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Advancing Free Trade for Asia-Pacific Prosperity

Chinese Taipei: Telecommunications Testing and Certification Services Reform

APEC Policy Support Unit
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EXECUTIVE SUMMARY

"Structural reform and services" is a major focus of the 2016 APEC Economic Policy Report (AEPR).[1] Structural reform in APEC relates to 'institutional frameworks, regulations and government policy (designed) so that barriers to market-based incentives, competition, regional economic integration and improved economic performance are minimized'.

This case study examines the APEC Telecommunications Mutual Recognition Agreement (APEC TEL MRA) on structural reform in Testing and Certification Services (referred to throughout as Conformity Assessment Bodies, or CABs) in Chinese Taipei. The case study has a secondary focus on the impact of these reforms on telecommunications manufacturing in Chinese Taipei. It is one of 9 similar case studies on structural reform in services and in global value chains commissioned by APEC in 2016.

The case study was compiled through a combination of secondary research and primary interviews with 18 participants from regulators, CABs and telecommunications manufacturers in Chinese Taipei.

Technical Standards

The case study is placed against the background of a national and international regulatory framework for testing and certifying manufactured telecommunications equipment. This regulatory framework is built on international technical standards that require conformity assessment for telecommunications equipment including electromagnetic compatibility (EMC) and electrical safety in order to be able to operate as part of a telecommunications network anywhere in the world.

Regulators in importing economies may accept the testing reports and equipment certification conducted by CABs in exporting economies as part of the testing and certification process. Some, however, will only accept testing and certification completed in the importing economy. This non-tariff measure adds to the costs of manufacturers, and slows access by consumers to new products.

The APEC TEL MRA, finalised in 1999, aimed to overcome this barrier by enabling economies to agree bilaterally to recognise each other's testing and certification reports. Under these bilateral agreements, CABs in each economy must comply with ISO/IEC 17025, a voluntary international standard "General requirements for the competence of testing and calibration laboratories". Chinese Taipei signed bilateral agreements with Australia; Singapore; Hong Kong, China; and the United States in 1999 and with Canada in 2007.

Regulatory Reforms

In Chinese Taipei, a number of structural reforms in the telecommunications sector preceded the TEL MRA, in order to reduce or remove supply-side barriers. This included privatisation of the main telecommunications service provider, opening the market to other fixed line service providers, and creating a market for 2G and then 3G mobile services.

[1] Announced at the second Structural Reform Ministerial Meeting held in Cebu, the Philippines in September 2015

Associated institutional reforms included establishment of the Bureau of Standards Metrology and Inspection (BSMI), the National Communications Commission (NCC) and the Taiwan Accreditation Foundation (TAF). BSMI and NCC are both regulators as required under the TEL MRA and TAF is the accreditor required under the TEL MRA.

Impacts

Since the signing of the TEL MRA bilateral agreements, the CAB industry has grown steadily and now numbers over 40 companies. These are a mix of SMEs, subsidiaries of larger companies based in Chinese Taipei, and subsidiaries of companies headquartered in Europe and the United States. CABs in Chinese Taipei now have 48 agreements with four partner economies (Australia; Singapore; Hong Kong, China; and the United States). These agreements accredit them for different types of technical testing of telecommunications equipment. CABs from Chinese Taipei are now the third largest national group of CABs recognised by the United States' Federal Communications Commission and also rank third on the list of CABs recognised by the Australian Communications and Media Authority (ACMA).

While the impact on the telecommunications manufacturing industry is difficult to determine, interviewees reported that testing times are halved when a Chinese Taipei-based CAB can complete the testing required on a new product. They also reported lower costs due to being able to complete testing domestically. There is also some indication that domestic testing has supported retention of research and development (R&D) in Chinese Taipei. Although trade and value add data are not sufficiently detailed to test this idea, the value of R&D and other business services to gross exports of computer, electronic and optical equipment from Chinese Taipei rose 8-fold from 1995 to 2008, plateaued in 2009 (possibly due to the global financial crisis) and then rose again another 1.5-fold from 2009 to 2011.

The impact on TAF has been significant as it must respond to changes in standards globally rather than just domestically.

Implementation Issues

Issues that emerged in the implementation of the APEC TEL MRA in Chinese Taipei included:

- reluctance of some economies to negotiate bilateral TEL MRAs due to the relatively small size of the Chinese Taipei's consumer markets at the time the APEC TEL MRA was introduced (hence making it of minor interest to larger exporters);
- the impact of fragmentation of global value chains on the approach taken by TAF to accrediting CABs;
- overlaps in the approach taken by NCC and BSMI, leading to difficulties in negotiating with some economies;
- a common world-wide, and ongoing, issue of post-market surveillance of products sold on the Internet;
- ongoing differences in technical standards in APEC and non-APEC economies; and
- ongoing non-tariff barriers affecting exports to and relationships with some APEC economies.

Conclusions and Lessons for Other Economies

The APEC TEL MRA was preceded by general telecommunications services reforms which opened up the national telecommunications service provider of the time to competition and made it easier for telecommunications manufacturers to import components. The APEC TEL MRA which followed these reforms then provided the framework through which Chinese Taipei's CAB industry could build capability and ensure that this occurred in line with international standards.

While the regulatory system is transparent and responsive, the division of responsibilities between NCC and BSMI has prevented Chinese Taipei from taking full advantage of the APEC TEL MRA. The government has begun amending the law in order to overcome the problem.

The reforms enacted and the broader market-focused approach of Chinese Taipei have allowed manufacturers in Chinese Taipei to complete their product testing domestically, thus enabling research and development to remain local and lowering testing costs and speeding the path to market. The Government's broad stated intention at the time was to grow the telecommunications manufacturing sector to drive down the cost of consumer access to telecommunications services and equipment. The NCC, however, had no manufacturing or service (CAB) industry impact measures in place as these had limited relevance to its remit. The data available to measure the impact on CABs in Chinese Taipei has been a side-effect of transparent policies operating in other economies, for example regulators in the United States and Australia.

The main lessons for other economies considering such changes are as follows:

- regulators need to consider how emerging technical changes (in this case the convergence of IT and telecommunications technologies) will affect the scope of what they regulate;
- regulators and accreditors need to understand the industrial structures of the companies they are regulating or accrediting, including their geographic reach and the implications of accrediting laboratories vs whole companies;
- it is important for the accrediting agency playing a pro-active role in supporting development of industry capacity as standards change. Linked to this issue is the desirability of developing key indicators that will enable regulators to assess the impact on both manufacturers and CABs from the commencement of these reforms;
- post-market surveillance should be considered by the regulator if regulatory or technical change (i.e. online purchasing) increases the risk of faulty products entering the domestic market; and
- regulators should ensure that manufacturing and CABs are involved in relevant APEC working groups and other formal or informal information-sharing events so that industry policy objectives can be addressed.

1. INTRODUCTION

This is a case study of the impact of the APEC Telecommunications Mutual Recognition Agreement (APEC TEL MRA)[2] on Testing and Certification Services (referred to throughout as Conformity Assessment Bodies, or CABs) in Chinese Taipei.[3] An MRA is an arrangement where participating economies state their willingness to recognise the results of conformity assessment testing conducted by authorised organisations in specific other economies.

The case study also comments on the impact of structural reform in CABs on the telecommunications manufacturing industry in Chinese Taipei. Chinese Taipei is a suitable case study because:

- it has implemented the APEC Telecommunication Mutual Recognition Agreement (APEC TEL MRA) progressively since the latter came into force in 1999 and its CABs have been recognised by several MRA partners (Hong Kong, China; Canada; Singapore; Australia; and the United States);
- the case study can explore the impact on CABs as service firms including their contribution to global value chains;
- the findings of the case study may be able to be generalised to other MRAs; and
- there is potential to also explore impact on the telecommunications sector as a major user of testing and certification services.

1.1 OBJECTIVES

Structural reform in APEC, as defined by APEC Leaders, relates to 'institutional frameworks, regulations and government policy (designed) so that barriers to market-based incentives, competition, regional economic integration and improved economic performance are minimized'.[4] The aim is to avoid 'excessive regulation, poor economic legal infrastructure and governance arrangements (in both public and private sectors), unclear property rights and the lack of effective laws to foster competition'. APEC has identified six key components of the structural reform agenda; our comments on the relevance of these to this case study are included below:[5]

1. removing barriers to the entry of domestic new entrants, and allowing existing firms to exit the marketplace in an orderly fashion if the market dictates that they cannot survive;
2. removing barriers to foreign competition, be it from cross-border trade or from foreign direct investment, and not just for particular trading partners;
3. ensuring that the minimum regulation exists to guide economic outcomes in those circumstances where markets alone may not deliver the most efficient outcomes;
4. ensuring that the right institutions are in place to review and remove the unnecessary impediments to the functioning of markets;

[2] Published in May 1988, APEC Publication APEC#202-TC-01.1

[3] Conformity assessment bodies (CABs) is a term used widely in the telecommunications industry to refer to those organisations which test telecommunications product for compliance with international safety and operational standards. Internationally, CABs form part of the wider testing and certification industry, which encompasses inspections of manufactured goods and factories, and certification of processes and people. Under the APEC TEL MRA, Conformity Assessment Body is the formal term used to describe that performs conformity assessment to an importing Party's Technical Regulations.

[4] APEC (2011): Impacts and Benefits of Structural Reform in Transport, Energy and Telecommunications Sectors in APEC Economies, APEC Policy Support Unit.

[5] Ibid., Box 1.2

5. ensuring that the right institutions are in place to design, implement, enforce and review the functioning of more appropriate regulation; and
6. developing transparency of institutional processes, including public sector management, so as to better serve the public good.

These case studies on structural reform in services sectors in APEC economies have been commissioned to provide in-depth expert analysis of successful services reforms and structural change in global value chains in the region. They will complement Individual Economy Reports (IERs), to be submitted by each economy as part of the APEC Economic Policy Report (AEPR) process. Drawing on findings from the case studies and IERs, APEC will study lessons learnt and recommend good regulatory practices to undertake structural reform in services. The aim is to be able to comment on prioritization and sequencing of reform measures, balancing of competing policy objectives, adjustment issues and areas where targeted technical assistance/capacity building would be useful for economies undertaking similar reforms in future.

This project complements a parallel APEC project titled "Case Studies on the Role of Services Trade in Global Value Chains (GVCs)" which aims to analyse case studies of market-opening services reforms in the APEC region and the effect they have had on GVCs.

1.2 METHOD

This case study gathered data through a mix of critical literature analysis and semi-structured interviews.

The interviews confirmed and commented on material from secondary sources and enabled us to explore and gather data on issues omitted from existing public studies, particularly economic impact measures. Interviews were semi-structured, to allow participants to bring in new information and enable the interviewer to expand on issues that emerged during the interview. Interviews also sought technical details on the nature of regulatory reform in Chinese Taipei and how the TEL MRA linked to structural changes in service sectors. A summary of the topics covered in the interviews is at Annex 1.

Potential interviewees were identified from government and industry websites, APEC reports (e.g. APEC Telecommunications Working Group members) and the academic literature and were initially approached by a written letter signed by the Policy Support Unit (PSU). Field work was conducted in May in Chinese Taipei.

The organisations that were eventually interviewed are listed in Table 1. The list includes the two relevant government regulators and the primary standards accreditation body in Chinese Taipei, three companies long-established as CABs and two manufacturers who use CAB services to support their export-oriented businesses. In all, 18 people were interviewed in these organisations. Representatives of regulators in Singapore; Hong Kong, China; and Canada, all of which have signed bilateral MRA agreements with Chinese Taipei, declined our request for interviews.

Table 1: Organisations Interviewed during Field Work

Organisation	Relevance	Reason for inclusion
National Communications Commission	Government regulator	The key regulatory agency for telecommunications and broadcasting
Bureau of Standards, Metrology and Inspection	Government regulator	National standards for certification and testing of electrical safety
Taiwan Accreditation Foundation (TAF)	Not-for-profit	Government-designated not-for-profit which accredits product certification bodies to ISO/IEC 17065 and laboratories to ISO/IEC 17025 and sponsors research into the impact of the APEC TEL MRA.
A Test Lab Techno Corp. (ATL)	Accredited Testing Laboratory (CAB) under the APEC TEL MRA Recognised Certification Body	Holds multiple accreditations under international standards and with a range of overseas standards organisations. Under APEC TEL MRA, the lab holds four accreditations with three economies, all achieved in 2010.
Bureau Veritas Consumer Products (Hong Kong, China) Limited	Accredited Testing Laboratory (CAB) under the APEC TEL MRA Recognised Certification Body	Holds nine accreditations across two accredited laboratories at HsinChu and Lin Kou under the APEC TEL MRA. Under APEC TEL MRA is accredited with four economies.
Communications Global Certification Inc. (CGC)	Accredited Testing Laboratory (CAB). Recognised Calibration Laboratory	Multiple accreditations under international standards.
ACER Inc.	Manufacturer	Manufacturer and exporter of telecommunications equipment (e.g. mobile phones) and computers with telecommunications capability
ASUS	Manufacturer	Manufacturer and exporter of telecommunications equipment (e.g. mobile phones) and computers with telecommunications capability

Source: Websites for the different organisations and the National Communications Commission (Chinese Taipei)[6]

Limitations of the method

The method has three main potential limitations: availability of statistics to provide objective verification of impacts, impacts of the passage of time, and the ability to directly distinguish changes brought about by the APEC TEL MRA from the effects of broader changes in the economy and the telecommunications sector.

