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RFID Systems and Technologies

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A SOAP capable HF-RFID-Reader

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with Focus on Communication Electronics

Agenda

▶ **Motivation**

▶ System Overview

▶ Hardware Structure

▶ Software Structure

▶ RFID and SOAP

▶ Web Server

▶ Summary

▶ Future Work

Motivation

Design of an HF-RFID reader with following most important constraints:

- Simple setup of an RFID reader system with multiple readers

- Easy integration in existing systems

- "open" standard communication via Ethernet (TCP/IP)

- Flexible software architecture to easily extent the system for future releases
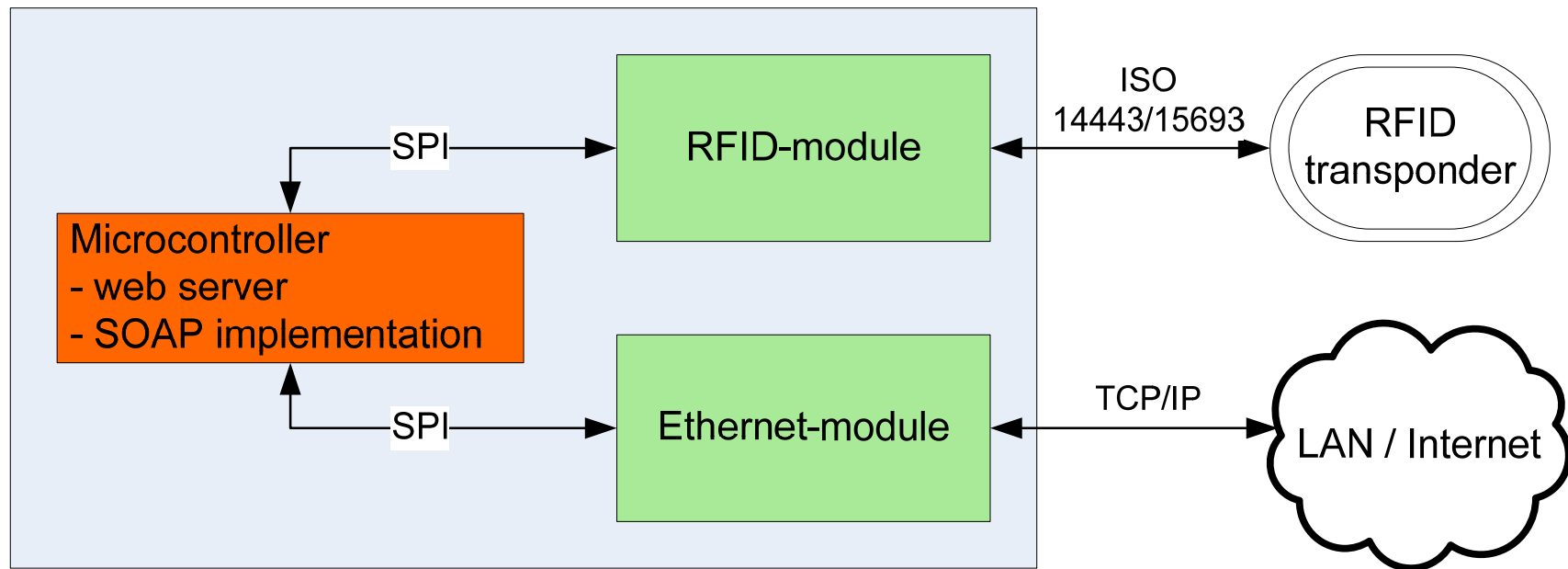
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System Overview

HF-RFID reader:

*   SOAP web service, Web Server, Telnet server
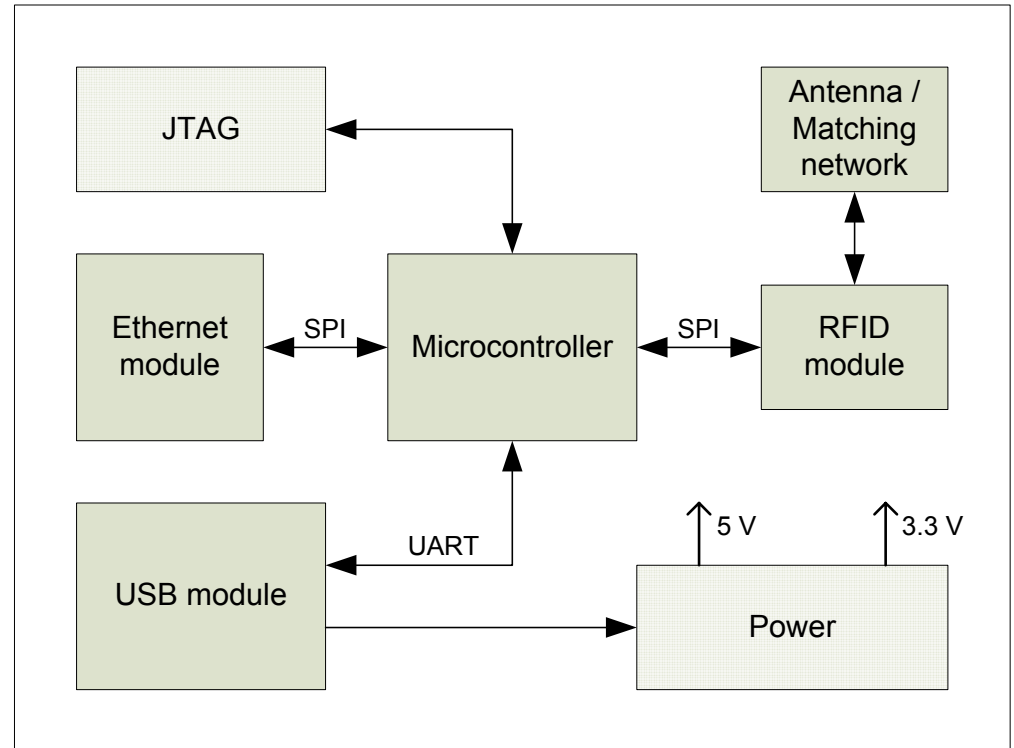
*   ISO 15693 and ISO 14443 at 13.56 MHz

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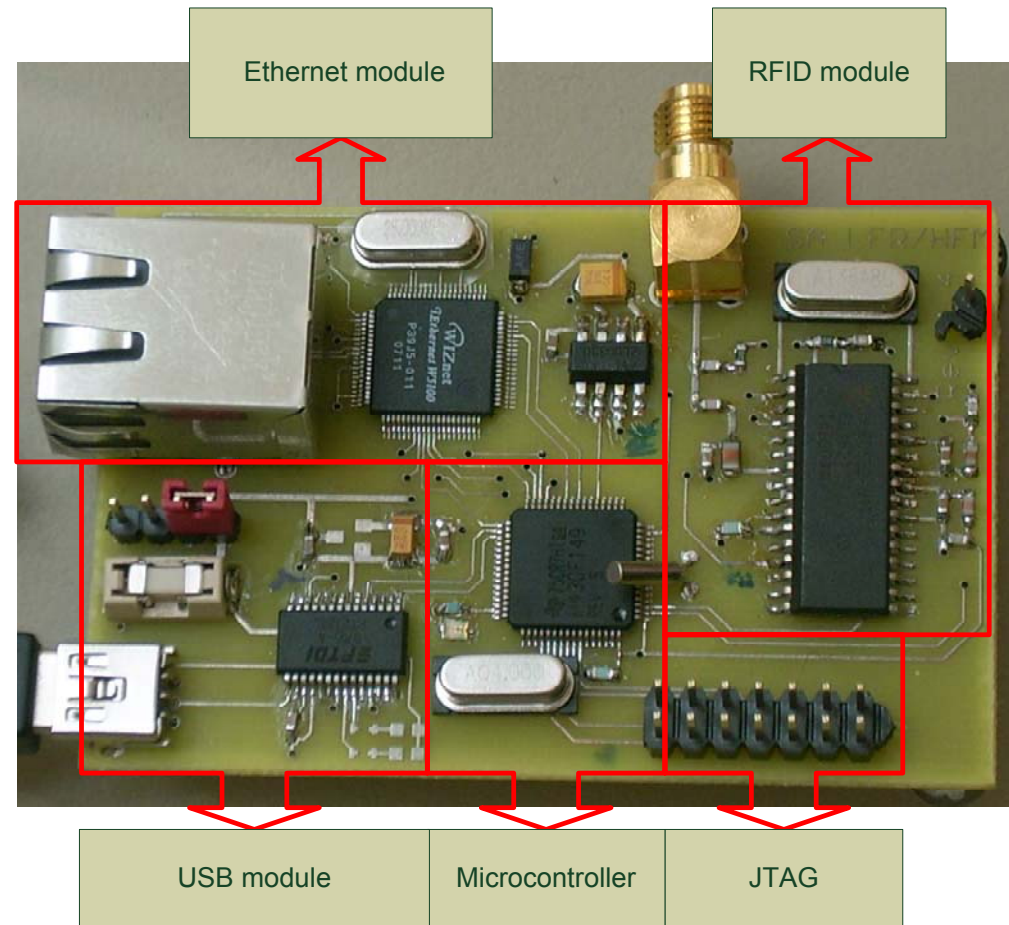with Focus on Communication Electronics

