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A SURVEY ON CONTEXT AWARE SYSTEM AND PROTOCOL IN INTERNET OF THINGS (IOT)

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Abstract:
Basically, the Internet is a global system of interconnected computer networks. The original Internet architecture was not designed to meet current demands and the continuous strain regarding sophisticated threats, performance, reliability, scalability and security. To overcome the problem of the current Internet especially focuses on the performance, reliability, scalability and security and despite the significant dropping price and increasing size of the storage. In IoT network data are gathered from different sensors in network number of sensors are deployed hence the amounts of data that are created today require ever-growing amounts of storage. However, data is not inherently associated with knowledge of their context. This information may be available at the communication end-points (applications) but not when data is in transit. So, it is not feasible to make efficient storage decisions that guarantee fast storage management, fast data mining and retrieval, refreshing and removal optimised for different types of data.
IoT is going to offer the vast number of application in the various platform. It generates the vast amount of data. There is a various problem regarding the generated data such as its storage, ownership, security, expiry and routing. In routing challenging issue is low-power and lossy radio-links, multi-hop mesh topologies, the battery supplied nodes and frequently changed network topologies.
The Context-aware system important role in the IoT because of the vast number of the data available and protocol is the heart of the communication between the source node to the destination node. In this paper, we survey the different types of the context-aware system and different types of the protocol. Furthermore, we will also discuss the how the proposed system is implemented according to the context-aware and protocol.

1. INTRODUCTION

The Internet of Things (IoT) is a new paradigm that combines aspects and technologies coming from different approaches. Ubiquitous computing, pervasive computing, Internet Protocol, sensing technologies, communication technologies, and embedded devices are merged to build a system where the real and digital worlds meet and are continuously in a symbiotic intercommunication. The IoT vision is building the block of a smart object by putting intelligence into everyday objects; they turned into smart objects able not only to collect information from the environment and manage the physical world but also to be interconnected, to each other, through the Internet to exchange data and information.

The many authors define the context in many ways but we are focused on this definition context is any information that can be used to characterise the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction between a user and application, including the user and applications themselves [1][2]. The characteristic of the context is divided into three categories such as First, acquiring Characteristics related to the acquisition of context, second, user-related Characteristics which focus on the demands of the user, third, consequences Characteristics which follow from the previous two.

In 1990s context-awareness as a core feature of the pervasive computing system. From the last decade its focus on desktop applications, web applications,

mobile computing, pervasive/ubiquitous computing to the Internet of Things (IoT). In the 21st Century in 1991 paper by Mark Weiser [3] introduce the 'ubiquitous computing' hence it is more popular. The author Schilit and Theimer [4] in 1994 use the term 'context-aware'. Then it is established as a public research area in computer science era. Many researchers have proposed definitions and explanations of different aspects of context-aware computing. In 1999 the author Abowd et al. [5] definition was widely accepted by the research community. In IoT, the large number of data are collected. Hence more time is required for the processing of that data, and these data are collected from the software and hardware. From the last decades, researchers and engineers have generated a system and solution using context-aware computing techniques with the help of the context-aware computing the collecting and analysing in these situations, sensor data from all the resources is possible.

The massive number of data are collected may not have any value until we analyse, interpret, and understand it[6]. Because in next decade[7] a large number of sensors already deployed, and it is predicted that the numbers will overgrow. The author Longman [8] defined the term context that is related to something, and that helps you to understand the situation or activity. Also, Sanchez et al. [9] explained the distinction between raw data and context information as follows:

Raw (sensor) data: It is unprocessed and retrieved the data from sensors directly.

Context information: It is generated by processing raw sensor data. Further, it is checked for consistency and metadata is added.

The routing is an essential factor in the communication between the source node to the destination node. The challenging routing issue is low-power and lossy radio-links, multi-hop mesh topologies, the battery supplied nodes and frequently changed network topologies. One of the severe problems of IoT is the provisions of the protocol because it contains multiple types of the network and each device in the network intercommunicate with each other. So many factors are affecting the routing process. Due to it, routing becomes a disreputable NFL (no free lunch) class of algorithm. According to Oladayo Bello et al. [10], an intelligent routing protocol can unleash the central power of any heterogeneous, dynamic, and complex network that is characterised by various influential circumstances such as varying topology and flow. The full functionality of IoT achieved, intelligent protocols required for D2D communication in IoT. Efficient and scalable routing protocols adaptable to different scenarios and network size variations, capable of finding optimal routes are necessary.

