ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645
**Indian Journal of Science and Technology,** *Vol 8(S5), 156–163, March 2015* DOI: 10.17485/ijst/2015/v8iS5/70209

# Defense IT Convergence in South Korea

**Kim Songi[1], Sim Seungbae[2], Jung Hosang[3] and Jeong Bongju[1]***

[1]Department of Information and Industrial Engineering, Yonsei University, Seoul, 120-749, South Korea; bongju@yonsei.ac.kr 2
[2]Center for Defense Acquisition, Korea Institute for Defense Analyses,Seoul, 130-729, South Korea
[3]Asia Pacific School of Logistics, Inha University,Incheon, 402-751, South Korea

## Abstract

In recent decades, the role of Information Technology (IT) has grown across the globe in the area of national defense, yet the value of emerging technologies may sometimes be over- or underestimated. IT technologies are grafted onto national defense systems in order to improve the accuracy of weapon system or support decision making process, which is defined as defense IT convergence. This study analyses the status of defense IT applications and identifies the tendency toward defense IT convergence in emerging technologies. To do this, we investigated 89 systems in South Korea and other countries, classifying systems by military domain category, and identifying their underlying technologies. These underlying technologies were placed on Gartner's hype cycle, indicating the position of the identified defense IT applications on this long-term cycle. Most countries, including South Korea, have a high level of practical use in most proven-technology: complex-event processing, machine-to-machine communication services, and predictive analytics. Interestingly, the results show that South Korea has a risk-avoiding tendency in defense IT policy, which means that the country has fewer technologies in the trigger level of the hype cycle compared to the international average. Also we found that the average number of technologies used in defense IT systems in South Korea is smaller than the international average, which means that South Korea is comparatively weak in integrating multiple technologies into systems.

**Keywords:** Aoronary Artery Disease, Coronary Angiography, Right Bundle Branch Block

## 1. Introduction

As the patterns of warfare has changed from mass destruction to intellectual attack, the investment in IT technology applications for defense systems has been increasing all over the world1. Command and control systems have grown as wired and wireless communications and controlling techniques have made guided weapons more accurate. The U.S. armed forces concentrate on developing new IT technology and combining it with defense systems. However, in South Korea, IT technology has been developed by private interests rather than by military organisations2. In this environment, it is essential to analyse the current level of defense IT convergence and compare it with the international trend in order to understand the weak points and potential development avenues.

According to the properties of a defense system, defense IT convergence cases are classified into 'inside weapon systems', 'between weapon and nonweapon systems', and 'inside nonweapon systems', as shown in Figure 1. Note that this study focuses on the first and the second cases.

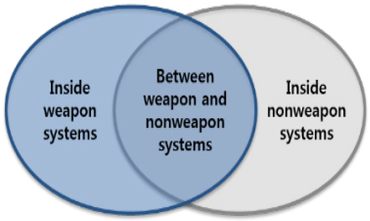


**Figure 1.** Classification of defense IT convergence.

*Author for correspondence

This paper is arranged as follows: after introducing military domain category and our methodology, we firstly investigated both domestic and international defense IT convergence cases especially based on their underlying IT technologies. Then, we classified them by military domain category, used for classifying defense systems into their main purpose, and compared the domestic and international results. At the second step, we applied Gartner's Hype cycle for emerging technology to previous results in order to understand the South Korean tendencies in defense IT convergence and compare them with international trends.

## 2. Military Domain Category

To investigate the defense IT convergence case, we first classify defense systems into four use military domain categories. Figure 2 shows a military domain categorization, which is widely used in studies of defense IT convergence1. We next describe the four categories.

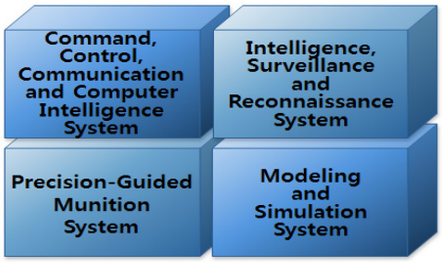


**Figure 2.** Military domain categorization.

First, command, control, communication and computer intelligence (C4I) systems concentrate on integrating and managing all the data and information in order to improve the effectiveness of command and control. C4I systems include information integration technology, data transmission and reception, and intelligent analysis of situations3.

