GRACE @ LIACS

Inauguration Event
2018/02/13

[This slide was not used during the presentation; it was added to make it easier to follow the slide deck.]

[Words of welcome by Aske Plaat, Scientific Director of LIACS]

[Greeting by Holger, special welcome to Martijn Ridderbos, Vice-President of Universiteit Leiden, Geert de Snoo, Dean of the Faculty of Science, and to everyone else from LIACS and beyond.]

SpaceX via YouTube

One week ago …

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Last Tuesday, SpaceX sent a Tesla roadster into space. Not an autonomous car (as you can see, it needs a driver), but pretty impressive nevertheless.

Wikimedia Commons

"SpaceX’s self-landing rocket is a flying robot that’s great at math.” (Tim Fernholz, Quartz)

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Even more impressively, two of the three cores of the Falcon Heavy rocket used for this launch were landed again, simultaneously and with amazing accuracy. How is this related to today's event? Advanced computation made it possible.

Advanced Computation

Evolution of computation:

- special-purpose computing machines
- freely programmable, universal computers
- automated programming, machine learning, AI
  → advanced computation, AutoML, AutoAI

Research on advanced computation:

- large amounts of computation, data
- experiments on highly controlled, configurable computing environments
  → advanced computing research laboratories

GRACE in Numbers

- 32 nodes; 1024 CPU cores; 12 GPUs
- 135 teraFLOPS = 135 trillion floating point operations / sec
- Fast interconnects: ~56 Gb/sec per link (Infiniband FDR)
- Power draw: 11 kW full load (4 kW idle)
- Compute power added to LIACS by grace: 67%

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Let’s illustrate these numbers:

all of grace (CPUs + GPUs) = 135 teraFLOPS - compare to:
- equals total compute power of the world’s top 500 supercomputers in in 2002 (15y ago)
- equals compute power of the world’s top-ranked supercomputer in 2005 (13y ago)
- would have been #500 supercomputer in the world in mid-2014 (3.5y ago)
- = ~10% of peak perf of current top cluster in NL (surfSARA)
- = ~0.5% of peak perf of current #1 cluster in Europe, Piz Daint (CH) = #3 worldwide
- = ~0.11% of peak perf of current #1 cluster in the world, Sunway TaihuLight (CN)
- = ~0.01% = 1/10k of total computing capacity of current top 500 supercomputers in the world

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In 2013, supercomputer power in all of NL amounted to 30 MFLOPS/capita (vs 94 on average for the entire EU).
At that time, Grace would have been equivalent to the fair share of ~4.5M people; and today it’s still ~450k people = 2/3 of the combined population of Leiden + The Hague. At LIACS, about 10 of us will use Grace, but we intend to do it for the benefits of all those whose fair share we use :-)

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Grace Hopper, after whom the cluster is named (more on her soon), used to give a famous demonstration. Look at this 20cm piece of network cable. This is how far an electrical signal travels within 1 nanosecond - the time one processing core of grace needs to perform about 2-3 operations. So every 20cm of distance corresponds to a delay of 2-3 operations - a very good reason to have a machine like grace close to those that use it (for research and certain applications, such as algorithmic stock trading).

[Note: In vacuum, it would be ~30cm per nanosecond, but signals travel slower in optical fibre and copper wire.]

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The network connections between the nodes of grace are very fast. For comparison:

- Louis Couperus, de stille kracht (a classic of Dutch literature, published in 1900) ~= 75.6k words ~= 425k characters w/ spaces, uncompressed = 3.4Mb => can be transmitted 16.4k times per second across a single interconnect in grace

- Johannes Jacobus (Han) Voskuil, Het Bureau (1996-2000) = seven volumes, 5,058 pages, 1,590,000 words
~= 10m characters w/ spaces, uncompressed = 80Mb
=> 700 times per second (~= 4900 volumes per second)
across a single interconnect in grace

- human genome (diploid) = 6,469.66 Mbases ~= 12.9Gb (uncompressed, 2 bits/base) = 130 printed volumes (found in the Science Museum in London)
=> 4.3 times per second
across a single interconnect in grace

