



# Taiwan Perspective: Developing Smart Living Technology

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**Abstract:** The pursuit of *Smart Living Technology* is a recent trend in which technology is applied to daily life to increase efficiency, affordability and sustainability. The principle behind *Smart Living Technology* is that technology should be used to advance the needs of human beings and to increase the quality of life by the power of human creativity while at the same time sustaining the environment for future generations. As such, intelligent networks should be adopted to provide humans with full information to control an individual's personal environment. Wireless technology can play a key role in enabling smart energy monitoring by allowing consumers to make more informed choices and to connect products and devices to a coordinated management system. The development of *Smart Living Technology* is based on the concept of user driven innovations. Various Living Labs have been established around the world as development centers for extension of this *Smart Living Technology*.

In this paper, the background and current developments of *Smart Living Technology* are reviewed, followed by real examples taking place in Taiwan. Finally, the focus and future plan for Taiwan are discussed including a strategy for further development of *Smart Living Technology* in Taiwan.

**Keywords:** *Smart Living Technology*; Information Communication Technology (ICT); smart home.

## Introduction

In the past ten years since the establishment of the internet era, sites like Google, Amazon, Wikipedia, YouTube and Facebook have created communities of connected users. Through these communities, many innovative human minds have evolved into collaborative intelligence. At a Web 2.0 Summit 2009, Tim O'Reilly predicted that the next five years would be web squared when "the Web meets World". That is, Web 2.0 technologies are now interacting with the real world through the use of sensors [1]. He believes that collective intelligence applications will be increasingly driven by

cascades of sensor data or information given off by devices. For example, smart phones today have built-in cameras, microphones, and sensors which provide information on the motion, proximity, location, and direction of the user. These sensors are equivalent to our human senses such as sight, hearing and touch. By connecting these senses to cloud computing databases and programs running on massive server farms, it is possible to create a smart living environment for humans. Since Taiwan is well-known for its information and communications technology, Taiwan is facing the "web squared challenge" by focusing on developing *Smart Living Technology*.



## Definition of Smart Living Technology

Increasingly, many countries around the world are adopting the idea of *Smart Living Technology*. It is an idea that tries to integrate technology with humanity [2]. The origin of *Smart Living Technology* is derived from the evolution of a technology-driven industry towards a humanities-oriented industry. *Smart Living Technology* seeks to bring innovative Information Communication Technology (ICT) to all aspects of human life, including assisting in obtaining the daily life necessities such as food, medication, housing, transportation, education and entertainment [3]. *Smart Living Technology* allows

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From October 2007 to August 2010, he held an adjunct appointment as Executive Vice-President of ITRI. Since August 2010, he has been appointed as the CEO of Institute for Information Industry (III). He is currently directing his efforts towards finding a paradigm to link Taiwan's research in engineering and applied sciences to the next-generation industrial and societal trends. His objectives, now and for the future, is to determine how he can help Taiwan's industries arrive at the next stage required for transforming Taiwan from a manufacturing-based economy to an innovation-based economy.

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humans to pursue Smart Living in which new smart choices are made in our daily life, in our work and in our entertainments so that there will be a better and healthier world for future generations.

## Why Smart Living Technology Is Important

The foundation of Smart Living is sustainability. To illustrate further, in our modern world, inhabitants of our global world are all interconnected environmentally, socially, and economically. The responsibility to take care of the planet for future generations belongs to everyone. These days, in both developed and developing countries, *Smart Living Technology* has gained more visibility as well as importance. Looking at the growth of Taiwan as an example (Figure 1), Taiwan industries primarily focused on mass manufacturing over the past several decades [4]. Taiwan represents a successful example of a country that has transformed itself from an underdeveloped nation into a developed nation over the last 50 years. However, under the current world environment, Taiwan's emphasis on mass manufacturing is not enough to allow it to maintain continued strong economic growth. Therefore, Taiwan needs to find a new direction for its industries to enhance its competitiveness and which can fuel national growth [5].

It has been proposed that Taiwan shift its focus from a mass production emphasis to a high-value creation emphasis in order to continue high economic growth. A high-value creation industry in Taiwan would need to be based on novel services, products, or systems. Taiwan's Ministry of Economic Affairs (MOEA) has directed that *Smart Living Technology* be a major focus in Taiwan as initiated by the Ministry of Economic Affairs' (MOEA) 2020 Foresight Program [6]. This new emphasis seeks to use more human-centered technologies to serve as a paradigm to ensure that mass production industries continue to develop during the transition towards high value industries in services, products, and systems.

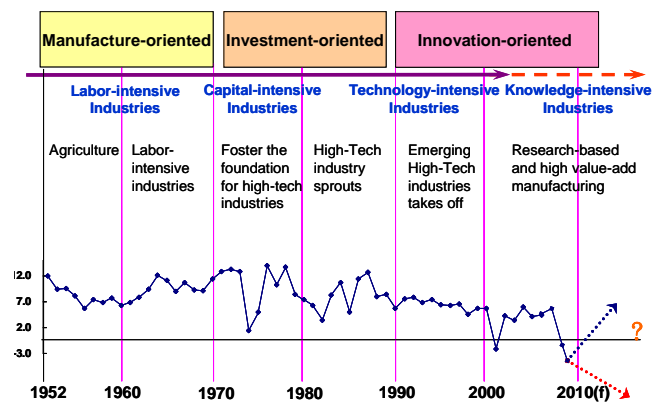


Figure 1. GDP Growth History in Taiwan [4].



