WIRELESS REAL-TIME GATEWAY (WRTG) FOR EMBEDDED DEVICES

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Abstract: *This paper discusses the hierarchical manufacturing approach and distributed model used by embedded systems for monitoring of particular environment's parameters. A set of sensors for the different nature of measurements could be attached to the* ***Wireless Real-Time Gateway****. The gateway is an intermediate unit of an appropriate systems. It allows some level of security and independency from the rest of the entire system. Used and implemented interfaces are UDP/IP/Ethernet from the embedded systems – inner site and wireless medium from the outer site. The possibility of real time support is also discussed. It allows the sensors to be connected to the system via embedded devices or directly through some standard interfaces to the wireless gateway machine. QNX Neutrino is used for operating system working on the wireless gateway.*

Keywords: distributed embedded systems, real-time gateway, wireless networking.

1. INTRODUCTION

In search of a common digital infrastructure increasing convergence trends require to interoperate devices, sensors and services in heterogeneous network environments throughout various application domains, e.g. home automation, agro-meteorological domain and etc [1]. Typically, network devices are mainly embedded devices connected to heterogeneous types of networks [2,3]. Currently, these networks range from IP-based networks like Ethernet or WLAN and IEEE1394, RS485, 1-Wire, CAN etc. The demand for control and access to the respective devices requires supporting technologies like *embedded Web Servers*, *Network Coprocessors*, *Distributed Middleware* or Gateways for e.g. protocol translation [4].

The implementation of Web Servers is usually paired with increased resource requirements in terms of CPU processing power and memory size. They require huge configuration efforts. Furthermore, Web Servers establish end-to-end sessions to the external access point, and hence they need a more sophisticated run-time environment that supports scheduling and file systems support.

Network Coprocessors are part of the hardware design of the embedded device and interface with its microcontroller. They contain a TCP/IP stack and potentially a Web Server or other configuration items. Functionality not included in the hardware design has to be supplemented by the applications in the embedded device. There is no possibility of a dynamic upgrade of the system-on-chip software.

Low-level gateways on the other hand act as an intermediary broker, supporting communication with external networks by protocol translations. They usually require a more powerful environment than it is provided by 8-bit or 16-bit microcontroller environments.

In order to overcome most of the drawbacks of separate solutions when connecting sensors, embedded devices and sensors networks through various wired and wireless networks, we propose a Wireless Real-Time Gateway (WRTG) realization.

The paper presents the architecture of implemented Wireless Real-Time Gateway and discuses the possibilities for real-time support used in distributed automation.

2. WIRELESS REAL-TIME GATEWAY

Prerequisites for realization and discussion of wireless gateway are based on OSGi technology [4]. This technology is precondition for service oriented gateway. This approach is very suitable for system interoperability that consists of different platforms. This scenario is most common. Moreover, service oriented gateway, unify distributed system to work as a data producing system, and what ever to be the request to the system, the requestor receive the information without getting any sense the way required data is gone to be delivered.

The purposes and aims seeded in front of gateway realization are closely related to distribution approach used by embedded systems, where all system functionality is distributed among small devices, marked by limited computing possibilities and memory usage. But using distribution approach compensates these limitations.

Gateway and currently wireless gateway is appropriate way for combining both approaches described above for providing service oriented architecture. This architecture allows to be pulled any functionality to upper layer in N-tier structure. Nevertheless shifting of some functionality, the overall working process still is not touched.

The WRTG is a parts of N-tier model for distributed automation [5]. This model generally consists of four tiers which are separated in their functionality and administration (Figure 1). It realizes **Data Tier** which produces and/or stores data. It depends on the corresponding upper tier server. In case of data logging service it can be a Database. In case of automation services – controller networks or sensors networks.

