

VIII International Conference on

Antenna Theory and Techniques

**To the memory of antenna science Atlantes
Pistol Kors A.A., Zelkin Y.G., Bakhrakh L.D.**

**Kyiv, Ukraine
September 20-23, 2011**

Organizers

- Ukrainian National Association “Antennas”
- IEEE MTT/ED/AP/CPMT/ SSC West Ukraine Chapter
- IEEE Kharkov Chapter SP01/AP03/C16/EMC27 of Ukraine Section
- National Technical University of Ukraine” Kyiv Polytechnic Institute”
- National University “Lviv Polytechnic”
- Kharkiv National University
- Kharkiv National Technical University of Radio Electronics
- Sevastopol National Technical University
- Dnipropetrovsk National University
- Institute of Radio Astronomy of the National Academy of Sciences of Ukraine
- Institute of Radio Physics and Electronics, National Academy of Sciences of Ukraine

Sponsorship

- IEEE Antennas and Propagation Society (AP-S)
- IEEE MTT/ED/AP/CPMT/ SSC West Ukraine Chapter
- IEEE Kharkov Chapter SP01/AP03/C16/EMC27 of Ukraine Section
- IEEE Ukraine Section
- National Technical University of Ukraine” Kyiv Polytechnic Institute” (Kyiv, Ukraine)
- “Radioelectronics and Communications Systems” International Journal (Kyiv, Ukraine)
- State Scientific Research Institute “Kvant Radar Systems” (Kyiv, Ukraine)
- UKRANTECH LLC Company (Kyiv, Ukraine)

HONORARY CHAIRMAN

Prof. **Yakov S. Shifrin**, Kharkiv National University of Radioelectronics, President of Ukrainian National Antenna Association, IEEE Life Fellow, Ukraine

CHAIRMAN

Prof. **Fedor F. Dubrovka**, National Technical University of Ukraine "Kyiv Polytechnic Institute", Honoured Scientist and Engineer of Ukraine, Ukraine

ORGANIZING COMMITTEE CHAIRMAN

Acad. **Mykhaylo Z. Zgurovsky**, Rector of National Technical University of Ukraine "Kyiv Polytechnic Institute", Ukraine

VICE CHAIRMEN

Prof. **Nikolay N. Kolchigin**, Karazin Kharkiv National University, Ukraine
Prof. **Oleksander G. Lukyanchuk**, Sebastopol National Technical University, Ukraine
Prof. **Ivan N. Prudys**, National University «Lvivs'ka Polytehnika», Ukraine

TECHNICAL PROGRAM COMMITTEE

Prof. Yakov S. Shifrin	Chairman, IEEE Life Fellow, Ukraine
Prof. Oleg O. Drobakhin	Dnipropetrovsk National University, Ukraine
Dr. Rostyslav F. Dubrovka	Queen Mary, University of London, UK
Prof. Peter Edenhofer	Ruhr-University of Bochum, Germany
Prof. Nikolay N. Gorobets	Karazin Kharkiv National University, Ukraine
Dr. Volodymyr I. Gouz	State Scientific Research Institute "Kvant Radar Systems", Kyiv, Ukraine
Prof. Anatoliy A. Kirilenko	Institute of Radiophysics and Electronics of NASU, Kharkiv, Ukraine
Prof. Victor F. Kravchenko	Kotelnikov Institute of Radio Engineers and Electronics, Moscow, Russian Federation
Prof. David I. Lekhovytskiy	Kharkiv National University of Radio Electronics, Ukraine
Prof. Aleksander M. Lerer	Southern Federal University, Rostov-on-Don, Russian Federation
Dr. Serhiy Ye. Martynyuk	NTUU "Kyiv Polytechnic Institute", Ukraine
Prof. Gennadiy A. Morozov	Tupolev Kazan State Technical University, Russian Federation
Prof. Viktor. I. Naidenko	NTUU "Kyiv Polytechnic Institute", Ukraine
Prof. Gennadiy P. Sinyavskiy	Southern Federal University, Rostov-on-Don, Russian Federation
Prof. Vadym I. Slyusar	Central Research Institute of Armaments and Military Equipment of Ukraine's Armed Forces, Kyiv, Ukraine
Acad. Dmytro M. Vavriv	Institute of Radio Astronomy of NASU, Kharkiv, Ukraine
Prof. Yuriy V. Yukhanov	Taganrog Technological Institute of Southern Federal University, Russian Federation
Prof. Oleg A. Yurtsev	Belarusian State University of Informatics and Radioelectronics, Minsk, Belarus

