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How to write a good CPU-based ITK-ThreadedGenerateData()

An Introduction to the „Advance“

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Bugsquashing Session @ MBI



DEUTSCHES
KREBSFORSCHUNGSZENTRUM
IN DER HELMHOLTZ-GEMEINSCHAFT

Enhance performance

Distributing tasks and processes

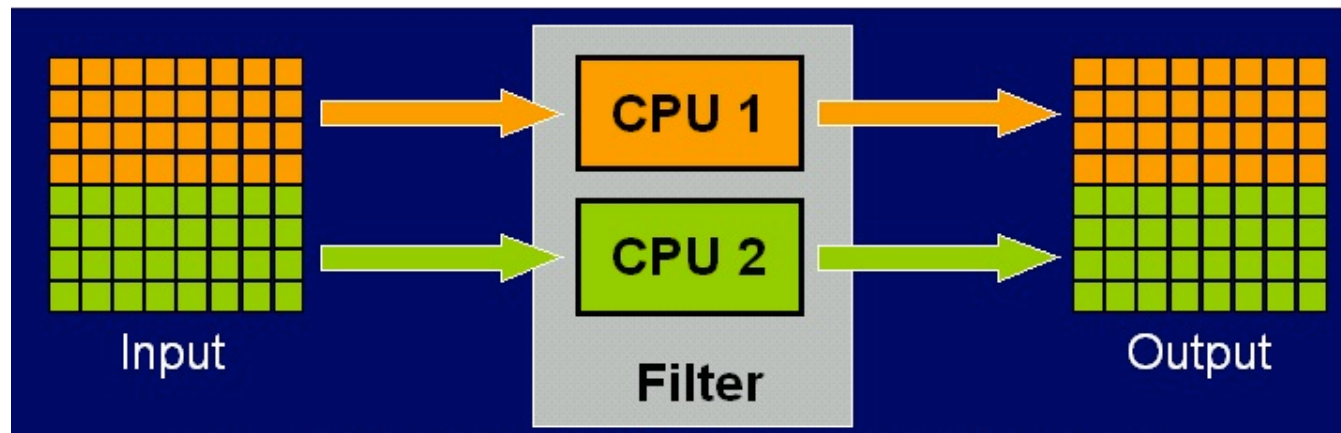
“P a R a L l E l I z E, cuz its cOOl”

Replace

```
virtual void GenerateData ()
```

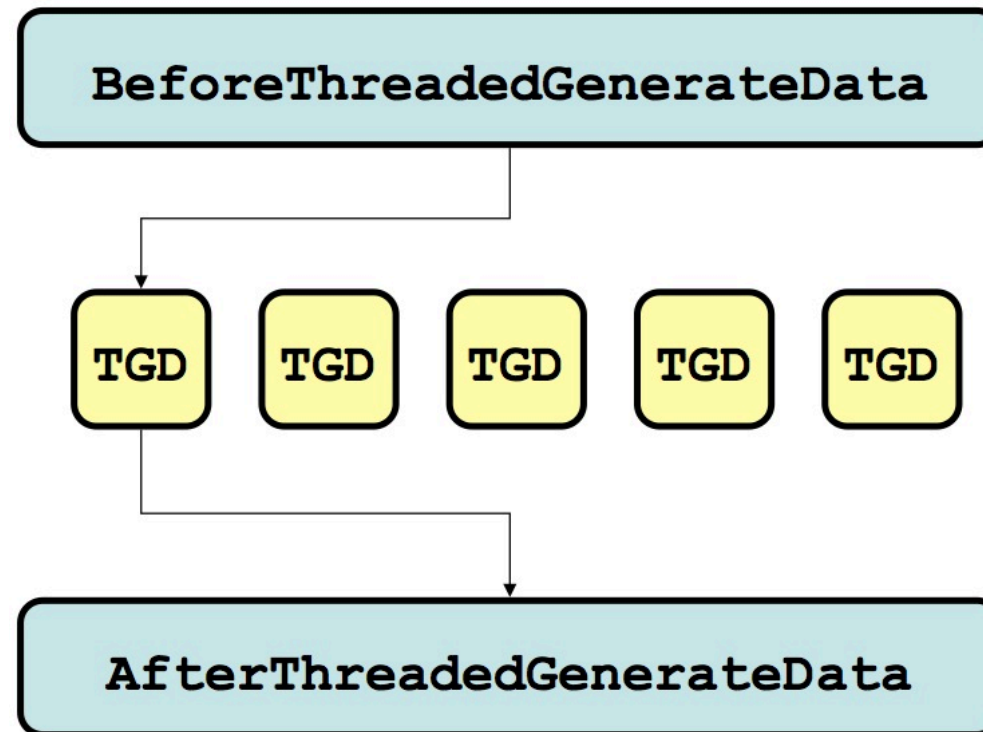
with

```
virtual void ThreadedGenerateData (RegionType& outputRegionForThread, int threadId);
```



