Open Source Telemedicine

Sana Android Client and OpenMRS

Winter 2012 IAP

Course Agenda

- General introduction to the platform
- How to get started developing
- Platform software components
- Topics related to the software
- Guest speakers.
- Case studies and related topics
- Hands on projects
- Plans for the future

Daily Schedule

Day	Agenda
Jan 26th	Introduction to the platform Development Environment Guest Speaker: Dr. Trishan Panch, Clinical perspectives on software tools
Jan 27th	Sana Android Client Project Discussion Guest Speaker: Members of hearing loss study from UFRN, Rio Grande Norte, Brazil
Jan 30th	Data Layer: Client and Permanent Data Stores, OpenMRS Guest Speaker: Chris Moses, Cardiovascular disease study, Philippines
Jan 31st	Dispatch layer Guest Speaker: Rich Fletcher, Medical Device Integration Hacking Day
Feb 1st	Systems and Scalability: Platform based approach Hacking day
Feb 2nd	Hacking day
Feb 3rd	Wrap up Participant project presentations

Open Source Telemedicine Introduction

Agenda

- Fundamental problem
- Goals
- Challenges
- Why Sana?
- Solutions

Fundamental Problem

Given a shortage of trained clinical specialists coupled with limitations on connectivity and a myriad of local challenges, how do we effectively project medical decision support and expertise into remote areas to capture and store data for future use as well as provide follow up instructions for care?

General Goals

- Measurable outcomes.
- High availability.
- Cost Efficiency.
- Interoperability.
- Customizable.

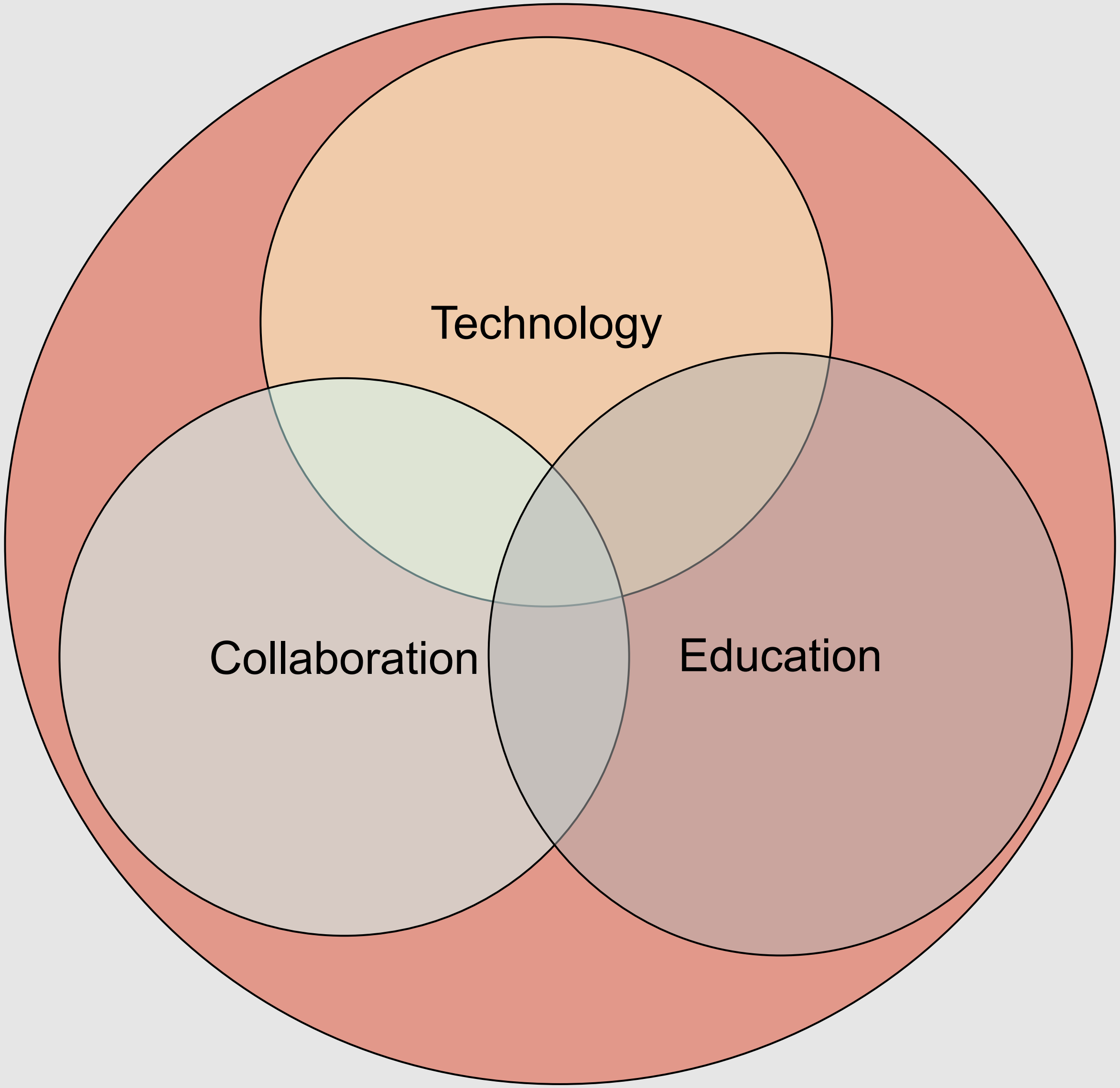
Challenges

1. **Physical barriers**
   Physical access may be difficult.
2. **Technical barriers**
   Connectivity can be poor or intermittent.
3. **Cultural and language barriers**
   Users will expect compliance with local and cultural norms.
4. **Technical skill barriers**
   User experience can limit adoption
5. **Financial Barriers**
   Cost of adoption may be prohibitive

Assumptions

- Technology can provide a path to addressing a number of the challenges.
- Technology alone will not solve the problems.
- No one group has all of the necessary skill and expertise.
- Collaborative innovation is necessary to address the wide range of local issues that face healthcare access and delivery
- Education of health providers as well as those managing healthcare systems is critical to long term success.

Our Approach



Addressing Challenges

- **Physical barriers**

Fundamentally, mobile networks provide increased connectivity into areas that were previously more difficult to access.

- **Technical barriers**

Given poor or intermittent connectivity, mobile networks alone are not a perfect solution. We employ a combination of techniques which react to local conditions and use a retry-on-fail approach to maintain high availability.
Integrates with other 3rd party Android apps.

