



CRAY T90/J90 Hardware Overview

San Diego Supercomputer Center

Agenda

- **NPACI PVPs**
- **CPU Architecture**
- **Memory Subsystem**
- **IEEE (T90)/CFP (J90)**

UCSD/SDSC

- **CRAY T916/14**
 - 14 CPUs
 - 4 GB Memory
- **HPSS Archival**
 - 60 TB Tape Storage
 - 250 GB Disk Cache

UTexas

- **J916**
 - 16 CPUs
 - 4 GB Memory
 - 40 GB Disk
- **J916**
 - 5 CPUs
 - 1 GB Memory
 - 40 GB Disk
- **CRAY DMF Archival**
 - 18 TB Available Tape Storage

Vector Hardware

Cray PVP CPUs have:

- **8 vector registers per CPU**
 - **vector registers hold 64 (J90) or 128 (T90) values**
 - **multiple issue memory references**
 - **arithmetic functional units segmented**
 - **chaining between functional units**
- **registers for evaluating 64 (J90) or 128 (T90) conditions for IF block in loop**

Vector Hardware

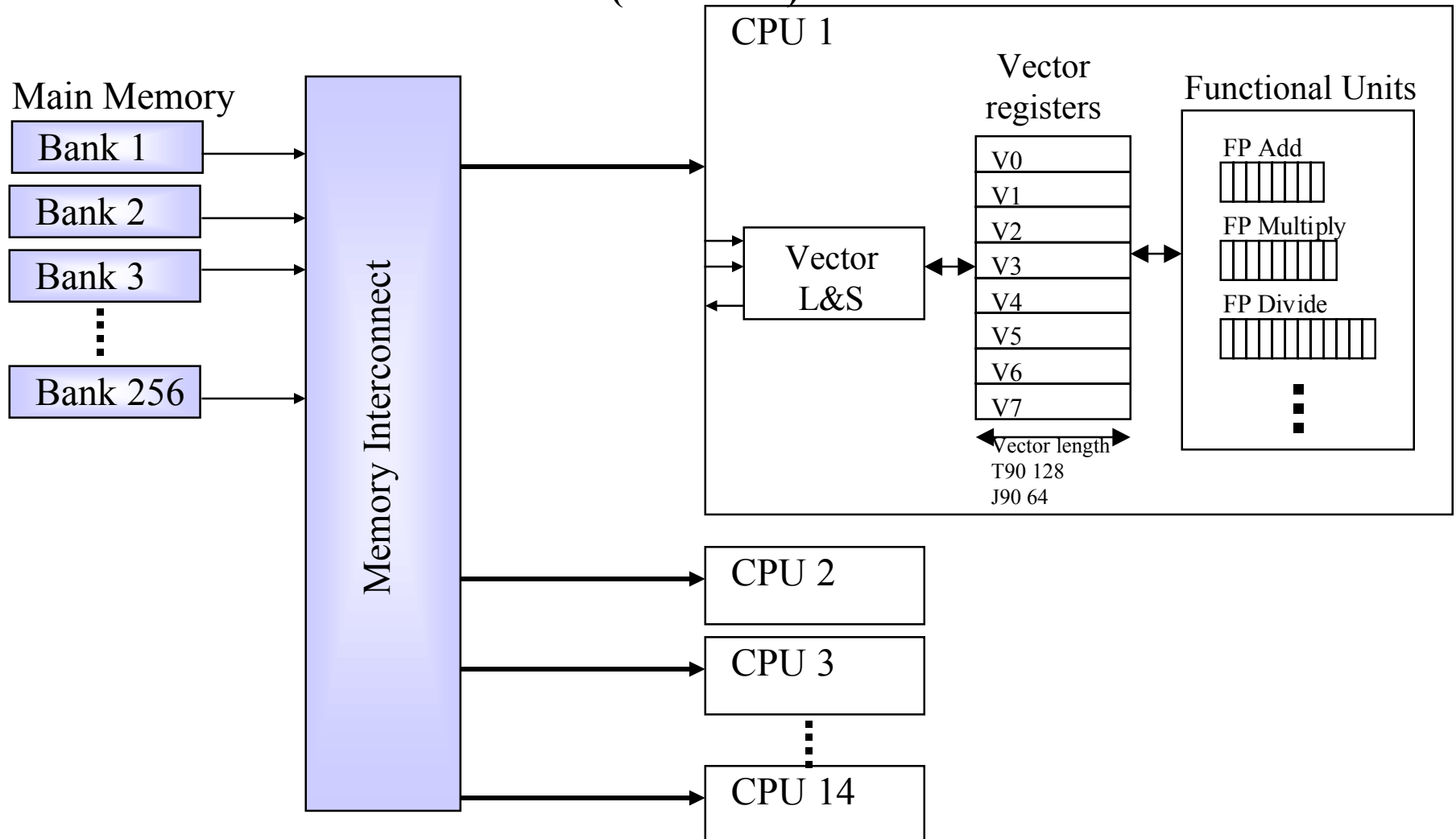
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– **functional units:**

