ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
IJARSMT
Volume 2, Issue 6, June 2016

Approach to design a FlexRay communication Node using FPGA

Abhijeet Pande[1], Mrs. Nandini Dhole[2]

PG Scholar, Dept. Of E&TC, RMD Sinhgad school of engineering Pune, Maharashtra, India[1]

Professor, Dept. Of E&TC, RMD Sinhgad school of engineering Pune, Maharashtra, India [2]

ABSTRACT— FlexRay is set to become a new standard for automotive communication replacing conventional protocols like CAN in applications like safety critical considering speed of operation, reliability and redundancy factors. A traditional approach is currently used to design a FlexRay node where a microcontroller with integrated FlexRay communication controller is being used as first choice by designers. But on the other side Field programmable gate arrays (FPGAs) are also gaining importance to be used in automotive systems where FPGA is the controlling device. In this paper a design approach for FlexRay communication node is proposed where different aspects that should be considered when a FlexRay communication node is designed are mentioned. Initial sections define major components that are required for communication node are described with function of each component explained. Later sections define a brief approach to design FlexRay communication node.

KEYWORDS- FlexRay, FPGA, Communication Node.

I. INTRODUCTION

There is an increase in no of processing units in an automotive system or vehicle which demands for communication protocols that can operate over higher baud rates but can provide required reliability. Also in safety critical applications it is necessary to have a redundancy in a system. All these requirements have shifted a preference towards FlexRay communication protocol, which can offer all these features over traditional protocols like CAN. In current vehicle applications FlexRay is used in anti-braking systems, traction control systems, steering system etc. It can be noticed looking all these applications that they need a high reliability and redundancy not only a faster communication. But along with protocol selection, system design is also important to achieve the requirements like reliability and redundancy where FPGAs are found to be more suitable considering their hardware architecture. Also now a days there are control units developed with FPGA in automotive applications as well. So there is a need to have a systematic study of the system components required to design FlexRay communication node using FPGA. This paper is organised as follows. Section II highlights architecture of FlexRay node and Section III mentions the current design approach to design FlexRay communication node. Section IV consists for the proposed design with FPGA with hardware and software considerations. Finally advantages and disadvantages of the proposed solution are highlighted with concluding remarks.

II. LITERATURE SURVEY

ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
Volume 2, Issue 6, June 2016

FlexRay communication controller consist of 4 major components host controller, communication controller, bus driver or transceiver and power supply. Among these selection of first three defines requirement for power supply. So in this literature design of power supply is not considered. Figure 1[2] shows architecture of FlexRay communication node.

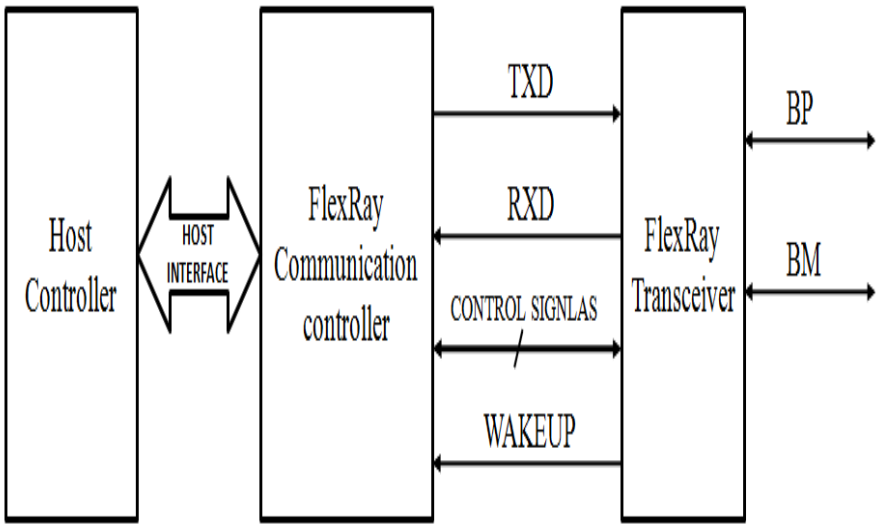

Fig. 1 Flex Ray Communication node architecture

A. HOST CONTROLLER

This is a main controlling element which initiates system and given commands to activate different modes of operation of FlexRay. Main application is controlled by host controller. It gives control signals to communication controller and transceiver to initiate data transmission and reception.

B. COMMUNIATION CONTROLLER

Communication controller takes care of protocol management of FlexRay communication. It acts as medium between host controller and bus transceiver. So task of communication controller is to encode data packet send by host controller to FlexRay protocol format and provide it to bus transceiver and vice versa.

