International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Architecture and Management of Medical Laboratory within a Hospital Center (CheBHosp)

Mohamad Ali Cheaito

Lebanese University, Faculty of science I, Computer Science Department, Hariri University Campus, Beirut-Hadath Lebanon

Abstract: ***This document represents the work on the architecture of a Laboratory of Medical Analysis Service within a Hospital center (LMASH). A LMASH service manages patient information either he is an external patient or an internal patient who has a stay at the hospital [1]We focus on all computing components available in the most medical laboratory, the analytical machines, and the employees of a LMASH who must communicate with a Medical Analysis Laboratory Information System (MALIS)[2].Our work consists on the distribution of data;the data is not recorded in a single database, but in more than one [3] based on its use,to not have performance issues when executing all the queries by the corresponding DBMS[4, 5,6]. On the other hand, all the equipment of a medical laboratory have a communication device, either it is a serial port or an Ethernet port;that is why there is an information flow from the analytical machine to a computer server allowing to manage all information and send it to the hospital's server to be linked to other medical services. The current work suggests architecture of distribution of equipment and represents a set of algorithms to communicate between machine and database installed on the server of LMASH and the hospital information system [7]***

Keywords: Architecture, Medical laboratory, communication, computer science, information system

1. Introduction

Our work is in the domain of computing and medicine. It represents a good architecture of an Information System of a Medical Analysis Laboratory (ISMAL) [8] within a hospital center. The architecture of a such medical laboratory information system must take into consideration the state of the hospital information system (HIS) architecture [9] integrating this laboratory. It must be integrated with the HIS to not have data redundancies [10] and to have more security when accessing and manipulating the data; as an example, the administrator system of the HIS [11] who is able to define the profile of any user having access to such medical analysis laboratory system. The coding and the database must be subdivided according to the state of use of data. Analytical Machines must have a protocol such as (ATM) allowing the automatic transmission of data between the machine and the ISMAL. The patient's information must be synchronized between the HIS and the ISMAL. The results provided by the medical machine must be implemented by a procedure allowing resolving errors before the doctor applies a medical treatment based on a false result. The medical laboratory like any warehouse must use a storage system allowing the coding, the input and the output of items, the notifications on the expiry date of the storage quantity of each item, and the management of all suppliers in the accounting system. The definition of such entity must be identified and codified once and only once in the HIS and its manipulation can be in the ISMAL. Within ISMAL there is a group of employees who are related to the human resources system. That is why our work must take into consideration the architecture of ISMAL with the set of subsystem and HIS.

2. Patient and Medical Laboratory

A medical analysis laboratory (or laboratory of medical biology) [12] is a structure where health professionals analyze different fluids of the body; such as blood, skin, urine, stool or mucous membrane. A medical biology laboratory can be private or under a hospital center. It includes many health professionals such as nurses, laboratory technicians, biologists and, more rarely, doctors.

The patient must be identified by a primary identifier describing the personal information distributed by the HIS, and a case identifier describing the case of entries that may be for an internal patient distributed by HIS, or for an external patient distributed by ISMAL (Fig 1)

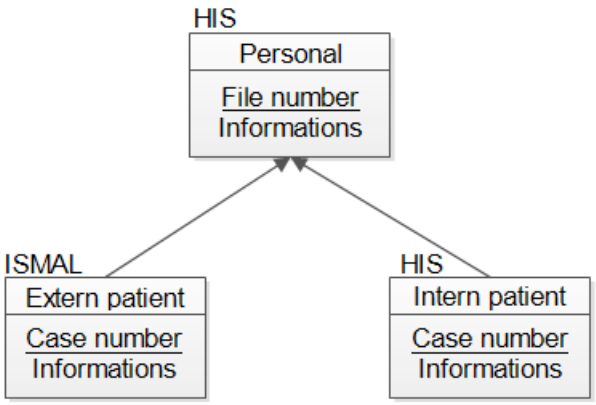


Figure 1: Patient and HIS and ISMAL system

In the case where the patient is transferred from an external state to an internal state, the information from an external state must be placed into a state of an internal patient.

