Increasing

Broadband Penetration and Quality for National Transformation

Based on Science,Technology and Innovation

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Increasing Broadband Penetration and Quality for National Transformation Based on Science, Technology and Innovation

Academy of Sciences Malaysia

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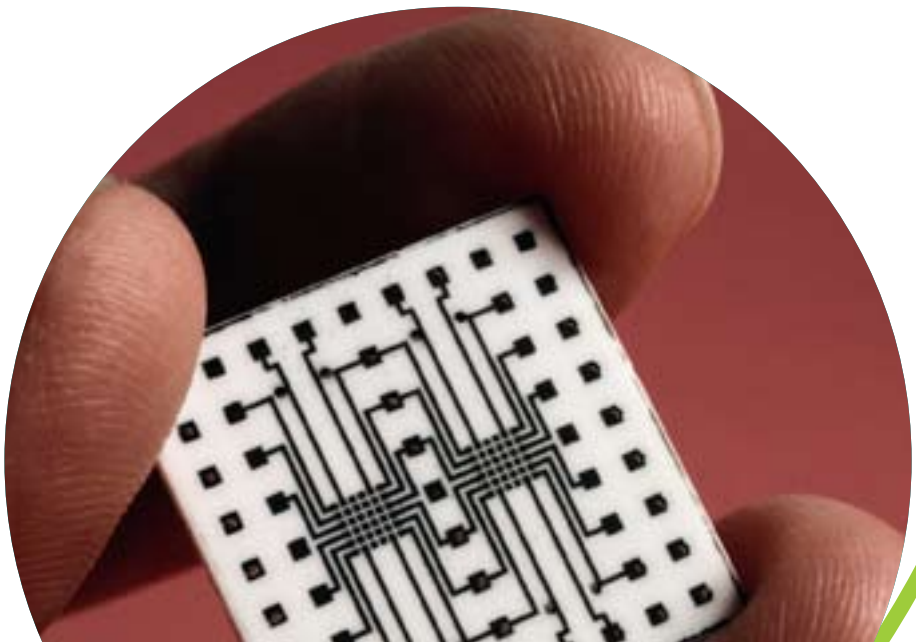

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FOREWORD

I would like to convey my congratulations to the ASM Working Group on Broadband Penetration for producing this Position Paper, apply entitled **Increasing Broadband Penetration and Quality for National Transformation Based on Science, Technology and Innovation.**

We believe that this Position Paper is most timely to address the critical issue of ICT infrastructure. Broadband penetration, quality and cost are key factors in national social and economic transformation in realizing our aspiration to become an innovative society.

As highlighted in this Position Paper, for Malaysia to reach the innovation-driven development stage, eight issues and challenges need to be urgently resolved:

(i) Deploying broadband as an enabler of socio-economic transformation;
(ii) Integrating the Malaysian science, technology and innovation community into global networks;
(iii) Intensifying application and content development activities;
(iv) Enabling small- and medium-scale enterprises to innovate based on information and knowledge;
(v) Adopting a dynamic definition of broadband;
(vi) Effectively managing the wide diversity of broadband services;
(vii) Ensuring that government policies and strategies, as well as their implementation mechanisms, are effective in creating a more level playing field for broadband service suppliers, in order to bring the cost down and raise the quality; and
(viii) Increasing cooperation and collaboration between key role players

The Academy of Sciences Malaysia believes that the formulation and application of effective broadband policies and strategies will better position the country to pursue the following objectives:

1. To ensure that the Malaysian science, technology and innovation community is nationally, regionally and globally connected, both physically and virtually, for more open cooperation and collaboration;
2. To enable the private sector and business community, especially entrepreneurs and small- and medium-scale enterprises, to leverage on ICT to become more innovative in growing their businesses; and
3. To facilitate the user community in applying ICT for life-changing and transformative development based on knowledge and innovation.

In addressing the issues and challenges identified above, the ASM proposes the following strategies and implementation measures for the government's consideration:

(i) Adopt a dynamic definition of broadband to fulfill today's applications while anticipating tomorrow's applications, ensuring also that it is compatible with Malaysia's development aspirations.

(ii) Provide quality broadband that is affordable to all citizens and businesses, irrespective of where they are located

(iii) The Academy of Sciences Malaysia (ASM) be given the mandate to lead the STI community in making Malaysia a globally-connected innovation hub.

(iv) Practice more transparent and inclusive engagement processes in policy-making, implementation, regulation and enforcement towards establishing a more level playing field in the provision of broadband infrastructure and services.

(v) Provide incentives, funding and other support mechanisms for the acculturation of the wider STI community, and in particular the SMEs, in the effective use of advanced productivity-enhancing tools and systems.

The publication of this Position Paper is in fulfillment of the Academy's many functions, among which are to provide independent advice to the Government through dissemination of ideas and suggestions amongst decision- and policy-makers, scientists, engineers and technologists through identifying where the innovative use of science, engineering and technology can provide solutions to particular national problems towards sustained national development.

Tan Sri Dr Ahmad Tajuddin Ali, FASc.
President
Academy of Sciences Malaysia

PREFACE

Science and its community of practitioners are driven to discover new knowledge from which innovations result. The advent of the Internet in the 1990s is one such innovation which is making far-reaching impact on the pursuit of science itself as well as on the wider community. By enabling knowledge distribution and use without restriction of time or space, the Internet is now reinventing the scientific enterprise. This is changing the very nature by which the scientific community works, learns and applies knowledge. A new virtuous circle is being nurtured wherein international interaction and collaboration is becoming the norm. The pace of change is happening at a rate that is unprecedented in human history.

Broadband, the cornerstone of the new age information and communication technology (ICT) infrastructure, is rapidly rising as the key enabler of scientific advancement. However, despite Malaysia's early adoption of ICT through the MSC initiative, we have yet to gain significant progress in applying ICT for economic and social development. Empirical evidence suggests that we have among the highest-cost broadband services in the world. Broadband speed and quality are also relatively low. These factors may account for the lower Internet contribution to the GDP.

This Position Paper is the final product arising from a series of Task Force meetings among participants drawn from among the members of the Academy of Sciences Malaysia's IT Discipline group, the academic community and PIKOM. A one-day round-table workshop was also organised which provided a platform for industry experts, ICT industry players, relevant government agencies, non-government organisations, service providers and other key stakeholders to share and deliberate on critical issues and challenges. The following questions were addressed:

1. How is Malaysia positioned in broadband penetration and application?
2. What opportunities can we pursue through better broadband? What threats arise if we fail to improve penetration?
3. What challenges does Malaysia face in capitalizing on broadband technology and the enhanced human and economic systems that it enables?
4. What are the major obstacles and constraints? How do we surmount them?
5. What role should ASM assume in taking this agenda forward?

The key message from this study is that the provision of broadband in Malaysia is at high cost, attributing to low penetration; in addition, low quality leads to low level of value-added economic and social activities which finally culminates in low level of preparedness for tomorrow's applications.

The broadband strategies enunciated in this paper should be followed through, and to ensure this the Academy needs to establish a multi-disciplinary Task Force to take the lead in monitoring, evaluating and anticipating global and local social and economic transformation that is underpinned by ICT. Specifically the Task Force should undertake the following:

(i) Monitoring broadband development (technologies, infrastructure, content, applications) globally and nationally;
(ii) Monitoring and evaluating implementation of national ICT policies and strategies;

(iii) Promoting enculturation of knowledge- enhancing applications and content within the STI community and other related communities and stakeholders; and

(iV) Undertaking futures studies (such as the Academy's Mega-Science Framework Study up to 2050), including scenario planning, fore-sighting and back-casting.

Finally, I am grateful to all the Task Force members and the participants of the Workshop for providing open and often blunt opinions and ideas, all of which have helped to develop a deeper understanding of the challenges before us and the potential solutions expressed in this Position Paper.

YM Tengku Datuk Dr Mohd Azzman Shariffadeen Tengku Ibrahim FASc
Chairman
ASM Working Group on Broadband Penetration

EXECUTIVE SUMMARY

Science, Technology and Innovation in the Knowledge Era

Advancements in science and the innovations that they spawn produce increasing technological impacts, not least on the scientific community itself. Since its commercial advent in the early nineties, Internet technology has been making profound impacts on science, the scientific community and its sustaining eco-system. The ways by which the scientific community works, learns and performs research have changed. In tandem, the rights, roles, responsibilities, rules and regulations of institutional governance in the scientific world also have been undergoing great upheaval. Virtual and global connectivity, interactions and networking irrespective of time, geography, demography, cultures, values and traditions have heightened international collaboration among scientists and changed the landscape of the scientific enterprise. Ever-increasing use of cross-boundary data, information and knowledge in research has widened the scope of science and research perspectives. Broadband, an integral part of the new age information and communication technology (ICT) infrastructure, is rising rapidly as the key enabler to these ameliorations. Specifically, it has been a powerful tool in greatly accelerating the production, distribution and sharing of data, information and knowledge among the researchers and user groups as well as other interest groups across the globe. Indeed, the pace of change is happening at an unprecedented rate that the world has not experienced before.

A study undertaken in 2011 by The Royal Society and published in its report entitled **Knowledge, Networks and Nations – Global Scientific Collaboration in the 21st Century**, states that "the connections of people, through formal and informal channels, diaspora communities, virtual global networks and professional communities of shared interests are important drivers of international collaboration. These networks span the globe. Motivated by the bottom-up exchange of scientific insight, knowledge and skills, they are changing the focus of science from the national to the global level".

The Academy of Sciences Malaysia, an independent science and technology think tank established by an Act of Parliament shares the view of the Royal Society. In order to intensify the networking of the scientific community domestically and globally, it stresses the critical importance of having fast, stable and affordable Internet broadband connectivity nation-wide. An advanced broadband infrastructure will enable Malaysian scientists to elevate national and international collaboration to a much higher level. It will also assist the public sector and the wider community, especially the business community, and in particular small and medium-scale enterprises, to leverage on the creative use of information and knowledge to innovate.

In their study, the Royal Society conducted an analysis of the top publishing cities from 2004–2008 and their growth since the late 90's, that is, from 1996 – 2000. In Canada, Toronto showed an increase of more than 20 places while in Europe, the cities of London, Madrid, Moscow and Rome showed similar increases. In South America, Sao Paolo in Brazil depicted a similar increase. In Asia, Beijing and Hong Kong in China and Tokyo in Japan showed increases of more than 20 places.

The Royal Society Report pointed out that global connectivity and networking is critical for the advancement of science owing to the following reasons:

- Science is increasingly global as it involves transnational collaboration, well supported by governments, businesses and third sector organizations;
- Increased activities, investments and scientific productivity has led to new emerging scientific nations like China, India and Brazil; outstripping the traditional scientific superpowers (USA, Western Europe and Japan);
- Traditional centres of scientific excellence and new players pointing towards an increasingly multipolar scientific world; and
- Beyond the traditional hubs science is also flourishing in driving economic and sustainability development.

Furthermore, the Report emphasized that global connectivity, networking, interaction and collaboration accords numerous benefits as follows:

- Scientists seek to work with the most outstanding scientists in their fields;
- Helps to build knowledge networks, providing access to complementary skills and knowledge; filling in knowledge gaps and resources; accessing high quality equipment and instruments; and shaping research agendas;
- Collaboration brings with it the obvious benefit of scale;
- Sharing the burden of research activity, breaking down complex tasks into manageable pieces; and
- Facilitates joint authorship, capacity building, geopolitical linkages and global networks of science.

The Report cited that, through global connectivity, many opportunities would arise in scientific collaboration as follows:

- The scientific world is increasingly interconnected, with increasing collaboration from 25% to 35% of articles published over the past 15 years;
- International collaboration entails connections of people through formal and informal channels, diaspora communities, virtual global networks and professional communities;
- Collaboration enhances the quality, efficiency and effectiveness of research;
- Scientists are increasingly collaborating to work with the best people, institutions and equipment around the globe;
- Focus of science changes from the national to global perspectives;
- Global networks span through bottom-up exchange of scientific insight, knowledge and skills; and
- Global collaboration brings benefits in increased citations, access to new markets, broadening research horizons and positive impact on the science system itself in bringing prosperity or addressing specific challenges.

In a following 2012 study by the Royal Society, entitled "Science as an Open Enterprise", it states that "the Internet provides a conduit for networks of professional and amateur scientists to collaborate and communicate in new ways and may pave the way for a second open science revolution, as great as that triggered by the creation of the first scientific journals." Clearly the Internet and the Web are about to unleash a revolution in the way that scientific activity is conducted.

Broadband Development - Penetration, Speed and Quality

In considering broadband quality and performance, it is undeniable that broadband services are critical for the advancement of global science, as well as for society and the economy at large. From the economic perspective, it has been estimated that a broadband contribution of 4% to GDP can be realized with 50% population penetration in USA; 0.6% to GDP with 15% population penetration in UK; and 0.9% to GDP with 50% population penetration in New Zealand. In the same vein, the Economic Planning Unit (EPU) of Malaysia had projected that achieving 50% household penetration can result in a tangible contribution of 1% to the country's GDP and also possibly contribute to creating some 135,000 jobs.

The Said Business School, Oxford University, with the support of Cisco, has been assessing broadband leadership in the global arena since 2008, and has in three consecutive years widened its scope for assessing broadband quality. For each country, the Broadband Quality Score (BQS) index is plotted against the household penetration rate.

The 2008 study showed that, in terms of global ranking, Malaysia came 48th among the 66 countries studied, ahead of China but behind Slovakia, Turkey, Russian Federation, Chile, Mexico and Argentina. In the same study for the ASEAN region, Malaysia ranked on par with the Philippines, Vietnam, Indonesia and Thailand. Because of low (less than 60%) household internet penetration and poor Broadband Quality Score (BQS) (less than 60), Malaysia was ranked in Band 4 behind the leaders in both quality and household penetration.

In 2010, the study covered 72 countries covering 40 socio-economic variables as well as 40 million records sourced from Speedtest.net. Analysis of quality divide showed that Malaysia is in the fourth band, that is, below quality leaders and penetration leaders, very far below the first band of broadband leader category. Of the 72 countries ranked, Malaysia occupied 58th position in the broadband leadership ladder.

Furthermore, when comparing with industrialized or newly-industrialized countries, particularly Singapore, South Korea and Japan in Asia, Malaysia's performance in Internet penetration is lagging significantly behind. This is shown in a joint study by the MCMC, International Telecommunication Union (ITU) and PIKOM, where the broadband penetration in South Korea has reached 83.7% followed by 80% in Japan and 70% in Singapore, with Malaysia only scoring 58% (DOSM and PIKOM, 2011).

Broadband performance is another important indicator that Malaysia lags in. When the performance of Malaysian broadband is benchmarked against the "today" and "tomorrow" application requirements, especially the speed as given by the Said Business School, the comparison shows that

only the average speed offered under the fixed broadband of 4.4 Mbps is able to meet the minimum criterion of 3.75 Mbps needed for downloading today's applications. These applications cover social networking, low density video streaming, basic video chatting, small file sharing and Standard Definition Internet Protocol TV (SD IPTV). The average speed of mobile broadband of 1.77 Mbps and 2.8 Mbps for mobile internet is far from adequate to meet today's application requirements. All the three types of broadband services are obviously inadequate to meet tomorrow's applications which demand an average download speed of 11.25 Mbps and latency of 60 milliseconds. Tomorrow's applications include visual networking, high density video streaming, consumer tele-presence, large file sharing and high definition Internet protocol TV (HDIPTV).

In the "level of preparedness" for application readiness, Malaysia is placed under the "below today's application threshold". The analysis also shows that in 2010 14 countries are already prepared for the Internet "application of tomorrow" compared to only one country in 2008. In this category, Korea ranked first and two other countries in Asia ready for tomorrow's applications are Japan and Hong Kong.

Broadband Supply and Use in Malaysia

Eight types of licensed services are provided by the telecommunications industry players. However, little is known about the actual services delivered in the market. Such information can only be gathered through demand-based consumer surveys where the users can be asked to provide the types of services they are subscribing to, the service quality level experienced and the level of customer satisfaction.

In the absence of demand side data, broadband services from the supply side can be analysed by examining the provision of broadband quality in terms of speed, capacity and price as well as unit cost for capacity and speed. Great disparity in the type of services rendered is seen in the type of broadband services listed. In order to minimize the variations, geometric averages were compiled instead of simple averages. As reflected in the range measures, for each type of broadband service, capacity, speed and average cost vary greatly. Indeed, such wide disparity reveals the poor broadband business practices prevailing in the country from the view-point of creating healthy competition among service providers. The highly-skewed distribution also sends confusing signals and poses difficulties for consumers to make an informed decision on their best option.

The McKinsey report (2011) entitled "Online and upcoming: The Internet's Impact on Aspiring Countries" conducted an analysis which shows that in 2010 ICT-related trade and private consumption in Malaysia made a 4.1 % contribution to Gross Domestic Product (GDP). Of this contribution, 8.0% was for export, 1.6% accounted for private consumption and 0.3% was on public expenditure. Private investment in ICT is only 0.3% of GDP, which is considered to be low.

On a global level, Malaysia ranked as one of the highest-cost countries as far as Internet subscription is concerned, which may account for the lower Internet contribution to the GDP. Internet contribution to GDP growth is likewise low as a result.

From its introduction in 2002, broadband penetration in Malaysia grew significantly from 0.1 to 58.0 per 100 households in 2011. The marked increase in the provision of broadband from 31.6% in 2009 to 55.6% in 2010 was due to inclusion of broadband-driven cellular phones following the definition of the International Telecommunication Union (ITU).

Earlier ITU had defined broadband in the context of computer-mediated devices like desktops or lap tops. The organization subsequently revised the broadband definition after considering the 4G capability of smart phones or tablet devices, which are on par with typical computers in terms of capacity, capability and performance. Taking into consideration the new definition and its scope of devices, the broadband penetration rate in Malaysia is expected to reach 75% by 2015. Specifically, this target is possible to be achieved when increasing numbers of cellular phone users, which had already reached a penetration rate of 116.6 users per 100 inhabitants in 2011, resort to 4G technology in the years ahead.

In 2010, Internet penetration in Malaysia had achieved the following: for every 100 inhabitants 14 users subscribe to fixed line / dial-up Internet, 11 users have fixed line broadband and 33 users mobile broadband, that is, totaling 58 Internet users per 100 inhabitants. The penetration rate is targeted to reach 61.5 users for every 100 inhabitants by 2012 and 75 users per 100 inhabitants by 2015. The inadequacy of mobile broadband speed and quality as noted earlier implies that the majority of broadband subscribers may not be able to run today's applications, let alone tomorrow's.

The 2011 McKinsey report estimated that 91% of Internet users in Malaysia are social media savvy. This proportion is well above the global average of 70%. Malaysians also outpace global trends in areas pertaining to search/navigation, photos, multi-media and blogs. These activities are considered low-value adding, reflecting a good consuming nation rather than a producing nation. The proportion of Malaysians involved in high-value adding services, such as retail, business, sports, education and auction, did not exceed 20%.

Broadband, Innovativeness and Competitiveness

A key development challenge that policy makers and development practitioners are bound to address is bridging the digital divide, in particular between urban and rural populations. In common with other technological innovations, broadband first gained a foot-hold among the urban population before diffusing into rural communities. Even among the urban users, it is the more educated and affluent segment who could afford the subscription cost and are likely to be innovators and early adopters of the new technology. Typically, new technology tools and services are introduced at high prices, but with increasing demand the price tends to come down, especially once critical mass is reached in terms of market viability and profitability. Malaysia saw introduction of broadband in 2002 and, over the last decade, broadband services have pervasively permeated many corners of the country. However, despite great development advancements, rural communities still lack quality infrastructure, such as roads, health amenities, education facilities, housing and sanitation, including broadband.

In a 2011 study conducted by Nair of Monash University, Sunway Campus, in the rural areas of Malaysia, development challenges are further exacerbated by the lack of access to affordable

information and communication technology services including quality broadband. Such shortfalls pose problems in attracting highly-skilled and educated workers to rural locations where much help is needed to upgrade the standard and quality of living. Due to poor connectivity, connectedness and networking among the poorer rural citizens, they continue to suffer deprivation in terms of access to knowledge, skills, information, resources and markets.