Addressing Challenges

- **Cultural and language barriers**

Components that can be localized.
Education and information resources can be modified to adapt to local norms.

- **Technical skill barriers**

Provide end users with an intuitive user interface.
Use a reasonably simple document format for any that may need to be edited by end users.

- **Financial Barriers**

All components are freely available.
Components are compatible with low-grade hardware to the greatest extent possible.

Sana Tech Solution

Provide a turn-key, open source, platform consisting of a mobile client, network transport layer, and permanent data store for collecting and moving data from remote areas to centralized clinical specialists and back.

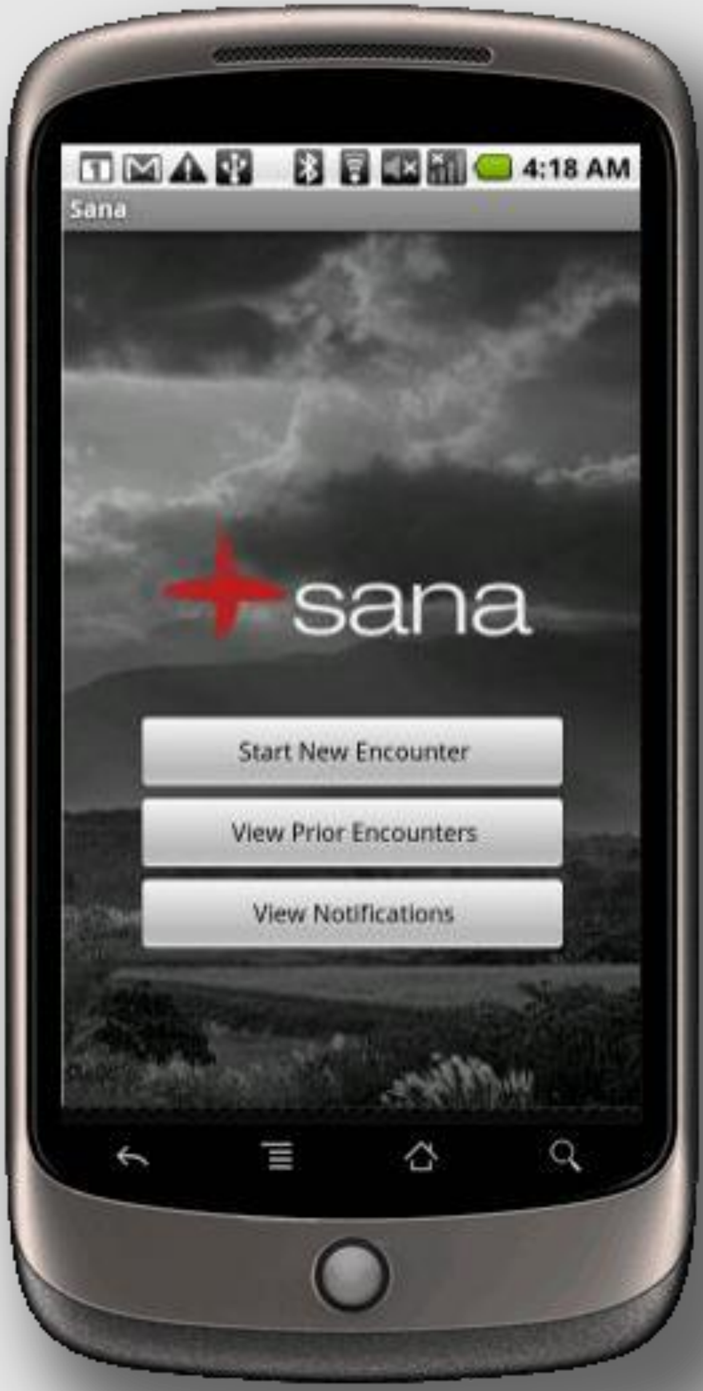
Sana Solution

Workflow

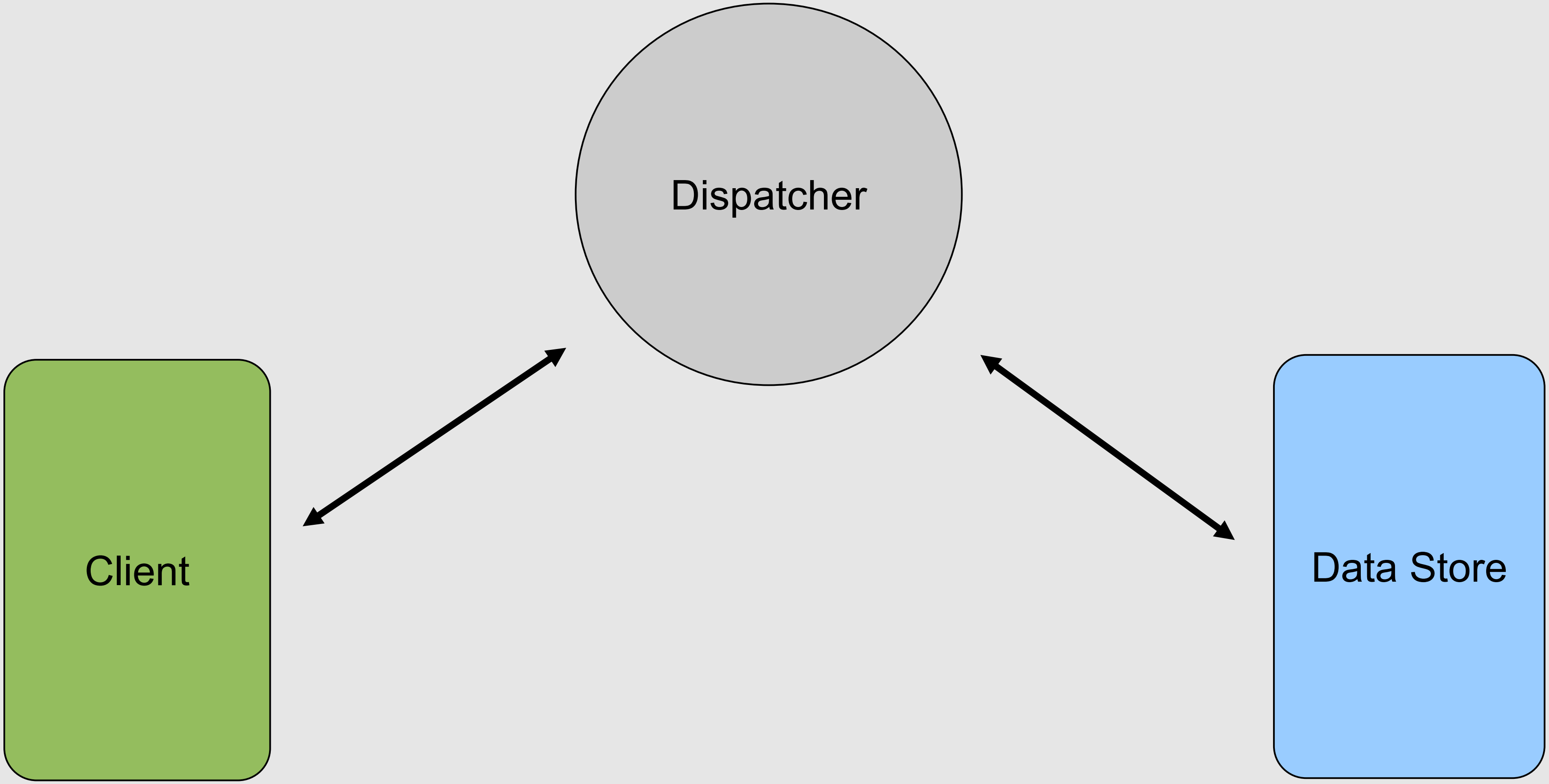
1. Data collection instructions are provided to a Clinical Health Worker, CHW, on a mobile device.
2. CHW collects data following those instructions.
3. Collected data is sent to a centralized medical records system.
4. Data is reviewed by a clinical specialist.
5. Notification of diagnosis and follow up instructions are returned to CHW.

