The New Effective Tool for Data Migration from Old PACS (Rogan) to New PACS (Fuji Synapse) with Integrated Thai Patient Names

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Objective: *To investigate consuming time and amount of data transfer for PACS data migration from the existing system to a new one by using new developed software tools.*

Material and Method: *The authors have developed a migration tool for PACS data migration and integrated Thai names into a new PACS by the following steps. First, look up the existing database table for hospital number (HN) and image names for each series number. Second, directly retrieve image from storage. Third, get the Thai name by searching HN from the hospital information system (HIS). Then, send the new study to the new PACS via hospital level7 (HL7) message. Finally, send images to the new PACS.*

Results: *The data were migrated from the existing PACS, integrated Thai name and sent them to the new PACS. The total migrated images of CR, CT and MR were 296,269, 692,860 and 42,941 images respectively. The average migrated images per series for CR, CT and MR were about 1.01, 89.84 and 15.53 images in successive order. The consuming time for data migration of CR, CT and MR were 685.8, 283.4 and 34.8 hours, respectively.*

Conclusion: *The authors successfully developed new application tool for PACS migration that used to migrate data from the existing PACS to the new one, which are powerful and highly flexibility tools, and including patient Thai name in patient information during data migration.*

Keywords: *PACS, data migration, HL7, DICOM*

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The main problem of the new picture archiving and communication systems (PACS) in any hospital is data migration. The difficulty depends on amount, structure of image collections in the existing PACS and error in the existing database as well as migration tool. The process of transferring data from the old PACS to the new one is challenging. The migration must be done every time when changing to the new system[1-6]. There are an estimated 1,200 to 1,500 PACS installations in the United States that are 2 or more years old. The number of older PACS that remain in operation will continue to increase for the next 5 to 10 years because there are significant hurdles to be overcome in upgrading and replacing PACS[7]. The different method of data transfers may affect the tangible cost, and working hour[8]. There are several considerations on migration steps including availability of DICOM sent on the existing system, availability of DICOM retrieve on the new system and downtime of the existing system during the migration. The authors would like to migrate PACS data in Siriraj Hospital from the existing system to the new one.

The authors have implemented the Rogan PACS, a client-server application, in Siriraj Hospital since 2001. The authors have a single server running the Rogan and 1.8 Terabytes IDE hard disks for image storages. The authors had 3 CR readers for the out-patient department, one spiral CT, two conventional CT machines and one 1.5 T MR machine. Total CR images in the Rogan are over 2 million images. In early 2005, the authors had a plan to replace the Rogan with

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the Synapse PACS. The Synapse is web-based application[3] which was available for the entire hospital data distribution. Moreover, the authors switched to Fuji Synapse PACS which had a better enterprise client/server distribution method than our existing PACS. During the Synapse implementation, the authors needed to transfer all images data from the Rogan to the Synapse. Unfortunately, there are no DICOM sending tools from old PACS (Rogan) and no DICOM retrieval tools at new PACS (Fuji Synapse), so image data cannot be directly sent from the Rogan to the Synapse. The authors developed new software tools for this data migration in Siriraj Hospital.

The purpose of the present study was to investigate consuming time and amount of data transfer for PACS data migration from the existing system to the new one by using new developed software tools.

Material and Method

Data migration

The authors used intermediate, personal computers running migration tool for data migrations. The basic functions of this migration tool were getting images from the Rogan, added Thai name, corrected wrong information and sending images to the Fuji Synapse. These computers were Pentium IV 3.0 GHz, 512 KB random access memories, 40 IDE hard disks and effective 100 Mbits connection.

The database of the Rogan (dBase V) was copied from its backup and transformed to Microsoft SQL database using importing tool. This Microsoft SQL was located in another computer running only Microsoft SQL server 2000, composed of Pentium IV 3.0 GHz, 512 KB random access memories, 40 IDE hard disks and effective 100 Mbits connection. Since the process of data migration was very fast, the database of the Rogan had to transfer to another place for data migration only.

