



# BLUE BRAIN TECHNOLOGY

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**ABSTRACT**–Human brain is the most valuable creation of God. The man is intelligent because of the brain. “Blue brain” is the name of the world’s first virtual brain. That means a machine can function as human brain. Today scientists are in research to create an artificial brain that can think, response, take decision, and keep anything in memory. The main aim is to upload human brain into machine. So that man can think, take decision without any effort. After the death of the body, the virtual brain will act as the man .So, even after the death of a person we will not lose the knowledge, intelligence, personalities, feelings and memories of that man that can be used for the development of the human society.

**Keywords:** Nanobotes, Neurons, Sensory System.

## 1, INTRODUCTION

Human brain is the most valuable creation of God. The man is called intelligent because of the brain. The brain translates the information delivered by the impulses, which then enables the person to react. But we lose the knowledge of a brain when the body is destroyed after the death of man. That knowledge might have been used for the development of the human society. What happen if we create a brain and upload the contents of natural brain into it?

This BLUE BRAIN project was founded in May 2005 by Henry Markram at the EPFL in Lausanne, Switzerland. Goals of the project are to gain a complete understanding of the brain and to enable better and faster development of brain disease treatments. The research involves studying slices of living brain tissue using microscopes and patch clamp electrodes. Data is collected about all the many different neuron types. This data is used to build biologically realistic models of neurons and networks of neurons in the cerebral cortex. The simulations are carried out on a Blue Gene supercomputer built by IBM, hence the name "Blue Brain". The simulation software is based on Michael Hines's NEURON, together with other custom-built components.

### 1.1 Blue Brain – Definition

It would be the world’s first virtual brain. The IBM is now developing a virtual brain known as the Blue brain. Within 30 years, we will be able to scan ourselves into the computers. We can say it as Virtual Brain i.e. an artificial brain which is not actually a natural brain, but can act as a brain. It can think like brain, take decisions based on the past



experience, and respond as a natural brain. It is possible by using a super computer, with a huge amount of storage capacity, processing power and an interface between the human brain and artificial one. Through this interface the data stored in the natural brain can be up loaded into the computer. So the brain and the knowledge, intelligence of anyone can be kept and used for ever, even after the death of the person.

## 1.2 Need Of Blue Brain

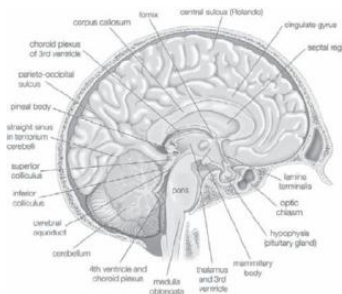
Human society is always in need of such intelligence and such an intelligent brain to have with. But the intelligence is lost along with the body after the death. The virtual brain is a solution to it. The brain and intelligence will be alive even after the death. We often face difficulties in remembering things such as people names, their birthdays, and the spellings of words, proper grammar, important dates, history facts, and etcetera. In the busy life everyone wants to be relaxed. Virtual brain may be a better solution for it.

## 1.3 Possibility

Many people believe firmly those we possess a soul, while some very technical people believe that quantum forces contribute to our awareness. But we have to now think technically. Really this concept appears to be very difficult and complex.

First, it is helpful to describe the basic manners in which a person may be uploaded into a computer. Raymond Kurzweil recently provided an interesting paper on this topic. In it, he describes both invasive and non-invasive techniques. The most promising is the use of very small robots, or nanobots. These robots will be small enough to travel throughout our circulatory systems. Traveling into the spine and brain, they will be able to monitor the activity and structure of our central nervous system. They will be able to provide an interface with computers that is as close as our mind can be while we still reside in our biological form. Nanobots could also carefully scan the structure of our brain, providing a complete readout of the connections between each neuron. They would also record the current state of the brain. This information, when entered into a computer, could then continue to function like us. All that is required is a computer with large enough storage space and processing power.

## 1.4 Natural Brain



**Fig: Natural Human Brain**

The brain essentially serves as the body's information processing centre. It receives signals from sensory neurons (nerve cell bodies and their axons and dendrites) in the central



and peripheral nervous system, and in response it generates and sends new signals that instruct the corresponding parts of the body to move or react in some way. It also integrates signals received with signals from adjacent areas of the brain, giving rise perception and consciousness. The brain weighs about 1500 grams (3 pounds) and constitutes about 2% of total body weight. It consists of three major divisions:

- The massive paired hemispheres of the cerebrum.
- The brainstem, consisting of the thalamus, hypothalamus, epithalamus, subthalamus, midbrain, pons and medulla oblongata.
- The cerebellum.