sana

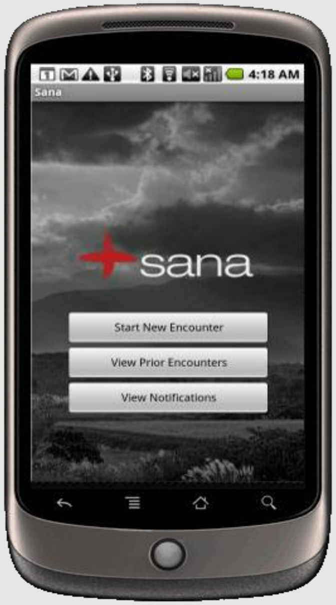
Open Source Telemedicine Platform Overview



Sana Platform

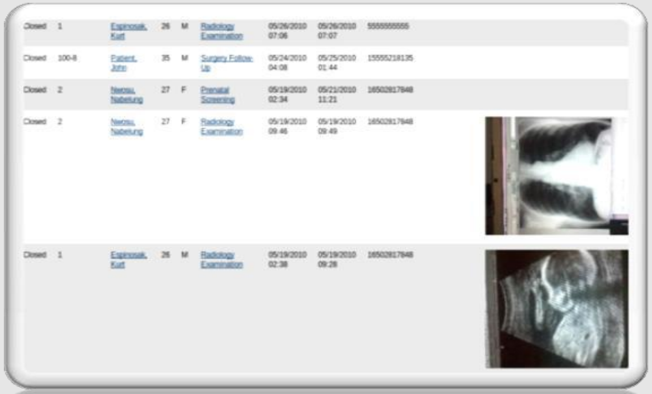


Sana Platform



Python

Django



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Closed	100-8	Patient, John	35	M	Surgery Follow-Up	05/24/2010 04:08	05/25/2010 01:44	15555218135
Closed	2	Nwosu, Nabelung	27	F	Prenatal Screening	05/19/2010 02:34	05/21/2010 11:21	16502817848
Closed	2	Nwosu, Nabelung	27	F	Radiology Examination	05/19/2010 09:46	05/19/2010 09:49	16502817848
Closed	1	Espinosak, Kurt	26	M	Radiology Examination	05/19/2010 02:38	05/19/2010 09:28	16502817848

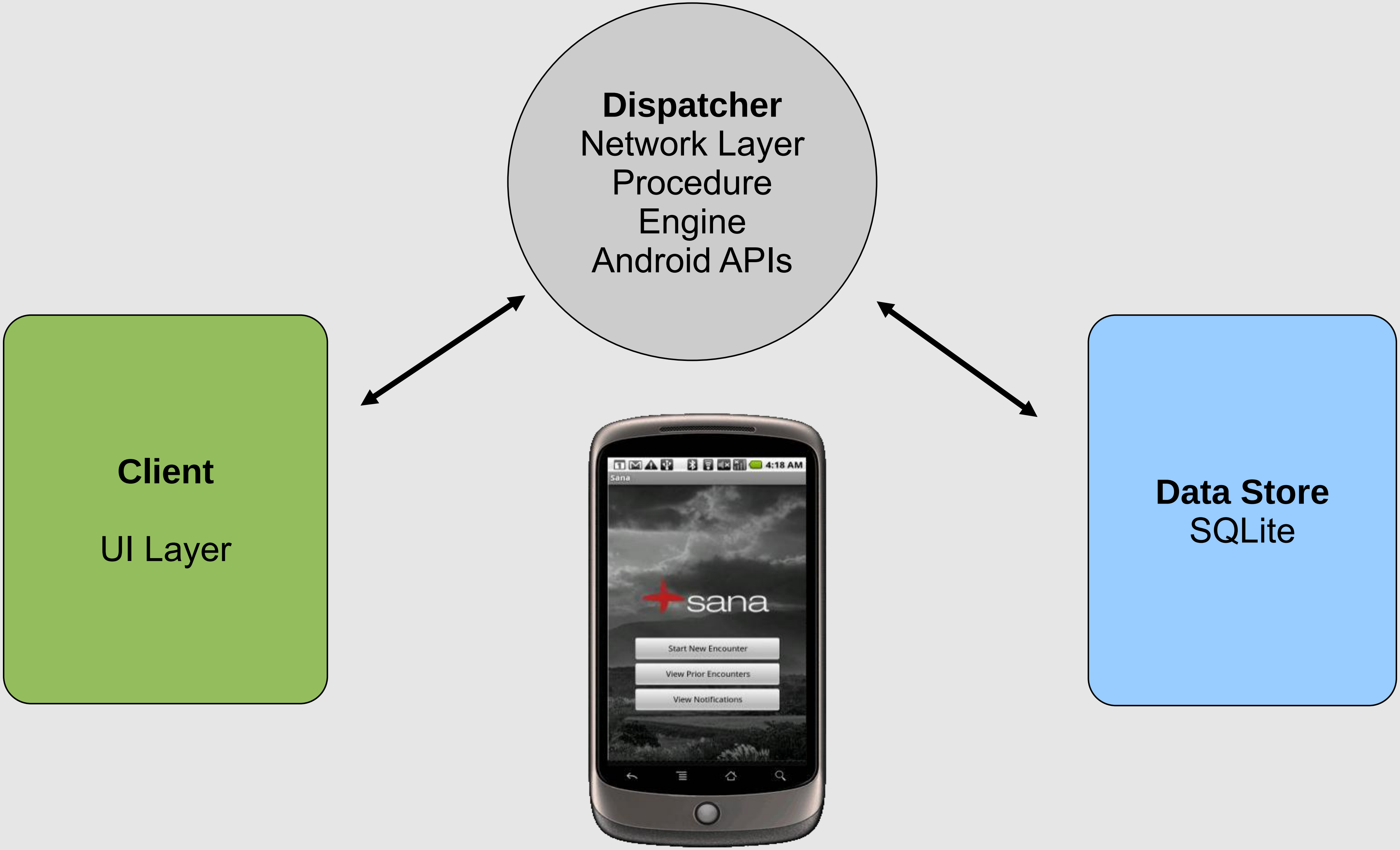
Mobile Client System
(Android)