Nair's study was based on analysis of factors that lead to innovativeness, grouped under "foundation conditions" and "driver conditions". The "foundation conditions" include infrastructure and info-structure where broadband is an integral component. "Driver conditions" entail intellectual capital development, interaction, integrity, incentives and institutions. Clearly foundation conditions are critical in enabling the driver conditions to enhance competitiveness. Nair's digital divide study on communities living in Government-assisted land schemes, privately-operated plantations, traditional agricultural communities, fishing villages and urban poor communities revealed that a number of weaknesses occurred in the so-called driver conditions. These include low learning skills, low proficiency in languages, especially English, which is considered the lingua franca of the Internet world, poor creativity in rural education settings, poor technology uptake and weak alignment to national innovation strategies, as well as the lack of local champions and effective local governance systems. The study succinctly revealed that the plantation communities, at the lowest level with only 5% Internet penetration rate reflects poor technology uptake in general. This is attributed to the lack of affordability, lack of knowledge about its productive use and, more importantly, they often see no relevance of Internet to their daily lives. In comparison, the urban poor communities on an average experience 35% connectivity. Still the bulk of poor urban community members also cited the same reasons as their counterparts in the plantation sector for poor technology uptake.

A competitive edge in broadband pricing is critical for the provision of data and Internet services, in order to realize their potential to advance development. The Multimedia Development Corporation (MDeC) commissioned a study in 2012 that was conducted by Frost and Sullivan to benchmark Malaysia's data services against selected countries in the region. The data services considered in the compilation include domestic leased line over Ethernet, international private leased line, domestic and international IP-VPN. For meaningful comparisons, only data services at 50 Mbps were considered. Data for 10 Mbps, 20 Mbps and 100 Mbps were not available for all the countries considered in the study. It can be seen from the summarized data that Malaysia is ranked in 12th, 13th and 14th positions respectively for the three service providers, behind Philippines and Singapore in this region. At the moment, Malaysia's position in the provision of data services is only better off compared to China, Thailand, Vietnam, and Indonesia. Singapore ranked number one.

Further analysis shows that average monthly tariff paid for data services in Singapore is only 65% of Malaysia's and similarly, in the Philippines, it is only 84% indicating that these two countries are more competitive. The study also indicates that monthly tariff pricing in Thailand and Vietnam are 1.54 and 2.34 times higher than in Malaysia.

Similar analysis was carried out on average monthly tariff for Internet services. Four types of Internet services, namely dedicated Internet access, shared broadband services, domestic and international transit and server collocation, were considered in the compilation of average monthly tariff and average rank scores. The computation considered only 100 Mbps Internet services for

which data were available for all the nations considered in the study. Interestingly, Malaysia ranked in the 4th position among the 18 service providers from 15 competing nations considered in the study, indicating its cost is higher when compared to Singapore, India and Hong Kong. Specifically, the average monthly tariff in Singapore is as low as 70% of what is incurred in Malaysia. However, in Philippines and Thailand, the average monthly tariff for Internet services is 1.13 and 1.28 times higher than in Malaysia respectively.

The key message from the above study is that the provision of broadband in Malaysia is at high cost, attributing to low penetration; in addition, low quality leads to low level of economic activities which finally culminate in low level of preparedness for tomorrow's applications.

The Global Competitiveness Index for 2012 can be used to clearly indicate Malaysia's current economic competitiveness in the global context. According to the GCI, Malaysia is still in transition from stage 2 to 3, that is, between efficiency-driven and innovation-driven. In comparison, South Korea and Taiwan are two Asian countries that have recently become innovation-driven economies. Comparison with Saudi Arabia shows that although it is in the transition stage between 1 (factor-driven) and 2 (efficiency-driven), it is ranked higher at 18 relative to Malaysia's 25. Countries like Saudi Arabia are demonstrating that Malaysia can be overtaken if it does not accelerate its development. South Korea and Taiwan both score highly in technological readiness, which depends to a large extent on Internet penetration and broadband speed and quality. Malaysia fares relatively poorly. Two other areas that Malaysia needs to improve urgently are innovation and higher education and training.

For Malaysia to reach the innovation-driven stage, eight issues and challenges need to be urgently resolved:

(i) Deploying broadband as an enabler of socio-economic transformation
(ii) Integrating science, technology and innovation (STI) community into global networks
(iii) Intensifying application and content development activities
(iv) Enabling small and medium-scale enterprises to innovate based on information and knowledge
(v) Adopting a dynamic definition of broadband
(vi) Effectively managing the wide diversity of broadband services
(vii) Ensuring that government policies and strategies, as well as their implementation mechanisms, are effective in creating a more level playing field for broadband service suppliers, in order to bring the cost down and the quality up
(viii) Increasing cooperation and collaboration between key role players

In addressing the various issues and challenges identified above, the Academy of Sciences of Malaysia proposes the following policies, strategies and implementation measures for the government's consideration. They are aimed at achieving the following objectives:

1. To ensure that the Malaysian science, technology and innovation community is nationally, regionally and globally connected, both physically and virtually, for more open cooperation and collaboration;

2. To enable the private sector and business community, especially entrepreneurs and small and medium-scale enterprises, to leverage on ICT to become more innovative in growing their businesses; and

3. To facilitate the user community in applying ICT for life-changing and transformative development based on knowledge and innovation.

Measures Proposed

The following specific measures are proposed:

(i) Definition of Broadband

Broadband has to be defined dynamically and should not be allowed to remain static. The definition should set standards that will enable all citizens to fulfill today's needs while anticipating future requirements. More importantly, the definition needs to be proactive and compatible with development aspirations of the country. Malaysia has declared its intention to become a leader in ICT and its applications with the establishment of the MSC. Therefore it is appropriate that the country deploys tomorrow's requirements today. This is the path that will take it to leadership position.

As a guide, future applications demand an average download speed of 11.25 Mbps and latency of 60 milliseconds for applications such as visual networking, high-density video streaming, consumer tele-presence, large file sharing and High Density Internet Protocol TV (HDIPTV). These should be the minimum standards to be achieved today, and offered at affordable cost to all citizens irrespective of location.

(ii) Quality and Cost of Broadband

The variation in capacity, speed and cost of broadband services among service providers must be minimized so as to ensure there is wider take-up by Malaysians. The basic minimum speed provided must be increased and broadband pricing reduced, making broadband more affordable to lower-income families. Policies to reduce pricing and to limit the types of services offered require the establishment of a more transparent regulatory regime. These policies must be closely monitored and firmly enforced. This will facilitate businesses and citizens in making better and informed decisions. This strategy can only be achieved by authorities facilitating, establishing and maintaining a healthy competitive environment for service providers.

To cater to the needs of low-income households, it is recommended that a domestic-access only broadband subscription be established, which can be offered at very low cost, but with the same quality standards. This will attract current non-users as well as those still using low-speed connections.

Broadband quality and pricing need to be regularly benchmarked to conform to future applications, as well as being competitive against regional and global competitors. By this means, Malaysia will not lose out to other competitors in the coming years.

(iii) STI Community Integrating into Global Networks

For Malaysian scientists to thrive in the national and global arena, there is a need to develop collaboration networks and platforms for greater national, regional and global cooperation in STI. In order to do this, affordable high quality and high speed broadband should be made available and accessible to all actors in the STI eco-system.

There must also be exposure, training, funding, incentives and rewards provided to key actors in order to stimulate and encourage attitudinal change. These key actors include those in the relevant ministries that are engaged in STI, such as MOSTI, MOHE, MOE and the Prime Minister's Department.

A monitoring and evaluation system should be implemented, perhaps in PEMANDU, to track progress in globalization of STI and collaboration within this community, as a means towards further improving and enhancing our performance.

(iv) Applications and Content Activities

In developing community-and business-relevant content and applications, service providers and developers should be encouraged to work closely together. Collaborative platforms should be established and operated by relevant agencies. Specifically, it is recommended that productivity-enhancing supply chains in priority industry sectors should be incentivized or fully funded by the Government.

(v) Small- and Medium-scale Enterprises (SMES) Moving Up the Value Chain

SMEs are an important endogenous source of growth towards building a high-income nation. In order to facilitate their key role in development, a broadband programme for SMEs should be planned and implemented strategically and holistically, integrating technology, infrastructure, people and institutional strategies.

To overcome the inherent problems faced by SMEs as outlined above, there is a need to formulate and implement receptivity to change programmes among them. Initially, resistance can be expected but with provision of adequate funding for well-crafted capacity and capability building programmes, SMEs will be able to migrate more readily to the information- and knowledge-based way of doing business. There is also a need to instill contemporary management skills and work processes among the management teams of SMEs. This should not be a one-off strategy. There must be continuous availability of expertise to provide ICT and process advisory and consulting services, and facilitation of in-service delivery processes and systems.

Government Policies and Strategies

Although various policies and strategies have been successfully implemented by the government in the past, there is a need to continuously review these policies and strategies as the Internet platform is fast-moving. One strategy that needs deeper consideration is the creation of a more level playing field for service providers. As has been done elsewhere, for example in Singapore, there is a need to appoint a neutral player to operate a shared network backbone. This operator has to ensure that all service providers are treated equally. In particular the backbone and backhaul services should be made available at very low cost, which is possible if the neutral service provider is not required to make profits. In the final analysis, the broadband customers, SMEs, businesses, scientists and the ordinary people, will benefit.

Another strategy which needs consideration by the government is the separation of wholesaling and retailing activities to avoid duplication in market practices and conflicts of interest. This unbundling of activities will ensure there is fairness in practice among all retailers which again will benefit all citizens.

The government has already made it a national policy to narrow the development gap between urban and rural communities. Providing equal access everywhere across the nation will narrow the digital divide and also enable the nation to also narrow the ICT-enabled innovation gap. There is an urgent need to establish a dedicated institution under the Rural Transformation Programme (RTP) to tackle rural connectivity issues and challenges.

Finally, a key national strategy is to ensure that the regulatory institution responsible for the Internet and broadband is more independent and autonomous in implementing and enforcing national policies, while employing a more participatory approach in consensus building by engaging regularly with all key stakeholders.

(vi) Co-operation and Collaboration between Key Role Players

To ensure success in implementing the proposed broadband policies and strategies towards driving the national development agenda to a higher level, key role players need to be intensely engaged with and fully mobilised. These role players are the stakeholders that fill the ICT-enabled development value-chain. Mobilising them by aligning their common interests will go a long way in enhancing the national STI performance.

As the country's top institution in the formulation of ICT policy and strategy, the National Information Technology Council (NITC Malaysia) has the national mandate to provide clear direction in championing and promoting development of broadband services, applications and content. However, it has to work closely with other role players. The ICT industry players have to assume a more proactive role in building capacity and capability among users and consumers, especially the SMEs, to apply broadband for innovation and productivity enhancement. Specific incentives need to be provided to encourage industry to assume this role effectively and efficiently. Regulatory agencies have to monitor, evaluate and guide industry towards achieving more balanced development. Community-based groups and Internet centres need to be remobilized to promote

wider usage, in addition to the development of applications, content and broadband-based infrastructure and services to enable social and economic transformation.

The Royal Society (2011) study shows that Malaysia is playing a relatively small role in science collaboration between South-South countries. Collaboration with the developed countries is even less significant. The Royal Society pointed out that global connectivity and networking is critical for the advancement of science. In overcoming this short-coming, the ASM is prepared to lead the STI community in making Malaysia a global hub for scientific knowledge and innovation networks.

Key Recommendations

The ASM makes the following key recommendations for the consideration of the government:

(i) Adopt a dynamic definition of broadband to fulfill today's applications while anticipating tomorrow's applications, ensuring also that it is compatible with Malaysia's development aspirations.
(ii) Provide quality broadband that is affordable to all citizens and businesses, irrespective of where they are located.
(iii) The Academy of Sciences Malaysia (ASM) be given the mandate to lead the STI community in making Malaysia a globally-connected innovation hub.
(iv) Practise more transparent and inclusive engagement processes in policy-making, implementation, regulation and enforcement towards establishing a more level playing field in the provision of broadband infrastructure and services.
(v) Provide incentives, funding and other support mechanisms for the acculturation of the wider STI community, and in particular the SMEs, in the effective use of advanced productivity-enhancing tools and systems.
(vi) In ensuring that the broadband strategies enunciated in this paper are followed through, the Academy will establish a multi-disciplinary Task Force to take the lead in monitoring, evaluating and anticipating global and local social and economic transformation that is underpinned by ICT, by:

- Monitoring broadband development (technologies, infrastructure, content, applications) globally and nationally;

- Monitoring and evaluating implementation of national ICT policies and strategies;

- Promoting enculturation of knowledge- enhancing applications and content within the STI community and other related communities and stakeholders;

- Undertaking futures studies (Mega-Science Framework Study up to 2050) such as scenario planning, fore-sighting and back-casting.

INTRODUCTION

In a study undertaken by The Royal Society and published in its report entitled **Knowledge, Networks and Nations – Global Scientific Collaboration in the 21st Century**, it stated that "the connections of people, through formal and informal channels, diaspora communities, virtual global networks and professional communities of shared interests are important drivers of international collaboration. These networks span the globe. Motivated by the bottom-up exchange of scientific insight, knowledge and skills, they are changing the focus of science from the national to the global level" (Royal Society 2011).

The Academy of Sciences Malaysia, an independent science and technology think-tank, established by an Act of Parliament, shares the view of the Royal Society that fast, stable and affordable internet connectivity is the ideal medium for Malaysian scientists to take their national and international collaboration to the next level. It will also assist the business community, especially small and medium enterprises, to leverage on the medium to grow their businesses.

BACKGROUND

Advancements in science and the innovations that they spawn produce increasing technological impacts, not least on the scientific community itself. Since its commercial advent in the early nineties, Internet technology has been making profound impacts on science, the scientific community and its sustaining eco-system. The ways by which the scientific community works, learns and performs research have changed. In tandem, the rights, roles, responsibilities, rules and regulations of institutional governance in the scientific world also have been undergoing great upheaval. Virtual and global connectivity, interactions and networking irrespective of time, geography, demography, cultures, values and traditions have heightened international collaboration among scientists and changed the landscape of the scientific enterprise. Ever-increasing use of cross-boundary data, information and knowledge in research has widened the scope of science and research perspectives. Broadband, an integral part of the new age information and communication technology (ICT) infrastructure, is rising rapidly as the key enabler to these ameliorations. Specifically, it has been a powerful tool in greatly accelerating the production, distribution and sharing of data, information and knowledge among the researchers and user groups as well as other interest groups across the globe. Indeed, the pace of change is happening at an unprecedented rate that the world has not experienced before.

It must be recognized that such phenomenal changes are occurring not only in the scientific world but also in all spheres of life. A study undertaken by the United Nations Conference on Trade and Development in its Information Economy Report (2010) on "ICTs, Enterprises and Poverty Alleviation" pointed out that ICT has the potential to contribute to poverty alleviation in developing countries. It cited examples of African, Middle East and other South nations, where affordable and accessible Internet linkages have had a positive impact on poverty in these countries. Banks have used mobile telephones to transact business even with people with no banking accounts. The study also states that some countries (e.g. Liberia and the United Republic of Tanzania) have been more successful than others in raising the level of mobile penetration, "partly as a result of more competitive wireless markets". Thus the impacts and effects of broadband on science and on other disciplines are mutually reinforcing, further accelerating the process of change in society as a whole.

BROADBAND PERFORMANCE, QUALITY AND COST

It is undeniable that broadband services are critical for the advancement of global science, as well as for society and the economy at large. From the economic perspective, it has been estimated that a broadband contribution of 4% to GDP can be realized with 50% population penetration in USA; 0.6% to GDP with 15% population penetration in UK; and 0.9% to GDP with 50% population penetration in New Zealand. In the same vein, the Economic Planning Unit (EPU) of Malaysia has projected that achieving 50% household penetration by 2010 can result in a tangible contribution of 1% to the country's GDP and also possibly contribute to creating some 135,000 jobs.

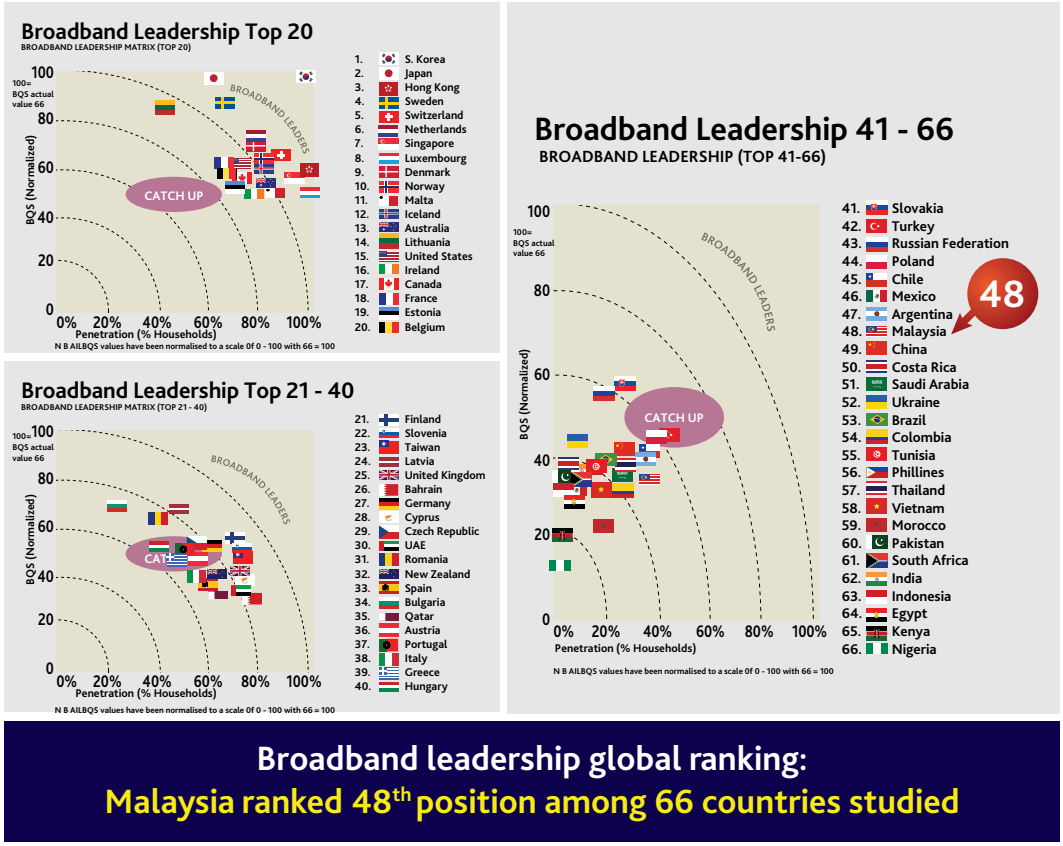
a. Global Ranking

The Said Business School of Oxford University, with the support of Cisco, has been assessing broadband leadership in the global arena since 2008 (refer *Appendix 1* – Situational Analysis). Initially, only the broadband diffusion factor was considered as a proxy measure for broadband leadership. However, recognizing the growing significance and pervasiveness of bandwidth-intensive applications, for the past three years the Said Business School has widened its scope for assessing broadband quality. Specifically, for each country, the Broadband Quality Score (BQS) index is plotted against the household penetration rate (*Figure 7*). The BQS is calculated for today's and tomorrow's applications, as follows:

- *BQS (today) =55% Download + 23% Upload + 22% Latency, where download requires 3.75 Mbps, upload of 1 Mbps and latency of 95ms.*

- *BQS (tomorrow) =45% Download + 32% Upload + 23% Latency, where download requires 3.75 Mbps, upload of 1 Mbps and latency of 95ms.*

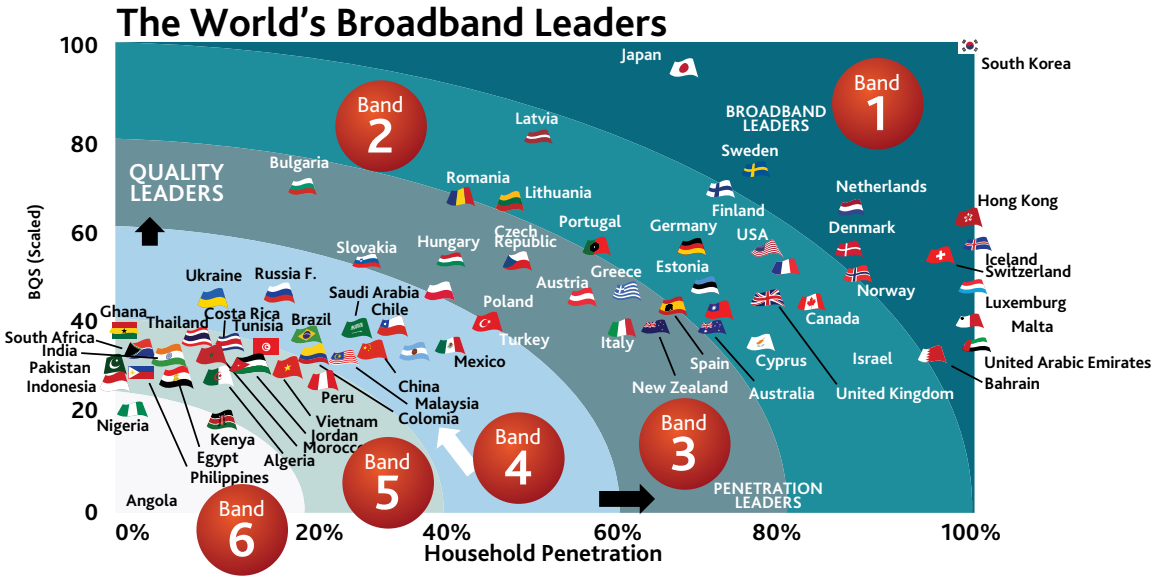
The early study showed that, in terms of global ranking, Malaysia ranked 48th among the 66 countries studied (*Figure 7*), ahead of China but behind Slovakia, Turkey, Russian Federation, Chile, Mexico and Argentina.



