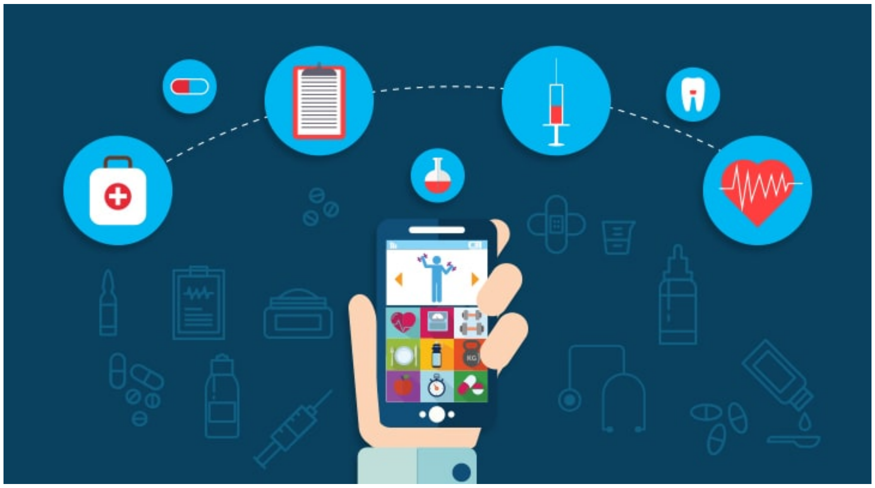
<u>Smart Cities: Smart Health System</u>



SYS 581 Final Report

We pledge our honor that we have abided by the Stevens Honor System.

Andy Molla
Peter Damianov
Gavin Snyder
Kristin Kim
Anjali Paliwal

May 9, 2022

Abstract

The USA Government has set out to develop and build a smart city capable of hosting over 50,000 residents and will be located within 50 miles of a nearby big city. The overall goal of the smart city is to be able to function on its own and utilize advanced technology to improve the lifestyles of its people. A part of the smart city, the smart health system is meant to serve as a way to maintain a healthy lifestyle for the residents in the smart city in an eco-friendly way. The team behind the development of the model smart health system has determined several key objectives to be met: that the health system must allow people to collect, track, analyze and share their health data in as secure and quick a way as possible.

To accomplish this, the team weighed several alternatives against each other. The chosen system, which is the use of both a cell phone application and additional wearable sensors like watches, was determined to be the most far reaching and effective solution. This proposed system will undergo rigorous testing of its five main subsystems–the App, Sensors, Data Servers, Trends & Evaluation System, and the HCP Viewing Interface–to ensure that stakeholder requirements are adequately met and any risks can be properly mitigated. The system would also undergo a modeling & simulation experiment to validate its capabilities. This system, should it be approved, would ensure highly secure transmission of health data and overall effective and accurate health data tracking that satisfies the requirements for the health system set out by the USA Government.

Table of Contents

Introduction

Smart Cities Mission Statement

The USA Government's goal for a smart city is for it to be developed according to these requirements:

"The USA government aims to establish a sustainable smart city which will host 50,000 people and be within 50 miles of a big city. "A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects". We will achieve this goal with a growing number of international and commercial partners, realizing economic benefits and strengthening America's leadership on smart cities".

The USA Government has thus made it their mission to develop a model sustainable smart city which is eco friendly and that will be able to house at least 50,000 people. The Smart city must maintain sustainable resources and provide a healthy and high quality life for their residents.

Smart Health Mission Statement

The overall goal of the smart health system, that belongs to the smart city, is to develop a health system which is consistent with the principles of a smart and eco friendly city and can provide a healthy lifestyle for the residents. As such, the mission to reach this goal involves creating a model of a smart health system that combines several new technologies to achieve the goal of being part of the intended smart city.

Problem Statement

Operational Need

The central need of having a smart health system is to essentially provide a platform for the population of the city and city health practitioners to collect, track, and analyze important health data that can have the potential to impact the effectiveness of city medical services. These city medical services include healthy lifestyle considerations on an individual level and also the various services offered by clinics and hospitals in the city towards the purpose of diagnosing and treating health conditions. Subsystems within the health system are necessary to provide these interfaces and interact with each other and the smart city, and generally revolve around a few key needs of the system.

The first need is the need to collect patient health data. This need is highlighted by the fact that patients and city residents would want to be able to store their data somewhere and be able to refer back to it later. The methods involved would serve to allow users to input their data into their phones or personal devices or allow their data to be collected by any personal sensors within these devices. This also allows health care professionals to gather data on a patient in order to aid in care or to improve daily healthy lifestyle suggestions.