Hardware Structure

- Microcontroller

- JTAG

- Power: 5 V and 3.3 V

- USB module

- Ethernet module

- RFID module

- Antenna / Matching Network

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Hardware Structure (cont'd)

- Microcontroller

- JTAG

- Power: 5 V and 3.3 V

- USB module

- Ethernet module

- RFID module

- Antenna / Matching

  Network

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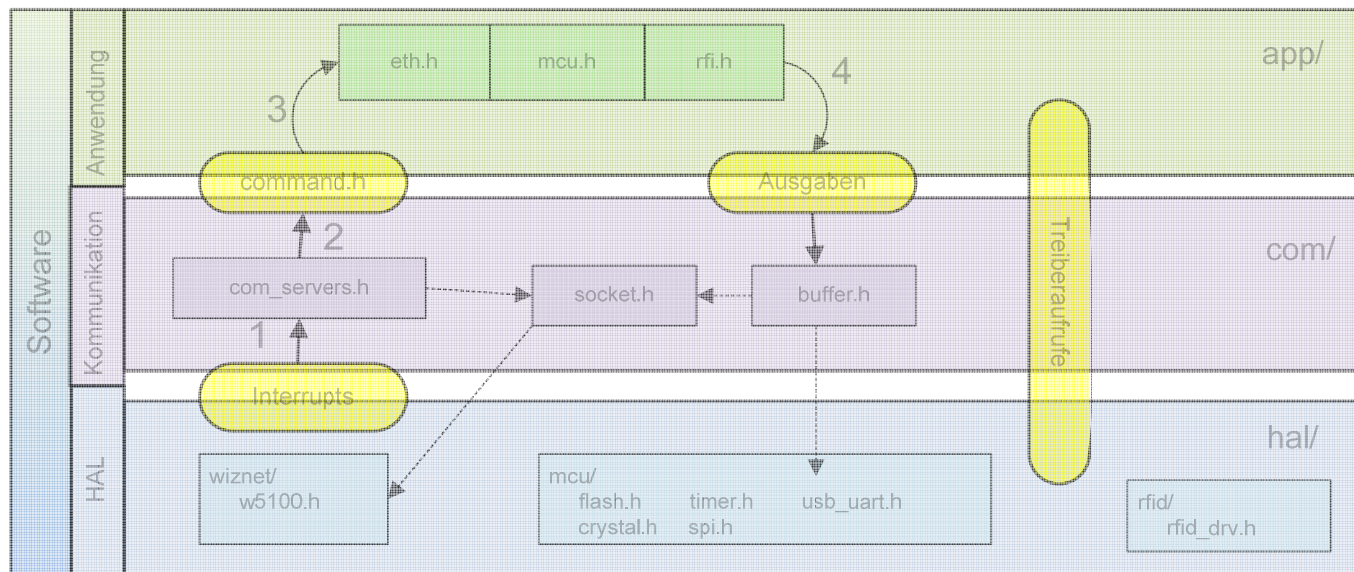with Focus on Communication Electronics

Software Structure

Firmware requirements:

- Easy extension for applications and hardware-drivers

- flexible connection of different communication interfaces

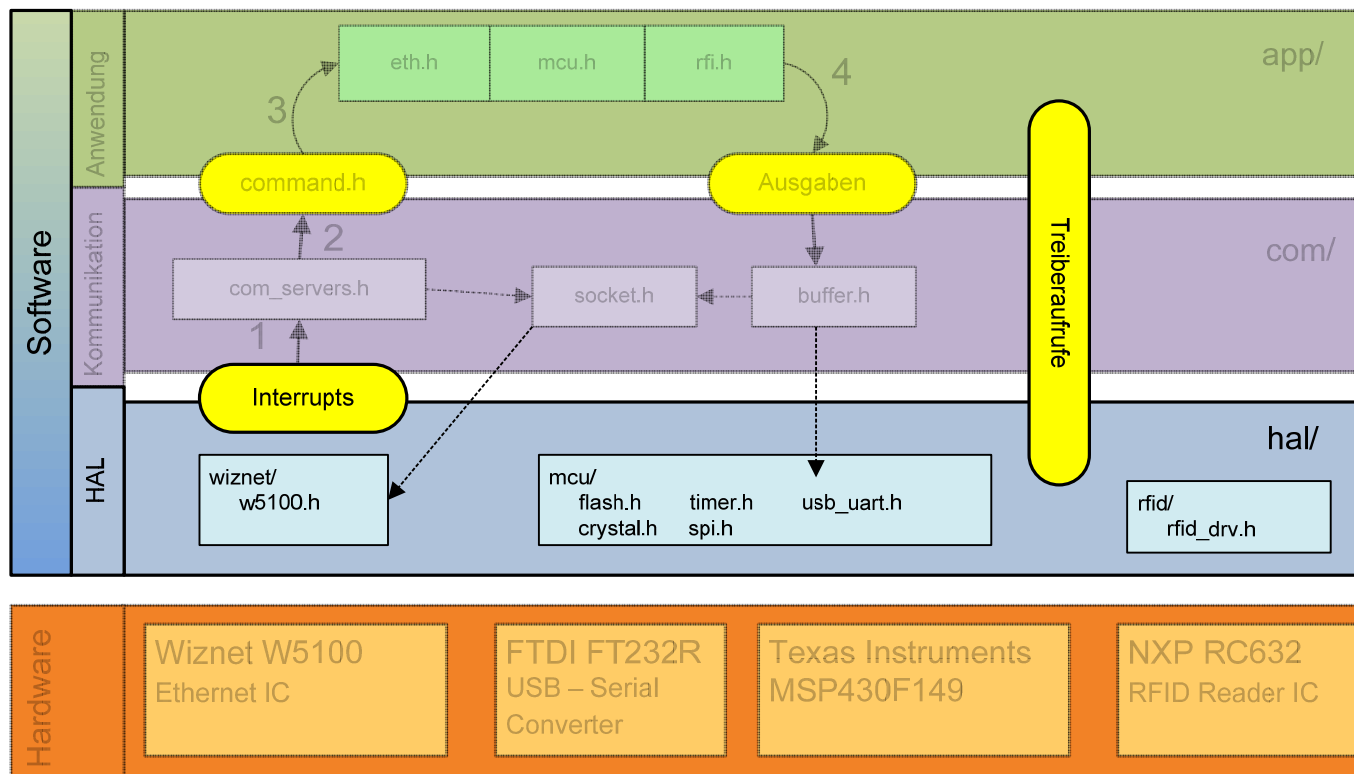- Encapsulation in modules

Software Structure (cont'd)