ORGANIZING COMMITTEE

Victoria O. Gogol	Secretary, NTUU "Kyiv Polytechnic Institute", Ukraine
Dr. Anatoliy O. Boryssenko	A&E Partnership, Belchertown, MA, USA
Kostyantyn V. Herasymenko	NTUU "Kyiv Polytechnic Institute", Ukraine
Dr. Viktor V. Hoblyk	National University "Lvivs'ka Polytekhnika", Ukraine
Sergiy M. Litvinsev	NTUU "Kyiv Polytechnic Institute", Ukraine
Dr. Nina G. Maksimova	Kharkiv National University of Radioelectronics, Kharkiv, Ukraine
Yuriy A. Ovsianyk	NTUU "Kyiv Polytechnic Institute", Kyiv, Ukraine
Dr. Volodymyr I. Rudakov	Central Research and Development Institute of Armament and Military Engineering, Kyiv, Ukraine
Prof. Oleksander I. Rybin	NTUU "Kyiv Polytechnic Institute", Kyiv, Ukraine
Prof. Volodymyr I. Shokalo	Kharkiv National University of Radio Electronics, Ukraine
Lucia M. Shykalova	NTUU "Kyiv Polytechnic Institute", Kyiv, Ukraine
Dr. Dmytro O. Vasylenko	NTUU "Kyiv Polytechnic Institute", Kyiv, Ukraine

TABLE OF CONTENTS

INVITED PAPERS (PL)

1.	ANTENNA SCIENCE ATLANTES Ya. S. Shifrin and V. F. Kravchenko	3
2.	RECENT ADVANCES IN ANTENNA RESEARCH AND DEVELOPMENTS AT NTUU “KPI” F. F. Dubrovka, R. F. Dubrovka, M. O. Dovbush, V. M. Hlushenko, M. M. Lytvyn, S. M. Lytvyn, I. M. Markovich, S. Ye. Martynyuk, Yu. A. Ovsyanyk, O. V. Tolkachov, Vasylenko D. O.	8
3.	BIOCHEMICAL OBSERVATIONAL SCIENCE AT THZ ENERGIES R. Donnan and R. Dubrovka	13
4.	STUDIES ON RADAR MEDICAL SENSORS A. Boryszenko and E. Boryszenko.	19
5.	LARGE-APERTURE SLOTTED-WAVEGUIDE ANTENNA ARRAYS: DEVELOPMENT AND FABRICATION ADVANCES S. S. Sekretarov, A. V. Somov, and D. M. Vavriv	22
6.	NEAR-FIELD MANIPULATION BY MEANS OF WIRE MEDIA R. Dubrovka and P. Belov	28
7.	VEHICULAR ANTENNAS FOR SATELLITE COMMUNICATIONS (SURVEY) A. V. Shishlov	34
8.	SYNTHESIS OF ARBITRARILY SHAPED IMPEDANCE REFLECTORS Y. V. Yukhanov, A. Y. Yukhanov, T. Y. Privalova	40
9.	WAVEFIELD CONTROL IN MULTIMODE CHANNELS BY THE USE OF SOURCE ARRAYS, WITH APPLICATION TO SHALLOW-WATER SOUND A. G. Luchinin, A. I. Malekhanov, and A. I. Khil’ko	46
10.	THIRTY YEARS EXPERIENCE IN DEVELOPMENT OF ADAPTIVE LATTICE FILTERS THEORY, TECHNIQUES AND TESTING IN KHARKIV D. I. Lekhovyt’skiy	51
11.	RESEARCH OF THE PROPERTIES OF CURVILINEAR THIN-WIRE RADIATORS (HELICAL ANTENNAS) M. B. Protsenko	57
12.	EVOLUTION OF ELECTROMAGNETIC WAVES RADIATED BY A HERTZIAN DIPOLE V. I. Naidenko	63
13.	NUMERICAL-ANALYTICAL IMPLEMENTATION OF GALERKIN TECHNIQUE FOR ANALYSIS OF WAVEGUIDE AND SLOTTED WAVEGUIDE ANTENNA ARRAYS M. B. Manuilov, A. M. Lerer and G. P. Sinyavsky	69
14.	ELECTRODYNAMIC ANALYSIS OF NANOSCALE ANTENNAS OF MILLIMETER AND OPTICAL BANDS A. M. Lerer, O. S. Labunko, P. V. Makhno, and G. P. Sinyavskiy	75

