Different Implementation of Network Level in Embedded Networking with QoS

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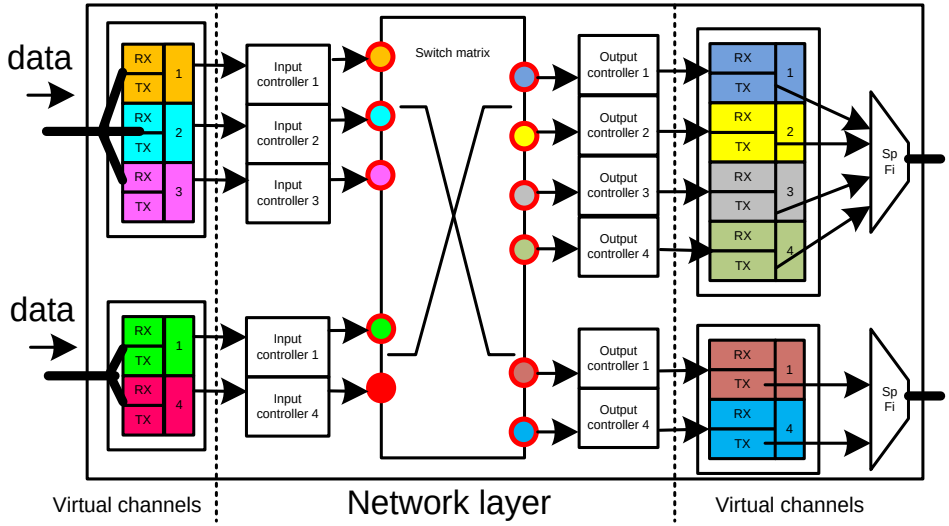
Introduction

- Performance of modern embedded systems depends on network architecture and structure
- Many existing embedded networks standards provide QoS features, which are implemented by means of virtual channels (VC)
- We chose 3 approaches to implementation technology of VCs
- SpaceFibre standard is our case study

Structures of network level



1st way

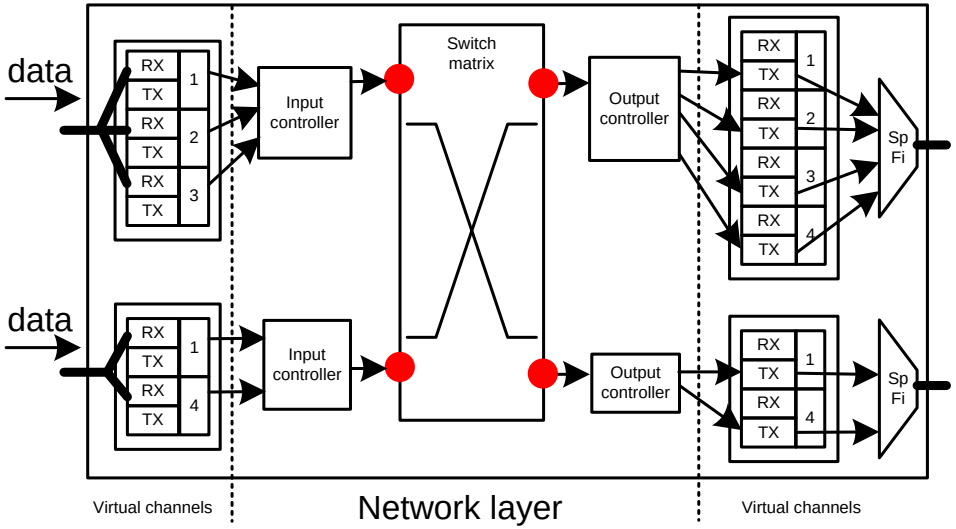
- Quantity of connection points to the switch matrix for every port is equal to virtual channels number in this port
- Timing characteristics in the network layer depend only on arbitration rules

2nd way

- Quantity of connection points for every port = 1
- Impact between data flows and corresponding disturbance of its timing characteristics is more essential than in the 1st way

