

# Multicore Computing

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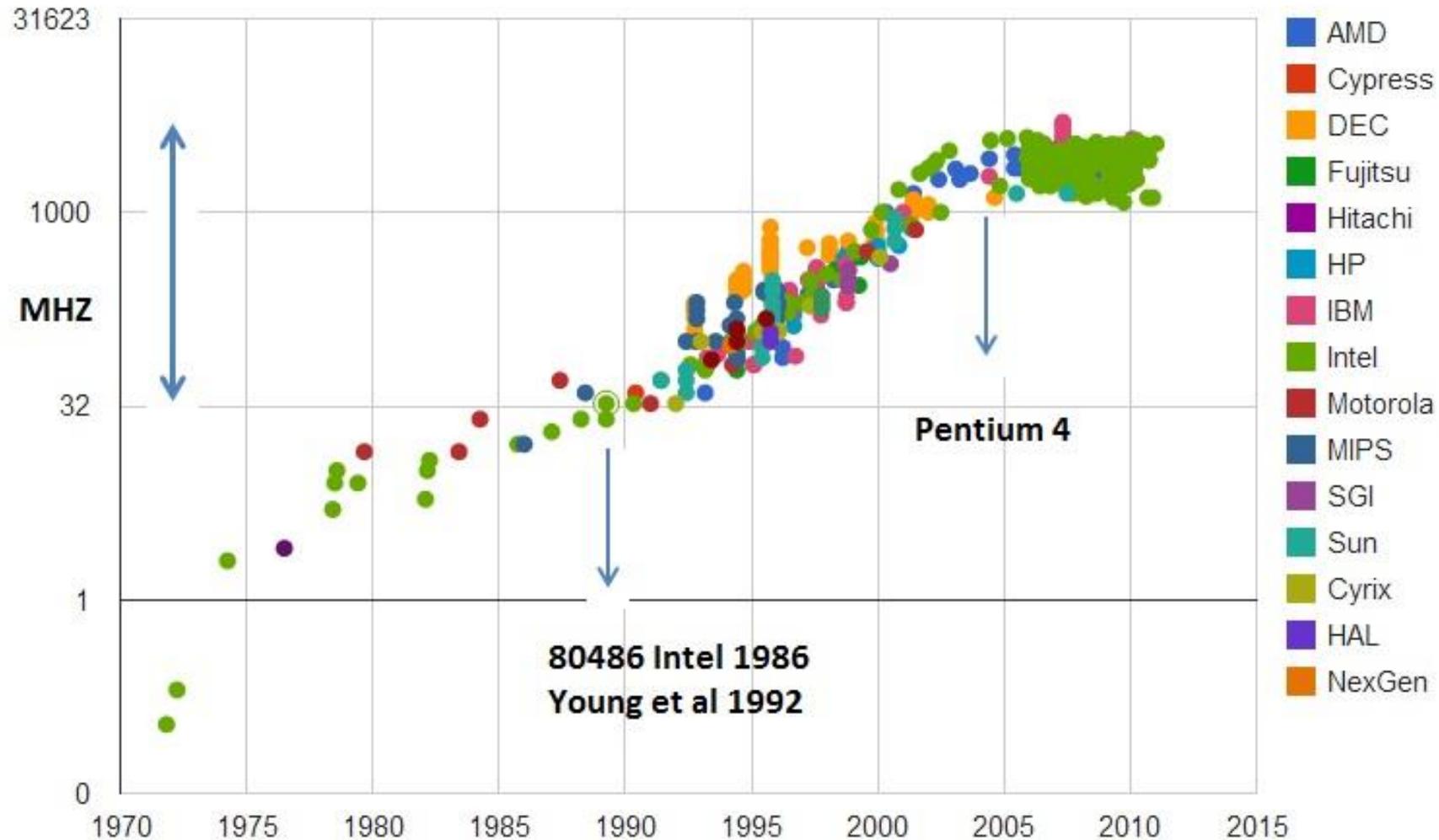
“Premature optimization is the root of all evil”