## **2, Functioning Of Natural Human Brain**

The human ability to feel, interpret and even see is controlled, in computer like calculations, by the magical nervous system. The nervous system is quite like magic because we can't see it, but its working through electric impulses through the body. One of the world's most "intricately organized" electron mechanisms is the nervous system. Not even engineers have come close for making circuit boards and computers as delicate and precise as the nervous system.

The three simple functions that it puts into action: sensory input, integration, motor output.

### **2.1 Sensory input**

When our eyes see something or our hands touch a warm surface, the sensory cells, also known as neurons, send a message straight to your brain. This action of getting information from your surrounding environment is called sensory input because we are putting things in your brain by way of your senses.

### **2.2 Integration**

Integration is best known as the interpretation of things we have felt, tasted, and touched with our sensory cells, also known as neurons, into responses that the body recognizes. This process is all accomplished in the brain where many neurons work together to understand the environment.

### **2.3 Motor Output:**

Once our brain has interpreted all that we have learned, either by touching, tasting, or using any other sense, then our brain sends a message through neurons to effector cells, muscle or gland cells, which actually work to perform our requests and act upon the environment.



**Fig: A single unit of neuron**

### 3, How Sensory Organs Work

#### 3.1 Nose

The smell reaches and travels to an olfactory bulb – a set of sensory nerves. The nerve impulses travel through the olfactory tract, around, in a circular way, the thalamus and finally to the sensory cortex of brain located between our eye and ear.

#### 3.2 Eye

Seeing action is conducted by the lens, which magnifies the image; vitreous disc, which bends and rotates the image against the retina, which translates the image and light by a set of cells. The retina with rods, cones and other cells and tissues at the back of the eyeball convert the image into nerve impulses which is transmitted along the optic nerve to the brain.

#### 3.3 Tongue

The microscopic buds with taste pore on the tongue convert the taste into a nerve impulse and the impulse is sent to the brain by a sensory nerve fibre.

#### 3.4 Ear

The sound waves reach the cochlea. Here the sound is divided into pitches. This organ transmits the vibration information to a nerve, which sends it to the brain.

### 4, Comparison between Natural and Simulated Brain:

By comparing the functions of natural brain with the simulation of electrodes it will be easy to build the blue brain.

Natural Brain	Simulated Brain
<p><b>INPUT</b> In the nervous system in our body the neurons are responsible for the message passing. The body receives the input by sensory cells. This sensory cell produces electric impulses which are received by neurons. The neurons transfer these electric impulses to the brain.</p>	<p><b>INPUT</b> In a similar way the artificial nervous system can be created. The scientist has created artificial neurons by replacing them with the silicon chip. It has also been tested that these neurons can receive the input from the sensory cells. So, the electric impulses from the sensory cells can be received through these artificial neurons.</p>
<p><b>INTERPRETATION</b> The electric impulses received by the brain</p>	<p><b>INTERPRETATION</b> The interpretation of the electric impulses</p>



from neurons are interpreted in the brain. The interpretation in the brain is accomplished by means of certain states of many neurons.	received by the artificial neuron can be done by means of registers. The different values in these register will represent different states of brain.
<b>OUTPUT</b> Based on the states of the neurons the brain sends the electric impulses representing the responses which are further received by sensory cell of our body to respond neurons in the brain at that time.	<b>OUTPUT</b> Similarly based on the states of the register the output signal can be given to the artificial neurons in the body which will be received by the sensory cell.
<b>MEMORY</b> There are certain neurons in our brain which represent certain states permanently. When required, this state is represented by our brain and we can remember the past things. To remember things we force the neurons to represent certain states of the brain permanently or for any interesting or serious matter this is happened implicitly.	<b>MEMORY</b> It is not impossible to store the data permanently by using the secondary memory. In the similar way the required states of the registers can be stored permanently and when required these information can be received and used.
<b>PROCESSING</b> When we take decision, think about something, or make any computation, logical and arithmetic computations are done in our neural circuitry. The past experience stored and the current inputs received are used and the states of certain neurons are changed to give the output.	<b>PROCESSING</b> In the similar way the decision making can be done by the computer by using some stored states and the received input and the performing some arithmetic and logical calculations.

## 5, Brain Simulation

### 5.1 Neuron:

The primary software used by the BBP for neural simulations is a package called NEURON. This was developed starting in the 1990s by Michael Hines at Yale University and John Moore at Duke University. It is written in C, C++, and FORTRAN. The software continues to be under active development and, as of July 2012, is currently at version 7.2. It is free and open source software; both the code and the binaries are freely available on the website. Michael Hines and the BBP team collaborated in 2005 to port the package to the massively parallel Blue Gene supercomputer.

