

# Evolution of Large-Scale Filmless Full-PACS in Korea

Hee-Joung Kim, Ph.D. Haijo Jung, Ph.D., Hyung-Sik Yoo, M.D, Ph.D.

Dept. of Radiology, Yonsei University College of Medicine  
Dept. of Medical Informatics, Yonsei University Medical Center  
BK21 Project for Medical Sciences, Yonsei University College of Medicine  
Research Institute of Radiological Science, Yonsei University  
Seoul, 120-752, Korea

## ABSTRACT

Filmless full-PACS in Korea has rapidly been growing, since government had supported collaborative PACS project between industry and university hospital in late of 1995. At the same time, a small company had started PACS business, while the Korea PACS society was being formed. In the beginning, PACS societies had focused on developing peripheral solutions such as DICOM gateway for image acquisition, x-ray film digitizer, and viewing software for research or management of personal image data, while Samsung Medical Center had started installing an imported partial PACS system which had recently upgraded with a new system. In similar time frame, a few hospitals had started developing and installing domestic large scale full-PACS system. Several years later, many hospitals have installed full-PACS system with national policy of reimbursement for PACS exams in November 1999. It is believed that Korea is the first country that adopted PACS reimbursement for filmless full-PACS as a national policy. Both experiences of full-PACS installation and national policy generated tremendous intellectual and technological expertise about PACS at all levels, clinical, hospital management, education, and industrial sectors. There are currently three types of PACS system which includes domestic, imported, and hybrid PACS system with imported solution for core system and domestic solution for peripheral system. There are more than 20 domestic PACS companies and they have now enough experiences so that they are capable of installing a truly full-PACS system for large-scale teaching hospitals. PACS societies in Korea understand how to design, implement, install, manage, sustain, and provide good services for large-scale full-PACS. PACS society has also strength for the highest integration technology of the Hospital Information. However, further understanding and timely implementation of continuously evolving international standard and integrated healthcare enterprise concepts may be necessary for international leading of PACS technologies for the future.

**Keywords:** PACS, Full-PACS system, International Standard, Integrated Healthcare Enterprise

## 1. INTRODUCTION

Korea PACS industry was greatly promoted by national policy of reimbursement for PACS exams from November 1999. It is important to understand Korea healthcare delivery system prior to understand full-PACS promotion in Korea. The Korea became one of the most economically successful countries among developing countries with the successful achievement of Economic Development Plans. The economic success had been accompanied by improvements in social welfare. The health insurance system was established on a compulsory basis. In July 1977, based on the new National Health Insurance Act, all companies with more than 500 employees were required to provide health insurance. During the next several years, the compulsory coverage requirement was gradually expanded to include companies with more than 300 employees, 16 employees, and finally all companies with at least 5 employees in 1988. It took 12 years to accomplish universal health insurance coverage for all of citizens after the Government first implemented the health insurance program in 1977. In July 2000, the integration of health insurance management system, including all insured persons, no matter if he/she is employed or self-employed, was finally accomplished. In addition the Health Insurance Review Agency(HIRA) was established in July 1, 2000, succeeding to the medical fees reviewing part of National Federation of Health Insurance(NFHI) which dissolved, on 30 June 2000. The HIRA was established to combine medical fees review and health care evaluation into an independent single agency separated from insurers, providers and other interested parties. The HIRA is responsible for reviewing medical fees, evaluating health care performance and the economy of health care service provided to health insurance beneficiaries.

## 2. PACS DEVELOPMENT AND INSTALLATION IN KOREA

Development of PACS in Korea was geared by Samsung Medical Center (SMC) PACS project<sup>2</sup> as early as in 1994. SMC had started a first phased full-PACS installation which was a fully imported system, whereas Asan Medical Center (AMC)<sup>3</sup> had started developing a domestic PACS solution as a long term project started in 1994 and completed full-PACS system in early of 2000. Korea PACS society was formed around this time and played very important role in PACS promotion. A collaborative PACS project with government support was started in 1995 and resulted in starting PACS business for partial solution and DICOM3.0 viewing software. A few companies had started providing mini-PACS solutions and a few mini-PACS systems were installed around this time<sup>4</sup>. Korea PACS society continued to promoting PACS area on both academic and marketing aspects. Hi-speed N/W over the country was installed with national support. By the end of 1990's, information technology and internet spread were very hot issues in Korea. Both PACS society and Hospital PACS users had been putting many efforts to get reimbursed for PACS exams. National policy of reimbursement for full-PACS exams was finally approved in Nov. 1999. This geared up a various size of PACS installation and small PACS companies had experiences of large-scale full-PACS installation within a short period of time. Table 1 shows capabilities of PACS installation for domestic small companies<sup>5</sup>. Approximately 21% of full-PACS for large and small hospitals were installed.

