



## Total Cost of Ownership: Onsite HPC

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# What is Total Cost of Ownership (TCO)?

- Total cost of ownership refers to all the costs associated with the use of computer hardware and software.
- TCO analysis serves as a planning and decision making tool.
- For a HPC system includes (not exhaustive)
  - Hardware
    - HPC system, storage, network, cooling, facilities (housing)
    - Commissioning and decommissioning
  - Software
  - People
    - Administration, technical support, user support
  - Operating
    - Electricity, maintenance
  - Others?

# Hardware

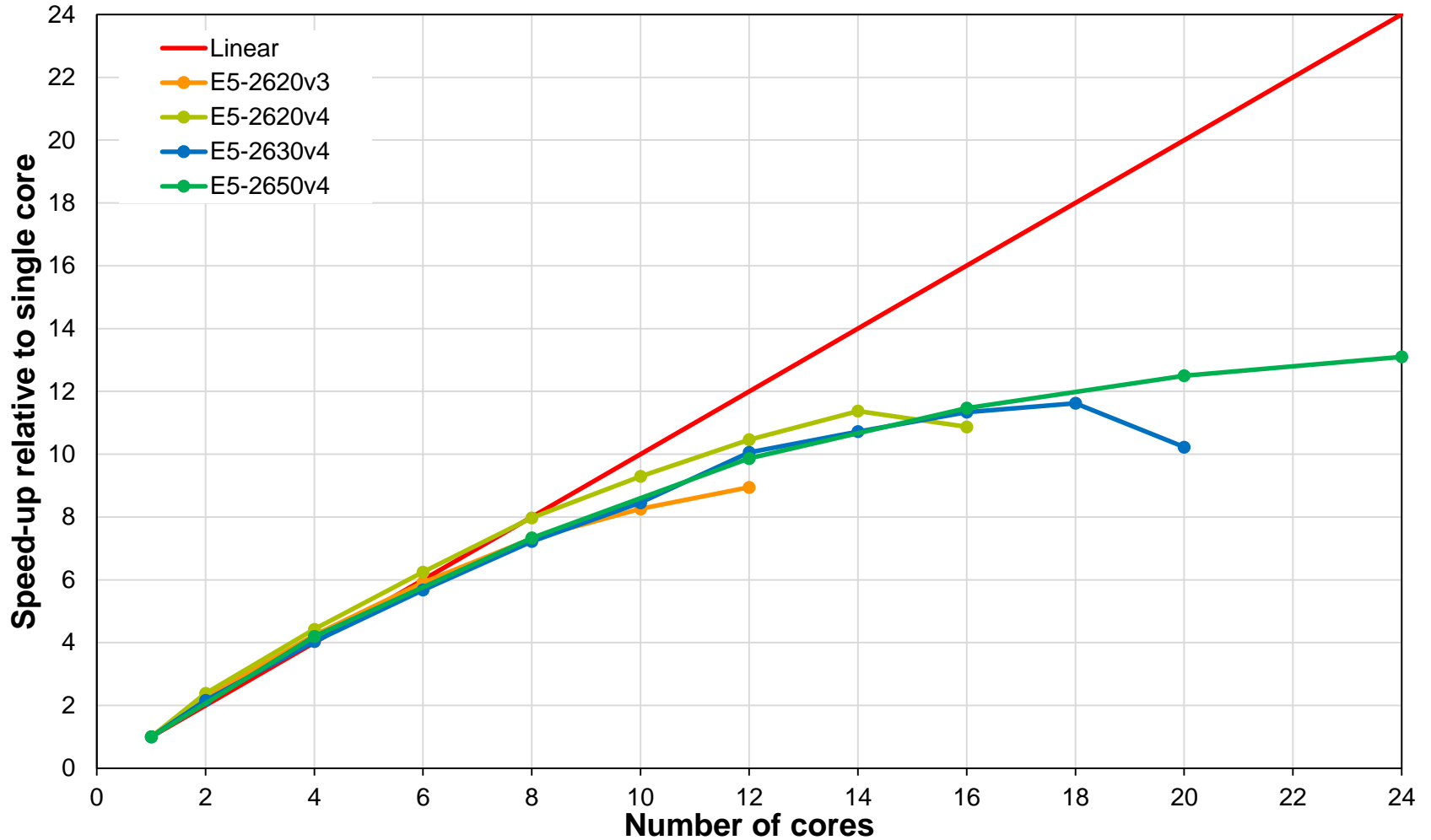
- Some questions
  - Which CPU
    - More cores is not necessarily better
  - GPU's
    - Does your software support them
  - How much memory per node
    - Know your software. e.g. Fluent/OpenFOAM ~ 1GB per million cells.
    - Rank
  - Interconnect
    - Latency then bandwidth.
  - Storage solution
    - NFS, Lustre, ?
  - Onsite, off site or hybrid

