COVENANT UNIVERSITY

Communication, Embedded Systems & Electrical Power Systems Research Cluster

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2015 – 2020

COMMUNICATIONS, EMBEDDED SYSYEMS & ELECTRICAL POWER SYSTEMS RESEARCH CLUSTER

As the name indicates, this research cluster is made of three main sub-clusters, which are:

a. Communication Engineering Research, which includes Computer Engineering Research (CCERC)
b. Embedded Systems Research, which include Machine-2-Machine Systems Research (M2M)
c. Power Systems Research, which includes Renewable Energy Research (EPS)

Lead Researcher: Prof. AAA. ***Atayero***

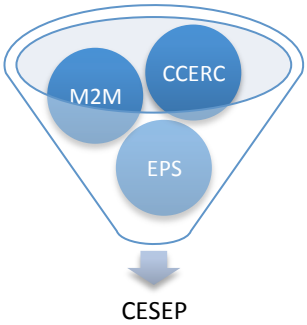

Fig.1 Cluster Relationships

The Communication, Embedded & Electrical Power Systems (CESEP) cluster is envisioned to be a hub of virulent research activities. The cluster shall be as innovative as it will be dynamic in research focus and output. At its onset, the sub-cluster heads have agreed to focus on the emerging and very promising research on the *Internet of Things (IoT).* This is without prejudice to other peripheral research and development activities that will be *pari passu* engaged on as required by the individual sub-clusters.

In this very innovative arrangement of cluster formation, the focus and drive for the next five years shall be on IoT engineering and concomitant RD&D activities. By providential design, the current research endeavors of the various scattered groups in the Department of Electrical & Information Engineering (EIE) are already addressing various aspects of the focus area. The University management's drive for consolidated and synergistic approach to R&D hereby finds fruition towards ensuring the enlistment of Covenant University in the Ivy League of world Universities.

The Communication and Computer Engineering Cluster (CCERC) in its present form is already addressing the problem of Authentication, Authorization and Accounting (AAA) of Next

Generation Networks (NGN) through a Biometric Signal Processing Research (CUiris). The cluster membership is now enlarged to infuse expertise for further research. The M2M Development Laboratory (which will now form the nucleus of the Embedded Systems & M2M sub-cluster) is already engaged in various projects bordering on security and surveillance (a very important aspect of IoT), as well as various other projects (see section II). The development competencies already demonstrated by this sub-cluster will serve the CESEP Cluster well, in terms of developing prototypes for research findings where necessary, as well as reverse-engineering already available products. The Electrical Power Systems cluster is also very actively researching into various areas of power systems. The onus of now rests on the sub-cluster to focus more on the *Smart* areas of power systems, for sustainability and environmental friendliness. This is an indispensable aspect of the IoTs.

Why IoT?

It is interesting to note that the IoT features repeatedly on the top priority list of information strategies for many developed nations (including USA, Japan, Korea, EU). In fact, IoT is on the current 5-year Chinese National Development Plan. This is informed by the fact that the market for IoT-related products and services is purported to be well in the excess of $13 trillion (USD) by 2024.

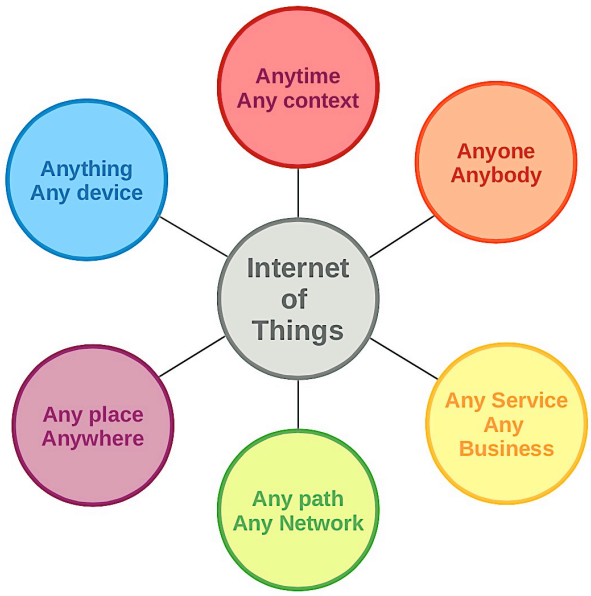

Fig.2 The *6A Connectivity Concept* of IoT [1]

The Internet of Things is envisioned to allow for the interconnectivity of *anyone* and *anything* at *anytime* and in *anyplace*. This connectivity should ideally be possible using *any service* over *any conduit*, path or network. This is popular referred to as *The IoT 6A Connectivity Concept* (see section I for more details). As is to be expected of contemporary, innovative, cutting-edge

research; the research proposals that the CESEP cluster will be presenting at different phases of the first five years will be capital intensive.

