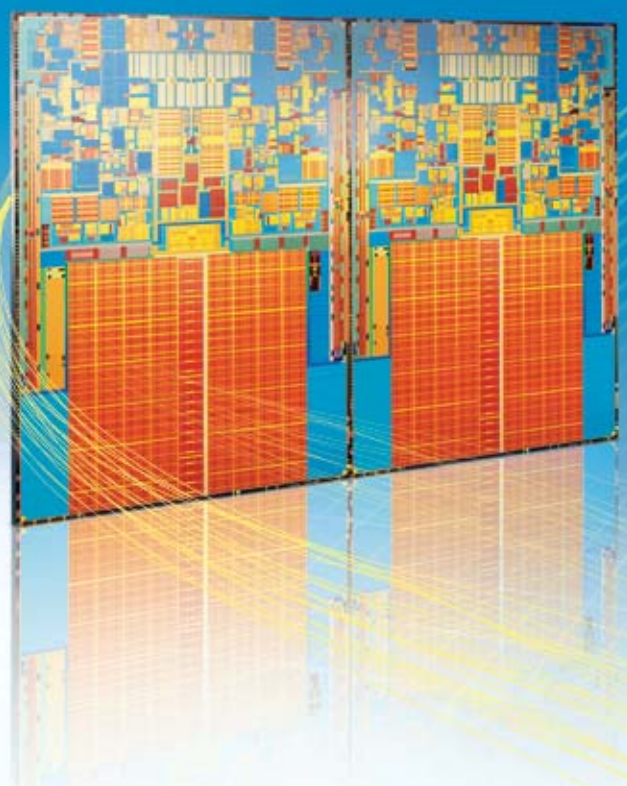
Game Threading Strategies for Next Generation Intel® Microarchitecture (Nehalem) Based Platforms



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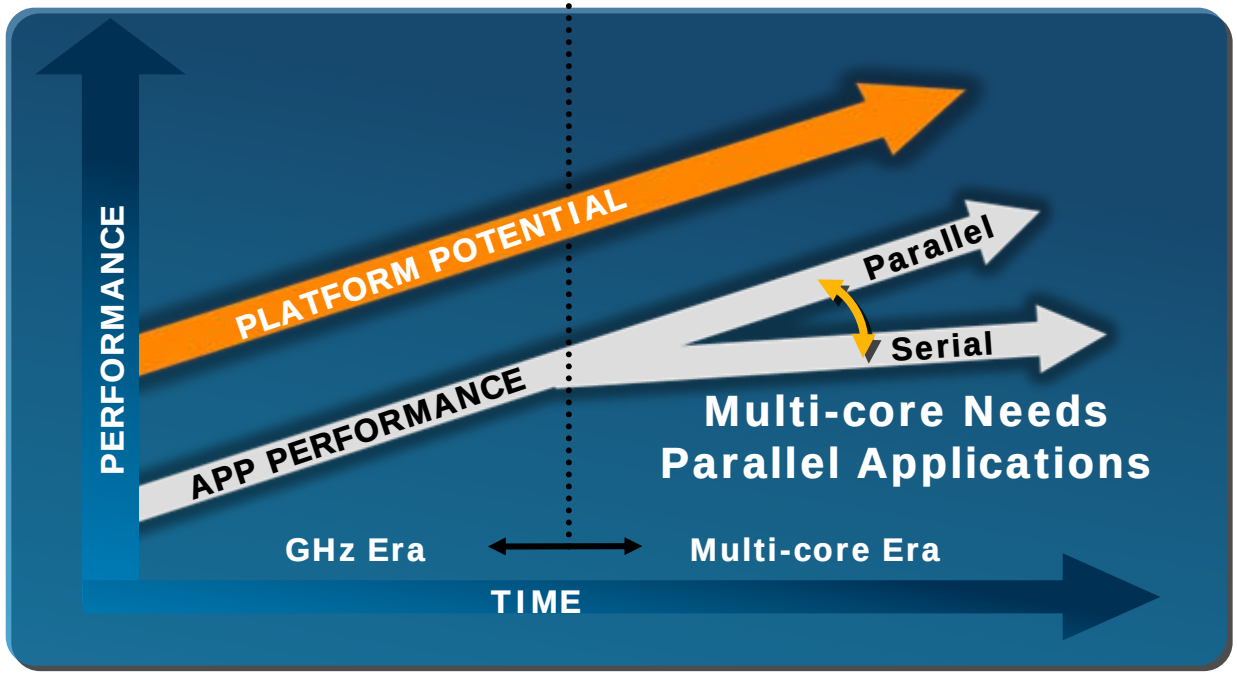
Tech Lead

VCTS002

Agenda

- Challenge
- Introducing Smoke
- Smoke Overcomes the Challenge
- Applying Smoke to Nehalem

Challenge



- The number of cores is increasing
- To really maximize performance and features, a game needs to fully utilize the CPU
- However, threading can be difficult

Threading games is hard, but worthwhile

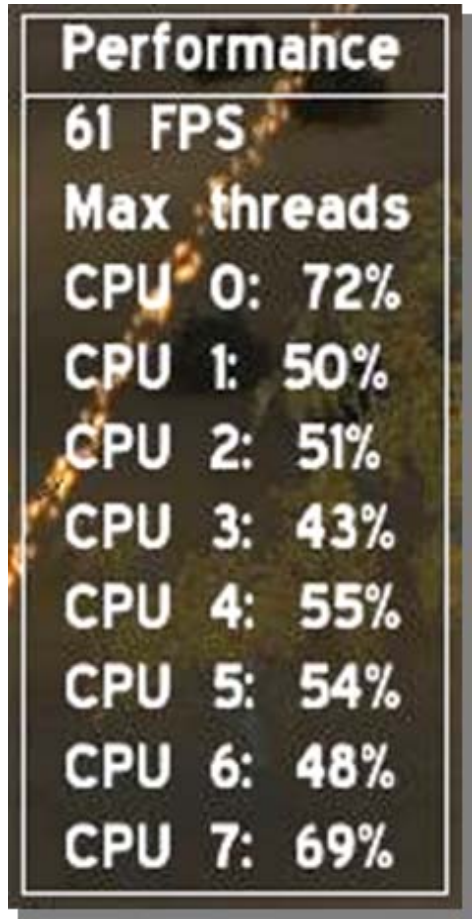
Smoke

A game framework that maxes the CPU

- Framework built by Intel for N-threads
- Demo uses real game technologies (Havok, FMOD, Ogre3D, DX9, etc.)
- Well partitioned and configurable

Why Smoke?

- Performance
  - Framework was designed to scale to N-threads
  - Discover game architectures that run well with 8 or more threads
- Prototype
  - Well partitioned and configurable
  - Easy to explore new game tech (e.g. procedural fire/smoke)
- Explore
  - Examine threading techniques
  - Understand interaction between systems
- Teach
  - Share source, demos, samples, workloads, white papers

