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EFFECTUAL TELEMEDICINE DELIVERY ON VIRTUAL PRIVATE CLOUD IN SECURED PERSPECTIVES

Jamal Kh-Madhloom[1], MohdKhanapiAbd Ghani[1]

[1]Biomedical Computing and Engineering Technologies (BIOCORE) Applied Research Group,
Faculty of Information and Communication Technology,
UniversitiTeknikal Malaysia Melaka, Malaysia

engineerjamal112@yahoo.com, khanapi@utem.edu.my

ABSTRACT

This research work focus on the delivery of telemedicine using network infrastructure and wireless technologies. The research work mainly address the use of software defined networking in association with Internet of Things (IoT) so that the effectual delivery of resources can be implemented in performance aware integrations. In traditional aspects, there are number of medical services in a hospital operation theatre which are required during operation. These services and modules include blood, anesthesia, oxygen and many others. In traditional aspects, these are statically taken by the doctors and operation theatre professionals which is not cost effective implementation. Many times, the resource can be in scarcity at other operation theatre. To this issue, the dynamic delivery of medical services can be done using software defined networking and Internet of Things. In addition, the use of cloud based technologies can be done for higher efficiency and overall performance of the implementation.

Keywords: Cloud Delivery of Health Services, Docker, Software Defined Networking, Telemedicine

Introduction

Telemedicine integrates the wireless technologies and paradigms for the delivery of medical services to remote points in the instance of emergency and disaster management. Many times, it becomes necessary to deliver the medical services instantly to a particular place and there is no scope of much delay. To avoid any type of delay and time related issues, the emergence of telemedicine is integrated. Using telemedicine integrated devices and technologies, the remote end points or patients can be delivered the medical services using wireless communications and computing infrastructure. There are assorted methods of delivering the telemedicine including cloud based operation theatres, Internet of Things (IoT) integrated blood delivery and many others.

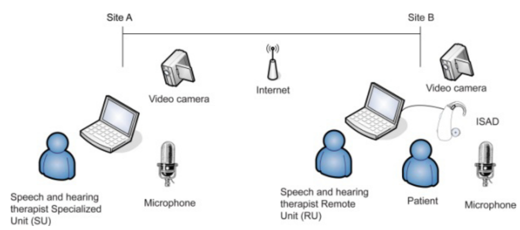

Figure 1. Delivery and Service Points in Telemedicine

Types and Taxonomy with Telemedicine

- Store and Forward
- Remote Monitoring
- Real Time Interactive Treatment
- Tele-Nursing
- Tele-Pharmacy
- Tele-Rehabilitation
- Tele-Trauma Health Care

Specialization Based Telemedicine Integrations

- Telecardiology
- Tele-EEG Monitoring
- Tele-Psychiatry
- Tele-Radiology
- Telepathology
- Tele-Dermatology
- Tele-Dentistry
- Teleaudiology
- Teleophthalmology

The basic motivation for developing the IoT architecture is to promote the reuse of various resources and to allow the rapid introduction and deployment of new IoT services and applications. Layered architecture: Various types of resources are needed for providing IoT services, such as devices for collecting data, networking resources for transferring the data, and computing resources for processing the data according to user needs. In order to organize and use the resources as a whole, the network architecture should be organized into a layered structure, each layer with clear responsibilities. Openness and programmability: This is the basis for the rapid introduction of new applications and services and the rapid proliferation of new businesses. Thus, the architecture should provide open programmable interfaces, functionalities, and services. In addition, data and methods for processing and obtaining the data should be open as well. In this way, services can be developed rapidly by reusing the same raw data and by annotating different context information, which may lead to more commercial services. Data provision and sharing at different levels: Providingdata (environment, people, and things) for services is oneof the major requirements set to IoT architecture. HorizontalIoT infrastructures should provide data for a wide range ofservices in different domains, which demands data at differentlevels. For example, some users may need only raw data forfurther analysis and use their own knowledge bases of specificdomains, while others may need meaningful information thathas been processed utilizing knowledge in the network, forinstance, information about weather in a city and conditions of its roads. Interoperability: Heterogeneous devices may produce datain various formats and models. In order to realize and support services in different domains, which may use different datamodels, patterns and communication protocols, interoperability should be supported in the network from the point of view of devices, data, and communication protocols.

