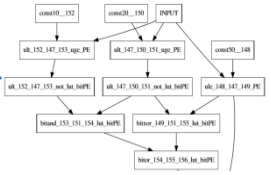
Halide App

pointwise,
conv12, conv21, conv31, convbw,
onebit_bool

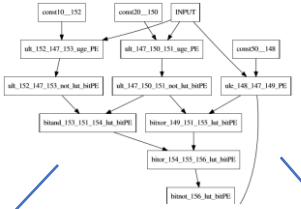
Halide Compiler
(coreir)

Directed Acyclic Graph

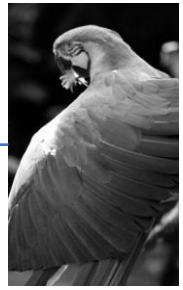


CoreIR Mapper

Directed Acyclic Graph



Halide
Compiler
(x86)



Input Image

Output Image (x86)

Smart PNR
(SMT)

Greedy PNR
(serpent)

CGRA Design Files

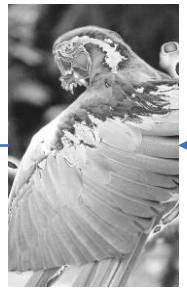
Genesis2 *.vp

CGRA Generator
(Genesis2)

CGRA Design
SystemVerilog *.vp

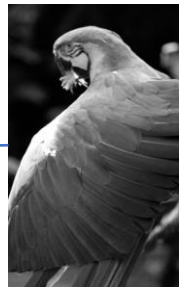
Config Bitstream

X86 == CGRA?
(PASS/FAIL)



Output Image (CGRA)

Verilator
Verilog Simulator



Input Image(CGRA)

Compile Halide to CoreIR

- *Examples from travis* *https://travis-ci.org/StanfordAHA/CGRAFlow/builds/393575195*
- Halide_CoreIR https://github.com/jeffsetter/Halide_CoreIR.git
  - Halide => coreir_design_top
  - Halide + img_in => img_out_x86

```
1652: make -C Halide_CoreIR/apps/coreir_examples/onebit_bool/ clean design_top.json out.png

1704: od -t u1 build/onebit_bool_input.raw       | head
0000000   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16
0000020  17  18  19  20  21  22  23  24  25  26  27  28  29  30  31  32
0000040  33  34  35  36  37  38  39  40  41  42  43  44  45  46  47  48
0000060  49  50  51  52  53  54  55  56  57  58  59  60  61  62  63  64
0000100  65  66  67  68  69  70  71  72  73  74  75  76  77  78  79  80
0000120  81  82  83  84  85  86  87  88  89  90  91  92  93  94  95  96
0000140  97  98  99 100

od -t u1 build/onebit_bool_halide_out.raw | head
0000000   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0000020   0   0   0   1   1   1   1   1   1   1   1   1   1   1   1   1
0000040   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000060   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000100   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000120   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000140   1   1   1   1
```

