



SHELF READINESS TECHNICAL APPLICATION

Simplified Docker-based Package and Deployment method for Bahmni, in an OpenHIE architecture.

Prepared by

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Acronyms

ACRONYM	MEANING
OpenHIE	Open Health Information Exchange
OpenMRS	Open Medical Records System
POS	Point of Service
ICT	Information, Communications and Technology
EMR	Electronic Medical Record
CHARESS	Centre Haïtien pour le Renforcement du Système de Santé
PEPFAR	The U.S. President's Emergency Plan for AIDS Relief
CDC	Centers for Disease Control and Prevention
MOH	Ministry of Health
NCD	Non-communicable disease
GSMA	Global System for Mobile Communications Association

Two-Sentence Overview

The goal is to improve the package and deployment process of Bahmni¹ to ease its deployment as a Point of Service (POS) Component within an OpenHIE architecture². This will be achieved through leveraging the Docker containerization strategy and developing an interactive, guided step-by-step process that extends the current Docker³ deployment method to add OpenHIE-specific configuration options.

High-Level Budget Summary

Total Project Costs	WORK PACKAGE 1 <i>HIE configuration module for Bahmni POS.</i>	WORK PACKAGE 2 <i>Extending Bahmni's docker deployment package and providing a stepwise deployment Wizard.</i>	Total Cost (USD) <i>(9-month project term)</i>
		USD 47,300.00	USD 49,587.00

Executive Summary

IntelliSOFT will use the investment from Digital Square to facilitate the resources needed towards shipping the proposed solution to the community. This will generally cover the development and administrative costs related to the project.

The Simplified Docker-based Package and Deployment method for Bahmni, aims to reduce the cost and skills required for software developers in deploying Bahmni as a POS system to the OpenHIE architecture. This aligns Bahmni to the DevOps guidelines and containerizations specified in the Instant OpenHIE.

With the above set goals, there are several low-level tasks that will be outlined in a detailed work plan. The goal will be achieved once all the related tasks are completed according to the set standards and quality assurance.

IntelliSOFT will make use of the expertise and experience acquired while working on past projects to ensure that the set goals of the proposed solution are met. Guided by the Principles for Digital Development⁴, IntelliSOFT will deliver a world-class product.

Consortium Team

IntelliSOFT will work closely with the OpenHIE Community and sub-communities within it like the OpenHIM & other relevant communities to achieve the proposed project goals.

¹ <https://www.bahmni.org/>

² <https://ohie.org/architecture/>

³ <https://www.docker.com/>

⁴ <https://digitalprinciples.org/>



IntelliSOFT Consulting Limited is a local Kenyan company with +10 years of experience in the development, implementation, and use of Information, Communications, and Technology (ICT) in the health sector across Africa. As a technology development firm, IntelliSOFT has proven expertise and experience in the entire digital health value chain from conceptualisation, design and development of digital health solutions to their deployment, support and maintenance particularly in Low to Middle-Income Countries. IntelliSOFT supports its clients to continuously optimize their business performance and productivity (including health outcomes) through effective implementation of “fit for purpose”, technology-agnostic digital health solutions appropriately optimized for the implementation context. We do this through the appropriate application of technology and data standards throughout the software development process of our digital health solutions. Our current primary focus is data systems for research for health and patient and population management.

Relevant Work Experience on similar projects.

