A System Design of Accelerating Biochemical Simulations on Programmable Hardware

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Motivation

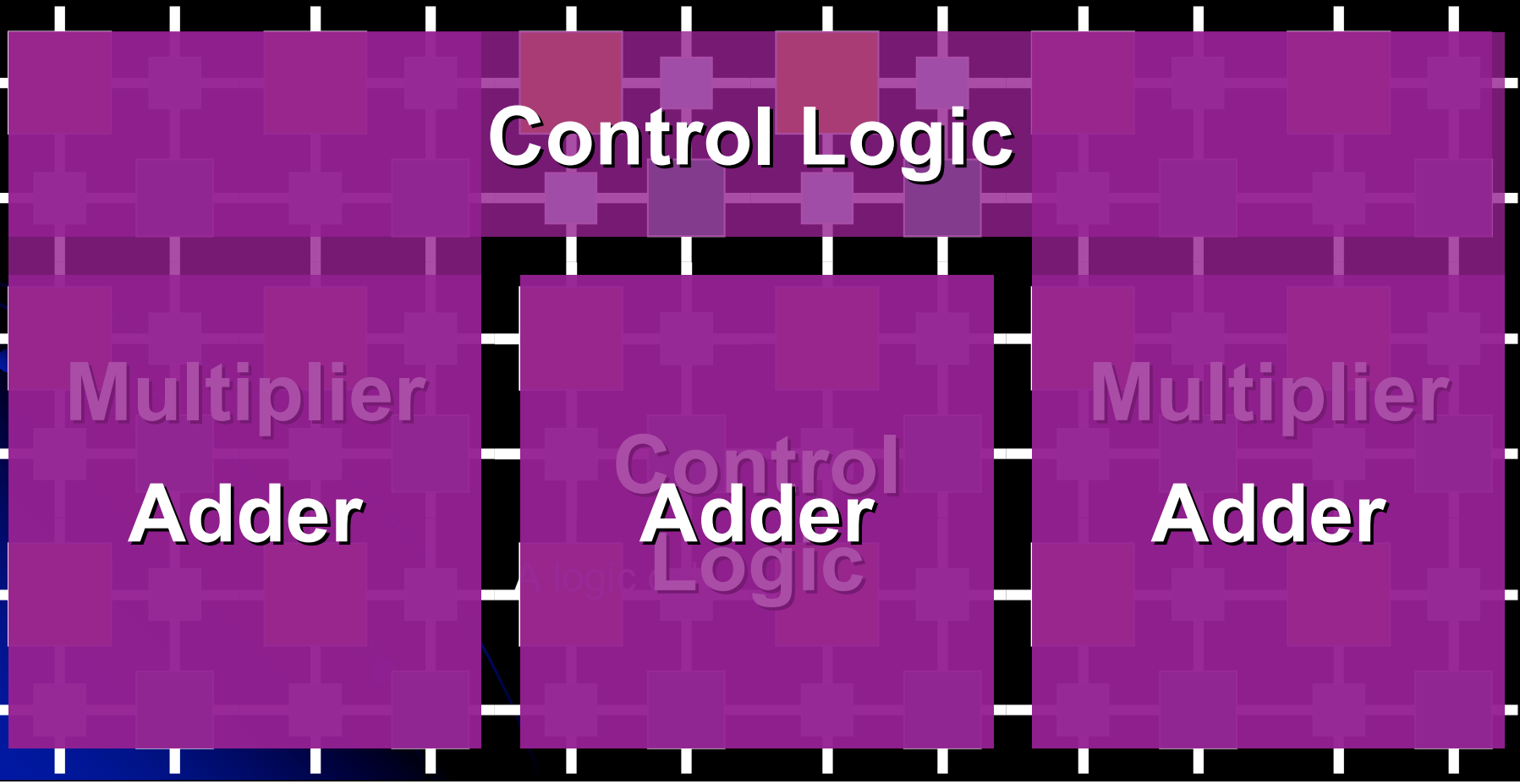
- Parameter-set discovery by computer
  - PC
    - Time consuming
  - Dedicated hardware
    - Highest computational speed
    - Unsuitable for running complicated applications

⇒ Programmable hardware: **FPGA**
(Reconfigurable Computing)

What's an FPGA?

