

LAPORAN AKHIR RISET ITB TAHUN 2007



**LEMBAGA PENELITIAN DAN PENGABDIAN PADA MASYARAKAT
INSTITUT TEKNOLOGI BANDUNG
2007**

LAPORAN AKHIR RISET

Riset Unggulan 2007

PENGEMBANGAN PERANGKAT LUNAK UNTUK SOFTWARE-DEFINED RADIO (SDR)

Periset Utama:
Dr. Bambang Riyanto Trilaksono

Nama KK/P/PP:
Sistem Kendali dan Komputer



**Riset ini dibiayai oleh ITB berdasarkan Surat Perjanjian Pelaksanaan
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November 2007**

I. HALAMAN IDENTITAS

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|----------------------|--|
| 1. Judul | : "Pengembangan Perangkat Lunak untuk
Software-Defined Radio (SDR)" |
| 2. Jenis Riset | : Unggulan |
| 3. Waktu Pelaksanaan | : Januari – November 2007 |
| 4. Tim Riset | |

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5.1 Anggota Tim Riset:

No	Nama dan Gelar Akademik	Bidang Keahlian	Instansi	Alokasi Waktu	
				Jam/Mg	Bulan
1.	Ir. Armein Z.R. Langi, M. Sc., Ph. D	DSP	ITB	1,25	11
2.	Dr. Ir. Adit Kurniawan, M. Eng.	Telekomunikasi	ITB	0,5	11

5.2 Asisten Peneliti/Mahasiswa:

No	Nama dan Gelar Akademik	Bidang Keahlian	Instansi	Alokasi Waktu	
				Jam/Mg	Bulan
1.	Eko Marpanaji, MT	DSP/Software Radio	S3 STEI ITB	2,25	11
2.	Andri Mahendra, ST	DSP	S2 STEI ITB	1	11
3.	Thay Liung	Telekomunikasi	S1 STEI ITB	1	11

5.3 Biaya yang disetujui oleh ITB : Rp 25.000.000,-

Mengetahui,
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II. EXECUTIVE SUMMARY

1. **TITLE OF RESEARCH** : Software Development of Software-Defined Radio (SDR)

2. **HEAD OF RESEARCH TEAM** :
Dr. Ir. Bambang Riyanto Trilaksono

3. **TEAM MEMBERS** : 1. Ir. Armein Z. R. Langi, M. Sc., Ph. D.
2. Dr. Ir. Adit Kurniawan, M. Eng.

4. **OFFICIAL ADDRESS** :

Research Place:

This research is conducted at Computer and Control System Laboratory and Signal and System Laboratory in Labtek VIII 4th floor ITB Bandung.

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5. **EXTENDED ABSTRACT:**

Software-Defined Radio (SDR) represents communication technology that has been developing in order to anticipate change of compatibility issues among standards. By using SDR, it is expected that the hardware investment caused by the change of communication standard can be reduced so that low cost communication service can be achieved. The existence of SDR technology has been much awaited for developing future communication system which is predicted to emphasize on wireless communication, including development of mobile phone and third generation (3G), Next generation networks (NGN), and Rural-Next Generation Network (R-NGN). Due to its flexibility, reprogrammability, scalability, and low investment/cost, SDR technology is expected to be suitable for telecommunications system in rural areas through-out Indonesia.

SDR technology promises to solve these problems by implementing the radio functionality as software modules running on a generic hardware platform. Further, multiple software modules implementing different standards can be present in the radio system. The system can take up different personalities depending on the software module being used. Also, the software modules that implement new services/features can be downloaded over-the-air onto the handsets. This kind of flexibility offered by SDR systems helps in dealing with problems due to differing standards and issues related to deployment of new services/features.

Development of communication system based on SDR requires thorough investigation on SDR architecture along with the required hardware and software. While SDR technology offers many advantages, at present no commercial SDR appearing on the market. This is mainly due to the huge of computing resources needed to run the software performing various radio functions. The proposed research will investigate the software architecture of software-defined radio as apart of main research in the development of computing platform of SDR using commodity component aimed at developing wireless communications in rural areas. This research is also continuation of preliminary research that was carried out under Riset Unggulan ITB 2006 which focused on hardware SDR architecture.

This research investigated the SDR software architecture and SDR software development for communication system. It is supposed that the software architecture of SDR resulted from this research can be used as basic concept in designing SDR platform because computation complexity and computation capacity can be determined from this software algorithm. Expected bit rate of SDR system is 256 kbps as mentioned in PPTIK road map with bit error rate (BER) less than 10^{-3} .

