

# Wirange: A Smart Wireless Field Test Analyzer on the Embedded Tablet

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## Abstract

*With the rapidly growing wireless deployment, the demand for the wireless field test increases rapidly. This paper proposes a new design for smart wireless field test analyzer on a 10.4" TFT LCD best finger touch screen-based embedded tablet device. Based on the advantages of portability on this platform, we have applied for an embedded system with the novel software architecture which provided customizable shell, system utilities and services. With this software architecture, it can be easily customized to specific applications for wireless field test analysis. The applications are widespread from site survey to floor planning. In this paper, we will propose several smart tools for wireless test analysis as examples.*

## 1. Introduction

Wireless area networks (WLAN's) have been growing fast recently in the enterprise, campus, stores, home and many other public areas. Successful deployment of an WiFi network requires careful planning and network design. This process includes determining network applications, coverage requirements, number of users, client device types, and equipment selection. In addition, unlike wired networks, planners must assess environmental obstacles that can impede radio frequency (RF) signal transmissions.

An existing WLAN network is often impeded by external frequency interferences and malfunction of the access points. Besides, balancing the network traffic to accommodate the workers' mobility and to maintain a quality of service (QoS) using a trusted tool is often required when the network is installed. Such a network measurement and analysis would require a portable test tool that uses a high-level, graphical user interface to interpret various themes on the spot and suggest actions to take. The test data need also to be recorded for a historic review, or simply for report generation.

The traditional method for performing an RF site survey includes a laptop equipped with an 802.11 PC Card and site survey software supplied at no additional cost from the radio card vendor. The software features vary greatly by vendor, but a common function among them all displays the strength and quality of the signal emanating from the access point. This helps determine effective operating range (i.e., coverage area) between end users and access points.

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For example, after "best guessing" the potential position of access points for adequate coverage and overlap, you verify your thoughts by placing an access point at each location, and then walk around with the laptop while monitoring and noting signal levels. The goal is to verify the maximum distances that will maintain adequate signal levels, generally the value that continues to enable operation at the planned data rate (e.g., 11 Mbps). If the predetermined location of an access point doesn't provide the coverage you had in mind, then reposition or include additional access points and repeat the testing.

This relatively inexpensive site survey tool has some drawbacks. For one, it's physically demanding to lug a laptop around a building all day when doing the testing. In addition, Laptop is not specifically designed for intuitive look and feel software for wireless test. You can ease this problem, though, by using one of the recently released 802.11 CompactFlash cards along with a pocket PC device. This reduces the physical demands of performing the tests, but you'll be lacking a significant capability: small screen and limited functions with only basic site survey functions.

The proposed hardware platform of Wirange is a ruggedized finger-touched 10.4" portable hand-held device powered by the battery and has a carry-bag that support single-handed usage scenario. The built-in WLAN card with embedded antenna can provide a physically non-extruding, optimized RF capability with accurate calibration for the measurement. In addition, we have proposed the Wirange provides the software package with the intuitive graphical interface presenting users a comprehensive graphical user interface on a large landscape on the screen. It has wireless testing capability for the IEEE 802.11 series. Furthermore, the proposed management software provides extra value to allow network installer, administrator and supervisors to do their work in a more productive way given that an intuitive graphical representation of the network presence, dynamic signal strengths and channel blockages can all be analyzed and compared against its previous data on the site map. The device also can seamlessly connect to the host computer to access the files on the fly during network testing operation, thereby reducing work overhead.

## 2. Hardware Architecture of the Wirange

In this section, we describe the design and features of a tablet-based wireless field test analyzer named Wirange developed by us. The goal is to build up this platform as an assessment, and utilize the embedded OS architecture like Microsoft CE.NET architecture to establish a smart wireless

filed test analyzer to satisfy the user's requirement with different user scenarios.

Fig. 1 depicts the hardware block diagram of the proposed Wirange tablet appliance system. The main components of this tablet appliance that addresses the low-power related design is described as follows.

