Slovak University of Technology in Bratislava

Faculty of Electrical Engineering and Information Technology

M.Sc. Florian Dietze

Summary of the dissertation thesis

ARBITRATION ADVANCES AND DETERMINISM IN A SINGLE CAR COMMUNICATION BUS

submitted to acquire the scientific-academic degree

“Philosophiae Doctor"

in the Doctoral study programme Mechatronic systems

Study field 5.2.1.6 Mechatronics

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Abstract

Thesis title: Arbitration Advances and Determinism in a Single Car Communication Bus

Keywords: Arbitration; Determinism; Automotive; Bus Layer modification;

This thesis attempts to find a way of merging the benefits of two different access methods into one system. This means combining the stability and efficiency of the system with the flexibility of the most common periodization model of today. The ultimate ambition would be to create a universal bus system for all purposes of automotive applications. Both methods are established standards, both access methods have their rights to exist and to a certain scope of advantages and both access methods have their restrictions. Combining both systems under consideration of special issues could lead to a bus system to replace the common standard using existing arbitration matrices and benefiting from advantages of determinism. The main research focus is to show a theoretic way of modifying both software physical layers in order to implement arbitration into a system. The scope of research here is to be able to demonstrate a theoretic way of modifying physical layer, time management and software to implement arbitration into a system, which is not really prepared for the special demands of this. This means adapting technically new access methods on existing bus technology. The conclusion is meant to be the base of future works on the bus access method. The benefit is to provide hardware and software engineers with ideas for designing new bus structures that are able to introduce bus technology.

Contents

1. Introduction

1.1. Objective of the Dissertation

This thesis attempts to find a way of merging the benefits of two different access methods into one system. This means combining the stability and efficiency of the system with the flexibility of the most common periodization model of today. The ultimate ambition would be to create a universal bus system for all purposes of automotive applications.

Both methods are established standards:

- The CAN bus provides an arbitration access method and is the most common bus interface in nearly every single modern car in this time. It has proven its benefits over decades in hundreds of millions of cars.
- The FlexRay bus is the logical consequence to the increasing amount of data between more and more ECUs in modern cars. It considers special demands of advanced driver assistance and active and passive safety on board.

Both access methods have their rights to exist and to a certain scope of advantages:

- CAN is established and is the most common in use. The CAN-matrices for every single system yet exists and has been improved over the years. Each supplier and standard for every vehicle manufacturer knows the method.
- The FlexRay standard has been negotiated between major car manufacturers, system suppliers and semiconductor producers. It meets all necessary requirements to be accepted by the automotive industry.

Both access methods have their restrictions:

- CAN has reached its limits. In the 2012, a version of a high-class sports utility vehicle (SUV) of one of the world´s leading car brands has been found to have seven different high-speed CAN subsystems to maintain communication. They are (1) drivetrain, (2) chassis, (3) comfort, (4) multimedia, (5) dashboard, (6) crash and (7) extended CAN and are all connected to a gateway—the neuralgic part of data transfer.

- FlexRay has no error detection and fault confinement like CAN. The dynamic segment does not meet the same flexibility as arbitration. It is not possible to perform a change from CAN to FlexRay without redefining every single message.

Combining both systems under consideration of special issues could lead to a bus system to replace the common standard using existing arbitration matrices and benefiting from advantages of determinism. The main research focus is to show a theoretic way of modifying both software physical layers in order to implement arbitration into a system.

1.2. Aims of the Dissertation

The scientific contribution of this work is characterized by the description of findings and describing theoretical ways to modify each aspect of bus properties to create a unique system that grants benefits for a radical approach. The sum of all modifications will lead to a revolutionary new bus access method that is suitable for both existing control units and fit for future demands, by eliminating the restrictions of existing bus technologies and simultaneously implying the benefits of the different access methods, as follows:

- Modification of the physical layer

The aim is to slightly modify the physical properties. It would be perfect to find a way of using the complete physical properties of an existing bus technology, since this would mean being able to keep all established communication modules, drivers, wiring, impedance networks, architecture and monitoring. The scientific scope of this dissertation is to describe a modification, which causes minimal modification effort on established technology. This is the basis for building the bus infrastructure needed to develop the communication systems itself. It is necessary to introduce three logical levels to realize differential signals with two dominant levels and a recessive level for arbitration algorithms. The choice of levels themselves is not really easy. On the one hand, a low differential voltage offers advantages in current consumption, when establishing a system with quite low impedance (around 120 ohms). On the other hand, the logical levels must differ enough during arbitration to be assigned correctly, even in critical situations (more than one ECU is trying to manipulate the logical level at slightly different time stamps).

- Time management

The time management is essential for a TDMA by topology. Therefore, most of the scientific work will be in this domain. The demand is to create a way to literally avoid collisions on the data highway. It is comparable to trying to find a way of merging a railway and motorway. The challenge is to put a rail on the same lane a car uses without delaying the time schedule. The scientific contribution is to provide ideas to future bus access methods. The ultimate goal is to keep all existing priority tables of arbitration systems and timetables of deterministic systems.

In order to establish a deterministic part in a system with arbitration, there is only one possibility.

The message with the highest prioritization must start at a predefined point of time, dependent on the time schedule. This is used as a coordination of the start of deterministic transmission. A key element to this is the network idle time. Since even the most important message can only start when no other transmission has taken place for a defined period of time, it is very important to force bus silence just a short time before the synchronization message. The idle time must not start too early, so there is no chance for other messages to start transmission just a short time before synchronization message.

- Software modification

Modification of both the physical layer and network timing properties logically leads to modifications of the data containers themselves. The aim is to adapt the data security, error and fault management to the changed environment. The scientific work is to restructure the frame format of each communication package. The header is responsible for both arbitration and determinism. The payload needs to be flexible and predictable. The trailer contains error and fault confinement.

However, to minimalize the influence of a new bus communication, the changes should not result in dramatic restructuring of the used software. It is the clear aim to carry over as much as possible of given software models. This leads to acceptance. There would be no benefit of introducing new features at the cost of complete remodeling of software.

- Overall conclusion

The final result is greater than the sum of all parts. This dissertation leads toward the revolution out of an evolution, as mentioned above. The scope of research here is to be able to demonstrate a theoretic way of modifying physical layer, time management and software to implement arbitration into a system, which is not really prepared for the special demands of this. This means adapting technically new access methods on existing bus technology. The conclusion is meant to be the base of future works on the bus access method. The benefit is to provide hardware and software engineers with ideas for designing new bus structures that are able to introduce bus technology.

1.3. Methodology

The first step is examine the scope of the research in modern car communication structures. The communication of three car concepts are described and compared to each other. This gives us a first impression on the demands of small cars, standard cars and high-end, luxury derivate.

The next step is to find a system, which fits the basic requirements to combine both benefits. Therefore a comparison between all common bus systems will lead to an adequate base. In order to successfully implement arbitration and determinism, three major factors of the system must be modified.

- Physical layer
- Time management
- Software

Adjusting these three factors will be the main part of the work. Each issue will be described in its own chapter in the main part.

To modify the physical layer means to modify voltage and current of the system. The bus management is based on different levels, dependent on the used technology. Arbitration needs dominant and recessive levels to realize the periodization of messages sending at the same time. Bus systems with high-speed and time-critical behavior, such as those used for high-speed deterministic transmission, are based on low voltage differential signals to increase stability and speed. Those LVDS signals are realized by having two dominant levels with little difference on the voltage.