Field Programmable Gate Array

- Hardware-level flexibility
  - A large number of "Logic cells" which can be anything



FPGA

Field Programmable Gate Array

- Provides optimal circuit for every application

Example:

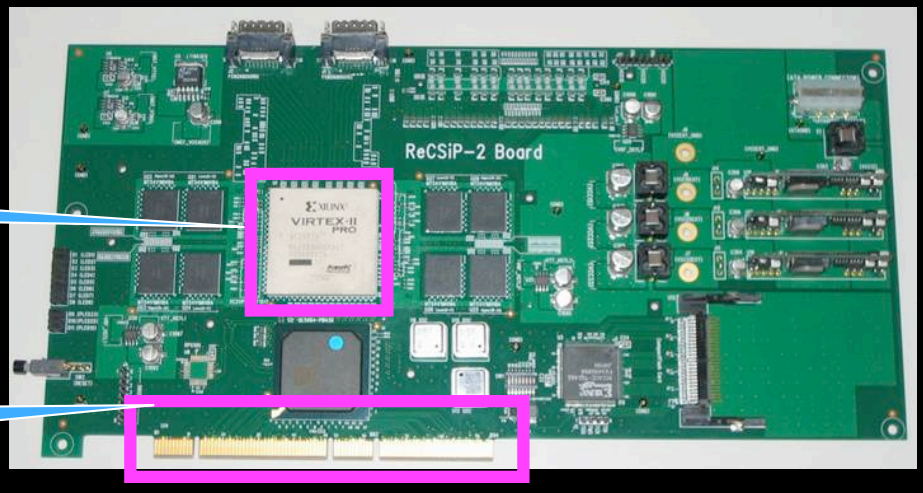
- Controller for cars, aircrafts
- Signal processing for communication facilities
- Scientific computing

→ How about using for biochemical simulation?

