



**NCBI BLAST
accelerated on the
Mitrion Virtual
Processor**



mitrion™
by mitrionics™

Why FPGAs?

- FPGAs are 10-30x faster than a modern Opteron or Itanium
 - Performance gap is likely to grow further in the future
 - Full performance at low power, uses around 25W per Chip
- Several major vendors now have FPGA modules
 - Cray XD1, soon on the XT3/4
 - Other names that I won't mention at CUG...

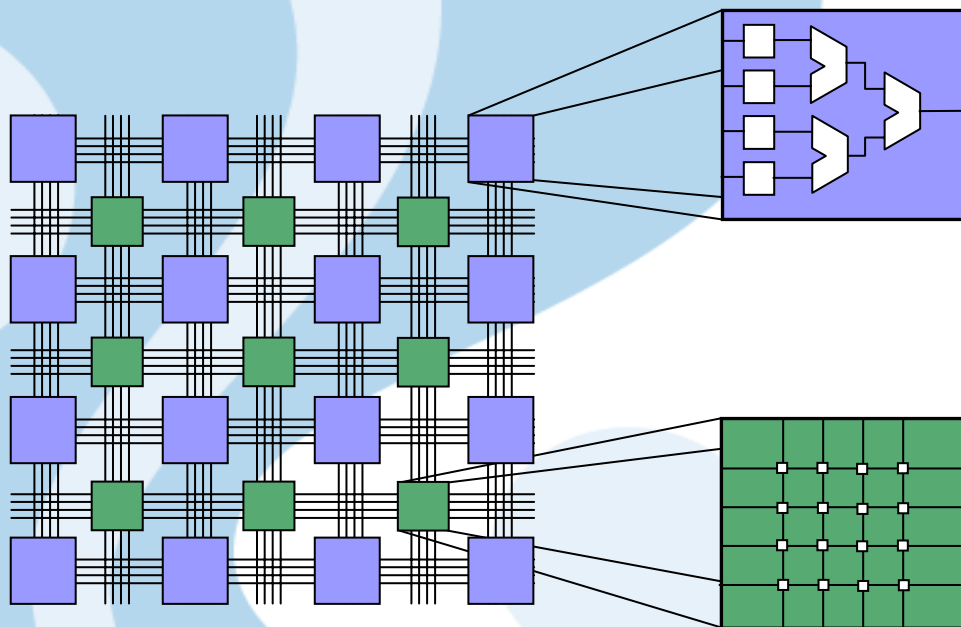


FPGAs

- An empty re-configurable silicon surface
 - Allows any circuit design to be configured into it
- Reconfigurable in ~100ms
- Reconfigurable any number of times

FPGAs

How a circuit is formed on an FPGA



Configurable computing element (LUT)

A look-up table for a simple Boolean operation

Configurable interconnect element

Configured to connect any LUT with any other LUT

Circuit Design vs Programming

- The difference between using VHDL and C is much more than syntax
- Circuit design works in the physical world of real electronics
 - Continual trade-offs and judgments regarding what will and what will not work
- Software programming works in the abstract world of pure logic
 - Perfect and exact execution according to the code (even bugs!)



Executing software

- To achieve the abstract world of software, a device that physically embodies a model of execution is required
 - The device operates in the real world
 - Its operations form the pure abstract world of software
 - This is the essence of a computer processor

The Mitrion Platform

1) The Mitrion Virtual Processor (MVP)

- A configurable processor design for a fine-grain massively parallel, soft-core processor
- 10-30 times faster than traditional CPUs

