PENGEMBANGAN PLATFORM KOMPUTASI *RECONFIGURABLE SOFTWARE-DEFINED RADIO* UNTUK *NEXT GENERATION NETWORK* (NGN)

LEMBAGA PENELITIAN DAN PENGABDIAN PADA MASYARAKAT
INSTITUT TEKNOLOGI BANDUNG
2006

LAPORAN AKHIR RISET

Riset *Unggulan 2006*

**Pengembangan Platform Komputasi *Reconfigurable Software-Defined Radio*
Untuk *Next Generation Network* (NGN)**

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   Networks (NGN)”
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II. EXECUTIVE SUMMARY

1. **TITLE OF RESEARCH** :
   Platform of Reconfigurable Software-Defined Radio for Next Generation Networks (NGN)

2. **HEAD OF RESEARCH TEAM** :

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3. **TEAM MEMBERS** :

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5. **EXTENDED ABSTRACT** :
   The objective of this research is to study Software-Defined Radio (SDR) architecture. The research is the first step in developing SDR platform which is flexible and re-configured. The result of this research can be developed to be demanded-application in the future to develop a wireless telecommunication system based on SDR.

   The research was begun with literature study and requirement analysis to determine diagram block of SDR architecture. Based on SDR architecture, the research was continued by developing software which was needed to execute radio function on SDR platform, also to test SDR system performance. This research used USRP (Universal Software Radio Peripheral) board as front end hardware and PC as processor which performed SDR system software.

   Flexibility of SDR architecture was tested by performing several SDR applications software. This research has been succeeded to perform SDR function as FM broadcasting receiver radio, AM receiver radio, and 2 m VHF communication receiver radio. The software used was based on open source of GNU Radio. On the other hand, this research also tested the performance of digital data communication using GMSK modulation scheme on SDR platform by measuring the value of packet error rate as variation of bit rate, modulation frequency, BT multiplication, data size, and gain (software) values.

   The conclusion gained from this research is that SDR architecture consist of two important parts; *front end hardware* which functions as analog and digital signal constraint, and *processor* to perform SDR software. In order to assure the characteristics of SDR platform (flexibility, re-configurability, and scalability), SDR platform has to posses plug and play facility also adequate capacity of processor computation to anticipate the changing of communication standard.

6. **DESCRIPTION OF RESEARCH AND RESULTS**

   Objective
   This research will study SDR (Software-Defined Radio) architecture which is flexible and able to be re-configured. The architecture used is according to the research topic that has been being discussed recently by GNU Radio group that is using USRP (Universal Software Radio Peripheral) board as front end hardware and PC as the processor. Based on this research we are looking forward to obtain certain description

about how to develop SDR architecture which is flexible toward standard alteration for software telecommunication development. This research is also initial step which is needed for NGN development based on SDR in Indonesia.

Concept and Methodology

Software-Defined Radio relies on software in performing radio function. We can implement the software to perform radio functions if the formed signal is digital signal. Therefore, ADC/DAC device is needed to separate analog and digital area in signal processing process. Generally, the hardware architecture of a SDR can be shown as Figure-1.

Recently, lots of architecture that used in this research are being researched and developed to various application of wireless communication based on radio. This research is along with the SDR architecture that can be re-configured and re-programmed. Moreover, the SDR research prime is computation aspect according to the researcher skill.
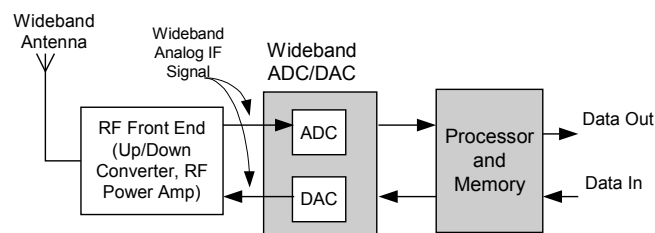

Figure 1. Diagram block of SDR architecture

Methodology is used to answer research question about how to develop SDR architecture especially in developing platform to perform SDR software. There are several steps on this research.

First, requirement analysis such as identification, determining specification, and determining block diagram needed in SDR architecture model, also required preparation of hardware and software.

Second, the software algorithm simulation used MATLAB continued by software implementation using programming language. To reduce the problem complexity faced in this research, the SDR architecture and software development are along with the architecture developed by GNU Radio group and use existed open source software.

Third, the assessment of SDR architecture model toward used hardware and software. The assessment was begun from each functions of hardware and software, and continued by the examination of all over hardware and software. The measure of performance is bit error rate value or packet error rate resulted by using bit rows as sent message in communication process.

Forth, the evaluation toward assessment results to extract required concept in continuing of SDR architecture development also to determine the next steps research.

Main results

The main results obtained based on the research are:

First, by using existed open source software in GNU Radio, this research has succeeded to perform SDR function as FM broadcasting receiver radio.

Second, this research also assessed digital data communication using point to point GMSK modulation. The SDR performance is measured by packet error rate value with variation of Eb/No, bit rate, GMSK modulation frequency, BT multiplication, gain (software) values, and the amount size of the sent data. Based on this experiment, a good performance for GMSK on this SDR platform can be achieved when Eb/No > 17 dB, bit rate equal to 256 kbps, frequency > 0.5 MHz, BT > 0.25, data size > 1000 bytes, gain

(software) > 90.

Third, SDR platform development involved the information of computation demand from application software that would be performed by processor both for receiver and transmitter system. The computation demand can be predicted from complexity of software algorithm including the anticipation of standard alteration which probably will be occurred in the future. Total of computation demand will determine the capacity of processor computation which is needed to assure SDR architecture flexibility and scalability, and usually is stated in MIPS (million instructions per second) or MOPS (million operations per second). The largest required computation is on the receiver system especially to filter alternative channels. Several researcher state that the required computation to select channel more or less is 100 up to 200 operation per sample. Moreover, by the sampling speed of 22.5 MSPS needs 2.250 up to 4.500 MOPS. Another required computation is modulation process on transmitter system and demodulation on receiver system which the value was determined by modulation type that was used. Besides required computation for channel selection and modulation, the required computation from controlling system and of software development are considered and anticipated. Mitola (2000) stated that to anticipate software development, it would be better to use processors that have computation capacity twice than required computation.

Advantage

The research about SDR includes every skill such as telemetric, digital signal processing, computer technique, software engineering, and microelectronic. Therefore, the research topics about SDR can be used by undergraduate, master, and PhD students as their final project. Results of SDR research can be implemented in a wireless telecommunication based on SDR in the future and it is very demanded in developing of Next Generation Networks (NGN) and also Rural-Next Generation Networks (R-NGN).