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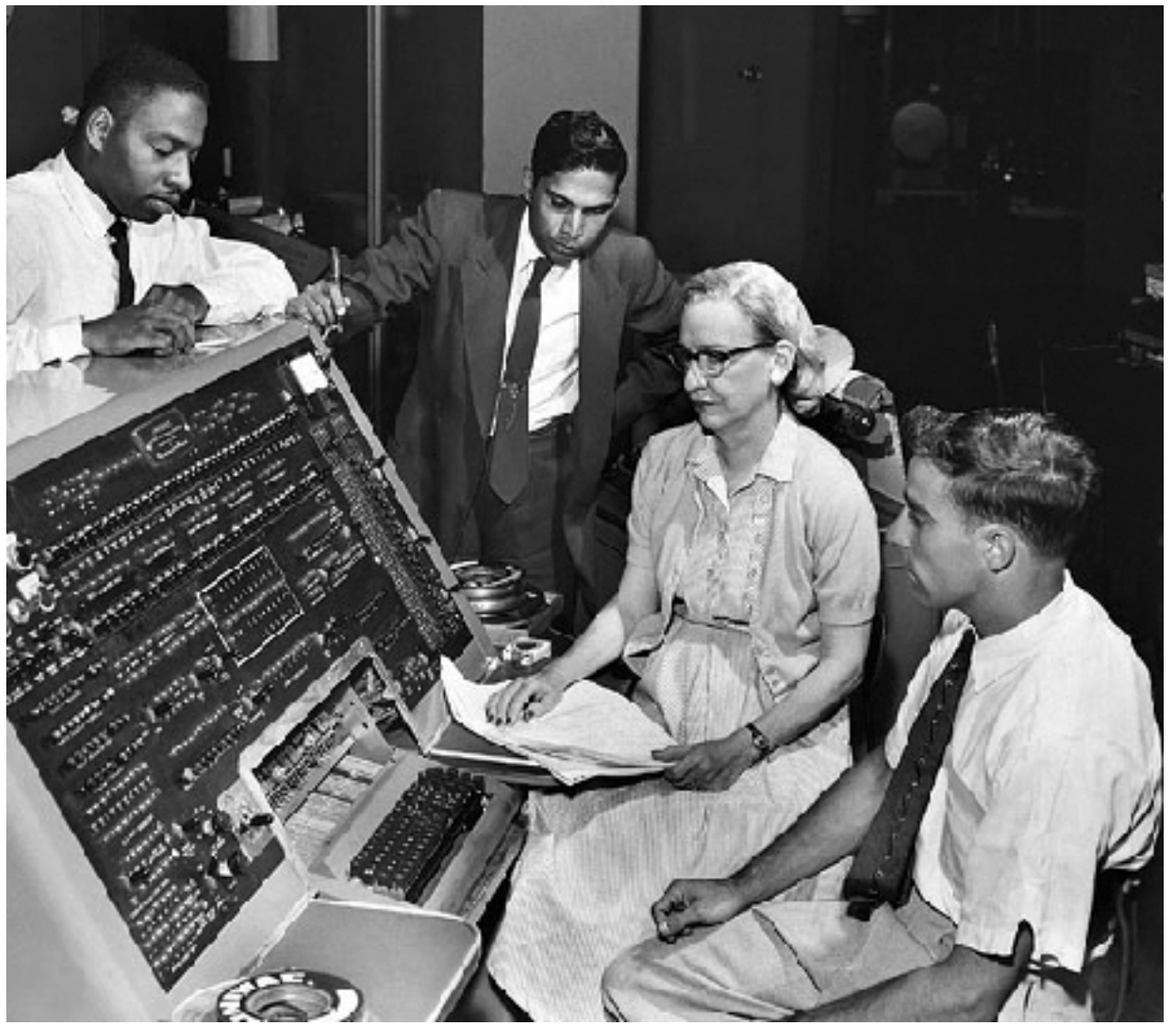
Grace, like any computer, primarily converts electricity into heat (and sound). How much electricity? At full load, as much as ~10 electric kettles (only) - that’s very energy efficient.

Why GRACE?

Grace Hopper (1906–1992; USA)

- One of the first programmers (Mark I, UNIVAC)
- Major contributions to development of high-level programming languages
- Inspiring and committed educator
- "outside all Navy, inside, a Pirate dying to be released"



The most important thing I've accomplished,
other than building the compiler, is training young people.
They come to me, you know, and say,
'Do you think we can do this?'
I say, "Try it." And I back 'em up. They need that.
I keep track of them as they get older and I stir 'em up at
intervals so they don't forget to take chances.

