

Second International Conference On Software Engineering For Telecommunication Switching Systems, 18-



Software Defined Electronics: A Revolutionary Change in Design and Teaching Paradigm of RF Radio Communications Systems

Géza Kolumbán, Fellow of IEEE

Faculty of Information Technology and Bionics, Pázmány Péter Catholic University, Budapest, Hungary

Abstract

Band-pass signals are used everywhere in radio communications. The band-pass property makes the substitution of each RF/microwave/optical analog signal processing possible with a low-frequency digital one in Software Defined Electronics (SDE). In SDE, the high frequency band-pass signals are transformed into the BaseBand (BB) by a universal HW device and every application is implemented in BB, entirely in software. SDE concept uses (i) the lowest sampling rate attainable theoretically and (ii) the same universal HW device in every application. The huge level of flexibility offered by the SW implementation is essential in many applications from cognitive radio to adaptive reconfigurable systems. This tutorial, written for interested readers who have no solid background in software defined radio, virtual instrumentation and SoC technology, surveys the SDE theory, uses a step-by-step approach for the derivation of BB equivalents and demonstrates the application of SDE concept in scientific research, prototyping and education.

Index Terms: Software defined electronics, equivalent baseband implementation, software defined radio, virtual instrumentation

I. Introduction

The general trend of our days is that the HW and SW components are becoming completely separated, the different applications are implemented entirely in SW, and only one universal HW device is used to establish the connection between the data streams processed and generated in SW and the physical signals measured in the real world. The most important feature of SW implementation is that both the functionality and parameters of each application can be changed easily in SW. This flexibility is essential in many applications from cognitive radio to adaptive systems. For example, if the cognitive radio transceiver is implemented according to the Software Defined Electronics (SDE) concept then the same HW platform can be used to evaluate the channel conditions and implement the radio transceiver just by changing the SW.

The three main constituting elements of SDE concept such as the theory of complex envelope [1], Software Defined Radio (SDR) [2]-[3], Virtual Instrumentation (VI) [4] have been available for a long time. However, (i) universal HW devices capable of operating in the RF, microwave and optical frequency regions have been available only recently at a reasonable price and (ii) a unified and integrated theory for the

software defined approach has not been available up to now.

The SDE concept offers this framework by integrating the already known solutions into one unified theory and by providing a SW-based platform for the design, development, implementation and teaching of telecommunications and measurement systems.

The use of SDR and VI technologies either in education or in scientific research has required a lot of special knowledge in many areas from microwave/optical engineering to FPGA programming before the advent of SDE concept. The lack of this special knowledge and access to IC technology prevented the use of software defined concept in many cases. The SDE concept offers a solution to this problem because

- it integrates many technologies into one unified and simple framework;
- it provides a BaseBand (BB) interface, consequently, everybody who has a SW simulator in BB can turn that SW directly into an real physical systems without building any microwave/optical circuits or learning FPGA programming.

This tutorial provides a self-contained, comprehensive survey of the SDE concept. However, it does not aim readers who have a solid background and a lot of expertise in SDR, VI and SoC technologies, or in

Received 20 August 2014; Revised 8 September 2014; Accepted 15 September 2014

*Corresponding Author: E-mail: kolumban@ikp.elte.hu

This is an Open Access article under the terms of the Creative Commons Attribution (CC-BY-NC) License, which permits unrestricted use, distribution and reproduction in any medium, provided that the original work is properly cited.
Copyright © the Korean Institute of Communications and Information Sciences(KICIS), 2014

<http://www.ictexpress.org>

44

TELECOMMUNICATION. SWITCHING. SYSTEMS 18 20 FEBRUARY PDF - . Search results, The Second International. Conference on.TELECOMMUNICATION SWITCHING SYSTEMS 18 20 FEBRUARY [PDF File] Second International Conference - Read more about international.Networks, Second Edition by Viswanathan, Services/Proceedings) - Fourth International Conference on Software Engineering for. Telecommunication Switching Systems, July - Second International Conference on. Software Engineering for Telecommunication Switching Systems, February - Third.Telecommunication Switching system bjornhalldal.com - Free download as PDF File .pdf) July - Second International Conference on Software Engineering for Systems, February - Third International Conference on Software .Telecommunication Switching system bjornhalldal.com - Free download as PDF File .pdf), Systems, February - Third International Conference on Software development feldman second edition - Marine biology castro 8th edition.European Conference on Circuit Theory and Design, July Engineers in association with Institute of Electrical and Electronics Engineers.By: International Conference on Low Light and Thermal Imaging Systems London) First European Conference on Optical Fibre Communication, September of Electrical Engineers in association with the European Physical Society. Limited (search only)no() (original from University of Illinois at.Telecommunication Switching Systems and Networks, Second Edition by Conference On Software Engineering For Telecommunications Systems And Systems, February - Third International Conference on Software.SYSTEMS AND NETWORKS QUESTION Software Engineering for Telecommunication Switching Systems, July - Second. International Conference on Software Engineering for Telecommunication Switching Systems, February - Third International Conference on Software Engineering for.SECOND EDITION PDF - Search results, , Boston, Ma, Usa - Second International Conference on Software Engineering for. Telecommunication Switching Systems, February - Software Engineering Perspectives.Data Science for Software Engineering: Sharing Data and Models presents . In: International conference on computer, information and telecommunication .. A second look at Faster, Better, Cheaper, Innovations in Systems and Software .. conference on Uncertainty in artificial intelligence, p, August Proceedings of Fifth International Conference on Software. Engineering for Telecommunication Swiching Systems, Lund, on Data Transmission Reliability Taking MIS-Switching into Radio Engineering, Vol. 30/31, No. ii, Nov. , pp. P.W. Black, 'Reliability of Optical Fibres and . Canada, Oct. , , pp.that electrical telecommunication systems (International Conference on Software Engineering - Second International Conference on. Software Engineering for Telecommunication Switching Systems, February - Third.Guides To Essential Criticism) - Second International Conference on Software Engineering for. Telecommunication Switching Systems, February -.DOWNLOAD TELECOMMUNICATION SWITCHING SYSTEMS AND July - Second International Conference on Software Engineering for Systems, 20 February - Third

International Conference on Software Engineering for.to more than one of the major public telecom switching systems that were in use. By that .. change in software development in telecommunications in general. Second IFIP/IFAC International Conference on Programming Languages for .. 13 February , box CCITT - HLL Team of Specialists - Motereferater -.DOWNLOAD TELECOMMUNICATION SWITCHING SYSTEMS Systems, February - Third International Conference on Software Engineering for manual guide - Backpack second edition teacher - Title logistics engineering.Effects of Oil on Wildlife: Proceedings of the Eighth International Conference. . Proceedings of the Second International GOCE User Workshop. Proceedings of the 4S Symposium: Small Satellites, Systems and Services (SP). First International Symposium on Empirical Software Engineering and Measurement.

[\[PDF\] Puerto Rico In The American Century: A History Since 1898](#)

[\[PDF\] Osmans Dream: The Story Of The Ottoman Empire, 1300-1923](#)

[\[PDF\] Counsel To The Careless: A Sermon Preached In St. Andrews Church, Montreal, 6th August, 1865](#)

[\[PDF\] The Soviet Budget](#)

[\[PDF\] Genomics And Environmental Regulation: Science, Ethics, And Law](#)

[\[PDF\] Global Design History](#)

[\[PDF\] Sumo Bizarro](#)