Versatile Sensor Node (VSN) platform - design of hardware and software

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Introduction

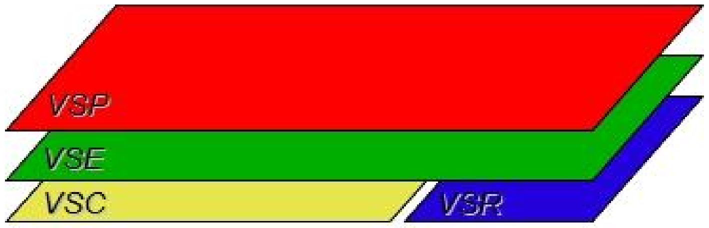
- A new WSN node - The Versatile Sensor Node
- Designed and developed in collaboration with ISOTEL d.o.o.
- Multiple purpose design, can be used in many different applications
- Open source software

Concept of the Versatile Sensor Node

- Modular base, which can be quickly adapted to various applications
- Powerful micro-controller with a ARM Cortex-M3 core
- Supports basic digital interfaces such as I^2C, SPI, UART, IrDA and analog interfaces ADC and DAC
- Dedicated radio module that supports ISM band frequencies (315 MHz, 433 MHz, 868 MHz, 915 MHz and 2400 MHz), Xbee and Bluetooth modules
- Various options for powering the nod

VSN Modules

- VSN comprises of at least two different modules
- The core module – VSC supports the micro-controller and power supply
- The radio module – VSR houses the low power radio interfaces
- The expansion modules – VSE



- The power module – VSP provides additional power supply options

VSC Module

- Used micro-controller is STM32F103 with 512 kB flash, 64 kB RAM and maximum clock of 72 MHz
- Additional memory 128 kB FRAM, miniSD card
- Supported interfaces USB, RS232, UART, IrDA, SPI, I^2C, 12 bit ADC, DAC, instrumental differential amplifier with settable gain
- Selectable system voltage (3,3 V, 3 V, 2,3 V)
- Battery charger and solar battery charger with MPPT (Maximum Power Point Tracker)

VSC Module power states

- The micro-controller has a few standard low power states
- Supported low power modes: Sleep, Stop and Standby
- Additional low power mode : Deep Hibernation
- Power consumption in deep hibernation is below 7 µA
- The node can be woken from deep hibernation using RTC alarm
- System state can be recalled from external high speed non volatile memory