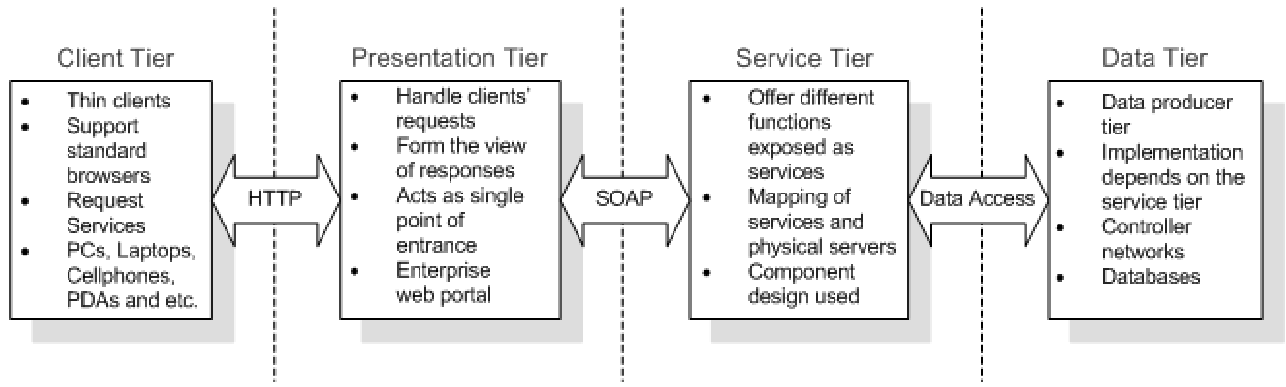

Figure 1. N-tier model for distributed automation.

The WRTG consists of two threads (Figure 2) – one for receiving requests from any source that is going to be served, while the second thread extracts all available information and sends it to some kind of data base. For test realization Data Base machine is and application that writes received data to a file, which content is read after any request is sent. The required data is read from the file and is sent in respond to requestor. The data is kept in XML format – used for data description.

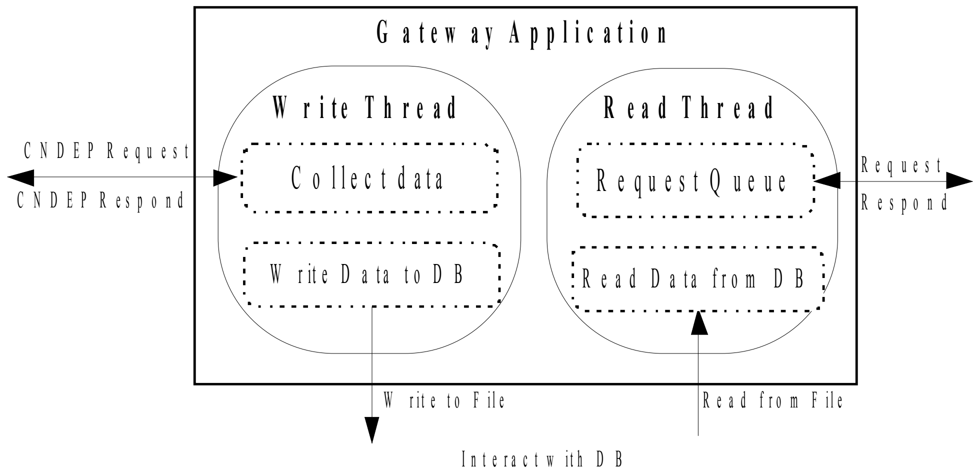

Figure 2. Working approach of WRTG.

The experimental realization of wireless gateway is done using only Ethernet interface from the inner site, where from the figure above could be noticed the usage of CNDEP, Bluetooth and 802.11b standards for wireless connection to a virtual requestor. CNDEP protocol is used for data extraction from embedded systems [6]. The current snapshot of CNDEP is its latest version – xCNDEP. It provides exchange of XML messages, which is very convenient in service architectures. This XML usage could provide shifting of some functionality of the entire system between tiers, which would be impossible if well known aforementioned marks of embedded systems were not improved and advanced. All efforts in this field are directed to provide high performance of embedded systems, including more connection possibilities, applying more powerful processors, adding more and more external memory as SD push-pull sockets and etc.