--- Sir Tony Hoare

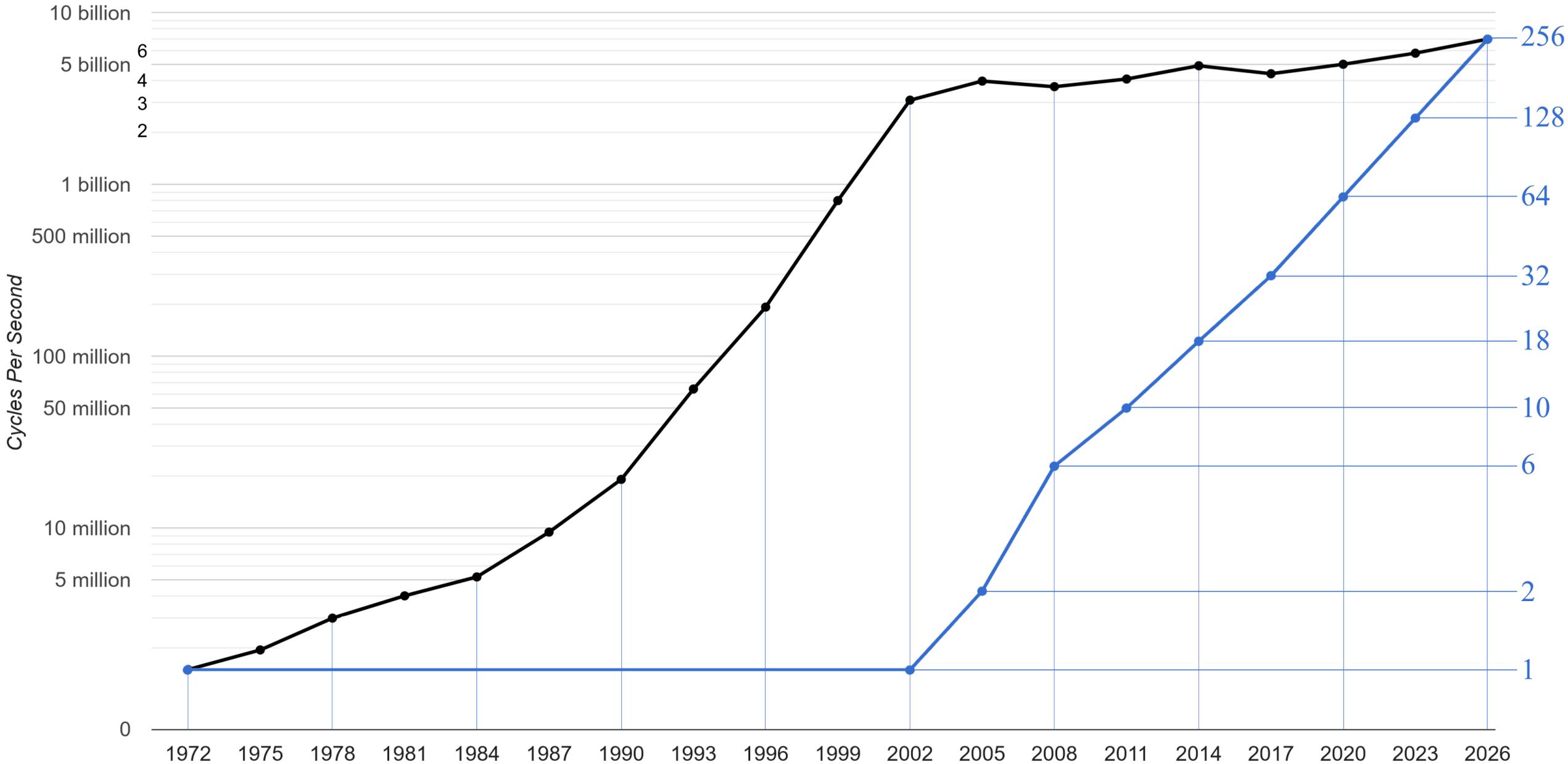


# CPU Clock Rate

Now our CPU clock is still around 2-3 GHz



# CPU Clock Rate + Core Count (Including "boost clock" and server core count, but no overclocking) (In Log)

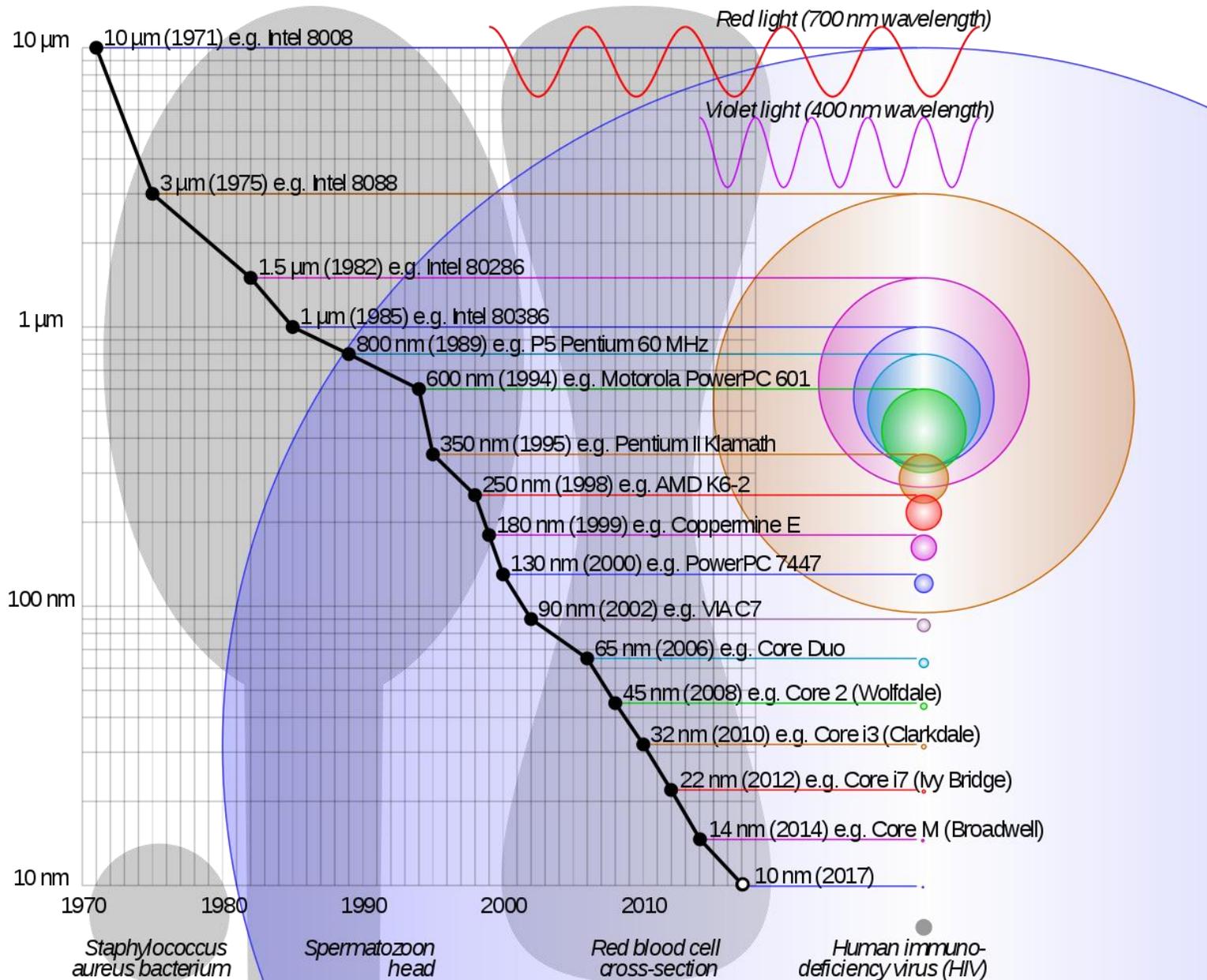


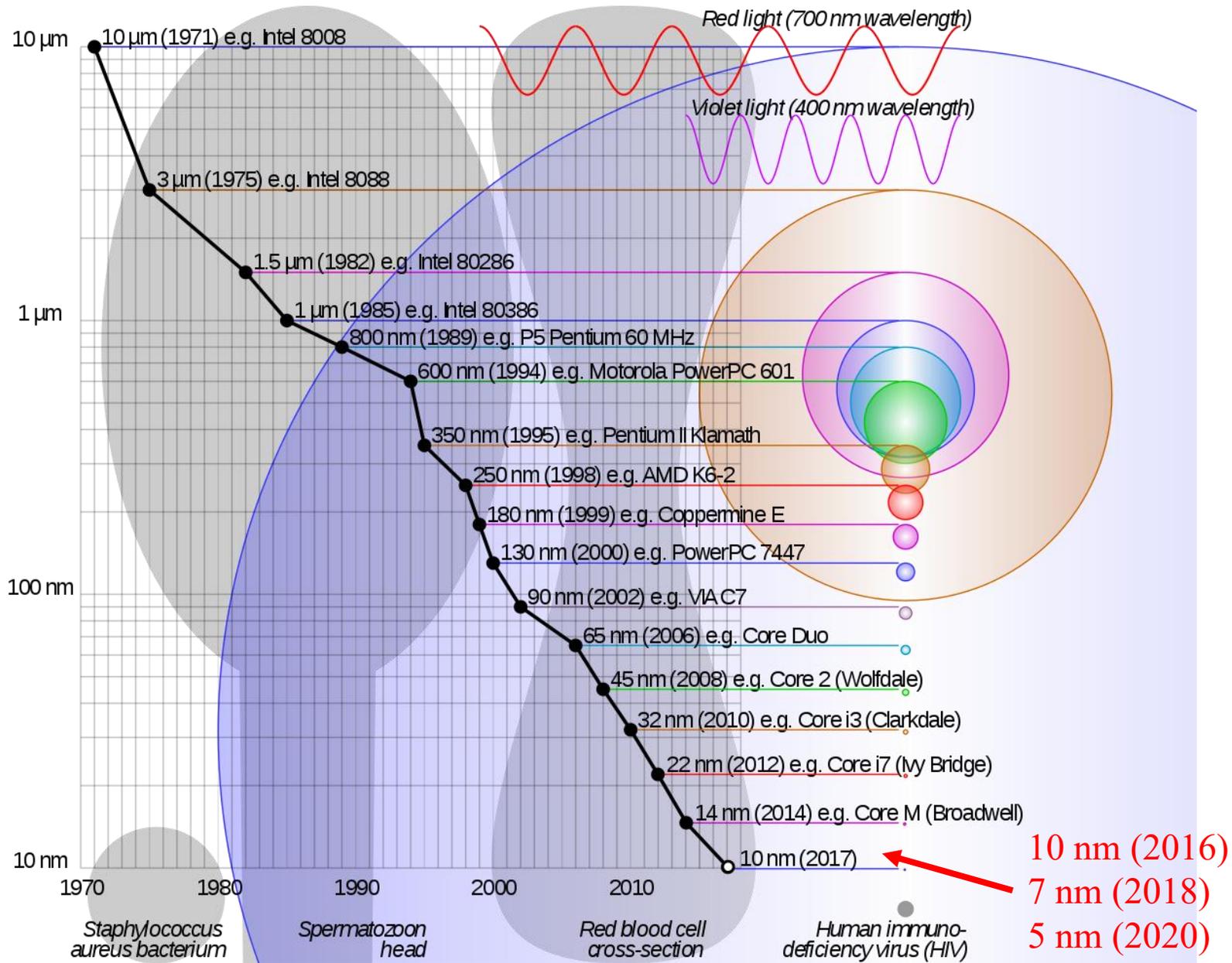
Source: <https://www.singularity.com/charts/page61.html> 1976- 1998 "Microprocessor clockspeed" (modified) | 1999-2026 Manufacturer specifications