# Benchmarking

- Intra vs Inter scaling
  - Intra
    - Scaling between cores in the same node
    - Speed-up relative to a single core
  - Inter
    - Scaling between nodes in the same cluster
    - Speed-up relative to a single node

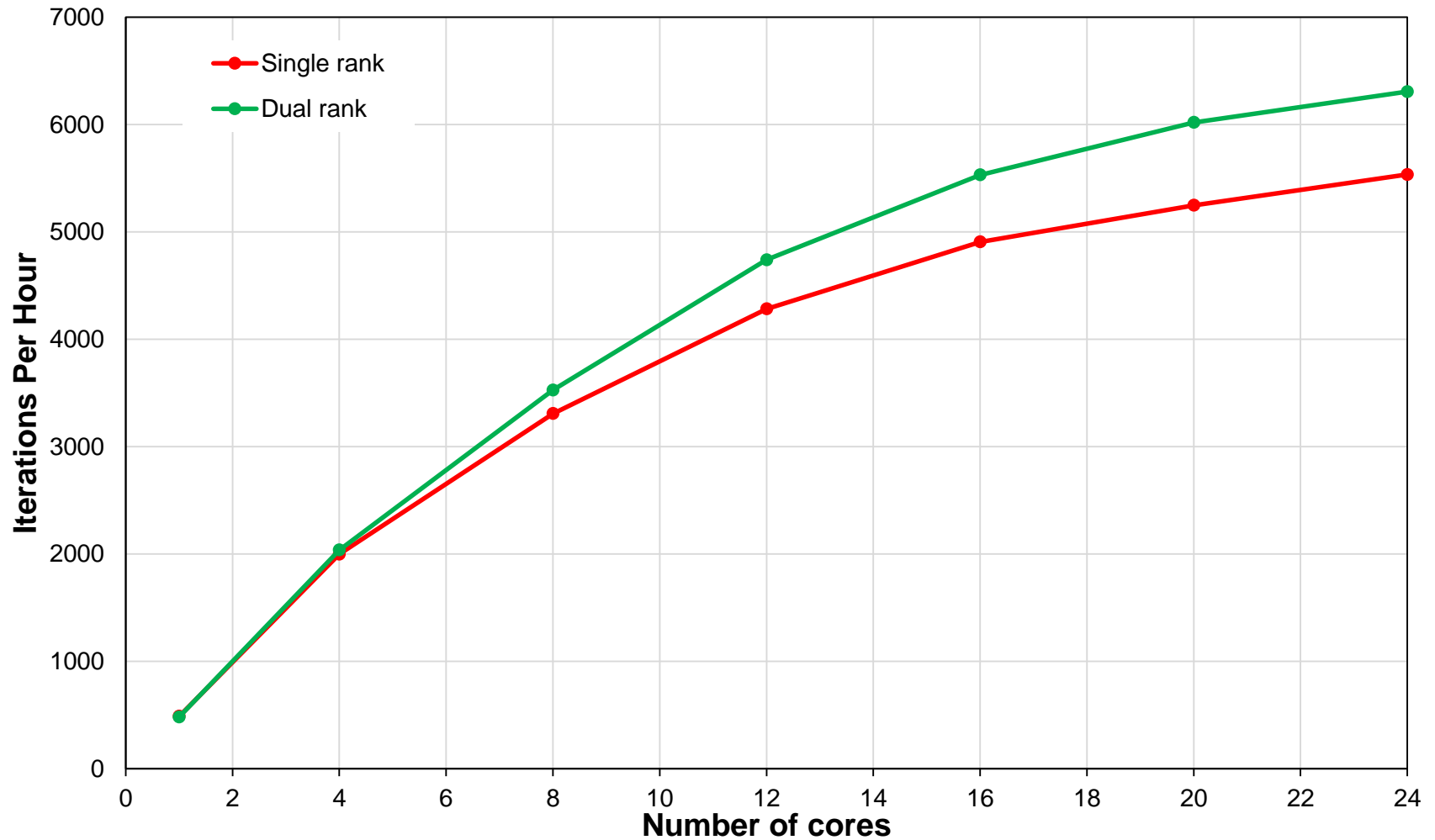
# Intra scaling

One node - Two CPUs

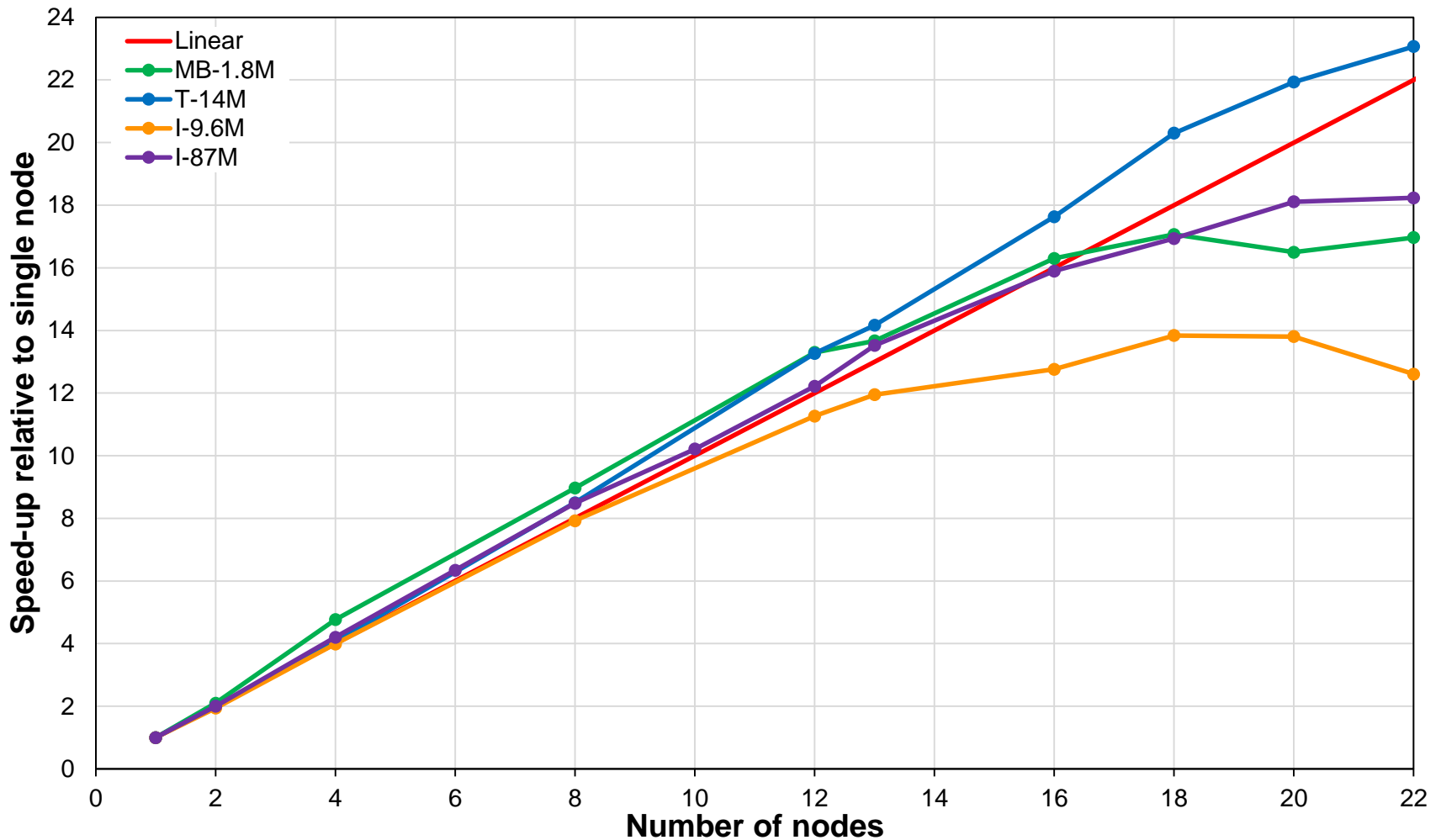


# Intra scaling

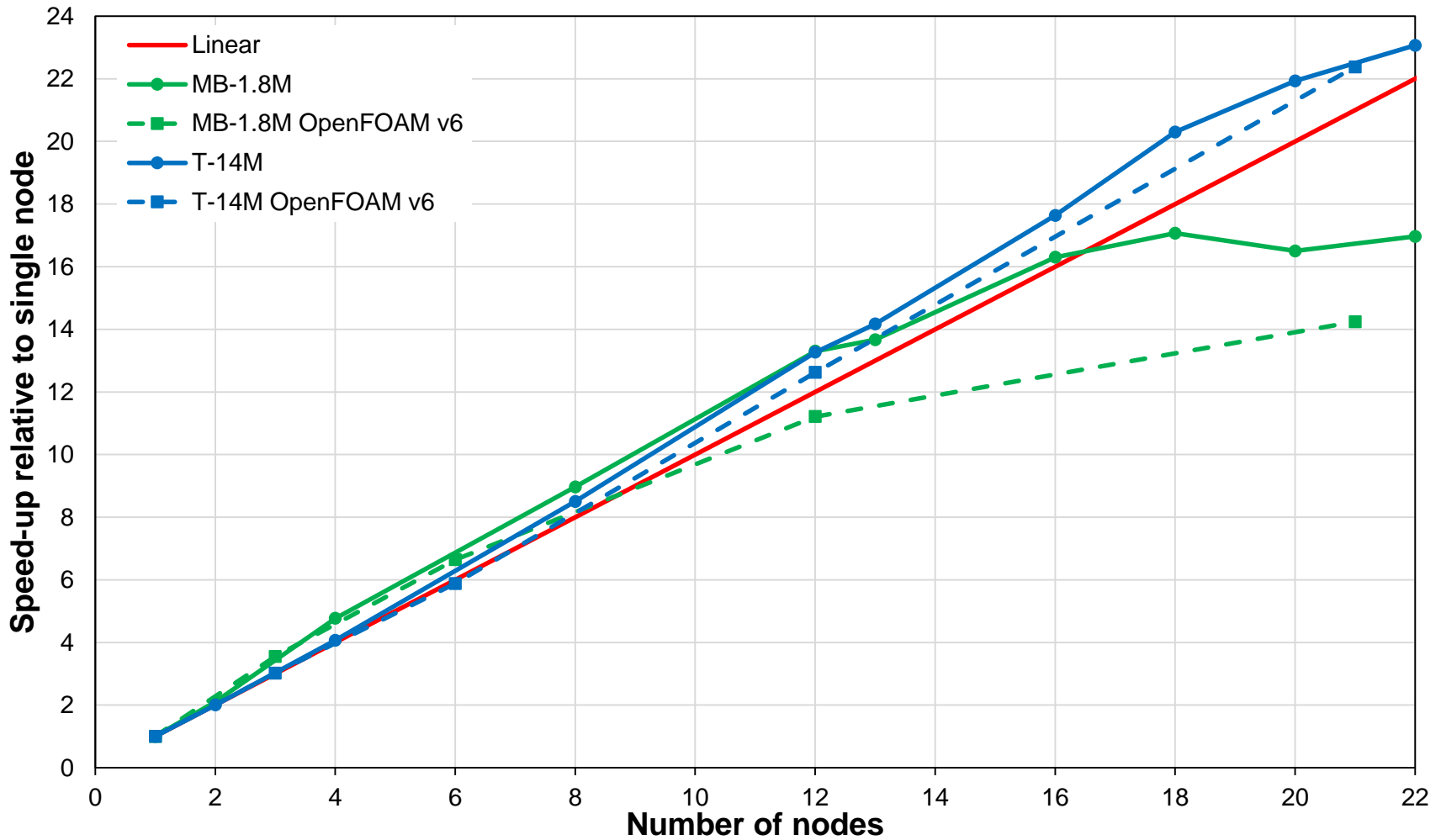
One node - Two CPUs



# Inter scaling



# Inter scaling





# Software factors

- For an article on the TCO of software focusing on the question of Open Source versus Proprietary see <https://www.appliedccm.com/deciding-between-open-and-proprietary/>