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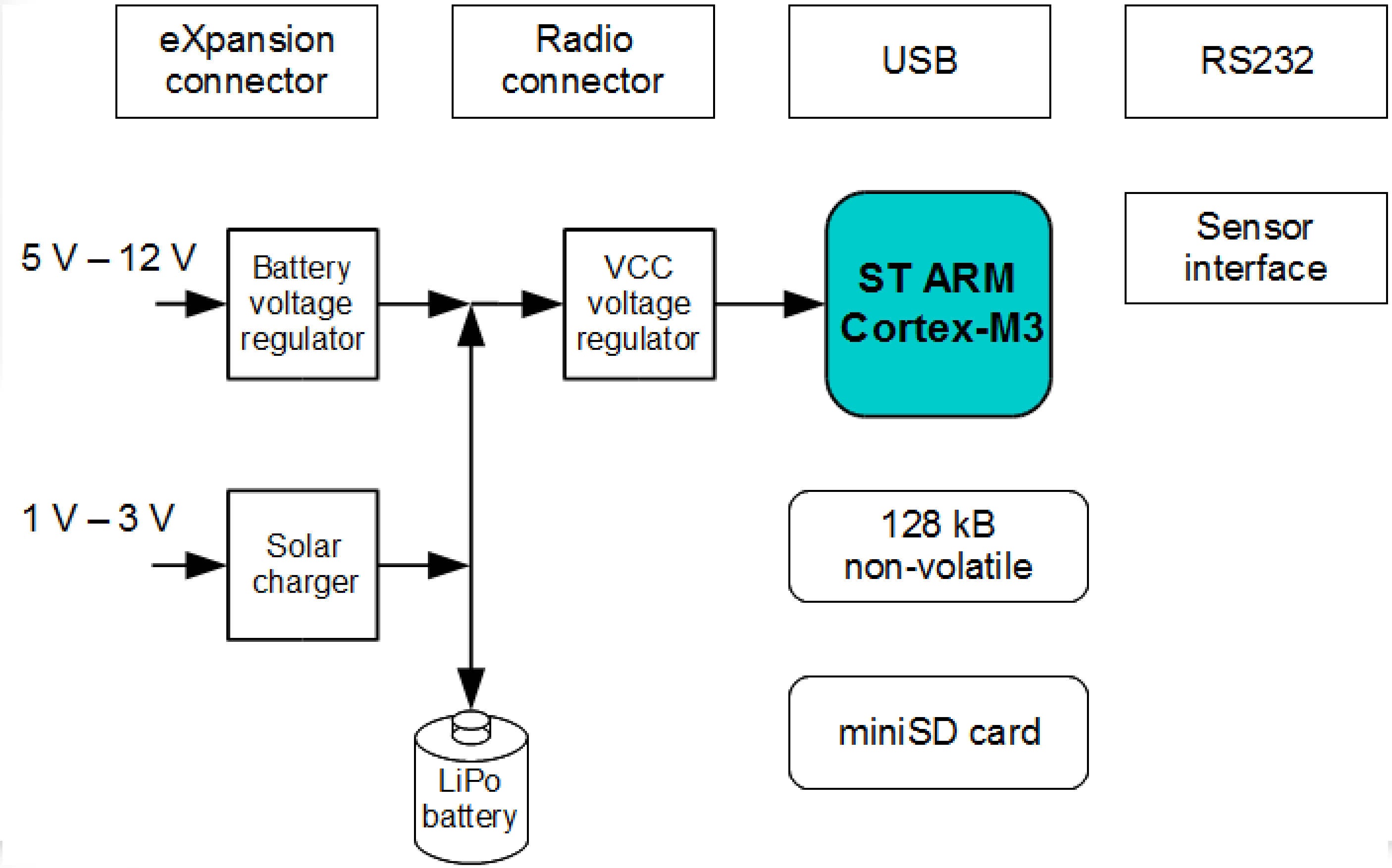
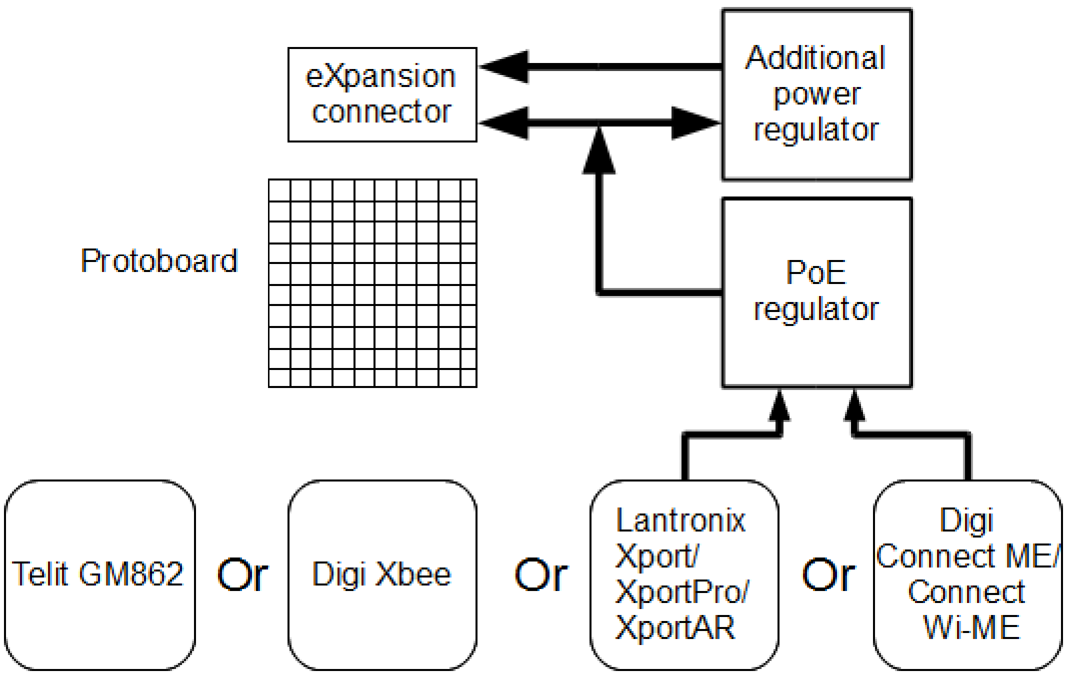
VSC module block schematic



