AN FPGA-BASED JPEG 2000 DEMONSTRATION BOARD

SPACE DYNAMICS LABORATORY

TOM WOOLSTON
NIEL HOLT
GAIL BINGHAM
GLEN WADA

PROJECT GOALS

- DEMONSTRATE THE JPEG 2000 STANDARD IN FPGAs
- PLACE AS MUCH TIER1 AND TIER2 FUNCTIONALITY INTO TWO XILINX VIRTEX II FPGAs

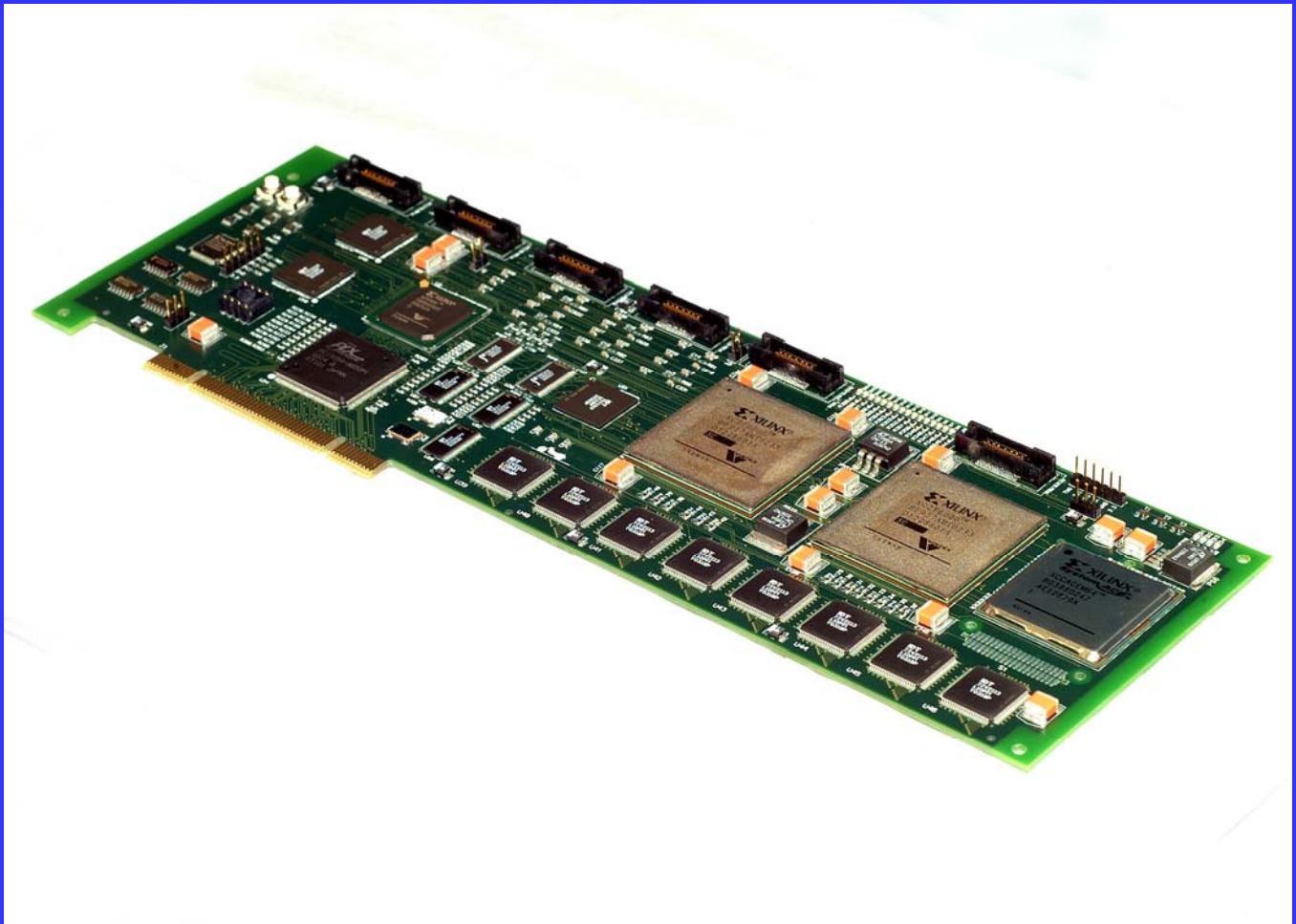
BOARD FEATURES

IMAGE SIZE	256 x 256 PIXELS MIN 1024 x 2048 PIXELS MAX
BIT DEPTH	8 or 12 BIT GRAYSCALE
THROUGHPUT	BENCH MARK 10 MPS 8 BIT 1024 x 2048 PIXELS
TILE SIZE	128 x 128 PIXELS
CODE BLOCK SIZE	32 x 32 PIXELS
WAVELET TYPES	5/3 and 9/7
OUTPUT QUALITY LAYERS	1
OUTPUT FILE SIZE	512 KBYTES