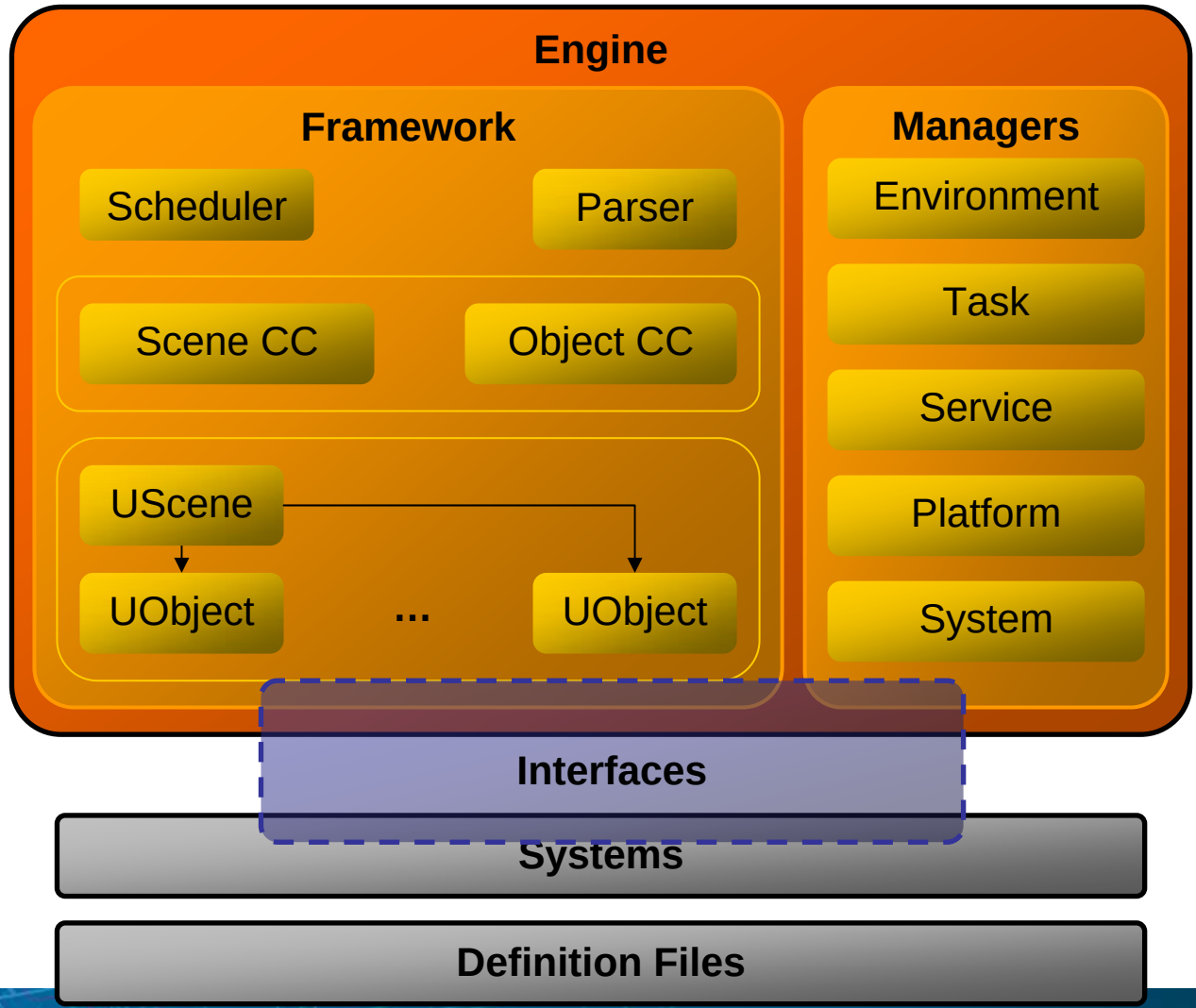


Smoke can show you how to thread effectively

The Framework

How is the Smoke highly threaded?

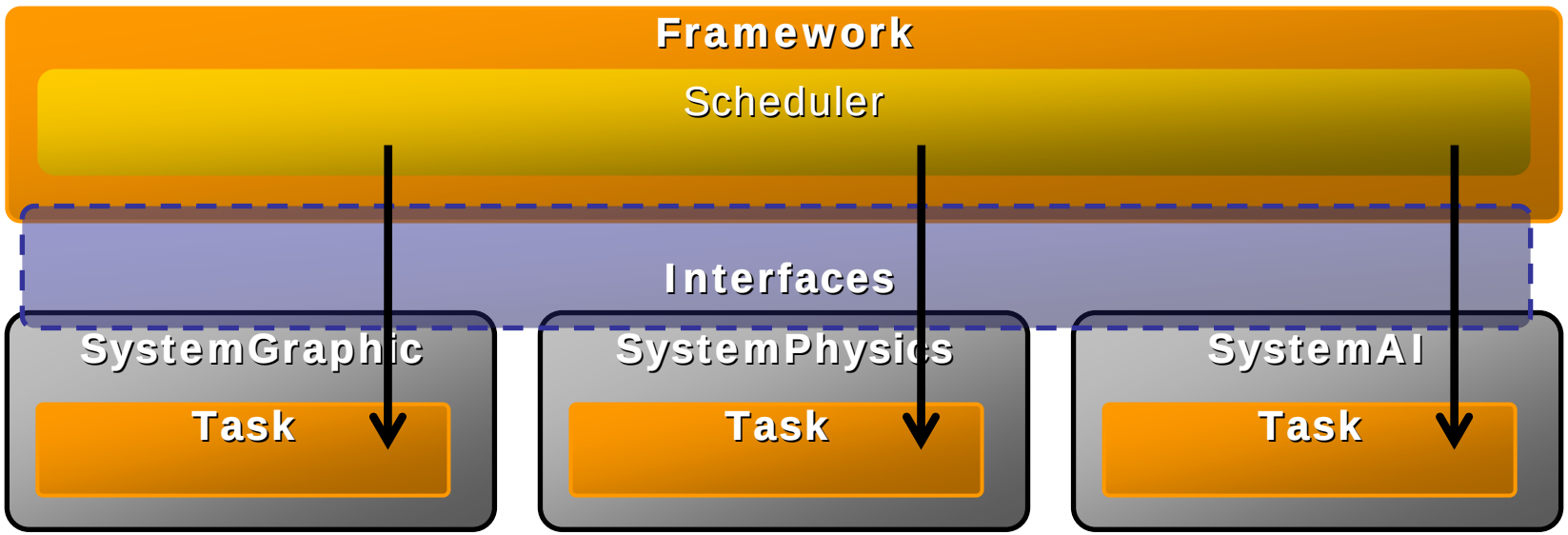
1. Scheduler manages System jobs
2. Change Control Manager minimizes thread synchronization
3. Data structured to support independent processing
4. System modularity (through interfaces)
5. Systems are specific to the demo (e.g. AI, physics, etc)



Key Design

1. Scheduler manage System Jobs

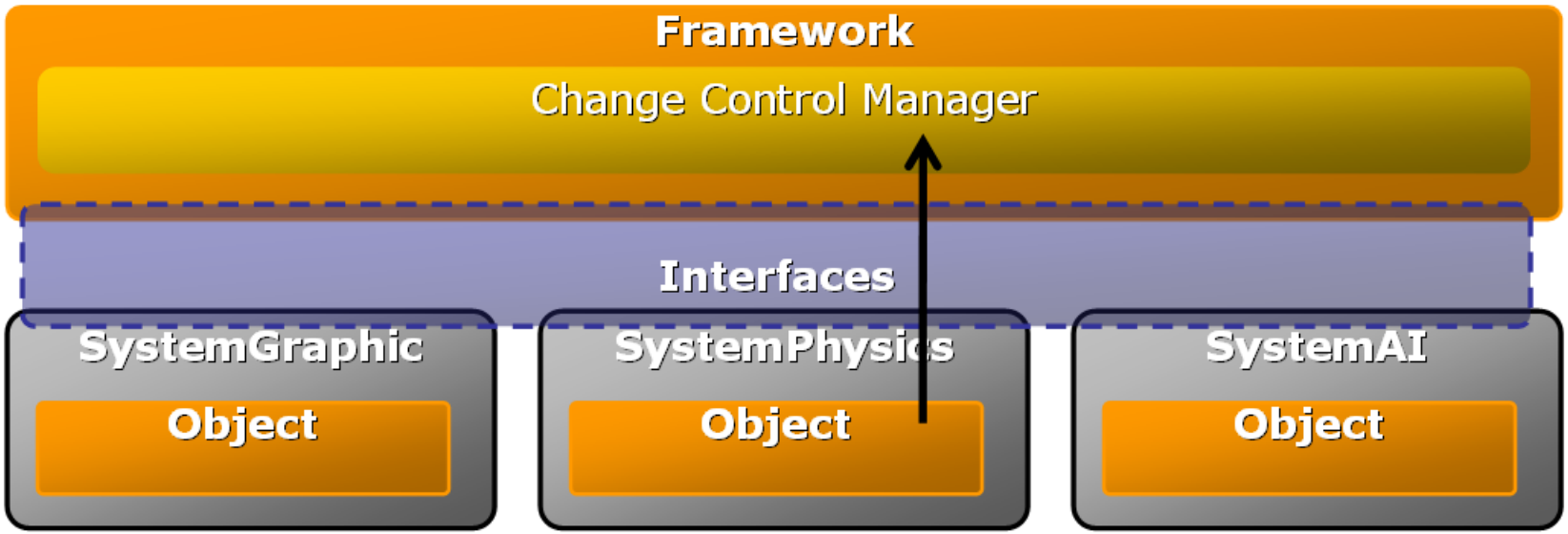
- Each System is a DLL
- Each component implements the proper interfaces to interact with the Framework (interfaces are just pure virtual base classes)
- The Scheduler will invoke the task for each system once a frame



Key Design

2. Change Control Manager minimize thread sync

- Data is shared between the Systems with the Change Control Manager.
- If one System changes an Object within a System all Systems with a matching Object will be notified about the change.
- This allows Systems to work independently.