This research will answered the research question how to develop a SDR systems software which has bit rate 256 kbps with bit error rate less than 10^{-3} , and what kind of

software architecture which is suitable for integration with recent communication protocol such as TCP/IP. The result of this research will give us a chance in developing of wireless communication system which cable network connection is impossible to be used due to geographical problems. Expected result of this research is a architecture of software prototype of digital wireless communication system based on SDR which is needed in developing of rural area system communication. Future work of this research is software integration with recent communication protocol such as TCP/IP protocol or VoIP protocol for IP based voice communication.

System configuration which used in this research is SDR platform which consists of USRP from GNU Radio as a front end and PC as a processor. System configuration of SDR using PC as the processor was often referred as Software Radio or shortened by SWR. Pursuant to configuration, hence modulator and demodulator scheme can be implemented in software, while A /D and D/A converter remain in hardware form which located in USRP. USRP and PC is connected using port USB version 2.0.

In this research, we measured the performance of GMSK, DQPSK, and DBPSK modulation scheme in order to investigated the SDR software using GNU Radio open source. GMSK and QPSK or DQPSK are chosen in this research because these modulation scheme are widely used in recent wireless and cellular communication systems such as Satellite, CDMA, and cable modem. Software to perform radio functions can be developed using open source from GNU Radio with some modification. Referred to this research result, we can conclude that modulation scheme of GMSK, DQPSK, and DBPSK which implemented at SDR platform using USRP from GNU Radio have better performance which is seen from PER value. Lowest PER value can be obtained at E_b/N_0 value > 20 dB for GMSK, DQPSK modulations, and $E_b/N_0 > 15$ dB for DBPSK modulations. Optimum bit-rate 256 kbps for GMSK modulation with maximum bitrate 1024 kbps, optimum bitrate 128 kbps for DQPSK modulation, and optimum bitrate 256 kbps for DBPSK modulation. Carrier frequency higher than 0.1 MHz for GMSK modulation and higher than 0,3 MHz for DQPSK and DBPSK modulation, BT of Gaussian filter larger than 0.25 for GMSK modulation, and roll-off factor (alpha) for DQPSK and DBPSK modulation equal to 0.4, optimum gain is 400 for GMSK modulation, payload size of GMSK modulation larger than 1024 byte, and optimum payload size of DQPSK and DBPSK modulation is 4092 byte.

In this research, performance of SDR software running on TCP/IP protocol is also evaluated. The performance criteria is evaluated as round trip time (rtt) using Internet Control Message Protocol (ICMP) as various of modulation scheme. Referred to this research, the average rtt value is 9 up to 11 ms using GMSK modulation, 24 up to 40 ms using DQPSK modulation, and 19 up to 35 ms using DQPSK modulation. Future work of this research is developing an application of SDR systems running on TCP/IP network such as VoIP communication and testing its performance.

6. LIST OF RESEARCH OUTPUT:

1. International Conference :

Bambang Riyanto T., Armein Z.R. Langi, Adit Kurniawan, Eko Marpanaji, Andri Mahendra, Thay Liung, 2007. "Software Architecture of Software-Defined Radio (SDR)," International Conference R-ICT 2007. Bandung, Agustus 6th-7th, 2007, Indonesia.

Eko Marpanaji, Bambang Riyanto T., Armein Z.R. Langi, Adit Kurniawan, Andri Mahendra, Thay Liung, "Experimental Study of DQPSK Modulation on SDR Platform," International Conference R-ICT 2007. Bandung, Agustus 6th-7th, 2007, Indonesia.

2. National Jurnal:

Eko Marpanaji, Bambang Riyanto T., Armein Z.R. Langi, Adit Kurniawan,

“Pengukuran Unjuk Kerja Modulasi GMSK pada Platform Software-Defined Radio (SDR),”. Telkomnika, Universitas Ahmad Dahlan Yogyakarta, (Accepted paper).

3. Draft of National/Regional Jurnal

Eko Marpanaji, Bambang Riyanto T., Armein Z.R. Langi, Adit Kurniawan,
“Experimental Study of Differential Binary Phase Shift Keying (DBPSK) on Software-Defined Radio (SDR) Platform.”

4. Prototype of SDR system running on TCP/IP network

