

## Study of potential of Wireless Internet Technologies in Manufacturing

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### Abstract

The paper analyses the development of advanced and Internet manufacturing technologies and the possibility of Wireless Internet Manufacturing (WIM). It presents the fundamental conditions of WIM and the applications of Wireless Internet, WIM and Wi-Fi. Three different WIM models with important kernel technologies and their solutions are discussed at length. They are important references of the application of Wireless Internet Manufacturing.

*Keywords:* Internet; Wireless Internet; Manufacturing; Kernel Technologies

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### 1. Advanced and Internet Manufacturing Technologies

In 50-60s the stratagem of manufacturing employed was the scale of manufacturing and its benefit that were based on a resource economy. In 70-80s the consideration was price and quality, and in 90s it changed to quick response to the market conditions. Then in 21st century the knowledge economy demands innovation in technology. In 70s the research highlight was CNC/FMS internationally, in 80s it was CIM, and in 90s it changed to Agile Manufacturing. Then next research focus moved on to Internet Manufacturing Technology. And it is anticipated in the future it will move to WIM.

In the 60s the production model of manufacturing was mainly to produce large quantity through automatically manufacturing line. At the end of the 70s and the beginning of 80s, a new production model and manufacturing technology of CIMS appeared. At the end of 90s people began to research the new production models and Internet Manufacturing Technology<sup>[1]</sup>. WIM is a new one after the advanced manufacturing technologies such as CIMS, Internet Manufacturing Technology and so on.

As advanced Internet Manufacturing is gradually gaining popularity in the world, industry is trying to introduce WIM in some countries. The ordinary PC laptops and PDAs (Personal Digital Assistant) etc. have been introduced with wireless adapters that help them connect to the Internet. It is anticipated that wireless Internet will be widely used in a number of enterprise applications. In this paper a scenario about wireless Internet in manufacturing will be presented. With the advent of very powerful mobile devices with wireless connectivity manufacturing enterprises are looking towards adopting these in a variety of manufacturing activities as a new paradigm to seek improvement in productivity and cost cutting.

### 2. The Foundations of Wireless Internet Manufacturing

There are a number of issues in the wireless space to consider before designing a solution for any particular manufacturing activity. Some of the issues, which would impact the success of the solutions, are wireless network technology and bandwidth, form factor of the mobile device, type of content to be transmitted, user interface, etc. In the following sections we will discuss the salient features under each of these issues.

3G will be a good foundation of WIM. Certainly on the 2G we can complete some of Wireless Internet Manufacturing. The three generations of WAN (Wide Area Network) air interfaces and wireless Internet are:

- 1G e.g. Frequency Division Multiple Access (FDMA) and Advanced Mobile Phone Service (AMPS) and, from 80s to now – each caller has a dedicated frequency channel. 1G is strictly for voice calls.
- 2G e.g. Time Division Multiple Access (TDMA) and Group Special Mobile (GSM) (or Global System for Mobile Communications), from 90s to now – callers timeshare a frequency channel: 9 callers use 3 channels.
- 3G e.g. Code Division Multiple Access 2000 (CDMA 2000) and Wide Code Division Multiple Access (WCDMA) and, from end of 90s to now. Each call is spread, randomly broken down, and mixed: 14 callers use the full bandwidth of one channel.

Now the worldwide mobile cellular subscribers: 1G AMPS 14%, 2G GSM 58%, TDMA (US) 8%, PDC-Personal Digital Cellular (JP-Japanese) 8%, CDMA 12%<sup>[2]</sup>. There is a little part in CDMA that would belong to 3G. From these data, it is clear that majority of cellular subscribers are on 2G.

#### 2.1. 2G Generation

The 2G air interfaces are cellular. It includes data services, fax, and email. Almost every wireless device sold in 2001 uses one of the second generation of air interfaces (i.e., TDMA, IDEN-Integrated Digital Enhanced Network (Motorola), PDC, or GSM).

CDMA was commercially introduced after TDMA. It is a radically different air interface, using military spread-spectrum technology. A CDMA tower and phone break a transmission into random pieces and space it out over the entire allocated 1.25 MHz bandwidth. The randomly spread frequencies are transmitted all at once. Over the air, it is secure. Unlike old AMPS phones where anyone can use a frequency scanner to listen in, CDMA is impossible or very difficult to detect. If you turn on a frequency analyzer, you will see only a noise floor buildup as multiple callers appear. The separation pattern, or “code,” is used to break up and reassemble the signal. Because CDMA spreads fragments over a larger frequency band, it is significantly more power efficient than TDMA technologies. This conserves battery life and is safer. CDMA escapes form rigid time slots, is dynamic, and can allow for variable sized bursts of data. Although GSM and TDMA are well evolved, CDMA has many advantages such as secure spread-spectrum signal; dynamic “burst” signal for data; improved handoff; better subscriber capacity; better sound quality, etc.

