Healthcare

Patient tracker and composite healthcare for NHS using hl7 data integration

Introduction

Various hospitals and government health care entities capture their patient's health records and logs. The data traditionally sits in different systems and in different formats. There has been a need for sharing the records or interoperate with different systems, hospitals, clinics, doctors or event government organizations. Hl7 standard has been there for some time which opens a door for such possibilities through a software system and set of APIs. However, this is quite a challenging piece of work and there are complexities involved which need to be solved thoroughly before such a system can be designed.

- Health care data follows hl7 standard and it is extremely complex in nature. Most of the existing systems find it very hard to process the data. Look at an example of hl7 data
- The data is nested, there are whole set of structuring and constraints that need to be followed as per hl7 guidelines. It is very hard to process such data.
- Following is the high-level requirement for such system
    - The data is connected and potential of improving the intelligence is huge - therefore Graph structuring is required for most of the data apart from document, and text data processing
    - Data moves in real-time, therefore, we need to capture, process, act and store in real-time in continuous manner. Need for real-time stream/timeseries processing is needed
    - Large data or binary data should also be stored and indexed. Secondary and Reverse indexing is required for high-speed retrieval or query
    - Vector indexing is needed for similarity (semantic) use cases – which is extremely important for various reasons in the system
    - High performance, huge scale, privacy, security, encryption, disaster recovery, replication etc. are first set of requirements for such system
    - User interfaces with charts, dashboards and interactive UI workflows for performance several actions
    - REST API for integration with other systems. Cloud or om-prem or hybrid deployments

What is hl7 standard?

HL7 stands for Health Level Seven International. It's a set of international standards for the exchange, integration, sharing, and retrieval of electronic health information. These standards define a framework for the exchange, management, and integration of electronic health information between various healthcare systems. HL7 standards are widely used in healthcare IT systems to ensure interoperability and facilitate the exchange of clinical and administrative data between different healthcare organizations and systems.

Why hl7 standard?

1. Interoperability: HL7 standards provide a common framework for structuring and exchanging healthcare information, regardless of the systems or applications used by different healthcare organizations. This interoperability is essential for improving care coordination, enhancing patient safety, and supporting clinical decision-making.

2. Data Exchange: HL7 enables the exchange of a wide range of healthcare data, including patient demographics, clinical observations, laboratory results, medications, and administrative information. This data exchange is vital for facilitating communication between different healthcare providers, such as hospitals, clinics, laboratories, pharmacies, and public health agencies.

3. Standardization: HL7 promotes standardized formats and protocols for representing and transmitting healthcare information. By adhering to these standards, healthcare organizations can ensure consistency in data exchange, reduce errors, and improve the efficiency of healthcare processes.

4. Integration: HL7 standards support the integration of disparate healthcare systems and applications, allowing them to work together seamlessly. This integration enables healthcare providers to access and share patient information across different systems, improving workflow efficiency and continuity of care.

5. Regulatory Compliance: HL7 standards are often required or recommended by regulatory bodies and healthcare organizations to ensure compliance with healthcare IT regulations and standards. Adhering to HL7 standards can help healthcare organizations meet regulatory requirements related to data exchange, interoperability, and patient privacy and security.

6. Facilitating Innovation: By providing a standardized framework for exchanging healthcare information, HL7 encourages innovation in healthcare IT solutions and interoperable healthcare systems. Developers can build applications and solutions that leverage HL7 standards, enabling new capabilities and functionalities to improve patient care and healthcare delivery.

The problem

Data exchange between different systems in healthcare is a complex subject. The widespread adoption of EHR systems and the digitalization of administrative processes within many healthcare organizations has resulted in large amounts of data.

Managing such a vast and intricate volume of data posed a significant challenge for existing systems. Moreover, retrieving the necessary information became an even more daunting task atop this complexity.

Challenges

1. Complexity: HL7 data is inherently complex, with numerous interdependencies between data elements. We must contend with parsing and interpreting this intricate data structure accurately.

2. Scalability: As the volume of HL7 data continues to grow, we must ensure that its systems can scale effectively to handle the increasing data load without sacrificing performance or reliability.

3. Interoperability: HL7 data often needs to be integrated with various other systems and formats within healthcare environments. we must ensure seamless interoperability between HL7 data and other data formats or standards to facilitate smooth data exchange and workflows.

4. Security and Privacy: Healthcare data, including HL7 messages, is subject to stringent security and privacy regulations. We must implement robust security measures to safeguard HL7 data from unauthorized access, breaches, or data leaks.

5. Data Quality: Maintaining the quality and integrity of HL7 data is crucial for accurate clinical decision-making and patient care. We must implement data validation and cleansing processes to ensure that HL7 data is accurate, complete, and consistent.

6. Performance: Processing HL7 data in real-time or near real-time to support critical healthcare workflows requires high-performance computing infrastructure and optimized algorithms. we must continually optimize its systems and algorithms to deliver timely and responsive HL7 data processing capabilities.

Why are existing systems not enough?