In accordance with this new emphasis, the Taiwan government has begun a series of new initiatives to incubate the new Smart Living service industry to become the new economic growth engine. The first of these initiatives began in 2006 under the auspices of the *Smart Living Technology* Program, funded by Taiwan's National Science Council [7]. Three new centers were created covering the northern, central, and southern parts of Taiwan. The second initiative was entitled the *Smart Living Technology* Application Project, also known as the "i-236 Project" [8]. The first numeral digit "2" represents an Intelligent Park and Smart Town (i.e. representing a geographic area/living zone to implement the social experiments). The second numeral digit "3" designates the three networks: (1) next generation broadband network, (2) sensor network, and (3) digital network, which represent the connectivity of the test sites. The third numeral digit "6" in the "i-236" represents the six sectors in which connectivity are to be examined: (1) safety & disaster prevention, (2) health care, (3) green energy & sustainability, (4) intelligent traffic management, (5) comfort & convenience, and (6) farming & leisure. In Taiwan, what has been initiated by the Ministry of Economic Affairs (MOEA) is now a new pattern for development of R&D projects to the service industry.

There are three underlying reasons why the Taiwan government formed a *Smart Living Technology* Initiative for fostering new industries. The first reason is based on the pervasive broadband internet infrastructure and ICT found in Taiwan. Taiwan has a highly educated work force and many have previous experience working in technology and high-tech companies. Technical professionals are typically more readily accepting of new technologies and products. Leveraging information and insight awareness can easily allow the creation of new service/business models to enhance further planned environments such as Living Zones or Living Labs [9]. More specifically, Living Labs and Living Zones can serve as excellent social experimental sites for testing new services and technologies [10].

The second reason for the *Smart Living Technology* Initiative in Taiwan is that *Smart Living Technology* enables new business opportunities for local industries. Taiwan possesses a reasonable market size with a large diversity of users. In addition, Taiwan is small enough that it does not threaten or jeopardize the prosperity of larger developed nations. International collaborations between various organizations around the world help to speed up the advancement of living lab experiments.

The third and last reason for the *Smart Living Technology Initiative* in Taiwan is that a more user-centric innovation model possesses a higher potential to create

higher profit-margin products and services. Previously, Taiwan's approach was more technology-driven rather than service-driven. Now, after many years, Taiwan is now geared for a user centric direction.

## What *Smart Living Technology* Brings to Society

*Smart Living Technology* is set to play an important role in Taiwan's future economic growth as a result of the many government policy enacted programs. The main advantages of *Smart Living Technology* lie in the level-up traditional industries with IT/ICT technology and which have a goal to create new business opportunities. Taiwan's policy makers believe that by successfully implementing a *Smart Living Technology* approach, Taiwan can build a dynamic career market to attract high level professionals to work or start businesses in Taiwan. More specifically, the "i236 Project" seeks to foster new industries by using Living Zone test beds to explore new business opportunities domestically and internationally. The i236 Project can also be used to encourage cooperation among governments, businesses, and academia in order to innovate and develop new technologies. It is with this vision that Taiwan has adopted *Smart Living Technology* as a tool in order to maximize Taiwan's global industrial competitiveness.

## Successful International Projects

In order to benchmark the success of Taiwan's *Smart Living Technology*, Taiwan's projects have been compared to other successful *Smart Living Technology* projects around the world. Such successful programs including the T-city of Germany [11], Panasonic Eco Idea House [12] and Aware Home at Georgia Tech [13], are summarized in Table 1. The concept of *Smart Living Technology* has not only been extended to cities and alliances (Germany), but also to schools (Georgia Tech) and enterprises (Panasonic). This phenomenon clearly depicts that a *Smart Living Technology* approach has gained increasing worldwide acceptance.

Over the last decade, rapid development and prevalence of ICT has made the daily life of each individual all connected. In 2005, to capitalize on this trend, Taiwan's Executive Yuan asked that developmental strategies for intelligent living space be included in its Strategic Review Board (SRB) Meeting, with a primary focus on integrating traditional industries and high-tech ICT industries [14]. During that meeting, the Executive Yuan set the concept of a technological life and defined intelligent living space as "a safe, healthy, comfortable and sustainable working and living environment."



Table 1: Successful International Projects

Project/Sponsor	Location	Start Year	Key Focus
T-City/ eutsche Telekom	Friedrichshafen, Germany (Europe)	2007	Learning and research, Mobility and transport, Tourism and culture, Citizens, city and the state, Business and work, Health and medical care
Panasonic EU House/ Panasonic	Tokyo, Japan (Asia)	--	Saving energy, Creating energy, Storing energy, Link for greener lifestyle. Panasonic presents a lifestyle with virtually zero CO <sub>2</sub> emissions throughout the entire home
Aware Home	Atlanta, Georgia (North America)	1998	Chronic care management in the home, Future tools for the home, Digital entertainment and media
i236 Project/ Taiwan government	Taiwan (Asia)	2010	Safety & disaster prevention, Health care, Energy sustainability, Intelligent traffic management, Comfort & convenience, Farming & leisure.

In the past, consumer needs and the issue of sustainability were rarely considered at the same time. Smart Living is the integration of people, objects, space, and environment, while incorporating the development of a user-oriented perspective with regard to awareness of systems along with the continued development of machine interfaces and machine learning [15]. New smart home design concepts also reflect the change in perspective to balance the needs of the environment and users, which can include items such as adjustments to room lighting, room temperature control and music control.

The three main functions of a Smart Home can be subdivided into three areas: (1) smart skin, (2) smart life, and (3) smart care. A Smart Home can be integrated to create a new space design by adopting smart materials, smart technology and smart designs (Figure 2) [16]. Currently, based on current technology, houses today only control appliances, room temperature and room lighting. Under a smart home concept, the house would incorporate a series of intelligent interactive systems which allow consumers to fully control own their personal environment. In other words, a smart home will be human-centric based on the belief that the root of technology is derived from human nature.

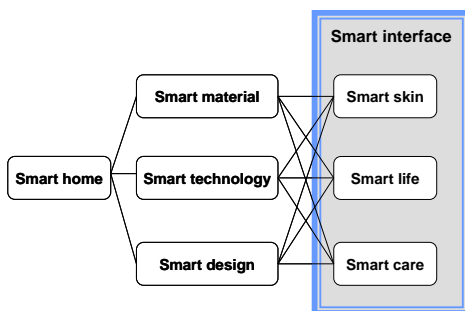


Figure 2. Smart home design. (Reprinted with permission from [16]. Copyright (2005) Insights of Smart Environments).