BAHMNI PROJECTS	
Project name	eHospital Implementation & ICT Infrastructure Upgrade
Project period	November 2016 to Date
Client	St. Joseph's Hospital
Project Brief	As part of our mission to use information technology to transform the health of people and lives through technology, IntelliSOFT got into a partnership with St. Joseph's hospital to implement eHospital, our local adaptation of the Bahmni solution. Our support to St. Joseph's hospital through this partnership includes; Customization and optimization of eHospital to meet their needs, deployment of eHospital, installation of a Local Area Network including requisite hardware (servers, desktop computers, mobile devices including tablets, and network devices), training health workers to meaningfully use eHospital, long term support and maintenance of eHospital. This is the first known implementation of an open source hospital-wide system in public health facilities in Kenya.
URL & References	URL: http://www.ehospital.co.ke/ Read more in the case study ⁵
Impact	Improved scheduling and management of patients, Improved capture, management and use of data for planning, direct patient management, and reporting (broadly for Monitoring and Evaluation)
<hr/>	
Project name	eHospital adaptation and implementation
Project period	August 2017 to Date
Client	CURE International ⁶
Project Brief	CURE International and IntelliSOFT mutually established a partnership with IntelliSOFT playing the role of a Health IT partner to CURE. Within this partnership, IntelliSOFT is implementing a hospital management information system for health facilities supported by CURE starting with those in Kenya at Kijabe. The HMIS called eHospital, a product of IntelliSOFT is powered by Bahmni. IntelliSOFT is a member of the Governing Committee of the Bahmni Coalition.
URL	URL: https://45.79.145.179/
<hr/>	
Project name	South Sudan EMR (SSEMR) <i>powered by Bahmni</i>
Project period	June 2019 to Date
Client	IntraHealth International

⁵ <http://www.ehospital.co.ke/wp-content/uploads/2018/11/St.-Josephs-eHospital-Case-Study-v1.2-PRINT.pdf>

⁶ <https://cure.org/about/>

Project Brief	Develop and implement an Electronic Medical Record System (EMR) to support South Sudan's National HIV program. The EMR solution will initially be deployed at two high volume health facilities in Juba and Nimule . The two facilities will also be connected to enable syncing and exchange of data. The next phase will scale up the EMR to other public health facilities as guided by the South Sudan MOH.
URL	https://ssemr.intellisoftkenya.com/bahmni/home
OPENHIE PROJECTS	
Project name	I-TECH Haiti iSantéPlus
Project period	June 2019 to Date
Client	I-TECH
Project Brief	IntelliSOFT is supporting the I-TECH Haiti team and its local partner, CHARESS, with software development on the CDC-funded Haiti HIS project, focusing specifically on the development of PEPFAR and Haiti Ministry of Health (MOH) reports for the iSantéPlus (OpenMRS) v1.0 release.
URL	https://github.com/IsantePlus
Project name	Cross-Border Health Integrated Partnership Project (CB-HIPP)
Project period	January 2020 to Date
Client	FHI360 through USAID funding
Project Brief	IntelliSOFT has been contracted to design, customize and deploy technology to strengthen the cross- border health system through the Cross-border Health Unit (CBHU) model to enable continuous and real-time generation and sharing of health information between health facilities and support the continuum of care for HIV, TB, FP/RH and MNCH for mobile cross-border populations.
URL	http://test.cbhipp.intellisoftkenya.com:9000/
OPENMRS RELATED WORK	
Project name	KenyaEMR <i>powered by OpenMRS</i>
Project period	2012 - 2013
Client	I-TECH Kenya
Project Brief	KenyaEMR is built on OpenMRS for Kenya's Ministry of Health with the national HIV program as the priority use case. The scope of that project included interoperability with DHIS2. KenyaEMR is implemented at 341 public health facilities, covering more than half of Kenya.
Project name	Nairobi County NCD EMS

