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TECHNICAL CHARACTERISTICS OF WIRELESSHART NETWORK

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ABSTRACT
The WirelessHART protocol is considered and described in the paper. An introduction to the protocol with the main information and the technical characteristics of WirelessHART is described first. Then the structure of the MAC is deeply explained, and a more exhaustive description of the communication protocol is presented and described.
Keywords: WirelessHART Network, Communication Protocol, Wireless Network

1. INTRODUCTION

WirelessHart protocol has relatively low speed of data transfer in the comparison with the IEEE 802.11b standard for computer wireless networks. This protocol works on the frequency of 2.4GHz in the ISM radio range using TDMA (Time Division Multiple Access) technique for access to communication medium [1]. WirelessHart has been the communication protocol which is organized like the ISO/the OSI 7 communication model. The complete time of communication is execute inside predetermined time slot of 10 ms. Set of the time slots form superframes for the data transfer and WirelessHart makes possible the jumping between communication canals in order to avoid interference and reduce multi-path fading effect. One or more appliance which send and which accept data can be determined to communicate mutually in one predetermined time slot [2]. In the Fig.1 it is presented the basic structure of WirelessHART network with obligatory components:

- WirelessHART Field Devices (WFD) that are connected towards processes or towards the plant equipment.
- WirelessHART Gateways that make possible communication between the host application and WFDs.
- WirelessHART Network Managers that are responsible for the configuration of network, i.e. arrange communication between WirelessHART appliances, manage routing and report about accuracy of WirelessHART network.

2. DESCRIPTION OF WIRELESSHART MAC PROTOCOL

The main task of WirelessHart MAC protocol is:

1. Synchronization of slots.
2. Identification of appliance which demands access to transfer medium.

3. Transfer of messages accepted from the network layer.
4. Eavesdropping of transfer of packages of neighboring knots.

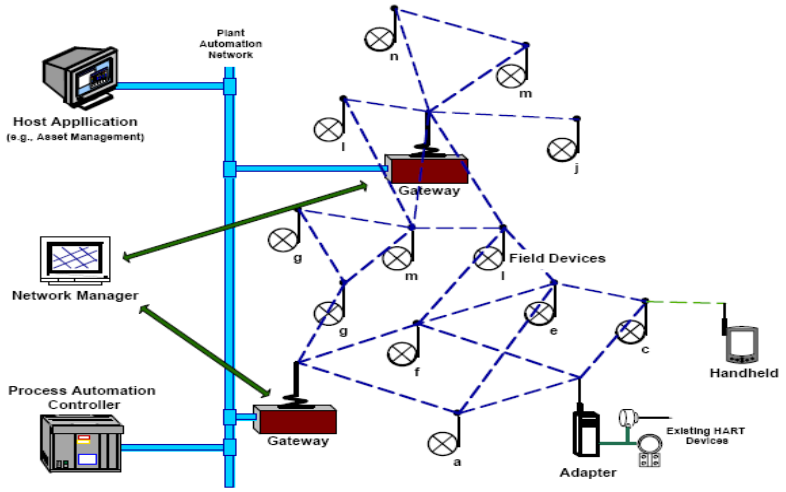

Figure 1. Structure of WirelessHART network

When the appliance wants to transfer message it must invite MAC function which checks if is appliance allowed to transfer message [2]. In other words, MAC protocol checks is worth slot reserved by the appliance which is invited MAC function, and if the slot is reserved the transfer will be allowed, and in contrary the transfer will be blocked.
Technique of jumping between transfer canals makes possible that different appliances transfer messages in one the same time slot using different transfer canals. WirelessHart also allows use of common slots and because of that the system of detection of collision is implemented. When the appliance tries transfer in the framework of common slot MAC function checks the status of canal. If the canal is occupied the back-off time is estimated.

2.1. TDMA technique

All communication appliances support multiple superframes formed of time slots where size and number of slots is fixedly determined. Sending of superframes is constantly repeated along beforehand defined time interval [3]. For successful and efficient TDMA communication key is synchronization of clock between all appliances in the network in order to appliances know when the start of slot appears.
Inside slot it is beforehand defined time interval, between the start of slot and start of sending of original message, what makes possible for source and destination node adjustment of frequencies of communication canals and allows the receiver eavesdropping of required transfer canal. Because exists the tolerance of generators of clock, receiver have to start eavesdropping of the transfer canal before the start time of ideal transfer of the package and after that it have to continue eavesdropping of transmission canal. When the transfer is finished, direction of communication turns and destination appliance sends to the source appliance confirmation about the successful reception of message (ACK).
For increasing of reliability it is used technique of jumping between transmission canals. Technique of jumping between transmission canals makes possible the work on different frequencies i.e. that different appliances transfer messages in the framework of same time slot using different transmission canals. In this way it is avoided appearance of interference and the multi-path fading effect is reduced [3]. When the appliance tries transfer in the framework of common slot, MAC function checks the status of canal and if the canal is occupied estimates the back-off time.

