Intergenerational Embodied Carbon

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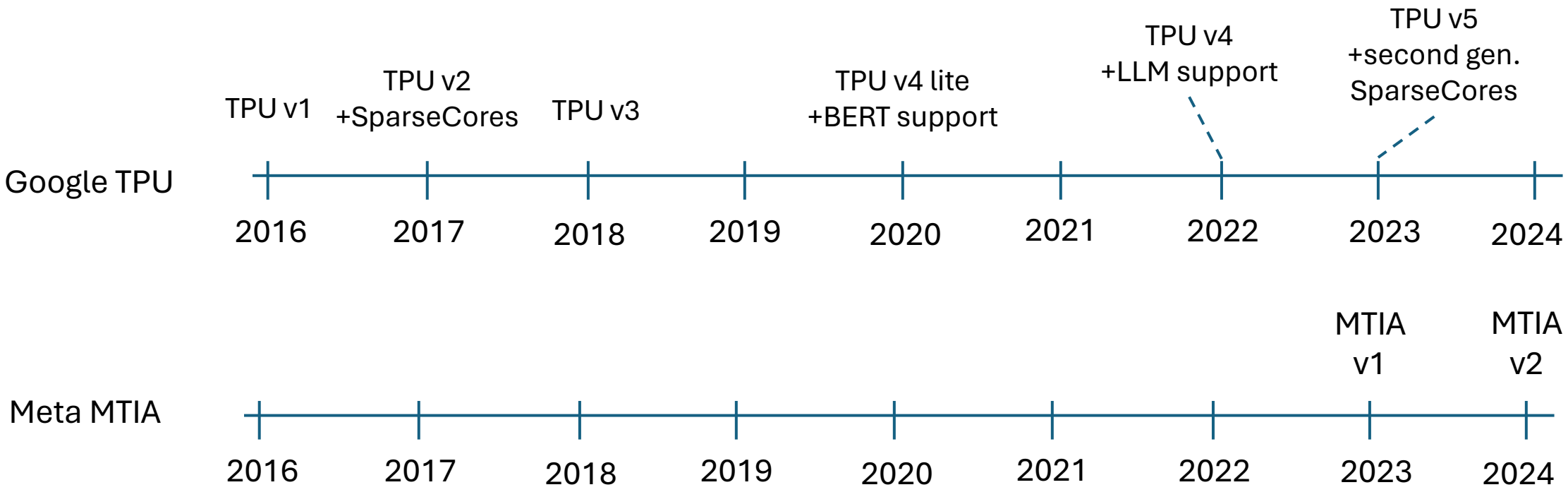
UNIVERSITY OF TORONTO

