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9th IEEE EAST-WEST DESIGN & TEST SYMPOSIUM (EWDTS 2011)

Sevastopol, Ukraine, September 9-12, 2011

The main target of the IEEE East-West Design & Test Symposium (EWDTS) is to exchange experiences in the field of design, design automation and test of electronic circuits and systems, between the technologists and scientists from Eastern and Western Europe, as well as North America and other parts of the world. The symposium aims at attracting attendees especially from the Newly Independent States (NIS) and countries around the Black Sea and Central Asia.

We cordially invite you to participate and submit your contribution(s) to EWDTS'11 which covers (but is not limited to) the following topics:

- Analog, Mixed-Signal and RF Test
- Analysis and Optimization
- ATPG and High-Level TPG
- Built-In Self Test
- Debug and Diagnosis
- Defect/Fault Tolerance and Reliability
- Design for Testability
- Design Verification and Validation
- EDA Tools for Design and Test
- Embedded Software Performance
- Failure Analysis, Defect and Fault
- FPGA Test
- HDL in test and test languages
- High-level Synthesis
- High-Performance Networks and Systems on a Chip
- Low-power Design
- Memory and Processor Test
- Modeling & Fault Simulation
- Network-on-Chip Design & Test
- Modeling and Synthesis of Embedded Systems
- Object-Oriented System Specification and Design
- On-Line Test
- Power Issues in Testing
- Real Time Embedded Systems
- Reliability of Digital Systems
- Scan-Based Techniques
- Self-Repair and Reconfigurable Architectures
- Signal and Information Processing in Radio and Communication Engineering
- System Level Modeling, Simulation & Test Generation
- Using UML for Embedded System Specification

CAD Session:

- CAD and EDA Tools, Methods and Algorithms
- Design and Process Engineering
- Logic, Schematic and System Synthesis
- Place and Route
- Thermal, Timing and Electrostatic Analysis of SoCs and Systems on Board
- Wireless Systems Synthesis
- Digital Satellite Television

The EWDTS'2011 will take place in Sevastopol, Ukraine. Sevastopol is a port city, located on the Black Sea coast of the Crimea peninsula. The city, formerly the home of the Soviet Black Sea Fleet, is now home to a Ukrainian naval base and facilities leased by the Russian Navy and used as the headquarters of both the Ukrainian Naval Forces and Russia's Black Sea Fleet.

The symposium is organized by Kharkov National University of Radio Electronics in cooperation with Sevastopol National Technical University and Tallinn University of Technology. It is technically co-sponsored by the IEEE Computer Society Test Technology Technical Council (TTTC) and financially supported by Virage Logic, Synopsys, Aldec, Kaspersky Lab, DataArt Lab, Tallinn Technical University, Cadence.

CONTENTS

Cybercomputer for Information Space Analysis

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Abstract

This article describes an infrastructure and technologies for analyzing information space, based on virtual cybercomputer. A model and metrics for cyberspace, where subjects are the interacting processes or phenomena with the physical carrier in the form of computer systems and networks, are proposed. The structural model of high-speed multimatrix processor designed for fast and accurate search of information objects in cyberspace is described.

1. Cyberspace analysis for searching, recognition and decision-making

A new personal or individual model of cyberspace in the form of virtual personal cybercomputer (VPC) emerges. Its parents may be on the one hand the real nanotechnology and digital systems-on-chips, and on the other one the virtual services for storage, processing and reception-transmission of information. The cause of appearing this model in the market is determined by follows: 1) the need to create "individual or personal virtual computer or space", which can not be lost or stolen; 2) unwillingness of users and the high cost of information and service duplication, if it has a few gadgets (tablet, smartphone, laptop); 3) high storage reliability and security of personal data and service throughout the life of the user. These conditions can only provide an individual cell in a "Swiss bank", which should and will be implemented in the next three years for each person on the planet in the form of Personal Cyberspace Cell (PCC). Two points of view in their development converge on a single concept, PCC = VPC, first comes from the side of cyberspace (computer science), the second – from the personal computer (computer engineering). Almost the complete absence of disadvantages PCC has the following advantages: 1) Functional invariance with respect to any hardware interface, connecting the user with the cyberspace. 2) Friendliness and intellectual adaptability to user on the format 24 hours / 7 days throughout his(her) live. 3) Authentication of user and PCC with respect to cloud and other services in cyberspace, which is now focused to dedicated hardware. 4) Reliability and availability, persistence and security of PCC, tolerance and physical invulnerability, due to its virtuality. 5) Effective relational structuring of data and services with intelligence to search, recognition and decision making. 6) High market appeal of ciberbanks and PCC formats (templates, standards), which are focused to needs of each person on the planet, in terms of money amounts to hundred billion dollars. 7) The ability to create virtual prototype of personal cybercomputer by limited number of promoted companies, which have access to the World Market, and two or three universities. 8) The estimated cost of such work to create the initial infrastructure for cyberspace banks is 0.5 – 1.5 billion dollars.

