Project AWAKE

„Analog Worlds and Artificial Kind Existence“

by

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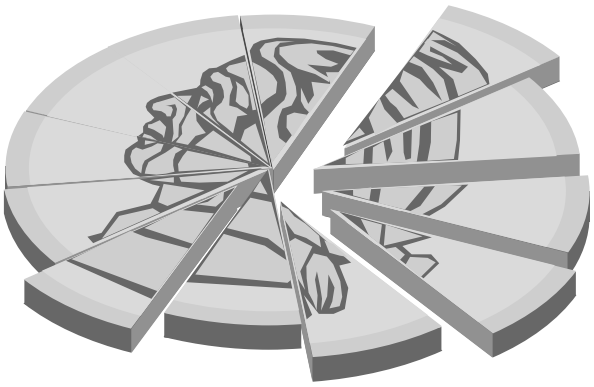

Part I. ***Business concept***

Part II. Technology overview

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PREREQUISITES

Type style

standard	- fluent text
CAPITAL LETTERS	- ACCENTUATION
bold	**- foreground**
italic	- *statement*
""	- quotation

Font color

black	- fluent text
red	- problem/error
green	- success
blue	- milestone

The following computer areas ought to be known in order to provide the best understanding:

1. theoretical models for data processing
2. hardware components
3. digital design and system architectures
4. software for operating systems
5. application development
6. application areas:
    a. as stand-alone tools
    b. as parts of different embedded systems like:
        - transport vehicles
        - artificial intelligence

Available documents

The following documents are available for this project:

1. **Business concept**, a detailed project description suitable for investors
2. **Technology overview**, about the developed technology, containing
    a. Collection. *"Men and machines"*, contents
    b. Paper One. AI, theoretical background
    c. Paper Two. The theory, concept presentation
    d. Book One. *"The actual problems in software development",* extract

Information reference

Internet links

Topic	Name	URL
Press	Finance	http://www.eejournal.com/archives/articles/20160323-fiduciary/
	Marketing	http://eejournal.com/archives/articles/20160531-x86/
	3D RAM	http://www.extremetech.com/computing/197720-beyond-ddr4-understand-the-differences-between-wide-io-hbm-and-hybrid-memory-cube
	FPGA SiP	http://www.eejournal.com/archives/articles/20130723-siliconcirc http://eejournal.com/archives/articles/20160525-coolingoff/
	Embedded systems	http://www.eejournal.com/archives/articles/20160127-devkits/ http://www.eejournal.com/archives/articles/20160112-embeddedvision/
Info	DSP	http://www.dspguide.com
PLD	FPGA	http://www.xilinx.com http://www.altera.com/
RAM	HMC HBM2 Wide IO2	http://www.micron.com http://www.skhynix.com/eng/product/dramHBM.jsp http://www.jedec.org/standards-documents/docs/jesd229-2
ASIC	FPGA to ASIC, 2.5 / 3D IC	http://www.easic.com http://www.esilicon.com/ http://www.tsmc.com/english/dedicatedFoundry/technology/future_rd.htm
	3D IC SiP SiCB ASIC	http://www.3d-plus.com http://www.xilinx.com/ http://zglue.com https://www.globalfoundries.com/
Board	COTS	http://www.ariradesign.com
Articles	Neural nets	https://en.wikipedia.org/wiki/Convolutional_neural_network https://en.wikipedia.org/wiki/Cellular_neural_network https://en.wikipedia.org/wiki/TrueNorth http://systemdesign.altera.com/neural-networks-rings-power/

PROJECT OVERVIEW

Investor relations

The topics

1. ***There are different methods known to achieve with computers artificial intelligence, AI***, from which the neural networks are the most likely one to represent the structure of a brain.
   The problem is the theory and the corresponding software. It is still unknown how individual elements build complex systems, in order to receive and process information.
2. For several decades people have speculated about ***a general-purpose FPGA-based computer system.*** Nowadays ***FPGAs can process up to hundreds of thousands tasks in parallel on a single chip (=IC).*** It is very difficult to write such programs for parallel processing, due to the involved high complexity. The best thing achieved are ***only*** some very specific applications in VHDL for only one single purpose, like usually some new video codec specifications for TV broadcast and telecommunication services or mainly used as "number crunchers" in order to process mathematical algorithms via many multipliers.

   There are the SAME problems as for AI.