C. BUS TRANSCEIVER

Bus transceiver converts bus level voltage to logic level voltages and vice versa. Basically data is transmitted to transceiver by communication controller which it converts to FlexRay bus level voltages. Similarly data available on FlexRay bus is received and converted to logic level voltages that is suitable for communication controller to process.

III. PRESENT ARCHITECTURE

As mentioned in earlier section FlexRay communication node is currently being implemented using microcontrollers that have integrated communication controller for FlexRay. So there are only two major

ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
Volume 2, Issue 6, June 2016

components required which are main microcontroller which acts as both host controller and communication controller and bus transceiver. Figure 2 [2] shows block level representation of this architecture.

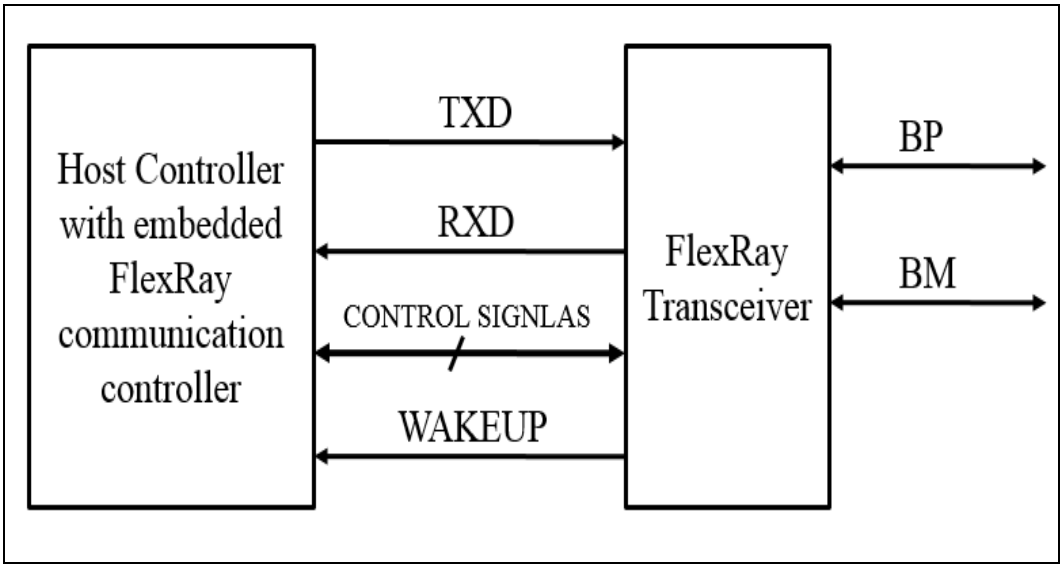

Fig. 2 Flex Ray node architecture with embedded communication controller

There are only two components required in this architecture microcontroller and bus transceiver. Transmit, receive, wakeup and control signals for the transceiver are interfacing signals whereas BP and BM are FlexRay bus level signals. This is traditional approach that is followed for any other communication also and is useful considering fact that a control module needs to perform many other tasks like analog signal processing, output valves turn ON and OFF etc. But as no of tasks increases memory requirements for such systems also increases and scheduling among the different tasks takes lot of efforts to optimise task management and priority settings. So though architecture looks simple at the hardware level considering no of components required there are software efforts involved for such a design architecture.

IV. PROPOSED SOLUTION

For FPGA based automotive systems there can be two approaches which depends on application requirements of system. First considers FPGA as a main processing element in which apart from FlexRay communication FPGA would be performing other processing tasks also which in traditional systems are performed by conventional microcontrollers. Figure 3[2] shows block diagram representation of this architecture. It is similar to traditional design approach that is explained in previous section with the difference is that microcontroller is being replaced by FPGA. So application management in this architecture is taken care by FPGA. As it has been mentioned in earlier sections communication controller takes care of protocol management for communication, in this approach communication controller along with other feature are also implemented in FPGA.

ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
Volume 2, Issue 6, June 2016

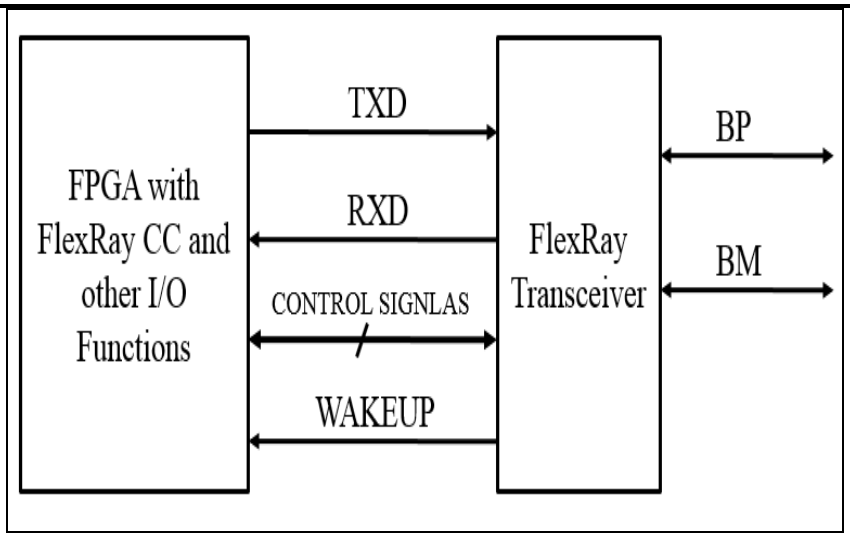

Fig. 3 FlexRay node with FPGA as main processor

In second approach FPGA can act as a slave device where it is only responsible for FlexRay communication only. So in this architecture only FlexRay communication controller is implemented in FPGA with some host interface through which it can communicate to host controller that can be a microcontroller or processor depending upon application requirements. All other signals that are interfaced to bus transceiver remains same with the difference that there is dedicated task assigned to FPGA which is FlexRay communication. So in such architecture smaller size FPGA would also work offering redundancy to main microcontroller. Figure 4[2] shows block level representation of this architecture.

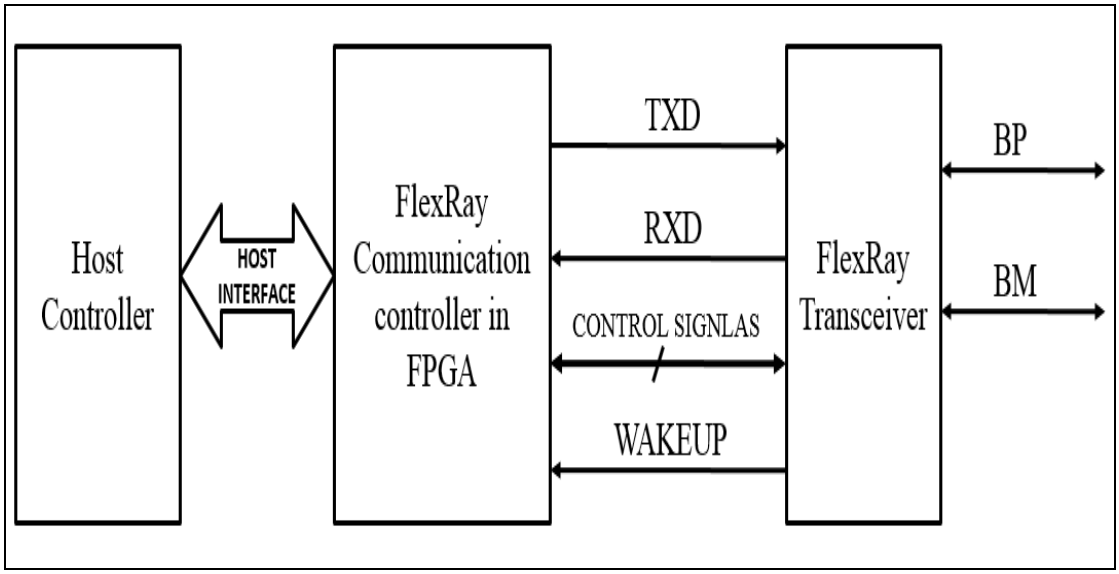

Fig. 4 Flex Ray node with FPGA as slave processor

An example of FPGA implementation is shown in Figure 5. It is implemented with Spartan 6 FPGA and a bus driver NCV7383DB0R2G. Host controller can be optional depending on system requirements which is also

ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
Volume 2, Issue 6, June 2016

shown in the previous section. FlexRay communication controller is implemented within the FPGA and it communicates on one side bus driver and on the other side to host controller over host interface.