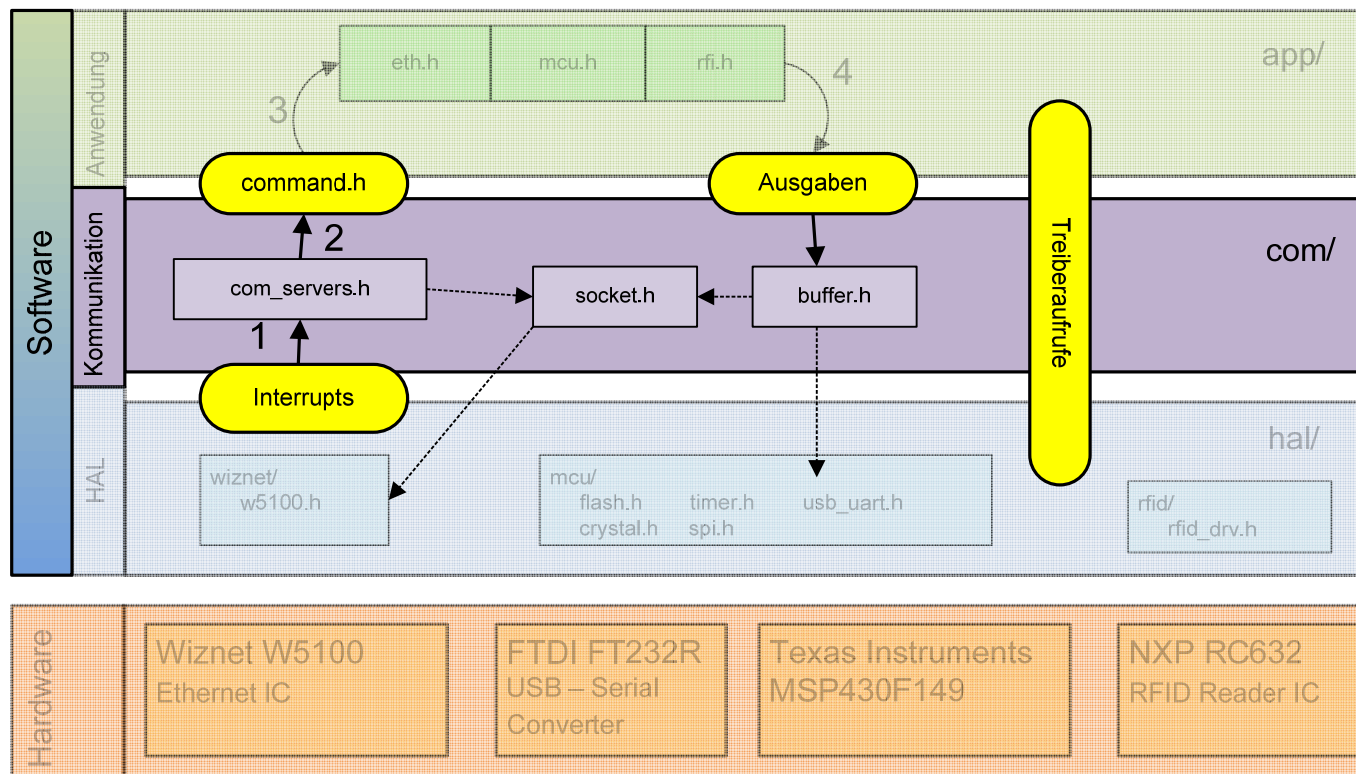▶ Hardware: Ethernet, USB, Microcontroller, RFID-Reader

Software Structure (cont'd)

▶ HAL (Hardware abstraction layer): hardware driver to encapsulate the hardware access for the communication layer
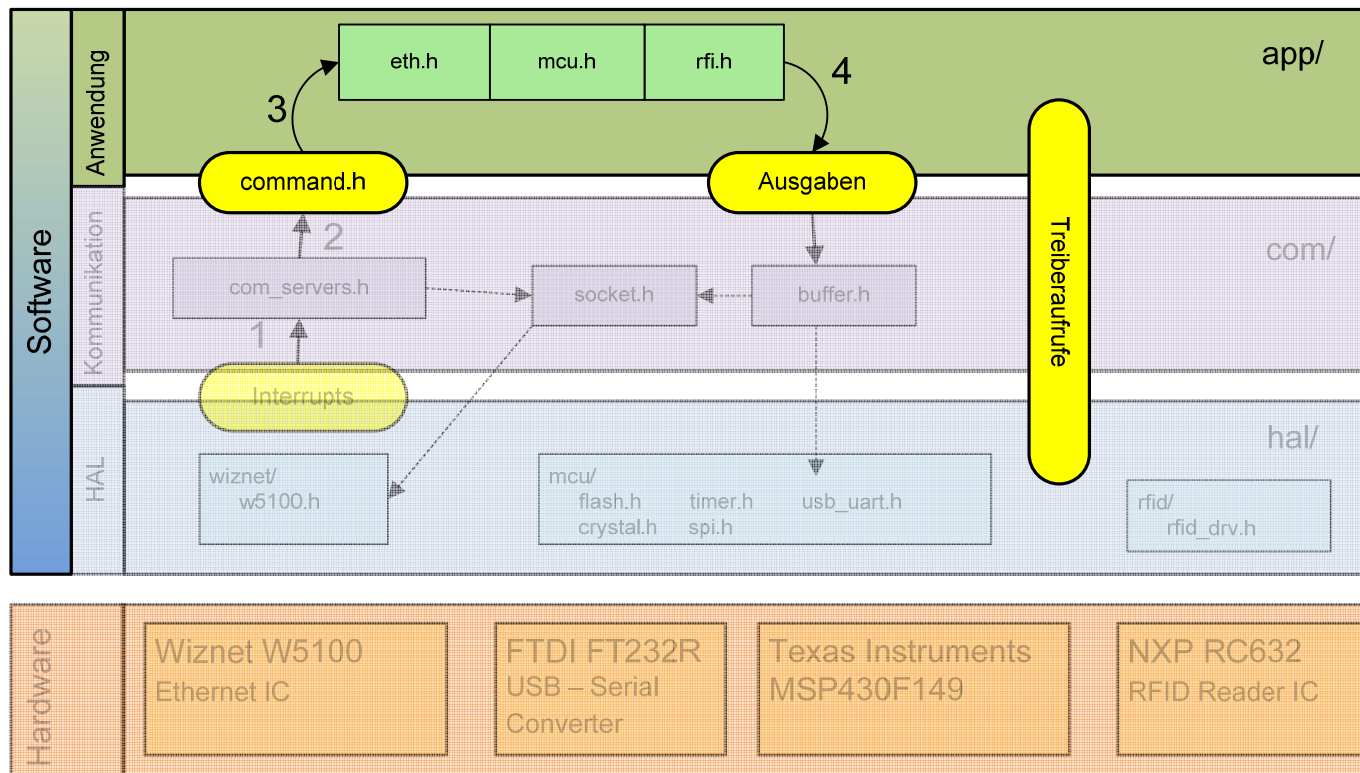
Software Structure (cont'd)

▶ Communication layer: evaluation of inputs and generation of outputs

→ provides transparent access for the applications

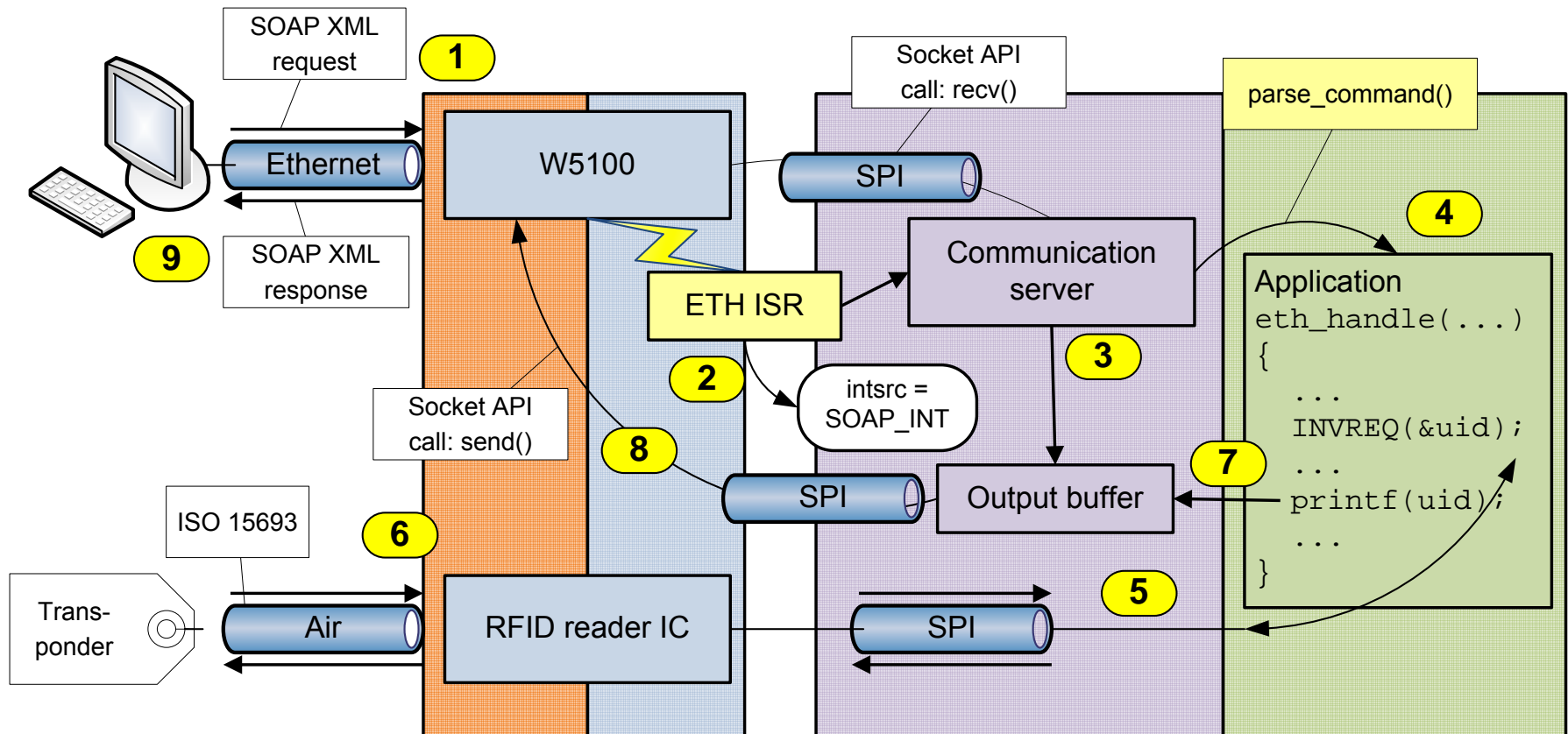# Software Structure (cont'd)