The second need is to be able to view and analyze patient health data. Health care professionals and even patients themselves want to see progress on the patient's health and being able to track this data would be of immense help. The way it would work would be to allow the data collected from patients with their permission to be analyzed for any new and concerning conditions that may affect certain residents of the city. This analysis can then later be used to inform the city residents of any potential harms that are active in their current lifestyle. It also allows these health care professionals to view patient health over time and be able to accurately predict patient outcomes or the predicted track of where a patient's treatments are headed.

The third need is to be able to facilitate a seamless interaction between patients and health care professionals with regards to patient data. This mostly involves the communication of said data and the acquisition of permission to use the data in a quick and timely manner. If any city residents are suffering from symptoms or were involved in a situation causing harm and requiring immediate medical attention, then data like blood type and height/weight would need to be shared. This is done through first use of the system whereby a patient can opt in to sharing their data should anything happen. If they opt not to, if something were to happen then they need only use their fingerprint to allow access. In that situation of medical attention, the data will then immediately and securely be shared with the hospital or clinic staff using the city's advanced communication system.

The fourth need is to be able to share aggregate health data externally or with the overall city population. This need is characterized by the ability for the city's residents to actually view accrued data and trends in order to inform them of potential health issues arising. This will be done through the use of an application on residents' personal devices that notifies the resident of any new developments.

Main Specifications

To maintain the foundation of our project, there are a few specifications that must be defined so that the project solves the problems it has identified. Firstly, the Smart Health System shall be able to prevent misdiagnosis and mitigate any potential of re-vaccination or a patient being re-diagnosed treatment that did not work in the past. Today, it is frustrating to transfer information from one medical provider to another, especially when transfers need to be done frequently.

The Smart Health System shall also keep track of important medical information. Patients with many allergies can find it very time-consuming to list off all of their allergies each time they need to fill out a medical application. With the introduction of this system, there will be no need to fill out these applications in the first place, as medical professionals will already have access to the data they need.

The final specification that this system must uphold is ease of access in terms of information. In case of emergency or in case a user switches doctors or hospitals, the system shall be able to quickly transfer all pertinent health information to medical staff and first-responders.

Stakeholders

The Smart Health System is designed so that every citizen within the smart city is considered a stakeholder. However, considering the different use cases within the system, it is important to categorize the citizens into 4 main stakeholder groups.

1. **Patients**

The patients are those who are currently looking for an appointment with a medical professional, or currently in their care. Patients are concerned with the time it takes to create an appointment with a medical facility, and that medical facilities are transparent and consistent with their available services.

2. **Health Care Professionals**

These are the citizens who treat patients in a medical environment, while being employed by a medical facility. Health Care Professionals are concerned with the accuracy of the information provided by the user and the time it takes to retrieve the patient's medical information.

3. **Medical Facilities**

After interactions between patients and health care professionals, lots of medical information can be gathered. Certain medical professionals within a medical facility, such as an epidemiologist, would be concerned with analyzing health trends across the population. This would require health trends to be aggregated to then be assessed by the medical facility to determine any possible outbreaks.

4. Smart City Residents

This stakeholder group includes the remaining citizens that have not yet been categorized. While these people aren't necessarily interacting with the medical industry, they could potentially benefit from dietary and lifestyle recommendations. This may include going out for a walk while the weather is nice, or a reminder to buy some vegetables while at the grocery store.

System Features

Currently, there are many software solutions to health collection and utilization. For Smart Health, we are taking advantage of the smart city environment to gain a competitive edge. To start off, since everyone's health information is in one place, doctors can provide evidence-based medicine and analyze a patient's remission rates. With this smart technology, it can shift the medical paradigm within the city from predictive practices to preventative practices.

Another factor that sets this system apart is how much time is saved for both patients and healthcare professionals. In many cases, a patient would have to call a medical facility to get into contact with a receptionist or similar role, to try and figure out the best time for both the doctor and the patient to meet. This phone call may not result in a reminder for an appointment, so it is up to the patient to remember the date and time of the appointment. With the Smart Health System, all of this is done on the app, where a medical facility's services are displayed, and appointments can be made in real time, without the need of making a phone call.

The final feature that makes this system special is the improved communication between different groups of citizens. With all medical information and services located in one place, everyone can have access to the same information in real time. The interconnectedness between medical facilities, insurance companies, doctors, and patients facilitates better collaboration between parties.