Why Now?

According to Gartner Research [6], which added the term IoT to their annual '*Gartner Hype Cycle*' that tracks the life cycle of technologies, IoT attained the peak of inflated expectations this year and will attain "*Plateau of Productivity*" in the next five to ten year (see Fig.3). This suggests that meaningful research into the IoTs must commence now for it to have any appreciable impact when the monetized IoT market comes off-age in less than a decade.

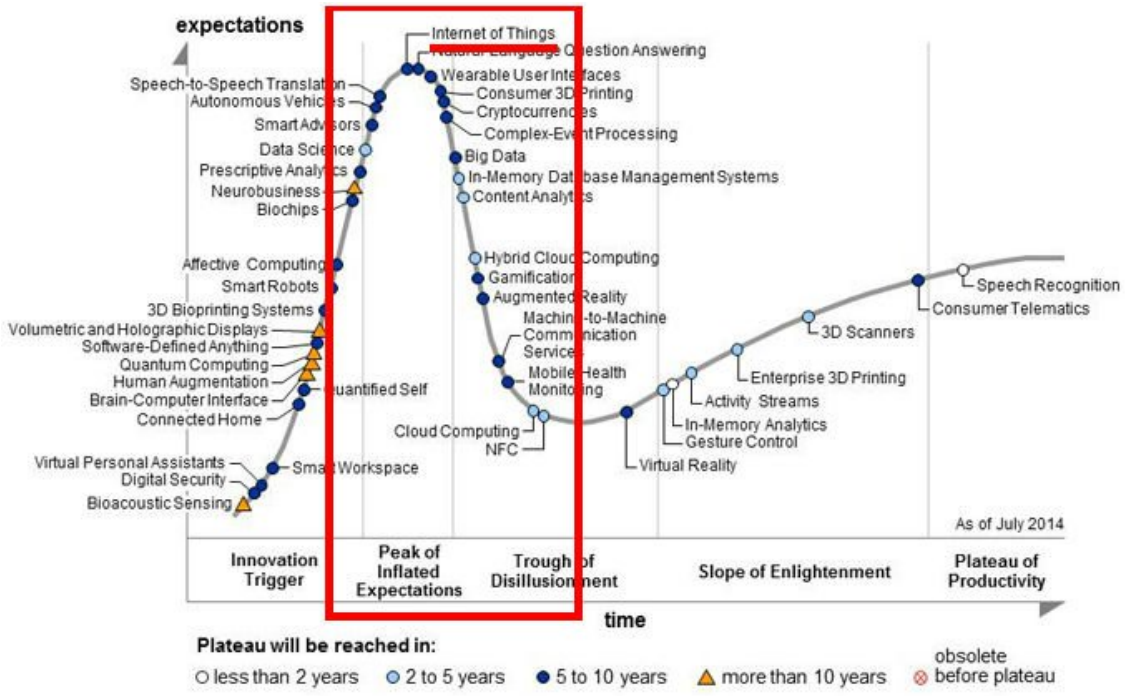

Fig.3 Gartner Technology Hype Cycle: From '*Technology Trigger*' *to* ' *Plateau of Productivity*' {Source: [6]}

I. Communication & Computer Engineering Research

Preamble

It is an established fact that by the year 2020 (barely six years from now), between 30 to 50 billion devices will be connected to the Internet thus forming the 'IoT' (a.k.a. Cloud of Things 'CoT', Internet of Everything 'IoE' ...). This will account for about six things (devices) per person. This is made possible in part by the advancement in sensor technology, BWAN, SON, cloud computing, context-aware computing *et cetera*. Most importantly, the adoption of the IPv6 scheme, which can accommodate 340,282,366,920,938,463,463,374,607,431,768,211,456 unique IP addresses, makes IoT possible as it can conveniently assign 100 unique addresses to each atom on Earth. It is expected that the IoT market will be in excess of $1,423.09 Billion USD by 2020. This is a new market with equal opportunities for everyone who will be well equipped to access it. The existing curricula of most HEIs was not designed to address this market specifically, as indeed it could not have been. The 'Things' to be interconnected will have to be designed, constructed and built by specially trained Engineers, Technicians, Technologists in ways as to make them extremely miniaturized, energy efficient, environmentally benign, 'Green' and sustainable [2].