Time management is very critical. The dimension of the network leads to delays between nodes placed far from each other. All nodes need to be synchronized to meet the benefits of deterministic segments.

The software needs to be modified to distinguish between data, which is critical to sending immediately and data best suited for a deterministic spread out. The key nodes should be able to differ between normal communication and special time critical circumstances, where both periodization and determinism lead to maximal performance.

Additional to the three car models that introduce CAN based communication, FlexRay and a hybrid of both, a fourth model will be figured out, representing the possible solution with the communication bus developed during this work.

In order to prove the benefit of the changes, a communication sequence during a very time-critical moment will be created based on a state diagram. The sequence must find a place on all three car concepts mentioned in the beginning, compared to the communication developed in this work.

2. Selection of an Appropriate Bus System

There are several factors that are associated with the roadway that influences the choice of the bus system. These include the street side factors, the available information on the next bus stop zone design types (STREET-SIDE FACTORS). The street side factors design will highly impact on the choice of the bus systems. The following street side items are to be considered when choosing a bus system.

The uniformity of the street side design will significantly affect the choice of an appropriate bus system. This is always a desirable feature, since it provides consistency, thus rare confusions are costly. Traffic rules are also a major factor to consider when making the choice of a bus system. The signals and signs should be located in areas that do not affect communication, to avoid confusion and misconceptions. The driveways are always not designed for bus topping thus should give clear indications to enhance communication. Distinctly, the bus stops should be clearly located to give full visibility and thus better communication (STREET-SIDE FACTORS).

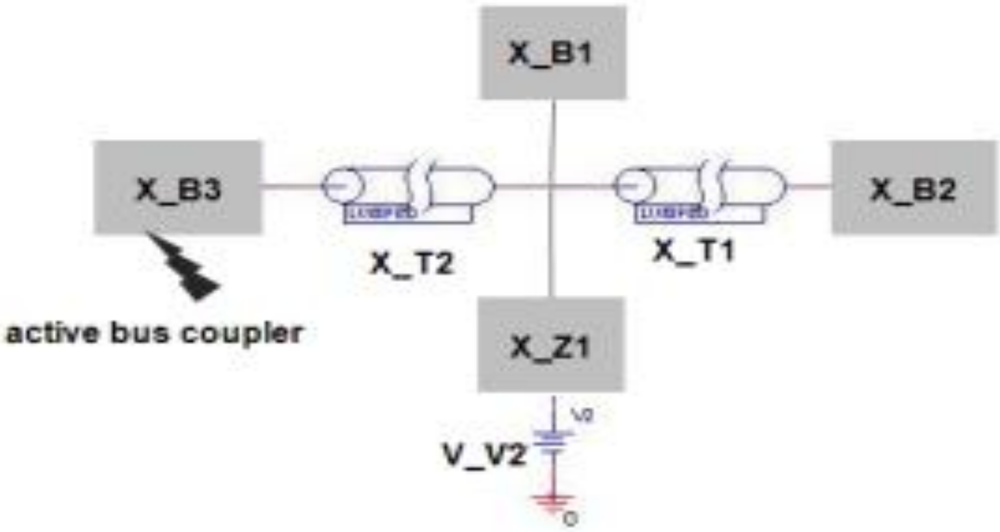
Selection of an appropriate bus system is also greatly influenced by the route planning of the road. Most transport systems have routes that are planned in isolation rather than as part of the coordinated networks, as this will affect the type of bus system to be used effectively. It is never appropriate for achieving the demands of a good number of travellers. Due to poor route planning, results of poor route coverage during communication can exist, such as excessive requirements for interchanges between routes and inconsistent frequencies.

Well-designed routes provide reliable links between all points where there is a need and are also available to provide the best services that could significantly meet the needs of the traveller. Some have always been designed to achieve already set standards or criteria, such as the optimum number of interchanges between routes and inconsistent journeys.

3. Modification of the Physical Layer

Considering the increasing performance and cost of the reduction of microprocessors, the disintegrated approach of systems automations has been applied frequently in the previous years. The current changes of the automation systems focus on the distribution systems to handle modular extensibility and avoid isolated applications and systems. The disintegrated approach suggests a connection of each sensor and actuator to a bus system via a bus coupler, resulting in generation of large distributed systems on which the performance will rely on the number of participants.

Recently, studies on physical layer simulations have been seen mainly in the field of automotive bus systems (Günther, 2010). The focus therefore lies on the more complex bus system topologies, such as the hardware structure in disintegrated building automation systems. Which consisted of more than 1,000 bus couplers? It has been networked in a transmission channel system as far as 1km without a repeater. Progressions of the physical topology or minor alterations of the physical layer equipment of a transport hub, for example, stub lines, jumbles or unsatisfactory dimensioning, could result in a negative impact to the sign honesty. A recreation-based examination is vital for this sort of expansive, dispersed computerization framework. Below is a clear design of a bus topology with three bus couplers at a maximum distance of 3m and the accordance of net list (Diekhake, 2013).

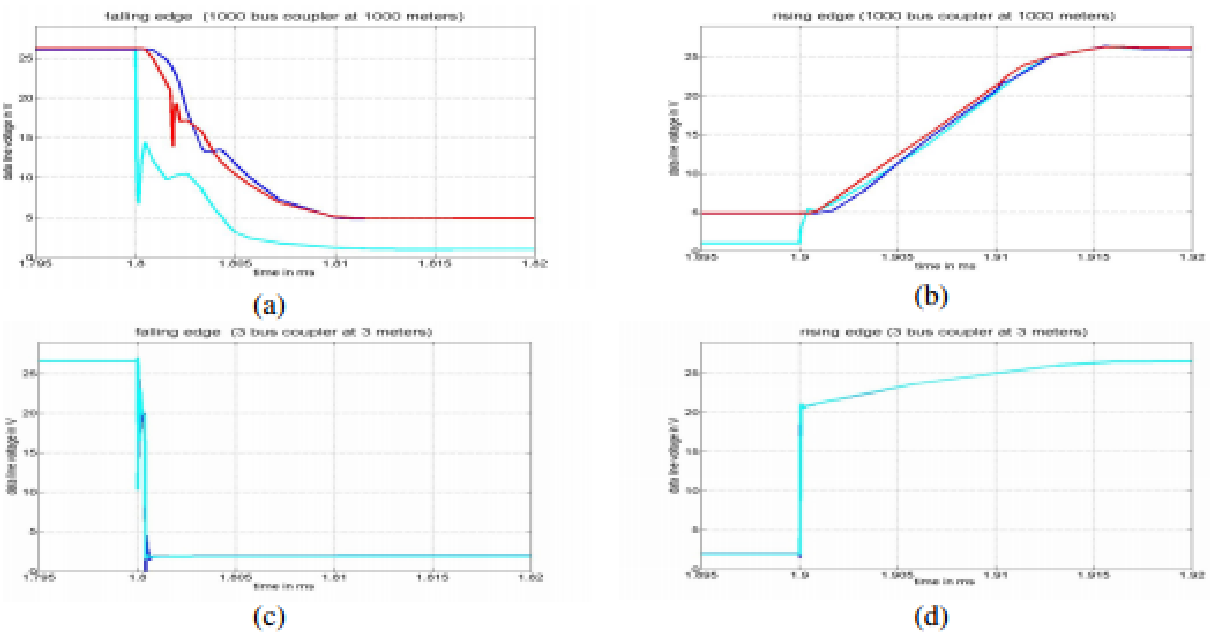



```
V_V2  1        0                                        30Vdc
X_Z1  0        2    1                                   ENERGY_SUPPLY_UNIT
X_B1  TX_1        2      0          RX_1                BUS_COUPLER
X_T1    3   2   GND_1   TLUMP128   PARAMS: R=0.05 L=0.075u C=55p  LEN=2
X_B2  TX_2      3      GND_1   RX_2                     BUS_COUPLER
X_T2    4   2   GND_2   TLUMP128   PARAMS: R=0.05 L=0.075u C=55p  LEN=1
X_B3  EVENT   4      GND_2   RX_3                       BUS_COUPLER
V_V3 EVENT  GND_2  PULSE 0V 5V 1000u 10n 10n 0.1m 0.198m
```

