SCRIBBLES: SRS DOCUMENTATION

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1. Introduction

1.1 Purpose:

The advent of the internet has transformed healthcare practices, introducing complexities and privacy vulnerabilities. Recognizing this, our system's main purpose is to centralize and streamline communication between doctors and nurses in emerging, small-scale hospitals/clinics; we do not intend for our system to be used in large hospitals with existing management systems.

Centralization: Our system aims to combat the silo mentality.
A significant communication issue in the healthcare industry is the silo mentality. Silo mentality refers to individual or group mindsets that can create divisions and generate barriers to communication in a healthcare organization. These mentalities can be attributed to issues such as hierarchical organizational structures to a lack of efficient communication channels. According to the World Economic Forum, a silo mentality can "reduce cost efficiency, impact the quality of care and lead to the duplication of services" — issues that can deeply affect patients that require attention from a variety of healthcare professionals. Our application plans to address this issue by creating a system of communication that focuses on integration and centralization, a value highlighted by the World Economic Forum. [1] [2]

Streamlining: Our system aims to bolster successful medical handoffs.
According to the HIPAA Journal, a publication that shares news and articles related to the American Health Insurance Portability and Accountability Act (HIPAA), which outlines standards for protecting sensitive health information, communication breakdowns during patient hand-offs are an important source of medical errors. These communication gaps need to be addressed due to their detrimental effects on patient safety. The HIPAA Journal outlines a variety of tech-oriented solutions that could help ameliorate this issue. One of these ideas is the introduction of secure text messaging between doctors and nurses which has the possibility of

improving “workflow and collaboration” that are crucial in completing successful medical handoffs. Our application plans to address this issue by creating a system that can streamline communication via the implementation of secure text messaging (and other features) as recommended by the HIPAA Journal.[3]

Streamlining: Our system aims to make information easily accessible to healthcare professionals inside and outside of the hospital.
Our application also aims to address the challenge of remote access to patient records for physicians both within and outside their workplace. Storing patient data within the application provides doctors with the ability to easily and securely access patient records when they are away from the hospital but need to retrieve data during emergencies or for other purposes quickly. Moreover, our mobile application offers a streamlined solution that facilitates quick retrieval of vital patient information - encompassing patient details, medical histories, and diagnoses - via an intuitive and readily accessible interface, enhancing efficiency for medical professionals.[4]

1.2 Scope:

The system to be produced, named Scribbles, is a mobile application tailored for healthcare professionals, primarily doctors and nurses, within small-scaled hospitals.

User Needs:

- Centralization - Silo Mentality
- Streamlining - Medical Handoffs
- Streamlining - Accessibility

Inside the Scope:

1. **Messaging:** The application facilitates secure end-to-end encrypted messaging between healthcare professionals, enabling quick communication for care coordination. **[silo mentality, medical handoffs]**
2. **Calling:** Scribbles provides a calling feature for real-time communication between healthcare team members. **[silo mentality, medical handoffs]**
3. **Pager Feature:** Scribbles will include a pager feature for urgent notifications and alerts within the healthcare setting. **[medical handoffs]**

4. **Patient Record Database and Remote Access:** Scribbles allows authorized users to access patient records remotely and add comments to them simultaneously, providing essential patient information at their fingertips. **[accessibility]**
5. **AI-Supported Analysis and Reporting:** Predetermined prompts will be provided to users where they will be able to query the AI for patient record summaries, overviews of last comments, key highlights from patient records, etc. This feature will be facilitated by OpenAI's Chat Completions API. **[accessibility]**
6. **Reminders:** Scribbles will allow its users to create manual customized reminders to facilitate the patient care routine and help them with efficient allocation of their time. **[centralization]**

Outside the Scope:

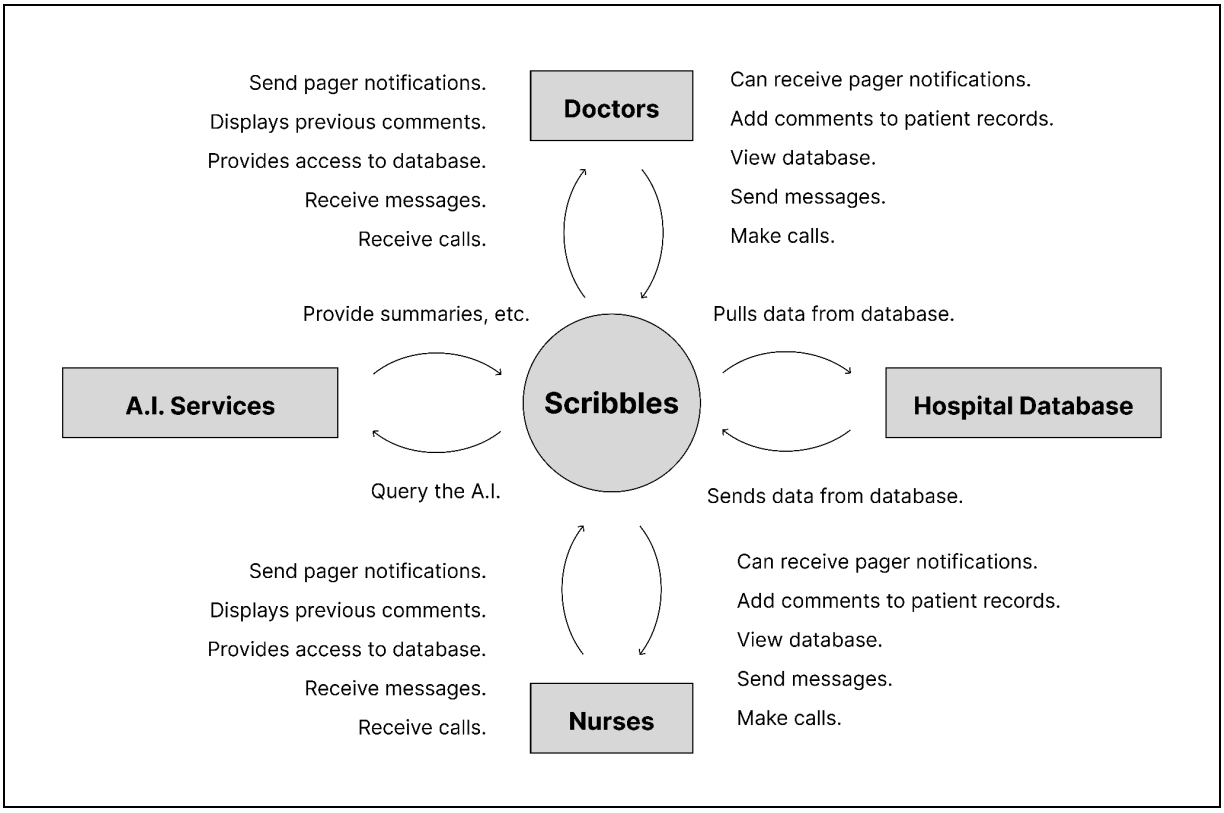
1. **Health Diagnosis:** The application does not offer medical diagnosis or advice to users.
2. **Administrative work:** The application doesn't look into the maintenance of the hospital's database; it rather fosters better management and communication by integrating with the existing hospital's database.
3. **Communication between patients and their respective doctors and nurses:** Our system does not allow calling or messaging between patients and doctors/nurses. Its scope is limited to healthcare professionals.
4. **Complete access to patient information:** Our system does not allow doctors and nurses to search for information about all patients in their hospital's database. They are only allowed to search for information about patients they're actually caring for.
5. **Administrative tasks related to patient appointments:** Our system does not include a calendar function for scheduling, modifying, or removing appointments. Our system also does not make use of scheduling algorithms for smart scheduling.

1.3 Product Overview:

1.3.1 Product Perspective:

System's Relationship to Other Related Products:

1. **Hospitals Database:** Scribbles integrates with the hospital's database to access patient records and doctor-nurse information securely, such that no information is leaked. Our system provides its users access to this information on the go with the aim of severing communication gaps.
2. **AI Integration API:** The system incorporates AI integration through an API, enabling advanced features such as AI-supported querying and summaries.
3. **Hospital Communication System:** Our system centralizes and replaces existing hospital communication systems.
    3.1. **Landlines:** Our system's calling function allows our users to be reached even when they aren't physically close to their specialty's landline.
    3.2. **Pager:** Our system's pager function allows our users to carry and focus on fewer devices while they are at work. Our system provides the functionality of the pager alongside other important communication features, such as calling and messaging.
4. **Desktop Computers:** Our system expands the reach of desktop computer information hubs at participating hospitals. Instead of having to approach an information hub, our users can look for the information they need directly from their smartphones.
5. **Nurse Call Systems:** Our system complements nurse call systems. Instead of simply calling a nurse over, our application will allow doctors to customize their requests for nurses, allowing for more precise communication.



