MOORE'S LAW AND THE DIMININSHING IMPORTANCE OF PARALLEL COMPUTING

- Moore's Law
- Production Code Cycles/Priorities
- Consequences for Parallelism
- The Evidence

MOORE'S LAW (1965)

Nr. of Transistors/Area: Doubles Every 18 Months ⇒ Speed/Memory Grows 1:10 Every 5 Years

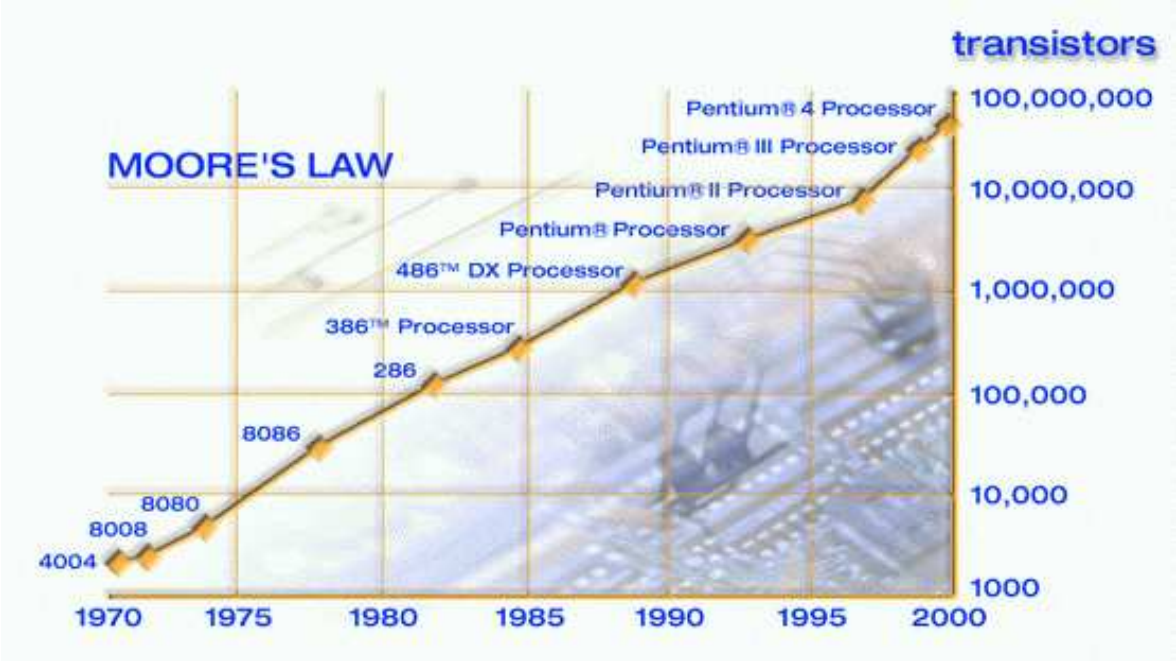

Figure 1 Growth of Transistors per Area/Chip

LIFECYCLE OF PRODUCTION CODES

- Conception
  - Define Purpose, Physics, Numerics
- Demonstration/Proof of Concept
  - Compare Large-Scale Runs to Experiments
  - Runtime: Days/Weeks
  - Critical Item: Credibility
- Production Code (Industrialization)
  - Benchmarking
  - Quality Assurance
  - Versions, Manuals, etc.
  - Critical Item: Options/Generality
- Widespread Use (Market Penetration)
  - Standard/Legacy Code
  - Critical Item: Options/Ease of Use

RUNTIMES/PARALLELISM AND LIFECYCLE

- Years 1:5: Conception
  - Runtime: Weeks
  - Machine: Largest Available DMP
  - Nproc: 10^4 [Parallelism Essential]
- Years 6:10: Demonstration
  - Runtime: Days
  - Machine: Large DMP/SMP
  - Nproc: 10^3 [Parallelism Important]
- Years 10:15: Production
  - Runtime: Hours
  - Machine: Large SMP
  - Nproc: 10^2 [Parallelism Required]
- Years 15:20: Widespread Use
  - Runtime: Minutes
  - Machine: SMP
  - Nproc: 10^1 [Parallelism Advantageous]
- Years 20:25: Standard/Legacy Code
  - Runtime: Seconds
  - Machine: PC
  - Nproc: 10^0 [Parallelism Insignificant]

EVIDENCE 1: CRASH SIMULATIONS

Requirements:

- Transient, Large Deformation CSD
- $O(10^5 - 10^6)$ Elements (Shells, Beams)
- $O(10^5 - 10^6)$ Timesteps

Life Cycle:

1960's: DYNA3D Impact Code from LLNL
1970's: Demonstration Runs for Cars
1980's: Production Codes (Industrialization)
1990's: Widespread Use
2000's: Thousands of Runs a Day on PC

EVIDENCE 2: EXTERNAL MISSILE AERO

Requirements:

- Steady, Euler CSD
- $O(10^6 - 10^7)$ Elements
- $O(10^3 - 10^4)$ Timesteps

Life Cycle:

1970's: Demonstration Runs at NASA
1980's: First Production/Legacy Codes
1990's: Widespread Use
2000's: Thousands of Runs a Day on PC