Filters may process their data in multiple threads in a shared memory configuration.

```
virtual void BeforeThreadedGenerateData ();  
virtual void AfterThreadedGenerateData ();
```



works on IMAGES only, but...

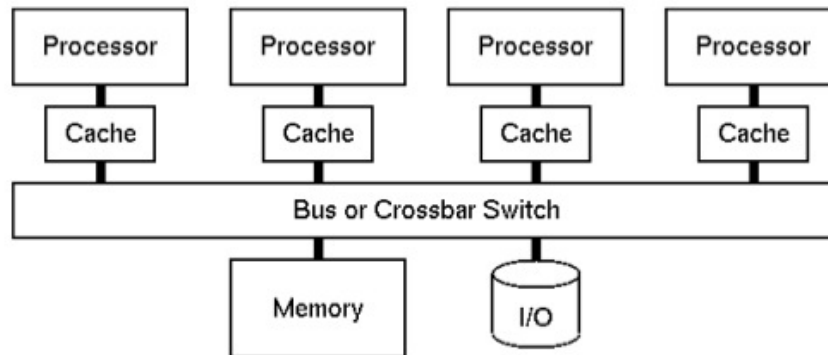
- **How to write an individual, good CPU-based multithreaded ITK filter; you need to understand:**
 - ITK::MultiThreader, for that you need to understand:
 - Principles of Parallel Computing
 - Principles of Current Multi-Core-Processor Architectures

- **Two major aspects in parallel computing**
 - Memory physically centralized or distributed
 - Address space shared or not

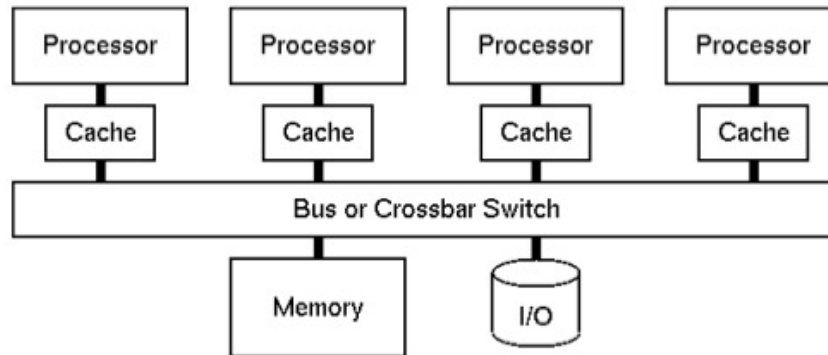
- **In ITK, threads from a common task share the same memory space**
- **In ITK, threads can simultaneously access variables, which were initialized before creating the threads**

- **Two major aspects in parallel computing**
 - Memory physically centralized or distributed
 - Address space shared or not
- **Do you know your Multicore Processor Architecture?**
 - Symmetric Multicore Chips (SMP)
 - Asymmetric Multicore Chips (AMP)
 - Dynamic Multicore Chips (DMP)