1.3.2 Product Functions

1. **<u>Feature 1:</u> Chatting**
    1.1. A service that doctors and nurses can use to communicate short messages regarding patient care with each other. They will typically use this feature when asking each other for clarification, when sharing small updates, or when asking each other short questions.

2. **<u>Feature 2:</u> Calling**
    2.1. A service that doctors and nurses can use to hold remote conversations regarding patient care. They will typically use this feature when the need for a short discussion arises or when an important piece of information needs to be communicated.

3. **<u>Feature 3:</u> Pager**

3.1. A service that users can use to page or call each other to a certain location inside the hospital. This feature will be used when the presence of any user is required at a particular location. This feature is distinguished from the chatting feature as this will be implemented as an emergency alert notification, which will be crucial in efficiently responding to hospital emergencies.

4. **Feature 4: Patient Record Database Integration**

4.1. A service available for users to view patient records and add comments to them on the go. Doctors and nurses will use this feature while caring for the patient — doing an initial review, adding notes during checkups, etc.

5. **Feature 5: AI Support System**

5.1. A service available to doctors and nurses to make the process of reviewing patient records more efficient. Predetermined prompts will be provided to users where they will be able to query the AI for patient record summaries, overviews of last comments, key highlights from patient records, etc. This feature will be facilitated by the AI Integration Module and OpenAI's Chat Completions API.

6. **Feature 6: Reminder Feature**

6.1. A service to help our users manage patient care. They will use this service to manually create reminders of scheduled visits, times to give medications to patients, etc.

1.3.3 User Characteristics:

1. **Language Proficiency Requirement**

Our application's first version is primarily in English, requiring users to be proficient in the language, either as native speakers or at proficiency levels B1 and B2. Proficiency in English is crucial for comprehending instructions and patient data and ensuring accurate communication within the healthcare system. To broaden the application's reach, we plan to implement translations and support multiple languages in future versions.

2. **Symbol Understanding for Navigation**

A basic understanding of symbols is essential for navigating the icons in the menu bar. This requirement acknowledges that the application uses visual elements, and users must be familiar with symbols to navigate through the interface efficiently. This is especially important for quick and intuitive access to features.

3. Accessibility Limitations

The initial application release lacks features for visually impaired and hearing-impaired individuals, as it relies on a pager system with sound buzzers and on-screen alerts. Caution is exercised in handling patient data due to its sensitive nature. Although the first version offers only enhanced contrast for better visuals, subsequent releases will address inclusivity more extensively, incorporating features like text-to-speech. This commitment is driven by ongoing studies and surveys aimed at improving accessibility.

4. Educational Requirements for Users

Regarding educational requirements, nurses using the application must be Registered Nurses (RNs) with a minimum of an Associate Degree in Nursing (ADN).[5] This ensures that nurses possess the foundational knowledge and qualifications necessary for their roles in patient care.

For doctors using the application, a significant educational background is expected. They should have a minimum of 12 years of education, including a four-year bachelor's degree, four years of medical school, a one-year hospital internship, and three to seven years of residency training. This extensive education equips doctors with the precision needed to navigate patient data responsibly and underscores the seriousness of maintaining the integrity of patient information.

5. Technical Expertise

Proficiency in smartphone navigation is crucial for users engaging with a hospital management app, as it directly influences the accessibility and effectiveness of vital healthcare functionalities. Familiarity with smartphone interfaces allows medical professionals and administrative staff to swiftly navigate through the

hospital management app, efficiently retrieving patient information, scheduling appointments, and managing critical operational aspects. This familiarity reduces the learning curve, enhancing overall user efficiency and effectiveness.

1.3.4 Limitations:

a) regulatory requirements and policies

1. **International Organization of Standardization (ISO) 13485**
   - 1.1. What? According to the ISO's website, the 13485 guidelines help with "managing quality throughout the life cycle of a medical device" (ISO).
   - 1.2. Where? ISO 13485 operates internationally.
   - 1.3. Who? These guidelines were designed for any party involved in the design, manufacture, implementation, or maintenance of a medical device or related technology. They are also useful in auditing processes conducted by regulatory organizations in the medical sphere.
   - 1.4. How? Risk management is an extremely important part of ISO 13485 that is directly related to our project. ISO 13485 holds that risk management "must be thoroughly documented and conducted throughout a product's entire lifecycle" (Wichelecki). This is particularly relevant to our system given the amount of important information it will handle via its communication features. Managing risks related to potential breakdowns of our communication functionalities will be key in accomplishing our goal of improving communication (rather than harming it!).[6] [7]

2. **General Data Protection Regulation (GDPR)**
   - 2.1. What? The GDPR is an all-encompassing privacy and security law that was developed by the European Union (EU). It defines guidelines for data processing and for protecting data subjects (Wolford).
   - 2.2. Where? These guidelines operate in countries that are a part of the EU.
   - 2.3. Who? Although these guidelines were originally intended for EU organizations, they may also be applicable to foreign companies that would like to utilize European data.

2.4. How? The GDPR outlines that data should be handled securely by the implementation of “appropriate technical and organizational measures" (Wolford). Although general, Ben Wolford, a data privacy journalist, explains that technical measures may include the implementation of two-factor authentication, end-to-end encryption, and access limitations for data (Wolford). Since security is of utmost priority to our system, these guidelines and their interpretation are useful in coming up with ideas on how to tackle this aspect of the app development process.[8]

3. Health Insurance Portability and Accountability Act (HIPAA)

3.1. What? According to the Center for Disease Control (CDC) of the United States of America, the Health Insurance Portability and Accountability Act (HIPAA) is “a federal law that required the creation of national standards to protect sensitive patient health information from being disclosed without the patient’s consent or knowledge” (U.S. Department of Health & Human Services).

3.2. Where? This government act operates in the United States.

3.3. Who? There are two main entities that HIPAA is intended for. The first are healthcare providers, which deal directly with patients, and the second are health plans, which are on the more administrative side (U.S. Department of Health & Human Services).

3.4. How? Since our app is looking to provide doctors and nurses access to patient information on the go, complying with HIPAA will be important for ensuring that our approach is secure. HIPAA’s “minimum necessary” principle will be particularly crucial in our decision-making process. HIPAA states that a “covered entity must make reasonable efforts to use, disclose, and request only the minimum amount of protected health information needed to accomplish the[ir] intended purpose” (Office for Civil Rights). One of the ways we could approach secure patient information disclosure is via the implementation of strict data privileges.[9]

4. Digital Imaging and Communications in Medicine (DICOM)

4.1. What? According to ScienceDirect, a digital platform for peer-reviewed research, the DICOM was “developed as a standard for handling, storing, printing, and transmitting information in medical imaging” (ScienceDirect).

4.2. Where? These standards operate internationally.

4.3. Who? These standards are intended for any party that utilizes medical images. These parties include but are not limited to radiology, cardiology or radiotherapy departments at different hospitals (The Medical Imaging Technology Association).

4.4. How? These standards may be related to our project if we decide to allow doctors and nurses to share images and videos via our messaging system.[10] [11]

5. Health Level Seven International (HL7)

5.1. What? According to HL7's website, the HL7 standards "provide a framework (and related standards) for the exchange, integration, sharing, and retrieval of electronic health information" (Health Level Seven International).

5.2. Where? These standards operate internationally.

5.3. Who? These standards are intended for healthcare providers to guide them in their clinical practice. Again, these standards are applicable internationally.

5.4. How? Section four of the HL7 standards is particularly relevant to our system because it outlines the "technical specifications, programming structures and guidelines for software" (Health Level Seven International) in the medical sphere.[12]

6. European Committee for Standardization / International Organization of Standardization (CEN / ISO) 13606

6.1. What? The CEN / ISO 13606 standard "define[s] a rigorous and stable information architecture for communicating part or all of the electronic health record (EHR) of a single subject of care (patient) between EHR systems, or between EHR systems and a centralized EHR data repository" (ISO 13606 Community).

6.2. Where? Since this standard was developed jointly by the International Standardization Organization (ISO) and the European Committee for Standardization (CEN) this standard is applicable internationally but more specifically in Europe.

6.3. Who? This standard is applicable to any organization that intends to build a system around or integrate the use of electronic health records (EHR).

6.4. How? Our system communicates with the database of participating hospitals to retrieve and display patient information for doctors and nurses. This standard is relevant to our project and can help us define the appropriate information architecture for communicating this information. [13]

7. Health Information Technology for Economic and Clinical Health (HITECH)

7.1. What? The Health Information Technology for Economic and Clinical Health (HITECH) Act was devised “to stimulate the adoption of electronic health records (EHR) and the supporting technology in the United States” (Petersen).