Purpose of this article is creation of the individual and virtual computer in cyberspace for intelligence transactions of data and services, focused on each person. The problems are: 1) Defining the functional infrastructure for virtual PCC. 2) Creating a structured database for storing information and services. 3) Developing a PCC template as a set of related services and tools focused to the needs of the user. 4) Developing a system for protection of personal cyberspace, data and services, including authentication, keys, digital signature, cryptography. 5) Creating intelligent tools for searching, pattern recognition and decision making as a set of filters, focused to a specific user. 6) Developing PCC prototype and its testing for different kinds of users. 7) Offering prototype to the companies, which have access to the market of electronic technologies, as well as public relations through Internet, TV, conferences and seminars.

References: Cyberspace and its analysis for searching information [1-5]; Hardware engines for high-speed information retrieval [6-10]; Synthesis of computer structures and functionalities [11-13].

The essence of the research is creation of the infrastructure for optimal organization of the individual cyberspace as a virtual computer with the following services: 1) e-mail and telephony; 2) Internet-browsers for searching, recognition and decision making; 3) audio and video players; 4) text and sound editors; 5) electronic banking and shopping; 6) individual business browser for the organization of working days; 7) browser for the management of holidays, culture and sport; 8) traveling browser; 9) structured relational database to store the history and all types of data; 10) external interface Public Relations; 11) medical care and services; 12) comprehensive security system for information and services.

Cybercomputer (personal and virtual) is virtual mapping functions of personal computer in cyberspace to perform intelligent transactions between data and services, individually focused on each person.

Cyberspace is a collection of interacting in metrics information processes and phenomena using computer systems and networks as a carrier. Metrics is a way to measure distances in space between the components of the processes and phenomena. Distance in cyberspace is xor-interaction of processes or phenomena components, represented by vectors, which have a scalar projection in the form of Hamming distance. Distance invariants are derivative, the degree of change, differences or similarity of the process or phenomenon components.

2. Evolution of cyberspace and Internet

To create a circuit that implements useful functionality, it should generate the primitives $P = \{P_1, P_2, ..., P_i, ..., P_n\}$ of the lowest level. To do this, it is necessary to create the filters $F = \{F_1, F_2, ..., F_j, ..., F_m\}$, which generate tables of primitive relations, taken from the information space of the world (Fig. 2).

The following blocks are represented here: Hu – user; $P = \{Da, Ho, Bu, Tr, So, Sh, Em, Sk, In, Ps, Mo, Pi, He, Ed, Co, Ba\}$ – Data, Home, Business, Traveling, Social, Shopping, E-mail, Skype, Infrastructure, Program services, Movie, Pictures, Health, Education, Conferences, Banking; $G = \{Sm, An, Iph, Ipa\}$ – Smartphone, Android, Iphone, Ipad. Having a standardized data structure for the individual portals and browsers, delivering new services with better performance, we should expect a gradual improvement of the quality for all cyberspace components. The final goal of such mutual and positive impact of the cyberspace infrastructure elements is developing common standards for interfaces and transformation of cyberspace into self-developing intelligent information and computing ecosystem.

