

Re: Moore's Law

村主崇行

京都大学

Jan 17, 2014

① Moore の法則の歴史

- 原典
- 3 年で 4 倍の初出
- Moore の法則・派生版

② Moore の法則再確認 2014

- 周波数
- 命令発行速度
- ピーク浮動小数点演算性能
- TOP500

Outline

1 Moore の法則の歴史

- 原典
- 3年で4倍の初出
- Moore の法則・派生版

2 Moore の法則再確認 2014

- 周波数
- 命令発行速度
- ピーク浮動小数点演算性能
- TOP500

原典

*The complexity for minimum component costs has increased at a rate of roughly **a factor of two per year**. Certainly over the short term this rate can be expected to continue, if not to increase. Over the longer term, the rate of increase is a bit more uncertain, although there is no reason to believe it will not remain nearly constant for at least 10 years. That means by 1975, **the number of components per integrated circuit** for minimum cost will be 65,000. I believe that such a large circuit can be built on a single wafer.*

— Gordon Moore, "Cramming more components onto integrated circuits",
Electronics Magazine 19 April **1965**

原典の価値

In April 2005, Intel offered US \$10,000 to purchase a copy of the original Electronics Magazine issue in which Moore's article appeared. David Clark, an engineer living in the United Kingdom had found the prized magazine under his floorboards and offer it to Intel.

David Clark had kept copies of the magazine for years, despite pleas from his wife to throw them away.

"I am really pleased about it because I studied physics and have always had interest in electronics. I could see the next 30 years were going to go like Moore's Law said, so I decided to go into electronics."



原典の価値

In April 2005, Intel offered US \$10,000 to purchase a copy of the original Electronics Magazine issue in which Moore's article appeared. David Clark, an engineer living in the United Kingdom had found the prized magazine under his floorboards and offer it to Intel.

David Clark had kept copies of the magazine for years, despite pleas from his wife to throw them away.

"I am really pleased about it because I studied physics and have always had interest in electronics. I could see the next 30 years were going to go like Moore's Law said, so I decided to go into electronics."



原典の価値

In April 2005, Intel offered US \$10,000 to purchase a copy of the original Electronics Magazine issue in which Moore's article appeared. David Clark, an engineer living in the United Kingdom had found the prized magazine under his floorboards and offer it to Intel.

David Clark had kept copies of the magazine for years, despite pleas from his wife to throw them away.

"I am really pleased about it because I studied physics and have always had interest in electronics. I could see the next 30 years were going to go like Moore's Law said, so I decided to go into electronics."



3 年で 4 倍の初出

"Moore also affirmed he never said transistor count would double every 18 months, as is commonly said. Initially, he said transistors on a chip would double every year. He then recalibrated it to every two years in 1975. David House, an Intel executive at the time, noted that the changes would cause computer performance to double every 18 months."

— Michael Kanellos, 2011

His prediction has proven to be accurate, in part because the law is now used in the semiconductor industry to guide long-term planning and to set targets for research and development.

— Disco and Meulen (1998).

Moore の法則・派生版

- **Transistor per integrated circuit** .
- **Computation speed** of a single chip.
- **Computation speed** of the world's fastest supercomputer .
- **Hard disk capacity per cost** roughly doubles in 18 months.
- **Network cable capacity** doubles every nine month.
- **Pixel per dollar** of a digital camera.
- The great Moore's law compensator: **Computation resource per given task** of Microsoft Office.

Outline

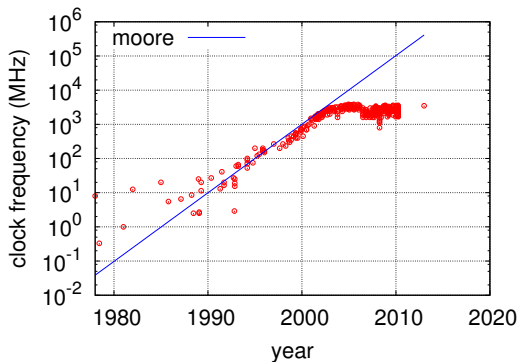
1 Moore の法則の歴史

- 原典
- 3年で4倍の初出
- Moore の法則・派生版

2 Moore の法則再確認 2014

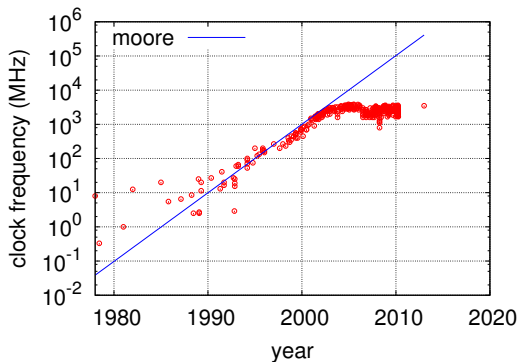
- 周波数
- 命令発行速度
- ピーク浮動小数点演算性能
- TOP500

周波数



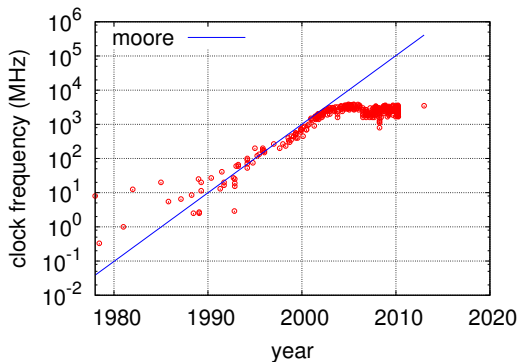
- '00 年代前半にサチった。
- 「Free lunch is over」「失われた 10 年」

