EMBEDDED SYSTEMS DESIGN AND DEVELOPMENT AND ITS RELEVANCE TO ACHIEVING VISION20:2020

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INTRODUCTION

- Nigeria often referred to as the Giant of Africa (Itibari, 2009; Anthony, 1998) has not really been able to show dominance in many of the metrics used in comparing nations.
- key metrics such include:
  - The standard of living of her people,
  - Gross domestic product (GDP),
  - Gross national income (GNI)
  - Non prevalence of HIV/AIDS,
  - Level of corruption,
  - Technological advancement,
  - Economic growth,
  - Per capital income, etc
- (NairaBrain, 2009; USAID, 2010; NigeriaWorld, 2009; Segun, 2010; Nigeria-Planet, 2011,)

WHAT DO WE HAVE?

Nigeria is a country with

- A vast land resource
- Endowed with abundant natural and human resources.
- Excellent weather conditions

OUR PRESENT CHALLENGES

- Low level of technological development
- Inability of our government and people to identify and summon the will to invest massively in key areas that will make the most impact on our economy.
- The prevalence of corruption in both the public and private sector, (NairaBrain, 2009)
- The lack of adequate commitment and dedication as well as unwillingness of Nigerians to make sacrifices.

Previous policies and programmes adopted by several Govts

- Over the years several governments in Nigeria have come up with different policies and plans aimed at achieving certain set goals which were clearly defined. These policies and plans include:
- The Colonial Development Plan (NPC, 2011)
- The Green revolution (NigerianWiki, 2008),
- Structural Adjustment Programme (SAP)(Ogugua, 1994),
- National Economic Empowerment and Development Strategy(NEEDS)(Ikeanyibe, 2009),
- Vision 2010 (NigeriaWorld, 1999), etc.

Any success yet?

These policies and plans have not yielded the expected results due to

- weak implementation
- lack of political will to see the development strategy through to the end (NPC, 2011).

This is evident considering the development and efficiency level of public infrastructures and systems ranging from

- bad roads,
- epileptic power supply,
- inadequate housing facilities,
- poor and inadequate water supply facilities,
- inadequate and inefficient security systems and health institutions,
- continual dependence on subsistence agriculture rather than mechanized farming,
- low commitment and dedication in the Public service,
- prevalence of corruption in all facet of our lives, etc.

The results

- poverty,
- hunger,
- lack of employment opportunities,
- fallen standards in education and living,
- low GDP,
- declining per capital income,
- insecurity,
- brain drain from the country,
- unstable exchange rate,
- high inflation rate, etc.

Indeed the problem of Nigeria has many faces but it must be tackled from front lines where the most efficient result will be obtained

Vision20:2020

- At the end of the 2008 Nigeria Economic Summit, a vision was identified to put the nation among the top 20 economies in the world by the year 2020 (SciCon, 2011).
- All stake holders involved in pursuing and implementing this vision must take necessary steps to prevent a repetition of history where the goals and objectives of the vision will not be realized by the end of the projected period.
- Key areas identified as front-liners in achieving the vision must be vigorously pursued so that maximum results will be obtained.

Objectives of the NV 20:2020?

The two broad objectives are to (NPC, 2011):

1. Make efficient use of human and natural resources to achieve rapid economic growth
2. Translate the economic growth into equitable social development for all citizens.

The development aspirations cut across four dimensions (NPC, 2011):

1. Social - building a peaceful, equitable, harmonious and just society;
2. Economic - developing a globally competitive economy;
3. Institutional - having a stable and functional democracy; and
4. Environmental – achieving a sustainable management of the nation's natural resources.

Why vision:20:2020?