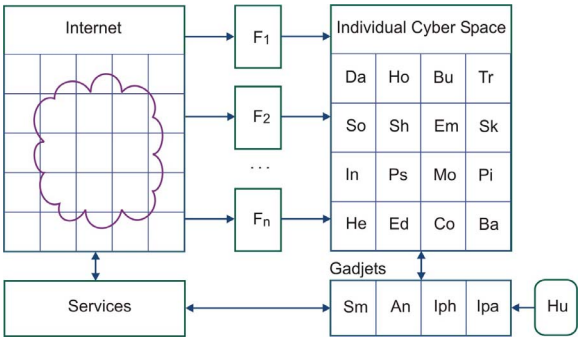

Fig. 1. Evolution of cyberspace and Internet

A typical two-level filter of messages for a particular user is shown in Fig. 2. It is focused on processing three kinds of letters: positive, negative and ambiguous (gray), which have to fall into the black or white (WS) pool. The idea of spam filter (SF) is detection of negative network mail by function And for every user and positive messages by function Or. All other ones fall into the gray area (X), which is constantly modified.

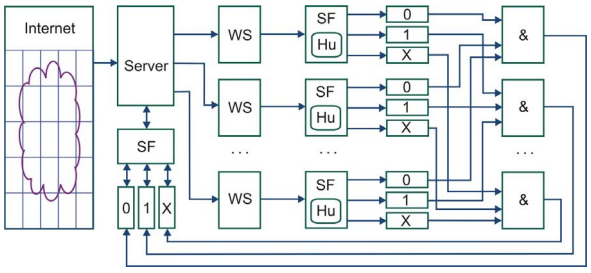

Fig. 2. Filter of network messages

Each message must be assigned to one of three pools (matrices): $L = \{L^0, L^1, L^x\}$ – positive, negative, ambiguous (unknown state). The corresponding libraries $B = \{B^0, B^1, B^x\}$ have the signatures in the form of a binary vector that specifies the membership relation for each message to the test parameters of spam recognition. During training Antispam system the spam func-

tion table (SFT) is generated that is open to the completion:

$$B = \left|B_{ij}\right| = B \times T,\ B = (B_1, B_2, ..., B_j, ..., B_n),$$
$$T = (T_1, T_2, ..., T_i, ..., T_m).$$

To determine the membership for a new message m in one of the message library types L the following criterion is used:

$$L = L \vee B_j \leftarrow \sum_{i=1}^{n} (B_{ij} \oplus_{i=1}^{n} m_i) = (0 \vee \min).$$

It defines the code distance by successive comparisons a new message and each component of three libraries. A simple multimatrix processor allows performing these logic operations in parallel. In operation of Anti-spam system each gray message is checked for the membership of two deterministic pools, which are constantly modified by updating the criteria by taking into account the user experience.

The presence of filters allows automating time-consuming processes for creating basic primitive libraries. With the specification of Fig. 3, presented after processing the verbal description in the form of a vector of input and output variables, it is easily to describe a strategy for building new functionality as the coverage problem by the library elements of the generalized vector <X,Y>.

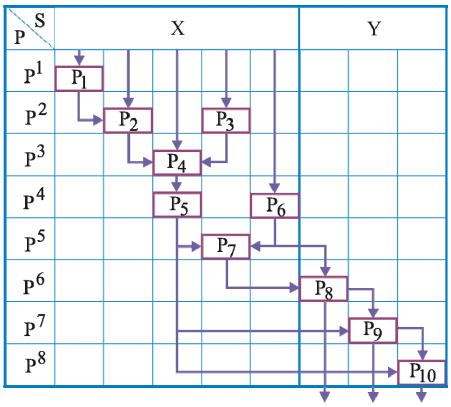

Fig. 3. Synthesis of specification coverage by primitives

The general solution of the problem is similar to the synthesis of an automaton model that defines the interaction of components in time and space. However, variety of not previously defined primitives excludes the possibility that means the necessity transition from strict determinism of digital automaton to the field of evolutional and deterministic solutions. At that the intelligence f is formulated as two functions (g– creation and h–repetition), where C, R – the processes for creating and repeating; N, L – the primitives (new and existent ones):

$$I = f(C,R) = C \oplus R;$$
$$1) C = g(R,N) = R \oplus N;$$
$$2) R = h(C,L) = C \oplus L.$$

1) Generation of the original functionality in the form of a specification vector for new useful for human or computer services. 2) Synthesis of a functional structure by covering the essential variables of the specification vector by minimal set of primitives from available libraries of the world to form the output vector of useful properties. Repeating the above two items to create a new primitive functionality necessary to solve the coverage problem. Two development spirals of the cyberspace subject are obvious. One goes up, towards the creation of new structural specifications. The second one goes down towards the creation of new primitives that indicates the appearance of original technologies.

