9.11 The total number of operations, N_{op}, is

$$N_{op} = \frac{N}{2} log_2(N) = \frac{1024}{2} log_2(1024) = 5120$$

These are performed in T_{FFT} = 1 ms which means that the number of operations per second is:

$$\frac{N_{op}}{T_{FFT}} = \frac{5120}{10^{-3}} = 5.12 \text{ MOp/s}$$

The clock frequency on the bit-serial lines through A-A' is

$$f_{CL} = \frac{N_{op}}{T_{FFT}} W_d = 5.12\ 10^6 \cdot 21 \approx 108 \text{ MHz}$$

The total bit rate through A-A' is $(4 + 4)\ 107\ 10^6 = 860$ Mbit/s

The bit rate through B-B' $\frac{W_m}{T_m} = f_m\ W_m = 21\ f_m$

The bit rates through the cuts must be equal

$$860\ 10^6 = 21\ f_m \Rightarrow f_m = \frac{860\ 10^6}{21} = 41 \text{ MHz}$$

The memory clock rate will be halved if the word length is doubled. A single fast RAM (41 MHz) is enough to support the butterfly PE.