**Processor:** Intel Xscale 400 MHz CPU.

**System memory:** Onboard memory with 64MB SDRAM.

**PCMCIA card 1 interface:** Provides the connection to wireless LAN modules with antenna built-in.

**PCMCIA card 2 interface:** It supports CF slot that can store wireless test data and logs.

**USB client interface:** Used to connect with PC to sync the data between PC and the Wirange.

**Flash ROM:** Onboard 32Mbits flash stores the boot-loader and OS image.

**TFT interface:** 800×600 non-interlaced 16bpp TFT.

**Audio:** It supports AC97 codec.

**Touch screen and controller:** This support finger-touch and drag-drop capability.

**Smart battery:** It can supply with the capabilities of recording battery capacity via SMBus.

**Navigation buttons:** Support as the short-cut to launch the frequent use functions e.g. screen keyboard.

Based on this proposed hardware platform, it can be designed as portable vehicle for anywhere WLAN analysis.

In later sections, we will explore the software architecture of the Wirange, which includes how we build up the application execution environment as well as the proposed features of the wireless field test analyzer on top of it. It includes site survey functions, network tester and floor planning.

### 3. Software Implementation of the Wirange

#### 3.1 Application Execution Environment of the Wirange

Fig 2. shows the software architecture of the Wirange. It is based on Microsoft Windows CE.NET porting its operating system and drivers on the hardware platform of the Wirange. In addition to the original software components on CE.NET, we have developed the system components of the Wirange to build up an integrated application execution environment to support various profiles of wireless field test analyzer. It includes the following features:

**Utilities:** system setting, Screen keyboard, buttons controls and advanced power management etc.

**Customizable graphical interface:** New shell design to provide Web-based graphic interface for easy to use purpose.

With this application execution environment, we have developed the .NET framework based embedded applications of the wireless filed test analyzer on top of it. Take wireless deployment as an example, we can refer the following steps are how users require the functions of these application tools:

**Site Survey before the WLAN is installed:** In this phase, a temporary AP will be placed in an initial spot while Wirange is used to measure the site surrounding until a good floor planning is composed. Based on network planning guidelines and the real test data results, the access point installation plan can be made.

**Network Installation and Testing:** When the WLAN is installed, Wirange can be used to test the receiving/transmitting capability of the access points, to help the network administrator identify the access-configuration strategies such that the network service quality can be satisfactory. The test results will be matched against the original design plan to ensure the proper network installation.

**Service and Maintenance:** When the WLAN is deployed, either on a regular basis or on call, network administrator need to do trouble-shooting and possibly adjust the network configuration. Such needs are often a result from unexpected signal interferences due to the signal echo from new construction, furniture and equipment, or the signal generated by other sources. Wirange can help to quickly retrieve the floor planning and to compare against its current situation for interference analysis.

**Report Management:** All the test data are organized into a structure to support easy viewing graphically, update, retrieve and printout from the server.

With the description of the above requirements, we are going to describe how we design the functions of the embedded software to fulfill those.

#### 3.2 Features on Site survey of Wireless Field Test

In the site survey functions we implement wireless analyzer framework to interface with low-level wireless driver to get the site survey information such as the list for access points or ad-hoc devices, wireless connection status etc. Then, we can base on the information to enhance the functions to channel statistics for radio frequency channel and the records for historic data for specific wireless signal strength as shown. Below, we will describe several special functions to support the site survey capability.

##### 3.2.1 Site survey information

Wireless analyzer framework will scan the wireless information and display the following information: Device type (Ad-hoc or Infrastructure), channel, SSID, Mac address, signal strength, WEP mode, vendor ID, support Rate, link quality, & Transmission rate.

##### 3.2.2 Channel statistics

Channel Statistics is divided to three parts: channel blocking, Ad-hoc distribution and Infrastructure Distribution. The detail description as below:

**Channel Blocking:** it displays the highest signal strength on each channel showing which channels have been blocked.

**Ad-hoc Distribution:** it displays the number of ad-hoc devices on that channel.

**Infrastructure Distribution:** It displays the number of access points on that channel.

### 3.2.3 Historic data

Historical Data is used to periodically record the data of signal strength and throughput result through visual curve graph. This helps users to identify the changes of the signal strength by observing the curve of the graph. It also supports save the record to files and capture the curve graph as bitmap file for future reference.

