Describing radio hardware and software using OWL-DL for software download and certification

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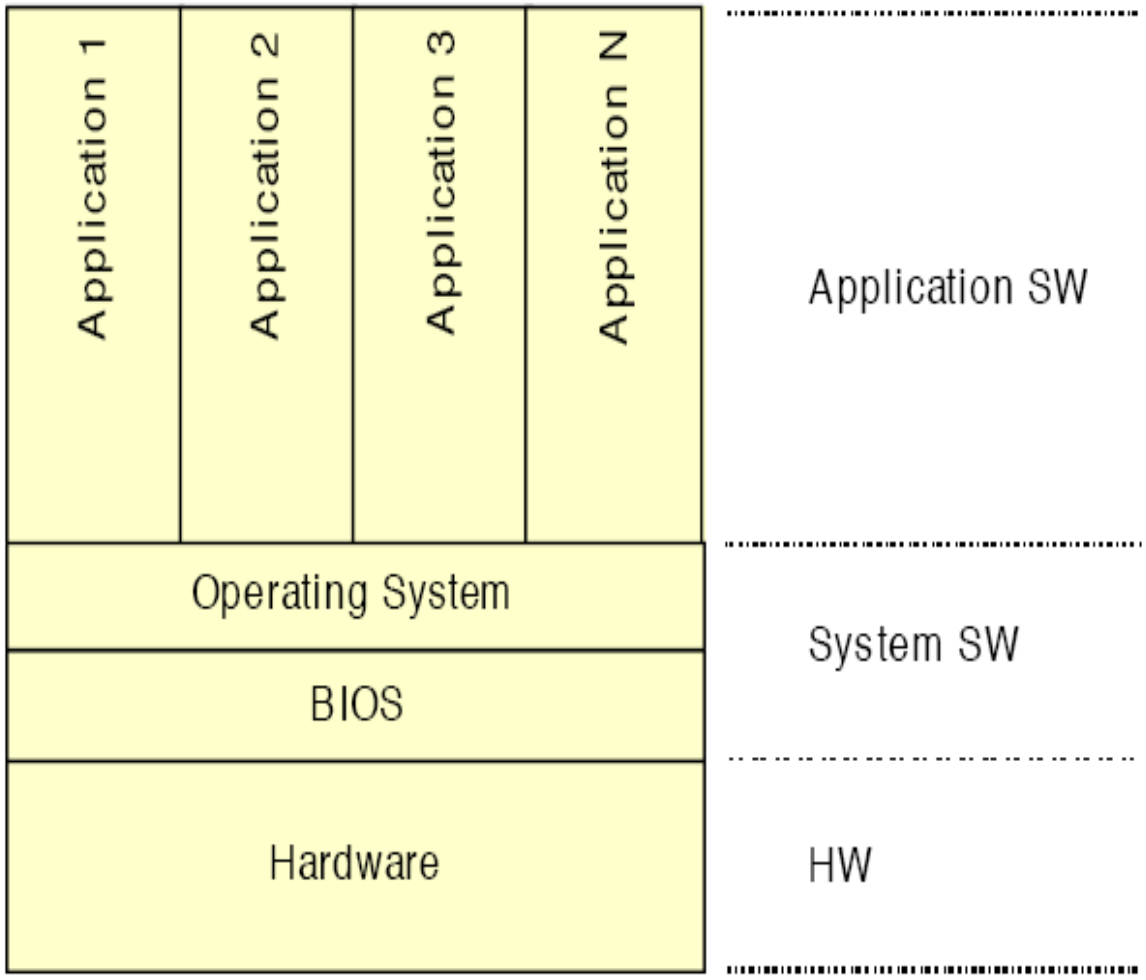
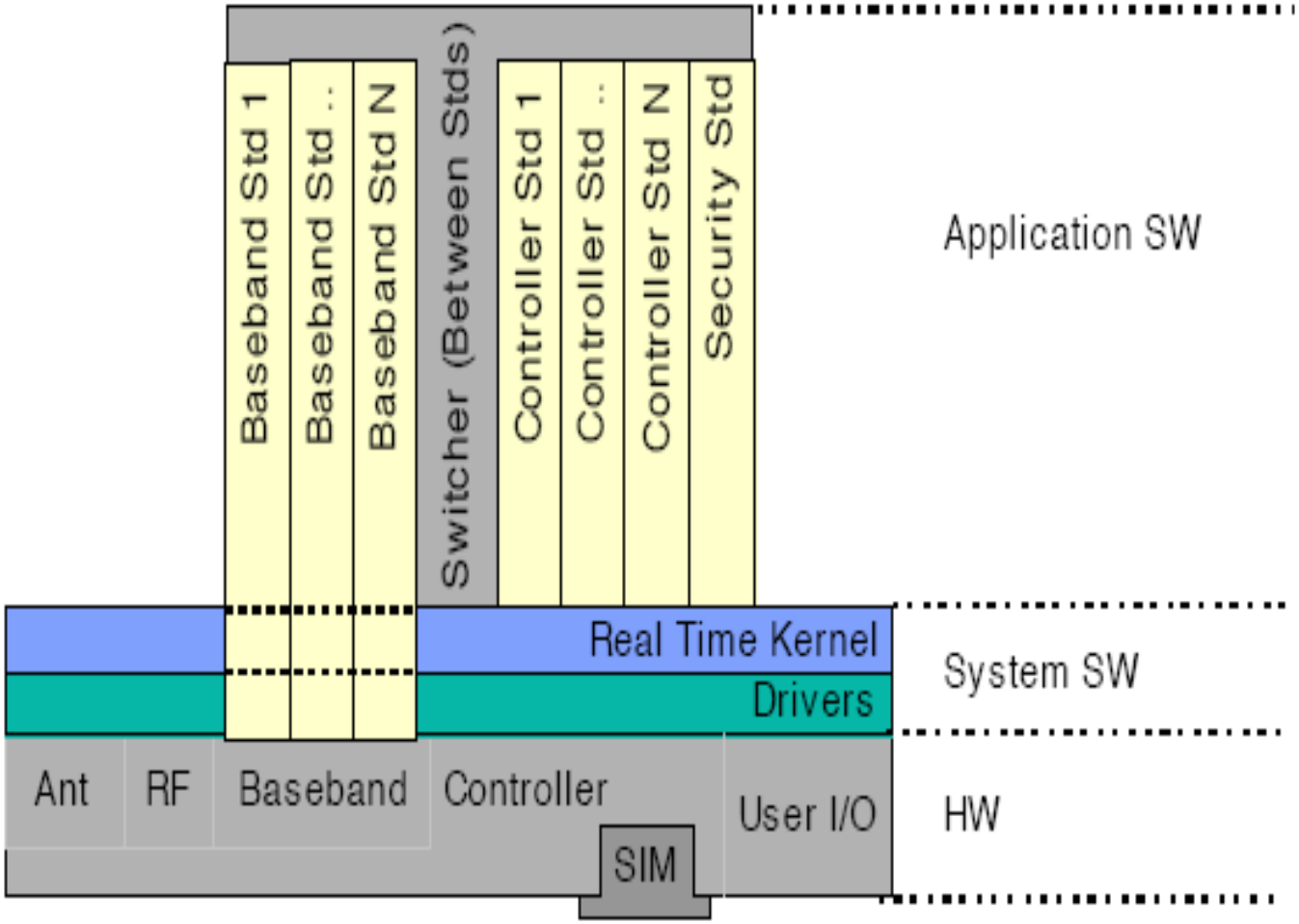
Presentation Overview