Generate the CGRA

- CGRAGenerator https://github.com/StanfordAHA/CGRAGenerator.git
  - Genesis2 => verilog

```
1904:
Here is what I built (it's supposed to look like an array of tiles).
... ...     io2  io3  io4  io5  io6  io7  io8  io9  io0A  io0B  io0C  io0D  io0E  io0F  io10  io11 ... ...
... ...  io16_12 ...  ...  ...  ...  ...  ...  ...  ...   ...   ...   ...   ...   ...   ...   ... ... ...
io13 io16_14 p15  p16  p17  m18  p19  p1A  p1B  m1C  p1D  p1E  p1F  m20  p21  p22  p23  m24 io16_25 io26
io27   ...   p28  p29  p2A  ...  p2B  p2C  p2D  ...  p2E  p2F  p30  ...  p31  p32  p33  ...  ...  io34
io35   ...   p36  p37  p38  m39  p3A  p3B  p3C  m3D  p3E  p3F  p40  m41  p42  p43  p44  m45  ...  io46
io47   ...   p48  p49  p4A  ...  p4B  p4C  p4D  ...  p4E  p4F  p50  ...  p51  p52  p53  ...  ...  io54
io55   ...   p56  p57  p58  m59  p5A  p5B  p5C  m5D  p5E  p5F  p60  m61  p62  p63  p64  m65  ...  io66
io67   ...   p68  p69  p6A  ...  p6B  p6C  p6D  ...  p6E  p6F  p70  ...  p71  p72  p73  ...  ...  io74
io75   ...   p76  p77  p78  m79  p7A  p7B  p7C  m7D  p7E  p7F  p80  m81  p82  p83  p84  m85  ...  io86
io87   ...   p88  p89  p8A  ...  p8B  p8C  p8D  ...  p8E  p8F  p90  ...  p91  p92  p93  ...  ...  io94
io95   ...   p96  p97  p98  m99  p9A  p9B  p9C  m9D  p9E  p9F  pA0  mA1  pA2  pA3  pA4  mA5  ...  ioA6
ioA7   ...   pA8  pA9  pAA  ...  pAB  pAC  pAD  ...  pAE  pAF  pB0  ...  pB1  pB2  pB3  ...  ...  ioB4
ioB5   ...   pB6  pB7  pB8  mB9  pBA  pBB  pBC  mBD  pBE  pBF  pC0  mC1  pC2  pC3  pC4  mC5  ...  ioC6
ioC7   ...   pC8  pC9  pCA  ...  pCB  pCC  pCD  ...  pCE  pCF  pD0  ...  pD1  pD2  pD3  ...  ...  ioD4
ioD5   ...   pD6  pD7  pD8  mD9  pDA  pDB  pDC  mDD  pDE  pDF  pE0  mE1  pE2  pE3  pE4  mE5  ...  ioE6
ioE7   ...   pE8  pE9  pEA  ...  pEB  pEC  pED  ...  pEE  pEF  pF0  ...  pF1  pF2  pF3  ...  ...  ioF4
ioF5   ...   pF6  pF7  pF8  mF9  pFA  pFB  pFC  mFD  pFE  pFF  p100 m101 p102 p103 p104 m105 ... io106
IO107  ...  p108 p109 p10A ...  p10B p10C p10D  ...  p10E p10F p110 ...  p111 p112 p113 ...  ... io114
...    ...io16_115 ..  ... ... ... ... ... ...  ... ... ... ... ... ... ... ... ... ... ... ...  ... ...
...    ...  io116 io117 io118 io119 io11A io11B io11C io11D  io11E io11F io120 io121 io122 io123 io124 io125 ... ...
```

Map, Place and Route App Onto CGRA

- CGRAMapper https://github.com/StanfordAHA/CGRAMapper.git
  - coreir_design_top => coreir_mapped

```
1728: ./CGRAMapper/bin/mapper build/onebit_bool_design_top.json build/onebit_bool_mapped.json
```

- smt-pnr https://github.com/cdonovick/smt-pnr.git
  - coreir_mapped => bitstream (pointwise, conv{12, 21, 31, bw})

```
2420: smt-pnr/run_pnr.py
                build/pointwise_mapped.json  build/cgra_info_16x16.txt
                --bitstream build/pointwise_pnr_bitstream …
```

- OR serpent-pnr https://github.com/StanfordAHA/CGRAGenerator.git
  - coreir_mapped => bitstream (onebit_bool)

```
1764:
json2dot.py < build/onebit_bool_mapped.json > build/onebit_bool_mapped.dot
serpent.py     build/onebit_bool_mapped.dot -o build/onebit_bool.bsb
bsbuilder.py < build/onebit_bool.bsb               > build/onebit_bool.bsa
```

Final Correctness Check x86 vs. CGRA

- Verilator testbench https://github.com/StanfordAHA/TestBenchGenerator.git
  - (img_in, bitstream, verilog) => img_out_CGRA

```
2276:
build/onebit_bool_halide_out.raw looks like this:
od -t u1 build/onebit_bool_halide_out.raw
0000000   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0000020   0   0   0   1   1   1   1   1   1   1   1   1   1   1   1   1
0000040   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000060   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000100   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000120   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000140   1   1   1   1


build/onebit_bool_CGRA_out1.raw looks like this:
od -t u1 build/onebit_bool_CGRA_out1.raw
0000000   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0000020   0   0   0   1   1   1   1   1   1   1   1   1   1   1   1   1
0000040   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000060   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000100   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000120   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1   1
0000140   1   1   1   1

TEST RESULT onebit_bool PASSED
```