

ZigBee-to-TCP/IP Gateway: New Opportunities for ZigBee-based Sensors Networks

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New network technologies for constructing wireless sensor networks are getting very common. ZigBee-based embedded systems are being used in new application areas where traditional network technologies can't be used with enough efficiency. Nevertheless, ZigBee cannot replace the traditional network technologies, because all of them are destined for different tasks which need to be solved in today's world.

A combination of traditional and new network technologies: new opportunities

The combination of ZigBee and TCP/IP technologies provides several important benefits. As a direct result, intelligent self-organizing and self-healing networks with small power consumption can be created with additional advantages provided by the TCP/IP-technology. Namely:

- 1 Get remote access to the coordinator of a ZigBee compatible network in order to change the control parameters and the setup from any client station that has internet connection.
- 2 Open the possibility to remotely upgrade firmware via Ethernet or over-the-air (wireless).
- 3 Increase the size of the ZigBee network by integrating several small networks, aggregating data from several gateways, and transferring them to a control center.

The last feature from list above looks especially attractive for sensors' networks where it is not necessary to send data from one part of ZigBee network to another, except the coordinator. All data transfer takes place from the network's nodes to one center and some control information is being sent in opposite direction.

Fact is, that the noise situation in frequency range is non-uniform in a big area. Usually coordinator decides which channel will be used by network. It scans all channels and selects the one which is free of noise. But the coordinator can only analyse the situation in a limited area which is less than the full area network.

The using of several small networks instead of big one allows to solve problems like this because small networks can independently select a free of noise channel.

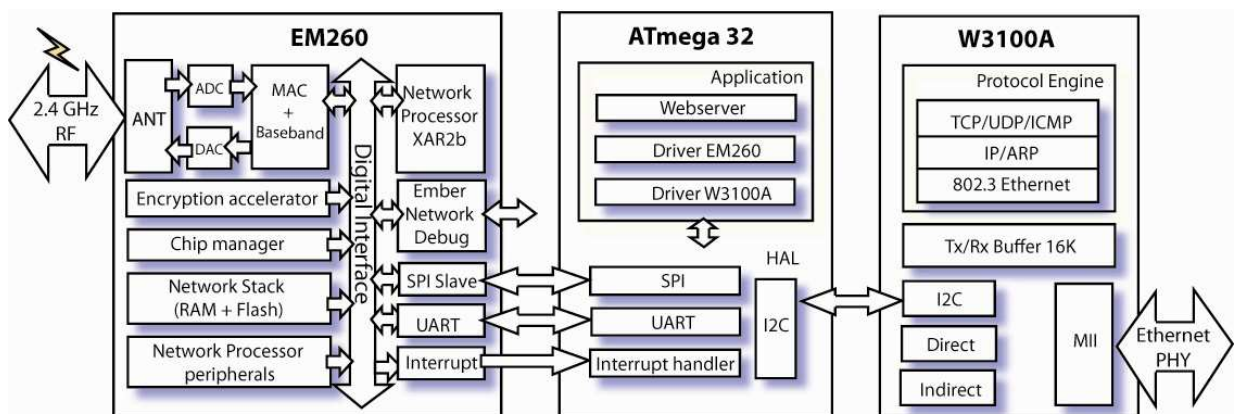
The task of data transfer between ZigBee and TCP/IP-based networks is being executed by a gateway.

Chosen hardware

For gateway realization the following three tasks need to be implemented:

- 1 ZigBee network processing;
- 2 Routine of main application;
- 3 TCP/IP network processing.

The structure of a system is shown in picture 1.



Picture 1. Structure of ZigBee-to-TCP/IP gateway

For the ZigBee network processing, Ember's chip EM260 has been chosen. EM260 is not only a transceiver of standard IEEE 802.15.4. It also contains a core for ZigBee network processing. It has a SPI interface and can be used with any support SPI microcontroller.

As like a host controller for the main application, an ATmega32 microcontroller has been applied. It allows to use the source codes of the sample application, which are provided by Ember company together with the EM260 Jump Start Kit.

The TCP/IP network processing is being realized by the hardware TCP/IP network processor W3100A from WIZnet company.

The use of a hardware implementation of the TCP/IP stack allows to free the host MCU from network processing. This feature is important for the system because the microcontroller ATmega32 isn't very powerful and can't execute both tasks together: main application routine and network processing.

Implementation

Implementation demands. The following features should be available in the ZigBee-to-TCP/IP gateway:

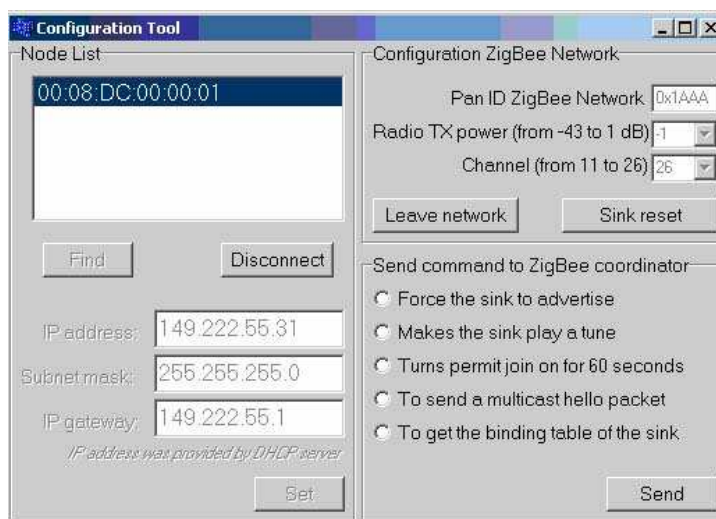
- 1 Configuration of TCP/IP parameters;
- 2 Configuration of ZigBee network options;
- 3 Transfer data through gateway.

As a result of this the DHCP-client software is realized for getting IP settings in networks with dynamically IP-addresses and a special utility ConfigTool is used for changing internet settings manually. And the gateway also contains TCP-server software for transferring data from Ethernet to ZigBee network and opposite direction.

Utility Config Tool: configuration TCP/IP parameters. ConfigTool is looking for gateways TCP/IP<->ZigBee in the network. It is able to find it in the network even if it doesn't have any information about the gateway's network settings.

If the gateway already has got network parameters from the DHCP-server, ConfigTool utility allows to display them. From this point on the user knows which IP-address he has to use for getting access to the gateway. If the network uses static IP-addresses, ConfigTool utility allows to set parameters manually.

Configuration ZigBee network options. For the configuration of ZigBee options it is possible to use the same ConfigTool utility. After setting the TCP/IP network parameters and getting access to the gateway via Ethernet, the extended window is shown and a special TCP port is being opened for configuration ZigBee network (picture 2). ConfigTool can change the PAN ID of the ZigBee network, select the frequency channel and define the output power of the transmitter. This utility can also send some helpful commands to the coordinator of the ZigBee network.



Picture 2. Config Tool application. Extended window

Transfer data. As soon as all parameters are set, the gateway is ready for working. From this point on all data coming to some defined TCP port will be transferred to the ZigBee network.

For the demonstration of gateway processing it is sufficient to use any standard TCP-client program, for example Hyper Terminal, configured for working in TCP-client mode. After having successfully established a connection between the gateway and the Hyper Terminal, data received by the coordinator will be shown in the HiperTerminal window. And messages typed into the Hyper Terminal window will be sent to the ZigBee network. Whether correct data has been received can be checked via the serial ports of the ZigBee routers.

The introduced system demonstrates the functioning of a ZigBee-to-TCP/IP gateway and allows to use the advantages of combined networks.