The notion described as the "Internet of Things" has been recognized by the media and leaders of industry as the next wave of innovation which promises to optimize our daily lives [3]. The Internet of Things (IoT), first coined by Ashton as the title of a presentation in 1999 [4], is a technological revolution that brings us into a new ubiquitous connectivity, computing, and communication era. As of now IoT is a very broad paradigm and many visions (e.g., "Internet oriented visions," "things oriented visions," and "semantic oriented visions" [5]) coexist.

Ipso facto, the research activities of the Communication and Computer Engineering Sub-cluster (CCERC) shall be focused on the relevant aspects of IoT Engineering for the next foreseeable future. This will be in synchrony with the other two sub-clusters making up the CESEPS Cluster of Covenant University. The CCERC shall be committed to achieving significant improvements in the lives of Nigerians and Africans. In order to achieve this, we shall embrace creative, groundbreaking and collaborative research activities that will immensely improve the quality of lives and develop capacity especially amongst the less developed and developing nations. The cluster will serve as a collaborator towards the achievement of some of the millennium development goals (MDGs) in the developing nations.

Vision

To be an internationally renowned interdisciplinary Research cluster that focuses on developing collaborative, pervasive, benign, and energy efficient technologies and applications for the improvement of lives and governance in developing nations.

Mission

To develop solutions to national problems, using IoT as a tool to improve the economy and lives of citizens, while striving to meet the MDGs.

Objectives

- To develop a new curriculum for IoT Engineering
- To improve the quality of I.T services nationwide through collaborative research and public awareness.
- To engage in public private partnership initiatives in creating knowledge and the know-how that will help transform the quality of living.
- To serve as a think-tank for solving some of the national problems and the millennium development goals (MDGs) in the developing nations.
- To develop innovative and life applicable solutions to the myriad of problems: socio-economical, political etc.

Activities

The CCERC sub-cluster will focus on research in:

- Internet of Things Engineering
- *Radio resource management in Next Generation Networks (NGN)*
- *Information technology development and deployment*
- *E-learning development and deployment*
- *Developing a web-bank of brown-eyed iris.*
- *Reduction of PAPR in OFDMA techniques*
- *Network Security*

Publication

The sub-cluster shall disseminate its research findings through:

- Annual Conference presentations
- Annual Journal Publications

Membership

Internal (List of Staff across the University*)

1. Prof. AAA. Atayero (Sub-Cluster Lead Researcher)
2. Prof. S.N. John
3. Dr. S.A. Daramola
4. Dr. J.A. Daramola
5. Dr. O.E. Agboje
6. Dr. C. Ndujiuba
7. Dr. F.E. Idachaba
8. Engr. A.A. Adewale

9. Engr. A.A. Adelakun
10. Engr. J.A. Badejo
11. Engr. A.S. Alatishe
12. Mrs. O.I. Oshin
13. Mrs. T.O. Odu
14. Mrs. T. Takpor
15. Mrs. A. Ifijeh

** More Researchers to be co-opted as need arises*

References

[1] C. Perera, A. Zaslavsky, P. Christen, D. Georgakopoulos, "Context Aware Computing for The Internet of Things: A Survey", IEEE Communications Surveys & Tutorials, Vol.16, No.1, 1st Quarter 2014.

[2] Ericsson, "More than 50 billion connected devices", Ericsson White Paper, 284 23-3149 Uen, Feb. 2011

[3] K. Ashton, "That 'Internet of Things' thing in the real world, things matter more than ideas," RFID Journal, June 2009

[4] L. Atzori, A. Lera and G. Morabito, "The Internet of Things: A survey," Computer Networks, Vol. 54, no. 15, pp. 2787-2805, October 2010.