Vision 20:2020 is important for the following reasons (NPC, 2011):

(1)The Need for Nigeria to plan development on a long- term basis in order to achieve structural transformation;

(2)The Need to reduce the country's overdependence on oil;

(3)The Need to effectively transform the lives of Nigerians in terms of significant improvements in their standards of living;

(4)The Need for the country to take its rightful position among the nations of the world

Necessary actions to be taken to achieve the vision in the vision statement

- Specific steps or actions must be taken in order to realize the vision. These steps include (NPC, 2011):

(1) Steps to urgently address the most serious constraints to Nigeria's growth and competitiveness. The domestic and external constraints that have been identified as hindrances to achieving the vision include (NPC, 2011):

(a) Poor and decaying infrastructure

(b) Epileptic power supply

(c) Weak fiscal and monetary policy co-ordination

(d) Fiscal dominance and its implications for inflation and private sector financing

(e) Pervasive rent-seeking behavior by private and public agents, including corruption

(f) Weak institutions and regulatory deficit

(g) Policy reversals and lack of follow-through

Necessary actions to be taken to achieve the vision in the vision statement

(h) Inordinate dependence on the oil sector for government revenue/expenditure

(i) Disconnect between the financial sector and the real sector

(j) High population growth which places undue stress on basic life- sustaining resources and eventually results in diminished well-being and quality of life.

(k) Insecurity of lives and property

(l) Threats of climate change, especially in relation to food production

(m) Vulnerabilities in the global economic environment, in particular, the global economic crisis and disturbances in the international oil market.

(2) Aggressively pursue a structural transformation of the economy from a mono-product to a diversified and industrialized economy.

(3) Investing in human capital to transform the Nigerian people into active agents for growth and national development.

Picture of the Desired Economy by 2020

- Under the NV20:2020 manufacturing and services are expected to dominate the structure of national output,
- gross national investment is expected to increase,
- the infrastructure base of production is expected to improve considerably.
- Income per capita should have risen to $US4,000 from the estimate of US$1,230 in the year 2008.

Picture of the Desired Economy by 2020

Activity Sector	Projected Share of Output by 2020 (%)	Existing Share of Output (%)
Agriculture	3-15	42.1
Industry	30 – 50	23.8
Manufacturing	15 – 30	4.0
Services	45 – 75	34.1

What we require

For Nigeria to realize the Vision 2020 and become the 20th largest economy, it must

- grow at least 9.5% annually within the next eleven years, 2010 included.
- It was ranked 44th ($174b (nominal), 2009) and chasing Belgium which is 20th ($471b, 2009), according to IMF (Admin, 2011).
- Making that jump will require a compounded interest of 298% by 2020 which will translate to 171% percentage growth in the GDP. This analysis assumes that the GDP of the 20th economy will remain constant in 2020.
- For a nation that has averaged about 5.5% in growth, in the last seven years, it does mean that it needs a new growth engine.

What is most important?

- It has been generally agreed by many stakeholders that investing in developing the Nation's technological education is a major key to achieving economic growth and development (Allafrica, 2009; Onyenekenwa, 2011; Accessmylibrary, 2008).
- Engaging in human capacity building through establishment and funding of research and training centers on embedded systems design and development will provide the platform for indigenous solutions in the form of equipments, machines, tools, products, etc ranging from very simple to complex systems to be developed.
- Hence the growing needs of our agricultural, manufacturing and other industrial sectors will be met.
- Countries that must lead other countries in economy, GDP, GNI, developed infrastructures, etc must first lead in the development and the sustenance of their technology.

What are Embedded Systems?

- Embedded systems are small, fast, and very powerful tools, gadgets and equipments which have become part of our everyday life.
- They are those computer systems that do not look like computer systems to the everyday user.
- They form a part of a larger system or product, part of anything, from mobile phones to medical devices, from agricultural farming tools to manufacturing equipments.
- An embedded system is a micro-processor based system that is built to control a function or range of functions and is not designed to be used by the user in the same way that a personal computer (PC) is (Heath, 2003).

What are Embedded Systems?