The Rogan retrieved the image by looking up the file name in the database and then directly copied it from the storage by mapping network drive

Integrated Thai name

The authors added the Thai name information to the patient data during data migration that was never found in old PACS. (The Rogan has only one field for names in English, but the Synapse has two fields for the patients' name in full and alias names.) After image retrieval from the Rogan to intermediate computer, the authors queried the hospital number for each image to get the Thai name directly from the HIS. Then, the authors sent the new patient information to the synapse worklist following HL7 format via TCP/IP protocol and waiting for image transferring. The new information that the authors used was event ADT A01 of ADT message (Fig. 1). The 9th element of PID segment was a proprietary part that used the alias patient name in the Synapse.

Finally, the authors sent images from intermediate computer to the Synapse by using DICOM connection between intermediate computer and the Synapse (Fig. 4).

Time consuming analysis

The authors calculated time consuming (Tc) for each image group during data migration by recording time stamp before (Tb) and after (Ta) migration in milliseconds. The Tc was Ta - Tb. The size of the image was also recorded in kilobytes. All time stamps were recorded from database server. The total migration time (seconds, hours and days) for each imaging modality was summation of Tc. However, time pause during migration for many reasons (such as application error, window crash, network loss, etc) was not recorded. The average migration time (second/image), and migration speed (kb/second) were also calculated. The unpaired student t test was used to compare migration speed for each imaging modality. The differences were considered significant when p-value less than 0.05.

Results

After the authors had developed, the authors started data migrations. There were only three modalities stored in the existing PACS - CR, CT and MR. The images were migrated separately according to modality types. The authors migrated CR first then CT and finally MR. The total images of CR, CT and MR were 296,269, 692,860 and 42,941 images respectively. The average images per series for CR, CT and MR were about 1.01, 89.84 and 15.53 images in successive order. The images that were collected in old PACS were lossless

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MSH|^~\&|SIRIRAJ||||||ADT^A01|MSG001|P|2.3||
PID|||HN||English||Birthdate|Sex|Thainame||||||||||
PV1||||||||||||||||||||||||||||||||||||||||||||||||
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Fig. 1 This figure shows example of event ADT A01 of HL7 message for sending worklist to the new PACS. There is integrated Thai name in proprietary part just behind the sex element