Three case studies around the world are detailed below:

*T-City in Friedrichshafen, Germany*

T-City in Germany is one of the successful cases that have adopted *Smart Living Technology* in a living zone trial. This large scale Living Lab program was sponsored by Deutsche Telekom. Its trial period began in 2007 and will run until 2012. The T-City project represents collaboration between government, academia, and businesses. The organizations working together include Alcatel-Lucent, Samsung, German Association of Towns and Municipalities, and the University of Bonn. The main goal of this T-City project was to determine if citizens can obtain a higher quality of life with ICT. Deutsche Telekom provided 80 million Euros for this project for the city of Friedrichshafen and its population of 57,000 people. As a result of the project, Friedrichshafen became the first city in Germany to implement multimedia applications.

As a result of winning the T-City competition, Friedrichshafen was equipped with the most modern broadband infrastructure for fixed-line connections and mobile networks. The idea was to create a more convenient and interesting lifestyle for its citizens. The T-City project concentrated its technology development in six areas that covered all aspects of city life [11].

1. Learning and research: A multimedia education platform was created which provide students and teachers with easy access to learning material. Students use the material at home when they are absent from class. In addition, teachers can archive their class lectures so students can retrieve them anytime for study or review.
2. Mobility and transport:
  - E-Ticketing: Tickets can be bought using a cell phone. This eliminates the need for cash and reduces the need for issuing paper tickets.
3. Tourism and culture:
  - Tour guide service: Citizens can plan their trips online; the smart phone can be used to track the current position of tourists via GPS.
  - Digital photo frame: Citizens can send their photos to their digital photo frame using their cell phone or via internet.
  - Hearing impaired public phone: Hearing impaired citizens can use touch screens to access sign language translators and to make calls.
4. Citizens and the state: Friedrichshafen citizens can apply for public services directly online which is not only convenient but also reduces overhead costs and increases efficiency for government offices.



Figure 3. Images from the T-city. (Reprinted with permission from [11]. Copyright (2010) Deutsche Telekom.)

5. Business and work:

- Smart metering application: This application can record electronic/gas usage on a specific platform.
- dDesk: dDesk is a mobile office system. By logging onto the internet, citizens can connect to the office platform by dDesk Key wherever they are.

6. Health and support: The Motiva system developed in the T-City project provide citizens with remote medical care. This system sends medical data to hospitals so the elderly and chronically ill can reduce their hospital visits.

From the T-city project experience, three consequences were observed. First, due to the increased demand on voice and text messages services, Deutsche Telekom enhanced and expanded its telecom services. Second, Deutsche Telekom obtained a more detailed understanding of its local citizen’s needs and could better tailor its services to meet customer demands. Third, Deutsche Telekom identified a good business model for enterprises to follow which states that enterprises should take responsibility to help the local community achieve a better quality of life through improved investments and research (Figure 3) [11].

*Panasonic EU House*

In Panasonic’s version to make ideas for life, its EU House is filled with Panasonic’s technologies to enable the consumer to have a comfortable, new lifestyle with an ecological emphasis. The concept of the EU House, to provide an economical and sustainable lifestyle, was built as a prototype for a home in the future which can reduce CO<sub>2</sub> emissions while providing a better quality living

environment. The main application scenario was to have a three generational family live together. The idea was to design a home which not only can double the quality of life, but also allows for a 60% reduction on impact to the environment.

The construction of the EU House was based on the concept of an Eco Life House. To achieve high energy efficiency, insulation was installed in the residential house. In addition, a rainwater utilization system along with tiles that possess an anti-pollution technology, were implemented. The EU house also contains a network which encompasses entrance security, smart food preservation, kitchen convenience, and sleeping condition control. An imaginary device to anticipate future energy applications that offer power and energy conveniences based on indoor requirements was conceived. The 79m<sup>2</sup>, two-story building was designed based on combining environmental protection with comprehensive housing requirements. The EU house looks simple but elegant; the first floor is equipped with French windows and the second floor contains the more private bedrooms. A small garden is located on the rooftop. In addition, to reduce dependence on oil fuel, Panasonic uses a combination of fuel cells, solar power, and wind power to provide alternative energy to the house.

Recently, the EU house was redesigned to become an Eco Idea House with the same goal to achieve a comfortable, environmentally friendly, sustainable home. As most of the world is dedicated towards reducing CO<sub>2</sub> emissions, Panasonic is also leading the way by developing a house which gives off almost zero CO<sub>2</sub> emissions. Panasonic believes that by upgrading the efficiency and effectiveness of home appliances and integrating natural resources (e.g. air, light, water and heat), an advanced economic and environmental lifestyle can be created. With the EU House, Panasonic has taken people and the environment into account to fulfill human needs (Figure 4) [12].



Figure 4. Eco Ideas House. (Reprinted with permission from [12]. Copyright (2010) Eco Ideas House.)



Figure 5. Aware Home. (Reprinted with permission from [13]. Copyright @ Georgia Tech Aware Home Research Initiative.)



Figure 6. Researcher Tiffany Chen at the Georgia Institute of Technology leading robot Cody by the hand in order to position Cody by the patient's bedside. (Reprinted with permission from [17]. Copyright (2010) 5<sup>th</sup> ACM/IEEE International Conference on Human-Robot Interaction.)

### Georgia Tech's Aware Home

Since 1998, Georgia Tech has gathered original innovations and ideas from teachers and students with an attempt to build a new living environment. The idea was to use current sensing technology, taking into consideration humanity and relationships as a center of focus, and adopt user perceptions towards environmental sensing and provide further assistance [18]. As life does not only revolve around work and the office, it is necessary to extend the research field to the home with a special emphasis on the perception of providing a comfortable and convenient living environment for the elderly and to provide help to the elderly to function in an environment of their liking (Figure 5) [13]. By providing an interactive system for the elderly, it allows them to remain in contact with family members so they are not cut off from society. In addition, as the elderly can face memory loss or deterioration, the system offers them devices to keep track of important information or schedule times.