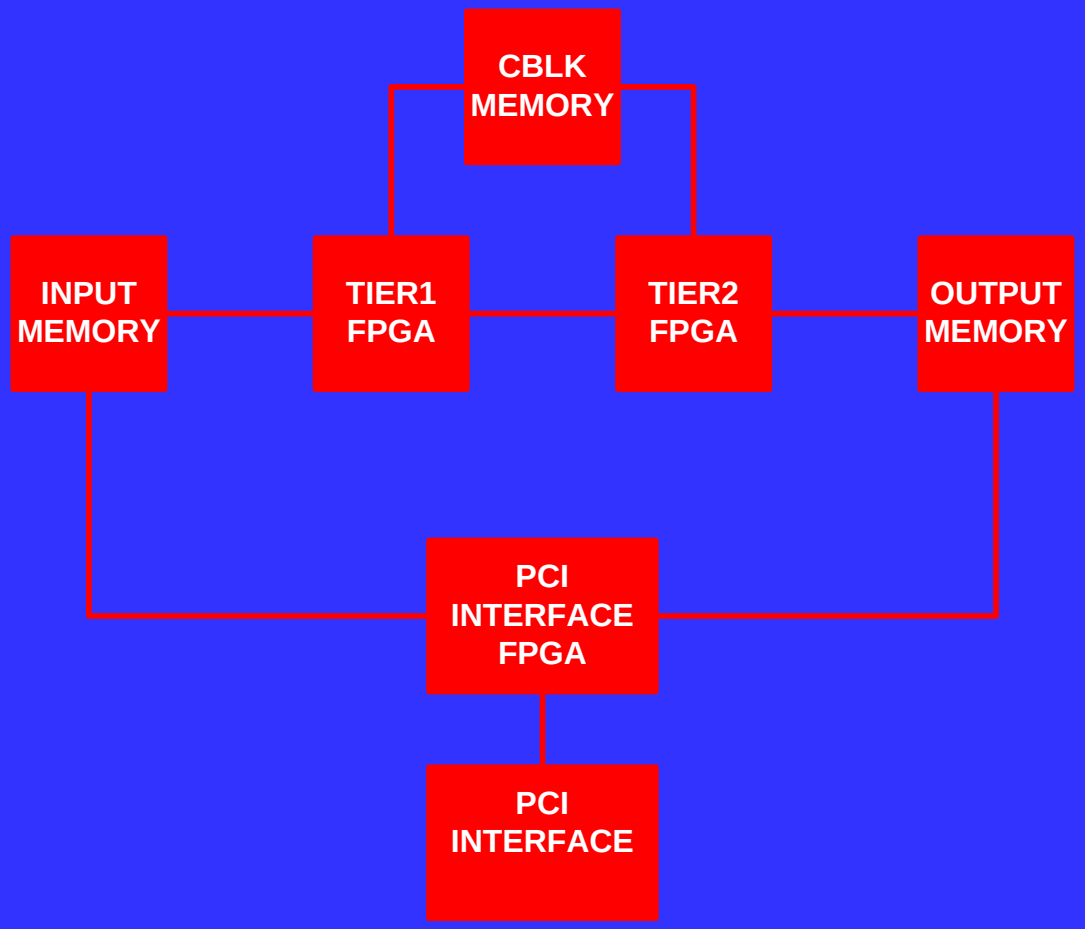
BOARD FEATURES

FILE TYPE	SEQUENTIAL TILE AND TILE PART
HEADER TYPE	UNWRAPPED J2K AND JP2 USING THE PART 1 REQUIRED BOXES
COMPRESSION MODE	LOSSLESS AND LOSSY BASED ON BIT RATE CONTROL OR IMAGE QUALITY
PCI INTERFACE	

