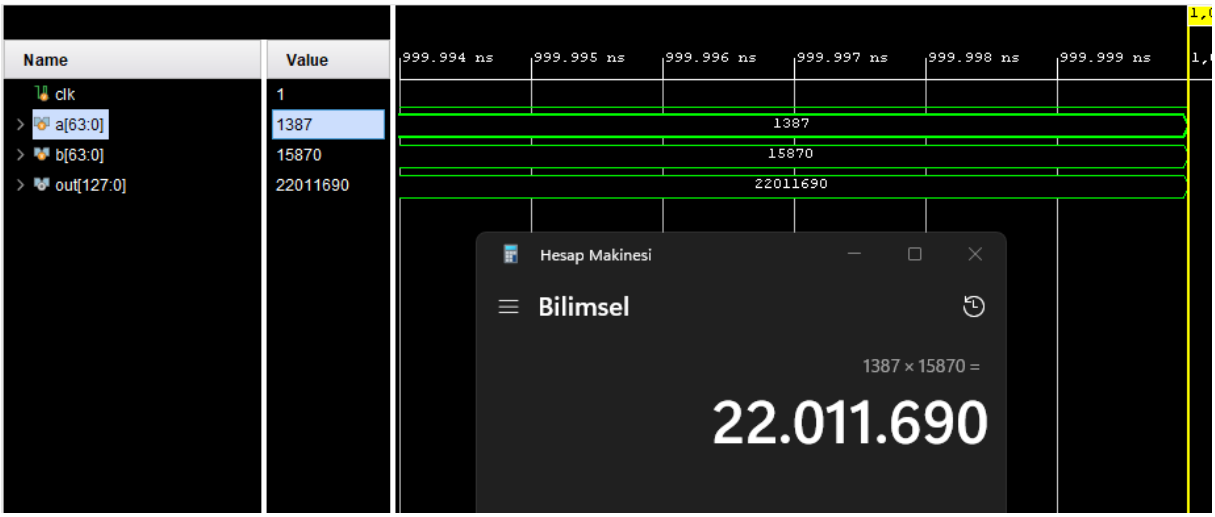
Muhammed Erkmen

Assignment – 4

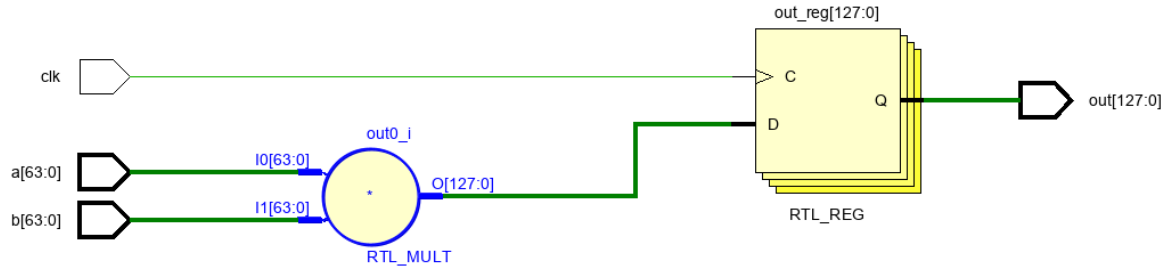
This assignment wants a 2-64 bit input 128bit output multiplier.

Question1:

Simulation results



RTL Schematic



Design Timing Summary

Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	-2,246 ns	Worst Hold Slack (WHS):	0,866 ns	Worst Pulse Width Slack (WPWS):	4,600 ns
Total Negative Slack (TNS):	-337,059 ns	Total Hold Slack (THS):	0,000 ns	Total Pulse Width Negative Slack (TPWS):	0,000 ns
Number of Failing Endpoints:	276	Number of Failing Endpoints:	0	Number of Failing Endpoints:	0
Total Number of Endpoints:	400	Total Number of Endpoints:	400	Total Number of Endpoints:	273

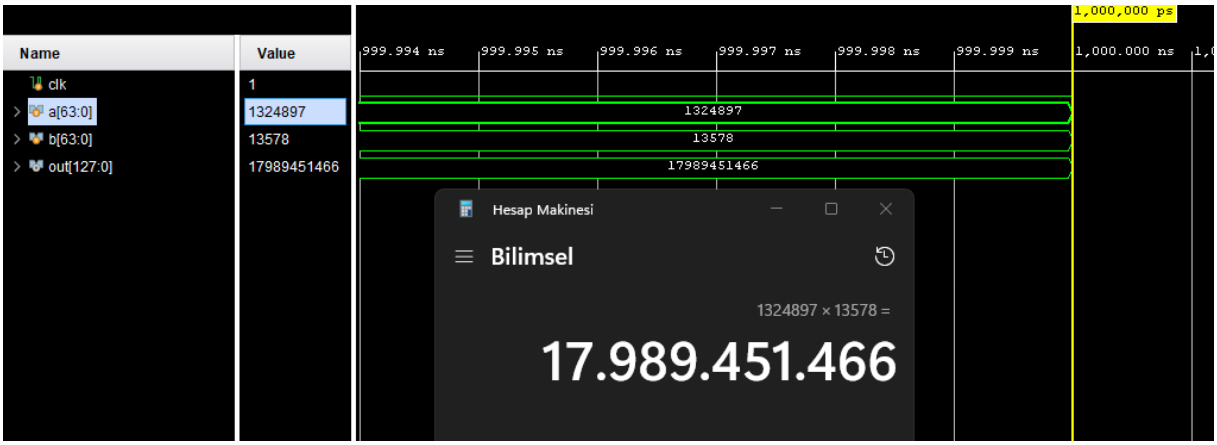
Timing constraints are not met.