Figure 1. Minimal Scale Hardware Architecture and SPICE-net List

After short-circuiting, the accompanying sign bend relies on sign uprightness properties, for example, reflection conduct and voltage changes. The accompanying necessities must be satisfied for every topology setup to ensure a sufficient sign respectability conduct:

- The voltage drop between the information line and the ground must be lower than 7 V/ 500 m, which ensures the distinguishing of the overwhelming flag by the recipient equipment.
- After the settling time and line postponement time of 11.9 V, the level flag on the information line must be lower than the limit voltage of 14 V, amid the falling edge and must be invaded amid the climbing edge, to guarantee a stable sign follow before the sign inspecting begins. (Diekhake, 2013)



Below are the simulation results for a large and minimal distributed topology.

Figure 2. Simulation Results for a Large and Minimal Distributed Topology

4. Time Management

4.1. Timing requirements

Bus systems such as FlexRay will always use the stopping time where different alternative solutions are that can be adjustments for any drift that might have happened previously with different processes within the cycle. The network idle time is thus a pre-defined, known length of ECUs that is utilized for the before-mentioned purpose. The bus systems communicate within different physical layers within the network. The lines are used for redundancy to ensure fault tolerance during message passing but can be transmitted through different messages. The communication network for the bus systems requires a common time base. For time synchronization, data messages are transferred in the static frequency within the process cycles. With the support of an exceptional calculation, the nearby clock-time of a segment is remedied in such a route, to the point that all neighborhood tickers operate simultaneously, according to the global time.

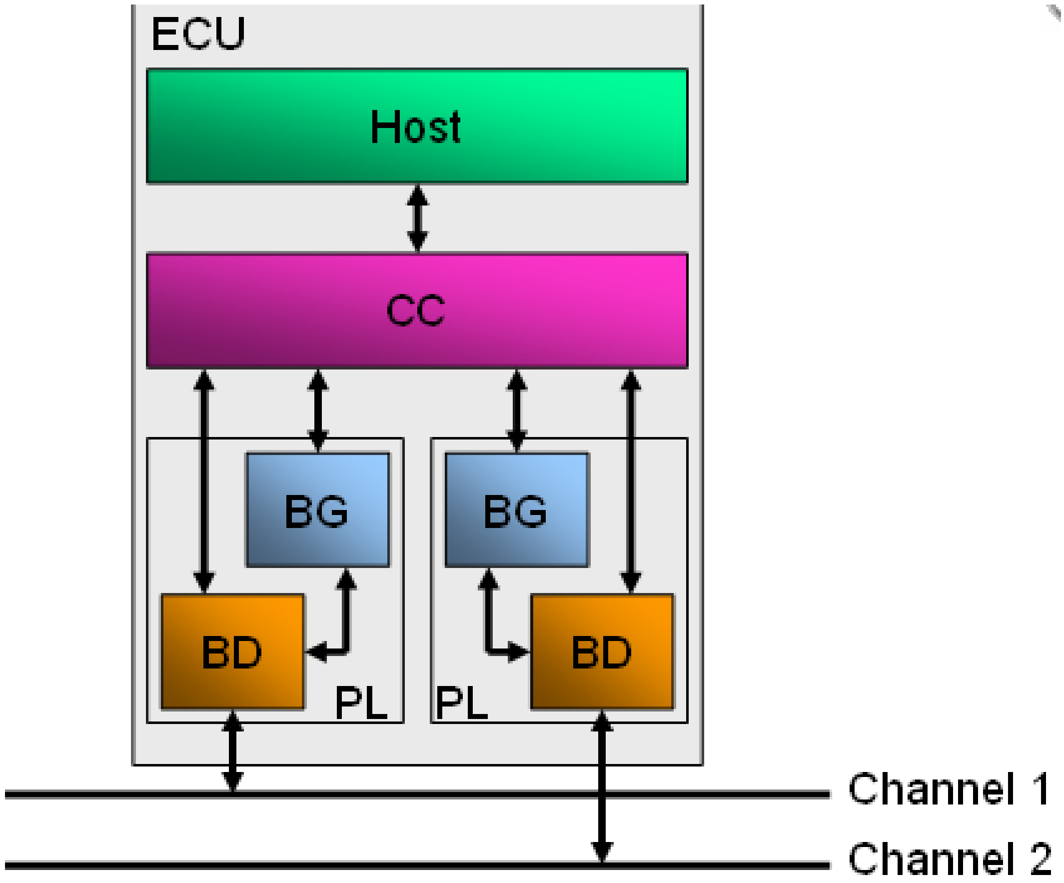


Figure 3. Structure of a FlexRay ECU

4.2. Error Detection and Avoidance

The bus system gives adaptable shortcoming tolerance by permitting single or double channel correspondence. For security-discriminating applications, the gadgets joined with the transport may utilize both channels for exchanging information. On the other hand, it is likewise conceivable to interface a one and only channel, when excess is not required, or to expand the transmission capacity by utilizing both channels for exchanging non-repetitive information.

Inside the physical layer, the bus system gives quick blunder location and motioning, in addition to slip regulation through a free bus guardian. The bus guardian is a physical layer tool that can be a threatening level of the obstruction channel brought about by correspondence that is not adjusted to the group’s correspondence plan (Eberspächer, 2014).

Conclusively, the exertion for an estimation-based dissection of the physical layer of extensive disseminated mechanization frameworks is to a great degree high and not useful.

Accordingly, a recreation-based investigation for this sort of mechanization framework is proposed in this commitment. The fundamental part models of a mechanization framework and their variable association by a topology net are depicted. The reenactment results for diverse careful investigations show different sign practices, subject to distinctive transport topologies and alterations of the transceiver equipment. Variable parameters permit the investigation of sign trustworthiness for diverse conditions. By and large, explanations about the sign honesty for complex computerization frameworks can be yielded by this reproduction (Diekhake, 2013).

4.3. Arbitration

A bus can be conceded to one processor per a case. A single processor can also be termed a as controller whereby the controller can constitute the system becoming a peripheral. System buses imparted between the signal controllers and an IO processor with various controllers that need to get to the bus; however, stand out where they can allow the bus expert status in any situations.

4.4. Prioritization

The system buses that are connected between the controllers and the input output processors, and various controllers that require to get the bus, stand out and can only be allowed by the bus expert status at any instance. The system buses are communicated among the controllers and an input processor together with several controllers, which have access permission to the bus, but it is by priority that the only controller that can be given to bus communication is the domain status with any point of time. The bus master thus will have authorization of bus accesses at any instance of time.

4.5. Methods

There are given standards and methods through which the present bus master can be authorized to access the bus. The process also at the same time is used to allow the master to leave the control of the pass and pass it to the succeeding bus on the list. There are two methods in bus arbitration (Kamal, 2008): (1) daisy chaing method and (2) polling method.