System Operational Concept

Evaluation of System Alternatives

To create a smart health system, we needed to come up with ways that patient information can be transmitted to healthcare professionals, and ways patients can be alerted of safety measures/other necessary or recommended solutions as given by the healthcare professionals. We had three design solutions in mind when considering which model to go with for our smart health system. All three solutions would accept and transmit patient data to healthcare professionals, however, the key differentiators between them were the manners in which that reception of data would take place. One of them was to place sensors around a city to track patients' healths, another was to create a wearable smart watch that tracks health information and has a screen to display information for a patient to interact with, and the one we ultimately selected was one where a patient would wear an optional sensor that would be connected to a mobile app on their phone that they could interact with. There are multiple pros and cons to all three solutions:

- Sensors placed around the city
    - Pros: This solution would allow for relatively continuous tracking of patient health data for the most part, and also allows healthcare professionals to pinpoint via geolocation data where exactly illnesses may be coming from.
    - Cons: This solution would be very costly, as we would have to set up big sensor blocks around multiple locations in the city. Upkeep would also be costly and in the case one sensor broke, it would not be able to track patient data in a certain location, making continuous tracking unreliable. Moreover, there is the concern about privacy with this solution, as patients may not want their health information to be shared wherever they go.
- Smart watch only (no phone)
    - Pros: This solution would allow for more continuous tracking than having sensors placed around the city. This is because the idea is the watch would be worn at all times. Moreover, there are less devices used in this case compared to the third solution (the one where the sensor and phone are used together), but only in the case the person chooses to wear a sensor. Also, a smart watch is kept on for longer than a phone is, and as mentioned, a person does not need to then be under a sensor in a city to have their health monitored.
    - Cons: One of the biggest cons for this solution is accessibility. As a smart watch's screen is smaller than a phone, it would be more difficult for a wide range of the smart city's population to be able to view and manipulate/interact with data or information they receive on the screen of the watch. This applies to the elderly, a population that is also more susceptible to several health-related concerns and whose eyesight may not be as strong as other age groups. Also, it is more common to have a phone than a smart watch as is, so in terms of transitioning people to living in the smart city, there would not be a large change.
- Wearable sensor and phone
    - Pros: This solution allows for more continuous tracking than the sensors, although slightly less than having a watch. However, as the sensor is an option to wear, if the person chooses to wear the sensor, it is as continuous as the watch-only solution. This solution also offers more privacy as patients can choose to be consistently monitored with a wearable sensor if they'd like, but they may also choose not to and may report as much/as little as they would like via their phone. Moreover, having a phone, the screen size is bigger, making it more accessible for a greater majority of the population.

  - Cons: If a patient chooses to not wear the sensor, there would be less continuous tracking. Moreover, two devices would be used at once if the sensor and phone are both being utilized, establishing a dependency on multiple devices which can get tricky.

Ultimately, we decided on going with the wearable sensor and phone option due to this solution achieving higher points in the Pugh Matrix established for this (see below: Mobile App):

	Weight	City of Sensors	Smart Watch Only	Mobile App
Criteria				
Privacy	3	-3	3	3
Security	4	4	4	4
Accessibility	2	0	-2	2
Accuracy	3	3	3	0
Communication	2	0	2	2
Safety	3	-3	3	3
Training	2	2	-2	-2
Efficiency	1	1	-1	-1
Usability	1	0	-1	1
Total		4	9	12

System Description

Our solution is a mobile app, with the optional wearable sensor connection that patients can use to have health data tracked and transmitted to their healthcare professionals, who in turn may be able to track health trends and make individual recommendations for patients as well.

There are several parts to this solution:

- **Wearable Sensor:** the actual sensor a patient may wear as an option to have their health consistently monitored, and the data would be shown on the smart health app.
- **Smart Health App:** the app a patient may view and edit their information that they choose to send to their healthcare professionals. It is also their interface in which they receive communication from the smart city in terms of health as well as information from their healthcare professionals directly.
- **Healthcare Officials Evaluation System:** this is where healthcare officials will receive data trends on patients' healths overall to determine if major illnesses are spreading, so they can keep track of overall health of the city and provide alerts as necessary.
- **Data Servers:** all information patients send will be stored in secure data servers.
- **HCP Viewing Interface:** healthcare professionals will be able to view individual patient health data here, and send recommendations/other information as well.

System Interactions

The entire Smart Health System would have interactions with the Information and Communications System, which handles the sending, storing, and receiving of information in the smart city as well as with the Infrastructure System in case certain buildings around the city are reported to be dangerous and the Agriculture System in case there are health related issues coming about as a result of contamination of the food supply of the smart city.