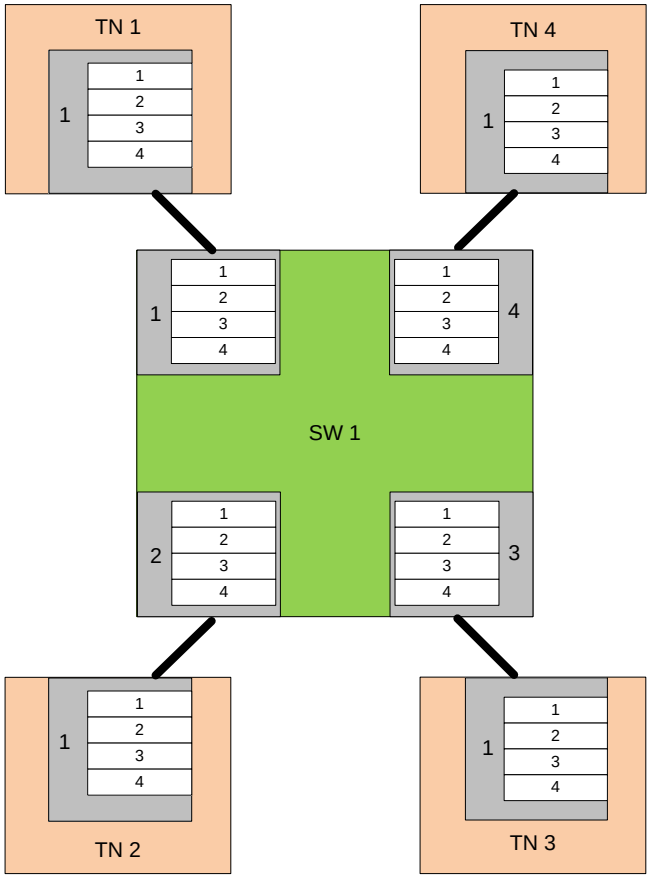
3rd way

- It is similar to 2nd way
- Packet transmission can be interrupted after N byte transfer

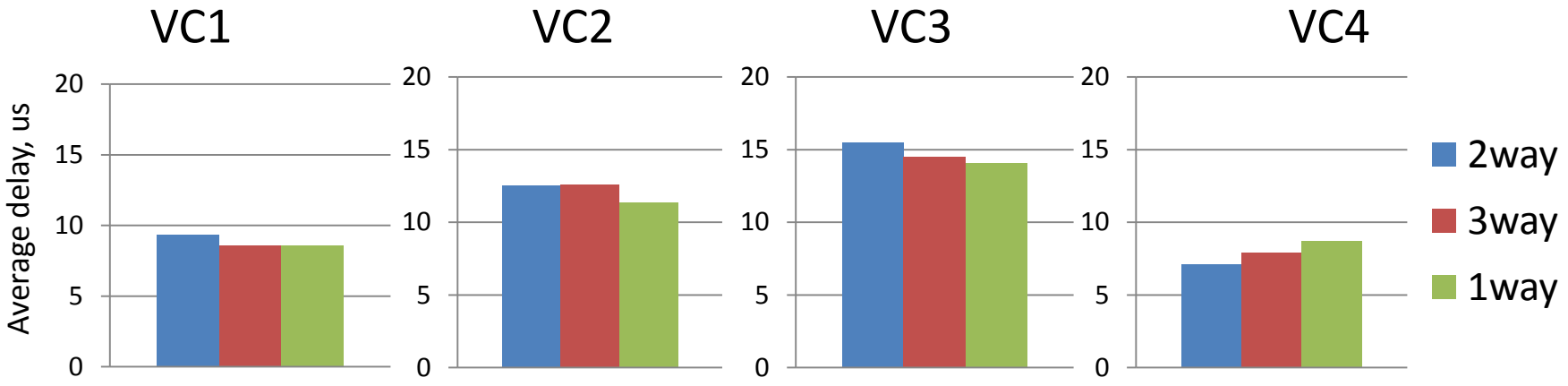


Network models

- 4 virtual channels
- Network
  - All terminal nodes (TN 1- 4) generate packets
  - Destinations are TN 1- 4
  - The terminal nodes send the generated packets to each virtual channel
  - The destination nodes for each virtual channel are chosen randomly
  - VC1 has the highest priority, VC4 – the lowest

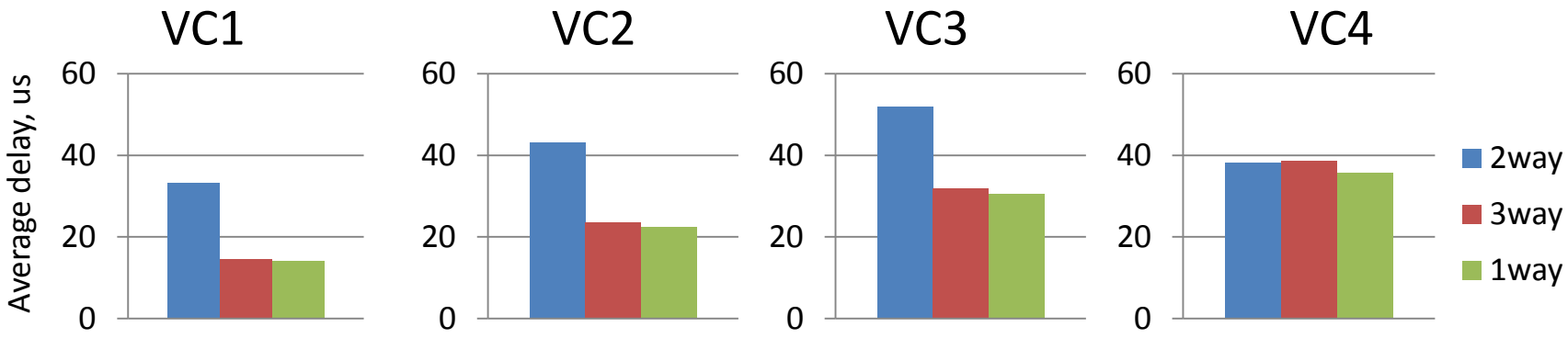


Average transmission time (1)