- **FP Add**
- **FP Multiply**
- **FP Divide**
- **FP Square root (T90 only)**

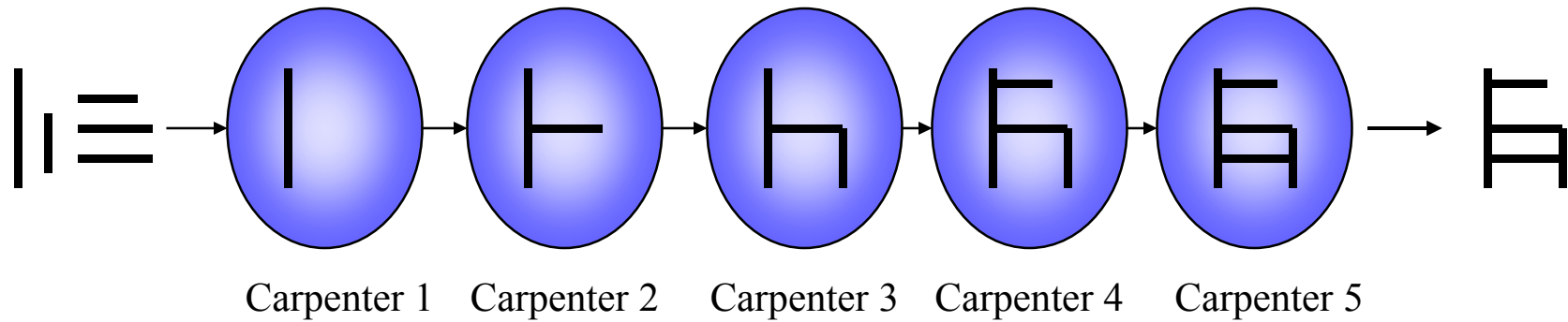
Vector Hardware

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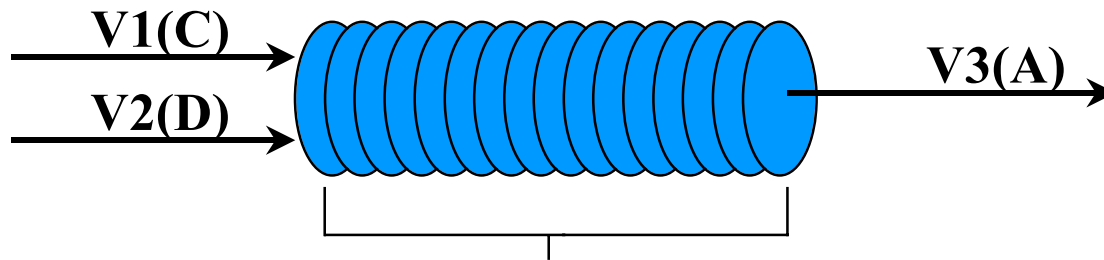