The Aware Home sought to incorporate sensing technology, internet and ICT into the house. The idea was to link together separated families while allowing the elderly to live independently and with dignity. The Award House advantage was that it linked together a residential sensing technology, voice system, remote control, and warning device. Due to the initial success of the Aware

Home, there is now a trend to build more smart homes. The idea behind this trend is the belief that by combining humanity, technology, software engineering and social implications, other fields such as awareness computing and individual care equipment, can be improved (Figure 6) [17].

### Path Towards *Smart Living Technology* in Taiwan: e-Taiwan to M-Taiwan to u-Taiwan

Following the success of the above cases, Taiwan developed its own strategy for implementing *Smart Life Technology* into Taiwan society. The Executive Yuan initiated a series of national development plans which capitalize on the successful examples found around the world. The three basic processes of the proposed plans to be implemented in sequence are: e-Taiwan, M-Taiwan and u-Taiwan. These three plans encompass effort across various government ministries towards the pursuit of a new technological era in Taiwan.

#### *e-Taiwan*

The Executive Yuan launched the e-Taiwan Plan in May 2002 to follow the trend towards global digital development, which also included the Challenge 2008: Plan for National Development [19]. With the efforts of the relevant government ministries, as well as six million broadband homes, combined with e-Life, e-Business, e-Government, and e-Transportation, five drivers were identified to propel Taiwan's development: economic development, information technology, government, services, and infrastructure.

The purpose of the e-Taiwan Plan is to push forward the national information communication infrastructure and e-Government. Based on public expectations for the advantages of e-Life, e-Taiwan takes the user into account to re-adjust the plan and strengthen information technology applications in order to set Taiwan as one of the most developed e-countries in Asia. In addition, improvements to information technology can narrow the gap between citizens by providing them with a means to facilitate communications over the internet.

The four areas of e-Taiwan, (e.g. e-Life, e-Government, e-Business, and e-Transportation) must rely on a complete internet infrastructure to become viable. A strong internet infrastructure is the most important infrastructure element in the six million broadband homes project. In other words, the six million broadband home project aims to establish a complete and fully functional information communications

network as the backbone of e-Taiwan. The development strategy of e-Taiwan is to use a national wireless and wired broadband infrastructure to build a safe and universally integrated broadband telecommunications environment with relevant applications to information security and Internet protocol version 6 (IPv6). The main purpose of the strategy is to support emerging and high-potential digital industries such as digital entertainment, digital archives, and digital learning.

The results of M-Taiwan are expected to have an impact on three basic fields: industry, society and the nation. Firstly, industries can look forward to seeing the integration of 5C (i.e. communication, computer, control, consumer and contents) in order to explore new business opportunities of potential markets. Secondly, the M-Taiwan project can be used to move society onto the next ICT generation by building a wireless network across the country. Third and lastly, strengthening the ICT

infrastructure and services can lead to increasing the international competitiveness of Taiwan by eliminating a digital gap, developing the M-City, and improving the openness and fairness of the market for global competition.

In summary, the vision of M-Taiwan was to make good use of a wireless network in order to integrate mobile applications and to expand markets. The project combined government and private resources to promote a series of wireless broadband applications which create a win-win situation for consumers, industries, and government. For the government, revenues collection can be increased while construction costs are reduced. For industries, the development of ICT can enliven the domestic economy. For consumers, the ultimate benefit is that they can now enjoy a new digital life and purchase wireless broadband applications at lower prices (Figure 8) [20].

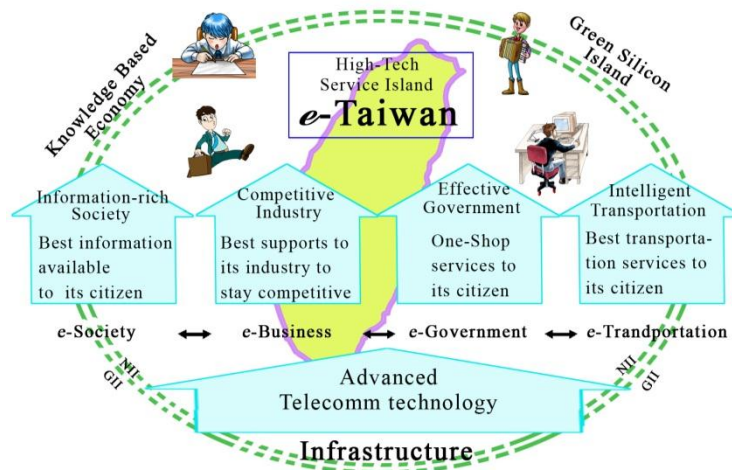


Figure 7. e-Taiwan infrastructure.