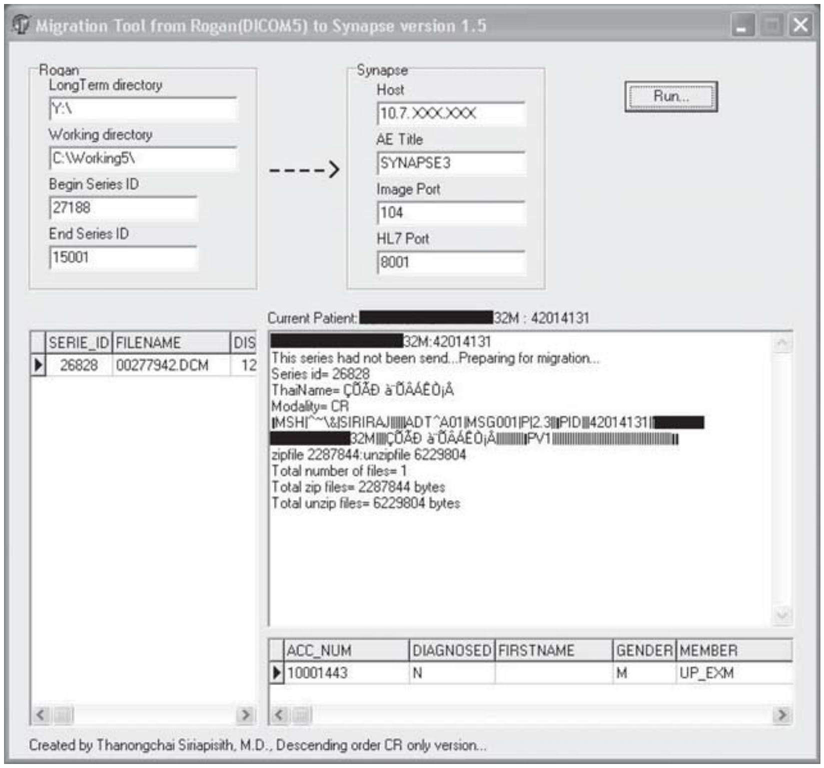

Fig. 2 The figure shows application tool at intermediate computer for data migration. The application directly gets images from long term directory (map drive) and sends by using DICOM send to synapse3, port 104. The upper part of this application shows computer information of exiting and new PACS for data migration and the lower shows current patient during migration

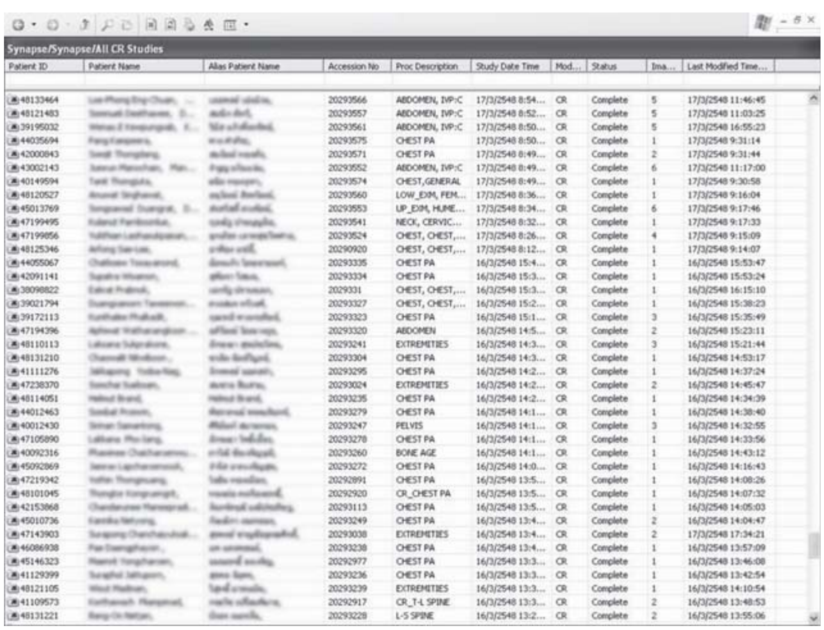

Fig. 3 Example of CR image data in new PACS which has patient ID in first column, patient name (English name) in second column and alias patient name (Thai name) in third column and accession no in fourth column proven that patient thai name can be added to new PACS

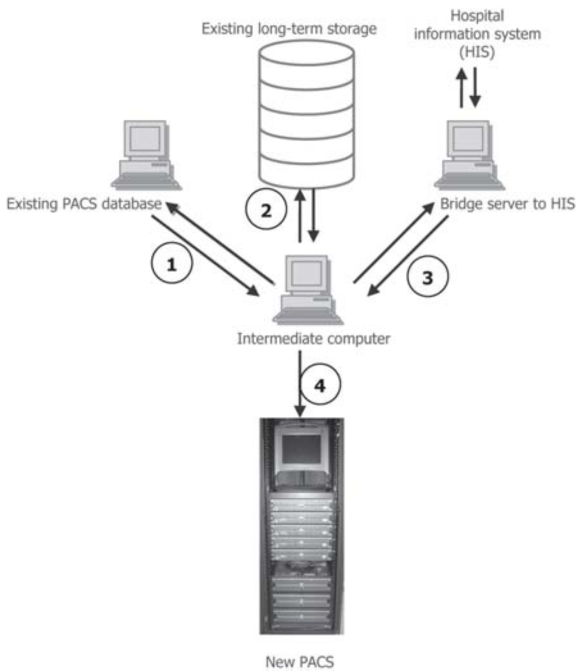

Fig. 4 The figure shows diagram of data migration. The first step looks old database table for hospital number (HN). The second step directly retrieved image from storage. The third step get thai name by searching HN to hospital information system (HIS). The forth step send new study to synapse via hospital level 7 (HL7) message and send images to synapse