[6] National Communications Commission (2016): List of Telecommunication Equipment and Test Labs & Certification Bodies, Available from: http://www.ncc.gov.tw/english/gradation.aspx?site_content_sn=81&is_history=0 (Accessed May 2016)

First, we had expected to be able to identify some impacts of the APEC TEL MRA from official telecommunications equipment export statistics collected by Chinese Taipei's statistic agency and international organisations such as United Nations Conference on Trade and Development (UNCTAD). While good statistical collections are available, there is no single agreed definition of telecommunications equipment in statistical collections[7,8,9] and the telecommunications manufacturing figures are grouped with data from computing and optical equipment manufacturers. Further, the relatively long (five yearly) time between national collections by the national statistical agency[10] means that the data sets are not frequent enough to be able to draw conclusions on cause and effect over the time period considered for this case study. Further comment about the availability and use of sources of national manufacturing statistics is in Annex 2. As the project progressed it became evident that data specifically about CABs from importing economies proved to be more reliable and was used in preference to manufacturing statistics.

Second, case studies are built on a combination of secondary sources and primary research. Of necessity, primary research is conducted through interviews with those involved at the time, and it is recognized that individual perceptions may lead to different interpretations of events by different people. We therefore used written reports as the main data source and asked interviewees to confirm or elaborate on these data, wherever possible. However, only a few interviewees had the sufficient length of time in the industry to fully track developments of the APEC TEL MRA since its inception, and comment on the industry changes that resulted.

Third, it was recognized that the impact of the APEC TEL MRA on trade data was likely to be minor when compared to other events such as the Asian Financial Crisis (1997) on pre-MRA data and the Global Financial Crisis (2008) on post-MRA data. Given the limited use made of trade data in the final case study, these issues proved inconsequential.

1.3 EXCLUSIONS

APEC members have negotiated and signed two other telecommunications-related MRAs, which have been excluded from this case study. The reasons for this are outlined below.

In 2002, APEC members commenced development of an MRA in Conformity Assessment of Electrical and Electronic Equipment (MRA CAEEE) as part of the 10th APEC leaders' Declaration.[11] Only 15 APEC economies have signed this arrangement. Of these, only Australia; New Zealand; and Singapore have agreed on mutual recognition of test reports and mutual recognition of certification.[12] The focused nature of the APEC TEL MRA and the

[7] OECD (1991): Telecommunications Equipment: Changing Markets and Trade Structures, No. 24 OECD Publishing, Paris, p.29.

[8] Gartner (2016): Telecommunications Equipment, Available from http://www.gartner.com/it-glossary/telecommunications-equipment (Accessed June 2016)

[9] The New York Times (2016): Communications Equipment, Available from: http://markets.on.nytimes.com/research/markets/usmarkets/industry.asp?industry=57121 (Accessed June 2016)

[10] See National Statistics, Chinese Taipei, http://eng.stat.gov.tw (Accessed June 2016)

[11] APEC (2015): APEC Electrical and Electronic MRA, APEC Committee on Trade and Investment. Available from: http://www.apec.org/Groups/Committee-on-Trade-and-Investment/Sub-Committee-on-Standards-and-Conformance/apec_eemra.aspx (Accessed June 2016)

[12] New Zealand Ministry of Business, Innovation and Employment (2015): APEC Mutual Recognition Arrangement for Electrical and Electronic Equipment, http://www.mbie.govt.nz/info-services/business/trade-tariffs/trade-environment/trade-agreements-and-partnerships/apec-mutual-recognition-arrangement-for-electric-and-electronic-equipment (Accessed June 2016, last updated December 2015)

broader buy-in from APEC economies made the TEL MRA a more suitable focus for a case study than the CAEEE.

In 2010, APEC also endorsed the MRA for Equivalence of Technical Requirements for Telecommunications (ETR MRA) which aims to build upon APEC TEL MRA through further reducing costs associated with the conformity assessment process by promoting the recognition of equivalent regulatory requirements.[13] Although APEC members have endorsed the ETR MRA, no arrangements have been made to give action to the agreement, and thus it is excluded from our analysis.

[13] APEC (2010): Mutual Recognition Arrangements for Equivalence of Technical Requirements, APEC Telecommunications and Information Working Group.

2. OVERVIEW OF TELECOMMUNICATIONS STANDARDS

Telecommunications equipment is highly complex and given the global nature of the industry, products built in one economy must be inter-operable with those built elsewhere. Over the years a complex set of international standards has been developed, based on technical requirements. This section provides an outline of these standards, which testing service organisations (CABs) are required to meet in order to form part of global value chains in this industry.

2.1 STANDARDS

International professional technical organisations have led the way in designing global technical standards. The key standards organisations relevant to this case study are shown in Box 1.

Box 1. Major Telecommunications Standards Technical Organisations

3rd Generation Partnership Project (3GPP) – a standards body that works within the scope of the International Telecommunications Union (ITU) to develop wireless technologies that build upon the base provided by the Global System for Mobile communication (GSM).
Global Certification Forum (GCF) – founded in 1999 as a partnership between mobile network operators, mobile device manufacturers and the testing industry, to create an independent certification program to help ensure interoperability between mobile devices and networks.
ITU – an organisation, founded in 1865 and now under the umbrella of the United Nations, which coordinates global telecommunication operations and services.
PTCRB – established in 1997 by North American mobile phone operators as their certification forum.
Both GCF and PTCRB have developed standards that comply with the overarching framework created by 3GPP.

In telecommunications, standards for testing set by governments are based on technical standards set by the international bodies outlined in Box 1. Different economies may then adopt international standards unchanged, amend them for domestic application, or develop their own standards. In theory, the existence of these standards means that a manufacturer can build a piece of telecommunications equipment (e.g. a mobile phone) have it tested once and, once approved, sell it world-wide, because the standards which have to be met in one economy are the same, or very similar to, those in another (practical differences, such as different power supplies, aside).

According to the World Trade Organisation (WTO), over 80 economies have domestic product regulations for telecommunications product safety and interoperability and while most accept international standards, some national standards have significant deviations which act as non-tariff barriers to global sales.[14]

Technical standards have been developed to ensure that telecommunications equipment is safe for humans to use, can be used without interference from other equipment, and can operate as

[14] Ibid, slide 6

part of a telecommunications network. Examples of relevant standards for mobile devices (the main focus of the testing organisations featured in this case study) are in Box 2. These standards are covered in more detail at Annex 3.

Box 2. Sample Telecommunications Standards

Bluetooth – the standard for short-range wireless interconnection of mobile phones, computers and other electronic devices.
Global Positioning System (GPS) and other satellite receiver testing – method of reproducing the environment of a GPS or other satellite receiver by modelling vehicle and satellite motion, signal characteristics, atmospheric and other effects.
GSM – the most widely used of the three digital wireless telephony technologies.
Long-term evolution (LTE) – the 4G telecommunications standard.
Multimedia Messaging Service (MMS) – a standard way to send messages, photos and video to and from mobile phones over a cellular network.
Over the Air (OTA) – a method of measurement for radiated radio frequency power and receiver performance
Specific Absorption Rate (SAR) – measures electronic energy absorbed by a body such as the human body.
Wide-band Code-division Multiple Access 3G Technology (W-CDMA) – another digital wireless telephony technology, used by the 3G network co-developed by the 3rd Generation Partnership Project (3GPP) members. The *CDMA* technology allows numerous signals to occupy a single transmission channel.

2.2 CONFORMANCE TESTING

An important step in the manufacture of telecommunications products, including mobile phones, is conformance testing (Box 3). Though a relatively small part of the total cost of production for a product, conformance testing is a step that must be passed successfully if the product is to be granted approval to be sold. Thus, conformance testing can be seen as a go/no go 'gate' through which a product must pass before any income can be made from the research and development (R&D), design and manufacture of a telecommunications product.

Box 3. Defining Conformance Testing

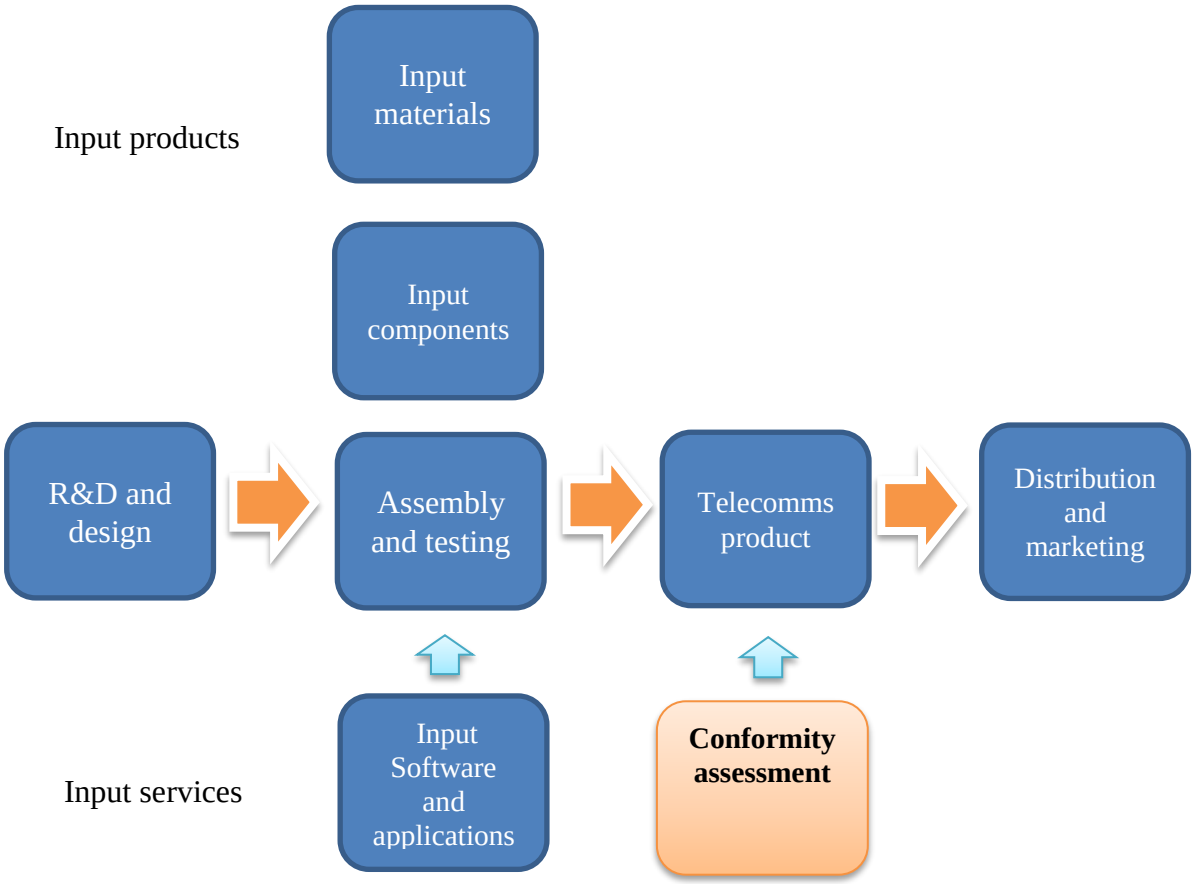
Conformance testing is a series of technical tests which ensures that a product, or part of a product (e.g. a component such as an antenna or SIM card) meets a defined set of standards. These standards are commonly defined by large, independent technical organisations. Testing brings a scientific approach and demands tight control over external influences and to assure repeatability and accuracy of results.

When a new component is introduced (e.g. introduction of Bluetooth in around 2001) then the component and its interactions with the existing product must be tested again. Similarly, if software which controls operation of a product is changed, then it must be re-tested.

The role of "conformance testing" (or "conformity assessment") is shown in Figure 1. Conformance testing is the last step through which products must go before they can be approved for sale. Conformance testing is essential for information and telecommunications products as they are designed for the global market, they have a large number of components drawn from global supply chains, they are constantly changing in response to both technical

developments and consumer demands, and they can be sold in different product configurations that are relevant to particular market groups (industry or consumer).[15]

Figure 1: Inputs to the Telecommunications Manufacturing Value Chain



[15] Rosenberg, J (2015): Conformity Assessment – the Impact of Trade in ICT, Presentation by the Information Technology Industry Council to the WTO Committee of Participants on the Expansion of Trade in Information Technology Products, Workshop on Non-Tariff Barriers Affecting Trade in ICT Products, 7 May 2015

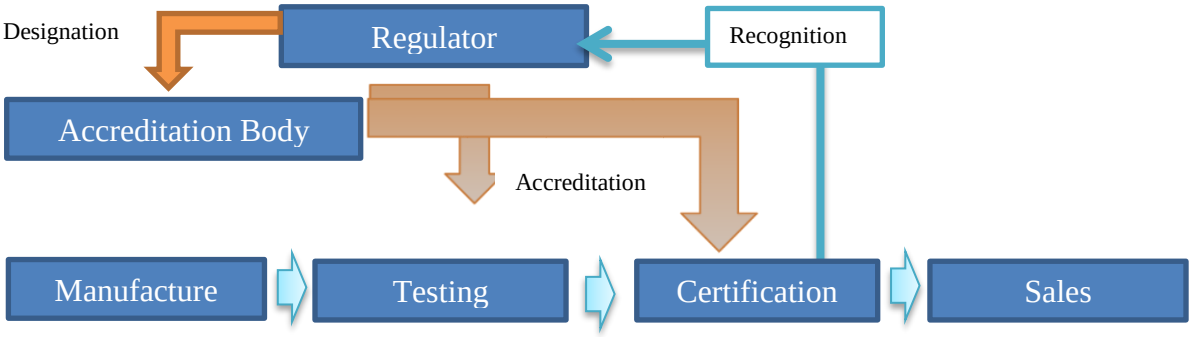
Because of the importance of testing to product (and hence consumer) safety, governments require conformance tests to be conducted by organisations which have high technical knowledge. These organisations are called by the generic term CABs.

CABs put products through a series of technical tests to ensure that they meet all the required standards. Such tests can take many hours. For example, a mobile phone may need 1000 hours of testing to ensure that it meets all the required technical standards for power use, ability to operate under a range of environmental conditions and ability to link with other parts of the telecommunications network. It must also ensure that it is safe for humans (regarding radiation emissions, operating temperature etc.). According to interviewees, testing is expensive, typically several hundred thousand US dollars[16] for each new product.

