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Logistic Services Using RFID and Mobile Sensor Network

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Abstract A Superiority in information technology became an important factor influencing success or failure of the national defense, and prompt delivery of information gathered from IT serves as a core factor in exhibiting combative power of the military. Furthermore, applications of these technologies can lead to increase in strategic capabilities like sensing and detection, exchanging and sharing advanced real time information and increasing community power of the strategic units. Therefore, the author wants to research core technology sector that can be developed and applied in preparation of ubiquitous national defense era. In particular, this paper aims to design Logistic system that is mobile sensor network and RFID based.

Keyword: Logistic, Mobile, RFID

1. Introduction

Living environment of mankind is becoming more automated and intellectualized, and evolving into information and knowledge centered cultural society. Following these revolutions in information technology, superiority in information technology became an important factor influencing success or failure of the national defense, and prompt delivery of information gathered from IT serves as a core factor in exhibiting combative power of the military. , the basic fundamental of military system, as well as the paradigm of a war, is changing remarkably. Concept of mass destruction using conventional weapons is changing in to concept of precision attacks which only destroys core military targets in precise manner [1].

2. Related Works(Ubiquitous Computing)

The word, "ubiquitous," which is widely known to us means "Anywhere Anytime," "Co-existing" in Latin. It is generally used to express existence of natural resources like an object or air, or to symbolize existence of supreme power transcending time and space.

In the information technology sector, ubiquitous is accepted as a new type of IT environment or IT paradigm like the "ubiquitous computing" or "ubiquitous network." Simply, ubiquitous communication or ubiquitous computing does not mean adding a function to a computer or putting something in it but means insertion of a computer that matches the role of an object like a cup, a car, eyeglasses or shoes and allowing communication between objects. Presently, as specialized tasks or Internet can be accessed through wire-less communication network using portable and convenient post PC products like PDA, Internet TV, Smart phones, etc, without the limitation of the time and space, it is forecasted that the ubiquitous computing will gradually grow in the future following development in technologies or products related to these devices [2].

The word "ubiquitous computing" originated from Mark Weiser, a researcher at the Palo Alto Research Center in the United States. Mark Weiser defined "ubiquitous computing" as an environment where users can acquire information needed from a network anywhere, anytime by actualizing communication network that does not have gap between cable, wireless or close range wireless network. Simply, he proposed actualization of network environment allowing connection to a computer attached to the network with-out the limitation of space and actualization of pocket size, computer built-in devices or humanized computer interfaces at the same time.

Table 1. Technology Sector

Technology Sector	Existing or Introducing Technologies	Evolution of Ubiquitous Technologies
Computer	-Micro-processing Chip -Advanced direct technologies such as nano and Parallel processing -Certification and Security Technology	Portable, built-in, invisible technology
Network	-Networking (IPv6) -Device Connectivity Technology (Including P2P related technologies)	Seamless connectivity technology
Human (Interface)	-Passive, Active Sensor Technology -Short Range Wireless Technology	Automated direct interface technology between a human and an object
Application	-P2P/GRID Technology -www.Java.XML	Network based complex application Middleware technologies

In addition, Mark Weiser defined four characteristics of ubiquitous computing.

First, a computer that is not connected to a network is not a ubiquitous computing. Second, as a humanized interface, it should be invisible. Third, computers must be accessible in reality not in virtual reality. Fourth, services must change following user environments (location, ID, devices, time, temperature, brightness, weather.

Along with these characteristics, he has newly defined evolution of computers centering on the relationship between the computer technologies and the human. The 1st wave as an era of main frame where multi-users shared one high costing computer.

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The 2nd wave as an era of personal computer where a single user used a computer. In addition, he defined ubiquitous computing era as time when people can utilize information from a network without being aware of existence of various built-in computers, and forecasted that changed in these technologies throughout 2005-2020 will create renovated ubiquitous culture. Presently, we are stepping towards ubiquitous society. Mark Weiser has stated the importance of study on five types of issues such as visibility, complexity, simplicity, connectivity, invisibility, for materializing ubiquitous computing society[2].
That is, network based application (complexity) suitable for ubiquitous era must be suggested basing on existing research works and theories. Ubiquitous computers must be-come more advanced in terms of performance, functionality and promptness (simplicity) than existing computers through the use of technologies such as Nano technology and parallel computing. Ubiquitous network must allot higher scaled computing space to the clients through improved internet, fast, reliable and safe communication services and acquisition of larger broadband channels (connectivity). Lastly, computer interfaces such as keyboard, mouse, etc., should be materialized (invisibility). Important keywords in ubiquitous computing are computer, network, human and application. Among technologies that exist or is being introduced to us based on these keywords, which may be utilized in the ubiquitous computing are shown in the table below. These technologies are either being used widely now or have reached the level of technical utilization, and forecasted to affect ubiquitous computing greatly. IPv4 is a 32bit addressing system with 4.3billion IP addresses. However, we are facing shortage of IP addresses and this problem may be solved using the IPv6. IPv6 is a 128bit addressing system that will soon to be introduced in the market, which is capable of allocating 340 gan(3.8 x 1038) IP ad-dresses, meaning to say that we will be free from the IP address shortage with application of this technology.

