MOBILE HANDLING OF ENVIRONMENTAL SENSITIVITY INDEX (ESI) DATASET

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ABSTRACT

Disasters such as coastal oil spills often have significant impacts on biological and human resources, and one of the primary objectives of spill response, after protecting human life, is to reduce the environmental consequences of the spill and cleanup effort. To best achieve these objectives there is the need to rapidly provide information support about resource location and protection priorities to on-site personnel in charge of spill response and crisis management.

The most widely used approach has involved the use of an Environmental Sensitivity Index (ESI) dataset. To date ESI datasets have been designed and targeted at emergency managers running static, desktop client systems, and are often used for long-term oil spill planning. During an emergency, the situation is often characterised by activities and locations not amenable to desktop information system. In order for on-site workers to benefit significantly from information about response decisions, resource allocation and other condition at their location, there is need to develop advance techniques for mobile and personalised exploitation of ESI data content. In this paper, we describe a framework for handling content in a personalised and adaptive way based on users interest, task and device (profiles).

1. INTRODUCTION

Oil spills have been implicated in many of the most dramatic episodes of environmental pollution and degradation. Although their direct impact is generally short-lived, they can have a devastating effect on the environment. Incidents have occurred and will continue to occur, worldwide and notably in the coastal zone, both off-and on-shore. In an effort to reconcile the conflict between environmental needs and development processes, to minimize spill impact on environment, and in response to the limited specific environmental information, most petroleum operators have created environmental sensitivity index (ESI) datasets that describe specific geographies and ecosystems at risk [2]. This are aimed at minimizing the effect of degradation of the environment.

Effective management and clean up of on-shore oil spills, requires not only equipment and personnel resources, but also detailed information on shore type, access points, environmentally sensitive areas and the location of all equipment [7]. Most of this information is contained within the environmental sensitivity index (ESI) datasets, which form a set of data indicating the physical, cultural, and biotic character and the sensitivity of the various ecological associations. They are also a tool for risk analysis with regard to evaluation of environmental effect of oil spill and response to such spill incidents [1].

To date ESI dataset have been designed and targeted at emergency managers running static, desktop client systems, and are often used for long-term oil spill planning. This process usually involves recording the ESI information on hard copies (notably in map form), which are then transported or faxed to a command Centre.
However, time is critical when responding to an oil spill incident, information need to be readily available to on-site workers in a dynamic and flexible way, reflecting their situation, task and available resources, notably their use of mobile technologies. These needs for having access to and interacting with, up-to-date digital spatial and non spatial information while in the field in a very personalised, adaptive and dynamic way raise challenging research issues: the ultimate aim is to efficiently use data to enable significant enhancement of remedial operation and consequently reduce ecological and financial disaster.

This paper is a first step in describing a framework for handling content in a personalised and adaptive way based on the user's interest, task and device. A user profile will be developed capable of use by many applications to specify information to deliver to mobile user in particular. A user' s profile describes what data objects are considered interesting, how useful these data objects are relative to each other, and the way in which these object can be exploited. Profiles for data delivery to a mobile user should contain two types of information. Firstly, the profile should describe the types of data that are of interest to the user. (This description must also encompass potentially newly created data in addition to existing data, and must be flexible enough to express relationships between different types of data. Secondly, because of bandwidth, device storage and other limitations, only a bounded amount of information can be sent to a device during data delivery. Thus, the profile must also express the user preference in terms of priorities among data items, context, device characteristics and other properties. [3]

2. SYSTEM ARCHITECTURE

In order to handle contents and data flow in a distributed communication and mobile service environment, a system is needed that will maintain communication connection and prepare data in a most personalised and adaptive form to meet user's interest and preferences for a particular task. Intuitively speaking, the data ought to follow users in their travels. While this may be impractical for all data for all users; it might be possible for popular data to move to a location that is closest (in terms of latency) to the highest number of interested users [6][8]. The architecture shown in Figure 1 is our view of a typical system architecture in which to deploy profile- based ESI dataset to support responders to disasters such as oil spill.

