A New Conception of Information Requisition in Web of Things

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Abstract

Objectives: The dynamic spanning tree approach from Requester Node to Responder Node has been proposed for WoT for information requisition. The objective is to eliminate data redundancy in multipath communication. Methods: A spanning tree algorithm has been proposed to create a dynamic single path from Requester Node (RN) to Responding Node (ReN) in WoT Graph. Before actual communication a virtual path is established between RN and ReN which helps in the reduction of multipaths, cycles and data duplicacy. Findings: The approach is implemented and tested on different scenarios of WoT graphs in NS-2 simulator and shows good results in terms of information requisition. In a WoT graph communication multiple path exists between sender and receiver nodes causing duplicate data packets and high traffic intensity in the network, while in WoT spanning tree there is a single path. Therefore, the network throughput and the efficiency increases manifold. Application: The rapid growth of WoT enabled internet applications, decision making, marketing, healthcare, monitoring and interlinked controlled devices generates high demand for reliable and timely information.

Keywords: Communication, Data Redundancy, Information Requisition, Sensors, Web of Things

1. Introduction

Web-of-things (WoT) is a physical network of several components like vehicles, business, gadgets, devices, etc. The interconnection is due to software interfaces, sensors and networking components. The devices have the capability to identify, sense the information within definite time and can send it to neighboring devices. Hence, WoT makes possible a direct interface between the real world and virtual world. WoT with embedded actuators provides emerging technologies like smart cities, intelligent medical system, smart transportation system, smart homes and intelligent business needs. WoT, thus gives a hub of interconnected devices or service as machine to machine communication having various protocols, applications and different domains.

1.1 Market Trends in WoT

CISCO imagined a market of approximately 50 billion interconnected objects by 2020[^2]. The economic worth obtained by this market suppose to be $19,000 B. The estimated revenues are $180 B in 2014 and could reach up to $1,003 B by 2020. The study of Frost and Sullivan states the estimation of connected living objects as $732 B by 2020. The interconnection is of business, service providers, manufacturers, vehicles and other sectors. IDC updated its 2014-2020 outlook on WoT at high level $1900 B in 2013 and $7100 B in 2020. This growth focuses on general public usage products and infrastructure. WoT is expected to become 212 B objects by 2020[^3]. An interconnected scenario of WoT is shown in Figure 1.

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2. Graphical View of WoT

With the invention of WoT with internet connected devices lead to generation of huge amount of information for some specific purpose. This information somehow needs to be indexed, stored and processed in an effective manner. The interconnection and information addressing in WoT can be viewed as a graph of object, where each object can work as “Requester Node” asking for some relevant information or “Service Provider” for providing some information to other objects. The WoT connection architecture with real objects can be realized in Figure 2 and can be represented as graph shown in Figure 3.
3. Information Requisition Concept in WoT Graph

A WoT graph $G(V, E)$ is an ordered graph with $V$ vertices and $E$ number of edges. Here, $V$ is a non-empty and the finite set of real objects and $E$ is a set of unordered pairs of different edges. Edges are defined by any two vertex $v_i$ and $v_j$ such that $v_i, v_j \in E$ and each edges $e \in E$.

$V = \{v_1, v_2, v_3, \ldots, v_n\}$

$E = \{e_1, e_2, e_3, \ldots, e_n\}$

Here vertices are nothing but WoT objects (sensor) node. And the edges are the links between these sensor nodes. Any vertex in the graph can work as “Requester Node (RN)” and can ask for some relevant information from other connected nodes. The information requisition process in the graph involves creation of spanning tree ($T = (V, E)$) by considering RN, as the root of the tree. The spanning tree helps in elimination of cycles, data redundancy and loops in information retrieval in the graph $G$ at any node. The spanning tree creation algorithm must run on to each RN whenever any information is demanded by it. The process of information requisition thus can be stated in two steps:

- Creation of Spanning Tree at RN.
- Information Requisition process at RN.

3.1 Creation of Spanning Tree at RN

Any sensor in the graph can work as RN node at any time. Before capturing any information from other nodes, the RN node should construct a spanning tree with all interconnected sensor nodes. The algorithm for spanning tree construction is shown in Algorithm 1.