2.3 CERTIFICATION

If the product passes all the required technical tests, the final step in the system is certification. This is an administrative process through which a certifier, which may be the manufacturer, submits a dossier to government or an approved third party Certification Body to confirm that all the required tests have been passed satisfactorily. It is only after the approved third party certifies the product conforms with the required standards that it can be sold to consumers (Figure 2).

Figure 2: Simplified Testing/Certification of Telecommunications Products



Source: derived from Sheng (2015) How Regulators in the Asia Pacific leverage the MRA and Accreditation to reduce NTBs on ICT products. Presentation to WTO

2.4 THE CONFORMITY ASSESSMENT INDUSTRY

The telecommunications manufacturing value chain is highly fragmented, due to outsourcing by key manufacturers. However, the manufacturing industry is concentrated geographically, due to the dominance of a small number of firms in the overall market (particularly for mobile phones, which is the sub-sector where Chinese Taipei has grown significantly).[17]
There have been major changes over the last 15 years. In 2000, the geographic hub of mobile phone manufacture was Germany, the UK and Finland; since then it has moved to China; Korea; Hong Kong China; Chinese Taipei; Hungary; and Mexico.[18] At the same time the

[16] Information about the actual costs was sparse and some respondents maintained that the costs were significantly lower
[17] Lee, J and Gereffi G (2013): The co-evolution of concentration in mobile phone global value chains and its impact of social upgrading in developing economies, part of series "Capturing the Gains – Economic and Social Upgrading in Global Production Networks", March 2013, Working Paper 25, www.capturingthegains.org
[18] Ibid page 5 and Fig. 3, using UN Comtrade Data. Chinese Taipei is not named in this data set but is included as the sole entry in "Other Asia nec" (not elsewhere classified)

industry has become more concentrated with the five largest exporting economies comprising 73% of exports in 2010 compared to only 52% in 2001.

In each location where manufacturing has grown, the associated contract manufacturing services have also become geographically consolidated. In many cases these companies followed their manufacturers when the latter set up new factories in lower cost locations. An example from broader telecommunications manufacturing is Foxconn, a contract manufacturing firm in Chinese Taipei which is now the world's third largest contract electronics manufacturer and supplies contract manufacturing services to manufacturers based in Brazil; Mexico, throughout Asia (including nine factories in China and seven in Malaysia) and Europe (four economies). Foxconn accounts for 44% of the global electronic manufacturing services market in 2010 and its income is tens of billions of dollars.

CABs are companies which have a high degree of engineering skill and are authorized to test and certify products for conformity with domestic or international technical standards. Barriers to entry are high, as each test that a CAB is authorized to conduct needs to establish a separate dedicated laboratory. According to interviewees, setting up these laboratories is very expensive – for example to set up a radio-frequency (RF) performance tester requires an investment of around US$1.5M to purchase equipment, train staff and develop testing protocols over a period of more than a year, with new equipment imported from the USA; UK; Japan; and Germany.

While the CABs can test telecommunications equipment for compliance with international and/or domestic technical standards, regulators need to ensure that the CABs themselves are competent to do this testing, and that their reports are reliable. This step is called accreditation and it is the final level of public control in the conformity assessment system. Best practice deems that accreditation of CABs is determined by a public or not-for-profit organisation as it is the final public sign that the CABs have the technical capacity to perform their services.

In practice, CABs are accredited by auditing their compliance with an international quality standard. In this case, the relevant standard is ISO/IEC 17025, "General requirements for the competence of testing and calibration laboratories".[19] While voluntary, the ISO standards have great sway over the industry globally. They are generally accepted as a minimum standard that a CAB needs to meet to be able to sell to a large manufacturer, which in turn is trying to export product internationally. ISO/IEC 17025 covers the level of qualifications of staff, the appropriateness of testing equipment, the overarching quality assurance system, sampling and inspection procedures, traceability of measurements to international standards, recording and reporting procedures and systems to safeguard integrity and probity.

Standards auditors check and certify CABs for compliance with this standard by a certifying organisation (e.g. a standards auditor). A testing or calibration laboratory that has been accredited to comply with ISO/IEC 17025 meets both the technical competence requirements and management system requirements that are necessary for it to deliver technically valid tests and calibrations, using equipment that has the required level of accuracy and can distinguish compliance from non-compliance.[20]

[19] ISO (2010) ISO/IEC 17025:2005 – General requirements for the compliance of testing and certification laboratories. Available from: http://www.iso.org/iso/catalogue_detail.htm?csnumber=39883 (Accessed June 2016)

[20] Lin, I-J (2013): How to Educate Testing and Medical Laboratories Together with Accredited Calibration Laboratories, NCSL Annual conference 2013

Once CABs are accredited as compliant with ISO/IEC 17025, regulators then accept the validity of their testing reports, particularly if the CAB is based in an exporting economy, rather than in the regulator's own jurisdiction. Requiring compliance with a recognised ISO standard reduces the risk to the regulator of accepting a testing or certification document from an unknown CAB.

2.5 PRACTICAL IMPLICATIONS FOR EXPORTERS

The conformance testing and certification process may be efficient domestically, but if regulators in an importing economy will not accept the CAB's testing reports, then there can be delays and exporting companies can incur additional costs as products must be tested and certified in the importing economy. The barriers can include redundant or unnecessary testing procedures, additional administrative burdens, delays in importing product with stock being held at frontiers while awaiting testing and clearance, and other costs which may make export uneconomic.[21] For example, interviewees reported transport costs were significant because their products contain batteries, and as such cannot be posted. Hence, all products sent overseas for testing are sent by courier, or in one case must be hand delivered. These restrictions also extend the testing cycle.

Under such conditions, domestic CABs may test the product for the domestic market, but CABs in the importing market must also test and certify the product before the regulator in the importing economy will approve the product for sale. If there are problems with any of the tests, the manufacturer must send an engineer overseas to address the issues. One interviewee maintained that they had never known of a product that passed all the tests at its first assessment, despite the best efforts of engineers and designers, so the probability of further engineering being required on a new product is high.

In the absence of MRAs, re-testing and approval delays can add significant costs to the underlying costs of new telecommunications products. The Information Technology Industry Council estimates that fixed costs for a single economy can be over US$10 million to meet conformity assessment requirements, and market delays and other losses can be in the range of US$100,000 to US$10 million. This, of course, reduces the availability of new product in some markets and also increases the price of the goods once landed.[22] The OECD estimates that differing standards and technical requirements across markets, which lead to the need for multiple testing and certification procedures, account for 2 percent to 10 percent of the costs of production.[23] World Bank modelling has proposed that a 1% increase in on-time compliance costs raises production costs by 0.6 percent.[24] Other papers (not in telecommunications) show direct links between a firm's decision to export and the existence of quality standards and testing procedures by the importing economy.[25]

[21] Rosenberg (2015) op cit slide 7
[22] Ibid
[23] OECD (1997): Product Standards, Conformity Assessment and Regulatory Reform – in Sectoral Studies Chapter 6 vol 1, OECD, Paris
[24] Maskus, K, Otsuki, T and Wilson, J (2004): The Costs of Complying with Foreign Product Standards for Firms in Developing Countries – an Econometric Study, 19 May 2004
[25] Wilson, J (2005): Standards and Trade – Empirical Evidence and Case Studies, Development Economics Research Group, the World Bank, ERS Conference 3 November 2005

The high costs of certifying products in both exporting and importing economies, and the amount of time this added to product approvals, was one of the key reasons APEC pursued development of the TEL MRA.

3. THE APEC TEL MRA

3.1 OVERVIEW OF MRAS

The APEC TEL MRA was the first multilateral agreement of its type in the world. Its intent is to reduce the costs of conformance testing where there were existing barriers to tests being accepted between economies. The aim was to streamline the flow of products between the parties to the MRA, promote market access, speed access to markets, help spread best practices and to reduce overall regulatory burdens.[26,27]

The APEC TEL MRAs was expected to bring a range of benefits to manufacturers, regulators, consumers, and CABs[28] (Table 2).

Table 2: Expected Benefits of the APEC TEL MRA

Stakeholder	Expected benefit of conformity regulations
Manufacturers	1. Testing and certification can be done once for multiple markets, reducing certification and compliance costs 2. Enhanced access to exports and faster access to international markets, particularly valuable for sectors with short product life cycles. 3. It can reduce the time to market for manufacturers of telecommunications equipment.
Regulators	1. Fewer regulatory resources required. 2. Savings in regulatory costs can be reallocated to other priority areas. 3. Engagement with other regulators can enhance knowledge of global trends and build capacity in regulatory systems. 4. Opportunity for further harmonisation
CABs	1. CABs can provide higher quality and higher value services
Consumers	1. An increased range of available technology 2. Faster access to new telecommunication equipment at a lower cost 3. Faster development of telecommunications and internet infrastructure.

Source: APEC (2016): APEC-TEL MRA, APEC Telecommunications and Information Working Group

The expected benefits are supported by studies which have shown that where an exporting economy complies with international standards there is an increase in exports, and at the same time when importing economies adopt international standards it increases imports. In other words, international standards have an overall positive effect on the extent of world trade.[29]

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[26] APEC (1998): Mutual Recognition Arrangement for Conformity Assessment of Telecommunications Equipment, APEC Telecommunications and Information Working Group.

[27] McCrum, W and Kwan, A (2013): Guidelines for the Development, Implementation and Management of of a Mutual Recognition Agreement/Arrangement on Conformity Assessment of Telecommunications Equipment, International Telecommunications Union

28 We follow APEC's definition that Conformity Assessment Body is "a body, which may include a third party or a supplier's testing laboratory, or a certification body, that performs conformity assessment to an importing Party's Technical Regulations".

[29] Swann, GP (2010): International Standards and Trade – a Review of the Empirical Literature, OECD Trade Policy Working Paper No. 97, OECD Paris

Other studies have modelled the impact of MRAs specifically, and propose that they produce trade diversion for non-participants, particularly those in developing economies.[30]

APEC formed the MRA Taskforce in 1996 under the APEC Telecommunications Working Group, with representatives from regulators in all 21 APEC member economies, led by Canada. In May 1998 the Taskforce completed the APEC TEL MRA basic framework, guiding principles and content. In June 1998, the APEC telecommunications ministers issued the "Ministerial Declaration on the APEC MRA for Conformity Assessment of Telecommunications Equipment" expressing support for these measures aimed at liberalizing telecommunications, and also making clear that APEC members would voluntarily implement the MRA schedule.

In the meantime, several economies had already signed bilateral MRAs. For example, Canada signed an MRA in telecommunications with Korea in 1997 and with the European Union (not part of APEC) in 1998.[31] The Korean agreement was then superseded by a bilateral arrangement under the APEC TEL MRA in 2002. By 2016, all 21 APEC member economies have signed the APEC TEL MRA.[32] The United States (United States) has also signed non APEC TEL MRA agreements with Japan and Mexico.

3.2 IMPLEMENTATION OF THE APEC TEL MRA

The APEC TEL MRA is now in place as a framework MRA under which APEC member economies can recognise each other's conformity testing of telecommunications equipment with the aim of facilitating trade. The APEC TEL MRA is implemented through a series of reciprocal bilateral agreements negotiated between APEC member economies. Member economies which sign bilateral MRAs must establish legally binding regulations and systems in their own economies to put the agreements into practice.

Equipment covered

The MRA covers the electromagnetic compatibility (EMC), electrical safety and telecommunications aspects of "all equipment subject to telecommunications regulation including wireline and wireless, terrestrial and satellite equipment."[33] This may include radio equipment, telecommunications equipment, and telephone terminal equipment, which may also be governed by electrical safety regulations."[34]

Such equipment can be broadly classified into:[35]

- terminal attachment and radio equipment (equipment which connects to the telecommunications network) including telephones, modems, fax machines (wired or radio-based) and satellite equipment whether or not it is attached to a telecommunications network;

[30] Pacheco, A (2006): Mutual Recognition Agreements and Trade Diversion – Consequences for Developing Nations, HEI Working Paper 20/2006, Graduate Institute of International Studies, Geneva
[31] About MRAs – Canadian government website http://www.ic.gc.ca/eic/site/mra-arm.nsf/eng/h_nj00048.html (Accessed June 2016)
[32] APEC (1998): op. cit.
[33] ibid.
[34] APEC (2016): APEC-TEL MRA, APEC Telecommunications and Information Working Group, Available from: http://www.apec.org/groups/som-steering-committee-on-economic-and-technical-cooperation/Working-groups/telecommunications-and-Information/apec_tel-mra.aspx (Accessed June 2016)
[35] McCrum and Kwan (2013) section 3.2

- EMC equipment; and
- electrical safety equipment.

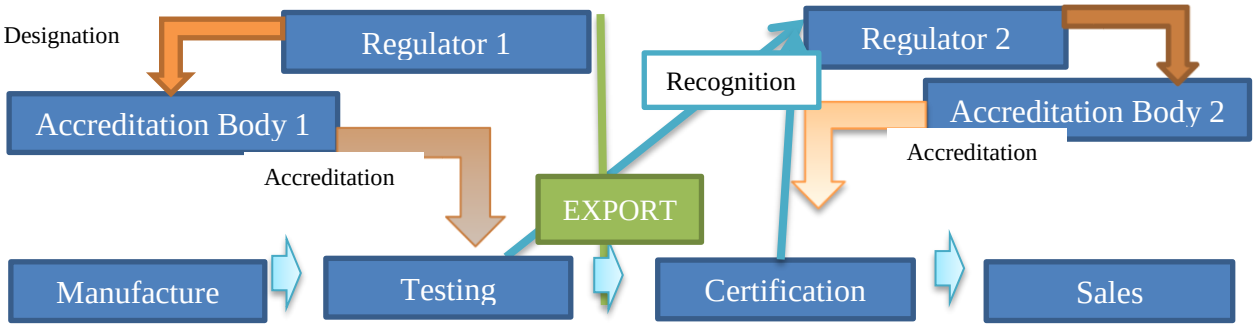
Provisions

The main provisions of the agreement apply to the designation and monitoring of CABs and procedures to mutually recognise CABs. The MRA sets out model administrative arrangements and transition procedures as well as overlying requirements for demonstrating competence of both testing and certification bodies. The MRA also maintains the rights of regulators to establish surveillance, recalls and other measures if equipment that has been certified is found to not meet the required regulations. Such actions are expected to comply with ISO/IEC 17065,[36] which places limits on testing regimes.

