Threads

2/7/25

Thread

- Unit of program execution
  - has own program counter, stack, etc
- All threads of a process share address space
  - same global variables, state of open files etc

Moore's law

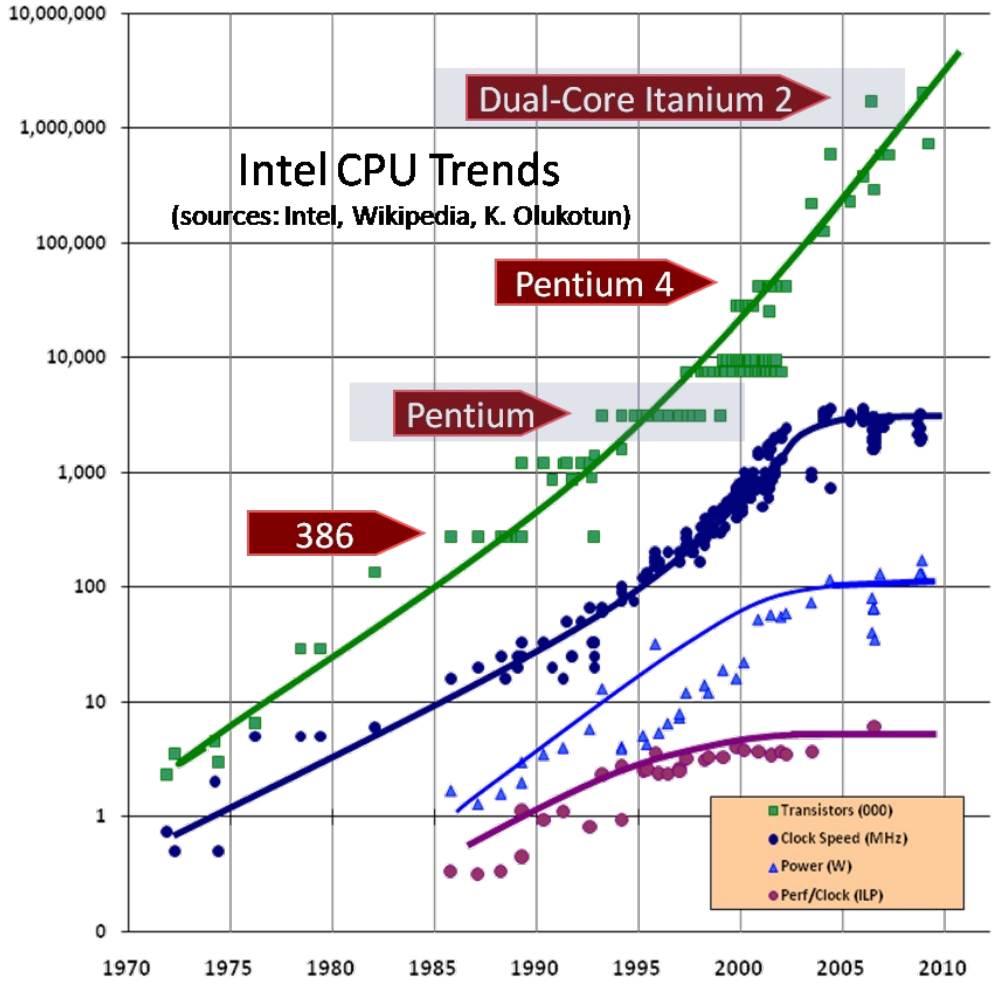
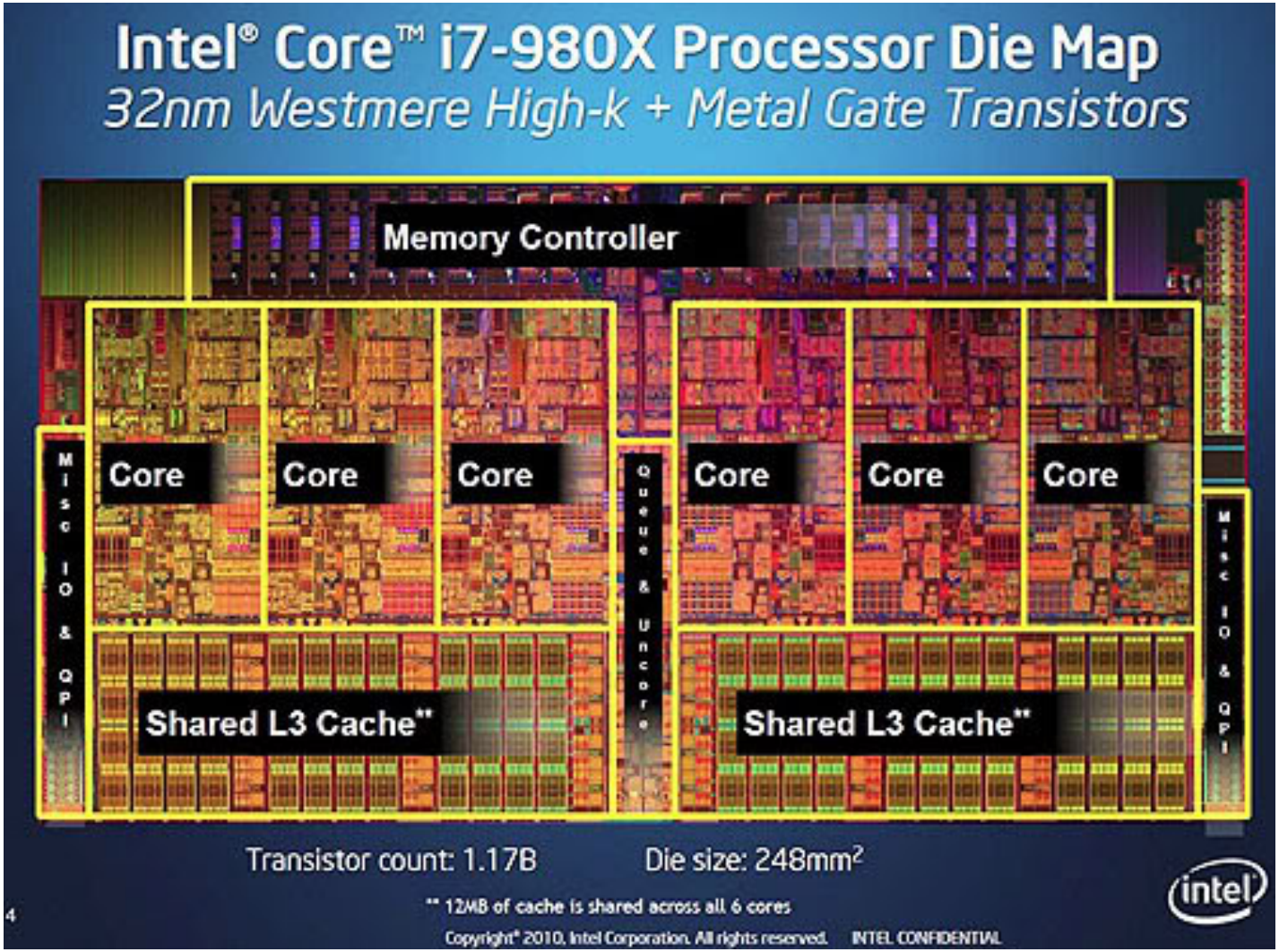