4.5.1 Daisy Chain Method

The daisy chain method is available for the sharing of the bus communication by multiple processors and controllers. I is incorporated in the use of the centralized bus arbitration process. The bus control will pass from one succeeding master to another that is held in the queue, recursively until it reaches a dead end. The bus control transmits within different controller units to C0 then C1 then to the next one in the line continuously up to a point of termination (Kamal, 2008).

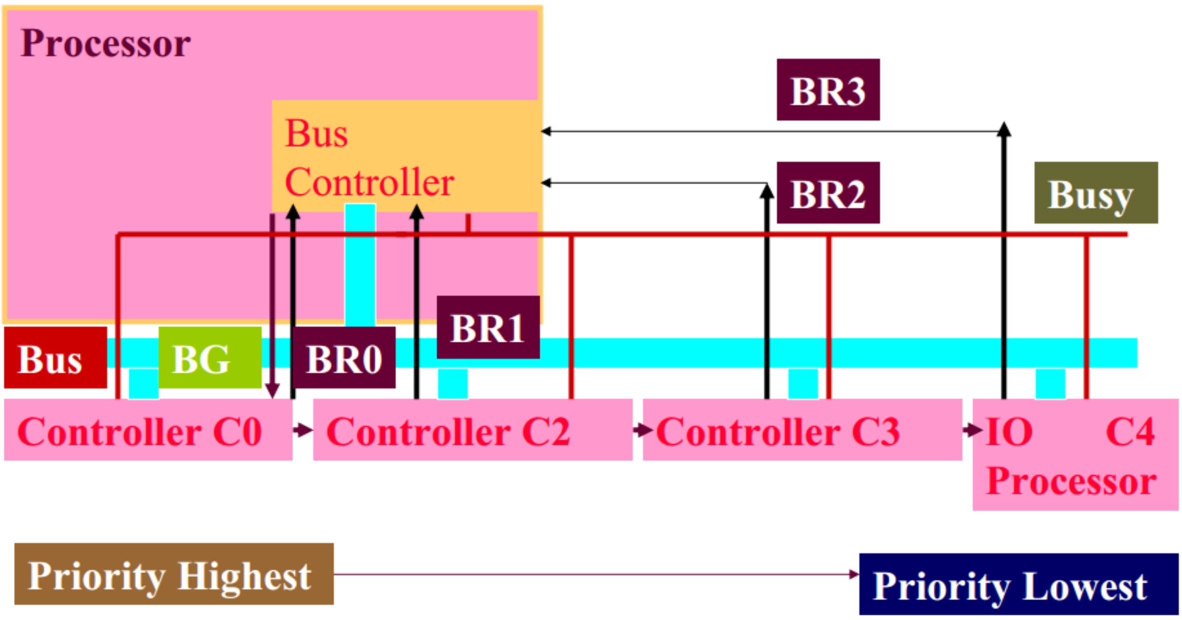


Figure 4. Daisy Chaining

(Kamal, 2008)

The bus signal that is granted performs in a different manner, since it is initiated to C0 and if C0, there will be no need for a token it I-passed to the next C1, and any controller that needs the bus will always raise a bus that needs a signal. There is busy–busy signal that is generated when the controller becomes the bus master. This is deactivated when the bus master no longer needs the bus.

4.5.2 Polling Method

In the polling method, a poll occurs with a value to be transmitted to the different controllers and is accumulated, considering that there are 10 controllers where the signals count change from p2, p1, p0 in a manner to proceed from 000, 001. If on count = I, then a signal is received in an incremental stoppages status, then BG is sent.

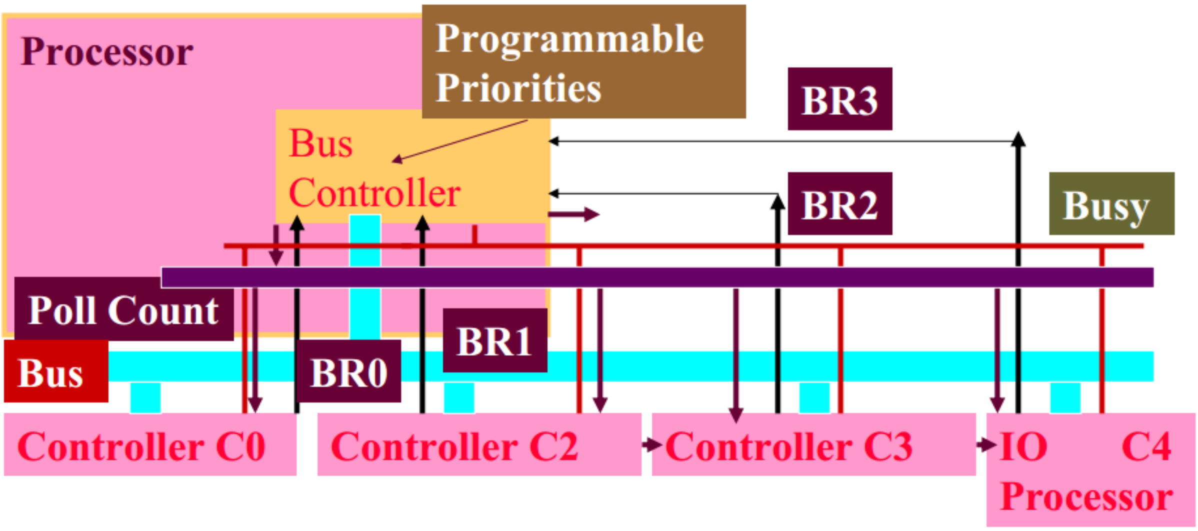


Figure 5. Polling Method

(Kamal, 2008)

The BUSY stimulates and acts as the bus master when the deactivation of the bus request. Incremental counting begins between the BUSY point and the BG point, which can be deactivated according to the priority, the master is set in (Kamal, 2008).

4.6. Interrupt

This is forcibly changing normal flow of control. Interrupts are mechanisms through which other modules may interfere with the smooth and normal sequence of processing within the bus system. To control the interrupts in a bus system, there is need to define the priorities where priority of Low level intervals can be replaced by higher ones. When higher priority interrupt has been processed, the processor returns to the previous interrupt (Stallings, 2002).

There are two main types of interrupts in the bus system.

a) Asynchronous: This is an interrupt that affects the bus system from an external source such as input/output devices. This is not related to the sequencing in the controllers.
b) Synchronous: These are interrupts that will be realized due to processor-detected exceptions; the synchronous interrupts can be corrected and will involve faults, traps and aborts. Aborts are performed on a major interrupt that could highly affect the performance of the bus system.