#### 2.2. 3G Generation

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3G is the world's first all wireless bit stream network intended for global coverage. 3G provides wireless Internet transmitting voice, data, photos, audio, and video – all data bits running on a wireless based cellular network. 3G has some remarkable features: it is always on; it allows easy transparent roaming from network to network, etc. It is largely based on CDMA technology and benefits from the many CDMA features.

Transparent roaming (or transient roaming) is the ability to continue a data or voice call over multiple networks without dropping the call. A person could smoothly communicate while traveling between home and office, visiting the countryside, and working at a business through interoperable handoffs among networks. 3G IMT-2000 (International Mobile Telecommunications 2000) allows transparent handoffs between terrestrial and satellite connections. Plans are afoot to deploy 3G services in China during 2008 Beijing Olympic games.

### 3. The applications of Wireless Internet

Successful mobile applications deliver simple choices and useful information. Great thing about wireless Internet technology is that it moves applications off the desktop and renders it mobile traveling with the user. Creating good wireless Internet applications and useful content is the key. Many new wireless Internet technologies will be introduced that will run faster than the wired connections we get today. The Ultra Wideband (UWB) wireless can transmit at 1 gigabit per second.

#### 3.1 Four wireless Internet applications for manufacturing

Wireless applications and their progression follow the popular evolution of the primary wired Internet applications. To plan a wireless mobile application, there are four functionally different wireless application families: messaging, browsing, interacting, and conversing.

*Messaging.* Using devices like the Nokia Web phone, RIM 957, or a Motorola pager, people send messages. They use Short Message Service (SMS) and other email protocols. The message channel is not just for messages. Developers write SMS applications, often with a SIM (Subscriber Identity Module) toolkit.

*Browsing.* With microbrowsers people use their Web phones, handhelds, pagers and so on to read Web sites that developers write in simplified HTML, WML, cHTML, HDML, and XHTML Basic.

*Interacting.* A large category of mobile interactive software is written by developers to run on the mobile device. This category is unlike the other application families. It does not require a connection. To work offline, professionals process records and gather information for business applications, and then connect as needed.

*Conversing.* In addition to calling someone directly, people can call into voice portals like Tellme and Wildfire to get information from Web servers. Software developers program voice gateways in Voice XML (eXtensible Markup Language) and VML (Voice Markup Language) to listen and to speak in the format of dialogs.

#### 3.2. The WIM applications

The main activities of manufacturing include the order generation, designs (including: concept design, detail design, structure design, model design, process planning design, analyzes, etc), factory or shop floor control, supply chain, assembly, sales, maintenance and service. At every step there will be data exchange and information flowing. Wireless Internet will play a more important role in them. By the technology we can increase the productivity, profits and reduce the time, errors. Personnel of a company would

become as designers, salesmen, maintainers, and so on at the same time if they were very smart and had the abilities. And people can work at any time and any place as long as they want to. Except the machining (shop floor) must be completed in the factories, many jobs can be finished in the mobile enterprises. Design data can be transmitted on the 11 Mbps (802.11b). So 802.11a and 802.11g are better to adapt for manufacturing.

#### 3.3. The Wi-Fi applications

Wireless Fidelity (Wi-Fi) technology, which is based on the IEEE 802.11b standard, transmits 11Mbps at 2.4GHz spectrum. Other related standards are 802.11a and 802.11g etc., which operate at the 5 GHz and 2.4GHz spectrum, and provide transmitting speeds of 54Mbps and 22Mbps respectively. And now, some cities, such as Long Beach, California, USA, have offered free Internet access with the hope of attracting business and tourism. For the business traveler, continuous connectivity via Wi-Fi will soon become a reality<sup>[3]</sup>. At some airports and conference centers, business travelers can use subscription-based Wi-Fi services.

A land-grab frenzy will propel the U.S. hot-spot market to grow by an estimated 46,000 new locations this year (2003). By 2007 the growth will be 530,000 hot spots in the U.S. In Europe, almost 800,000 hot spots will be installed by 2007, while in Asia, by even the most pessimistic estimates, there will be more than 1 million hot spots by 2007. A more optimistic estimate places that figure at almost 4 million by that year<sup>[4]</sup>.

Five major Asian telecommunications carriers recently have joined forces to create a group called the Wireless Broadband Alliance that will integrate 8,600 Wi-Fi hotspots in five countries under a single service. The five carriers are China Netcom Communication Group Corp., Korea Telecom Corp., Maxis Communications Bhd. of Malaysia, and Singapore's StarHub Pte. Ltd. and Australia's Telstra Corp. Ltd. The number of hotspots will increase to 20,000 by the end of 2003, including coverage of 17 international airports. An important aspect of the scheme is to provide seamless Wi-Fi roaming through the five countries.