GENERAL ANTENNA THEORY (GAT)

1.	TO HISTORY OF RADIO ENGINEERING’S TERM “ANTENNA” V. I. Slyusar	83
2.	THE ENERGY OF THE FIELD RADIATED BY HERTZ DIPOLE I. S. Volvach, O. M. Dumin, and O. O. Dumina	86
3.	SHAPE TRANSFORMATION OF WAVE BEAMS FALLING ON QUASIPERIODIC LAYERED STRUCTURES M. Andreev, V. Borulko, O. Drobakhin, and D. Sidorov	89
4.	ORIENTATION AND DISPERSION DIAGRAMS OF SPATIALLY-POLARIZING SELECTIVE STRUCTURES IN THE FORM OF THE CYLINDER WITH THE STAR CONTOUR E. D. Bezuglov, Y. D. Bezuglov, and D. D. Gabriel’yan	92

5.	MATHEMATICAL MODELING OF A WIDEBAND CONICAL ANTENNA WITH OPEN SEMITRANSSPARENT SURFACE EXCITATION V. A. Doroshenko, Y. D. Shimuk, A. V. Artjukh, A. V. Sova	95
6.	SPECTRUM EXTRAPOLATION FOR COMPLEX SOURCES VIA TWO-CHANNEL VERSION OF A PRINCIPLE OF MINIMAL SPATIAL EXTENSION OF SOLUTION V. F. Borulko and S. M. Vovk	97
7.	OPTIMIZATION OF BISTATIC GPR SYSTEM POSITION IN A PROBLEM OF SMALL-SIZED SUBSURFACE OBJECTS DETECTION L. A. Varyanitzha-Roshchupkina . .	100
8.	COUPLED PLASMA CYLINDRICAL COLUMNS AS SUB-WAVELENGTH ANTENNA N. P. Stogniy and N. K. Sakhnenko.	103
9.	SPATIAL FIELDS COHERENCE IN THE FOCAL PLANE OF REFLECTOR ANTENNAS L. M. Lobkova, V. V. Golovin, and U. N. Tyschuk	106
10.	INFLUENCE OF MUTUAL COUPLING BETWEEN TWO VIBRATORS ON VALUE OF THEIR RESONANT LENGTH N. P. Yeliseyeva	109
11.	DIFFRACTION PROBLEM IN BISTATIC ZONE OF RADIO ACOUSTIC SOUNDING SYSTEMS N. I. Slipchenko, Liu Chang, and A. Yu. Panchenko.	112

ANTENNA ARRAYS (AA)