Phases

Members can agree bilaterally to recognise two levels of certification, known as Phase I and Phase 2.
In Phase 1, member economies recognise conformance testing performed in the exporting economy and will accept test reports from CABs in that economy (Figure 3).

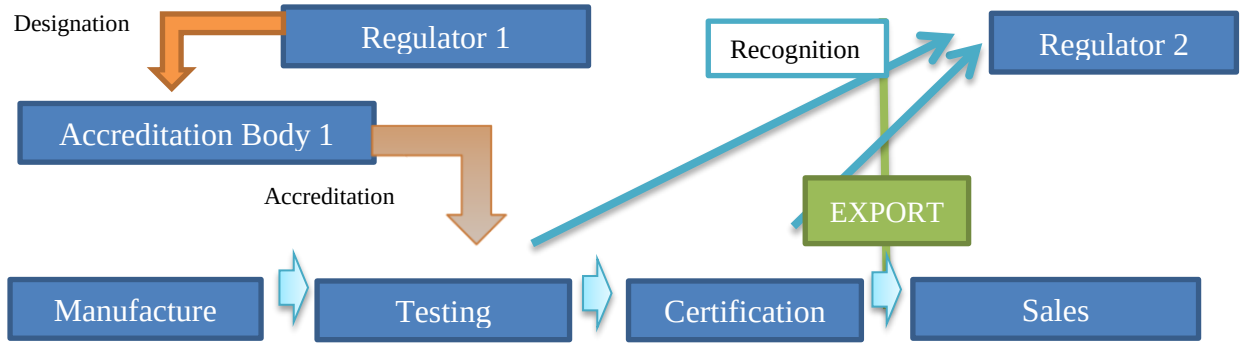
Figure 3: Steps in Testing/Certification of Telecommunications Products under Phase 1



Source: Derived from Sheng (2015) op cit

In Phase 2, member economies recognise and accept equipment certification and recognise the bodies that provide that certification (Figure 4).

Figure 4: Steps in Testing/Certification of Telecommunications Products under Phase 2



Source: Derived from Sheng (2015) op cit

[36] International Standards Organisation (1996): General Requirements for Bodies Operating Product Certification Systems, modified by ISO/IEC 17065:2012

While the use of the terms Phase 1 and Phase 2 implies that economies enter agreements sequentially, this is not required. Economies can agree to a Phase 2 arrangement without having a Phase 1 agreement first (e.g. Chinese Taipei and Canada).

As of September 2005, 19 of the 21 APEC economies (i.e. all except for Chile and Russia) had already stated they were participating in the MRA Phase 1. With regard to implementing Phase 2, "mutual recognition of certification bodies", only five economies have made clear their willingness to participate: Canada; Hong Kong,China; Singapore; the United States; and Chinese Taipei.

Administrative Framework for Implementation

The APEC TEL MRA sets out a number of organisations which are needed to successfully implement the MRA in member economies:[37]

- Regulatory authority: an entity with legal authority for regulating telecommunications;
- Joint committee: a committee of the parties established to manage initiation and implementation of the MRA;
- Designating authority: a government authority or body appointed by government to designate a CAB to perform conformity testing or certification under the MRA;
- Accreditation body: a body which is responsible for assessing competencies of testing and certification bodies; and
- CAB: a third party or a supplier's testing laboratory designated or a certification body that can perform conformity assessment.

Different economies can adopt different schemes under the terms of the APEC TEL MRA. The next Chapter discusses how this has been achieved in Chinese Taipei and what conditions applied in Chinese Taipei prior to the MRA's introduction.

[37] McCrum and Kwang (2013) op cit

4. THE CHINESE TAIPEI TEL MRA

This chapter discusses the development and implementation of the APEC TEL MRA in Chinese Taipei, including the drivers for the reform, the implementation steps, the current situation and the lessons learned. The following chapter further investigates the impact on Chinese Taipei since the APEC TEL MRA was implemented.

4.1 PRE-IMPLEMENTATION

Chinese Taipei was closely involved in the development of the structure of the APEC TEL MRA and the associated implementation guidelines. The APEC TEL MRA development occurred when Chinese Taipei was seeking economic growth through a combination of deregulation and industry support programs.

The stated purpose for Chinese Taipei's participation in the APEC TEL MRA was to "achieve the goal of reaching parity with international norms, reduce the cost and time schedules for Chinese Taipei manufacturers in overseas sales of their products, expand Chinese Taipei's overseas trade network for telecommunications equipment and grow the capacity of domestic testing labs and certification bodies."[38] While these are largely demand-side issues, the removal of supply-side barriers was an important first step in increasing the capacity for manufacture of telecommunications products in Chinese Taipei.

Supply-side barriers

Supply-side barriers are those which relate to the establishment and management of a market by government and associated regulatory agencies. Chinese Taipei's significant structural reform in telecommunications aimed to remove such barriers, commencing in the mid-1990s and peaking in the period 1995-1999 (Table 3). The aim of this reform was to enable growth in the provision of telecommunications services as part of overall economic restructuring.

[38] Ibid, page 21

Table 3: Key Structural Reforms in Telecommunications, Chinese Taipei , 1987-2009

	1987-1994	1995-1999	2000-2004	2005-2009
Basic telephony	Deregulation of CPE markets reduce restrictions on international access	Telecommunications Act, Organizational Statute of the DGT, Statute establishing Chung-Wha Telecom Co., Ltd	Fixed line market liberalized and privatisation of Chung-Wha Telecom Acceded to WTO	
Mobile phone market	Paging service liberalised	2G market licensed	3G market liberalised	Wireless broadband access licensed
Manufacturing	Lift restrictions on import of components	Manufacturers from US and elsewhere allowed to set up in Chinese Taipei		
Institutional structures		DGT established	TAF formed	DGT replaced by NCC
APEC TEL MRA		First Phase 1 agreements		First phase 2 agreement

Source: Derived from Table 19.1 in Lee (op cit), Chen, (2000) and author's analysis

During this time the government's Directorate General of Telecommunications (DGT) lost its monopoly power as a result of the 1996 Telecommunications Act, and related legislation. This Act allowed private telecommunications service providers to enter the Chinese Taipei market, and made the DGT the primary regulator, while at the same time banning it from service provision.[39]

During the mid-to-late 1990s Chungwha Telecom, the service provider established under the 1996 Telecommunications Act, was active but local demand outpaced supply. The government announced approval for eight new entrants to the mobile supply market.[40] Other reforms included enabling foreign ownership of telecommunications services firms.[41]

In the same decade, labour force changes reduced the economy's previous competitiveness in low-margin industries, while liberalisation in finance and foreign exchange[42] led to high-tech R&D into semi-conductors and telecommunications – particularly through the Industrial Technology Research Institute (ITRI) and the HsinChu Science Park – and built capacity in design of telecommunications products.[43] Other barriers including limits to import of digital switches, were lifted in 1997. By 1998 the manufacturing industry was importing 44% of its

[39] Lee, R C (2011): Telecommunications in Chinese Taipei in Impacts and Benefits of Structural Reform in the Transport, Energy and Telecommunications Sectors, APEC, 2011
[40] Kawakami (2007): The Rise of Taiwanese Family-owned Business Groups, in Jilberto, A and Hogenboom, B et al – Big Business and Economic Development – Conglomerates and Economic Groups in Developing Countries and Transition Economies Under Globalisation, Routledge
[41] Carr, R et al (1998): Telecommunications Equipment – United States Performance in Selected Major Markets. Staff Research Study, Office of Industries, United States International Trade Commission, Publication 3150, December 1998
[42] Fu et al (2014), Industrial policy, Structural Change, and Pattern of Industrial Productivity Growth in Taiwan, 3rd World KLEMS Conference, Tokyo, Japan
[43] Ibid

component parts from the United States.[44] Interviewees confirmed the importance of the United States as a source of printed circuit boards during this period for local telecommunications manufacturers. By the finalisation of the TEL MRA, Chinese Taipei's telecommunications manufacturing industry comprised 300 companies, employed 25,000 people and accounted for 1% to 2% of total world production. Main export markets for finished products were the United States, the European Union, China and South-east Asia.[45]

Demand-side barriers

Once supply-side barriers are reduced or removed, regulators can attend to demand-side barriers, which are normally considered from the perspective of the consumer e.g. price, choice, and ease of moving to new providers. In this case the demand side of the equation is mediated by regulations put into place by importing economies, namely recognition of testing and certification reports from CABs in Chinese Taipei (Table 4).

Table 4: Pre-MRA Arrangements for Testing Product Exported from Chinese Taipei

Economy	Acceptance of Chinese Taipei's CAB reports (pre-MRA)
Australia	Required an Australian-based CAB to review the testing report from Chinese Taipei-based CAB
Canada	No, testing must be conducted in Canada for Terminal Telecommunication Equipment
Hong Kong, China	Yes, would accept Chinese Taipei's CAB reports
Japan	Required a Japan-based CAB to review the testing report from Chinese Taipei-based CAB
Mexico	No, testing must be conducted in Mexico
China	No, testing must be conducted in China
Singapore	Yes, would accept Chinese Taipei's CAB reports
Korea	No, testing must be conducted in Korea
United States	Required a United States-based CAB to review the testing report from Chinese Taipei-based CAB

Source: Case study interviews

At the time of signing the APEC TEL MRA, the testing industry, according to interviewees, was largely limited to testing of goods being imported into Chinese Taipei. The APEC TEL MRA provided a way for these demand-side regulatory issues to be addressed.

4.2 IMPLEMENTATION FRAMEWORK

Chinese Taipei has established a domestic regulatory framework that meets the requirements of the APEC TEL MRA. This includes two regulatory agencies and an accreditor.

Regulators and designating authorities

Chinese Taipei has two organisations which regulate different aspects of telecommunications products and testing and certification processes – the NCC and the BSMI. The overlap is a direct result of the convergence of telecommunications and IT products over the years.[46]

[44] Ibid Chapter 9
[45] Ibid Table 9-3 and Table 9-4
[46] Sheng, R (2015): op cit. page 6

The NCC was established in 2006 and took over the functions of the DGT and the Department of Broadcasting Affairs (part of the Government Information Office). The NCC is now responsible for regulating telecommunications and broadcasting services and its combined remit reflects the convergence of broadcasting and telecommunications technologies in recent years. According to the government:[47]

> *"The NCC is the first legitimate regulatory agency in Chinese Tapei independent from an executive branch. The NCC analyzes the development of digital convergence to formulate a direction for communications regulatory reform in accordance with the basic supervisory principles of the Fundamental Communications Act as well as national policies and objectives. NCC aims to regulate the communications sector from an objective, neutral, and professional standpoint, to ensure effective competition in the market, to safeguard public interest, to promote the development of communications services, and thereby enhance the nation's competitiveness."*

The main regulatory instrument is the Telecommunications Act. The NCC's 2006 Strategic Plan, sets itself the task of revising the relevant articles of this Act to support coordination, revising and augmenting regulations on certification assessment of safe IT products to enhance their international competitiveness and eliminating the upper limit for price adjustment for non-dominant market players in order to enliven the market.[48]

The NCC has a broad scope of work to undertake. Of relevance to this case study, the NCC: develops telecommunications policies and regulations; processes applications for licences; oversees communications operations; sets engineering and technical specifications and conducting type-approvals; sets info-communications security standards and regulations; and engages in international matters relating to communications operation.[49] Those directly relevant to the telecommunications industry include regulation of radio frequency devices, telecommunications terminal equipment, low power radio wave telecommunications devices, radio waves emitted by industrial and scientific equipment, and telecommunications terminal equipment.[50]

The BSMI is an agency of the Ministry for Economic Development. BSMI is responsible for: the development of national standards; the verification of weights and measuring instruments; the inspection of commodities; and the provision of other certification or testing services. For the APEC TEL MRA, BSMI's main focus is the promotion of measure-instrument inter-comparison among metrological laboratories, particularly for electrical safety testing.[51] BSMI also helps domestic laboratories to maintain or acquire testing laboratory qualifications recognized by foreign governments in addition to being recognized as a qualified product.[52]

For telecommunications equipment, the NCC regulates components such as operating frequencies and bandwidth and the BSMI regulates operation against electrical safety and

[47] About the NCC – Introduction, website at http://www.ncc.gov.tw/english/content.aspx?site_content_sn=284 (Accessed May 2016)
[48] National Communications Commission (2006): Administrative Plan,
[49] Duties, Missions and Authorities of NCC, at http://www.ncc.gov.tw/english/content.aspx?site_content_sn=12 (Accessed May 2016)
[50] Chen, Major (2009): Chinese-Taipei Regulatory Requirements for Telecommunications and Information Technology Equipment, American TCB Taipei Office
[51] BSMI 2007 Plans and Policies, at http://www.bsmi.gov.tw/wSite/ct?xItem=4074&ctNode=817 (Accessed May 2016)
[52] BSMI (2014): Annual Report 2013

testing standards. This has caused some difficulties in dealings with some overseas economies, as will be discussed on page 26.

Joint committee

There is no formal joint committee. According to interviewees, as the economy is relatively small and the local informal networks are strong, there was no need for a formal structure to manage the relationship between the regulators.