Toshiba Computer Systems Group (TCSG) formally launched a project to deploy 10,000 hot spots in the U.S. by the end of the year of 2003. The TCSG Company intends to become the dominant supplier of 802.11b hot spot infrastructure.

The applications of Wireless Internet show that many countries are interesting them and have been adopting some activities to occupy the market and to attract business and consumers. It is clear that the applications of Wireless Internet have a great market. It is important to pay more attention to them.

### 4. Models of Wireless Internet Manufacturing

There are three models here:

- Perfect new model  
This would require perfect new wireless Internet infrastructure including the contents. Under the model all the application devices can operate smoothly and reliably. There will not be any conflicting problems. The system will be seamlessly integrated with each other. The system can work efficiently. But it will need a lot of time and people to construct and manage them. And it does not have the feature to connect with the wired Internet and cannot directly use the legacy content and data.

- Combining model  
This kind of model will exist with the wired Internet and wireless Internet. The key problem is interface technology that must be solved perfectly before its wide application. In this model the legacy or new contents and data can be used by wired Internet and wireless Internet. But there will be many conflicting problems and the devices could not be compatible with others.

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Some devices need middleware to connect with the system. Standardization will be needed for transmission of messages to various kinds of devices.

- A model based on Wired Internet

Some people think that the Wireless Internet is about to make Internet movable. A person could smoothly communicate by Internet at anytime from anywhere. As long as the moving device could be connected in the wired Internet, the Wireless Internet will have been set up. We do not need create any contents and the contents in the wired Internet can be used by Wireless Internet devices. Reality we could not directly use those data that stored in the wired Internet. They will be conversed usually before application effectively.

Comparing the three models, the second model is better. That can use the original resources and create some special usages.

## 5. Kernel Technologies

The wireless Internet technology is in its infancy, and new users to the technology often have many complaints. It is clear that battery charges last a short time and wireless coverage is limited. But consumers expect more. The common complaints are:

- The aspect of quality: the device is too heavy, technology is too immature, too little content available, security not reliable, and so on.
- The aspect of price: the device is expensive, network charges too high.
- The aspect of convenience: the device is not like desktop, coverage too limited, too hard to use, the fonts too small, the application runs differently on each device, does not work in other countries, etc.

There are still some problems the users have not considered, such as the electromagnetic spectrum.

The kernel technologies that in the application of wireless Internet technology must be solved are followings.

**Spectrum.** The electromagnetic spectrum is not unlimited. From longer wavelength (lower frequency) to shorter wavelength (higher frequency) occupied respectively by Sound Waves, AM Radio, FM Radio, SM Radio, Cellular Phone, Radar, etc. If we do not pay more attention to the use of electromagnetic spectrum, there will be no electromagnetic spectrum to use in the near future. A good plan of using electromagnetic spectrum should be made by the government of a country and the organizations of the world.

**Transmission speed.** From 1G to 3G the transmission speed increases greatly. New generation of wireless communication will continuously appear within ten to fifteen years. As long as there is the demand of high transmission speed, scientists and engineers will find good methods to solve the problem.

**Security.** From above we know that using CDMA will provide security. Varieties of security methods having wide implications are being researched. There are a lot of technologies and methods for security now. For example, Japanese inventor Mikio Hasebe, patented a method of sending an email to a lost or stolen device that will lock the appliance or erase its data. With this method, the owner of a wireless-enabled device chooses a password and a security response. If the laptop is stolen or mislaid, the owner can write the password in the email and send it to the device. The device self-destructs immediately.

**Structure of data and Database.** People have had experience about how to use different databases in different operation systems. But in the Wireless Internet the devices are very different and the operation system are different. Till now there are not good data structures and databases for Wireless Internet or for Wireless Internet Manufacturing.

**Middleware.** The middleware is important for accessing Intranet or enterprise system from mobile locations through the

use of the efficient and secure wireless. There are many companies researching this problem in the world. The leading wireless middleware company is Broadbeam. Aether is number two. IBM Websphere and so on. They offer the following features:

- Data compression.
- Security. Through various forms of encryption and authentication, they provide end-to-end security between mobile wireless devices and servers.
- Microbrowser and proxy server software.
- Cross-platform development tools are designed to produce multiple-platform targets from one application.
- Roaming across data network management and remote administration for large numbers of devices.

**Simplify.** From the complaints of consumers it is clear that simplification is very important. In all research jobs every body should pay more attention to it.

## 6. Conclusion

The technology of Wireless Internet develops quickly. Though it is still in its infancy there are some enterprises using it for their manufacture activities. There is no doubt that the Wireless Internet has a great potential. It will be useful in many areas. Early adopters of this technology will lead the future competition. Now the most successful application of WIM is in the aspect of management and sales. It is hoped that subsequently the applications will spread quickly to other areas of manufacturing.

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