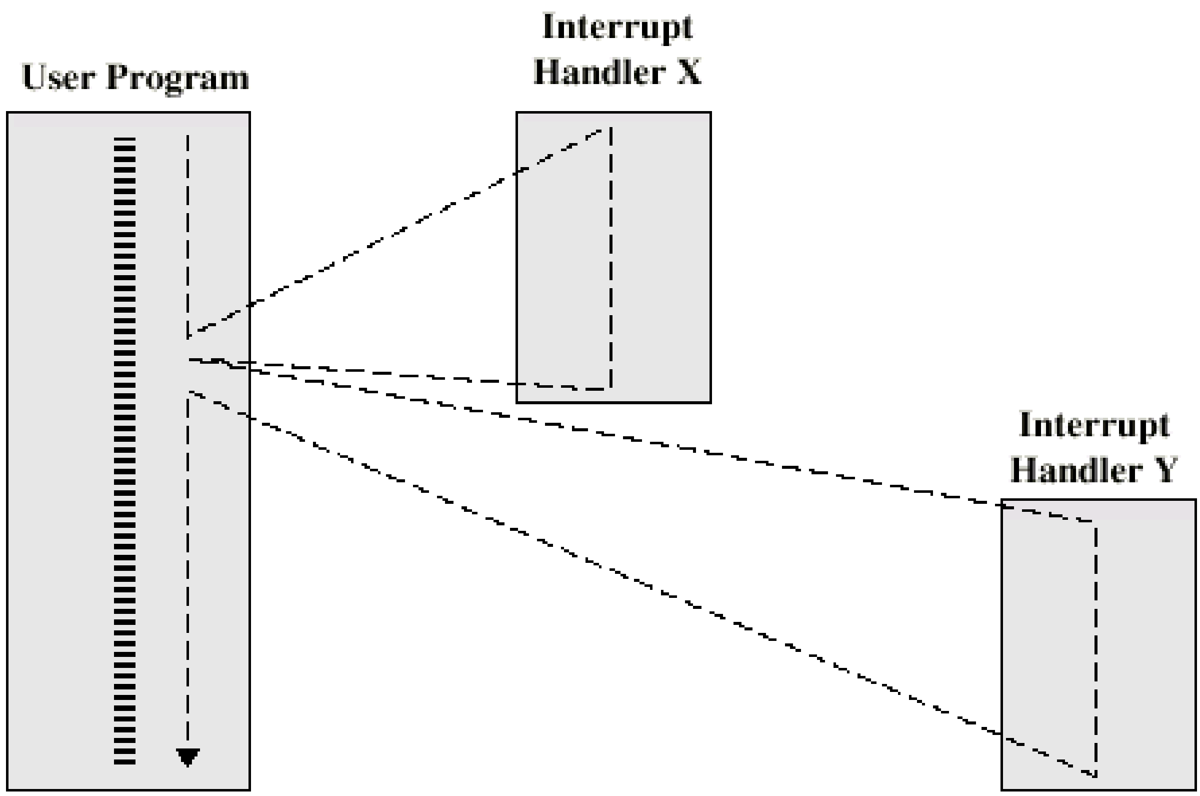


Figure 6. Multiple Interrupts – Sequential

4.7. Trigger

There are several types of triggers in regard to bus system controls. We have event-triggered and time-triggered. The event triggered CAN bus is setup as a defector standard device, which can be applicable for different power control systems that can be used for automotives or trains. There has been a high demand for the time-triggered events, since buses with time-triggered operation modes play a major role in future automotive networks, thus most people choose time-triggered operation events. Permission to establish a certain level of access to the bus communication system that can be predefined before controlling are established windows, leading to advantages of different levels of mentoring behavior on normal processes within the network operation. Therefore, time-triggered concepts potentially provide high performance to deduct any message errors or failure within the network system. There are many other factors that can help or be used as a guarding system to a synchronized communication bus system to take care of any network failure or redundancy.

The main privilege of event-triggered systems is their capability to vastly interact with different asynchronous external network activities, which can be predicted in prior processes. This indicates a real-time efficient system that integrates the performance of the systems with high flexibility levels with actual redesign demands in a complex system setup (Albert, 2004).

5. Data Content

Bus systems transmit binary data between different controllers. The bus system will always receive and transmit its data from the control unit through a dedicated wire. The necessity of the wiring increases with an increase in the electronic systems. Wiring devised independently for the transmission of data is very hectic and it is difficult to find spaces in the body to hold all the wiring, thus resulting in a lack of reliability and more complicated troubleshooting. The bus system is a solution to the above problems. It provides greater reliability for handling the data, as it reduces the different wiring systems that are required from communication. Reduction of the wire significantly decreases the interface size between controlling units within the different nodes, making it more efficient in data handling. It enhances data handling by providing multiple usages of the transmission controls from one point to another. It offers expandability and flexibility in the configuration of the systems and future applications. It also reduces the cost of components, assembly and troubleshooting for handling the data (bus system trouble shouting).

5.1. Bitrate

The bitrate refers to the transfers per second of data. This could be explained as the number of operations transferring data that occur per second. CAN bus systems support bitrates in the range that is lower than 1kBit/s up to 100kBit/s. Within the CAN network, each member has its own clock generator, which is always a quartz oscillator. The principle of timing the bit time is always configured individually for each CAN node, since creation of a common bitrate, even though the CAN nodes' oscillator periods may be different. The oscillator's frequencies are not absolutely stable; they experience small variations, which are caused due to the change in temperatures or voltage. CAN nodes are always baled to compensate for the different bitrates, by resynchronizing to the bit stream provided by the variations remaining at the constant oscillator tolerance range (Robert Bosch GmbH).

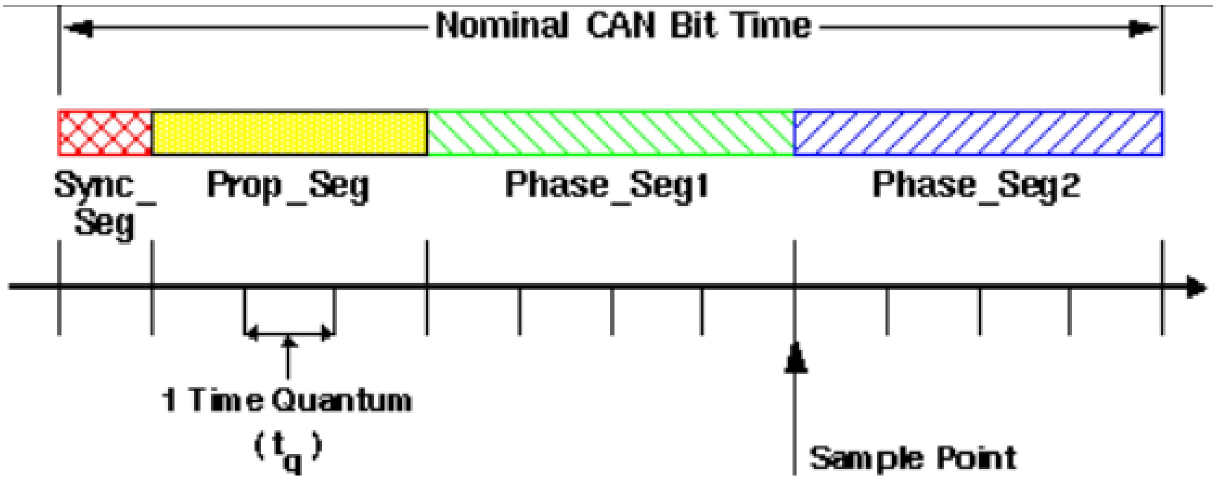


Figure 1 : Bit Timing

Parameter	Range	Remark
BRP	[1 .. 32]	defines the length of the time quantum t_q
Sync_Seg	1 t_q	fixed length, synchronization of bus input to system clock
Prop_Seg	[1 .. 8] t_q	compensates for the physical delay times
Phase_Seg1	[1 .. 8] t_q	may be lengthened temporarily by synchronization
Phase_Seg2	[1 .. 8] t_q	may be shortened temporarily by synchronization
SJW	[1 .. 4] t_q	may not be longer than either Phase Buffer Segment
This table describes the minimum programmable ranges required by the CAN protocol		

Figure 7. Parameters of the CAN Bit Time

5.2. Redundancy

Redundancy always ensures achievement of reliability in systems; a redundant two-wire bus provides a high reliability system. The exertion to accomplish high dependability in information transforming, information stockpiling and correspondence frameworks has required the utilization of hardware to screen parameters, for example, temperature, fan pace, and framework voltages. These circuits are frequently conveyed through 2-wire serial transports, for example, Sambas or I2c. Excess subsystems are paramount in high unwavering quality frameworks, and the 2-wire transport subsystem is no special case. High dependability 2-wire transport frameworks consolidate two expert controllers in a repetitive setup, to keep up the framework operation if one expert fizzles or is evacuated. In a repetitive setup, each expert is joined with it 2-wire transport, while the greater part of the slaves are associated with a solitary downstream excess transport. Either ace can take control of the excess transport whenever.