Intelligence, Surveillance and Reconnaissance (ISR) systems gather information about targets, which are the basis for decision-making in C4I systems. ISR systems perceive the state of a battlefield environment and include detection radar, optical sensors, and acoustic sensors.

Precision-guided munition (PGM) systems are used to improve the accuracy of weapon system such as vehicle weapon systems, naval weapon systems, and aircraft weapon systems.

Modeling and simulation (M&S) systems use modeling and simulation techniques to analyse and evaluate the results of training, missions, or battles.

## 3. Methodology

To understand the weak points and suggest direction of improvement for South Korea's defense IT system, it is essential to analyse the current levels of defense IT convergence and compare them with the international trend. This study adopts Gartner's hype cycle for identifying the tendency of defense IT convergence. Each year, Gartner presents hype cycles for a number of IT technologies. The cycle shows the maturity, adoption and social application of specific technologies[4].

As shown in Figure 3, the cycle consists of five maturity levels: 'technology trigger', 'peak of inflated expectations', 'trough of disillusionment', 'slope of enlightenment', and 'plateau of productivity'. From the 'technology trigger' level to the 'peak of inflated expectation' level, the media and public have an increasing interest in these technologies. However, after the 'trough of disillusionment' level, attention decreases rapidly as the media become disillusioned with these technologies.

Although various kinds of technologies are addressed within the framework of hype cycle, this study focuses on the hype cycle for emerging technology. Some emerging technologies have been overestimated by technologists5,6, such that their true value turns out to be less than expected, while others have been mainly underestimated [7]. However, emerging technologies may result in exceptional benefits when they are used to develop radically new products[8,9]. Due to these features, the acceptance level of emerging technologies can be considered as a measurement of the risk-taking tendency.

Figure 4 depicts Gartner's hype cycle for emerging technology reported in July 2012[4], which is used for our research. In this study, 37 systems for South Korea's defense IT convergence were referenced in the Agency for Defense Development website[10] and 52 systems for world-wide cases were collected from the literature[11–12.] Note that reports are published once a month, reflecting recent trend in a similar level as website. Afterwards, the underlying technologies of all 89 systems were analysed especially focusing on the emerging technologies in Figure 4.

