Mobile Health
Architecture, Applications, Security

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2. mHealth

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Introduction

m-Services

mHealth

Use cases for mHealth
Functionnal Requirements
Architecture
Applications and Services
Security

EpharmacyNet Project

Description
Interactions
Mobile Telephony ...

- High rate of expansion\(^a\)
- Introduction of new generation mobile networks (3G, 4G, LTE; etc.)\(^b\)
- Primary alternate solution for rural environment.

\(^a\) 5% in 1998, 50% in 2008 and one can estimate to 99% in 2018.

\(^b\) With a penetration rate of 0% in 1998, 19% in 2008 and one can estimate to 90% en 2018.
Innovative mobile Services

All new services that can take advantage from the rapid growing of mobile telephony and mobile internet:

1. Mobile Money or mMMoney
2. Mobile Education or mEducation
3. Mobile Agriculture or mAgriculture
4. Mobile Health ou mHealth
Introduction

m-Services

mHealth

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EpharmacyNet Project

Description
Interactions
How to use ICT to improve care delivery efficiency in health domain?
Objective

- How to use ICT to improve care delivery efficiency in health domain?

mHealth

→ A new EHealth approach to increase means and efficiency of care delivery: diagnosis, remote monitoring of chronic diseases\(^a\) (including diabetes, COPD) care/medicine prescription, advice etc.

\(^a\) 63% of mortality in 2010 according to WHO.
Introduction
mHealth
EpharmacyNet Project

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mHealth eco-system

Roles and components of a mHealth system:

- Patient: is a person with some kind of health problem.
- Clinician: is a healthcare professional who is treating or helping the Patient with the health problem, i.e., a nurse, a General Practitioner, or a specialized physician.
- HealthCare Provider (HCP): is the entity that is utilizing a mobile health Service in the monitoring, diagnosis, and treatment of the Patient.
- Mobile Health Service (mHS): is the service that connects the Patient to the Clinician, and ensures data measures, transport, and protection.
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mHealth eco-system

Roles and components of a mHealth system:

**mobile Health Service provider (mHSP):** is the entity providing the mHS through a mobile health Platform (mHP).

**mobile Health Platform (mHP):** is the IT system connected to the mobile network to provide all necessary functionality.

**mobile Health Device (mHD):** is a device needed to use the mHS and to connect to the mHP.
The use cases investigated in this presentation are:

1. Consumer purchases mobile health service.
2. Healthcare Provider prescribes mobile health service.
   (a) Prescribed mobile health service with a mobile health Gateway Device.
   (b) Mobile health service connected to Healthcare IT system.
3. Prescribed mobile health service for Disease Management.

Note that, health problems considered in this presentation and the use cases are all low risk.
Use case 1: Consumer purchases mHS

This use case describes a system that allows remote monitoring of a patient by a subscriber (parent, insurance company, etc.):

*Subscriber & Observer*

**mHealth Service Provider**

**Patient**

*Figure 1: Consumer purchases mHS*
Use case 2: Healthcare Provider prescribes mHS

This use case includes intervention of HCP for measuring and remote monitoring\textsuperscript{1}.

\textbf{Figure 2:} HCP prescribes mHS

\textsuperscript{1} For instance a GP may need to monitor daily records of blood sugar level for a patient suffering of diabetes.
Use case 2a: Prescribed mobile health service with a mHGD

This use case differs from the previous with the introduction of a gateway: mHGD that aggregates data from different sensors.

**Figure 3:** Use case 2a: Prescribed mobile health service with a mHGD
Use case 2b: mHS connected to Healthcare IT system

This use case introduces new devices at the HCP side, such as EHR and PHR servers:

**Figure 4**: mHS connected to Healthcare IT system

2. E(P)HR: Electronic (Personal) Health Record
Use case 3: Prescribed mHS for Disease Management

Use case 3 is the most complex:

**Figure 5:** Prescribed mHS for Disease Management

3. It is unlikely to find or implement such a system in developing countries because it requires important infrastructures, high knowledge, development and user experiences in mHealth domain.
Use case 3 : Prescribed mHS for Disease Management

- Educative system
- Patient : reacts and adjusts his insulin level himself.
- HCP : modify the Patient self management level according to seen improvements.
Requirements overview

- Scalability
- Interoperability
- Security
Fonctionnalities of the mHD

1. Easy to use according to the target group.
2. Unique ID.
3. GSM connectivity.
4. Secure.
Fonctionnalities of mHS

1. Online Helpdesk.
2. Web portal.
3. Easy setting of parameters.
4. Use of international standards for messaging and communication.

4. Especially threshold values that match therapy goals.
## Security requirements

1. End to end security using a unique asset of MNO.
2. Users authentication.
3. Registration of users and mHD to HCP (billing).

Overall, mHS continuity levels must match the level of medical risk associated with it.
Interoperability

1. Use of international standards and messaging formats: HL7, IEEE11073, etc.

2. mH application must be able to communicate with the IT system of the HCP.