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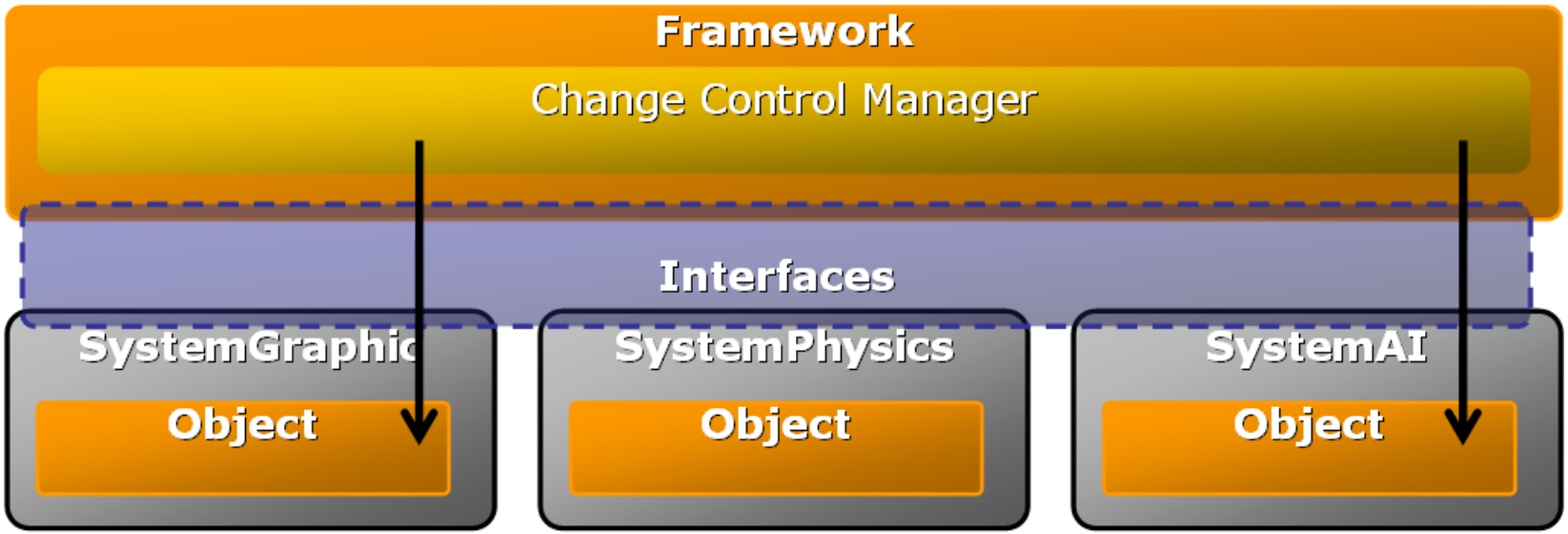
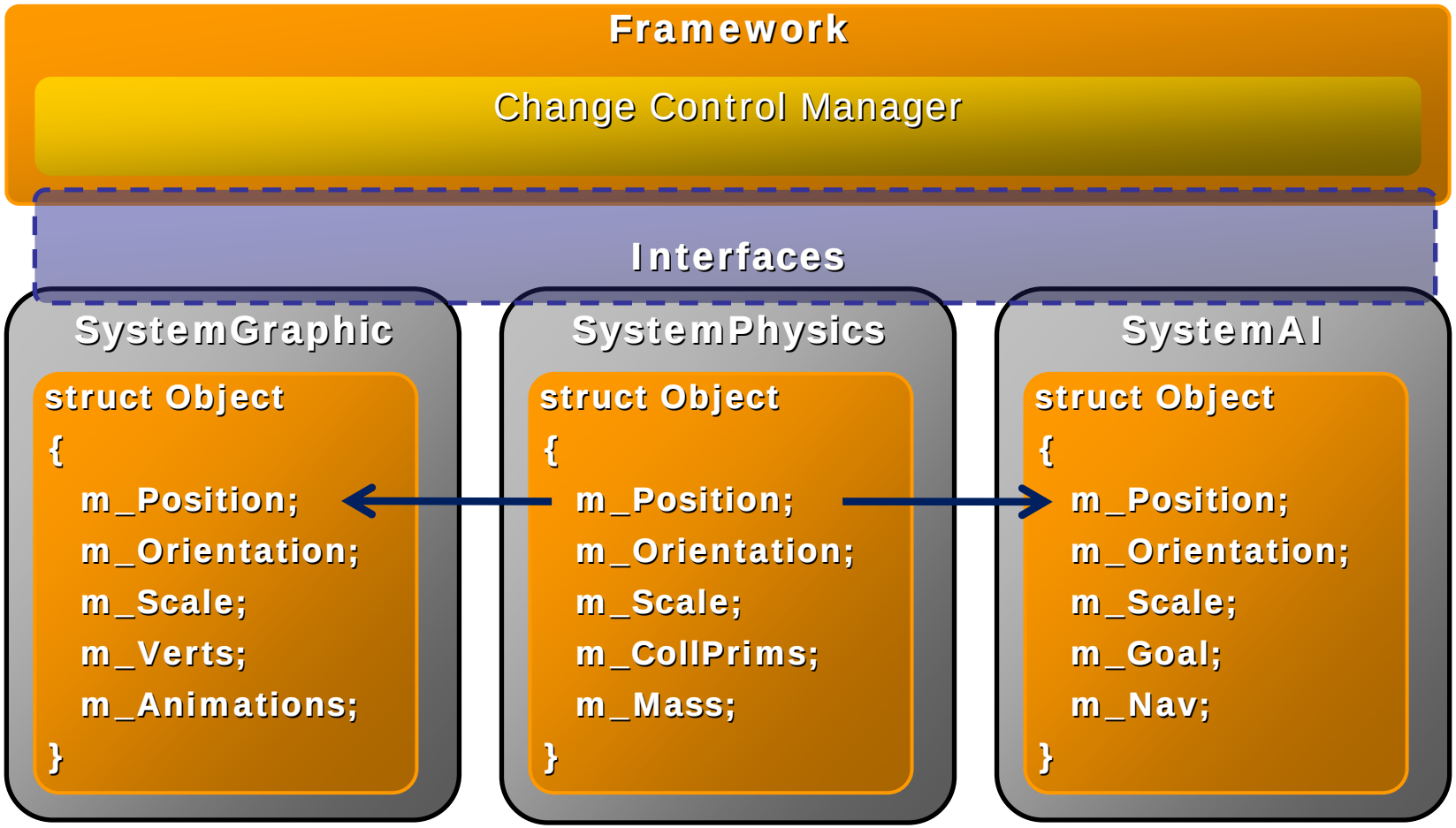