Source: Said Business School, Oxford University (2008).
Figure 7. Broadband Leadership Global Ranking.

In the same study for the ASEAN region, Malaysia ranked on par with the Philippines, Vietnam, Indonesia and Thailand (Figure. 8). Because of low (less than 60%) household internet penetration and poor Broadband Quality Score (BQS) (less than 60), Malaysia was ranked in Band 4 behind the leaders in both quality and household penetration.

Source: Said Business School, Oxford University (2008)



Source: Said Business School, Oxford University

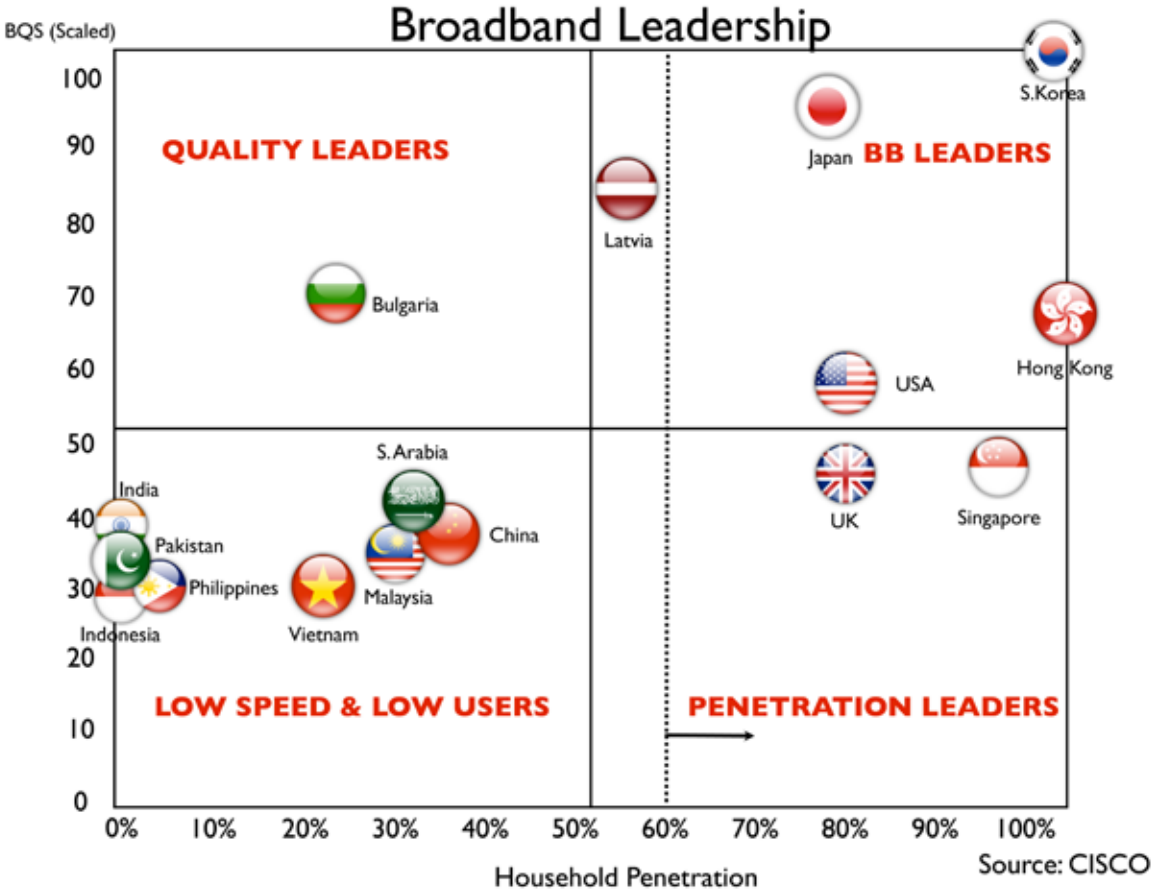
Broadband leadership group ranking:
Malaysia ranked on par with Philippines, Vietnam, Indonesia and Thailand

Figure 8. Broadband Leadership ASEAN Ranking.

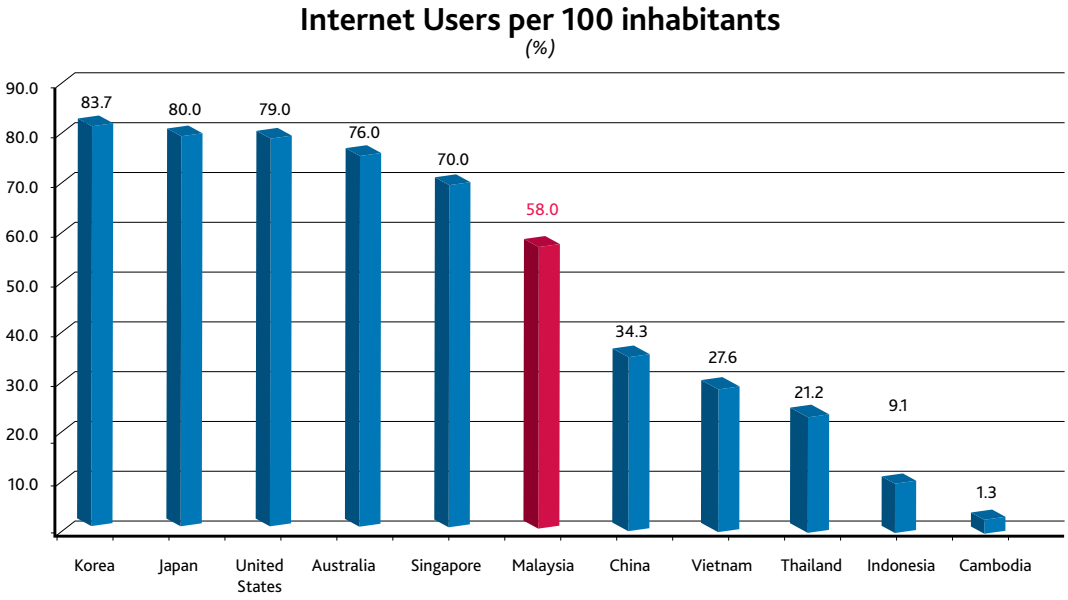
In 2010, the study covered 72 countries covering 40 socio-economic variables as well as 40 million records sourced from Speedtest.net.

Analysis of quality divide showed that Malaysia is in the fourth band, that is, below quality leaders and penetration leaders, very far from the first band of broadband leader category. Of the 72 countries ranked, Malaysia occupied 58th position in the broadband leadership ladder (*Figure 9*).

Furthermore, when comparing with industrialized or newly-industrialized countries, particularly Singapore, South Korea and Japan in Asia, Malaysia's performance in Internet penetration is lagging significantly behind. For instance, in a joint study by the MCMC, International Telecommunication Union (ITU) and PIKOM, the broadband penetration in South Korea has reached 83.7% followed by 80% in Japan and 70% in Singapore (*Figure 10*), with Malaysia only scoring 58% (DOSM and PIKOM< 2011).



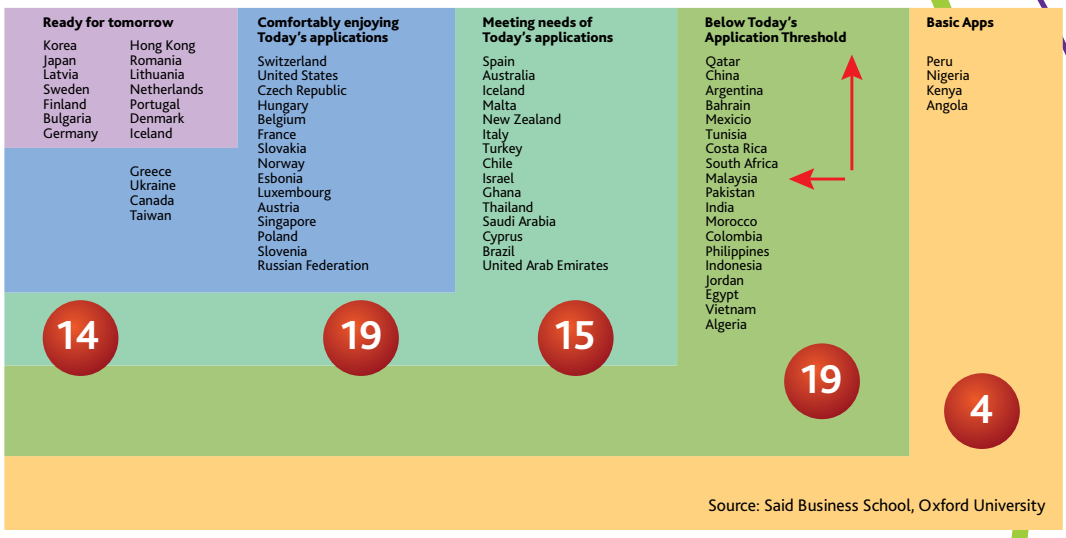
Source: Said Business School of Oxford University.
Figure 9. Broadband Leadership of 72 Countries in 2010.



Source: MCMC , International Telecommunication Union and PIKOM.
Figure 10. Internet Users Per 100 Inhabitants in 2011.

Broadband performance is another important area that Malaysia lags in. When the performance of Malaysian broadband (*Figure 11*) is benchmarked against the "today" and "tomorrow" applications requirements, especially the speed as given by the Said Business School, the comparison shows that only the average speed offered under the fixed broadband of 4.4 Mbps is able to meet the minimum criterion of 3.75 Mbps needed for downloading today's applications. Today's applications cover social networking, low density video streaming, basic video chatting, small file sharing and Standard Definition Internet Protocol TV (SD IPTV). The average speed of mobile broadband of 1.77 Mbps and 2.8 Mbps for mobile internet is far from adequate to meet today's application requirements. All the three types of broadband services are also inadequate to meet tomorrow's applications which demand an average download speed of 11.25 Mbps and latency of 60 milliseconds. Tomorrow's applications include visual networking, high density video streaming, consumer tele-presence, large file sharing and high definition Internet protocol TV (HDIPTV) (*Figure 12*).

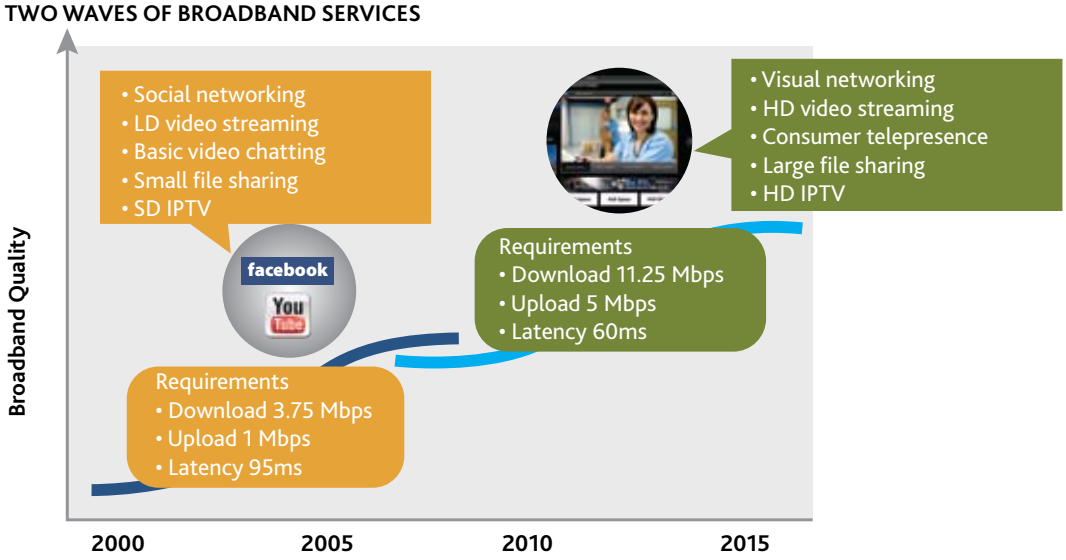
Broadband quality ranking - by application preparedness



Broadband quality ranking:
Malaysia ranked as "below today's application threshold" broadband quality

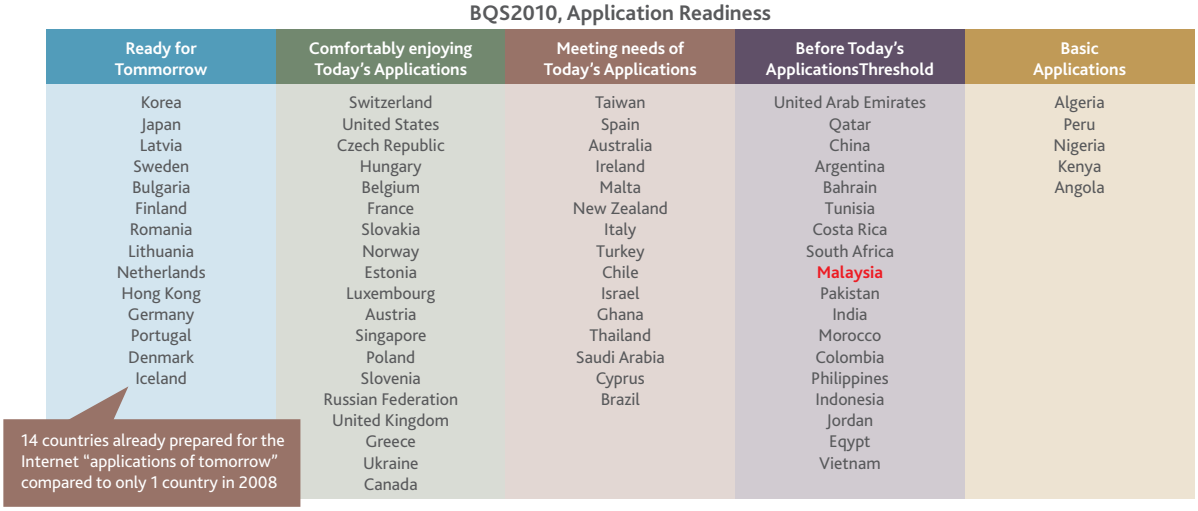
Source: Said Business School, Oxford University (2008).
Figure 11. Broadband Quality Ranking.

Changing QUality Requirements



Source: Said Business School, Oxford University (2008).
Figure 12. Changing Quality Requirements.

In the "level of preparedness" for application readiness, Malaysia is placed under the "below today's application threshold" (*Figure 13*). The figure also shows that 14 countries are already prepared for the Internet "application of tomorrow" compared to only one country in 2008. In this category, Korea ranked first and two other countries in Asia ready for tomorrow's applications are Japan and Hong Kong.



Source: Said Business School of Oxford University.

Figure 13. Level of Preparedness for Today and Future Internet Applications by Country.

b. Types of Broadband Services

Box 1 shows the type of broadband services licensed in the country. The list shows the best-effort data on the type of services provided by various telecommunications industry players. However, little is known on the actual items delivered in the market unless demand-based surveys on consumers are carried out where the users can provide the types of services they are subscribing to, the service level quality as well as customer satisfaction.

Description of Broadband Service	Package Download Speed: Range	Remark
Cellular Broadband	384 kbits/s to 42 Mbits/s	Celcom, Digi and Maxis confine to 384 kbit/s to 7.2 Mbits/s range, while U Mobile provides up to 42 Mbit/s
Digital subscriber line (DSL)	384 kbit/s – 20 Mbit/s	Internet Service Providers (ISP) and technology include : • Giga Broadband (VDSL 2-5 Mbit/s); • Jaring Flite Wired (ADSL 1 Mbit/s); • Maxis Wired (ADSL 256kbits/s – 9 Mbit/s); • PersiaSYS Ultraband (Cable ETTH: 700kbit/s- 8 Mbit/s); • TIME Business DSL (ADSL 2-50 Mbit/s) • Time Business DSL (SDSL 2- 10); • Time Broadband Consumer (ADSL 1.5 Mbit/s- 6 Mbit/s); • TMNet Streamyx (ADSL / SDSL 384kbits – 4 Mbits) • TM UniFi (VDSL 5-20 Mbit/s)
Fibre Optic	2 Mbit/s-50 Mbit/s	TM UniFi (FTTH: 5 -20 Mbit/s); TIME Fibre Broadband (FTTH : 2-50 Mbit/s); Maxis Home Broadband (FTTH : 4-30 Mbits) Service Providers: • Cyberjaya Metro Fibre Network (CMFN) (FTTB and FTTB, mainly in Cyberjaya); • Metrofon (FTTH; KL & Selangor); • Penangfon (FTTH; Penang); • Maxis High Speed Home Broadband (Subjected to TM UniFi); • Time Fibre Broaband (50 Mbits available in Mt Kiara region); • TM Unifi (Selangor currently; e-commerce, VOIP, IPTV) *Note: FTTH – Fiber-To-The –Home; FTTB - Fiber-To-The –Building;*

Wireless Broadband	WIMAX (384 kbit/s- 15 Mbit/s)	Internet Service Provider (ISP) • Airzed (1-2 Mbit/s); • AsiaSpace WiMAX (AMAX) (1-1.5 Mbit/s); • Redtone WiMAX (512 kbit/s- 1.0 Mbit/s); • Axis Broadband (512 kbits); • Izzi Broadband (IBurst technology) (1 Mbit/s); • Hotgate Technology Inc (Various broadband technologies); • JARING Flite Wireless (SOMA FlexMAX Mobile WiMAX System; 384 kbit/s- 1 Mbit/s) • Packet One (1-5 Mbit/s); • YTL Communications (Uncapped up to 15 Mbit/s)
Hotspot	WiFi 802.11b(384 kbit/s-512 kbit/s)	ISP • JARING Flite WiFi (60 hotspots); • P1 Hot Zone (> 200 hot spots); • Streamyx ZONE (> 1,000 hot spots)
Leased Line	Giga Speed Capacity	Service Providers • City Broadband (over fiber optic); • TM METRO (4 Mbp/s-1 Gbp/s); • TIME Ethernet Leased Line (point to multipoint connectivity); • TIME International Leased Line (IPLC)
VSAT		Service Providers • H-Vision IPSTAR Satellite Broadband , 2-way satellite connection; • Sabah.Net IP STAR Satellite Broadband, 2 way satellite connection; • TIME Satellite Broadband (1.5 Mbit/s -4 Mbp/s), entire nation including rural areas
WiMAX	Not less than 1 Mbit/s	Service Provider • Bizsurf (M) Sdn Bhd; • MIB Comm Sdn Bhd; • Asiapace Dotcom Sdn Bhd; • Redtone-CNX Broadband Sdn Bhd

Source: "http://en.wikipedia.org/wiki/Internet_in_Malaysia" (2011).
Box 1. Provision of Broadband Services in Malaysia.

c. Broadband Quality

The type of broadband services provided in the country from the supply side can be understood only by examining the provision of broadband quality in terms of speed, capacity and price as well as unit cost for capacity and speed. In the absence of demand-side data, as mentioned earlier, which only can be collected through primary surveys covering households and business establishments, the best effort information from supplier side is used. A close examination on the type of broadband services listed showed great disparity in the type of services rendered. For minimizing the variations, geometric averages were compiled instead of simple averages. The results are shown in Table 1. As reflected in the range measures, it can be seen that, for each type of broadband services capacity, speed and average cost vary greatly. Indeed, such wide disparity reveals the poor broadband business practices that prevail in the country from the view-point of creating healthy competition among service providers. The highly-skewed distribution also sends confusing signals and poses difficulties for consumers to make an informed decision on the best option.