7.2. Where? These standards operate in the United States.

7.3. Who? The HITECH act comprises four different sections which allude to the types of organizations this standard may be applicable to. HITECH is applicable to organizations that test, apply and promote health information technology.

7.4. How? Testing our system presents a significant challenge given the sensitive nature of the information our software would handle and given the nature of our user’s jobs. The guidelines this act provides for testing health information technology are thus extremely relevant to our system.[14]

8. Cybersecurity Act

8.1. What? The Cybersecurity Act includes “EU wide rules for the cybersecurity certification of products, processes and services” (European Commission).

8.2. Where? These standards operate in member states of the EU.

8.3. Who? These standards are intended for and enforced by the governments of European Union member states. Their job is to “ensure that the integrity and security of public communications networks are maintained, with obligations to ensure that operators take technical and organizational measures to appropriately manage any risks to the security of networks and services” (European Commission).

8.4. How? An important part of the Cybersecurity Act is its guidelines related to vulnerability assessment (IT Governance Ltd) This is particularly relevant to our project since security is one of our main priorities. Conducting vulnerability assessments that comply with the Cybersecurity Act is thus a priority for our system. [15] [16]

9. Software as a Medical Device (SaMD): Clinical Evaluation by the International Medical Device Regulators Forum (IMDRF)

9.1. What? The SaMD: Clinical Evaluation is a document by the International Medical Device Regulators Forum (IMDRF) that has as its purpose to provide a “path for global regulators to converge on terminology, a risk-based framework, an understanding of quality management system principles” and to ensure that “Software as a Medical Device (SaMD) [is] clinically meaningful to users”.

9.2. Where? This document is applicable internationally.

9.3. Who? As its description outlines, this document is intended to guide global regulators in the oversight of SaMD services. It is important to note though that the document is not regulated.

9.4. How? Section six of the document outlines clinical evaluation processes that are meant to be used when assessing the performance of SaMDs once implemented. While our project may not reach the stage of implementation during the semester, this document can be useful in identifying improvement opportunities for our system.[17]

10. International Standards Organization / Institute of Electrical and Electronics Engineers (ISO / IEEE) 11073

10.1. What? The ISO / 11073 standards define “nomenclature for communication of information from point-of-care medical devices” (ISO).

10.2. Where? These standards are applicable internationally.

10.3. Who? While the standards cover several communication-related guidelines for health communication devices they primarily focus on outlining guidelines for “acute care medical devices” and for distributing “patient vital signs information” (ISO).

10.4. How? In the future these guidelines could be relevant to our system. Particularly if we decided somehow to implement the communication of patient vital signs information. [18]

b) hardware limitations

1. Microphone and Speaker Quality

The microphone and speaker quality on mobile devices can vary, affecting the clarity of communication. Producing a loud buzzer sound may be limited by the

device's built-in speaker capabilities. In a hospital setting, ambient noise can also interfere with audio quality. Research into the specific devices commonly used in hospitals can provide insights into their microphone and speaker capabilities. Investigate the maximum decibel levels supported by the devices commonly used in hospitals. The system can also consider providing options for external speakers or integrating with existing hospital notification systems.

2. **Network Connectivity**

   Unstable or poor network connectivity can lead to dropped calls, delays, and poor call quality. Hospitals may have specific network infrastructure challenges. Ensuring compatibility with existing hospital networks and potentially implementing features for low-bandwidth scenarios is crucial.

3. **Battery Life**

   Continuous use of calling/chatting apps can drain the device's battery quickly, which may not be ideal for healthcare professionals who need their devices for various tasks. Investigate the energy consumption patterns of the app and explore optimizations to minimize battery usage. Additionally, consider providing hospitals with charging stations.

4. **Bluetooth/Wi-Fi Range**

   The effective range of Bluetooth or Wi-Fi can limit communication within a hospital, especially in multi-story buildings, basements, and elevators. To tackle that, the system will understand the range of limitations of these technologies and explore solutions such as signal boosters or alternative communication methods to cover larger hospital areas.

c) interfaces to other applications

In dealing with external patient databases, potential variations in data standards or formats pose interoperability challenges for our application, hindering communication and information display. To address this, we plan to implement data transformation and mapping mechanisms for a consistent data representation across diverse databases.

For hospital management applications reliant on external APIs, the risk of disruptions arises from API updates or deprecation, affecting system functionality and causing downtime or reduced performance. To mitigate this, the system will proactively track API updates, employ versioning strategies, and establish contingency plans for abrupt changes.

It's important to note that using the OpenAI API comes with constraints, as it charges 0.002 cents per 1000 tokens, and each interaction typically ranges from 3000 to 5000 tokens. Consequently, monthly costs for a single user can amount to up to $25, highlighting a limitation associated with API usage.[19]

d) parallel operation

The hospital management application's limitation on parallel operations is crucial for ensuring seamless communication among multiple users. It supports simultaneous communication between nurses, doctors, and their respective peers to prevent disruptions during peak usage. However, it's essential to recognize the associated limitations, such as challenges with network congestion or data prioritization. Addressing factors like connection pooling, concurrency control, and the specified constraint of 100 open connections (mentioned in requirements) is necessary to optimize performance and maintain uninterrupted communication among healthcare professionals.

e) audit functions

To fortify audit functions and elevate security measures, the system records all password entries, maintaining a comprehensive log. This meticulous recording of password-related activities serves as a crucial component in the proactive analysis of potential security breaches. However, it is essential to acknowledge the limitations associated with auditing, as the process can be time-consuming. Despite its benefits, storing the vast amount of data generated poses a limitation since big data storage for long periods of time can be expensive. Nevertheless, reporting and analyzing login attempts contribute to a robust auditing mechanism, enabling timely detection, analysis, and response to any security incidents or anomalies within the specified timeframe.

f) control functions

The limitation related to control functions introduces considerations in the application's ability to manage and oversee critical operations, encompassing the recording, processing, and transmission of interpreted data. Control functions play a pivotal role in ensuring the integrity and security of the application. However, limitations may arise in the form of challenges associated with implementing robust control measures. These controls include validity checks, authentication, authorization (restricting access to approved healthcare providers), and input controls (any alterations made to patient data). The limitation becomes apparent in situations where these controls may not be foolproof, leading to potential vulnerabilities in the application's security and data integrity. There could be limitations in providing comprehensive details on application usage, behavioral characteristics, and the impact of threats on both users and the application itself. These limitations underscore the importance of continually refining and enhancing control functions to fortify the application against potential risks and vulnerabilities.

g) higher-order language requirements

Higher-level languages abstract away many of the low-level details, making it easier to write and understand code. However, this abstraction comes at the cost of reduced control over security-related aspects. Python's automatic memory management, while convenient for developers, may introduce security risks as it might not provide the same level of control and predictability as low-level language.

In terms of energy efficiency, the more streamlined and optimized nature of low-order language code can contribute to better performance with lower energy consumption compared to the more abstracted and interpreted nature of higher-order languages.

h) signal handshake protocols (e.g., XON-XOFF, ACK-NACK)

In a hospital setting, the implementation of a handshake protocol among nurses and doctors is crucial for efficient and secure communication. Analogous to handshaking in computing and telecommunications, this protocol authenticates and coordinates communication links, negotiating parameters such as information transfer rate and coding alphabet. While the handshake enhances communication reliability and enables quick and secure exchange of emergency notifications, the choice of protocols for signal handshakes can introduce complexities in security. Achieving an optimal balance

between security measures and time efficiency is essential, as overly complex security protocols may hinder the speed of communication, especially in critical situations where quick information exchange is vital. The automated compatibility of handshake protocols with diverse healthcare systems aligns well with the dynamic nature of healthcare environments, streamlining communication processes but necessitating careful consideration of security intricacies.

i) quality requirements (e.g., reliability)

The system exhibits several limitations that revolve around the quality requirements, specifically reliability, and efficiency, in the context of an emergency notification system utilizing a buzzer. Efficiency is crucial, requiring the system to transmit notifications quickly and effectively to ensure timely responses in emergency situations. Another limitation arises in the requirement for the buzzer to override the silent mode set by the user on their device, as any failure to achieve this override effectively would compromise the system's ability to alert users promptly.

j) criticality of the application

Health sector applications are critical due to the extreme sensitivity of handled information, where any oversight can lead to severe consequences. The high stakes emphasize the exceptional importance of data, requiring meticulous adherence to limitations and protocols. Stringent compliance with numerous regulations is mandatory to meet legal and ethical standards. Users, especially doctors, have limited access to specific patient data, which is crucial for maintaining confidentiality. This critical nature necessitates an unwavering commitment to regulatory compliance, data confidentiality, and precise user access management for optimal patient care and information security.

k) safety and security considerations

Despite prioritizing secure communication and implementing HIPAA-recommended features like secure text messaging, there can be certain limitations. The application ensures HIPAA compliance, utilizing TLS for secure communication and AES-256 encryption for data at rest, with regular key rotation enhancing data security. However, vulnerabilities arise when interfacing with databases using outdated cryptographic protocols, limiting the application based on the security protocols of other databases.