System Requirements

For the five subsystems, the critical system requirements are

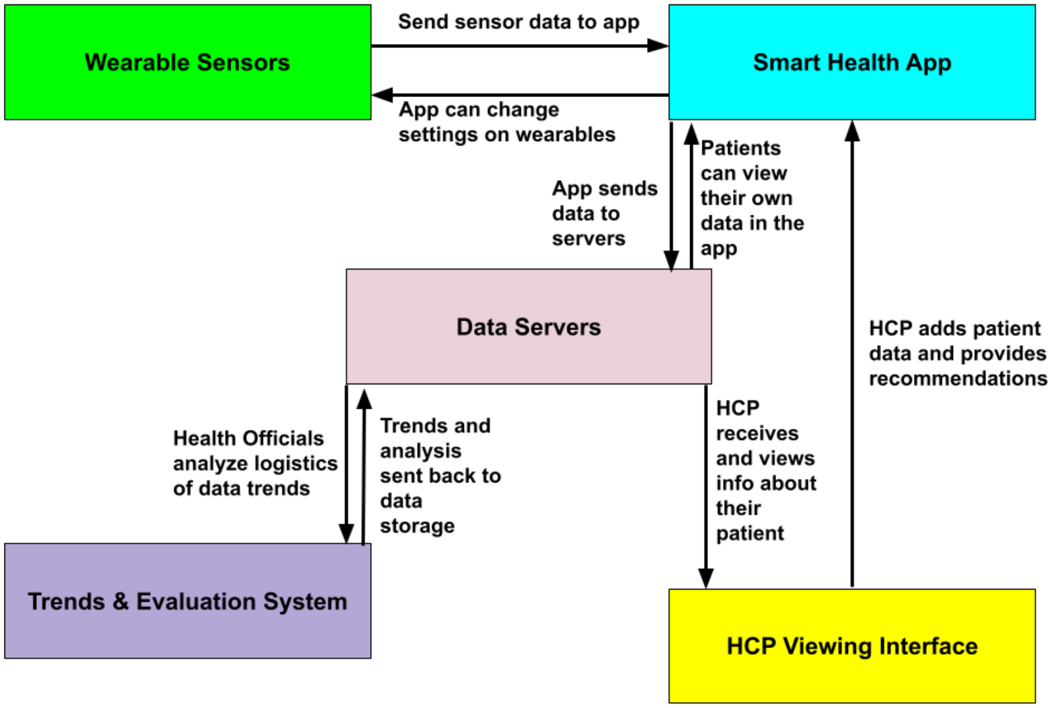
1. **Accuracy**: Smart Health Care system must prevent incidents, not just predict, and accurately analyze the city health trends
2. **Safety:** In Smart Health Care system, users can tune what information gets recorded by the system, allowing them to only share information about their health that they are comfortable sharing
3. **Efficiency:** Smart Health Care system optimally utilizes time for diagnosis and improve decision making
4. **Communication:** Smart Health Care system proactive sends notification and allows better collaboration among departments and patients

Functional Breakdown

Top Level Functions

Collection of User Health Data, Maintenance & Storage of Data, Evaluation & Analysis of Data, HCP Viewing of Patient Data are the 4 top level functions of Smart Health System, all of them in both external and internal operations with other subsystems. In detail, Data Servers subsystems are closely connected to the maintenance and storage of data, and Wearable Sensors and Mobile App subsystems are mainly responsible for the collection of health data. Trends and Evaluation subsystems deal with the evaluation and analysis of data, and the last subsystem, HCP Viewing System, is heavily connected with HCP viewing Patient information functions.

Functional Views



This figure shows the purposes and interactions between the different parts of the system and their functions. Wearable sensors would collect patient data via its sensor technology, and then send patient health data to the app. The app allows the patient to view their data on its interface, and allows them to modify their information as well as adjust what data gets collected by the sensors. The data servers store the patients' information from the app as well as collect trend data from the trends and evaluation system. The trends and evaluation system collects patient information in the form of collections, by which officials working on that end may manipulate and visualize the data being received in the system. The HCP viewing interface collects individual patient info data, and displays it on a screen. The HCP can then send patients recommendations via the interface, which then gets sent back to the smart health app.

Function Interactions

In our smart health system, five subsystems interact with each other to deliver the most accurate and efficient system structure to users. Not only interacting within the five subsystems, they interact both internally and externally to maintain the best collection of users' health data and execute the highly sophisticated analysis and aggregation of data for patient diagnosis.