VSE Module

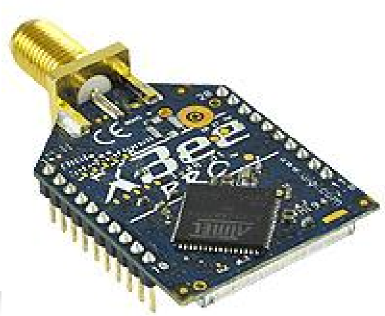
- Communication expansion module which supports:
  - Serial to Ethernet (Xport, Xport Pro, XportAR, Connect-Me) converters from Lantronix and Digi with PoE power supply
  - Serial to Wi-Fi (Connect-Wi-Me) converter from Digi
  - Telit GM862
  - Xbee or Bluetooth modules
- Development module with a standard 20 pin JTAG connector, and small protoboard
- Full size protoboard for application testing

Communication VSE module block schematic



VSR Module

- Low power radio module
- Supports ISM band frequencies from 315 MHz to 2,4 GHz
- Sub GHz frequencies CC1101 from Texas Instruments
- 2,4 GHz frequency band CC2500 from Texas Instrument
- Optionally a Xbee or Bluetooth module can be attached



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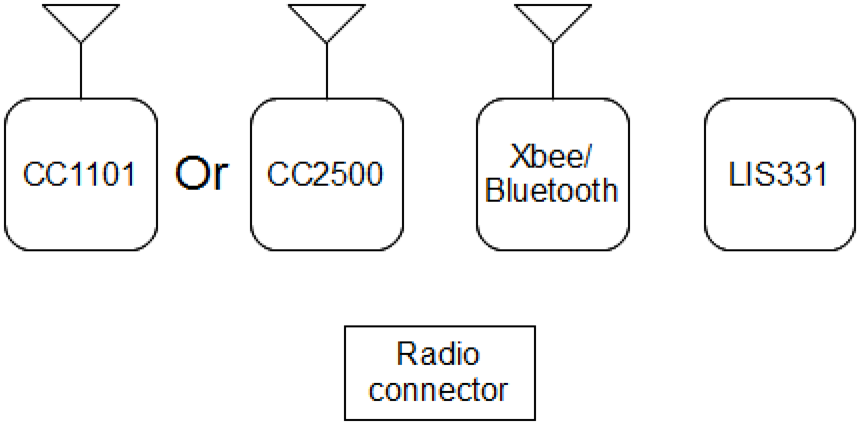
VSR Module block schematic