2. RELATED WORK

IoT and Wireless sensor network depends on the context-aware system and routing protocol. Context-awareness as a core feature of the pervasive computing system. The characteristic of the context is divided into three categories such as First, acquiring Characteristics related to the acquisition of context, second, user-related Characteristics which focus on the demands of the user, third, consequences Characteristics which follow from the previous two.

2.1 Context-Aware Systems

The context-aware system compared according to the [11][12] it shows in table 3 and for the comparison it consider the following parameters such as Modelling, Reasoning, Distribution, History and Storage, Knowledge Management, Event Detection, Level of Context-Awareness, Data Source Support, Quality of Context, Data Processing, Dynamic Composition, Real-Time Processing and Registry Maintenance and Lookup Services. On this parameters provide the details of these in the literature. Further, explain the parameters in details.

IoT Systems	Context-Aware Features (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Hydra	K,Ow,Ob	R,O	Q	✓	✓	✓	H	P	V	-	-	-	-
COSMOS	Ob	R	Q	-	-	✓	H	P	-	A	✓	-	✓
SALES	M	R	Q	-	-	✓	L	P	-	F	-	-	✓
C-Cast	M	R	P,Q	✓	-	✓	H	A	-	-	-	-	✓
CoMiHoc	Ob	R,P	Q	-	✓	✓	H	A	V	-	-	-	-
MidSen	K	R	P,Q	-	✓	✓	H	P	-	-	-	-	✓
CARISMA	M	R	Q	-	-	-	H	M	C	-	-	-	-
ezContext	K,Ob	R	Q	✓	✓	✓	H	A	-	A	-	-	✓
Feel@Home	G,Os	O	P,Q	-	✓	✓	H	A	-	-	-	-	✓
UbiQuSE	M	R	Q	✓	-	✓	H	A	-	-	-	✓	-
CONASYS	K,M	R	P,Q	✓	✓	✓	H	A	V	F	-	✓	✓

Table 1: Context-aware systems comparison.

2.1.1 Modelling

The context modelling is divided into two parts[13] such as new context information defined in the term of attributes, characteristics and relationship with the existing define context and in second parts the outcome of the first needs to be validated and new context information needs to be merged and added to the existing context information. When the context information is needed, then it is available. The author [14][15] surveyed the most popular context

modelling techniques, and it is based on the following techniques, and each has its advantages and disadvantages.

Key-Value Modelling: The key is provided with every data in this model. The key-value technique is an application-oriented and application limited technique that accommodates the idea of temporary storage. The context information in key-value technique is defined in the different format such as text files and binary files, and it is a straightforward technique to represent the context information. It is easily managed when they have a smaller amount of the data present, but it is not scalable not suitable to store complex data structures.

Markup Scheme Modelling (Tagged Encoding): The Markup Scheme Modelling data using tags and some example of tags can be seen as the fields of an eXtensible Markup Language (XML) file (e.g., <field>). Which is used for the storing the context within the tags and it is better than the key-value modelling technique. Using markup tags is that it allows efficient data retrieval [14]. Markup schemas such as XML are widely used in almost all application domains to store data temporarily, transfer data among applications, and transfer data among application components, and markup languages do not provide significantly advanced abilities to allow reasoning.

Graphical Modelling: In the graphical modelling context are in the form of relationship. The Unified Modelling Language (UML) [16] and Object Role Modelling (ORM) [17] are the examples of the relationship. The low-level representation of the graphical modelling technique could be varied such as the SQL database, NoSQL database and so on.

Object Based Modelling: Object-based (or object-oriented) concepts are used to model data using class hierarchies and relationships, and Object-Oriented paradigm promotes encapsulation and re-usability.