Internal Function	Inputs	Outputs
Collection of User Health Data	Wearables and entered app data	Packaging of data to be sent to storage
Maintenance & Storage of Data	Data packages	Unpacking and structuring data depending on data type
Evaluation & Analysis of Data	All unvalidated user data in storage	Trends & analysis models, evaluated health data
HCP Viewing of Patient Data	Individual user data	A visual of the patient's health history

Internal Function	External City System(s)	Inputs	Outputs
Collection of User Health Data	Info & Comms	Raw user health data	N/A
Maintenance & Storage of Data	Info & Comms	Stored user health data	N/A
Aggregation & Analysis of Data	Info & Comms	City Health data	N/A
	Infrastructure	Health information about users in certain buildings	Information on if a building is safe/unsafe to inhabit
	Agriculture	Information on if certain foods are causing symptoms	Guidance for necessary food recalls
HCP Viewing of Patient Data	Info & Comms	Patient-specific data	N/A

Internal Function Interactions

1. Collection of User Health Data (Internal)

Internally, the collection of user health data is made through the Wearable Sensors and Mobile App System. In terms of inputs and outputs that the systems take in and execute, wearables and entered app data are taken in as inputs and outputs are the data that are packaged to be sent to the server storage.

2. **Maintenance & Storage of Data (Internal)**

After the outputs are sent out, maintenance and storage of data are securely done through one of the core subsystems, Data Server Systems, and here, unpacking and structuring the data are processed depending on data type.

3. **Aggregation & Analysis of Data (Internal)**

Also, as the data comes in, evaluation and analysis of data are processed right away to validate all invalidate user data sent to the storage. Then, trends and analysis models that are helpful for patent evaluation are executed out to a different subsystem to be processed further.

4. **HCP Viewing of Patient Data (Internal)**

At the last destination of this data collection and process cycle, HCP Viewing of Patient data is internally processed and successfully displays a visual of the patient's health history, and this takes inputs of all the individual user data sent to each subsystem.

External Internal Function Interactions

1. **Collection of User Health Data (External)**

In a larger context, those aforementioned internal functions are externally utilized with various city systems. Info & Commons will co-operate the collection of user health data, and this takes a raw user health data.

2. **Maintenance & Storage of Data (External)**

On the other hand, maintenance and storage of data will take in user health data stored in the system for a secure protection of the data.

3. **Evaluation & Analysis of Data (External)**

For aggregation and analysis of data, three different external city systems contribute: Info & Comms, Infrastructure, and Agriculture. Info & Comms take in general city health data and trends. However, the Infrastructure City System utilizes health information about users in certain buildings as this system is in charge of all the city building and structures, and this benefits the main Smart Health system by providing accurate and live information that tells whether a building is maintained safe or unsafe to inhabit. The last external city system for aggregation and analysis of data, the Agriculture City System provides a guidance for necessary food recalls and this rubricates the recalling process and healthy food chain system in the city by applying and analyzing information to tell if a certain food is causing symptoms or likely to cause any potential diseases in the city.

4. HCP Viewing of Patient Data (External)

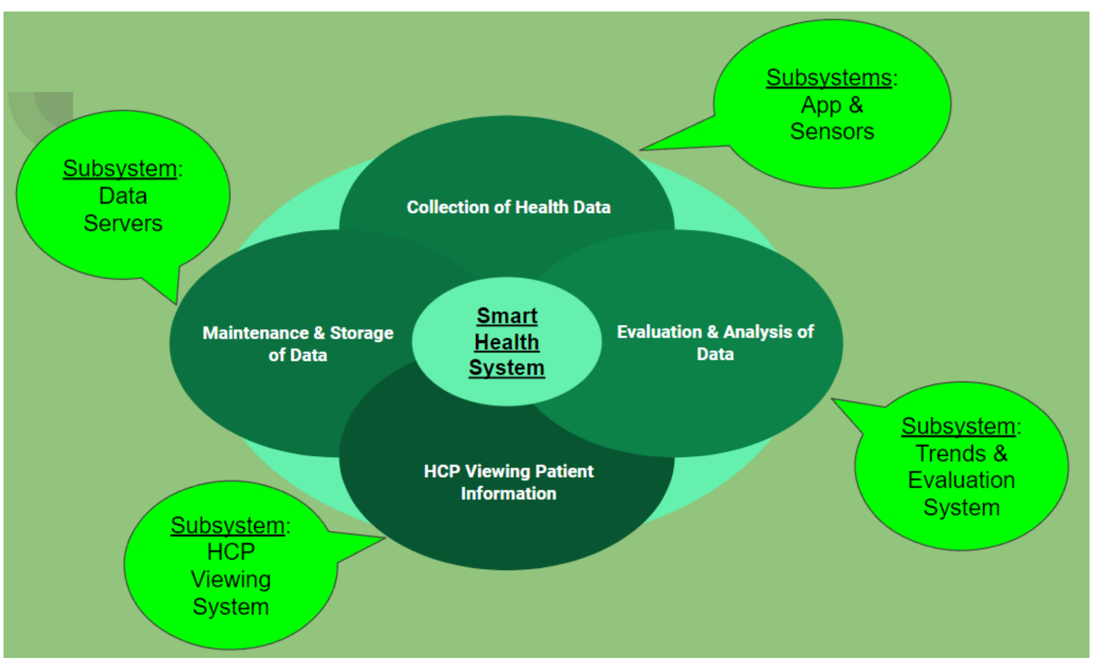
HCP Viewing of Patient Data is connected to Info & Comm of external city systems similar to previous external functions that are mentioned above. This system functionality will take in specific patient data to display on the interface for users, health care professionals to refer.