Key Design

3. Data structure to support independent processing

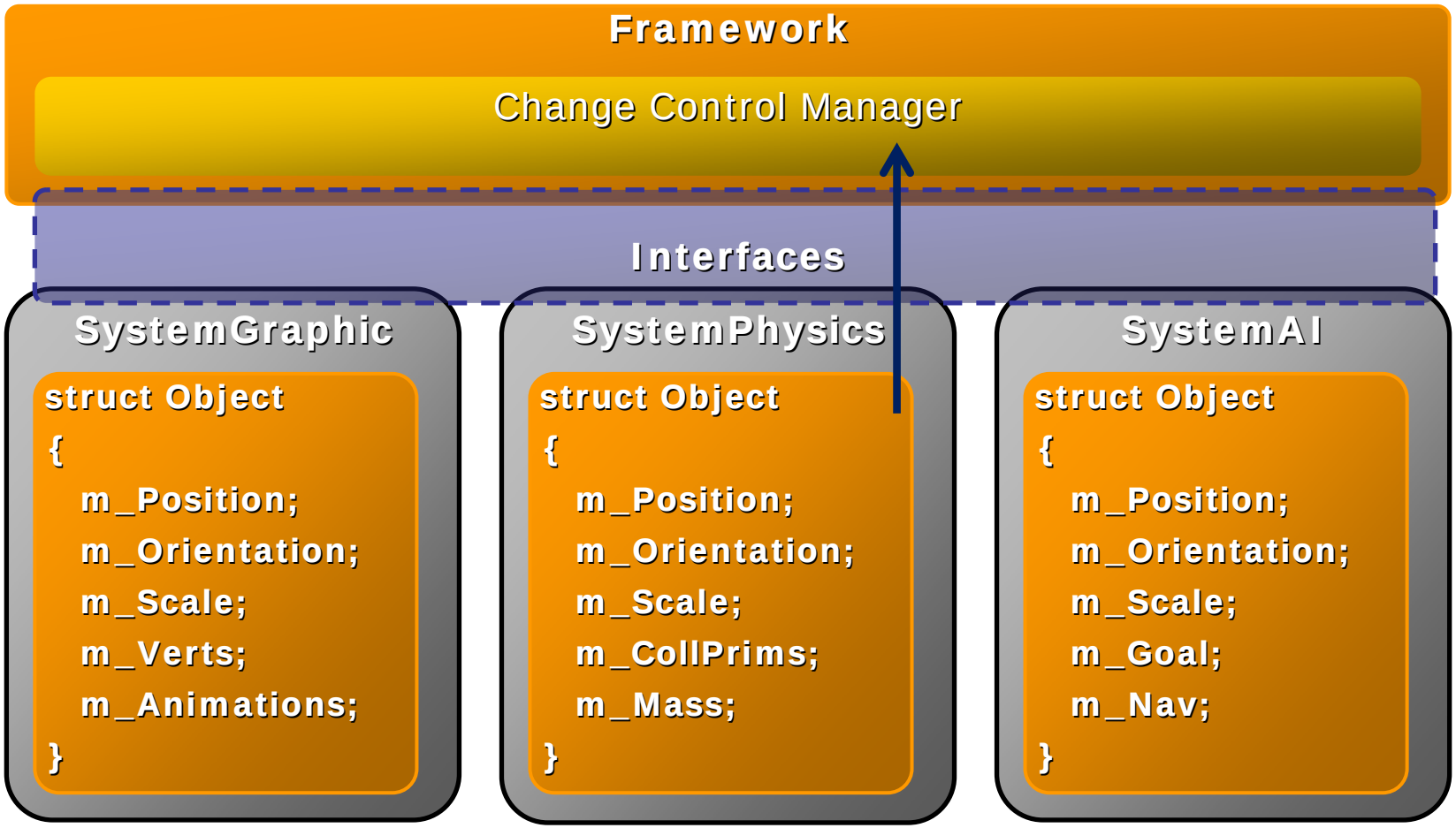
- Each System subscribes to desired changes during initialization



Key Design

Each System stores a copy of the data it needs

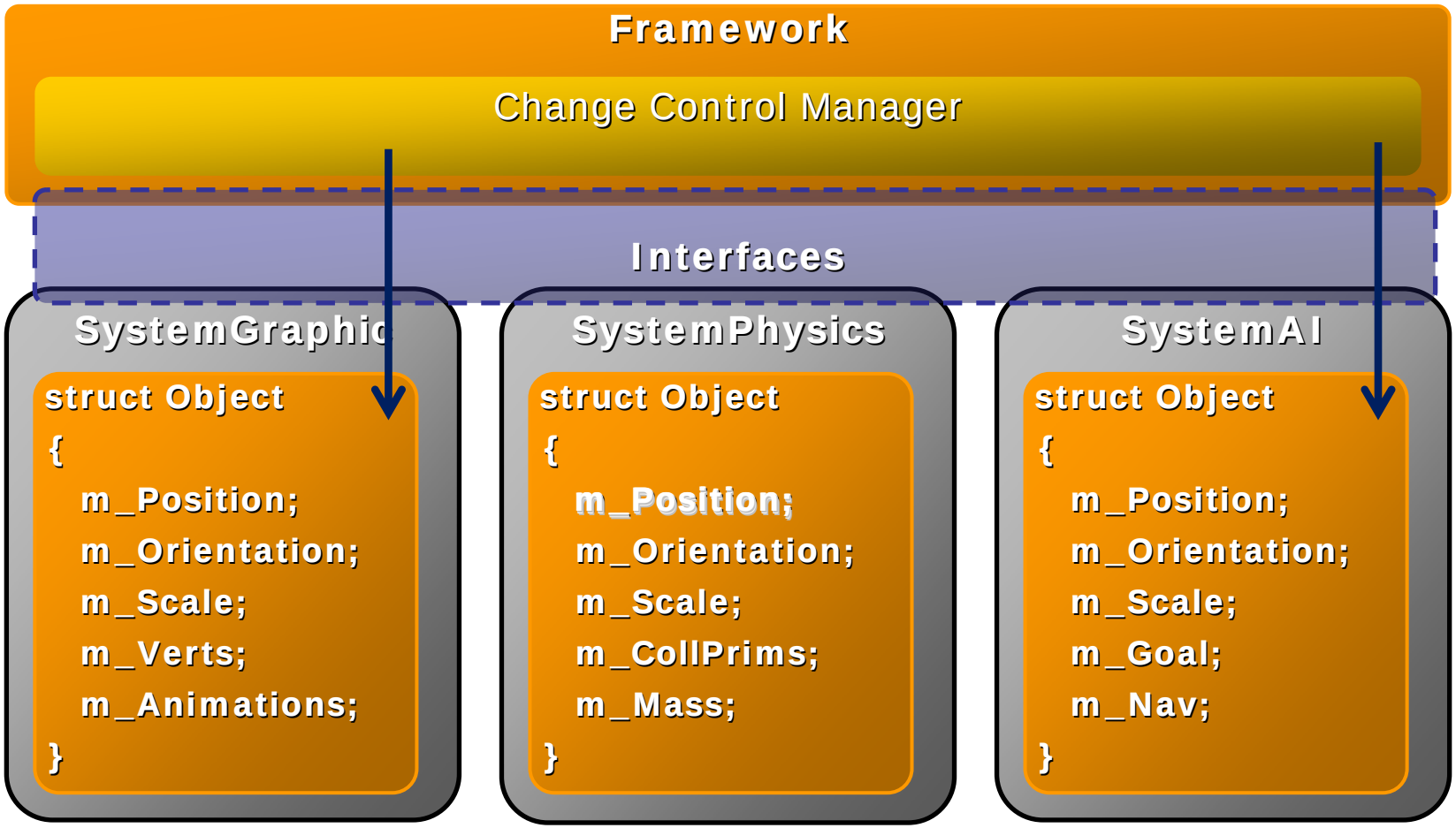
- When a System modifies its data, it tells the Change Control Manager



