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Essentials of NoSQL Database in building applications based on Internet of Things (IoT)

[1]Jhanavi Shah (15MCA165) **and [1]Chandni Jani** (15MCA171),
Institute of Technology, Nirma University, India.

[2]Prof. Smita Agrawal & [2]Prof. Parita Oza,
Institute of Technology, Nirma University, India.

[3]Dr. Atul Patel,
Dean of CMPICA, CHARUSAT University, Changa, India.

Abstract

The Internet of Things (IoT) is the network of things can exchange the information. In which things like devices, vehicles, buildings and various items embedded with electronics, software, sensors, and network connectivity which that enables these things to collect and exchange data. Data exchanged by IoT based application is heterogeneous in nature. Relational database like Oracle are of great help for single company or department, but it cannot provide the scalability which is needed for cloud or Internet of Things. This paper presents the essentials of NoSQL in building applications based on Internet of Things. Paper also talks about various types of NoSQL databases. Features, advantages and limitations of NoSQL are also presented in the paper.

1. INTRODUCTION

Internet of Things (IoT) signifies an innovative ideas for ability to sense the network devices and collect data from the different devices around us, and then share that data across the Internet as and when required. After collect these data from different devices[1] it can be processed and used for various different purpose like home

automation system, smart city, air pollution control system and so on. Data in the Internet of Things is heterogeneous in nature because it is almost by definition not completely known in advance[2]. The digitalization is moving so rapidly due to that systems must be secured, flexible, allowing the introduction of new devices/sensors and the data they produce. Data generated in exponentially rate of different sensors, applications, API, devices and things are represent the most of the characteristics like variety, velocity, volume of Big Data [3][4]. For different variety of these semi – structured data there is a requirement of NoSQL[5]. According to DataStax CTO Jonathan Ellis, "Relational databases like Oracle are great for dealing with data from a single company or department, but cannot provide the scale or availability that a database designed for the cloud like [NoSQL] Cassandra can."[6]

For the before many ten years, knowledge base experts have hung their hats on a single quality example supported by all knowledge base the Structured Query Language (SQL). We were dependent on the table-oriented relational knowledge based system for storing the data and for retrieving data according to our needs without much thought to any other possibility taking place in the future. Those times however are changing. The NoSQL Database system tosses the structured design of relational database system for storing the data. To remove some of the design forces in Relational Database the NoSQL [5] Database system is used. NoSQL knowledge bases have gained condition of having general approval in the nearby years and have been good in many producing systems. The end, purpose of this paper is to get clearly the current needs that have led to the evolution of Why NoSQL Database for Internet Of Things, Why of relational knowledge-base system were not able to meet these requirement and a short discussion of some of the good NoSQL knowledge for data storage.

2. LITERATURE SURVEY

This study on NoSQL audits with the goal of following:

- Providing a viewpoint in a field
- Providing direction to specialists to pick the fitting information store, and
- Identifying difficulties and opportunities in the field.

Uncommonly, the most unmistakable arrangements are thought about concentrating on information models, questioning, scaling, and security related abilities. Highlights: capacity to scale read demands and compose demands, specifically dividing, consistency and simultaneousness control. Further, utilize cases and situations in which NoSQL and NoSQL data stores have been used and the suitability of changed answers for distinctive arrangements of utilizations is analysed. Subsequently, this study has recognized difficulties in the field, including the assorted qualities and irregularity of phrasings, constrained documentation and seat checking criteria, and non-presence of institutionalized inquiry dialects.

2.1. Types of NoSQL Database

2.1.1. Column-Oriented Database

The main four basic building blocks on the Big Table or Column Store[7] are: 1. Column 2.Super Column 3. Column Family 4. Super Column Family Column consists of name and value pair which is similar to the columns of relational databases. Number of columns are grouped into super column. Columns are warehoused into rows and when rows contains column only it is known as column family. When rows contains super columns it is known as super column family.

Example: Cassandra; Cassandra[8] is an open source database arrangement of facebook. Cassandra System is a conveyed framework in which heaps of hubs are created, to different hubs a compose replication is done, and to a sure hubs read solicitation will be sent. For a Cassandra bunch, to accomplish adaptability including a hub is sufficient. Cassandra additionally underpins rich information structure and intense inquiry dialect.

2.1.2. Document-Oriented Database

At its most fundamental level the model is simply that we pile and fetch documents, just the same as an electronic filing cabinet. Documents incline to comprise the usual property which is having key-value pairs, but where values itself can be tilts, charts, or alike allowing for usual orders in the document just as we are used to with arrangements like in JSON and XML. Documents can be saved and fetched by their unique identification. Document store provides and ID's to be remember by application to which it is interested in. But in general document store relies on indexes to access of document based on their property and attributed.[7][12]

Example: MongoDB;MongoDB[9] is a database framework between of connection and non-social database framework, It's components are: it is non-social information base, which includes the most essential and is for the most part like as the social information base framework; Support complex information: MongoDB support BJSON information structures to store complex information; Powerful Query Language: it lets the majority of purposes, uses like question in single-table of social information base framework, furthermore bolster rundown file. High-pace access to extensive information: when the information goes over breaking points of 50gb, MongoDB is snappier 10 times than mysql. As a result of these qualities of MongoDB, numerous tasks with expanding truths are offering thought to as utilizing MongoDB rather than connection database framework.

