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BULGARIAN HEALTH INFORMATION SYSTEM BASED ON THE COMMON PLATFORM FOR AUTOMATED PROGRAMMING

Research in Progress, Conference Track: IS Case Studies

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Abstract

Challenges to the national health system related to medical activities financing and quality of care are described. Bulgarian Health Information System design is presented based on the activity-based funding model, international health informatics standards and the common platform for automated programming. Platforms realised by eHealth and IT technology leaders (Ireland, Finland, Oracle USA) are presented. The technical requirements to the National Health Information System (NHIS) are prepared with a focus on domain independent common platform, specialised health components, high scalability, flexibility and reusability. The synergetic use of widely used international health standards for semantic interoperability is presented (ContSys, HISA, EHRCOM, and CDR). NHIS common structure is proposed based on cloud computing, SOA and knowledge based automated software engineering (KBASE) complemented with customised components, including kernel, internal healthcare components and external interfaces.

Keywords: SOA, Cloud computing, Knowledge based automated software engineering, common platform for automated programming, eHealth, activity-based funding, health informatics standards, ISO 13940 ContSys, ISO 12967 HISA, ISO 13606 EHRCOM, ISO/TS 29585 CDR.

1 Introduction

Three important problems (World Bank, 2015; Ministry of Health Bulgaria, 2015) of the Bulgarian Healthcare system could be identified: (1) Medical activities (MA) financial reporting mechanism stimulates collection of inadequate and imprecise information; (2) Low level of MA quality due to lack of MA standardization and insufficient quality control; (3) The collected incomplete historical data make the healthcare planning process ineffective and inefficient.

A number of reform initiatives have already been undertaken based on the National Health Strategy for the period 2014-2020 (Ministry of Health Bulgaria, 2015).

This article describes the extension of Bulgarian healthcare reform to Electronic Healthcare (eHealth) based on the following instruments: (1) Replace the existing MA financial reporting mechanism with Activity-based funding (ABF) model; (2) introduce into practice the three important health informatics international standards ISO 13940 ContSys, ISO 12967 HISA and ISO EN 13606 EHRCOM and the international technical specification ISO/TS 29585 CRD; (3) develop the NHIS.

NHIS shall be developed for large and various publics (patients, insurers, health professionals and staff, public health institutions, politicians and government, health sector managers, researchers and media). This system needs to adapt to rapid legal and technological changes in the domain area. This means that NHIS shall be realised as integrated, centralised system, supporting high level of standardi-

zation of the information exchange, based on service oriented architectures and cloud computing management.

2 eHealth Information Systems review

2.1 Reviewed systems

The review will cover platforms realised by some of the eHealth and IT technology leaders. Four eHealth platforms are selected, compared and analysed: (1) the Irish eHealth Architecture (HSE Design Authority Ireland, 2015), (2) Oracle Enterprise Architecture for Health Insurance Exchange (Desai, 2011; Stackowiak, 2015), (3) the Finnish National Kanta services architecture (Bergman, 2016) and the Turkish Health Information System (Dogac, 2014).

The results of the comparative analysis are shown in *Table 1*. In the rows of the table are presented healthcare business and SOA components. In columns titled 1 – 4 are included the compared eHealth frameworks (1 – Ireland, 2 – Oracle, 3 – Finland, 4 - Turkey). In column titled 5 are presented requirements for Bulgarian eHealth system – NHIS, realised at design phase. At the intersection of rows and columns is presented one of the following symbols: 1 – “the framework has the corresponding characteristic”, 2 – “the framework covers partially the corresponding characteristic”, empty symbol – “the framework does not possess the characteristic”, ? – “no information is found on whether the framework has that characteristic.”

This analysis shows that: (1) a clear trend is the realisation of similar systems as SOA Cloud computing instruments; (2) depending on country specific conditions systems may be centralised or distributed but data are synchronised in real time; (3) market oriented functions of the systems are not well defined; (4) financial and insurance functions of the systems are based on wide range of technical solutions.