Logic-Based Modelling: The logic based modelling represents the context in the form of facts, expression and rules.

Ontology-Based Modelling: In this model, the context is organised into ontologies using semantic technologies.

Section 2.1. The following abbreviations are used to denote the context modelling techniques employed by the system: key-value modelling (K), markup Schemes (M), graphical modelling (G), object oriented modelling (Ob), logic-based modelling (L), and ontology-based modelling (On).

2.1.2 Reasoning

It is a method of gathering new knowledge based on the available context[18]. It is also explained in high-level context reasoning from the set of context, and it is also called as the inferencing. It is classified into six categories [11][19] such as supervised learning, unsupervised learning, rules[20][21], fuzzy logic[22], ontological reasoning, and probabilistic reasoning. Section 2.2: The following abbreviations are used to denote the reasoning techniques employed by the system: supervised learning (S), un-supervised learning (U), rules (R), fuzzy logic (F), ontology-based (O), and probabilistic reasoning (P). The symbol (X) is used where reasoning functionality is provided but the specific technique is not mentioned.

2.1.3 Distribution

Context distribution is a relatively straightforward task, and It provides methods to deliver context to the consumers. From the consumer perspective, this task can be called context acquisition. Two methods are commonly used in context distribution [11] such as Query and Subscription. Section 2.1 The following abbreviations are used to denote the distribution techniques employed by the system: publish/subscribe (P) and query (Q).

2.1.4 History and Storage

It is essential in both cases regular context-aware computing and IoT[23] and historical data used because for getting the exact information. According to the historical data such as user behaviours, preferences, patterns, trends, needs, and many more for understanding. The symbol (✓) is used to express that context history functionality is facilitated and employed by the system.

2.1.5 Knowledge Management

The knowledge is essential for the various task performed in the IoT middleware solutions such as knowledge of sensors, domains, users, activities, time or defines the 5 W's. It is used for tasks such as the automatic configuration of sensors to IoT middleware, automatic sensor data annotation, reasoning, and event detection. The symbol (✓) is used to denote that knowledge management functionality is facilitated and employed by the system in some perspective.

2.1.6 Event Detection

In the IoT network, the communication between the machine to machine and machine to a person are based on the, and it is also called as the triggers. In most of the events are also depends upon the historical data for getting the exact knowledge. The symbol (✓) is used to denote that event detection functionality is facilitated and employed by the system in some perspective.

2.1.7 Level of Context Awareness

The level of the context-aware is depended upon two levels such as the hardware or low level and software or high level. In the low-level context-awareness is used to promote tasks such as efficient routing, modelling, reasoning, storage and event detection [24] and in the high-level access to a broader range of data and knowledge as well as more resources, which enables more complex reasoning to be done. Section 2.1 some abbreviation is used for the defining the low-level (L) and high-level (H).

2.1.8 Data Source Support

Different sources are capable of providing context such as (P) denotes supports from only physical sensors, Software sensors (S) denotes supports from either virtual sensors, logical sensors or both, (A) denotes that the solution supports all kinds of data sources (i.e. physical, virtual, and logical) and (M) denotes that the supports from the mobile sensors.

2.1.9 Quality of Context

The quality of the context is denoted by two parts conflict resolution functionality (C) and context validation functionality (V). The Conflict resolution is critical in the context management domain [25], and second, it ensures that collected data is correct and meaningful. The quality of the context depends upon some parameters such as range, limit, logic, data type, cross-system consistency, uniqueness, cardinality, consistency, data source quality, security, and privacy.

2.1.10 Data Processing

Data processing denotes the behaviour of context aggregation functionality (A) and context filter functionality (F). The context aggregation it is easy forms to collect similar information together, and Context filter functionality makes sure the reasoning engine processes only essential data.

2.1.11 Dynamic Composition

The programming is essential in IoT middleware solution that dynamic composition without requiring the developer or user to identify specific sensors and devices. It can understand the requirements and demands of each situation and organize according to them. The symbol (✓) denotes the presence of dynamic composition functionality in the system in some form.

2.1.12 Real Time Processing

In the IoT, it is processed or interact by the real time. It is an essential factor in the context-aware system. The symbol (✓) denotes the presence of real-time processing.