▶ Application layer: process commands, generates driver calls and returns results. Applications are Web Server, SOAP Web Service, …

Software Structure (cont'd)

Example of a SOAP request:

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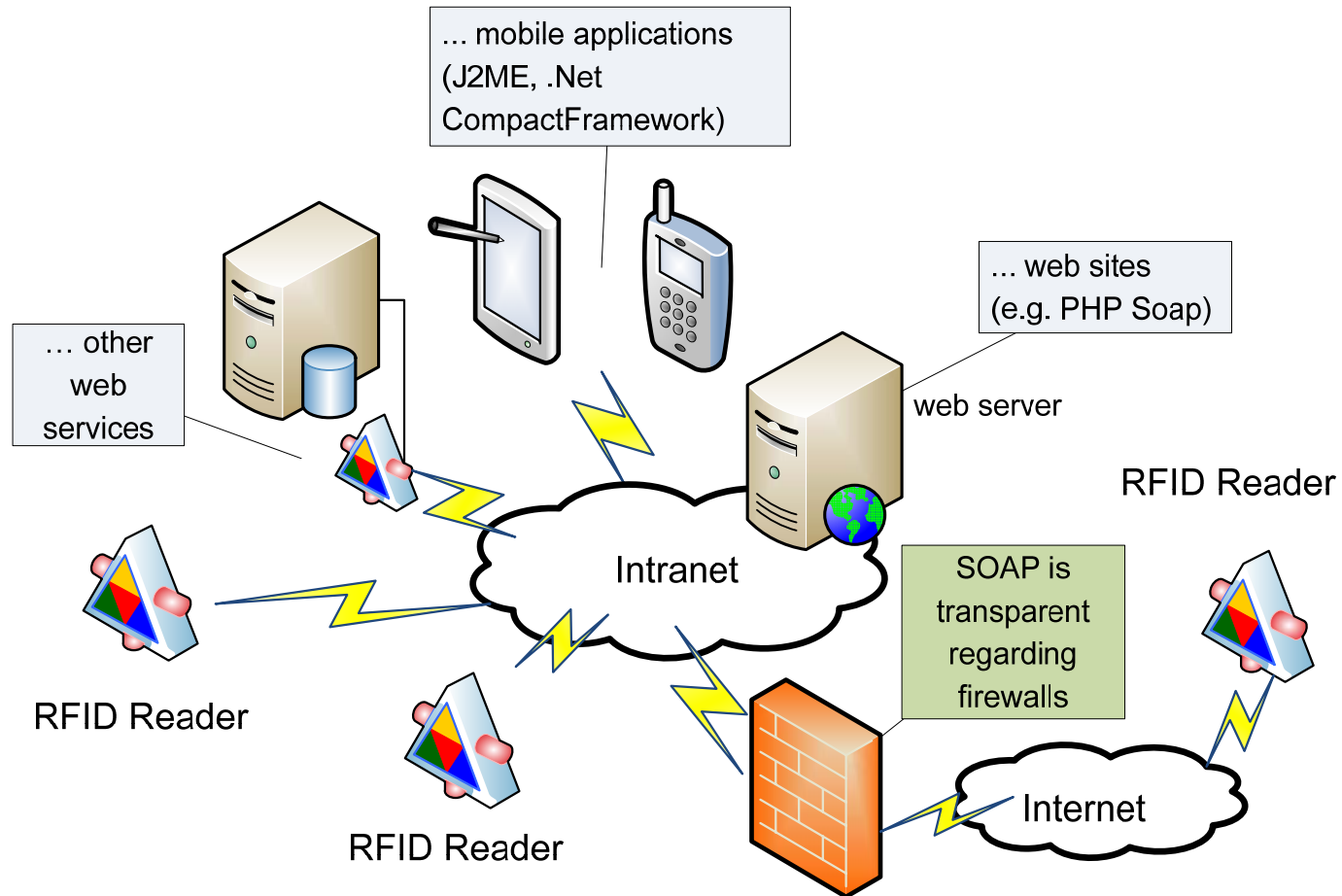with Focus on Communication Electronics

RFID and SOAP

Introduction to SOAP:

- ▶ "Simple Object Access Protocol"

- ▶ SOAP is a web service

- ▶ Communication via XML-based data

- ▶ Data Transfer via Internet protocols such as http, smtp, … over TCP/IP

- ▶ No problems regarding proxies and firewalls

- ▶ SOAP is platform and language independent

- ▶ Defined by World Wide Web Consortium (W3C)

RFID and SOAP (cont'd)

Embedding the readers as web services in ...

... mobile applications (J2ME, .Net CompactFramework)

... web sites (e.g. PHP Soap)