The author

I am a computer technical specialist with 30 years of international experience in software development in Europe, USA and Asia. As a project leader, development manager, trainer, consultant and developer I am working in several countries for many companies from different branches of business with a variety of concepts and technologies for all types of computers.
I spent about 10 years on computer research and the result is ***a new computer technology*** as described in my writings called *"Men and machines"*, consisting of 6 books and 18 dissertations.

The business

In the mean time I can convert all my knowledge into the following real software product:

"Artificial intelligence with BASIC thinking capabilities by simulating different brain structures"

as software applications in a high performance multiple processor FPGA-based computer system .

In analogy with the real world, where intelligence is embedded within living organisms,

There are the following 3 levels of complexity for brain structures:

1. Insects, with max. 1 M neurons
2. Mammals, with max. 1 G neurons
3. Primates, with max. 100 G neurons

However, the total numbers of required digital neurons for an ANS is much smaller.

Goals and possibilities

The product

Cell automatons define a processing space, where all data is processed parallel and simultaneously.
The basic problem is the coordination and communication between the cells within the given space.
Conventional neural networks process data structures "similar" to existing living biological neuronal tissue, but the data values are unfortunately based on the statistics of the examples for a single particular task and besides this, produced with an external program. **There is no embedded self-learning mechanism.**

The SUMMARY of my research is:
Cell automatons and neural networks have a high potential, yet their actual use is unsatisfactory.
IF these two theoretical models are merged into a new one and extended with a time dimension,
THEN different brain structures can be simulated as software applications in a computer system.

Due to the fact that this computer system will have to:

1. ***process huge data streams***, CONTINUOSLY using millions of parallel processing engines;
2. ***in real-time mode***, ALWAYS providing acceptable processing and respond times;
3. ***all-the-time***, WITHOUT depending on mandatory external interference;
4. ***stand-alone***, ONLY performing its self-learning mechanism;

the traditional and wide available processor-plus-software solution is absolutely NOT feasible,
instead a FPGA-based hardware-only design will be used to facilitate all the mentioned features.

A software package with the new technology specifically designed for parallel and real-time tasks
is the "equivalent" to an operating system used for computers with ONLY one execution engine.
The software is hardware dependent, so the system architecture and the components are crucial!

The GOALS of this project are:

1. ***the implementation of AI as applications for FPGA-based computers***
2. ***the integration of these computers in ready-to-use embedded systems***

The hardware

The project has high requirements for components as well as for the system architecture, such as
reuse of hardware, software and application components; high execution speed with massive parallel real-time processing; huge distributed memory capacity; scalable and clustered systems, network connectivity, flexibility, modularity, ready to use and easy to maintain product, etc.
The proposed architecture is modular, consisting of several main boards.
The number of boards is scalable and they are connected altogether in a specific way, namely vie Ethernet.
This system architecture is flexible for various hardware configurations AND processing modes.
Regarding other system architectures, there is no standard for FPGA computers, all actual boards and systems are self-made, some need a PCI interface and are called **COTS**, **C**ommercial **O**ff **T**he **S**helf.

Application fields

The application fields for artificial intelligence are numerous, like:

1. ***industrial facilities***; for administrating complex real-time processes
2. ***transport***; for using auto pilots
3. ***automation***, for using robots

Current status

Actual status in robotics

USA and Japan are the leading nations, they are spending without remorse tremendous financial budgets. Furthermore, Japan wants to build up a new industry with robots, the trade volume for this branch is estimated with USD 25 billion/year, the government installed a special commission only for this purpose, located at the famous MITI, where all vital decisions are taken for the Japanese industry.
The social acceptance for robots is growing very fast. The city of Fukuoka allows robots to walk unleashed, Japanese people and especially women and kids are fond of any mechanical, electrical or software creatures, like dogs, cats, etc., they believe each of them has a soul and are considered as living creatures.
Big US companies also try their luck either by founding "AI competence centers" or by buying the most promising startups, but ***with little or no success at all***. As the latest example shows, Google bought a robot company called Boston Dynamics, but now, they want to sell it, because no money can be expected for this investment, due to the lack of "useful" products. Even the Wall Street has doubts in making money with AI.
Therefore the related question is: Where are the results spending all this money trying to talk to machines?
The most important annual fare for robotics is Robodex. seeing the presented products there is nothing new, ***only some very expensive toys for public relations, which can be rent for a price about USD 1 million/year***.
The expectations were higher than the presented products. As a matter of fact, ***there is no progress***, on the contrary there are too many obstacles and nobody has any answers to the great number of raised questions.
There is not even a theoretical model for AI, only the requirements were well defined, many decades ago.