### 5.2 Workflow Of Neuron:

The simulation step involves synthesizing virtual cells using the algorithms that were found to describe real neurons. The algorithms and parameters are adjusted for the age, species, and disease stage of the animal being simulated. Every single protein is simulated,



and there are about a billion of these in one cell. First a network skeleton is built from all the different kinds of synthesized neurons. Then the cells are connected together according to the rules that have been found experimentally. Finally the neurons are functionalized and the simulation brought to life. The patterns of emergent behaviour are viewed with visualization software. A basic unit of the cerebral cortex is the cortical column. Each column can be mapped to one function, e.g. in rats one column is devoted to each whisker. A rat cortical column has about 10,000 neurons and is about the size of a pinhead.

The latest simulations, as of November 2011, contain about 100 columns, 1 million neurons, and 1 billion synapses. A real life rat has about 100,000 columns in total, and humans have around 2 million. Techniques are being developed for multiscale simulation whereby active parts of the brain are simulated in great detail while quiescent parts are not so detailed.

Every two weeks a column model is run. The simulations reproduce observations that are seen in living neurons. Emergent properties are seen that they require larger and larger networks. The plan is to build a generalized simulation tool, one that makes it easy to build circuits. There are also plans to couple the brain simulations to avatars living in a virtual environment, and eventually also to robots interacting with the real world. The ultimate aim is to be able to understand and reproduce human consciousness.

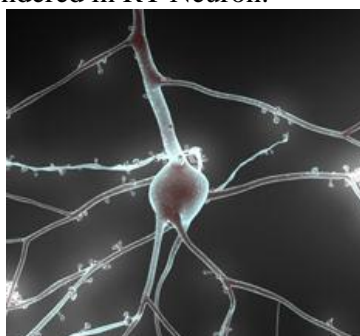
## 6 BBP-SDK:

The BBP-SDK (Blue Brain Project - Software Development Kit) is a set of software classes (APIs) that allows researchers to utilize and inspect models and simulations. The SDK is a C++ library wrapped in Java and Python.

### Visualisation Of Results:

## 7 RT Neuron

RT Neuron is the primary application used by the BBP for visualization of neural simulations. The software was developed internally by the BBP team. It is written in C++ and OpenGL. RT Neuron is ad-hoc software written specifically for neural simulations, i.e. it is not generalizable to other types of simulation. RT Neuron takes the output from Hodgkin-Huxley simulations in NEURON and renders them in 3D. This allows researchers to watch as activation potentials propagate through a neuron and between neurons. The animations can be stopped, started and zoomed, thus letting researchers interact with the model. The visualizations are multi-scale that is they can render individual neurons or a whole cortical column. The image right was rendered in RT Neuron.



**Fig: Visualisation Of RT Neuron**



### Computer Hardware:

The primary machine used by the Blue Brain Project is a Blue Gene supercomputer built by IBM. This is where the name "Blue Brain" originates from. IBM agreed in June 2005 to supply EPFL with a Blue Gene/L as a "technology demonstrator". The IBM press release did not disclose the terms of the deal. In June 2010 this machine was upgraded to a Blue Gene/P. The machine is installed on the EPFL campus in Lausanne (Google map) and is managed by CADMOS (Centre for Advanced Modelling Science).

The computer is used by a number of different research groups, not exclusively by the Blue Brain Project. In mid-2012 the BBP was consuming about 20% of the compute time. The brain simulations generally run all day, and one day per week (usually Thursdays). The rest of the week is used to prepare simulations and to analyse the resulting data. The supercomputer usage statistics and job history are publicly available online - look for the jobs labelled as "C-BPP".



Fig: Blue Gene/ P

### Blue Gene/P technical specifications:

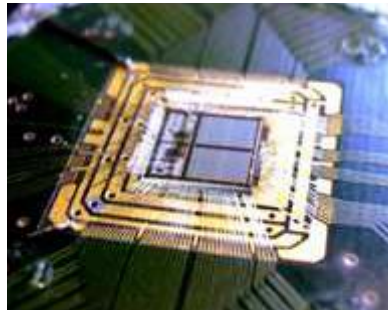
- 4,096 quad-core nodes.
- Each core is a [PowerPC 450](#), 850 MHz.
- Total: 56 teraflops, 16 terabytes of memory.
- 4 racks, one row, wired as a 16x16x16 3D torus.
- 1 PB of disk space, GPFS parallel file system.
- Operating system: Linux SuSE SLES10

This machine peaked at 99th fastest supercomputer in the world in November 2009.



Fig: Blue brain Storage rack

- Silicon Graphics: A 32-processor Silicon Graphics Inc. (SGI) system with 300 Gb of shared memory is used for visualization of results.



**Fig: 32-Processor**

- Commodity PC clusters: Clusters of commodity PCs have been used for visualization tasks with the RT Neuron software.