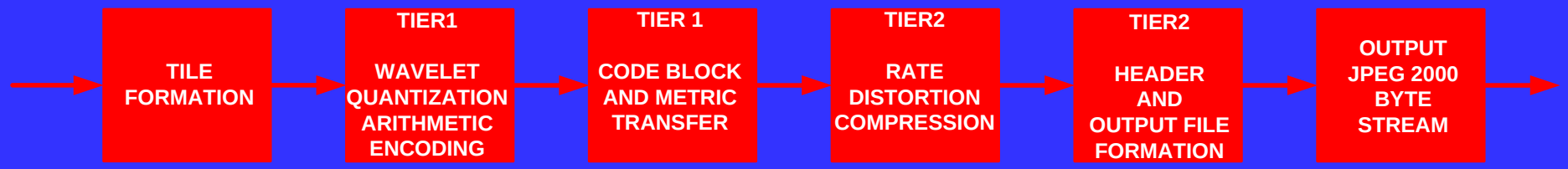
BOARD PICTURE



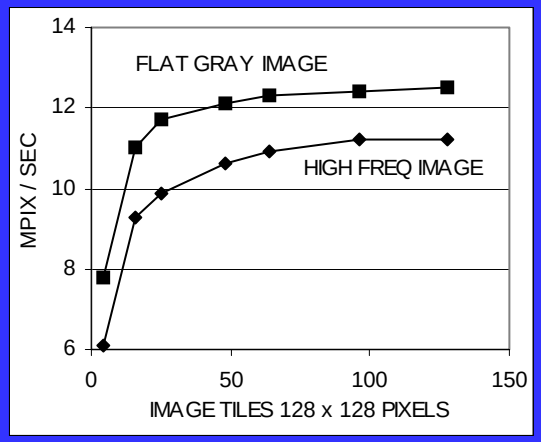
FUNCTION BLOCK DIAGRAM

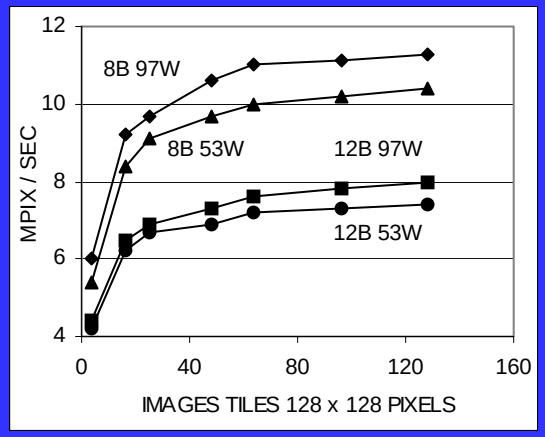


DATA FLOW


TILE FORMATION
TIER1
WAVELET QUANTIZATION ARITHMETIC ENCODING
TIER 1
CODE BLOCK AND METRIC TRANSFER
TIER2
RATE DISTORTION COMPRESSION
TIER2
HEADER AND OUTPUT FILE FORMATION
OUTPUT JPEG 2000 BYTE STREAM

THROUGHPUT



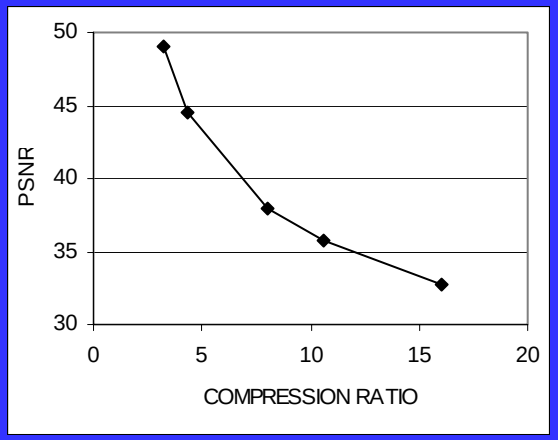


THROUGHPUT = IMAGE PIXELS / COMPRESSION TIME

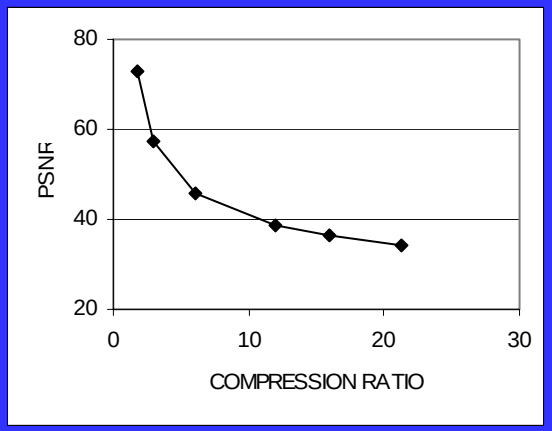
COMPRESSION TIME STARTS AFTER THE IMAGE IS LOADED INTO THE INPUT MEMORY

COMPRESSION TIME ENDS WHEN THE EOC MARKER IS PLACED IN OUTPUT MEMORY

8 BIT PSNR vs COMPRESSION RATIO



12 BIT PSNR vs COMPRESSION RATIO



TILE OF INTEREST

CR = 4.4

CR = 18.5

FILE TRANSMISSION ERROR RECOVERY

DATA DROPOUT DURING TRANSMISSION WILL CAUSE FILE CORRUPTION

TWO TYPES OF ERROR RECOVERY ARE POSSIBLE WITH THE COMPRESSED FILES GENERATED WITH THIS DEMONSTRATION BOARD.