Current project status

In order to build a robot with basic thinking capabilities the following things are ready:
the AI theory, the technical concept, the corresponding hardware architecture, the design of the software framework, the corresponding application structure and all 3 levels of complexity for the final products.
Currently a feasibility study is in progress by using VHDL and FPGA development boards from Xilinx.

Boards with the desired hardware architecture are today not available, ***there are some "similar" products***.
But these "***similar"*** COTS boards are not modular, contain multiple high performance Xilinx FPGAs on interconnected cards and boards, provide usually a PCIe interface and cannot work in embedded systems.
When using these similar boards to build a prototype, some features will be lost or cannot be implemented!
The costs for a working prototype using adequate ASIC are quite high, min. USD 100 million. But, a feasibility study containing only a pre-defined structure with level 1 by using it as an embedded system with a VHDL operating system and some applications, is in fact the same as a common prototype with level 1, namely it will demonstrate the theory, the concept and the neural net based ANS within the FPGA SiP.

Business conclusion

The general situation is the following:

1. ***There is enough money, will and acceptance for robots with artificial intelligence***
    a. the industry, the governments as well as the common people
    b. everybody is sure that this step can be achieved and should be done
2. ***Concerning the use of robots, the plans are ready, they should do the work, which:***
    a. is exhausting, dangerous or annoying for humans
    b. requires accurate reaction times in different environments
3. ***The actual technical level of the computer industry is capable of:***
    a. providing processing components with acceptable performance
    b. building corresponding computer systems with the necessary flexibility

Yet the breakthrough know-how is missing in order to allow a substantial achievement of this kind.
This new computer technology is the missing link in the equation, also for parallel processing software.

PRODUCTS

This product will be a complete autonomous system with the corresponding connected devices.
As soon as the system is powered up, the AI applications will run without any user intervention.
The accumulated knowledge will be stored automatically in certain periods of time, daily or weekly.
The hereby learned know-how does not need any supplementary computer capacity!

Background

Intelligence can only exist in an environment as being part of an object with a certain given structure.
An object receives different types of signals from the outside world by using specific sensors, which will transform these signals into internal information and send them further to the embedded body intelligence. The intelligence will process the information and will generate a response to this stimuli by sending new information to specialized body components, which on their side will cause a body reaction, forming a cycle.
This is the process we know today about biological intelligence, from insects via mammals to humans.

Some **FACTS** become obvious in this case:

1. There is an environment containing many objects of different size and complexity.
2. There are some objects, consisting of different connected components.
3. Inside certain objects there is a specialized component, which does intelligence.
4. The structure of intelligence is given by certain elements, which build a system as networks.
5. The purpose of every intelligence is the cooperation with all the other body components, by performing its own specific tasks; means receive, process and send information.

Intelligence is a system of elements connected to other components of a certain given body.
Intelligence is always active, means the processing is real-time, all-the-time and stand-alone.

In analogy to a real world environment with some objects inside, consisting of several connected components, this software creates a cyber-space called Analog World, ***AW***, containing several different neural networks. They are building together a closed system of elements, which is connected to the given hardware devices. The system functionality and purpose is to do intelligence by processing information with the same mechanism just like every biological organism, while using all the adjacent input and output components. This is an equivalent to a biological nervous system, hereafter referred to as ***ANS***, artificial nervous system. By placing the ***ANS in a "body"***, e.g. a vehicle or a house, then we have an artificial intelligent creature***, AIC***. The ***AIC is peaceful***, means it has no pre-defined aggressive instincts, it is an artificial kind existence***, AKE.*** Starting with ***AW*** and ending with ***AKE***, the result is *Analog Worlds and Artificial Kind Existence*.

A comparison between a biological life form and an AKE is appropriate, desired and also very useful.
Depending on the specific body structure, its corresponding possibilities and the adjacent embedded ANS, only with the basic logic capabilities needed to administrate and coordinate the body components for a general purpose containing the related tasks in a real-time mode, we can categorize AKEs as:

No.	Type	Purpose (usage)	Artificial "body"	Biological "equivalent"
1	Administrator	Administrative work	plant, facility	insect colony with territory
2	Navigator	Automatic pilot	ship, car, plane	fish, mammal, bird
3	Android	Autonomous work	(human) robot	human, with different levels of education

A lot of biological logic still needs to be researched and understood, analyzed, implemented and tested, before it can be transformed into suitable functionality and technically applied, this means:
BASIC thinking capabilities can be implemented*, even if higher and very complex ones are also possible.*

Description

The ANS of an AKE has some features, which build the basis for all its other capabilities:

1. **a short and a long term memory**, enables **recognition**
2. **a self-learning mechanism**, enables **accumulation of knowledge**, can be turned off on demand
3. **adaptation to the environment** - of its action - as a result of the first two

What kind of basic thinking capabilities can be expected an AKE to have?