web server

... other web services

RFID Reader

RFID Reader

RFID Reader

RFID Reader

Intranet

SOAP is transparent regarding firewalls

Internet

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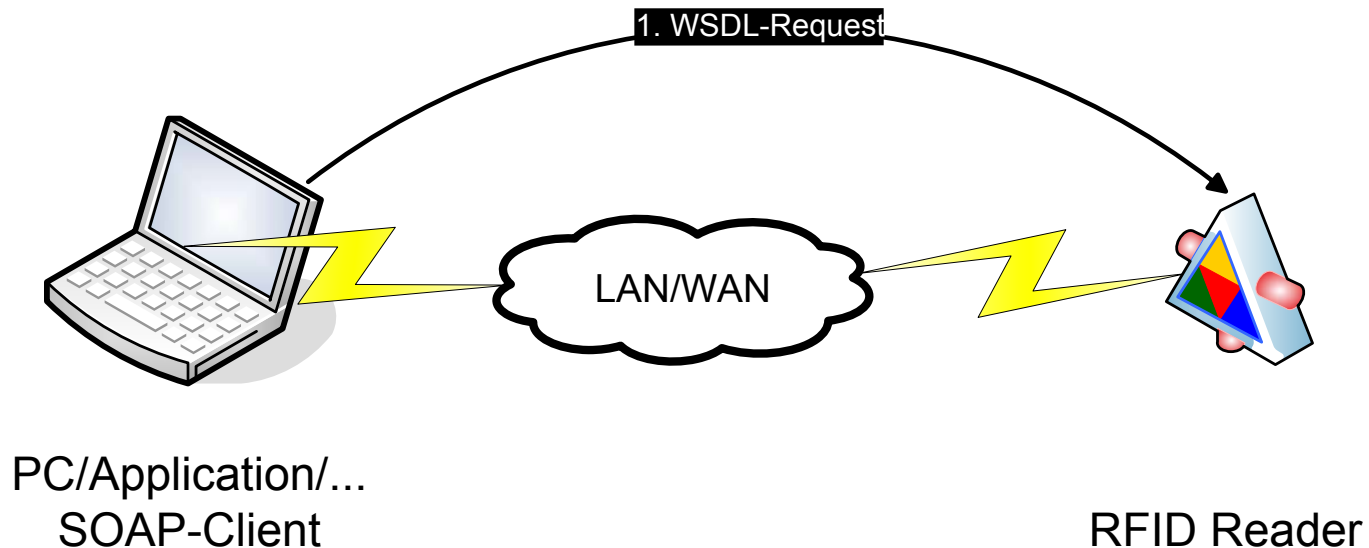with Focus on Communication Electronics
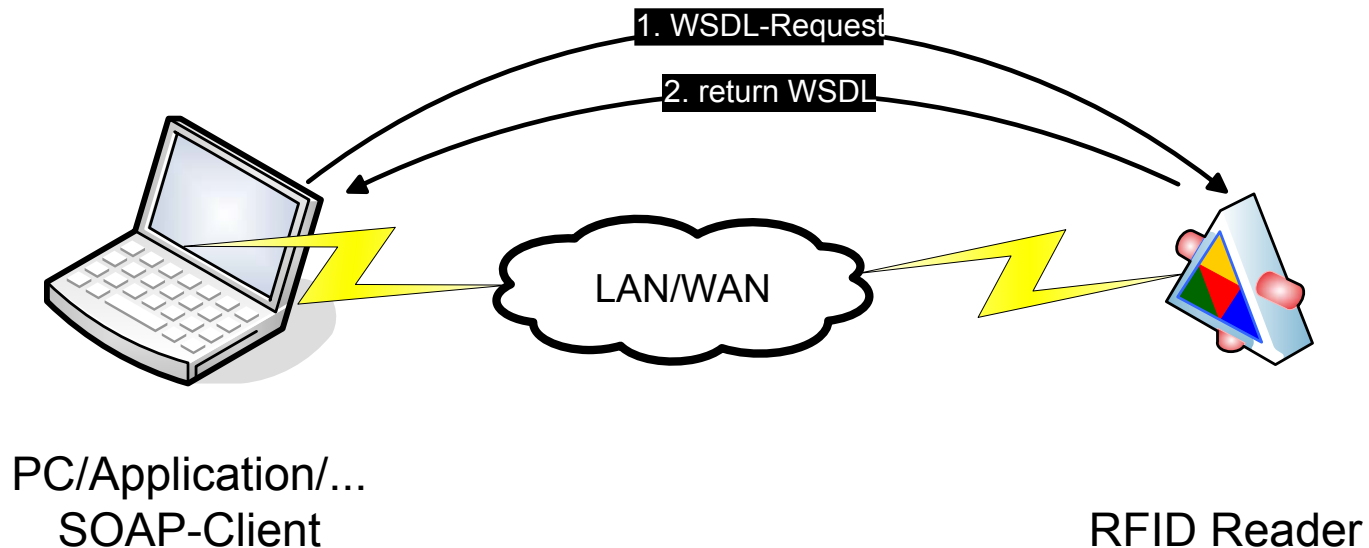
Introduction to SOAP

How does SOAP work?

(1) SOAP-Client (application, computer) requests WSDL-file from reader

  ▶ WSDL contains description of the SOAP web service

  ▶ Function definitions, address, …

PC/Application/...
SOAP-Client

RFID Reader

Introduction to SOAP (cont'd)

(1) SOAP-Client (application, computer) requests WSDL-file from reader

(2) The RFID reader (with SOAP web service) returns WSDL-file

- ▶ SOAP-Client generates function definitions from WSDL-file

- ▶ SOAP-Client extracts address of the RFID reader

1. WSDL-Request

2. return WSDL

LAN/WAN

PC/Application/...
SOAP-Client

RFID Reader

Introduction to SOAP (cont'd)

(1) SOAP-Client (application, computer) requests WSDL-file from reader

(2) The RFID reader (with SOAP web service) returns WSDL-file

(3) The SOAP-Client generates SOAP-requests and the RFID reader replies with SOAP-responses

1. WSDL-Request

2. return WSDL

LAN/WAN

PC/Application/...
SOAP-Client

RFID Reader

3. SOAP
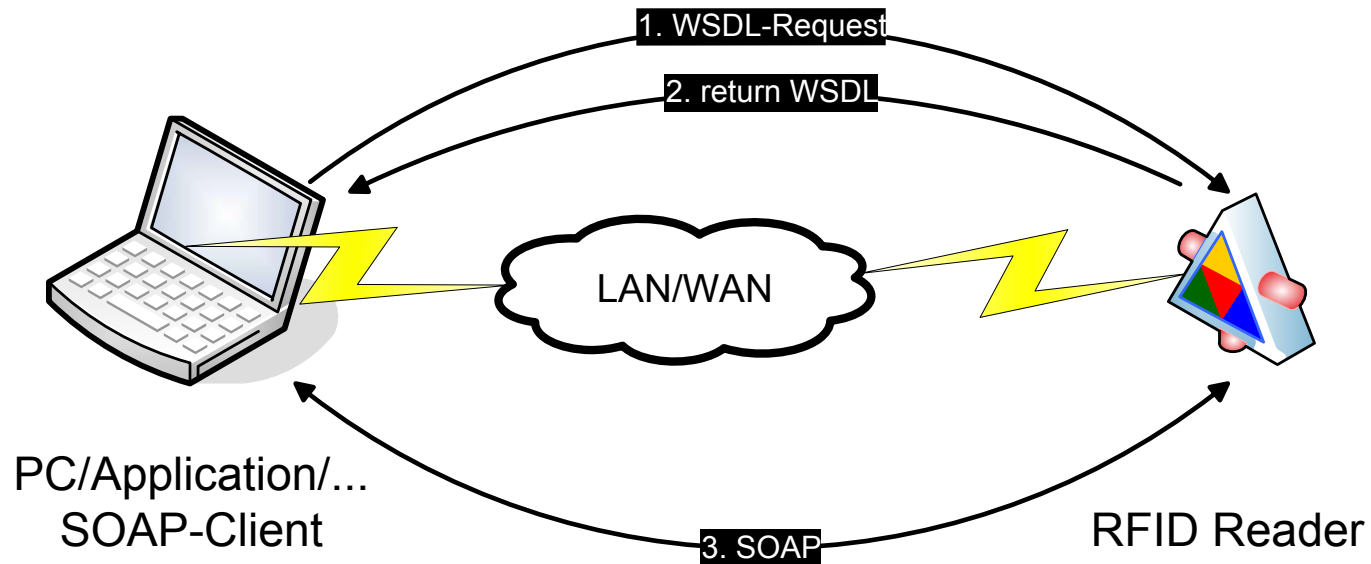
Implementation of SOAP

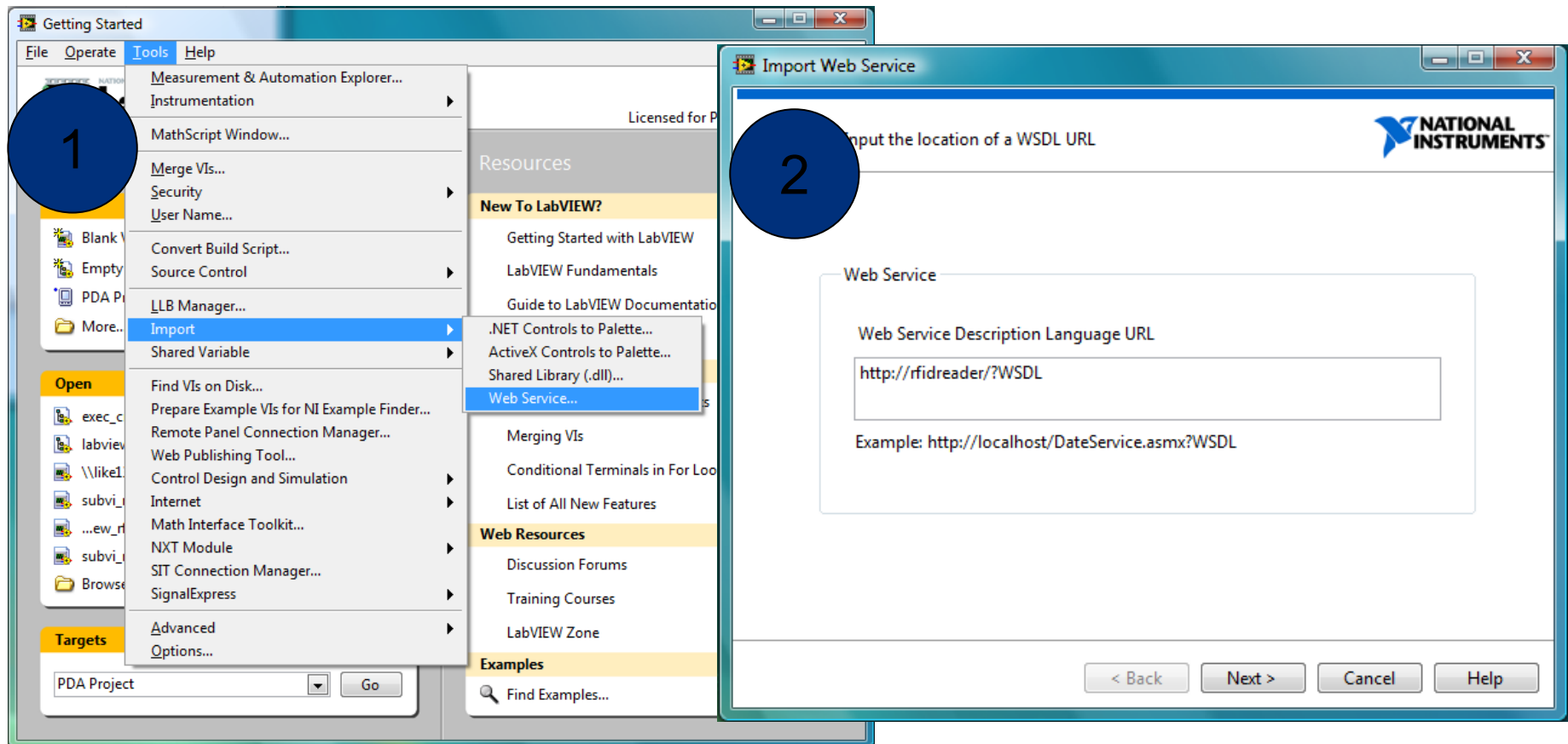Software which supports SOAP:

- .NET
- Java
- LabVIEW
- C/C++/C#
- PHP
- …
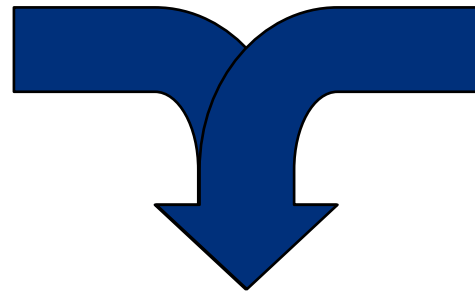
Advantages of SOAP:

- No additional drivers
- OS independent
- Use of XML data provides interfaces for human-machine and machine-machine communication

- Easy implementation into existing (RFID) systems
- Easy to create new RFID infrastructure systems

Implementation of SOAP (cont'd)

Integration of the SOAP RFID system in LabVIEW:

Implementation of SOAP (cont'd)

Integration of the SOAP RFID system in LabVIEW:
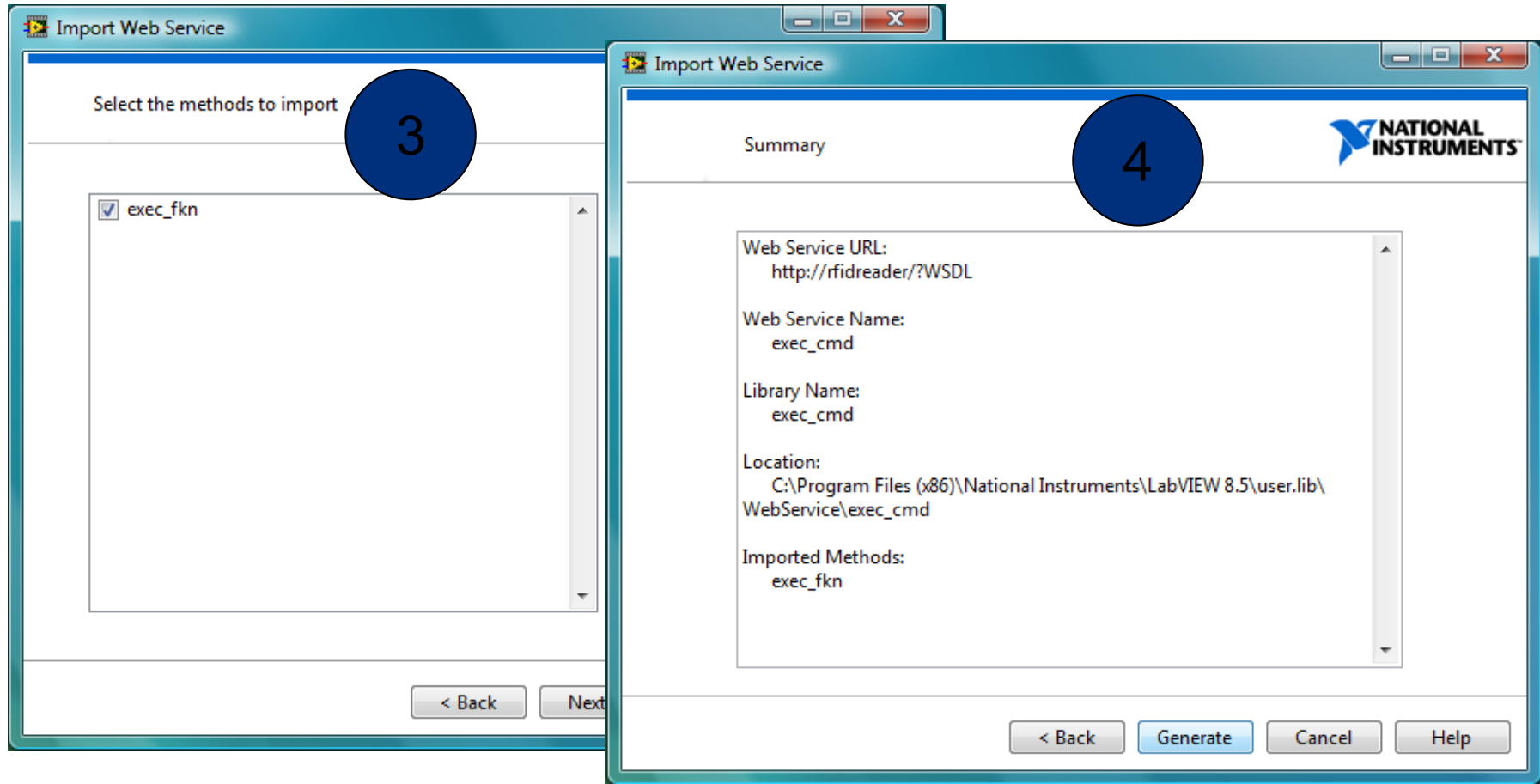
Implementation of SOAP (cont'd)