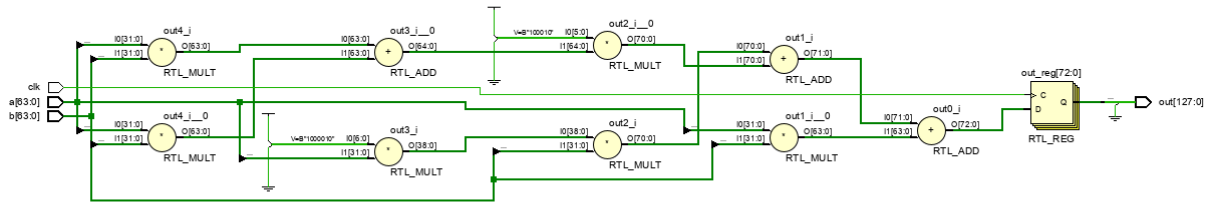
Maximum Operation Frequency is 1/(T-WNS) = (10^9)/(12,246)

Fmax = 81,65931 MHz.

Question2

In this part, karatsuba algorithm has been used to make multiplication faster.





Design Timing Summary

Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	-0,983 ns	Worst Hold Slack (WHS):	0,339 ns	Worst Pulse Width Slack (WPWS):	4,650 ns
Total Negative Slack (TNS):	-18,933 ns	Total Hold Slack (THS):	0,000 ns	Total Pulse Width Negative Slack (TPWS):	0,000 ns
Number of Failing Endpoints:	39	Number of Failing Endpoints:	0	Number of Failing Endpoints:	0
Total Number of Endpoints:	146	Total Number of Endpoints:	146	Total Number of Endpoints:	74

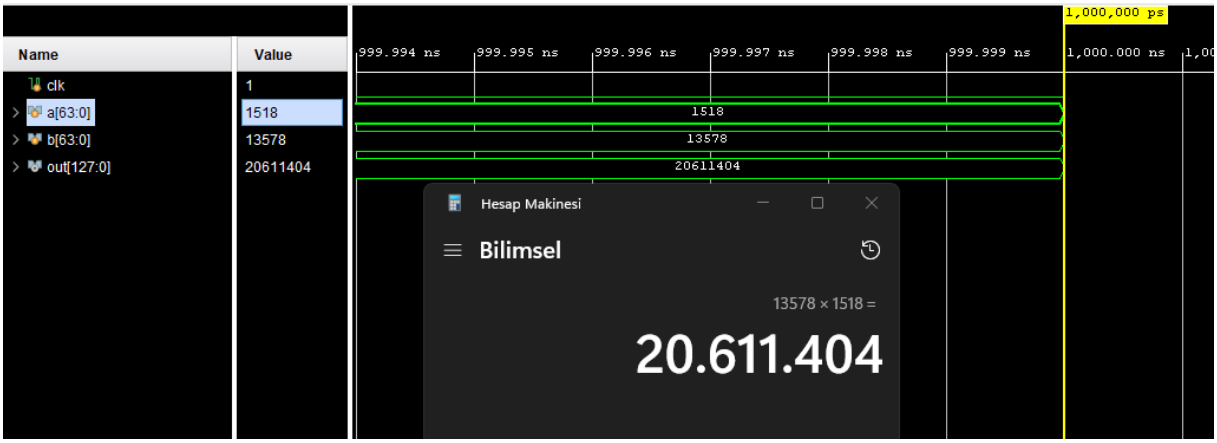
Timing constraints are not met.

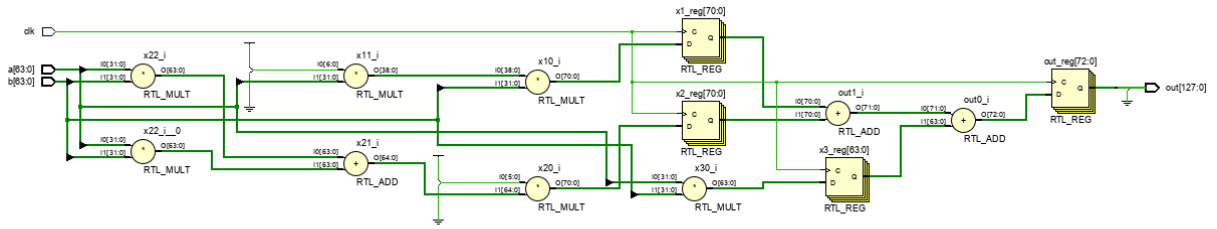
Max Operation Frequency = 1/(Ts – WNS)

Fmax = 91,0498 MHz

Question 3

In this question, i divided the operations to 3 parts with using pipelines. Kept results in 3 different registers and than calculated the output in another register.





Design Timing Summary

Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	-2,539 ns	Worst Hold Slack (WHS):	0,092 ns	Worst Pulse Width Slack (WPWS):	3,100 ns
Total Negative Slack (TNS):	-268,135 ns	Total Hold Slack (THS):	0,000 ns	Total Pulse Width Negative Slack (TPWS):	0,000 ns
Number of Failing Endpoints:	214	Number of Failing Endpoints:	0	Number of Failing Endpoints:	0
Total Number of Endpoints:	584	Total Number of Endpoints:	584	Total Number of Endpoints:	216

Timing constraints are not met.

Fmax = 1/(T-WNS) = 1/7-(-2.539) = 104.832 MHz

Application	Clock Period	WNS	Fmax
* operator	10nS	-2.246	81.659 MHz
Karatsuba	10nS	-0.983	91.0498
Karatsuba & Pipeline	7nS	-2.539	104.832 MHz