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REAL-TIME DISTRIBUTED IOT MIDDLEWARE FOR FLOOD FORECASTING AND MONITORING SYSTEM

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ABSTRACT

Flood Alert system for lakes and reservoirs require real-time data in order to inform the status of the change in flood level and conditions to the public. Climate changes, polluted rivers, lakes in urban areas are the main reason for flooding. And lack of communication between weather monitoring departments, water commission and the public in rainy seasons is another reason. To address the communication issues, the proposed paper introduces a real-time distributed IOT framework to interconnect all subsystems in wide area network. The real -time distributed system easy to use for define and sharing real-time data across systems, platforms, networks in wide area networks. The wide area network consists of water reservoirs, surrounding areas where human living and public and private meteorological departments associated with water and weather

Keywords: *Data Distribution Service, Internet of Things, Flood Forecasting system, Geographic Information System, Publisher, Subscriber.*

I. INTRODUCTION

India is one of the flood-affected countries in the world and accounts for one-fifth of global death count due to floods. The lack of communication and coordination between people and weather meteorological department during natural calamities like flood, hurricane, earthquake, and cyclone which makes the huge loss of human and natural resources in a short while. In this current era, usage of smart devices like mobile phone, television internet users are more. Even though reaching right message to right people at right time is still uncertain. The intention of use Data Distribution Service in flood forecasting system is to publish the message about risky flood area where the possibility is there to happen and save them.

After identifying the area next step is to provide an efficient system to make real-time decisions during a critical situation like pre-disaster, during-disaster and post-disaster phases. The majority of the flood alert systems are not efficient and also connecting all water reservoirs in a distributed network is complicated due to following reasons.

Communication between sensors, internet, embedded and mobile devices are request and response basis and also hardware or software system failures will reduce the total system performance. The existing distributed or client-server methods are not efficient for sending a large amount of data in low latencies. The system is tightly coupled, so the participation of nodes in large area network is not fast and smooth. Devices connected to large distributed network depend on each other as a platform dependent module. There is no interoperability between devices and operating systems. Flood forecasting system requires the dynamic discovery approach to reach the peer level system to share the data and make quick decisions. [3] The real-time flood forecasting system requires the dynamic data about rainfall level and condition, dam and lakes water level by using various smart intelligent devices being interconnected.

The objective of this study is to develop a distributed framework to connect all information devices on reservoirs using the IOT framework to save human and their valuable resources from the flood .

II. DDS AND GIS INTEGRATION FOR REAL-TIME SYSTEMS

Information communication basically identifies as three models such as Client-Server, Point-to-Point, and Publish-Subscribe from the view of the distributed application. based messaging middleware system. DDS based publish-subscribe middleware system integrating small-scale embedded devices, legacy systems, and high-end systems. DDS will support the feature of interoperability where services developed by C++ can communicate service developed by java, as well as services running in windows can communicate services running on Linux. Also, DDS will support different type of network transmission methods to overcome all network issues from any abrupt situations.

Publish-subscribe distributed service virtually eliminate complex network programming. Systems are loosely coupled. where systems can easily join the network and leave from the network if the domain name, topic name and data type is matched. Each application can be part of the single or multiple partitions. Also, a single application can be publisher or subscriber or both. Any participant can write into and read from global data space. Interconnected information and sensors devices in flood alert system have shared global data space, where the publisher can publish the data it has and subscribe the data it needs during a disaster without failures.

DDS: A Real-Time Publisher/Subscriber

DDS follows the Object Management Group (OMG) standard completely with data-centric concepts. The main reason behind using DDS is to generate communication between nodes or systems in an Anonymous, Asynchronous and Asymmetric situation across heterogeneous distributed nodes or systems. Data Distribution Service specification is to facilitate the efficient distribution of data in a distributed system for real-time applications. DDS integrated thousands of devices and its performance and easy communication helps to develop military combat systems, air traffic management, and power plant control systems, etc.