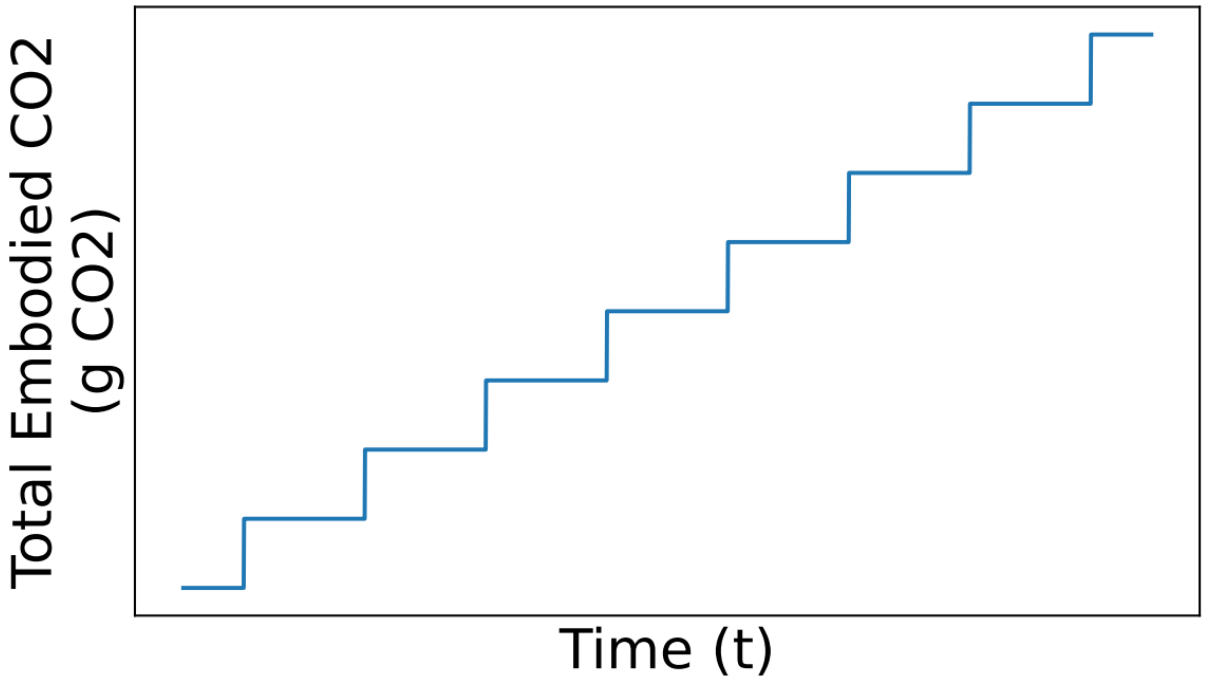
Accelerators Come in Families



- Companies are pushing new technology fast

Generations Create Carbon

- Carbon footprint consists of operational carbon *and* embodied carbon
- Even when a new generation reduces operational carbon, embodied carbon can only go up
- Companies have promised “net-zero” datacenters but ignore embodied carbon



New Chips are Not Always Environmentally Responsible

- Prior work[1] has characterized the carbon footprint of individual devices
- We propose a model that characterizes the return on “investment”
- If datacenters truly reach net-zero operational carbon, do designers still need to care about sustainability?

[1]ACT: designing sustainable computer systems with an architectural carbon modeling tool (Gupta et. Al), FOCAL: A First-Order Carbon Model to Assess Processor Sustainability (Eeckhout), ect.

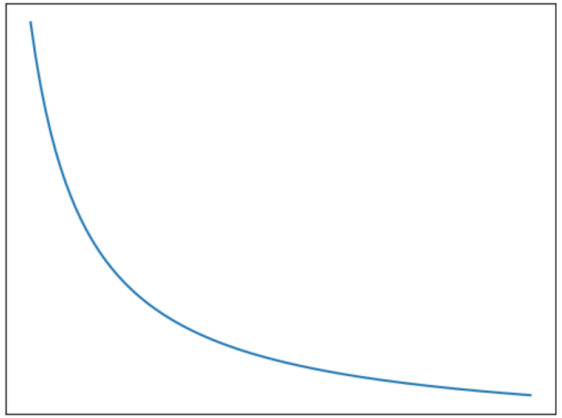
Amortizing a Chip Over Computations

- A chip will enable some amount of computations over its lifetime

- The enabled computations per gram embodied carbon goes down the longer a chip is in use