- It is a combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a dedicated function (Netrino, 2011).
- In some cases, embedded systems are part of a larger system or product, as in the case of an antilock braking system in a car.
- Although the user can make choices concerning the functionality, he cannot change the functionality of the system by adding or replacing software as is possible with the PC.
- In a PC, you can change functionality from word processing to games and then to mathematical computation by simply changing the software application but this is not possible in embedded systems.
- An embedded system is designed to perform one or a few dedicated and/or specific functions but with choices and different options (Michael, 2007; Heath 2003).

Examples of embedded systems.

The digital revolution, started decades ago, has reached a stage that we cannot conduct our normal modern daily lives without this technology.

- phone,
- television,
- an automatic washing machine
- Traffic control systems
- Temperature control systems
- MP3 player etc.

The colossal growth of processing power in small packages has fuelled the digital revolution.

All sectors of the economy have been influenced by the digital revolution and the industry has experienced tremendous developments in all aspects of engineering disciplines (Bruce, 2011).

Research methodology

- A hypothesis that massive investment in research and development of embedded systems technologies is key to achieving vision20:2020 (which aim to make Nigeria one of the first 20 economies in the world) is set.
- To verify the claim, some selected developed and emerging economies were investigated and the key factors that determined their growth were identified.
- Based on the findings conclusions and recommendations were made to support or discard the hypothesis.

European economies

- The European industry projected to invest more than N 22 billion per annum in embedded systems research and development by 2009 (Kostas, 2006). This is almost double what it invested in 2003.
- Because of the importance of embedded systems technology for key industrial sectors (from industrial automation and medical equipment to automotive and avionics), the European Commission has devoted a specific part of its Information Society Technologies (IST) program to embedded systems research (Kostas, 2006).
- From 2003 to 2006 alone, it has invested €140 million in collaborative projects between industry, academia and research centers (Kostas, 2006).
- These projects focus largely on systems design, safety- critical systems, embedded computing, middleware platforms, wireless sensor networks, and distributed and hybrid control systems.
- Embedded systems were also one of the six “pillars” of ICT research in the European Commission‘s proposals for the 7th Framework Programme, that started in 2007 (Kostas, 2006).

European economies

- In 2004, the Technology Platform ARTEMIS (Advanced Research and Technology for EMbedded Intelligence and Systems) was set up.
- ARTEMIS is an industry-led initiative to reinforce the EU's position as a leading global player in the design, integration and supply of embedded systems (Kostas, 2006).
- The driving force behind ARTEMIS is the vision of a society where all systems, machines, and objects have become digital, communicating, self-managed resources.
- These transformations are possible through advances in embedded systems technologies and their large-scale deployment, not only in industry and services, but in all areas of human activity (Kostas, 2006).

European economies

Such developments have a range of important consequences for society and the economy which include (Kostas, 2006):

- Life in our society and its safety and security will depend increasingly on embedded systems.
- The competitiveness of European industries, in almost all sectors, will rely on innovation capabilities in the area of embedded systems.
- Given the dramatically increasing importance of embedded systems to productivity growth, these technologies will be critically important in redressing the present imbalance in productivity growth between Europe, the US and Asia.
- Maintaining a leading position in embedded systems technology will require significant investment in research and development that is focused on specific joint priorities.

German Economy

- “The financial and economic crisis is presenting Germany with enormous challenges. To emerge from this crisis even stronger than before, we will have to make immense joint efforts. In addition to managing the crisis in the short term, we will have to commit ourselves to a path of growth and economic success. Investments in education, science and research are the right way to make such a commitment” (BMBF, 2009). Prof. Dr. Annette Schavan, a member of the German Bundestag, Federal Minister of Education and Research in the year 2009.

German Economy

- Research and innovation are indispensable for highly developed, resources-poor countries such as Germany.
- Innovative goods and services keep the economy moving, creating jobs and high incomes.
- Production, value creation and employment grow far more strongly in highly innovative companies than they do in weakly innovative ones.
- The prosperity of the country, and of its citizens, depends on research and innovation, as does the country's ability to provide for its citizens' futures and their quality of life (BMBF, 2009).