Accreditation

TAF is the only accreditation body recognized by Chinese Taipei regulatory authorities to accredit domestic third parties for conformity assessment against national, regional and international standards. TAF was formed by the Ministry of Economic Affairs in 2003 to take over the two previous accreditation bodies (one of which was BSMI).[53] TAF is not-for-profit and is self-funded but its scope of activity is still supervised by government to ensure its activities compliant with the purpose of the establishment. TAF is a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) and the International Accreditation Forum (IAF) Multilateral Recognition Arrangement (MRA), which enhance the acceptance of conformity assessment results across economic borders.

TAF's primary role is to accredit testing, medical and calibration laboratories to the required ISO standard. As noted earlier, for telecommunications conformance this is ISO/IEC 17025. TAF's staff must therefore be technically qualified engineers and be competent in what is required under international standards and testing regimes. TAF must ensure that the CABs it accredits maintain physical standards of measurement very accurately, comply with relevant international standards, are able to calibrate their instruments accurately, and are technically competent.[54]

As at July 2013, TAF had accredited 1251 testing laboratories, 251 medical laboratories and 198 calibration laboratories (including 98 electrical calibration laboratories) in Chinese Taipei.[55] Of these, TAF has accredited 17 testing and certification laboratories as CABs under ISO/IEC 17025.

Companies (manufacturers, CABs and others) can apply to TAF for accreditation at any time. They may request for accreditation of a specific test (e.g. if a CAB wishes to commence OTA testing where it has previously not had that capacity) or they may ask TAF to accredit that they can undertake testing in accordance with standards applicable in another economy (e.g. in compliance with Australian New Zealand standards). Interviewees reported that each time a CAB needs to get accredited for a new capability, this takes only two to three months from the time that TAF is approached.

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[53] The former Chinese National Laboratory Accreditation (CNLA) scheme (formed in 1990 to provide the accreditation services for laboratories) and the Chinese Quality Management & Environmental Management Accreditation Board/Chinese National Accreditation Board (CNAB) formed in 2001 to accredit management systems, product, auditor certification bodies and auditor training organisations. CNAB, the MOEA founded the TAF Preparatory Office on 31 July 2002 to take care of preparatory work, including fund raising and register documents preparation.

[54] McCrum and Kwan (2013) op cit. section 1.4

[55] Lin, I-J (2013): op cit.

When needed, TAF will also re-accredit organisations when standards change. Fortunately, in telecommunications these change slowly – years rather than months. TAF is alerted to impending change by either the manufacturers or the CABs, and can then use its technical expertise to work out the differences between the existing and proposed standards. TAF can then run training courses on the new standard, as necessary. This gives CABs time to change their own testing regimes to meet TAF's technical requirements and to become re-accredited prior to a new standard coming into effect. TAF needs to put considerable resources into developing its assessment capability when the technical change is significant.

TAF also plays an important role in communicating between industry and BSMI/NCC, in that they help NCC and BSMI understand technical issues in their considerations of regulatory change. It has significant connection to other accreditation bodies, regional bodies and accreditation-related organisations and is a member of the Asia Pacific Laboratory Accreditation Cooperation, Pacific Accreditation Cooperation, International Laboratory Accreditation Cooperation and the Multilateral Recognition Arrangement.[56] TAF has participated in the APEC TEL MRA Taskforce since its inception through its membership of the APEC Telecommunications Working Group. In this role TAF has enabled manufacturers and CABs to attend APEC meetings as part of Chinese Taipei's industry delegations.

4.3 APEC TEL MRA BILATERAL AGREEMENTS

TEL MRAs signed as bilateral agreements between Chinese Taipei and other economies allow CABs in Chinese Taipei to test and/or certify particular pieces of telecommunications equipment for export, and for companies in Chinese Taipei to import equipment which has been tested and/or certified in partner economies. Table 5 summarises the APEC TEL MRA agreements most relevant to this case study.

Table 5: Summary of Relevant APEC TEL MRA Arrangements

	Australia	**Canada**	**Chinese Taipei**	**Hong Kong, China**	**Japan**	**Malaysia**	**Singapore**	**Korea**	**USA**	**Viet Nam**
Australia	N/A	Phase 1	Phase 1	Phase 1			Phase 1		Phase 1	Phase 1
Canada	Phase 1	N/A	Phase 1 & Phase 2	Phase 1 & Phase 2			Phase 1 & Phase 2	Phase 1	Phase 1 & Phase 2	Phase 1
Chinese Taipei	Phase 1	Phase I & Phase 2	N/A	Phase 1			Phase 1		Phase 1	
Hong Kong, China		Phase 1 & Phase 2	Phase 1	N/A			Phase 1		Phase 1 & Phase 2	
Japan					NA				Phase 1	
Malaysia						N/A	Phase 1			
Singapore	Phase 1	Phase 1 & Phase 2	Phase 1	Phase 1		Phase 1	N/A		Phase 1 & Phase 2	
Korea	Phase 1	Phase 1		Phase 1				N/A	Phase 1	Phase 1
USA	Phase 1	Phase 1 & Phase 2	Phase 1	Phase 1 & Phase 2	Phase 1		Phase 1 & Phase 2	Phase 1	N/A	Phase 1
Viet Nam	Phase 1	Phase 1						Phase 1	Phase 1	N/A

Source: based on Sheng, R (2015), op cit

[56] Ibid page 3

Chinese Taipei has signed a Phase 2 agreement with Canada – this means that a CAB located in Chinese Taipei can sign all the necessary documents for a product to be sold in Canada, once it has been tested successfully (that is, Phase 2 includes Phase 1). Canada is the only economy with which Chinese Taipei has successfully signed a Phase 2 agreement. During this period, the US has signed Phase 2 agreements with Canada; Hong Kong, China; and Singapore.[57]

4.4 CABS

Following signing of the MRA bilateral agreements, it took some years for Chinese Taipei's CABs to develop. We have collated information on 34 CABs in Chinese Taipei. The industry is a mix of small-to-medium enterprises (SMEs) owned locally, subsidiaries of larger companies, and large companies with laboratories that specialise in testing and certification (Table 6 – for more detail see Table 28).

[57] National Standards Institute (2016): APEC Mutual Recognition Arrangement for Conformity Assessment of Telecommunications, U.S. Department of Commerce, Available from: http://gsi.nist.gov/global/index.cfm/L1-4/L2-16/L3-90 (Accessed May 2016)

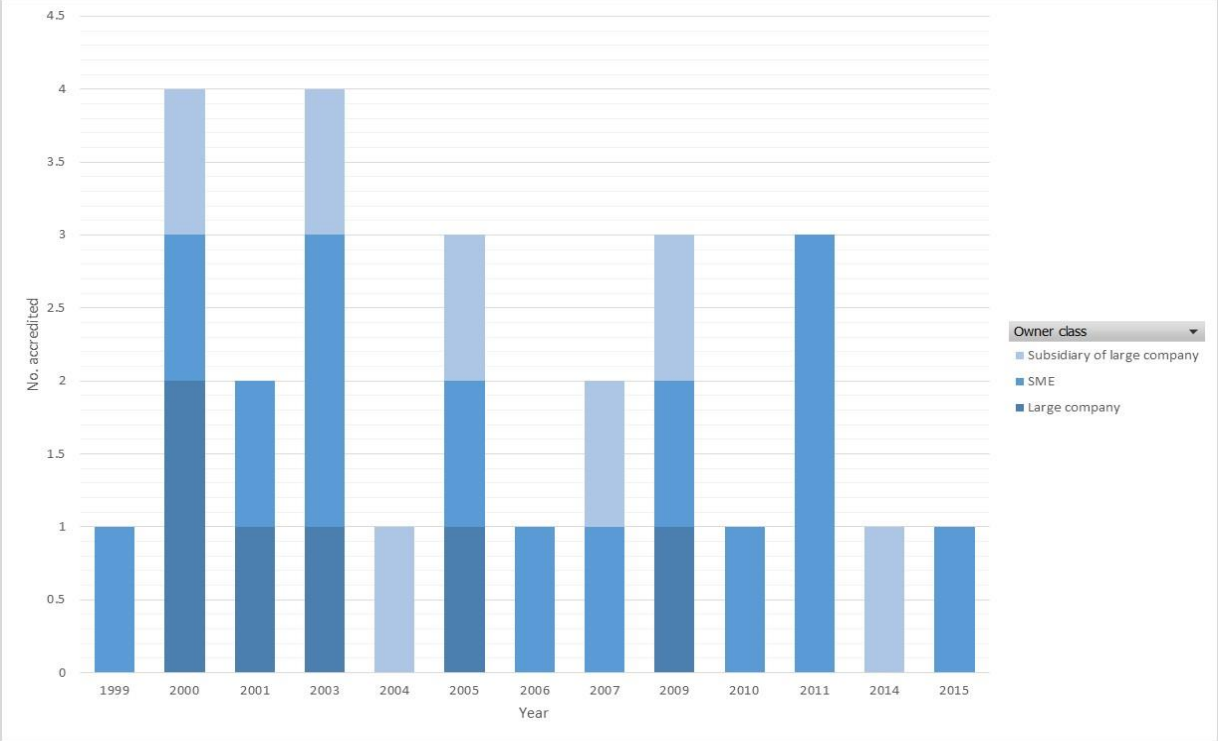
Table 6: Summary of CABs in Chinese Taipei

	Chinese Taipei ownership	Example (owner)	International ownership	Example (owner)
SMEs	16	A Test Lab, Cerpass, Max Light, Quietek, Spectrum Training and Research Lab, Training Research Co.	0	
Subsidiaries of larger companies	7	PTT Laboratory (TECO Imaging Systems), Communications Global Certification (HTC), Foxconn (Hon Hal)	2	Intertek Testing Services Taiwan (Intertek plc – UK) SGS Taiwan (SGS Group)
Large companies	7	Sporton International MITAC, Wendell	2	Bureau Veritas (Bureau Veritas Europe), TUV Rheinland (TUV Rheinland, Germany)

Source: Author's analysis, n=34

Information is available on the years that 27 of these companies became accredited with ISO17025 (Figure 5). The first accreditation for APEC TEL MRA was signed in 1999 and there has been a steady growth in certifications since. There is no trend evident by type of company.

Figure 5: Accreditation of Chinese Taipei CABs for ISO/IEC 17025 by year



Source: Author's analysis, n=27

CABs in Chinese Taipei now have 48 Phase 1 agreements with four partner economies (Australia; Singapore; Hong Kong, China; and the United States). These agreements have been signed incrementally since the APEC TEL MRA was signed.[58] Three CABs are accredited with Hong Kong, 5 with Singapore, 14 with Australia, 9 with Canada and 15 with the US. Each

[58] National Communications Commission, Mutual Recognition Arrangements, Chinese Taipei

CAB is accredited for different types of telecommunications equipment. There is a wide variety of accreditations for both types of equipment and economies.

Annex 4 provides detail of accredited CABs; see also Annex 3 for accreditations by type of equipment and economy.

5. IMPLEMENTATION ISSUES

Several implementation issues emerged through discussions with interviewees. These included the small size of the domestic consumer market at the time the TEL MRA was signed, changing industry structure, the regulatory structure in Chinese Taipei (still ongoing), and the need for post-market surveillance. Other ongoing issues include the costs of meeting multiple standards in economies where MRAs are not in place, and other non-tariff barriers.

Reluctance of some economies to negotiate

In general, economies are likely to be willing to put time and effort into negotiating an MRA with an economy which provides a suitably large market for their own manufacturers or which provides a large source of imported goods. Interviewees reported that this put Chinese Taipei at a disadvantage at the start of the MRA as it did not have a significant consumer market. There are still some economies (mainly those which offer large potential markets for Chinese Taipei) with which Chinese Taipei would like to sign an MRA but have not been able to do so for various reasons. In some cases, as has been noted already, the MRA is unnecessary because practices are already effectively harmonised.

Recognition that CABs cross borders

It has become common for companies in Chinese Taipei to set up subsidiaries in other economies. TAF initially did not anticipate that such structural change would also apply to CABs. The original expectation was that a CAB accredited for Chinese Taipei would operate domestically. However, some Chinese Taipei CABs expanded internationally, and others were bought out by international companies, or subsidiaries of larger companies.

TAF's original process accredited the company rather than the original laboratory and hence it was not possible to identify whether an accredited CAB had conducted their suite of tests in Chinese Taipei or elsewhere. Some partner economies queried the validity of some tests that had been conducted by an accredited CAB but in a laboratory that had not been investigated by TAF. As a result, TAF altered its policies and now accreditation for CABs is granted branch by branch (lab by lab), including where located in overseas economies, and the testing report states at which branch the test was carried out. This has increased the work for TAF but it was necessary to maintain the validity of the system.

Overlaps in approached by NCC and BSMI

As already noted, Chinese Taipei has signed a Phase 2 agreement with Canada, but it only has a Phase 1 agreement with the US and no agreement at all with Mexico. Together, however, these three economies make up the North American market, which is treated as a single export market by manufacturers in Chinese Taipei.

At the moment, the CAB tests the product and sends the report to the certification agency in the other economy (e.g. from Chinese Taipei to the United States), as there is no Phase 2 agreement with the United States. Hence, the value of the Phase 2 agreement with Canada is reduced as CABs still have to get US certification for a product that a Chinese Taipei-based CAB can certify for Canada. This still creates delays and additional costs for manufacturers in Chinese Taipei.

Interviewees suggested that these problems would be overcome with a Phase 2 agreement at least with the US. Chinese Taipei-based certifiers could also help manufacturers understand foreign certification rules better.

According to interviewees, the US has been unwilling to negotiate a Phase 2 agreement with Chinese Taipei because of overlaps in roles of BSMI and the NCC. This difficulty is also alluded to in presentations by US trade envoys on MRA issues.[59] According to the NCC, this problem is recognized by Chinese Taipei and is being addressed by the government.

