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Implementation Bidirectional 32-Bit Switching System using VHDL

Divya Srivastava
Electronics & Communication,
BIET, Lucknow, India
divya.div1912@gmail.com

***Abstract*-In this paper our research focuses on Landline Switching for two different channels using VHDL, each channel has 16 users. They can communicate with either intra channel or inter channel. We also discuss providing Caller ID facility in this paper. In this paper the data coming in through the inlets are written into the data memory and later read out to the appropriate outlets. The incoming and outgoing data is usually in serial form, where the data is written in and read from the memory in parallel form. Therefore it becomes necessary to perform serial to parallel conversion and parallel to serial conversion at the inlets and outlets respectively. We are using 32 bit Opcode for communication between these channels or within the channel. In this paper we define all the functions by Opcode. Opcode is responsible for caller id also and decides what data we are going to transmit or receive. We have implemented our work by Xilinx ISE i.e. liable for synthesis also. To simulate this process we are using Modelsim 10.2a.**

Keywords: Caller ID, Opcode, Switching, VHDL, VLSI.

1. Introduction

The transmission of telegraphic signals over wires was the first technological development in the field of modern communications. Telegraphy was introduced in 1837 in Great Britain and in 1845 in France. In March 1876; Alexander Graham Bell demonstrated his telephone set and the possibility of telephony, i.e. long distance voice transmission. Mr. Graham Bell demonstrated a point-to-point telephone connection. A network using point-to-point connection is shown below figure 1.

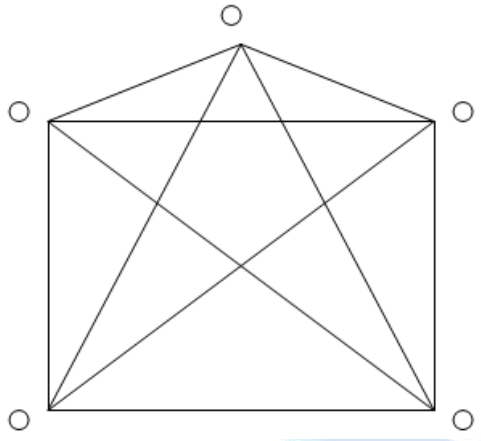

Fig 1. A network with point to point connection [1].

In general case with n entities, there are N (N-1)/2 links, therefore the number of links required with moderate or higher values of n to have fully connected system becomes very large. Consequently, practical use of bell's invention on the large scale or even on the moderate scale demanded not only the telephone sets and the pair of wires, but also the so called the switching system. With the introduction of switching system, the subscribers are not directly to switching system, which results in increment in speed or response and most efficient way to connect the connection. When a subscriber wants to communicate with another a connection is established between the two at the switching system [1].

In this switching system only one link per subscriber is required between subscriber and switching system and the total number of such links is equal to the number of subscriber connected to the switching system. Earlier switching system were manual and operator oriented. Limitations of operator oriented switching system were quickly recognized and automatic changes came into existence. Automatic switching systems can be classified as electromechanical and electronic. Electromechanical switching system include step by step and crossbar systems the step by step is common known as stronger switching system. The control functions in a stronger switching system are performed by circuits associated with the system. Crossbar systems had hardwired control systems, which uses relays and latches. These systems have limited capability and it is virtually impossible to modify them to provide additional functionalities.

1.1 Basics of Switching System

A major component of a switching system or an exchange is the input and output circuits called inlets and outlets. The primary function of the switching system is to establish a path between inlet and outlet. The hardware used is the switching network. If there are N inlets and M, outlets, when N=M the network is called symmetrical network. The inlets and outlets may be connected may be connected to local subscriber or trunk from / to other exchanges .when all inlets and outlets are connected to subscriber lines the logical connection appears, In this case the output lines are folded back to input and hence called the folded network [1].

The four types of connection can be established:

1. Local call connection between two subscribers in the system.
2. Outgoing call connection between an incoming trunk and a local subscriber.
3. Incoming call connection between an incoming trunk and a local subscriber.
4. Transit call connection between an incoming trunk and outgoing trunk.

2. Related Work

R. Nandhini et al, worked on the Quality of Service (QoS) and spectral efficiency in land mobile satellite (LMS) communications drops drastically in the presence of shadowing and multipath fading. Method for increasing QoS and spectral efficiency, is done by without any increasing in total transmit

power, bandwidth or antenna gain by using multiple-input multiple-output (MIMO) techniques. In order to carry out the performance assessment this work addresses related MIMO satellite propagation channel modelling issues which lead to a new mathematical model to accommodate the multi-satellite transmission. The omni directional antenna's two RHCP and two LHCP used for complete analysis [2].