[5] B. Raunio, "The Internet of things," SE's Internet guide, Nr. 16, English Edition, version 1.0, http://www.internetdagarna.se/program-2009/5-november, 2009

[6] "A Brief History of The Internet of Things", Online, http://postscapes.com/internet-of-things-history, Accessed 2014.10.06

II. Embedded MACHINE-TO-MACHINE AND EMBEDDED SYSTEMS RESEARCH CLUSTER (M2M-EMBEDDED)

Preamble

In the last decade, human development has witnessed an acceleration of connectivity unparalled in world history.

In just few years, we have move beyond simply using our machines to connect with other people and can now program them to connect directly to one another, allowing for the collection and processing of information on an unprecedented scale. The new connectivity of both physical infrastructure and devices is being referred to as the 'Industrial Internet', or 'the internet of things', while the technology that facilitates this connectivity is most commonly called 'Machine to Machine' (M2M).

The Machine–to–Machine and Embedded Systems research cluster shall be committed to achieving significant breakthrough on this technologies that will provide unprecedented opportunity to improve society's resources and time efficiency. As a whole, Information and Communications Technologies, of which M2M is a subset, can improve the efficiency with which society undertakes tasks large or small in ways that were, until recently entirely impossible.

By 2020, there will be 12.5billion M2M/embedded devices globally, up from 1.3billions devices today (Hatton 2012). To put this in perspective, mobile internet use, which is also fast becoming a part of our daily experience, is growing at only a fraction of the rate of M2M and the 400million mobile internet of 2007 are predicted to grow to two billion users by 2015 (Richmond).

Thanks to advances in wireless communications and IP Networking, Machine–to–Machine (M2M) communications provide a huge opportunity for growth in M2M service application in Nigeria. Future M2M/Embedded Systems are envisioned to connect billions of existing and new devices, ranging from high-end smart mobile terminals to low-cost and resource-constrained wireless sensors or Radio Frequency Identification (RFID) tags. M2M Technologies can be beneficially applied to a broad range of use cases for smart grid, telematics, e-Health/mHealth, Vehicular networking and systems, Industry Control, Home automation and environmental monitoring.

To achieve our objectives in this cluster, we shall engage interdisciplinary and multidisciplinary approach by including the best brain in this area of research. We do hope that this research cluster will give birth to other sub-clusters that will actually solve societal problems in our great country Nigeria.

VISION

To be an International research cluster that will act as a central player in the development of creative world acclaimed products.

MISSION

To provide a strategic scientific platform for proper research work that will deliver products meant to solve societal challenges.

OBJECTIVES

M2M and Embedded System Clusters aim to be an internationally recognized cluster that fosters world class technological research and benefit the populace through better innovative products and designs.

- To support an environment that facilitates collaborative research and tackles major problems that requires diverse skill sets and resources.
- To encourage development of M2M and Embedded Systems innovations with commercial potentials
- To improve the interaction between basic research and its translation to support delivery of evidence-based, cost-effective M2M services of the highest international standard.
- To encourage our Kings and Queens to seek careers in M2M and Embedded Systems research, its translation and Commercialization.

ACTIVITIES

The M2M and Embedded Systems Cluster will pay attention to the following research areas:

- E-Health and Assisted living.
- Smart Meters, Smart Grid and Green Energy
- Intelligent Transport Systems, E-Vehicles, Goods Tracking.
- Production Line Management, Quality Control.
- Electronic Monitoring and Surveillance Systems.
- Remote Data Acquisition
- Wireless Communication Protocols
- Single Board Computer Embedded devices.
- Artificial Intelligence
- Cybernetic
- Embedded Modules
- Educational Training Systems.
- Re-Engineering
- PCB Fabrication, Access Control.
- RFID Technology
- Circuit Reverse Engineering.

PUBLICATIONS

The cluster disseminate its research its findings through:

- Journal Publications
- Conference Presentations

RESEARCH CLUSTER PATENT APPLICATION

- Wireless Smart Electricity Meter
- GPS based belt tracker
- Vehicle Accident Alert System.
- RFID Electronic Attendance Techniques
- e-SIWES portal and hardware
- An intelligent Executive Chair
- A covert Acoustic System

MEMBERSHIP

Internal (List of Staff across the University)

- Dr. Victor Olu. Matthews (HEAD)
- Prof. C.A. Loto
- Prof. S. Misra
- Dr. Agboje
- Dr. S.N. John
- Dr. C. Nduijuiba
- Dr. E. Adetiba
- Dr. F. Idachaba
- Dr. N.A. Omoregbe
- Dr. A.A. Azeta
- Dr. Ajayi
- Dr. Ibidun.