DDS capabilities and strength meets the requirement of flood alert system with high performance, deterministic data delivery, high throughput and data accuracy. Legacy systems can be integrated with an advanced system without complexity for message communication using DDS by its interoperability support and its easily adapting technology.

In DDS domain publishers and subscribers nodes can be part of the network without any request and response. Data flow on DDS will efficiently do a role on a complex architecture and develop the intelligence systems. Quality Of Service establish the contact between publisher and Subscribers. DDS is flexible, dynamic and scalable architecture to adapt and extend the system to changing environments and requirements.

DDS Quality of Service

DDS QoS controls the behavior of all entities such as Topic, DataWriter, DataReader, publisher, subscribers and Domain Participant and its associated with all entity objects. Entities bind QoS to send and receive data reliably and also responsible to store the data permanently or temporarily based on the user's request. Its confirm the efficient use of resources and a give importance to priority messages. Another advantage is a lifetime of the data can be set by the publishers and support transaction on low bandwidth. DDS is supporting 22 different types of QoS policies. The QoS are Durability, Reliability, Deadline, History, Latency Budget, Time Based Filter, Content Based Filter, Presentation, Lifespan, Durability, Ownership, Liveliness, Partition, Reliability, and Destination Order, Resource Limit, Ownership Strength, Durability Services.

Geographical Information System

A geographic information system (GIS) or geospatial information system is integrated with DDS to view the location of systems, water reservoirs on a map with graphical view also helps for capturing, analyzing and managing the data. Objects are located on a map with geometrical symbols like circle, points, lines, and polygons. GIS uses two types of images i.e. vector and raster to draw symbols and positions on the map.

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GIS is widely used for navigation. Along with GPS positioning system, it can give an accurate position of the person, vehicle or an entire system. The details about our source, destination, the distance between them, way-points, associated terrain during the navigation can be obtained from the GIS-based system. A map software incorporating GIS with all associated data and aid for navigation such as planning, guiding, tracking during a disaster will be developed along with integrating to a GPS based positioning system.

III. DDS ENABLED IOT

The real value of the Internet of Things (IoT) is ubiquitous information availability that connects devices to form large distributed systems to provide better safety, comfort, and efficiency in communication. IOT technology should enable Data distribution service for reliable and flexible communication. The features of DDS IOT bring the large system of the system into the advanced developed environment. DDS is one of the platforms to connect devices with IT infrastructure. Its publish thousands of message in an at a time. Here instead of system data is centralized which will avoid a single point of failure. These DDS functionalities do the important role in defense, healthcare, banking and industrial area. DDS characteristic of centralized data is ideal for IoT.

IV. DDS, GIS, AND IOT ENABLED FLOOD ALERT SYSTEM

Data Distribution Service enabled IoT technology will combine all wireless sensors devices, Doppler Weather Radar, monitoring sensors, embedded devices, smart mobile devices, desktop computer, local servers, servers in data centers. These device connected in a distributed network that is Local Area Network or Wide Area Network via a range of wired and wireless communication technologies includes Ethernet,

Bluetooth, Wi-Fi, GPRS, GSM, 3G, 4G. The DDS-IOT technology based flood forecasting and monitoring system for water reservoirs is a platform independent system.

Fig 1. Shows decentralized broker less architecture to enable data sharing between weather meteorological department and humans. Real-time Analytics and Control Services from water reservoir sites could write the message with latitude and longitude position into DDS based Global Data Space to publish on a specific topic name.

Water commission departments could subscribe data from global data space in wide area network and publish into local area network groups. Therefore multiple groups can link without sacrificing performance and security and provide intra node communication through shared memory. DDS routing service links different local area networks to the desperate geographically dispersed system. DDS entity is attached to listener object to notify every event to monitor the flood forecasting system.