Figure 20 demonstrates a circuit utilizing two Ltc4302's, each one devoted to an expert, to permit either ace to take control of a repetitive 2-wire transport. The Ltc4302's GPIO pins default to a high impedance state at force up, so 10k draw up resistors R5, R6 and R13 set every GPIO voltage high. With each Ltc4302's Gpio1 pin associated with the CONN pin of the other, both Ltc4302's are dynamic at force up and can be gotten to through their SDAIN and SCLIN pins (Ziegler, 2004).

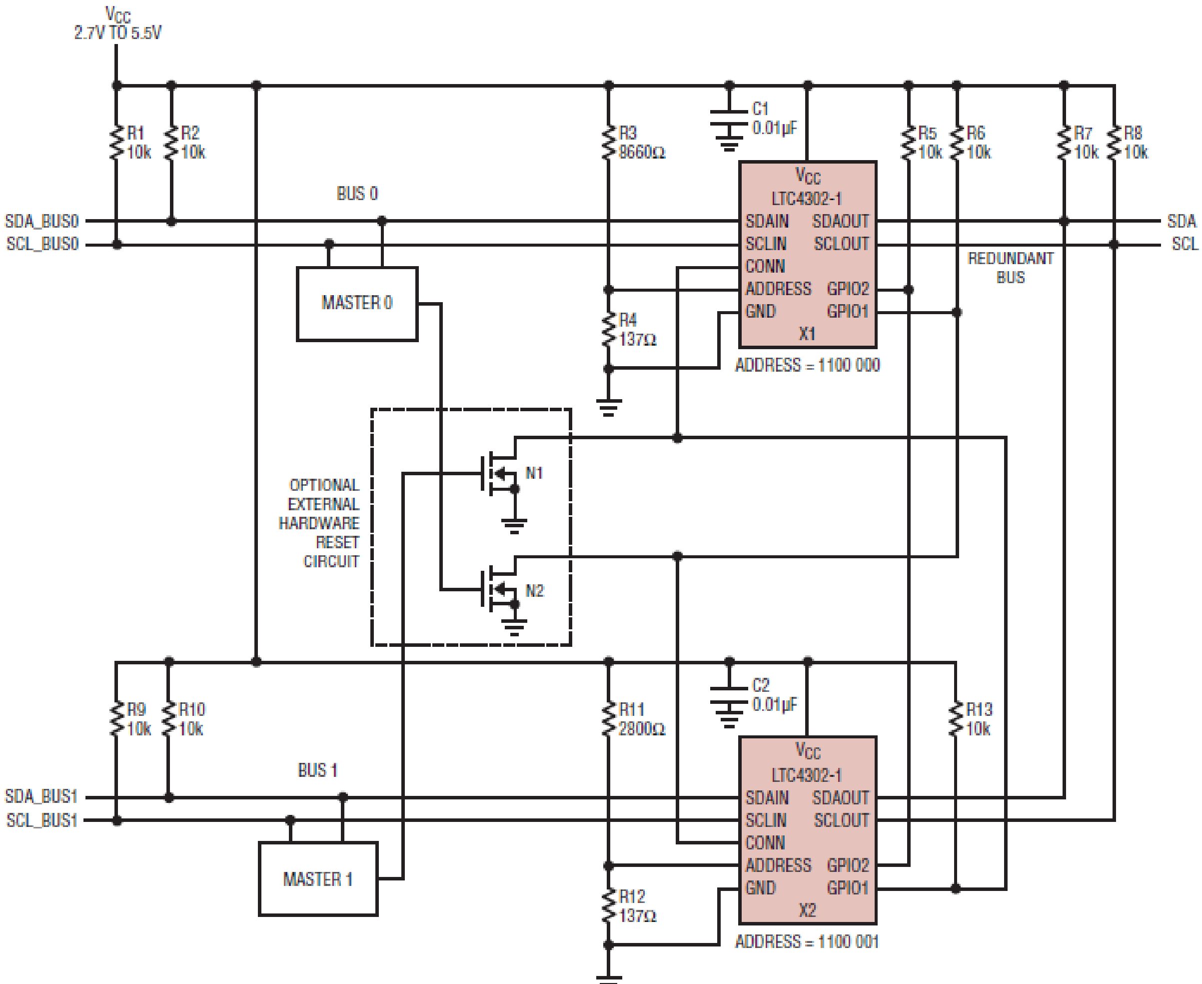


Figure 8. Two LTC4302s in a Redundant Bus Application with a Hardware Reset on the CONN Pins

5.3. Data Length

A Cs31 bus system dependably contains a stand out transport expert (essential unit or coupler), which controls all activities on the bus. Up to 31 slaves can be associated with the transport, e.g. remote modules or slave-arranged fundamental units. Other than the wiring directions demonstrated underneath, the wiring also has earthling guidelines furnished with the portrayals of the modules are furthermore legitimate.

5.4. Summary

Bus systems are providing better ways of communication that reduce costs and resources that are needed to set up the network services. They provide more reliability due to redundancy of the wire bus. It offers expandability and flexibility in the configuration of the systems and future applications.

6. Results Analysis Discussion

A bus owner arbitration decision means a selection of controlled nodes that can act as an arbitration to access bus communication in the meantime. This is the key factor in the different Spiral reuse processes within the FireWire sets of protocol, for example, sizes and priorities of packets. This is to basically gain a full understanding of the decision-making process, which is the main focus of this thesis.

We assume that all data transactions take a fixed duration of transmit time, $T_{data,}$ since correlated transmissions happen simultaneously; the duration for all transactions in the same row to complete is T_{data}. Then taking N_{rows} to denote the number of rows it takes to accommodate a total of N_{trans} transactions, then summation of the time taken for completing all data transactions, T_{total} is given by $N_{rows} \times T_{data}$. Throughput refers to the dataset values and the time slot, which is named by N_{trans} / T_{total}. The minimum value of T_{total} can be obtained by taking all the transactions in the minimum possible N_{rows}, as shown in the above figure. Consequently, this will create the SFP throughput rate within the network. This statement is considered as true but only if all the dataset transmissions occur within the same time slot. Finding an optimal minimum value of T_{total} for a group of transactions with different durations is difficult. In a spatial reuse FireWire protocol, requirements exist for the network in a random manner due to the different intervals arrival. It is very difficult to manage accurate forecasting requirements at any time, which is considered as a scheduling issue, especially if it is online. Applying any strategy at any given time to minimize T_{total} will not necessarily result in the lowest time used for the transmission. It is the same concept applied for the arbitration of artificial algorithm that helps in undertaken autonomous decisions with the minimum dataset values. The rearrangement of the automated cache helps in achieving linear results to show the positive correlation between datasets within different transmission processes. The different transmissions between datasets as mentioned earlier will go through different priority levels for the parent, i.e. same family, or pattern nodes, i.e. protocols, are set up according to priority and label.