- Introduction
  - Computer architecture and radio device architecture
  - Software download
- Radio hardware and software descriptions
- Examples
- Radio software certification
- Conclusions

Generic Computer Architecture



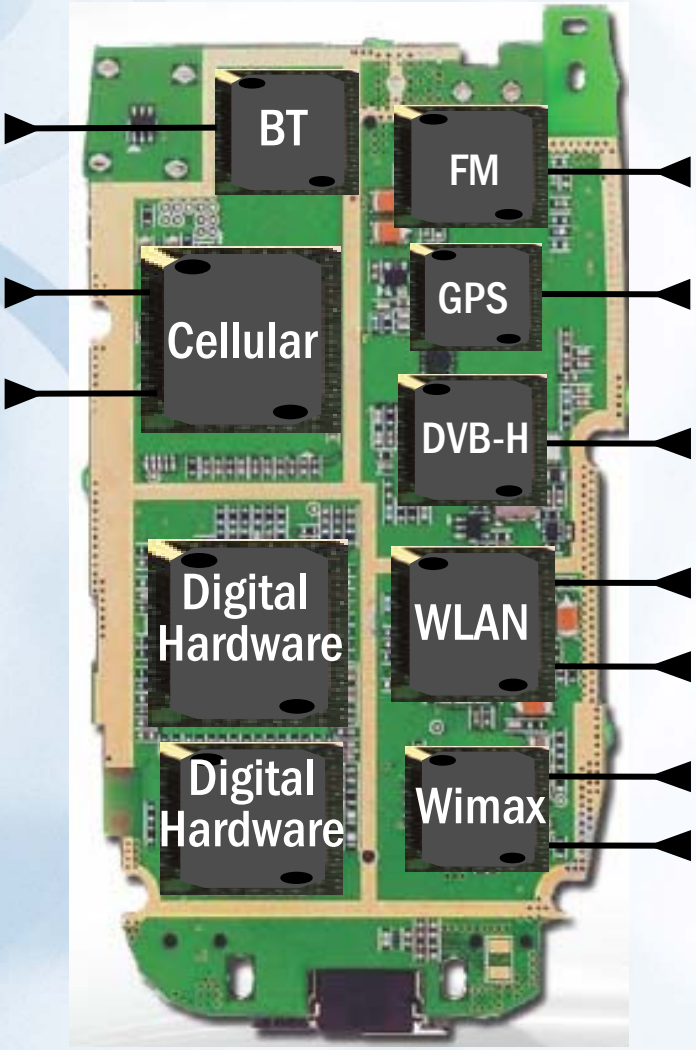
SDR architecture

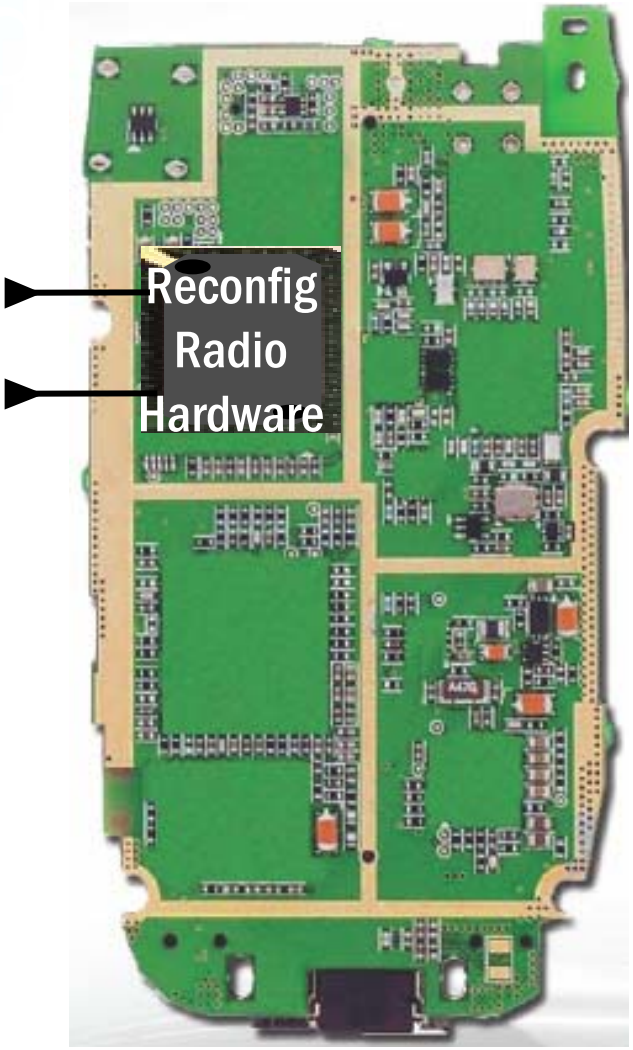


Radio architecture

- Radio software is dependent on radio hardware
- The hardware cannot support all waveforms
  - Unless it is truly, truly SDR