With regards to Mexico, interviewees saw the absence of a Phase 1 agreement with Mexico as a further gap which interfered with smooth entry of product to the North American market. Manufacturers also sell product in Mexico but testing must be in Mexico itself. The possibility of prioritizing this as a new Phase 1 agreement was discussed in interviews.

Post market surveillance

According to interviewees, post-market surveillance has arisen as an important issue. Post-market surveillance is "an activity conducted to assess the compliance of regulated equipment deployed in the marketplace to applicable technical standards and labelling requirements."[60] As noted earlier, the potential need for post-market surveillance is recognized under the APEC TEL MRA. Best practice under ISO/IEC 17065 and can take the form of a sample test plan which tests the marketed product against the specifications for which it has been certified.

Market surveillance emerged as an issue after the APEC TEL MRA Taskforce realized that enhanced market access under the MRA increased the risk of faulty goods and the associated need for product recalls. This issue was taken up in the APEC Telecommunications Working Group and in 2010 Market Surveillance Guidelines for Telecommunications Equipment were issued. These Guidelines recommend targeting specific goods (e.g. as a result of complaints, past history of compliance, emergence of new-to-market technologies, and the level of potential harm due to non-compliance) and then auditing equipment to verify compliance. If the equipment is non-compliant then the regulator must take action (e.g. a recall).

In Chinese Taipei, NCC conducts post-market surveillance in concert with recognized certification bodies such as TAF. However, it should be noted that the issue was raised because of risks identified from regulators and CABs in the region. Some economies have now had to change the way their accrediting organisation is governed to overcome these problems.

Ongoing differences in technical standards

Despite the usefulness of the MRA and the existence of a strong international standards framework, interviewees noted that there are still some problems caused by differing national standards, often due to only minor differences. Sometimes, the tests required for two markets will both be based on the same umbrella technical standard (set by PTCRB etc.), but the CAB has to produce two reports – one for one economy and one for another – on the one product, with minor wording and name changes.

[59] Chen, Major (2009) *op cit* slide 35
[60] APEC Telecommunications Working Group (2010): Market Surveillance Guidelines for Telecommunications Equipment

Sometimes there are more fundamental differences. These may be due to real differences, for example EMC testing is often extended because different economies use different power supplies (110 volts vs 240 volts). They can also be due to other economies having their own requirements for domestic testing, for example, interviewees mentioned difficulties with India which not only has different technical standards, but requires exporters to test all equipment within that c before it can be sold there.

Ongoing non-tariff barriers

Despite the MRA within APEC, manufacturers face significant other non-tariff barriers to export to some economies. Interviewees reported that the company must set up manufacturing in some economies or use expensive domestic CABs.

Similarly, some economies require a local representative to submit the Self Declaration of Conformity. Manufacturers in Chinese Taipei must therefore find a company in those economies to submit the test report. This is controlled by requiring the applicant to have a local address and/or credit card from a local bank.

6. IMPACT OF THE APEC TEL MRA ON CHINESE TAIPEI

The APEC TEL MRA has had a significant impact on the testing and services industry in Chinese Taipei with benefits flowing through to manufacturers and consumers. Impacts identified during this case study are summarised in Table 7 (refer also to the theoretical benefits in Table 2) and are expanded on in the following sections.

Table 7: Demonstrated Benefits of TEL MRA on Chinese Taipei

Stakeholder	Expected benefit of conformity regulations	Comment
Manufacturers	1. Testing and certification can be done once for multiple markets, reducing certification and compliance costs	Yes
	2. Enhanced access to exports and faster access to international markets, particularly valuable for sectors with short product life cycles.	Yes
	3. It can reduce the time to market for manufacturers of telecommunications equipment.	Yes
Regulators	1. Fewer regulatory resources required.	No
	2. Savings in regulatory costs can be reallocated to other priority areas.	N/A
	3. Engagement with other regulators can enhance knowledge of global trends and build capacity in regulatory systems.	Yes
	4. Opportunity for further harmonization	Yes
CABs	1. CABs can provide higher quality and higher value services through offering a broader range of services.	Yes
Consumers	1. Increased range of available technology	Yes
	2. Faster access to new telecommunication equipment at a lower cost	Yes
	3. Faster development of telecommunications and internet infrastructure.	Yes

Source: Author's analysis

As previously discussed it has not been possible to identify measures of impact by reviewing telecommunications export and import statistics. Instead, impact measures on the telecommunications industry have been derived from comments by interviewees. Impact on the testing industry has been measured by review of historical changes in the size of the testing industry and Chinese Taipei's ranking against CABs from other economies in those economies with which Chinese Taipei has APEC TEL MRA agreements.

6.1 TELECOMMUNICATIONS EQUIPMENT MANUFACTURERS

Chinese Taipei's success as an exporter of electronic goods is a reflection of growth and structural reform since the late 1990s.[61] Between 1999 (at the commencement of the MRA), and 2003, telecommunications manufacturing grew from less than USD$2 billion to over USD$13.8 billion, with the largest growth in wireless (from USD$1.25 billion to USD$9

[61] Ibid

billion, doubling each year).[62] Another analysis at about the same time reported that 'electrical and optical equipment' was the strongest performing industry.[63]
Since then, the industry has continued to grow. In 2014, Chinese Taipei was the 7th largest exporter of electrical and electronic equipment globally, with the industry having grown 364% in terms of export value since 2001 from USD$33 billion to USD$123 billion.[64]

While the growth in the industry cannot be attributed solely to the APEC TEL MRA, there is no doubt that the APEC TEL MRA has affected Chinese Taipei-based manufacturers' ability to export to preferred economies. There is some evidence from economic modelling – a study commissioned by the NCC and published in 2014 concluded that the APEC TEL MRA had increased Chinese Taipei's exports of mobile phones and laptop computers to other APEC members.[65] The study found that compulsory testing requirements in importing economies had a negative effect on trade flows for mobile phones and laptop computers and that the APEC TEL MRA alleviated the negative effects for these products. The same effect is not shown for longer life cycle products such as set-top boxes and routers.

Impacts on speed to market have also been significant. According to interviewees, testing takes up to twice as long for markets where there is no MRA in place, compared to those where reports from Chinese Taipei-based CABs are accepted (Table 8). In some circumstances, interviewees reported that they were able to reduce delays by "pre-testing" in Chinese Taipei.

Table 8: Current Impacts of APEC TEL MRA on Manufacturers

Economy (Agreement phase)	Acceptance of Chinese Taipei's CAB reports	Typical testing cycle
Australia (1)	Yes, but require Australian agent to lodge documentation	2-3 weeks
Canada (2)	Accepts both testing and certification from CABs in Chinese Taipei	2-3 weeks
Hong Kong, China (1)	Yes, no change from prior to TEL MRA	2-3 weeks
Japan (nil)	Still requires testing to be checked by a Japan-based lab – CABs in Chinese Taipei have formed alliances with CABs in Japan for this purpose	4 weeks
Mexico (nil)	No, testing must be conducted in Mexico	6 weeks
China (nil)	No, testing must be conducted in China	6-8 weeks
Singapore (1)	Yes, no change from prior to TEL MRA	2-3 weeks
Korea (nil)	No, testing must be conducted in Korea	4-6 weeks
United States (1)	Yes, accepts testing reports from CABs in Chinese Taipei	2-3 weeks

Source: Case study interviews

[62] Boulton, W (2002): Taiwan Telecommunications Industry in Iskander, M et al, Asian Telecommunications Update, Chapter 7 pp57-72
[63] Fu T et al, op cit. (2002): Taiwan Telecommunications Industry in Iskander, M et al, Asian Telecommunications Update
[64] International Trade Centre (2016): List of exporters for the selected product, Available from: http://www.trademap.org/tradestat/Country_SelProduct_TS.aspx (Accessed June 2016)
[65] Wang, C-C., and Jang, C-LJ. (2014): The impact of the APEC MRA for Conformity Assessment on Telecommunications Equipment on Trade: Evidence from Taiwan, Global Journal of Business Research 8:3, 1-7.

These are all largely fixed costs related to introducing a new product to the market, a finding supported by the Wang and Jang study.[66]

Interviewees reported that the APEC TEL MRA has enhanced manufacturers' links internationally. They are now closely linked in to changing technical standards in major markets.

6.2 R&D

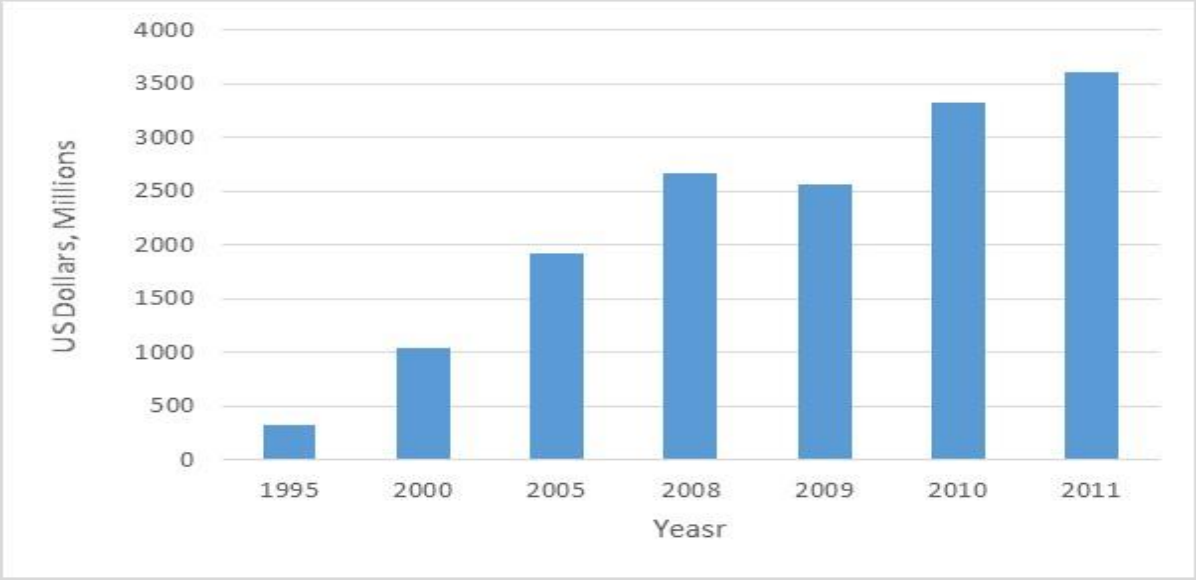
Interviewees for the case study alluded to the importance of testing in Chinese Taipei allowing R&D to stay in the domestic economy. This was particularly important in the case of competition with economies where there was no Phase 1 agreement – R&D is still in Chinese Taipei because the design, testing and pre-testing can be done domestically. This was seen as important because the economy has already reduced competitiveness due to rising costs of labour and manufacturing. Once the product is tested and certified domestically, then it can be manufactured in a lower-cost economy.

TiVA data appear to confirm this assertion – Figure 6 shows the contribution to value add by R&D and other business services to gross exports of computer, electronic and optical equipment from Chinese Taipei in the years 1995, 2000, 2005 and 2008-2011. It shows the value of these inputs rose 8-fold from 1995 to 2008, plateaued in 2009 and then rose again another 1.5-fold from 2009 to 2011. In 2006, approximately 75 percent of Chinese Taipei's business enterprise R&D was attributable to either electronic parts and components manufacturing, or computer, electronic and optical products manufacturing and 31 percent manufacturing exports were attributable to information and communications technologies.[67] Although a deeper analysis of this issue is beyond the scope of this study, further research could examine the links between CABs and manufacturers in relation to the formers' support for R&D either domestically, or as Chinese Taipei companies expand internationally, particularly to China.

[66] Ibid page 2

[67] Chen, S-H, Wen, P-C and Liu, M-C (2011): Trends in Public and Private Investments in ICT R&D in Taiwan, JRC Technical Notes, JRC63993-2011, European Commission Joint Research Centre for Prospective Technological Studies Seville, Spain

Figure 6: Contribution of R&D and Other Business Services to Value Add in Computer (etc.) Exports for Chinese Taipei



Source: TiVA database origin of value added in gross exports, C73T74 (R&D and other business services) to Computer, Electronic and Optical Equipment Industry, 1995-2011

6.3 REGULATORS AND THE ACCREDITATION AUTHORITY

While the effort in developing the MRA and implementing it in Chinese Taipei was significant, the initiative formed part of a larger effort to deregulate telecommunications services and to develop the manufacturing industry. Interviewees reported that the main issue for regulators was restructuring the domestic legal framework to adopt conformity assessment procedures and to support regional harmonization.

The main impact on TAF has been to lift its capability to accredit CABs against international standards. The regulators rely on TAF to evaluate the CABs, so as to ensure that all imported and exported telecommunications equipment complies with legal and regulatory requirements (i.e. standards and specifications). TAF is now well-connected to similar international organisations and has a generally higher capacity to evaluate CABs against international standards. This has placed a greater burden on its resources but much of the additional cost is passed on to manufacturers as TAF operates on a cost-recovery basis.

While the extra workload is significant, some interviewees also noted that the development of the TEL MRA had saved APEC from developing its own standards organisation (e.g. to match the approach taken in Europe which has a Europe-wide CE mark). It is difficult to know which of these approaches would have required less effort but in any case once an industry is linked in globally, any accreditors and regulators will need to increase their effort in maintaining awareness and knowledge of global technical changes.

