well drilling operations, was designed using Microsoft Access 2000. The main focus here is the lost or down time associated with equipment and other operations during well drilling.

The “NPT” database which is made up of different files (tables) is then connected to WML (Wireless Markup Language) codes through a web application platform. In this study, ColdFusion is chosen as the web application platform although ASP, ASP.Net or JSP can be used for the same purpose.



**FIGURE 3:** Software Architecture for the Mobile Monitoring System



**FIGURE 4:** Data Flow diagram for the Mobile Monitoring System

## **4. THE DESIGN METHODOLOGY AND IMPLEMENTATION**

The model structured design technique was adopted during the design stage of this application. This technique is a process oriented technique for breaking up a large program into a hierarchy of modules that result in a computer program that is easier to implement and maintain (Whitten, et al., 2001).

The entire system was broken down into subsystems (modules), which were designed separately and then later integrated to form a whole. These subsystems are referred to in WML and other middleware like ColdFusion as “Decks”. A deck is made up of one or more “cards”.

In this system, ColdFusion serves as an application platform (middleware) for WAP enabled applications which allow embedded WML for WAP to run as a single program. ColdFusion has the capability of extracting record(s) from database application (Anderson, 2000). Coding was done in ColdFusion environment using WML together with CFQUERY and SQL to interact with the database. The testing of the system was done using ccWAP phone emulator. Phone emulators are virtual devices that emulate mobile phones on your PC, which can be used to test WML codes without using actual device. Phone emulators can browse local files even when there is no WAP gateway.

### **4.1 System Implementation and Deployment**

The system was designed in such a way that any level of users can easily use it. To startup the system, the user just need to type in the URL that refers to the deck that contains the homepage. If the URL is properly typed, a connection to the server is established and the welcome screen is displayed. The user can easily move backward and forward without previous knowledge of the mode of operation of the application. Users can be thought how to use this application in less than 20 minutes!

### **4.2 The Program Modules**

The entire system was broken into subsystems. Each subsystem was designed as a deck of cards, which can be activated at the different menu as the user navigates through the system just like going from one web page to the other, and from one site to the other. The modern structure design approach adopted made the program more interesting and it enhances easy modification and debugging.

### **4.3 The User Interface Design**

The user interface was made as brief as possible for proper paging knowing fully well that the application is to run on non-PC terminal (mobile phone). Each screen display carries sufficient instructions as to what operation is being performed at any time the user select a function. Scrolling is also possible to enable user move the displayed information up or down the screen, one line at a time.

The first screen that will be displayed after the user has successfully established connection between the server and the mobile phone is the “welcome screen”.



FIGURE 5: Welcome Screen and the Option menu

The next screen is the “login screen” where the user is expected to key in his/her user name and password. The user’s name and password is stored in the users table in the “NPT” database. It is encrypted to achieve confidentiality of the system.



FIGURE 6: List of rig and the display of list of wells in a rig



FIGURE 7: Equipment failure report for a contractor and scroll down effect

#### 4.4 Using the System

The application is user-friendly enough for the user to move back and forward without much assistance. The action to be triggered by a key on the device is placed very close to the key on the display. When the information required cannot be displayed on the mobile screen at once, the user can easily use the scroll key to move up and down.

### 5. CONCLUSION

The study has practically demonstrated the feasibility of designing mobile monitoring system for effective monitoring of equipment failure and other oil well drilling events where lost or down time were incurred. Since this system is designed to run on mobile devices such as mobile phone and PDA, it is readily accessible to all parties and stakeholders involved.

The application when deployed could ensure time saving and cost reduction for new oil wells. The service providers (servicing companies) can easily access the reports for the just completed oil well without visiting the 'focal point man' of the petroleum company. Also, all the team members of the petroleum company in charge of monitoring drilling can access the lost or down time reports via their mobile phone. All information needed for planning new wells are readily made available by the system.

The servicing companies have all they need for future learning and planning. They know which equipment failed and when, which operation techniques resulted in lost time and who was responsible. They are in good position now to guard against future occurrence in the next well. Thus, lost or down time is reduced drastically and some hundreds of thousands or millions of dollars is saved.

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