Project period	December 2017 to September 2019
Client	African Institute For Health & Development (AIHD) for Nairobi County
Project Brief	IntelliSOFT was contracted to customize and develop modules for provision of care for Diabetes & Hypertension clients. The Nairobi Non-Communicable Diseases Quality Management System is an Electronic Medical Digital Health System (Nairobi County NCD QM EMS) built on top of the OpenMRS RefApp.
URL	https://test.aihd.intellisoftkenya.com
Impact	Significant improvement of adherence to clinical guidelines in the management of hypertension and Diabetes Mellitus (DM) thus strengthening the health care system through improved capacity in the management of the selected NCDs within Nairobi's informal settlements.
Project name	
	Sustainable Development Goals (SDGs) Monitoring and Reporting System for Africa
Project period	April 2018 to Date
Client	The Sustainable development Goals Centre for Africa (SDGC/A)
Project Brief	Develop and implement an Africa wide Pan African Monitoring and Reporting (M&R) system to support 54 African countries to report on SDGs. Additionally, develop and support countries to take up and use the country-level system "National MRS" to collect data, monitor and report their progress on SDGs and Agenda 2063. Thirdly, develop and implement a Web based Data Portal accessible to the general public who have an interest in knowing the progress of the African Countries on SDGs.
URL	Benin MRS: https://test.sdgca.intellisoftkenya.com/nationalmrs/ Ethiopia MRS: https://test.ethiopia.intellisoftkenya.com/dhis/ Panafrikan MRS: https://test.sdgca.intellisoftkenya.com Portal: https://test.sdgca.intellisoftkenya.com/sdgportal/home/
Impact	Anticipated to support African governments better monitor their socio-economic development as defined by SDGs, and also painlessly meet their continental and global reporting obligations against the Agenda 2013 and SDGs respectively.
OTHER PROJECTS	
Project name	OpenMRS and Bahmni Powered Electronic Patient Tracking System (ETPS) and Point of Care System
Project period	September 2018 to January 2020
Client	Jembi Health Systems

Project Brief	IntelliSOFT was contracted to develop and provide quality assurance for the OpenMRS and Bahmni powered Electronic Patient Tracking System (ETPS) and Point Of Care System that would be implemented across Mozambique.
URL	https://www.jembi.org/Project/Point-of-Care-System-in-Mozambique
Impact	In addition to providing accurate data to the national system, the POC system has strengthened the provision of care and monitoring of HIV patients.
Project name	Afya Moja - A Digital Health Passport
Project period	January 2020 to Date
Partners	Ask-A-Doc, Carepay, Savannah Informatics, Safaricom and GSMA.
Project Brief	IntelliSOFT is collaborating with Ask-A-Doc, Carepay, Savannah Informatics, Safaricom and GSMA to develop a mobile-based Digital Health Passport that will enable patients to share their real-time medical information with medical practitioners.
USSD Code	*384*90#

Proposed Project Team

Name	Position	Task
Steven Wanyee	Project Director	Overall Project Lead
Peter Anampiu	Business Analyst	Lead in project administration and finance
Susan Gathu	Technical Project Manager	She will provide leadership in Technical Project Management.
Kenneth Ochieng	Lead Software Developer	Lead Software Developer and will provide leadership in software development.
Kelvin Murumba	Software Developer	Software developer and will support the development of relevant HIE and components.
Lucy Kimotho	Quality Assurance	Continuous Quality Assurance

Background or Problem Statement

Currently, Bahmni relies on two methods of package management i.e. Redhat Package Management (RPM)⁷, which is the recommended method, and Docker. However, none of these methods supports quick deployment of Bahmni in a Health information Exchange(HIE) architecture as per the vision of the Instant OpenHIE project. The two methods currently do not support the packaging and deployment of Bahmni in an OpenHIE architecture.

One of the goals of the Instant OpenHIE project is to reduce the costs and skills required for software developers to deploy an OpenHIE architecture. As such, IntelliSOFT proposes to extend Bahmni's Docker deployment method to allow for ease of its deployment as a Point of Service (POS) Component within an OpenHIE architecture using a wizard-based command-line interface.

In addition to simplifying the deployment process, this will allow for setting up of additional OpenHIE-specific configuration options using a guided step-by-step process. In doing so, we will align Bahmni to the DevOps guidelines and containerization deployment that is illustrated through use within the Instant OpenHIE project.

Digital Health Technologies

The first step will be to prepare Bahmni to be able to exchange messages with other HIE components . This will include setting a new OpenMRS module for Bahmni that will be responsible for introducing OpenHIE-specific configuration settings to Bahmni as well as facilitate the exchange of data between Bahmni and the other systems exchanging information. The proposal will work with simple use cases in which Bahmni is supposed to exchange basic data (demographics, clinical encounters) with another component in the HIE via the Interoperability Layer.