2.1.3. Key-Oriented Database

Key-value store database is friends of the document store family. Key – value store

database is intended for storage of data in a schema less way. In this database, all of its data consists on an indexed key – value pair.[7][10]

Example: Flare; Flare[10] was experienced development by the second biggest SNS , Flare is more grounded than TC in view of the adaptability has been extended. Flare included a system point PC before information servers with a specific end goal to oversee information at back, so client can enter or erase information, and it additionally underpins failover. Notwithstanding, Flare just backings the me stored endorsed plan, when utilizing Flare, you can't utilize the table shaped information structure of TC, yet just can utilize TC's Key-esteem information base organized.

2.1.4. Graph-Oriented Database

Graph database is a collection of vertexes and edges. Graph database is a set of nodes and relationship between them.[11]Example: Allegro Graph; Allegro Graph is a modern, high in performance and persistent graph database. Allegro Graph uses memory efficiently in combination with data based storage, enabling it to scale to billions of data while maintaining superior performance. Allegro Graph supports SPARQL, RDFS++ and Prolog for reasoning numerous client applications. Allegro Graph is designed for a standard format for linked data to store RDF triples. For viewing the graph a custom browser, Guff is available.

2.2. Web of Things

The Web of Things is such a concept that defines a future in which day to day life non-living/ living things are being fully connected through the WWW. The prerequisite for communication with “things” need such embedded computer systems which enable communication. Sensors / devices would then be able to communicate with each other with Web standard which are exists. With this, several technologies and protocols like URI, HTTP , HTTPS , TCP , JSON, XML , RSS feed , REST , etc. are exists and widely used by various community. Web Mining is defined as “extracting knowledge from web”[13][14]. Semantic Web[15] is used to link data web whatever we call it ,but it represent the next evolution in connecting information in web. It enables data which is to be linked from a source to other source and it is to be understand by computer so that they can perform increasingly sophisticated task on our behalf. Objects (things) are the resources for Semantic web and Ontologies [16] are for knowledge representation in semantic web.

2.3. Eventual fate of Internet of Things

Web of Things introduces the meeting of advances in remote network, expanded information stockpiling limit and batteries, the IoT would be unthinkable unless sensors. Sensors distinguish and measure changes in position, light, and so forth and

they are important to transform a huge number of items into information producing that can write about their status. Our responders from Asia were more probable saying that their organizations are putting resources into sensors, trailed by Latin America. On the other side, N-American responders were unrealistic to say that their organizations are putting resources into sensors and they have no arrangements to close the worldwide crevice. Asia(28%) and Africa (15%) hope to put more in sensors this year, yet just 10% of respondents from European organizations and 5% of respondents from North American organizations said they have to want to support their ventures.

2.4. The Internet of Thing matters to shoppers and business

The Internet of Things can assist shoppers with improving so as to achieve objectives their choice making limit by means of the enlarged insight. For any large organizations, the Internet of Business Things encourages different organizations to achieve upgraded procedure and advancement and by gathering and providing details regarding information which is gathered from the business environment. Most of the organizations are adding sensors as per need like to individuals, places and procedures to gather and observe data and build directness. Figure 1 is a showing Technology roadmap for evolution of the Internet of Things[10] which highlight that Internet of Things was considered as one of six Disruptive Technologies that may have an impact on U.S. national power[10].