周波数



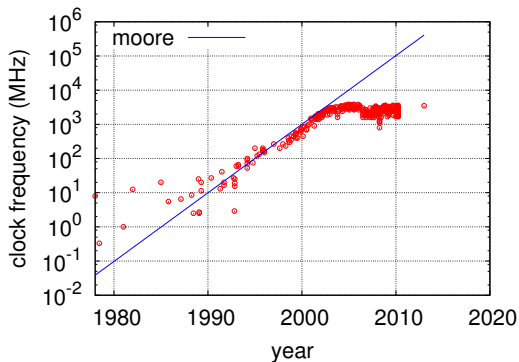
- '00 年代前半にサチった。
- 「Free lunch is over」「失われた 10 年」

周波数



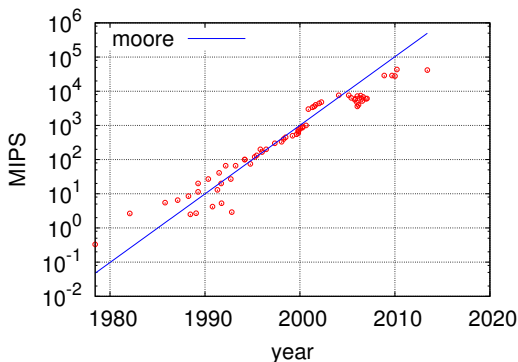
- '00年代前半にサチった。
- 「Free lunch is over」「失われた10年」

周波数



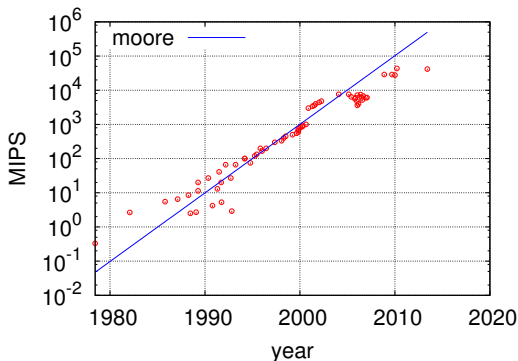
- '00 年代前半にサチった。
- 「Free lunch is over」「失われた 10 年」

命令発行速度



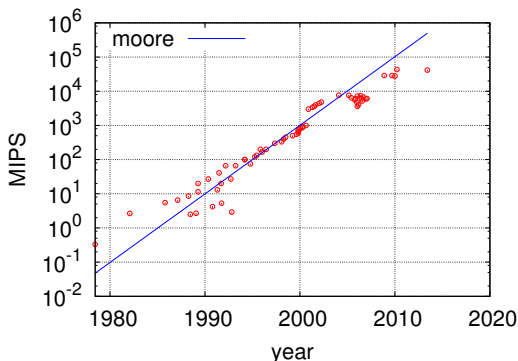
- MIPS = 1 秒に 100 万命令発行できる能力 (Mega Instructions Per Second)
- スレッド数 (含 HT) \times 周波数
- これも 2010 年ころには伸びに翳りが。

命令発行速度



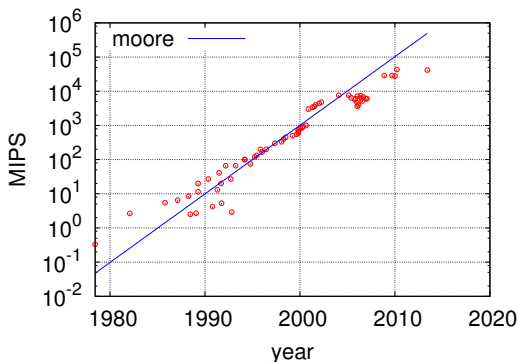
- MIPS = 1 秒に 100 万命令発行できる能力 (Mega Instructions Per Second)
- スレッド数 (含 HT) × 周波数
- これも 2010 年ころには伸びに翳りが。

命令発行速度



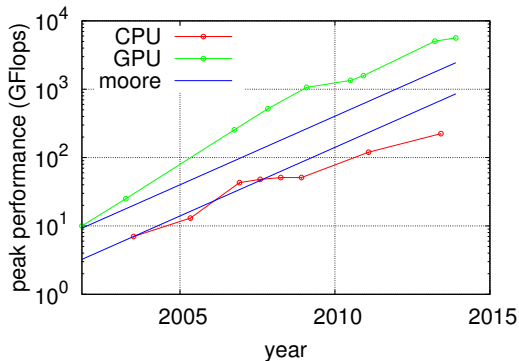
- MIPS = 1 秒に 100 万命令発行できる能力 (Mega Instructions Per Second)
- スレッド数 (含 HT) × 周波数
- これも 2010 年ころには伸びに翳りが。

命令発行速度



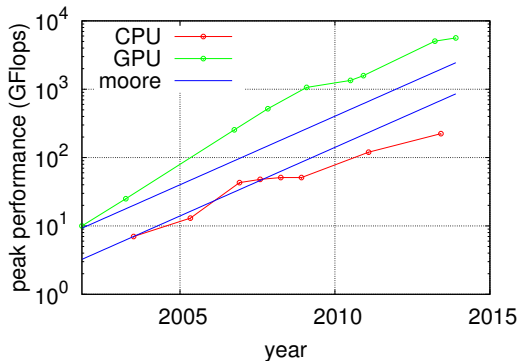
- MIPS = 1 秒に 100 万命令発行できる能力 (Mega Instructions Per Second)
- スレッド数 (含 HT) \times 周波数
- これも 2010 年ころには伸びに翳りが。

ピーク浮動小数点演算性能



- CPU はやはり脱落気味？
- GPU は「Supermoore」と言って宣伝していたが...

ピーク浮動小数点演算性能



- CPU はやはり脱落気味？
- GPU は「Supermoore」と言って宣伝していたが...

TOP500

