



Highly-Scalable Reconfigurable Computing

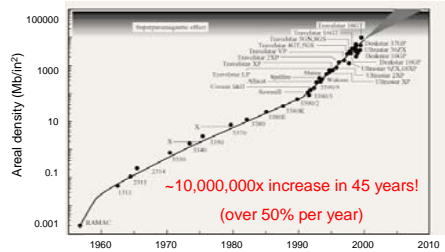


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Need

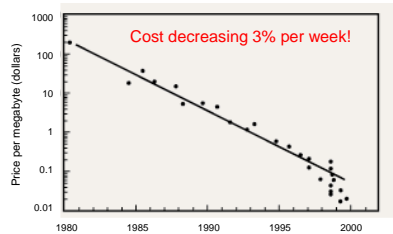
Massive data: the storage industry shipped 6,000,000,000,000,000 bytes last year

Data density is increasing faster than Moore's Law:



Magnetic disk storage areal density vs. year of IBM product introduction (From D. A. Thompson)

And costs are dropping as a result:



Price history of hard disk product vs. year of product introduction (From D. A. Thompson)

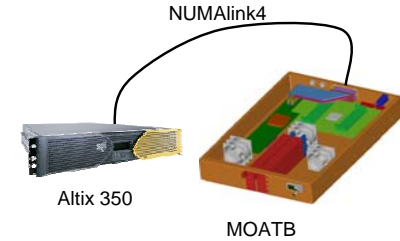
The result is that it is less expensive to save data rather than decide whether or not it can safely be discarded. **What do we do with all this data?**

What are we doing?

SGI is building systems that incorporate reconfigurable hardware into its NUMAlink scalable interconnect.

Exegy is developing applications that can exploit the availability of high-volume data and reconfigurable hardware.

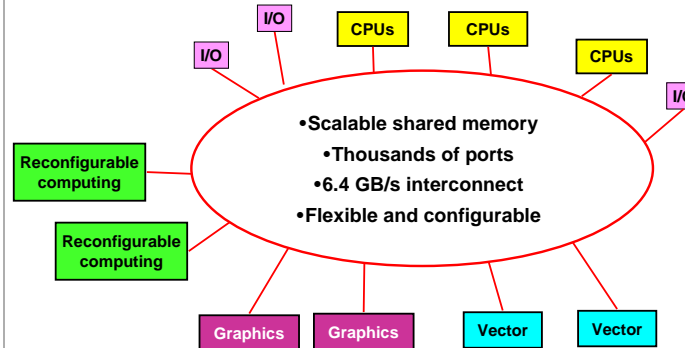
Initial Prototype Configuration [1]



Initial prototype system consists of:

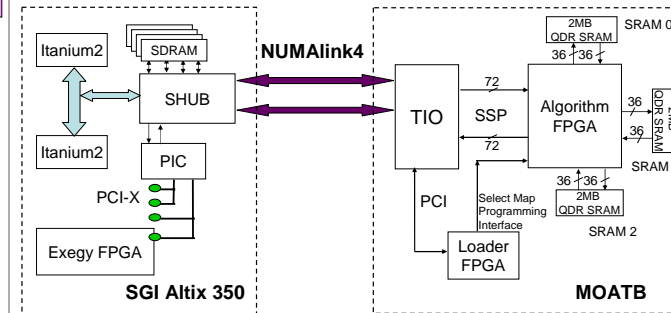
- Altix 350 server with two Itanium2 processors
- MOATB with Xilinx Virtex II FPGA
- NUMAlink4 interconnect

Altix® System Architecture



Scalability:

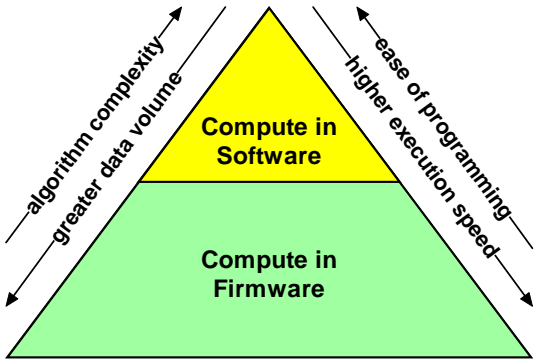
- 10240 processors (512 per node)
- 160 TB memory (8 TB per node)
- Cache-coherent NUMAlink interconnect within nodes, non-cache-coherent between nodes
- 512 I/O channels



Firmware components of applications can be deployed in:

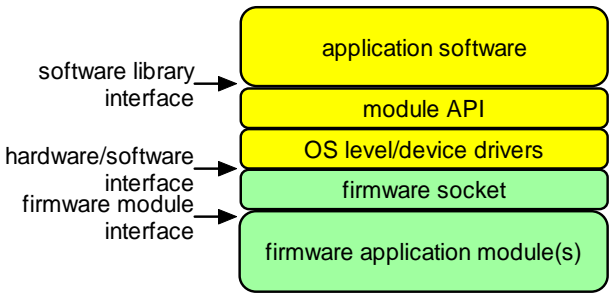
- Algorithm FPGA within MOATB
- Exegy FPGA attached via PCI-X bus

Hardware/Software Application Partitioning



Application Deployment Pyramid

Application Development Framework



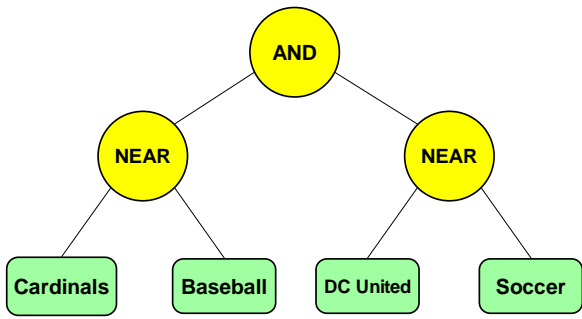
- Top and bottom layers define the application
- Middle three layers are application independent

Applications

- Text search (exact and approximate)
- Biosequence search
- Structured record search
- Encryption/decryption
- Signature hashing
- Science data mining
- Compression/decompression

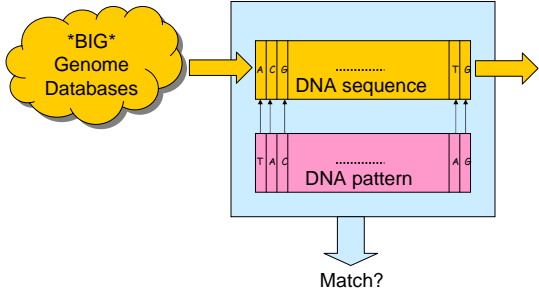
Example Text Search Query [2]

(Cardinals NEAR Baseball) AND (DC United NEAR Soccer)



- Individual keywords are searched in FPGA firmware
- Combining operations are performed in software

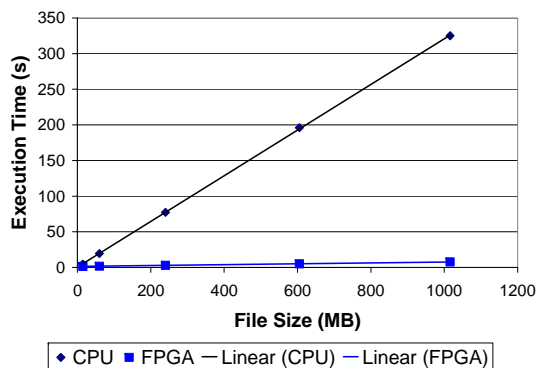
Biosequence Similarity Search [3]



- Approximate search implemented as three-stage pipeline:
1. Word match (in firmware)
 2. Ungapped extension (in firmware)
 3. Gapped extension (in software)

Prototype Performance

Triple DES encryption application



Single FPGA performance is > 40x single CPU