2) The Mitrion-C programming language

- An intrinsically parallel C-family language

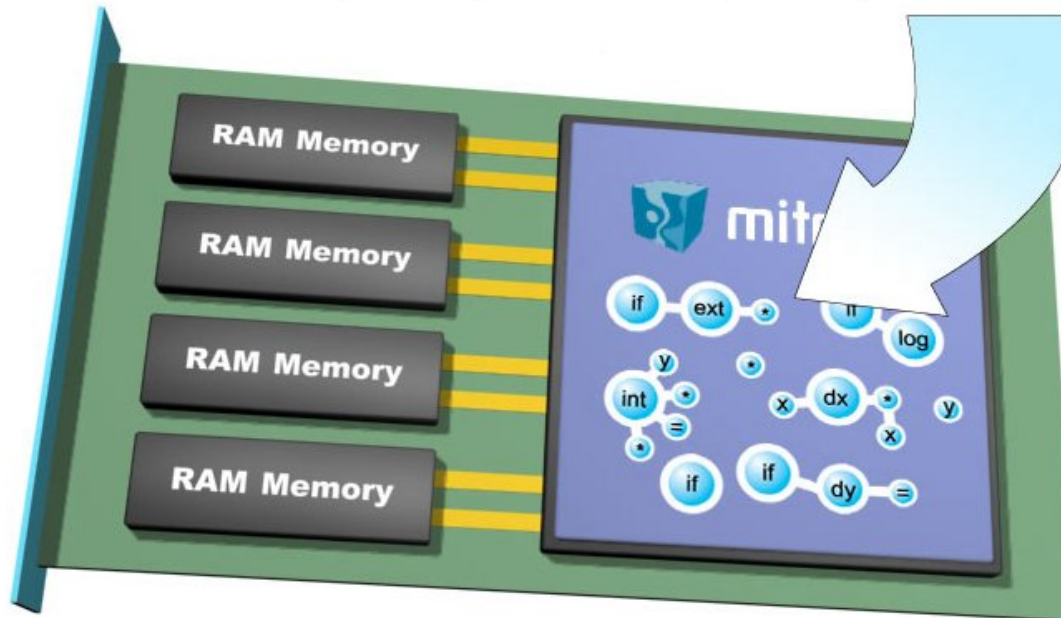
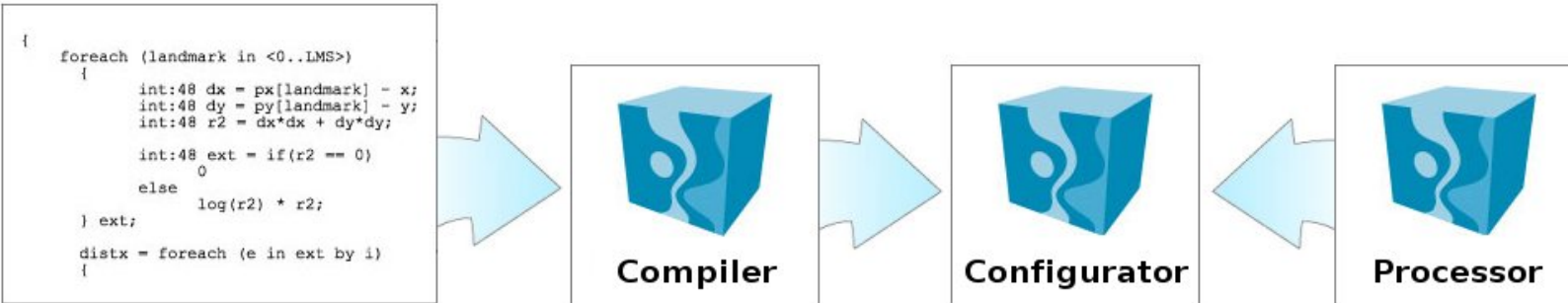
3) The Mitrion Software Development Kit