⁷ https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/5/html/deployment_guide/ch-rpm
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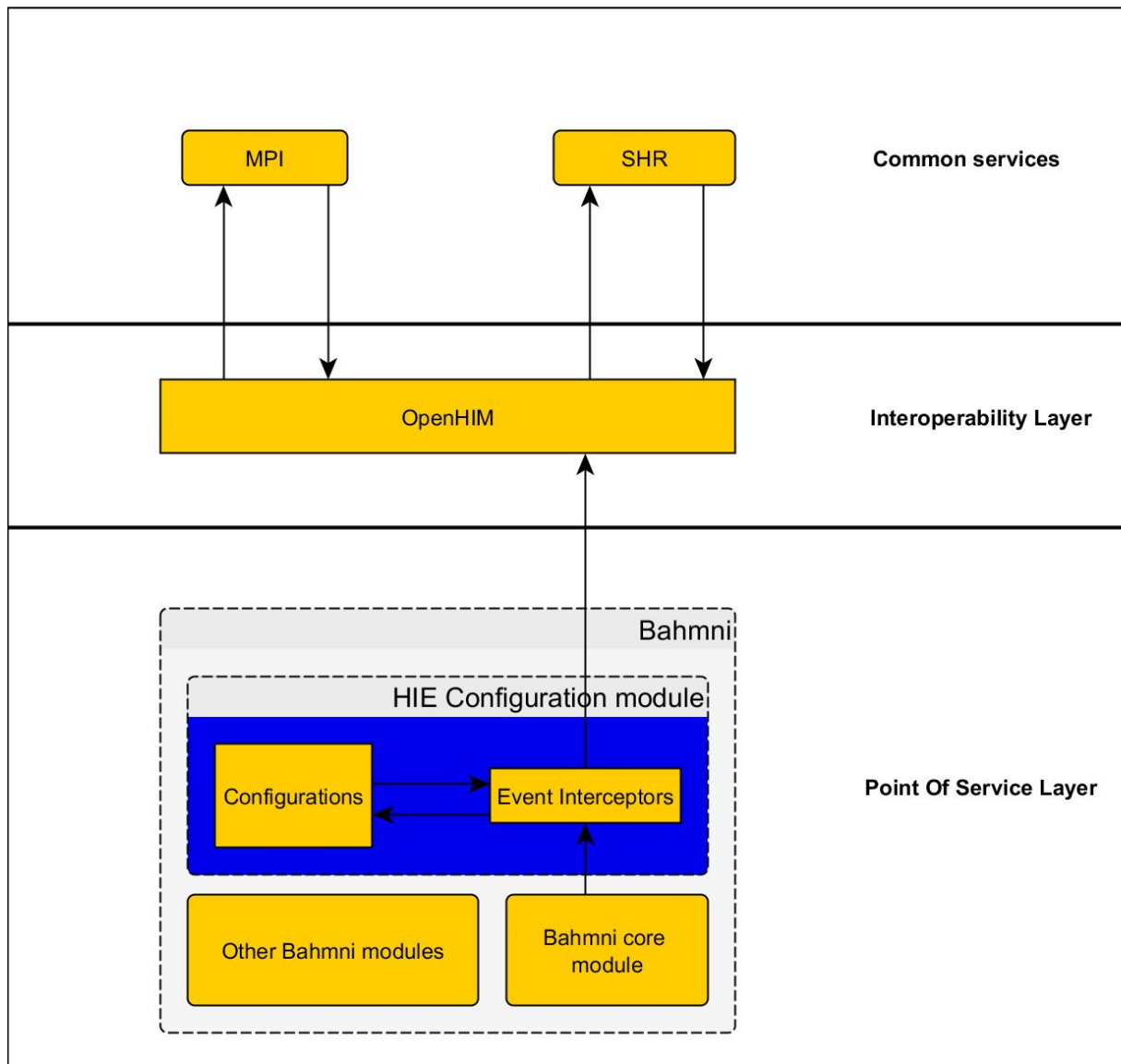


Figure 1: An illustration of how the HIE configurations module will plug into Bahmni

The second phase will leverage the existing Bahmni docker package management method and will provide additional OpenHIE specific configuration parameters that will be fed to Bahmni during deployment. To provide a simplified way of setting those configurations, this proposal introduces an interactive, guided, step-by-step process through a command line interface (CLI) wizard. The wizard will collect configuration data from the user and update the relevant Docker files accordingly. Docker will use those configurations to fire up an instance of Bahmni that plugs into an OpenHIE architecture.