6.1. Request Cache

All SFP nodes are implemented in a scheduled event or cache, which is identified in the form of two-dimensional pooling with the optimum number of a pool, known as N, representing the optimum number of nodes that can be supported effectively, while other nodes are based on three independent N called arrays as follows:

Packet size array.

1. Packet phase array
2. Packet priority array

Each of the above arrays will handle and keep all measurements of every packet size field value with a priority level to be able to synchronize the requests. A protocol algorithm is set up to determine both the source and designation addresses where the different values of the requested transmission are, as follows:

- Source is 2,
- Designation is 8,
- Process phase is current,
- The length is 1500 bytes, and
- Priority is set to high.

At every index slot, a signature is requested to identify the addresses for both the source and designation. Since the source address of this request is 2, its signature is 2. Therefore, while the start signature will be the slot between 2 and 8 to be set as a correspondence entity, whether it is right or left, this is identified by the degree of its closeness within the network processes. In the given algorithm, the source is identified as the left address while the designation is the right one. For instance, signature “4” is considered to be the entity of the start of the network and it is characterized with a flag of 1-bit with the value of 0 while the array of “10” value will be 1, as indicated as follows:

a) Packet-phase entity is set to current

b) The size of the packet entity is set up to 1600

c) Priority is set up to high

A request counter is set to identify the requests number in the cache within the same defined addressed memory used within each transmission requests.

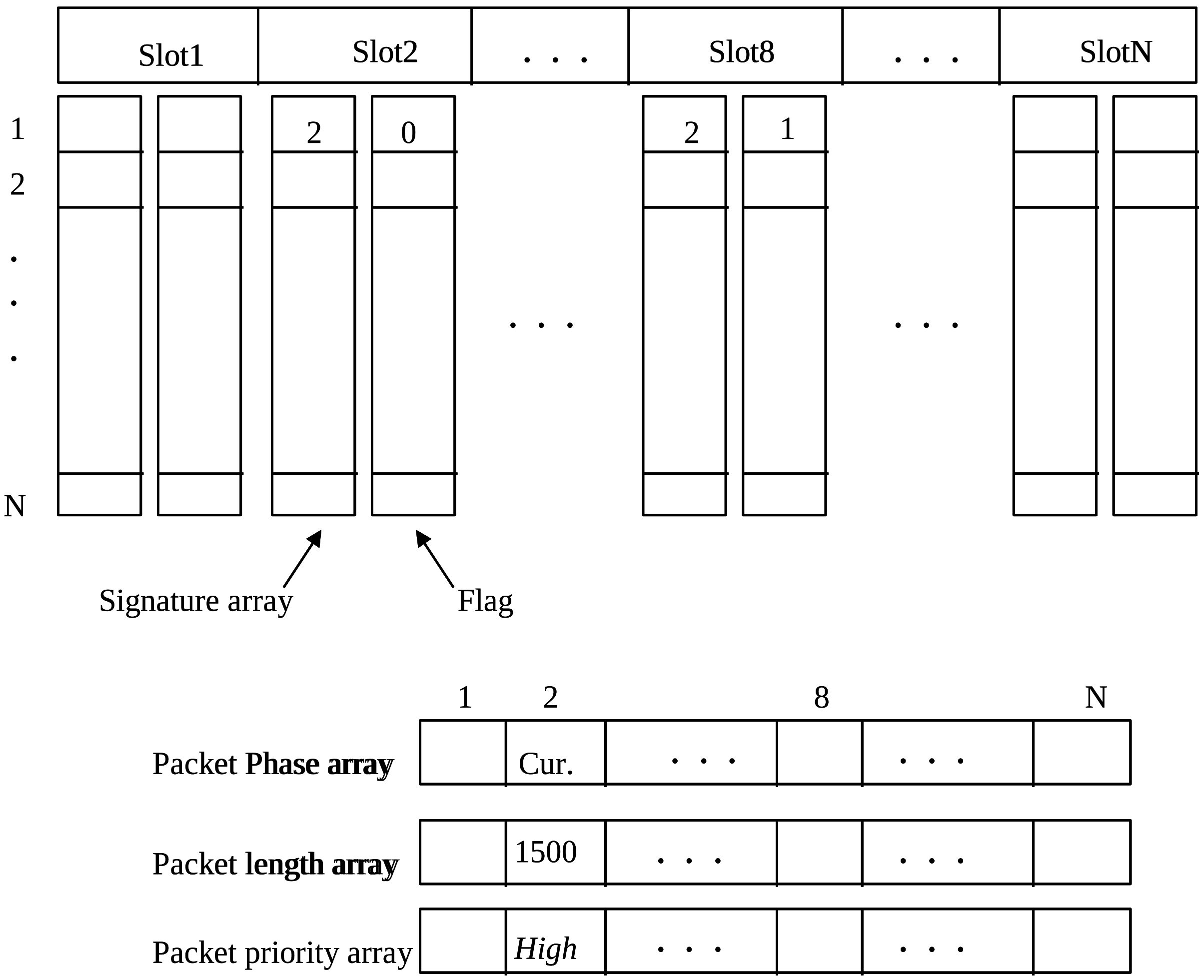


Figure 9. Request Cache

6.2. Build-in Decision Algorithm

The decision build-in algorithm is to be set with two main roles. First, it groups the transmission into different mini data sets that can enhance the transaction in a form of priority within the packet. However, neither the priority nor the fairness can be changed and fixed, as the packet also selects properties that are not altered. There are two methods to undertake the different transmission requests grouping, which is based mainly on the left hand side sources. Originally, one set is left to be empty and is assigned with a low priority to assign the different transmissions, where another set is required to be assigned to enhance the synchronization of the process.

Approach 1

- For every transaction, process is set to 1
- For (each set Set_i, i from 1 to current number of sets) do
- If (the request is compatible with all requests in Seti) then
- Assign the request to Seti
- Else
- Create a new set Set_{i+1} and assign the request to it

The next method is based on the observations of more than one transmission request that are I at the left address, which must be greater than the right one. The queue is set up according to the addresses set for both left and right dataset settings. When the right address is pulled in the queue, a signature is set up, creating different stacks of new datasets.

However, the complexity of the method raises the need for build-in decision-making arbitration, by dividing the number of the requests cache with the number of correlated ones. The requests are placed in a slot and recognized by N, which is related to the number of the slot itself. A family group of the requests are grouped together in a way in which stacks are created in rows or lines to ensure the synchronization of the identified requests. Every line as well is associated with a number to represent the stack, according to its priorities

Algorithm Build-in Decision

- For cache slots request
- For each I set to the value of 1 which represent the transaction number
- If (R_i has associated flag set to 1) then
- Push R_i on the stack
- For (i=1 to number of requests for this slot) do
- If (R_i has associated flag set to 0) then
- If the load is found to be empty, then
- The value of index is set to be equal to index + 1
- Assign Ri to the set Sindex
- Else
- Pull R from the load
- Assign R_i to the same set as R
- While J is set to 1 which represent the priority level
- While If, many priorities exist represent by J then
- A dataset is selected to the maximum in the transmission requests
- Then a grant to be transmitted to the selected dataset
- Exit request

6.3. Arbitration Granting

For the entire optimum data packet, which is an arbitration-automated decision, the bus owner broadcasts a grant packet, which is in the transmission process, where the bus owner will be the last to complete in the network with no collision. A duplicate grant packet copy is to be in a loop process, which can include:

a) Granted address list: the list of all datasets identified by the bus owner, which can list different network nodes in the data packet transmission.