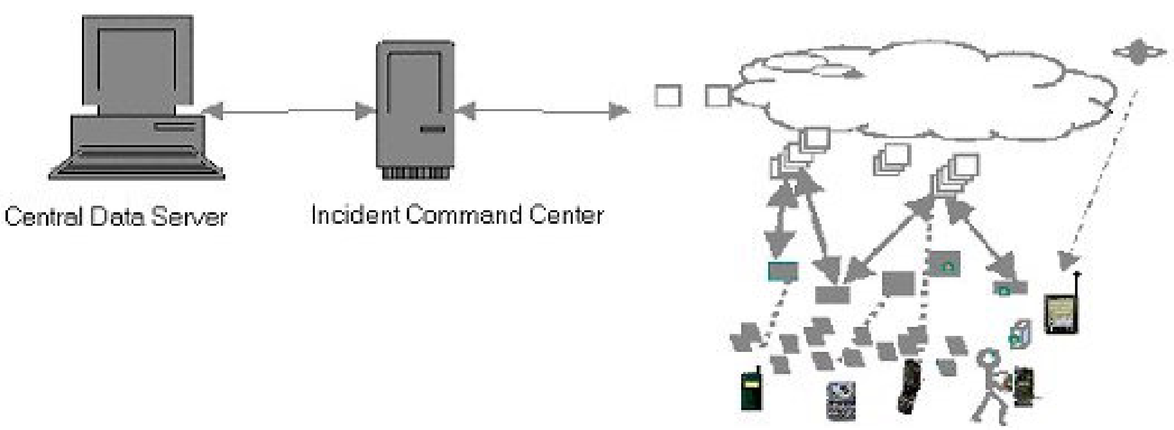

Figure 1. Architecture for mobile data handling

The architecture is proxy-based and usually the bandwidth between the proxy and data server is much higher than that between the proxy and client. The proxy makes requests to the central data server and based on the supply from that server decides and perform the necessary adaptations prior to sending the adapted subset to the mobile client. The first layer of the architecture is the Central Data repository of ESI datasets and where a portion of interest is compiled and forwarded to the middle layer. The second layer (Incident Command Centre) is where most of the data personalisation and adaptation takes place. This layer receives profiles from local incident responders and manages these profiles with respect to data of interest and the profiles are use to make data adaptation decisions. The third layer is the personalised delivery of subsets of data to the responders, in response to a specific request or as a multi-user broadcast.

3. PERSONALISATION AND ADAPTATION

Personalised and adaptive data handling is the ability of the handling technique to adapt to a specific user in terms of the task and current context, ideally based on user profiles. Users tasks and context define the amount and detail of information extracted from servers to a mobile device [5]. Adaptation can take place at different levels, for example :-

- The content can be adapted to the user task.
- Data to be transmitted can be adapted to a specific device with particular characteristic (e.g. display size and resolution, memory, CPU etc)
- Data could be further adapted for transmitting over wireless network (compression due to limited bandwidth)
- Visualization of the information can be adapted to the user requirements.

The development of users profiles for personalised and adaptive data management in several systems [9][11][12], has revealed drawbacks in implementation. In particular, the creation of-one profile to capture every aspect of the working environment, results in a large and unstructured set of properties, difficult to handle. Much use of such profiles is image centric, we propose an approach which deals with several classes of profiles, covering different aspects of the systems, selectable as needed to perform a particular task. The design also gives us the option of being able to separate dynamic profiles from static. For example, a device profile describing the properties of worker's PDA is static whilst its task is dynamic. Figure 2 below describe the adaptation mechanism.