3. Application in Military

3.1 Mobile Sensor Network

Sensor network will consist of various sensor nodes equipped with sensing function, information processing function and communication functions. These nodes will be as-signed to a specific strategic mission and create ad-hoc network among them automatically to collect information from the real world and to provide application services by processing these data. Sensor network technology in the national defense sector can be used in the various types of field sectors. For example, large number of sensor nodes such as smart dust or miniature unmanned UAV, etc., can be assigned to the strategic location in the field to carry out surveillance and reconnaissance missions. It is noted that the number of sensor network will exceed ad-hoc network by far. These sensor nodes will be closely distributed in a small area executing broadcasting communications. Also, these sensors are by far smaller than the ad-hoc network nodes utilizing low power batteries thus replacement might not be easy. As fundamental units of the sensor network, sensor nodes will be assigned to strategic locations to collect data, process data and to transmit processed information to the upper level networks through the mobile communication devices. Sensor nodes are micro controller installed mini-computer systems. Thus, the operating system of the sensors nodes to process sensing applications and to communicate between nodes, will run under sensor node hardware with limited hardware resources. The sensor node OS should be small, electric consumption should be minimal, and should be designed to manage process and memory efficiently while providing low power communication services among sensor nodes. Also, in order for the sensor network to service various types of tasks, general purpose hardware or software will not be used. Hardware and software can vary depending on the applications thus the operating system should be flexible and designed with modules to be effectively used for other types of hardware. Sensor nodes should be de-signed to withstand various types of external factors for it is difficult to maintain or re-pair sensor nodes once they have been assigned and the operating environment might be inferior. Lastly, simplicity of ad-hoc routing protocol used in forming sensor network and programming should be considered. These data will be transmitted between sensor nodes using RF signals by the radio equipments. Transmission and reception of RF signals will fall under the physical layer, the lowest level of the OSI model. As the low layer creating data links, MAC connected to the radio device will service data packet exchange among other nodes. Network protocol of sensor network should provide ad-hoc routing services and communication services to other sensor network and military communication net-work such as military communication satellite and TICN system. In order to provide these services, sensor network protocol requires few additional specifications in comparison to existing network protocols. Such as efficient power management, data centered, overall collection of data, attribute based address and location recognitions.
Efficient power management should be solved by considering overall factors using electricity to create the sensor network. This is closely related to the low power routing. Data centered means that sensor nodes will not be entitled to a dedicated address within the sensor network for communication but the sink (base node) will broadcast Interest to all sensor nodes and sensor nodes matching the Interest will transmit data to the sink. Meaning to say that the addressing scheme will require attribute based addressing scheme. Combined data collection means that a node will collect data from several nodes and processes these data and transmit meaningful information to the base node. This will reduce the number of transmission and electric consumption and will solve implosion and overlap problems that can occur from the data centered routing.
Implosion is transmission of the same data through various routes and the overlap problem occurs when various nodes accumulates unnecessary data during surveillance of the same area. In the attribute based addressing scheme, dedicated address is not provided to nodes. Thus, the sink node will query data (attribute) Interest to sensor nodes and only specific nodes matching the query will transmit data.

Also, sensor nodes operated under limited number of energy sources should operate without replacement for months to years depending on the characteristic of the application thus the life cycle of the child node will depend on the management of the energy sources attached to the sensor nodes during the construction. Presently, methods and materials for low power consumption is actively being developing and utilized for the designing of sensor nodes.
Location searching technology is required to collect location of each sensors located within the sensor network, either through centralized or distributed method.

Processing accurate location of sensor nodes will provide geographical information of the event occurrence, allowing routing and target detection functions based on the processed geo-graphical information.