3. The cyberspace metrics

Suppose there are a finite number $n \neq 0$ of points in the space, closed a cycle, where each one is specified by a binary vector of the length k:

$$A = (A_1, A_2, ..., A_i, ..., A_n) = \{(a_{11}, a_{12}, ..., a_{1j}, ..., a_{1k}),$$
$$(a_{21}, a_{22}, ..., a_{2j}, ..., a_{2k}), ..., (a_{i1}, a_{i2}, ..., a_{ij}, ..., a_{ik}), ...$$
$$..., (a_{n1}, a_{n2}, ..., a_{nj}, ..., a_{nk})\}, a_{ij} = \{0,1\}.$$

The distance between two points is determined as:

$$d_i = d_i(A_i, A_{i+1}) = a_{i,j} \oplus_{j=1}^{k} a_{i+1,j}.$$

The metrics β of cybernetic or vector logic binary space is determined by zero xor-sum of the distances d_i between the non-zero and finite number of points in the cycle:

$$\beta = \oplus_{i=1}^{n} d_i = 0. \qquad (1)$$

In other words: the metrics β of cyberspace is zero xor-sum of the distances between finite number of points, closed in a cycle. The sum of k-dimensional binary vectors, specifying the coordinates of the cycle points, is equal to zero.

The metric β of the vector logical multivalued space, where each coordinate is defined in the alphabet that constitutes the boolean $a_{ij} = \{\alpha_1, \alpha_2, ..., \alpha_r, ..., \alpha_m\}$, is

symmetric difference of distances between finite number of points closed in a cycle, and equal to the empty set:

$$\beta = \underset{i=1}{\overset{n}{\Delta}} d_i = \varnothing ,$$

Δ	0	1	x	∅
0	∅	x	1	0
1	x	∅	0	1
x	1	0	∅	x
∅	0	1	x	∅

∩	0	1	x	∅
0	0	∅	0	∅
1	∅	1	1	∅
x	0	1	x	∅
∅	∅	∅	∅	∅

∪	0	1	x	∅
0	0	x	x	0
1	x	1	x	1
x	x	x	x	x
∅	0	1	x	∅

The truth tables for other basic set-theory coordinate operations, used below, are presented here. Information structure of cyberspace has to be hierarchical and closed, both globally and locally, at any hierarchy level.

The unit cell of the space structure should be triangular. This ensures the reduction of cyberspace information volume, in the limit – on the third. It means the increase in productivity of all transceivers and stores of world content on 33%. Plane interpretation of cyberspace is shown in Fig. 4.

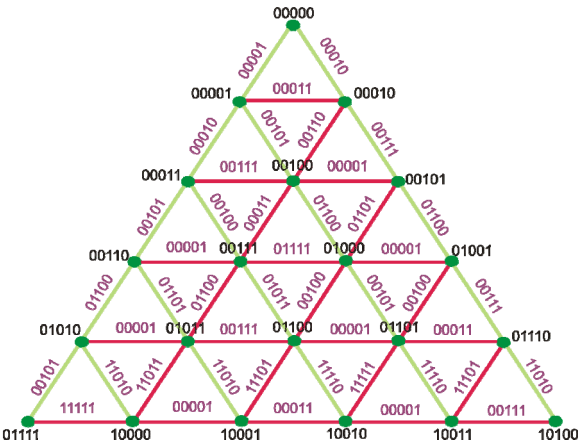

Fig 4. Triangle cyberspace

In general, the functional dependence of the ratio «recoverable sides of closed in the triangle space – the total number n of layers in triangular structure» is defined by the expression:

$$\eta = \frac{\sum(i+1)}{\sum(3\times i)}\Big|_{i=\overline{1,n}} = \frac{1}{3}\left(\frac{2}{n+1}+1\right) = \frac{1}{3}\cdot\frac{2+n+1}{n+1} = \frac{n+3}{3(n+1)}.$$

The triangular space metric is the most economical one, because it creates the shortest distances and ways between objects due to the transitive closure.