EXTERNAL (LIST OF EXTERNAL COLLABORATORS)

- Prof. Koval Veleri Victorovish (Ukraine) (Ukraine Telecommunication Academy)
- Prof. Titenko V. (Ukraine Telecommunication Academy)
- Prof. Anoprienko (Donesk National University)
- Dr. Osianoh Glenn Aliu (Germany)
- Engr. Samuel Osafehinti (Microelectronics Design Nig. Ltd)
- Engr. Idiris Olawale. D (AET Technologies Nig. Ltd)

ONGOING/ PROPOSED PROJECTS

- Bank Surveillance System
- Wazobia Tourist Location Announcer
- Semi Humanoid Robotic System
- Analog Meter Reader Wireless Interface
- Remote Controlled Domestic Generator
- Zig bee Home Automation
- X10 Based Anti-tamper System
- Projector Protector Surveillance System
- Pico scope Enable Electronic Circuit Design.
- Terracotta Eyes
- Audio Lecture Recorder with Dater Time Stamp.
- Automobile Over speed Multilingual Announcer and Reporter
- Internet Enable Electronic Multi-purpose Board.
- e-Voting Machine for Cooperate Organization Using RFID Card
- Automated Wireless Lawn mower

III. Electrical Power Engineering Research

Preamble

The Electric Power and Energy Systems (EPES) group forms a core research area of the Department of Electrical and Information Engineering.

Our research cluster is motivated by the need to address the issues related to the design and operation of modern, "smarter", greener electric power grids. In addition, renewed interest in hybrid-electric distributed systems and home automation calls for advances in the area of energy conversion and power electronics.

The EPES research cluster has close links with the other groups within the University tackling problem in many highly strategic an challenging areas of research across energy and industrial sector and home automation.

Vision

To answer the question on how ideas and research findings in the energy sector can be converted into competitive products so that the transition from the present-day system to a future sustainable energy system will succeed.

Mission

This research cluster focuses on critical areas, which include clean energy, power security, Power System planning and the next-generation workforce. All members of this group share the vision for this initiative.

Objectives

- To partner with various industries in the energy sector and institution to lead critical research activities.
- To integrate the research and development needs of industrial partners with the resources and capabilities of the faculty and university in areas including advanced power electronics with impact for areas such as voltage security and clean energy.
- To train and equip the Next-Generation power and energy workforce.
- To provide students at both graduate and undergraduate levels, the opportunities to work on real engineering challenges thus establishing very strong networks and readily available employment opportunities for the students.
- To conduct research that is challenging, problem - solving and immediately applicable to areas of power system stability and condition assessment of critical infrastructure, renewable energy and distributed generation integration to the main national grid.

Activities

Our primary research thrusts are in:

- Power system dynamics and control.

- Operational decision-making.
- "Smart-grid" applications.
- System reliability.
- Energy
- Voltage security
- Economics of systems and markets.
- Electric machine and power electronics systems.
- Renewable energy sources.

Publications

The cluster shall disseminate its research findings through:

- Journal publications.
- Conference presentations.

Membership

Internal (List of Staff across the University)

1. Prof. C.O.A. Awosope (Sub-Cluster Lead Researcher)
2. Prof. Wara
3. Dr. A.U. Adoghe
4. Dr. A.F. Agbetuyi
5. Engr. H. Orovwode
6. Engr. I. Samuel
7. Engr. J.O. Olowoleni
8. Engr. A.A. Awelewa
9. Engr. R.S. Adesuyi
10. Mr. G. Afolabi
11. Mr. J.O. Odetola
12. Mr. M. Daramola
13. Mr. K.V. Adeyeye

On-going/Proposed Projects

- Innovative optimal integration of wind and solar resources for reliable and sustainable power generation.
- Decision process for electric power system asset management.
- Forecasting grid congestion for transmission grid operation and investment.
- Development and evaluation of system restoration strategies from outages.
- Adding intelligence to LED lighting