2.2. Definition of common slots

WirelessHART allows definition of common slots using which more appliances can try transfer of messages, so that inside slot there is no collision. If it comes to the collision then destination node is not able successfully to receive the message and it will not be confirmation of successful transfer of the package. In order to reduce probability of repeats of collision, source appliances will use accidental back-off delays in situations when transfer into common slot is not confirmed. Appliance will save two variables for the every neighboring knot:

- Back-Off Exponent (BOExp) and
- Back-Off Counter (BOCntr).

That variables are preset on the value 0, and when comes to failing of transaction in the common slot it is calculated back-off time on the basis of BOExp variable. For every unsuccessful attempt of transmission from the source appliance into common slot it is increased BOExp variable and is calculated sequence of numbers which consists from integer numbers {0, 1,...L} where is: $L=(2^{BOExp}-1)$. On the basis of calculated assumptions of BOExp variable it is chosen accidental value of BOCntr variable, and for every next transfer to the neighboring knot it is decremented its value. Only in case when the value of BOCntr variables is zero it is able to realize transfer from source appliance to common slot [3].

2.3. Communication tables

All appliances have set of tables which control communication required by the appliance. The communication tables and connections between them are presented in Fig.2. and include following possibilities:

- Super frameworks are beforehand adjusted by the network manager and interconnections inside super framework are adjust that determine the communication with the determined neighboring knot.
- Table of neighboring knots consists of list of all appliances with which may be in possibility to communicate.
- Table of graphs consists of routes which are uses for transfer of message from its source to its destination.

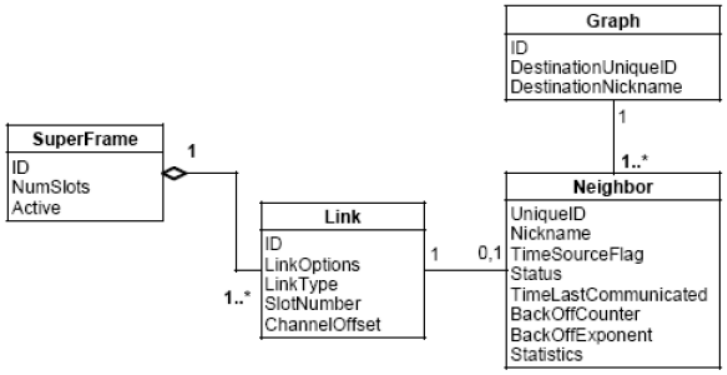

Fig. 2. Communication table

2.4. Table of appliance

In the framework of WirelessHART protocol has been specified that every appliance has special table in which are defined all details of communication [2]. In the Table 1. is presented structure of table of appliance with possible values for every field:

- **FrameID** consists of the ID framework i.e. the value which shows the unique identification number of superframe. This value is essential because in WirelessHART the every appliance must support the option of multiple superframes.

- **TimeSlot** is list of slots across which appliance wants to communicate.
- **ChOffset** is the canal value offset and shows which canal uses the appliance for the data transfer.
- **DevAddress** shows with which appliance would be need to realize communication, and in case of transfer the field in this column presents the address of destination appliance.
- **LinkOpt** shows which type of communication is. If in the framework of this field is value 0, it means that the appliance receives messages and if is value 1, this means that the appliance transmits messages.

Table 1. Table of appliance

FrameID	TimeSlot	ChOffset	DevAddress	LinkOpt
{1..Nbrframes}	{1..NbrSlots}	{1..Nbrch}	{1..NbrNodes}	0=RX 1=TX

3. NETWORK MANAGEMENT

Appliance which performs all activities of network management is Network Manager. Network Managers can be more, but it is necessary that exists one central Network Manager, which will control work of all other Network Manages [1].
By adaptation network, Network Manager will constantly adapt the network so that constantly collects data from the appliances about accuracy of network and uses this information for forming of routes. Functions of Network Manager for network management are:

- Support to appliances which are connected in the network,
- Establishment of the routes,
- Planning of exchanges of data,
- Planning of managing functions,
- Adapation of network plannings.

4. CONCLUSIONS

It can be concluded that WirelessHART is backward compatible component with existing HART appliances and applications, financially profitable, which has the rational access to wireless communication supporting industrial requirements for simple, reliable and sure wireless communication technology. It Satisfies necessary communication requirements that the compatible equipment must support and insure the interoperability. So, all kinds of wireless appliances of other manufacturers can be substituted without complex system operations. WirelessHART is sure and strong wireless network technology which presents high reliable and effective industrial solution.

5. REFERENCES

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