They found that the performance of availability and the capacity of a LMS system has been presented. The proposed channel model for the evaluation of the system performance was a multi state Markov chain statistical modeling approach. From the results it is shown that using the transmission diversity with the combination of a combining technique, they can improve the availability to capacity ratio. The results showed that the channel capacities are dependent on the elevation angle under a given satellite A technical method for increasing the system's capacity and QoS, without the increase of available bandwidth, is the use of multiple beam coverage. It is worth noting that the EGC is recommended for application in LEO LMS systems because it introduces less complexity, less cost and better percentage of time for which the CNR > CNRmin than the MRC.

Huaqing Li et al, they discussed the second-order local consensus problem for multi-agent systems with nonlinear dynamics over dynamically switching random directed networks. Through apply the orthogonal decomposition method and the state vector of resulted error dynamical system can be decomposed as two transversal components and one of which evolves along the consensus manifold and the other evolves transversally with the consensus manifold. There is many sufficient conditions for reaching almost surely second-order local consensus are derived for the cases of time-delay-free coupling and time-delay coupling respectively. For the case of time-delay-free coupling, they find that if there exists one directed spanning tree in the network which corresponds to the fixed time-averaged topology and the switching rate of the dynamic network is not more than a critical value which is also estimated analytically, then second-order dynamical consensus can be guaranteed for the choice of suitable parameters. For the case of time-delay coupling, they not only prove that under some assumptions, the second-order consensus can be reached exponentially but also give an analytical estimation of the upper bounds of convergence rate and the switching rate. Finally numerical simulations are provided to illustrate the feasibility and effectiveness of the obtained theoretical results [3].

They found the problem of second-order dynamical consensus over the random switching directed networks has been studied in detail. Note that our theoretical results are only limited to the local consensus, despite to the fact that some numerical results seem to indicate that the stronger property of global consensus might in fact be exhibited by the case-study system. The orthogonal decomposition method is used to simplify the theoretical analysis. They pose the second-order nonlinear consensus problem in a stochastic framework where the communication among the agents is modeled as weighted directed random switching graph. The theoretical results show that the local consensus can be achieved almost surely if the time-averaged communication network supports the consensus and the time delay and switching rate are less than two upper bounds respectively, which are estimated analytically. The obtained results are quite powerful, and can be further used to solve various switching cases for complex dynamical networks. In that framework of random switching networks, the following issues deserve careful studied: i) consensus of agents with different nonlinear dynamics; ii) consensus of agents with time-varying delay couplings; iii) cluster consensus; iv) consensus with the communications constraints, such as packet losses, channel noises, limited width, ect. These roblems will be discussed in future works [3].

Roberto Conti et al, worked on an engineering tool called TrEnO devoted to the simulation and the optimization of performances and thermal behavior of railway traction systems. The analysis is performed following a multidisciplinary approach considering the interaction of thermal, electro-mechanical and pneumatic brake systems with on board safety devices. The proposed approach is quite innovative respect to pre-existing tools available in literature, which are often more specialized over a specific category of components and subsystems (as for example power electronics), since it supports the automatic code generation for RT target. This mandatory requirement is related to the improvement of the simulation speed and to integrate the tool in HIL and SIL applications which are often used for fast prototyping and testing of safety on board subsystems. The scheme of the corresponding simulation model, developed in Matlab-Simulink: a modular architecture in which different models of traction and vehicle subsystems should be rearranged in order to simulate different engineering layout, is chosen [4].

They presented the main features of the tool TrEnO developed to analyse and optimize the performance of a train from an energetic and efficiency point of view. Currently the development of TrEnO tool is practically complete and some preliminary validation tests are quite encouraging. Further activities are on-going in order to validate the code especially for the part concerning thermal model, where less data were available during the first development phase and for which an extended experimental feedback is needed. Also a major effort has to be performed in order to extend and apply the use of TrEnO both for simulation and fast prototyping of prognostic and diagnostic applications. Authors wish to thanks all the people of the group AnsaldoBreda SPA, and particularly Eng. Ghislanzoni, which have supported the research activities with data, know-how transfer and over expected cordiality [4].

Ibrahim Aref et al, they evaluate and investigate performance of a digital communication system, this work presented a new approach that can be used to model, design and develop a stochastic digital channel simulator to plug into any digital communication system under different modulation schemes. Data packet structure that has been used with this system is based on a High-Level Data Link Control standard. The simulation tool is a SystemC that is provide various features to perform system level modeling and simulation. Challenge was how to efficiently simulate this channel by using the hardware modeling features available in SystemC, and then how they

have developed this channel. Also discussed how the modeling features can be used to simulate different noise sources that can be used to introduce noise events depends on specific distribution [5].