- Destination address list
- Reset status
- Bus owner:

$$T_{drain} = \frac{L_{pkt}}{R} + N_{hops}T_{repeat} + D_n T_{prop}.$$

L_{pkt} denotes the size in bits of the data packet arbitration. N_{hops} is the number of intermediate nodes between the present bus owner and the granted node, D_n is the rough distance estimate between the present bus owner and the granted node, and T_{repeat} is the repeated nodes within the network path where waiting time can occur.

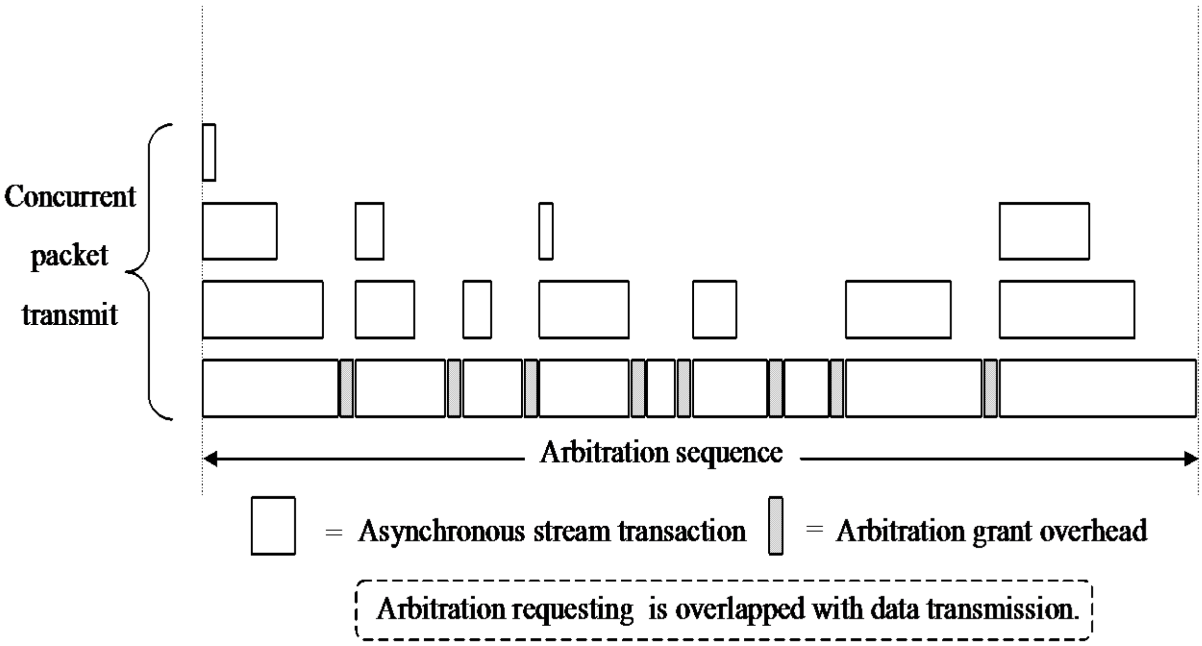


Figure 10. Arbitration Sequence in SFP

Taken from 12

6.4. SFP Traffic Categories

The transmission in the datasets Data is based at different variables, as in which recognizes the following:

1. Asynchronous transactions: does not require arbitration in the receiver.
2. Asynchronous streaming: needs streaming in the queue, which helps with the different subtasks

6.5. Summary

SFP design principles are summarized as follows:

- SFP is incorporating a new dataset transmission at the different layers that make use for both existing and reuse cables within the process. The communication level exists with different communication nodes, which can be build up with more than one pair that operates as two independently halved duplex lines. The need for flow of transmission synchronization can help in releasing the unblocked addresses and overlap different arbitration levels.

- The packet contains all the data necessary for the transmission as sizes, addresses, and priority levels. Transmission between packets moves via autonomous decision through the arbitration process respectively through different caches.

- There is a repeat path between the SFP for FireWire to achieve the different packet designations.

- SFP supports the three levels of priority, to ensure automated arbitration decision-making along the different network nodes.

The simulation helps in modeling the different queuing times and visualizes the throughput. Discrete is event simulation carried by different variables where all models are developed with the use of a library function. All models include T_{prop} and T_{repeat}delays. A range was selected to investigate the different arbitration levels.

6.6. Analytical Results

IEEE 1394b greatly exhibits a short queuing time that can accommodate up to 94% of the load for better performance. This helps with the different overlapping processes in the attribution and transmission within the different datasets to eliminate or reduce the different gaps that may occur. This waiting time is approximately 15 times less than the normal transmission time with the average video and different traffic patterns within the spatial for different improvement experiments that exist in the different network nodes with the SFP, according to the size, load percentage at the overhead, and priority. The results show that higher priority gives better results in queuing time than medium size by almost 6 times, while the medium gives 100 times less than the smaller one. This is achieved via a synchronized stream and in the pooling queue for the different combinations for different trails. The throughput here is a max of 5% in the value. This illustrates that SFP does not coordinate with the throughput while rendering service to strike a priority balance.

7. Conclusion

Part A

This research represents the possibility of the reuse of Spirals. FireWire protocol is a new concept to be adopted for bus arbitration that can be configured as a daisy-chained technology. While the ones used in a shared network are based on daisy chains, basic and equally vital in a large scale video is SFP, rooted according to IEEE 1394b standards and maintains a simplified repeat path. This is where the efficiency of SFP is improved through the reuse of bandwidth and Qi's support for packet videos by a real-time priority-based bus access functionality.

This thesis effectively established through research the development of proposed communication settings within a video system that are useful for a medium network access level. The tasks can include:

i. The intensive examination of the performance of the video network system and as identified by the system, is a cheap technology for video surveillance systems.

ii. IEEE 1394b FireWire is analyzed as a potential technology adventure for video surveillance. Performance shortcomings to the reuse of the Spiral in the FireWire network in the priority level transmission and the developed model results show there is a pulling buffer to enhance the efficiency performance with the isochronous for better use rate.

iii. The experimental protocols are set up accordingly, as mentioned in (ii), in a way to improve the efficiency and throughput, according to IEEE 1394b standards, for better use of the provided variables such as size, level of synchronal transactions, and priorities.

In the last years, there has been an increased need for cost-effectiveness in electronic systems, which has had an impact on almost all manpower endeavors. In the past, manufacturing and process plants were controlled mechanically, i.e. manual or by using electronic controls. However, private devices that have developed rapidly replaced traditional mechanical equipment that depends mainly on manual manpower.

This undertaking of electronic systems is for the requirement of new communication protocols in the field identified by electronic controllers. These communication protocols are often known as fieldbus protocols. Recently, digital and electronic systems, for use in initializing different levels of platform networks, used different sectors as industrial and service sectors using Ethernet at different physical layers within the network.

Moving on to automotive technology, it can be said that it is highly dependent on electronic devices that maintain the main tasks and sub-tasks needed for different systems. Today, the need for the passenger consists of standard units, according to the ECUs and therefore, it is practically impossible to employ point-to-point communications to maintain and set up required connections between different subsystems. Therefore, well-organized digital communication buses are constructed to communicate these different signals. These complexities create strong requirements in the today’s automotive communication.

Any vehicle’s materials requirements depend upon various communication channels. Different types of network nodes or channels utilized among the various components are governed by the type of material to meet health and safety requirements and standards.

Part B

As mentioned earlier in chapter 1, it was very important to build the main research area concept and extend previous researcher work to help in with:

a) understanding the research concept,
b) extending the work of previous research, and
c) achieving the research aims and objectives of this thesis.

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