Compiler Optimizations for Performance

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Example I: Computer Games

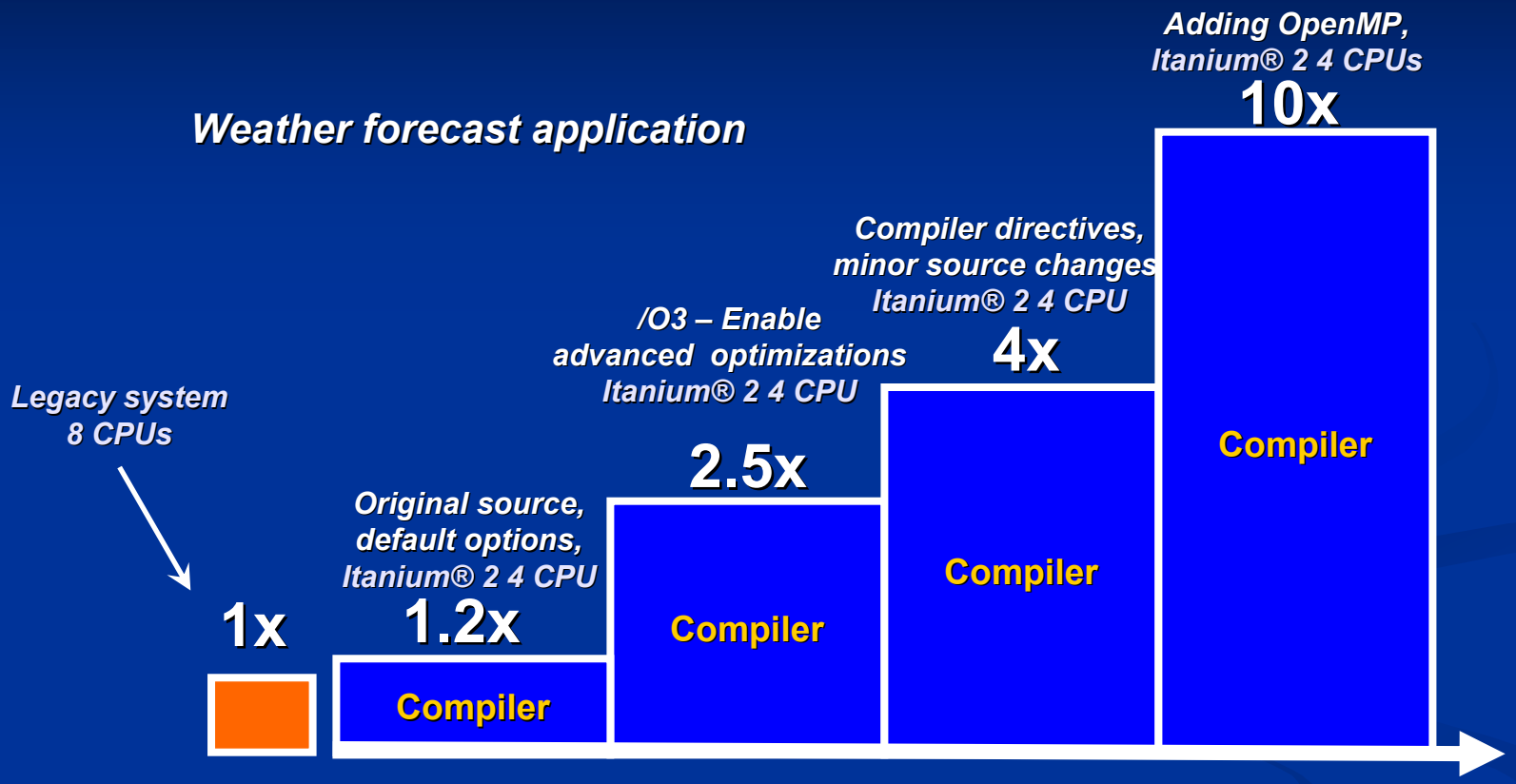
- Pocket Quake* II - Compiler Benchmark
  The demo compares two compiled versions of the same benchmark. The better optimized version provides about 2X performance boost on Pocket Quake II.