They explored a new approach to model and developed a digital channel using SystemC at a high level of abstraction and then as future work they can refine the design down to a level that allows hardware implementation (RTL level). Although, much works have found in literature on modeling with SystemC, but to our knowledge, this is a new technique that has been done in digital channel modeling using SystemC, and much work with it, is still as future potential. Also, they can say that Systemic is provided various features to perform system level modeling and simulation, which are missing in the generic HDL's such as VHDL and Verilog and it is intended to enable system level design and IP exchange. Moreover, they need to say that system C is not the perfect solution for all tasks, but it combines many design characteristics that are missing in other language [5].

3. Methodology:

3.1 Principle of Landline Switching

In this design, the data coming in through the inlets are written into the data memory and later read out to the appropriate outlets. The incoming and outgoing data is usually in serial form, whereas the data are written into and read out of the memory in parallel form. Therefore it becomes necessary to perform serial to parallel conversion and parallel to serial conversion at the inlets and outlets respectively.

For convenience, the in and data out parts of the MDR are shown separately for the data memory. Since there is only one MDR a gating mechanism is necessary to connect the required outlet/inlet to MDR. This is performed by the in gate and out gate units. The information is not transferred in real time: it is first stored in the memory and later transferred to the outlet. There is a time delay between the acquisition of a sample from an inlet and its delivery to the corresponding outlet. This switching system can be controlled in following three ways:

1. Sequential write/Random read.
2. Random write/Sequential read.
3. Random input/Random output.

In the first two methods of control, the sequential / random read / write operations refer to the read / write operations associated with the data memory. In both these cases, the inlets and outlets are scanned sequentially. In last case, the inlets and outlets are scanned randomly, and the data memory is accessed sequentially.

3.2 Sequential write / random read:

In this method the inlets are scanned in the first phase one after another and the data is stored in the data memory sequentially. There is a one to one correspondence between the inlets and the locations of the data memory. The control memory locations contain the addresses of the inlets corresponding to the outlets.

3.3 Features:

- Dual way 32 user support
- Sequential Input Random Read
- Caller Id Facility
- Inter and Intra exchange
- 16 Bit data transfer
- Inband Signalling
- Synchronization clock
- Reset features

The opcode assumed is of 32 bit in which each bit is having some specific function. Starting from right hand side, the bit 0 to 15 represents data, bit 16-21 are zero, bit 22-25 represent source subscriber, bit 26-29 represent destination subscriber, bit 30 represent whether the call is inter exchange or intra exchange and bit 31 represent whether the subscriber is enabled or disabled.

E	I	D3	D2	D1	D0	S3	S2	S1	S0	X	X	X	X	X	X
D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0

Fig 2. 32 bit OPCODE

3.4 Inter Exchange:

For inter exchange value of I will be 1 in that case 16 users in each exchange can communicate with each other. Exchange 1 have 16 user and Exchange 2 have 16 user if we are working on Inter exchange then 16 user of exchange 1 can communicate with 16 users of exchange 2 and also 16 user of exchange 2 can communicate with 16 users of exchange 1.

3.5 Intra Exchange:

For intra exchange value of I will be 0 in that case 16 users in one exchange can communicate with each other. Exchange 1 have 16 user and Exchange 2 have 16 user if we are working on Intra exchange then 16 user of exchange 1 can communicate with 16 users of exchange 1 only they cannot communicate with exchange 2 users and also 16 user of exchange 2 can communicate with 16 users of exchange 2 only they cannot communicate with exchange 1 users.

3.6 Data Memory:

We have 17 bit of std_logic type data memory for 16 locations i.e. we can have 16 bit of data which we can transfer for intra exchange exchange1 to exchange1 all users and exchange 2 to exchange 2 all users. In case of Inter Exchange we can transfer 16 bit of data exchange 1 to exchange 2 all 16 users and exchange 2 to exchange 1 all 16 users.

3.7 Control Memory:

We have 16 locations of integer type for control memory. It decide all the function of whole system i.e. which exchange of caller want to communicate which exchange user. It will decide by caller id of all users and they have what data all information is passing through control memory.

