

PROBLEM OF PACKET LOSS IN WIRELESSHART NETWORK

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ABSTRACT

The problem of packet loss in wireless networks is considered and described in the paper. An introduction to the main causes of the problem are described first. Then the behaviour of different wireless protocols (Wlan, ZigBee, WirelessHART) is presented and described. Some possible techniques to reduce the effects of packets loss in a wirelessHART networked control system are analyzed in the last section.

Keywords: WirelessHART Network, Communication protocol, Wireless Network

1. INTRODUCTION

Usage of wireless communications in network managing systems has the large number of advantages. Firstly, the setting up of wireless sensors is fast and cheap. Mainly, because of absence of cables between the sensor and acquisition system and because of the constant price reduction of equipment for the wireless connecting. Also, absence of cables gives larger freedom, for example sensor installed on the industrial manipulator. Price which is paid for usage of wireless networks is the smaller reliability, in other words the communication canal (radio frequency range) may be attacked by direct interference from other networks which work on same frequencies, and this interference and other noise sources lead to the error in the transmission of bits and losses of packages. Loss of packages may be caused by different factors:

- Interference of canals.
- Weakening of canal.
- Collision of packages transferred by more knots at the same time.

2. CAUSES OF LOSS OF PACKAGES

2.1. Interference of canals

It is necessary to mention that interference primarily appears because of influence of other networks which work in the same frequency range. Wireless network protocols, as are Wlan, ZigBee and WirelessHART, all work in the same ISM range (2,4 - 2,5 GHz). In order to limit packages lost because of the network interference, it is necessary good settings of knots as the function of measured values of noise [2]. Main characteristics of these three protocols are shown in Table 1.

2.2. Problem of weakening

Weakening is phenomenon which happens when in the wireless communication presence of barriers between radio transmitter and receiver creates the more paths for the transferred signal. The accepted signal is therefore composition of more copies of transferred signal which arrive in different time intervals. Every copy of signals has different suppression, delay and offset of phases in respect to different ways from radio transmitter to receiver [3]. The main effect of this phenomenon is the changing of intensity of signal on the receiver. There are two kinds of weakening: slowly and fast weakening. The first is variation in intensity of signal which is changed in time, while the fast weakening is variation of amplitude of signal which changes fast. The correct way of avoiding of problems of weakening is the technique of frequency jumping, because in this way it is possible to reconstruct accepted signal without errors.

2.3. Packages lost during collision

The last cause of loss of packages depends on the MAC protocol that is used in the wireless connection, and the collision can appear between messages which are sent in the same time. It will be considered protocol for the multicellular access to the carrier of signal with possibility of avoiding of collision CSMA/CA that is used in 802.11 standard. In this protocol when the knot needs to transmit it firstly checks the medium in order to convince that the neither other knot performed emission and if the canal is free, then performs transfer of the package. In another case, knot is performing randomly the choosing of back-off factor which determines the time of waiting in order to be permitted the sending of package. During the period when the canal is free, knot which is performed emission decrements its back-off counter, and when the canal is occupied knot does not decrement back-off counter. The knot transfers package when the back-off factor reaches the zero value [2]. Avoiding of collision decreases the possibility of its appearance, but it is not possible to determine the collision if it appears. In fact, determining of collision how it is determined by the Ethernet, may not be applied in the radio frequency transmission IEEE 802.11, because the knot when is emitting is not able to hear neither other knot in the system which may be also emitting signal. If the source knot does not accept ACK because of the collision, reactivates the back-off algorithm in order to come to repeated transfer of message, and if the number of collisions exceeds the maximal number of the repeated transfers i.e. the retransmissions, the package is lost.

3. PROBLEM OF LOSS OF PACKAGES IN NETWORK MANAGING SYSTEMS

Increase of network managing systems is directly related to the spectacular development of communication networks in industrial applications, which strongly are presumed on the characteristic of communication canal.

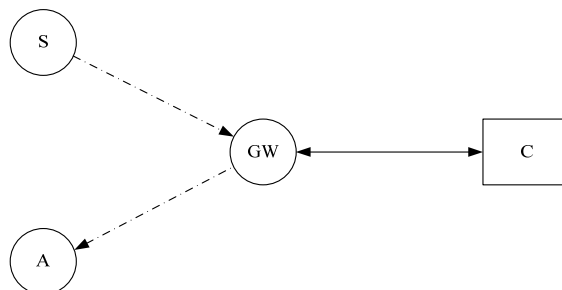


Figure 1. Scheme of communication between appliances

In the Fig. 1. it is presented sensor which sends readings off to the controller which conditions the signal and sends it to actuator, and both communications are enabled by the wireless connecting. It is possible that comes to the loss of packages in both directions of communication: from the sensor towards the controller and from the controller towards the sensor. If packages are lost in the first direction of communication the controller has no feedback from the process and managing signal will be analyzed

taking into account the loss of data and will try to establish the lost data. If it comes to the loss on the occasion of the data transfer in the other direction it is needed actuator which can remember and use the previous value of managing signal [3].

3.1. Comparison of wireless networks protocols

Here is presented the comparison between wireless networks which use the different MAC protocols. The aim is to presents behavior of the different wireless protocols used in managing systems. Protocols which function in the same range (the ISM range 2.4 GHz):

- WLAN,
- ZigBe and
- WirelessHART.