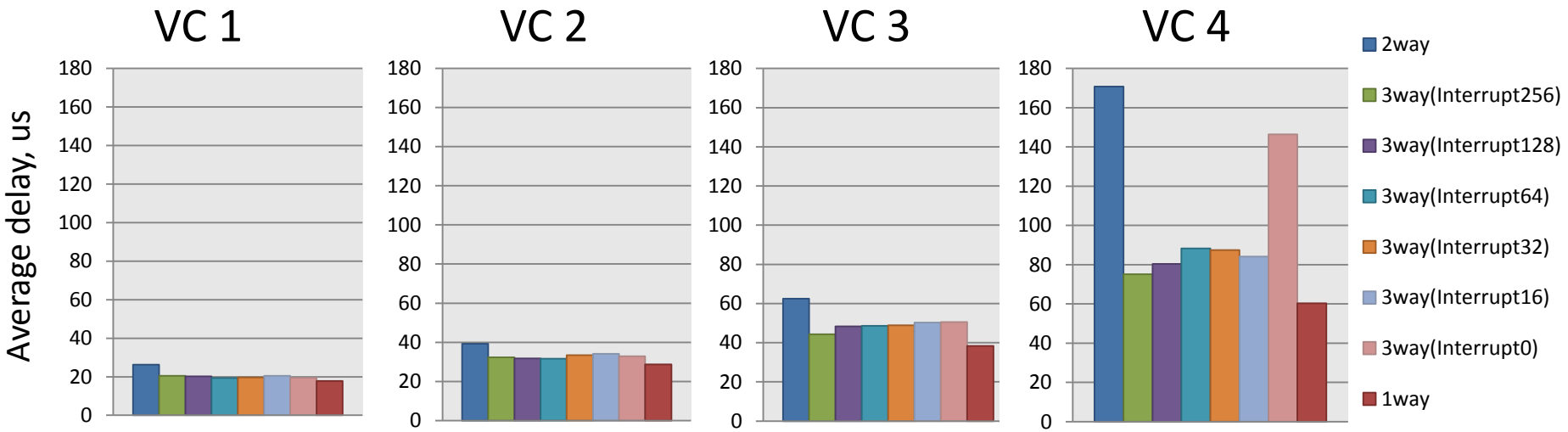
- Packet Size = 250 byte
- VC4 packet is generated first, then VC3 packet, then VC2 packet, then VC1 and so on repeated in loop. Delta between packet generation– 100 ns
- The average packet transmission time for three ways is almost similar

Average transmission time (2)



- Packet Size = 750 byte
- VC4 packet is generated first, then VC3 packet, then VC2 packet, then VC1 and so on repeated in loop. Delta between packet generation– 100 ns
- Timing characteristics of the 2nd way are worse in comparison with the 1st and 3rd way
- Timing characteristics of 3rd way are almost similar to the 1st way

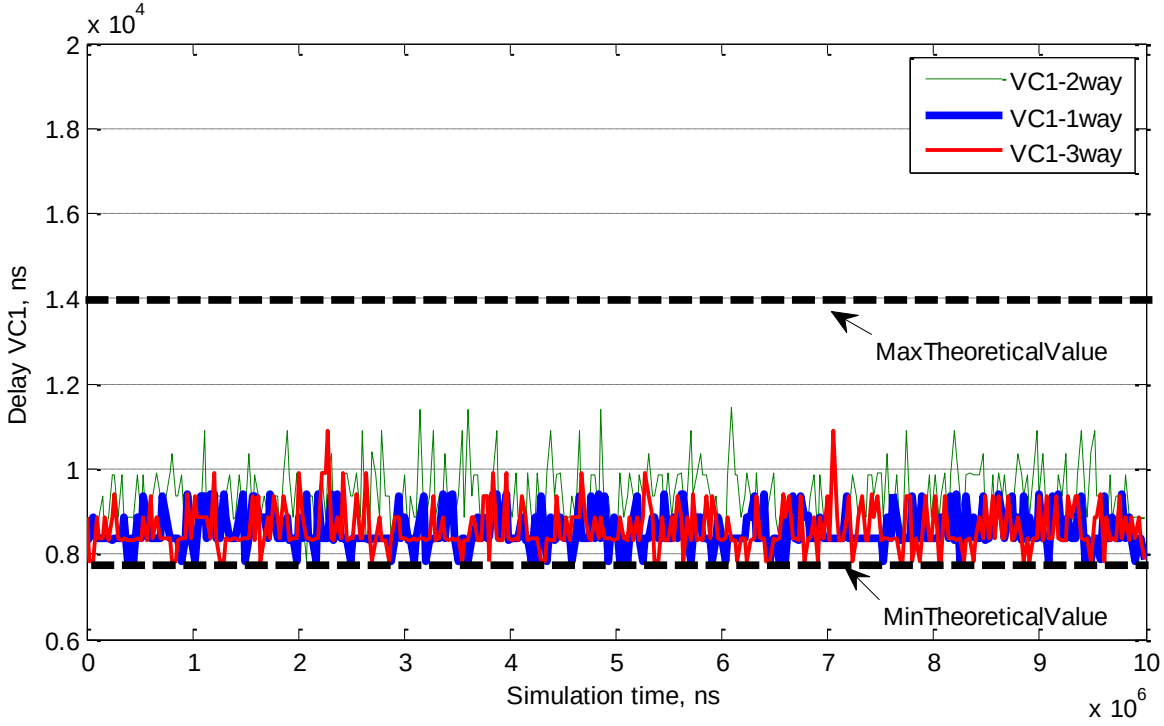
Average transmission time (3)