- Compiler
- Debugger/Simulator
- Processor configurator
- IDE

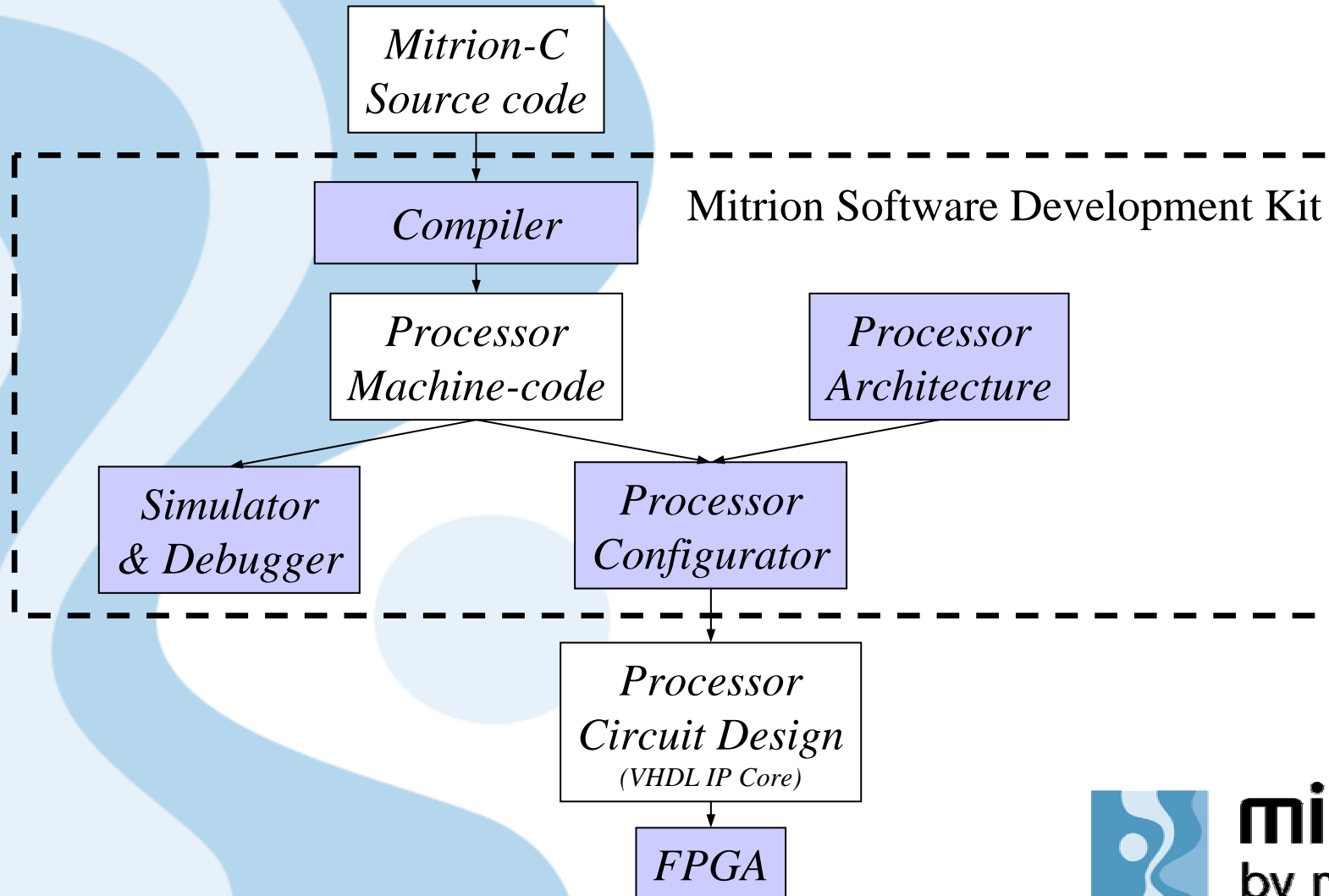


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The Mitrion Platform



Compiling A Mitrion-C Program



Mitrion Offers Portability And Scalability

- You program the processor, you do not design a circuit for a specific FPGA platform

Just configure a processor for the new platform from your old source-code.

- Easy upgrades to the next generation of performance available.
- Exchange code with colleagues on other platforms



FPGA Memory Bandwidth

- An FPGA module typically has several different bandwidth regions:
 - System memory: 3-6 GB/s
 - Attached memory: 10-20 GB/s
 - Internal memory: 0.5 TB/s (!)
- Apart from parallelism and adaptability, the third main reason for the high performance of FPGAs