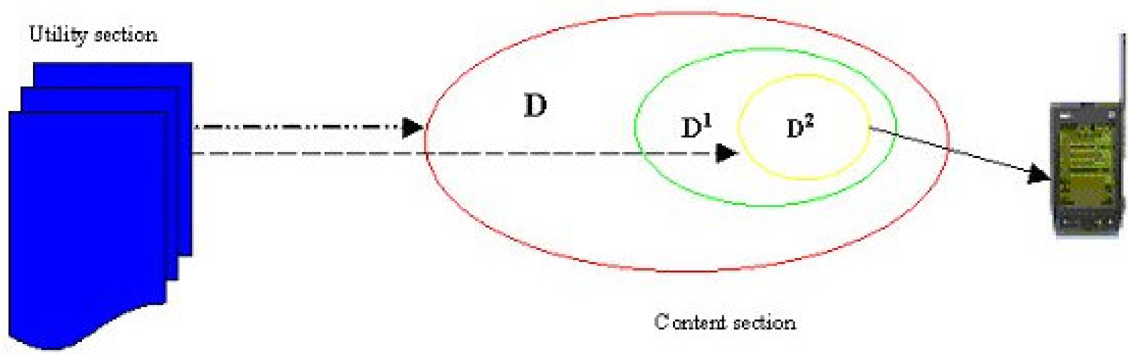

Figure 2. Adaptation techniques in a data delivery system

The content section specifies what information is required, specifically the ESI dataset and its semantic type. The utility section determines the variables (profile description) of how this information should be delivered to appropriate responders. The figure shows a mobile data delivery system, where D, D^1 and D^2 denote progressively smaller subsets of data objects, which are determined by the utility section. D is the set of all data object, specified to be of interest, within the ESI domain specification:- D^1 is the reclassified instances of data objects in D and D^2 is the chosen data delivered, i.e. the subset of object in D^1 that the utility section chose to deliver to the mobile device on the basis of a utility variable specification.

The process checks which responder has requested information and selects a rule set based on the client profile. For example, if the user has a device with limited memory, the utility delivers a subset that meets the memory constraint and best satisfy the user's objectives. Table 1. list example specific details of D, D^1 and D^2.

D Complete ESI dataset				D^1 Added value, selected analysis	D^2 Data sent
				HPP	Removal,
Shoreline type	Inland/Interior	Biological	Others	ESR	Substitute,
Marine	Urban	Plants	Socio-economic data	REL	Colour-dept
Brackish	Agriculture	Mammals	Weather Information	HPP with REL	reduction, Colour
Fresh water	Forest	Birds	Terrain	HPP with ESR	to grey, text prior
Others	Wetland	Reptiles	Road network	ESR with REL	to maps etc. of
	Water	others	Tidal amplitude	Where;	HPP, ESR, REL
	Others	Fish		HPP = habitat priority protection area objects	
				ESR = environmental sensitivity ranking objects	
				REL = response equipments location objects	

Table 1. Example specific details of D, D^1 and D^2

4. ALGORITHMS TO SUPPORT CONTENT ADAPTATION

The need to choose a subset of objects to be allocated to a device extremely limited in computing resources:- such as storage, memory, CPU, screen size and resolution [4] is likely to become increasingly common in mobile data-handling environment. In these situation profiles are used to ensure that the subset of objects to be delivered have high value to the incident responder.

We have examined a greedy resource allocation algorithm for processing profiles to decide on an appropriate selection of objects. The optimisation problem, involves searching through a set of configurations to find one that minimizes or maximizes an objective function defined on these configurations. In order to solve a given optimisation problem, a sequence of choices is examined, starting from some well-understood starting configuration, and then iteratively makes the decision that seems best from all of those that are currently possible. Formally, an optimisation problem can be stated as follow, given:

a. *A finite set of known objects, D, such that for any object, $D^2 \in D^1$, $s(D^2)$ is its size(say in bytes),*
b. A *weight, W that specifies for any subset, $D^2 \subseteq D^1$, its value, $v(D^2)$,*
c. *A device capacity, C (say in bytes*)

Determine the subset $D^2 \subseteq D^1$ that satisfies the constraint,

$$\sum (s(D^2) \leq C)$$

And that maximizes the Objective (value) function.

The greedy approach is sub optimal in some situations, in that it assumes that a single profile determines how a given resource gets allocated, but in practice, a given resource may be allocated on the basis of considering a range of competing profiles. One approach to adapting the greedy algorithm to handle *n* profiles is to merge the *n* profiles into one *superprofile* [3], but this has the disadvantage of creating a large and unstructured set of properties.