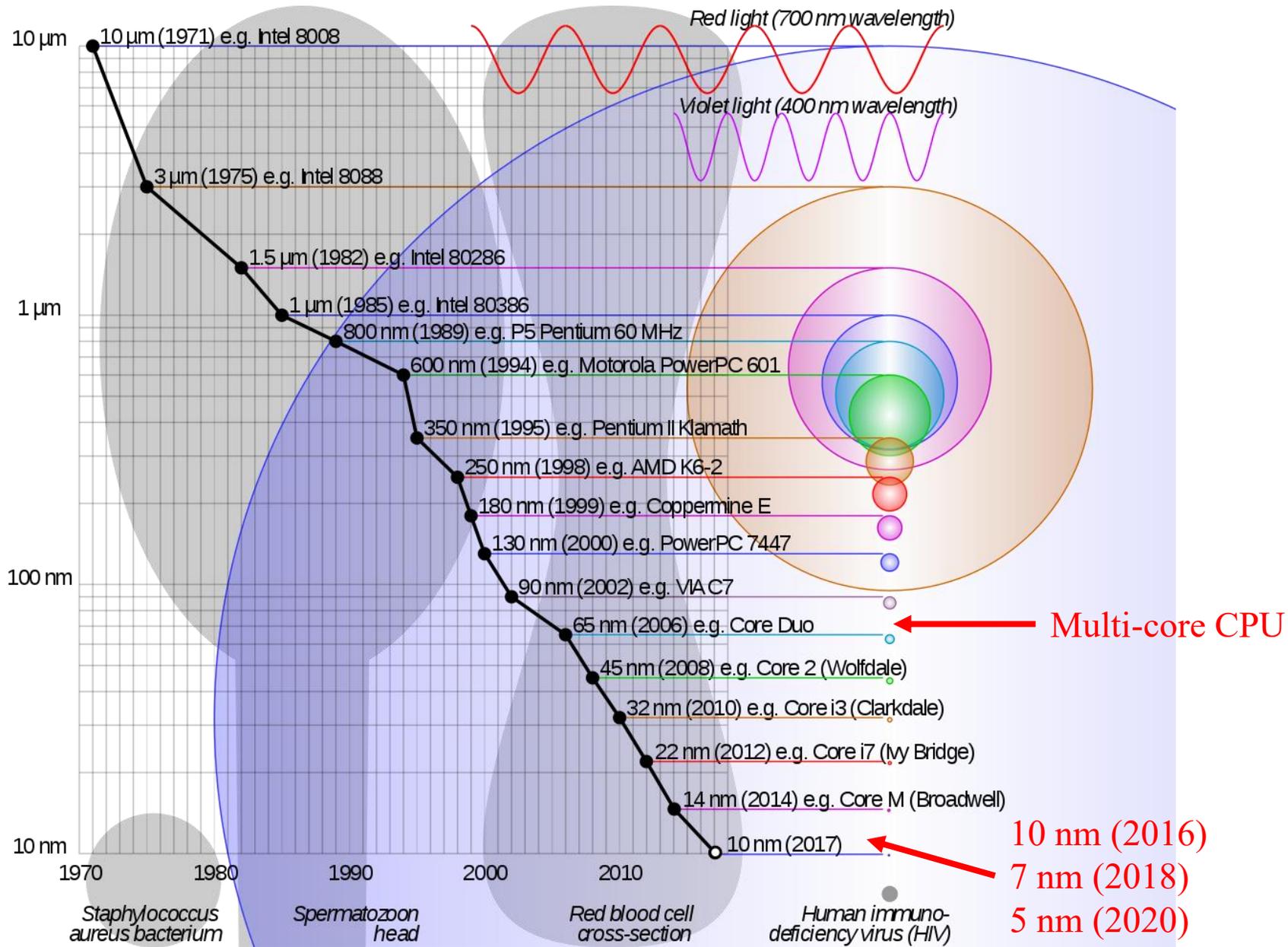
Method: Fastest / heighest (not coupled) core count CPU released (1999-2024) 2026 - Leaks + conservative prediction