Table 1. Examples of large-scale full-PACS installation in Korea .

PACS vendor				
	Domestic Vendor		Foreign Vendor	
Hospital	S	A	Y	S
Beds	1500	2200	1650	1200
Exams/day	2500	3300	2200	1500
Out patients/day	5500	6500	5500	6000
Gbytes/day	40	47	44	22
Tbytes/yr	1.5	1.7	16	0.8
Imaging Modalities	76	98	69	47

## 3. EVOLUTION OF PACS SOLUTION

PACS in Korea had started with partial solution, viewing software, and mini-PACS installation. Their core technologies were accumulated by developing DICOM gateways for interfacing various imaging modalities and DICOM3.0 viewing software. A few vendors had installed a number of mini-PACS systems until 1999 and greatly increased their full-PACS installation for not only mini or mid size but also large size hospitals. At the same time, a number of PACS vendors are dramatically increased within a last few years. They are from IT vendors, PACS vendors, HIS vendors, and newly formed vendors. However, a few vendors had installed most of hospitals' PACS system and the remaining vendors installed a few hospitals. However, domestic vendors have several characteristics of their PACS solution. Most of them provide perfect solution for HIS/RIS/PACS integration using DICOM and HL7 standards or their own system, whereas foreign vendors provide partial solution. Domestic vendors can provide Korean characters (Hangul), whereas foreign vendors can only provide partial solutions for Hangul, although they are trying to provide Hangul, Japanese, and Chinese characters which use same multi-byte character sets. User friend software and fast support for user's request would be very special characteristics of domestic PACS solution. Recent PACS provides total imaging solutions including nuclear medicine, endoscopic, and pathologic imaging modalities. In near future, all imaging modalities could be included as a PACS solution. Figure 1 shows an example of a large-scale full-PACS solution.

There are more than 20 domestic PACS vendors and 2 imported PACS vendors in Korea. Domestic PACS vendors may have various characteristics such as; 1) inexpensive solution, 2) full support for Hangul, 3) good customization (HIS/PACS interface), 4) fast response for user requirement, 5) utilization of new technology, 6) IT engineers with

