

**CRAY**



# Compiling Environment Practical Session



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# Introduction

- Compile a real world application/tool
  - There is lot of effort going into the development
- Use different compilers
  - Cray
  - Intel
  - GNU
- Discover common problems

- **HPL (High Performance Computing Linpack Benchmark)**
  - HPL is a software package that solves a (random) dense linear system in double precision (64 bits) arithmetic on distributed-memory computers
- **External Dependencies**
  - MPI (e.g. CrayMPI, OpenMPI, IntelMPI, MVAPICH2)
  - BLAS or VSIBL library for simple vector operations such as scaled vector addition (DAXPY:  $y = \alpha x + y$ ) and inner dot product (DDOT:  $a = \sum x_i y_i$ ) ( e.g. Cray LibSci, MKL, ATLAS)



- **Output**

- HPL reports back the number of arithmetic operations performed in the given time for the given problem and validates the solution is within acceptable limits. E.g.:

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T/V	N	NB	P	Q	Time	Gflops
WR01L2L2	5000	32	4	1	7.00	1.191e+01

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$\|Ax-b\|_{\infty} / (\text{eps} * \|A\|_1 * N) = 0.0426255 \dots \text{PASSED}$   
 $\|Ax-b\|_{\infty} / (\text{eps} * \|A\|_1 * \|x\|_1) = 0.0281393 \dots \text{PASSED}$   
 $\|Ax-b\|_{\infty} / (\text{eps} * \|A\|_{\infty} * \|x\|_{\infty}) = 0.0054928 \dots \text{PASSED}$

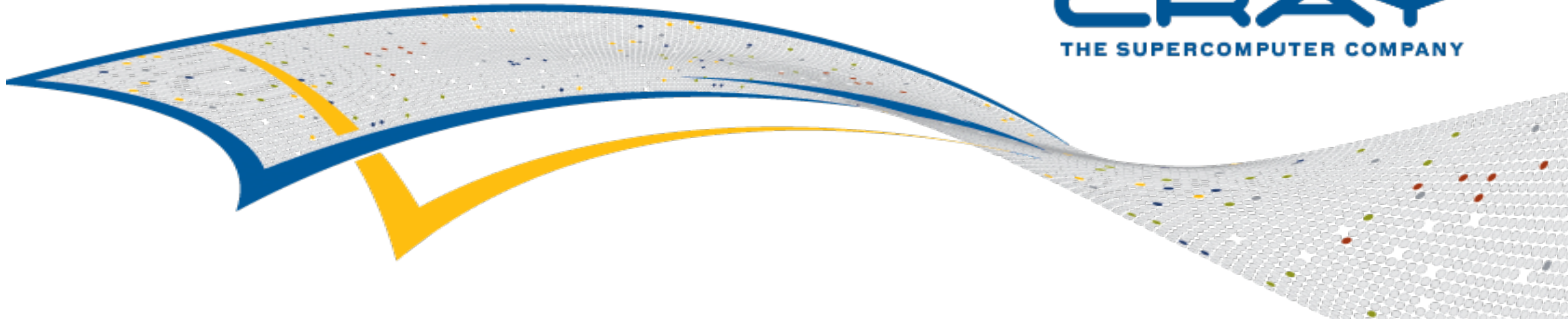
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- **TOP 500**

- HPL results are used to score top 500 Supercomputers
- First efforts started at 1979, from 2005 it has the form we see today