German Economy

- In Germany, the proportion of value-added products and services based on research is higher than in any other industrialized country (BMBF, 2010).
- The export of technological goods makes up one fifth of the country's economic output. Hence, research and development are very important to the economic power and economic growth in Germany (BMBF, 2010).
- Since 2005, the German central government expenditure on research has risen by 21 percent; private sector investment in research has increased by 19 percent (BMBF, 2010).

German Economy

- This puts Germany in the leading group among European countries (BMBF, 2010). They have also steadily increased the number of scientific publications and patents.
- The Federal Report on Research and Innovation underlines the key findings of the report on research, innovations and technological performance which showed that Germany has a powerful and internationally recognized scientific system and a high proportion of innovative enterprises (BMBF, 2010).

German Economy

- In recent years, the German Federal Government has moved research and innovation closer to the core of its growth policy.
- It has consistently given priority to education, research and innovation. The German Federal Government's research and innovation policy measures were re-initiated and bundled together to form the High-Tech Strategy (BMBF, 2010).
- The central and local government reform initiatives the Excellence Initiative (Exzellenzinitiative), the Higher Education Pact (Hochschulpakt) and the Joint Initiative for Research and Innovation (Pakt für Forschung und Innovation) have strengthened the performance capability of the German science system and made Germany even more attractive as a scientific location (BMBF, 2010).
- This High-Tech Strategy, the reform initiatives and the strategy for the internationalization of science and research complement each other perfectly.

German Economy

- The following data and facts show that the chosen path is the correct one (BMBF, 2010; BMBF, 2009):

1. In 2007, absolute expenditure on R&D in Germany was higher than in any other country in Europe. Compared internationally, only the USA, Japan and China spent more on R&D.
2. According to preliminary calculations by the Federal Ministry of Education and Research (BMBF), expenditure on R&D as a percentage of GDP rose to about 2.64% in 2008. This is the highest level since German reunification and a further step towards the 3% targeted of the Lisbon Strategy.
3. In absolute terms, total expenditure on R&D (government, industry and others) between 2005 and 2007 increased from 55.7 billion euros to 61.5 billion euros. This corresponds to an increase of approximately 10%. A further increase to over 65 billion euros was expected in 2008.

German Economy

4. Central government expenditure on R&D increased from 9 billion euros in 2005 to 10.9 billion euros in 2008, a rise of around 21%. In 2009, central government expenditure on R&D increased further to 12.1 billion euros (target), a rise to 12.7 billion euros is planned for 2010.
5 Despite the uncertainty caused by the financial and economic crisis in 2008, German companies have increased internal expenditure on R&D, compared to the previous year, by 7% (to 46.1 billion euros).

   As a result, enterprises in Germany increased their annual R&D investments between 2005 and 2008 by around 19% (7.4 billion euros). Increases were recorded by large, small and medium-sized enterprises.
6. Never before have so many people in Germany been employed in R&D: in 2008, the number of researchers, laboratory technicians and engineers employed in industry rose to 333, 000 (measured in full-time equivalents). Compared to 2005, this is an increase of almost 30 000 people.

German Economy

7. The proportion of research-intensive products and services providing added value is more than 45% in Germany higher than in any other industrialized country. The USA, which was ahead in 2000, has now been surpassed (BMBF, 2010).

- Statistics have proven that, by the end of 2008, there was a positive innovation climate in Germany.
- Around 31% of companies can trace their innovation behavior back to central government's improved research and innovation policies.

German Economy

- Key technologies, such as biotechnology and nanotechnology, optical technologies, micro system, materials and production technologies, aeronautics technology, as well as information and communication technology are the drivers of innovation and form the foundation for new products, processes and services (BMBF, 2010).
- These technologies all depend on embedded systems

British or UK Economy

"In these tough economic times for our world we look to science to provide new solutions, new technologies, new opportunities to further our common goals" (STFC, 2011). Rt Hon Gordon brown who was Prime minister of the United kingdom from 2007 to 2010.