Mobile Dispatch Server

Medical Records

(Java, OpenMRS)

Sana Mobile Client



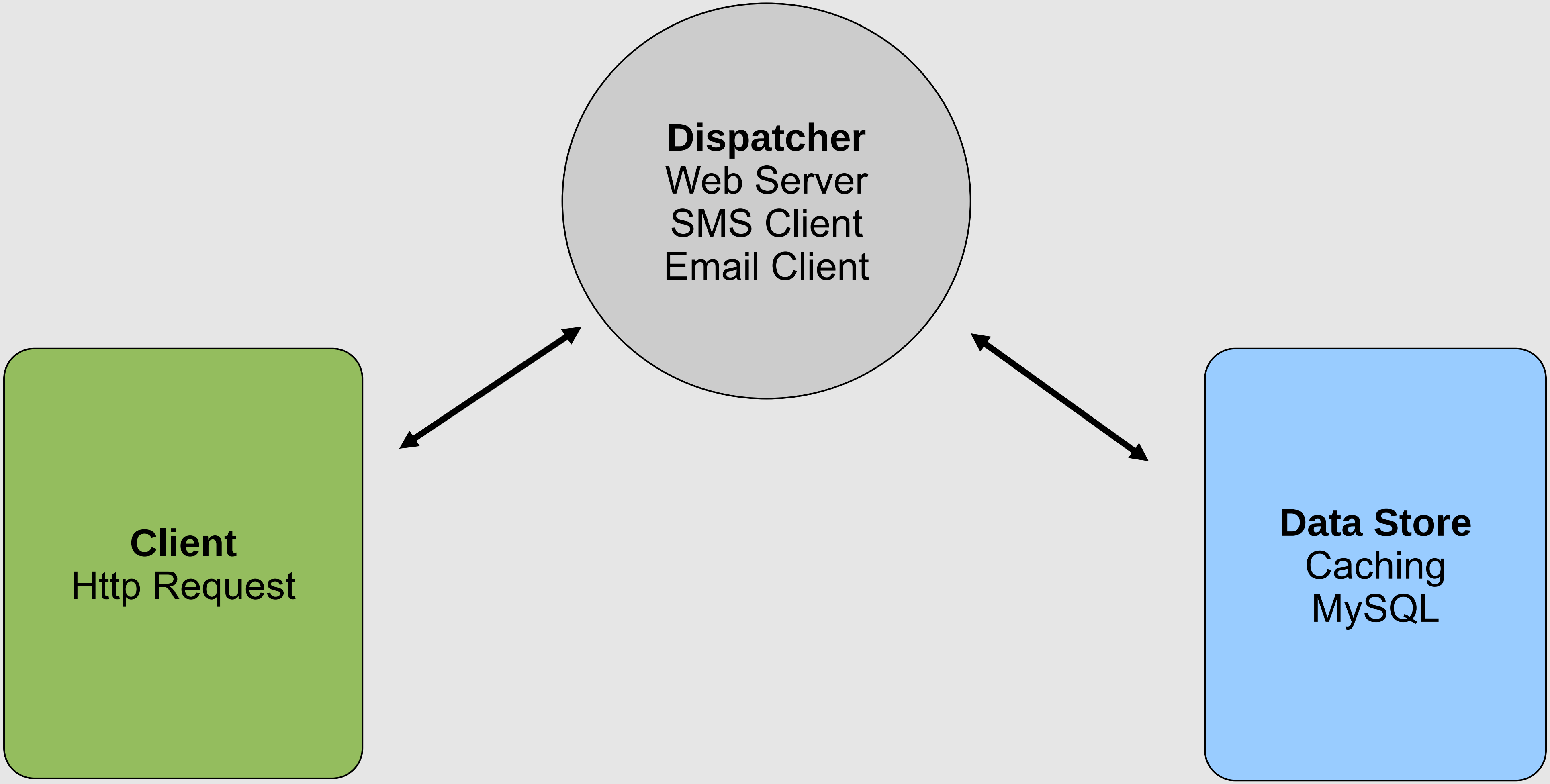
Dispatcher
Network Layer
Procedure Engine
Android APIs