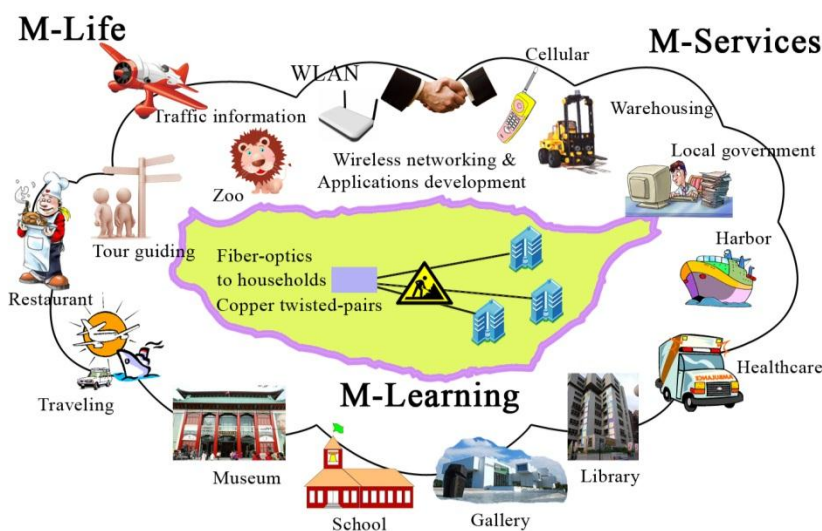


Figure 8. M-Taiwan structure

*u-Taiwan*

Based on the results of e-Taiwan and M-Taiwan, the idea of u-Taiwan was created in 2008, which is based on the expectation that Taiwan can become a *Ubiquitous Network Society* in the years to come. The core essence of u-Taiwan is to use technology to solve social development issues and to promote social development such as by studying energy shortages, the aging population, low birth rates, and security. Technology is seen to play a key role in solving problems effectively, improving the quality of life, and increasing economic competitiveness.

Innovation (**INNOVATE**) forms the basis of u-Taiwan. The Executive Yuan instructed various government ministries to participate together for the next five years with the project which follows seven policies:

1. **Infrastructure:** to promote relevant laws and regulations for a better network society, cultivate cross-field professionals and strengthen a universal application of literacy in order to promote the quality of the social network.
2. **Next generation network:** to build a high-speed internet, wireless broadband networks and sensor networks to accelerate a digital convergence to satisfy the next generation's need for an u-Life.
3. **e-Opportunity:** to use government and private resources in order to provide all groups with equal opportunities and in order to bridge social gaps with technology.
4. **Value-added ITes** (IT enabled services): to strengthen competitiveness of local industries and to develop the ICT business simultaneously in order to improve technical services.
5. **life enhancing Application:** under a user perspective, to find new applications in order to solve various life issues and make life easier.
6. **Trust Taiwan:** to complete a national ICT security system and to build a network trust mechanism to upgrade public acceptance for u-Life applications.
7. **Electronic governance:** to reinforce the e-Government platform, improve public service standards, encourage citizen participation, and strengthen societal trust in order to upgrade services, social care, and civic participation.

In summary, the main purpose of u-Taiwan is to meet people's demand for innovative services, along with a safe living environment connected by a high-speed internet convergence along with intelligent sensing spaces and simple interfaces.

Table 2. Development Strategy for Intelligent Taiwan [21]

<b>W</b>	Wireless Broadband & Convergence Network
<b>I</b>	Cultural and Creative Industries
<b>S</b>	Superior e-Government
<b>D</b>	Demand-Driven Applications
<b>O</b>	Opportunity Equivalence
<b>M</b>	Manpower Cultivation

*Intelligent Taiwan*

The Intelligent Taiwan program was started in 2009. The main components of Intelligent Taiwan can be seen in Table 2 [21]. The three main purposes of Intelligent Taiwan were:

1. To construct an intelligent-based environment, to develop innovative technology services and to provide people with a safe and convenient living space,
2. To develop cultural and creative industries that shape Taiwan's culture and lifestyle,
3. To strengthen language capabilities, to shape a learning society and to complete vocational education by improving the quality of personnel training.

It is expected that the development of the information and communication infrastructure as well as the six new industrial programs of Intelligent Taiwan can transform Taiwan from a manufacturing-based society to a services-based society, which can overall enhance the international competitiveness of Taiwan. More specifically, the vision of Intelligent Taiwan is to make Taiwan a safe, convenient, healthy, and cultural society. The project seeks to promote key ICT applications in order to solve social development issues and to promote the development of technology services. The project is focused on the integration of technology and culture. The emphasis on technology development is applications-oriented due to our rapidly changing lifestyles. The application goals were set to establish an intelligent living environment which works together with developing innovative technological services to promote energy saving concepts in order to provide citizens with a good living environment. In summary, the program was designed to allow all citizens to enjoy a good e-life through multiple channels despite their educational, economic, regional, and physical differences.

In addition, the programs also included promoting critical applications that can meet the needs of daily life. It also called for the expansion of the domestic market which can improve the vitality of industries through a strengthened network communications technology.



Finally, the network communication infrastructure can be used to become the backbone to propel six new potential industries, such as biotechnology, tourism, green energy, medical care, sophisticated agriculture, and cultural creation. The idea behind this is to incorporate the idea of energy conservation with a carbon reduction emphasis. By expanding ICT and implementing a lifelong learning concept, not only would it benefit Taiwan citizens but it can also give Taiwan a platform for demonstrating the potential of information technology to the world.

### *National Science Council—Smart Living Technology Program*

In 2007, in order to push the division and integration of both a horizontal and vertical knowledge supply chain, Taiwan's National Science Council launched a *Smart Living Technology* program by combining technology, humanity and culture. The program integrates together many other National Science Council programs. It took the Open Innovation by the Open Business Model to become the core of *Smart Living Technology* an implementing an internet platform to realize the connection between people and industrial technology [22]. In the program, three **Smart Living Interactive Innovation Centers** were established. These centers include the INSIGHT Center at National Taiwan University (NTU) in northern Taiwan, the Eco-City Center at National Chiao Tung University (NCTU) in central Taiwan and the Touch Center at National Cheng Kung University (NCKU) in southern Taiwan. Within three years, due to good funding and resources, these centers have developed inter-institutional integrated research, have built-up a large number of technical applications related to innovative smart living and have increased professional training to expand the cooperation among industry, government, academia, and research organizations. Furthermore, to import the innovative model of a Living Lab which works in coordination with user experiences, the innovative Centers have provided an invaluable showpiece for sustainability, durability and recyclability