compressed by different compression ratio depending on details and resolution of images. The compression ratio that was found on this data migration for CR, CT and MR were 1.08, 2.11 and 1.01, respectively. After image decompression, the total amount of uncompressed migrated data of CR, CT and MR were about 628.2, 282.0 and 5.9 Gigabytes, respectively. The time for image migration composed of retrievably compressed image from storage, uncompressed file and sent to the new PACS via DICOM send. The image sending, including several groups occurred for each series and sent together to the new PACS. However, the migration speeds for each modality were different. The migration speed for CR, CT and MR were 246.4, 137.15, and 49.1 kb/second, respectively. The CR migration was significantly faster than CT ($p < 0.05$) but not for MR ($p < 0.05$). In addition, the amount of data of each modality was roughly different. The total days for CR, CT and MR migration were about 28.6, 11.8 and 1.5 days respectively (Table 1).

Discussion

In the early 1980s, the development of computer technology and digital imaging detectors initiated implementation of PACS in the medical environment. Thai PACS implementation began in 2001 and has expanded continuously since. PACS is quite useful in diagnostics, clinical practice, and research. The improvements in computers, networks, and storage of media technology, as well as the development of computer software and operating system, resulted in a high-performance PACS. In the development of current technology, many imaging modality (such as CT and MRI) produce new imaging pattern and more slices that required high-performance PACS. These innovations have facilitated the upgrade or replacement of PACS, for which hospitals should plan thoroughly and

Table 1. Amount of data occurred after complete data migration grouping by imaging modality (CR, CT and MR). The total migration time, average time and migration speed of data migration were calculated for each group of CR, CT and MR

Modality	CR	CT	MR
No of images	296,269	692,860	42,941
No of series	294,292	7,712	2,765
Average images per series	1.01	89.84	15.53
Compressed data (Gbytes)	580.3	134.5	5.9
Uncompressed data (Gbytes)	628.2	282.0	5.9
Average compression ratio	1.08	2.11	1.01
Image size (Mbytes)	2.01	0.20	0.14
Average image data per series (Mbytes)	2.24	38.3	2.25
Total migration time (seconds)	2,468,909.0	1,020,325.4	125,287.1
Total migration time (hours)	685.8	283.4	34.8
Total migration time (days)	28.6	11.8	1.5
Average time (second/image)	8.3	1.5	2.9
Migration speed (kb/second)	246.4	137.15	49.1

prepare carefully in order to migrate the data of the existing PACS to the new PACS while optimizing the performance and minimizing the cost required for the migration[1].

The present results indicate that the total migration times for CR, CT and MR are different depending on the amount the data. Normally, the migration time is greater on the large amount of image data. However, the migration speed of CT images is faster than that of MR images. The application migrate all images in the same series to the new PACS. The more images per series (89.84 images per series for CT and 15.53 images per series for MR) are migrated faster if the image size is not much different (0.2 Mbytes for CT and 0.14 Mbytes for MR). The migration processes are composed of multiple pieces of data. One piece of data occurs by getting all images in one series from existing PACS, creates connection to new PACS and sends these images together to new PACS, and migration speed is calculated by bytes of data divided by migration time so fewer fragments of the same amount of data resulting in faster migration speed. For CR and MR which have same images data per series about 2.24 and 2.25, respectively, the CR migrates faster because fewer fragments of data for one series 1.01 images/series compared with MR 15.53 images/series. The reason is one image creates one process in the computer for data copy that requires time to do.