- In the vision document of the UK's Science and Technology Facility Council (STFC), the need for science and technological innovations to drive the economy has been clearly articulated.
- The UK needs to turn more dreams into realities if it is to remain economically competitive globally and thus be able to afford to maintain high standard of living and high social values (STFC, 2011).
- The UK is not a low cost economy based on extractive industries or cheap labour. To compete they need to innovate (STFC, 2011).

British or UK Economy

- The UK needs to use the prodigious talents, knowledge and curiosity of their scientists and engineers to encourage innovation, and thus help build a more sustainable economy, able to recover rapidly from slowdowns of the kind currently being experienced, and move forward robustly to address the global challenges humankind faces over the next 20 years and beyond (STFC, 2011).
- The Rt. Hon. David Willetts, the UK Minister for Science and Universities visited China in June 2011 to reinforce the position of UK and China as partners for growth through science and education. This shows the importance that the British government attaches to the use of technology to enhance economic growth.

British or UK Economy

- The UK economy at a glance shows that it has benefited immensely from its technology base.
- For example, Electronics, Photonics and Electrical Systems (EPES) manufacturing employs more than 330,000 people in 14,000 UK businesses, with £42 billion turnover (TSB, 2011).
- This is 10% of UK manufacturing industry (TSB, 2011).
- EPES distribution, wholesaling and retail adds £73 billion and electricity transmission and distribution a further £55 billion (TSB, 2011).
- The value added by these activities totals 4% of GDP, with telecommunications adding a further 2%, and EPES technology underpins activity throughout the remainder of the economy (TSB, 2011).

British or UK Economy

- The UK boasts nearly a third of Europe's silicon design companies three times as many as either France or Germany (TSB, 2011).
- The Technology Strategy Board recognizes the importance of these technologies to the UK economy, and will continue to champion a sector that received over £114 million of investment from the Technology Programme during 2004-2008 (TSB, 2011).
- The economic benefits (the goal of the UK's EPES strategy) can be achieved by developing ideas from the science base into industrially relevant new EPES technologies, and onwards to become products in the marketplace.
- they can also be achieved by the adoption of existing technologies into new applications in the healthcare, transport, energy, retail and environmental sectors (TSB, 2011).
- This benefits both the technology providers in the device industries and the technology adopters in the end-use markets.

British or UK Economy

- This UK strategy has identified five technology pillars for investment, where Technology Strategy Board involvement will have a significant and lasting impact on the UK economy (TSB, 2011):

1. Control systems and power engineering,
2. Plastic and printed electronics,
3. Data and image acquisition,
4. Communications,
5. Systems design and integration.

These technology pillars all make use of embedded systems. Hence design and development of embedded systems technologies will provide a platform for a lasting impact on the economy of UK.

British or UK Economy

- The economic importance of technology and innovation is great since, according to Mokyr: “The difference between rich nations and poor nations is not […] that the rich have more money than the poor, but that rich nations produce more goods and services (Panayotis, 2004).
- One reason they can do so is because their technology is better; that is, their ability to control and manipulate nature and people for productive ends is superior” (Mokyr, 1990).
- If Western Europe has been superior, in terms of economic growth, compared to most of the African, Central-Eastern and Former Soviet Union (F.S.U.) countries,
- This is undoubtedly, at least partly, due to its technological superiority (Panayotis, 2004).

United States of America Economy

- Between 1991 and 2000, the US economy grew at an exceptional rate. The gross domestic product (GDP) rose by an average of 4% per annum between 1994-1999, with the rate reaching 4.2%, 4.3%, respectively, between 1997 and 2000 (Bisht, 2001).
- Policies to promote technological advance are playing a significant role in the economic growth strategies of most mature and emerging economies (Bisht, 2001).
- Long-term studies show that advances in technology have been responsible for as much as one half of economic growth in the United States over the past 50 years, through improvements in capital and labor productivity, and the creation of new products, services, and systems (Bisht, 2001).
- In other countries, the contribution of technology to economic growth has been even greater. For France, technology is estimated to have accounted for 76 percent of economic growth, for Germany, 78 percent, for the United Kingdom, 73 percent; and for Japan, 55 percent (Bisht, 2001).