SMP Architecture

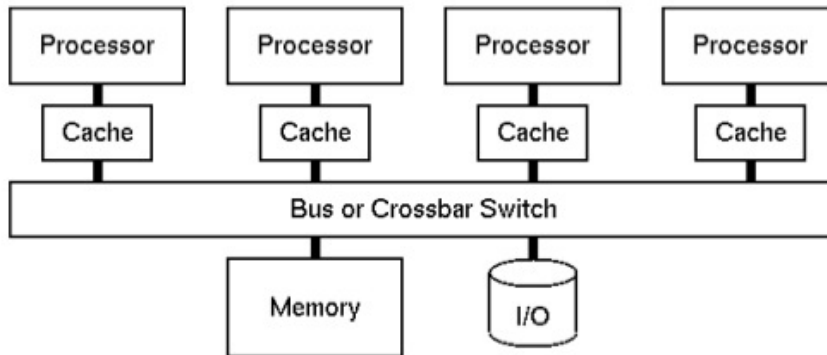


SMP Architecture



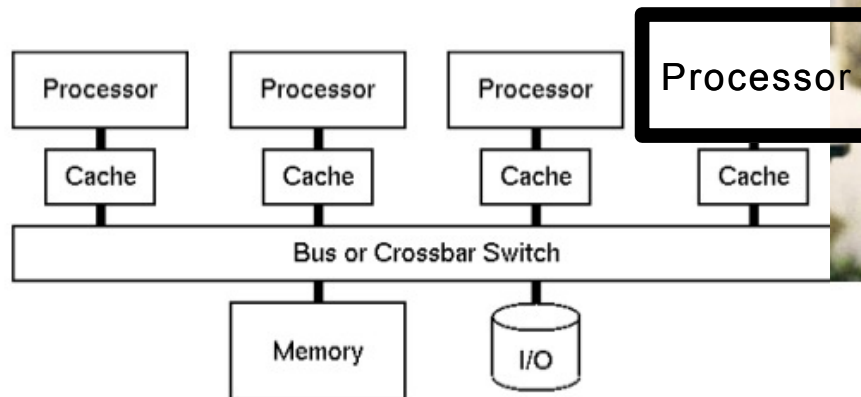
What about Intels TurboBoost technology in Core-iX chips?

