This conference is supported by The Ministry of Education, Youth and Sports from the Large Infrastructures for Research, Experimental Development and Innovations project „IT4Innovations National Supercomputing Center – LM2015070“.
Subjective perception:

CPU:
- 2000: 1c
- 2010: 4c
- 2023: 64c

GPGU:
- 2000: 13 SM K20
- 2010: 56 SM P100
- 2010: 80 SM V100
- 2010: 108 SM A100
- 2023: 220 SM MI250X

KNC, KNL
TOP500 data:

Performance share: 23%
Performance share: 41%
Performance share: 71%
COMPUTE TRENDS

From scalars to FMAs on matrices:

\[
\begin{align*}
A & + B = C \\
A1 &+ A4 + B1 &+ B4 = C1 &+ C4 \\
A1 &* B1 &* B4 = C1 &+ C4 \\
A &* B &+ C = D
\end{align*}
\]

Independent data streams

CPU: \(2*8*5 = 80\)

GPU: \(12*32*8 = 3072\)
From “code it yourself” to “use frameworks”:

<table>
<thead>
<tr>
<th></th>
<th>Code yourself</th>
<th>Use libs</th>
<th>Use Frameworks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Language</td>
<td>FORTRAN, C</td>
<td>FORTRAN, C, PYTHON</td>
<td>PYTHON, etc.</td>
</tr>
<tr>
<td>Lib</td>
<td>none</td>
<td>BLAS, LAPACK, TBB</td>
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</tr>
<tr>
<td>Framework</td>
<td>none</td>
<td>none</td>
<td>PyTorch, etc.</td>
</tr>
</tbody>
</table>
HYPERQUEUE

Problem:
- Large amount of jobs?
- Very large amount of small jobs?
- Only 1 or few cores per job needed?
- Complicated job dependencies?

Answer: Use hq!

https://it4innovations.github.io/hyperqueue/stable/
https://docs.it4i.cz/general/capacity-computing/##hyperqueue
```c
printf("Norm y: %f\n", dnmr2_(&NMAT2,y,&ONEI)/NMAT);
printf("Norm z: %f\n", dnmr2_(&NMAT2,z,&ONEI)/NMAT);

//release memory
free(x);
free(y);
free(z);
free(dx);
free(dy);
free(dz);
free(e);
free(xe);

return 0;
}```
COMPUTE TRENDS - SERVICES
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