# Why the Clock Rate Does Not Increase?

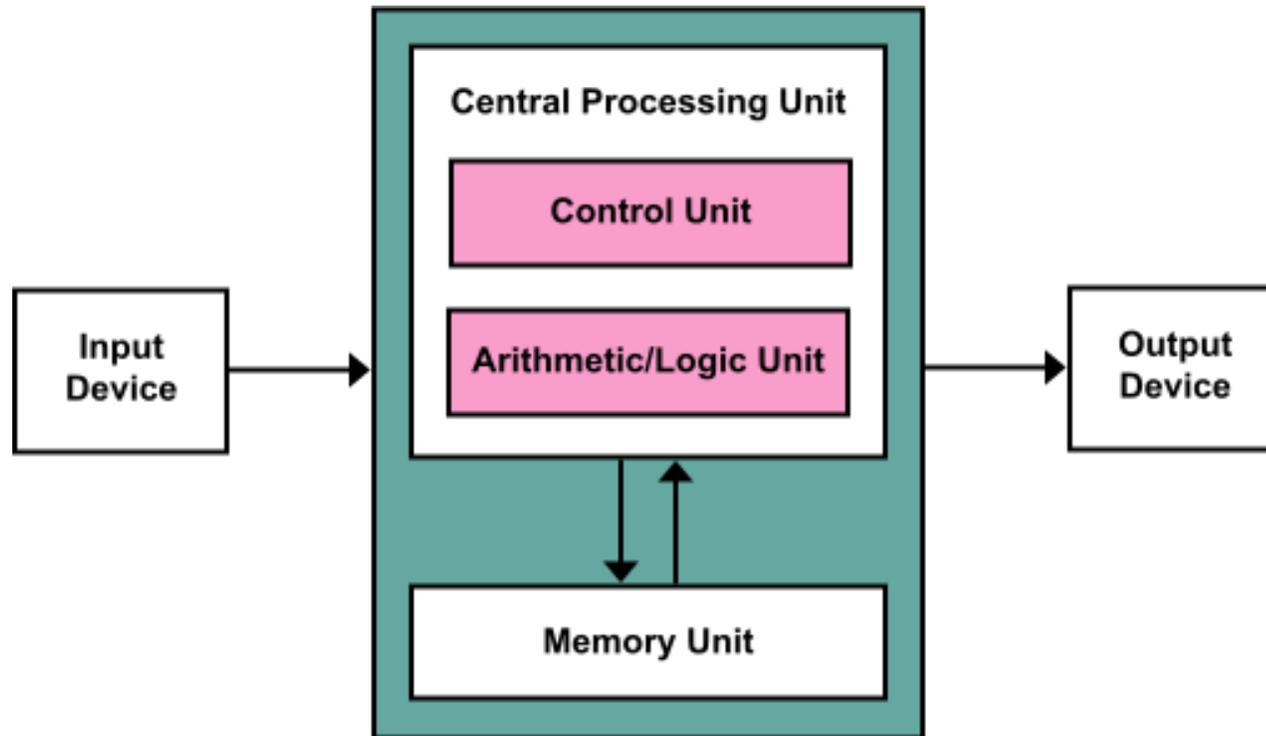
- Power density becomes extremely high
- Heating







# Major Components of a CPU



# Execution of Instructions

- Instruction Fetch
- Instruction Decode
- Memory Access
- Register Writeback

# Execution of Instructions

- Instruction-level parallelism
- SIMD Intrinsics
- Hyper-Threading
- Out-of-order-execution
- Branch Prediction
- Meltdown

# Threads

- Process Control Block
  - Process structuring information
  - Process State
  - Process Number (PID)
  - Program Counter (PC)
  - CPU Registers
  - Memory Management Information
  - Accounting Information
  - I/O Status Information
  - ...

# Thread Scheduling

- Context Switching
  - Save/Load PCB
- Thread Pool

# OpenMP: Quick Start

```
#pragma omp parallel for schedule(static) num_threads(8)
for (int i = 0; i < N; ++i) {
    b[i] = a[i] + 1;
}
```

# OpenMP: Quick Start

```
int sum = 0;
```

```
#pragma omp parallel for schedule(static) reduction(+:sum) num_threads(8)
```

```
for (int i = 0; i < N; ++i) {
```

```
    sum += a[i];
```

```
}
```

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