3. Laboratory of Medical Analysis and Medical Machine

The laboratory of medical analysis [13] today must include, within its center, machines of numeric analysis allowing to realize the analytical results of a sample taken from the patient [14] All medical machines are qualified as a machine for analysis hematology, chemistry, endocrinology. The analytical machines must include in their computer system a coding of all analysis operations done to allow the mapping with the ISMAL [15]. The technician has to enter the patient

ID on the system of the correspondent machine, and when the analysis step is completed, the technician confirms the transfer of results to the server ISMAL; this system applies the integration between the system of the machine and the HIS system and transfers the result automatically to the HIS system by its own coding (Fig 2)

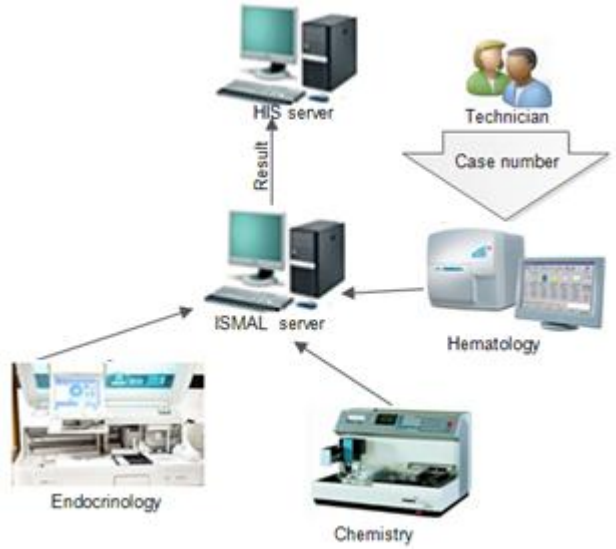


Figure 2: Architecture of machines and servers in ISMAL

4. Machine and HIS coding

The coding allows the mapping between the coding in the machine and the HIS (see Table 1)

Table 1: Coding of results obtained by the hematology machine

Machine code	HIS Code	Description	Unit	Normal Value
WBC	01001	WBC	Cu.mm	4500-1150
LYM	01002	Lymphocyte	%	17-39
MON	01003	Monocyte	%	2-8
NEU	01004	Neutrophils	%	40-60
EOS	01005	Eosinophils	%	1-5
BAS	01006	Basophils	%	0-1
RBC	01007	RBC	10^6cu.mm	M 4.5-6.5 F3.8-5.8
HGB	01008	Hemoglobin	g/dl	M 13-18, F 12- 16
HCT	01009	Hematocrit	%	40-54
MCV	01010	MCV	fl	80-94
MCH	01011	MCH	pg	27-32
MCHC	01012	MCHC	g/dl	30-35
RDW	01013	RDW	%	11-16

A set of the codes by a single sampling are identified by a single identifier CBCD = (WBC, RBC, HGB, HCT, ...), the payment amount of this set of elements is parameterized by the number of L (CBC=40L) Each L is evaluated according to the patient's insurance company or his degree of stay if he is an internal patient (amount = number of L * value of L).

5. Medical Laboratory and Accounting Service

An internal or external patient must register his or her payment in an accounting system that must be a sub-service of ISMAL. The accounting service assigns to each medical code an accounting number as a mapping between the medical procedure and the chart of accounts, and it must ensure a code to identify the department using this action "cost center". Suppliers are identified in the chart of accounts.

Supplier (Accounting number, name, address, phone, currency...) (Fig 3)

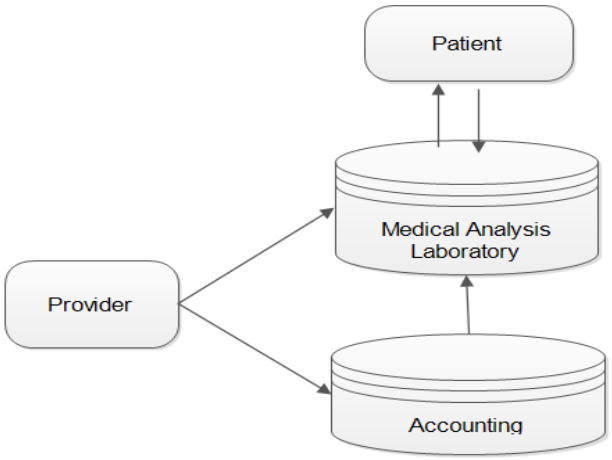


Figure 3: Patient Architecture, Payment and Purchasing Service

In order to make a balance between purchases and sales each invoice must be transferred from SILAM system to the accounting system allowing evaluating the gain of each item as well as the balance sheet of each department.