There are 2 major factors, which decide about this matter:

1. **the body, the connected devices,** meaning what physical possibilities an AKE has
   a. **input devices**, e.g. cameras, microphones, sensors, etc.
   b. **output devices**, e.g. loudspeakers, etc.
   c. **internal devices**, e.g. sensors, etc.
2. **the mind, the corresponding logic,** meaning what is the purpose of an AKE
   a. **basic pre-defined capabilities**, depending on the connected devices
      - audio processing
      - video processing, according to the device data, e.g. white/black, colored
      - locomotion, according to its output devices working as acors
   b. **extended capabilities**, as a result of the basic features and pre-defined capabilities
      - direct internal-output reflexes, e.g. expressing own needs like hunger
      - direct input-output coordination of actions
      - search certain objects in a given environment, e.g. search for food
   c. **basic thinking capabilities**, as a result of the training
      - basic association logic
      - communication with other intelligent individuals using a small vocabulary with a reduced grammar, e.g. a primitive language

Higher mental functions like abstract thinking and consciousness need additional space.

Functionality

After the body is assembled and active, the corresponding specific software will be uploaded and installed. The initial data is similar with the pre-defined knowledge of a new born biological organism, e.g. a kid, therefore a certain period of time will be needed to train the AKE in order to adapt itself to the environment. The learning process is achieved by establishing new connections between the neurons.

The time needed for the AKE is not as long as for life forms. Why? There are several reasons for this.

1. the AKE will not grow because the body development is not needed, it is finished
2. the AKE consumes only electric energy or other energy type, means no nutrition exchange
3. the ANS of and AKE is by far not as complex as a biological central nervous system
4. 4. the speed of establishing new connections between neurons is much higher for an AKE.

Depending on the purpose, different knowledge is needed, which will be accumulated during its training, which consists of specific know-how and environment. It is expected that the AKE will need only a few months, depending on the ANS complexity, to achieve a satisfactory development, in order to be ready.
Once the whole development is completed, copies of the ANS structure can be made and implemented ONLY into other identical bodies, since the ANS of an AKE is very body specific.
Due to the fact, that the self-learning mechanism can be turned on or off, it is possible to deliver systems without this basic feature or only partially connected e .g. only to short or long term memory.

MARKETS

Actual embedded systems

The intelligence of actual embedded systems is always "hardwired", means the logic is programmed for a specific task of a before well-defined purpose and cannot be transferred to other different fields of activity. The logic inside is entirely ***"handmade"***, means by people, ***there is no self-learning mechanism at all***. Besides this, ***the "logical connectivity" with other "intelligent" systems is also absolutely not available***, which could and should enable an ***"exchange of logic between systems with different internal structure"***.
There is no format for storing artificial intelligence, NOT EVEN a theoretical definition of logic.
There are by far no theories or artificial systems neither at the present time nor possible in the near future, which could fulfill all the features and capabilities of a previous described AKE, not even approximately.

Intelligent embedded systems

The need of embedded systems with AI containing an interface accessible for humans is highly desirable. The on-board logic is today an important criteria for customers to buy and use such future embedded systems. The actual problems like hot-lines, time expensive diagnosis, special tools for maintenance of HW and SW, "Chinese written" user manuals or difficulties with the remote control will and should gradually disappear. The training of high specialized personnel and the corresponding simulators will lose their actual necessities.

Customers

The customers, which these products will supply are of an industrial nature,
means ONLY companies will be delivered, no common individuals.
The **possible countries** are as follows:

a. USA/Canada
b. Japan, China, South Korea, Singapore
c. EU countries

The **possible customers** for this project are from the following branches:

a. industrial facilities, e.g. plants for manufacturing
b. transport, e.g. aviation, naval
c. communication

Each customer has:

a. needs and finance
b. intentions and plans
c. information and opinion

Concerning high tech products, the customers can be categorized by their buying attitude and corresponding shares of the market as:

No.	**Attitude**	**Market %**
1	Buy the best product	5
2	Buy a good product	20 – 25
3	Buy the cheapest product	70 – 75

The **groups of customers for this project are** clients with:

1. a need for such products
2. high financial possibilities
3. willing to buy the best and most innovative products available

SALES AND DISTRIBUTION

Benefits and advantages

What would happen if a driver/pilot would be replaced by an artificial intelligence?