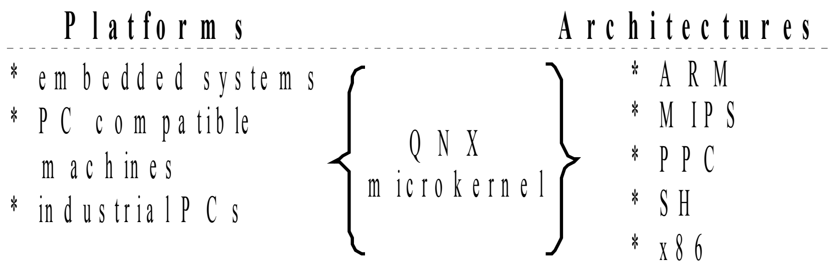

Figure 3. QNX Deployment

For implementation of the discussed functionalities of the system in real-time a usage of QNX as Real-Time OS [7] is proposed. QNX could be installed on different platforms - Figure 3. These platforms are suitable for appropriate usage concerning functionality and it is closely connected to their price and size. Technical comprising principals between platforms are computing power and memory restrictions. On the other hand these platforms could use different types of processor's architecture.

Employing QNX Momentics Development suite any application designed and developed using that studio could be build for proper architecture.

3. REALISATION

The QNX owes some specific features. The way OS interacts with drivers and peripheral devices is shown on Figure 4.

Traditionally, more gateways act as a middleware, which sits between the main application and the operating system. However, in discussed realization the proposed WRTG architecture is extended into the network's protocol stacks and corresponding applications, as it is shown on Figure 4.