2.1.13 Registry Maintenance and Lookup Services

The (✓) symbol is used to denote the presence of registry maintenance and lookup services functionality in the systems, and this functionality provides different elements such as context sources, data fusion operators, knowledge bases, and context consumers to be registered.

2.2 Routing Protocol in Internet of Things (IoT)

Table 2 shows the various routing protocol with advantages and disadvantages[26].

Protocol	Virtue	Shortcoming
AOMDV-IoT	i. It maintains the internet connection table for details of the next node. ii. communication between two node is depend upon the four message.	i. It does not provide any security mechanism in the data routing. ii. Not understand the context and not optimise its routing path. iii. It routes the data based on minimal hop count but which may not be necessarily energy efficient solution. iv. It stores the information of only one possible route towards the specified destination which may increase the delay and failure rate of data delivery in case of link failure.
SMRP	i. SMRP is a multi-hop protocol. ii. It provides the security to the data from the malicious attacks, and the security is	i. It is not context aware protocol, and it does not conserve the energy of the nodes while routing due to that it may result in less network lifetime. ii. It requires more

	enhanced by scrambling the sequence of the 'reserved' bits in the HELLO message.	memory for the store the encrypted file on every device and the encrypted file size is depends upon the device in the network. If the device is less on the network it requires the small in size but the device increases the EF also increase, and it requires more memory. ii. The number of the device in the IoT network depends upon the owners and need to be specified before the actual network formed.
EARA	i. It is context-aware routing protocol and multihop.	i. Security of data is not considered. ii. The threshold value of the change in energy may affect the performance of it.
RPL	i. It does not require translation gateways for accessing the nodes within the network from outside world it is based on the end to end IP. ii. It dynamically adapts the sending rate of the routing control messages which will frequently be generated only if the network is in unstable condition. iii. It allows optimisation of the network for different application scenarios and deployment.	i. It does not support multipath routing. ii. In IoT network the energy balancing and load balancing are not taken into consideration.
Multi-parent routing in RPL	i. It supports the multipath routing to improve the fault tolerance, congestion avoidance and quality of the service. ii. It also increases the network lifetime by balancing the traffic load amongst multiple parents.	i. If energy is low then life of the network is poor. ii. Rouitng is depend upon the energy level.
PAIR	i. It is multihop and contexts-aware routing protocol. ii. It solves the handshaking between the nodes of the heterogeneous network by trying to give some incentive to the relying node.	i. The security attributes is not considered. ii. It requires more memory as compared to buffer capacity if the alternate path is finding when the link break is accrued in the communication.
REL	i. For the link to the routing, it considers the link of quality. ii. The link quality is good then more chance of successful packet delivery, which saves more energy. iii. The excessive use of single path or single node is avoided because of the load balancing mechanism.	i. It is based on the energy and link quality. ii. Path is selected form the two values.

3. PROPOSED WORK

3.1 Development of Context-based Routing Protocol (CRP)

CRP is a distance vector routing protocol for IoT that makes use of ICMPv6. The term distance vector refers to the fact that the protocol manipulates vectors (arrays) of distances to other nodes in the network devices running the protocol are connected in such a way that no cycles are present. It is an Intra-domain routing protocol. It requires that a router inform its neighbours of topology changes periodically and have less computational complexity and message overhead. Distance-vector routing protocols are based on calculating the Direction and Distance to any link in a network[27].

- "Direction" usually means the next hop address and the exit interface.
- "Distance" is a measure of the cost to reach a particular node.
- The least cost route between any two nodes is the route with minimum distance.
- Each node maintains a vector (table) of minimum distance to every node.
- The cost of reaching a destination is calculated using various route metrics

For this purpose, a Destination Oriented Directed Acyclic Graph (DODAG), which is routed at a particular destination, is built. The CRP term calls this specific node a DODAG root and the graph is constructed by the use of an Objective Function (OF) which determines how the routing metric is determined. In other words, the OF defines how routing limitations and other functions are taken into account during topology configuration. In unusual cases, a network has to be optimised for different application outlines and deployments. For illustration, a DODAG may be constructed in a way where the Expected Number of Transmissions (ETX) or where the current amount of battery power of a node is considered. For this reason, CRP allows building a logical routing topology over an existing physical infrastructure and context id. It specifies the so-called CRP Instance which defines an OF for a set of one or more DODAGs.