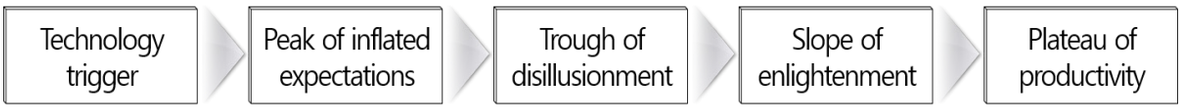


**Figure 3.** The five levels of the hype cycle.

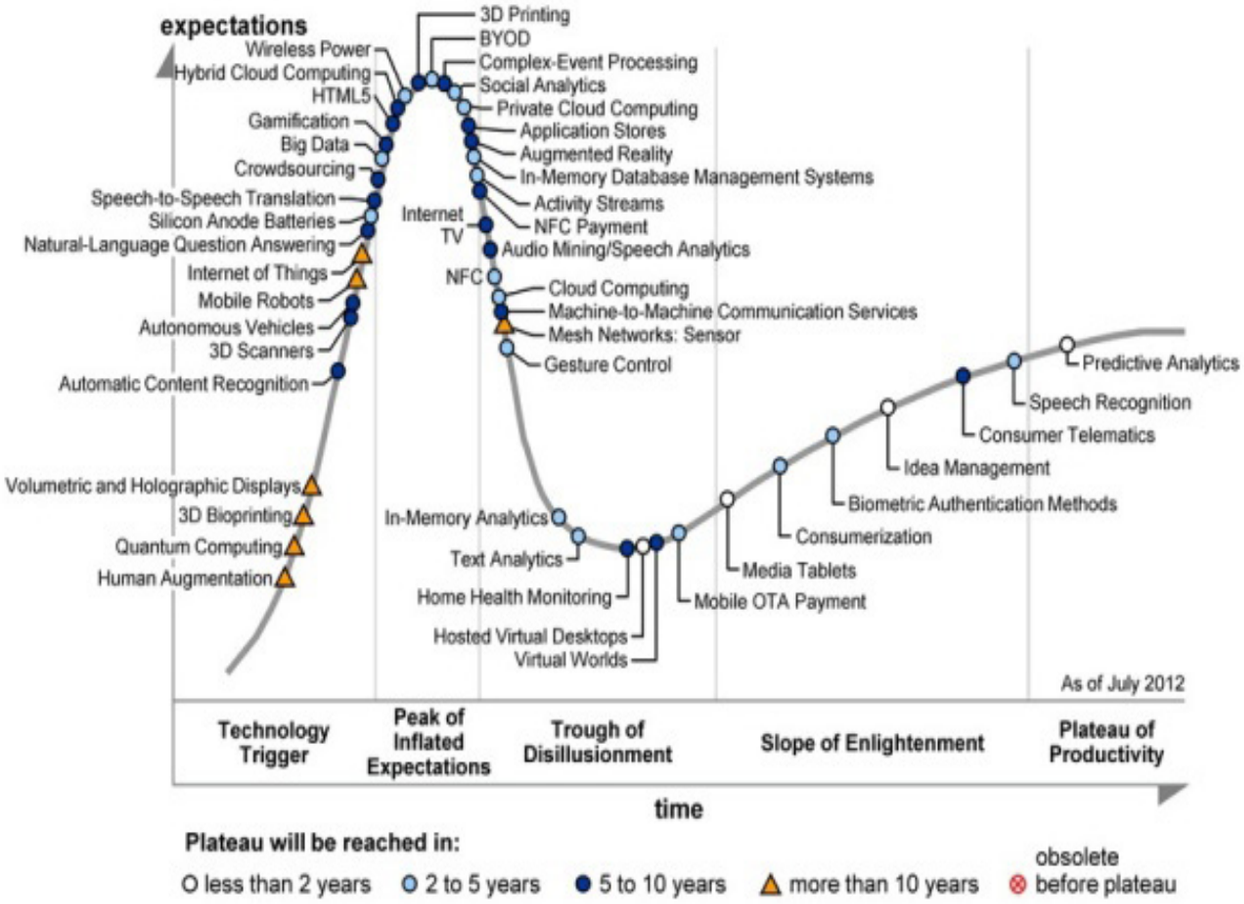


**Figure 4.** Hype cycle for emerging technology.

**Table 1**. Case study design

| Defense Domain | Number of IT Systems | |
|---|---|---|
| | Domestic | International |
| C4I | 6 | 14 |
| ISR | 4 | 12 |
| PGM | 12 | 17 |
| M&S | 15 | 9 |
| Total | 37 | 52 |

Table 1 represents the number of domestic and international defense systems, which are including IT technologies, classified in the defense domain. The result of analysing the underlying IT technologies for domestic and international cases is shown in Tables 2 and 3 respectively. Note that each IT system could contain one or more underlying IT technologies.

Table 4 summarises the domestic and worldwide IT maturity in national defense, respectively. Each level of IT maturity is connected to an individual level in the hype cycle. In the C4I and ISR areas, the number of defense