Functional Unit

Chair Building Function Unit



• Fully Segmented - $A(I) = C(I) * D(I)$



Multiply pipeline length

Segments

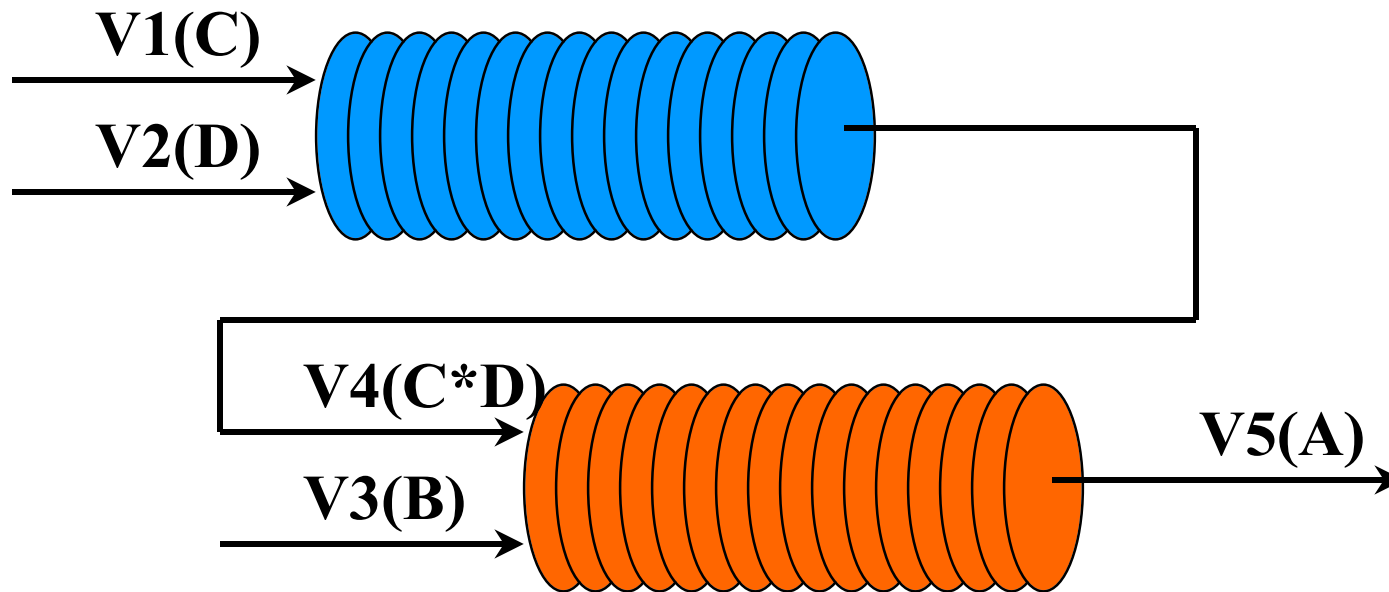
* ~10

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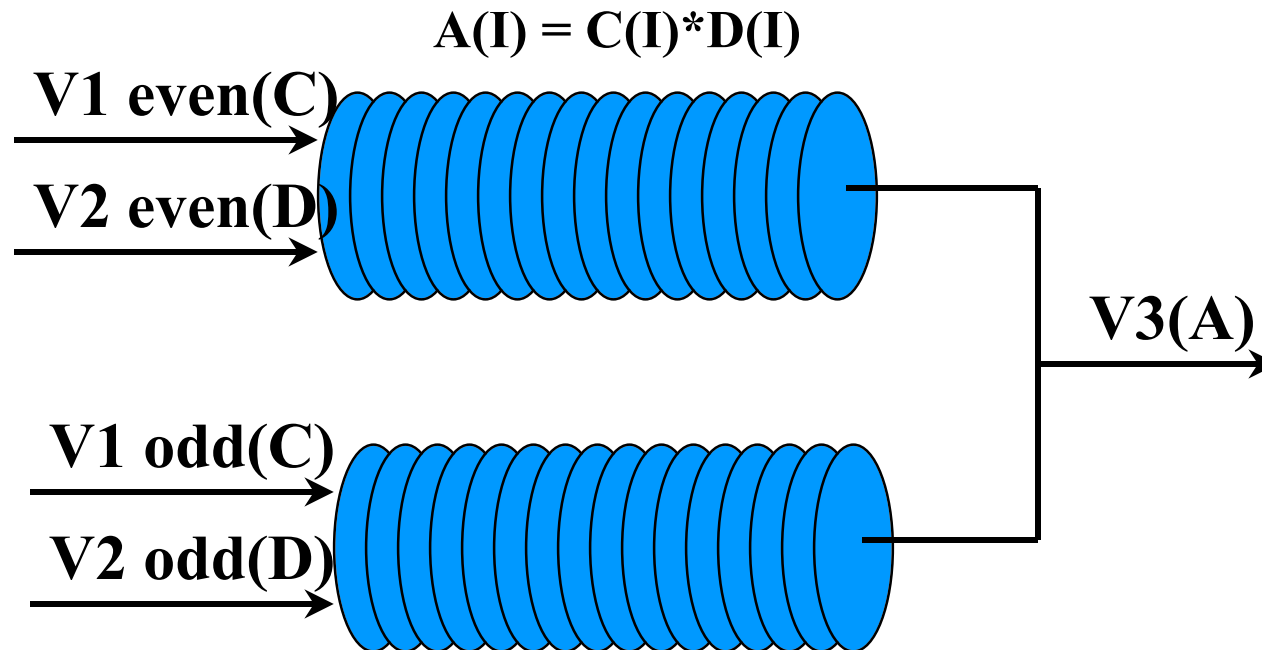
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Functional Unit, cont'd