Exchange of message, maintaining the data evolving systems in flood monitoring framework is much easier and dynamics. Based on the situation, DDS will decide where to send data and will inform the participants in the domain and its filtering options avoid to send irrelevant information at the needless time.

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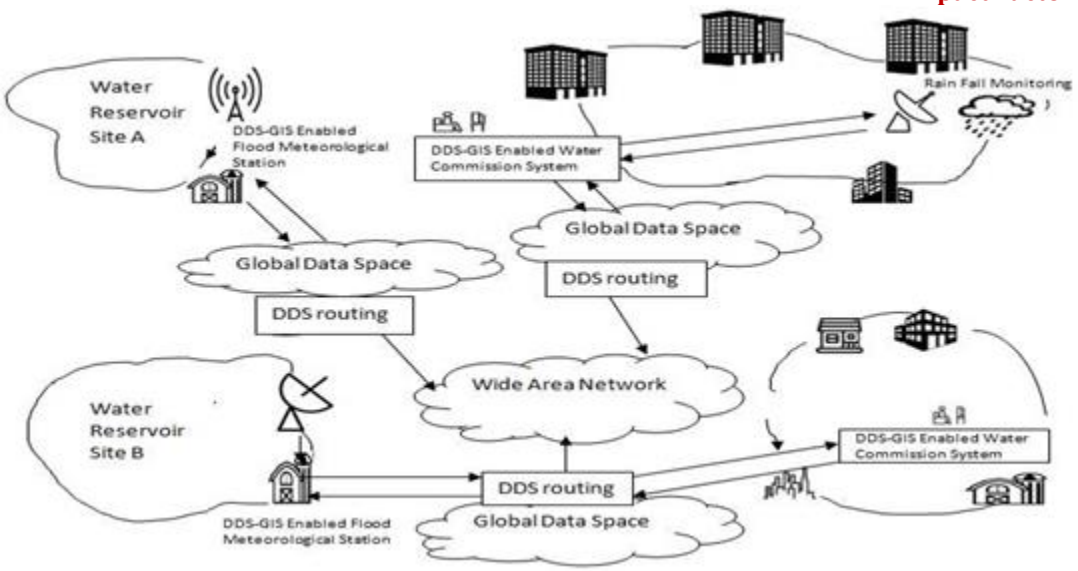

Fig 1. With DDS and IOT integration, how the system has been connected in WAN

The purpose of this idea is to make smart IOT system to bring together humans and systems to taking effective decisions and the approach is to support complex system. This next generation technology will remove the communication gap and intimate the flood forecast information to the public at right time during flood, hurricane, cyclone, hail and heavy rainy seasons. The distributed computing network is self discovering system to connect and reconnect after disruption while natural calamity happened. DDS has the advantage that is persists published and subscribed data to disk for late joining receivers to read the data from global data space. Despite publisher is no longer available, subscribers could read the data if not received yet.