Major Subsystems

Linking Subsystems to Functions

As depicted in the figures below, the link between subsystems and functions is as follows:

- The Collection of Health Data is performed by the sensors in a user's phone and wearables, which are then recorded by the app on the user's smartphone
- The Maintenance and Storage of Data is performed by the Data Servers, which will collect all information that was sent to the app and also send the information whenever an authorized user has requested certain data
- The Evaluation and Analysis of Data is performed by the Trends and Evaluation System, which will observe the data and report if there are any health trends with certain groups or across the entire city, such as if there is a rampant case of the flu or if certain individuals in a certain part of town all have similar symptoms
- Health Care Professions Viewing Patient Information is performed by the HCP Viewing System, which enables authorized doctors or nurses to have access to and view a certain patient's health data and history for treatment purposes



Internal Function	Inputs	Outputs
Collection of User Health Data	Wearables and entered app data	Packaging of data to be sent to storage
Maintenance & Storage of Data	Data packages	Unpacking and structuring data depending on data type
Evaluation & Analysis of Data	All unvalidated user data in storage	Trends & analysis models, evaluated health data
HCP Viewing of Patient Data	Individual user data	A visual of the patient's health history

Subsystem Requirements

Wearable Sensors Requirements
- Wearable Sensors shall collect accurate health data from patients
- Wearable Sensors shall monitor patients to record any changes
- Wearable Sensors shall accommodate patients' daily activities

Smart Health App Requirements
- Smart Health App let patients enter, remove, and edit any information
- Smart Health App notify if data input by patients don't match data from wearable sensors
- Smart Health App provide an UI with a high usability
- Smart Health App control the data collection through sensors

Healthcare Officials Evaluation System Requirements
- Healthcare Officials Evaluation System shall execute logistics of data trends by computing machine learning models
- Healthcare Officials Evaluation System shall send back the data analyzed to the data server

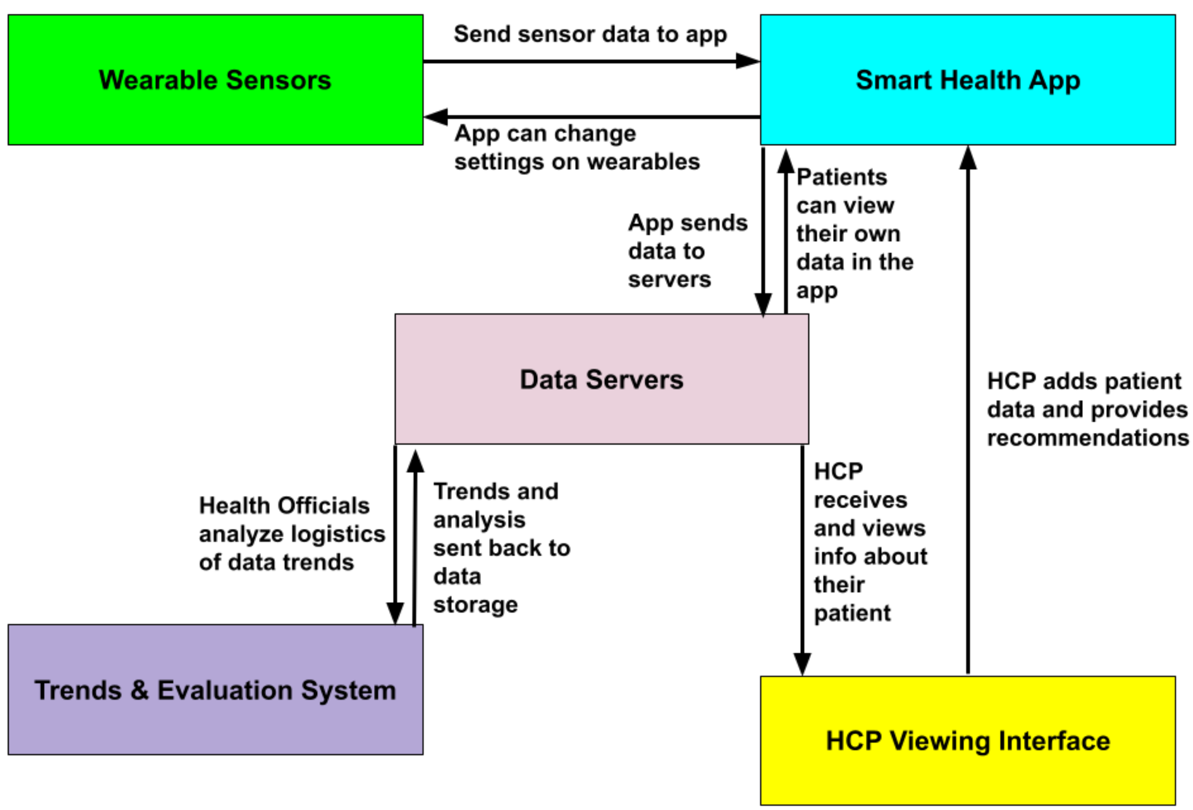
Data Servers Requirements
- Data Servers shall securely store the data sent from other subsystems
- Data Servers shall maintain a minimum of 512 GB disk space available
- Data Servers shall maintain a minimum of 1 Gbps Ethernet connections
- Data Servers shall maintain static ports and a static IP address
- Data Servers shall execute requested data to other subsystems.