The wireless LAN protocol is defined by the IEEE 802.11. ZigBee is the technology of the wireless communications with small consumption and presents the standard international protocol which uses physical and MAC layers defined by the IEEE 802.15.4 what is the standard of the wireless communications of short distance for range 2,4 GHz. WirelessHART makes possible cheap and relatively slow, for example in the comparison with 802.11g, wireless connection with HART enabled appliances [2]. WirelessHart communication is time divided, where every slot is of 10 ms, and time blocks can be intended to once knot and use TDMA, or can be divided between more knots and use CSMA/CA. Main characteristics of these three protocols are describe in the Table 1.

Table 1. Main characteristics of WLAN, ZigBee and WirelessHART-a

| | WLAN | ZigBee | WirelessHART |
|----------------|---------------|---------------|--------------|
| Data Rate | 2-54 Mb/s | 20-250 kb/s | 250 kb/s |
| Packet length | 34-2346 bytes | 128 bytes | 128 bytes |
| Freq. hop. | YES | Not specified | YES |
| Power Consump. | high | low | low |

4. ADJUSTING AND RESULTS OF SIMULATIONS

To analyze diversely of the behavior of the three protocols in the industrial plant it will be presented simulation of networked managing system whose scheme is shown in the Fig.2. All the simulations are performed in Simulink surrounding using the modified TrueTime simulator [1].

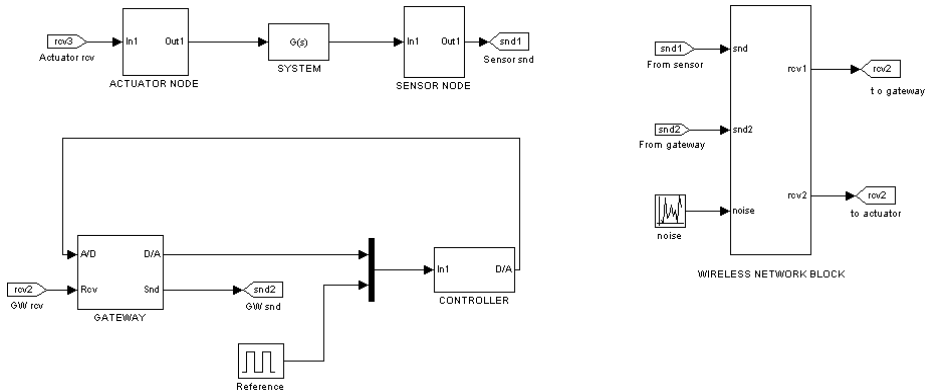


Figure 2. Simulink scheme of network control system

In this managing system it is only one loop in which sensor sends readings off to gateway which is responsible for communication with the controller using the protocol for the wire data transfer and for the sending managing signal to the actuator using the wireless network, like on the Fig.1.

During choice of the transfer function of system which WirelessHART can control only are processes which have time constant at least of tenths of milliseconds. This is imposed by the MAC protocol which uses TDMA with time intervals of 10 ms. In every interval it is possible only one transfer (in the frame of the same canal) so that, when it is spoken about the managing system, the smallest delay between reading off and excitation is 20 ms. It is possible if the task of actuators executes immediately after the task of sensors, like in Fig.3. In the first time period sensor (S) sends readings off to the gateway (the GW) and in the second time period gateway sends the managing signal to the actuator. Controller (C) executes the command between time periods of duration of tasks of sensor and actuator[1].

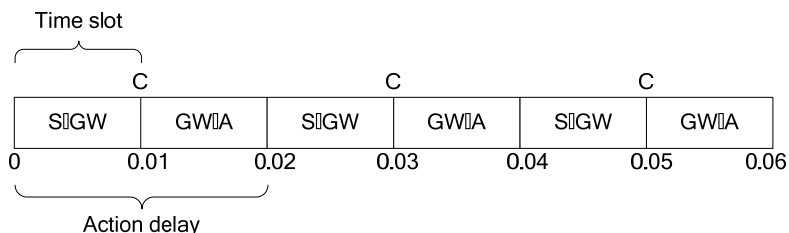


Figure 3. Illustration of communication delay in WirelessHART -u.

From the Fig.4. it can be noticed that the controller is not needed time space for the execution of task. That is because of the fact that the controller with gateway communicates across the wire. If it is the run time of task of controller equal to the total time period (10 ms), the best is gives one free period between the reading off and reaction in order to enable that the controller finishes its calculations. The output is the square wave with the amplitude 1, time period of 5 seconds and working cycle of 50%, and the used PID-controller[1].

5. CONCLUSIONS

Result of quantity of lost packages for the every protocol is that ZigBee protocol is realized highest losses of packages. This happens because of the need to use smaller strength of sent signal in order to extend the duration batteries of the appliance. In fact, smaller strength of sent signal gives the smaller ratio of signal/noise what means that it is larger possibility of loss of package. WLAN has the best behavior towards the number of lost packages, but the consumption is very large so that the life cycle of batteries of appliances is to short. Aside from this, these protocols are not deterministic because of the usage of CSMA/CA MAC of protocol, in other words the neither appliance does not know when transfer will be realized because its message can collide with messages of other appliances and transfer may be slowed down i.e. are hampered. If the number of appliances in the network grows, increases also possibility of collisions, increasing also possibility of losing of packages. The good exchange is presented by the use of WirelessHART and TDMA technique, so that every appliance knows the time period in which message will be sent and collision will not appear, and the possibility of losing of packages is equal zero. TDMA technique permits communication with small strength of supply because appliances are active only in the period of communication. Per contra, in order to use WirelessHART in the network managing system it is necessary to check if the managing system has the time constant of tenths of milliseconds, and if the system is faster then the WirelessHART can not be used.

6. REFERENCES

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