ABOUT GLOBALFOUNDRIES

GLOBALFOUNDRIES is the world’s first full-service semiconductor foundry with a truly global footprint. Launched in March 2009, the company has quickly achieved scale as one of the largest foundries in the world, providing a unique combination of advanced technology and manufacturing to more than 150 customers. With operations in Singapore, Germany and the United States, GLOBALFOUNDRIES is the only foundry that offers the flexibility and security of manufacturing centers spanning three continents. The company’s three 300mm fabs and five 200mm fabs provide the full range of process technologies from mainstream to the leading edge. This global manufacturing footprint is supported by major facilities for research, development and design enablement located near hubs of semiconductor activity in the United States, Europe and Asia. GLOBALFOUNDRIES is majority owned by the Advanced Technology Investment Company (ATIC).

For more information, visit http://www.globalfoundries.com.
Wireless communication is ubiquitous in our lives and prevalent in numerous applications that we take for granted to access information wherever we are. An example, internet access over WiFi is getting more widespread in homes, businesses and hot spots. To increase capacity and to address new applications, the underlying WiFi standards are evolving into new versions of the IEEE802.11x family, where IEEE802.11p is one of the latest amendments to the standard which adds wireless access in vehicular environments (WAVE).

The WAVE standard as well as government frequency allocation is playing an important role in making wireless communication in cars widespread, which, in turn, will increase road safety as well as reducing emissions from cars stuck in traffic.

Catena is a Design House, with its headquarters in the Netherlands. We focus on the development of advanced and complex Systems on Chip (SoC), targeting various applications like Digital Radio, FM Tuners, GPS, Bluetooth, WiFi and MEMS-based Accelerometer and Gyroscopes. Since our formation in 1986, Catena has successfully brought consumer and automotive products into the market for both start-ups and large semiconductor companies.

In close partnership with GLOBALFOUNDRIES, Catena has silicon proven its WiFi and WiMAX development platform in the GLOBALFOUNDRIES Enhanced SoC-Oriented 65nm Low-Power RF Process (65nm-LP e RF). The WiFi/WiMAX platform support quadruple frequency bands in a 2x2 MIMO configuration and integrates both the RF Frontends as well as the Catena Baseband processor. This platform, which can be seen in Figure 1, is now being customized for a number of WiFi applications, e.g. for WAVE.

In 2008, the European Commission allocated the frequency band 5.85 - 5.925 GHz for Intelligent Transport Systems (ITS), with the intention to ensure compatibility with the U.S., allowing the same RF interface and antenna system to be used in the two markets.

In 2010, the amendment to the 802.11 standard was approved and published, resulting in WAVE or IEEE 802.11p. WAVE is a derivative of the IEEE 802.11a standard, where the main differences are to cope with rapid changes in the physical layer properties and short duration communication which is supported. Short duration communication typically exists in safety applications, e.g. when warning a
driver about nearby and fast approaching cars, which makes it obvious that long delays could become devastating and hence, cannot be tolerated. The communication must also be efficient in non-safety applications, e.g. when a service provider updates digital maps when passing by a roadside unit or when driving through a road toll station at high speed. In addition, the complex radio environment from fast moving vehicles and reflections from buildings and other objects in the urban environment imposes additional challenges in the implementation of the physical layer.

To be able to develop an optimized system for a complex application like ITS, it is important to concurrently optimize both hardware and its embedded software. Since the embedded firmware of the software programmable baseband processor will be optimized in field trials, the system has been partitioned as shown in Figure 2 below. The RF sections have been developed and manufactured using the 65nm-LPe RF CMOS technology, where the high performance of the Radio is utilized with 65nm-LPe RF provided by GLOBALFOUNDRIES.

![Figure 2. High level block diagram of Catena 802.11p system](image)

The RF Frontend is using direct conversion for both the transmitter and receiver, which eliminates expensive and external filters. Support for digitally controlled AGC provides fast gain adaptation, low noise, and high dynamic range. The analog baseband filter is calibrated with an internal tuning loop and the filter supports modulation bandwidths up to 20 MHz. An internal crystal oscillator is implemented to allow the use of a low cost crystal and if an external baseband processor is used, a clock output buffer delivers the system reference frequency. Two fractional-N synthesizers are used to support simultaneous 2x2 MIMO and dual channel operation. An auxiliary ADC is implemented for calibration purposes and to serve various external functions like power and temperature measurements. Control of the chip is done via a four-wire SPI interface or a five wire JTAG interface. External pins are available to support fast RX-TX switching and RX gain control.

The Catena software programmable baseband processor is currently implemented in FPGA, which allows optimization of software algorithms for Doppler shift and Multi-Path signal handling. The Catena baseband processor also handles the lower layer MAC functions such as modulation, de-modulation, filtering, I/Q correction and gain control. The upper layer MAC and application specific software is to be implemented on an embedded core, e.g. from ARM.

The RF Frontend chip and the software defined Baseband processor in the FPGA are put together in a Car-ITS development platform, which is used for performance validation as well as in field trials. A picture of the existing Catena Car-ITS development platform can be seen in Figure 3 next page. The measured RF performance of the system matches well with the simulated performance, which gives confidence when new products are being developed using GLOBALFOUNDRIES technologies. The selection of RF devices and passive components in the GLOBALFOUNDRIES 65nm-LPe RF technology makes the implementation of RF functions straightforward and area efficient.
When the field trials of the Car-ITS system are finalized, the complete system will be integrated onto a SoC in 65nm-LPe RF. Since 65nm-LPe RF process node is automotive qualified, bringing such SoC into production for automotive applications is straightforward. Additional features, e.g. GPS and GLONASS, can be brought into a customized Car-ITS SoC by using the silicon proven Catena System IP. If the digital content becomes large, the system can be ported into GLOBALFOUNDRIES 40nm-LP CMOS technology.

The development of platforms for WiFi, first addressing the IEEE 802.11a/b/g/n standards and now the 802.11p standard, makes it easy for Catena to address specific customer requirements and to quickly reach volume production of advanced RF SoCs using the mature technologies from GLOBALFOUNDRIES. The RF Frontend developed at Catena is optimized for interfacing with either the software defined Baseband processor from Catena or alternatively with a third party Baseband processor. With the development platforms from Catena and the automotive qualified technologies from GLOBALFOUNDRIES, customized and automotive graded WiFi solutions can be brought with fast time-to-market.

About Catena

Catena is an independent design house working with System and IC development for various communication applications; e.g. GSM/GPRS, WCDMA, WLAN, Bluetooth, GPS, Satellite receivers, FM Tuners, TV Tuners and Medical Electronics. Our projects are mainly one chip solutions including RF, Analog, Mixed Signal, DSP and Embedded Software. Catena was founded in the Netherlands in 1986 and employs 150 skilled engineers. We have a total of four design centres, two in the Netherlands, one in Sweden and one is Austria. Our customers are both large multinational semiconductor companies as well as smaller high innovation companies, with whom we have established successful long term co-operation and increased customer revenues. We are working in BiCMOS and CMOS technologies, from 40nm and above.

More information can be found at www.catena.nl