### **JuQUEEN**

JuQUEEN is an IBM Blue Gene/Q supercomputer that was installed at the Jülich Research Center in Germany in May 2012. It currently performs at 1.6 peta flops and was ranked the world's 8th fastest supercomputer in June 2012. It's likely that this machine will be used for BBP simulations starting in 2013, provided funding is granted via the Human Brain Project. In October 2012 the supercomputer is due to be expanded with additional racks. It is not known exactly how many racks or what the final processing speed will be. The JuQUEEN machine is also to be used by the research initiative. This aims to develop a three-dimensional, realistic model of the human brain.



**Fig: JuQUEEN Supercomputer In Germany**

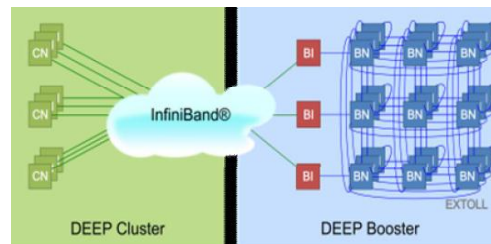
### **Deep - Dynamical Exascale Entry Platform**

DEEP (deep-project.eu) is an exascale supercomputer to be built at the Jülich Research Centre in Germany. The project started in December 2011 and is funded by the European Union's 7th framework program. The three-year prototype phase of the project has received €8.5 million. A prototype supercomputer that will perform at 100 petaflops is hoped to be built by the end of 2014. The Blue Brain Project simulations will be ported to the DEEP prototype to help test the system's performance. If successful, a future exascale version of this machine could provide the 1 exaflops of performance required for a complete human brain simulation by the 2020s. The DEEP prototype will be built using Intel MIC (Many Integrated Cores) processors, each of which contains over 50 cores fabricated with a 22 nm process. These processors were codenamed *Knights Corner* during development and subsequently





rebranded as *Xeon Phi* in June 2012. The processors will be publicly available in late 2012 or early 2013 and will offer just over 1 teraflop of performance each.



**Fig:**

### Uploading Human Brain

The uploading is possible by the use of small robots known as the Nanobots. These robots are small enough to travel throughout our circulatory system. Traveling into the spine and brain, they will be able to monitor the activity and structure of our central nervous system. They will be able to provide an interface with computers that is as close as our mind can be while we still reside in our biological form. Nanobots could also carefully scan the structure of our brain, providing a complete readout of the connections. This information, when entered into a computer, could then continue to function as us. Thus the data stored in the entire brain will be uploaded into the computer.



**Fig: Nanobot - Magnified**

### Applications Of Blue Brain:

1. Gathering and testing of 100 years data.
2. Cracking the neural code.
3. Understanding the neocortical information processing.
4. A novel tool for drug discovery for brain disorders.
5. A global facility.
6. A foundation for whole brain simulations.
7. A foundation for molecular modelling of brain function.

### Advantages:

1. We can remember things without any effort.
2. Decision can be made without the presence of a person.
3. Even after the death of a man his intelligence can be used.



4. The activity of different animals can be understood i.e. by interpretation of the electric impulses from the brain of animals, their thinking can be understood easily.
5. It would allow the deaf to hear via direct nerve stimulation, and also be helpful for many psychological diseases. By downloading the contents of the brain that was uploaded into the computer, the man can get rid of from the madness.

#### **Limitations:**

1. We become dependent upon the computer systems.
2. Others may use technical knowledge against us.
3. Computer viruses will pose an increasingly critical threat.

#### **Future Perspective:**

The synthesis era in neuroscience started with the launch of human brain project and is inevitable phase triggered by a critical amount of fundamental data. The data set does not need to be complete before such a phase can begin.

Detailed models will probably become the final form of databases that are used to organize all knowledge of the brain and allow hypothesis testing, rapid diagnoses of brain malfunction as well as development of treatments for neurological disorders. In short, we can hope to learn a great deal about brain function and dysfunction from accurate models of the brain.

A model of the entire human brain at the cellular level will probably take the next decade. As with deep blue, Blue Brain will allow us to challenge the foundations of our understanding of intelligence and generate new theories of consciousness.

#### **CONCLUSION**

In conclusion, we will be able to transfer ourselves into computers at some point. Most arguments against this outcome are seemingly easy to circumvent. They are either simple minded, or simply require further time for technology to increase. The only serious threats raised are also overcome as we note the combination of biological and digital technologies. While the road ahead is long, already researches have been gaining great insights from their model.

Using the Blue Gene supercomputers, up to 100 cortical columns, 1 million neurons, and 1 billion synapses can be simulated at once. This is roughly equivalent to the brain power of a honey bee. Humans, by contrast, have about 2 million columns in their cortices. Despite the sheer complexity of such an endeavour, it is predicted that the project will be capable of this by the year 2023.

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