The protocol examines to avoid routing loops by computing a node's position relative to other nodes concerning the DODAG root. This position is called a Rank and improves if nodes go away from the root and decreases when nodes move in the other direction, respectively. The Rank may be equal to a fair hop-count distance, may be calculated as a function of the routing metric or it may be calculated concerning other constraints. The CRP specification defines four types of control messages for topology maintenance and information exchange. The first one is called DODAG Information Object (DIO) and is the primary source of routing control information. It may store information like the current Rank of a node, the current CRP Instance, the ICMPv6 address of the root, and so on. The second one is called a Destination Advertisement Object (DAO). It allows the support of down traffic and is used to generate destination data upwards along the DODAG. The third one is named DODAG Information Solicitation (DIS) and makes it possible for a node to require DIO messages from a reachable neighbour. The fourth type is a DAO-ACK and is assigned by a DAO recipient in response to a DAO message. The CRP specification defines all four types of control messages as ICMPv6 information messages with a requested type of 155. This new type has been officially confirmed by IANA [28].

Another important consideration about the protocol's design is the maintenance of the topology. Since most of the devices in a LAN are typically battery powered, it is essential to restrict the amount of sent control messages over the network. Several other routing protocols broadcast control packets at a fixed time interval which causes energy to be wasted when the network is in a stable condition.

The figure shows the DODAG root, and above the root, there is a context routing engine for processing of the fuzzification and defuzzification of the knowledge.

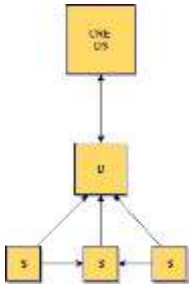

Figure 1: DODAG

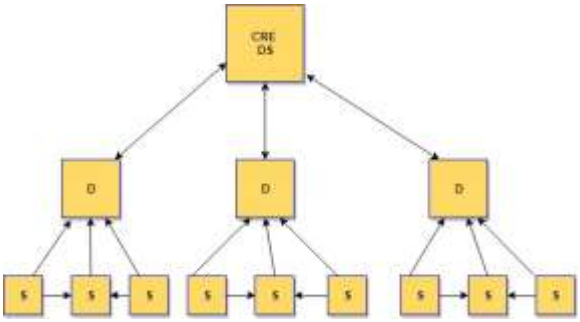

Figure 2: DAG

The following table 3 shows the comparative analysis of the existing protocol and the propose protocol i.e. context based routing protocol[26].

Protocol	**Context aware**	**Secure**	**Multi-hop routing**	**Supports dynamic topology**	**Incentive based**	**Considers Link quality**
AOMDV-IoT	No	No	Yes		No	No
SMRP	No	Yes	Yes		No	No
EARA	Yes	No	Yes		No	No
RPL	Yes	Yes	Yes	Yes	No	No
Multi-parent routing in RPL	Yes	No	Yes	Yes	No	No
PAIR	Yes	No	Yes	Yes	Yes	No
REL	Yes	No	Yes		No	Yes
CRP (Propose Protocol)	Yes	Yes	Yes	Yes	Yes	Yes

4. CONCLUSION

IoT is going to offer the vast number of application in the various platforms. It generates the vast amount of data. There is a various problem regarding the generated data such as its storage, ownership, security, expiry and routing. In routing challenging issue is low-power and lossy radio-links, multi-hop mesh topologies, the battery supplied nodes and frequently changed network topologies.

In this survey, we are focused on the different context-aware system which depends upon the various parameters, and the Context-aware system plays a vital role in the IoT because of the huge number of the data available, and protocol is the heart of the communication between the source node to the destination node. In this paper, we studied the different types of the context-aware system and different types of the protocol. Furthermore, we will also discuss the how the proposed system is developing according to the context-aware and protocol.

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