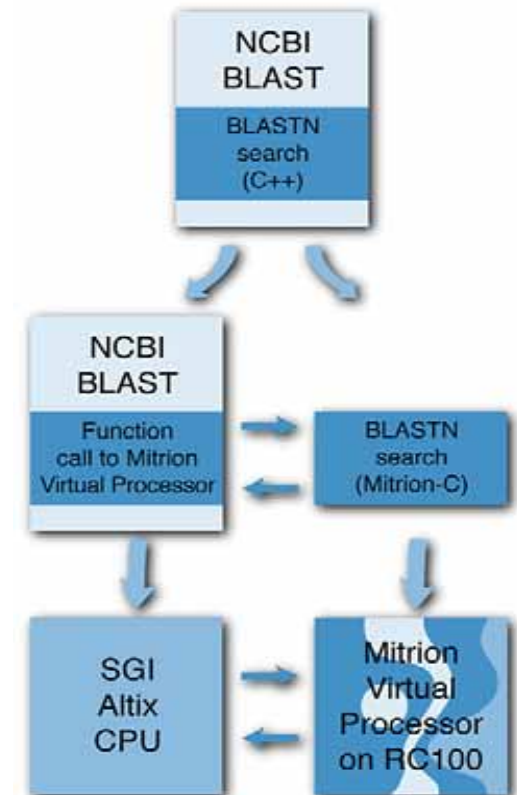
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**NCBI BLAST
accelerated on the MVP**

Mitrion-Accelerated NCBI BLAST

- Built on the NCBI “blastall” application
 - Identical interface and output options
- BLASTN algorithm is accelerated:
 - Critical parts ported
 - Runs on the Mitrion Virtual Processor in FPGA hardware



NCBI BLAST accelerated on the MVP

- Mitrion BLAST is open-source, released under GPL
 - Requires at least MVP on Virtex4-LX200
 - Not a Black Box, anyone can add to it
 - Total Mitrion-C code is less than 1300 lines
 - Free to download
- Currently in Beta
- 17x-20x performance increase vs standard NCBI BLAST run on the SGI Altix 4700



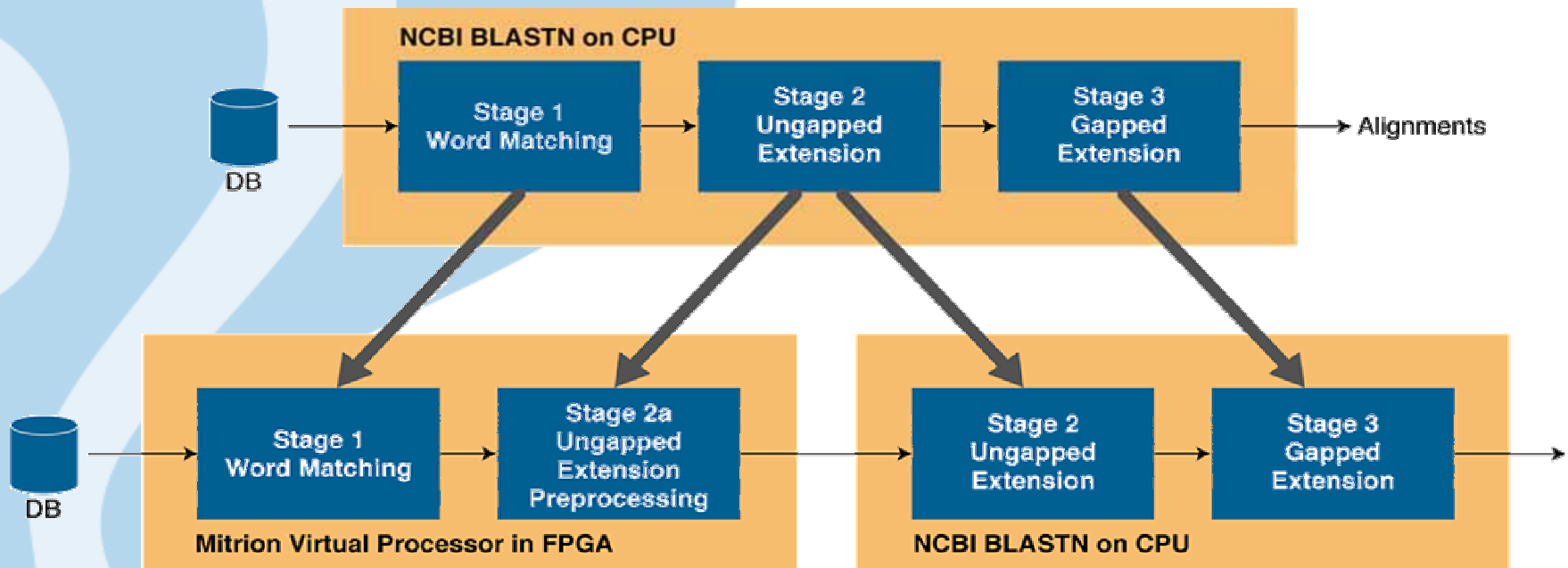
NCBI BLAST accelerated on the MVP

Main limitations:

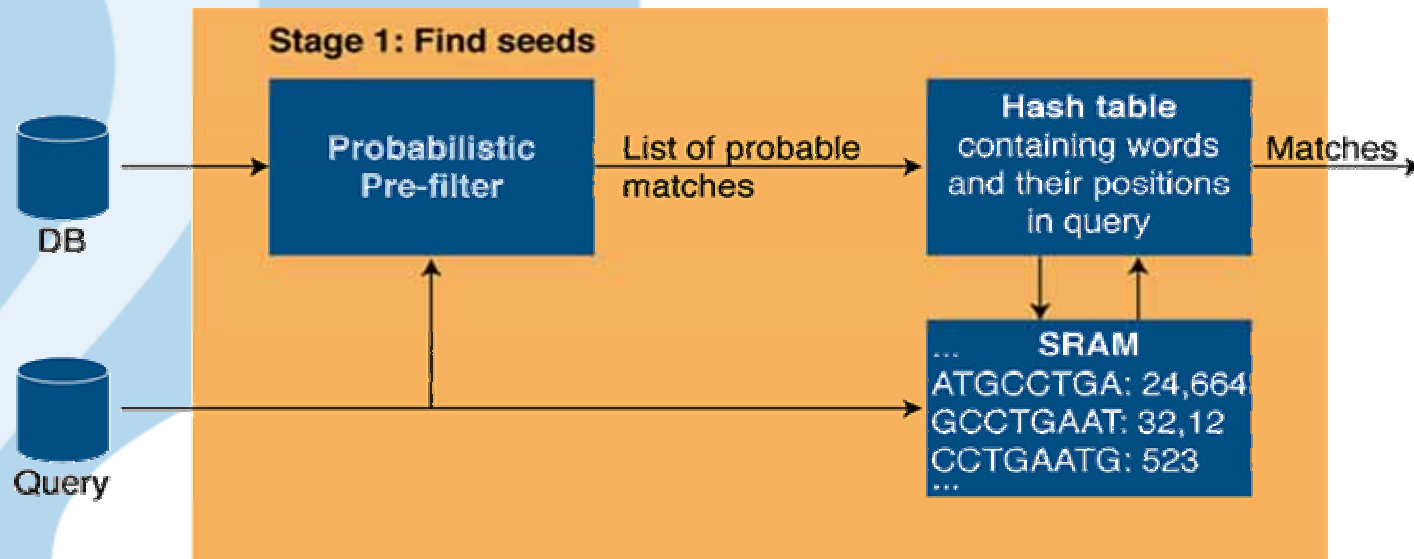
- BLAST-N only
 - BLAST-P in development
- Currently limited to less than ~100K queries (unlimited database sizes)
- Gapped extension not run on MVP
 - Small percentage of run-time for most queries