3.8 Caller ID:

We have 32 location 16 locations for source and 16 locations for destination. If exchange1 work as a source for intra exchange then destination will be exchange1 in this case Caller ID will decide that which location will receive the data and also tell to destination that which location transmit this data. If exchange1 work as a source for inter exchange then destination will be exchange2 in this case Caller ID will decide that which location will receive the data and also tell to destination that which location transmit this data. If exchange2 work as a

source for intra exchange then destination will be exchange2 in this case Caller ID will decide that which location will receive the data and also tell to destination that which location transmit this data. If exchange2 work as a source for inter exchange then destination will be exchange1 in this case Caller ID will decide that which location will receive the data and also tell to destination that which location transmit this data.

4. Working Specifications:

Phase 1: Input Subscribers in both the exchanges are scanned sequentially. It takes 16 clock cycles to scan 32 subscribers in order to know their status, that is they want to transmit or not. This is called a sequential scanning. The date to be transmitted is stored in data memory in sequential order. The information relating to the called subscriber is stored in control memory in sequential order and caller id number is stored in the caller id memory in the sale way. So we can say system is sequential write.

Phase 2: When all the scanning is finished the location of the data memory is read according to the corresponding location of the control memory. For example, if first location of data memory has data 'd' and corresponding location in control memory is 2, this means that 'd' will be communicated to the 2nd user of the exchange, thus we can say the system is random read.

To decide where the data will be communicated we use a bit in our op code as 'I' bit. If 'I' =1, then it is interexchange i.e. the read out data will be given to user of other exchange. Thus communication between the subscriber of two exchanges can be made possible and hence the name interexchange.

If 'I' = 0, then it is called as Intraexchange i.e. the read out data, will be given to the user of the same exchange. Thus communication between subscribers of the same exchange is made possible, and hence the name Intraexchange.

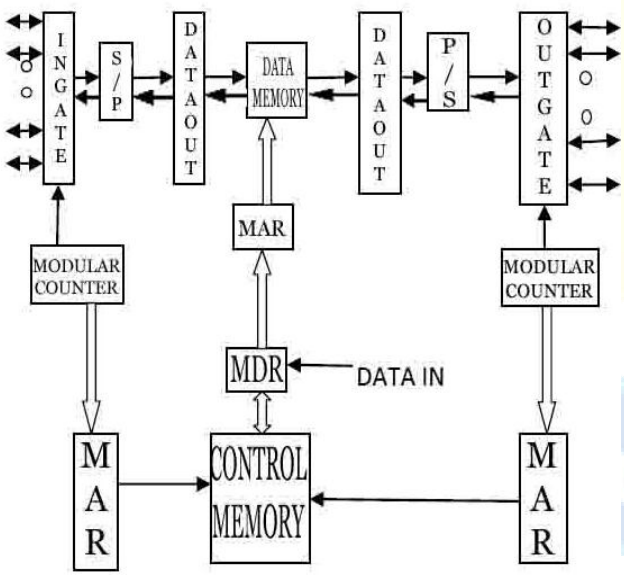

Fig 3. Dual Way Structure of Switching System

The exchange between caller id memories is done only if the particular user is enabled. Same is the case with data memory. A particular user is enabled if its opcode 16th bit is 1 and disabled if it is 0.So caller must be enabled and called user must be disabled in order to make a call successful. The communication means just to transfer the data (0- 15 bits of opcode) between entities and is shown by overwriting the data bits if called sub=scriber. Caller id facility enables the called user to see who is calling by checking his relevant bits of opcode (25 to 22) fig 3 shows the structure of switching system.

5. Result and discussion:

There are two exchange centers which taken as 'din' and 'dout'. Our work has been implemented for Inter exchange and Intra exchange both. If we take 'I' is one then our design will work for inter exchange. If we take 'I' is zero then our design will work for Intra exchange. Our design is depend on some more inputs clock, reset and enable. If reset is high then our design will not perform any function, all functions performed on low reset and positive edge of clock. If enable is zero then there is no exchange of data will take place. Our exchanges, work on high enable bit.

In this case it shows the inter exchange for first exchange. Here we take enable bit 1, I as 1, source address is 0101, destination address is 0110 data for transmission is "AD01". We receive the data on second exchange dout on 6th address shown in figure 4.