This underscores the necessity for compatibility despite the system's ongoing commitment to robust security measures.

l) physical/mental considerations

While notifications on the phone can undoubtedly enhance communication, they concurrently pose a limitation by potentially becoming sources of distraction for doctors. This distraction may divert their attention from critically pressing emergencies happening in their immediate surroundings, demanding their immediate and undivided focus.

m) limitations that are sourced from other systems, including real-time requirements from the controlled system through interfaces

The limitations stemming from interfacing with other systems, particularly in real-time scenarios, present challenges for doctors relying on AI APIs. The need for doctors to recheck the output of AI API results from the potential inaccuracy of the generated information. This rechecking process, while necessary for ensuring accuracy in medical practices, introduces inefficiencies in terms of time. The requirement for manual verification can be cumbersome and may contribute to delays in decision-making processes. Moreover, the possibility of mistakes arising from misinterpretation or oversight during the rechecking phase further highlights the limitations associated with relying solely on AI outputs. Balancing the benefits of AI with the need for thorough verification poses a significant challenge in optimizing the integration of these systems into medical practices.

1.4 Definitions

1. **Electronic Health Records (EHR):** EHR refers to digital versions of patients' paper charts. These records contain information about a patient's medical history, diagnoses, medications, treatment plans, immunization dates, allergies, radiology images, and laboratory test results.

2. **Lightweight Directory Access Protocol (LDAP):** LDP is a networking protocol used for accessing and managing directory information services over a network. It provides a standardized way to store, retrieve, and manage information about users, devices, and other resources in a hierarchical directory structure.

3. **Voice over Internet Protocol (VoIP):** VoIP is a technology that enables multimedia sessions and voice communication to be sent over the Internet in place of traditional phone lines. VoIP allows analog audio signals to be transformed into digital data packets for transmission via IP networks, like local area networks (LANs) and the Internet.

4. **Health Level 7 (HL7):** HL7 is a widely adopted set of standards governing the exchange and integration of electronic health information among various healthcare systems and organizations. It offers a framework for healthcare IT systems to communicate with each other, facilitating the easy transfer of patient data, clinical data, and administrative records between various platforms.

5. **End-to-end encryption (E2EE):** a security protocol used in communication systems; E2EE makes sure that only the intended recipients are able to access the information being communicated. E2EE encrypts data on the sending device and decrypts it on the receiving device.

6. **Load testing:** A testing method that is employed to determine how well a system handles concurrent transactions. It helps with identifying performance bottlenecks and how a system may react to high volumes of activity.

7. **Web Content Accessibility Guidelines (WCAG):** Standards for ensuring digital content is perceivable, operable, understandable, and robust for users with disabilities.

8. **AES-256 encryption:** A widely-used encryption algorithm that employs a 256-bit key size, providing strong security for data protection.

9. **Transport Layer Security (TLS):** Protocols ensuring secure communication over a network, protecting data integrity and privacy during transmission.

10. **Role-based access control (RBAC):** A method of restricting system access based on the roles of individual users within an organization, enhancing security and managing permissions effectively.

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3. Requirements

3.1 Functional Requirements (18)

1. The system shall allow users to initiate and receive voice calls from other doctors and nurses within the application.
    1.1. The system shall offer users the option to initiate a phone system call instead of an in-app call in scenarios of low network connectivity.

2. The system shall implement a messaging system that allows doctors and nurses to send text, images, and file attachments securely within Scribbles.
    2.1. The system shall allow the users to send messages of up to 1000 characters under normal network conditions.
3. The system shall allow authorized users to view the Electronic Health Records (EHRs) of a select group of patients (patients that they are personally caring for).
4. The system shall allow authorized users to summarize and retrieve highlights from Electronic Health Records (EHRs) using Artificial Intelligence (AI), generating comprehensive summaries and recommendations to support clinical decision-making processes.
    4.1. The system shall provide AI capabilities by utilizing Open AI's Chat Completion API key.
5. The system shall allow users to "page" one another by determining a recipient, location, and level of urgency and by inputting an optional custom message.
    5.1. The system shall send a push notification to the recipient that includes essential information such as room number, floor number, and patient name.
    5.2. The system shall notify "paged" users by employing different sound alerts depending on the request's level of urgency.
        5.2.1. The system shall generate emergency notifications using a loud buzzer sound.
    5.3. The system shall send push notifications to users' devices for pager alerts with delivery confirmation and escalation protocols for unacknowledged notifications.
    5.4. The system shall acknowledge receipt of a pager notification from a nurse/doctor within 5 seconds of pressing the emergency button. If a specific nurse does not respond within 10 seconds, the notification should be forwarded to another healthcare professional.
6. The system shall allow users to set reminders for appointments, medication schedules, and other important tasks.
    6.1. The system shall allow users to create reminders by inputting a title, date, time, and description.
    6.2. The system shall provide users the option to create recurring reminders.
7. The system shall authenticate users through login credentials such that only legitimate doctors and nurses working in the hospital can access it.

7.1. The system shall enable doctors and nurses to configure multi-factor authentication to secure their login process.

3.2 Performance Requirements (8)

1. The system shall utilize a Lightweight Directory Access Protocol (LDAP) for user onboarding with a response time of no more than 8 ms. [Onboarding] [20]
2. The system shall provide responses from the A.I. client in an average of 20 ms. [A.I. Integration] [21]
3. The system shall be able to retrieve Electronic Health Records (EHR) from a hospital's database within 5 to 10 ms. [Patient Records] [22]
4. The system shall ensure that patient information accessed through Scribbles is updated in real-time, with synchronization between the mobile application and the hospital's database occurring every 5 minutes. [Patient Records]
5. To provide accurate offline access to Electronic Health Records (EHR), the system shall automatically refresh cached data that hasn't been synced every 24 hours. [Patient Records] [23]
6. The system shall, by default, set the pager's push notification priority as "urgent" for distinction amongst other notifications. [Pager] [24]
7. The system shall utilize a Voice over Internet Protocol (VoIP) that has a latency time of no more than 150 ms. [Calling] [25]
8. The system shall utilize a messaging server that has a latency time of no more than 250 ms. [Messaging] [26]

3.3 Usability Requirements (18)

1. The system shall ensure all messages are delivered within 10 seconds of sending, with read receipts and delivery confirmations provided to users to track message status and ensure timely communication.
2. The system shall provide offline access to cached patient records, allowing healthcare professionals to continue accessing essential information during network outages.
3. The system shall provide technical assistance to users through an in-app user manual.
4. The system shall have a mechanism for collecting user feedback and suggestions for continuous improvement.

4.1. The system shall semi-annually enable users to evaluate their experience with the application through a pop-up window featuring a 5-star rating prompt.

4.2. The system shall semi-annually enable users to evaluate their experience with the application through an in-app survey featuring open-ended questions.

5. The system shall allow users to customize their notification preferences for all application functionalities, including sound, vibration, and display settings, to suit their individual needs and preferences.
6. The system shall immediately alert users when a request takes more than 5 seconds to process, making them aware that they're experiencing low internet connectivity and that for the time being, they should avoid using the application to communicate in emergency situations. [27]
7. The system shall immediately alert users when a request takes more than 30 seconds to process, making them aware that they've lost internet connection and that they should consider utilizing other means of communication until they are able to get back online.[28]
8. The system shall maintain a consistent navigation system that allows users to switch between the application's main functionalities: messaging, calling, accessing patient records, the pager, and reminders.
9. The system shall comply with the Web Content Accessibility Guidelines (WCAG) to ensure optimal readability.[29]

9.1. The system shall ensure that no text is smaller than 12 points.

9.2. The system shall make use of a legible typeface such as Arial, Helvetica, or Times New Roman.

10. The system shall make a 1-minute walkthrough of the application's functionalities available to new users upon registration.[30]
11. The system shall prompt users to call back or message each other in case of a missed call.
12. The system shall provide users with a range of location and urgency selections when creating pager requests to reduce the chance of error. [31]
13. The system shall provide users the option of refreshing cached patient records to avoid misinformation.

13.1. The system shall prominently display the last time it updated cached patient records (which should, at maximum, be 24 hours) for users to clearly understand the data they currently have available.