This research work focus on the delivery of telemedicine using network infrastructure and wireless technologies. The research work mainly address the use of software defined networking in association with Internet of Things (IoT) so that the effectual delivery of resources can be implemented in performance aware integrations. In traditional aspects, there are number of medical services in a hospital operation theatre which are required during operation. These services and modules include blood, anesthesia, oxygen and many others. In traditional aspects, these are statically taken by the doctors and operation theatre professionals which is not cost effective implementation. Many times, the resource can be in scarcity at other operation theatre. To this issue, the dynamic delivery of medical services can be done using software defined networking and Internet of Things. In addition, the use of cloud based technologies can be done for higher efficiency and overall performance of the implementation.

As telemedicine is one of the emerging domain, there is need to evaluate the number of excerpts from existing research papers, periodical and magazines to know about the recent work going on in this segment. In addition, as IoT is integrated with wireless based implementations, there should be the evaluation of IoT technologies so that the cumulative association can be made.

Work	Author	Year
Telemedicine-based proactive patient management during positive airway pressure therapy	Woehrle, H., Ficker, J. H., Graml, A., Fietze, I., Young, P., Teschler, H., & Arzt, M.	2017
Managing Migraine via Telemedicine: Clinical Effectiveness and Process Implications.	Rajan, B., Seidmann, A., & Friedman, D	2017
Telemedicine quality and outcomes in stroke: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association.	Wechsler, L. R., Demaerschalk, B. M., Schwamm, L. H., Adeoye, O. M., Audebert, H. J., Fanale, C. V., & Rosamond, W. D.	2017
Trajectory of cost overtime after psychotherapy for depression in older Veterans via telemedicine.	Egede, L. E., Gebregziabher, M., Walker, R. J., Payne, E. H., Acierno, R., & Frueh, B. C.	2017
Self reported outcomes and adverse events after	Aiken, A. R., Digol, I.,	2017

medical abortion through online telemedicine: population based study in the Republic of Ireland and Northern Ireland.	Trussell, J., & Gomperts, R. (2017).	
Telemedicine in prehospital stroke evaluation and thrombolysis: taking stroke treatment to the doorstep.	Itrat, Ahmed, Ather Taqui, Russell Cerejo, Farren Briggs, Sung-Min Cho, Natalie Organek, Andrew P. Reimer	2016
The empirical evidence for telemedicine interventions in mental disorders. *Telemedicine and e-Health*	Bashshur, R. L., Shannon, G. W., Bashshur, N., & Yellowlees, P. M.	2016
Using off-the-shelf medical devices for biomedical signal monitoring in a telemedicine system for emergency medical services.	Thelen, S., Czaplik, M., Meisen, P., Schilberg, D., & Jeschke, S	2016
Clinical telemedicine utilization in Ontario over the Ontario Telemedicine Network.	O'Gorman, L. D., Hogenbirk, J. C., & Warry, W.	2016
A telemedicine-based intervention reduces the frequency and severity of COPD exacerbation symptoms: a randomized, controlled trial.	Cordova, F. C., Ciccolella, D., Grabianowski, C., Gaughan, J., Brennan, K., Goldstein, F., ... & Criner, G. J.	2016
Interactive telemedicine: effects on professional practice and health care outcomes.	Flodgren, G., Rachas, A., Farmer, A. J., Inzitari, M., & Shepperd, S.	2015
Telemedicine-based collaborative care for posttraumatic stress disorder: a randomized clinical trial	Fortney, J. C., Pyne, J. M., Kimbrell, T. A., Hudson, T. J., Robinson, D. E., Schneider, R., ... & Schnurr, P. P.	2015
Virtual visits—confronting the challenges of telemedicine.	Kahn, J. M.	2015
SUNDROP: six years of screening for retinopathy of prematurity with telemedicine.	Wang, S. K., Callaway, N. F., Wallenstein, M. B., Henderson, M. T., Leng, T., & Moshfeghi, D. M.	2015
Robust and imperceptible dual watermarking for telemedicine applications.	Singh, A. K., Kumar, B., Dave, M., & Mohan, A.	2015

FREE AND OPEN SOURCE TOOLS FOR IoT PROGRAMMING

Usage of Sensor Data in Cloud Environment

The huge generation, processing and storage of sensor data is involved in the Internet of Things. To manage and control all these aspects, cloud is required. For this, the effective implementation of cloud infrastructure is required. In the upcoming years, the Internet of Things (IoT) will be transformed to the Cloud of Things (CoT) because it will be very difficult to manage huge data or BigData without cloud integration.

Real Life Implementations and Applications of IoT

From building and home automation to wearables, the IoT touches every facet of our lives. Many corporate giants including Texas Instruments, Cisco, Ericsson, Freescale, GE are working in the development as well as deployment of IoT scenarios. The companies are making and developing the applications easier with hardware, software and support to get anything connected within the IoT. A set of key markets exists for the IoT with potential for exponential growth.

