# Incorporating Wireless Technology into Virtual Organizations Supporting the Work of Healthcare Teams

[1]Mohyuddin, [1]W.A. Gray, [2]David Morrey, [2]Wendy Jones
[1]*Department of Computer Science, Cardiff University, Cardiff, CF24 3AA, UK,*
[2]*Clinical Information Unit, Velindre NHS Trust, Cardiff, CF14 2TL, UK*
*Mohyuddin@cs.cf.ac.uk, W.A.Gray@cs.cf.ac.uk,*
*Dave.Morrey@velindre-tr.wales.nhs.uk, Wendy.Jones@velindre-tr.wales.nhs.uk*

## Abstract

*This study investigates how a virtual organization can be built in a distributed computing environment which includes wireless technology to support the work of a multi-disciplinary healthcare team collaborating to provide patient care in the cancer domain. It focuses on identifying the functionality required at the wireless device interface to provide the information from distributed resources needed by different members of the healthcare team to fulfill their role in a patient's care at the point of care. It presents the concept of virtual organization in a clinical environment supporting multi-disciplinary care teams whose members are collaborating to treat a patient more effectively by providing and storing relevant data from a variety of medical records / data resources available in a distributed computing environment to the virtual organization. An analysis of the healthcare teams at the Velindre Cancer Hospital, NHS Trust has identified the functionality and information required by different members of the care team at the point of care. This information will be used in the next stage of the project to inform the creation of a prototype virtual organization which will be used to evaluate this approach to supporting the work of healthcare teams. The paper concentrates on the role of wireless devices in the virtual organization particularly their use at the point of care.*

## Keywords

Virtual Organizations, Wireless Technology Application, Point of Care Computing, Patient Care Teams.

## Introduction

This paper investigates how wireless technology can be incorporated into healthcare information systems providing support to members of a multi-disciplinary care team caring for the patients at the Velindre NHS Trust Hospital. These care teams consist of medical professionals providing different skills needed in the treatment of the patient – clinician, nurses and therapists in this initial study. However, it is intended to include more skills in the future, if our prototype proves the feasibility of this approach. An initial study conducted at the hospital showed that different types of carers were accessing information from a variety of resources and that they needed different functions depending on their role in the team, for example, a nurse could be capturing basic medical data such as the temperature and blood pressure of the patient at the bedside, while a clinician might want to access data from a varied set of information resources available through the distributed computing environment to help his decision making in the future treatment of the patient. It was also clear that the care team could be crossing a number of levels of patient care as the patient could be an in-patient or an out-patient attending one or more hospitals. This means that the care team's members could be coming from what is known as secondary and tertiary care organizations. Our initial analysis suggested that an approach based on creating a virtual organization in the distributed computing environment would enable this collaborative working to be supported. This virtual organization would have access to a variety of information resources traditionally used in medical healthcare systems, but would utilize wireless technology to support the point of care activities of the members of the care team.

## Background & Problem Analysis

Wireless technology application is one of the growing fields today. It provides information access anywhere and anytime. It is applicable in many different generalized fields where automation can take place and information is required in real time and on the move. Healthcare is one of the biggest industries of the world; and it currently requires fundamental changes. Rise of patient volumes, shortage of active staff, medication errors and unavailability of centralized and shared information resources are some of the main issues that are currently faced by the hospitals [1, 2]. Real time information access to the patient records at the bedside is an important change, as it makes the information available at the point of care which will lead to better decision making and improved patient treatment. Usage of fixed wired computer systems is limited because these systems cannot provide this information where the health professionals often need it at the bedside. Thus it is important to identify how wireless technologies can be incorporated in such systems [3, 4]. The chances of success of wireless technologies are bright in healthcare where other systems have failed because of two important reasons. Firstly, wireless technologies harmonize well with the inherent mobile workflow of the clinical environment which is important to the healthcare professionals [5]. Secondly, the previous experience of clinical information systems has already created the valuable information resources and knowledge of how healthcare data can be used and this can be utilized by wireless systems to deliver the information where it is needed. Wireless technologies fit well into clinical settings because they do not change the current infrastructure, as these technologies complement the current infrastructure of wired computer systems and can be used in an unobtrusive manner at the bedside. Thus they can play a part in improving the services available for better patient care.

