Ryan Joseph Talalai

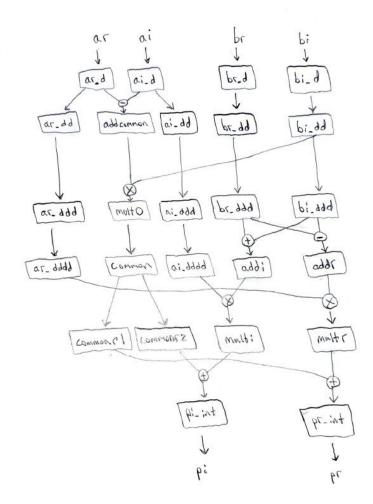
CMPEN 417

Lab 2

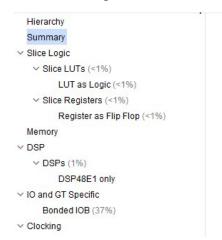
Part 1:

Pipelined Design:

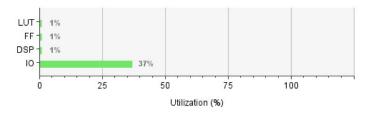
Ryan Palalai Pipeline design



Resource Usage:



| Resource | Utilization | Available | Utilization % |
|----------|-------------|-----------|---------------|
| LUT | 39 | 53200 | 0.07 |
| FF | 216 | 106400 | 0.20 |
| DSP | 3 | 220 | 1.36 |
| 10 | 74 | 200 | 37.00 |



Timing Summary:



WNS = 17.180 ns

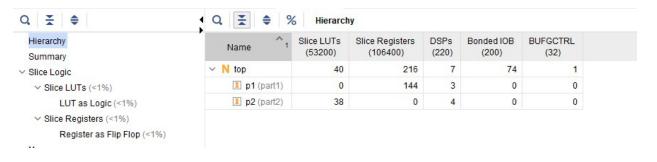
Frequency = 354.6 MHz

Waveform:

| | | 0.000 ns | | | | | | | | | | | |
|----------------------|-------|-------------|-----------|--------------|---------------|------------|-------------|--------------|--------------|---------------|------------|-------------|-------------|
| Name | Value | 0.000 ns | 50.000 ns | 100.000 ns | 150,000 ns | 200,000 ns | 250.000 ns | 300,000 ns | 350,000 ns | 400,000 ns | 450.000 ns | 500,000 ns | 550,000 ns |
| > W A1[17:0] | Х | | × | X | 0 | X | , | X : | 62136 | X : | 62140 | X | , |
| > W a1[17:0] | X | | × | Z | 62135 | * | ž | X : | 62141 | * | 62139 | k | 262136 |
| > ₩ B1[17:0] | X | | х | 2 | 62135 | X | 9 | X | 1 | | 62139 | X | 6 |
| > W b1[17:0] | x | | × | 2 | 62135 | X | ò | X | 26 | 2141 | | X | • |
| > M A2[17:0] | x | | x | * | 7 | | 62135 | | 62137 | \times | 5 | X | 7 |
| > W a2[17:0] | X | | × | × | 7 | * | 62140 | X : | 62137 | * | 62143 | × | 262142 |
| > W B2[17:0] | x | | × | 2 | 62143 | \times | 5 | * | 62141 | * * | 62136 | × | 0 |
| > W b2[17:0] | x | | × | 2 | 62140 | X | 62143 | X | • | * : | 62140 | _ | 262137 |
| > W A3[31:0] | X | | × | * | i | 42: | 4967294 | 421 | 4967288 | * | i | <u> </u> | 7 |
| > W a3[31:0] | X | | × | | | 9 | | X | 6 | 425 | 4967289 | _ | 6 |
| > W B3[31:0] | X | | × | | 8 | XX | 6 | × | 4 | * | 7 | _ | 6 |
| > W b3[31:0] | X | | × | × | 7 | 42 | 4967290 | 421 | 4967291 | * | ò | × | 6 |
| > ♥ re1[35:0] | X | | × | X | 68719476583 | X | 81 | X | 68719476695 | \rightarrow | 5 | \sim | 0 |
| > W im1[35:0] | x | | × | X | 9 | X | 18 | X | 12 | X | 37 | X | 68719476688 |
| > ₩ re2[35:0] | Z | | | | | | | | | | | | |
| > W im2[35:0] | Z | | | | | | | | | | | | |
| > ♥ re3[63:0] | Z | | | | | | | | | | | | |
| > W im3(63:0) | Z | | | | | | | | | | | | |
| ¼ clk | 0 | AAAAAAAAAAA | nannanana | INTRANARARAN | INTANARARAANA | | annanananda | AAAAAAAAAAAA | INDANANANANA | Idanananana | ANDARARARA | INTANANANAN | nananananan |
| > W A1_var[17:0] | X | | × | | 8 | X | 9 | * | 62136 | * | 62140 | _ <u> </u> | ò |
| > W a1_var[17:0] | X | | x | 2 | 62135 | X | ž | X : | 62141 | 2 | 62139 | | 262136 |
| > W B1_var[17:0] | X | | | 2 | 62135 | X | ģ | X | 4 | * | 62139 | × | 6 |
| > W b1_var[17:0] | X | | | 2 | 62135 | X | ò | X | 26 | 2141 | | | • |
| > № A2_var[17:0] | х | | x | X | 7 | * | 62135 | X : | 62137 | * | 5 | -k | 7 |
| > W a2_var[17:0] | X | | | X | 7 | * | 62140 | X : | 62137 | * | 62143 | * | 262142 |
| > ₩ B2_var[17:0] | X | | × | 2 | 62143 | | s | X : | 62141 | , | 62136 | | • |
| № b2_var[17:0] | х | | × | 2 | 62140 | * | 62143 | * | ò | * | 62140 | X | 262137 |
| > ₩ re1_expect[35:0] | X | | x | 6871 | 9476583 | | 81 | 687 | 19476698 | \downarrow | 5 | X | ò |
| ■ im1_expect[35:0] | х | | ж | * | 9 | X | 18 | ¥ | 12 | * | 37 | 697 | 19476688 |
| ➤ re2_expect[35:0] | X | | | | 21 | 687 | 19476687 | ¥ | 21 | 687 | 19476692 | 687 | 19476722 |

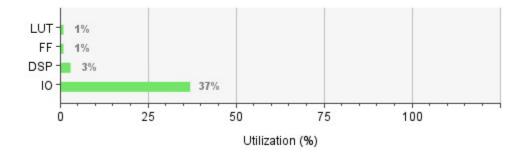
Part 2:

Resource Usage:



Summary

| Resource | Utilization | Available | Utilization % |
|----------|-------------|-----------|---------------|
| LUT | 40 | 53200 | 0.08 |
| FF | 216 | 106400 | 0.20 |
| DSP | 7 | 220 | 3.18 |
| 10 | 74 | 200 | 37.00 |



Timing Summary:

Design Timing Summary

| Setup | | Hold | | Pulse Width | |
|------------------------------|-----------|------------------------------|----------|--|----------|
| Worst Negative Slack (WNS): | 15.643 ns | Worst Hold Slack (WHS): | 0.144 ns | Worst Pulse Width Slack (WPWS): | 9.500 ns |
| Total Negative Slack (TNS): | 0.000 ns | Total Hold Slack (THS): | 0.000 ns | Total Pulse Width Negative Slack (TPWS): | 0.000 ns |
| Number of Failing Endpoints: | 0 | Number of Failing Endpoints: | 0 | Number of Failing Endpoints: | 0 |
| Total Number of Endpoints: | 723 | Total Number of Endpoints: | 723 | Total Number of Endpoints: | 220 |

WNS = 15.643 ns

Frequency = 229.5 MHz

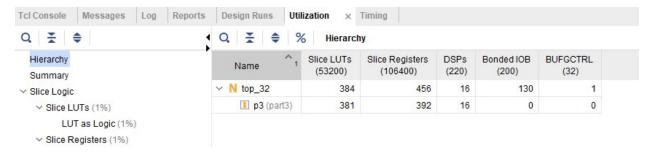
PART2_CYCLES = 2;

