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Topic: WirelessHART: Data Link Layer and MAC

700.460 Sensor Networks

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Table of contents

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Motivation

- **WirelessHART (Wireless Highway Addressable Remote Transducer) is an open wireless communication standard specifically designed for process measurement and control applications for industrial automation.**

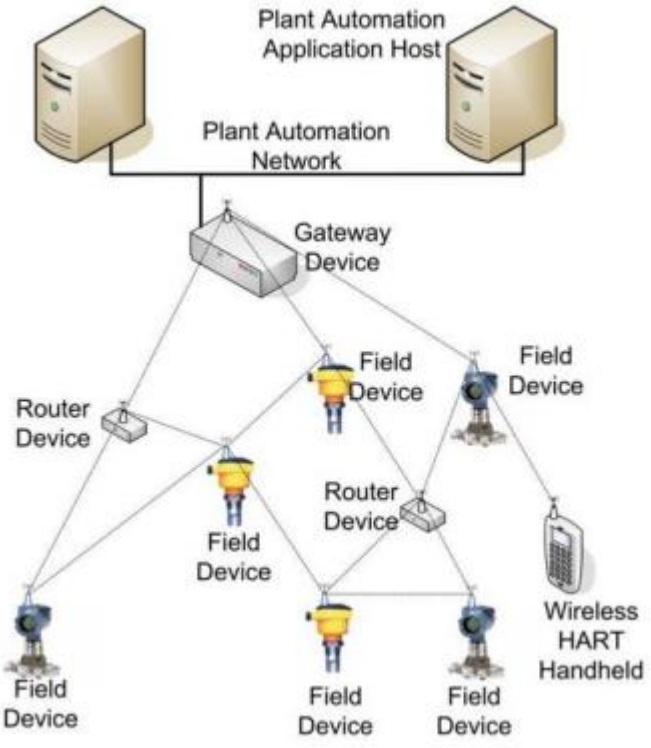
Source: https://en.wikipedia.org/wiki/WirelessHART

Basic Concept

- Operates 2.4GHz ISM
- Complete solution for process applications
- Adopts IEEE 802.15.4 as the physical layer.
- Time-synchronized MAC layer
- 10ms TDMA industry standard AES-128
- Supports self-organizing and self-healing mesh networking
- Network Manager

Source: https://www.researchgate.net/figure/Overall-architecture-of-WirelessHART_fig1_329979498

Basic Concept



Basic elements of a typical WirelessHART network include:

(1) Field Devices that are attached to the plant process,

(2) Handheld which is computer used to configure devices,

(3) A gateway that connects host applications with field devices and

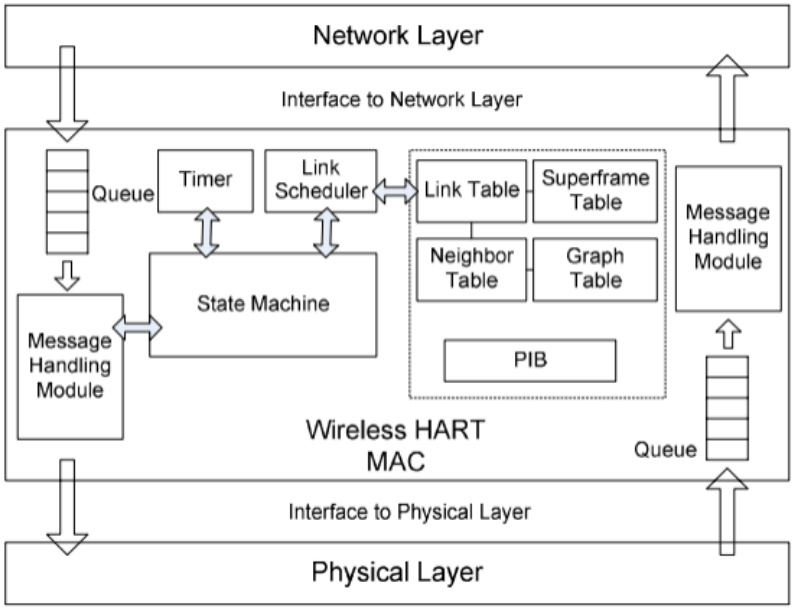
(4) A network manager that is responsible for configuring the network.

