ECE4011/ECE 4012 Project Summary

Project Title	Wireless Communication RF Scanner
Team Members (names and majors)	Sahil Gupta Avnish Kumar Cameron Karlsson Pooja Modi Vatsal Patel Prahlad Venkatesh
Advisor / Section	Greg Durgin / A05
Semester	2013/Fall Circle: Either Intermediate (ECE4011) or Final (ECE4012)
Project Abstract (250-300 words)	Our project is to create a wireless communication transceiver that will be used in a mobile environment for measuring the RF performance of mobile telephone networks. We will be building this device for a company called DasPoint Inc, which uses these transceivers to measure signal strength for telecommunication companies. The current device they use is bulky and is heavy to carry around to perform vehicle-based or walk-based tests. This product will integrate various components needed for the transceiver and will transmit all the results on an Android device. This will make the whole testing process less bulky. It will also provide a much more user-friendly interface to the people conducting these tests and will give them much more control and debugging tools on-site while they are conducting the tests. The transceiver will be used to measure propagations from distributed antenna systems to optimize the locations of antennas for optimal signal. The receiver will also be used by cellular companies to measure signal strength and the network congestions to fix problems in the network. Since the device will be capable of capturing signals from 300MHz to 3.8GHz, various other wireless signals can also be analyzed. This device will allow a dynamic bandwidth selection from 50 KHz to 20 MHz. It will be able to perform these actions with the help of a RF snapshot recorder capability and GSM/CDMA decoding capability. The device will also have an integrated GPS to provide accurate timing and location data. The device would cost about $1500 for the parts to develop. The market value for the device would be about $3500 including the R&D and support costs. The cost of the device would be about the same as the current products in the market, but the efficiency of the device would save companies a lot of cost. Using this device would require less manpower and time to analyse a specific network; therefore, reducing operating costs for the companies using this device.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	(i) USB 2.0: will be used to interface the development PC with the Odroid board for programming the device. (ii) Wireless Network protocols: will be monitored in the device to log signal and communication statistics. LTE, EDGE, HSPA, HSPA+, UMTS, GSM, and CDMA network protocols will be monitored. (iii) Bluetooth: also known as the IEEE 802.15 standard, Bluetooth will provide a wireless communication interface for nearby communication with data recording devices, or the development PC. Bluetooth operates in the 2.4GHz frequency range. (iv) JDK: Java development library with math and hardware management functions to control the Odroid.
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	(i) Battery life of the transceiver - Li‐ ion batteries are used because we need light-weight batteries that last for at least 6 hours. (ii) Size and weight - Must make it as small and light as possible to ensure portability. (iii) Cost - Cost is not a major factor for most decisions. We expect the total materials cost to be less than 2k per unit in small (less than 10) quantities. (iv) Processing speed - Processing speed is a primary constraint. We want the units to be faster than the scanners we currently use. But as a first step of the project we really need to analyze the capacity of the processing units in the system to make sure that we balance the signal processing load correctly to achieve the rates we need.
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	The device that we plan to use as a development board, the Odroid, has a processor with a clock speed of 1.7 GHz. This is more than double of that of the Raspberry Pi, which has a processor clock speed of just 700 MHz. However, the Raspberry Pi is just $35 whereas the Odroid is $135. It was decided that processing power was of primary importance, and therefore the Odroid was chosen. Additionally, the tradeoffs between different communication devices, namely USB 2.0 and Bluetooth, were also considered. Bluetooth has wireless capability whereas USB 2.0 is based on wired communication. However, Bluetooth's latest version has a transfer rate of 24 Mbps, which is miniscule compared to USB 2.0's 480 Mbps. However, convenience and portability is of primary importance here, and therefore Bluetooth will be used. The third tradeoff that we took into consideration is that between HackRF and bladeRF. bladeRF has a bandwidth of 28 MHz, whereas HackRF has a bandwidth of 20 MHz. bladeRF also has a higher sample size than HackRF. Additionally, bladeRF has FPGA logic elements whereas HackRF has none. Since we need FPGA logic elements in our design, we have decided to choose bladeRF.

Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	Increasing the processing speed to do computation regarding signal measurement is the key to making testing experience smooth for the transceiver. Algorithms that compute signal strength, power level, quality level and other parameters along with filtering of cellular network signals will require very fast DSP microcontrollers/embedded computing systems. The processing will take place either on-board chip on the mobile station (MS)/wireless transceiver or interface (mobile device/desktop/laptop) depending on the processing power needed, user convenience in using the MS/wireless transceiver and inter-device communication between MS and the interface. Possible interfaces involved in the wireless transceiver are mobile device, desktops and/or laptops. These devices will display: 1) The results of signal measurement done for the cellular network involved. 2) RF snapshot of the signals captured from the cellular network. There are two on-board chips namely, ODroid and Nuand RF Blade, chosen to build the wireless transceiver. Since, Nuand RF Blade has a very powerful FPGA, it will be useful in running algorithms mentioned above. Due to the lack of GPS and RF capabilities, ODroid chip was chosen. The platform chosen to provide mobile interface for reading the signals is Android. Since Android is open-source and has a large user base, developing front-end application in this platform gives us an edge over using other platforms.