With the inherent complexity of HL7 data, existing systems face challenges in storage and processing. The sheer volume and intricate interconnections within this data pose significant hurdles. Executing data operations or running complex queries demands substantial time and resources.

Consequently, developing a user interface atop such a system becomes time-consuming, and crafting queries to extract necessary data adds further complexity.

Solution

Hl7 data demonstrates a high degree of interconnectedness and complexity, adopting a graph-based storage model, composed of nodes and relationships, offers a superior representation of the data. This approach enhances both the storage efficiency and the comprehension of the dataset's structure and interrelations.

Benefits

1. Interconnectedness and Complexity: HL7 data, are characterized by intricate relationships and dependencies among various data elements. Storing such data in traditional formats may lead to inefficiencies and difficulties in understanding the underlying connections.

2. Graph-based Storage: By organizing the data as a graph, where nodes represent individual data points and relationships denote the connections between them, the inherent complexity of the dataset can be captured more accurately. This model provides a visual and intuitive representation of the data's interconnections.

3. Storage and Understanding: Storing the data as nodes and relations within a graph not only optimizes storage space but also enhances data comprehension. The graphical representation allows analysts and stakeholders to visualize the relationships between different data points, facilitating a deeper understanding of the dataset's structure and dynamics.

4. Query Complexity: By organizing data in this graph format, querying becomes more straightforward as it aligns with the inherent structure of the information, making it easier to traverse and extract relevant data points.

5. Retrieval time: Retrieval time for data is notably reduced compared to traditional storage methods, as the graph structure enables more efficient navigation through interconnected data elements.

6. Data Accuracy: The adoption of this storage approach not only improves operational efficiency but also enhances the accuracy of the data by preserving its inherent relationships and dependencies.

7. Flexibility: Graph databases are schema-less or have flexible schemas, allowing for dynamic changes in data structure without requiring a predefined schema. This flexibility is advantageous for accommodating the evolving nature of HL7 standards and healthcare data.

8. Efficient Querying: Graph databases excel at traversing relationships between data entities, making complex queries more efficient and performant. This capability is particularly valuable for healthcare applications where queries often involve navigating through interconnected data elements.

9. Real-Time Insights: Graph databases enable real-time analysis and insights by providing fast query response times, even with large and interconnected datasets. This rapid querying capability is crucial for supporting decision-making processes in healthcare environments where timely information is critical.

10. Interoperability: HL7 data often needs to be integrated with data from other sources, such as electronic health records (EHRs) or medical imaging systems. Graph databases facilitate seamless integration by providing a unified platform for storing and querying heterogeneous healthcare data.

11. Scalability: Graph databases are inherently scalable, capable of handling growing volumes of HL7 data with ease. As healthcare data continues to proliferate, the scalability of graph databases ensures that performance remains consistent even as the dataset size increases.

Solution Details

Entities

1. Patient
2. "Me" - as a user
3. Hospital Service
4. Diagnostic department
5. Pathway
6. Ordered Procedures
7. Status
8. Order
9. Aggregated status
    a. Computed field - % complete.
10. Demographic information
    a. Patient Identifiers
    b. Name
11. Address
12. Observations
    a. Height
    b. Weight
    c. BMI
13. Practitioner
14. Practitioner role
    a. Technician
    b. Principal Result Interpreter
    c. Assistant Result Interpreter
    d. Responsible Observer
    e. Primary Care Practitioner / 4P
    f. Referring doctor
    g. Consulting Practitioner
    h. Attending Practitioner
    i. Admitting Practitioner
15. Pathway Information
    a. Reason for referral
    b. Reason for admittance
    c. Date of referral
    d. Date of admittance
    e. Referral priority
16. Future event
    a. Schedule, slots
17. MDT
    a. Past
    b. Scheduled
18. Future event activation
19. Referral activation
    a. Accept
    b. Reject
    c. Reassign
    d. Request for more info

Patient Tracker

As a user, we should be able to view list of patients that are related to

- Me
- My hospital service
- A schedule MDT
    - That is related to me (my MDT's) or my hospital service
- For each of the patients, we should be able to see the status of their ordered procedures, grouped by hospital service

A computed field is needed that determines the % of the ordered procedures that related to the specific order and diagnostic department/hospital service that have the status F or COMPLETE

For each of the patient also we need to be able to view following

- Full name
- Patient id
- Birth date
- Address
- Primary care practitioner (GP)

For each Patient, we also need to have Pathway information as it relates to the User's relationship with patient

- Date of Admittance or Referral
- Reason for Admittance or Referral
- Previous MDT "date"
    - Scheduled for MDT "date"
    - Key Practitioners that are involved (by Role).

For each patient, we also need to have key observations

- Height
- Weight
- BMI

Patient Tracker - Orders and Results - Line Item modal

1. When I click on the individual statuses of the "aggregated status", I need to see/access the line item (can these line items be expandable as some of this is only needed if there is an exception)
    - Ordered Procedures,
    - Their Status,
    - The ordered date
    - Last updated
    - Practitioners by Role (Technician, Principal Result Interpreter. Assistant Result Interpreter, Responsible Observer)

2. Create <schedule> and <slots> <future event>

    - As a user, I need to be able to create future events like clinic's, MDT's etc and to be able to add dates, start and finish times, as well as the number of available slots.
    - I also need to be able to add details like the location and URL for the online meeting.
    - I also need to be to add Practitioners and attendees from a list of system users / user groups.