**Table 2**. Case study results for domestic defense IT systems

| System | Underlying IT Technology | State | System | Underlying IT Technology | State |
|---|---|---|---|---|---|
| D_C4I_01 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Mesh networks: sensor | Operating | D_PGM_10 | ▪ Other | Developed |
| D_C4I_02 | ▪ Complex-event processing<br>▪ M-to-M communication service | Operating | D_PGM_11 | ▪ Other | Tested |
| D_C4I_03 | ▪ Complex-event processing<br>▪ M-to-M communication service | Operating | D_PGM_12 | ▪ Other | Operating |
| D_C4I_04 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Mesh networks: sensor | Operating | D_M&S_01 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_C4I_05 | ▪ M-to-M communication service | Developed | D_M&S_02 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Predictive analytics | Operating |
| D_C4I_06 | ▪ M-to-M communication service | Operating | D_M&S_03 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_ISR_01 | ▪ Complex-event processing | Operating | D_M&S_04 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_ISR_02 | ▪ Other | Developed | D_M&S_05 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_ISR_03 | ▪ Autonomous vehicles | Operating | D_M&S_06 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_ISR_04 | ▪ Autonomous vehicles<br>▪ M-to-M communication service | Developed | D_M&S_07 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_PGM_01 | ▪ Complex-event processing<br>▪ M-to-M communication service | Operating | D_M&S_08 | ▪ M-to-M communication service<br>▪ Predictive analytics | Operating |
| D_PGM_02 | ▪ Complex-event processing<br>▪ M-to-M communication service | Operating | D_M&S_09 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Predictive analytics | Operating |
| D_PGM_03 | ▪ Other | Operating | D_M&S_10 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Predictive analytics | Operating |
| D_PGM_04 | ▪ Automatic content recognition<br>▪ Mobile robots<br>▪ Complex-event processing<br>▪ M-to-M communication service | Developed | D_M&S_11 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Predictive analytics | Operating |
| D_PGM_05 | ▪ Complex-event processing | Operating | D_M&S_12 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_PGM_06 | ▪ M-to-M communication service | Operating | D_M&S_13 | ▪ M-to-M communication service<br>▪ Predictive analytics | Operating |
| D_PGM_07 | ▪ M-to-M communication service | Operating | D_M&S_14 | ▪ Complex-event processing | Operating |
| D_PGM_08 | ▪ Autonomous vehicles | Testing | D_M&S_15 | ▪ Complex-event processing<br>▪ Predictive analytics | Operating |
| D_PGM_09 | ▪ Other | Operating | | | |

IT convergence cases was more than that in the PGM and M&S area. However, in domestic results, there are 13 cases in the M&S area, which supports that South Korea has a high level of M&S systems. Based on these results, both the international and domestic defense IT cases are largely focused on technologies in levels 2 and 3. . In the in ISR area, 14 international cases applied first-level emerging technologies in contrast to only two cases in South Korea.

**Table 3**. Case study results for international defense IT systems

| System | Underlying IT Technology | Nation | State | System | Underlying IT Technology | Nation | State |
|---|---|---|---|---|---|---|---|
| I_C4I_01 | ▪ Complex-event processing<br>▪ M-to-M communication service<br>▪ Mesh networks: sensor | U.S. | Operating | I_PGM_01 | ▪ Automatic content recognition<br>▪ Mobile robots<br>▪ Complex-event processing | U.S. | Developed |
| I_C4I_02 | ▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Mesh networks: sensor | U.S. | Operating | I_PGM_02 | ▪ Complex-event processing<br>▪ Audio mining<br>▪ M-to-M communication services | U.S. | Developed |
| I_C4I_03 | ▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Mesh networks: sensor | U.K. | Tested | I_PGM_03 | ▪ Other | Iran | Developed |
| I_C4I_04 | ▪ BYOD<br>▪ Complex-event processing | U.S. | Developed | I_PGM_04 | ▪ Complex-event processing | U.S. | Developed |
| I_C4I_05 | ▪ BYOD<br>▪ Application stores<br>▪ Activity stream<br>▪ M-to-M communication services | U.S. | Operating | I_PGM_05 | ▪ Complex-event processing | France | Developed |
| I_C4I_06 | ▪ BYOD<br>▪ Application stores<br>▪ Audio mining/speech analytics<br>▪ M-to-M communication services | U.S. | Operating | I_PGM_06 | ▪ Complex-event processing | Russia | Tested |
| I_C4I_07 | ▪ Complex-event processing | U.S. | Developing | I_PGM_07 | ▪ Complex-event processing | Iran | Developed |
| I_C4I_08 | ▪ M-to-M communication services | U.S. | Testing | I_PGM_08 | ▪ Autonomous vehicles | U.S. | Tested |
| I_C4I_09 | ▪ BYOD<br>▪ M-to-M communication services | U.S. | Developing | I_PGM_09 | ▪ Other | U.S. | Developing |
| I_C4I_10 | ▪ Automatic content recognition<br>▪ Complex-event processing<br>▪ M-to-M communication services | U.S. | Developing | I_PGM_10 | ▪ Other | U.S. | Developing |
| I_C4I_11 | ▪ M-to-M communication services<br>▪ Mesh networks: sensor | U.S. | Operating | I_PGM_11 | ▪ Other | U.S. | Developing |
| I_C4I_12 | ▪ Complex-event processing | U.S. | Operating | I_PGM_12 | ▪ Other | South Africa | Operating |
| I_C4I_13 | ▪ M-to-M communication services | Germany | Developed | I_PGM_13 | ▪ Other | U.S. | Operating |
| I_C4I_14 | ▪ M-to-M communication services | Germany | Developed | I_PGM_14 | ▪ Other | China | Operating |
| I_ISR_01 | ▪ Automatic content recognition<br>▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Mesh networks: sensor | U.S. | Developed | I_PGM_15 | ▪ Other | U.S. | Tested |
| I_ISR_02 | ▪ Automatic content recognition | U.S. | Testing | I_PGM_16 | ▪ Complex-event processing | Russia | Developed |
| I_ISR_03 | ▪ M-to-M communication services<br>▪ Mesh networks: sensor | U.S. | Testing | I_PGM_17 | ▪ Automatic content recognition<br>▪ Complex-event processing | U.S. | Tested |
| I_ISR_04 | ▪ Other | Australia | Developed | I_M&S_01 | ▪ Complex-event processing<br>▪ Predictive analytics | U.S. | Operating |
| I_ISR_05 | ▪ Automatic content recognition<br>▪ Complex-event processing | Italy | Tested | I_M&S_02 | ▪ Complex-event processing<br>▪ Predictive analytics | U.S. | Operating |