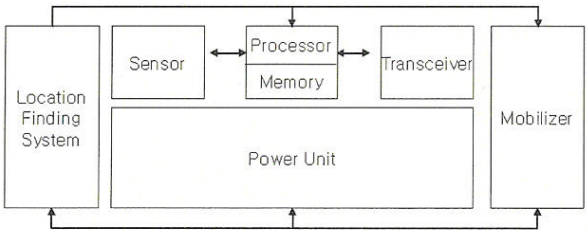

Fig. 1. Structure of Sensor node

These location data will become absolute or relative location information depending on the types of the application. Generally various measurement techniques utilizing supersonic or RF are being suggested for location measurement within the sensor network. Normally the location should be measured based on the arrival time, signal strength, direction and distance from the base. Due to the large number of applications that can be used within the sensor network, large types of sensors exist. Sensor can be largely classified in to 3 types; Passive, Passive0-Array and Active. Sensors such as vibration, illumination intensity, temperature, etc, falls under the passive sensors, bio-chemical, infrared, etc, falls under the passive-array sensors and radar, sonar, etc, falls under the active sensors. Presently active movements for standardization is under way and the author will commonly discuss low pricing, standard interface, network, smart sensing and actuation.

3.2 RFID

RFID is a core factor in constructing ubiquitous logistic support. In the0 ubiquitous logistic support, identification, location check, status check such as damages, usability measurement, route tracking, etc, of all weapon system will be processed in real-time without help of man. In addition, headquarter, militant units and logistic support units can acquire real-time information of the supplies suitable for the war situations, can request supply, operate repair systems, search the optimal route for supply and process priority supply orders in real-time. In the perspective of the combined war management, the ubiquitous logistic support will bring large impact.

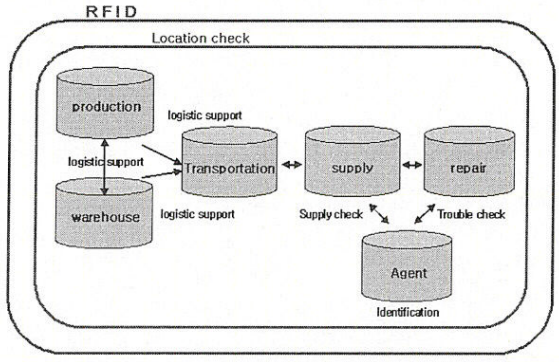

Fig. 2. Structure of Logistic system

All weapon systems, vehicles, equipments, military facilities, supplies, parts, ammunitions, etc would be attached with wireless recognition tags and chips having functions for sensing, data processing, data saving and communications, for creation of ad-hoc network among them, to be connected to future military communication networks such as the military satellite communication and TICN system. RFID will utilize radio frequency for confirming materials, entry (or transfer) of staff, locations, or to identify categories. RFID system may function properly by combining reader, transponder and computer or any other devices that can process data [3].

The RFID reader contains electronic circuits that transmits and receives frequency from and to the transponder (or to tags). The microprocessor built-in to the reader will encode signals transmitted by the tags, will authenticate the data signals, may save this information in the memory devices and may transmit this information when necessary. The reader contains antenna for transmission and reception of signals. Antenna used to transmit and receive signals may either be attached to the circuit board directly or may be contained in the private case. Within the tag, custom built IC chips serves as an important part, controlling communication from and to the reader. The storage device within the chip is divided in to various sections. A section for storing certification number and other data and another section to receive signal activating tags from the reader for transmitting information of the tag. Within the tag, capacitor for synchronizing frequencies with the antenna attached to the chip is installed. Tags normally contain memory devices to store data per address and capacities ranging from 8bit to 16K BIT is normally used. Most of the RFID systems are custom designed and allotted with dedicated frequency and antenna size for smooth operation. Signals transmitted by the reader through the antenna have adequate size of signal range. When the tag passes through the signal range of the antenna of the reader, the tag will sense the signal transmitted by the reader and starts to transmit information stored within the tag to the reader. Generally, frequency signals transmitted by the reader to the tags contain timing information, providing enough electric force to activate the tag. When the tags transmit data to the reader, the reader alters this information to digital signals and decides authenticity of the information transmitted by the tags through the CRC checks. Tags are generally classified in to active and passive. Active types require batteries. It either receives operation power from external devices or from batteries attached to non-metallic case of the tag. Advantages of these types are reduction of unnecessary powers from the reader and possibility of extending signal recognition distance from the reader. For the disadvantages, operation time may be lim-ited to the life of the batteries, can be used under optimal environment only and having higher costs than passive types. Passive type tags do not require internal or external power sources and can be operated using electric signals transmitted by the reader. For the advantages, passive tags are lighter and cheaper than the active tags and can be used for semi-permanently. On the other hand, the passive tags have disadvantages of having shorter recognition distance and requiring higher power loads for the readers. These tags can be classified in to 3 groups following the functionality. First, read and write, second, write once and read often, third, read only type. These types of tags can be applied to both the passive and active tags. Distribution and retail sectors can utilize status check and location detection function of the RFID ubiquitous network optimally. RFID tags attached