Client

UI Layer

Data Store
SQLite

Mobile Dispatch Server

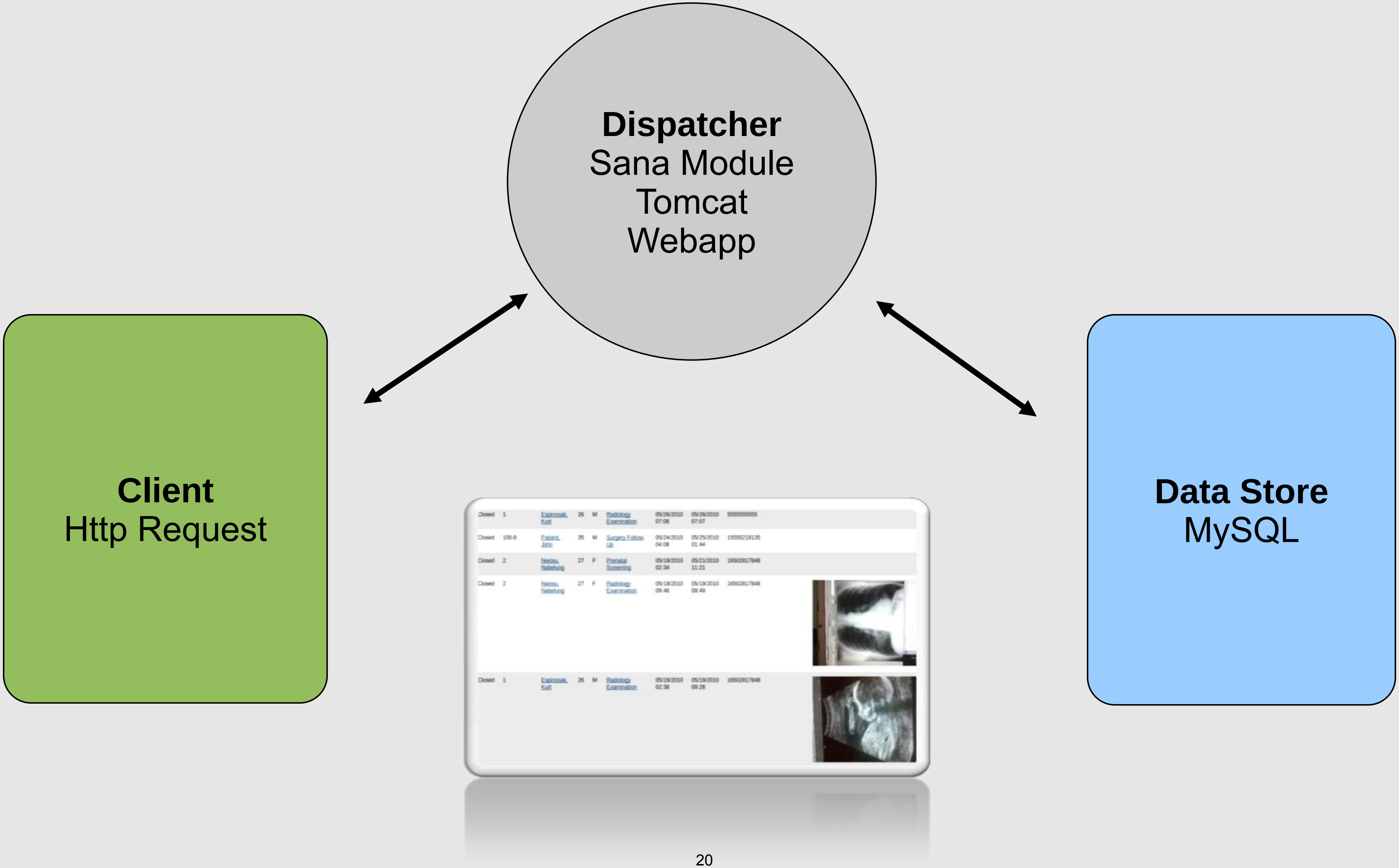


Dispatcher
Web Server
SMS Client
Email Client

Client
Http Request

Data Store
Caching
MySQL

OpenMRS Modules



Dispatcher