Building GRACE

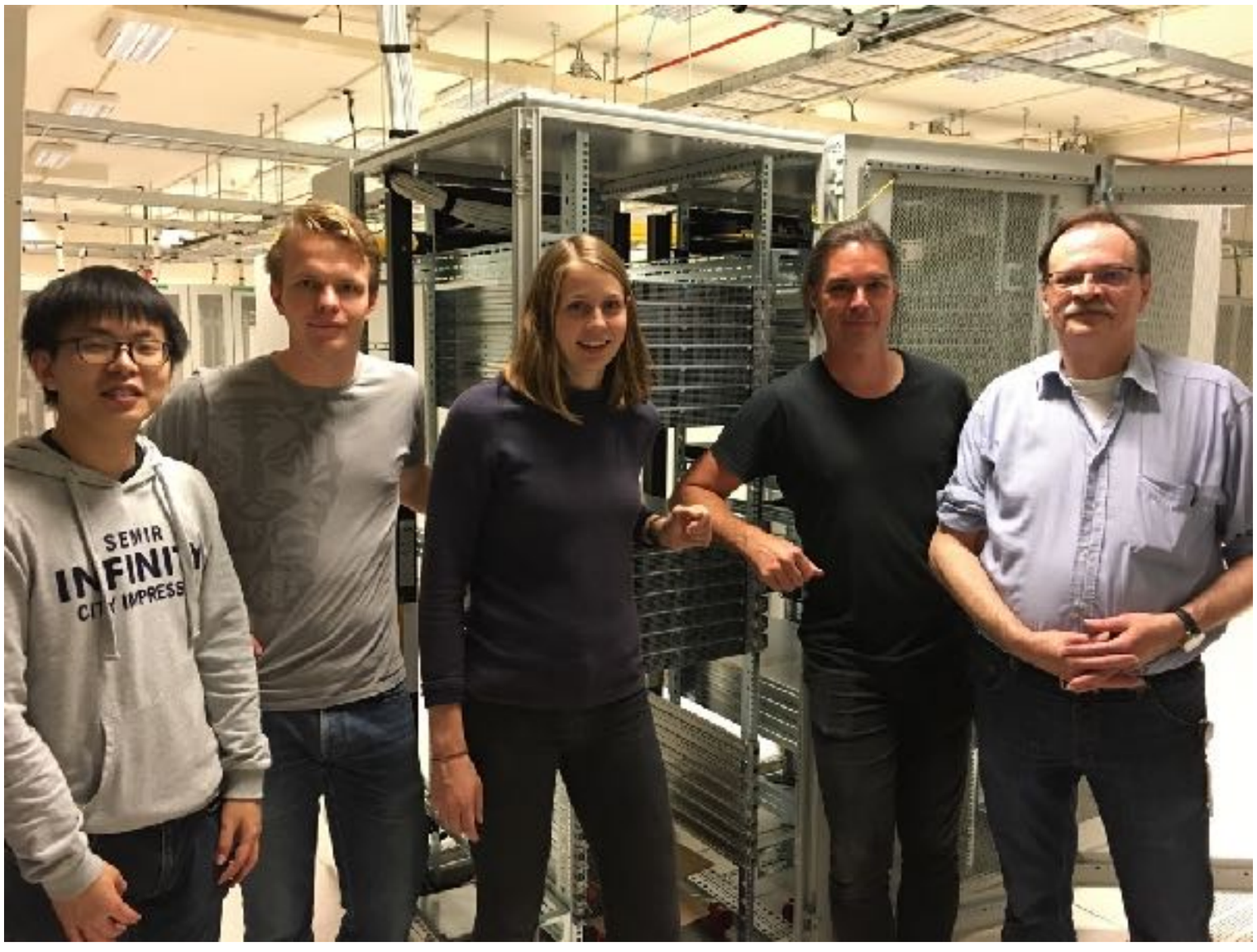
[This slide was not used during the presentation; it was added to make it easier to follow the slide deck.]

Grace was not built by a company - it was put together by us.

LIACS is a place where folks not only do great work, but also have fun. As we did with the boxes containing the nodes of grace. Perhaps too much fun - let's hope when we start up Grace in a few minutes, everything works as it should :-)

Building GRACE

Building GRACE



Building GRACE

Many thanks:

- Vianney Govers (LIACS)

- Lars Kotthoff
  (formerly UBC; now University of Wyoming)

- Chuan Luo, Jesper van Engelen;
  Aske Plaat, Lise Stork (LIACS)

- Bert van Polen, Bart Hoogervorst,
  Ron Devilee (ISSC)

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