5 CASE STUDY

To further illustrate the intended system, we are using data from the ESI dataset of the Nigeria Oil Mining Licence (OML) 11. The OML 11 block is one of the largest concessions for oil exploration and production located in the southern part of Nigeria. It extends from Latitude 4^0 28'N to 5^0 2' and Longitude 7^0 2'E to 7^0 39'E. Most of the block lies within the Niger Delta, and it cover an estimated area of 3096 square km, (Figure 3). It was awarded to Shell Petroleum Development Company (SPDC) of Nigeria in 1960 for oil exploration and production, but has significant environmental vulnerability.

An oil spill incident in such an area requires a flexible and mobile response, ideally carried out by a number of workers equipped with limited storage capacity PDA-based devices incorporating the type of profiles outlined above. Relying on static, desktop information systems in such a scenario is likely to lead to delay, inefficiency in allocating resources and uncertainty in managing emergency.

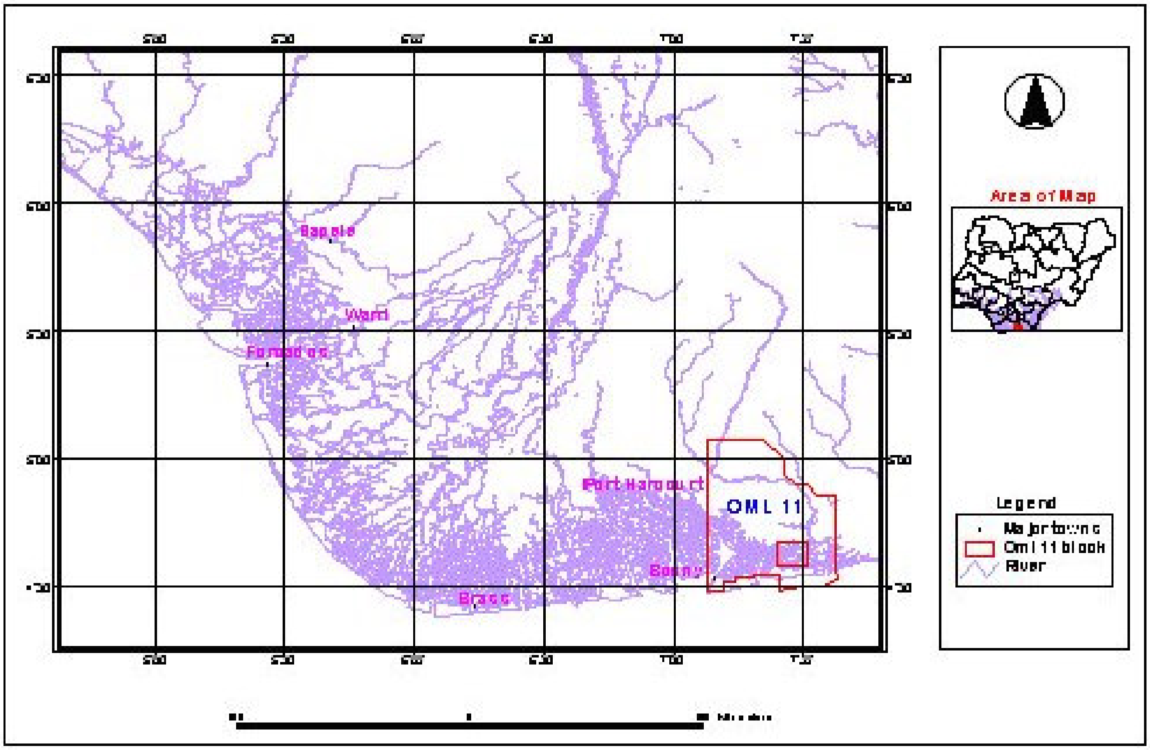

Figure 3 Map showing the location of OML11

In order to establish priority protection area related to the oil spill, and to aid decision making, the mobile worker requests data from the incident command centre. The command centre examines the client device profile before making adaptation decisions. A utility module, in choosing a subset of data to be allocated to the responder, searches through the complete geographical dataset (D) in central server, (see figure 4), and selects appropriate subsets (D^1), that have maximum weight. This weight corresponds to a value measured in the Utility module, taking into account a range of parameters relating to the location of the worker, the immediate task required, the nature of the team (if any) he is working with, the range of practical emergency response tools he has access to and the nature of the environment which is being threatened. Some parameters, such as capacity of the PDA are definite variables governing the data to be downloaded- in this case, its total size.