3.4 Interface Requirements (7)

1. **Login Interface**
    - 1.1. Name of item: Login Credentials
    - 1.2. Description of purpose: To authenticate users and grant access to the system.
    - 1.3. Source of input: User input (username and password).
    - 1.4. Valid range: N/A
    - 1.5. Accuracy and/or tolerance: N/A
    - 1.6. Units of measure: N/A
    - 1.7. Timing: Upon initiation of the application.
    - 1.8. Relationships to other inputs/outputs: Directly impacts access to system features.
    - 1.9. Data formats: Plain text (username and password).
    - 1.10. Command Formats: N/A
    - 1.11. Data items or information included in the input and output: Username, password.

2. **Messaging Interface**
    - 2.1. Name of item: Secure Messaging
    - 2.2. Description of purpose: To facilitate secure, end-to-end encrypted messaging between healthcare professionals for care coordination.
    - 2.3. Source of input: User input (message content, recipient).
    - 2.4. Valid range: Message length within 1 to 1000 characters.
    - 2.5. Accuracy and/or tolerance: N/A
    - 2.6. Units of measure: Characters
    - 2.7. Timing: Real-time transmission upon user's initiation.
    - 2.8. Relationships to other inputs/outputs: Relies on user authentication and network connectivity.
    - 2.9. Data formats: Text messages, files (pdf, word, etc.).
    - 2.10. Command Formats: N/A
    - 2.11. Data items or information included in the input and output: Message content, sender, recipient, timestamp.

3. **Calling Interface**
    - 3.1. Name of item: Real-time Calling

3.2. Description of purpose: To enable real-time voice communication between healthcare team members.
3.3. Source of input: User input (initiation of call, recipient selection).
3.4. Valid range: N/A
3.5. Accuracy and/or tolerance: N/A
3.6. Units of measure: N/A
3.7. Timing: Real-time transmission upon user's initiation.
3.8. Relationships to other inputs/outputs: Requires user authentication and network connectivity.
3.9. Data formats: Voice data packets.
3.10. Command Formats: N/A
3.11. Data items or information included in the input and output: Caller, recipient, call duration, timestamp.

4. Pager Interface

4.1. Name of item: Pager Notifications
4.2. Description of purpose: To deliver urgent notifications and alerts within the healthcare setting.
4.3. Source of input: System-generated alerts or user-generated alerts.
4.4. Valid range: N/A
4.5. Accuracy and/or tolerance: N/A
4.6. Units of measure: N/A
4.7. Timing: Immediate transmission upon generation of alert.
4.8. Relationships to other inputs/outputs: Relies on user preferences for alert settings.
4.9. Data formats: Text notifications.
4.10. Command Formats: N/A
4.11. Data items or information included in the input and output: Recipient, location, level of urgency, and custom message.

5. Reminders Interface

5.1. Name of item: Customized Reminders
5.2. Description of purpose: To allow users to create manual customized reminders for patient care routines.

5.3. Source of input: User input (title, date, time, and description).
5.4. Valid range: Reminder length within 1 to 1000 characters, timing within future timestamps.
5.5. Accuracy and/or tolerance: N/A
5.6. Units of measure: Characters for reminder content, timestamp for timing.
5.7. Timing: Reminder notification triggered at specified time.
5.8. Relationships to other inputs/outputs: Linked to user notification preferences.
5.9. Data formats: Text reminders.
5.10. Command Formats: N/A
5.11. Data items or information included in the input and output: Title, date, time, and description.

6. AI Interface

6.1. Name of item: AI-Supported Analysis and Reporting
6.2. Description of purpose: To provide users with summarized patient record information and insights through AI-generated responses.
6.3. Source of input: User query.
6.4. Valid range: N/A
6.5. Accuracy and/or tolerance: N/A
6.6. Units of measure: N/A
6.7. Timing: Upon user query initiation.
6.8. Relationships to other inputs/outputs: Depends on the user's access permissions and system database.
6.9. Data formats: Text queries and responses.
6.10. Command Formats: N/A
6.11. Data items or information included in the input and output: User query, AI-generated response containing summaries, overviews, and highlights from patient records.

7. Electronic Health Records (EHR) Interface

7.1. Name of item: Patient Information Display
7.2. Description of purpose: To display essential patient information retrieved from the hospital's database.
7.3. Source of input: System database.

7.4. Destination of output: User interface (display screen).
7.5. Valid range: N/A
7.6. Accuracy and/or tolerance: N/A
7.7. Units of measure: N/A
7.8. Timing: Upon user request or system-initiated action.
7.9. Relationships to other inputs/outputs: Relies on user authentication and database connectivity.
7.10. Data formats: Structured patient data (e.g., demographics, medical history, diagnoses).
7.11. Command Formats: N/A
7.12. Data items or information included in the input and output: Patient demographics (e.g., name, age, gender), medical history, diagnoses, treatment plans, medications, allergies, immunization dates, lab results, imaging reports, and progress notes.

3.5 Logical Database Requirements (15)

1. The system shall comply with the HL7 Fast Healthcare Interoperability Resources (FHIR) standard by integrating with hospital databases through the use of HL7's API.
2. The system shall employ checksum verification for patient records, ensuring data integrity and detecting any unauthorized alterations or tampering attempts.
3. The system shall implement fine-grained access control mechanisms to restrict access to sensitive patient data, ensuring that only authorized healthcare professionals can view patient records based on their roles.
4. The system shall respond to a query of the patient database within 200ms. This response time is considered a maximum limit under normal operating conditions.
5. The system shall retain cached information only, preventing users from downloading or exporting patient records onto their mobile devices.
6. The system shall allow — contingent on each individual hospital's proprietary database system and server — at least 500 read transactions per second.
7. The system shall comply with Article 33 of the General Data Protection Regulation (GDPR) by alerting the hospital's database of a breach within 72 hours of identification.[32]

8. The system shall minimize the load imposed on the hospital’s database server by employing a connection pooling mechanism that supports a maximum of 100 open connections.[33]
9. The system shall maintain its own database to store information regarding its messaging, calling, and reminder capabilities.
    9.1. The system shall store user messages in its own database by utilizing a message entity with attributes: message ID, sender ID, receiver ID, content, and timestamp.
        9.1.1. The system shall store user messages for 1-year maximum in the case a user opts out of the auto-deletion mechanism.
    9.2. The system shall store calling information on its own database by utilizing a calling entity with attributes: call ID, caller ID, caller ID, duration and timestamp.
        9.2.1. The system shall maintain a 3-month calling log that stores caller information, callee information, call duration and the start and end time of a call.
    9.3. The system shall store reminders in its own database by utilizing a reminder entity with attributes: user ID, reminder title, reminder date, reminder time, and description.
        9.3.1. The system shall store non-recurring user reminders for 1 year maximum.

3.6 Design Constraints (15)

1. The system shall be downloadable from the App Store for iOS devices and Google Play for Android devices.
    1.1. The system shall be compatible with iOS versions 12 and above and Android versions 8 and above.
2. The system shall have an interface that adheres to the platform-specific design guidelines, including the iOS Human Interface Guidelines for iOS and Google's Material Design guidelines for Android.
    2.1. The system shall ensure consistency in layout, navigation, and interaction patterns, optimized for touch interaction and adaptable to various screen sizes and resolutions.

3. The system shall be optimized to achieve CPU utilization below 20% on average and memory consumption below 100 MB, ensuring efficient performance on devices with limited processing power and memory capacities, such as older budget devices.[34]
4. The system will integrate standardized authentication protocols to interface with the OpenAI's API, leveraging industry-standard practices such as OAuth 2.0 or API keys.[35]
    4.1. The system is constrained by OpenAI's rate limit for free usage, which includes 3 requests per minute or 200 requests per day will output a total of 40,000 tokens per request.
        4.1.1. The system would have to limit the AI response according to the rate limit allowed or would have to charge extra ahead.
5. The system shall be compliant with HIPAA, which imposes design constraints by mandating security and privacy measures, such as using AES-256 encryption, having role-based access controls, and audit trails for healthcare applications.
6. The system's design constraints its initial version to English only, with subsequent versions enabling support for multiple languages prevalent in healthcare settings, requiring the implementation of language localization and user interface adaptation mechanisms.
    6.1. The system shall include date formats and other regional preferences based on the user's location.
7. The system's user interface elements, including text, images, and records, will comply with the Web Content Accessibility Guidelines (WCAG) to ensure accessibility for users with disabilities.[36]
    7.1. The system shall be perceivable; that is, there will be screen reader support such that any non-text content sent over chats will have text alternatives so that it can be converted to other forms, such as Braille, for people to read.
    7.2. The system will support keyboard navigation for all interactive elements, allowing users to navigate through the interface and perform actions without the need for a mouse.
    7.3. The system will include a high contrast mode, allowing users with visual impairments or those who prefer increased contrast for improved visibility to switch to a color scheme with higher contrast ratios between foreground and background elements.