No	Comparative Criteria	Comparative Sub-criteria	1	2	3	4	5
1	Channels	Common, Consumer, Producer, Provider	1	2	2	1	1
2	Market Development	Product Management, Care Service Line Development, Marketing, Sales, Agent/ Broker Management	1			2	2
3	Care Delivery	Population Health Management, Care Management/Transitions of Care, Health Care Provider Automation, Clinical Process Management, Clinical Services, Departmental Support Services	1		2	2	2
4	Insurance Service & Administration	Group Management, Member Management, Member Claims, Customer Care, Actuarial Services		1		1	2
5	Care Administration	Provider Network Sufficiency, Managed Care Contract Modelling, Patient Access & Management, Billing & Payments	1			1	1
6	Health Research & Trial	Institutional Review, Clinical Research Management, Clinical Trial Management	1	2	2		
7	Enterprise Functions	Finance & Accounting, Audit & Compliance, Human resources, Enterprise Planning & Delivery, IT Services, Facilities, Supply Chain	1	2		2	2
8	Integration	B2B Gateway, Health Exchange Integration, Services & Service Coord. , Template Services	2	2	2	2	1
9	Analytics & Information Management	Analytics, Information Management, Business Intelligence	2	1	2	1	1
10	Architectures	Business Architecture, Information Architecture, Platform Management, Network Infrastructure, Application Middleware, Security	1	1	2	1	1

Table 1. Healthcare Frameworks comparative analysis results

2.2 NHIS technical requirements

Based on the review NHIS technical requirements have been drawn up. NHIS shall (1) be a platform independent system that can operate in a data centre or in the cloud; (2) be an integrated and centralised SOA-based architecture; (3) be composed of a kernel (common systems and information resources) and separate business modules which operate independently and communicate through the kernel; (4) be highly scalable; (5) be composed of kernel and business modules developed using components which are reusable within this and other systems; (6) use technologies that enable a high degree of automation of the development process.

3 NHIS development concept

3.1 Healthcare funding framework

The payment of hospital care services in Bulgaria is currently based on clinical pathways (CP). The system has objectively proven insufficient effectiveness since heterogeneous clinical conditions are grouped in the CP, there is lack of care, follow-up and reporting on accompanying diseases and complications, healthcare providers report medical activities that are not performed, actual healthcare needs are difficult to plan and prevent. We need a proper mechanism to break the formal direct relationship between the medical process and the financing process by taking the necessary decisions on the course of treatment consistent with the actual condition of the patient and the complexity of the case. This mechanism is called Activity-based funding or case-mix funding. This means that *patient care* as opposed to *hospitals* will be funded with revenue being determined on the basis of agreed target levels of activity using average prices for each Diagnosis-Related Group (DRG). DRGs are a classification which groups hospital case types that are clinically similar and are expected to have a similar hospital resource usage (Health Service Executive Ireland, 2015). Countries such as the United Kingdom, France, Germany, Finland and others have adopted ABF-style funding methods (Sutherland, Repin and Crump, 2012).

Figure 1 presents the flow of data and participants in the collection of information on the health status, health services, medications, supplies, etc.

Medical and Financial reports are prepared and submitted by healthcare providers (e.g. hospital care providers, outpatient care providers, etc.). These reports are submitted directly to the central NHIS through the respective TIS (Template Information System) component or using the capabilities of a corporate IS communicating online with NHIS through a standard protocol. Patient health information and related medical expenditure information are verified by the MA (Medical Activity) Verification Manager. If correct, they are stored in the EHR (Electronic Health Record) and CDR (Clinical Data Repository) databases respectively. Guidance for correction is sent back to healthcare providers in case of nonconformity.

Medical reports are then processed by the MA Grouping Manager in order to cluster reported cases in groups. Resulting DRG medical reports and associated Financial reports are transferred to the Calculation Manager for DRG costing based on national average cost per case. Cost Correction Manager shall afterwards determine the relative weight of the reported DRG considering complication of cases with the same disease. The final price of the DRG is calculated by the Cost Correction Manager from the base average cost and relative weight given to the DRG.

Calculated Eligible costs are transferred to the Health Insurance Fund for validation and payment. Healthcare providers are notified once the Eligible costs are validated.

Algorithms for the MA Verification Manager, MA Grouping Manager, Calculation Manager and Cost Correction Manager are developed and maintained by the Ministry of Health and the Health Insurance Fund.

Components of the Case-mix calculation module are described in section 4 below.