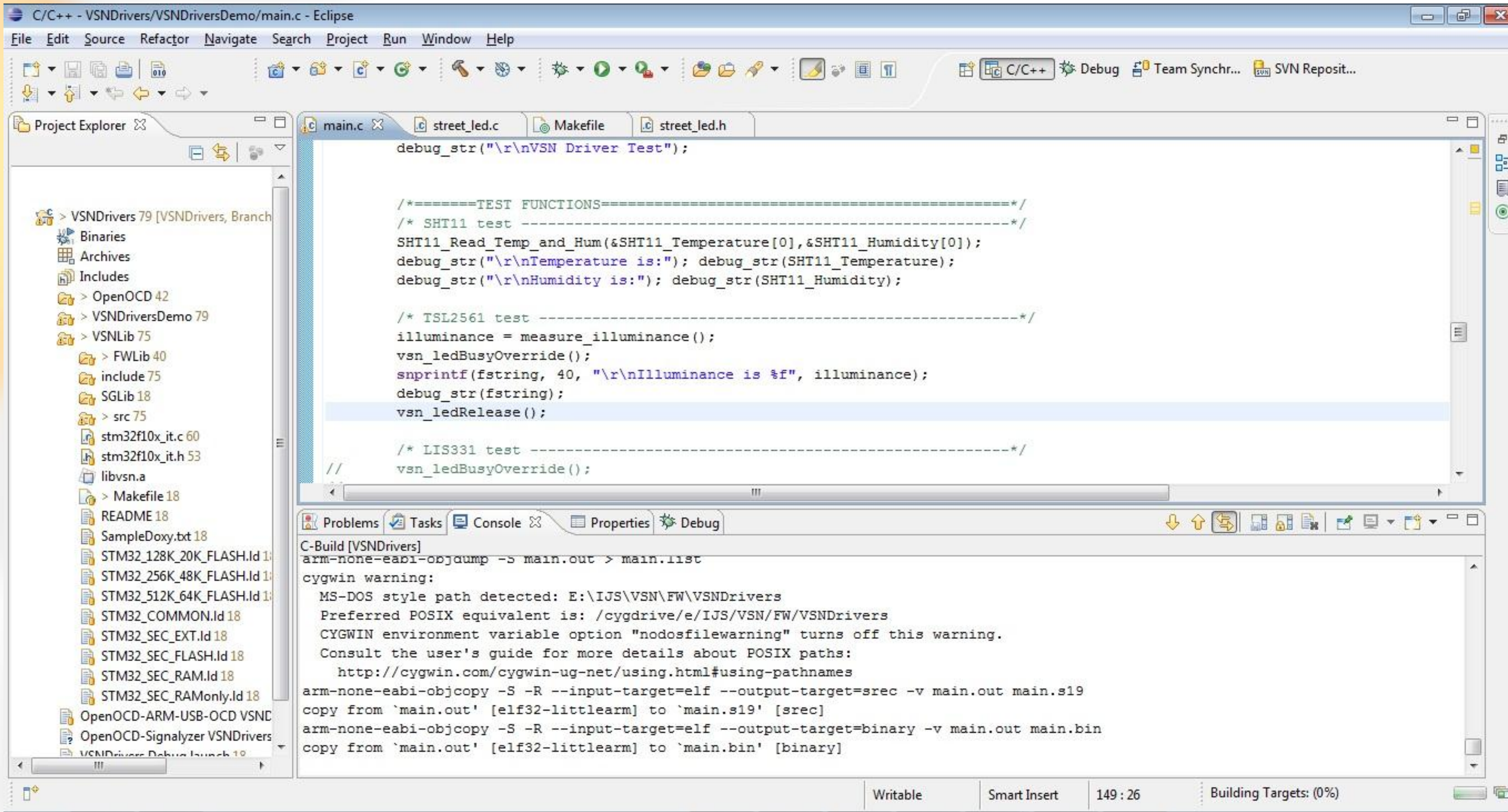
Tools and principles used in VSN design process

- For developing two layer PCBs we used CadSoft Eagle Student edition
- For hardware simulation we used SpiceOpus, a free Spice package
- Most of circuits can be designed with the help of application notes and fine tuned with simulation and trial and error

Software development tools

- Professional
  - Keil, full development system
- Open Source
  - Development environment: Eclipse IDE
  - Tool-chain: Sourcery G++ Lite
  - Cygwin, Linux environment for Windows
  - JTAG server: OpenOCD
  - JTAG hardware interface: Olimex ARM-USB-OCD

Eclipse IDE C/C++



Project build system

- Fully customizable build system based on makefiles
- Requires knowledge of how the building system works
- Provides full control of the build process

http://imgs.xkcd.com/comics/compiling.png

The ST Standard Peripheral Library

- We use the ST Standard Peripheral Library V3.1.2
- The library deals with register and bit peripheral access so we don't have to
- The library provides macros for various register addresses and states
- All other software including the device drivers are build on top of this library

Driver development general pointers

- The STM32F103 Reference manual is your best friend
- The sensor/device datasheet is your second best friend
- If your best friends fail to provide you with enough information ask Google
- Have patience

Driver development procedure

1) Identify the sensor/device interface
2) Connect the sensor/device to appropriate pins on VSN
3) Initialize the identified clocks and peripherals of the micro-controller
4) Write a test driver to check if all is working correctly
5) Complete the driver, use interrupts and DMA to maximize the performance

Thank you for your attention.

Questions?

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