Use Cases and User Stories

Use case 1: A developer wants to set up a new instance of Bahmni that will share Patient Identifiers and Demographics with a Client Registry through the Interoperability Layer in an OpenHIE architectural set up.

User story: A developer fires up a command line interface and begins the deployment process. He/she will be prompted for input in a guided process. The input will be saved as configuration settings and used by Docker behind the scenes to fire up the Bahmni instance. At the end of the deployment process, you will have a Bahmi instance that is able to share data with the Client Registry.

Use case 2: A developer wants to set up a new instance of Bahmni to share Patient Clinical Encounters with a Shared Health Record through the Interoperability Layer in an OpenHIE architectural set up.

User story: A developer fires up a command line interface and begins the deployment process. He/she will be prompted for input in a guided process. The input will be saved as configuration settings and used by Docker to fire up the Bahmni instance. The Bahmni instance will be able to share data with the Shared Health record.

Objectives and Activities

- a. To reduce the cost and skills required for software developers in deploying Bahmni as a POS system to the OpenHIE architecture in the alignment of Bahmni to the DevOps⁸ guidelines and containerizations specified in the Instant OpenHIE.
- b. To simplify the deployment process, by allowing for setting up of additional OpenHIE-specific configuration options using a guided step-by-step process.

⁸ <https://www.atlassian.com/devops>

Work package 1: HIE configuration module for Bahmni POS

This work package will be conducted by IntelliSOFT Consulting LTD and will enhance Bahmni's docker-based installation method to provide an easy way for developers to plug an instance of Bahmni to a OpenHIE architecture during installation. The work package will involve building a module that will be responsible for introducing HIE-Specific configurable capabilities to Bahmni to allow it to communicate with other components in an OpenHIE architecture. The module will also be responsible for routing messages between Bahmni and the other HIE components.

Objective 1.1: To package Bahmni as a POS that can plug into an OpenHIE Architecture. It includes addition of relevant configurations that will enable sharing of data with other components via the Interoperability Layer.

Activity 1.1.1: Build an OpenMRS Health Information Exchange (HIE) Configurations Module for Bahmni. This module will be responsible for introducing HIE-specific configurations to Bahmni. As such, users will have an interface through which to manipulate and/or validate HIE specific configurations.

Activity 1.1.2: Implement the routing mechanism that will be responsible for facilitating communication between Bahmni and the other HIE components based on the set configuration options.

Work package 2: Extend Bahmni's docker deployment package and provide a stepwise deployment Wizard

This work package will be undertaken by IntelliSOFT and will rely on the output of Work package 1. It will extend the Bahmni docker package by adding HIE-specific configuration options that will be applied to Bahmni, as defined in Work Package 1, during installation. To simplify the deployment process, the work package will also provide a stepwise installation wizard that will guide the person doing the installation.

Objective 2.1: To automate the configuration process of Bahmni through a command line interface wizard during deployment.

Activity 2.1.1: Extend Bahmni's docker package to include HIE specific configurations options

Activity 2.1.2: Implement a stepwise command line user interface that will be responsible for interactively capturing configuration options and updating the docker files accordingly.

Community Feedback

IntelliSOFT will regularly engage with the Bahmni community for input and feedback on the architecture and approach for introducing HIE-Specific configurations to Bahmni and the Docker deployment package.

IntelliSOFT will also engage with the OpenHIE community especially the DevOps community for input, feedback and review of the architectural approach. This will include relevant updates during the monthly calls and a demo of the solution towards the end of the project.