6.4 CABS – THE TESTING AND SERVICES INDUSTRY

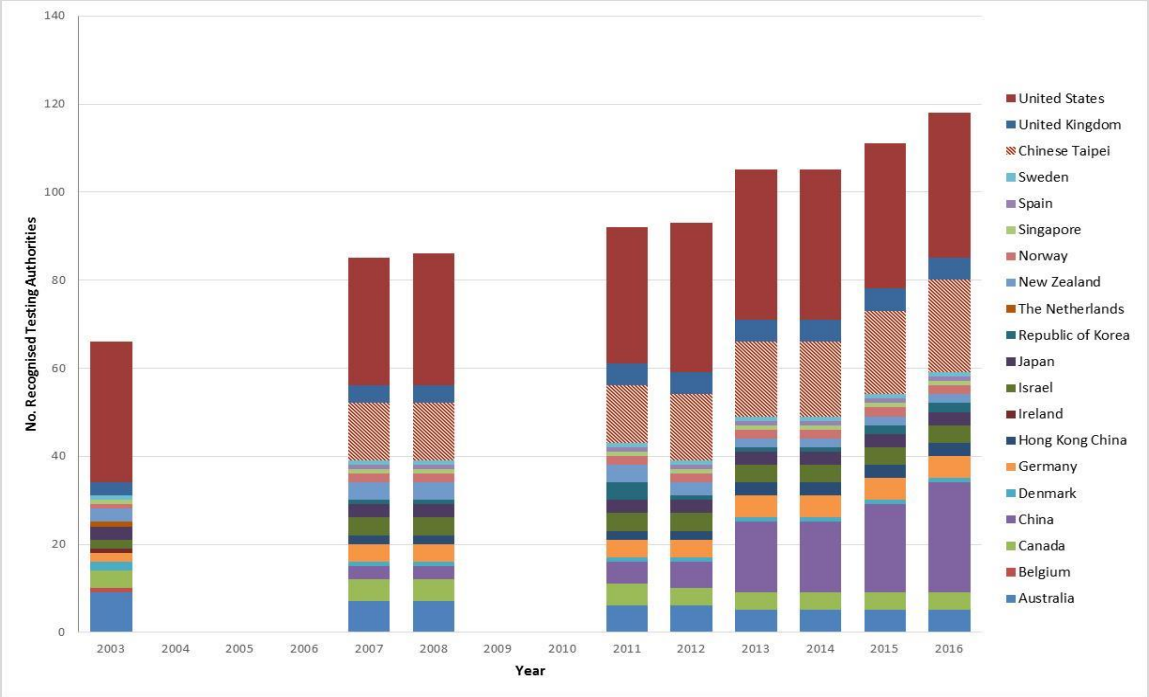
According to interviewees, there has been significant growth in Chinese Taipei-based CABs since the late 1990s. As a result of the APEC TEL MRA the CABs have increased in number and competence. They have become more closely integrated into global value chains, partly

due to industry restructuring, and play a significant role world-wide, for example PTCRB-accredited Chinese Taipei-based labs for testing EMC make up 13 percent of those globally.[68] The best objective support for this assertion comes from the regulators in the economies with which MRAs have been signed. Current data is available for the United States and historical data has been obtained for Australia.

In the US, Chinese Taipei is now ranked third on the Federal Communications Commission list of recognised test firms (behind China and Japan) and is second on the list of recognised accredited test firms (behind the US).[69]

Similarly, the National Accreditation and Testing Laboratory (an Australian organisation similar to the TAF) recognised 111 testing authorities in 2015, led by the US (33) and China (23), with Chinese Taipei third (21).[70] Chinese Taipei's recognition grew substantially from zero in 2003 to 13 in 2007 and 2008 to 21 in 2016 (Figure 7). Recognition of testing authorities in other economies has been static or declining, with the exception of those from China which also had no testing authorities recognised in 2003 but now has 25 recognised.

Figure 7: Historical Trends in Recognising Overseas Testing Authorities by Australia



Source: Author's analysis of National Association of Testing Authorities Australia – Recognised Testing Authorities lists for 2003, 2007, 2008, and 2011-2016, updated annually in June or July

6.5 CONSUMERS

The overall technical and regulatory framework operating in telecommunications helps ensure that products manufactured in one economy will be able to be operated in other economies. Although consumers were not interviewed for the study, both manufacturers and CABs were of the opinion that consumers (worldwide) benefit through gaining access to new and improved

[68] Chen, H (2015): What NTBs and MRA Mean to ICT Industry, presentation to WTO Workshop, 7 May 2015
[69] Author's analysis of FCC data.
[70] National Accreditation and Testing Laboratory (2016): Recognised Testing Authorities, Available from: http://www.nata.com.au/nata/images/pdf_files/rtalist.pdf (Accessed June 2016)

equipment more quickly, and with greater surety of its safety and operability. The testing and certification process for telecommunications equipment is likely to be quite opaque to consumers but demand will rise whenever consumers see new products launched internationally. A smooth and efficient testing and certification process enables manufacturers and their resellers to meet this demand as quickly as possible.

6.6 NEXT STEPS IN REFORM

A number of interviewees commented on issues that still faced Chinese Taipei and that may be receptive to regulatory reform. It should be stressed that these are suggestions rather than official government policy, and cover three topics – cybersecurity, ongoing market surveillance issues, and deregulation for low risk products.

First, is the potential extension of the APEC TEL MRA to cybersecurity.[71] APEC has issued a cybersecurity strategy,[72] which highlights the need for legal and regulatory frameworks that underpin trade, investment and growth in consumer confidence, including domestic cybersecurity laws, domestic security incident response teams and combatting of cybercrime. The APEC Telecommunications and Information Working group, which developed the APEC TEL MRA, has since held a workshop on the issue to share basic concepts and seek member economies' input and suggestions around a fundamental cybersecurity framework.[73] An extension of the APEC TEL MRA to cybersecurity could lay the overarching framework for economies to address this issue, in much the same way as it has provided the framework for recognition of testing regimes.

Second is an issue common to all regulators – the import of potentially non-compliant products by private citizens following online (internet) purchases. There are some pressures in Chinese Taipei to ease compliance requirements generally as a result, but heightened risks of post-market issues are recognised by the NCC.

This matter is linked to the issue of post-market surveillance. Interviewees noted that Canada has a two-step process where there is double-checking of products before approval. According to interviewees, post-market issues are of less concern there than in Chinese Taipei, where there is only one check.

Both these matters are being considered by the NCC, which wants to understand how other economies manage imported products that are not compliant, especially since the Internet market is growing so rapidly. Chinese Taipei is keen to discuss this with other economies under the APEC Telecommunications Working Group or APEC TEL MRA meetings. While the issue has been raised before, there have been no solid solutions, partly because MRA meetings are mainly for information sharing.

Third is ongoing reduction of regulatory burden in lower risk areas. While APEC economies have generally required all devices that intentionally generate and emit radio frequencies to comply with the conformity assessment procedure, Chinese Taipei has recently started reviewing the relevant technical regulation on low-power radio frequency devices and may

[71] Sheng, R (ND): op cit

[72] APEC (2005): Strategy to Ensure a Trusted, Secure and Sustainable Online Environment, Inter-sessionally endorsed by Senior Officials in November 2005

[73] http://www.apec.org/groups/som-steering-committee-on-economic-and-technical-cooperation/working-groups/telecommunications-and-information.aspx

exclude them from the list of regulated devices. NCC and BSMI will work together on this, in consultation with industry.

There are some precedents in other economies, where such devices may be exempt from licensing requirements as long as they are operating within approved technical standards. In other economies such devices may be managed under a class licence. For example, the Australian class licence which, for no fee, automatically authorises all users of such devices to share the same part of the radio spectrum provided that the devices comply with all radio-communications standards.[74]

[74] Radio Communications (Low Interference Potential Devices) Class Licence 2015 http://www.acma.gov.au/theACMA/lipd-class-licence-spectrum-acma (Accessed May 2016)

7. CONCLUSIONS AND LESSONS FOR OTHER ECONOMIES

The APEC TEL MRA was preceded by general telecommunications services reforms which opened up the (then) national telecommunications service provider to competition and made it easier for telecommunications manufacturers to import components. These reforms also increased manufacturing competition by allowing new manufacturers to establish in the market, and allowed the development of the mobile telephony market by allowing new service companies to establish domestically.[75] The APEC TEL MRA which followed these reforms then provided the framework through which Chinese Taipei's CAB industry could build capability and ensure that this occurred in line with international standards.

Chinese Taipei has set up a transparent regulatory system to manage these reforms. TAF was formed from the merger of two pre-existing organisations in order to provide a focus for capacity-building and standards recognition using a governance framework (as a not-for-profit) that enables to operate independently while still remaining under government supervision. It plays a central role in helping CABs meet international standards and keeping them aware of international technical changes.

The NCC and BSMI regulate telecommunications and electrical safety respectively and are required to hold public hearings before making any major changes to the regulatory regime; hence the process is transparent. However, the division of authority between the operations of the two organisations has prevented Chinese Taipei from taking full advantage of the APEC TEL MRA. The government has started to address this issue.

The reforms enacted, and the broader market-focused approach of Chinese Taipei, have allowed domestic manufacturers to test their product locally, thus enabling R&D to remain local and lowering testing costs and speeding the path to market. The Government's broad stated intention at the time was to grow the telecommunications manufacturing sector to drive down the cost of consumer access to telecommunications services and equipment. The NCC, however, didn't put any manufacturing or service (CAB) industry impact measures into place as these had limited relevance to its remit. The data available to measure the impact on CABs in Chinese Taipei has been a side-effect of transparent policies operating in other economies e.g. regulators in the United States and Australia.

As noted in earlier discussion, interviewees felt that the main gap in the steps taken was the lack of focus on a post-market surveillance system, and realization that fragmentation of global value chains meant that the accreditation system needed to work at a laboratory rather than company level.

Finally, while Chinese Taipei has reaped benefits from Phase 1 agreements with several economies, it appears there are gaps in coverage that are continuing to cause impediments in exports to some significant markets. Though the underlying purpose of these regulations is to support industry development, further consideration of desired industry outcomes and actions needed to support these fall outside the scope of the authorities of both regulators in Chinese Taipei. The APEC TEL Working Group is a useful forum to provide local industry with the potential to influence new Phase 1 and Phase 2 agreements that will support industry policy objectives.

[75] Lee, R-C *op cit*

Lessons and Recommendations

The main lessons from this case study for other economies considering such changes, highlight the importance of the roles of regulators and accreditors and their awareness of economic development objectives of regulatory reform.

First, regulators need to consider how emerging technical changes (in this case the convergence of IT and telecommunications technologies) will affect the scope of what they regulate. Regulatory frameworks must keep pace with technical change so that they do not themselves create barriers to the government's other objectives (e.g. trade objectives, while maintaining safety objectives). Regulators could address this by establishing dialogue with economic development agencies in response to technical convergence. In addition, regulatory impact statements could expressly consider the impact of technical convergence over time, either at the time of decision or at planned review intervals.

Second, regulators and accreditors need to understand the industrial structures of the companies they are regulating or accrediting. In Chinese Taipei, TAF was initially unaware of the implications of certifying a company as oppose to a laboratory. TAF was also unaware of potential impact of the size of the company and its resulting reach across borders. While both issues were rapidly addressed, additional consultation with manufacturers or CABs at the time the accreditation system was established, may have flagged this issue and enabled it to be addressed from the start. Participation in fora that enable accreditors to learn from other economies where similar issues have been addressed would also help in the planning stages.

Third, the Chinese Taipei case study has shown the importance of the accrediting agency playing a pro-active role in supporting development of industry capacity as standards change. The domestic CAB industry is heavily skewed towards SMEs which, while technically competent, have limited resources available to track changes and trends which are initiated in other economies and by international technical organisations. TAF has played an important role in developing and maintaining international technical networks that give it forward notice of technical changes and enable it to develop training and awareness courses for its SMEs so that they are compliant when the change occurs.

Linked to this issue is the desirability of developing key indicators that will enable regulators to assess the impact on both manufacturers and CABs from the commencement of these reforms. This is particularly important given Chinese Taipei's wish to improve trade. The difficulty of teasing out the impact of testing and certification reforms from large economic trends has already been noted and the lack of detail in trade data has made it difficult to obtain detailed information. Post-event modelling and this case study have identified positive impacts, but a more formal set of impact measures would have enabled the government to identify these trends much earlier and would have either confirmed the wisdom of the regulatory change or enabled the government to correct any mis-application.

Fourth, post-market surveillance should be considered by the regulator if regulatory or technical change (i.e. online purchasing) increases the risk of faulty products entering the domestic market. This may be necessary because of safety but it is also important for consumer confidence in the integrity of the testing and certification system. Regulators need to weigh up the both risks and benefits as well as establishment and implementation costs.

Fifth, regulators should ensure that manufacturing and CABs are involved in relevant APEC working groups and other formal or informal information-sharing events so that industry policy objectives can be addressed. While this has happened in Chinese Taipei, it became apparent during the case study that the NCC, with no authority over the manufacturing sector, had limited knowledge of changes in focus of manufacturers in relation to their export objectives. The dialogue with manufacturers and CABs needs to be maintained. There is more than one successful model available here – in addition to involvement in APEC working groups, regulators can participate in industry consultation via industry associations, and can also establish formal consultation fora (e.g. annual roundtables).