United States of America Economy

- In a recent appearance before the Joint Economic Committee of Congress, Federal Reserve Chairman Alan Greenspan observed that "something special has happened to the American economy in recent years”.
- An economy that twenty years ago seemed to have seen its better days, is displaying a remarkable run of economic growth that appears to have its roots in ongoing advances in technology" (Microsoft, 1999).
- Mr. Greenspan went on to note that technology is enabling businesses to better manage everything from employees to inventories.
- In addition, it is helping eliminate unnecessary production processes, speeding the delivery of goods to market, compelling businesses to keep prices low and, most important, enabling companies to better meet individual customers' needs (Microsoft, 1999).

United States of America Economy

- the U.S. Department of Commerce issued a report noting that although the information technology industry accounts for only about 8 percent of America's gross domestic product, it generated more than one-third of the nation's economic growth from 1995 to 1998 (Microsoft, 1999).
- The Commerce Department study, “The Emerging Digital Economy II”, also noted that falling prices in the information technology sector cut overall inflation by 0.7 percent.
- Meanwhile, the technology industry showed dramatic increases in productivity: an average of 10.4 percent annually from 1990 to 1997, compared with less than 1 percent outside the technology sector (Microsoft, 1999).
- The technology sector has done a magnificent job creating new opportunities and helping build a productive American economy.
- Healthy competition, innovation and consumer choice are clearly the most effective tools to ensure that this prosperity continues (Microsoft, 1999).

United States of America Economy

- The information and communications technology industry has impacted the US economy positively over the years. This is evident in several reports of researches carried out (Robert, 2002; Michael, 2001; InfoUSA, 2011; Microsoft, 1999; Futurework, 2011; C-Span, 2011)
- Numerous examples illustrate this:

1. A manufacturing plant can be operated by a handful of technicians controlling robotic systems.
2. State-of-the-art inventory systems can supply needed parts “just in time” for assembly.
3. New jobs have been created in airfreight and delivery systems to service such just-in-time inventory operations.
4. Handheld mobile phones have become commonplace, and digital phone systems will soon be able to reach anyone in the world via satellite.

- One thing stands out in all of these: The ICT sector, which is responsible for the massive growth experienced in the US economy, is driven by embedded systems made using embedded systems technologies. Today, it won’t be wrong to say “embedded everything” as almost any equipment or gadget you find is made using embedded systems technology. This is the driving force behind the US economy.

Asian Countries

- Asia is equally aware of the significance of embedded technologies for future economic growth and prosperity.
- Government-backed programs exist in Japan, Korea and China, each with its own flavor and emphasis (Peter, 2006).
- All these regional and national programs are driving towards the pervasive use of embedded devices in a multitude of applications across industries and large infrastructures, health and entertainment, fixed and mobile networks.

Chinese Economy

- The Chinese Government as a matter of policy rewards those who return to china with a new technology (David, 2009).
- This is a measure taken to develop the Chinese technology and hence enhance their economy. China's central government, local governments, universities, research laboratories, and the marketplace all reward mainlanders who return to China with technology.
- This strategy has made China economy a threat to the US economy and many researcher are already speculating that China will soon be the no one economic giant in the world (Oded, 2005).
- In the late 1980s, the Central government's Torch Plan established New High Tech Development Zones in cities around China (David, 2009)
- By 1991, there were 27 such parks; by 1997, there were another 25 parks (David, 2009).
- These zones established incubators for returnees, which protect them from the vicissitudes of China's bureaucracy and marketplace until their firms are ripe; but to receive special privileges, projects have to involve new technology and local Science and Technology.
- Bureau must certify that such projects included new technology.