Sana Module
Tomcat
Webapp

Client
Http Request

Data Store
MySQL

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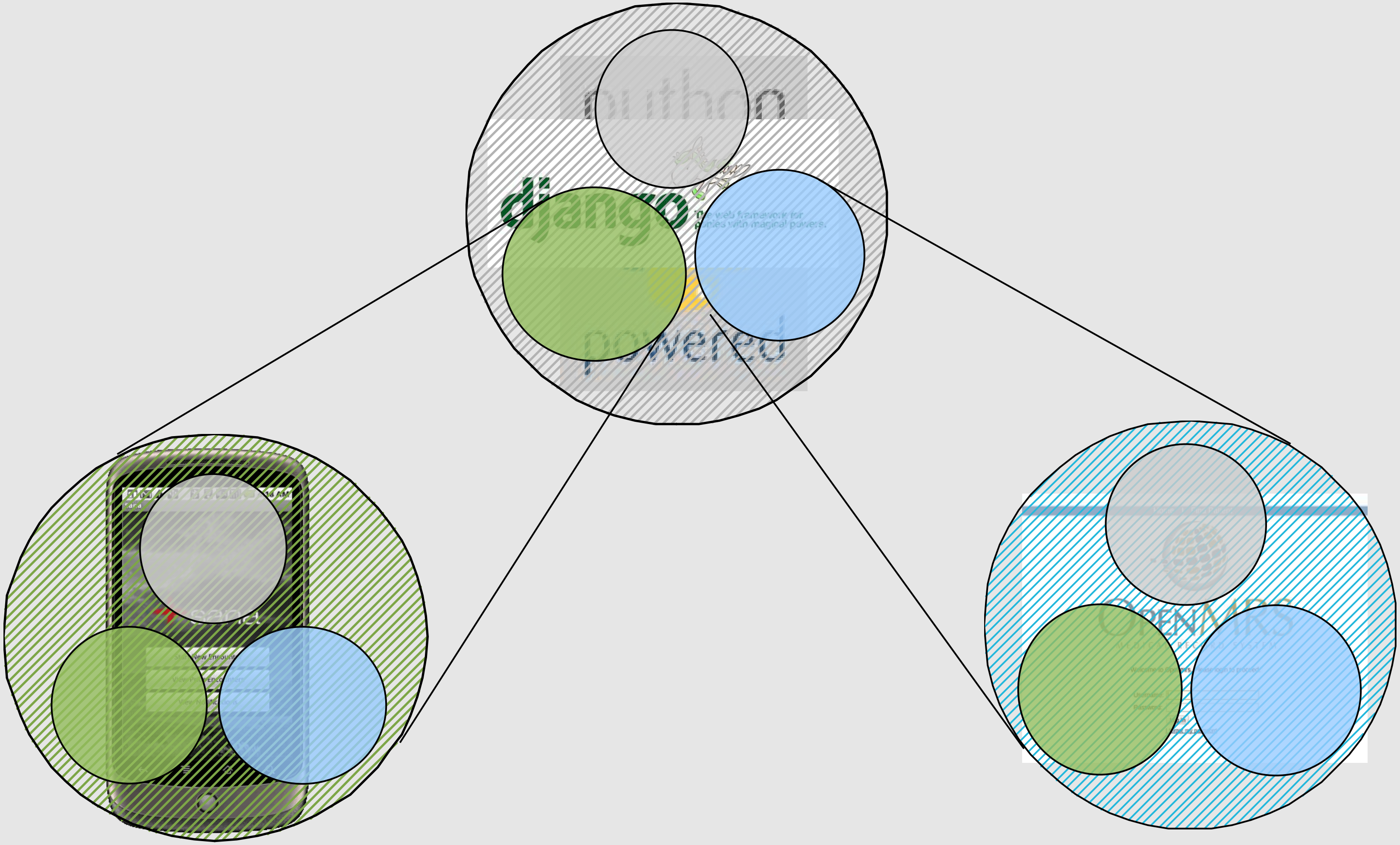
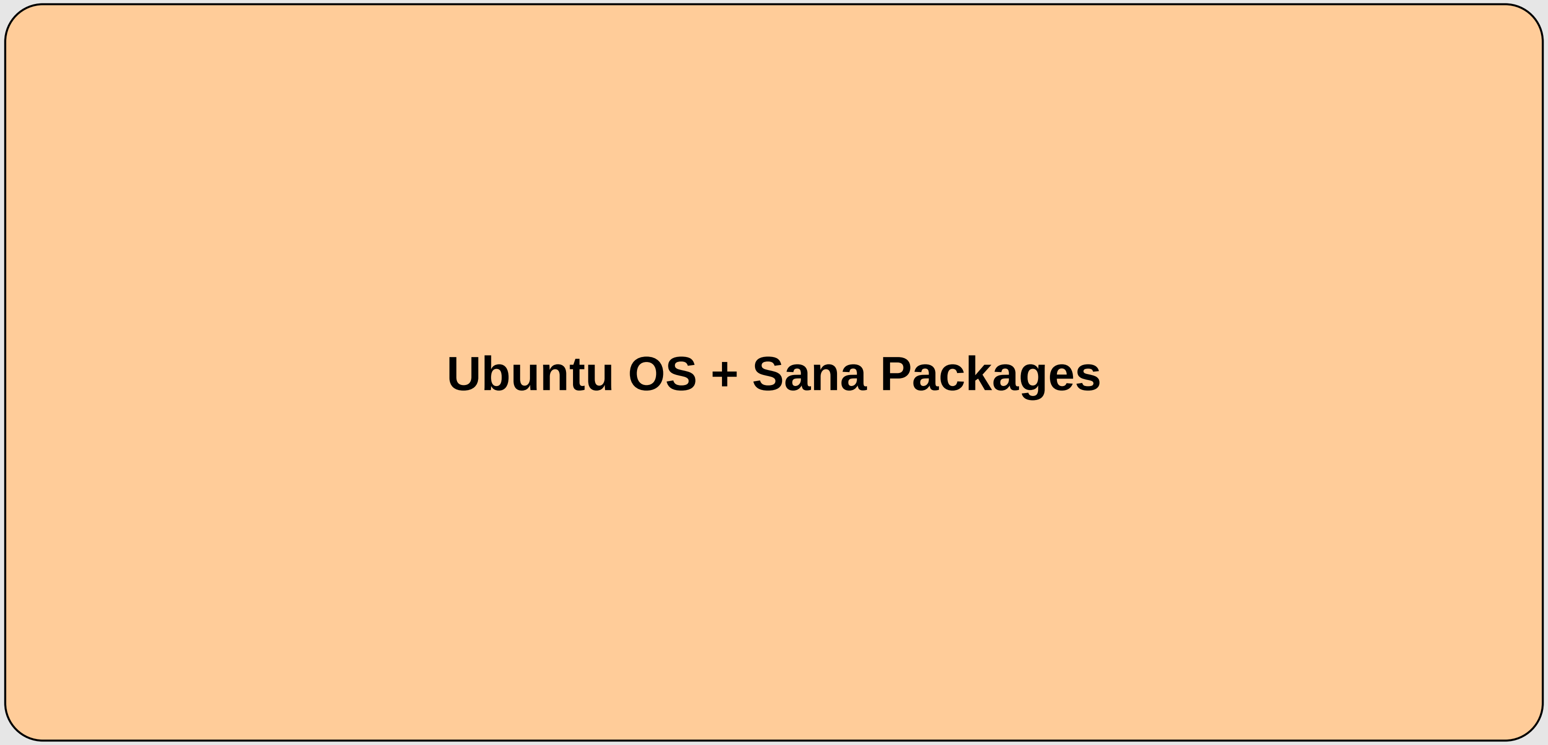
Design Patterns