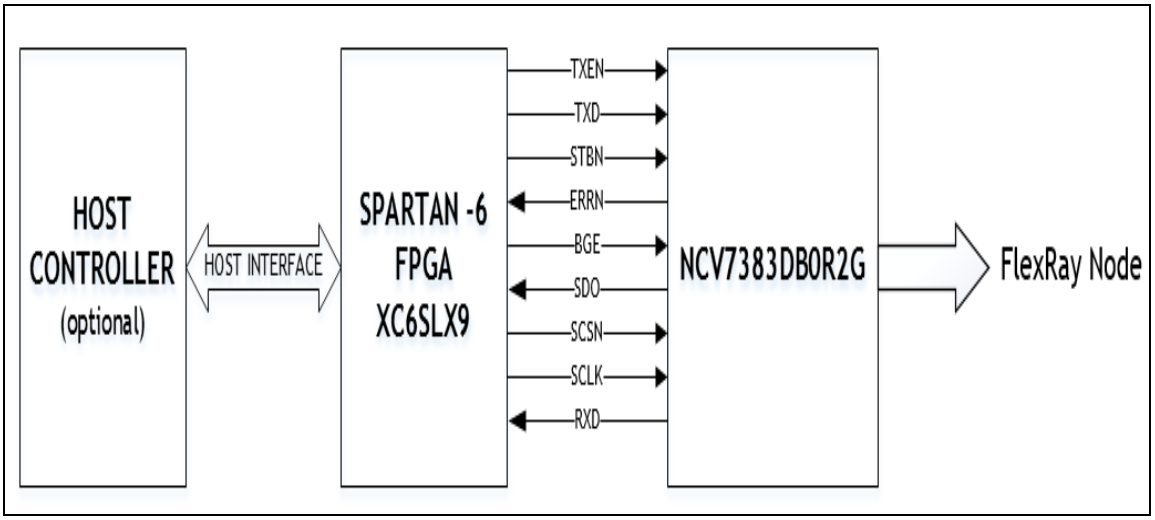

Fig. 5 Flex Ray node with Spartan-6 FPGA

V. ADVANTAGES AND DISADVANTAGES

Advantages:-

- Proposed solution offers good level of redundancy considering hardware architecture of FPGA
- In application where analog processing is not required this solution can be better solution as digital driving and sensing can be effectively managed in FPGA
- Each core of FPGA would act as a separate control unit so level of scheduling required in case of microcontroller approach may not be required.
- OEMs (Original Equipment Manufacturer) can use this approach to develop their own ASICs (Application Specific ICs) where their organization specific data can be encoded. This is easily possible in FPGA and would be useful in multiple applications.

Disadvantages:-

- This approach has newly been introduced so it may not be possible to use this to upgrade or modify existing systems as this would take lots of software efforts.
- In case of FPGA as a slave two programming cycles are required so that is an additional effort required in software development.
- FPGAs limitations to process analog processing and floating point arithmetic can deviate designers to go for traditional approaches only.

VI. CONCLUSION

This strategy is mainly useful for automotive systems using FPGA where it might be used as a main processing device or slave device. In both cases the communication controller for FlexRay is implemented within FPGA

ISSN (Online) : 2454-4159
International Journal of Advanced Research in Science Management and Technology
Volume 2, Issue 6, June 2016

that acts as a standalone FlexRay core and manages all protocol level architectures. For FlexRay communication parameters like redundancy and reliability are important as it is used in safety critical application which can be satisfied comfortably by FPGA designs, allowing manufactures and OEMs access to encode their critical data easily which makes diagnostic functions quite useful and easier. With all these possibilities application requirements for control modules in automotive systems drives architecture selection for FlexRay communication node as with the level of processing required like floating point processing FPGA approach may not be an intelligent choice.

REFERENCES

[1] **Extensible FlexRay Communication Controller for FPGA-Based Automotive Systems by ShankerShreejith, Student Member, IEEE, and Suhaib A. Fahmy, Senior Member, IEEE.**

[2] **Implementation of FlexRay Node in automotive systems by . Abhijeet A. Pande and Mrs. Nandini V. Dhole, Dept of Electronics and Telecommunication Engineering, RMD Sinhgad school of Engineering, Pune Maharashtra.**

[3] **A Controller Area Network Bus Transceiver Behavioral Model for Network Design and Simulation by William Prodanov, Student Member, IEEE, Maurizio Valle, Member, IEEE, and Roman Buzas.**

[4] **Advanced Features and Industrial Applications of FPGAs—A Review by Juan J.Rodríguez-Andina, Senior Member, IEEE, María D. Valdés-Peña, Member, IEEE, and María J. Moure, Member, IEEE.**

[5] **Design and Realization of FlexRay Communication Unit in Vehicle Network - Yi Wang, Hui Pan, Jiawen Liang.**

[6] **An Introduction to FlexRay as an Industrial Network- Robert Shaw, Brendan Jackman Automotive Control Group, Waterford Institute of Technology, Waterford, Ireland.**

[7] **FlexRay Communications System Protocol Specification Version 2.1 Revision A.**