- Medical and healthcare systems
- Building and home automation
- Transportation
- Wearables - Smart watch for Location and tracking
- Building & home automation
- Smart cities
- Smart manufacturing
- Employee safety
- Predictive maintenance

- Health care
- Remote monitoring
- Ambulance telemetry
- Drug tracking
- Hospital asset tracking
- Access control
- Automotive

Open Source Cloud Platforms for Internet of Things

Numbers of open source platforms are available to simulate the IoT infrastructure and related protocols.

OpenIoT - OpenIoT is an open source middleware for getting information from sensor clouds, without worrying what exact sensors are used. OpenIoT is now included in the teaching program (syllabus) of Santa Clara University, CA, USA. The master program includes theory in Internet of Things and practical experience. OpenIoT among other IoT tools from CISCO, ARM etc are pioneers in this program in the University. Dr Martin Serrano from the OpenIoT project will be teaching IoT principles and also facilitate lab experiments and projects for the students that will be using the OpenIoT middleware. This is the first wide adoption of OpenIoT in education and outside of Europe. [Source - http://openiot.eu]

OpenIoT is a joint effort of prominent open source contributors towards enabling a new range of open large scale intelligent IoT (Internet-of- things) applications according to a utility cloud computing delivery model. OpenIoT is perceived as a natural extension to cloud computing implementations, which will allow access to additional and increasingly important IoT based resources and capabilities. In particular, OpenIoT provides the means for formulating and managing environments comprising IoT resources, which can deliver on-demand utility IoT services such as sensing as a service.

OpenIoT is pertinent to a wide range of interrelated scientific and technological areas spanning:

(a) Middleware for sensors and sensor networks,
(b) Ontologies, semantic models and annotations for representing internet-connected objects, along with semantic open-linked data techniques
(c) Cloud/Utility computing, including utility based security and privacy schemes.

From a more technical point of iew, the OpenIoT middleware infrastructure allows flexible configuration and deployment of algorithms for collection, and filtering information streams stemming from the internet-connected objects, while at the same time generating and processing important business/applications events.

AllJoyn

Originally created by Qualcomm, this open source operating system for the Internet of Things is now sponsored by one of the most prominent IoT organizations - The AllSeen Alliance, whose members include the Linux Foundation, Microsoft, LG, Qualcomm, Sharp, Panasonic, Cisco, Symantec and many others. It includes a framework and a set of services that will allow manufacturers to create compatible devices. It's cross-platform with APIs available for Android, iOS, OS X, Linux and Windows 7.

Contiki

Contiki is the open source OS for the Internet of Things. It connects low-power microcontrollers to the internet and supports standards like IPv6, 6lowpan, RPL and CoAP. Other key features include highly efficient memory allocation, full IP networking, very low power consumption, dynamic module loading and more. Supported hardware platforms include Redwire Econotags, Zolertia z1 motes, ST Microelectronics development kits and Texas Instruments chips and boards. Paid commercial support is available.

Raspbian

While the Raspberry Pi was intended as an educational device, many developers have begun using this credit-card-sized computer for IoT projects. The complete hardware specification is not open source, but much of the software and documentation is. Raspbian is a popular Raspberry Pi operating system that is based on the Debian distribution of Linux.

RIOT

RIOT bills itself as "the friendly operating system for the Internet of Things." Forked from the FeuerWhere project, RIOT debuted in 2013. It aims to be both developer- and resource-friendly. It supports multiple architectures, including MSP430,

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ARM7, Cortex-M0, Cortex-M3, Cortex-M4, and standard x86 PCs.

Spark
Spark is a distributed, cloud-based IoT operating system. Spark includes a Web-based IDE, a command-line interface, support for multiple languages, and libraries for working with many different IoT devices. It has a very active user community, and a lot of documentation and online help are available.

Freeboard
Freeboard aims to let users create their own dashboards for monitoring IoT deployments. The code is freely available on GitHub or you can try the service for free if you make your dashboard public. Low-priced plans are also available for those who want to keep their data private. Sample dashboards oon the site show how they can be used to track air quality, residential appliances, distillery performance or environmental conditions in a humidor.

Exciting Printer
Exciting offers an open source kit for experimenting with IoT printing. It makes it possible to build your own small printer and use that printer to print out information obtained from various IoT devices. For example, it could print out a list of daily reminders, the weather report, etc. And in a interesting twist, if you want to contact the project owners, you can draw a picture that will be printed on the IoT printer in their office.

DeviceHive
This project offers a machine-to-machine (M2M) communication framework for connecting devices to the Internet of Things. It includes easy-to-use Web-based management software for creating networks, applying security rules and monitoring devices. The website offers sample projects built with DeviceHub, and it also has a "playground" section that allows users to use DeviceHub online to see how it works.