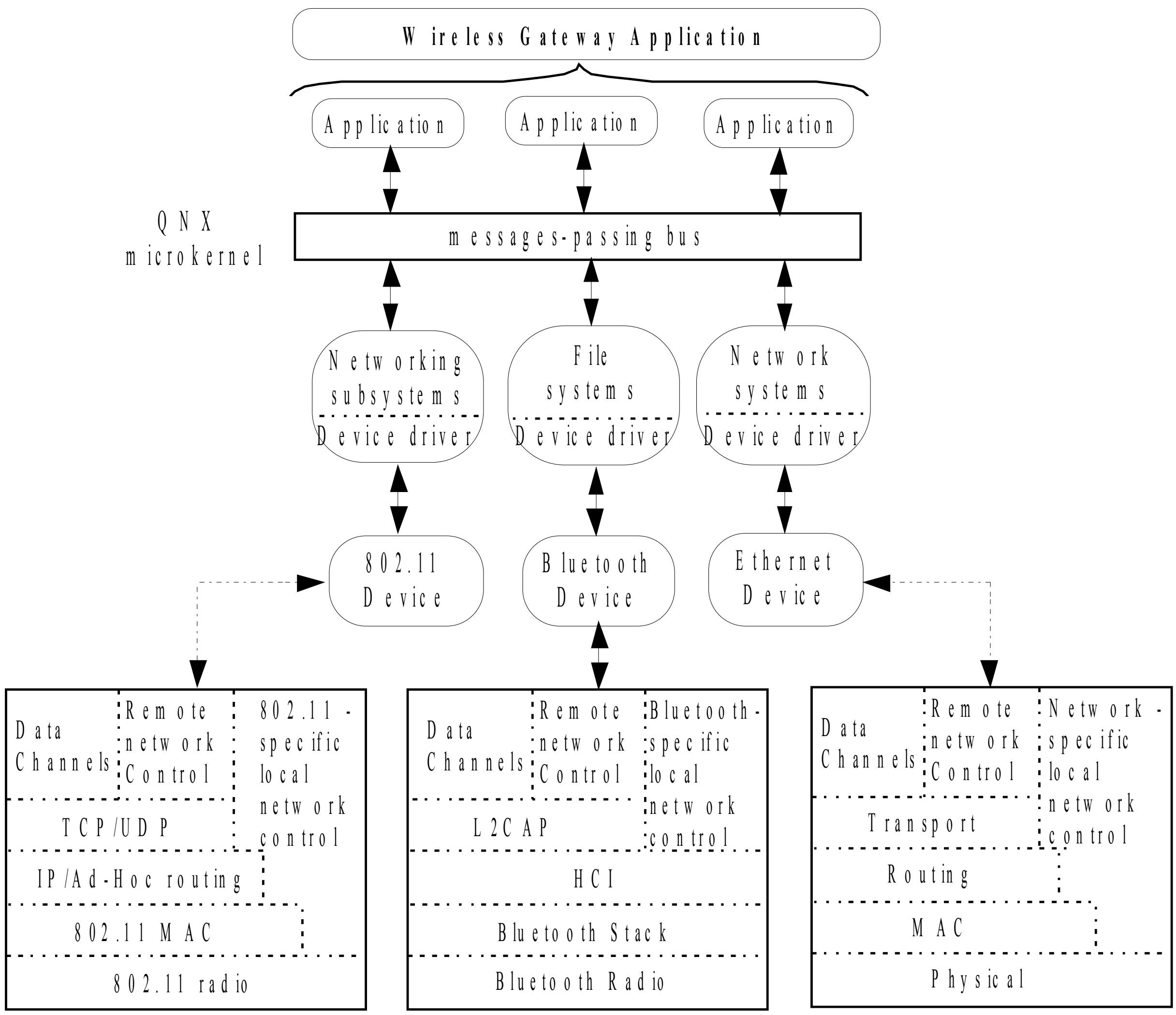

Figure 4. Specific features and interaction of QNX with peripheral devices.

Realization of gateway application on QNX platform is done over QNX Neutrino 6.3.0. The used approach is open source. Wireless communication is accomplished by Bluetooth module/device. The reasons for choosing that way for communication are the low power consumption, the ability for adjusting different levels of Bluetooth stack that is suitable for experiments and the wide-spread usage of Bluetooth (any mobile device owes such interface for providing communication).

The Bluetooth stack that is used for current realization is from Technical University California, MOJAVE work group [8]. The Bluetooth driver that is implemented is for Broadcom chips, which defines presence of Broadcom firmware [9]. Employed device for current realization is Fujitsu-Siemens, which uses Broadcom communication chip.

The development studio is QNX Momentics development suite, which is capable for programming in JAVA and C/C++ for different QNX Platforms and is capable to build these applications for all Platforms presented on Figure 3. The current solution requires C/C++ QNX project.

The gateway implementation is a standard socket application in C/C++. From inner site it is using AE_INET socket – standard Ethernet sockets, and from the other site - AF_BLUETOOTH sockets for Bluetooth communication – these sockets are domain 31. The most used protocol for Bluetooth applications is L2CAP, which protocol is also implemented by Mojave WG.

Figure 4 presents the most common ways for wireless communications without Zigbee. Although, concerning power consumption Zigbee is the best way for wireless communication, the second is Bluetooth and the worst way is 802.11x device, Zigbee standard is avoided intentionally because of absence of available QNX driver. Discussing wireless interfaces the possibility to adjust different layers of Bluetooth stack should also be mentioned. This option and considerably low power consumption makes the communication really appropriate. These features of wireless interfaces are significant for future work and direction for development.

4. CONCLUSIONS AND FUTURE WORK

This paper discusses realization of wireless gateway, which is able to support all necessity real-time requirements. The current realization proves the ability to be created such a gateway for communication. Although, the current paper do not discusses and presents any investigation of real work of the gateway the approbation of proper behavior is experimented.

Future investigation of time requirements and system's delays are necessary to be presented. Because of platforms nature consuming computing power and memory limitations are needed to be comprised, it is necessary to be investigated requirements that XML technology faces to work properly with sensible respond times.

Real possible area for deployment of Wireless Gateway is implementation in system for monitoring of health parameters like heart rate, respiratory rate, body temperature, ECG signals, etc. in mobile health applications.

Another direction for future extension of discussed system involves connection of sensors and sensors' networks using 1-wire and RS 485 interfaces to Gateway machine.

Concerning wireless communication GPRS technologies and the possibilities that Sony-Ericsson GPRS modules offer should be mentioned for future development of Wireless Gateway. This way is really very promising for huge data transfer, including vast cover areas that mobile operators offer to these modules, defines the future success of the system.

5. ACKNOWLEDGEMENTS

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