Source: https://www.researchgate.net/figure/Overall-architecture-of-WirelessHART_fig1_329979498

WirelessHART Architecture

Logical Link Control → Data Link Layer

Design of the data link layer is given, which consists of:



1) Interfaces

2) Timer

3) Communication Tables

4) Link Scheduler

5) Message Handling Module

6) State Machine

Source: https://www.researchgate.net/figure/Overall-architecture-of-WirelessHART_fig1_329979498

MAC Protocol Description

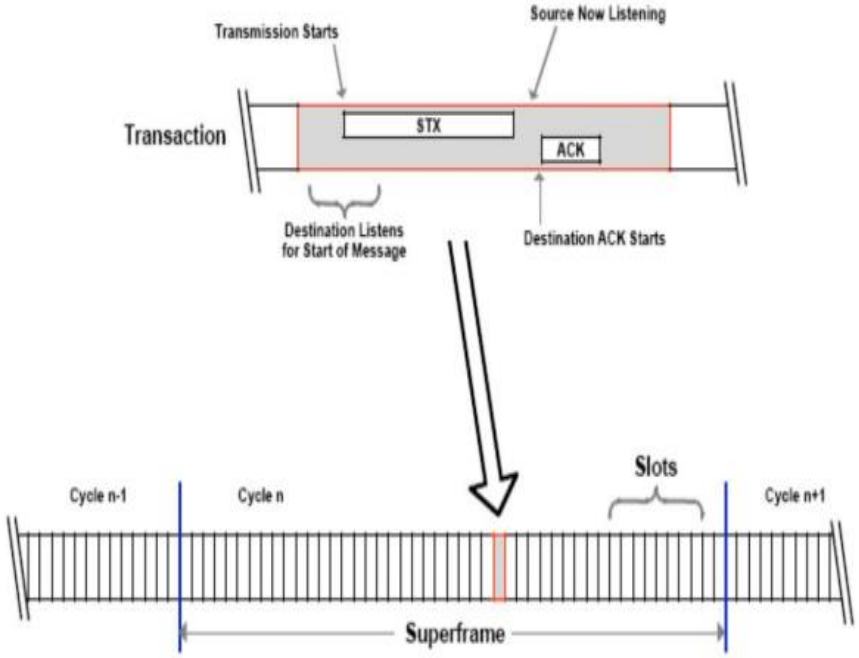
The main tasks of **M**edium **A**ccess **C**ontrol protocol are:

- Slot synchronization
- Identification of devices that need to access
- Propagation of messages received from the Network
- Listen for packets being propagated from neighbors

Source: https://www.researchgate.net/figure/Overall-architecture-of-WirelessHART_fig1_329979498