Click object in Powerpoint presentation mode to start film

Less optimizations

More optimizations

Example II: Weather Forecast



Optimizations may improve performance significantly.

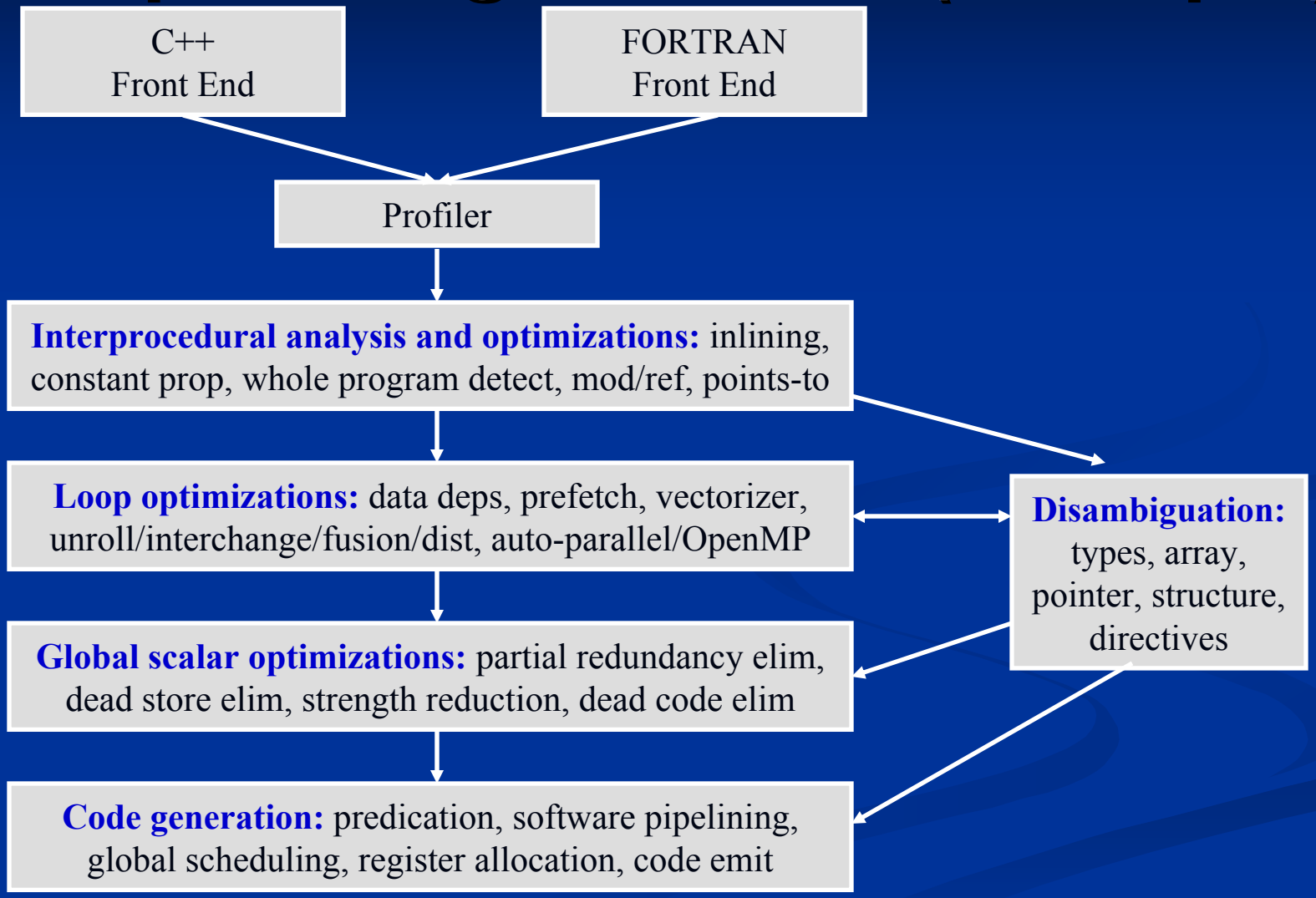
Compiler Features (example)