6. Medical Laboratory and database

The data storage of a medical service must be in a database. Its organization must be distributed according to the case of use of each transaction (Fig 4) and it must allow a simple archiving. Here is the set of corresponding table

PERSONAL (AdmiP, Name, Birth, Address, Tel ...)
PATIENT (Admi, AdmiP, date of entry ...)
TRANS (Admi, Type, Serial, Line, Code, Number of L, Price of L)
TRLAB (Admi, Type, Serial, Line, CodeR, Result)

Depending on the use case, we record the information which is the base of defining the set of codes, required to ensure the patient information to bill the payment, and enter the results requested by the patient.

INSURANCE (AdmiA, Name, Date, Contract number, Address, Tel ...)
LBDAT (Code, Description, Number of L)
LBVAL (Code, AdmiA, Price of L)
RLAB (CodeR, Code, Lab, Type, Unite)
NLAB (CodeA, Line, Sex, AgeL, AgeH, ValueL, ValueH, MinValue, MaxValue)

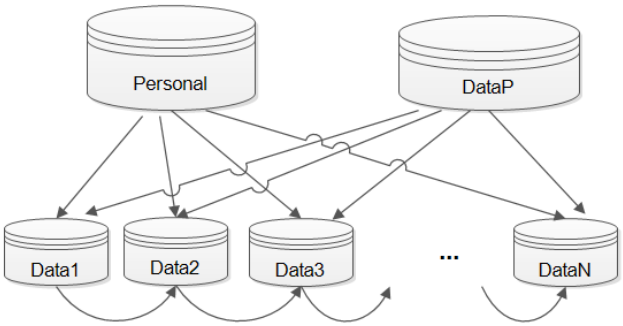
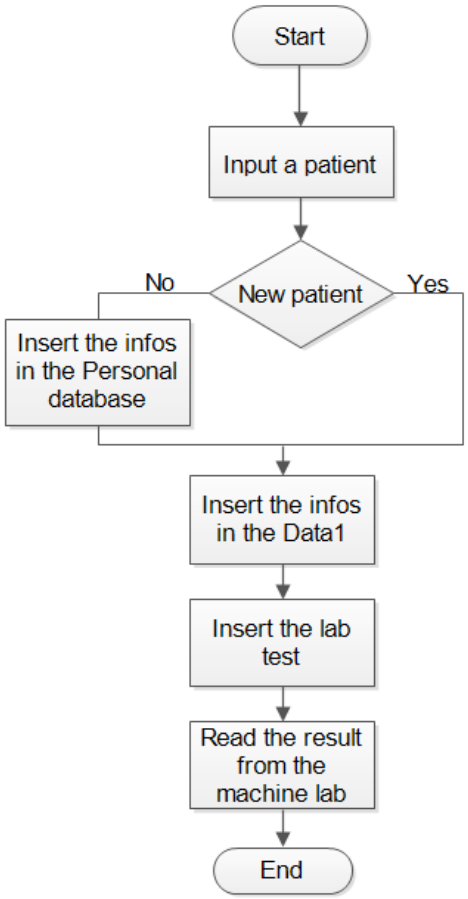


Figure 4: Database Distribution Architecture

DataP = {INSURANCE, LBDAT, LBVAL, RLAB, NLAB}
DataI = {PATIENT,TRANS,TRLAB}
Personal = {PERSONAL}

7. Algorithm to capture a patient



8. Medical Laboratory and Human Resource Service

The employees of the medical laboratory service must be entered in the Human Resources Service (HRS) (Fig 5), which is responsible of the payment management, the attendance and the leave management of employees. So, records of employees must be identified by a simple assignment to the employees by the SRH, and for each employee we must indicate the accounting number to registerhis payments. In addition, it is necessary to attribute to each employee the number of days allowedas an annual leave(15 days / year).