HCP Viewing Interface Requirements

- HCP Viewing Interface shall take inputs from data servers and display properly
- HCP Viewing Interface shal let HCP to adds patients data and provide recommendations

Subsystem Interactions

The Smart Health system's internal subsystem interactions are as depicted in the following graph:



The Smart Health System's external subsystem interactions are as depicted in the following chart:

Internal Subsystem	External System	External Interface Inputs	External Interface Outputs
Wearable Sensors	N/A	N/A	N/A
Smart Health App	Info & Comms System	Patient data to be sent to the data servers	N/A
HCP Viewing Interface	Insurance Companies	Individual patient health data	Insurance rates based on patient health
	Pharmaceutical Companies	Health information regarding a company's specific treatment	Information on how successful their treatment is
Data Servers	Info & Comms System	Authentication to access the stored data	N/A
Evaluation System	Pharmaceutical Companies	City health data trends	Information on what treatments are in demand at the moment

Subsystem Alternatives & Tradeoffs

For Wearable Sensors & Smart Health App Combination:
Simplicity has given up to increase functionality by providing more accessible User Interface on Smart Health App, instead of managing all the controls through the wearables

Healthcare Officials Evaluation System
Simplicity in the system has been given up to enhance the validity of the analyzed data and short modeling time has been given to maintain the maximized accuracy in city trends.

Data Servers System
Low database maintenance cost has given up to guarantee security and low database maintenance cost has given up to increase query performance of data transfers

HCP Viewing Interface
Patients in person interaction has taken off to lessen time constraints and location constraints that patients experience

System Risks & Mitigation

The subsystems that communicate the most with other subsystems are the app and the data servers. As such, not only should external adversaries be considered when assessing risks, but the internal users as well, since they are given lots of freedom in terms of information input into the app.

1. **Patients can enter falsified or misleading information into the app**

Within the Smart Health App, users can input their personal info and some medical info into the app. Considering some users may not give an accurate measurement of their height or weight, or for some reason the wearable sensors malfunction, on a general scale there we assigned a medium probability of this occurring, with a high impact. To mitigate this, we will require that the patient's health care provider confirm the new information before proceeding with care.

2. **Data corruption due to power loss**

With all applications with server side storage, power is always an issue. If there were to be a power outage during the time requests are being handled to and from the server, those requests could be lost, resulting in missing information which could potentially be difficult to recreate. To mitigate this medium possibility, medium impact risk, we will implement robust power management and protection involving external storage drives and generators as a backup.

3. **Unauthorized users accessing health information**

Hackers and cyber security measures are always evolving, so there is always a chance an intruder can gain access to a user's information. This could lead to the first risk stated, where the attacker maliciously changes health information in hopes of a medical procedure going wrong due to missing allergies, falsified surgical information, etc. To mitigate this risk, patients are able to adjust what information gets collected. Only health care providers and health care officials that have some relation to the patient are granted access to their information.

Integration & Testing

Modeling & Simulation

There are three main goals in terms of modeling and simulation of the Smart Health System:

1. **Stress Test with All Residents**

The system must be able to function with minimal latency and perform successfully in the unlikely case that all 50,000 residents of the Smart City are using the system at once, be that by uploading or changing data that has been stored or retrieving the data. A simulation enables this testing to occur with absolute certainty and allows the development team to see what the system's bottlenecks are.

2. **Testing During Emergencies**

The system must be able to perform as intended during times of crisis or emergency, since it is during those times when people may get injured and would need their health information viewed by a medical professional. A simulation enables all cases of emergency to be tested, such as a power outage across the city or some form of natural disaster, to see if and/or when the system may not function.

