The mixed telemetry/image USN in the overload conditions

Ammar Muthanna*, Andrey Prokopiev**, Andrey Koucheryavy***

* State University of Telecommunication, Pr. Bolshevikov, 22, St.Petersburg, Russia
**UbiTel, Ruzovskaya, 21, St.Petersburg, Russia
***Central Science Research Telecommunication Institute, First Proezd Perova Polya, 8, Moscow. Russia

ammarexpress@gmail.com, a.prokopiev@ubitel.ru, akouch@mail.ru

Abstract — The Internet of Things (IoT) is a new concept for telecommunication development. The IoT and things determinations are considering in accordance the ITU-T recommendations. The Ubiquitous Sensor Network (USN) is one of the general IoT components. The traffic models for such network are the important field of research presently. The mixed telemetry/image USN behavior in the overload conditions is the investigation goal of this paper. This investigated USN is multi-application network with AODV (Ad Hoc On Demand Distance Vector) signaling protocol. The paper results show that the USN efficiency can reduce in the overload conditions likely the same effect for the PSTN and NGN networks.

Keywords— IoT, USN traffic, image applications, Hurst parameter

I. INTRODUCTION

The Internet of Things (IoT) is the new ITU-T concept for the network development. The IoT will be based on the Ubiquitous Sensor Network (USN) [1, 2]. So the USN traffic models should be studied well. The USN traffic models considered for telemetry applications in [3], for medical applications in [4]. The image applications are very special for USN in accordance with the necessary big data capacity for transmission and rates. Usually, the USN for the image applications includes the telemetry sensor nodes too. The USN traffic models for mixed telemetry/image application were studied in [5].

II. SIMULATION MODEL AND TOOLS

Two types nodes randomly located in the network. The first type of sensors is nodes that gathering telemetry data, whose task is to transfer small amounts of data with a given period. The transmission frequency is determined for each node type accidentally ranges of 15-60 seconds in steps of 15 seconds. The second type of sensor node is transmitting images. Each

distribution that was confirmed by Kolmogorov–Smirnov criteria.

The mixed telemetry/image USN behaviour in the overload conditions is the investigation goal of this paper. The Hurst coefficient as a function of the nodes number for differences ratio between telemetry and image nodes are obtained by simulation in the ns-2 system. The image nodes share decreases adduce to the decrease the Hurst parameter value at the first step. The Hurst parameter value reduces this then the image nodes share will be too much. It proves that the USN efficiency can reduce in the overload conditions likely the same effect for the PSTN [12] and NGN networks [13].

The results can be enhanced to M2M networks [14].

This article is divided into several parts. The first part presents the results of modelling the USN during increasing the number of nodes - sources of image data. The second part is devoted to the scenario with increasing the number of telemetry nodes, while the sensor field and the number of nodes - sources of image data don’t changing. The last part presents conclusions and the future work.
of these nodes transmits at a random time interval batch of packets that simulate the transfer of photos size of 640x480 pixels. The amount of data transmitted is randomly selected based on the evaluation of the results get in previous works [5].

The Network simulator 2 system was used for modelling. TCL scripts are generated by scripts in the Python programming language.

III. OVERLOADING BY IMAGE DATA

In order to analyse the changes of the Hurst coefficient while changing of number of nodes several tests were performed. Maintaining the total number of nodes equal to 55, authors gradually increasing the number of nodes - sources of image data. The number of nodes varied from 5 to 53 in steps of 2.

The simulation results for selected scenarios with random variables cannot be used to evaluate, so every type of scenario was performed 100 times and the average Hurst coefficient used calculated.

The simulation results are shown in Figure 1, the results for black and white images show as 'x' and for colour - as 'o'.

As we can see, parabola can be used as a function. Using the mathematical capabilities of the library NumPy the curve parameters were get for the black-and-white and color images. The results are presented in Figure 2 and 3 respectively.

The overload condition is a state when the network can’t handle fully photo transfer. It is easily seen that the Hurst coefficient reaches its maximum in about 30 nodes - transmitters. It's clear that the result of changes in the structure of traffic, and therefore the Hurst coefficient changes caused by network overloading.

We can use the Hurst parameter derivative further. If it is greater than zero means Hurst coefficient is growing and has not reached its maximum. In the case of a negative value of the derivative, we can talk about the problems in the sensor network.