Sana Platform
Operating System



Ubuntu OS + Sana Packages

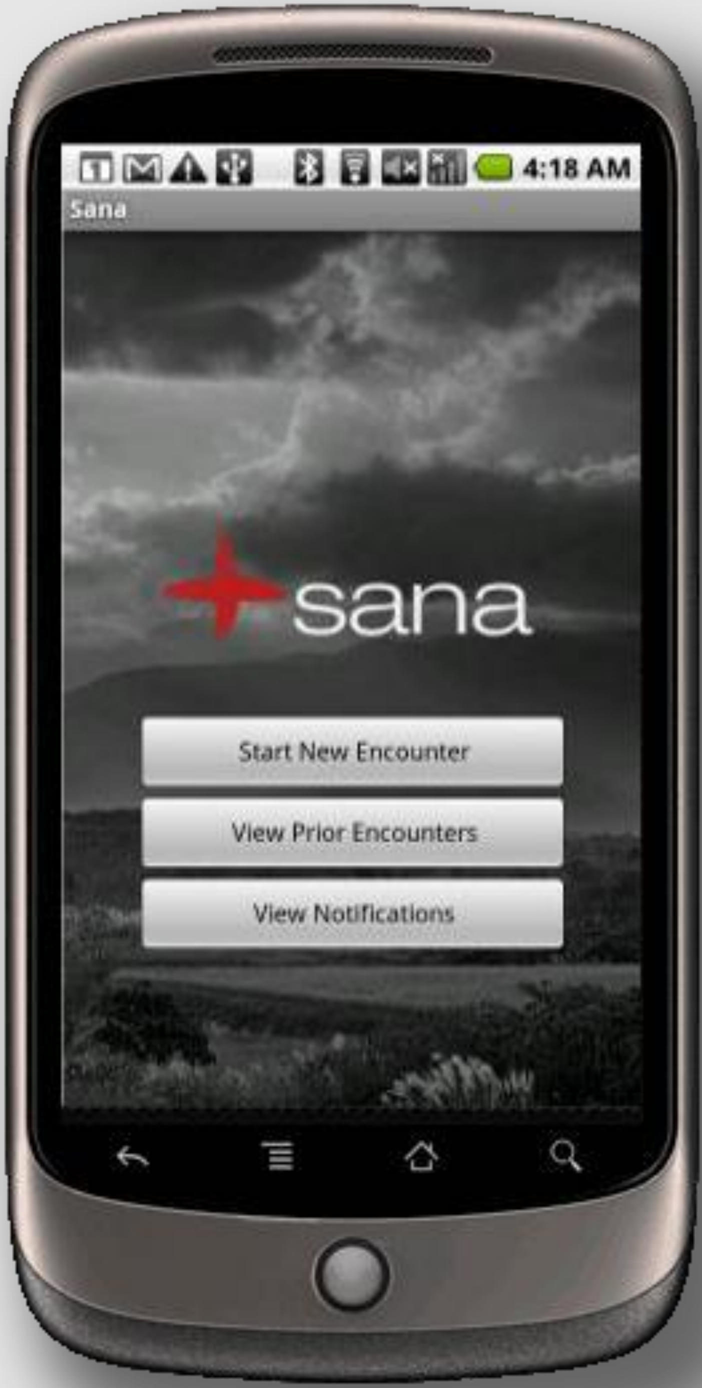
Sana provides prebuilt packages for Ubuntu – a Linux based OS

Sana Platform

Why Open Source?

1. Reduces financial barriers.
2. Freedom to modify and adapt to our needs.
3. Open standards.

Open Source Telemedicine Workflow



Sana Platform

Workflow Implementation

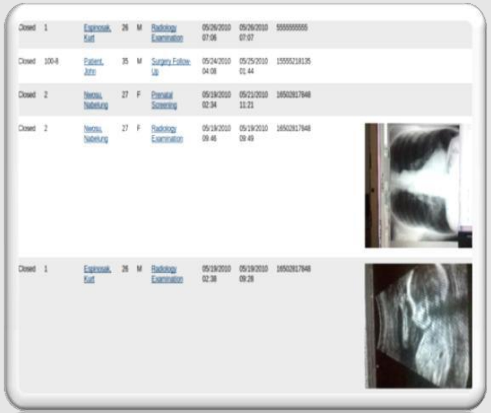
Supports text and binary data

Customizable decision trees

Integrated with digital medical records system

Optimized data transfer for poor coverage areas

CHW collects data and uploads over GPRS, 3G, or Wifi



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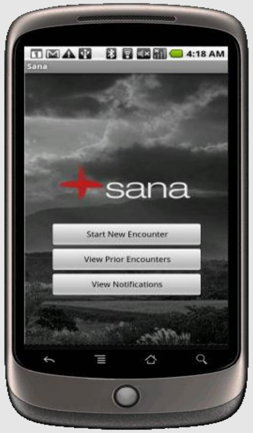
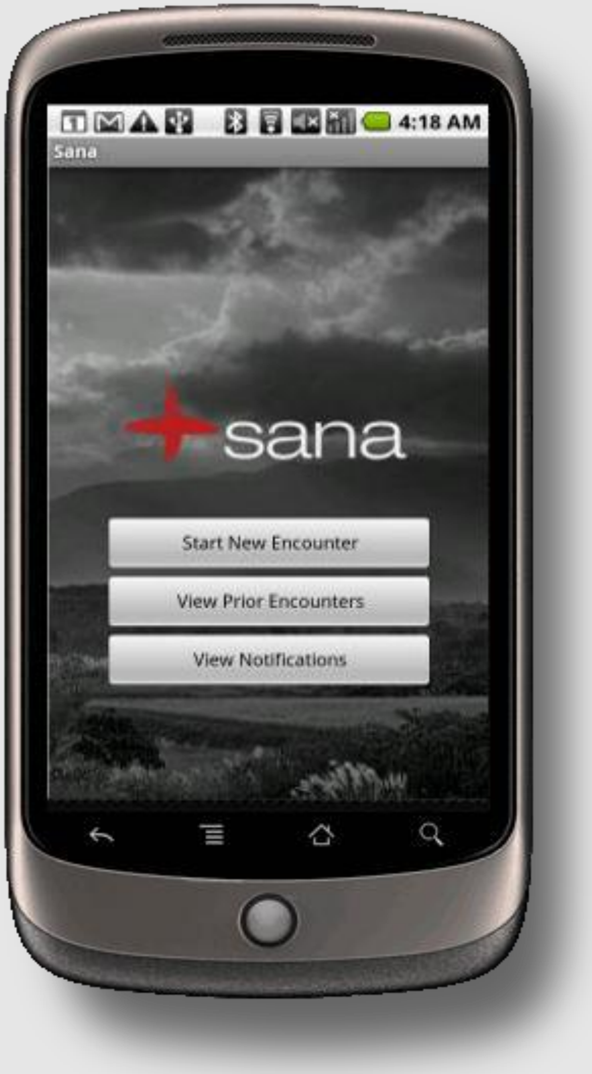


Clinical Specialist reviews encounter through OpenMRS and sends notification back to the mobile client

Sana Platform



Android Client

1. CHW Instructions are form based – XML

2. GUI layer interprets instructions into more user friendly format – buttons, etc.

3. Integrates with full data capture capabilities of device.

4. Integrates device capabilities for patient education and CHW instruction.

5. Local data storage.

6. Agile and secure network layer.

Sana Platform

Sana XML Forms

1. Step wise data collection using markup language.
2. Collection of specific data types.
3. Conditional branching logic.
4. Required constraint.
5. Plugins

Sana Platform

Sana XML Forms

Example:

```
<Procedure title="Example" author="Sana">
    <Page>
        <Element type="RADIO" id="1" concept="TEST SELECT ONE"
            question="Demonstrate selecting a single value"
            answer="1" choices="1,2,3,4" required="true"/>
    </Page>
    <Page>
        <ShowIf>
            <Criteria type="EQUALS" id="1" value="4"/>
        </ShowIf>
        <Element type="PLUGIN" id="2" concept="SUBJECT VIDEO"
        question="Video media file for patient encounter"
        action="android.media.action.VIDEO_CAPTURE"
        mimeType="video/*" answer="" />
    </Page>
</Procedure>
```