**Table 3**. Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| I_ISR_06 | ▪ Other | U.S. | Tested | I_M&S_03 | ▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Predictive analytics | U.S. | Operating |
| I_ISR_07 | ▪ Automatic content recognition<br>▪ Autonomous vehicles<br>▪ M-to-M communication services | U.S. | Developed | I_M&S_04 | ▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Predictive analytics | U.S. | Operating |
| I_ISR_08 | ▪ Automatic content recognition<br>▪ Autonomous vehicles<br>▪ M-to-M communication services | U.K. | Operating | I_M&S_05 | ▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Predictive analytics | U.S. | Operating |
| I_ISR_09 | ▪ Automatic content recognition<br>▪ Autonomous vehicles<br>▪ M-to-M communication services | Israel | Tested | I_M&S_06 | ▪ Complex-event processing<br>▪ M-to-M communication services<br>▪ Predictive analytics | U.S. | Operating |
| I_ISR_10 | ▪ Automatic content recognition<br>▪ Autonomous vehicles | U.S. | Developed | I_M&S_07 | ▪ Activity stream<br>▪ Gesture control | U.S. | Operating |
| I_ISR_11 | ▪ Automatic content recognition<br>▪ Autonomous vehicles | U.S. | Developed | I_M&S_08 | ▪ Activity stream<br>▪ Gesture control | U.S. | Operating |
| I_ISR_12 | ▪ Automatic content recognition<br>▪ Complex-event processing | Germany | Developing | I_M&S_09 | ▪ Activity stream<br>▪ Gesture control | U.S. | Operating |
| | | | | I_M&S_10 | ▪ Activity stream<br>▪ Gesture control | U.S. | Operating |

**Table 4**. Case study summary for domestic and international cases

| Defense Domain | IT Maturity Level in Domestic Case | | | | | IT Maturity Level in International Case | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Level 1* | *Level 2* | *Level 3* | *Level 4* | *Level 5* | *Level 1* | *Level 2* | *Level 3* | *Level 4* | *Level 5* |
| C4I | - | 4 | 8 | - | - | 1 | 14 | 16 | - | - |
| ISR | 2 | 1 | 1 | - | - | 14 | 3 | 5 | - | - |
| PGM | 3 | 4 | 5 | - | - | 4 | 8 | 3 | - | - |
| M&S | - | 12 | 8 | - | 13 | - | 9 | 7 | - | 6 |
| **Proportion (%)** | 10 | 35 | 29 | 0 | 26 | 31 | 34 | 25 | 0 | 10 |

## 4. Results

Figure 5 summarises the domestic case studies: for each underlying IT technology, it indicates the number of domestic defense systems applying that technology. The emerging technologies used for defense systems are automatic content recognition, autonomous vehicles, and mobile robots in the first level and complex-event processing in the second level. In the third level, machine-to-machine communication services, mesh networks, and gesture control are used. Finally, in the fifth level, predictive analytics is the only technology used.