3.7 Software System Attributes (15)

1. The system shall implement end-to-end encryption (E2EE) of users' messages using the Advanced Encryption Standard (AES) and a key length of 256 bits to protect patient confidentiality. **[Messaging]** [37]
2. The system shall auto-delete user messages based on their preference, which could range from after viewing 24 hours to 30 days to an entire year. **[Messaging]**
3. The system shall implement end-to-end encryption (E2EE) of pager requests using the Advanced Encryption Standard (AES) and a key length of 256 bits. **[Pager]**
4. The system shall utilize Transport Layer Security (TLS) to encrypt calling data with a handshake completion time of no more than 500 ms. **[Calling]** [38]
5. The system shall provide users the option to set a 4-digit PIN lock for the application. **[Interface]**
6. To ensure HIPAA compliance, the system shall employ role-based access control (RBAC) to provide only authorized users access to Electronic Health Records (EHR). **[Patient Records]**
    6.1. The system shall use AES-256 encryption to encrypt all patient data stored within the application so that only authorized doctors can decipher it for use.
7. The system shall log all user activities within Scribbles, including login attempts, data access, and modifications, with timestamps and user identifiers recorded for audit purposes.
8. The system shall store a local cache of patient data on users' devices, allowing offline access to essential information during network disruptions for up to 24 hours.
9. The system shall conduct regular load testing using simulated user traffic to evaluate performance metrics, with load tests conducted quarterly.
10. The system shall enforce data encryption in transit and at rest when querying patient information using industry-standard cryptographic protocols (e.g., TLS for data in transit, AES-256 for data at rest), with regular encryption key rotation conducted every 90 days to enhance data security.
11. The system shall prompt users to re-enter their password after 10 minutes of inactivity to avoid any breach of patient data consistent with HIPAA regulations.
12. The system shall implement AES-256 encryption for encrypting all password entries, ensuring robust security and protection of sensitive data.

13. The system shall possess a flexible architecture that can seamlessly adapt to variations in the structure of the hospital's database, facilitating smooth integration with the system, particularly for Electronic Health Record (EHR) companies.
14. The system shall only provide anonymized patient information to the AI summary feature to comply with relevant healthcare data protection regulations such as HIPAA.

3.8 Additional Information

4. Verification

The following are the verification approaches and methods we plan to use to qualify our system. We describe each by answering these questions:

- What is the technique, and what is it used for?
- Why is this technique relevant to our project?
- How will we use this technique?

1. Prototyping
    1.1. What? Prototyping involves the creation of a preliminary model to visualize the final system and to share it with stakeholders for feedback.
    1.2. Why? Our system will have multiple features, each with its own interface and individual functionalities. Showing a prototype to stakeholders is an effective way of communicating these intricacies in a clear and meaningful way. This technique also allows us to note and relate specific feedback from stakeholders directly to our application’s individual functionalities.
    1.3. How? We’ve already approached this technique by creating a first iteration of wireframes, which we’ve run through a potential user. You can find our wireframes and our notes from interviewing this stakeholder in the appendix of this document.
2. Compliance Review
    2.1. What? The goal of a compliance review is to conduct an assessment of the way a system integrates and respects relevant standards and regulations.
    2.2. Why? Since our system is intended to be used at a hospital and by healthcare professionals, it is bound by a lot of standards and regulations regarding the use

of patient data, security, and privacy. It is essential for us to conduct a compliance review to ensure that our system is not only fit to operate in these settings but that it will also be legally allowed to do so.

2.3. How? One way we're already doing this is by defining some compliance-related requirements in section 3 of this document. Most of these requirements mention how our system will align itself with HIPAA and GDPR, the two most significant regulations at hand. Another method we're exploring is initiating conversations with experts in the field — like members of hospital administration — to find gaps in our design.

3. User Acceptance Testing (UAT)
    3.1. What? User Acceptance Testing (UAT) refers to any testing that involves end-users, in our case, doctors and nurses.
    3.2. Why? It is critical that our system involves end-users during its verification process so that our team can really understand what is most important to them and so that our system is able to actually accomplish its goal of improving communication within hospitals.
    3.3. How? Given the sensitive nature of our end-user's jobs we may have to conduct UAT under certain controlled conditions and environments to avoid risking a patient's life. Developing a beta would be a good way to approach this.
4. Data Integrity Checks
    4.1. What? Data integrity checks seek to verify if the system's data is accurate, consistent, reliable, and complete. They may also involve checking for security considerations that may compromise data integrity (which is particularly relevant to our system).
    4.2. Why? As mentioned above, data integrity checks may involve checking for security considerations that may compromise data integrity. In our requirements, motivated by different regulatory constraints, we established guidelines for handling both patient data and data generated by the application. This technique is useful in checking that we've implemented all of these requirements and that they are working as intended.
    4.3. How? In our requirements, we detailed how we would use tools such as end-to-end encryption, checksum verification, and roles-based access control to ensure data integrity is maintained across different aspects of our application.

Implementing them and ensuring their accuracy of them would be a good way for us to ensure data integrity.

5. Appendices

5.1 Assumptions and dependencies:

1. **Name of assumption:** System built for iOS and Android
   What are we using this for? The system will be compatible with iOS version 12 and Android version 8 and above.
   How could it affect the system? The system would have to update some of the features according to any new releases of the Android or ios version so that the system functions perfectly even with newer versions.

2. **Name of assumption:** OpenAI API
   What are we using this for: The system will be using OpenAPI's Chat Completion API key to create AI-generated summaries of the patient's records
   How could it affect the system: The potential commercialization of OpenAI's API services, currently offering users free access to $5 worth of tokens, may necessitate adjustments to our plans in anticipation of full commercialization. Additionally, updates or modifications to the API itself could necessitate changes in how the system integrates and interacts with OpenAI services. [39]

3. **Name of assumption:** The system will be able to establish a connection with the external Database
   What are we using this for? The system uses the external database to retrieve the patient's records as requested by the authorized health professional based on the role-based access control of the system.
   How could it affect the system? Changes in database configurations or schema may affect how information about healthcare professionals and patient records is retrieved. These variations could require adjustments to maintain smooth integration and continuous access to patient records.

4. **Name of assumption:** The system will be utilizing the current industrial standard modules of encryption - AES-256
   What are we using this for? The system shall be using this to encrypt all the records that are being received or cached so that only the authorized health professional can decipher the record and access it.
   How could it affect the system? According to the current cryptographic journals, AES-256 is considered impervious to all attacks, except for brute force, which attempts to decipher messages using all possible combinations in the 128, 192, or 256-bit cipher. But deciphering a cryptographically encrypted message of 256-bit length is computationally impossible, but if someone is able to do so then the system shall upgrade the module to a more secure version.[40]

5. **Name of assumption:** VoIP [Voice over Internet Protocol]
   What are we using this for? The system will integrate VoIP technology to enable real-time audio communication between healthcare professionals and patients for telemedicine consultations.
   How could it affect the system? Changes in VoIP protocols, bandwidth requirements, or compatibility with different network infrastructures could affect the quality and reliability of audio communication within the system. Additionally, any advancements or updates in VoIP technology may necessitate adjustments or upgrades to ensure seamless integration and optimal performance within the system.

5.2 Acronyms and abbreviations:

1. ADN - Associate Degree in Nursing
2. AES - Advanced Encryption Standard
3. AES-256 - Advanced Encryption Standard with a key length of 256 bits
4. AI - Artificial Intelligence
5. API - Application Programming Interface
6. CDC - Center for Disease Control
7. CEN - European Committee for Standardization
8. CPU - Central Processing Unit
9. DICOM - Digital Imaging and Communications in Medicine

10. E2EE - End-to-End Encryption
11. EHR - Electronic Health Records
12. EU - European Union
13. FHIR - Fast Healthcare Interoperability Resources
14. GDPR - General Data Protection Regulation
15. GDPR - General Data Protection Regulation
16. HIPAA - Health Insurance Portability and Accountability Act
17. HITECH - Health Information Technology for Economic and Clinical Health
18. HL7 - Health Level 7
19. ID - Identification
20. IEEE - Institute of Electrical and Electronics Engineers
21. IMDRF - International Medical Device Regulators Forum
22. iOS - iPhone Operating System
23. ISO - International Organization of Standardization
24. IT - Information Technology
25. LDAP - Lightweight Directory Access Protocol
26. N/A - Not Applicable
27. PIN - Personal Identification Number
28. RBAC - Role-based Access Control
29. RN - Registered Nurse
30. SaMD - Software as a Medical Device
31. TLS - Transport Layer Security
32. VoIP - Voice over Internet Protocol
33. WCAG - Web Content Accessibility Guidelines

5.3 Appendix

Delivery 1 Feedback Response

Hi Dena,

This is our response to your Deliverable 1 comments. We start by responding to your summarizing comment — since it involves a small shift in our focus — and proceed by responding to your other individual comments.