So, the overload control can be made by the Hurst parameter functions derivatives value change. For example we can handle batch of traffic and save calculated Hurst parameters during the time line. Based on Spencer’s formulas we can choose the basis of the calculated parameter is it random or matches the distribution. After the derivative changes sign the overload conditions can be defined.
IV. OVERLOADING BY TELEMETRY DATA

Second case, examined by authors is an increase the number of nodes collecting telemetry data, while maintaining the size of the sensor field and the number of nodes that transmit the image data don’t changing. For this simulation were performed scenarios with increasing total amount of nodes from 20 to 150 for scenarios with 5, 10, 15 and 20 nodes - image sources. Each scenario was execute 100 times.

The simulation results for a 5 nodes transmit images are shown in the Figure 4. The results for black and white images are shown as ‘x’ and for color as ‘o’.

![Figure 4. The Hurst coefficient as a function from number of telemetry transmitters](image)

While increasing the number of nodes - sources of telemetry data, load created by nodes - sources of photo ceases to affect the overall structure of the load and the coefficient of Hurst stabilized. The log(1/x) function can be used. Comparative characteristics for black-and-white images are shown in the Figure 5 and in the Figure 6 for color images. As the number of photo sources and in consequence of the amount of the transmitted load, Hurst coefficient has lower values on all the investigated intervals.

![Figure 5. The Hurst coefficient approximation for different number of black and white photo transmitters](image)

![Figure 6. The Hurst coefficient approximation for different number of color photo transmitters](image)

Analyzing the results we can see that the presence of photo traffic lead to bigger value of Hurst coefficient. The increasing the number of telemetry nodes contribution of photo nodes becomes not significant and value of Hurst coefficient decreasing.

V. CONCLUSIONS

It proves that the USN efficiency can reduce in the overload conditions likely the same effect for the PSTN and NGN networks.

The Hurst coefficient reaches its maximum in about 30 nodes - transmitters. It’s clear that the result of changes in the structure of traffic, and therefore the Hurst coefficient changes caused by network overloading. The Hurst coefficient functions derivatives can be used for the USN overload detection.

The photo traffic in mixed USN network has a bigger value of Hurst coefficient. The increasing of the number of telemetry nodes contribution of photo nodes becomes not significant.

The routing in the USN is developed further. The new routing protocol RPL (Routing Protocol for Low energy and lossy networks) [15] became the standard protocol for USN networks. This protocol is designed for IPv6 low power and lossy networks. The directed acyclic graphs are the base for RPL.

Each connection in the RPL network is described by set of metrics such as bit rate, power consumption, encryption support, etc., based on which acyclic graphs are created. In one network possible to create multiple graphs and the node will transmit data depending on the purpose of the data. The graphs for telemetry and image data transmission can be organized by most energy efficient way in the RPL networks.

The future works will include traffic models in the mixed USN network with RPL protocol investigation.
REFERENCES


A.Muthanna was born in Lahj, Yemen 01.01.1984. Graduated from St. Petersburg State University of Telecommunications in 2009 bachelor’s degree and in 2011 master’s degree. He is PhD student at“Telecommunication Networks” department. A.Muthanna’s scientific areas of interest are traffic models for ubiquitous sensor networks. In 2012/2013 he take part in Erasmus student program in the University of Ljubljaran in Faculty of Electrical engineering.

A.Prokopiev was born in small Siberian town Angarsk 11.12.1983. He was studied in St. Petersburg State University of Telecommunication. In 2006 he received Engineer degree. He became PhD in 2012. After graduating A.Prokopiev works in a small company targeting on the market of wireless sensor networks (WSN), radio frequency identification (RFID) and real-time location system (RTLS). Starting with Engineer position in 2007, right now he became Head of technical department. Scope of interests includes Ubiquitous Sensor Networks and RTLS systems. Papers of A. Prokopiev published in science journals in Russia and discussed on international conferences. He is also co-author of book dedicated to wireless self-similar networks.

A.Koucheryavy was born in Leningrad 02.02.1952. After graduated from Leningrad University of Telecommunication in 1974 he going to Telecommunication Research Institute named LONIIS, where A.Koucheryavy working up to October 2003 (from 1986 up to 2003 as the First Deputy Director ). He became the Ph.D and D.Sc in 1982 and 1994 respectively. A.Koucheryavy is the St. Petersburg State University of Telecommunication (SUT) professor from 1998. He is SUT department “Telecommunication Networks” chief from 2011. Prof. A.Koucheryavy is the advisor of the Central Science Research Telecommunication Institute and St. Petersburg Branch of “GIPROSVYAZ” Institute simultaneously. He is honorary member of A.S.Popov society. Prof. A.Koucheryavy was the vice-chairman Study Group 11 ITU-T (Study periods 2005-2008, 2009-2012 ). His scientific areas of interest are the network planning, teletraffic theory, IoT and its enablers.