### *Ministry of Economic Affairs: i236 Project (Smart Living Technology Application Project)*

The i236 project seeks to create **two smart living zones** (Smart Town & Intelligent Park for large scale trials in domestic markets) with innovative and sustainable service/business models for **six applications**: safety & disaster prevention, health care, energy sustainability, intelligent traffic management, comfort & convenience

and farming & leisure. System solutions with emerging technologies were developed using **three communication networks** (e.g. broadband networks, digital-TV and sensor networks). The goals of the i236 project were as follows:

- To foster new industrial eco-systems through living zones as domestic markets to create new business opportunities,
- To strengthen global competitiveness of industries in Taiwan,
- To create more than 1 million experienced users,
- To develop 20 innovative smart living services
- Ministry of Economic Affairs: Smart Energy Network System Technology Development Project

This project proposes to use ICT technology to integrate energy management and efficiency monitoring which can be further developed to create a Smart Energy Network System without changing the existing infrastructure. The project goal is two-fold. On one hand, the business aspect of the project proposes to develop a highly-efficient air conditioning control system in order to stabilize the energy supply in a high technology industry. On the other hand, the project can develop a low-cost, multi-functional energy management system for residents.

### *Ministry of Interior: Smart Living Space*

In recent years, the public concern towards safety, sustainability, health care and convenience of a Smart Living space have led the Ministry of Interior to create a blueprint for the development of a smart living space within eight years. The idea is to integrate technology and daily life closely to fulfill people's needs. All in all, it is hoped that the innovative development in *Smart Living Technology* can not only bring about cooperation among industry, academia and government, but it can also upgrade the quality of life of citizens while strengthening global competitiveness.

In addition, developing a Smart Living space at an initial stage can be used to attract potential industries to create open interactive networks. Therefore, new service models and smart facilities need to be created to deliver services to homes directly and quickly at low service costs. During the middle stage of the process, a services business can set goals by helping communities promote *Smart Living Technology*, involve residents more in their daily lives, and then use the information to modify the intelligence service model. Finally, at the mature end of the process, it is expected that the concept of Smart Living can be expanded to all families in Taiwan.



## Future Goals, Strategies and Applications

To improve the quality of life with high-technology, it is important that countries enact the appropriate technology policies. Taiwan has been following this trend for the past few years. Experts and specialists from different fields have been working together, dedicated to the development of relevant applications such as e-Health and *Smart Living Technology* applications, which are in response to the challenges of future needs and can be used to improve satisfaction with life. In order to fulfill people's hopes towards a better future, the Ministry of Economic Affairs has plans to develop 20 *Smart Living Technology* applications and services by the year 2012. Experimental service applications are to be undertaken as well as the opportunity to collect user experiences as reference for future policies. The future vision of such a development is to localize living applications, industrialize services, and globalize service products. All of this should make Taiwan a global leader in *Smart Living Technology* by the year 2020.

To achieve the above-mentioned goals, three key strategies need to be implemented: (1) strengthen R&D & innovation, (2) create differentiated services, and (3) enhance international competitiveness.

### *Strengthen R&D & Innovation*

In order to take the lead in industrialization, it is essential to create leading products and high value innovation through technology integration and innovative applications. The steps involve

- (1) using ICT-enabled applications to create a total solution that can be combined with services and technology;
- (2) taking current businesses as the foundation to develop and increase innovation services with revenue collection, and
- (3) developing high performance, large capacity or reliable innovation services and business models.

### *Create Differentiated Services*

*Servicizing products* and *productizing services* are the two elements identified to create differentiated services. *Servicizing products* means to provide a service or a function rather than a product. *Productizing services* means to create services that are reusable, standardized (modularized), scalable, and exportable. In addition, the services should be based on software/hardware IP. The services should create value and profits. With regard to the system architecture, it should be aimed at the integration of software, hardware and services.

## *Enhance International Competitiveness*

Differentiated services can be adopted for real-world field trials. In order to enhance the international competitiveness of Taiwan, three steps should be implemented to increase the globalization of these new differentiated services/systems.

### **Step 1: Select Trial Zones for Smart Towns and Intelligent Parks**

Smart Living is the idea to merge technology into daily life so as to create a safer, more comfortable, convenient and sustainable living environment. The technology in our daily life can be classified into six categories: food, medicine, housing, transportation, education and entertainment. To incorporate these six fields, a Living Lab can be established. According to the definition as defined by the European Commission, "a Living Lab is a user-driven open innovation ecosystem based on a business-citizens-government partnership which enables users to take an active part in the research, development and innovation process." A Living Lab trial allows us to determine people's needs directly and facilitate the commercialization of excellent *Smart Living Technology* services and products. Through the use of Living Labs, people can better realize what technology can offer.

From the successful Living Labs in Germany and Japan, Taiwan has launched its own Living Labs in northern, central, southern and eastern Taiwan. In addition, the creation of a Smart Town and Intelligent Park are also focal areas to promote *Smart Living Technology* for future applications.

### **Step 2: Build Business Models and Service System Prototypes**

Smart Living services and systems can be developed using user-driven innovation and undertaking user trial experiences (e.g. user trials or user experiences). The service system prototypes in Taiwan can be verified and adjusted accordingly. During the process, innovative business models can also be developed.

### **Step 3: Export Business Models and Service Systems**

Concerned enterprises can also take advantage of the Living Labs trials to adopt such things as systems integration, ICT-based service systems, industrial domain knowledge, systems service processes and the establishment of brand names.



Current Applications in Taiwan

Applications currently seen in Taiwan include the following:

1. In-Joy-Life Smart Tourism (Figure 9-11) [8]

Puli and Sun Moon Lake are two famous popular tourist spots in central Taiwan which attract tourists all year around. Due to the high number of tourists who visit these sights, the Taiwan government has coordinated with private corporations to build a novel smart service

incorporating a travel card to offer a series of travel packages. Using the travel card, tourists can go shopping at any of the registered stores. The travel card coordinates the transportation, which also includes a one day bus tour, ferry tickets on the lake and bicycle rentals. In addition, the combination of restaurants, accommodations, transportation and entertainment not only brings business to the suppliers, but it also allows the tourists to have a more enjoyable and convenient stay during their visit.