First Rank	Name	Computer	Site	Manufacturer	Total Cores	Rmax (TFlops)	Rpeak (TFlops)	Power (kW)	Efficiency
1	Sunway TaihuLight	Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway	National Supercomputing Center in Wuxi	NRCPC	10649600	93014593.88	125435904	15371	74.15%
2	Tianhe-2 (MilkyWay-2)	TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P	National Super Computer Center in Guangzhou	NUDT	3120000	33862700	54902400	17808	61.68%
3	Titan	Cray XK7 , Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x	DOE/SC/Oak Ridge National Laboratory	Cray Inc.	560640	17590000	27112550	8209	64.88%
4	Sequoia	BlueGene/Q, Power BQC 16C 1.60 GHz, Custom	DOE/NNSA/LLNL	IBM	1572864	17173224	20132659.2	7890	85.30%
5	Cori	Cray XC40, Intel Xeon Phi 7250 68C 1.4GHz, Aries interconnect	DOE/SC/LBNL/NERSC	Cray Inc.	622336	14014700	27880653	3939	50.27%
6	Oakforest-PACS	PRIMERGY CX1640 M1, Intel Xeon Phi 7250 68C 1.4GHz, Intel Omni-Path	Joint Center for Advanced High Performance Computing	Fujitsu	556104	13554600	24913459	2718.7	54.41%
7		K computer, SPARC64 VIIIfx 2.0GHz, Tofu interconnect	RIKEN Advanced Institute for Computational Science (AICS)	Fujitsu	705024	10510000	11280384	12659	93.17%
8	Piz Daint	Cray XC50, Xeon E5-2690v3 12C 2.6GHz, Aries interconnect , NVIDIA Tesla P100	Swiss National Supercomputing Centre (CSCS)	Cray Inc.	206720	9779000	15987968	1312	61.16%
9	Mira	BlueGene/Q, Power BQC 16C 1.60GHz, Custom	DOE/SC/Argonne National Laboratory	IBM	786432	8586612	10066330	3945	85.30%
10	Trinity	Cray XC40, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect	DOE/NNSA/LANL/SNL	Cray Inc.	301056	8100900	11078861	4232.63	73.12%
11		Cray XC40, Xeon E5-2695v4 18C 2.1GHz, Aries interconnect	United Kingdom Meteorological Office	Cray Inc.	241920	6765250	8128512		83.23%
12	Marconi Intel Xeon Phi	CINECA Cluster, Intel Xeon Phi 7250 68C 1.4GHz, Intel Omni-Path	CINECA	Lenovo	241808	6223040	10832998		57.45%
13	Pleiades	SGI ICE X, Intel Xeon E5-2670/E5-2680v2/E5-2680v3/E5-2680v4 2.6/2.8/2.5/2.4 GHz, Infiniband FDR	NASA/Ames Research Center/NAS	HPE/SGI	241108	5951550	7107148.8	4407	83.74%
14	Hazel Hen	Cray XC40, Xeon E5-2680v3 12C 2.5GHz, Aries interconnect	HLRS - Höchstleistungsrechenzentrum Stuttgart	Cray Inc.	185088	5640170	7403520	3615	76.18%
15	Shaheen II	Cray XC40, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect	King Abdullah University of Science and Technology	Cray Inc.	196608	5536990	7235174	2834	76.53%
16	Pangea	SGI ICE X, Xeon Xeon E5-2670/ E5-2680v3 12C 2.5GHz, Infiniband FDR	Total Exploration Production	HPE/SGI	220800	5283110	6712320	4150	78.71%
17	Stampede	PowerEdge C8220, Xeon E5-2680 8C 2.700GHz, Infiniband FDR, Intel Xeon Phi SE10P	Texas Advanced Computing Center/Univ. of Texas	Dell	462462	5168110	8520111.6	4510	60.66%
18	Theta	Cray XC40, Intel Xeon Phi 7230 64C 1.3GHz, Aries interconnect	DOE/SC/Argonne National Laboratory	Cray Inc.	207360	5095840	8626176	1087	59.07%
19	JUQUEEN	BlueGene/Q, Power BQC 16C 1.600GHz, Custom Interconnect	Forschungszentrum Juelich (FZJ)	IBM	458752	5008857	5872025.6	2301	85.30%
20	Cheyenne	SGI ICE XA, Xeon E5-2697v4 18C 2.3GHz, Infiniband EDR	National Center for Atmospheric Research (NCAR)	HPE/SGI	144900	4788190	5332320	1727	89.80%
21	Vulcan	BlueGene/Q, Power BQC 16C 1.600GHz, Custom Interconnect	DOE/NNSA/LLNL	IBM	393216	4293306	5033165	1972	85.30%
22	Abel	Cray XC30, Xeon E5-2698v3 16C 2.3GHz, Aries interconnect	Petroleum Geo-Services	Cray Inc.	145920	4042460	5369856	1800	75.28%
23	ANEMOS (CCA)	Cray XC40, Xeon E5-2695v4 18C 2.1GHz, Aries interconnect	ECMWF	Cray Inc.	126468	3944680	4249325	1897	92.83%
24	VENTUS 2	Cray XC40, Xeon E5-2695v4 18C 2.1GHz, Aries interconnect	ECMWF	Cray Inc.	126468	3944680	4249325	1897	92.83%



# Thank You!