The authors decided to use the existing PACS as a production server during data migration because at the beginning of migration, most of the data were in the existing PACS. Furthermore, time was needed to train new PACS users. However, the users can use either existing or new PACS during data migration. Generally, the data migration occurs by using DICOM send function at old PACS server sending images to new PACS. It may cause slow down the existing PACS server, because the existing server must process other jobs at the same time as DICOM retrieve, DICOM query and DICOM send for client machines. As a result, the authors used intermediate machine for data migration only. It gets images directly from storage so that it does not interfere with the processing of the existing PACS server. Also, it sends images by DICOM to the new PACS. The advantage of the authors' method is that it runs faster, in the background, and does not interfere with other application process of the existing PACS server. However, there is no previous report of migration speed of this data.

This proposed data migration method can be applied with any PACS depending on data structures of the existing one. Most of the existing PACS store images as compression files in long term storage and the pointer for each image stores in database tables. By using DICOM send, the data sending to the new PACS is almost the same for every system. Noticeably the application entity, IP address and port number are required for target the new PACS.

The DICOM sends from the existing PACS or DICOM retrieve from the new one directly moves data without modification. The intermediate machines can be modified if some errors are found in the existing PACS such as wrong identification of patients, wrong name and VOI look up table (LUT) as well as adding Thai name into the new PACS during data migration (Fig. 5).

The Rogan supports only one name for each patient whereas the Synapse supports two - "Patient

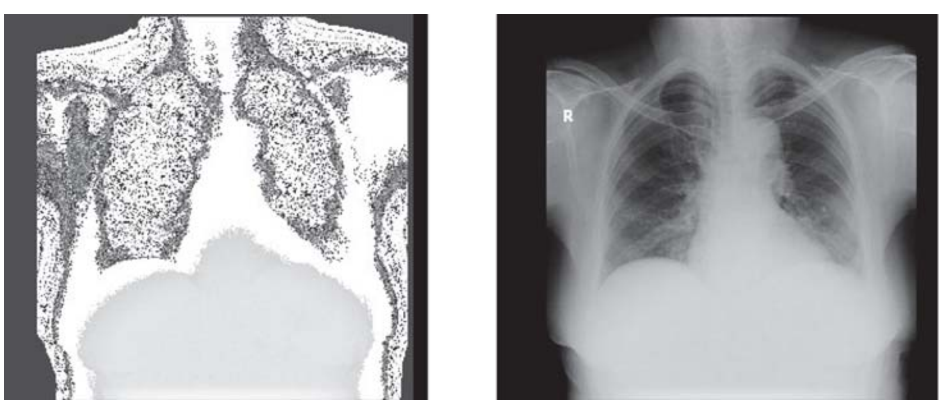

Fig. 5 Example of chest CR image before (left) and after (right) remove LUT during data migration: the LUT is embedded within CR image but the new PACS dose not support LUT. The LUT may causes bizarre visualization of image (left) that must to remove during data migration. This migration tool can be also removed abnormal LUT

and Alias Patient Name". As a result, the authors can add the local Thai name for each patient. During image retrieval, the authors extracted HN for the patient and directly queried Thai name from HIS. The authors decided to use the Thai name as "Alias Patient Name" in the Synapse by sending new patient information HL7 message (ADT A01 or ORMO01) to the Synapse HL7 module just before sending images to the Synapse DICOM server. This is an advantage of the authors' software. It can integrate Thai name to target the new PACS (if it supports the alias name) during image migration. The integrated Thai name cannot be done by using direct DICOM sent from the existing PACS to the new one.