- O2: scalar optimizations and basic scheduling
- O3: optimizations for technical computing applications (loopy codes)
- O1: optimizations for server applications (straight-line and branchy codes with flat profile)

Compiler Features (example)

- PGO (profile-guided optimizations): using profile to guide optimizations.
- IPO (inter-procedural optimizations): multi-file inlining, interprocedural optimizations.
- Parallel: automatic parallelization
- OpenMP: exploiting thread-Level parallelism
- Optimization report: compiler optimizations performed or not done

Compiler Organization (example)



Example: Software Pipelining

```
L1: ld4  r4   = [r5], 4;   //  0
    add r7   = r4, r9;   //  2
    st4  [r6] = r7, 4     //  3
    br.cloop L1;;
```

4 cycles per iteration

Example: Software Pipelining

- Exploit parallelism across loop iterations.

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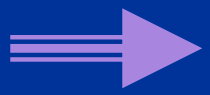

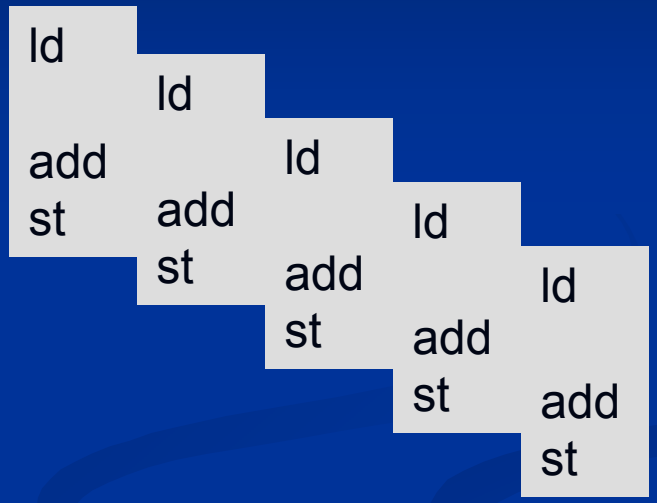

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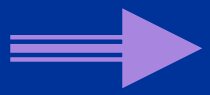

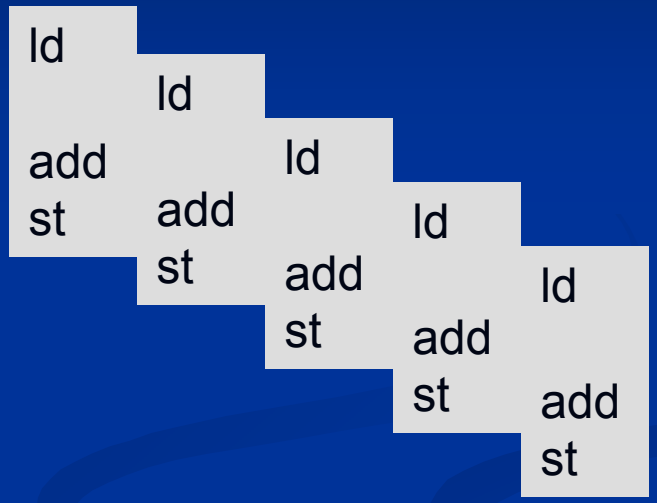

4 cycles per iteration

```
L1:
(p16) ld4  r32  = [r5], 4        // cycle 0
(p18) add r35  = r34, r9       //  cycle 0
(p19) st4  [r6]  = r36, 4       //  cycle 0
          br.ctop L1;;          //  cycle 0
```

1 cycle per iteration (with architecture support)

Course Emphasis

- Compiler foundation
  - Theoretical frameworks
  - Algorithms
- Experimentation
  - Hands-on experience
  - Non-goal: how to build a complete optimizing compiler
- Exposure to real world impact
  - How they worked in practice