Type of Broadband Services	Capacity Quota(GB)		Monthly Fee (RM)		Download Speed (Mbps)		Unit Cost Per GB (RM)		Unit Cost Per Mbps (RM)	
	Geometric Average	Range	Geometric Average	Range	Geometric Average	Range	Geometric Average	Range	Geometric Average	Range
Fixed Broadband (FB)	34.1	5.0-120.0	133.6	49-249	4.4	0.4-20.0	3.9	2.1-11.8	30.6	12.5-122.5
Mobile Broadband (MB)	4.34	0.5-16.0	79.44	30-248	1.77	0.4-7.2	18.54	6.6-60	44.7	6.7-225.7
Mobile Internet (MI)	2.1	0.1-20.0	63.2	18-198	2.8	0.4-7.2	30.9	5.0-180.0	20.2	2.5-125.7

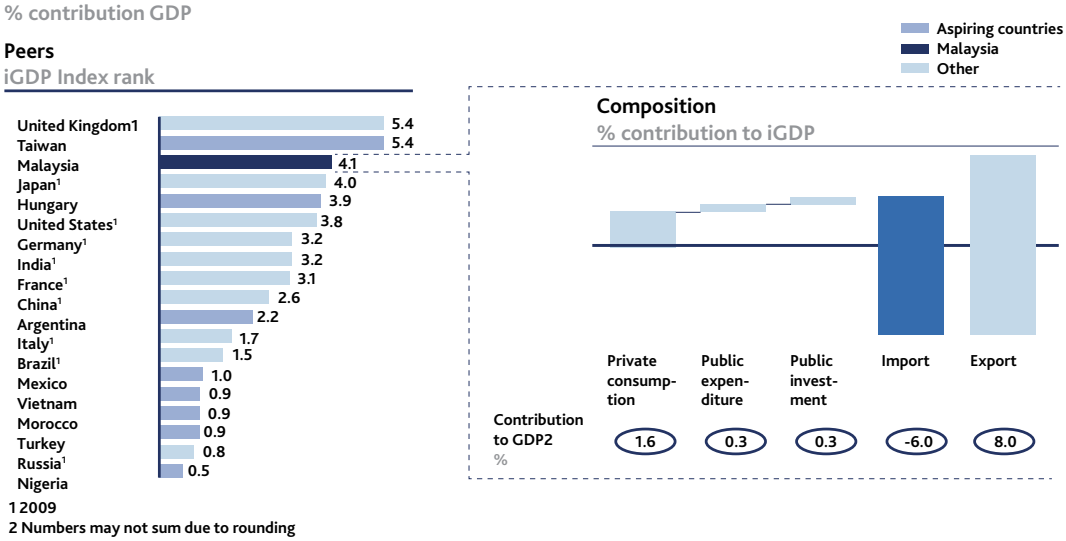
Source: Summary compiled from www.sayacincau.com/2011/07/17/broadband-in-Malaysia-2011-cost-comparison/

Table 1: Performance of Broadband based on Supplier Data.

The McKinsey Report (2011) analysis showed that ICT-related trade and private consumption made a 4.1% contribution to Gross Domestic Product (GDP). As shown in *Figure 14a*, of this contribution, 8.0% was for export, 1.6% accounted for private consumption and 0.3% was on public expenditure. Private investment in ICT is only 0.3% of GDP, which is considered to be low.

On a global level (*Figure 14b*), Malaysia ranked as one of the highest-cost countries which may have contributed to the lower internet contribution to the GDP. Internet contribution to GDP growth is low as a result.

Malaysia's ICT-related trade and private comsumtion are driving the Internet's strong impact on the economy



Source: McKinsey (2011).

Figure 14a. ICT Related Trade and Private Consumption Contribution to GDP.

d. Broadband Penetration in Malaysia: 2002-2015

With its introduction in 2002, broadband penetration in Malaysia grew significantly from 0.1 to 58.0 per 100 households in 2011 (*Figure 15*). The marked increase in the provision of broadband from 31.6% in 2009 to 55.6% in 2010 was due to inclusion of broadband-driven cellular phones following the definition by the International Telecommunication Union (ITU).

Prior to this, ITU had defined broadband in the context of computer-mediated devices like desktops or lap tops. The organization subsequently revised the broadband definition after considering the 4G capability of cellular or iPad devices, which are on par with typical computers in terms of capacity, capability and performance. Taking into consideration the new definition and its scope of devices, the broadband penetration rate in Malaysia is expected to reach 75% by 2015. Specifically, this target is possible to be achieved when increasing numbers of cellular phone users, which had already reached a penetration rate of 116.6 users per 100 inhabitants in 2011, resort to 4G technology in the years ahead.

Internet landscape and impact statistics

Top quartile
Second quartile
Third quartile
Bottom quartile

	Internet users Million	Internet penetration % of population	Fixed broadband subscribers % of population	Mobile broadband subscription % of population	Median monthly cost of 1 Mbps % of population	Online retail share of retail % of population	Internet contribution to GDP[1] % of population	Internet contribution to GDP growth[1] % of population
Argentina*	26	64	10	13	16	1.1	2.2	2.7
Brazil	79	41	7	11	17	3.1	1.4	2.4
Canada	28	81	30	15	5	0.9	2.7	10.2
China	486	36	9	2	11	1.1	2.6	3.4
France	50	78	33	36	8	3.8	3.2	17.6
Germany	67	82	32	36	4	3.8	3.2	24.3
Hungary*	7	68	20	30	3	1.1	3.9	11.4
India	98	8	1	1	59	0.3	3.2	5.2
Italy	33	54	22	59	7	0.9	1.7	12.2
Japan	101	79	27	88	-	3.2	4.0	-
Malaysia*	16	55	7	27	50	4.4	4.1	2.3
Mexico*	39	34	10	8	22	0.5	1.0	2.2
Morocco*	16	49	2	10	-	0.5	0.9	1.2
Nigeria*	52	33	<1	3	-	0.1	0.5	0.9
Rusia	61	43	11	17	5	2.1	0.8	0.9
South Korea	40	83	36	91	-	12.3	4.6	16.0
Sweden	8	90	32	84	3	3.8	6.3	32.9
Taiwan*	16	72	23	-	-	3.0	5.4	12.7
Turkey	36	49	10	18	9	0.8	0.9	1.5
United Kingdom	53	85	31	56	4	7.7	5.4	22.7
United States	250	81	27	54	5	4.0	3.8	14.9
Vietnam*	27	31	4	13	41	-	0.9	1.6

" Focus aspiring countries
1 Internet contribution to GDP calculate in 2010 for Argentina, Hungary, Malaysia, Mexico, Morocco, Nigeria, Taiwan, Turkey, Vietnam and 2009 for all other countries . Internet contribution to GDP growth is calculate from 2005 to 2010 for Argentina, Hungary, Mexico, Morocco, Nigeria, Taiwan, Turkey, Vietnam, and from 2004 to 2009 for all other countries.

SOURCE : Internet World Statistics, 2010; Hungarian Central Statistical Office 2010; Economist Intelligence Unit Telecoms and Technology Report data for 2010, published in 2011; Morocco, Agence Nationale de Reglementation des Telecommunications, 2010; Malaysia Communications and Multimedia Commission data for 2010, published in 2011; ICT Vietnam Whitebook data for 2010; published 2011; International Telecommunication Union, World Telecommunication/ICT Development Report and database, 2010; World Bank population data, 2010; Cost of 1 mbps from Speedtest.net pulled in November 2011, PPP adjustment to US dollar using World Bank 2010 conversion rate; Euromonitor International, 2010; McKinsey analysis

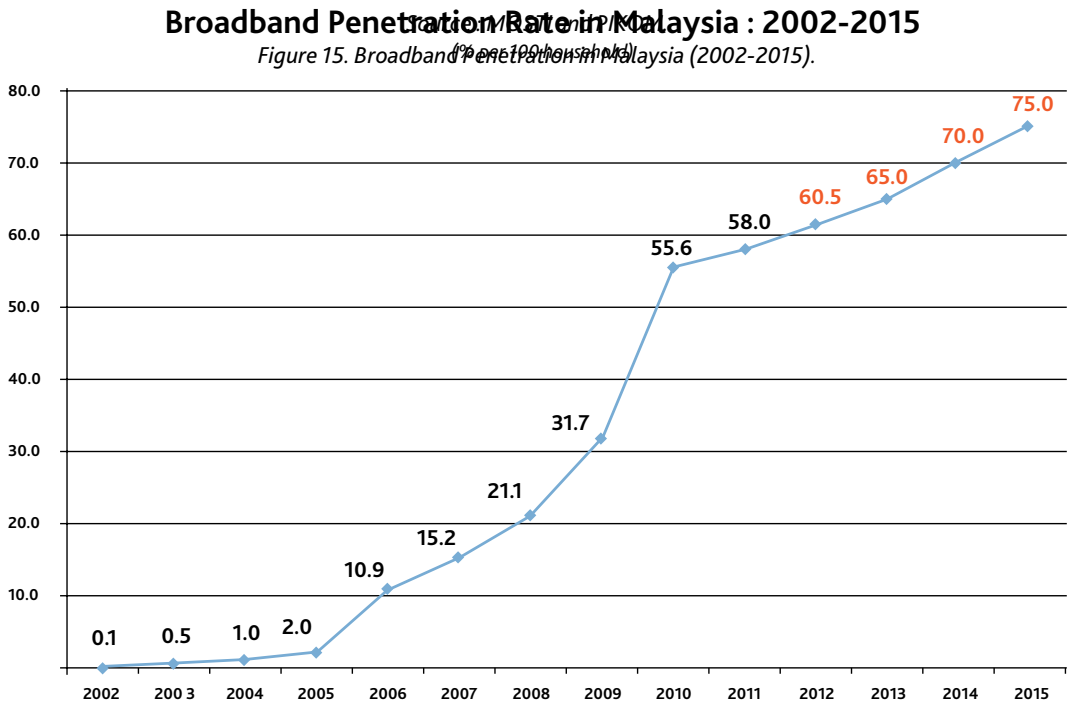
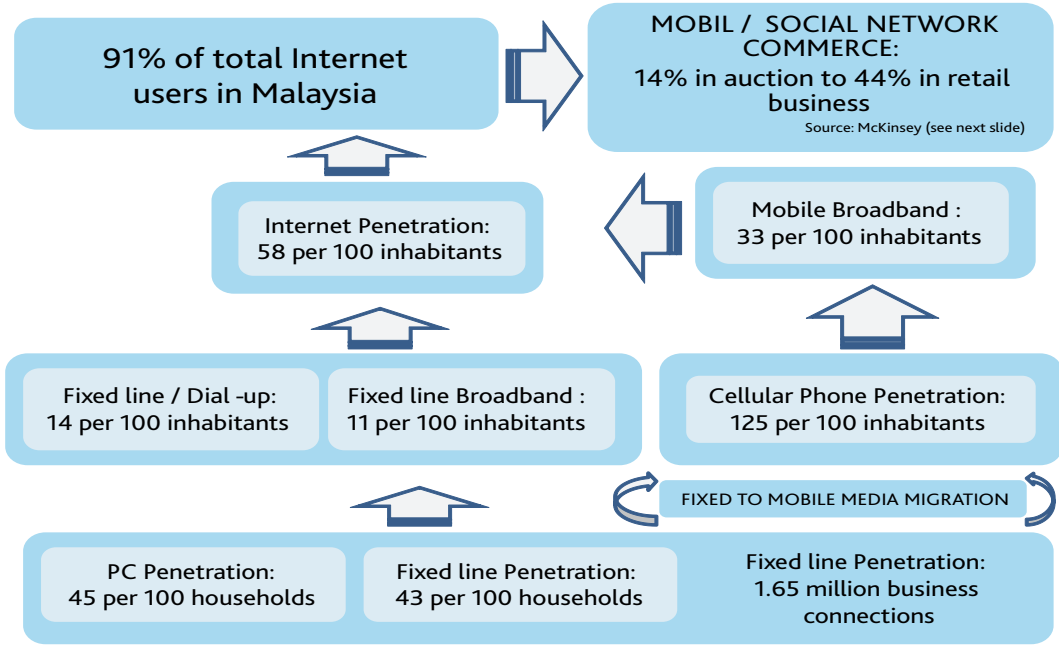


Figure 15. Broadband Penetration in Malaysia (2002-2015).

e. Broadband Usage Patterns

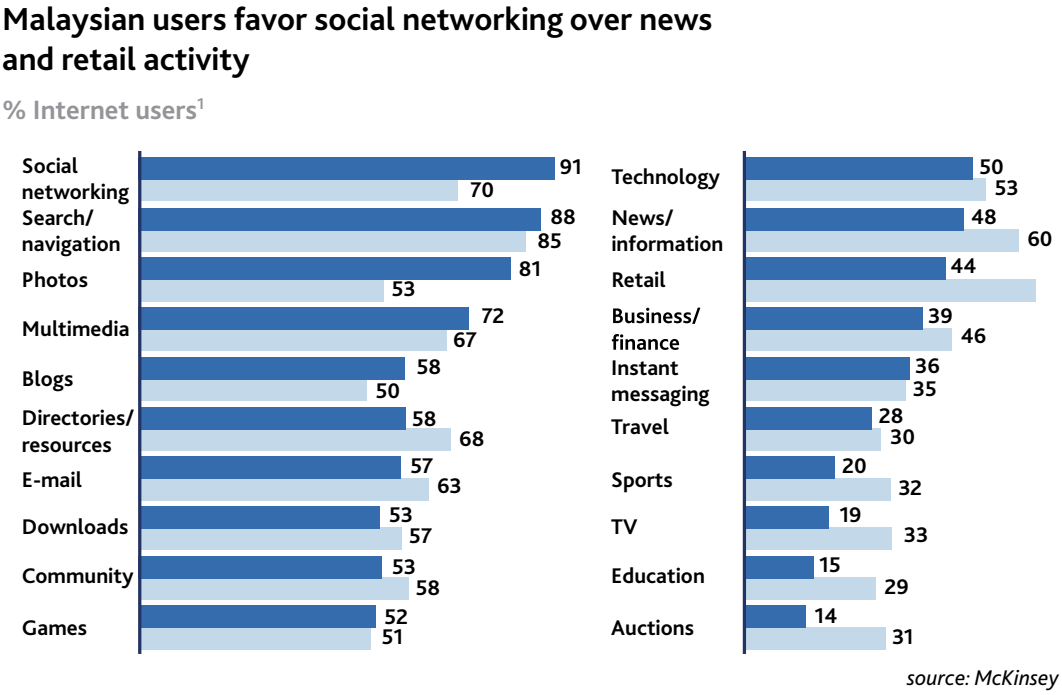
Figure 16 shows the status of Internet penetration in 2011 in Malaysia. Specifically, the data shows that for every 100 inhabitants 14 users subscribe to fixed line / dial-up Internet, 11 users are in the fixed line broadband and 33 users in the mobile broadband, that is, totaling 58 Internet users per 100 inhabitants. The penetration rate is targeted to reach 61.5 users for every 100 inhabitants by 2012 and 75 users per 100 inhabitants by 2015. The inadequacy of mobile broadband as noted earlier implies that the majority of broadband subscribers may not be able to run today's applications, let alone tomorrow's.



Source: DOSM and PIKOM (2011).

Figure 16. Internet Penetration in Malaysia.

McKinsey (2011) estimates that 91% of Internet users in Malaysia are social media savvy. This proportion is well above the global average of 70% (*Figure 17*). Malaysians also outpace global trends in areas pertaining to search/navigation, photos, multi-media and blogs. These activities are considered low-value adding, reflecting a good consuming nation rather than a producing nation. It can be seen from *Figure 17* that the proportion of Malaysians involved in high-value adding services, such as retail, business, sports, education and auction, did not exceed 20%.



Source: McKinsey (2011).
Figure 17. Internet Usage Distribution in Malaysia, 2011.

f. DNA of An Innovation Ecosystem

According to Nair (see *Box 2*), the DNA of an innovation eco-system is characterized by the 7i-Innovation-Helix. This consists of two important building blocks called the foundation conditions (reach conditions) and driver conditions (richness condition).

If innovation is the life-blood of a knowledge society, then infostructure (broadband) are the intricate communication networks that transport innovation throughout society. The communication network enables people and enterprises to source inputs for wealth creation from multiple channels. It allows economic agents to increase market reach for their products and services at relatively low cost – a source of competitive advantage in the new economy.

The second building-block of an innovation ecosystem is the driver condition (*Box 2*).

The DNA of an Innovation Ecosystem

Source: Nair (2012): ICT Strategic Review 2012.
Box 2. The 7i Framework on Innovation.

The foundation condition describes the physical infrastructure and infostructure, which are defined as follows:

- Physical infrastructure consists of transportation system, housing, healthcare and other facilities for save and high quality living; and
- Infostructure is the digital communication network that connects people to the global community.