Chinese Economy

- The national real GDP of China has increased tremendously, giving an annual average real GDP growth rate of 9.8 percent in the past two decades (Kui-Wai, 2007).
- China experienced a double or close to double digit real GDP growth rate for the period of 1992 – 2004 (Kui-Wai, 2007).
- This growth is attributed to the development of the Chinese technology which has positively impacted the economy.
- It was shown that productivity change or the growth of total factor productivity (TFP) is a composition of technical progress, technical efficiency change and scale of economy (Kumbhakar, 2000).
- and other types of machinery (Barry, 2010).

Chinese Economy

- The export processing zones established in China in the 1980s initiated a complete transformation of China's coastal regions.
- The export processing trade, supported by a strong manufacturing base established in the 1950s and complemented by technology imported since the 1980s, progressively became a catalyst for China's economy (Barry, 2010).
- Following in the footsteps of other Asian catch-up countries, China's exports rapidly started moving up the value chain away from low-tech products.
- Between 1992 and 2005, China's medium- to high-technology exports grew 22 per cent annually, while high-technology exports grew by 32 per cent (Barry, 2010).
- By 2008, 43 per cent of China's exports were directly related to machinery, mechanical appliances and electrical equipment, and China now dominates the global markets for these

Chinese Economy

- Huawei Electronics, one of the major companies responsible for the global emergence of Chinese technology and innovation, has consistently spent 10 percent of its revenue on R&D every year (Barry, 2010).
- The firm's credentials as an innovator are beyond question, yet its greatest achievement is that it so effectively fused two often disparate elements: good quality at low prices.
- Capital accumulation, labor growth and technology progress are major factors to long-term economic growth on modern economic growth theory.
- China's economy keeps sustained, rapid, healthy development and wins remarkable achievements since they began to reform and open up (MA, 2008).
- In summary, advancing technological innovation, increasing total factor productivity and promoting industrial restructuring and optimization are the key factors for improving the quality of economic growth and ensuring economic sustainable development (MA, 2008).

Japanese Economy

- Japan is a leading nation in scientific research, particularly technology, machinery and biomedical research.
- Nearly 700,000 researchers share a US$130 billion research and development budget, the third largest in the world (McDonald, 2006).
- Japan is a world leader in fundamental scientific research and she has a large industrial capacity, and is home to some of the largest and most technologically advanced producers of motor vehicles, electronics, machine tools, steel and nonferrous metals, ships, chemical substances, textiles, and processed foods (WikipediaJapan, 2011).

Japanese Economy

- Efforts by North American manufacturers to close the perceived gap with Japan have often been frustrated because of the ability of Japanese corporations to implement new technologies and introduce new products within very short cycle times (Hannam, 1990; Weirmair, 1990; Clark & Takahiro, 1989).
- Japan achieved sustained growth in per capita income between the 1880s and 1970 through industrialization driven by technological advancement.
- This trend continued till the year 1990. Moving along an income growth trajectory through expansion of manufacturing is hardly unique.
- Indeed Western Europe, Canada, Australia and the United States all attained high levels of income per capita by shifting from agrarian-based production to manufacturing and technologically sophisticated service sector activity (Mosk, 2004).

Japanese Economy

- Japan experienced a miracle Growth as a result of a protracted historical process involving enhancing human capital, massive accumulation of physical capital including infrastructure and private manufacturing capacity, the importation and adaptation of foreign technology, and the creation of scale economies, which took decades and decades to realize (Mosk, 2004).
- With average growth rates of 10% in the 1960s, 5% in the 1970s, and 4% in the 1980s, Japan was able to establish and maintain itself as the world's second largest economy from 1968 until 2010, when it was supplanted by the People's Republic of China (Wikipediaeconomyofjapan, 2011).

Japanese Economy

- On November 12, 2007, Tata Consultancy Services (TCS) (BSE: TCS.BO, NSE: TCS.NS), a leading IT services, business solutions and outsourcing organization, announced a series of investments in the field of embedded Systems to help Japanese corporations innovate and remain globally competitive (TCS, 2007).
- TCS will invest $10 million over the next 12 months for a dedicated Innovation Lab for embedded systems research in key verticals like automotive, consumer electronics, telecom, and office automation to fuel innovative solutions focused on the needs of the Japanese market (TCS, 2007).