Your Comment: *All in all: The choice of an app or a system should be* ***trying to solve a problem existing or do extra helpful features that don't currently exist.*** *This proposal for this app would be more suitable for a small clinic that still doesn't have a system in place for instance while still focusing on how to mitigate the privacy concerns. However, for a big hospital that already has a system in place, this app doesn't seem to be doing anything extra that would be beneficial in comparison to the current system.* ***So, it is recommended to apply this system for a small clinic that still has no system in place for instance as that would be more practical.***

Our Response:

- We agree with changing the target of our application to smaller hospitals or clinics considering that larger hospitals may already have a similar system in place. When we were conceptualizing our system we were reflecting on our experiences back home and we did not have as broad of a perspective as we do now. We've reflected this change in our Assignment 1 and Deliverable 2 submissions. Our target customers are now small hospitals.
- In terms of solving a problem, or doing extra helpful features that currently don't exist —
    - Our system will solve the problem of decentralized communication or silo mentality as we mentioned in the purpose section of this document **(please refer to Purpose section)**. To solve this problem our application will bring together common communication systems that doctors / nurses already use, like messaging and calling, and will connect them to useful resources that doctors / nurses commonly refer to like patient records and reminders. By centralizing communication our system expects to improve the quality of treatment and patient outcomes. [41]
    - Referencing the domain analysis of one of our teammates, we've verified that our system will in fact be doing extra features that competing systems don't currently have **(please refer to Appendix section, Domain Analysis subsection)**. Competitors like Klara, QliqSOFT and TigerConnect all include messaging and calling features. QliqSOFT specifically has the capacity to read Electronic Health Records (EHR) but does not connect with hospital databases like we intend to. None of the systems analyzed include a reminder or pager feature. There are however standalone applications that do this. Nevertheless, they don't quite achieve our purpose or truly reap the benefits of centralization.

Your Comment:

Calling: doesn't really need a separate application since it is ***already done*** *from reception or work mobile phones.*

Chatting : most if not ***all current hospital systems have*** *an embedded chat feature with current users so having this separately in another app won't be something new.*

Our Response: Since we've changed our focus to small hospitals we can assume that these hospitals don't currently have embedded chat features and that, because of their smaller scale and more dynamic personnel, they will most likely require the use of a more dynamic calling solution facilitated by our application.

Your Comment:

Pager: When the presence of a doctor/nurse is required, or in case of emergencies as you mention, the hospital system ***would already be having loud announcements with specific codes for instance. A pager wouldn't do something extra in this case that a loud hospital announcement or a phone call wouldn't do.***

Our Response: The pager system we are envisioning would very much emulate the niche of modern pager systems that are used in conjunction with mobile phones and their messaging / calling functionalities. Our pager will have a strong focus on emergency and stand-out notifications **(please refer to our Usability Requirements)** which differentiate pagers from mobile phones today. [42]

Your Comment:

Patient Record database feature: Accessing patient records has a lot of ***privacy concerns****. ID or personal identification documents, medical history are all quite sensitive information to be always available on a mobile phone for hospital employees such as doctors and nurses. Usually, the hospital system in place* ***would already have a database with the patient records.*** *A doctor will do the review/checkup/diagnosis all in their office for instance or in the patient room: in either case, he is either using the patient board or the system on the PC in front of him.* ***Using a mobile phone with a smaller screen when a pc is already available doesn't seem logical in the situation.***

Our Response:

- In this submission we've written a variety of requirements that explain how we are planning to deal with the privacy concerns that would arise from utilizing patient records

in our application **(please refer to our Logical Database Requirements and Software System Attributes)**.

- One of our team members conducted an interview with a potential user and documented their findings in our appendix section. Our interviewee expressed interest in the patient record function and highlighted that the feature may be particularly useful in hospitals that don't have information hubs or share printed versions of the records only. **(please refer to the Appendix section)**.

Your Comments:

- *Feature 5: This could be integrated to an already existing system, but how the integration is to take place, the **feasibility of such integration** would need to be taken into consideration as well before proceeding.*
- *The mention of **using paid APIs** should be elaborated upon in the risk section.*
- *Carefully consider all the factors related to integration with external entities or using APIs and study if this is actually **feasible** within the context of your project or not before proceeding.*

Our Response:

- For this submission we worked on defining a little bit more what using paid APIs, specifically OpenAI's API, would look like. We elaborated more on the feasibility of this, and how pricing plays a role, in our limitations section **(please refer to our Limitations section, Interfaces to other applications subsection)**.

Your Comment:

*More details regarding risk mitigation should be provided. 1st risk: what are such **comprehensive privacy and security guidelines** that you plan to implement? Those should be mentioned clearly.*

Our Response:

- We've compiled a list of 10 comprehensive privacy and security guidelines that we plan to implement under our limitations section (please refer to our Limitations section, regulatory requirements and policies subsection).

Your Comment:

*You mention that acquiring data for **testing** will be difficult in the constraints. How do you plan to handle that constraint?*

Our Response:

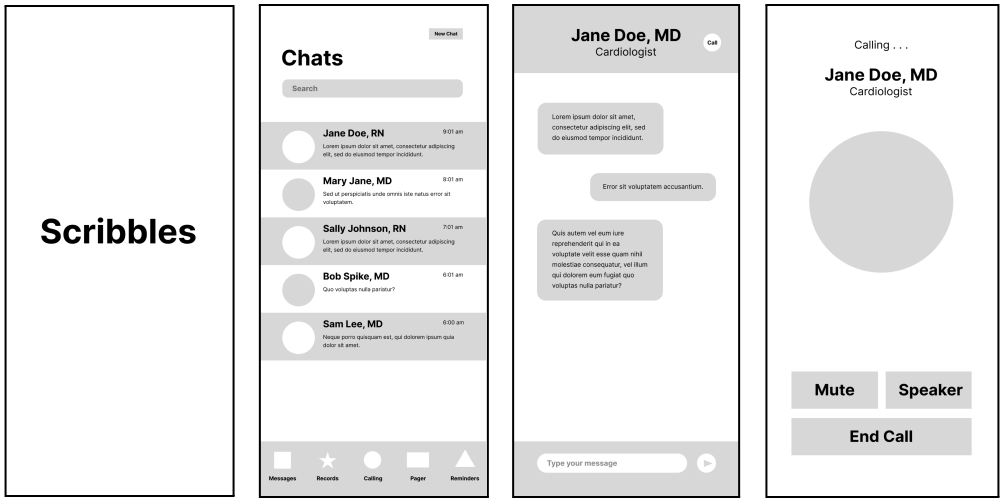
Now that we've done some research on what verification could look like we are thinking of doing User Acceptance Testing to gather some data on the spot. To overcome the constraint of using sensitive data we're thinking of conducting this kind of testing under experimental or controlled conditions **(please refer to the Verification section, User Acceptance Testing subsection)**.

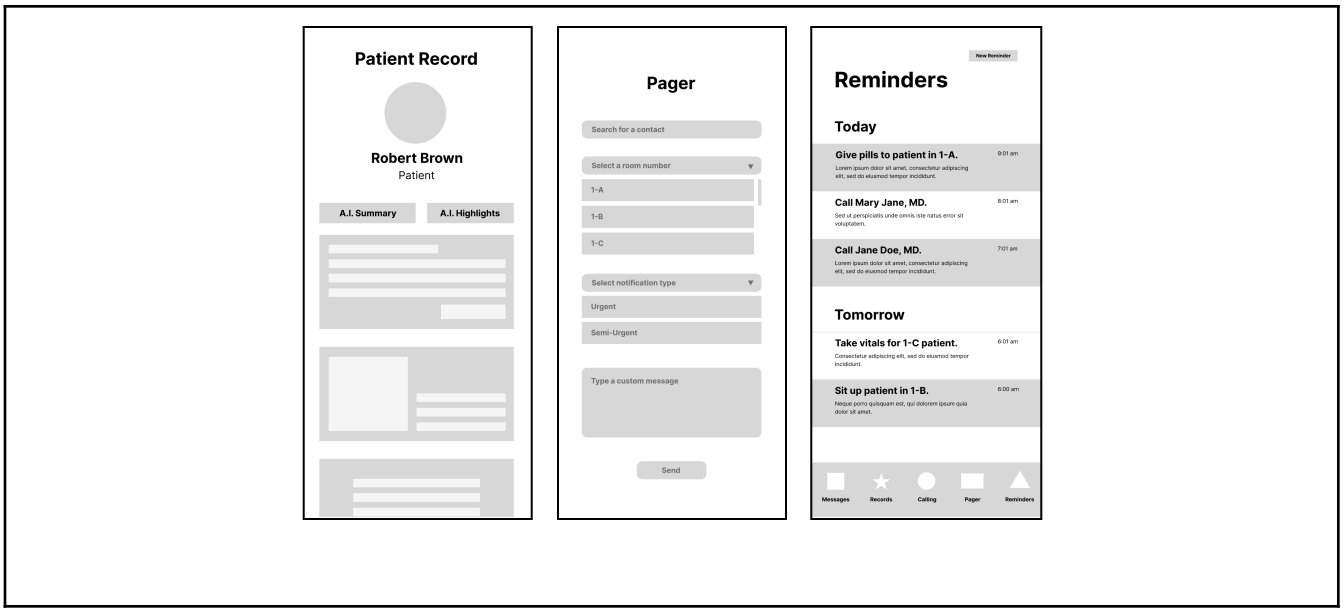
Please let us know if you have any questions.