The driver condition is defined by the factors given below:

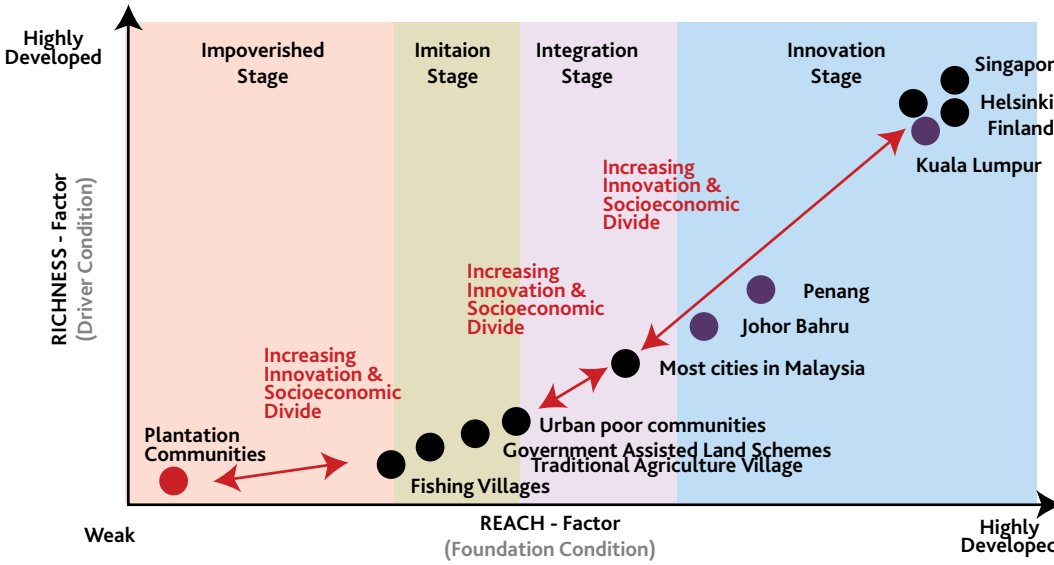
- Intellectual capital development – the skill sets and entrepreneurial acumen for a knowledge society;
- Interaction (smart and strategic partnerships) – effective flow of information, ideas and knowledge between stakeholders in the economy – effective People-Public-Private Partnerships (PPPP);
- Integrity systems - good governance and ethical values, which include adherence to best practices and global standards and benchmarks
- Incentives -fiscal and non-fiscal support systems to stimulate creativity and innovation
- Institutions – "systems of established and embedded social rules that structure social interactions" to foster a culture of innovation and creativity for the betterment of society.

g. Digital Divide

One of the development challenges that policy makers and development practitioners are bound to address is bridging the digital divide, in particular between urban and rural population. In common with other technological innovations, broadband first gained a foothold among the urban population before diffusing into rural communities. Even among the urban users, it is the more educated and affluent people who could afford the subscription cost and are bound to be innovators and early adopters of the new technology. Typically, new technology tools and services are introduced at high prices, but with increasing demand the price tends to come down, especially once critical mass is reached in terms of market viability and profitability. Malaysia saw introduction of broadband in 2002 and, over the last decade, broadband services have pervasively permeated many corners of the country. Despite great development advancements, rural locations still lack quality infrastructure, such as roads, health amenities, education facilities, housing and sanitation, including broadband.

The challenges in the rural areas are further accentuated by the lack of access to affordable information and communication technology services including quality broadband. Such shortfalls pose challenges in attracting highly-skilled and educated workers to rural locations where much help is needed to upgrade the standard and quality of living. Due to poor connectivity, connectedness and networking among the poorer rural citizens, they continue to suffer deprivation in terms of access to knowledge, skills, information, resources and markets (Nair 2011).

The digital divide study conducted by the Monash University of Sunway Campus in Malaysia on communities living in Government-assisted land schemes, privately-operated plantations, traditional agricultural communities, fishing villages and urban poor communities revealed a number of weaknesses in the driver conditions (see *Box 1* for an explanation of foundation and driver conditions). These include low education skills, low proficiency in languages, especially English, which is considered the lingua franca of the Internet world, poor creativity in rural education settings, poor technology uptake and weak alignment to national innovation strategies, as well as the lack of local champions and effective local governance system (Nair 2011). *Figure 18* shows the relative positions of the target communities in the development profiling measured in terms of richness factor (driver conditions) and reach factor (foundation conditions). The foundation conditions include infrastructure and info-structure where broadband is an integral component. Undeniably the foundation conditions are critical in enabling the driver conditions entailing intellectual capital development, interaction, integrity, incentives and institutions. The study succinctly revealed that the plantation communities, at the lowest level with only 5% Internet penetration rate reflects poor technology uptake in general. This is attributed to the lack of affordability, lack of knowledge of productive use and, more importantly, see no relevance of Internet to their daily routines. In comparison, the urban poor communities on an average experience 35% connectivity. Still, the bulk of poor urban community members also cited the same reasons as their counterparts in the plantation sector for poor technology uptake.



Source: Prof. Mahendhiran Nair of Monash University — "Inclusive Innovation and Sustainable Development: Leapfrogging. to a High Income Economy" Published in "ICT Strategic Review 2011/12: Transcending into High Value", PIKOM

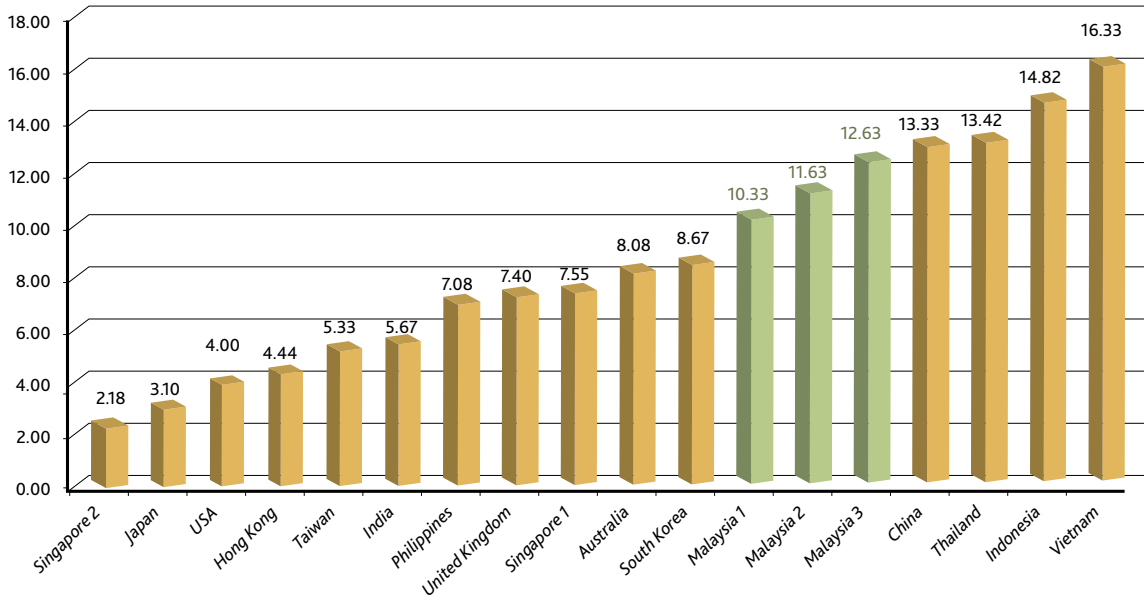
Figure 18. Digital Divide Gap in Malaysia 2010.

h. Average Monthly Tariff for Data Services

A competitive edge in broadband pricing is critical for the effective and efficient provision of data and Internet services. *Figure 19* shows the ranking of 18 suppliers from 15 nations based on the average monthly tariff incurred for data services. The data services considered in the compilation include domestic leased line over Ethernet, international private leased line, domestic and international IP-VPN. For making meaningful comparisons, only data services at 50 mbps were considered in the analysis. Data for 10 mbps, 20 mbps and 100 mbps were not available for the countries considered in the study. It can be seen from the summarized data that Malaysia is ranked in 12th, 13th and 14th positions respectively for the three service providers, behind Philippines and Singapore in this region. At the moment, Malaysia's position in the provision of data services is only better off compared to China, Thailand, Vietnam, and Indonesia. Singapore ranked number one.

Averange Rank Scores for Overall Data Services :

Monthly tariff criterion used for ranking, aggregation and averaging over 11 types of Internet services



Source : Compiled from MDeC /Frost & Sullivan study on broadband services (2012).
Figure 19. Average Ranking Based on Monthly Tariff on Data Services by Country.

Further analysis shows that average monthly tariff paid for data services in Singapore is only 65% of Malaysia's (*Table 2*) and similarly, in the Philippines it is only 84% indicating that these two countries are more competitive in pricing. The result also indicates that monthly tariff pricing in Thailand and Vietnam are 1.54 and 2.34 times higher than in Malaysia.

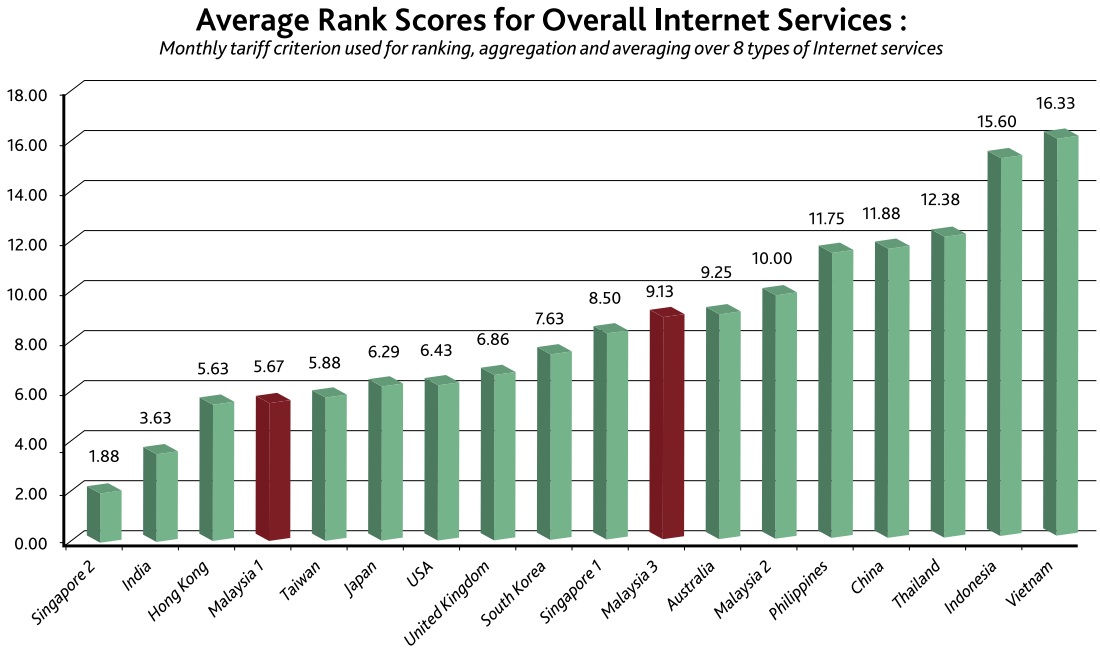
AVERAGE MONTHLY TARIFF FOR DATA SERVICES								
TYPE OF INTERNET SERVICES (50 Mbps)			Singapore 1	Singapore 2	Philippines	Thailand	Vietnam	Malaysia 3
Data Servives	Domestic leased line over Ethernet	Last mile	9,100	8,000	7,800	12,600	30,400	13,200
		50 Km end-to-end charge	12,600	10,000	12,900	17,600	76,300	15,400
	International private leased line to:	United Kingdom	71,500	50,000	82,800	157,800	166,000	87,200
		USA	58,700	45,000	81,000	146,000	182,300	71,200
		Hong Kong	26,700	20,000	30,400	106,400	124,300	36,400
		Japan	29,500	23,000	41,400	106,400	124,300	36,400
	Dosmestic and International IP-VPN	Port, Cloud and leased line charges	25,100	12,000	16,300	40,200	116,100	24,500
		United Kingdom (end-to-end)	82,800	75,000	75,600	118,600	151,600	88,500
		USA (end-to-end)	92,300	80,000	85,000	128,000	147,500	97,900
		Japan (end-to-end)	82,200	80,000	75,000	118,000	132,100	87,900
		Hong Kong (end-to-end)	85,000	75,000	81,000	124,000	125,500	105,400
Average Monthly Tariff (RM)			**40,703**	**31,979**	**40,932**	**75,093**	**113,894**	**48,867**
BENCHMARKING AVERAGE MONTHLY TARIFF AGAINST MALAYSIA								
TYPE OF INTERNET SERVICES (50 Mbps)			Singapore 1	Singapore 2	Philippines	Thailand	Vietnam	Malaysia 3
Data Servives	Domestic leased line over Ethernet	Last mile	0.69	0.61	0.59	0.95	2.30	1.00
		50 Km end-to-end charge	0.82	0.65	0.84	1.14	4.95	1.00
	International private leased line to:	United Kingdom	0.82	0.57	0.95	1.81	1.90	1.00
		USA	0.82	0.63	1.14	2.05	2.56	1.00
		Hong Kong	0.64	0.48	0.72	2.10	2.65	1.00
		Japan	0.84	0.63	1.14	2.92	3.41	1.00
	Dosmestic and International IP-VPN	Port, Cloud and leased line charges	1.02	0.49	0.67	1.64	4.74	1.00
		United Kingdom (end-to-end)	0.94	0.85	0.85	1.34	1.71	1.00
		USA (end-to-end)	0.94	0.82	0.87	1.31	1.51	1.00
		Japan (end-to-end)	0.94	0.91	0.85	1.34	1.50	1.00
		Hong Kong (end-to-end)	0.81	0.71	0.77	1.18	1.00	1.00
Overall Comparison			**0.83**	**0.65**	**0.84**	**1.54**	**2.33**	**1.00**

Source : Compiled from MdeC / Frost & Sullivan study on broadband services (2012).
Table 2. Benchmarking Monthly Tariff for Data Services by Selected Countries.

i. Average Monthly Tariff for Internet Services

Similar analysis was also carried out on average monthly tariff pricing for Internet services (*Figure 20* and *Table 3*). Four types of Internet services, namely dedicated Internet access, shared broadband services, domestic and international transit and server collocation, were considered in

the compilation of average monthly tariff and average rank scores. The computation considered only 100 mbps Internet services for which data were available for all the nations considered in the study. Interestingly, Malaysia ranked in the 4th position among the 18 competing suppliers considered in the study, indicating its cost is higher when compared to Singapore, India and Hong Kong. Specifically, the average monthly tariff in Singapore is as low as 70% of what is incurred in Malaysia. However, in Philippines and Thailand, the average monthly tariff for Internet services is 1.13 and 1.28 times higher than in Malaysia, respectively.



Source : Compiled from MdeC / Frost & Sullivan study on broadband services (2012).
Figure 20. Average Ranking Based on Monthly Tariff on Internet Services by Country.

Monthly Tariff for Internet Services (Ringgit Malaysia)						
Type of Internet Services (100 Mbps)		Singapore 1	Singapore 2	Philippines	Thailand	Malaysia 3
Dedicated Internet access (100 Mbps)	Port and dedicated charges	43,600	43,600	43,600	43,600	43,600
Shared broad band (100 Mbps)	Shared broadband internet	23,500	15,000	25,400	33,300	26,400
Dosmestic & International Transit (100Mbps)	Port, Cloud and Access charges	56,500	25,000	58,100	70,900	52,400
	UK Internet Transit	25,100	20,000	28,200	37,700	27,300
	USA Internet Transit	18,800	15,000	30,800	25,100	18,800
	Japan Internet Transit	18,800	15,000	22,600	23,500	20,100
	Hong Kong Internet Transit	18,800	15,000	19,100	25,700	20,400
Server collocation (100 Mbps)	Server collocation	37,300	35,000	46,800	35,100	36,500
	Average	27,833	20,485	32,999	37,299	29,116
Type of Internet Services (100 Mbps)		Singapore 1	Singapore 2	Philippines	Thailand	Malaysia 3
Dedicated Internet access (100 Mbps)	Port and dedicated charges	0.90	0.72	1.12	1.63	1.00
Shared broad band (100 Mbps)	Shared broadband internet	0.89	0.57	0.96	1.26	1.00
Dosmestic & International Transit (100Mbps)	Port, Cloud and Access charges	1.08	0.48	1.11	1.35	1.00
	UK Internet Transit	0.92	0.73	1.03	1.38	1.00
	USA Internet Transit	1.00	0.80	1.64	1.34	1.00
	Japan Internet Transit	0.94	0.75	1.12	1.17	1.00
	Hong Kong Internet Transit	0.92	0.74	0.94	1.26	1.00
Server collocation (100 Mbps)	Server collocation	1.02	0.96	1.28	0.96	1.00
	Overall	0.96	0.70	1.13	1.28	1.00

Source : Compiled from MdeC / Frost & Sullivan study on broadband services (2012).
Table 3. Benchmarking Monthly Tariff for Data Services by Selected Countries.

The key message from the above discussion is the following. The provision of broadband in Malaysia is at high cost, attributing to low penetration; in addition, low quality leads to low level of economic activities and low level of preparedness for tomorrow's applications.

ISSUES AND CHALLENGES

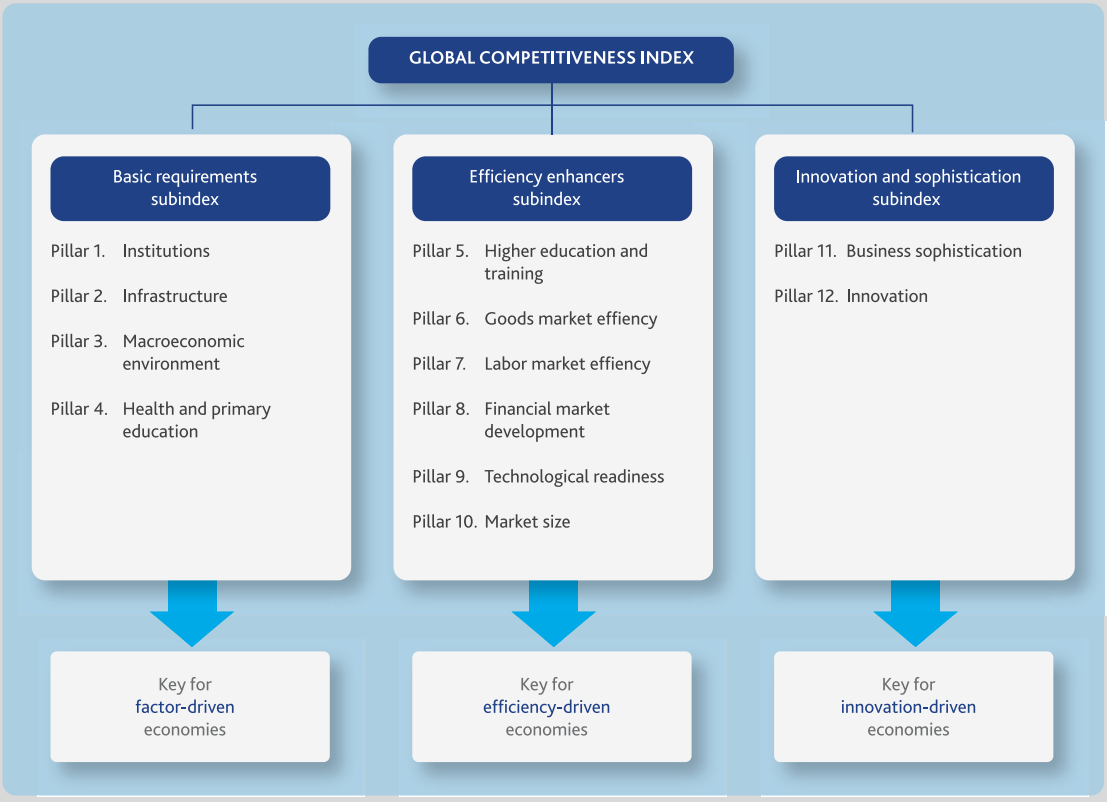
The Global Competitiveness Index (*Box 3*) can be used to measure Malaysia's economic competitiveness in the global context. The Index has three sub-indices as follows:

- Basic Requirements Sub-index;
- Efficiency Enhancers Sub-Index; and
- Innovation and sophistication Factors Sub-Index.

The Basic Requirements Sub-Index is underpinned by 4 Pillars, which are, "Institutions", "Infrastructure", "Macroeconomic Environment" and "Health and Primary Education". These Pillars are the key for "Factor-Driven Economies".

The Efficiency Enhancers Sub-Index is in turn underpinned by 6 Pillars, which include "Higher Education and Training", "Goods Market Efficiency", "Labour Market Efficiency", "Financial Market Development", "Technological Readiness" and "Market Size". These Pillars are the key for "Efficiency-Driven Economies".

The third Sub-Index, the "Innovation and Sophistication Sub-Index", has 2 Pillars, which are "Business Sophistication' and "Innovation". These Pillars form the key for "Innovation-Driven Economies".
When these Pillars are plotted as a web-diagram, they show the profile of a nation's stage of development. Using this plot, Malaysia lies in transition from stage 2 to 3, that is, between efficiency-driven and innovation-driven (*Figure 21*). Compare the Malaysian plot with those of S. Korea and Taiwan, two global economies which are innovation-driven economies (*Figure 22* and *Figure 23*) and that of Saudi Arabia (*Figure 24*) which is considered to be in the transition stage between 1 and 2, that is, factor-driven to efficiency-driven.