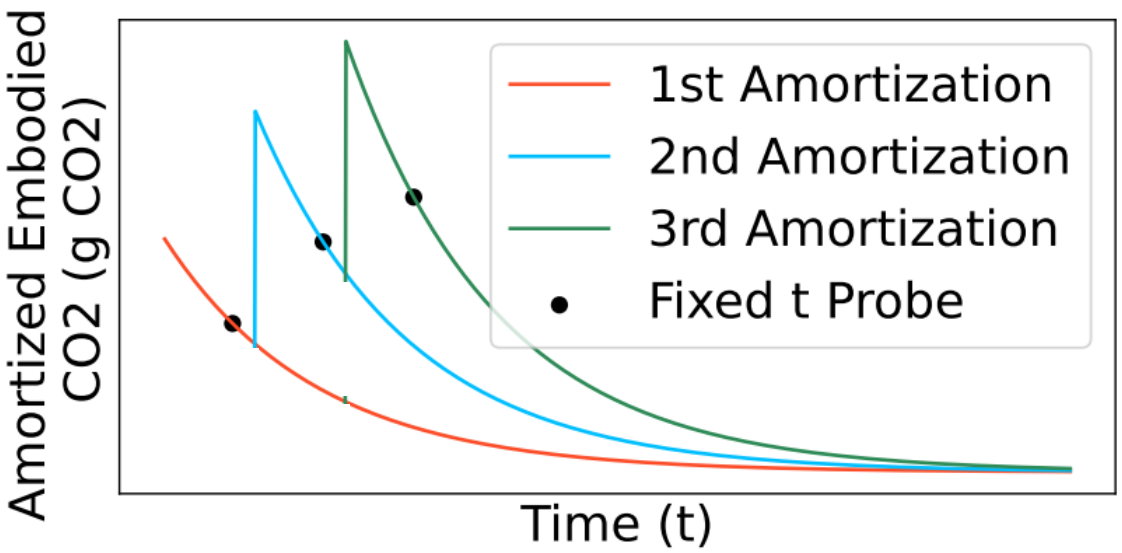
Term	Meaning
p	Performance (FLOP per unit time)
EC	Embodied Carbon footprint of the chip
t	Time the chip is in use

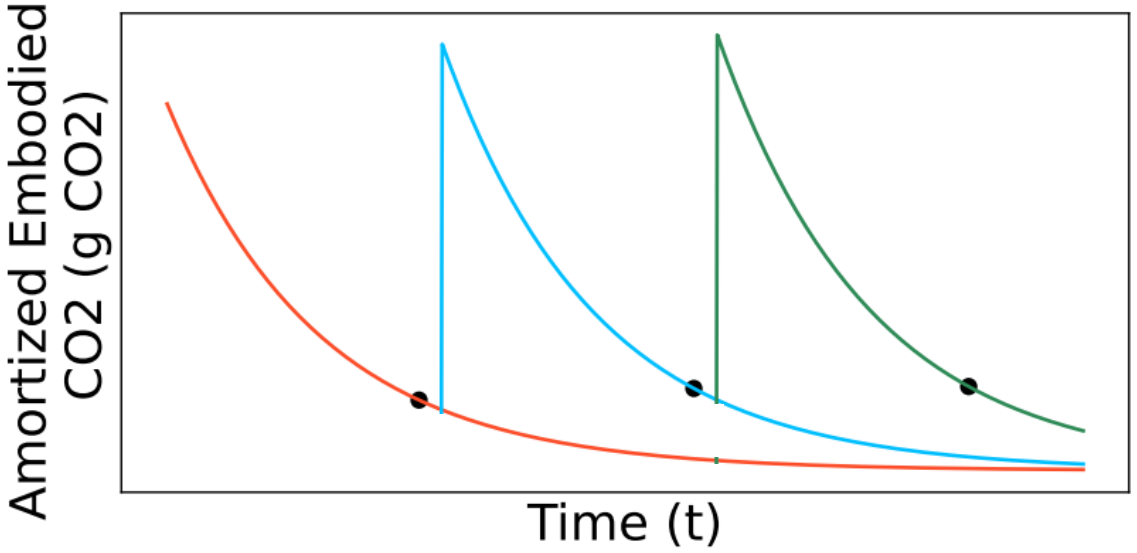
$$\frac{1}{p} \cdot \frac{EC}{t}$$



Amortizing Through Generations

- Future generations are an additional investment into the same computations





Conclusion

- Embodied carbon cost grows monotonically across generations
- Hyperscalers spend this cost in exchange for computations
- Are all computations worth this cost?
  - Are all *applications* worth this cost?

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