Looking at the existing infrastructure of hospitals, one of the main constraints for accessing health information is the unavailability of medical records / resources during the physician-patient interaction. There is a need for more interaction among the patient care team members for managing and handling the patient records in better ways and for internal communication. There is also a need to look for better ways of supporting patient treatment at the point of care by utilizing the information provided by the work of the other patient care team. Though each team member has different tasks to do, they also use / share some common information during the patient treatment for example checking the patient's vital signs. In practice work, it happens that sometimes the same tasks are repeated by the team members due to the lack of interaction. It is also observed that some of the patient information is not recorded at all during the treatment process, or if it is taken then it is not updated into the electronic patient record as is the case of manual bedside charting by nurses. Sometimes team members may be at remote places from where they can access the patient record. These requirements emphasize the need for an infrastructure such as a virtual organization supporting collaborative working with wireless connection to the point of care. This will act as a central platform for team members for patient record management and mutual interaction among them. Wireless technologies fit well into this situation. These technologies are not replacements of the clinical desktop systems; rather, they complement them in terms of functionality. The handheld devices allow the care team members to access and process the patient information at the point of care and in other required settings, thus making them free from the roundtrips of office for accessing wired desktop systems and from manual records and paper work. These devices can be used mainly for information access, information recording and information processing purposes at the point of care thus improving productivity and decision making [6]. The devices being small are also less intrusive.

## Virtual Organizations Background

There is no exact definition of a virtual organization, as different authors use different features to define virtual organization. Generally, the term represents individual companies or groups of people contributing their shared resources to a distributed computing environment, so it appears to be a single organization. Some authors also state that virtual organizations are established for limited time and for geographically dispersed members [7]. We use the term to define a computing environment which supports collaborative working of a group of people. This environment is dynamic in which features may be added or removed along with the requirements over time. We identify from the different definitions and examples of virtual organization, the following as important features to our work: 'trust among the team members; building flexible teams; communication, co-operation and co-ordination among members' [8]. Due to the dynamic nature of a virtual organization, there must be support systems which can deal with a variety of tasks and members interaction. The virtual organization system must be able to describe the features and functionalities, and must provide an interface for team formation, manage accessibility to the virtual organization by team members and enable them to carry out the required tasks

for their roles. In large enterprises, there may be different communities which are linked together in the virtual organization, but they have a common defined goal which forms the basis of the virtual organization [9]. The paradigm of a virtual organization works well with different forms of organization because it is based on the functionality and tasks level of the organization which can be managed easily [10]. There are plenty of examples of virtual organizations which merge together to create a platform for information access and sharing [11-14]. Most of the current work in this area looks at the aspects of virtual organization formation, access control for members, team work and behaviour, mutual agreement and framework as described in [7, 8, 10, 15-17]. The role of virtual organizations in the field of healthcare has not been widely investigated. As the team members work together to achieve a certain business goal of a virtual organization, it is clear that this is relevant to the work of healthcare teams. For these reasons we felt a virtual organization was a suitable model to provide distributed computing support for a multi-disciplinary care team and that incorporating wireless devices into the virtual organization could provide team members with information on the move and at the point of care.

## Theory / Work Overview

Virtual Organizations are already in existence and represent different individuals or organizations collaborating together for information / resource access and sharing. These individuals and organizations may be distributed in various geographical areas; but when in a virtual organization, they form a shared community. Various examples of medical grids give implementation of virtual organizations in bio-medical projects. But in our approach, the focus is on a virtual organization which is formed to support the collaboration of different members of the care team in treating a patient. Taking the healthcare environment into consideration, we are focusing at secondary and tertiary care level where patient information can be accessed from the existing resources like the database of the hospital or other resources available at intranet or internet level using wireless applications as an integral part of the distributed system. This information can be accessed and processed according to the roles and availability by the members of the patient care team. In our work, a prototype wireless application / system provides the interface for the virtual organization at the point of care. It allows different patient care team members to interact with patient records and relevant associated data at the point of care which is of utmost importance to the care team members

(consultants, nurses and therapists). The activities of these team members at the Velindre Hospital were analyzed by doing a case study to determine the functionality the virtual organization needed to give them at the point of care.

This study was important as the structure of a virtual organization needs to support the functional requirements of the patient care team in a clinical environment and must be based on the tasks and functionality required. Thus, the virtual organization has a twofold capacity of data representation. On one side, the data available from the existing resources like information systems / databases can be displayed on the handheld devices, thus improving the existing infrastructure. On the other hand, additions can be made to the existing structure by capturing information which is not currently available in the electronic repository of the enterprise or from available resources, and storing it in the virtual organization's resources.

