Lighting interface to wireless network

Jaroslav Meduna

meduna@mikroklima.cz

Mikroklima s.r.o., Czech Republic

ABSTRACT

Wireless communication may help to make step over lighting systems limitation, in inter operability and poor connectivity to external world. There are potential in CoAP, which is effective protocol, based on HTTP. Synergy in OS Contiky has significant drive for implementation heterogenous communication from one world to other. Using IPv6 and its benefits go to new generation of smart things.

1. Introduction

Common lighting network uses wired connections. Over the time were evolved different standard, but characteristics remain the same. Major systems are KNX, DALI and DMX512. Our project used DALI standard [1] based on IEC 60929/1 and IEC 62386 [2]. Communication system consists of one DALI control module and up to 63 devices. DALI modules can connect to external worlds via a gateway [3].

Optimized IPv6 for wireless system is called 6LoWPAN [4]. For lighting and building automation application is important factor easy to use, install and maintenance the product. From this point of view is useful automatic network discovery and routing. When RPL comes to uIPv6 [5] stack, path to smart routing is opened. The uIPv6 is certified by IPv6forum [6].This stack is included in Contiki [7] operating system, which has vital community.

Radio channel bandwidth is limited, therefore is data rate typically mid or low. For this reason is compression or special effective protocol important. Constrained Application Protocol (CoAP) [8] may save up to 95% of XML header ballast using W3C EXI compression [9].

 2. Frequency

Important feature of wireless system is range and robustness. Common application used one of three ISM [10] frequency band: 433 MHz, 869 MHz and 2.4 GHz. Signal propagation on different band is complex, but typical value proven in practice take gain 9 dB between 2.4 GHz and 869 MHz. Between 869 and 433 MHz it is about 6 dB. These values are close to Friis transmission equation [11]. For example, typical radio has +10 dBm RF output and antenna gain is zero. Path lost for distance 20 meters and two walls in the sight is 117 dB at the frequency 2.4 GHz. It give RSSI +10 - 117 = -107 dBm. Using 869 MHz frequency it give -98 dBm, and for 433 MHz -92 dBm. It is look, that lower band give better communication range. Disadvantage of band 433 MHz is heavy interference in the background. Therefore, we chose band 869 MHz.

Robustness is also important. On the market is available a number of radio chips. Typical solution for low power is SoC (system on chip). Long lasting brand Chipcon is now under Texas Instrument global company. We are looking for high sensitivity narrow band SoC. Improved version of the CC1100

industry standard is CC1101 chip [12]. Inside is DSP FSK transceiver up to 500 kbps, -112 dBm sensitivity and +12 dBm output RF power. Excellent receiver selectivity and blocking performance does not required external preselector, like SAW filter.

3. DALI to CoAP IPV6 gateway

DALI network has fast timing, from the narrow band radio point of view. Only chance to connect from the rest of world is GW (gateway). Second side of GW must use standard, robust and secure protocol. This type of protocol is CoAP, secure layer may be added by DTLS [13]. The middleware is the process database, where is placed environment image from DALI network. Its advantage is that there is not required configuration.