4. Engine for cyberspace analysis

For high-speed navigation in cyberspace (searching objects and evaluating their interaction) it is needed a simple and fast multimatrix processor (MMP), where each operation (and, or, xor, slc) processes in parallel and very fast only one binary operation on the matrices (two-dimensional data arrays). The number of instruction-oriented primitive matrices creates a system – heterogeneous multimatrix processor of binary operations with the buffer M, Fig. 5.

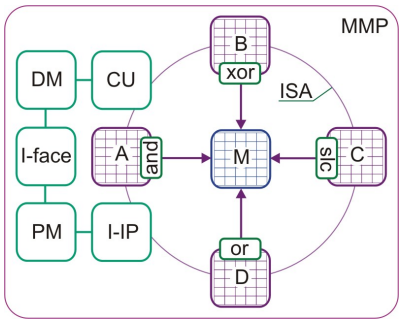

Fig 5. Multimatrix processor of binary operations

Multimatrix processor module involves 4 memory blocks with built-in instructions (A – and, B – xor, C – slc – shift left crowding, D – or) and buffer memory M. The module is focused on the parallel execution in this case one of four instructions (ISA – Instruction Set Architecture) by using matrices of binary data of the same dimension $M = M\{and, or, xor, slc\}\{A, B, C, D\}$ and saves the result in the buffer M.

MMP feature that is not the matrix cell has the command system of the four instructions, and each instruction has its own cell matrix as the data for parallel processing, which significantly simplifies the control structure and the whole device. The MMP complexity is moved on the data structure, where the matrix memory has a single hardware-implemented built-in instruction that allows realizing a primitive control system for parallel computing processes (SIMD – Single Instruction Multiple Data), which is sequential in nature, and therefore there is no need to create a super complex compilers, focused on parallelization of computational processes. Here, each matrix processor executes a single operation, built-in storage elements of the matrix. But there are situations, when the matrix level (M-level) of data definition is redundant to perform operations on Boolean (B-level) or registration

(R-level) variables. For such case, it is necessary to have the hierarchy of data levels. The typical MMP blocks are: memory for data (DM) and programs (PM), control unit (CU), interface (I-face) and Infrastructure IP (I-IP), as well as multimatrix processor module, which includes 4 memory blocks with built-in operations (A – and, B – xor, C – or, D – slc – shift left crowding) and buffer memory M.

The applications of vector-logic or matrix technology for analyzing the processes or phenomena: 1) text recognition in the entry registration cards; 2) personal identification by photographs, close to the standard images for visa documents; 3) search of analogs in the Internet by the given patterns; 4) sorting images in the database according to the classes and attributes; 5) fingerprinting and creation of classified intelligence library; 6) recognition and classification of software viruses; 7) handwriting recognition and personal identification by the essential characteristics of letter writing; 8) identification of targets and moving objects (aircraft, ships, cars); 9) synthesis or correction of images by the typical existent characteristics; 10) control robotic systems; 11) pattern recognition for smell, taste, sound, heat and radio frequency; 12) recognition of linguistic structures and primitives, and their estimation when comparing with benchmarks; 13) dynamic visualization of consistent and smooth transformation of one image in any other.