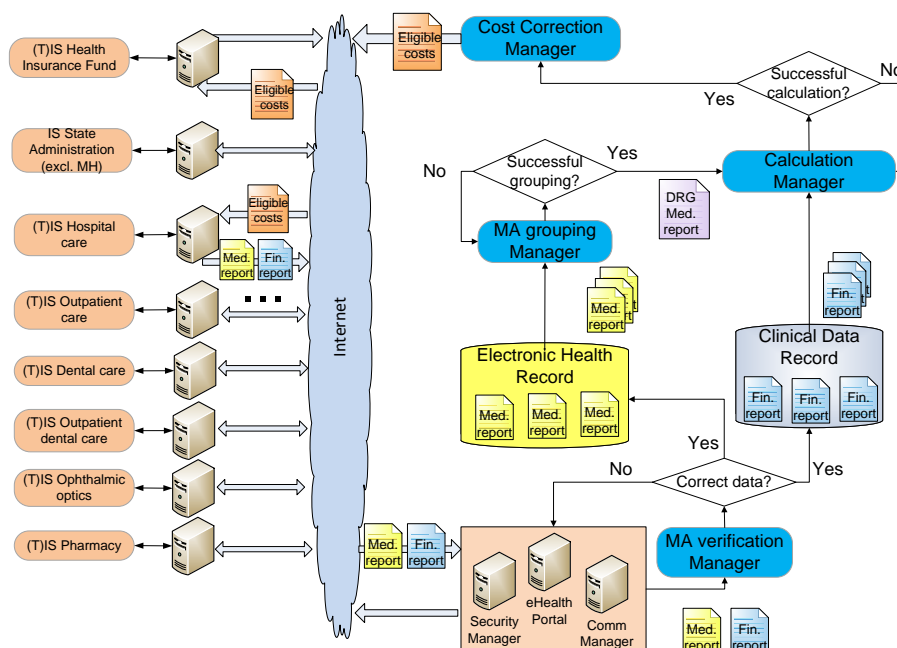


Figure 1. Case-mix calculation

3.2 Healthcare informatics standards framework

The standardization framework proposed here is shown in Figure 2. The framework incorporates four main zones as follows:

NHIS Correspondents Zone - The main purpose of this zone is to ensure, through the ISO EN 13940 ContSys standard, semantic interoperability of information exchanged between correspondents through the whole information lifecycle. This zone includes all TIS external to NHIS, divided into three large groups - systems of healthcare providers outside the Ministry of Health, systems of insurers providing payments to healthcare providers and other governmental and non- governmental organisations using medical information. These systems communicate via standardised devices and protocols with NHIS medical components presented in section 4 below. The rules for semantic interoperability of information are stored in a single ContSys DB for all actors. These rules usually represent good medical practices described as business processes, including methods of performing the activities, medical entities and their tasks in process implementation, required tools, duration, sequence and variants of individual operations.

Communication Zone - This zone is realised on the basis of ISO EN 12967 HISA standard. Within this zone are performed different types of verifications and transformations of information during the transition from one user group to other or to the system data warehouses. The rules for verification, transformation, routing and storage of information are set out in HISA DB. The communication process is managed by the HISA Manager.

Health Information Zone - The purpose of this zone is to record in the formats of the ISO EN 13606 EHRcom standard the full data set for each user of the Bulgarian health system. The information is exchanged from the NHIS Correspondents Zone through the Communication Zone DB Manager responsible to record this information in the EHR DB. Information could be accessed following the above steps in reverse order. Information is used following legally defined access rights.

Financial information Zone - The main task of this zone is to store in ISO/TS 29585 standard format the full range of financial and other useful data for MA performed. The information is exchanged from

NHIS Correspondents Zone through the Communication zone to the DB Manager responsible to record this information in the CDR DB. Information could be accessed following the above steps in reverse order. Information is used following legally defined access rights.