Box 3. Global competitiveness index.

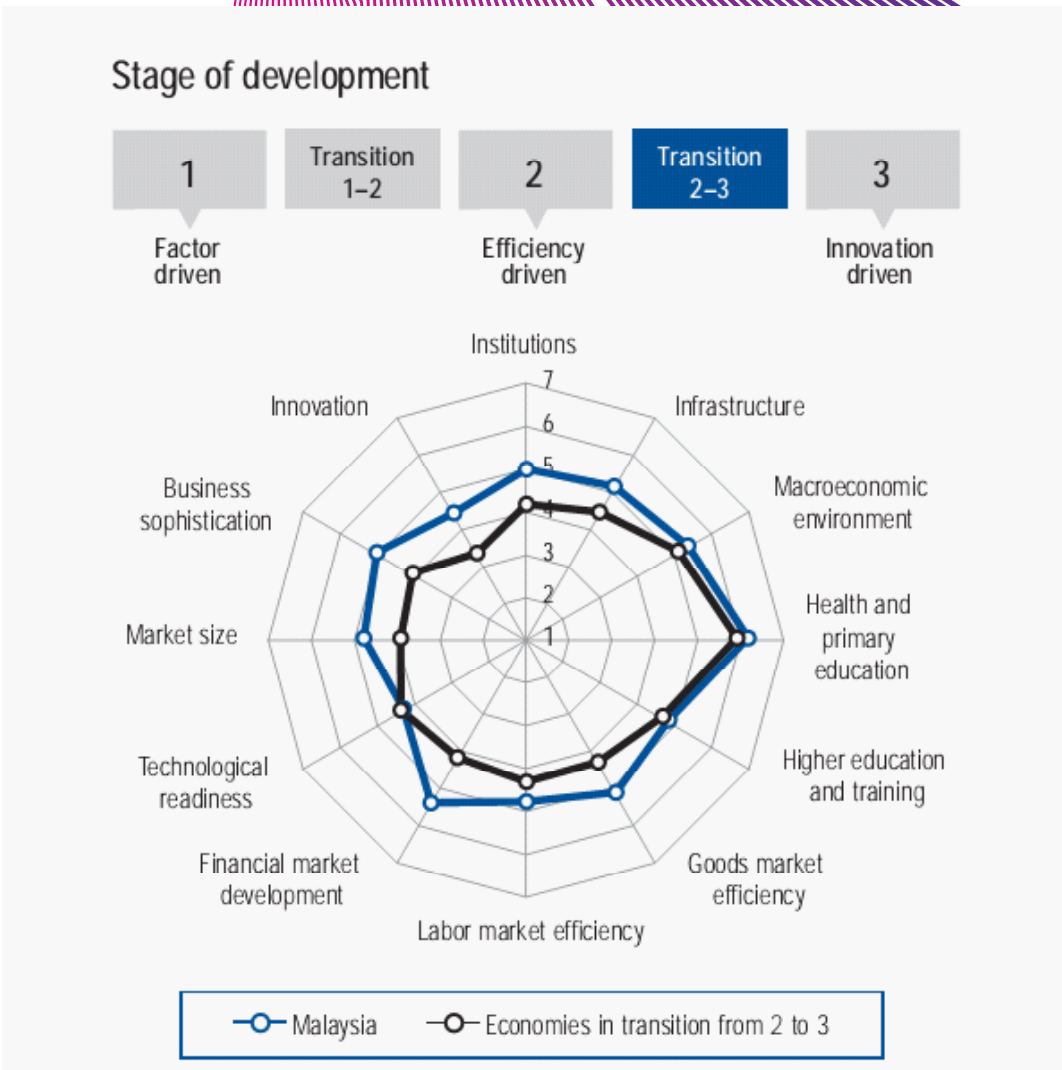


Figure 21. Malaysia's development profile.

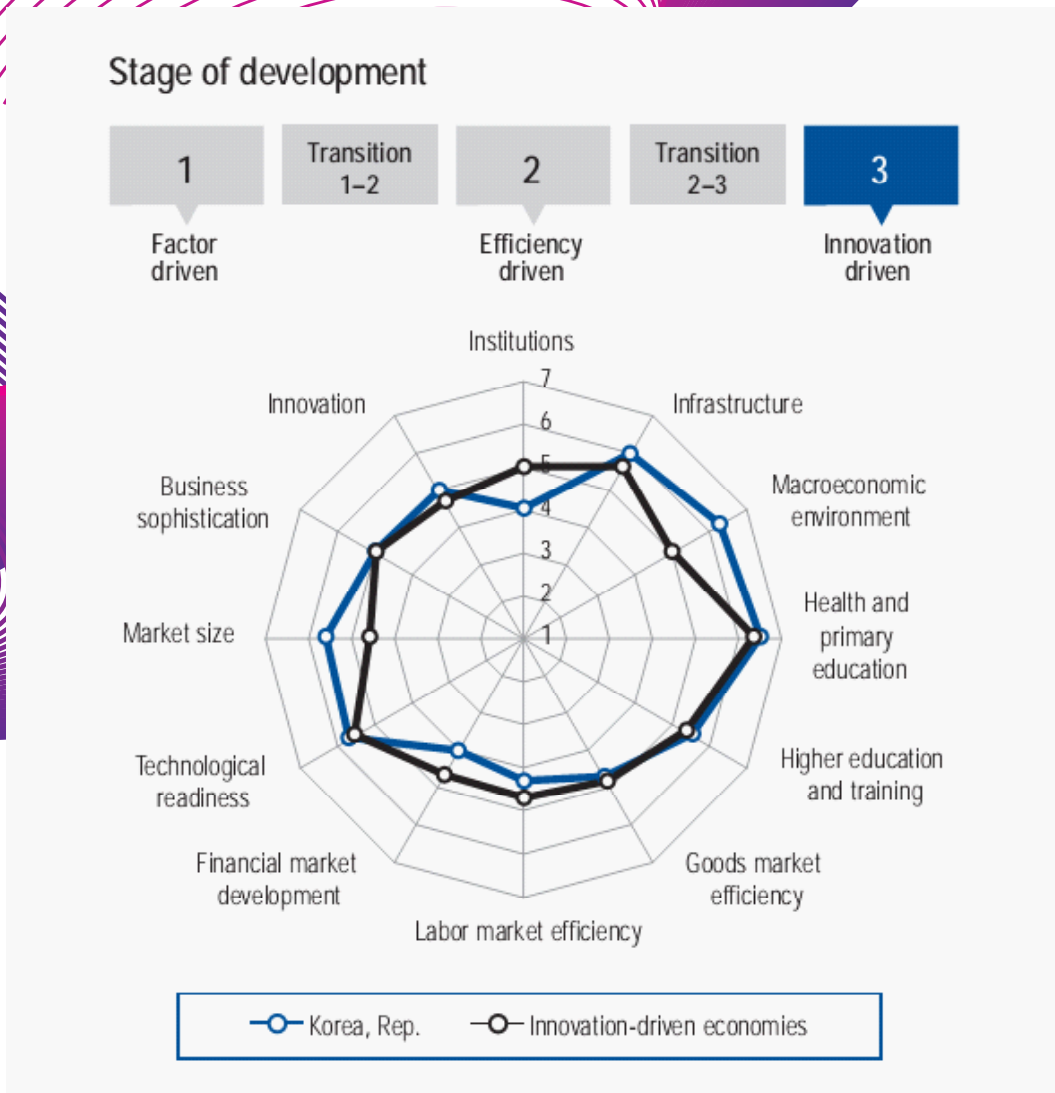


Figure 22. South Korea's development profile.

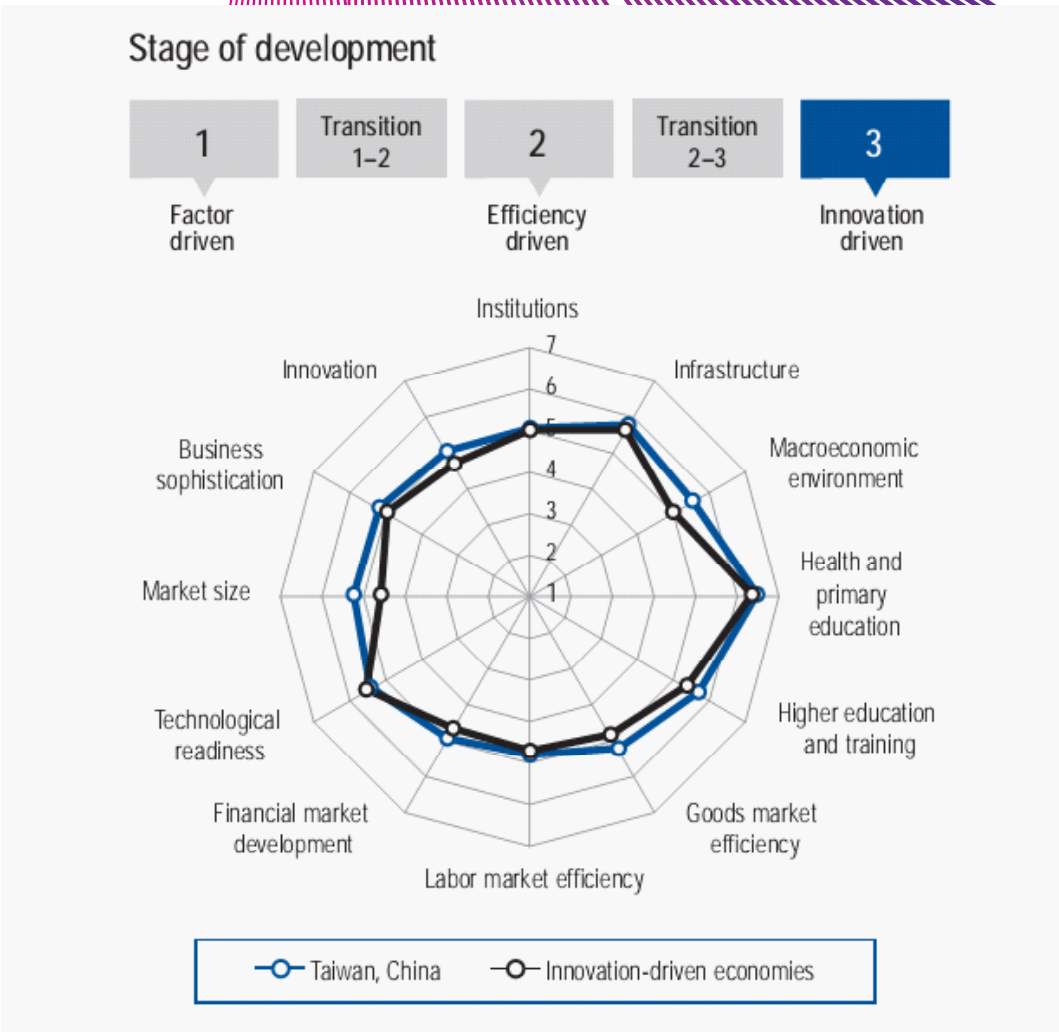


Figure 22. Taiwan's development profile

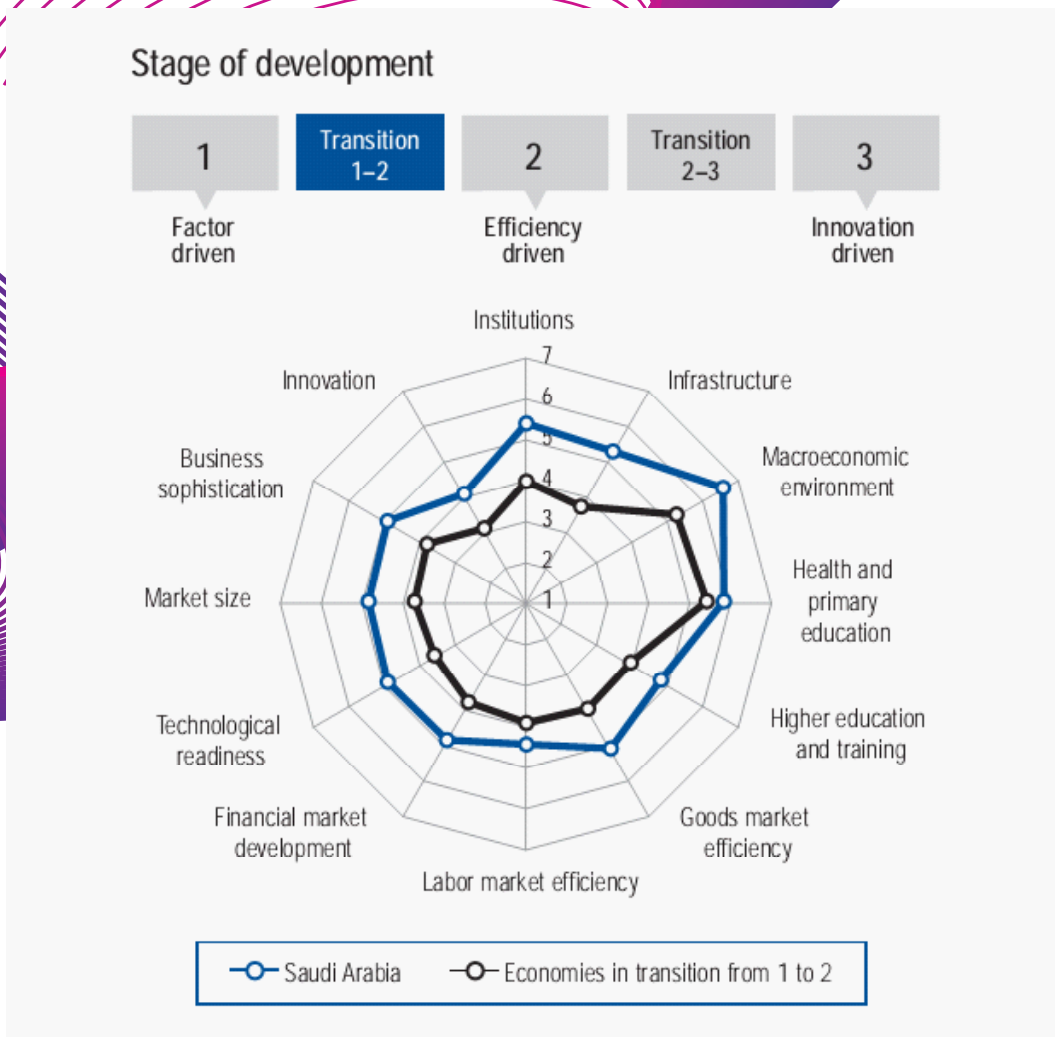


Figure 23. Saudi Arabia's Development Profile.

It is apparent that both South Korea and Taiwan are success stories in emergent Asia as they have both become innovation-driven economies and societies. Both countries score highly in technological readiness, which depends to a large extent on Internet penetration and broadband speed and quality. Malaysia fares relatively poorly. Two other areas that Malaysia needs to improve urgently are innovation and higher education and training.

Saudi Arabia is at a different stage of development, but nevertheless is ranked higher, coming at number 18 compared to Malaysia's 25. Countries like Saudi Arabia are giving Malaysia a wake-up call. They may overtake Malaysia if we do not move up faster in strengthening the basic factors of competitiveness. Broadband is one of the most important factors with many implications for science, technology and innovation, as discussed in the above paragraphs.

For Malaysia to reach the innovation-driven stage, a number of issues and challenges need to be resolved, especially in the following areas:

(i) Broadband as an enabler of socio-economic transformation

The potential of ICT in creating an innovative learning society has not been properly exploited. Access to information and knowledge without restriction of time or space offered by Internet opens up new opportunities for learning, unlearning and relearning. The radical shift from the industrial model of development to the knowledge model implies the need for rapid learning in order to initiate transformative change among members of society. Socio-economic transformation will take place only when this new learning is translated into life-changing work and life processes that become the norm for much of the Malaysian community.

The Multimedia Super Corridor's (MSC) objective is to build a cluster of ICT companies that can develop applications to increase domestic productivity, thereby creating a sustainable knowledge-based economy and knowledge society. This has not been realized. Malaysia's productivity growth has actually slowed down despite the massive efforts to develop an ICT industrial cluster. Current Internet usage is highly biased towards social interaction and entertainment (e.g. 91% of Internet users are in social networks, while in comparison, only 14% are in auctions or 44% in some form of retail businesses).

A low level of usage for innovation and development is evident. For example, only 15% access health services (e.g. 66% use e-government services for filing taxes) and 5% access education. Malaysians are good consumers (e.g. 66% use e-government services for filing taxes) but poor producers of innovative Internet applications. Indigenous content remains insufficient and underdeveloped. There is also a lack of proper tracking mechanisms for monitoring and evaluation of socio-economic and governance transformations arising from ICT. As the McKinsey report shows, Malaysian users are superficial consumers of ICT products and services. Deep-rooted life-changing applications with potential to increase productivity have yet to become widespread. As a result, the economy and society lack the agility to adapt to disruptive and rapid changes due to technological upheavals.

(ii) Science, Technology and Innovation (STI) Community Needs to Integrate into Global Networks

Malaysian professionals, intellectuals, researchers, academia and industry have been relatively inward-looking and have not globally networked in science, technology and innovation activities as the evidence in the Royal Society report shows. They have also remained largely remote and disconnected from the wider community of non-professionals and lay public. Mindset, attitudes, values, lack of awareness and weak regional and global links may be some of the reasons behind this poor record of integration and collaborative efforts. The "not invented here" syndrome may also be at play. There are limited efforts to exploit global STI output which are already available, raising the possibility that we may be reinventing the wheel. There is poor understanding or appreciation of the global innovation eco-system which demands collaboration between diverse players, including the wider public. Last but not least, the low quality and high cost of BB are major obstacles.

(iii) Application and Content Activities

The inadequacy of affordable high bandwidth broadband connectivity poses challenges to value creation and productivity enhancement activities. Lack of platforms for cooperation and collaboration among service providers, community of practitioners and user communities in developing indigenous content and applications largely leads to the prevailing weaknesses. Furthermore, productivity-enhancing supply chains lack national-level ownership, incentives, coordination and promotional programmes. Potential users lack awareness of, and exposure to, productivity-enhancing ICT-based tools and processes. Thus, the low level of uptake produces lower demand for, and production of, such products and services, thereby reinforcing and perpetuating the vicious circle of low application and content development.

(iv) Small- and Medium-enterprises (SMEs)

The uptake of broadband services by SMEs is severely limited, despite their important role in the economy and society. SMEs' current economic contribution is 31 % to GDP, 19% of export and 56% of employment. SME Corp. (2011) reported that the SMEs' contribution to GDP is targeted to reach 40% by 2020. The following are some of their weaknesses as reported by workshop participants. SMEs are complacent, sticking to traditional modes of doing business. They lack awareness on how ICT can improve their businesses, partly due to lack of ICT literacy. They lack financial resources for acquiring ICT infrastructure, tools and services. They also lack financial resources to employ expertise. SMEs are generally reluctant to embrace the ICT work culture. They suffer from a "fear factor", relating to business security, safety and authentication challenges, and are basically described as techno-phobic.

(v) Definition of Broadband

The International Telecommunication Union (ITU) defines broadband in terms of ISDN services providing at least 2.0 Mbps. This is obsolete in the light of the dynamic change in applications and content. Likewise, the definition of broadband by Telekom Malaysia as 4 Mbps under the Broadband for General Population (BBGP) programme is also out-of date. Malaysia's best effort speed offered

under the Fixed Broadband (FB) services netted an average rate of 4.4 Mbps, which is only adequate for social networking, low density video streaming, basic video streaming like You Tube, small file sharing and Standard Definition Internet protocol TV (SDIPTV) and not adequate for future applications (note: best effort does not mean actual data speed experienced by users). Fixed Broadband (FB) or Mobile Broadband (MB) with average speed of 1.77 Mbps or Mobile Internet (MI) of 2.8 Mbps are not adequate for future applications requiring at least 11.25 Mbps. 14 countries including Korea, Japan and Hong Kong in Asia are already equipped for future applications such as high density video streaming, high density Internet protocol TV (HD IPTV), visual networking and consumer tele-presence.