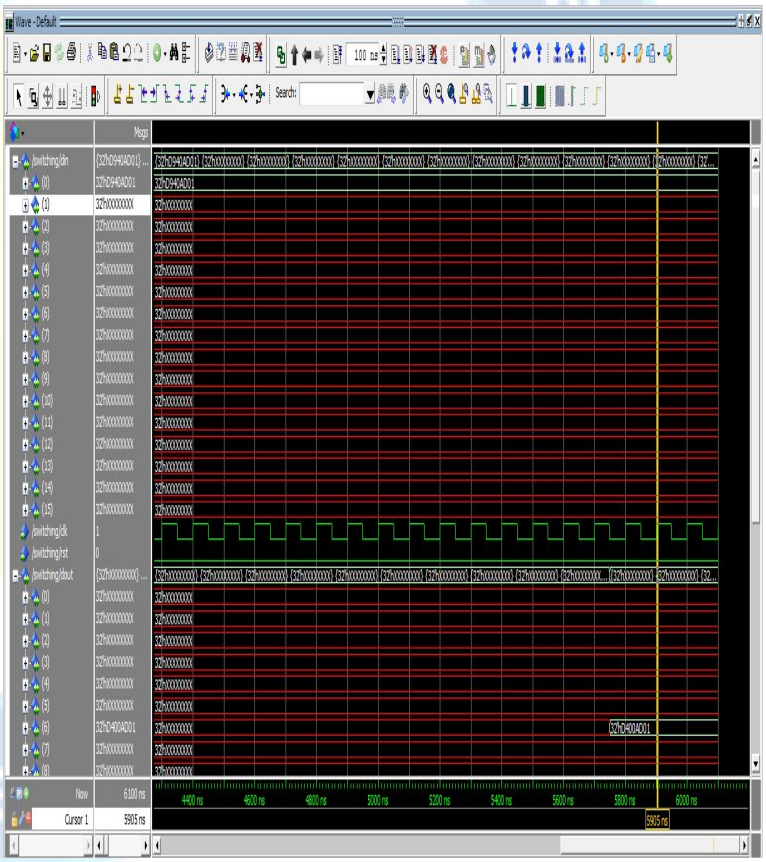

Fig 4. Simulation result for First Exchange (Inter Communication)

In this case we shows the intra exchange for first exchange. Here we take enable bit 1, I as 0, source address is 0110, and destination address is 0101 data for transmission is "AD01". We receive that data on first exchange din on 6th address shown in figure 5.

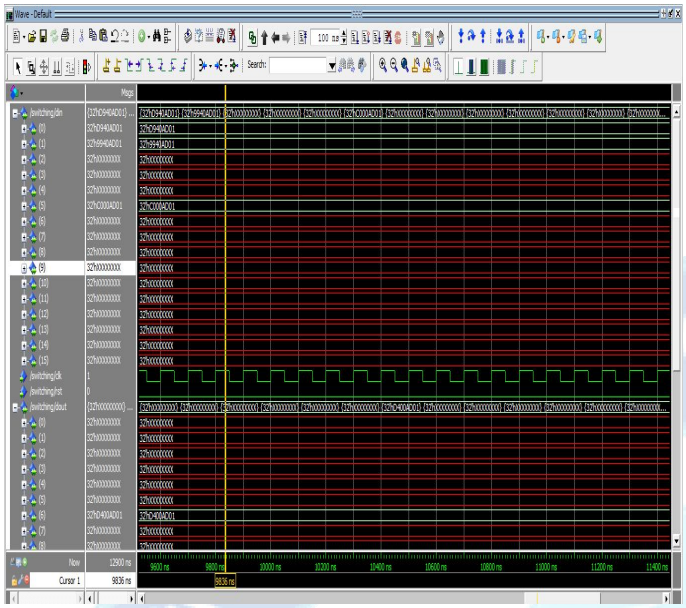

Fig 5. Simulation result for First Exchange (Intra Communication)

6. Conclusion:

The aim of work was to enable us to design ICs for the Switching System. Presently switching systems uses routers, multiplexers, switches etc that leads to low efficiency as they are analog in nature and have a high power requirement. In contrast we have tried to make this whole system digital to increase the efficiency, lower the power requirement, and reduce the delay. VHDL has been used to write all the programs for the ICs because of its user-friendly nature and thus modifications if required for further development shall not prove to be an obstacle. As we know, the process of making ICs is time consuming and an expensive venture so we must be sure about the working results of the ICs in advance as we can't accept errors later.

In our design we used 3659 slices out of 192 i.e. only 1905% we used in our design, 2678 slices of flip flop used out of 384 i.e. only 697% utilized, 6267 Look Up Tables (LUT) are used out of 384 i.e. 1632% utilized in our design and 1 global clock we have used out of 4 i.e. 25% we used in our design then we conclude that it will take less hardware to perform whole operations. We get total delay of our design is 7.148ns if describe that delay i.e. 5.753 ns is from logic delay means which component used in our design that are taking delay to perform operation and 1.665 ns for routing delay means connection delay of our design. So we conclude that our design is fast and using less hardware.

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