Digital Radio vs SDR





Software Download

- Types of software
  - Any software application
  - software bug fixes
  - **Radio software (of interest here)**
- Methods
  - Using a computer; not wireless
  - Over the air (OTA) – most interesting
- Many challenges – **sw/hw compatibility**; security; regulatory, etc.

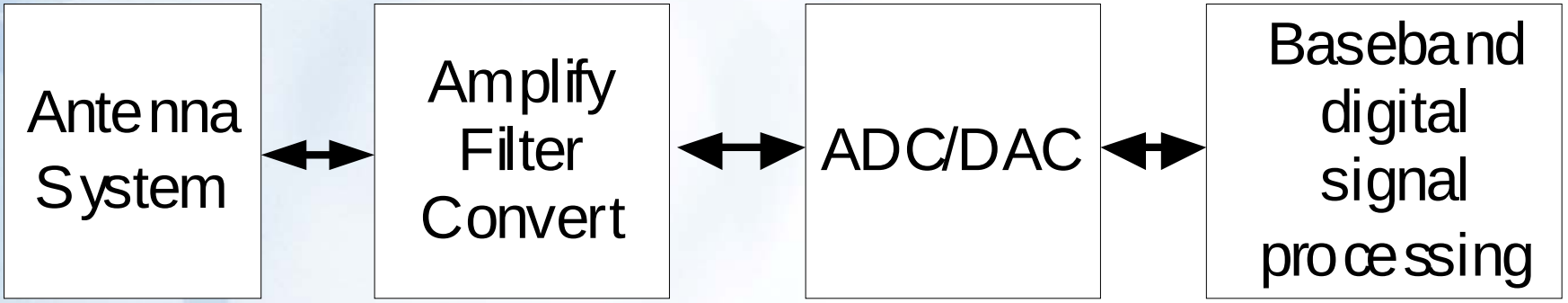
Problem

- OTA is fine, but is the radio hardware compatible with the software about to be downloaded?
  - Can you make your phone to support Wi-Max?
- The problem is not trivial because
  - The hardware cannot be made independent of the software
  - Radio hardware architectures are diverse
- Databases are an inadequate solution

Methodology

- The current tool is database technology
  - Your service provider knows everything about your phone
  - This is OK if there is no software download
  - Not rich enough
- Manually check for hw/sw compatibility
  - OK in a research lab, but even there it is not simple
- **Proposal: ontology-based description** and automatic check for compatibility