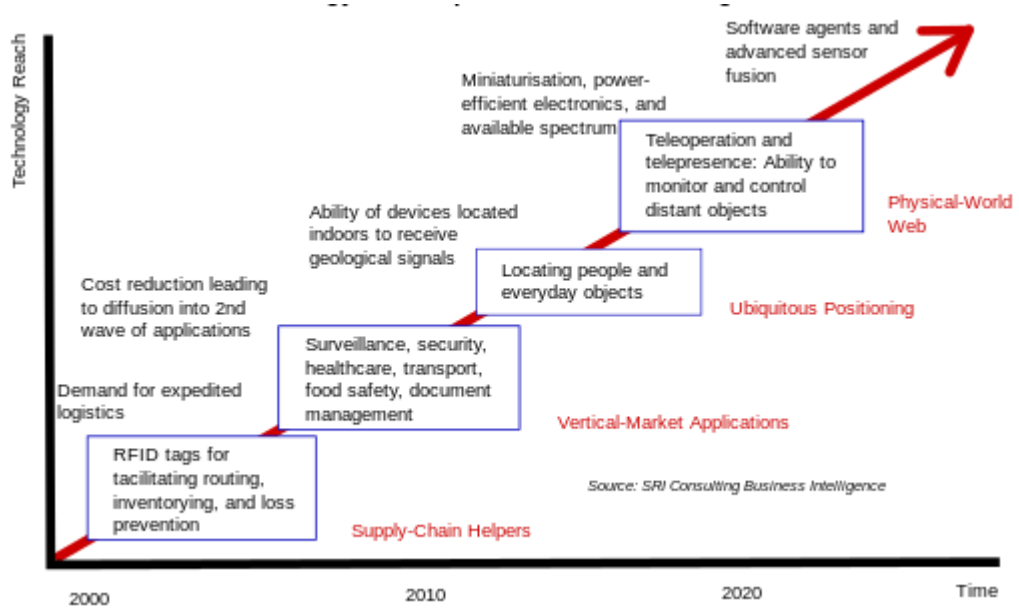

Figure 1 : Technology Roadmap: The Internet Of Things

Source: SRI Consulting Business Intelligence[10]

3. DATA STORAGE: RELATIONAL DATABASE OR NOSQL DATABASE

The relational model invoke the data and categorized it into many interrelated table that include rows and columns. Tables reference through foreign keys that are stored in table. NoSQL support semi-structured volatile data It does not include schema Read/Write throughput is very high it stands for Analytical tool of vast data it can even be hosted in cheap hardware machines memory caching option is available in the query building Faster development life cycles are been available in NoSQL. In NoSQL Database there is no static table used. It gets its all data from a columns and use it as required.

Why IOT uses SQL: It provide with table based databases, it even facilitate predefined schema SQL is vertically scalable defining and manipulating the data would become efficient with the help of SQL because it implements ACID properties SQL provide the real-time performance required to deliver big data scale across any number and states, this means real-time actionable insights into call processing for improved scheduling and incident management of the companies.

ACID v/s BASE Theory (SQL and NoSQL respectively):

ACID transactions between clusters require a two- phase, applies tightly couples them and reduces availability

- Transaction coordinator has each node indicate if the commit is possible
- The transaction coordinator ask both nodes to apply the commit In ACID
- If either or both nodes veto the commit, the transaction coordinator asks both nodes to roll back the commit

BASE transactions between cluster are decoupled, eventually consistent, reliable, and higher Availability

- Use an asynchronous, ordered message queue
- Add a log table to target database to track good execution of queue messages
- Entries into the log table occur when messages are perfectly executed in the
- Target database.
- Messages in the queue are not queued only after the log confirms and executed.

4. FEATURES OF NOSQL

Less Downtime: The elastic nature allows for the workload to automatically be spread among any number of servers. This means that traffic, interactive website, can add data to a server means formatting them to specific extension. As technology, these data outputs become old .NoSQL allows for the changed data format with no requirements, thus providing the shelf of all systems on your network.

High Storage Capacity: In comparisons to RDBMS, NoSQL is capable for handling far more data in terms of volume. This leads to a less expensive storage costs for a company. As the level of information over an channel figures to grow over time

Self-Sufficiency: NoSQL technology that requires few maintenance end when compared to SQL. NoSQL's updates can be almost non-exist system lag in service. This allows the technical team of any company to focus efforts on other areas of the enterprise. This benefit can result in savings to a business over time.

5. ADVANTAGES OF NOSQL DATABASE FOR INTERNET OF THINGS

New Devices a Data: NoSQL enables you to store and process data of any type like events, time, series data, geographic coordinates, text and binary data, etc. You can adapt the structure of data just by adding new fields, making it simple to handle the rapidly changing data generated by Internet Of Things devices.

Horizontal Scalability: Sharing distributes data across all of commodity servers, with complete application transparency. With options for scaling like range-based, hash-based and location-aware sharing NoSQL can support thousands of nodes, billions of data and thousands of ops per second, without requiring to build custom partitioning and caching layers.

In-Place Analytics: With its rich index and query support, including secondary and text search indexes, the aggregation framework and native NoSQL can run complex data or report analytics in-place.

Security: Robust authentication, authorization, auditing and encryption controls protect valuable data.

6. LIMITATIONS OF NOSQL DATABASE FOR INTERNET OF THINGS

Maturity: The maturity of the RDBMS is important. RDBMS is stable and functionally reach. Where in NoSQL have pre-productive versions with many key features implemented in future.

Support: When there is system fail, companies require high level of support which is provided by the RDBMS vendors. In contrast the NoSQL systems are mostly open source projects and NoSQL database companies are small start-ups so getting a proper output is difficult.

Analytics and business intelligence: NoSQL database is unable to provide ad-hoc query and analysis for the large number of data. Even to manage all this data programming expertise is required. The commonly used Business Intelligence tools do not provide proper connectivity to NoSQL.

Administration: The goal of NoSQL to provide a non-admin solution is not possible right now. As it requires skilled person to implement it and maintain it.

7. CONCLUSION

For implementation of IoT based application NoSQL is one of the essential requirement. NoSQL supports BASE theory. In IoT based application, data generation rate is exponential which generates heterogeneous / semi-structured data. For such semi structured data different types of NoSQL databases and its applications are presented in the paper. This paper also gives insight of NoSQL Databases features, advantages and limitations with respect to Internet of Things.

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