1.	DETECTION OF SOLID EARTH EXCITATIONS BY LASER SEISMO-ACOUSTIC ANTENNA ARRAY V. V. Kravtsov, M. N. Dubrov, and M. S. Remontov	117
2.	NOISE-PROTECTED ANTENNA FOR A PULSE ACOUSTIC ATMOSPHERIC SOUNDER Ya. S. Shifrin, Y. N. Ulianov, V. I. Vetrov, V. L. Misailov	120
3.	SPATIAL POLARIZING FILTERS, TRANSFORMERS OF A FIELD POLARIZATION AND POLARIZING MANIPULATORS BASED ON PRINTED REFLECTARRAYS A. O. Kasyanov.	123
4.	THE EFFECT OF DEFECTIVE RADIATORS AND MODULES ON CHARACTERISTICS OF ARRAY ANTENNA WITH COMPLEX APERTURE AND MULTI-FACETED ARRAY ANTENNA V. Kizimenko, D. Moskaliyov, N. Naumovich, A. Yubko, and O. Yurtsev	126
5.	THE INFLUENCE OF INTERCHANNEL AND INTRACHANNEL NONIDENTITIES ON ANTENNA ARRAY CHARACTERISTICS V. Kizimenko, D. Moskaliyov, N. Naumovich, O. Yurtsev.	129
6.	CHARACTERISTICS OF LINEAR SLOTTED WAVEGUIDE ARRAYS ON THE RECTANGULAR WAVEGUIDE WITH TWO-LAYER DIELECTRIC FILLING AT EXCITATION BY THE SLOWED DOWN DOMINANT MODE A. A. Lyakhovskiy, A. F. Lyakhovskiy, N. K. Blinova, and L. P. Yatsuk.	132
7.	3D SCANNING BY MULTILAYERED CIRCULAR TSA ARRAY WITH PULSE EXCITATION N. N. Kolchigin, O. V. Kazansky, D. D. Ivanchenko, Liang Jing Feng, He Shi, Zheng Yu	135
8.	THE DIRECTION FINDING ACCURACY OF THE RECTANGULAR DIGITAL ANTENNA ARRAY IN A CASE OF ADC JITTER M. V. Bondarenko	137
9.	PYRAMIDAL DESIGN OF NANOANTENNA ARRAYS V. I. Slyusar and D. V. Slyusar	140
10.	ANTENNAS BASED ON DIELECTRIC RESONATORS AND MICROSTRIP LINES IN CASE OF THEIR ORTHOGONAL MUTUAL ORIENTATION I. V. Trubarov	143
11.	SHORT-WAVE BAND LINEAR ANTENNA ARRAY CONSISTING OF “BUTTERFLY” RADIATORS V. P. Kudzin, V. N. Lozovsky, and N. I. Shlyk	146
12.	AN ESTIMATION OF DIRECTIVITY CHARACTERISTICS OF ANTENNA ELEMENTS IN ANTENNA ARRAY WITH COUNTING OF SIGNAL CONJUGATE COMPONENTS V. S. Kopyievska and V. I. Slyusar	148

PYRAMIDAL DESIGN OF NANOANTENNA ARRAYS

Slyusar V. I., Slyusar D.V.

Central Research Institute of Armaments and Military Equipment of Ukraine's Armed Forces, Kiev, Ukraine
E-mail: swadim@inbox.ru

Abstract

Vertical designs of nanoantenna arrays as a part of multilayered nanonodes for realisation of wireless networks on the chip (WiNoC) on the basis of technologies MI-MO and MultiUser MIMO are presented.

Keywords: wireless networks on the chip (WiNoC), system on crystal (SoC), MI-MO, MultiUser MIMO, nanoantenna arrays.

I. Introduction

Known variants of use in the key elements of wireless networks on chip (WiNoC) nanosize MIMO-arrays are based on the use of nanoantennas of placing of nanochips and having the directivity characteristics of antenna's, squeezed from the substrate of a crystal [1]. More advanced solution [2] is based on the multilayered realization of stack (as a rectangular tower) designs of microassemblages (nanocircuits) in which each level contains the dipole antennas intended for communication in a tower-chip and between several analogous microassemblages (fig. 1). However in [2] for a wireless communication between "microtowers" only single dipole antennas whereas for the creation WiNoC is expedient to pass to application vertically oriented nanoantennas arrays. The possible variants of such antennas constructions are presented in the report, which application will increase the speed of data transmission in WiNoC.

II. The main part

One of the possible ways of increasing the capacity of wireless communication channels between WiNoC nanochip is perfection of tower technology [2] by combining the individual antennas face stacking structure (Fig. 1) into a single antenna array.