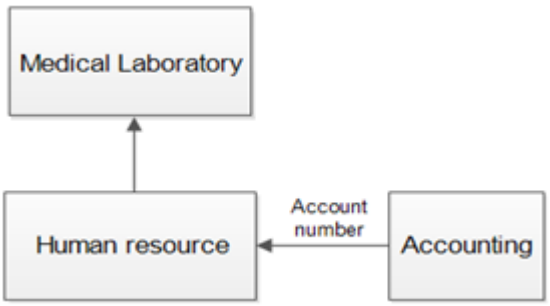


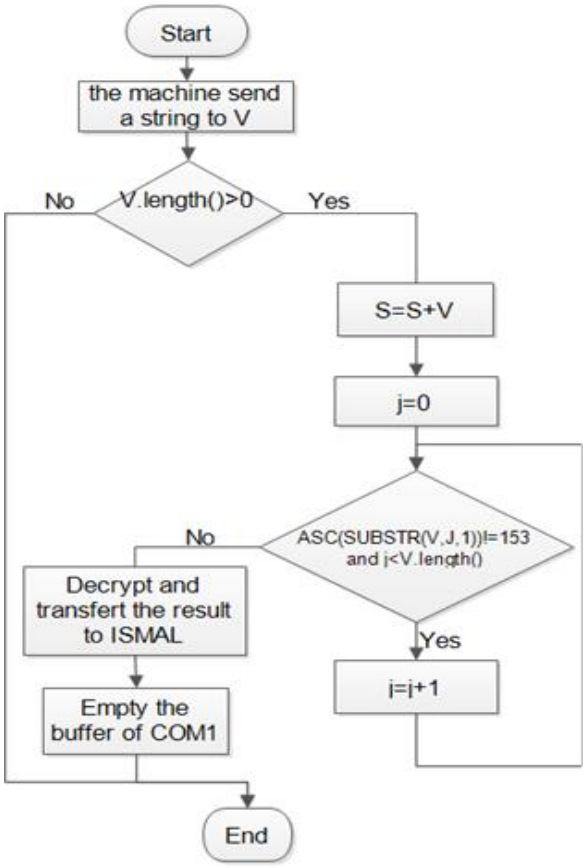
Figure 5: LAM Architecture and Human Resource Service

9. Laboratory and Communication Protocols

Most medical machines support an RS-232 serial communication channel on their peripherals [16]. In order to establish an effective communication [17] it is necessary to define the protocol [18] using, the bandwidth, the coding used, and the framing… For these reasons Microsoft offers an MScomm application allowing managing the serial port (Fig 6).

Figure 6: Communication between medical machine and a serial port

10. Communication algorithm of a Machine pentra60 via a serial port



11. Conclusion

The domain of health is today considered as a domain that must be computerized on a large scale [19, 20]. The complexity of medical information is obvious [21, 22]. It seems clear to us today that health information systems must evolve to integrate a flexible architecture to be manipulated simply by non-computer users. The coding includes ambiguities on the choices made by the user, and the users training will be complex. For this reason, our proposal relies on the manipulation of the information by making a simple connection with the server of databases and allowing refreshing the information in a simple way. The roles of the user according to the specific case of hospital centers focus on the use of an information system. The automatic communication between a medical machine and ISMAL makes it possible to secure the data entry by optimizing the manual role of the user; in addition we gain more time to send the results to the medical services and the doctors concerned. In the future, the integration of data must be an important factor in the decision to treat the patient by an intelligent system based on a coding and classification of all the information.