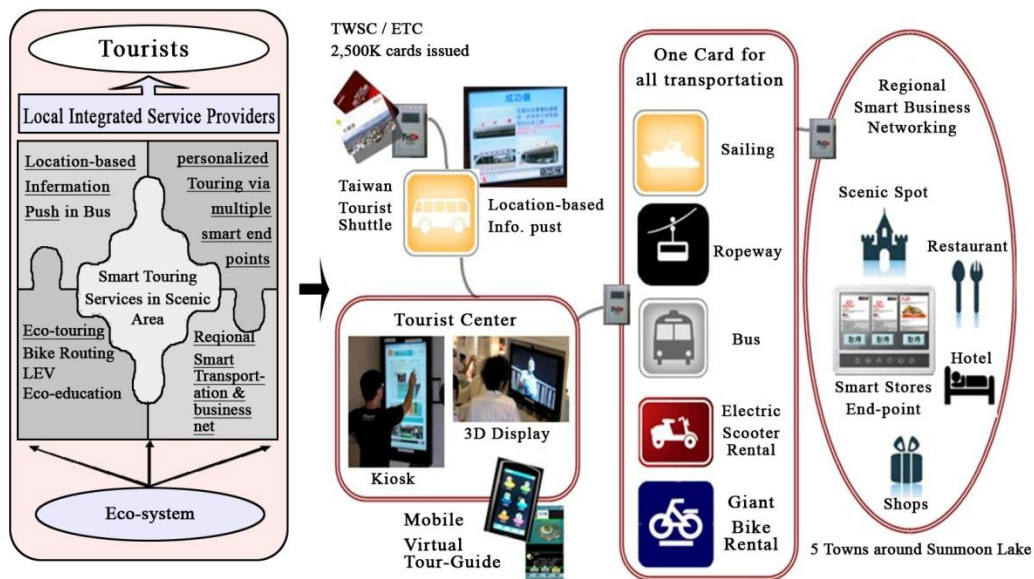


Figure 9. Concept of In-Joy-Life smart tourism [8].

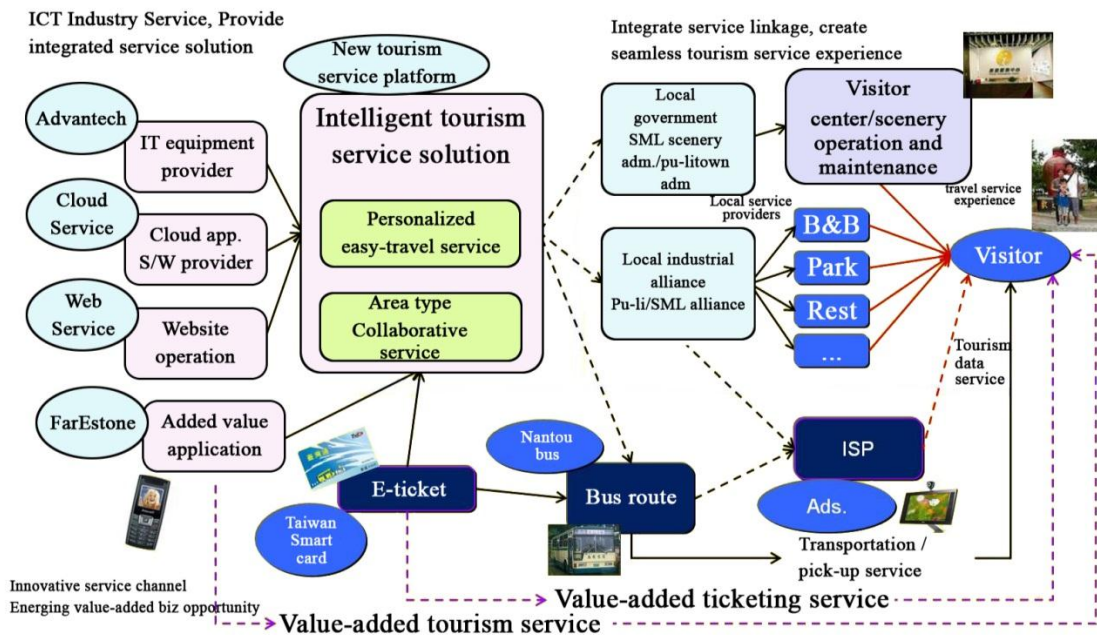


Figure 10. In-Joy-Life smart system [8].

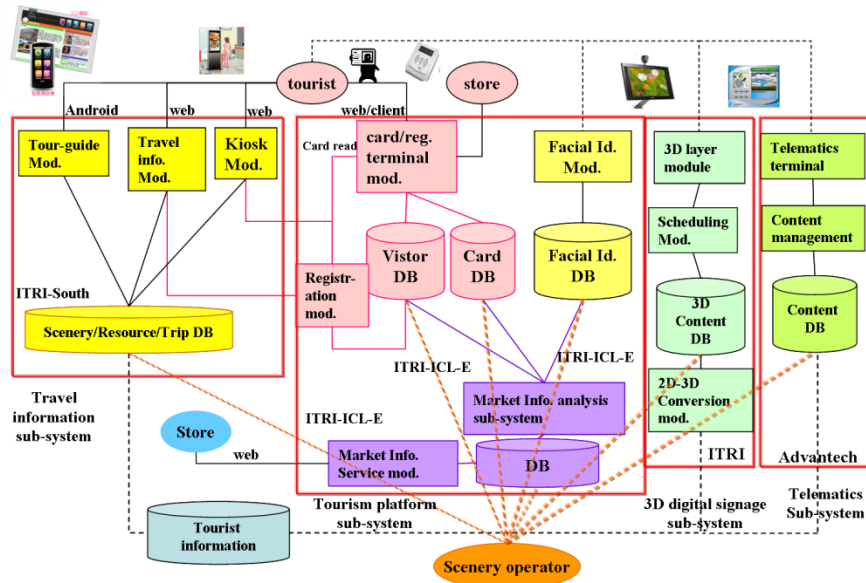


Figure 11. Structure of In-Joy-Life smart tourism [8].