At multi-layered technology of nanotowers levels making in each levels can be located not line of emitters, but a flat digital antenna array (two-row, three-row, etc.). Besides, on some layers tower nanochip can be installed one common nanoantenna array. As a working range of frequencies for wireless transmission of data is advisable to choose terahertz.

The selective calculation of corresponding lengths of waves is simple to use known relations, and for the frequency $1 \text{ THz} = 10^{12} \text{ Hz}$, we obtain $\lambda = 300$ microns. Similarly, for the 100 THz wavelength $\lambda = 3$ microns. Thus, when the antenna elements in an antenna array are located with a step in the half of wave-length at the carrier frequency signal 100 THz

interelement distance between emitters will be equal 1.5 microns. To have a representation about scales of the corresponding geometry as an example, it is necessary to indicate that at such a step of array along the wall of corps of microelectronic chip with 1,5 mm can be placed in 1000 nanovibrators elements. Besides, if the size of the corps of system on a crystal, for example, 30 mm, at the same frequency of 100 THz it is simple to receive that within the microchips corps is placed about 10000 lengths of waves. It allows to operate on the analysis parameters of nanoantennas arrays in WiNoC structure with concept of a far-zone of the antenna.

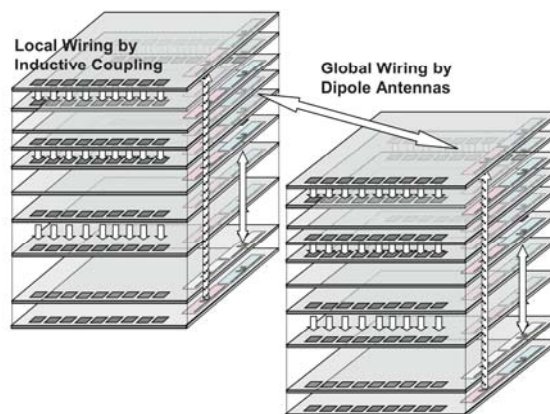


Fig. 1. Stacked constructions of microassemblages of tower type in composition of WiNoC [2].

Usually in the literature indicates that the far zone of antenna lies in the distance more than 100 lengths of waves. In this case, even if the distance between nanochips more than 300 microns can be applied electro-dynamics model of the far zone antenna, which greatly simplifies signal processing.

For narrowing the directivity characteristics of partial-emitters array antenna space between nanochips can be filled with a metamaterial with a negative index of refraction (Fig. 2).

Such the waveguide channel will allow substantially to decrease the level of radiation penetrating

outside the corps of microchip. Besides, the use of metamaterials will shorten the wavelength of radiation that will provide an opportunity to increase the density of configuration the nanochip in the crystal.

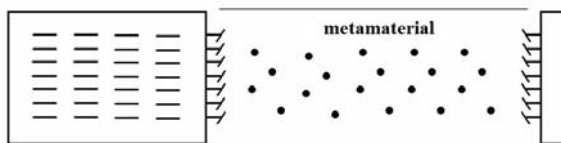


Fig. 2. The vertical configuration of electrically small nanovibrator antennas in multilayered three-dimensional nanochip (side view).

Frequency-division or time-division multiplexing of signals can be added polarization-division multiplexing. For this purpose have to apply nanoantennas of double polarization, for example, turnstile vibrators (fig. 3).

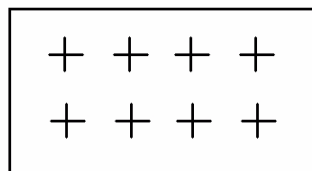


Fig. 3. Polarization-division multiplexing of channels.

The optimal placing of the nodes stations of WiNoC (nanonodes) on a chip can be carried out in accordance with methodology of Ermolaev S.Y. [3], supposing the use of ant algorithms for topology optimization of the base stations and adapted taking into account the model of distribution of signals into the corps of the system on a crystal.

At the multilayered topology of nanochips for the increase of efficiency of dispersion of radio waves in interests of technology of MIMO is worthy the using of pyramidal structures nanostations. In this case, circular, rectangular or multi-faceted pyramid forms, which nanovibrators are located on vertical walls can be used (fig. 4).