References

[1] Szymanowicz A, Alibeu C, Chassepoux S, Houlbert C, Jaouen E, Poupon C. Principes recommandés pour sécuriser l'identification du patient, de la demande d'analyse et du compte rendu des résultats biologiques. Ann Biol Clin 2009 ; 67 : 109-16.
[2] Christian Lovis, Stéphane Spahni, Nicolas Cassoni-Schoellhammer et Antoine Geissbuhler. Comprehensive management of the access to a component-based healthcare information system.Studies in health technology and informatics, vol. 124, pages 251_256, 2006.:2006tn
[3] Mohammad Ali Cheaito , Marwan Cheaito: The Concept of a Medical Information System By Rate of Use (CheBHosp), Health Informatics-An International Journal (HIIJ), Vol 4, No 1/2,May 2015, Page:23-33, DOI:10.5121/hiij.2015.4201
[4] Beginning SQL Server Modeling 2010 ISBN 978-1-4302-2752-6 eBook.
[5] Leopoldo E. Bertossi. Consistent query answering in databases. SIGMOD Record, vol. 35, no. 2, pages 68–76, ACM Press, New York, 2006. iv, 87, 206
[6] Artjom Klein, ArashShaban-Nejad, Gregory W Rose, Alan J Forster, David L Buckeridge, Christpher JO Baker 2013] Semantic quering of relational data for clinical intelligence: a semantic-based approach Journal of Biomedical Semantics March 2013, 4-9
[7] C.OumarBagayoko, J.-C. Dufour, P. Avillach, C. Quantin, M. Fieschi .Reflections on the patient identification in the Healthcare Information Systems, ELSEVIER MASSON, IRBM 29 (2008) 302-309.
[8] Mohammad Ali Cheaito , Marwan Cheaito: A Storage and Research Model of Medical Imaging in a Hospital Information System , International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064,Volume 5, Issue 5, May 2016, Page:420-423
[9] Mohammad Ali Cheaito , Marwan Cheaito: Concept of Graphical Interface of a Medical Information System (CheBHosp) , International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 , Volume 4, Issue 12, December 2015, Page:156-159
[10] Berrut C., “Une méthode d'indexation fondée sur l'analyse sémantique de documents spécialisés. Le prototype RIME et son application à un corpus médical”, Thèse de doctorat de 3ème cycle, Université de Grenoble, 1988, 206 p.
[11] Erik K Fromme, TawniKenworthy-Heinige, Michelle Hribar 2010 Developing an easy-to-use tablet computer application for assessing patient-reported outcomes in patients with cancer. SupportiveCae in Cancer June 2011, Volume 19, Issue 6, PP 815-822.
[12] Patrice Degoulet et Marius Fieschi. Informatique médicale. ElsevierMasson, 1998. :1998vb
[13] Daniel, C., Albuisson, E., Avillach, P., Burgun, A., Chêne, G., Cuggia, M., ... & Goldberg, M. (2013) *Informatique biomédicale et recherche en santé Informatique translationnelle*. In Informatique médicale, e-Santé (pp. 463-493). Springer Paris
[14] Les données du patient partagées : la culture du partage et de la qualité des informations pour améliorer la qualité des soins. Rapport au ministre de la santé. 2003. Disponible sur le site : http://www.d-mp.org/docs/Rapport fieschi.pdf, consulté le 20 octobre 2007.
[15] SushilJajodia, PierangelaSamarati, Maria Luisa Sapino& V. S. Subrahmanian. Flexible support for multiple access control policies. ACM Transaction on Database Systems, vol. 26, no. 2, pages 214–260, ACM Press, New York, 2001. 46, 47, 52, 62, 63
[16] American Standards for Testing and Materials (ASTM). (Standard Guide for Properties of a Universal Healthcare Identifier (UHID), Designation: E1714-95, Volume 14.01, issued June 2000.
[17] Elisa Bertino, Barbara Catania, Elena Ferrari & Paolo Perlasca. A logical framework for reasoning about access control models.ACMTransactions on Information &System Security, vol. 6, no. 1, pages 71–127, ACM Press, New York, 2003. 46, 47, 51, 52, 63, 147
[18] Sutherland I.E., “SketchPad: A Man-Machine Graphical Communication System”, Proceedings AFIPS Spring Joint Computer Conference, Detroit, MI., 1963, Vol. 23, P. 329-346.
[19] Ronald Fagin. Inverting schema mappings. In StijnVansummeren, editeur, PODS’06 : 25th ACM SIGACT-SIGMOD-SIGART Symposiumon Principles of Database Systems, Chicago, Illinois, pages 50–59. ACM Press, 2006.iv, 85, 87, 170, 206, 207
[20] Jain R., “NSF Workshop on Visual Information Management Systems”, Proceedings of the SPIE – The International Society for Optical Engineering, 1993, Vol. 1908, P. 198-218.
[21] David F. Ferraiolo, Richard D. Kuhn &RamaswamyChandramouli.Role-based access control.Artech House Publishers, 2003.ii, 24, 25, 27, 28, 29, 34, 35, 39, 40, 51, 56, 70, 71, 77, 105, 117, 130, 137, 138, 139, 154, 162, 204, 241
[22] Joseph Y. Halpern & Vicky Weissman.Using First-Order Logic to Reason about Policies. In CSFW’03 : 16th IEEE Computer Security Foundations Workshop, Pacific Grove, California, pages 187–201. IEEE Computer Society, 2003. 46, 47, 51, 63, 114, 128, 146, 201