The spanning tree for the graph in Figure 3 can be converted to the spanning tree by using Algorithm 1. Any node in the graph can work as RN (root) of the tree. The location of the interconnected objects is fixed and hence acting as fixed sensor nodes while the RN is rotating in the graph. As an example, different spanning tree with different RNs are depicted in Figure 4 to Figure 8.
Algorithm 1. Spanning tree

Requester_Node = {0};
Other_Node = \{v_1,v_2,v_3, \ldots, v_{n-1}\};
Spanning tree = {};
While ( Other_Node not equal to empty)
{
Find link or edge e = ( l, m )
l\in Requester_Node
m\in Other_Node
e has minimum distance
Spanning_tree = Spanning_tree \cup \{e\};
Requester_Node = Requester_Node \cup \{m\};
Other_Node = Other_Node – \{m\};
}

Figure 4. Spanning tree with RN = 45.

Figure 5. Spanning tree with RN = 15.
3.2 Information Requisition Process at RN

The pseudo code for data requisition in the spanning tree is written in Algorithm 2. The data requisition at RN takes place in multi-hop sequence, i.e. from leaf node to the RN node with a path obtained in the spanning tree.
4. Discussion and Further Research Directions

Due to the cheap embedded system, millions of interconnected devices expose what they sense, detect, listen and observe from the real world through internet. With Web of Things devices communicate together for sharing information to their nearby stations or to far-flung servers. The software and sensors are performing these operations in a more efficient way. WoT has changed the picture how a human interacts with the real world. A human talk to televisions, computers, vehicles and other device through voice processing chip and embedded sensors. Health sensors send and receive data from doctors and hospitals and hence interfacing digital and physical world. In with the invention of smart phones an always-on, mobile and almost free connectivity, networking, portable and inexpensive computing, easy handling is possible. This leads to government, companies and individuals to find and use any kind of information on WoT. In

| Algorithm 2: Information Requisition at RN |
|------------------------------------------|
| 1: T = (VT, ET), VT = V, ET ← Null       |
| 2: //v is no. of nodes                   |
| 3: //s is sensor node                    |
| 4: R is requester node                   |
| 5: for i←1 to v-1                        |
| 6: If v equal to leaf()                  |
| 7: for k←1 to max (depth)               |
|   //depth is the height of the spanning tree |
| 8: mark the node s as the visited node   |
| 9: find its parent p(s)                  |
| 10: if p(s) equal to R                   |
| 11: data aggregate                       |
| 12: break;                               |
| 13: end if                               |
| 14: end for                              |
| 15: end if                               |
| 16: end for                              |
| 17: return T                             |
WoT is promising the concept of “smart” everything. It is a key part of smart building, smart transportation, smart cites and any other smart proposal. For a consumer wearable WoT devices are opening a new direction of interest. The health or medical field is the most benefited area of WoT wearable’s as they sense and collect data of concern and send it to the servers. The Government is in more need of WoT collected data for policy making, decision making and fine tuning of various government services. Likely industries are interested in data obtained from WoT as embedded intelligence, knowledge and in decision making. Manufacturing companies are also taking advent of WoT in implementing robotics systems, tooling, guiding sensors and many more along with human operators. Though, many emerging technologies are making WoT more reliable, high speed connectivity, low latency and reliable data network, yet several challenges need to be addressed on WoT like: Security of data on WoT, Indexing of data, Fast information retrieval, Searching of information on WoT, Data collection and aggregation and many more. Thus, in this article a new approach for information requisition has been proposed in WoT. Since WoT is a graph of interconnected objects, information retrieval at any node can cause redundancy and duplication of data. To eliminate these problems a spanning tree approach has been suggested. In the approach any object in the connected graph can work as requester node and can demand for any relevant information from internet. Since WoT is an interconnection of real objects any of the nodes in the network can respond back to the requester node. The demanded information reaches the RN node through multipath routes and causes increased traffic, cycle and redundancy in the network. Therefore, before requesting a information the RN should find the attached server nodes in the nearby location and creates the spanning tree, by nominating itself as root node. The approach thus, opens a new area of investigation in terms of dynamic routing of information, node selection and multi-path routing and dynamic tree creation.

5. References

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