Figure: Herb Sutter "The free lunch is over: A fundamental turn toward concurrency in software" Dr. Dobb's Journal, 30(3), March 2005. http://www.gotw.ca/publications/concurrency-ddj.htm

How hot is your CPU?

- https://www.youtube.com/watch?feature=player_detailpage&v=7uBNCN6v_gk#t=30

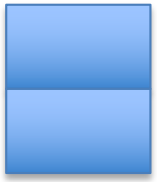
Parallel computing in the small



http://i561.photobucket.com/albums/ss59/gamenews86/Die_Map.jpg

Why have multiple threads?

- Performance
  - run like this



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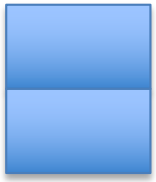
  - run like this 

    instead of this 
- Responsiveness
  - one thread runs user interface while others compute in background (ex: mobile platforms, web servers)

Two relevant concepts

- Parallelism
  - Using more resources to complete job faster
  - Ex: multiple cooks splitting food prep
- Concurrency
  - Managing access to shared resources
  - Ex: two cooks both trying to get dish into oven

Situation: You call a professor to see if they are free to meet. They say “yes”, but another student is in their office by the time you get there.

Is this situation an example of an issue with parallelism or concurrency?

A. Primarily parallelism
B. Primarily concurrency
C. Equally both
D. Neither
E. What are we talking about again?

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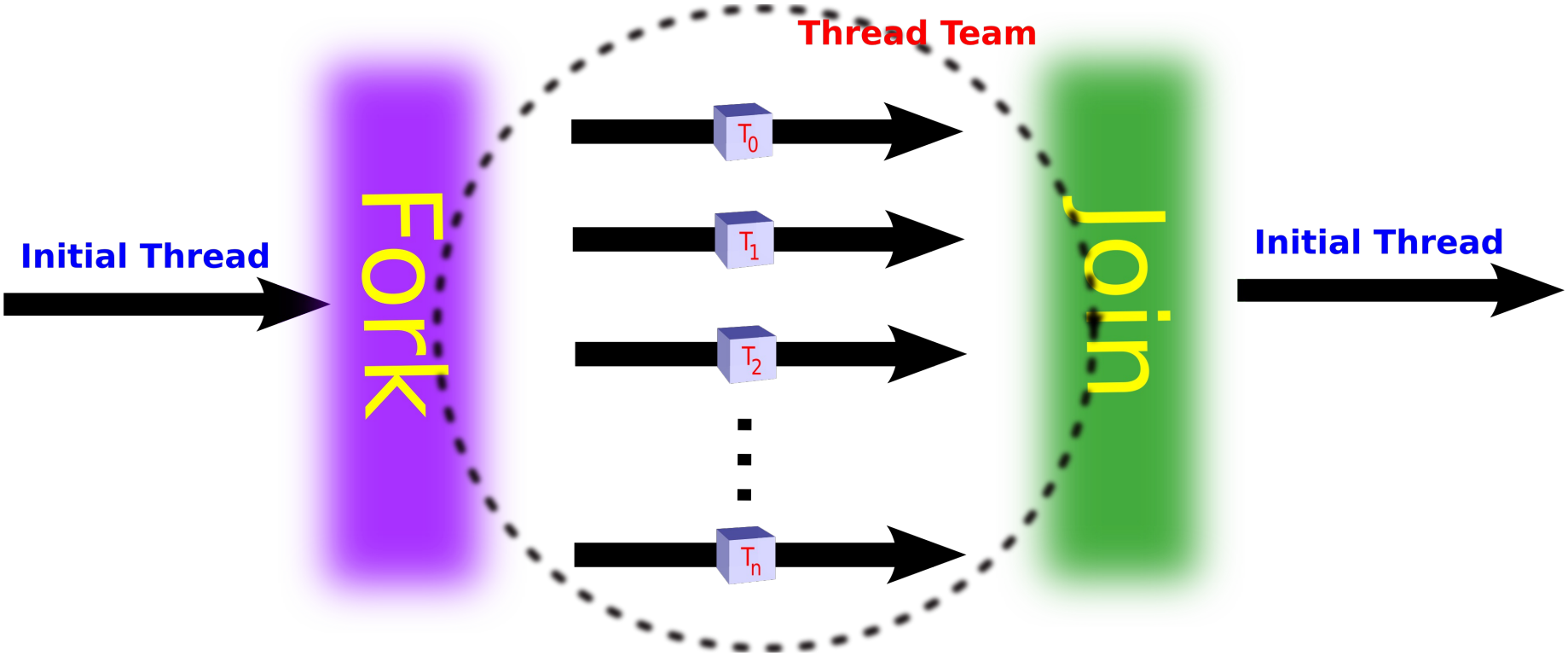
Fork-join pattern



http://cnx.org/contents/66607f05-723f-47b7-a3ef-0c1f17ee00ee@7.1:6/An_Introduction_to_High-Perfor

How do we do this in C?

- pthreads:

  pthread_create(pthread_t, NULL, function, arg)

  pthread_join(pthread_t, NULL)

Using threads for parallelism

- Move code for thread into a function
- Create a struct to hold arguments
- Make threads and pass appropriate structs
- Cast arguments from void*
- Join threads
- Cast return values from void*

Speedup

$$\text{Speedup} = \frac{\text{Serial (non-parallel) running time}}{\text{Parallel running time}}$$

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- Linear speedup: speedup equal to the number of processing elements
- Sublinear speedup: less than this
- Superlinear speedup: more than this

Is speedup a topic related to parallelism or concurrency?

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Why not linear speedup? (1)

- Some parts of the code can't run in parallel
  - Initialization
  - I/O
  - critical sections: areas where we ensure at most one thread is running

Why not linear speedup? (1)

If B = fraction of program that must run serially

T_1 = total time on 1 processing element

What is best possible time on p elements?

A. $T_1/p + B$

B. $T_1 B/p$

C. $T_1(1-B)/p + B$

D. $T_1(1-B)/p + T_1 B$

E. None of the above

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