Waveform:

| | | 0.000 ns | | | | | | | | | | | |
|--------------------|-------|----------|---------------|---------------|---------------|---------------|------------|---------------|--------------|-------------------|--------------|---------------|-------------|
| Name | Value | 0.000 ns | 50.000 ns | 100.000 ns | 150.000 ns | 200.000 ns | 250.000 ns | 300.000 ns | 350.000 ns | 400.000 ns | 450.000 ns | 500.000 ns | 550.000 ns |
| ₩ a3[31:0] | х | | ж | | | 9 | | X | 6 | 429 | 1967289 | X | 6 |
| ₩ B3[31:0] | x | | × | | 8 | * | 6 | X | 4 | * | 7 | X | 6 |
| ₩ b3[31:0] | x | | x | × | 7 | 421 | 4967290 | 4294 | 967291 | X | ò | | 6 |
| ₩ re1[35:0] | X | | | | 68719476583 | X | 91 | X | 68719476695 | X | 5 | \rightarrow | 0 |
| ₩ im1[35:0] | X | | × | | 9 | X | 18 | X | 12 | | 37 | - | 68719476688 |
| ₩ re2[35:0] | X | | | _ | 21 | 687 | 19476687 | X | 21 | 6871 | 9476692 | 687 | 19476722 |
| ₩ im2[35:0] | x | | | 687 | 19476701 | 687 | 19476725 | ¥ | 21 | 6871 | 9476724 | 687 | 19476687 |
| ♥ re3[63:0] | Z | | | | | | | Z | | | | | |
| ₩ im3[63:0] | Z | 4 | | | | | | | | | | | |
| ¼ clk | 0 | | ianbaanaaaaaa | indonnananana | nahananananan | ndananananan | nnnnnnnnnn | ndananananan | ahaanaanaana | dananananan | nhannannanna | ndanananana | antennana |
| ₩ A1_var[17:0] | x | (| х | V | 8 | 1 | 9 | 26 | 2136 | 2 | 62140 | — | 0 |
| ₩ a1_var[17:0] | x | | | | 262135 | \downarrow | ž | Zé | 2141 | 2 | 62139 | | 262136 |
| ■ B1_var[17:0] | x | | | | 262135 | | 9 | ¥ | 4 | 2 | 62139 | — | 6 |
| ₩ b1_var[17:0] | x | 4 | × | | 262135 | $\overline{}$ | ò | \downarrow | 26 | 2141 | | | ò |
| ₩ A2_var[17:0] | x | | | | 7 | 1 | 62138 | 26 | 2137 | ¥ | 5 | — | 7 |
| ₩ a2_var[17:0] | x | | | | 7 | V : | 62140 | 26 | 2137 | 2 | 62143 | 7 | 262142 |
| ₩ B2_var[17:0] | x | / | × | | 262143 | 1 | 5 | 26 | 2141 | 2 | 62136 | | ó |
| ₩ b2_var[17:0] | х | | | | 262140 | Ţ . | 62143 | ₹ | ò | 2 | 62140 | | 262137 |
| ▼ re1_expect[35:0] | × | | | 687 | 19476583 | | 81 | 6871 | 9476695 | Ţ | 5 | — | ò |
| ■ im1_expect[35:0] | x | | | | 9 | \downarrow | 18 | | 12 | | 37 | 687 | 19476688 |
| ▼ re2 expect[35:0] | x | 7 | | | 21 | 687 | 19476687 | 7 | 21 | 6871 | 9476692 | 687 | 19476722 |
| ₩ im2_expect[35:0] | x | | | 687 | 19476701 | 687 | 19476725 | ₹ | 21 | 6871 | 9476724 | 687 | 19476687 |
| ₩ A3_var[31:0] | x | | | | i | 425 | 4967294 | 4294 | 967288 | $\overline{\psi}$ | 1 | \neg | 7 |
| ₩ a3_var[31:0] | x | | | | | Ţ | | ↓ | 6 | 429 | 4967289 | \rightarrow | 6 |
| ₩ B3_var[31:0] | х | | | | 8 | ¥ | 6 | ₹ | 4 | | 7 | —— | 6 |
| ₩ b3_var[31:0] | x | | | | 7 | 429 | 4967290 | 4294 | 967291 | \uparrow | 0 | \Rightarrow | é |
| ₩ re3_expect[63:0] | X | | | | -55 | | 42 | \Rightarrow | -2 | \uparrow | 7 | \Rightarrow | 6 |
| ₩ im3 expect[63:0] | x | | | | 79 | $\overline{}$ | 66 | ightharpoons | 64 | | -49 | ₹ | 78 |
| PART1_CYCLES[31:0] | 6 | | | | | 1 | | -\ | | 1 | | | |
| PART2_CYCLES[31:0] | | | | | | | | | | | | | |