Sana Platform

Mobile Dispatch Server, MDS

1. Connection Based REST API-JSON formatted HTTP requests.

2. Supports packetization

3. Communicates with EMR

4. Sends SMS and email notifications

5. Typically configured to run on same server as EMR

Sana Platform

Encounter upload example

POST mds encounter url
upload url
Request params:
Params:

- Encounter identifier
- Encounter identifier
- Client id
- Client id
- Authorization
- Authorization
- Collected Data
- Collected Data

Recieves “OK” from MDS
to MDS

POST OpenMRS

Request

Responds “OK”

Sana Platform

Dispatch Server
Packetization Implementation

1. Client sends binary data as smaller file POST requests.
2. Client algorithm will reduce packet size based on network conditions.
3. Mobile client will retry on fail.

Sana Platform

OpenMRS

- Free, Open Source EMR
- Active deployments globally
- Deployed as Tomcat web application
- Extensive plug-in system

Sana OpenMRS Modules

- **Sana Queue Module**
- - Supports uploads from MDS
- - Stores uploaded encounter data directly into the OpenMRS tables
- - Stores a queue table in the OpenMRS database, linked to OpenMRS
- Encounter table
- - Provides views of items waiting to be reviewed as a queue
- **Media Viewer Module**
- - Flash/JS based visualizer for rich media content
- **REST Module**

  - RESTful access to the OpenMRS data model

Sana Platform Scalability

- Target baseline is to be compatible with OpenMRS performance.
- Platform capable of handling thousands of patient encounters/reviews daily including significant binary content.
- Additional content/plugins can be added at run time

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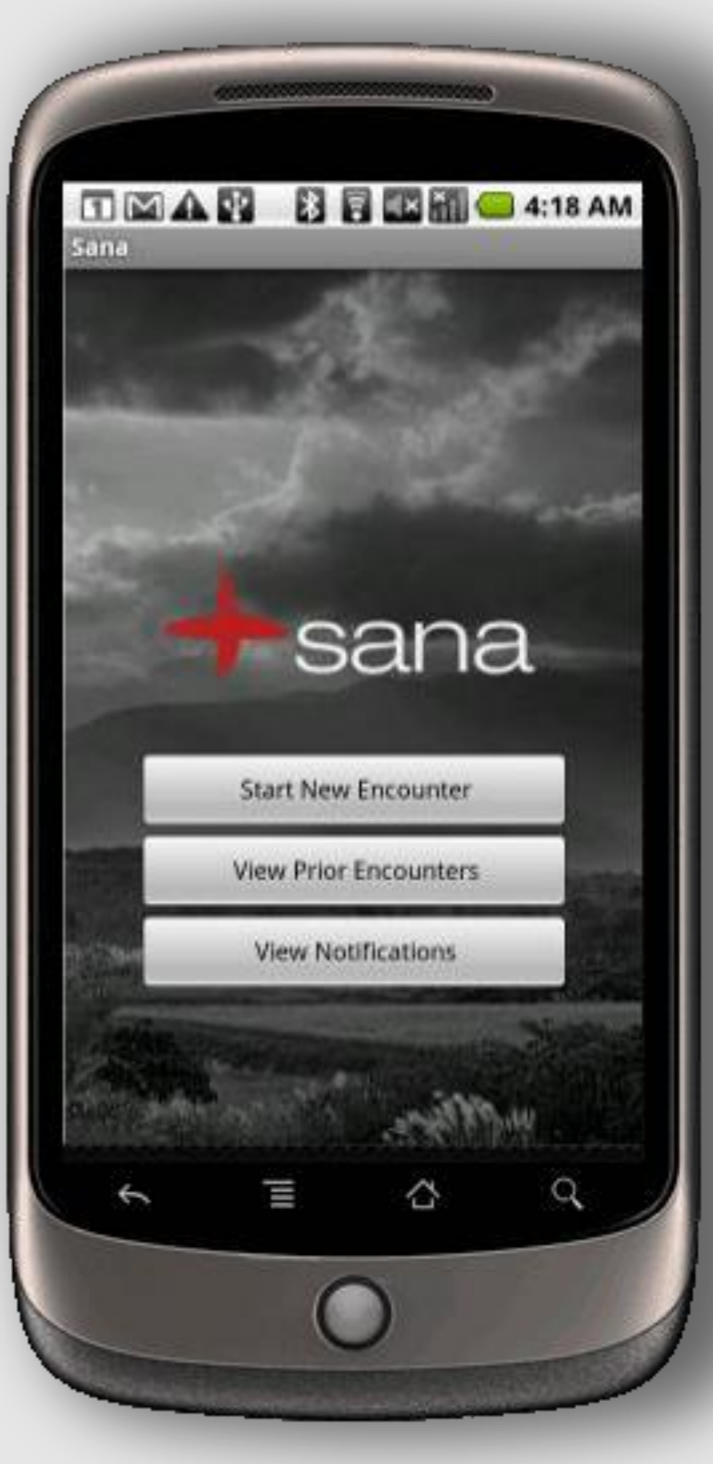
Open Source Telemedicine Roadmap



Going forward

Generic architecture applicable to any areas that may suffer from differential access to skilled personnel and provides analysis.

1. **Generalized analytics API**
2. **Common language.**
3. **User land tools.**
4. **Ready made systems.**

Going Forward

Issues and areas of research. Examples

1. Ease of Use

Examples:

- WYSIWYG Form builders
- Automatic client content updates

2. Administration

Examples:

- Conten/tPackage Management

  Central repositories for content and diagnostic tools
- Network diagnostic tools
- Remote client management

3. Network Architecture

Examples:

- Increased support for varied network topologies
- Load balancing

4. UI independent analytics libraries

- jSana, pySana

Going forward

How to get involved

1. Join the mailing lists.
2. Attend the development workshops and meetings.
3. Attend the general meetings.
4. Let us know about yourself.
5. Check out the code.
6. Have fun and remember that work you do for Sana does have a direct impact.

Additional Information

Sana Wiki

Additional details are available on the Sana Wiki:

http://sana.mit.edu/wiki

Includes installation and configuration for developers and end users.