1. The vehicle would look different.
    a. there would be no cabin necessary
    b. the fuel consumption would be less than before
2. There would be no employee.
    a. no salary
    b. no social insurance
    c. no qualification problems
    d. no regulations for how much time one would be allowed to work
    e. no illness cases
    f. no strikes for more money
    g. no social problems with other people
    h. no legal problems with authorities
    i. no influence from outside or inside

This means: the costs would go down and there are new possibilities.

Of course, NOT every activity can be performed by an artificial intelligence, e.g. art, fashion, design, etc.

Prices

The price for a certain product is established usually by some given factors:

1. the product
    a. purpose and quality
    b. benefits and advantages
    c. influence and possibilities
2. the costs
    a. materials and components
    b. development and production
    c. transport and advertising
3. the profit
4. the market
    a. delivered quantity or amount
    b. similar products available
    c. government regulations

Each of these factors can have different values in this equation, e.g. positive, negative or zero.

For calculating the complete price for an ANS, there are 2 main components:

1. Hardware, depending on the hardware supplier
2. Software, provided by the computer company

The price for the ANS hardware will depend on the needed hardware configuration.
The price for the ANS software will depend on the required configuration.
For possible configurations, please see the next page with AKE types.

The complete price for such an ANS will be in any case at least € 1-100 million, depending on its complexity.

Product catalogue

Components

A complete AKE will consist of the following components:

No	Component	Description
1	Body with specific devices	e.g. vehicle with engine
2	Body hardware ANS	FPGA-based system
3	Body hardware ANS connected devices	Analog, serial, digital, etc.
4	Body software ANS initial data	Pre-defined knowledge
5	Body software ANS trained	Accumulated knowledge

ANS connected devices

No	Name	Type	Description
1	Standard	Serial/digital input/output	Audio, Video, audio, sensors
2	Extended	Analog and wireless	scanners, WLAN, Satellite / LTE / 5G

Size

No	System size	No of processing ICs
1	Small	n.n.
2	Medium	n.n.
3	Large	n.n
4	Huge	depends on the contained knowledge

Each processing IC will have adjacent memory, as RAM and NVRAM.

Types

The products can be delivered in ***different ANS configurations***, depending on the required:

1. **ANS interfaces**, to connected devices
2. **ANS specialty**, pre-defined knowledge and accumulated knowledge
3. **ANS features**, self-learning mechanism turned on/off, connected to short/long term memory
4. **ANS size**, depends on interfaces and specialty

No	AKE type	Connected devices			ANS Specialty	ANS size
		Input	Output	Internal		
1	Administrator				Plant	
2	Navigator				Auto pilot	
3	Android				Autonomous	

- the blank cells are currently not known, their value will be filled after the prototype is completed

REQUIREMENTS

Technical

1. developers, FPGA development in VHDL
2. location, working space, tools and all other necessary conditions
3. FPGA-based system, "**similar" COTS product** versions made by external supplier

No	Size	Amount	No of boards	No of processing ICs
1	Small	1		
2	Medium	1		

COMPANY DEVELOPMENT

Under these circumstances, the following assumption can be made:

Phase 1
Year 1 - 2 Development of the feasibility study with level L1 using FPGA SiP

Phase 2
Year 3 - 4 Development of the prototype with level L2 using FPGA SiP

Phase 2
Year 5 - openDevelopment of final products by using dedicated ASICs

For the final products, FPGAs will be replaced by own proprietary ASICs, preferably by pre-defined chips, like the Nextreme products from eASIC, or using FD-SOI with 22/12 nm technology from Global Foundries.

Regarding the final ASIC, there are different possibilities to achieve this:

1. **ASIC, only as standalone logic IC, directly converted from FPGA design**
2. **ASIC, as PoP, Package on package, to be used in conjunction with RAM, e.g. LPDDR4**
3. **SiP, as System in Package, as ASIC + full HBM as bare die**
4. **SiP, as Sytem in Package, as ASIC + part HBM as bare die, where the HBM contains only the RAM dies but without the adjacent logic die, which will be replaced by the ASIC**
5. **3D IC, similar to SiP**
6. **MCM, as multiple bare die SiPs placed next to each other in one package**
7. **SiCB, Silicon Circuit boards, similar to using Silicon Interposers**

Regarding ready made products for sales and distribution, kindly see the corresponding company URL.