4. Implementation

Regarding a Comparative Study on Available IPv6 Platforms for Wireless Sensor Network [14], where authors compare available platform, we choose Contiki system running on ARM Cortex M3 platform with Texas Instrument CC1101 radio chip. DALI implementation is based on MIDAM standard [15]. Power is taken from building system 24 VAC line or standard 230 VAC power cord. Edge routers are powered by PoE. SCADA server is based on softPLC system. Considerable property of this system is compatibility with PLC (power line communication) system based on 6LoWPAN system [16].
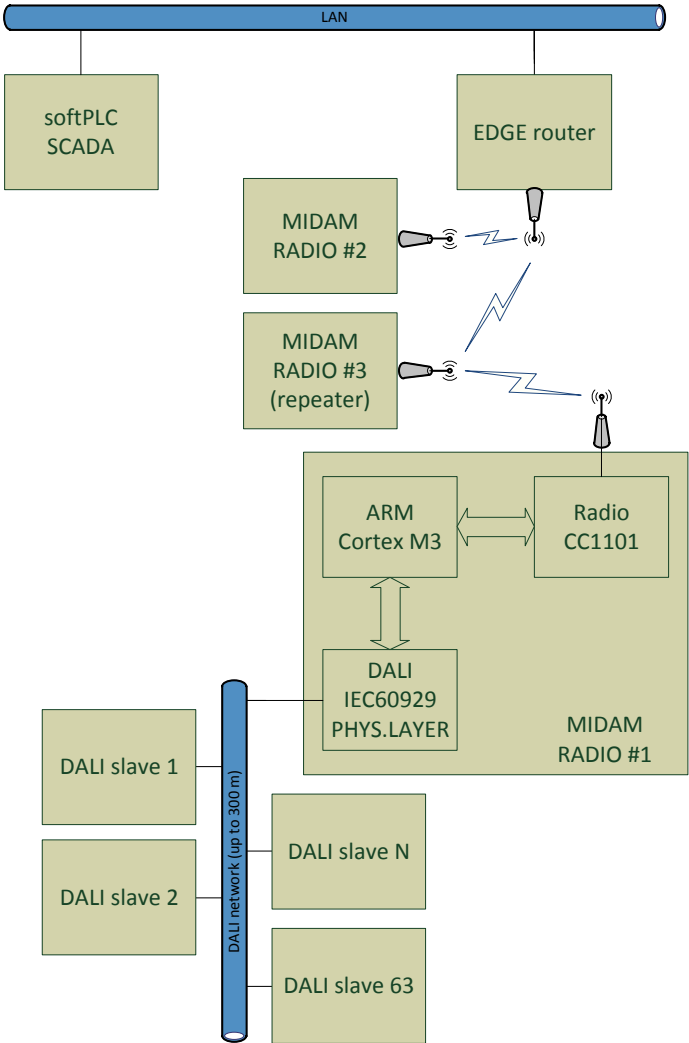
5. Conclusion

Discovering IPv6 wireless world makes big room for ideas, which is not possible yet. System has huge scalability. Communication platform converge, using heterogeneous WAN is easier. New protocols help with reliability, compression or security. Modern operating system, like Contiki has feature for fast FOTA (update firmware over the air) using partial upgrade or multicast.

6. Refferences

[1] DALI-AG http://www.dali-ag.org/

[2] International Electrotechnical Commission http://www.iec.ch/

[3] DALI manual, DALI-AG 2001, chapt. 3.3 DALI is pure subsystem within Building Management

[4] G. Montenegro, N. Kushalnagar, J. Hui, and D. Culler. Transmission of IPv6 Packets over IEEE 802.15.4 Networks. RFC 4944 – proposed standard, September 2007

[5] M. Durvy, J. Abeillé, P. Wetterwald, C. O'Flynn, B. Leverett, E. Gnoske, M. Vidales, G. Mulligan, N. Tsiftes, N. Finne, and A. Dunkels. Making Sensor Networks IPv6 Ready. In Proceedings of the International Conference on Embedded Networked Sensor Systems (ACM SenSys), pages 421–422, Raleigh, North Carolina, USA, Nov. 2008.

[6] IPv6forum http://www.ipv6ready.org/

[7] Contiki - The Operating System for Connecting the Next Billion Devices - the Internet of Things, http://www.sics.se/contiki/

[8] Z. Shelby, K. Hartke, C. Bormann, B. Frank. Constrained Application Protocol (CoAP)

[9] W3C EXI, http://www.w3.org/XML/EXI/

[10] Industrial, scientific and medical bands defined by ITU, http://www.itu.int/ITU-R/

[11] Harald T. Friis, Proceeding of the Institute of radio engineers, vol. 34, p. 254

[12] Texas Instrument CC1101, http://focus.ti.com/docs/prod/folders/print/cc1101.html

[13] E. Rescorla, N. Modadugu. Datagram Transport Layer Security. RFC4347 – proposed standard, April 2006

[14] Usman Sarwar, Gopinath Sinniah Rao, Zeldi Suryady, and Reza Khoshdelniat. A Comparative Study on Available IPv6 Platforms for Wireless Sensor Network. World Academy of Science, Engineering and Technology 62 2010

[15] MIDAM control system, http://www.midam.cz/

[16] Maxim PLC G3 profile specification, http://www.maxim-ic.com/products/powerline/pdfs/G3-PLC-Profile-Specification.pdf