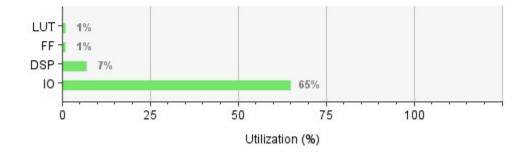
Part 3:

Resource Usage:



Summary

| Resource | Utilization | Available | Utilization % |
|----------|-------------|-----------|---------------|
| LUT | 384 | 53200 | 0.72 |
| FF | 456 | 106400 | 0.43 |
| DSP | 16 | 220 | 7.27 |
| 10 | 130 | 200 | 65.00 |



Timing Summary:

Design Timing Summary

| etup | | Hold | | Pulse Width | |
|------------------------------|-----------|------------------------------|----------|--|----------|
| Worst Negative Slack (WNS): | 14.159 ns | Worst Hold Slack (WHS): | 0.152 ns | Worst Pulse Width Slack (WPWS): | 9.500 ns |
| Total Negative Slack (TNS): | 0.000 ns | Total Hold Slack (THS): | 0.000 ns | Total Pulse Width Negative Slack (TPWS): | 0.000 ns |
| Number of Failing Endpoints: | 0 | Number of Failing Endpoints: | 0 | Number of Failing Endpoints: | 0 |
| Total Number of Endpoints: | 1448 | Total Number of Endpoints: | 1448 | Total Number of Endpoints: | 465 |

WNS = 14.159 ns

Frequency = 171.2 MHz

PART3_CYCLES = 3;

Waveform:

| | | 0.000 ns | | | | | | | | | |
|------------------------|-------|----------|--------------|--------------|-------------|-------------|-------------|-----------------|-------------|-------------|--------------|
| Name | Value | 0.000 ns | 100.000 ns | 200.000 ns | 300.000 ns | 400.000 ns | 500.000 ns | 600.000 ns | 700.000 ns | 800.000 ns | 900.000 ns |
| > W B3[31:0] | X | <u></u> | } | | · | | ļ | | 4294967291 | · | 4294967294 |
| > W b3[31:0] | х | × | 7 | 4294967290 | 4294967291 | • | 6 | 1 | 4294967292 | 3 | - |
| > W re1[35:0] | x | х | 687194765 | 83 X 81 | X 687194766 | 95 X 5 | ν • | 18 | X 687194767 | 32 X 4 | 25 |
| > W im1[35:0] | х | х | 9 | 18 | 12 | 37 | 6871947668 | 88 (687194767: | 30 92 | 687194767 | 16 (6871947. |
| > W re2[35:0] | х | × | 21 | 68719476687 | 21 | 68719476692 | 68719476722 | 68719476711 | 68719476730 | 68719476726 | 6871947672 |
| > W im2[35:0] | х | × | 68719476701 | 68719476725 | 21 | 68719476724 | 68719476687 | 68719476715 | 9 | 68719476706 | 6871947672 |
| > ₩ re3[63:0] | х | × | -55 | X 42 | √ -2 | 7 | γ 6 | X -13 | X 63 | 20 | y -4 |
| > W im3[63:0] | X | × | 79 | 66 | 64 | -49 | 78 | -1 | -7 | 20 | 16 |
| ¼ clk | 0 | | | ^ | ^ | ^ | ^ | ^ | ^ | ^ | ^ |
| > W A1_var[17:0] | х | × | | 9 | 262136 | 262140 | • | 262142 | 4 | 262139 | 9 |
| > W a1_var[17:0] | х | × | 262135 | 2 | 262141 | 262139 | 262136 | 4 | | 262 | 143 |
| > W B1_var[17:0] | x | × | 262135 | 9 | 4 | 262139 | 6 | 262141 | 9 | 0 | 3 |
| > W b1_var[17:0] | x | × | 262135 | • | 262 | 141 | - | 262141 | 5 | 4 | 262142 |
| > W A2_var[17:0] | х | × | 7 | 262135 | 262137 | 5 | 7 | 1 | • | 262142 | 3 |
| > W a2_var[17:0] | X | × | 7 | 262140 | 262137 | 262143 | 262142 | 5 | 262141 | 4 | 3 |
| > W B2_var[17:0] | х | × | 262143 | 5 | 262141 | 262136 | - | 262139 | 262141 | 262139 | 262141 |
| > W b2_var[17:0] | X | × | 262140 | 262143 | - | 262140 | 262137 | 4 | 262142 | 5 | 0 |
| > W re1_expect[35:0] | х | × | 68719476583 | 81 | 68719476695 | 5 | | 18 | 68719476732 | 4 | 25 |
| > W im1_expect[35:0] | х | × | , | 18 | 12 | 37 | 68719476688 | 68719476730 | 92 | 68719476716 | 6871947671 |
| > W re2_expect[35:0] | X | × | 21 | 68719476687 | 21 | 68719476692 | 68719476722 | 68719476711 | 68719476730 | 68719476726 | 6871947672 |
| > W im2_expect[35:0] | х | × | 68719476701 | 68719476725 | 21 | 68719476724 | 68719476687 | 68719476715 | 9 | 68719476706 | 6871947672 |
| > W A3_var[31:0] | x | × | 1 | 4294967294 | 4294967288 | 1 | 7 | 4294967292 | 4294967289 | 8 | 2 |
| > W a3_var[31:0] | х | × | | 9 | 6 | 4294967289 | 6 | 1 | 7 | 4294967292 | 429496728 |
| > W B3_var[31:0] | x | × | | 6 | 4 | 7 | 6 | 3 | 4294967291 | 1 | 429496729 |
| > W b3_var[31:0] | x | × | 7 | 4294967290 | 4294967291 | - | 6 | 1 | 4294967292 | 3 | - |
| > W re3_expect[63:0] | х | × | -55 | 42 | -2 | 7 | 6 | -13 | 63 | 20 | -4 |
| > W im3_expect[63:0] | x | × | 79 | 66 | 64 | -49 | 78 | -1 | -7 | 20 | 16 |
| > ₩ PART1_CYCLES[31:0] | 6 | | | | | | 5 | | | | |
| > W PART2_CYCLES[31:0] | 2 | | | | | | 2 | | | | |
| > W PART3_CYCLES[31:0] | 3 | | | | | | 3 | | | | |
| , | | | | | , | | | | | , | |
| ₩ re3[63:0] | Y | х | -55 | Y 42 | y -2 | 7 | y 6 | y -13 | Y 63 | Y 20 | y -4 |
| | X | × | 79 | V 66 | 64 | V -49 | 78 | V -13 | -7 | 20 | 16 |
| ₩ im3[63:0] | Х | ^ | /9 | , | Λ 64 | A -49 | λ /8 | λ | Α/ | Λ 20 | X 16 |
| ▼ re3_expect[63:0] | Х | X | -55 | 42 | -2 | 7 | 6 | -13 | 63 | 20 | -4 |
| ₩ im3 expect[63:0] | X | × | 79 | 66 | 64 | -49 | 78 | -1 | -7 | 20 | 16 |