- **Vector Chaining - $A(I)=B(I)+C(I)*D(I)$**

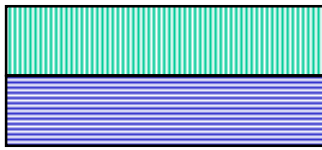


Dual Pipes

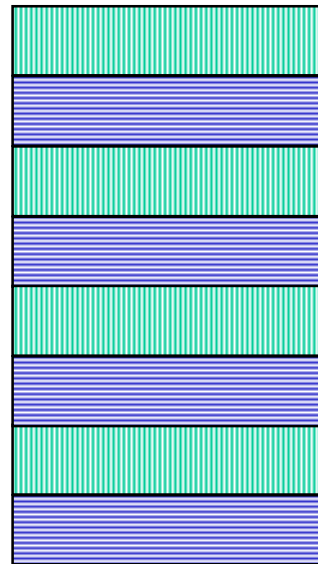


Scalar Cache

- **Scalar and Address References**



J90
128 Words (1KB)
2-way Set Associative



T90
1024 Words (8KB)
8-way Set Associative

J90

- **10ns clock (100MHz)**
- **2 Ports to Memory**
 - **800 MB/s**
 - **2 Read or 1 Read & 1 Write**
- **1 KB Scalar Cache (2-way)**

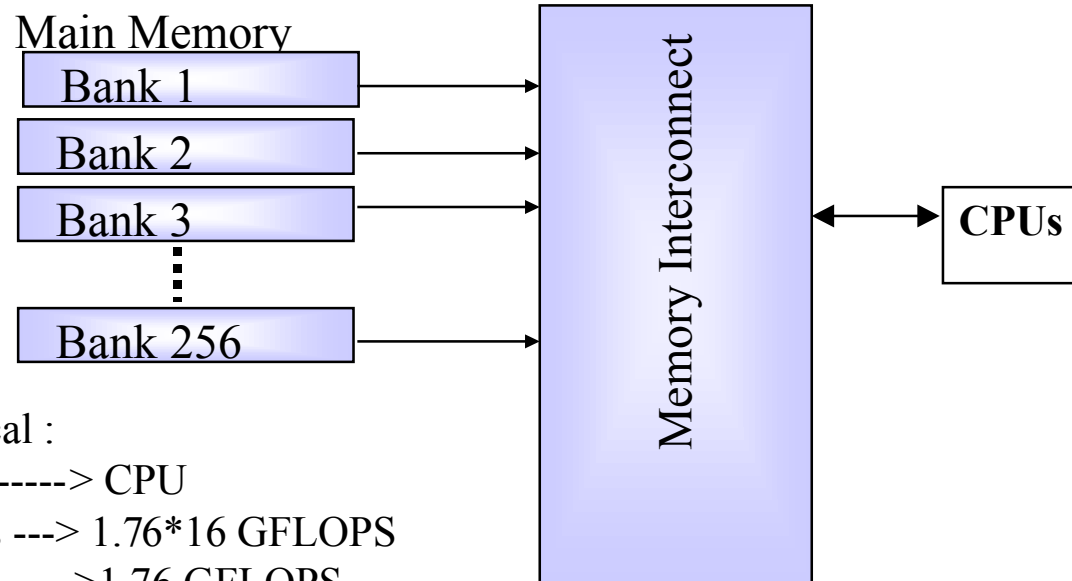
T90

- **2.2ns clock (440MHz)**
- **4 Ports to Memory**
 - 2 Read & 1 Write
 - 1 Dedicated to Cache
- **8 KB Scalar Cache (8-way)**
- **Dual Pipes**