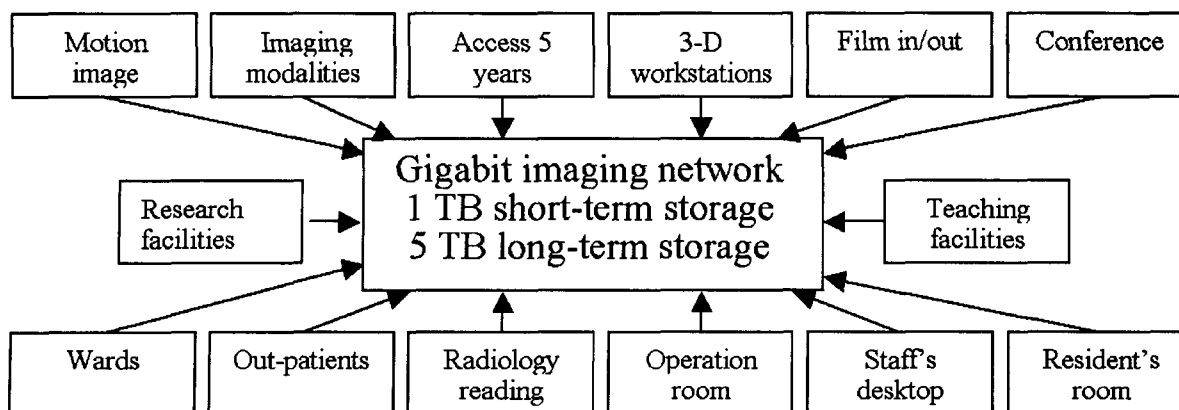


Figure 1. Example of a large-scale full-PACS solution

PACS experience, etc, although their technologies are still needed to be proven. With good experiences of large-scale full-PACS installation, many PACS vendors know; 1) how to design PACS, 2) how to localize and customize, 3) how to incorporate with DICOM3.0<sup>6-8</sup>, 4) how to install, 5) how to provide training, 6) how to deal with imaging systems/companies, 7) how to model cost benefit, 8) how to work with various decision makers, 9) how to lead and track world trend, 10) how to be cost effective, 11) how to implement new operational protocol, 12) how to manage, 13) how to improve radiology service, 14) how to manage the process, 15) how to sustain the operations for long term base, 16) how to stay current state of the art technology. Domestic PACS vendors are very good at staying current state of art technology and international standard. As an example, two domestic vendors had participated IHE demonstration at RSNA meeting in 2001. Table 2 shows large-scale PACS experiences of both domestic and foreign vendors for HIS/PACS integration.

Table 2. Large-scale PACS experiences for HIS/PACS integration.

PACS Vendor				
	Domestic Vendor		Foreign Vendor	
Hospital	S	A	Y	S
HIS/PACS	Integration	Integration	Partial integration	Partial
DICOM/HL7	O	X	O	X
Multi-Byte Characters	O	O	Partial O	X

With successful large-scale full-PACS installation, PACS vendors are interested in developing solutions for better image quality, security, teleradiology, telemedicine, 3-D, computer aided diagnosis (CAD), dental PACS, and etc.. Figure 2 shows an idea of future PACS for total digital imaging.

#### 4. DISCUSSION AND CONCLUSION

PACS in Korea has been rapidly growing, since government had supported collaborative PACS project between industry and university hospital. PACS installation in Korea was greatly promoted by national policy of reimbursement for PACS exams in November 1999. The domestic PACS society was also playing very important role to promote PACS installation. Both experiences of full-PACS installation and national policy generated tremendous intellectual and technological expertise about PACS at all levels, clinical, hospital management, education, and industrial sectors. Most PACS in Korea provide good solution for HIS/RIS/PACS integration using DICOM and HL7 standards or their own system. There are more than 20 domestic PACS and 2 imported PACS vendors in Korea. Domestic PACS vendors can provide PACS solutions with various characteristics such as full support for Hangeul, good customization (HIS/PACS interface), fast response for user requirement, IT engineers with PACS experiences, although their technologies are still needed to be proven. With good experiences of large-scale full-PACS installation, many PACS

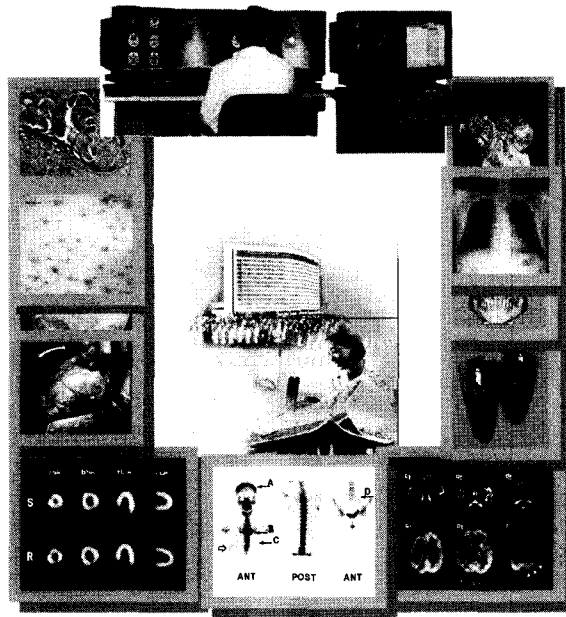


Figure 2. PACS for total digital imaging

vendors know how to design PACS, localize and customize PACS, deal with imaging systems/companies, work with various decision makers, lead and track world trend, implement new operational protocol, improve radiology service, manage the process, sustain the operations for long term base, and stay current state of the art technology. Enough experiences of full-PACS installations in Korea lead PACS to their filmless full-PACS solutions. However, further understanding and timely implementation of continuously evolving international standard and integrated healthcare enterprise concepts may be necessary for international leading of PACS technologies for the future.

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