Summary on

WirelessHART: Data Link Layer and MAC

lecture

[700.460] Sensor Networks

Lecturer: Univ.-Prof. Dipl.-Ing. Dr. Bernhard Rinner

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Alpen-Adria-Universität Klagenfurt

Florian Posch

Franz Christian Stebe

Authors:
Florian Posch,
Franz Christian Stebe

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Franz Christian Stebe

1. Motivation

The wirelessHART has a lot of advantages for the industry. It can reduce the costly and bulky cabling. You can install it in any location independent of the environmental conditions [11]. The HART (Highway Addressable Remote Transducer) was standardized about 30 years ago and is a very widespread protocol standard in industry. Due to the costs and often laziness to link it up it is estimated that only about 10% of HART devices are wired to a control system. WirelessHART is specifically design for process measurement and control applications for industrial automation. It therefore is useable in harsh environments. It is capable of real-time applications and very failsafe. Due the Wireless factor, it makes the planning and setup easier than HART. It uses flat mesh networks where messages are repeated by networks clients [4].

2. Basic Concept

Like for example WirelessHART operates at 2.4 GHz in the license free ISM radio band. Which means everyone can use it without the need of buying frequencies. It is a wireless version of the already established HART communication system and provides a complete solution for process applications [1,2].

For the physical layer it adopts IEEE 802.15.4 low-rate wireless personal area networks, which is also the base for the well-known Zigbee standard.

WirelessHART mainly uses TDMA with strict 10ms time channels and features network wide time synchronization, channel hopping and channel blacklisting.

The network builds itself (mesh network). If another device needs to be integrated into the network, a password needs to be entered in the device and it will be automatically included. The Network is self-healing and uses redundancies if a device on a transmission path fails.

WirelessHART uses a central network manager, which is responsible for maintaining up-to-date routes and communication schedules and to guarantee network performance.

Some basic elements of a typical WirelessHART network include field devices (Sensors), a handheld (configure devices), a gateway which connects host applications to the field devices and a network manager which is responsible for configuring the Network.

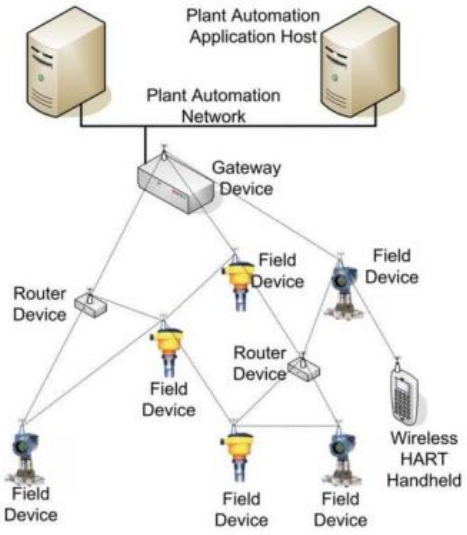

Figure 2-1: WirelessHART network [5]

3. DLL and MAC

In Figure 3-1 the Layers of the WirelessHART are shown [3].