FILES GENERATED USING THE SEQUENTIAL TILE FORMAT WILL LOOSE THE PART OF THE IMAGE CONTAINED IN THE MISSING BYTES, HOWEVER THE OTHER TILES WILL NOT BE AFFECTED BY THE MISSING BYTES

FILES GENERATED USING THE TILE PART FORMAT CAN GENERALLY DISPLAY THE ENTIRE IMAGE, AFTER SOME DATA DROPOUT, BUT THERE WILL BE SOME LOSS OF IMAGE QUALITY OVER THE ENTIRE IMAGE.

ERROR RECOVERY SEQUENTIAL TILE FORMAT

ORIGINAL IMAGE

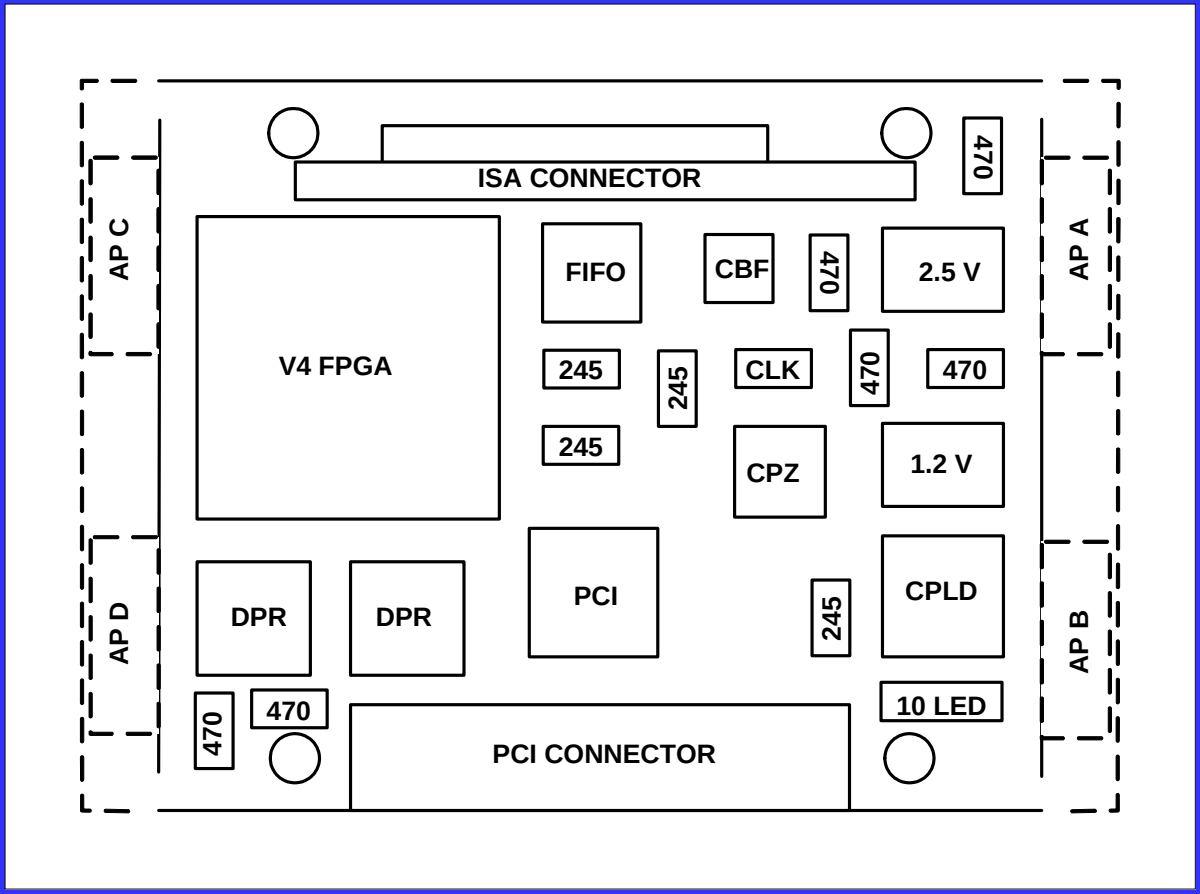
RECOVERED IMAGE

ERROR RECOVERY
TILE PART FORMAT

ORIGINAL IMAGE

RECOVERED IMAGE

SECOND GENERATION DESIGN



CONCLUSION

EXPERIENCE WITH JPEG 2000 IN A HARDWARE ENVIRONMENT

LESSONS LEARNED WILL AID IN THE DESIGN OF FUTURE SYSTEMS THAT WILL HAVE MORE FUNCTIONALITY AND SMALLER BOARD DESIGNS

THANK YOU