- 'Most expensive', 'most well-known' or 'most popular' doesn't necessarily mean most suitable.

# Real example

PARAMETERS	
Cost of electricity \$/kWhr	\$0.28
PUE (ratio of total power used by the datacentre vs power delivered to the HPC systems)	1.20
Capital (i.e., total amount spent on the hardware)	X
Number of racks [calculated]	1
Power consumption kW/rack [calculated]	7.00
Power consumption kW/node	0.35
Utilisation (i.e., percentage of the available cycles that are used)	0.85
Service time (i.e., percentage of time that the system is available to users)	0.95
Total number of core-hrs user per year [calculated]	3,395,376
Cost of a person per year	X
Price per node	X
Nodes per rack	20
Price per rack [calculated]	X
Cores per node	24
Cost of hosting per rack per year	X
Effort spent on procurement & commissioning (weeks)	4
Effort spent on decommissioning (weeks)	2
System management team (weeks)	4
User support team (weeks)	0

# Real example cont'd

Year	Fraction
Hardware	55%
Electricity	12%
Cooling	2%
Datacenter	9%
Procure & Commission	3%
Decommissioning	1%
Sysadmin	20%
User support	0%
TOTAL	

Actual TCO/core-hour = 4.5 ¢

# Questions

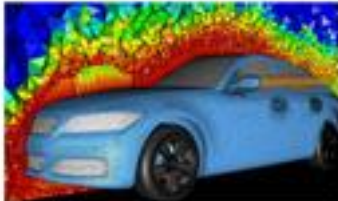
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