### 3.2.4 Report generator

Report generator is a smart tool with wizard to store the valuable information. The information sources are site survey information, throughput data and ftp data from network tester. This report generator will output as text. Each file includes the header information with user name, test point, site survey information and detail connection information.

### 3.2.5 Smart Tips

The function of smart tips implements as instant help agent. After user enable the smart tips, it will popup the how-to description with XML formats once he touches the area what he would like to know the tip information as what he see as what he get.

Fig. 3 is one screen shot of site survey functions we have developed. User can get the major information within one screen during field test. The upper screen is site survey information and lower screen is the detail information for one remote device to be connected or associated. With the concept of digital dashboard, it is implemented as browser-based graphic user interface with JavaScript to access the Active-X components for local information. Hence, it can be easy to customize the different graphic user interface through the solution providers.

## 3.3 Features on Network Tester of Wireless Field Test

In addition, to access the wireless information, user required network testers to identify if the problem is network layer or wireless layer. Wirange develops the test utilities includes throughput Testing, browser, FTP client and Ping function.

The output data of different utilities helps the user to comply with the information of wireless to trouble shoot the overall network environment.

## 3.4 Features on Floor Planning of Wireless Field Test

In this section, we resolve the problem description to wireless deployment issue by using floor planning. The floor planning stands for planning the wireless deployment within the areas like office, school, and hot spots. The users need an intuitive user interface and software to guide them to setup the wireless equipments such as access points. In addition, they need the way to trouble shoot and maintenance the deployment.

As shown in Fig. 4, it is the application architecture of floor planning. The definitions of those major software objects and its relationship are described as below:

**Display agent:** This agent provides appropriate visual cues on the sitemap for user decision making, the visual feedback of user operation and the visual cues of operation mode.

**Interaction agent:** It interprets all user operations and calls up appropriate application by user request.

**Networking agent:** It includes all Wirange floor planning functions related to networking, such as WLAN site survey function or FTP function. It also will return the networking test result to the display agent for creating feedback to users.

**Drawing agent:** It is a painter function for editing background site map of floor planning. Users have to switch to drawing mode to draw on the background map.

**Creation wizard:** It leads user to go through whole process for creating or editing sitemap. Project creation wizard, access point creation wizard, test point creation wizard, networking object creation wizard, common object creation wizard and preference wizard are sub wizard of creation wizard.

**Map generator:** The agent retrieves all information from database for generating a static sitemap, and stores all revised information back to database. Its main function is generating a static map for floor planning.

**DB:** A relational database stores all information about sitemap.

From above, Wirange proposes the ORDI (Object-Related Digital Interactive) methodology which means it uses the concept of zooming to display visual 3D floor plan. Take Fig. 5 as an example, if the user is going to deploy wireless LANs on a campus, it can drag-drop the dynamic objects e.g., Access point, test point. Each dynamic object is an object with database and it can be update if required. Hence, it can edit the information off-line to get the real test data on the filed. In addition, there is graph objects e.g. buildings, layers of floor and floor. Users can drag a building graph object and defines it layer of floors. Then, it can select the specific layer of floor to enter detail geographic or floor layout.

Hence, through this concept, we have designed this hierarchical structure and database. Users can load the CAD file or bitmap file as the background of the layout then users can put into each object and its data with this intuitive ORDI user interface at deployment time.

As to the maintenance time, user can retrieve the historic ORDI map and get it original layout as well as the value of test point to assist the judge the problems e.g. the malfunction of one access point, new interference etc.

## 4. Conclusions and Future work

Wirange has been implemented to have the wireless filed testing capability for WiFi environment.

The built in WLAN card with antenna can provide a physically non-extruding, optimized RF capability with accurate calibration for the measurement.

This proposed management embedded software based on Microsoft Windows CE.NET provides extra value to allow network installer, administrator and supervisors to do their work in a more productive way given that an intuitive

graphical representation of the network presence, dynamic signal strengths and channel blockages can all be analyzed. Thereby it is reducing work of administrator.