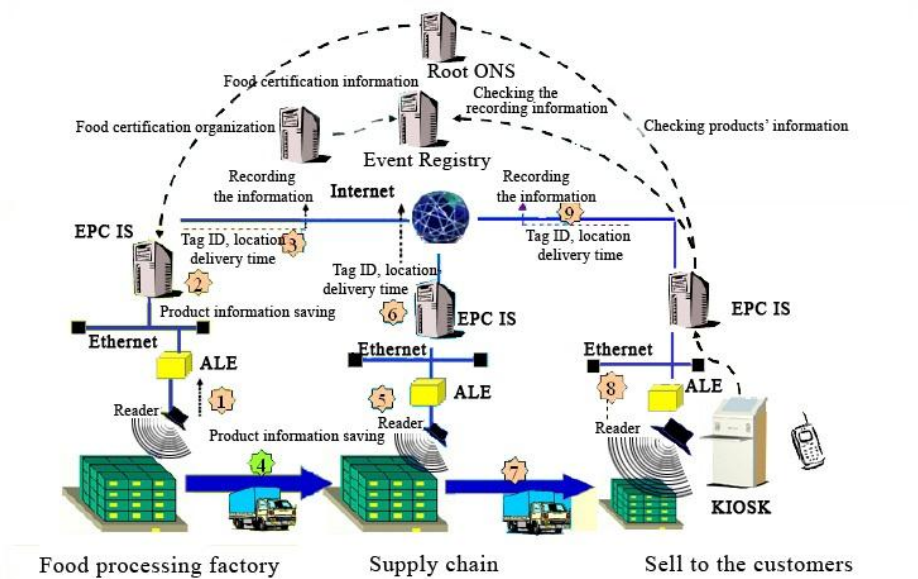


Figure 12. Food production and record tracking system [8].

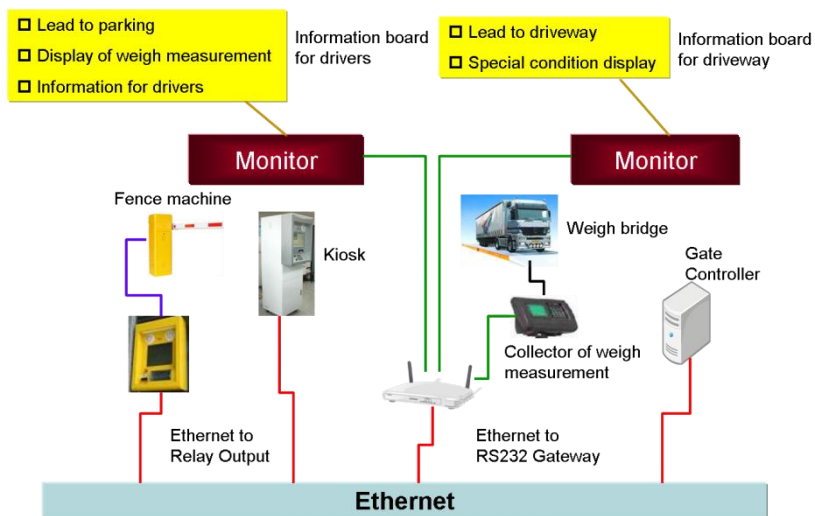


Figure 13. Process of Auto Gate System [23].

## 2. Food Production Management and Promotion & Record Tracking System (Figure 12) [8]

A Manufacturing Execution System (MES) is a pioneering technology developed in Taiwan which is applied to food production control. The MES concept takes a graphical process design to effectively link raw materials and production processes to a tracking system. This tracking system can handle problems with food traceability efficiently from several hours to a few minutes. At the current stage, some food suppliers, (e.g. RT Mart chain) already use this system. RFID smart boxes reduce labor cost and decrease the time required for labeling. Experts forecast that the collaboration between food suppliers and the RFID industry will work even closer together as the new technologies are developed further. It is expected that this new business will be worth more than NT \$50 million.

## 3. RFID-based Auto Gate System at Harbors/Ports (Figure 13) [23]

A RFID-based Auto Gate System has been developed to keep track of delivery vehicles entering and leaving the harbor/port. Identification of vehicles and drivers inside the harbor/port is complex, not to mention the difficulty of keeping track of the various shipping containers, vehicles, and ships. Therefore, by creating a highly efficient tracking system, Taiwan has developed one of the thinnest "electronic papers" which is based on an active RFID smart card. The card issuing machine has functions such as automatic writing and fault reclamation, in addition to being damp-proof. The system coordinates the positioning information from all the facilities in the harbor/port. The first Auto Gate System was implemented at Taipei Port to keep track of the shipping container companies. A RFID-based Auto Gate System was found to improve efficiency by decreasing labor costs while increasing security and accuracy of the information. The success of the Auto Gate System allowed the harbor/port to increase its competitiveness and improve data automation from the previous conventional paperwork. It is expected that the Auto Gate System will be expanded to other harbors/ports in Taiwan, such as Kaohsiung port or Taichung port.

## Summary

To continue Taiwan's economic growth, Taiwan has shifted its focus from a mass production emphasis to a value chain emphasis. To assist in this new focus, the Taiwan government has initiated a series of programs to incubate new Smart Living service industries to become Taiwan's new economic growth engine. *Smart Living*

*Technology* plays a critical role in creating differentiated and high-value services. Such programs can localize living applications and increase investment of local enterprises. In the long run, such programs can globalize service products. Our successful Taiwan business model can be exported to other countries around the world. In this way, Taiwan can expect to continue its role as global leader in *Smart Living Technology*.

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