As the amount of information collected and processed in a C4I system becomes diversified and huge, not only the C4I system, but also other systems such as complex-event processing and machine-to-machine communication services are actively applied. In addition, automatic content recognition, autonomous vehicles, and mobile robots are used since robot and automatic technology has had a high profile for a long time. Meanwhile, the number of cases of predictive analytics represents a high level of battlefield modeling and simulation technology in South Korea.

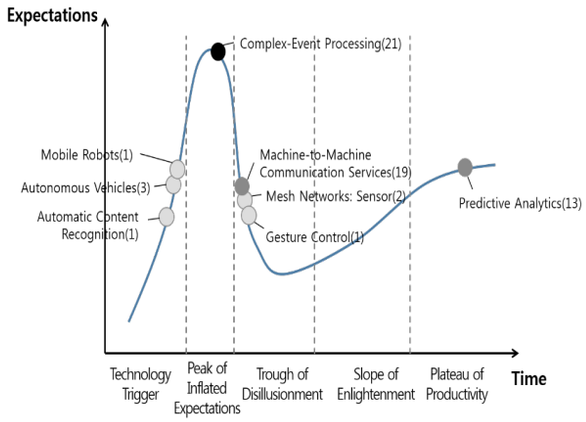


**Figure 5.** Maturity level of IT technologies adopted in domestic defense IT systems.

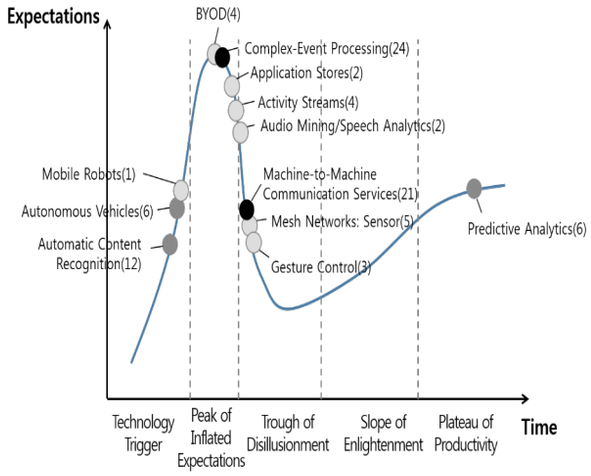


**Figure 6.** Maturity level of IT technologies adopted in domestic defense IT systems.

Figure 6 presents the results for the international cases. First of all, the results show that emerging technologies in the technology trigger level have been highly developed, including automatic content recognition and autonomous vehicles. It indicates that other countries tried to graft technologies in the first level onto the national defense system. Mobile robots are relatively rare as they require quite complex technology and greater investment.

In the international cases, the technologies used from the peak of inflated expectations level are complex-event processing, BYOD (Bring-your-own-device concept), application stores, and activity streams. Complex-event processing enables machines to process a massive amount of information that can be applied to various systems regardless of the military domain category. As mobile technology has become widespread, applications such as BYOD and application stores have become more popular. Activity streams support processing real-time information of location and state from mobile devices carried by soldiers. In the trough of disillusionment level, machine-to-machine communication services have already become widespread in defense systems. This has been developed and applied quickly; that is because to support C4I systems effectively, information must be exchanged from various machines or systems and communicated between reconnaissance equipment, combat equipment, and control systems1. To increase the analysis level of sound information, audio mining/speech analytics are applied to sonar systems in both C4I and ISR systems.

Predictive analytics, which is in the plateau of productivity level and already widely commercialised, is usually applied to M&S systems in order to help commanders make decisions in various situations.