3. Technology to be used: Bluetooth, Zigbee or USB between sensors and gateway.
Interoperability

**Figure 6:** Interfaces and Standards. (Source: Continua Health Alliance)
mHealth network Architecture
Figure 7: mHealth Reference network Architecture
mHealth network protocols suite

**Message Transport**
- **IHE PCD- 01 HL7 v2.6 with IEEE 11073 Semantics**
- **Web Services (WS-I BP)**
- **SOAP 1.2**
- **Internet Protocol (IP)**
  - agnostic (can be WiFi, Cellular, Ethernet, ...)

**Figure 8:** Continua certified WAN interfaces
### Examples

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<td>• Individuals -Low Income / Low Reach -Primarily Rural Areas</td>
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<td>• Apps</td>
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**Figure 9:** Applications and services mHealth
## Examples

| Monitoring | • Individuals suffering from chronic diseases or recovering from acute conditions  
|           | • Elderly |  | • Chronic Disease Management  
|           |          |  | • Independent Aging  
|           |          |  | • Post Acute Care  
|           |          |  | • Trackers for Body Vitals and Activities  
|           |          |  | • Reporting and Alert Messages  
|           |          |  | • Device-linked  
|           |          |  | • Mobile Operators  
|           |          |  | • Device Vendors  
| Healthcare Systems Strengthening | • Institutional – Hospitals  
| Emergency Response | • Solutions based  |  | • Trackers for Body Vitals  
|                      |          |  | • Interactive Consultation  
|                      |          |  | • Device-linked  
|                      |          |  | • Device Vendors  
|                      |          |  | • Mobile Operators  
| Healthcare Practitioner Support | • Institutional – Hospitals  
|                      | • Physicians  |  | • Information Lookup and Decision Support Systems  
|                      |          |  | • Medical Information  
|                      |          |  | • Apps  
|                      |          |  | • Internet-based  
|                      |          |  | • Content Developers  
|                      |          |  | • Mobile Operators  
| Healthcare Surveillance | • Institutional - Government - NGOs  
|                      | • Healthcare Workers  |  | • Health Surveys & Surveillance  
|                      |          |  | • Data Collection and Reporting Support  
|                      |          |  | • Apps  
|                      |          |  | • Internet-based  
|                      |          |  | • Mobile Operators  
|                      |          |  | • Content Developers  
| Administration | • Institutional – Hospitals  
|                      | • Physicians  |  | • Appointment Reminders  
|                      |          |  | • Reminders  
|                      |          |  | • SMS (including USSD)  
|                      |          |  | • Content Developers  
|                      |          |  | • Mobile Operators  

**Figure 10:** mHealth Applications and services
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Security requirements are an important aspect of mobile health system:

1. Device and data security
   (a) In memory
   (b) Processing
   (c) Transmission

2. Confidentiality and integrity of information

3. User authentication

4. System availability and access to resources

5. Non repudiation (useful in case of medical prescription)
Security overview

There are different ways to achieve security requirements in a mHS:

- Focus on mHD-mHP connection.
- Use of available unique asset of MNO (IMSI, IMEI, PIN, etc.).

1. Standard 3G, GSM radio encryption
2. Transport Layer Security (TLS) with Generic Bootstrapping Architecture (GBA)
3. Mobile health application embedded on the UICC

5. Any design should also consider risk and regulation
Solutions based on a mobile health application on the UICC:

- UICC contains (U)SIM for authentication.
- UICC has enough storage to hold extra applications.
- Experiences of mobile money, mobile banking.
- More efficiency: XML, PKCS#7, S/MIME, OpenPGP encryption with non repudiation required on mHCD.
A mobile health application on the UICC\(^6\) has many advantages including:

- Universality
- Portability
- Accessibility
- Interoperability
- Payment integration, tracking.

But ...

\*\*\*\*

6. There are three ways to do that: pre-loading, loading at a Point of Interaction and OTA
1. Introduction
   - m-Services

2. mHealth
   - Use cases for mHealth
   - Functionnal Requirements
   - Architecture
   - Applications and Services
   - Security

3. EpharmacyNet Project
   - Description
   - Interactions
EpharmacyNet (← Ecare)

1. Aims to reduce issues associated with Pharmacy Tourism
2. Had been tested in Benin in 2010 with 434 patients
3. 2010 IHI award in Washington DC
Interactions in EpharmacyNet

In an EpharmacyNet system:

- A Patient gets a medical prescription
- EpharmacyNet platform consists in centralized databases
- The Patient connects to EpharmacyNet system
- The user interface displays a list of nearest pharmacies matching the request
- Electronic, online and cash payment
- Home delivery
Interactions in EpharmacyNet

**Figure 11:** EpharmacyNet procedures and actors
Interactions in EpharmacyNet

Figure 12: Communication in EpharmacyNet
Mobile Health Systems can help to improve care delivery:

- Increase of care centres (virtually)
- Reduction of delay associated with medical interventions and medicine delivery
- Increase of social wellness
- Better monitoring and statistics at national level
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