3. **Stress Test In Various Situations**

The system must be able to handle a plethora of different scenarios in regards to its usage, such as if 30,000 residents are all uploading data at the same time while the remaining 20,000 residents are attempting to view their own data. Running the tests with that many testers is incredibly unlikely, since it would be nigh impossible to have all 50,000 residents all ready to perform an indefinite number of tests.

Testing Plan

The system will be tested as follows:

- A simulation of the system will be constructed to stress test the system
    - The simulation will run through many potential scenarios that may break the system, such as a mass-use stress test of all residents of the smart city in an indefinite number of permutations.
    - The simulation will run through multiple different natural disasters to determine where in the system or system interactions there is a vulnerability
- The developers of the system will attempt to hack into the system via a fuzzer as well as via DDOS attacks and injections to highlight any security vulnerabilities
- Before primary launch of the system, tests will be conducted to make sure that information can be sent and received seamlessly with up to 1,000 volunteers as beta-testers
    - The beta-testers will be compensated for finding bugs and faults with the system, as well as reporting when the system is operating slowly or if there are ever any outages during the beta period
    - There will be multiple beta periods lasting approximately 2 weeks per period, for a total of at least 4 beta periods
- The interactions of the Smart Health System with all relevant external systems will be tested, making sure that when certain criteria are met that the specified interactions take place
    - For instance, if multiple residents of the same building exhibit symptoms of asbestos exposure, the Infrastructure System will be alerted with a recommendation to have the building inspected

Acceptance Plan

The system shall be ready for full release when the following criteria have been met:

1. **The system has 99% uptime and is capable of reporting data corruption from power loss**

The system should only ever be unavailable during maintenance periods, which will only last for an hour at most. If there must be extended maintenance, the development team will roll back to a previous version of the system while they look into a solution to the problem. The system should also be capable of telling users if, during an outage, any attempts to store data or change data in the system failed.

2. **The system is capable of defending itself against 99% of hacking attempts**

Ideally, the system should be able to defend itself against all attempts at hacking. However, 100% protection is incredibly unrealistic to promise, and would cause an indefinite delay of the launch of the system.

3. **The system is capable of detecting when false information has been inputted with 98% accuracy**

There is no express reason to input incorrect information into the system by any individual, since it just increases the odds of misdiagnosis. Since it is not as likely to happen on purpose, there is some leeway with the minimum accuracy threshold.

Disruption	Outputs	Rationale
Patients can enter falsified or misleading information into the app	Impact (skewing of data) of using false info for diagnosis	We want medical staff to be able to help patients to the best of their ability, and falsifying or mistakenly-entered health information carries a greater risk of misdiagnosis
Data corruption due to power loss	Time that the system can withstand power loss Amount of data that would be lost	In understanding what information was lost, it becomes possible to tell users that any data entered within a certain time frame did not get sent to the database and must be re-entered
Unauthorized users accessing and manipulating health information	Impact of data manipulation Ability for data transmissions to withstand security threats	We want to ensure that our users' sensitive information is kept a secret from hackers or other harmful individuals. By having an understanding of our own system's strength of security, we can properly inform our users how safe their information is with us, what might be leaked in case of an attack, and that we know what our current vulnerabilities are and that we are working on strengthening them

System Qualities of Robustness

The main system qualities of Robustness for the Smart Health System are as follows:

Reliability	Add multiple checks to determine if information was stored/accessed successfully, incorporate system rollbacks in case of software failure
Maintainability	Update software as bugs are discovered or reported, add new features (such as additional collected health data as sensors get better)
Supportability	Train staff to answer questions and provide troubleshooting support on a hotline
Availability	Add a backup power supply to the database center to ensure that the system stays running even in cases of emergency
Testing	Develop test cases, systems tests, and integration tests to ensure that the system will continue to run as intended during and after development, integration, and deployment

- Reliability - ability of the system to perform as intended
- Maintainability - ability of the system to be upgraded or downgraded as necessary
- Supportability - ability of the users of the system to access help in using the system
- Availability - ability of the system to always be up, running, and functional
- Testing - test cases are constantly being run to make sure the system is operating as intended, and to determine if there is a specific issue or issues with any aspect of the system

References

"How Mobile Phone Sensors Are Used for Health Monitoring." Cprime Studios, 27 Jan. 2022, https://cprimestudios.com/blog/how-mobile-phone-sensors-are-used-health-monitoring.

Liyana. "12 Best IPhone Health Monitoring Devices: The Best Apple Health Devices to Ensure a Healthy Life." MashTips, 11 June 2021, https://mashtips.com/ios-health-monitoring-devices/.