Thank you!

Wireframes and Interview

Prototype: Wireframes
These are some basic wireframes we created using Figma. They are meant to show the application's most important features. They are not intended to show the entire application.





After creating the wireframes we decided to show them to a doctor (Dr. Iliana Cuellar Cortes) for feedback. What follows are the questions we came up with and some notes from the interview. The questions were translated into Spanish since Dr. Iliana only speaks Spanish.

[Walkthrough Prototype]

1. **Can you see yourself using this application? When do you see yourself using it? Do you have a specific scenario in mind?**
   ¿Usarías esta aplicación? ¿Cuándo la usarías? ¿Tienes algún escenario en mente?

- Dr. Iliana found the patient record accessing feature very useful.
- Dr. Iliana liked the idea of having an accessible directory of other specialists and nurses. She feels like she spends a lot of time looking for this information in her phone.
- Although we had originally intended the feature for nurses, Dr. Iliana believes the reminders feature would benefit Doctors as well. Sometimes doctors have to remind nurses or patients of certain things depending of course on the nature of the situation. Dr. Iliana currently keeps track of her reminders on paper.
- In some hospitals Dr. Iliana has worked at, medical records are still being kept on-paper and not digitally. She dislikes the idea of having to search for these medical records all

over the hospital. She believes implementing our application in places like these could be extra useful.

- Dr. Iliana engages in holistic consultation practices and often collaborates with other specialists in caring for patients. She believes the chat feature could help facilitate these conversations. Especially for quick questions!
- Dr. Iliana expressed frustration at the amount of information she unorderly carries on her phone. She liked the idea of having all of her work materials live in one place.
- Dr. Iliana often references or compares patient files. Having them all easily accessible from her phone was something she was excited about.

2. **What is your favorite feature or part of the application? Is there anything that surprised you?**
   ¿Cuál es tu funcionalidad o parte favorita de la aplicación? ¿Hay algo que te haya sorprendido? ¿Por qué?

- Dr. Iliana was excited about the fact that our application was mobile as she doesn't have to carry a computer with her or sit at a desk to get the information she needs.
- Dr. Iliana was also excited about the fact that everything lives in one place.

3. **Is there anything that you feel is missing?**
   ¿Sientes que algo le falta a la aplicación?

- Dr. Iliana expressed interest in being able to message the hospital's lab or the hospital's X-Ray department to be able to obtain patient studies and preliminary interpretations in a quicker way.

4. **Did any feature or aspect of the application seem redundant or unnecessary? Why?**
   ¿Hay alguna funcionalidad que te haya parecido innecesaria o superflua?

- Dr. Iliana was initially hesitant about the pager but ended up liking the feature. She suggested that we make a strong differentiation between the chat and pager feature by using different types of notifications. Pager notifications, she suggested, could make an alarming and high-pitched noise to differentiate them from the normal messaging ping

tone.

5. **Is there a feature you would change? How would you change it?**
   ¿Hay alguna funcionalidad que cambiarías? ¿Cómo la cambiarías?

- Again, Dr. Iliana offered some suggestions to improve the pager feature via the use of push notifications with different alarming ringtones.

6. **Do you think this application would make your job easier? Why?**
   ¿Crees que esta aplicación facilitaria tu trabajo? ¿Por qué?

- Dr Iliana thinks that this app would make her job easier by saving her time in:
  - Looking for other specialists / colleagues
  - Accessing patient records
  - Contacting other specialists / colleagues
  - Finding nurses and colleagues

7. **I understand time efficiency is a top priority in the healthcare industry. Do you think the app is quick to use? How would you speed up the functionality?**
   Sé que la eficiencia y velocidad son importantes en cuidar la salud de tus pacientes. ¿Crees que la aplicación es rápida de usar? ¿Cómo la harías más rápida?

- Dr. Iliana encouraged us to explore alternative ways of nudging the user via the use of sounds, colors and other active means of getting their attention.

8. **Finally, can you rank the demonstrated features?**
   Finalmente, conforme a tu propio criterio, ¿Puedes clasificar la lista de funcionalidades?
   a. **Chatting** ***(Chatear)***
   b. **Calling** ***(Llamadas)***
   c. **A.I. Integration** ***(Inteligencia Artificial)***
   d. **Patient Record Accessing** ***(Expedientes Médicos)***
   e. **Pager** ***(Buscapersonas)***

f. **Reminders *(Recordatorios)***

- Dr. Iliana provided the following ranking:
    1. Patient Record Accessing
    2. Reminders
    3. Calling
    4. Pager
    5. A.I. Integration
    6. Chatting

Domain Analysis

Klara Klara is a multi-channel patient communication platform.	
Features: What is this application doing?	**Feedback:** What can our application learn?
● Allows patients and doctors to video call each other. ● Allows patients and doctors to message each other. ○ Allows photos to be sent. ● Allows patients and doctors to send documents. ● Allows patients to complete eForms. ● Allows the creation of shared inboxes between patients and healthcare providers to exchange information. ● Allows patients to schedule appointments. ● Allows patients to receive personalized reminders. ● Allows for relevant patient messages to be exported into Electronic Health	● Providing the necessary infrastructure for the ***exchange of images***. ● Providing the option for exporting certain information relevant to a patient to an ***Electronic Health Record (EHR) service***.

Record (EHR) services.	

QliqSOFT QliqSOFT is a HIPAA-compliant healthcare communication platform for doctors, nurses, patients and caregivers.	
Features: What is this application doing?	**Feedback:** What can our application learn?
● Allows for secure messaging between doctors, nurses, patients and caregivers. ○ Messages are stored behind the hospital's firewall. ● Allows for chronic care management. ● Allows for location tracking between users. ● Allows for barcode scanning of medical products. ● Allows for scheduling of on call appointments. ● Allows for the storing and exchange of documents. ● Allows for image capturing with a HIPAA compliant camera. ● Allows for the upload of information to Electronic Medical Records (EMR). ○ EMR integration. ● Secures access to web pages using TLS (HTTPS) to ensure full encryption of information.	● Providing message storing behind the hospital's ***firewall***. ● Providing a ***HIPAA-compliant_camera***. ● Providing ***EMR integration***. ● Providing ***HTTPS technology*** to encrypt information on the web.

TigerConnect TigerConnect is a secure text messaging and collaboration platform for healthcare workers that leverages the use of clinical data.

Features: What is this application doing?	**Feedback:** What can our application learn?

● Allows for messaging between “care teams”.
  ○ End-to-end encrypted
  ○ Auto-deleting
  ○ HIPAA-compliant
  ○ HITRUST-certified
● Allows for PIN locking of the application.
● Allows for the exchange of nurse call alerts.
● Allows for voice and video calling between doctors and nurses.
● Allows for the casting and receiving of system alerts.
● Allows for categorizing of on-call / on-shift healthcare workers.
● Allows for group conversations between healthcare providers regarding patient care.
● Allows for the onboarding of users through Lightweight Directory Access Protocol (LDAP).
● Allows access to be revoked for users who have lost their devices.
	● Providing a messaging application that features:
	  ○ ***End-to-end encryption***
	  ○ ***Auto-deleting messages***
	  ○ HIPAA-compliance
	  ○ HITRUST-certification
	● Providing users the option to set ***PIN lock*** for the application.
	● Providing user onboarding through a ***Lightweight Directory Access Protocol (LDAP)***.
	● Providing the option to ***revoke access*** for users that have lost their devices.