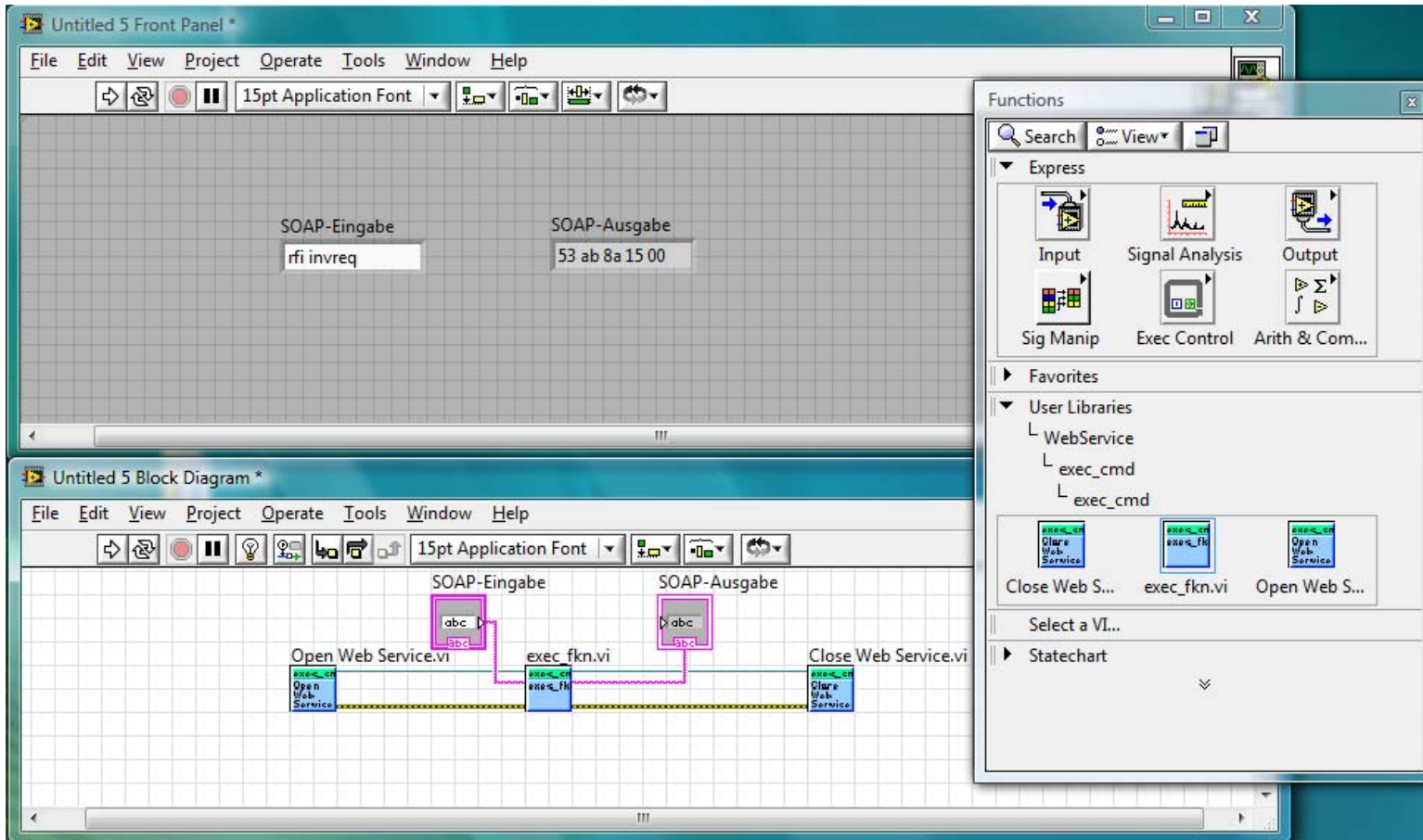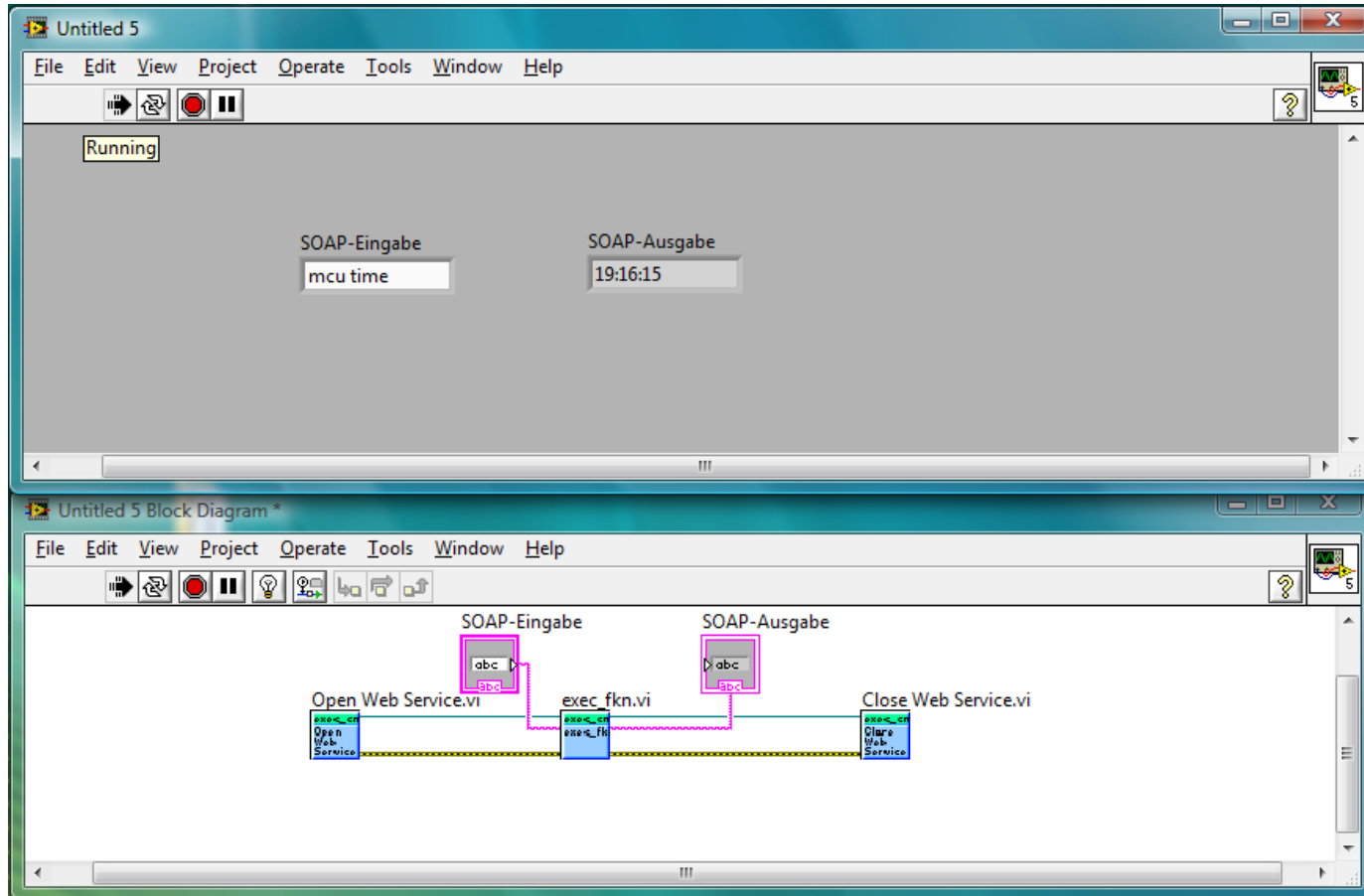Integration of the SOAP RFID system in LabVIEW:

Implementation of SOAP (cont'd)

Integration of the SOAP RFID system in LabVIEW:

Implementation of SOAP (cont'd)

Integration of the SOAP RFID system in Java mobile (Emulation):
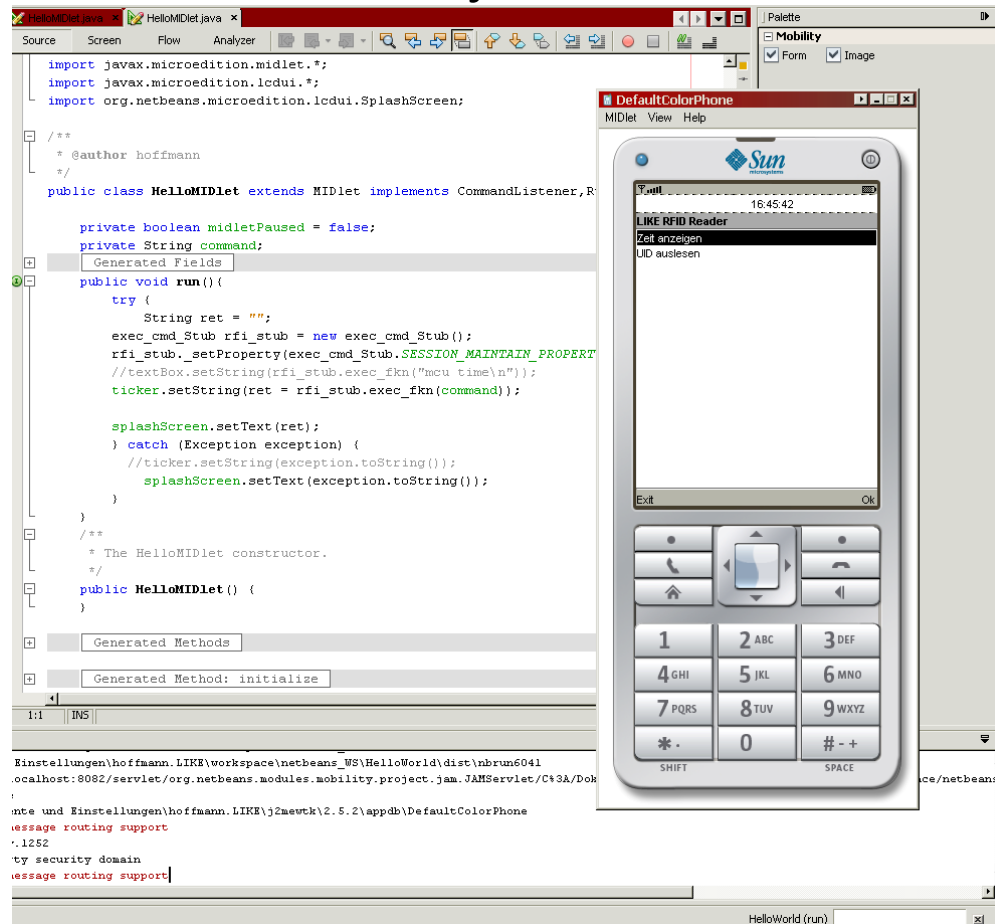
Implementation of SOAP (cont'd)