Figure 5a shows the results of sub-setting the ESI dataset for the purpose of addressing vegetation sensitivity and consequent oil containment priorities. Figure 5b shows a different subset for use by a mobile worker planning human evacuation along communication lines, primary roads.

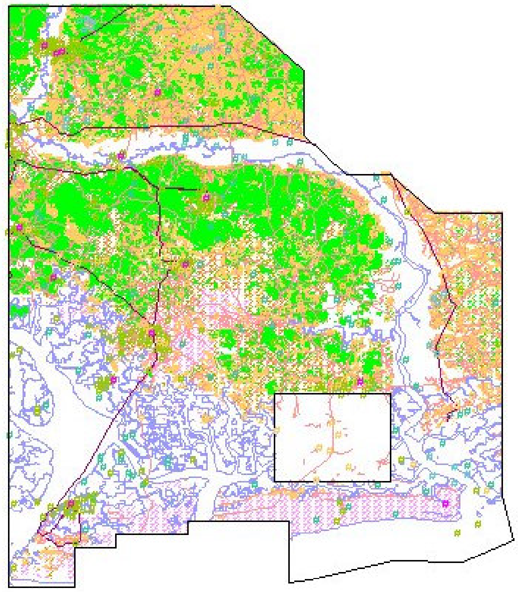

Figure 4. A sample D

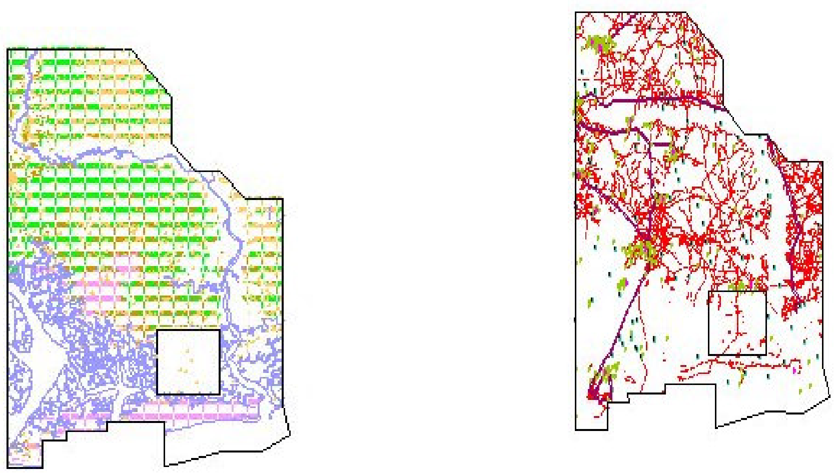

Figure 5. Samples of D^1

In effect, what is required when dealing with the responsive download of geographical data for the purpose of real-time emergency planning is a form of database generalisation. If this is predicated on the capabilities and requirements of the end user, in this case the mobile worker in the environmentally sensitive delta, then the hazard can be addressed more efficiently. The use of specific profiles, unique to each mobile device, is suggested as a major objective in achieving this aim.

6. CONCLUSIONS

Personalised content delivery depends upon knowledge of a user's interests and context, information maintained in user profiles. In this paper, we have described a typical framework for mobile handling of ESI dataset based on user profiles. To fully deploy a personalised and adaptive content delivery, we need to develop a set of techniques including modules for selecting users preferences, detecting client capability etc. We view the framework described in this paper as a first step in the migration of data handling technique into mobile applications. This could spawn a rich area of research in mobile data management for supporting emergency response to disaster management, since such domains are characterised by environments and circumstances that change. Specifically, the availability of resources and services may change significantly during the course of typical oil spill incidents. As a consequence mobile applications need to be capable of adapting to these changes.

It is important to note that although most attempts at mobile solutions have focused more on the latest gadgets or communication protocols, information flow management plays a central role in the development of mobile geographic information handling for applications such as emergency response. Application and information flow designers must begin to consider fast changing working environments.

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