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Smart and Connected e-Health R&D Platform

A Lab Approach for e-Health Research and Development

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Abstract—This HealthCom short paper reports our new lab approach in the Smart and Connected e-Health Services (SCeHS). It summarizes the architecture and platform plan, the functional resources, and the application flows enablement SDN, connected via data virtualization and exchange protocols, for the purpose of e-Health service development and deployment.

Keywords—Smart-and-Connected e-Health; e-Health Lab Plan; e-Health Services; e-Health Compliance; Availability and Quality

I. INTRODUCTION

The purpose of Smart and Connected e-Health Service (SCeHS) program is to develop next generation healthcare I.T. solutions to improve patient outcomes, decrease costs, and address the complexity of challenging e-Health problems in interconnection infrastructure, data processing flows and security.

Our pursue of e-Health fundamental research is to enable interoperable and scalable infrastructure, applications, and services for effective sharing and usage of electronic health record data, data representation including semantic metadata, and networked applications that access such data. We investigate aspects of a continuously scalable universal exchange [1,2,3,4] for current and future e-Health with data originating from diverse sources in multiple formats, with advance network processing methods for controlling and maintaining data integrity, provenance, security, privacy and reliability of original as well as aggregated data, providing trustworthy patient identification and authentication and access control protocols, and maintaining sensitivity to the legal, cultural and ethical issues associated with universally accessible e-Health data. This paper reports our lab R&D approach to improve quality and productivity of healthcare delivery networks.

The e-Health R&D platform consists of the infrastructure layer, a tool set platform, a functional layer and the e-Health resource layer, connected via data virtualization and exchange protocols, for the purpose of application flows and e-Health service development and deployment with quality of service controls.

II. SMART AND CONNECTED E-HEALTH LAB PLATFORM

A. Smart and Connected

Figure 1 below depicts an environment that creates, validates and deploys e-Health application flows by combing e-Health solution framework with an innovative test bed and deployment platform.

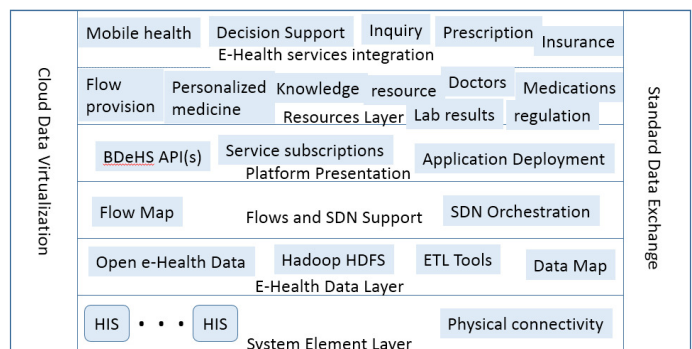


Figure 1. e-Health Lab Platform Architecture

After the initial framework of e-Health interconnection solutions presented in [1,5,6] where networking and communication services are the primary objectives, our lab approach will maximize the data transformation and exchange capabilities. Standard data exchange is augmented by an overarching data service strategy with the ultimate goal of converging the service provider centric record into a patient-centric and patient-owned records for treatment, medication, billing and holistic case histories that are beyond PHR (patient health record). The detail technology will be reported in a separate technical paper.

To achieve the goal of big data e-Health services and transformation, the data relationship are extended into the system element layer where each element will represent a complex HIS/CIS/RIS/e-Subscribe with external connectivity as well as perfected archives of EMR, LOCIC, PACS, DICOM, NCPDP and insurance records. Due to diverge sources and varying format structures, data maps and processing tools are included in the e-Health data enhancement layer.

The smart and connected big data functions are formulated into BigData/eHealthService (BDeHS) APIs for planning evidence-based programs, for predicting disease onset to intervene earlier, for delivering the right case services to support the individual with the exact treatment to improve quality and for optimizing e-Health care resources, and so on.

Although we minimize the physical connectivity with external HIT systems in this lab environment, the networking service layer still play a key role in development of new services of this platform as various network deployment scenarios have to be considered when the applications and services are to be deployed into production HIT environment. As such, a number of flows and software defined networking controls are going to be incorporated along the way while we are perfecting the data-centric platform.

A number of e-Health resources beyond the data models and connectivity controllers are being developed to facilitate innovative e-Health service flows, mobile health interfaces, security control and audit functionality and additional Big Data resources.

Integration engines of this lab platform are to achieve Level 5+ and go beyond [7] of “Machine-interpretable data transmission of structured messages containing standardized and coded data; idealized state in which all systems exchange information using the same formats and vocabularies”. The integrations allow rapid roll out of application services into various e-Health application domains.

B. Application Domains

Our lab design accommodates the different service context management for various providers (the so called covered entities and their associates) and patients. There are large numbers of communication flows that go beyond a dedicated end point for patients. In addition, we have to consider multiple domains across multiple industries (that go beyond the core healthcare providers and patients).

Key domains include Electronic Health Records including data interoperability, security and privacy. Another domain is big data medicine where personal genetic markers in DNA assist in disease prevention, diagnosis, and treatment decisions, has continued to progress. The third domain includes remote clinical care, diagnostics, and electronic patient monitoring driven by the pervasiveness devices and wireless capability, by the relative affordability of devices, and by new remote clinical care technologies that enable doctors to provide medical assessments and treatments from a remote location away from the patients without onsite specialist medical doctors.

Additional application domains include personalized medicine, which is combined with e-Health computing and genomic technologies to utilize information about a person’s genes, proteins, and environment to prevent, diagnose, and treat disease. Clinical decision supports, operational quality monitoring, insurance and billings are all interested components of our application domains.

C. SDN Multi-Domain Orchestration and Controls

To simulate a diverse interconnection environment in the Lab, we decided to utilize a SND orchestration engine for rapid adaptation to new connectivity flows and requirements.

A software-defined and application-oriented network orchestration and control framework allows our lab to replicate a data center environment with simulated service providers involved all the e-Health flows. This rapid deployment technology will support policy-based interfaces between domains of covered entities and between application flows and the control components of a domain. SND allows scale and avoids state explosion as the deployment grows with more (external) data center domains. And it supports tiered domains using different networking technologies.

In addition, network to service level quality of service are measured to guide future deployment of connectivity when the new e-Health application services are to be rolled out into health IT production environments.

III. E-HEALTH FLOWS: VALIDATION

The U.S. Department of Health and Human Services published the Final Rule [3] for Health Information Technology that included standards of implementation and certification criteria for e-Health technology, which required security context management to accommodate more types of patient data being efficiently shared and further expansion of access to patient data due to accelerated conversion of data into useful intelligence. The Final Rule listed the functions or services and promoted enhanced interoperability, functionality, utility, and security of EHR technology. Our lab platform is in the process of enhancement through the capabilities they include and the standards to meet for certification to demonstrate Meaningful Usage of e-Health technology in improving health care.

In addition, our platform is also going through the enhancement process in order for conformance to the emerging EU standards[8].

During the Beijing HealthCom-2012 keynote speech, representative from the China Health Service ministry presented a grand vision of 3-tier health information deployment plan. Once those standards become available, our lab platform has to be further validated to meet those flows and standards as well.

IV. SUMMARY

The presented lab solution provides a platform to enable further R&D of our various e-Health solution frameworks. Through an innovative transformation from SP centric record model into a holistic patient ownership design, it enabled a futuristic toolsets for data functions, e-Health resources integration, innovation in services, conformance to regulatory changes and guarantee e-Health security.

The operational capabilities form the foundation for future implementation of emerging standards, rapid data conversion and utilization, as well as enable rapid deployment of new e-Health application flows.

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