Devicehub.net
Devicehub.net is the open source backbone for the Internet of Things. It's a cloud-based service that stores IoT-related data, provides visualizations of that data and allows users to control IoT devices from a Web page. Developers have used the service to create apps that track health information, monitor the location of children, automate household appliances, track vehicle data, monitor the weather and more.

IoT Toolkit
The group behind this project is working on a variety of tools for integrating multiple IoT-related sensor networks and protocols. The primary project is a Smart Object API, but the group is also working on an HTTP-to-CoAP Semantic mapping, an application framework with embedded software agents and more. They also sponsr a meetup group in Silicon Valley for people who are interested in IoT development.

Mango
Mango bills itself as "the world's most popular open source Machine-to-Machine (M2M) software." Web-based, it supports multiple platforms. Key features include support for multiple protocols and databases, meta points, user-defined events, import/export and more.

Nimbits
Nimbits can store and process a specific type of data—data that has been time- or geo-stamped. A public platform as a service is available, or you can download the software and deploy it on Google App Engine, any J2EE server on Amazon EC2 or on a Raspberry Pi. It supports multiple programming languages, including Arduino, JavaScript, HTML or the Nimbits.io Java library.

OpenRemote
OpenRemote offers four different integration tools for home-based hobbyists, integrators, distributors, and manufacturers. It supports dozens of different existing protocols, allowing users to create nearly any kind of smart device they can imagine and control it using any device that supports Java. The platform is open source, but the company also sells a wide variety of support, ebooks and other tools to aid in the design and product development process.

SiteWhere
This project provides a complete platform for managing IoT devices, gathering data and integrating that data with external systems. SiteWhere releases can be downloaded or used on Amazon's cloud. It also integrates with multiple big data tools, including MongoDB and ApacheHBase.

ThingSpeak
ThingSpeak can process HTTP requests and store and process data. Key features of the open data

platform include an open API, real-time data collection, geolocation data, data processing and visualizations, device status messages and plugins. It can integrate multiple hardware and software platforms including Arduino, Raspberry Pi, ioBridge/RealTime.io, Electric Imp, mobile and Web applications, social networks and MATLAB data analytics. In addition to the open source version, a hosted service is also available.

Arduino

Arduino is both a hardware specification for interactive electronics and a set of software that includes an IDE and the Arduino programming language. Arduino is a specialized tool for making computers than can sense and control more of the physical world than your desktop computer.

Eclipse IoT Project

Eclipse is sponsoring several different projects surrounding IoT. They include application frameworks and services; open source implementations of IoT protocols, including MQTT CoAP, OMA-DM and OMA LWM2M; and tools for working with Lua, which Eclipse is promoting as an ideal IoT programming language. Eclipse-related projects include Mihini, Koneki and Paho. The website also includes sandbox environments for experimenting with the tools and a live demo.

Kinoma

Owned by Marvell, the Kinoma software platform encompasses three different open source projects. Kimona Create is a DIY construction kit for prototyping electronic devices. Kimona Studio is the development environment that works with Create and the Kinoma Platform Runtime. Kimona Connect is a free iOS and Android app that links smartphones and tables with IoT devices.

M2MLabs Mainspring

Designed for building remote monitoring, fleet management and smart grid applications, Mainspring is an open source framework for developing M2M applications. It capabilities include flexible modeling of devices, device configuration, communication between devices and applications, validation and normalization of data, long-term data storage, and data retrieval functions. It's based on Java and the Apache Cassandra NoSQL database.

Node-RED

Built on Node.js, Node-RED describes itself as "a visual tool for wiring the Internet of Things." It allows developers to connect devices, services and APIs together using a browser-based flow editor. It can run on Raspberry Pi, and more than 60,000 modules are available to extend its capabilities.
[Source - datamation.com]

Conclusion

This research work focus on the delivery of telemedicine using network infrastructure and wireless technologies. The research work mainly address the use of software defined networking in association with Internet of Things (IoT) so that the effectual delivery of resources can be implemented in performance aware integrations. In traditional aspects, there are number of medical services in a hospital operation theatre which are required during operation. These services and modules include blood, anesthesia, oxygen and many others. In traditional aspects, these are statically taken by the doctors and operation theatre professionals which is not cost effective implementation. Many times, the resource can be in scarcity at other operation theatre. To this issue, the dynamic delivery of medical services can be done using software defined networking and Internet of Things. In addition, the use of cloud based technologies can be done for higher efficiency and overall performance of the implementation.

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