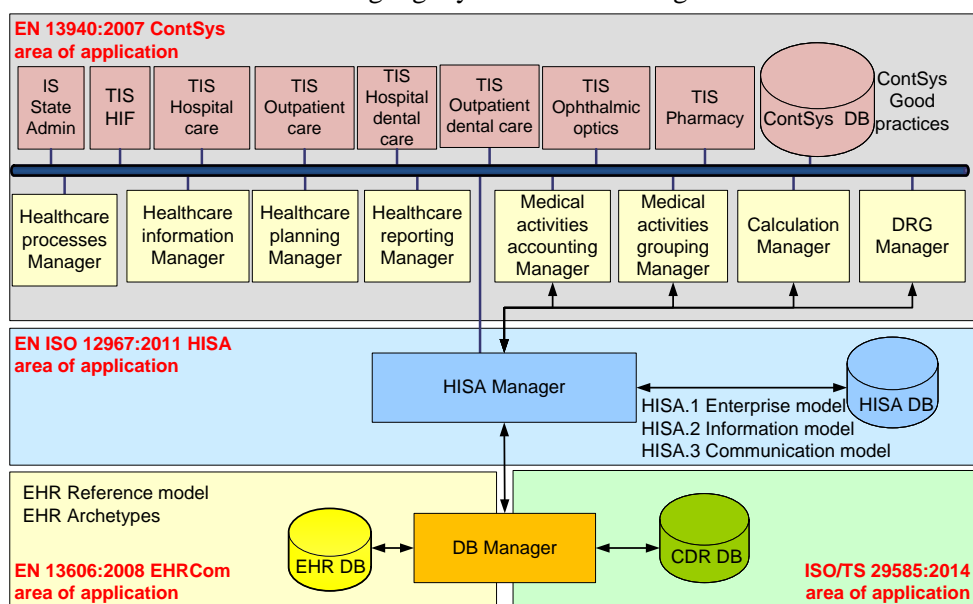


Figure 2. eHealth standards application concept

3.3 Healthcare technological framework

NHIS platform is based on the Cloud Computing instruments, Service Oriented Architectures and Common Automated Programming Platform for Knowledge Based Software Engineering as defined in Stanev and Koleva (2015-1). The Platform is composed of components and packages as described in Stanev and Koleva (2015-2).

4 NHIS technical solution

NHIS overall structure is presented in Figure 3. It is composed of the kernel components, NHIS internal healthcare components as well as interfaces to external healthcare systems. All kernel components are used for both standard and subject areas.

NHIS internal healthcare components are described below.

L5 Applications Layer, P15 Activity Management Package: MA Verification Manager - Provides open interfaces for the exchange of statistics and economical information on medical expenditures incurred through a web service. **Cost Correction Manager** – Responsible to carry out checks on data quality; generate response files; interface and grouping of data; prepare analyses of medical statistics and cost data, clinical pathways analyses, case- mix analyses, reports. **MA Grouping Manager** - National system for classification of patients (cases) that provides a clinically sound way of relating the number and types of patients treated to the resources required by the hospital. **Calculation Manager** - Costing of hospital services (activities) on the basis of a full amount of expenses actually made by the hospital including determining the actual cost of all hospitalised cases, analysis by clinical pathways, by expenditure type, etc.

L5 Applications Layer, P14 Collaboration Management Package: Healthcare planning Manager - Allows the development of various health plans, including healthcare organizations work plans, medical activities plans, prevention activities plans, planning visits to medical professionals, etc.