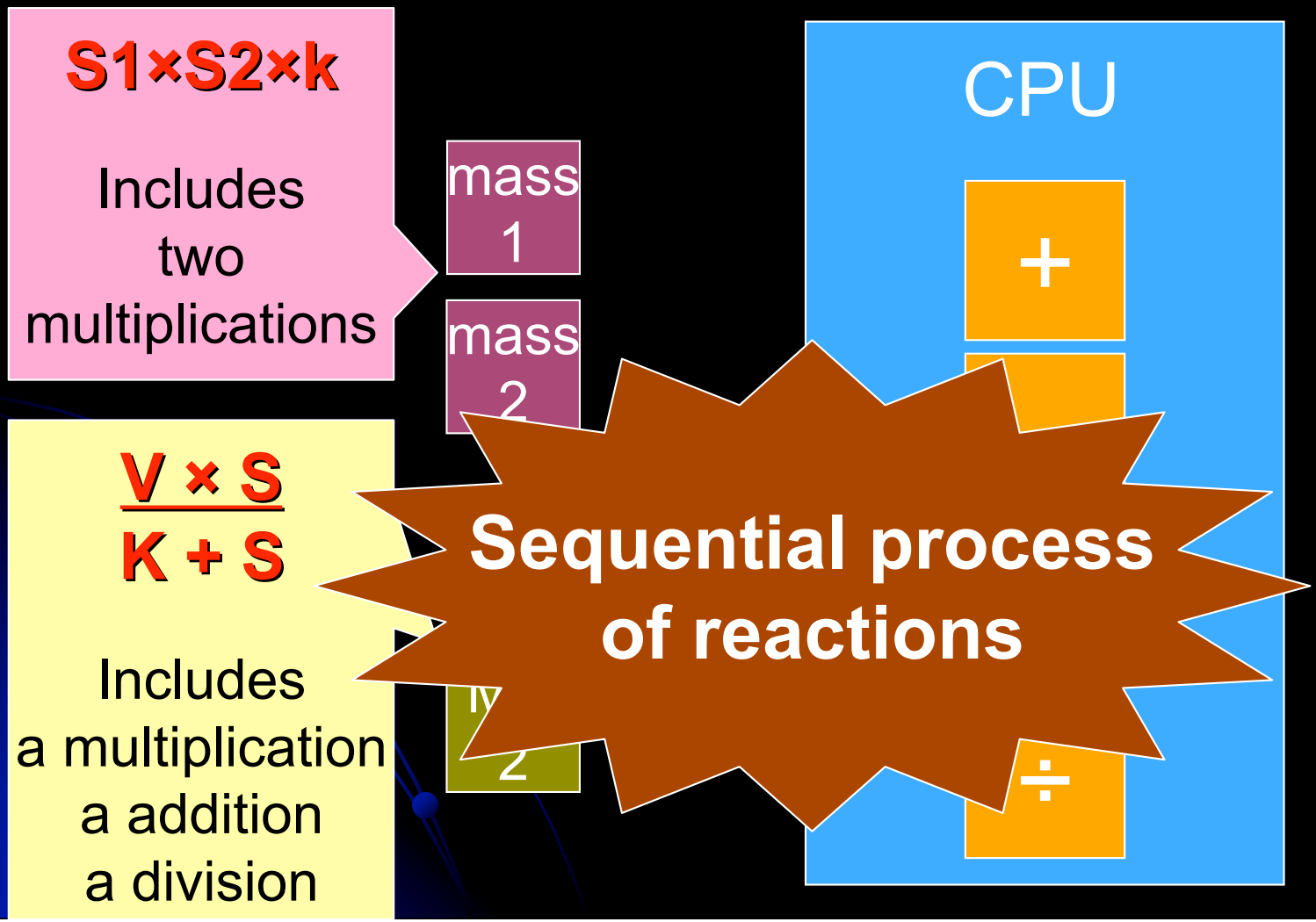
ReCSiP

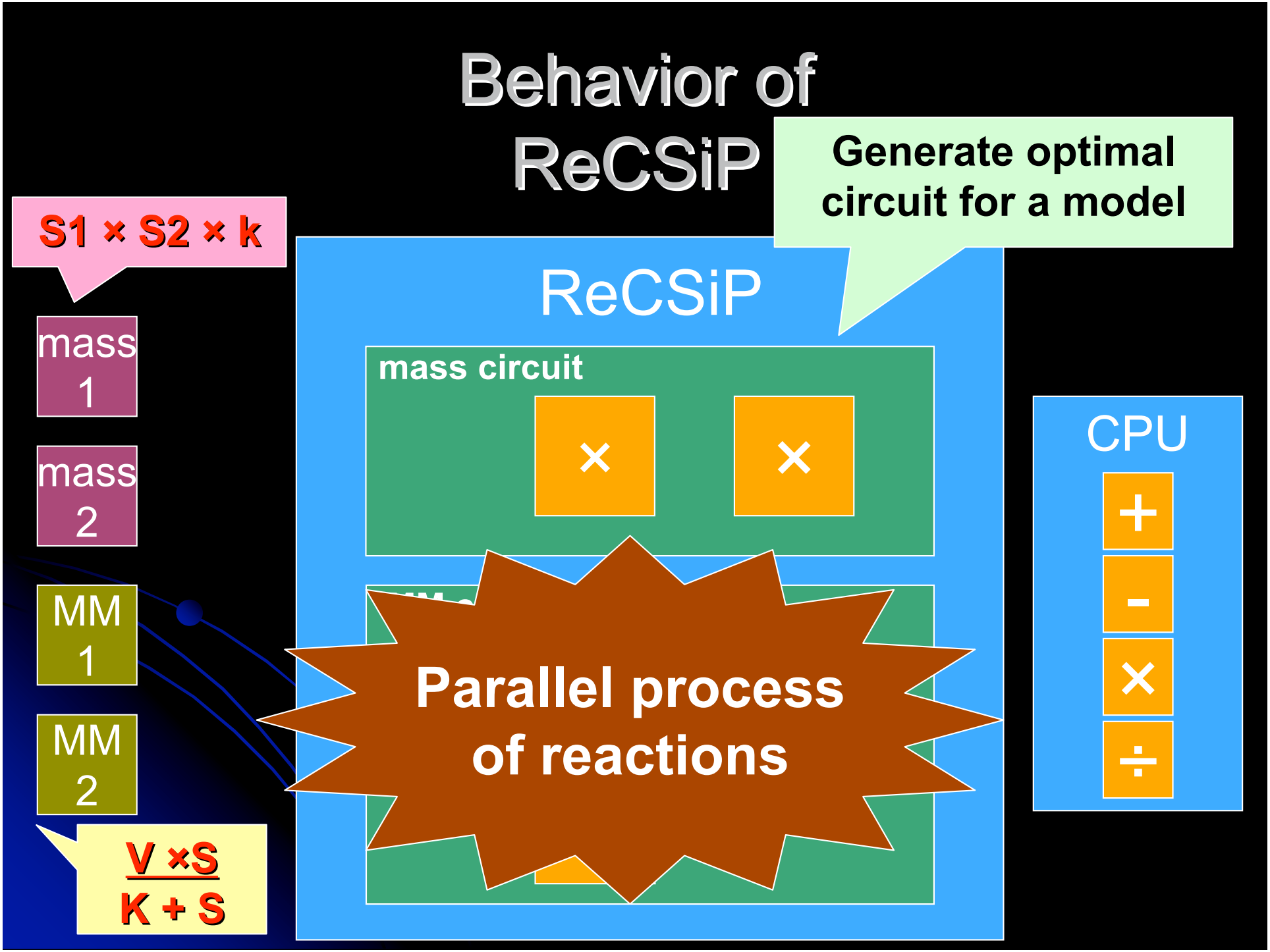
Reconfigurable Cell Simulation Platform

- FPGA-Based Computing Platform
- PCI card for PC
- Optimal circuits for biochemical simulation
- Deterministic method simulation
- Much faster than other software based simulators