Key Design

Systems copy data from other Systems as needed

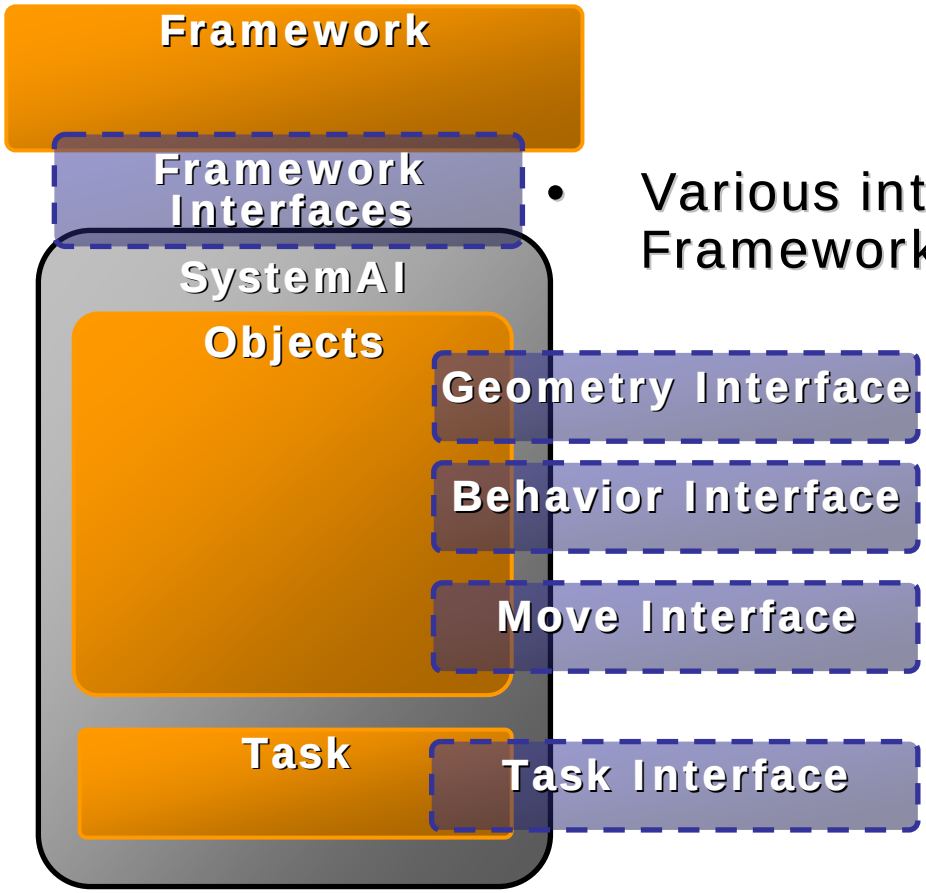
- When a System is told about a data change, it will get all the required information from the changing System



Key Design

4. System modularity (through interfaces)

- Interfaces are used to build up the interaction between Systems. This allows for high modularity.



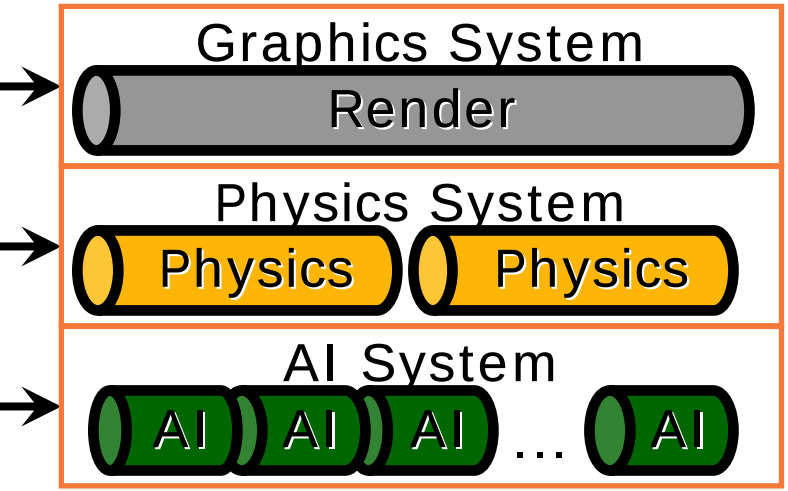
- Various interfaces to work within the Framework
- Change positions, etc
- Change behavior (generic state)
- Moving object (velocity, etc)
- Update and do work

Let's put it all together and see a frame

1. At the start of a frame, Systems run and subdivide tasks
2. Sub-tasks are added to a pool
3. Worker threads process sub-tasks
4. Tasks post changes as needed
5. Changes sent to observers at the end of the frame

A Frame

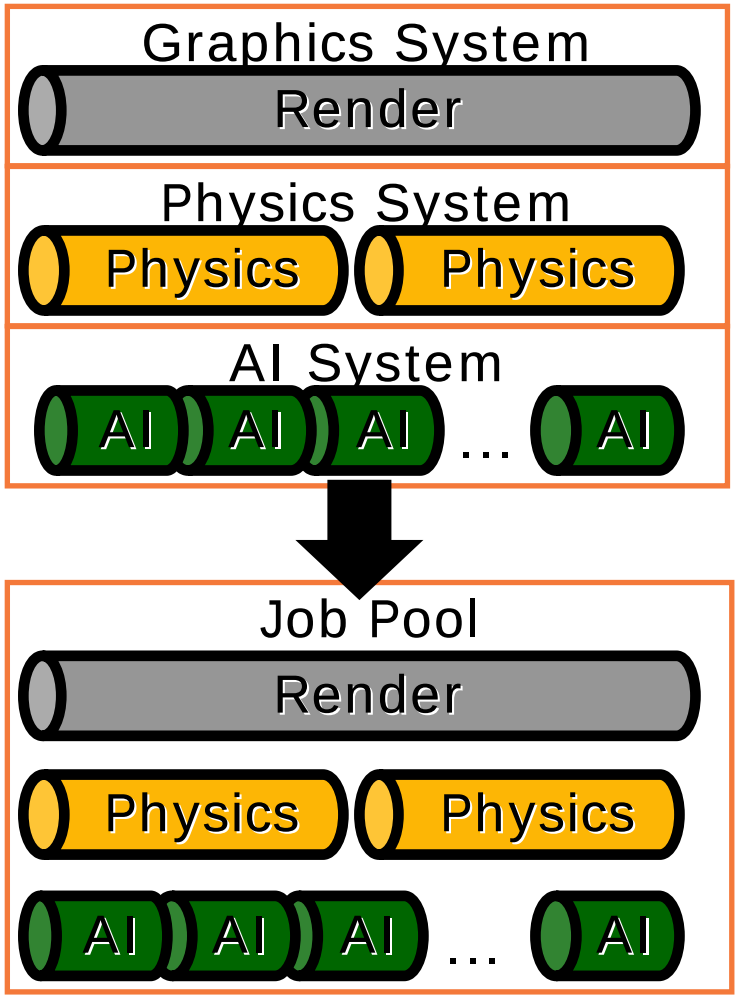
1. Systems subdivide tasks



- Scheduler invokes each system per frame
- Systems subdivide work into sub-tasks
- Systems can subdivide work based on a “natural” granularity
- Good middleware makes this easy