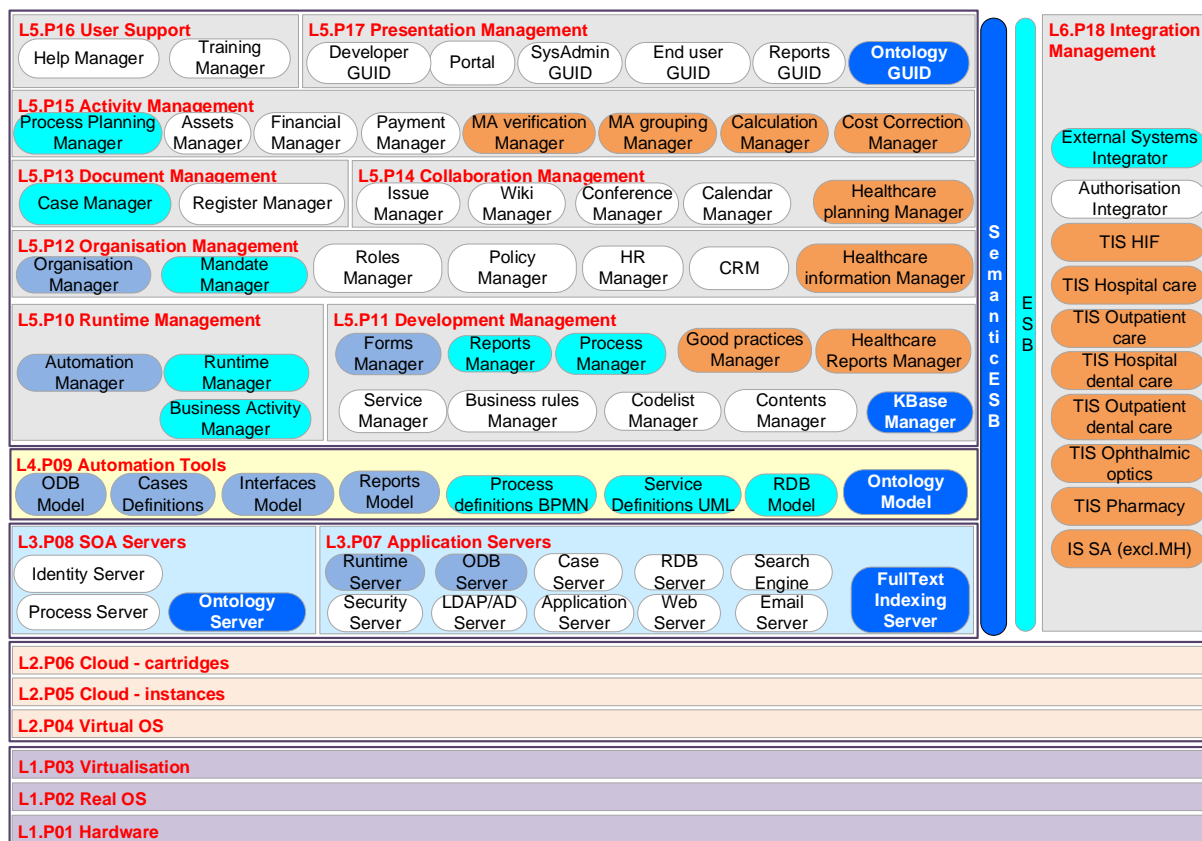


Figure 3. NHIS platform

L5 Applications Layer, P12 Organization Management Package: Healthcare information Manager

- Used to create different data sets of medical information, to describe the structure of data, to ensure data migration, to verify the accuracy of data on migration, to define the rules for formal and logical control of these data, to manage the process of data collection.

L5 Applications Layer, P11 Development Management Package: Good practices Manager - Used to set best practices represented by medical activities business processes, including information about operations performed, who performs them, what is their duration and value, what are the tools used, etc. The tool also performs control whether the activities described meet the requirements of the standards implemented in the system. **Healthcare reports Manager** - Used to generate new forms of medical documents and registries as well as their integration into the system by using other tools from P09 and P11. Provides for generation of reports necessary for the various system actors, taking into account their access rights.

External NHIS correspondents are presented in brief in section 3.2 – NHIS Correspondents Zone.

5 Conclusions

The results of the comparative analysis presented in *Table 1* indicate certain similarity of NHIS design with the Turkish eHealth IS. Major outcomes of health transformation programmes in Turkey are achieved through the introduction of performance based payment system in hospitals, unification and standardization of health insurance schemas, deployment of a national health information system, focus on prevention (EY, 2015). Taking into consideration the similar technical solutions, used instruments, and achieved results in the realization of their system (EY, 2015; Dogac, 2014; OECD, 2015) we expect the following NHIS advantages that could double the effectiveness of healthcare expendi-

tures in Bulgaria within a short period after the deployment of all NHIS key functions: (1) The Activity Based Funding model would improve the accuracy in determining the financial costs and minimise subjectivity in reporting on the work performed. Thanks to the adoption of the case-mix financing mechanism in Turkey the public healthcare expenditure share of Gross Domestic Product slightly increased through the years to stabilise at the end of the period at 4-4,5% interval covering 80-90% of the total healthcare expenditures (EY, 2015; OECD, 2015); (2) The introduction of standards and best practices accessible to a wide range of professionals will significantly increase the quality of care. Standardisation is one of the main reasons to increase patient satisfaction in Turkey from 39% at the start of the program in 2002 to 76% in 2013 (EY, 2015); (3) Using SOA and Cloud Computing provide better flexibility and adaptability of the individual NHIS components while the cost of developing and operating NHIS on the selected architecture and technology would significantly reduce maintenance and enhancements costs. Easily adaptable at reasonable cost the Turkish health IS facilitated the improvement of healthcare services efficiency. The number of outpatients per day per physician increased from 12% to 50% from 2002 to 2013. Furthermore the accessibility of health services in this period increased from 3,2% to 8,2% (EY, 2015).

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