Behavior of Software-based simulator



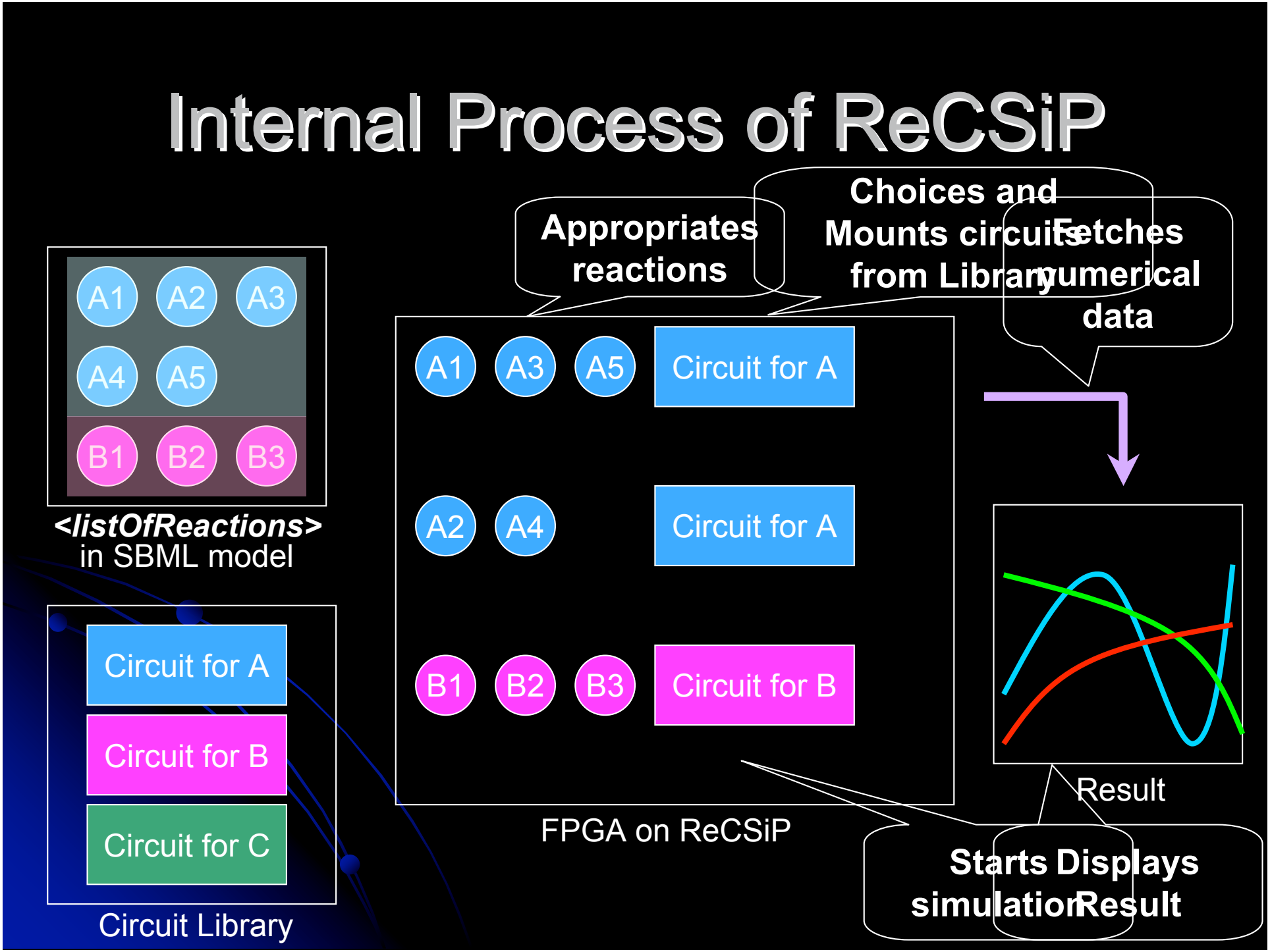

Behavior of ReCSiP
Generate optimal circuit for a model
S1 × S2 × k
mass 1
mass 2
MM 1
MM 2
V ×S
K + S
ReCSiP
mass circuit
×
×
Parallel process of reactions
CPU
+
-
×
÷

How to use ReCSiP

- Plug “ReCSiP board” in your PC
- Install “ReCSiP Interface Software”
- Load an SBML file into the software
- Wait a moment, and get result

⇒ **It’s so easy!**

Internal Process of ReCSiP



Performance of ReCSiP

- Maximum performance

Integrator	Pentium4 3.2GHz	ReCSiP	Gain
Euler	6.43	540	83.98
Heun	3.14	270	85.98
RK4	1.17	90	76.92

(M reaction/sec)

- 80 times faster than Pentium4

Conclusion

- ReCSiP: FPGA-based Simulator
  - Accelerates biochemical simulations
  - A small plug-in card for PCs
- Common status
  - Some part are yet unavailable
- Future works
  - Various SBML models will be loadable
    - Circuit library includes only limited circuits now
  - Stochastic simulation

The END

~~We'll have demonstration here from now~~

~~Please visit us.~~