The four radio hardware blocks

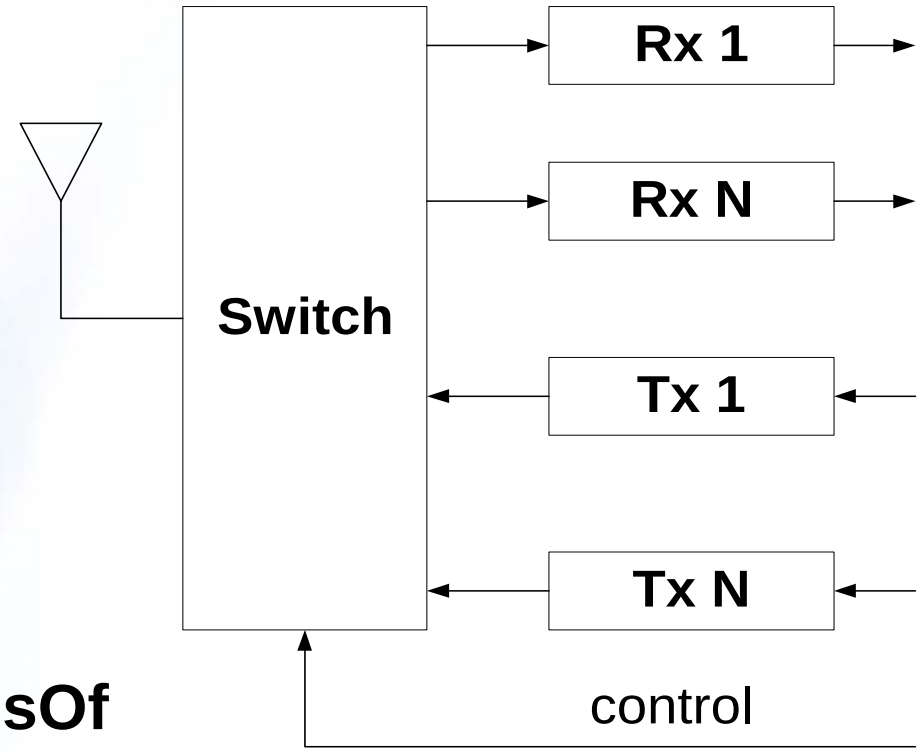


Parameters of radio hardware

- Antenna system
  - Center frequency, bandwidth, no. of antennas
- Radio front-end
  - Receiver: BW, NF (sensitivity)
  - Transmitter: BW, center frequency, power
  - Number of front-end chains
- ADC - SNR, sampling frequency
- DAC – SFDR
- Digital hardware – MIPS, memory

Radio architecture description

device1 **SubClassOf** (*contains* antenna1) **and** (*contains* ADC1) **and** (*contains* ADC2) **and** (*contains* DAC1) **and** (*contains* DAC2) **and** (*contains* rx_1) **and** (*contains* rx_2)



Antenna_System **SubClassOf** (*connected_to* **value** rx_1) **or** (*connected_to* **value** rx_2) **or** (*connected_to* **value** tx_1) **or** (*connected_to* **value** tx_2)

Radio software description

- As an example, consider IEEE 802.11a:
  - Center frequency between 5.15 - 5.825 GHz
  - BW = 20 MHz
  - Full duplex – false; (RX and TX on the same freq, different time instants)
  - Receiver sensitivity at most - 82 dBm
  - SNR at least 18 dB (6 Mb/s) and 35 dB (54 Mb/s; assume ADC with 6 bits resolution
  - Assume digital hardware 9000 MIPS

802.11a description example

- IEEE802.11a **SubClassOf** *contains min* 1 (Antenna_System **and** (*current_bandwidth* **some int**[>=20]) **and** *connected_to* **min** 1 (Receiver and (*connected_to* **min** 1 (Analog_Digital_Converter and (*number_of_bits* **some int**[>=6]) and *connected_to* **min** 1 (*Digital_Signal_Processing_Module* **and** *MIPS* **some int**[>=9000])))))

802.11n example

- Min 2 antennas (4 is optional)
- BW min 20 MHz (40 MHz optional)
- Many optional features – TX beamforming, STBC
- A device may only be able to run the mandatory features
  - Therefore download only mandatory part of 802.11n software

Software certification

- It is very desirable to be download software from any vendor onto any device
  - Will create significant new industry of “third-party software vendors”
- Free OTA software download is currently not sanctioned by the FCC
  - Impossible to test every radio hardware platform with every piece of radio software

Software certification goal

- Vendors now can release a description of the software together with the software itself
- The certification will involve verifying the description
- Then, the software can be downloaded onto devices with which the descriptions match

Some conlusions

- The developed technology will allow automatic OTA software download
  - Allowing, for example, software applications to be distributed to hardware platforms already deployed
- Significant for radio software certification
- What is the relationship with the SCA?
- Comments and suggestions are welcome

Some references

- T. Cooklev, M. Cummings, “Networking Description Language for Ubiquitous Cognitive Networking”, SDR Forum Technical Conference, Washington, DC, 2008.
- S. Li, M. Kokar, “Developing an ontology for the cognitive radio, SDR Forum Technical Conf., Washington, DC, 2009.
- M. Kokar, L. Lechowicz, “Language Issues for Cognitive Radio,” Proceedings of the IEEE, vol. 97, April 2009

Q & A