Such placing of elements of antennas on a nanochip allows to decrease the shading of nanostations each other and improves the conditions of refraction of radio waves into the corps of SoC. With the same purpose the pyramidal nanochips inside WiNoC can have different height. For example, in the center of crystal is a minimum height, on periphery is a maximum. Perhaps the opposite decision when the nanochip of maximum height takes place in a center, and the decrease of their levels goes to periphery. Nanopyramids of equal height in principle can be alternated taking into account configuration of subnet on a crystal.

On the top of pyramid for connection with a macrolevel are offered to place dielectric resonator antenna (DRA) (fig. 5) or other types of by volume electric small emitters, and also the printed microstrip

antennas.

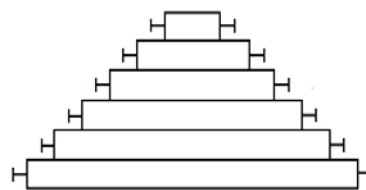


Fig. 4. The pyramidal configuration of electrically small nanovibrator antennas in a multilayer three-dimensional nanochip (side view).

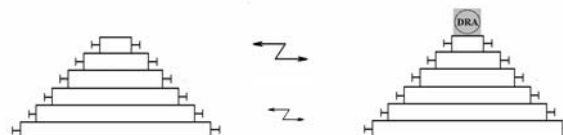


Fig. 5. The nanosystem MIMO with the DRA in the top layer of one of nanopyramids for realization of radiosluice with a macrolevel.

It should be noted that for realization of high-speed transmission of the system MIMO is sufficient to form 4 - 8 levels of nanopyramid, although, if speed of transmission is not critical, it is possible to be limited by the pair of levels.

To improve the manufacturability of the pyramidal arrays is preferred to use the horizontally located single vibrators or small element Uda-Yagi nanoantennas (fig. 6) on the pedestals of pyramid [4].

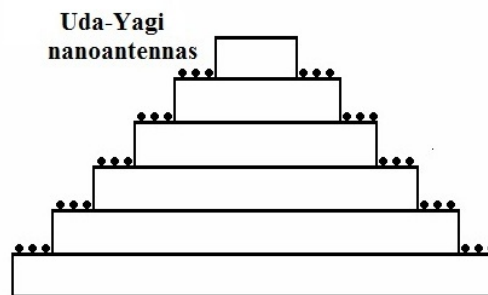


Fig. 6. Horizontally located Uda-Yagi nanoantennas in composition the vertical arrays of nanoemitters.

The length of the step pyramid to accommodate Uda-Yagi nanoantenna depends on the wavelength, interelement distance of vibrators in the antenna and their quantities. So, at half-wave step elements and the carrier frequency signal 100 THz for placing of 4 vibrators in structure the Uda-Yagi nanoantenna, in this case is necessary to provide the length of the pedestal in the horizontal plane not less than 8 microns.

In the more general case in different levels of a pyramid can be used different types of antennas (vibrators, Uda-Yagi etc.), interleaving flat and linear arrays with different quantity of radiators at various length of the stage of nanopyramid. It allows to involve different ranges of frequencies in levels for re-

alization of frequency division of channels and improvement of electromagnetic compatibility of nanochips.

Let's consider the case of placing in the levels of pyramidal nanochips of different amount of Uda-Yagi nanoantennas, having in the composition a different amount of elements for providing of communication of data on a few frequencies.

As an example, Fig. 7 shows a top view of corresponding options of three-level pyramidal nanochips. On a pedestal of the first level in each side of a pyramid are located 4-element nanoantenna arrays on the basis of Uda-Yagi radiators for realization with cooperating nanonodes of the chip system multi-MIMO under scheme $N \times 4 \times 4$, where N – number of nanonodes.

In the second tier of nanopyramid, having a smaller useful area, in each of verges it is placed for two Uda-Yagi nanoantennas, providing forming multi-MIMO of network size of $N \times 2 \times 2$ in other frequency range, for example, the greater wave-length, due to released as a result transition to a two-element antenna array of useful area. DRA is located on the third tier of nanochip and it providing connection with a macrolevel.

