International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 6, October 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Cellular Computing

Matthew N. O. Sadiku[1], Nana K. Ampah[2], Sarhan M. Musa[1]

[1]Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, Texas
[2]Lone Star College, Kingwood, Houston, Texas

ABSTRACT
Cellular computing is a discipline that deals with the analysis and modelling of real cellular processes for the purpose of computation. It essentially uses engineering principles to study and manipulate cells. This paper provides a short introduction to cellular computing. We also highlight underlying challenges and avenues of implementations of cellular computing.

KEYWORDS: *cellular computing, natural computing, parallel computing*

How to cite this paper*:* Matthew N. O. Sadiku | Nana K. Ampah | Sarhan M. Musa "Cellular Computing" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-6, October 2019, pp.479-480, URL: https://www.ijtsrd.com/papers/ijtsrd23385.pdf

IJTSRD23385

INTRODUCTION

Over the years, human beings have designed various machines to assist in daily activities. Inspiration from nature can lead us towards new and unconventional methods and tools. The biologically inspired design methods, evolution, and development, have been addressed as possible design methods for cellular computers [1]. Cybernetics assumes that most biological entities can be modelled as machines. A cellular computing system has been proposed as a new system architecture to end the dominance of conventional architectures.

Cellular computing (also known as computation in living cells) promises to provide new means for doing computation more efficiently-in terms of speed, cost, power dissipation, information storage, and solution quality. It is simply a synonym for parallel computing. It may serve as a "backend processor" to a conventional system or as a complete stand-alone loosely coupled system [2].

The field emerged in 1994 when Adleman demonstrated for the first time how a computation may be performed at a molecular level. Many results have been presented in this field during the past few years by computer scientists, biologists, and complexity theoreticians.

CONCEPT OF CELLULAR COMPUTING

The biological cell is the smallest independent, self-contained, and self-reproducing unit of any living organism. A cell is so complex that it may be regarded as a multi-layered system or "software system." A cellular computer is made of the basic modules which are connected in a regular way. Cells as well as their biological molecules (i.e. proteins, enzymes, etc.) can process information. A simplistic schematic comparison of the architecture of a computer and a cell is shown in Figure 1 [3].

A cell is an independently sustainable and self-replicating unit of any organism. At its heart, cellular computing consists of three principles: simplicity, vast parallelism, and locality [4].

Simplicity: The basic computational element in cellular computing is simply the cell. For example, an AND gate is simple.

Vast parallelism: Cellular computing involves parallelism on a much larger scale, with thousands of processors. To distinguish this huge number of processors from that involved in classical parallel computing, the term vast parallelism is used. The intrinsic parallelism of cellular computer can be used for solving hard problems in a feasible time.

Locality: Cellular computing is also distinguished by its local connectivity pattern between cells. A cell can only communicate with a few other cells, most of which are physically close. A local problem involves computing a property that can be expressed in purely local terms, as a function of the local cellular neighborhood.

APPLICATIONS

Cellular computing has only been investigated from the "top down" perspective. In this computing paradigm, individual cells perform a part of the computation communication taking place only between cells which are within a short distance from one another. Logic gates (NOT, XOR, AND, NAND gate) in cellular computing are constructed from networks of gene regulation in genomes [5].

The potential applications vary from reprogramming immune cells to fighting infections without inducing harmful side-effects. Cellular automata is the quintessential example of cellular computing. It consists of an array of cells. It is a true parallel interpretation for both development and behavior. It has been used to generate random numbers and perform binary addition. It has also have been applied as a model for studying phenomena in many fields such as physics, biology, and computer science. The state-of-the-art now uses multicellular complexes and engineered cell-cell communication.

CHALLENGES

The cellular computing principles are appealing from a hardware point of view.

Construction of cellular architectures involves an abstraction from the organisms in nature. The level of abstraction level is dictated by the realistic biological information in the model and the available computation power. A very interesting challenge is the creation of an artificial cell. Since cellular computing is different from the single sequential processor, new programming techniques are needed. Finding local interaction rules to solve global problems poses a challenge for the system designer.

Engineering the first digital control system into a living cell and engineering the system support for experimental cellular engineering into living cells have been challenging. These challenges must be addressed before cellular computing can become a mainstream paradigm.