Schedule

The following is a high-level work plan.

Activity	Team Location Month/Quarter	[Month/Quarter]								
		[M]	[M]	[M]	[M]	[M]	[M]	[M]	[M]	[M]
		1	2	3	4	5	6	7	8	9
DEVELOPMENT										
Define requirements for the HIE Configurable module. i.e the configurations components needed for the HIE module.	IntelliSOFT, Kenya	█								
Develop the HIE configuration module prototype.	IntelliSOFT, Kenya	█	█							
Community engagement on the prototype.	IntelliSOFT, Kenya		█							
First iteration of the HIE Configuration Module.	IntelliSOFT, Kenya		█							
Preliminary documentation and examples available for testing and feedback.	IntelliSOFT, Kenya		█							
Define requirements for the Bahmni docker package.	IntelliSOFT, Kenya			█	█					
Design the prototype for the extended Bahmni docker package.	IntelliSOFT, Kenya				█	█				
Community engagement for the extended Bahmni docker package.	IntelliSOFT, Kenya					█				
First iteration for the extended Bahmni docker package.	IntelliSOFT, Kenya					█				
Furthur community engagement	IntelliSOFT, Kenya						█			
Further Iteration of the extended docker package	IntelliSOFT, Kenya						█			
Design prototype for the Bahmni Docker command line interface wizard.	IntelliSOFT, Kenya						█			

Community engagement for the Bahmni Docker CLI wizard.	IntelliSOFT, Kenya									
First iteration for the Bahmni Docker CLI wizard.	IntelliSOFT, Kenya									
Further community engagement.	IntelliSOFT, Kenya									
Perform testing and the quality assurance process.	IntelliSOFT, Kenya									
Document and fix issues found.	IntelliSOFT, Kenya									
Documentation	IntelliSOFT, Kenya									

Deliverables

Project Phase	Deliverable	Month/Quarter Due
Pre-implementation	<ul style="list-style-type: none"> Project work plan. This will include a detailed plan of the activities anticipated during the project lifecycle. System Requirements Specification document. This document will capture the requirements for the proposed digital solution and will be informed by the analysed user requirements (based on the use cases and scenarios). System Design document. This will provide a representation of the intended architecture design of the proposed system. A risk management plan will be developed to facilitate monitoring and evaluation of the proposed project activities. 	[M1]
Development, Testing & Quality Assurance.	Work Package 1: Dockerized Bahmni POS	[M2 - M5]
	<p><i>Objective 1.1:</i> To package Bahmni as a POS that can plug into an OpenHIE Architecture.</p> <ul style="list-style-type: none"> i. <i>Activity 1.1.1:</i> This activity will result in the delivery of an OpenMRS Health Information Exchange (HIE) Configurations Module for Bahmni. ii. <i>Activity 1.1.2:</i> This activity will result in the delivery of an implemented routing mechanism that facilitates communication between Bahmni and the other HIE components based on the set configuration options. 	
	Work package 2: Stepwise deployment Wizard	
	<p><i>Objective 2.1:</i> To automate the configuration process of Bahmni through a command line interface wizard during deployment.</p> <ul style="list-style-type: none"> <i>Activity 2.1.1:</i> This activity will result in the delivery of an extended Bahmni docker package with HIE specific configurations options. <i>Activity 2.1.2:</i> This activity will result in the delivery of a stepwise command-line user interface for capturing configuration options and updating the docker files. 	
Deployment	Deployment will entail a stable release of the following:	[M5 - M6]

	<ol style="list-style-type: none"> 1. Dockerized Bahmni POS 2. Step-wise deployment wizard 	
Support and Project Closure	Final project report - This report will provide a detailed description of the final results of the project and will be presented during the closure of the project.	[M5 - M6]
During project lifecycle	<ol style="list-style-type: none"> 1. Financial reports and invoices. 2. Regular status reports. 	[M1 - M6]

Global Good Maturity Model Assessment

The image below represents the self-assessment results of eHospital for the Global Utility, Community and Software indicators. This assessment can also be found [here](#).