BLASTN Overview

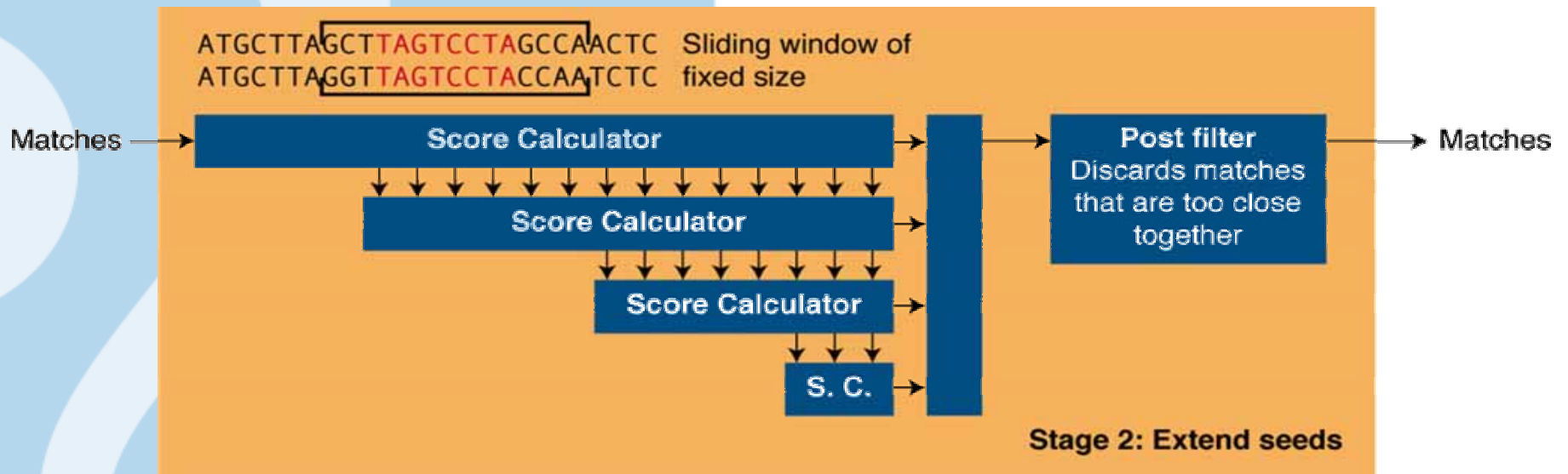
- Three-stage deployment of BLAST



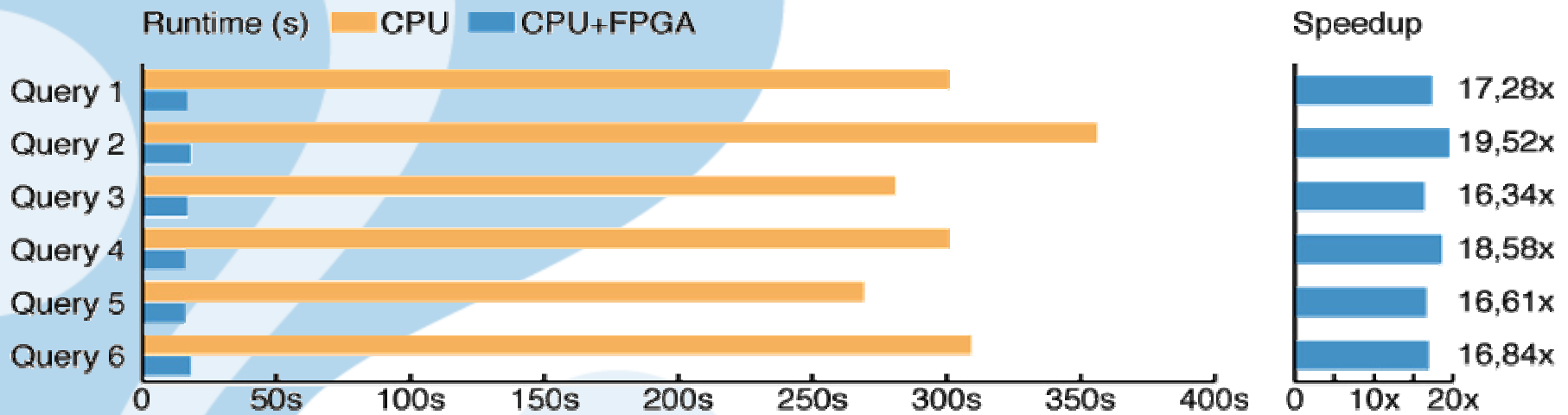
Mitrion BLASTN Stage 1



Mitrion BLASTN Stage 2



Mitrion BLASTN Performance



The Mitrion-C Open Bio Project

- Open source development of key Bioinformatics applications for the Mitrion Virtual Processor at Sourceforge.net:

<http://mitc-openbio.sourceforge.net/>

MGLQIMITRION-CPORNSLKKKEIIPQLLVNRTTMVTRFVLVGFSSLGELQLLLFVIF
RTHETPMYGFLFILSOPENCFIVPROJECTHLLSATKSI SFVACAAQLFFPLGFACTNC
TLVMNKRLGLGLVSLFSESG **BIO**ALVATNLICDMPFCGPNRVNHYFCDMAPVIKLACTD



- Currently BLAST, others to come...



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