- Exponential distribution of packet generation time
- Packet Size = 750 byte
- Average lower priority packet transmission time increases with growth of interruptions frequency

Theoretical & simulation results comparison

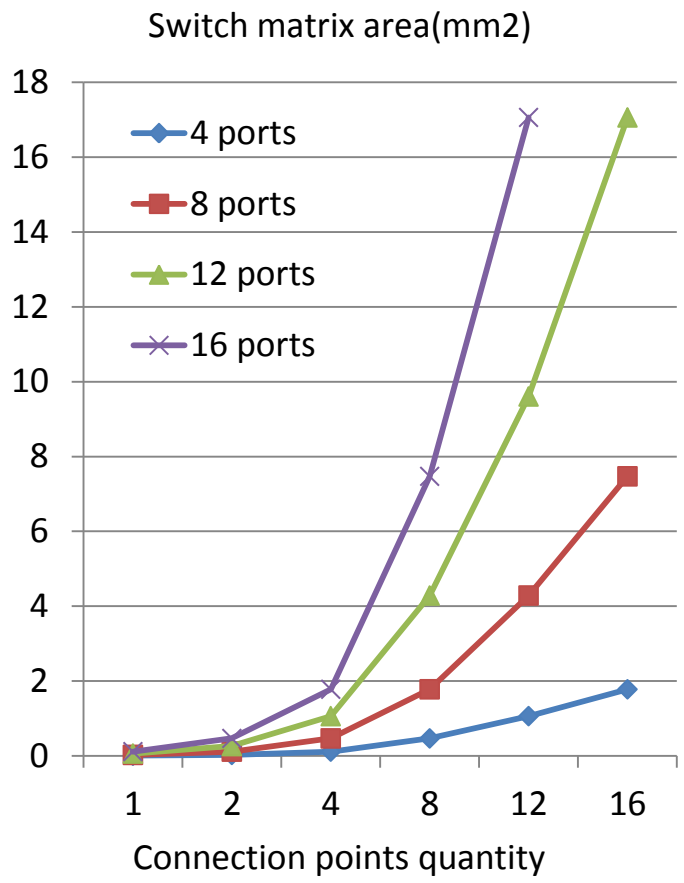
- Theoretical minimum delay is equal to simulation results
- Theoretical maximum delay is more than simulation delay



Hardware costs

Using Cadence RTL Compiler and Encounter and UMC 120 nm technology library

- 1st way
  - quantity of connection points > 4, hardware cost grows essentially
  - quantity of ports – 16, quantity of virtual channels ≥ 16 - the logical synthesis is impossible
  - quantity of ports ≥ 8, quantity of virtual channels ≥ 8 - the physical synthesis is problematic
- 2st and 3rd way
  - It can be implemented with greater amount of virtual channels because 1 connection point per port is used



Conclusion

- Timing characteristics of the 2nd way are worse in comparison with the 1st and 3rd way, if packet length is larger than the 256 bytes
- Average packet transmission time and achievable link utilization in case of 3rd way are almost similar to the 1st way
- 2nd and 3rd way have hardware costs less than 1st way
- The 3rd way is optimal from point of view of hardware costs and average packet transmission time

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DCNSimulator

- DCNSimulator is based on Qt and SystemC
- It consists of the simulation engine and libraries of network components
- In this study we used the router and node models which provide Virtual Channel mechanism and Network Layers only
- The results of the simulation can significantly depend on the router model implementation features (local clock frequency, link capacity)