Japanese Economy

- TCS as a world-class Manufacturing and Hi-Tech hub, have identified Embedded Systems as one of the key focus areas for their growth strategy in Japan (TCS, 2007).
- Masahiko Kaji, President of TCS Japan said that with a significant talent shortage facing the Japanese market, TCS is investing in Embedded Systems R&D and Japan specific Delivery Center, to help their customers in applied innovation and reducing their go-to-market cycle time (TCS, 2007).
- There is no doubt that this feat has been achieved by the people of Japan due to advancement in their technology as well as readiness to massively invest in development of newer technologies.

South African Economy

- Today South Africa is following the steps of the US in trying to build a knowledge based economy where economic growth is driven by information and knowledge creation and easy transfer as provided by a strong ICT platform (Breitenbach, 2005; Wolf, 2001).
- The South African Government as a matter of policy supports the formation of ICT clusters in different regions (Sagren, 2003) as well as advances in science technology and innovation since it gained independence (OECD, 2000).
- South Africa is the economic powerhouse of Africa, leading the continent in industrial output and mineral production and generating a large proportion of Africa's electricity (Tradingeconomics, 2011).
- The Gross Domestic Product (GDP) in South Africa expanded 4.8 percent in the first quarter of 2011 over the previous quarter.
- From 1993 until 2010, South Africa's average quarterly GDP Growth was 3.27 percent reaching an historical high of 7.60 percent in December of 1994 and a record low of -7.40 percent in March of 2009 (Tradingeconomics, 2011).

South African Economy

- South Africa has a productive and industrialized economy that exhibits many characteristics associated with developing countries, including a division of labor between formal and informal sectors and an uneven distribution of wealth and income.
- The primary sector, based on manufacturing, services, mining, and agriculture, is well developed (Tradingeconomics, 2011).
- Not only is South Africa itself an important emerging economy, it is also the gateway to other African markets.
- The country plays a significant role in supplying energy, relief aid, transport, communications and investment on the continent. Its well-developed road and rail links provide the platform and infrastructure for ground transportation deep into Africa.

Conclusion and Recommendations

- The investigation carried out points to one fact: Better technology then better economy.
- Every other factor like population strength (e.g China), natural resource endowment, etc only ride on developed technology.
- Embedded systems form the bedrock of most technology systems found today. This means that developing embedded systems technologies will provide the platform for other technologies to thrive.

Conclusion and Recommendations

- Nigeria as a nation has lots of advantages such as abundant human capital, natural resource endowment, good climatic conditions, etc.
- By summoning the will to have and implement policies to develop our indigenous embedded systems technologies (through massive investment in research and development as well as collaboration between academia and the industry), we will see unprecedented growth in our economy.
- This is how it happened in the US, the UK, Germany, China, Japan and even South Africa.
- We must take the same steps if we are to get the same results.
- It is therefore very clear that Nigeria must invest massively in embedded systems research if she must be among the first 20 world economies by the year 2020.

Conclusion and Recommendations

- The following are some recommended steps the nation should take to develop embedded systems technologies in Nigeria:

1. Have at least 10% of the nation's budget invested in Research and development
2. Encourage inflow of technologies into the country by rewarding those who return with new technologies.
3. Encourage development of new and indigenous local technologies when identified.
4. Establish and fund research and development centers on embedded systems design and development
5. Provide the platform for a sound technical education right from primary to tertiary levels.
6. Fight corruption at all levels without discrimination.
7. Provide the platform for technological breakthroughs to be transformed into products and services by creating a cordial collaboration between the academia, research institutes and the industry.
8. Invest in provision of basic infrastructure such as Power supply, good roads, etc.
9. Improve on the present security situation in the country.

By taking these steps, we will advance speedily on our journey to fulfilling vision 20:2020

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