Peak Speed

- **Chained functional units allow up to two FLOPS per clock period.**
- **Dual vector pipes (T90 only) can double this to 4 FLOPS per clock period**
- **J90 peak speed: 200 Mflops**
- **T90 peak speed: 1.76 Gflops**
- **But memory bandwidth can limit peak performance**

Memory Subsystem



Theoretical :
Memory -----> CPU
450 GB/s ---> 1.76*16 GFLOPS
~24GB/s ----->1.76 GFLOPS
~3Gword/s----->1.76 GFLOPS

Memory references <2 CPU Bound
FLOPS >2 Memory Bound

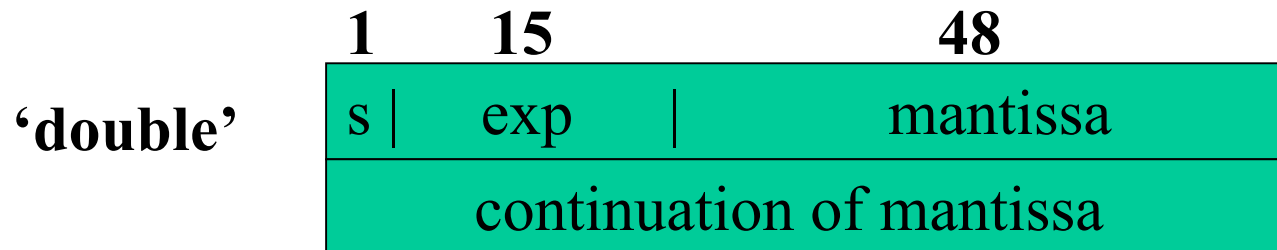
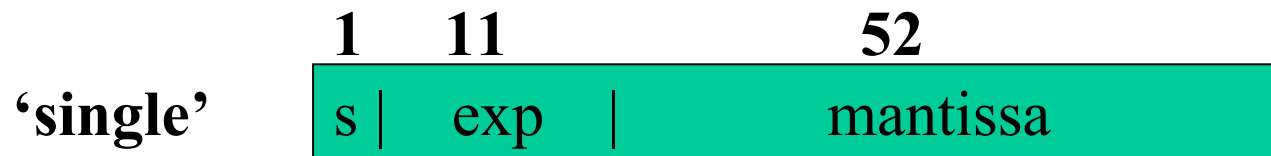
Memory

- **J90**
 - **512 MB to 8000 MB**
 - **256, 512, 1024 Memory Banks**
- **T90**
 - **4096 MB (for T916 systems)**
 - **256 Memory Banks**

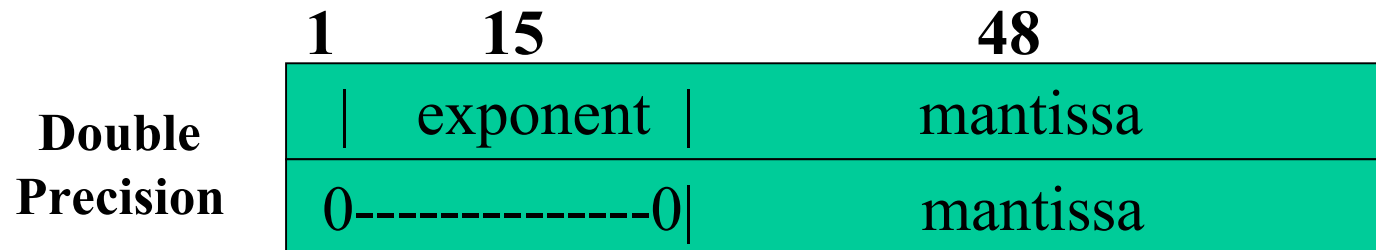
Single vs Double Precision

- **Single precision = 64 bits!**
- **Double precision = 128 bits**
- **DP 20 times slower (done in software), almost never needed**
- **f90 -dp ...**
double precision constants and intrinsic calls automatically converted to single precision

Cray T90 (IEEE) FP Format



Cray J90 CFP Format



Precision

Representation	Precision	REAL		INTEGER	
		Digits	(Exp) Range	Digits	Range
IEEE	15	53	307	63	18
Cray J90	13	47	2465	46/63	13/18

Porting Binary Data Files

- **NPACI provides excellent document for porting binary files between all NPACI machines (and workstations):**

http://www.npaci.edu/T3E/binary_files.html