A Frame

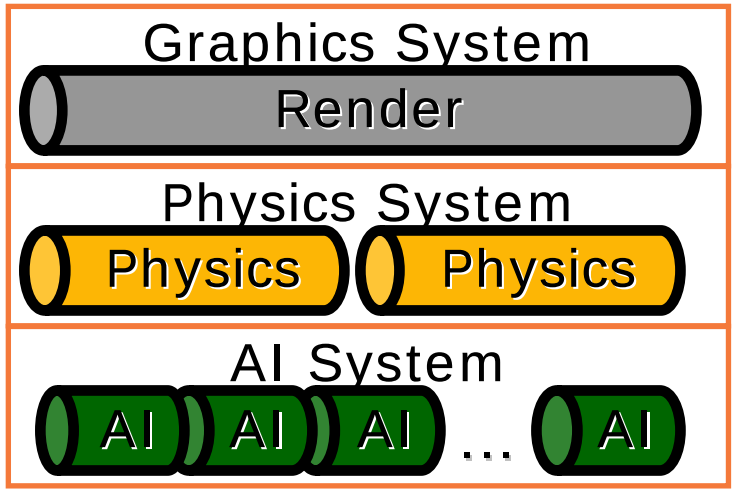
2. Add sub-tasks to a pool

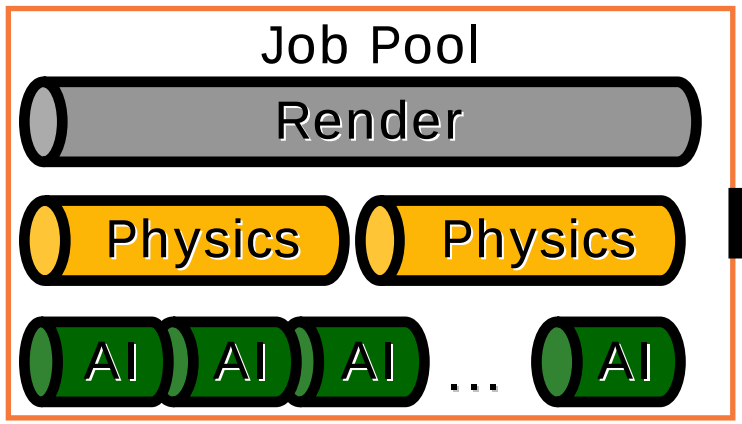


- All sub-tasks in single job pool

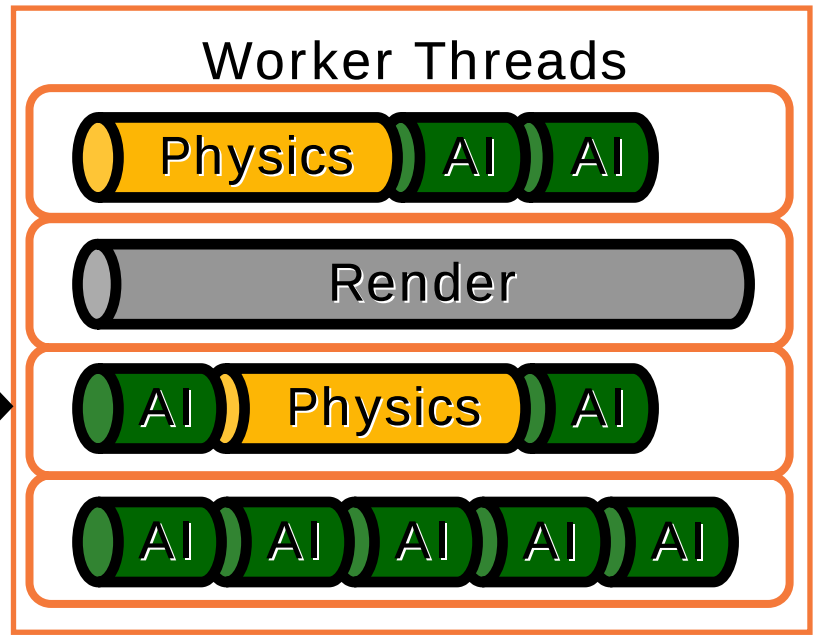
A Frame

3. Worker threads process sub-tasks



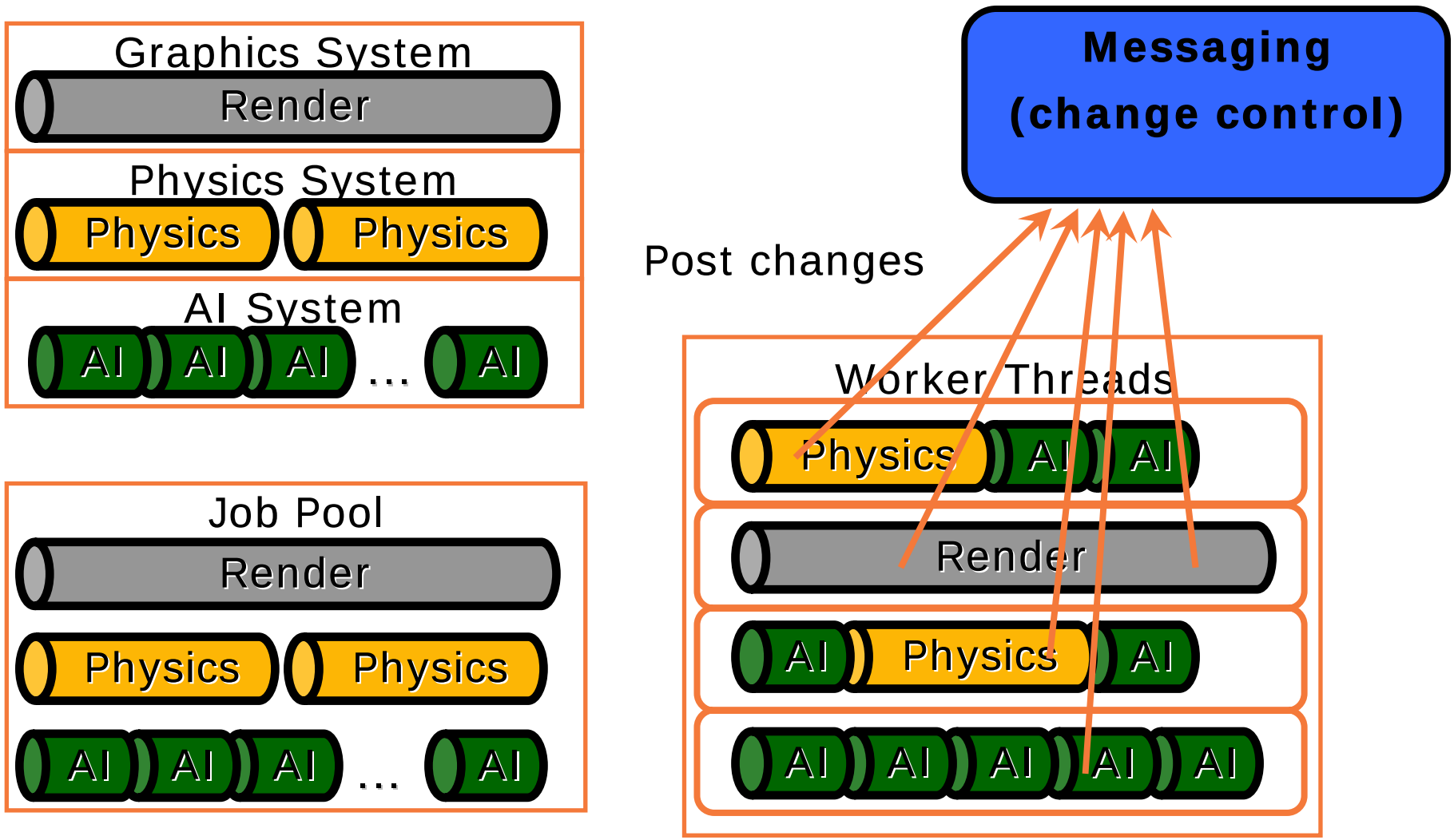


- N worker threads, 1 per core
- Sub-tasks spread out as needed



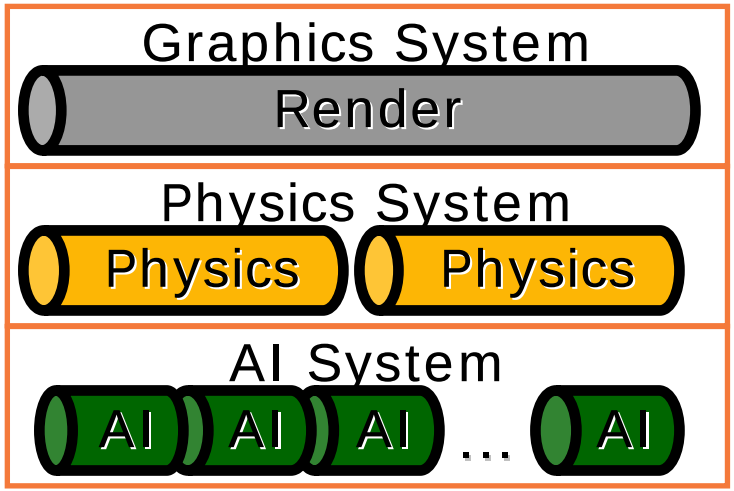
A Frame

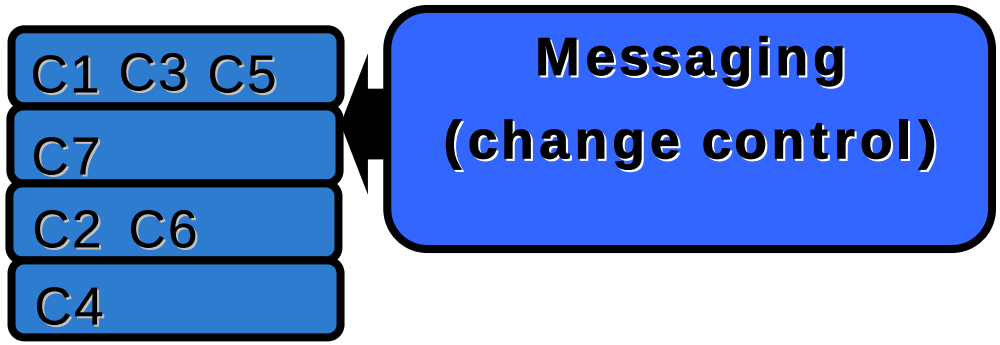
4. Tasks post changes

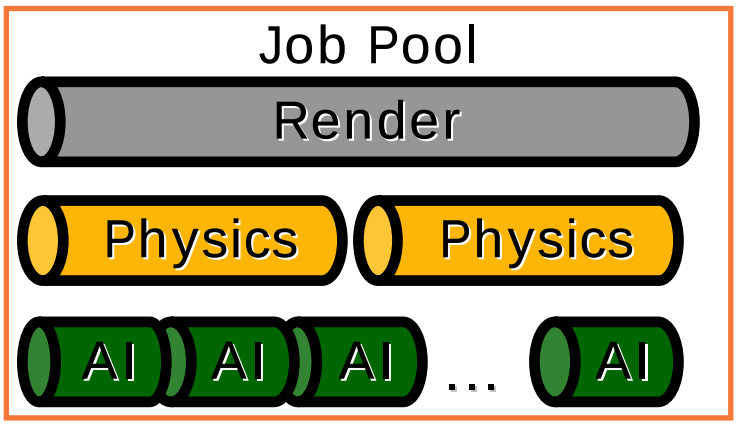


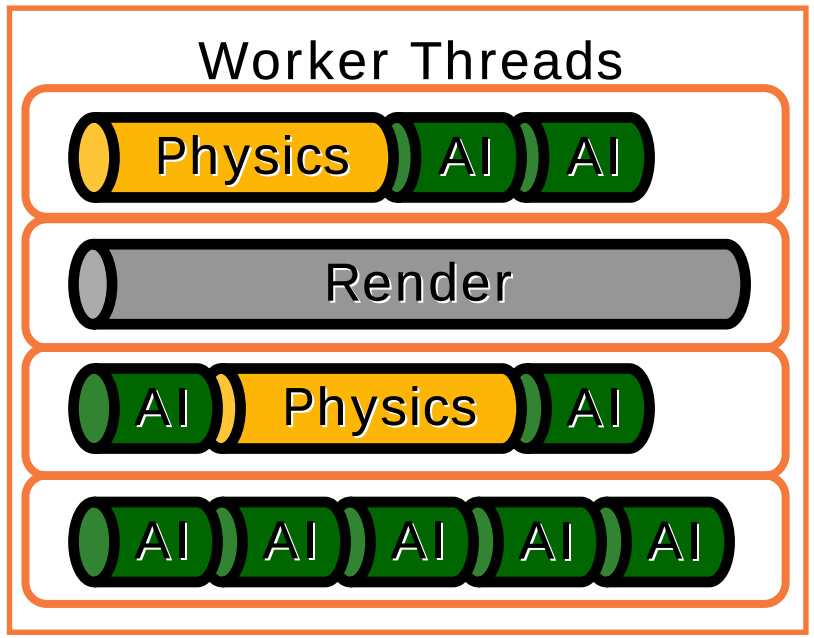
A Frame

Worker threads have unique changes queues



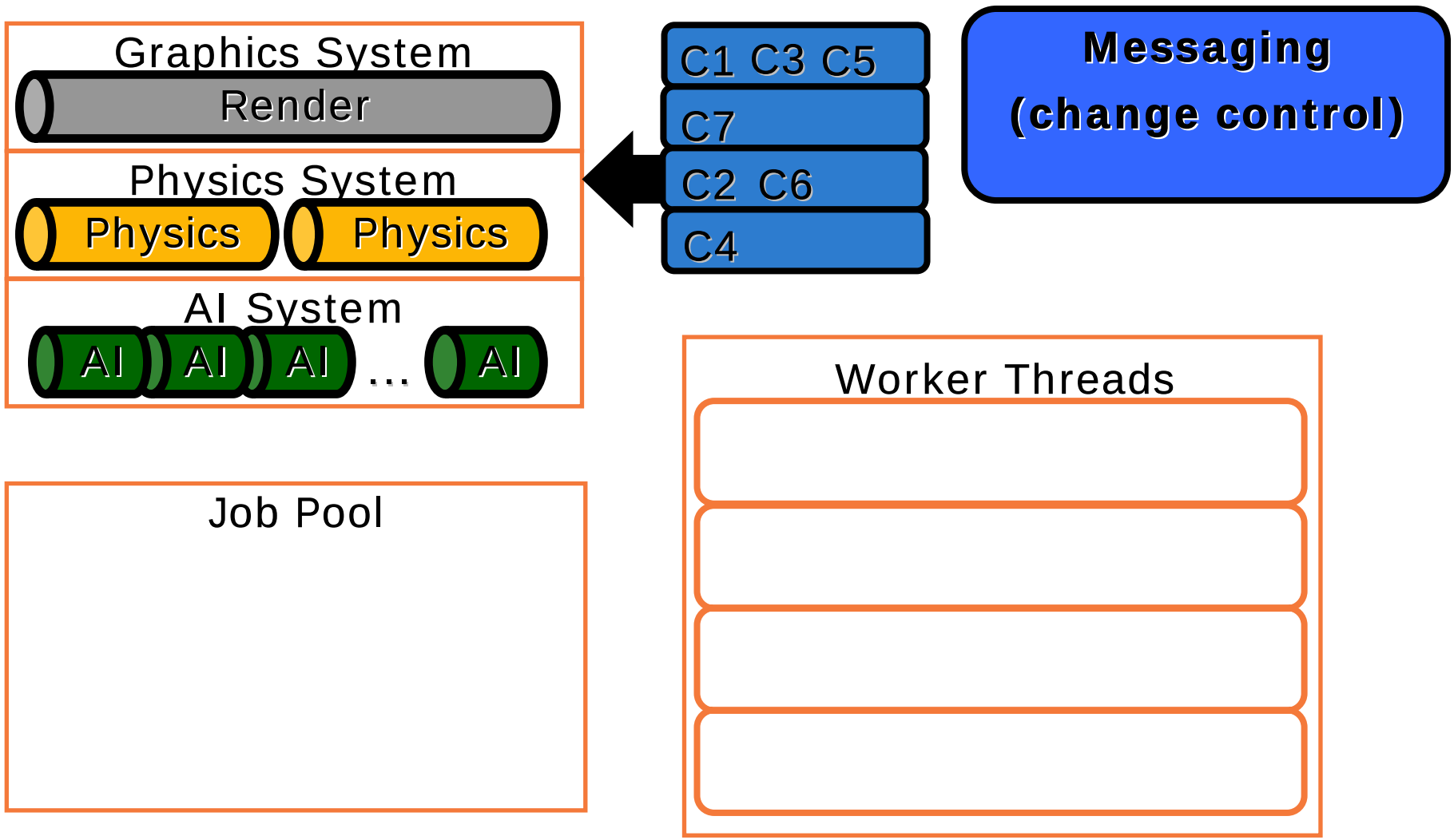






A Frame

5. Changes are sent to observers

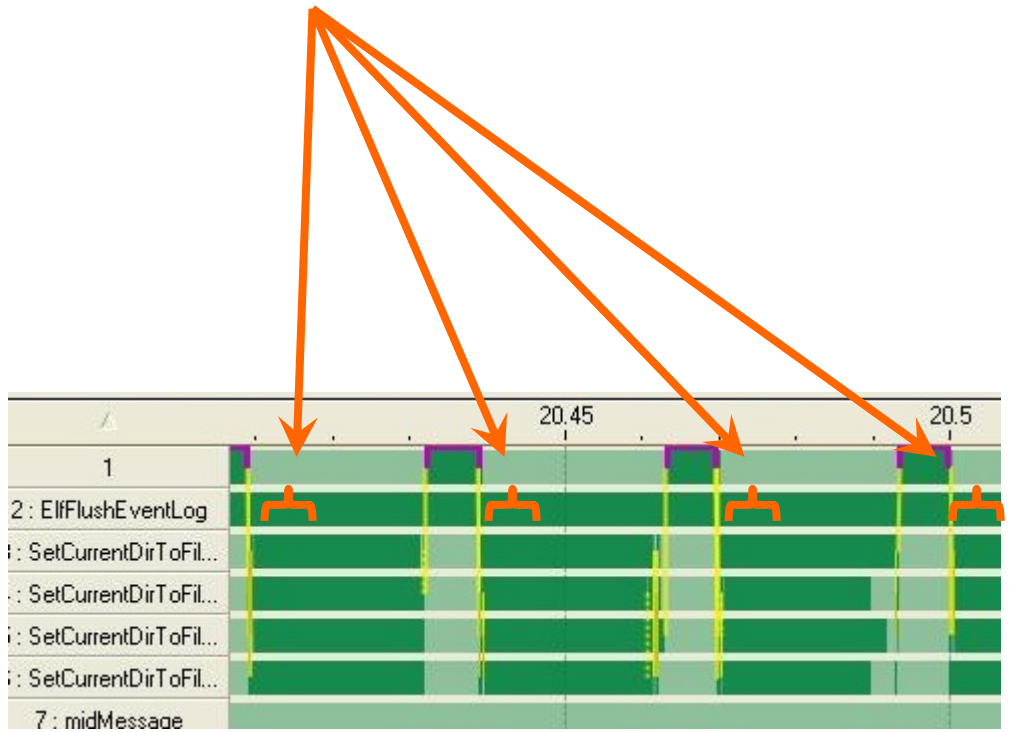


Minimizing serialization is a challenge

Heavy contention on global sync object within the Change Control Manager

Before optimization

Per-thread sync within the Change Control Manager

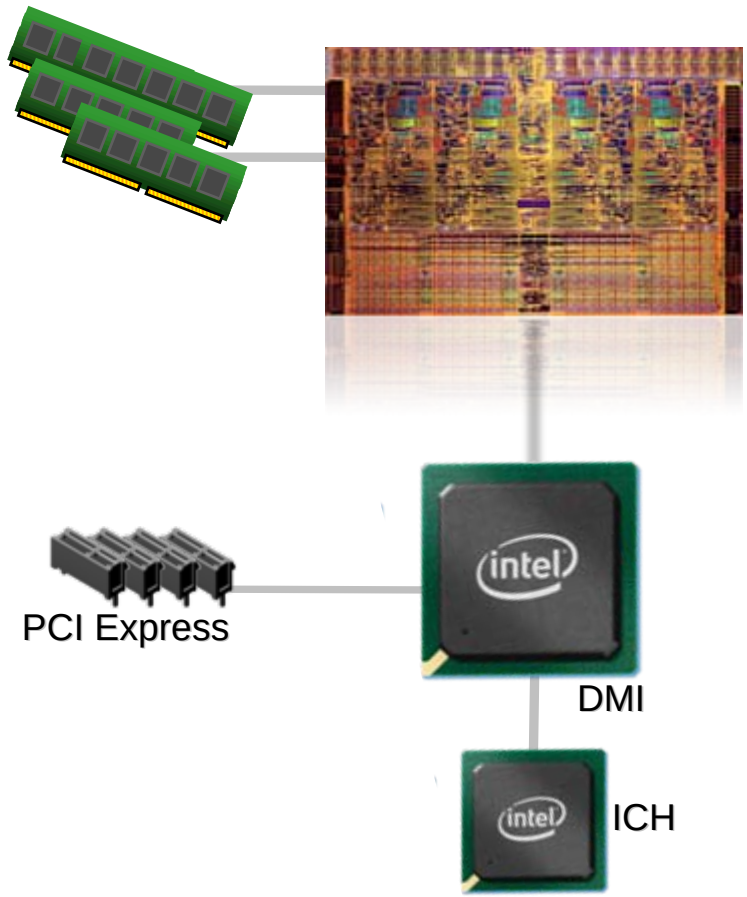


After optimization

Use these techniques to make your game really scale

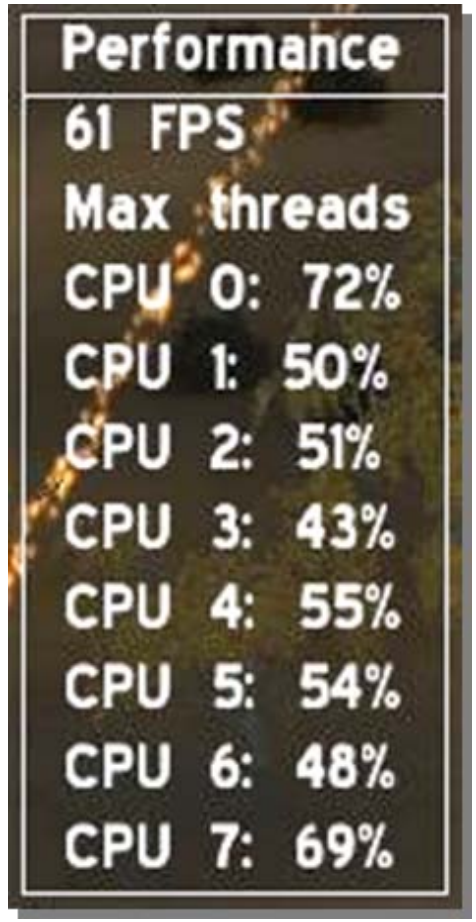
Nehalem – Overview

- Unified Cache
- Hyper-Threading Technology
- SSE 4.2
- Intel® QuickPath Architecture
- DDR3 w/ 3 Channels



Nehalem – Smoke

- More threads!! The easiest way to get a performance increase is to take advantage of all cores.