4. Multilevel model and method (engine) for searching design solution

Multilevel model is presented by multitree B, where each node is a three-dimensional table of possible functional solutions, and the arcs outgoing from it are down-ward transitions for the case, where partial coverage of functionality is fixed:

$$B = [B_{ij}^{rs}],\ \text{card}B = \sum_{r=1}^{n} \sum_{s=1}^{m_r} \sum_{j=1}^{k_{rs}} B_{ij}^{rs},$$

n – a number of levels for solution multitree; m_r – a number of functional solutions that meet the specifications at the level r; k_{rs} – number of components in the table B^{rs}; $B_{ij}^{rs} = \{0,1\}$ – component of the decision tables, determined by coverage signals of the functionality by alternative solution $T_{i\text{-}A_i}$ relative to the observed monitor A_i. Each node-table has number of top-down outgoing arcs equal to the number of functional blocks, which form the specification of the considered level. Multitree structure corresponding to the multilevel synthesis model is shown in Fig. 6.

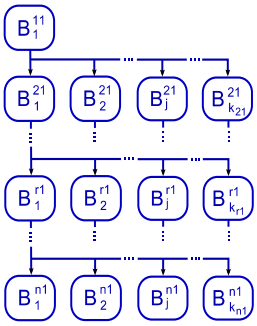

Fig 6. Fragment of multitree for digital system synthesis

Process model or method for searching solution by multitree is creating the engine for traversal of tree branch on the depth, specified by the user:

$$B_j^{rs} \oplus A^{rs} = \begin{cases} 1 \to \{B_j^{r+1,s}, R\}; \\ 0 \to \{B_{j+1,}^{rs}, G\}. \end{cases}$$

Here vector xor-operation is executed between the columns of the matrix and the vector of the current specification, taken from the main parameters of functionality. If at least one coordinate of vector xor-sum is equal to one $B_j^{rs} \oplus A^{rs} = 1$ (uncovered parameter) then one of the following action is performed: the transition to the activation matrix of lower level $B_j^{r+1,s}$ or selection of other functionality B_j^{rs}. At that analysis is carried out, what is the most important: 1) time – then searching for other suitable functionality is performed 2) money – then a transition down is carried out to clarify the differences in specifications, when the synthesis of a smaller unit greatly reduces the cost of designing. If all the coordinates of the resulting xor-sum vector is equal to zero $B_j^{rs} \oplus A^{rs} = 0$, it means complete coincidence of the specification and library solution, then transition to the next matrix column is performed for the analysis of its suitability relatively the vector specification.

Thus, the presented analytical form of the engine makes it possible to realize effectively synthesis of arbitrary complex technical system, using existing libraries of similar or related solutions. The advantages

of this engine lie in the simplicity of model preparation and presentation for synthesizing functionality by the solution tables for a given specification. As an example of searching for the optimal solution, the solution table B and specification V are shown below:

B_{ij}	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}	B_{14}	V
P_1	1	.	1	.	.	.	.	.	1	.	.	.	1	.	0
P_2	1	.	.	1	.	.	.	.	.	1	.	.	.	1	1
P_3	1	.	.	.	1	.	.	.	.	.	1	.	1	.	0
P_4	.	1	.	.	.	1	.	.	.	1	.	.	.	1	1
P_5	.	1	.	.	.	.	1	.	.	.	1	.	1	.	0
P_6	.	1	.	.	.	.	.	1	.	.	.	1	.	1	1

This solution is the column B_{14} that turns to zero vector the result of xor-operation: $B_{14} \oplus V = 0$. Other solutions have non-zero code distance (less attractive variants) between the specification and the existing library modules.

5. Conclusion

1. A model of evolving cyberspace, where subjects are the interacting processes or phenomena with the physical carrier in the form of computer systems and networks, is proposed. Standardization of space and all the interacting entities, including the negative ones, can be realized on the basis of beta metrics that adequately estimates the measure of relationship interaction in cyberspace.

2. A universal non-arithmetic model for structural evaluating the relationship of two objects in cyberspace is developed. It can detect any type of set-theory or vector interaction of objects, when solving practical problems of pattern recognition and diagnosis of technical products.

3. The architecture of multimatrix processor, focused to improve the performance of decision-making in the library space, is proposed. It is characterized by using parallel logic vector operations and, or, xor, slc, which makes it possible to improve significantly (x10) the performance of functionality synthesis.

4. The model for synthesizing functionality of a digital system in the form of multitree and method of traversal the tree nodes, implemented in the engine to search a solution of given depth, which greatly increases the performance of software and hardware design, are presented.

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