MAC Protocol Description

Slot synchronization



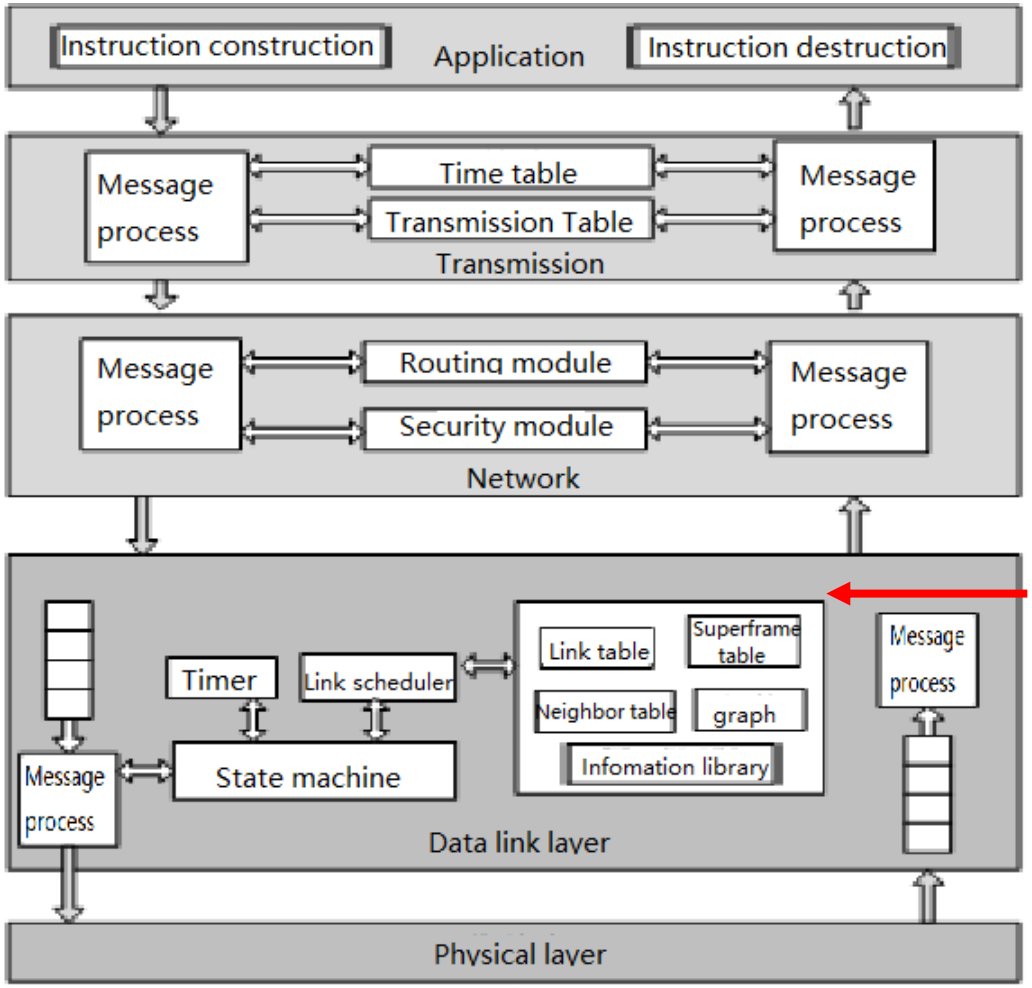
Superframe Structure

Time Division Multiple Access (TDMA)

- **Shared Slot**
- **Limited to 10 ms**

Source: https://www.researchgate.net/figure/Overall-architecture-of-WirelessHART_fig1_329979498

MAC Protocol Description



Tasks:

- Identification of devices that need to access
- Listen for packets being propagated from neighbors
- Listen for packets being propagated from neighbors

Implementation:

- Neighbor table
- Link table
- Graph table
- Superframe table

Source: https://www.researchgate.net/figure/Overall-architecture-of-WirelessHART_fig1_329979498

Devices in the Industry

Endress+Hauser's SWA70 *Wireless*HART Adapter

- Parallel transmission of process information from an existing wired installation
- Collection of process information from rotating or mobile installations
- Integration of new measuring points into existing systems
- Applications with environmental limitations to cabling (e.g., electromagnetic fields or limited accessibility)

Source: https://www.controlglobal.com/industrynews/2016/endress-hauser-smart-adapter-adds-wirelesshart-to-field-devices/

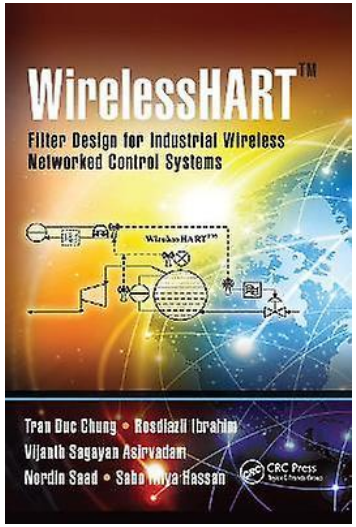
Conclusion

- Uses 2.4GHz license free frequency
- Communication is coordinated with TDMA
- Slotted ALOHA
- Built on IEEE 802.4.15 standard
- Self-healing network
- Robust security mechanisms (AES-128 encryption)

References

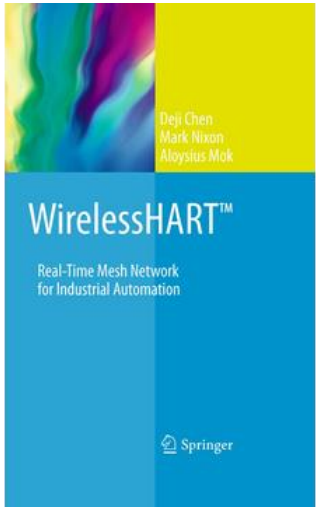
[1] https://www.rfwireless-world.com/Articles/wirelessHART.html
[2] Paper by Jianping Song "WirelessHART: Applying Wireless Technology in Real-Time Industrial Process Control", IEEE Real-Time and Embedded Technology and Applications Symposium, 2008
[3]https://library.e.abb.com/public/eb20fe80a391ca8485257bc600667573/When%20HART%20Goes%20Wireless%20Understanding%20and%20Implementing%20the%20WirelessHART%20Standard.pdf
[4]https://library.e.abb.com/public/eb20fe80a391ca8485257bc600667573/When%20HART%20Goes%20Wireless%20Understanding%20and%20Implementing%20the%20WirelessHART%20Standard.pdf
[5]https://www.researchgate.net/publication/289665245_Implementation_of_the_WirelessHART_MAC_layer_in_the_OPNET_simulator

Books



WirelessHART Filter Design for Industrial Wireless Networked Control Systems

This book presents a guideline for EWMA filter design for industrial wireless networked control system both theoretically and practically. The filterâs key advantages are simple effective low computational overhead. plants.



WirelessHART™ - Real-Time Mesh Network for Industrial Automation

The process control industry has seen generations of technology advancement, from pneumatic communication to electrical communication to electronic c-munication, from centralized control to distributed control. At the center of today’s distributed control systems are operator workstations.

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THANK YOU