There is an urgent need to redefine broadband speed and quality dynamically according to the needs of the time, by fulfilling today's applications and anticipating tomorrow's requirements.

(i) Diversity of Broadband Services

Broadband capacity, speed and cost are highly diverse among service providers. Service providers provide a wide range of services that are confusing and pose difficulties for customers to make informed decisions. Wide diversity of services is giving rise to opaque and unfair market practices. Both businesses and individual customers lack adequate information on the type of services offered. Customers are unhappy with rigid terms and conditions attached to the services as well as penalties imposed on breaching those terms and conditions.

(ii) Government Policies and Strategies

Current Government policies or their implementation seem to favour service providers rather than users and consumers. Incumbent telecommunication service providers have greater advantage than new entrants to the market. For example, infrastructure cost offered to new entrants is high, despite the fact that much of the infrastructure was originally developed from public funds. Fair pricing and a competitive environment is thus questionable. Overlapping roles and functions of ministries and agencies in policy-making, implementation and regulation lead to confusion and lack of a comprehensive and strategic development approach. Implementing institutions often do not act effectively and efficiently as change agents. Finally, institutional frameworks for tracking, monitoring and evaluation are inadequate, rendering accurate feedback and corrective action ineffective.

(iii) Cooperation and Collaboration between Key Role Players

The key stakeholders in promoting the wider use of broadband for transformative change are the public sector, especially the regulating agencies and development institutions, the private sector, including entrepreneurs, and community groups, in particular, user groups. There is limited engagement among these stakeholders. Users are not united and mobilised to demand better services at lower cost. Service providers have the upper hand in negotiations, with incumbents getting special protection. The end result is all-round complacency where a "good enough" culture prevails. In the meantime, more competitive countries around the world are practising a culture of leadership in innovation, and giving Malaysia a run for the money. The obvious outcome for Malaysia will be decreasing competitiveness in comparison with these agile fast movers.

WAY FORWARD

In addressing the various issues and challenges identified above, the Academy of Sciences of Malaysia proposes the following policies, strategies and implementation measures for the government's consideration. They are aimed at achieving the following objectives:

1. To ensure that the Malaysian science, technology and innovation community is nationally, regionally and globally connected, both physically and virtually, for more open cooperation and collaboration;

2. To enable the private sector and business community, especially entrepreneurs and small and medium-scale enterprises, to leverage on ICT to become more innovative in growing their businesses; and

3. To facilitate the user community in applying ICT for life-changing and transformative development based on knowledge and innovation.

The following specific measures are proposed:

i) Definition of Broadband

Broadband has to be defined dynamically and should not be allowed to remain static. The definition should set standards that will enable all citizens to fulfill today's needs while anticipating future requirements. More importantly, the definition needs to be proactive and compatible with development aspirations of the country. Malaysia has declared its intention to become a leader in ICT and its applications with the establishment of the MSC. Therefore it is appropriate that the country deploys tomorrow's requirements today. This is the path that will take it to leadership position.
As a guide, future applications demand an average download speed of 11.25 Mbps and latency of 60 milliseconds for applications such as visual networking, high-density video streaming, consumer tele-presence, large file sharing and High Density Internet Protocol TV (HDIPTV). These should be the minimum standards to be achieved today, and offered at affordable cost to all citizens irrespective of location.

ii) Quality and Cost of Broadband

The variation in capacity, speed and cost of broadband services among service providers must be minimized so as to ensure there is wider take-up by Malaysians. The basic minimum speed provided must be increased and broadband pricing reduced, making broadband more affordable to lower-income families. Policies to reduce pricing and to limit the types of services offered towards establishing a more transparent regulatory regime must be closely monitored and firmly enforced. This will facilitate businesses and citizens in making better and informed decisions. This strategy can only be achieved by authorities facilitating, establishing and maintaining a healthy competitive environment for service providers.
To cater to the needs of low-income households, it is recommended that a domestic-access

only broadband subscription be established, which can be offered at very low cost, but with the same quality standards. This will attract current non-users as well as those still using low-speed connections.

Broadband quality and pricing need to be regularly benchmarked to conform to future applications, as well as being competitive against regional and global competitors. By this means, Malaysia will not lose out to other competitors in the coming years.

iii) Science, Technology and Innovation (STI) Community Integrating into Global Networks

For Malaysian scientists to thrive in the national and global arenas, there is a need to develop collaboration networks and platforms for greater national, regional and global cooperation in STI. In order to do this, affordable high quality and high speed broadband should be made available and accessible to all actors in the knowledge and innovation eco-system.

There must also be exposure, training, funding, incentives and rewards provided to key actors in order to stimulate and encourage attitudinal change. These key actors include those in the relevant ministries that are engaged in STI, such as MOSTI, MOHE, MOE and the Prime Minister's Department.

A monitoring and evaluation system should be implemented, perhaps in PEMANDU, to track progress in globalization of STI and collaboration within this community, as a means towards further improving and enhancing our performance.

(iv) Applications and Content Activities

In developing community- and business-relevant content and applications, service providers and developers should be encouraged to work closely together. Collaborative platforms should be established and operated by relevant agencies. Specifically, it is recommended that development of productivity-enhancing supply chains in priority industry sectors should be incentivized or fully funded by the Government.

(v) Small and Medium Enterprises (SMES) Moving Up the Value Chain

SMEs are an important endogenous source of growth towards building a high-income nation. In order to facilitate their key role in development, a broadband programme for SMEs should be planned and implemented strategically and holistically, integrating technology, infrastructure, people and institutional strategies.

To overcome the inherent problems faced by SMEs as outlined above, there is a need to formulate and implement receptivity to change programmes among them. Initially, resistance can be expected but with provision of adequate funding for well-crafted capacity and capability building programmes, SMEs will be able to migrate more readily to the information- and knowledge-based way of doing business. There is also a need to instill contemporary management skills and work processes among the management teams of SMEs. This should not be a one-off strategy. There

must be continuous availability of expertise to provide ICT and process advisory and consulting services, and facilitation of in-service delivery processes and systems.

(vi) Government Policies And Strategies

Although various policies and strategies have been successfully implemented by the government in the past, there is a need to continuously review these policies and strategies as the Internet platform is fast-moving. One strategy that needs deeper consideration is the creation of a more level playing field for service providers. As has been done elsewhere, for example in Singapore, there is a need to appoint a neutral player to operate a shared network backbone. This operator has to ensure that all service providers are treated equally. In particular the backbone and backhaul services should be made available at very low cost, which is possible if the neutral service provider is not required to make profits. In the final analysis, the broadband customers, SMEs, businesses, scientists and the ordinary people, will ultimately benefit from this move.

Another strategy which needs consideration by the government is the separation of wholesaling and retailing activities to avoid duplication in market practices and conflicts of interest. This unbundling of activities will ensure there is fairness in practice among all retailers which again will benefit all citizens.

The government has already made it a national policy to narrow the development gap between urban and rural communities. Providing equal access everywhere across the nation will narrow the digital divide and also enable the nation to also narrow the ICT-enabled innovation gap. There is an urgent need to establish a dedicated institution under the Rural Transformation Programme (RTP) to tackle rural connectivity issues and challenges.

Finally, a key national strategy is to ensure that the regulatory institution responsible for the Internet and broadband to be more independent and autonomous in implementing and enforcing national policies, while employing a more participatory approach in consensus building by engaging regularly with all key stakeholders.

(vii) Cooperation and Collaboration between Key Role Players

To ensure success in implementing the proposed broadband policies and strategies towards driving the national development agenda to a higher level, key role players need to be intensely engaged with and mobilised. These role players are the stakeholders that fill the ICT-enabled development value-chain. Mobilising them by aligning their common interests will go a long way in enhancing the national STI performance.

As the country's top institution in the formulation of ICT policy and strategy, the National Information Technology Council (NITC Malaysia) has the national mandate to provide clear direction in championing and promoting development of broadband services, applications and content. However, it has to work closely with other role players. The ICT industry players have to assume a more proactive role in building capacity and capability among users and consumers, especially the SMEs, to apply broadband for innovation and productivity enhancement. Specific

incentives need to be provided to encourage industry to assume this role effectively and efficiently. Regulatory agencies have to monitor, evaluate and guide industry towards achieving more balanced development. Community-based groups and Internet centres need to be remobilized to promote wider usage, and the development of applications, content and broadband-based infrastructure and services to enable social and economic transformation.

The Royal Society (2011) study shows that Malaysia is playing a relatively small role in science collaboration between South-South countries. Collaboration with the developed countries is even less significant. The Royal Society pointed out that global connectivity and networking is critical for the advancement of science. In overcoming this short-coming, the Academy of Sciences Malaysia (ASM) is prepared to lead the STI community in making Malaysia a global hub for scientific knowledge and innovation networks.

KEY RECOMMENDATIONS

The ASM makes the following key recommendations for the consideration of the government:

(i) Adopt a dynamic definition of broadband to fulfill today's applications while anticipating tomorrow's applications, ensuring also that it is compatible with Malaysia's development aspirations.

(ii) Provide quality broadband that is affordable to all citizens and businesses, irrespective of where they are located.

(iii) The Academy of Sciences Malaysia (ASM) be given the mandate to lead the STI community in making Malaysia a globally-connected innovation hub.

(iv) Practise more transparent and inclusive engagement processes in policy-making, implementation, regulation and enforcement towards establishing a more level playing field in the provision of broadband infrastructure and services.

(v) Provide incentives, funding and other support mechanisms for the acculturation of the wider STI community, and in particular the SMEs, in the effective use of advanced productivity-enhancing tools and systems.

ROLE OF THE MINISTRY

- ✓ Monitoring broadband development (technologies, infrastructure, content, applications) globally and nationally;
- ✓ Monitoring and evaluating implementation of national ICT policies and strategies;

ROLE OF THE ACADEMY OF SCIENCES MALAYSIA

- ✓ Promoting enculturation of knowledge- enhancing applications and content within the STI community and other related communities and stakeholders;
- ✓ Undertaking futures studies (Mega-Science Framework Study up to 2050) such as scenario planning, fore-sighting and back-casting

APPENDIX 1

SITUATIONAL ANALYSIS

In their study, the Royal Society undertook an analysis of the top publishing cities from 2004 – 2008 and their growth since the late 90's, that is, from 1996 – 2000. In Canada, Toronto showed an increase of more than 20 places while in Europe, the cities of London, Madrid, Moscow and Rome showed similar increases. In South America, Sao Paolo in Brazil depicted a similar increase. In Asia, Beijing and Hong Kong in China and Tokyo in Japan showed increases of more than 20 places (*Figure 1*).

Key City with highest publication output in the period 2004-2008 growth is since period 1996-2000

- Decreased or stayed constant
- Increased 5-10 places
- Increased 10-20 places
- Increased 20+ places

Source: Knowledge, Networks and Nations: Global scientific collaboration in the 21st Century, The Royal Society, 2011

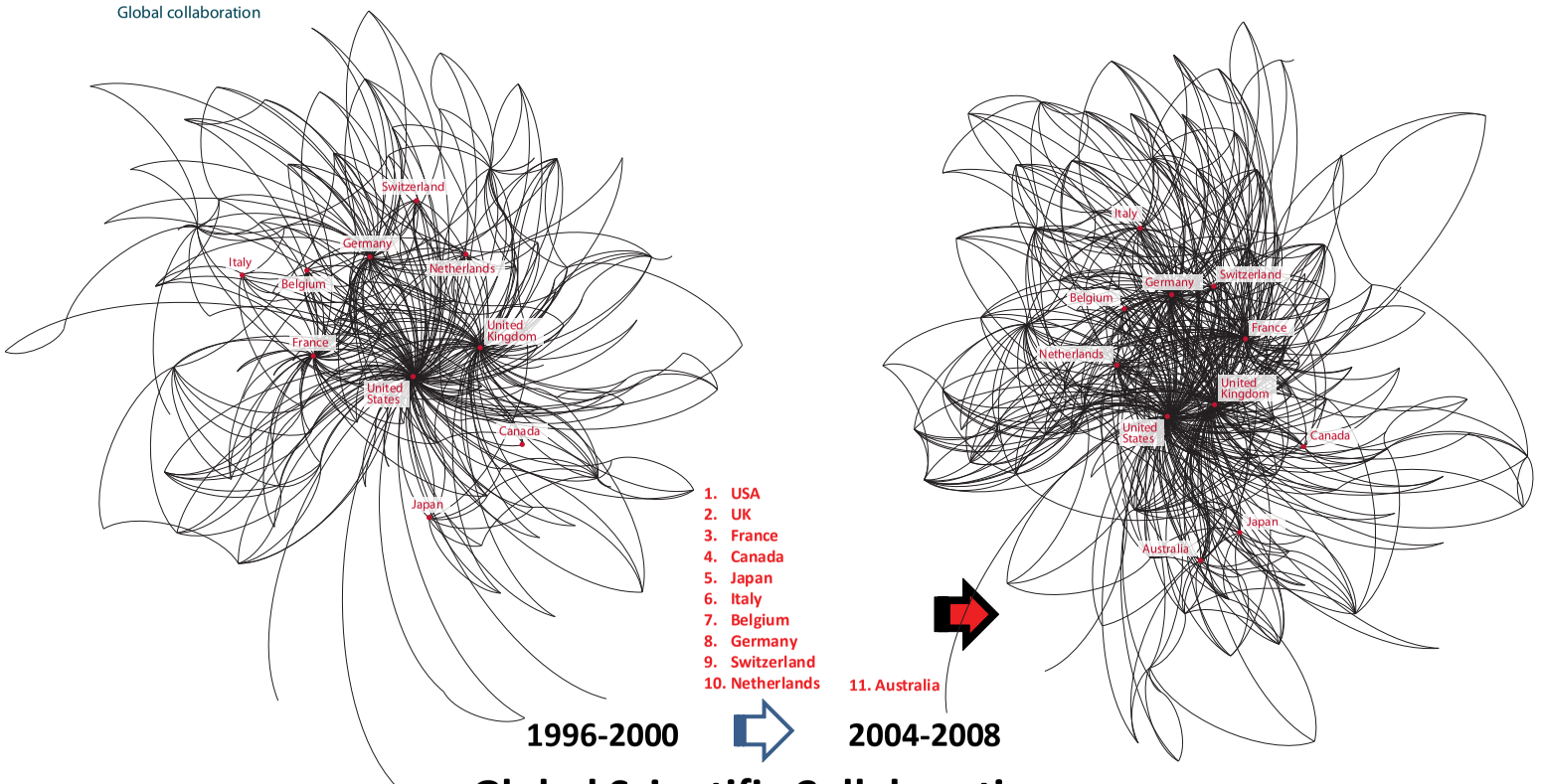
Trend 1 : Scientific landscape in 2011- Top 20 publishing cities 2004-2008 and their growth since 1996-2000

Global connectedness is critical for global scientific collaboration

Source: Royal Society, 2011.

Figure 1. Changing Trends in Global Connectivity and their Growth since 1996-2000.

However, in post 2000, there was an explosive expansion in international scientific collaboration from the traditional nations such as the USA, Europe (France, United Kingdom, Belgium, Switzerland and Netherlands), and Japan to include other nations such as Canada, Italy and Australia (*Figure 2*).



Source: Knowledge, Networks and Nations: Global scientific collaboration in the 21st Century, The Royal Society, 2011

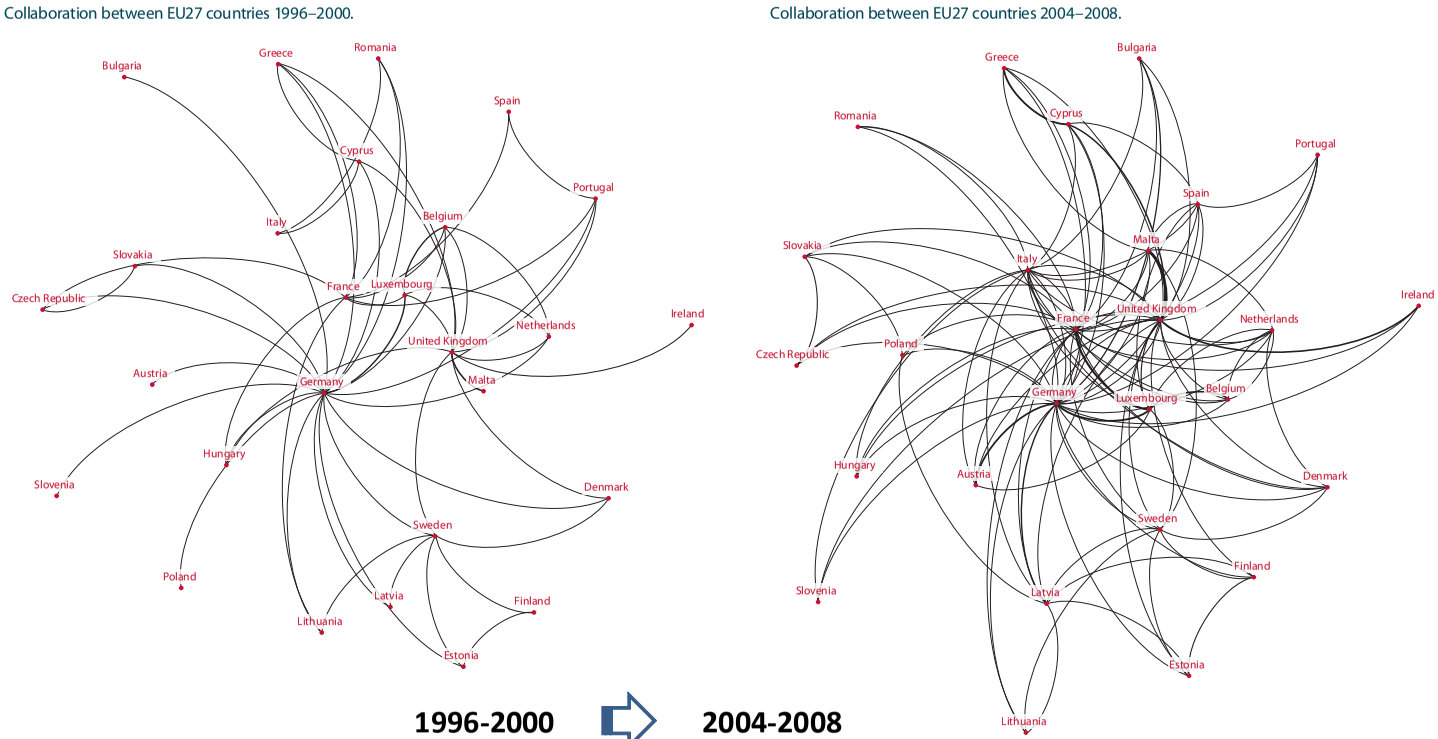
Trend 2 : International collaboration landscape changing from USA, Europe and Japan dominance to other countries

Countries like Australia have joined the ranks

Source: Royal Society, 2011.

Figure 2. International Collaboration Network Dominance Changing from USA, Europe and Japan's Dominance to other countries.