## Study Results

It is clear from the Velindre NHS Trust's annual report [18] that it is a dynamic organization providing a diverse range of health services supported by computerized information systems. The annual report 2003 / 2004 of Velindre NHS Trust [18] shows that the systems needed improvement and that Welsh Assembly Government [19] is also looking to use new Information and Communication Technologies (ICT) to improve the patient information quality support for healthcare professionals.

Our study was conducted to determine how the different members of a healthcare team at the Velindre NHS Trust could be supported by wireless devices linked to a virtual organization. As the team members may be at remote locations, it is necessary for the virtual organization structure to cover internet enabled domains. After deciding on the feasibility of the virtual organization in the healthcare infrastructure, we looked at the roles of the members of the healthcare team and the data resources needed for the wireless handheld devices to support their work. Looking at the clinical aspects, we analyzed the tasks that can be performed using wireless devices by the patient care team members - doctors, nurses and therapists. We also identified the tasks that are better suited to the desktop systems in the virtual organization due to handheld devices limitations. The study emphasized the point of care computing requirements to be provided by utilizing wireless devices in the virtual organization environment. The outcome of the study is shown in the Table1. A tick sign in the wireless devices column shows the tasks which are doable using wireless

devices; while a cross shows the tasks which are better done using desktop systems or manual work.

**Table1. Analysis of tasks of patient care team's members**

| Members of patient care team / Tasks domain | Tasks at point of care | Wireless devices |
|---|---|---|
| **Clinicians** | Accessing physical / vital signs like temperature, pulse rate, respiratory rate, blood pressure, body weight etc. | ☑ |
| | Checking the laboratory test results | ☑ |
| | Consulting reference notes / guidelines for decision making like blood pressure classification readings, average pulse rate for age-wise children and adults | ☑ |
| | Checking right pharmacy / medicine on the basis of patient's symptoms | ☑ |
| | Accessing treatment history | ☑ |
| | Current treatment status of the patient | ☑ |
| | Current location status of the patient | ☑ |
| | Current disease status of the patient | ☑ |
| | Patient record retrieval using scanning barcode through devices | ☑ |
| | X-Ray and other large image analysis | ☒ |
| | Patient's referrals, detailed reports etc | ☒ |
| | Data entry / order entry involving time consuming and detailed keyboard input | ☒ |
| | Searching, comparing and consulting the cases for best evidence based medicine | ☒ |
| **Nurses** | Electronic data capture / recording of physical / vital signs like body temperature, pulse rate, respiratory rate, blood pressure, body weight etc, with updates in master record in central repository | ☑ |
| | Alerts and reminders for checking patient status and treatment | ☑ |
| | Checking drugs details and timings of dosage given to patients | ☑ |
| | Electronic bedside charting | ☑ |
| | Right identification of the patient and knowing their current status and details | ☑ |
| | Pre-defined screens for data capturing | ☑ |
| | Step by step workflow process recording, for example, patient's check-in / position status, physical / vital signs notes etc | ☑ |
| **Therapists** | Checking the previous therapy records / past history | ☑ |
| | Checking patient's disease symptoms and vital signs | ☑ |
| | Checking social history / living conditions of the patient | ☑ |
| | Knowing the last time examination and action measures | ☑ |
| | Last intervention done and current status | ☑ |

## Conclusion & Future Directions

This paper introduced and discussed the concept and aspects required to establish a virtual organization computing resource in a clinical environment, which supports information access and capture by the members of a care team utilizing wireless devices at the point of care. It has identified the functionalities that should be supported at the wireless devices linked to the virtual organization. These functions will be used in the next stage of this project to create a prototype virtual organization which will be evaluated by the healthcare team members to determine the suitability of this approach. It should be noted that in order to develop a full working virtual organization further consideration must be given to other factors like security issues, data and display size limits, limited power of mobile devices and bandwidth issues of the wireless devices. It must also be remembered that these devices are not a substitute for the desktop systems and applications but a complement to them in the virtual organization. So these devices cannot be utilized for every kind of medical applications, rather their best use must be determined so that the mobile, real time and decisive applications they enable

can lead to an improved infrastructure of healthcare through better support of the team.

Thus, we are working on the functional requirements of virtual organization and the utilization of handheld devices in a clinical setting, with the collaboration of healthcare professionals in the field. We are also looking at the common tasks, practices and exact information requirements of the members of the care team with aim of creating a virtual organization which provides better support for their work. As we receive feedback from the healthcare professionals on this approach, we will be working to improve the prototype.

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