3. Patient Tracker Add to <future event>

    As a user," when I click the Add to <future event>, open a modal to allow me to add the patient to a scheduled (future) event via a Calendar view or a filterable drop down"

4. Patient Tracker - <Future event> Dashboard

As a user, I need to be able to view upcoming MDT's (that are related to me/my hospital service) and the aggregated value of how many patients are ”ready for <event>"

- For example, in MDT's its the % of completed tests/results/appointments
- For other situations, it could be the number of patients who have responded to an invitation to book an appointment

5. Patient Tracker - Referral Management

As a user I need to be able to view a list of referrals that are related to

- me,
- my hospital service,

For each Patient also need to be able to view their properties

- Full Name
- Patient Id
- Date of birth
- Address - unless the patient has the Consent Type "Location Hiding" >=1. If the patient has this consent type then address/phone/email etc fields should not be returned.
- Phone Number - unless the patient has the Consent Type "Location Hiding" >=1. If the patient has this consent type then address/phone/email etc fields should not be return
- Their Primary Care Practitioner (GP) - Consent Type "Location Hiding" >=1. If the patient has this consent type then GP should not be returned.

For each Patient, we also need to have Pathway information as it relates to the user’s relationship with patient

- Date of referral
- Reason for referral
- Referral priority
- Key Practitioners that are involved (by Role).

As a user I need to be able accept, reject or reassign the referral or request additional information from the referring doctor.

Composite care record

All information related to the patient and their history

Other details

Graph Structuring of the hl7 data

sub	sub_label	rel	obj	obj_label
MessageID	Signal	associated_with	Patient_UID	Patient
MessageID	Signal	associated_with	ProblemID	Active_Problem
MessageID	Signal	assigned_location	AssignedPatientLocation	Point_Of_Care
MessageID	Signal	prior_location	PriorPatientLocation	Point_Of_Care
MessageID	Signal	associated_with	AttendingDoctor	Practitioner
MessageID	Signal	associated_with	ReferringDoctor	Practitioner
MessageID	Signal	associated_with	ConsultingDoctor	Practitioner
MessageID	Signal	associated_with	AdmittingDoctor	Practitioner
MessageID	Signal	associated_with	PatientPrimaryCareProviderNameID No^PatientPrimaryCareProvider	Practitioner
MessageID	Signal	associated_with	ProcedureCode	Therapeutic_Or_Preventive_P rocedure
MessageID	Signal	associated_with	Health_Care_Activity	Health_Care_Activity
MessageID	Signal	is_associated_with	MessageID	record_artefact
MessageID	Signal	associated_with	SendingFacility	Health_Care_Related_Organi sation
MessageID	Signal	on_wait_list_for	HospitalService	Hospital_Service
MessageID	Signal	is_associated_with	HospitalService	Hospital_Service
MessageID	Signal	associated_with	DiagnosisCodeDG1	Sign_Or_Symptom
MessageID	Signal	is_associated_with	DiagnosisCode	Disease_Or_Syndrome
Patient_UID	Patient	has_allergy	AllergenTypeCode	Allergies
Patient_UID	Patient	consents_to	NodeID	Consent
Patient_UID	Patient	is_associated_with	Sexual_Orientation	Sexual_Orientation
Patient_UID	Patient	Lives_in	AddressID	Address
AddressID	Address	associated_with	PatientAddress	Postcode
SendingFacility	Health_Care_Related_ Organisation	associated_with	PatientAddress	Postcode
SendingFacility	Health_Care_Related_ Organisation	primary_care_organisation	PatientPrimaryFacility	Health_Care_Related_Organi sation
SendingFacility	Health_Care_Related_ Organisation	operated_by	EventFacility	Health_Care_Related_Organi sation
ReferringProviderID	Practitioner	referring_provider	Health_Care_Activity	health_care_activity
AttendingDoctor	Practitioner	in_role_of	AttendingDoctor	Practitioner_role
ReferringDoctor	Practitioner	in_role_of	ReferringDoctor	Practitioner_role
ConsultingDoctor	Practitioner	in_role_of	ConsultingDoctor	Practitioner_role
AdmittingDoctor	Practitioner	in_role_of	AdmittingDoctor	Practitioner_role

tPrimaryCareProvider	Practitioner	in_role_of	PatientPrimaryCareProviderNameIDNo	Practitioner_role
DiagnosingClinician	Practitioner	in_role_of	Role	Practitioner_role
ReferredProviderID	Practitioner	in_role_of	Role	Referred_Provider
ReferringProviderID	Practitioner	in_role_of	Role	Referring_Provider
DiagnosisCode	Disease_Or_Syndrome	was_participant	DiagnosingClinician	Practitioner
Health_Care_Activity	health_care_activity	referral_to_provider	ReferredProviderID	Referred_Provider