In the EU countries, the EU's Framework Programme had enabled increase in research output from 32% to 46% of total publication output (*Figure 3*). Under the 7th Framework Programme for Research (FP7), as part of a €10.8 billion budget for research and innovation agreed for 2013, the European Commission had announced an €8.1 billion euro package of calls for proposals ("http://ec.europa.eu/research/fp7/index_en.cfm"). This was the final and largest ever package of FP7 calls, and is an important part of the Commission's commitment to work for growth and jobs in



Scientific collaboration among EU 27 nations

Source: Knowledge, Networks and Nations: Global scientific collaboration in the 21st Century, The Royal Society, 2011

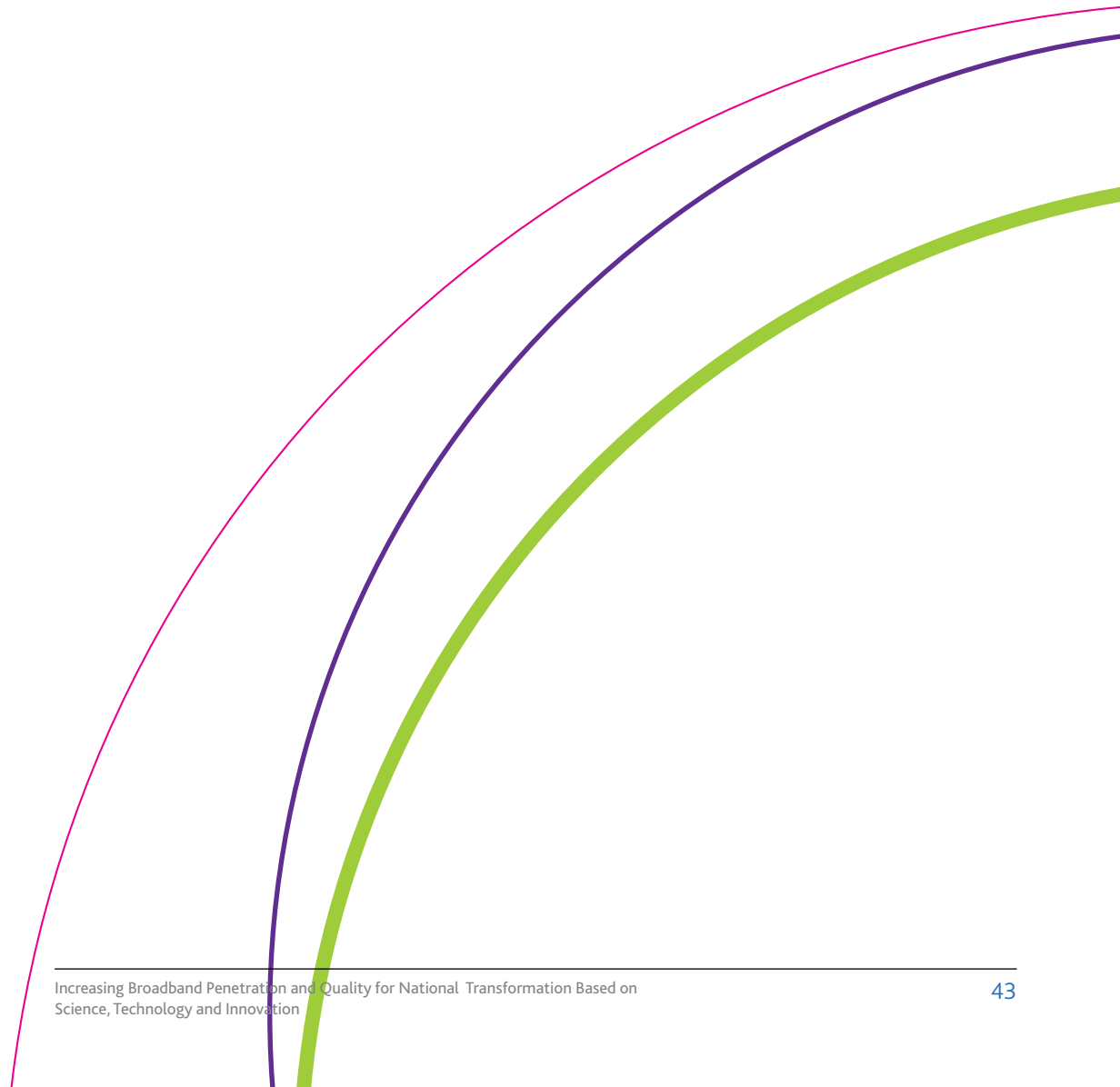
Trend 3 : Expanding EU27 research collaboration

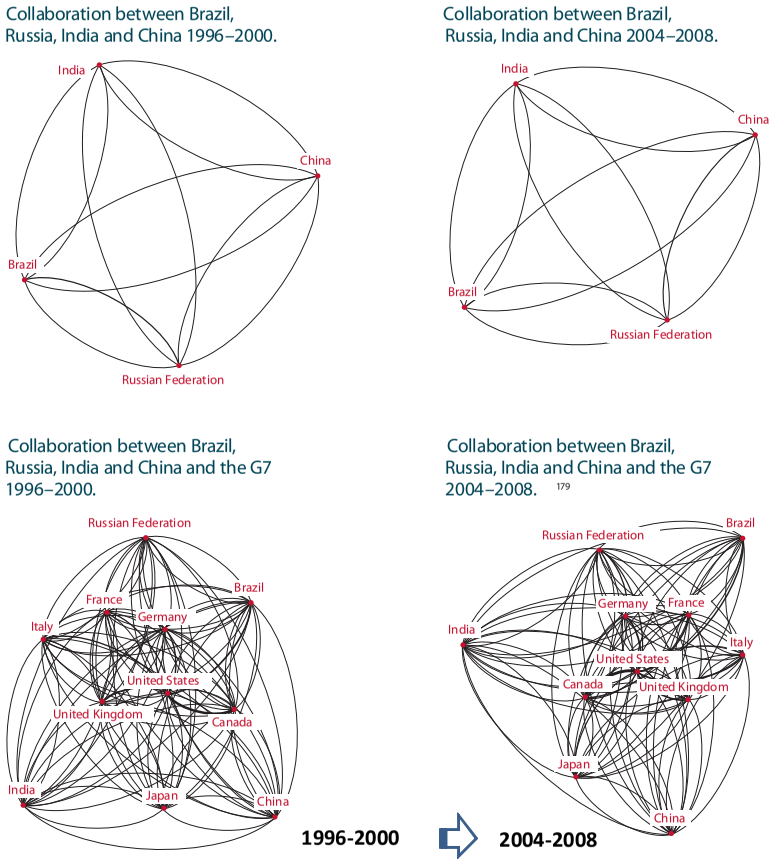
European Commission's Framework Programme(FP) has enabled increase in research output from 32% to 46% of total publication output

Source: Royal Society, 2011.

Figure 3. Scientific Collaboration among EU Countries Pre- and Post-2000.

Europe. The budget and work programme will be for proposals in thematic areas, such as to preserve oceans and water, determine better use of raw materials, efficient energy, promote efficiency in the processing of biological resources, develop smart cities and tackle issues such as public sector reform, brain research and anti-microbial resistance. The budget also aims to "making Europe a destination for world-class researchers" as another key priority. It further reported that the European Research Council would "invest over €1.7 billion in the best researchers and additional €963 million will support mobility through "Marie Curie Actions". An important element of the FP7 budget is the recognition of small and medium-sized enterprises as being vital for innovation. Special incentives to participate with a total package of €1.2 billion were provided for this group.





Scientific collaboration : G7 and BRIC Nations

Source: Knowledge, Networks and Nations: Global scientific collaboration in the 21st Century, The Royal Society, 2011

Trend 4 : Increasing scientific collaboration among BRIC nations and G7 countries, though within BRIC is limited

G7 research partnership is a force to be reckoned with in the dynamics of global science

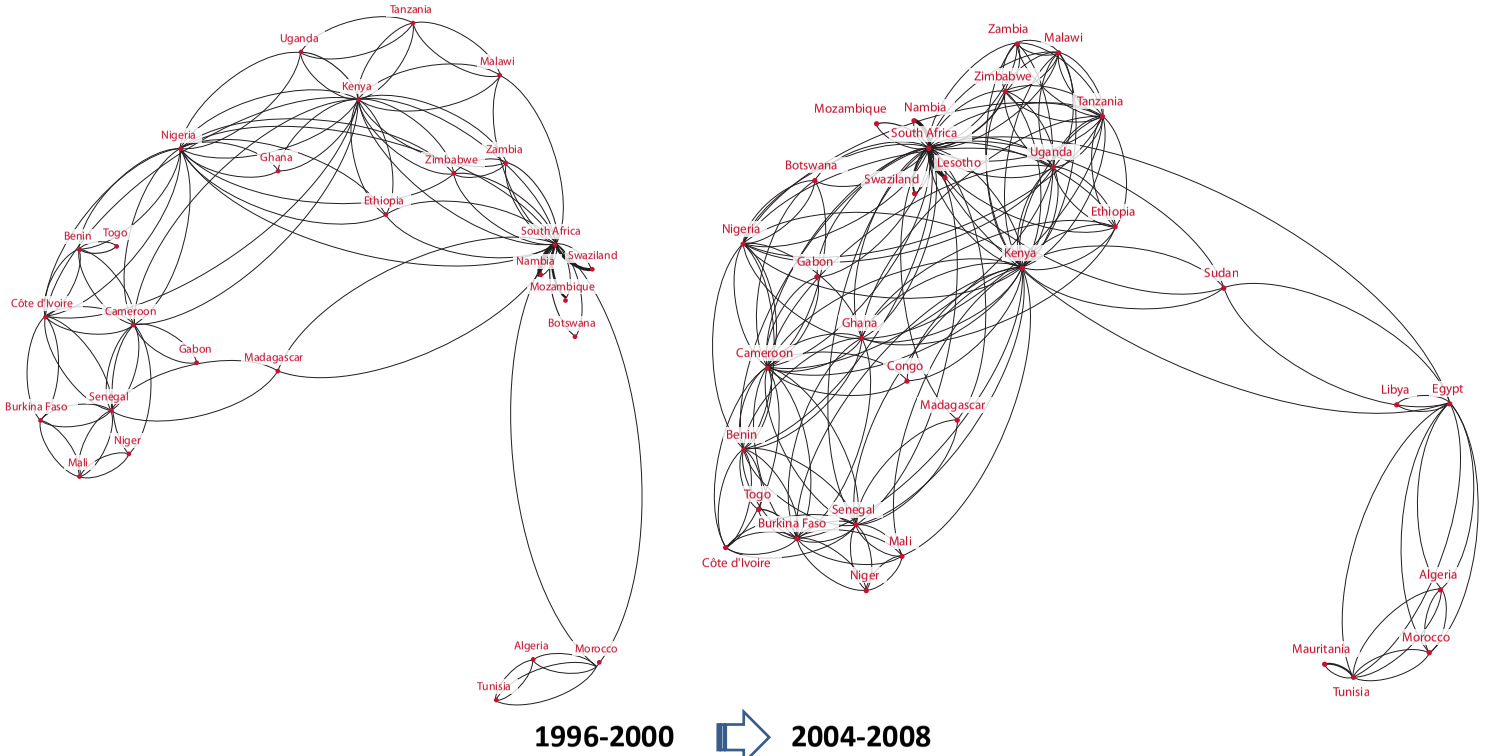
Source: Royal Society, 2011.

Figure 4. Scientific Collaboration among BRIC nations and G7 Countries.

This trend of increasing scientific collaboration is similarly seen among BRIC nations and G7 countries when comparing pre-2000 and post-2004 data (*Figure 4*). The Royal Society report further stated that the G7 research partnership is "a force to be reckoned with in the dynamics of global science".

In the African continent, a similar explosion of scientific collaboration is seen with South Africa becoming the key touch-point in scientific research collaboration. This region is seeing more new entrants in the collaborative effort (*Figure 5*).

Collaboration between African countries



1996-2000 ⇨ **2004-2008**

Scientific collaboration among African nations

Source: Knowledge, Networks and Nations: Global scientific collaboration in the 21st Century, The Royal Society, 2011

Trend 5 : Expanding regional collaboration

South Africa has become linchpin of African collaborative research efforts with increasing new entrants

Source: Royal Society, 2011.

Figure 5. Scientific collaboration among african nations.

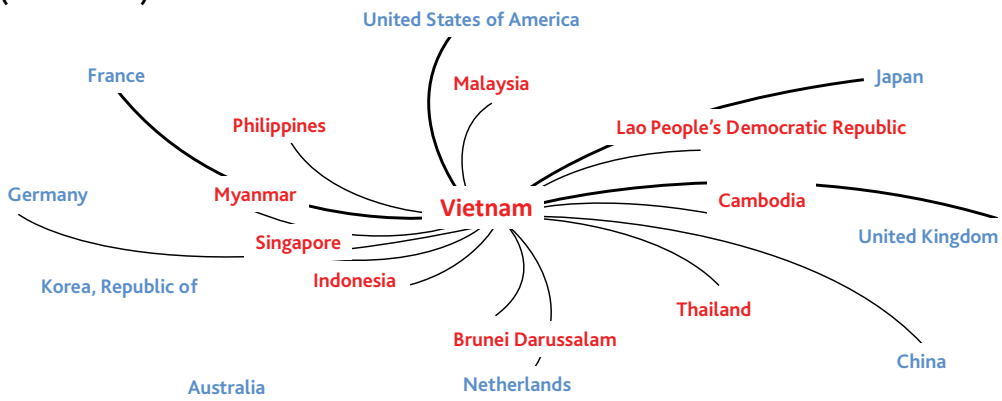
Closer to home, the Royal Society study reports that the South-South developing countries' scientific research collaboration is still at a minimal level. However, the study noted that Vietnam was taking a lead role in South-South collaboration as well as in fostering scientific research links with developed nations (*Figure 6*). It is unfortunate that Malaysia is shown as playing a relatively small role in science research collaboration in South-South countries, and less still with other international collaborators.

The Royal Society Report (2011) pointed out that global connectivity and networking is critical for the advancement of science owing to the following reasons:

1. Science is increasingly global as it involves transnational collaboration, well supported by governments, businesses and third sector organizations; and

2. Increased activities, investments and scientific productivity has led to new emerging scientific nations like China, India and Brazil; outstripping the traditional scientific superpowers (USA, Western Europe and Japan).

Vietnamese collaborative papers as a proportion of total output (2004-2008)



The inner circle shows the collaborations with other. South-east Asian neighbours and the outer with the countries where the proportion of collaboration is highest. The thcikness of the line indicaters the volume of output

Source: Knowledge, Networks and Nations: Global scientific collaboration in the 21st Century, The Royal Society, 2011

Trend 6 : Individual countries taking leading role

Within developing countries collaboration is still at minimal level; however countries like Vietnam taking lead role in South-South collaboration and fostering research scientific links with developed countries

Source: Royal Society, 2011.

Figure 6. Vietnam taking a lead role in Scientific Collaboration in South-South Countries .

1. Traditional centres of scientific excellence and new players pointing towards an increasingly multipolar scientific world; and
2. Beyond the traditional hubs science is also flourishing in driving economic and sustainability development.

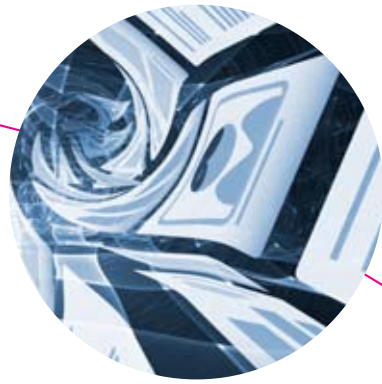
Furthermore, the Report emphasized that global connectivity, networking, interaction and collaboration accords numerous benefits, as follows:

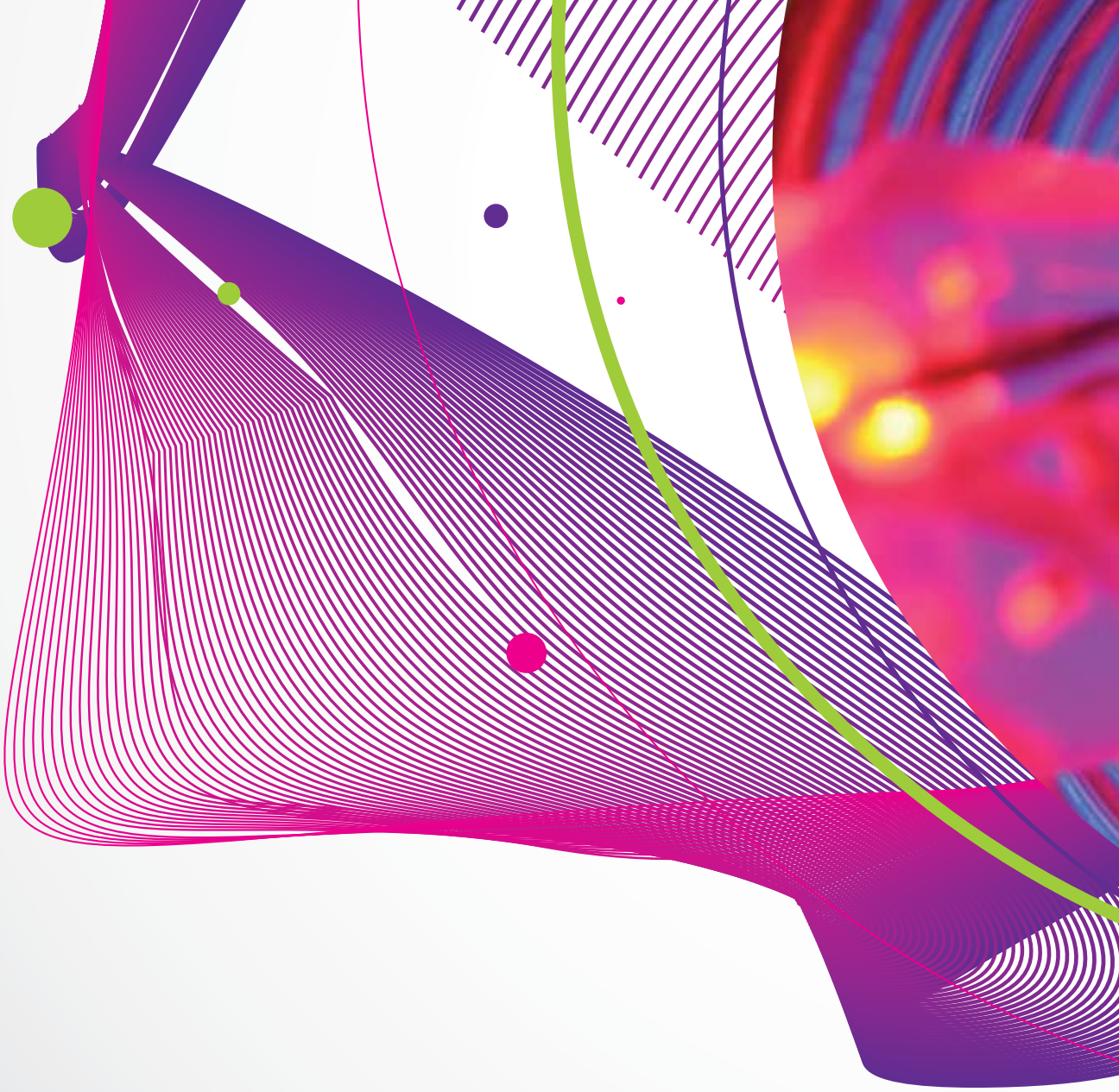
- ✓ Scientists seek to work with the most outstanding scientists in their fields;
- ✓ Helps to build knowledge networks, providing access to complementary skills and knowledge; filling in knowledge gaps and resources; accessing high quality equipment and instruments; and shaping research agendas;
- ✓ Collaboration brings with it the obvious benefit of scale;
- ✓ Sharing the burden of research activity, breaking down complex tasks into manageable pieces; and
- ✓ Facilitates joint authorship, capacity building, geopolitical linkages and global networks of science.

The Report cited that, through global connectivity, many opportunities would arise in scientific collaboration, as follows:

1. The scientific world is increasingly interconnected, with increasing collaboration from 25% to 35% of articles published over the past 15 years;
2. International collaboration entails connections of people through formal and informal channels, diaspora communities, virtual global networks and professional communities;
3. Collaboration enhances the quality, efficiency and effectiveness of research;
4. Scientists are increasingly collaborating to work with the best people, institutions and equipment around the globe;
5. Focus of science changes from the national to global perspectives;
6. Global networks span through bottom-up exchange of scientific insight, knowledge and skills; and
7. Global collaboration brings benefits in increased citations, access to new markets, broadening research horizons and positive impact on the science system itself in bringing prosperity or addressing specific challenges.

The Royal Society, in a following report entitled "Science as an Open Enterprise" (Royal Society, 2012), further stated that "the internet provides a conduit for networks of professional and amateur scientists to collaborate and communicate in new ways and may pave the way for a second open science revolution, as great as that triggered by the creation of the first scientific journals."





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