- Use a thread pool if possible. Creating threads is not free.
- Find a natural granularity. This is important to keep in mind with middleware.
- Smoke was created for Nehalem and future processors by targeting N-threads.



Nehalem – Best Practices

- Hyper-Threading just means more threads. The easiest way to unlock Nehalem's performance is threading.

- Load balance is important. Threads on a single core have their own registers but share execution resources.

- Don't use spin locks. Threads that are spinning will just waste resources useable by other threads. Use critical sections and mutexes.

- Keep cache coherency in mind. Threads should work on blocks of data instead of interleaved data.

Helpful tips

- Do:
  - Keep systems modular to help agile development. We swapped out three different physics systems with minimal impact to development deadlines.
  - Don't use spin locks.
  - Find the best task granularity for each system.
  - If possible, support multiple threading subsystems to simplify debugging.

- Don't:
  - Don't ignore thread interaction between systems, especially middleware.
  - Don't Panic. No one method works for everybody.

Techniques to maximize performance on Nehalem

Summary

- Threading games is hard, but worthwhile
- Smoke can show you how to thread effectively
- Use these techniques to make your game really scale
- Techniques to maximize performance on Nehalem

Call to Action

- Contact us at SmokeCode@Intel.com and we'll keep you up-to-date
- For more info on Nehalem and other Intel products visit: softwarecommunity.intel.com

Additional sources of information on this topic:

Sessions:

- Intel® Larrabee: A Many-Core x86 Architecture for Visual Computing [Tue 9:45-10:35]
- Game Threading Strategies for Next Generation Intel® Microarchitecture (Nehalem) Based Platforms [Tue 10:45-11:35]
- Tools for Optimizing Visual Computing [Tue 3:00-3:50]
- Enhancing C/C++ for the Next Wave in Throughput and Visual Computing [Tue 4:00-4:50]
- Developing Connected Visual Computing Experiences using Open Source Software [Tue 5:00-5:50]
- Enhancing the Media Experience with Intel® Integrated Graphics [Wed 1:40-2:30]
- DisplayPort: Foundation and Innovation for Current and Future Intel® Platforms [Wed 2:40-3:30]

Chalk Talks:

- Intel® Visual Computing Trends [Wed – 4:00-4:50]
- Intel® Visual Computing Technology: Media and High Definition Playback [Thur 10:10-11:00]
- Intel® Visual Computing Technology: Display Subsystem [Thur 11:10-noon]

Community:

- Display Port Community

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