ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

EE 314 Term Project

Spring 2022
FPGA Implementation of Simple Quality of Service (QoS) based Queueing

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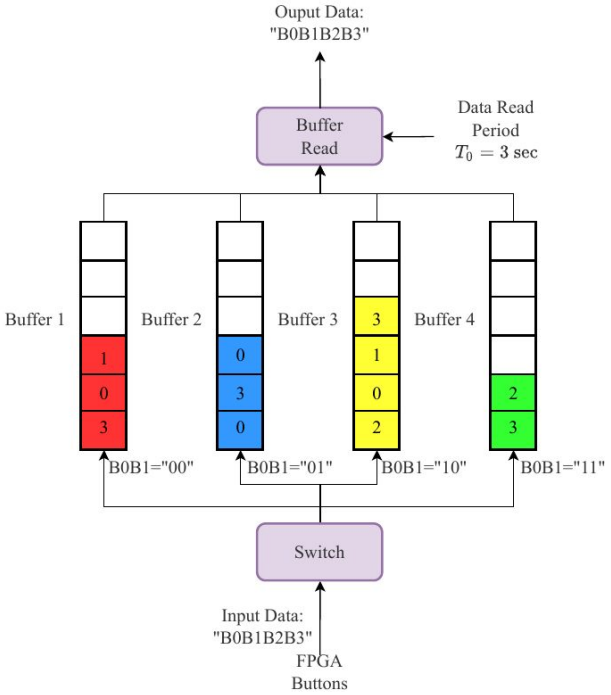
Problem Definition

- QoS (Quality of Service) Network
- Optimize data flow according to:
  1) Latency Requirements
  2) Reliability Requirements

Problem Definition: System Description



Number of transmitted packets transferred as Output Data

Buffer 1	Buffer 2	Buffer 3	Buffer 4	Total
40	20	15	50	125

Number of recieved packets from FPGA buttons

Buffer 1	Buffer 2	Buffer 3	Buffer 4	Total
50	25	15	50	140

Number of dropped packets

Buffer 1	Buffer 2	Buffer 3	Buffer 4	Total
10	5	0	0	15

Problem Definition:
Specifications and Requirements

2.2 Project Requirements

To define the requirements one by one as a list:

- You are going to design the main screen using the VGA interface, at 640× 480 resolution. On your main screen, which may resemble Figure 1,
  1. You should present the buffers and the available data values inside the buffers.
  2. The number of transmitted packets, the number of received packets, and the number of dropped packets should be printed.
- When new data arrives via FPGA buttons, buffer contents and the corresponding numbers on the right-hand side should change.
- At every 3 seconds, a single register from one of the buffers is read and should be printed as output. Also, necessary deletion operations and number updates should be performed.

Solution Proposal:
Reliability and Latency Criteria

Latency Decision Parameter:

t[3:0]: Clock count since a data arrived in buffer i is stored in t[i]

Reliability Decision Parameter:

f[3:0]: fullness of each buffer i is stored in f[i]

Solution Proposal:
Weighted Decision Algorithm

Latency Weights:

W_L[3:0]: Should be pre-defined as a system parameter

$$W_{L1} > W_{L2} > W_{L3} > W_{L4}$$

Reliability Weights:

W_R[3:0]: Should be pre-defined as a system parameter

$$W_{R4} > W_{R3} > W_{R2} > W_{R1}$$

Solution Proposal:
Weighted Decision Algorithm

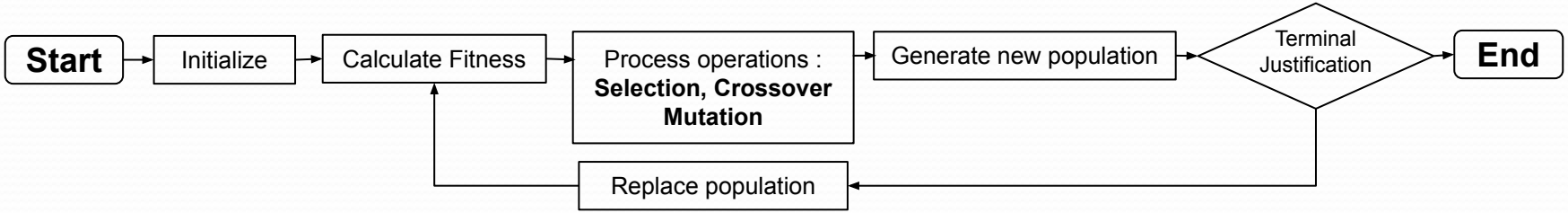
Overall Decision Function:

R[3:0]: Weighted sum of the latency and reliability decision parameters calculated as follows:

$$\begin{bmatrix} R_1 \\ R_2 \\ R_3 \\ R_4 \end{bmatrix} = \begin{bmatrix} W_{L1} \cdot t_1 + W_{R1} \cdot f_1 \\ W_{L2} \cdot t_2 + W_{R2} \cdot f_2 \\ W_{L3} \cdot t_3 + W_{R3} \cdot f_3 \\ W_{L4} \cdot t_4 + W_{R4} \cdot f_4 \end{bmatrix}$$

Solution Proposal:
Determination of Weights

- Genetic Optimization: NSGA-II Algorithm
- Cost function evaluated for every simulation
- Find the best possible weights for a randomized input



Solution Proposal:
Cost Functions

Drop Penalties:

d[3:0]: Drop count for every buffer per simulation

D[3:0]: Should be pre-defined before the optimization

Latency Penalties:

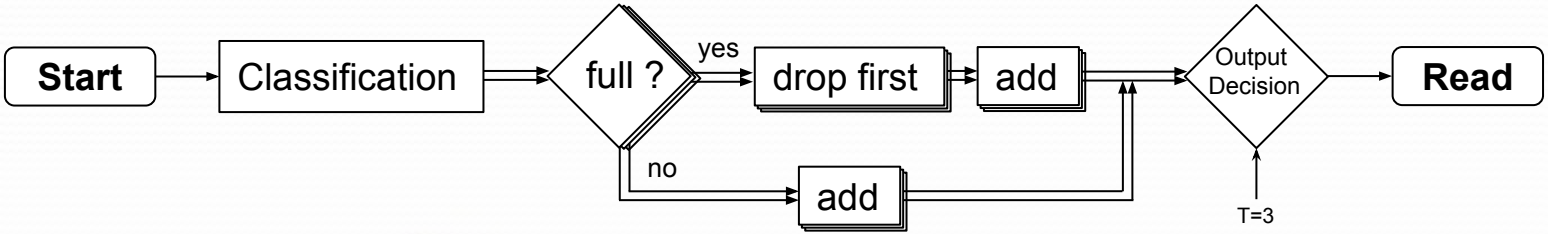
a[3:0]: Average latency for each buffer, per simulation

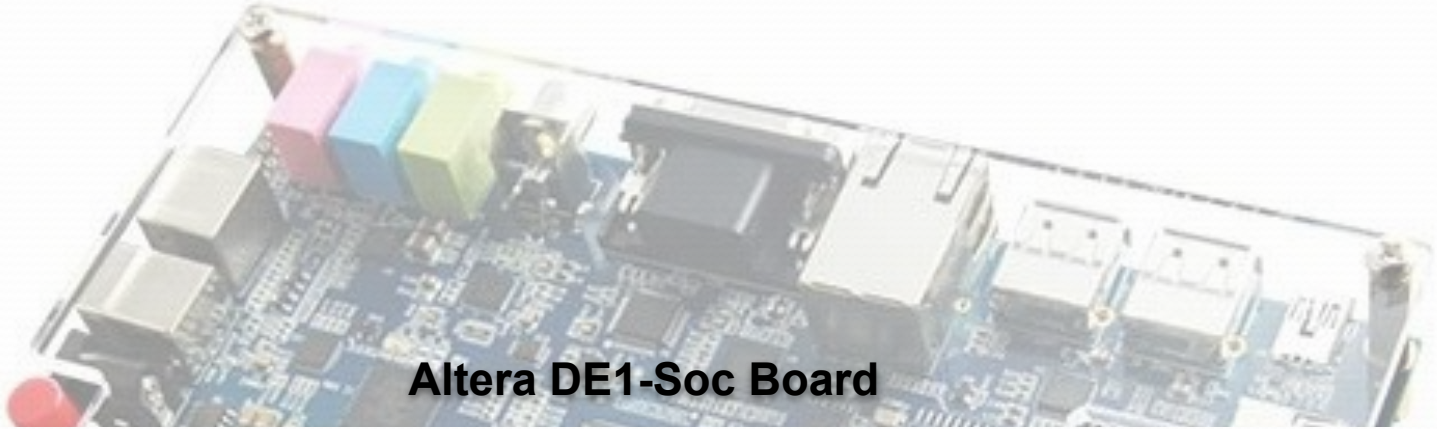
L[3:0]: Should be pre-defined before the optimization

$$C_R = D_1 d_1 + D_2 d_2 + D_3 d_3 + D_4 d_4$$

$$C_L = L_1 a_1 + L_2 a_2 + L_3 a_3 + L_4 a_4$$

Solution Proposal:
Algorithm Flowchart





Altera DE1-Soc Board

Thank you for your attention.