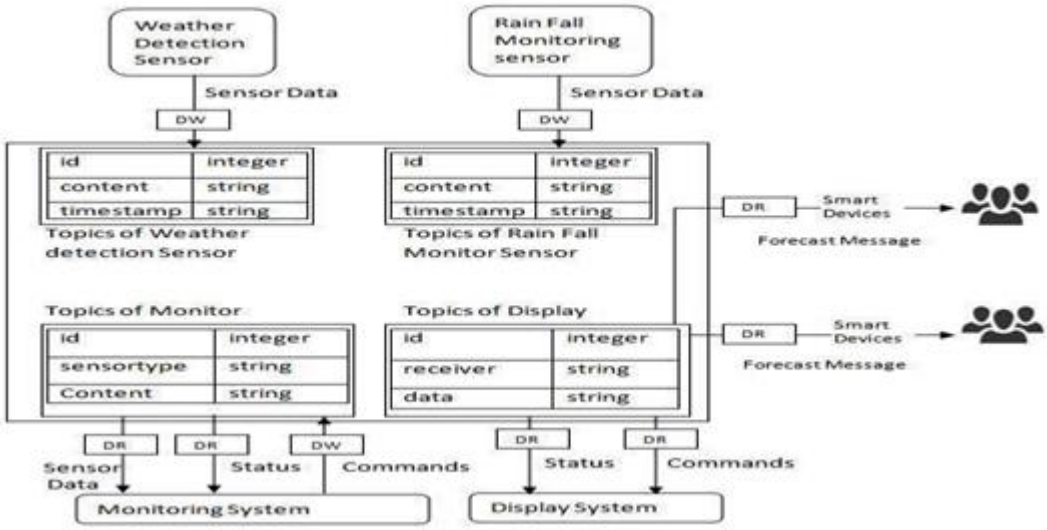

Fig 2. The overview of DDS-GDS Publish Subscribe Architecture

In DDS-IOT enabled Flood alert system the role of GIS is understanding the geographical location to improve the functionality. GIS spatial analysis saves the life of human and valuable resources from the flood. Mainly GIS and

IoT integration facilitate to know the current status and location of devices dynamically. And combing that technology aware the human about preparedness plan, response plans, mitigations plans, and rehabilitation plan.

DDS bundled with GIS create a platform to disparate documents (photographs, plans, etc) and the management of geographic data necessary for GIS to display for forecasting and monitoring flood forecasting system. GIS map shows the latitude and longitude positions of the devices with other metadata information. Users can track the location when water commissioning department send alerts. Adding and leaving nodes from DDS domain will reflect dynamically in GIS map.

Fig 2 shows the sensors and applications communicated over DDS network. [5] DDS Global Data Space with multiple participants and applications can share information as instances by reading and write data objects addressed by system defined topic name with defined data types and key. Each node can be a publisher and subscriber. All Data Writers such as Doppler weather radar, weather sensor, monitoring sensors and Data Readers such as weather meteorological department, water commission and public communication departments with data types would communicate within the Domain. [1] In this large, heterogeneous flood forecast system, domains are segregated as control domains, command domains, status data domain and the combination of control/command/status domains. Domains will disseminate the warning and alerts for the possibility of flooding in the expected area, the potential for rapid flooding. How DDS and GIS integration works for flood forecasting and alarming before the flood as well as after that its guide to find the location where recovery is needed urgently by its real-time communication. Data which was stored using durability persistence QoS helps for analyzing the reasons and damage to avoid a huge loss in future.

V. FLOOD FORECAST SYSTEM ON UNRELIABLE AND CONSTRAINED NETWORK

Now advanced real-time forecast systems are available for data collection and data processing. But disseminate data on low bandwidth, constrained and unreliable network, DDS is the efficient mechanism to minimize packet overheads and maximize data to packet size ratio. In DDS data type information exchange is not a continuous process at runtime; it's a onetime process at discovery time at low bandwidth and high latency distributed system. Also, it can run over various types of transport protocols and overcome the network issues without any breaks.

1) Transport Priority and Latency Budget QoS: It informs to DDS about the urgency of transmitting data that means prioritization of the message to distribute. DDS packet sequencing features to support multiple means of transport between nodes; it's avoided packets loss and ignores packets if already received.

Data timeliness and delivery QoS: These QoS are reconstructing the distributed network for guaranteed data delivery in a timely manner.

Reliable value in Reliable QoS: Reliable QoS policy promises to deliver the data to eligible data readers despite disruption situation.

Transport priority QoS: It will prioritize the data relative to more or less important to read the subscribers.

VI. CONCLUSION

The proposed paper explained IOT architecture based Data Distribution Service technology used to design flood forecast and monitoring. A number of heterogeneous application landscapes with processes that utilize different hardware architectures, operating systems and programming languages can be communicated in real time using DDS and its QoS features to forming a high-performance network. The proposed paper is designed with the qualities of reliability, safety, predictability, and security in order to take a decision at distraction situation without failures

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