Integration of the SOAP RFID bile (Emulation):

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Web server

▶ Realized as a compact web server in microcontroller

▶ Accessible via web browser: http://rfidreader/

▶ Works on port 80 → no problems with proxies and firewalls

▶ Execute all reader functions by calling

http://rfidreader/?***modul_function*** e.g.:

http://rfidreader/?rfi_invreq to receive the transponder's UID or

http://rfidreader/?mcu_time to get the current time

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Summary

A SOAP capable RFID reader was introduced:

▶ HF-RFID system based on a 16-Bit microcontroller at 4 MHz with USB and Ethernet connectors

▶ Flexible software architecture (3 software layers: HAL, communication and application) to easy extend the system functions

▶ Implementation of a SOAP web service to be platform and OS independent (no extra drivers), only TCP/IP via http connection necessary

▶ Additional compact web server implementation

▶ Low power consumption: 535 µA in lowest power mode

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Future work

- Creation of independent RFID sensor nodes by creating an SOAP-based interconnection between the RFID readers

- Power over Ethernet capability to use only "one" cable

- Further reducing of size and power consumption

- Extension to more RFID standards and/or frequencies (realized: ISO 15693 and ISO 14443 at 13.56 MHz)

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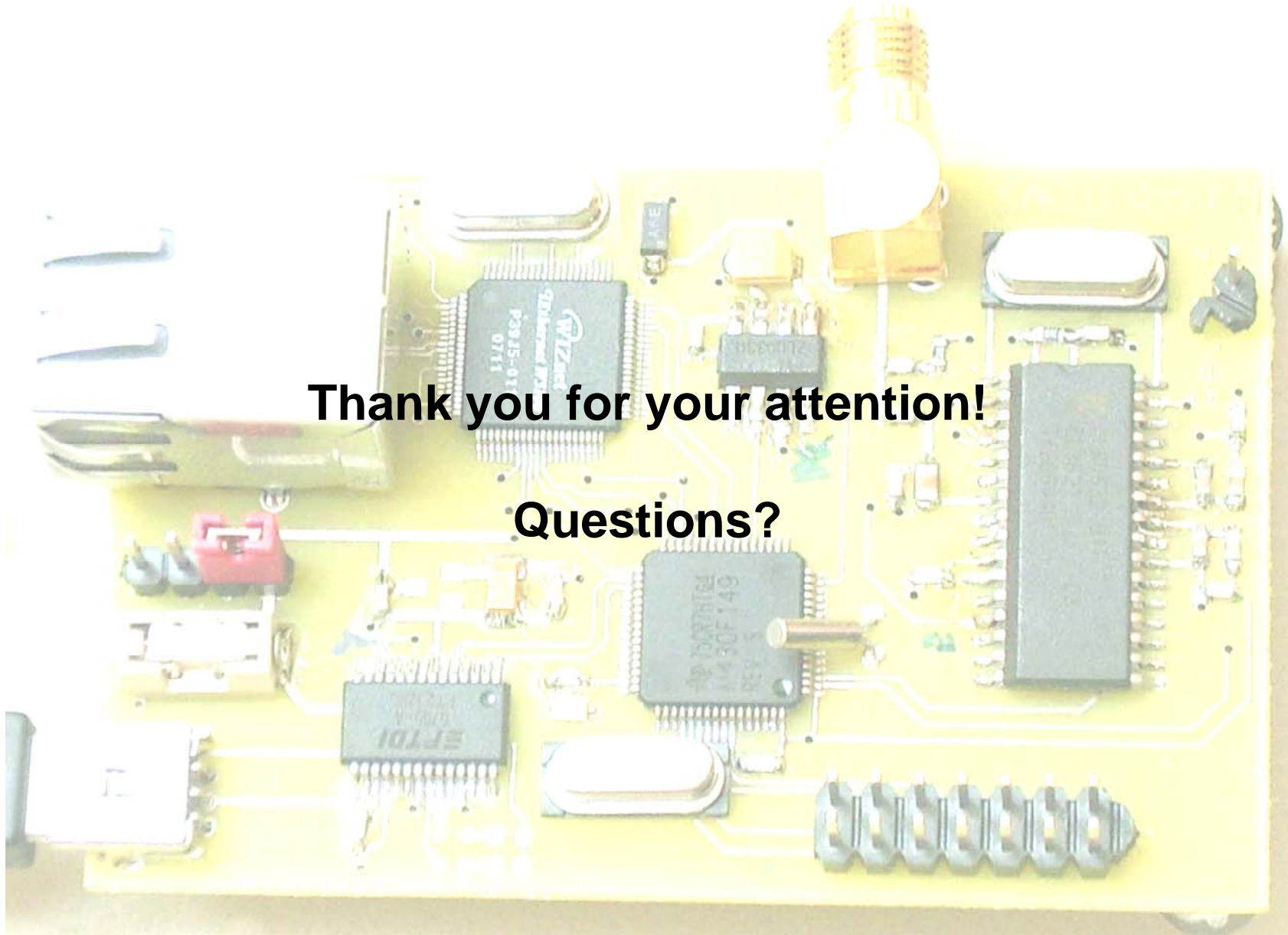
Thank you for your attention!

Questions?

▶ WSDL:

```xml
- <definitions targetNamespace="http://rfidreader:3333/SOAP/"
    xmlns:http="http://schemas.xmlsoap.org/wsdl/http/"
    xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
    xmlns:s="http://www.w3.org/2001/XMLSchema"
    xmlns:s0="http://rfidreader:3333/SOAP/"
    xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
    xmlns:tm="http://microsoft.com/wsdl/mime/textMatching/"
    xmlns:mime="http://schemas.xmlsoap.org/wsdl/mime/"
    xmlns="http://schemas.xmlsoap.org/wsdl/">
  - <types>
    - <s:schema elementFormDefault="qualified"
        targetNamespace="http://rfidreader:3333/SOAP/">
      - <s:element name="exec_fkn">
        - <s:complexType>
          - <s:sequence>
              <s:element minOccurs="1" maxOccurs="1" name="command"
                type="s:string" />
            </s:sequence>
          </s:complexType>
        </s:element>
      - <s:element name="exec_fknResponse">
        - <s:complexType>
          - <s:sequence>
              <s:element minOccurs="0" maxOccurs="1" name="exec_fknResult"
                type="s:string" />
            </s:sequence>
          </s:complexType>
        </s:element>
      </s:schema>
    </types>
  - <message name="exec_fknSoapIn">
      <part name="parameters" element="s0:exec_fkn" />
    </message>
  - <message name="exec_fknSoapOut">
      <part name="parameters" element="s0:exec_fknResponse" />
    </message>
  - <portType name="exec_cmdSoap">
    - <operation name="exec_fkn">
        <input message="s0:exec_fknSoapIn" />
        <output message="s0:exec_fknSoapOut" />
      </operation>
    </portType>
  - <binding name="exec_cmdSoap" type="s0:exec_cmdSoap">
      <soap:binding transport="http://schemas.xmlsoap.org/soap/http"
        style="document" />
    - <operation name="exec_fkn">
        <soap:operation soapAction="exec_fkn" style="document" />
      - <input>
          <soap:body use="literal" />
        </input>
      - <output>
          <soap:body use="literal" />
        </output>
      </operation>
    </binding>
  - <service name="exec_cmd">
    - <port name="exec_cmdSoap" binding="s0:exec_cmdSoap">
        <soap:address location="http://like188:3333/SOAP" />
      </port>
    </service>
  </definitions>
```

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Appendix

▶ SOAP-Request:

```
– <soapenv:Envelope
    xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
    xmlns:soap="http://rfidreader:3333/SOAP/">
    <soapenv:Header />
– <soapenv:Body>
  – <soap:exec_fkn>
      <soap:command>mcu time</soap:command>
    </soap:exec_fkn>
    </soapenv:Body>
  </soapenv:Envelope>
```

Appendix

▶ SOAP-Response:

```
– <SOAP-ENV:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-
   Instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:SOAP-
   ENV="http://schemas.xmlsoap.org/soap/envelope/">
   – <SOAP-ENV:Body>
      – <exec_fknResponse xmlns="http://rfidreader:3333/SOAP/">
         <exec_fknResult>Time: 11:50:02</exec_fknResult>
      </exec_fknResponse>
   </SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```