TD-LTE software radio testbed: illustration of BS controlled D2D communication

Nicolas Malm, Jussi Kerttula, Liang Zhou, Yihenew Beyene, Olav Tirkkonen, Riku Jäntti, Kalle Ruttik
Aalto University, Department of Communications and Networking, P.O. Box 13000, FI-00076 AALTO, Finland
[n.n]@aalto.fi

***Abstract*—In this work we report a testbed that is specially designed to support synchronized cellular type radio interface. It follows TD-LTE specification and gives access to the full communication stack. As such it is suitable platform for testing D2D connections operating inside TD-LTE frame structure. We describe the system architecture and the design solutions. We show how a D2D link can be integrated into cellular radio interface. Currently we are conducting the system performance measurements and will report the early measurement results.**

I. Extended abstract

License free frequencies are the current preferred choice for providing direct device to device (D2D) connections. Unfortunately, the systems operating in ISM bands are not capable to provide communication with strict delay and quality guarantees. Such guarantees are possible in cellular systems operating in licensed bandwidth. However, current cellular systems are not designed to support direct D2D connections. The support for D2D is considered for future systems in standardisation bodies. In this work we describe our network testbed that allows to implement and test different LTE-D2D configurations.

The LTE radio interface treats resources as a time frequency grid from where the communications links get their share. In most general form the resources in the grid can be allocated to any radio link. The link do not have to be only between base station and user equipment (BS-UE) but can also be between UE-UE ie. direct links. According to this view, the RRM in the BS is a spectrum controller that distributes the resources and helps to guarantee the quality of the links. The transmitters can use the spectrum with whatever protocol as long as they stay within their allocated time frequency resource and power mask. The D2D transmitters can use the time frequency grid allocated by the RRM. For such usage the D2D nodes have to synchronize to LTE frame structure and be capable to generate signals that fit into LTE time frequency grid.

We have created a testbed which architecture is specially tuned for cellular type synchronous two way communication. Current implementation follows TD-LTE specification. The platform uses USRPs as remote radio heads and all the baseband processing is carried out by general purpose PCs.

A cellular system provides synchronized frame structure. In LTE case the incoming data stream is chopped up and encoded into 0.5 ms subframe slots. The synchronized communication is slotted communication where the transceiver operates on blocks of data in each slot. Once the incoming user-data is provided the subframe processing can be pipelined (Figure 1). Out testbed splits processing not by functions in the base band processing pipeline but along the time sliced blocks. The data for the subframe slot is processed by the sequence of functions inside the pipeline block. This splitting is different from other common software radio platforms where the individual baseband processing functions are encapsulated into blocks. (For instance in GNU radio [1]). In those platforms the processing pipeline is created by connecting individual blocks. Code development and processing in such conventional system is slowed down by the interfaces between the blocks.

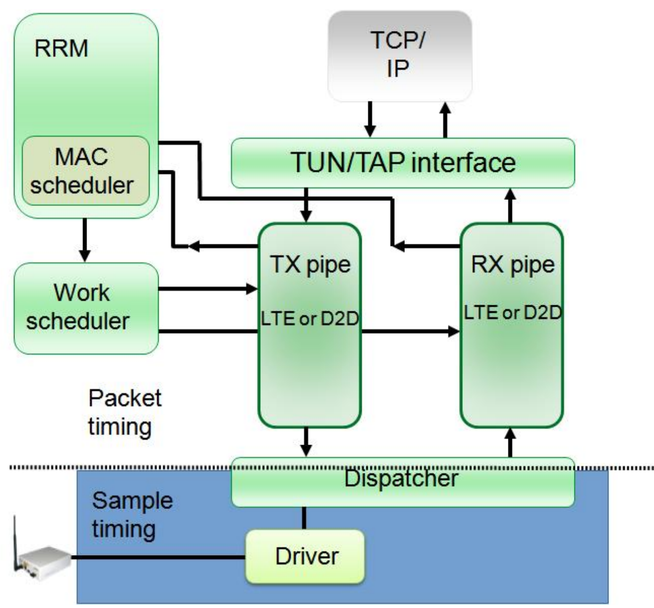

Fig. 1. Testbed software architecture.

Benefit of our approach is that the programmers do not have to define the interfaces between the functions. The code in pipeline resembles sequence of functions (in style of Matlab). The processing in pipeline is not aware of timing constraints. Time related processing is hidden from the developer of the baseband functionality. The time limitations posed by the real time nature of the baseband processing are handled by the scheduler and other supporting functions surrounding the pipeline. The details how the created platform handles timing is reported in [2].

The pipeline processes data in one subframe slot. By changing the processing in the pipeline we can easily create different type of communication systems. We illustrate that by making pipelines that handle D2D communication. The D2D pipeline creates subframes that are inserted into TD-LTE frame structure.

We are conducting measurements of the basedband processing and radio interface performance. The architecture is capable to support two-way communication with LTE imposed 4 ms round-trip delay. The baseband processing performance is characterized by processor load while transmitting and receiving the packets. One interesting parameter is how well a PC can handle LTE frame decoding in non real time Linux system. We measure the processor load as the function of transmitted data and characterize the probability that the PC system is not capable to meet processing deadlines. The radio interface performance is characterized by channel quality information. In the presentation we will report early results of these measurement campaigns.

REFERENCES

[1] GNURadio. GNURadio website. http://gnuradio.org/redmine/, 2014.

[2] Jussi Kerttula, Nicolas Malm, Kalle Ruttik, Riku Jäntti, and Olav Tirkkonen. Implementing td-lte as software defined radio in general purpose processor. In *Proceedings of the 2014 ACM Workshop on Software Radio Implementation Forum*, SRIF '14, pages 61–68, New York, NY, USA, 2014. ACM.