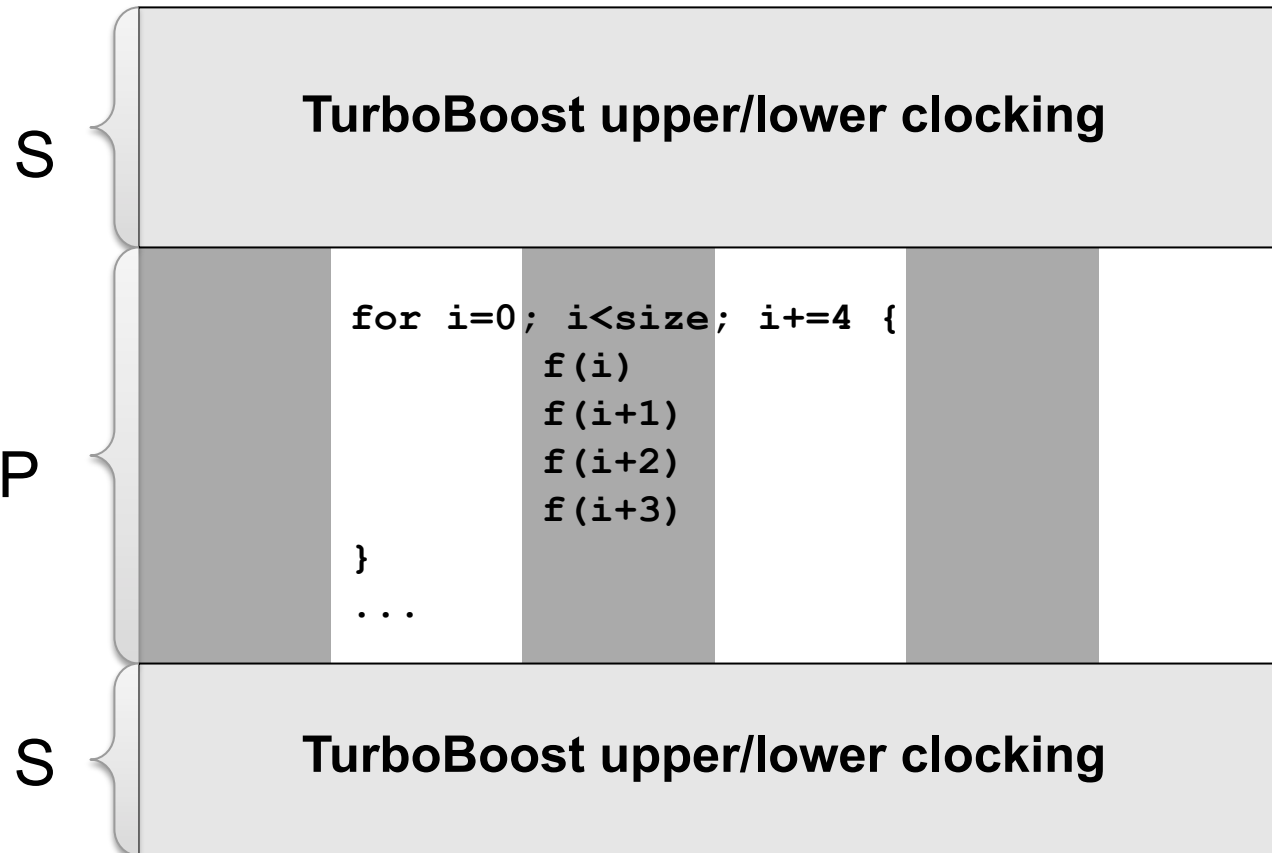
SMP Architecture



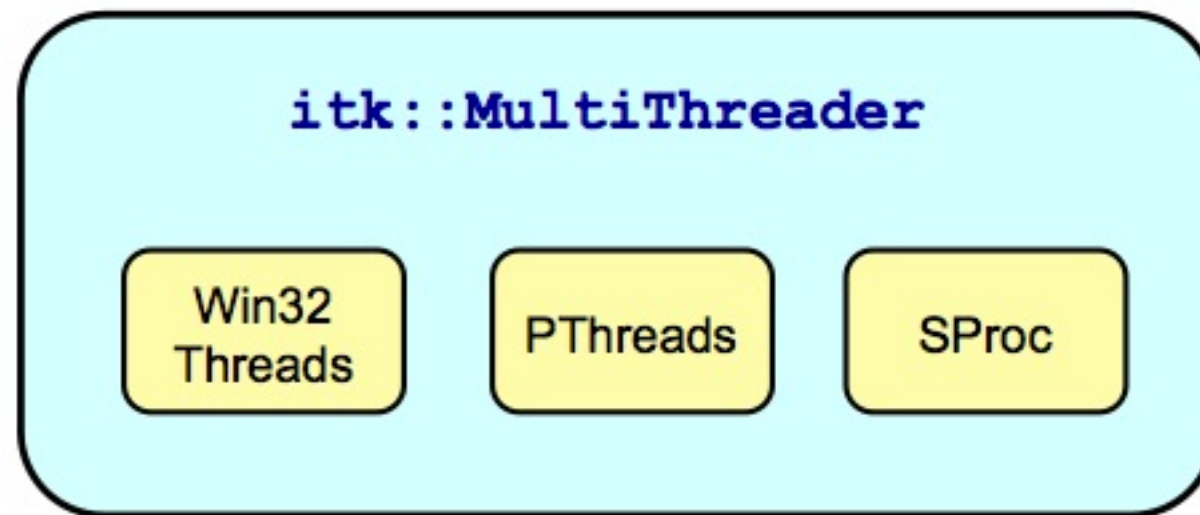
What about Intel's TurboBoost technology in Core-iX chips?

AMP Architecture





- Design your code smart
- Trust your brain more than multiple threads
- Do not try to parallelize everything (-> *Ahmdals Law*)
- Analyse bottlenecks and time consuming methods
- Design serializable code compact so that you can use the full performance of an AMP processor.



... to be continued ...

- ITK Multithreading
 - <http://www.itk.org/Doxygen/html/ThreadingPage.html>
- ITK SoftwareGuide
- Insight Toolkit – Advanced Course
 - <http://www.na-mic.org/Wiki/images/2/24/Insight-MultiThreading.ppt>
- CPU/GPU acceleration on ITK filters
 - http://www.vtk.org/Wiki/ITK_Release_4/GPU_Acceleration
- Amdahls Law in the Multicore Era
 - http://www.cs.wisc.edu/multifacet/papers/tr1593_amdahl_multicore.pdf
- Evaluation of the Core-i7 TurboBoost feature
 - <http://www.cs.sfu.ca/~fedorova/papers/TurboBoostEvaluation.pdf>