Jung et al [1] used backup CD and DLT (digital linear tape) loaded into mini-PACS and send to full-PACS via DICOM send that is manually transferred to the new PACS for about 12.3 TB (all modality). They required every CD or tape to be manually loaded into mini-PACS. This method require manual labor. The authors had the same problem with Jung et al, which existing PACS do have DICOM send or DICOM communication to new PACS. The authors' method use intermediate software that automatically gets images from existing PACS and sends it to new PACS. This method does not require labor during migration. The data can be migrated overnight.

The other method of PACS migrations[2,9] that had been proposed, was to migrate the long-term archive such as DLT or MOD (magneto-optical disk) jukebox to a new tape jukebox that had data transferred from media to media. No DICOM software was required by this method. The benefit of this method was that, it was performed during clinical operation continuously in the background, similar to the authors method. However, this method was limited for new PACS, which used archive media in tape jukebox.

There is also limitation of the authors' method. It can be used for migration from only Rogan PACS because it gets images directly from archive. However, it can be used for every new PACS because it use DICOM transfer for moving images to new PACS. The software is not compatible with other existing PACS because of database and archive independence.

Conclusion

The authors successfully developed a new application tool for PACS migration. It is used to migrate data from the existing PACS to the new one. It is a powerful and highly flexibility tool and it includes the patient's Thai name in patient information form Rogan PACS during data migration.

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การพัฒนาโปรแกรมใหม่สำหรับการโอนย้ายข้อมูลจาก PACS เก่าไปยัง PACS ใหม่ ประกอบกับการใช้ชื่อภาษาไทย

ทนงชัย สิริอภิสิทธิ์, ตรงธรรม ทองดี

วัตถุประสงค์: *เพื่อศึกษาเวลาที่ใช้รวมทั้งปริมาณข้อมูลที่ทำการโอนย้ายจาก PACS ที่มีอยู่ไปยัง PACS ใหม่ด้วยโปรแกรมที่ได้พัฒนาขึ้นมาใหม่*

วัสดุและวิธีการ: *ผู้นิพนธ์ได้พัฒนาโปรแกรมสำหรับการโอนย้ายข้อมูล PACS รวมทั้งการรวมชื่อภาษาไทย เข้าสู่ PACS ใหม่ ด้วยขั้นตอนดังนี้ ขั้นตอนแรกนำหมายเลขผู้ป่วยและชื่อของรูปภาพของผู้ป่วยนั้นมาจากฐานข้อมูล ขั้นตอนที่สองนำรูปภาพออกมาจากที่เก็บ ขั้นตอนที่สามค้นหาชื่อภาษาไทยจากระบบฐานข้อมูลโรงพยาบาลโดยใช้หมายเลขผู้ป่วย ขั้นตอนที่สี่ส่งข้อมูลการตรวจไปยัง PACS ใหม่ และขั้นตอนสุดท้าย ส่งภาพที่ต้องการย้าย เข้าสู่ระบบใหม่*

ผลการศึกษา: *ข้อมูลที่ได้ทำการย้ายจาก PACS เก่า รวมชื่อภาษาไทยและส่งเข้าสู่ระบบใหม่ มีปริมาณข้อมูล CR, CT, MR 296,269, 692,860, และ 42,941 ภาพ ตามลำดับ จำนวนภาพเฉลี่ยต่อชุดสำหรับ CR, CT, MR ประมาณ 1.01, 89.84 และ 15.53 ภาพ ตามลำดับ เวลาที่ใช้ในการโอนย้ายข้อมูลสำหรับ CR, CT, MR 685.8, 283.4, 34.8 ชั่วโมง ตามลำดับ*

สรุป: *ผู้นิพนธ์สามารถพัฒนาโปรแกรมเพื่อใช้สำหรับโอนย้ายข้อมูล PACS จากระบบเก่าเข้าสู่ระบบใหม่ ซึ่งเป็นอุปกรณ์ที่มีประสิทธิภาพและมีความยืดหยุ่นสูง และรวมชื่อภาษาไทยเข้าไปในข้อมูลผู้ป่วยได้เป็นผลสำเร็จ*