CONCLUSION

A cellular system may function as a "backend processor" to a more conventional uniprocessor system or as a complete stand-alone functionally distributed loosely coupled system. Today's reconfigurable technology provides vast parallelism that may be exploited in the design of a cellular computer. More information on cellular computing can be found in books in [6, 7].

REFERENCES

[1] G. Tufte and P. C. Haddow, "Towards development on a silicon-based cellular computing machine," *Natural Computing,* vol. 4, 2005, pp. 387–416.

[2] J. Shao and G. E. Quick, "Implementation considerations of mapping lisp onto a cellular computer system," *SIGPLAN Notices*, vol. 20, no. 9, September 1985, pp. 87-93.

[3] D. Wang and M. Gribskov, "Examining the architecture of cellular computing through a comparative study with a computer," *Journal of Royal Society Interface*, vol. 2, 2005, pp. 187-195.

[4] M. Sipper, "The emergence of cellular computing," *Computer,* July 1999, pp. 18-26.

[5] J. Smaldon et al., "A computational study of liposome logic: Towards cellular computing from the bottom up," *System and Synthetic Biology*, vol. 4, no. 3, September 2010, pp. 157–179.

[6] M. Amos (ed.), *Cellular Computing*. Oxford Universirty Press, 2004.

[7] C. Baatar, P. Wolfgang, and T. Roska (eds.), *Cellular Nanoscale Sensory Wave Computing.* Springer, 2010.

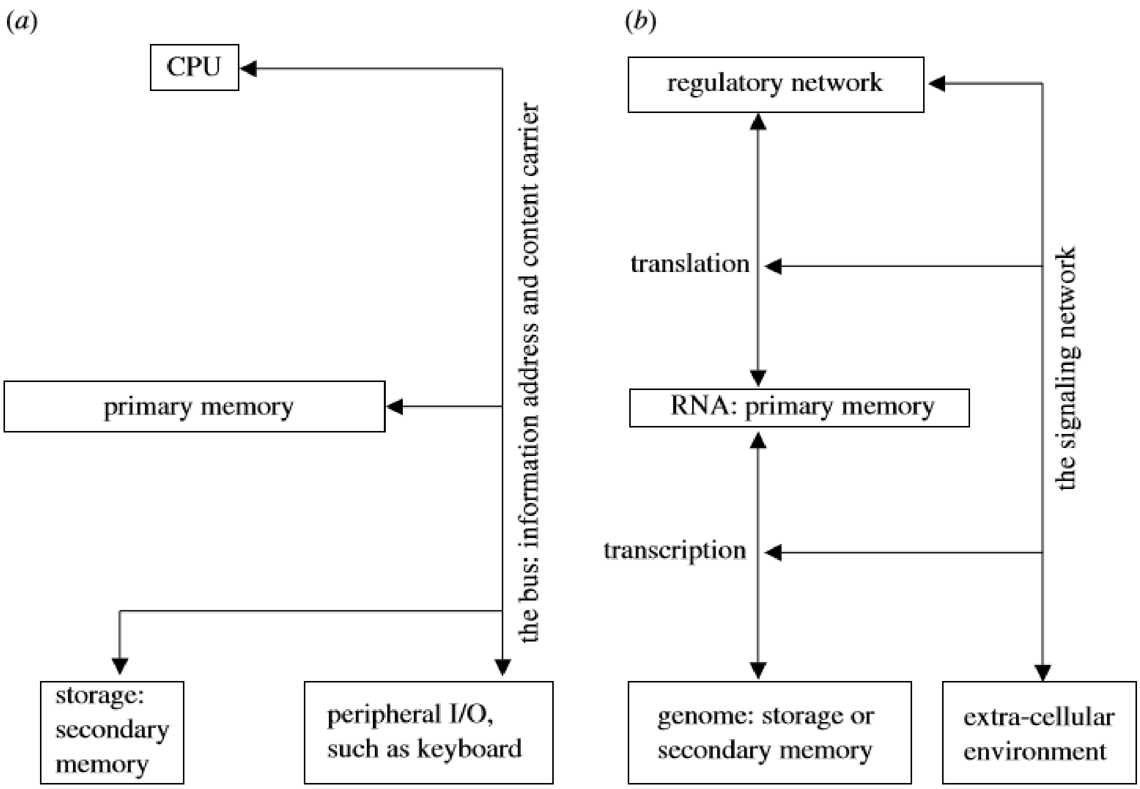

Figure1. A simplistic schematic comparison of the architecture of a computer (a) and a cell (b) [3]