Furthermore, we have developed a wireless tablet appliance as a reference platform to implement the smart wireless field test analyzer. As to the embedded software, we have explored the functions for wireless field test analyzer including the measurement of site survey functions

### 5. References

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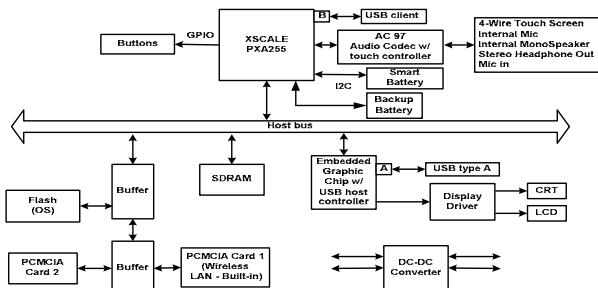


Fig 1. Hardware block diagram of the Wirange system

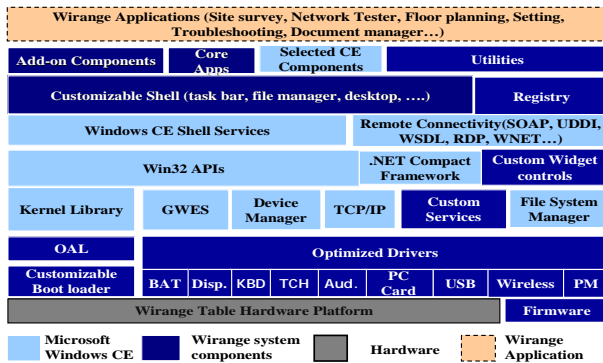


Fig 2. The software architecture of the Wirange

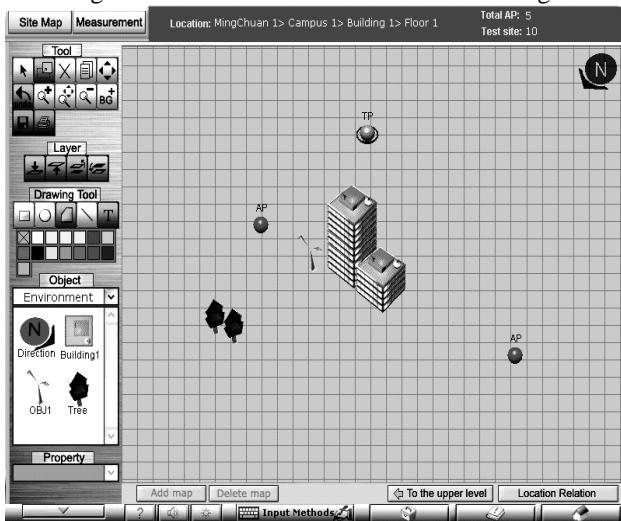


Fig. 5 The Screen shot of floor planning for the Wirange



Fig. 3 Screen shot for site survey functions for the Wirange

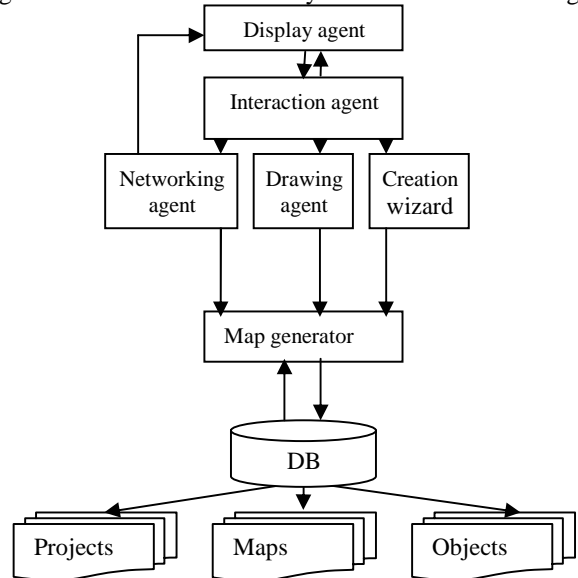


Fig. 4 Software Objects of floor planning for the Wirange