First, compared with the international situation, the number of technologies in the technology trigger level is relatively lower in domestic cases. In particular, automatic content recognition has had low attention from South Korea in contrast to international defense IT systems. Also, although South Korea has a high level of mobile technology, which has been commercialised, there is no case related to mobile technology. Therefore, we can conclude that the defense policy of South Korea tends to wait until the value of newly emerging technology is proven, which is called a risk-avoiding tendency.

Second, the international cases show more variety in the kinds of technologies applied. In the domestic cases only 8 kinds of technologies are applied, compared to 12 kinds of technologies in the international cases. To analyse the diversity of the applied technologies, the average number of IT technologies applied to a single case is calculated for each result. For international case analysis, the value is 2.14, which is slightly higher than 1.97 calculated for the domestic case analysis, which means that South Korea is comparatively weak in integrating multiple technologies into systems.

## 6. Conclusion

As the patterns of warfare have changed from mass destruction to intellectual attack, it is essential to analyse the current level of defense IT convergence and compare it with international trends.

This study aims to analyse the defense IT convergence cases and find which emerging technologies play an important role in them. Also, this research identified the level of South Korea's defense IT convergence technology and then compared it with the international levels.

This study investigated 37 systems for South Korea's defense IT convergence case and 52 systems for the rest of the world. We analysed the underlying IT technologies used, especially focusing on emerging technologies on Gartner's hype cycle. The results of both the international and domestic defense IT cases are largely focused on technologies in the second and third level. In international cases, however, 14 cases were applied to first-level emerging technologies in the ISR area in contrast to South Korea's only two cases. The number of IT technologies applied in C4I and ISR area was more than that in the PGM and M&S area, while ISR has a lower number of technologies in the domestic case study results. On the other hand, there are 13 cases in M&S area in the domestic results, which supports that South Korea has a high level of technology advancement in M&S systems. Within the framework of hype cycle, both international and domestic results have a high number of systems using complex-event processing, machine-to-machine communication service, and predictive analytics. However, there are some differences between the two results. First, the number of technologies in the technology trigger level is relatively lower in the domestic cases. In particular, automatic content recognition and mobile technology have received comparatively little attention from South Korea in contrast to international cases, which indicates that South Korea has a risk-avoiding tendency in defense policy. Second, for the domestic case analysis, the average number of IT technologies applied to a single case is slightly lower than that in the international case analysis.

## 7. References


1. Chung K, Chung M. IT-defense convergence technology for preparing future battlefield environment. Commun Korean Instit of Inform Scient and Engin. 2013; 31(1):97–105.
2. Kye J, Lim D, Choi W, Song Y, Han S. National defense IT development direction based on interoperability. Commun Korean Instit of Inform Scient and Engin. 2013; 31(1):106–17.
3. Kye J, Lee J, Lim D. Trends and strategies on defense information technology based IT convergence technology. Elect and Telecommun Trends. 2013; 28(2):132–44.
4. Gartner. 2013; Available from: http://www.gartner.com/technology/research/hype-cycles/.
5. Groen AJ, Walsh ST. Introduction to the field of emerging technology management. Creat and Innov Manag. 2013; 22(1):1–5.
6. Gillier T, Piat G. Exploring over: the presumed identity of emerging technology. Creat and Innov Manag. 2011; 20(4):238–52.
7. Linton JD, Walsh ST. Acceleration and extension of opportunity recognition for nanotechnologies and other emerging technologies. Int Small Bus J. 2008; 26(1):83–99.
8. Allarakhia M, Walsh S. Managing knowledge assets under conditions of radical change: the case of the pharmaceutical industry. Technovation. 2011; 31(2):105–17.
9. Kassicieh SK, Kirchhoff BA, Walsh ST, McWhorter PJ. The role of small firms in the transfer of disruptive technologies. Technovation. 2002; 22(11):667–74.
10. Korean Agency for Defense Development. Available from: http://www.add.re.kr/.
11. Defense Agency for Technology and Quality. J Defen Sci and Technol Inform. 2013; 39.
12. Defense Agency for Technology and Quality. J Defen Sci and Technol Inform. 2013; 38.