to products (or box, transportations, fork lift, etc) allow efficient tracking of location of the product, stock management, customer management and automated trans-action. As mentioned in the early part, utilization of RFID technologies in logistics sup-port tasks, where large number of stocks is being maintained in comparison to private sectors and frequent miss delivery is occurring due to lack of inter-connection among producers and consuming troops, will greatly improve efficiency of the task. All military weapons, vehicles, military facilities, supplies, ammunitions, etc can be controlled through out processes such as production, supply, transportation, stock management, repair management and disposal, using a chip. Which means that the RFID installed military supplies, can be connected to the delivery route information to find the optimal path for delivery to the supply units, and the supply units can recognize the necessary supplies for each consuming units for future delivery of supplies. Using the communication between RFID chip and information system, adequate level of supply can be man-aged without the help of man hours. Also, supplied logistic support supplies would be connected to the repair system during the expected lifespan. Information such as location and status of the equipment will be used for calculating weapon system and utilization frequency in real-time. Efficiency of the equipment will be raised by assigning maintenance support units immediately when necessary [4], [5].

4. Considerations during Applying Technology to Military

Costs should be considered in building ubiquitous defense (u-Defense). From the time of the development, each weapon system will consists of parts attached with RFID tags and network able mini-computers like the wearable computer introduced in the private sectors. Cost of the RFID is very high compared to the price of a barcode. For example, thousands of parts of a tank has to be installed with RFID tags, the increase in cost will be dramatic. However, South Korea have developed world's first metallic electronic tag(RFID) having broadband range of 50 MHz. The Electronics and Telecommunication Research Institute (ETRI) have announced on the 15th date of this month that they have developed metallic RFID having range of 50 MHz and can be synchronously utilized from various countries such as South Korea, United States, Europe, etc. The metallic RFID is a device allowing convenient management of products by being attached to electronic products, vehicles, metallic structures, etc, and had 10~15 MHz activation range. RFID developed by ETRI supports all the ranges of frequencies used in North America (902~928 MHz) and domestically. Also by utilizing RFID engineering technologies, dual frequency RFID supporting 860~870 MHz (Europe) and 900~930 MHz (Korea, North America) can be designed. Recently developed metallic RFID are 2 types having Width • Length of 74.5×24.mm and 153×24.5mm each, with thickness of 3mm. Recognition range reaches to 3~5m in all RFID frequencies. ETRI have announced that they can reduce the production costs of RFID by 90% from 1000~2000 to 100~200 by using Styrofoam or synthetic resins. Basing on these, gradual technical development in RFID technologies will cut costs of productions and will shorten the era of perfectly constructing u-Defense [6].

5. Conclusion

In this paper, have discussed about the plans for applying recent u-Logistic technology to the military sector had been suggested. Particularly, the author have suggested plans for utilizing combined future information technologies such as mobile, wireless sensor net-work and RFID for the logistic supply in construction of u-Defense system. By utilizing these information technologies, combat power and strategic capabilities of the military can be enhanced greatly. In order to activate information based national defense, changing stereotype concepts to accept information technology environment is a must. With the information technology minds, we should successfully construct combined defense information system at the early stage and should operate these systems effectively. Also, aggressive investment in terms of fighting power improvement is required for the information technology based and scientific national defense, thus, limited defense budget should be effectively utilized to raise small but powerful advanced information technology units and the utilization of potentials of private sectors should be optimized to raise low cost- high efficient military power.

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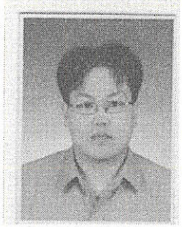

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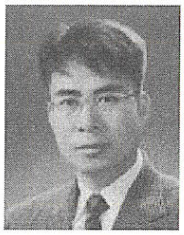

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