For increase of distance of communication of a wireless network at a crystal (WiNoC) with external consumers it makes sense to use co-operative data transmission with the help of using clustering distributed the nanosystems of MIMO on a crystal.

Depending on distance of connection the size of cluster can be adaptive change by an association four and more than nanochips in one emitter. The example of four element cluster is presented on fig. 7. The similar decision by "a nested doll" principle is possibly too for simultaneous multifrequency communication, thus the upper level of nanochips is united in one cluster, more low lying - in others clusters. Thus, it is formed clusters, which enclosed each other and differing with a working range of frequencies, quantity of united nanochips.

Separate clusters, forming MIMO-system, can have a not-identical topology, to minimize regional effects, sidelobes of directivity characteristics of antenna's elements of antenna's array, to reduce the mutual coupling of the radiators. For each range can have its own configuration of clusters and their optimal topology.

As a result connection is provided in the different ranges of frequencies, in a few standards simultaneously, for the decision of different on the functional setting tasks, for example, in combinations of type "communication + GPS + rectenna" (for the feed of chip).

The configuration of the separately taken clusters of nanoantennas schemes can be optimised by means of genetic algorithm, by analogy to the printing antennas having the fragmented structure, protected by the patent of the USA № 6323809. Such decision allows to optimize the form of directivity characteris-

tics, polarization characteristics, and at inphase radiation - to provide demanded level SWR in a wide band frequency response of the antenna at work on a radiation.

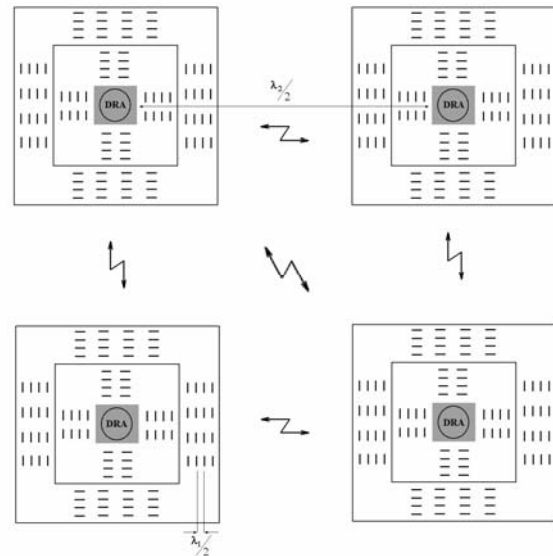


Fig. 7. Three-level pyramidal nanochips with Uda-Yagi antennas and DRA.

The considered cluster principle can be used and for connection inside of WiNoC. A cluster can form the identical levels of several pyramidal nanochips. It will allow to use comparatively a low-frequency radiation inside a crystal, to improve the energy of radio waves at communication of data between the remote peripheral areas of chip.

III. Conclusion

The offered variants of vertical configuration of MIMO-arrays of nanoantennas elements allows to raise the carrying capacity of communication of WiNoC channels by using of multiple elements antennas constructions. Perfection of their design and the analysis of electrodynamics by modeling are the purpose of the further researches.

REFERENCES

1. Slyusar V.I., Slyusar D.V. System on chip with wireless communication of nanomodule. //13 th International Youth Forum "Radioelectronics and youth in the XXI Century". - KNURE, 2009. - P. 307 (in russian). - http://www.slyusar.kiev.ua/HNURE_2009.pdf.
2. Takamaro Kikkawa. Wireless Inter-Chip Interconnects Using IR-UWB-CMOS. //10th IEEE International Conference on Solid-State and Integrated Circuit Technology (ICSICT), Shanghai. - 1- 4 Nov. 2010. - Pp. 623 – 626.
3. Ermolaev S. Y. The optimal placement of base stations. //Telecommunication Sciences. – 2011. - № 1 (in russian).
4. Declarative patent of Ukraine on an useful model № 60938.//Slyusar V.I., Slyusar D.V. – Patent Publication Data: 25.06.2011, bul. № 12.