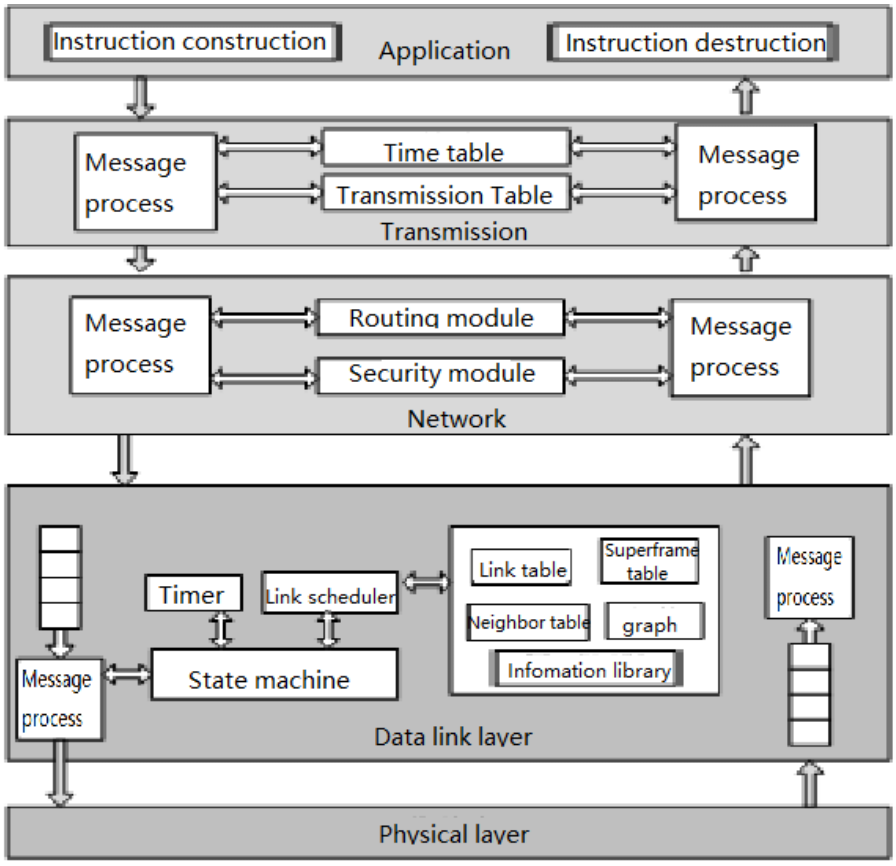

Figure 3-1: Overall Architecture of WirelessHART [3]

Based on the definition IEEE the layer in the WirelessHART protocol is build up by a software protocol stack architecture as shown in Figure 3-1 [2,3]. In the figure following five layers are shown:

- the physical layer,
- the data link layer,
- the network layer,
- the transport layer,
- and the application layer.

The application layer consists of a command builder and a parser. The transport layer consists of a message processor, a transmission channel table and a time table. The network layer consists of a message processor, a routing module, and a security module [8,9]. The data link layer is processed by a state machine and a message processor with is connected to a link scheduler to access the link, superframe, neighbor tables and the graph. Finally, the data link layer is connected to the physical layer.

The main parts of the data link Layer consists of:

Interface (Message Process)

The message process handles the interface between the MAC and PHY layer and defines the service provided to the network layer.

Timer

Fundamental module in WirelessHART is a timer. The timer provides accurate timing to ensure the timing operating of the system.

Tables (Link, neighbor, superfrane)

The network communication is organized by tables in the data link layer. The superframe table and link table includes communication configurations assigned by the network manager. The neighbor table includes neighbor nodes that can be reached directly, and the graph table is used to store routing information.

Link Scheduler

The link scheduler determines the slot to be accessed based on the communication schedule in the superframe and link table. The scheduler organizes transaction priorities, link changes, and the enabling and disabling of superframes.

State Machine

The state machine consists of three primary components: the TDMA state machine, the transmit and receive engines. The TDMA state machine is for executing the transaction in a slot and adjusting the timer clock. The transmit and receive engine deal with the hardware directly to send and receive a packet over the transceiver.

4. Conclusion

It gives the possibility to easily connect sensors without cables. This a great advantage in cases where there isn't enough space for the cables or in cases where it isn't possible to use cables (rotating devices). Due to the fact, that it uses the ISM band it isn't needed to buy frequencies [1,2].

The main communication is done with TDMA, which on the one hand needs precise synchronization but if this is given it works well with sensor networks. In TDMA it is possible to reduce idle listening which is a huge energy waster, and it is real-time capable. Additionally, to the TDMA slots there is also the possibility to use Slotted ALOHA [3,5,6].

It uses a self-building and self-healing mesh networks, which makes the setup rather easy and the network robust. Additionally, it uses AES-128 encryption to ensure security.

Authors:
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Franz Christian Stebe

5. References

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