GLOSSARY OF TERMS

3GPP -	3rd Generation Partnership Project
ACMA	Australian Communications and Media Authority
AEPR	APEC Economic Policy Report
APEC TEL MRA	APEC Telecommunications Mutual Recognition Agreement
BRA	Basic Rate Access
BSMI	Bureau of Standards, Metrology and Inspection
CABs	Conformity Assessment Bodies
CAEEE -	Conformity Assessment of Electrical and Electronic Equipment
CE	Customer Equipment
CPE	Customer premises equipment
DCS	Digital communication system
DEL	Direct exchange lines
DGT	Directorate General of Telecommunications
DSL	Digital subscriber lines
DVB-T2	Second generation Digital Terrestrial Television Broadcasting System
EMC	Electromagnetic compatibility
ETR MRA	MRA for Equivalence of Technical Requirements for Telecommunications
FTNS	Fixed Telecommunications Network Services
GCF	Global Certification Forum
GPS	Global Positioning System
GSM	Global System for Mobile Communication
GVC	Global Value Chains
ICIO	Inter-Country Input-Output
IDTV	Integrated Digital Television
IER	Individual Economy Reports
ISM	Industrial, scientific and medical
IRD	Integrated Receiver Decoder
ITE	Information Technology Equipment
ITRI	Industrial Technology Research Institute
ITU	International Telecommunications Union
LEC	Local Exchange Carriers
LTE	Long Term evolution
MMS	Multimedia Messaging Service
MRA	Mutual Recognition Agreement
NCC	National Communications Commission
OTA	Over the Air
PRA	Primary Rate Access
PSTN	Public Switched Telephone Network
PTN	Public Telecommunications Network
PSU	Policy Support Unit
R&D	Research & development
RF	Radio-frequency
SAR	Specific Absorption Rate
SME	Small to medium enterprise
TAF	Taiwan Accreditation Foundation
TiVa	Trade in Value Add

TE	Terminal equipment
TTE	Telecommunication terminal equipment
UNCTAD	United Nations Conference on Trade and Development
U-NII	Unlicensed National Information Infrastructure
US	United States
W-CDMA	Wide-band Code-division Multiple Access 3G Technology
WTO	World Trade Organization

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ANNEXES

ANNEX 1 – GENERAL INTERVIEW GUIDE

Case Study of Chinese Taipei for Services and Structural Reform Semi-structured interview Questions

Circulated following the letter of introduction

Scope: Impact of the APEC TEL MRA on testing and certifications and associated telecommunications equipment manufacturing industries in Chinese Taipei

Purpose of interviews:
Understand broader national context of regulation (focus on utility patent changes of 2006)

a) Confirm our understanding of regulation and industry from our literature reviews

b) Identify gaps in our understanding, especially industry influences which explain main trends

c) Identify policies and events that might alter our interpretation of facts and issues

d) Deepen our understanding of the sequence of reforms and how regulatory and policymakers balanced competing objectives, addressed adjustment issues, and targeted assistance and capacity building to maximise flow on effects for the economy

Interviewees will be from government, universities and the private sector

a) Regulators in Chinese Taipei

b) Equipment testing industry

c) Telecommunications manufacturing industry

d) Regulators or industry representatives in Singapore and Canada (economies that export to, or import from, Chinese Taipei and have been recognised under the agreement)

Use of interview material:

Detailed notes will be confidential but will be used for the written case study. Interviewee names and contact details will be provided to APEC as part of reporting but be listed in the final report (e.g. the report will use terms such as "representatives of" a particular organisation or government agency). The final report may have a list of organisations consulted during the development of the case study.
Person conducting interviews:

Dr Lyndal Thorburn
Senior Associate
Sustineo Pty Ltd, 27 Torren St Braddon ACT 2602 Australia

Interview structure - general

Note – main focus of discussion (time spent) was on item 3

1. Introduction

The research topic, its purpose, process and stage in the project.

2. The current understanding in the case study

Summarise what we know for this case study/industry sector, and seek comment.

3. How these regulations work in the overall national context

As relevant to the (Chinese Taipei-based) interviewee:

a) Background to the development of the TEL MRA and its introduction into Chinese Taipei
b) Considerations prior to introduction including industry consultation
c) Competing issues that arose at the time
d) Other policies that affected introduction of the MRA by Chinese Taipei especially moves from Phase 1 to Phase 2
e) For Standards that have been updated since accreditation, does the accreditation still stand?
f) Details of any capacity building programs for the testing industry or the telecoms manufacturing industry
g) Adjustment issues experienced by regulators, industry etc
h) Expected impact of the regulatory change vs actual observed impacts
i) Objective measures of impact: labour force productivity, growth or changes in structure of testing industry and/or telecoms manufacturing industry

In relation to above was the whole process repeated for Phase 2 vs Phase 1 recognition?

4. Gaps

What other events have resulted in the trends that we see in this case study? Focus on national level – this economy vs. others

Who else should we speak to?

5. Further references

What other sources documents might be available?

Interview questions - detailed

Introduction

Structural change is defined by APEC as institutional frameworks, regulations and government policy (designed) so that barriers to market-based incentives, competition, regional economic integration and improved economic performance are minimized'. APEC has identified six key components of the structural reform agenda:

1. Removing barriers to the entry of domestic new entrants, and allowing existing firms to exit the marketplace in an orderly fashion if the market dictates that they cannot survive.
2. Removing barriers to foreign competition, be it from cross-border trade or from foreign direct investment, and not just for particular trading partners.
3. Ensuring that the minimum regulation exists to guide economic outcomes in those circumstances where markets alone may not deliver the most efficient outcomes.
4. Ensuring that the right institutions are in place to review and remove the unnecessary impediments to the functioning of markets.
5. Ensuring that the right institutions are in place to design, implement, enforce and review the functioning of more appropriate regulation.
6. Developing transparency of institutional processes, including public sector management, so as to better serve the public good.

History – NCC/TAF

What made Chinese Taipei participate in the APEC TEL MRA – what benefits were expected and how were these to be measured? Why was this a priority?
When Chinese Taipei participated in the Taskforce, did TAF exist?

Coordination – pre-implementation – NCC/TAF/BSMI

Was the original coordination agency DGT?
What was set up within CT to coordinate development of the MRA? (aware that NCC only formed in 2006)?
How was it decided that NCC and BSMI would be the regulatory authorities jointly and why two not one?
What industry consultation was done at the time?
How were the first economies for Phase 1 decided and why is Canada the only one that has signed Phase 2? (noting that Chinese Taipei had signed Phase 1 by 1999 and by 2005 there were still 2 APEC economies that had not signed anything).
Was the process different for Phase 2 vs Phase 1? What additional issues were faced?
The agreement covers any equipment regulated by telecoms authority – how does NCC (BMSI?) define what equipment it regulates? (legislation) (Telecommunications Act?)
How are the industry standards-setting responsibilities of NCC matched with the telecomms regulatory responsibilities of NCC?
How do all these regulations work in the national context?

Coordination – now – NCC/TAF/BSMI

How does the joint committee operate?
What are the major policy decisions and how is industry consultation on these managed?
What effects on industry are there and how are these evaluated? (quantitative vs qualitative?)
How does NCC/BSMI liaise with telecommunications industry policy people?
Is there a policy review cycle?
More than ten years has elapsed since the Phase 1 agreement 1999 – have there been policy changes in response to industry or other input?

What has been the benefit to the regulator (resourcing, international engagement, harmonization)?
BSMI's role in measuring-instrument comparisons?
Agreements with other economies – what is the process? There were a lot in 2000, do the agreements pre-date the accreditation process or did they come first?
If you were doing this again, what would you do differently?
What have been the main lessons learned?

Accreditation - TAF
(Aware that TAF formation post-dates 1999 commencement of accreditation)
What is the process to recognise a CAB (steps) – the CABs are recognised according to the standard in the other economy? E.g for Hong Kong, China the CABs meet HKTA standards
What happens when the standard changes?
How does TAF measure the benefits of accreditation?
What other issues were faced?
What have been the main lessons learned?
If you were to design this process again, what would change?

CABs
How does TAF decide who to accredit for what – do CABs apply, does TAF decide what is needed and advertise? what is the role of the industry association?
Was there a capacity building program and how was this funded?
Why do different CABs only get accredited for one or two things?
Benefits to TAF as an accreditor -

Industry impacts (TAF/ITRI/CABs)
What was the state of the testing and certification in industry in Chinese Taipei at the time the MRA was proposed?
What has happened since?
Adjustment issues?
How is the impact measured? There don't seem to be many major trends emerging out of national statistics; (labour force, exports, imports, manufacturing)
How has the manufacturing industry been changed since the MRAs?
How has the testing industry been changed since the MRAs?

Phase 1 to Phase 2
In relation to above was the whole process repeated for Phase 2 vs Phase 1 recognition?

Gaps
What other events have resulted in the trends that we see in this case study? (TC vs elsewhere)
Who else should we speak to?
What other sources documents might be available?

ANNEX 2 – AVAILABILITY OF STATISTICAL DATA

Chinese Taipei has good economy level statistics which can be mapped against the International Standard Industries Classification[76] and other classification systems where the level of detail is sufficient. Chinese Taipei's national census, held every five years, publishes data at 4 digit level and below, including (relevant data in bold):

- Manufacture of Electronic Parts & Components (includes manufacture of **semi-conductors**; manufacture of **electronic passive devices**; manufacture **of bare printed circuit boards**; manufacture of **optoelectronic materials** and components; manufacture of **other electronic parts & components**)
- Manufacture of Computers, Electronic & Optical Products (includes manufacture of computers & peripheral equipment; manufacture of **communication equipment**; manufacture of **audio and video equipment**; manufacture of magnetic and optical media; manufacture of measuring, navigating, control equipment, watches and clocks, manufacture of irradiation & electromedical equipment; manufacture of optical instruments & equipment;
- Manufacture of Electrical Equipment (including: manufacture of power generation, transmission and distribution machinery; manufacture of batteries; **manufacture of wiring and wiring devices**; manufacture of lighting equipment; manufacture of domestic appliances; manufacture of other electrical equipment

Censuses before and after the signing of TEL MRA agreements were reviewed, but it was expected that the impact of TEL MRA agreements may be small in the overall national picture. This is due to the sequential nature of signing of MRA agreements with other economies, the likely minor impact of the signing of the MRA with both Singapore and Hong Kong, China, and the broader impact of major events such as the Asian Financial Crisis (1997) and the Global Financial Crisis (2008).

The International Trade Centre has a website which compiles trade statistics under a number of categories, the most relevant being Product Group, Section 85: *Electrical machinery and equipment and parts thereof* which includes Electrical apparatus for line telephony or line telegraphy (8517), Transmission apparatus for radio-telephony, radio-telegraphy, radio-broadcasting or television (8525) Reception apparatus for radio-telephony, radio-telegraphy or radio-broadcasting, (8527) and Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (8434). These will be reviewed seeking trends information relevant to Chinese Taipei.

The OECD also hosts the OECD-WTO Trade in Value Add (TiVA) data set[77] which also provides a central source of information on trade data. It aims to provide better tracking of global production networks and supply chains than is possible with conventional trade statistics and contains a range of indicators measuring the value added content of international trade flows and final demand. The indicators are derived from the 2015 version of OECD's Inter-Country Input-Output (ICIO) Database. Sample relevant search terms are:[78]

[76] United Nations (2008): International Standard Industrial Classification of All Economic Activities (ISIC) Series M Rev 4 No. 4

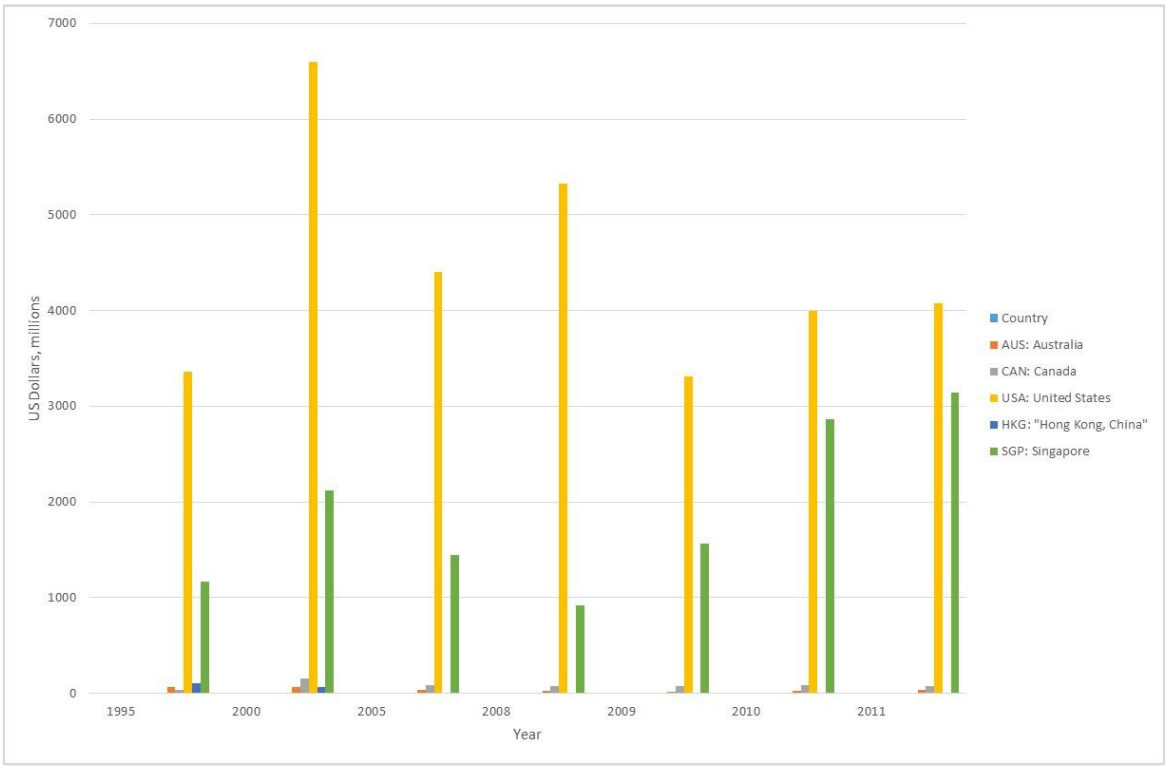
[77] OECD (2016): OECD.Stat, Available from: www.stats.oecd.org (Accessed May 2016)

[78] OECD (2015): TiVA 2015 Definitions, Version 2, Available from: http://www.oecd.org/sti/ind/tiva/TIVA_2015_Indicators_Definitions.pdf (Accessed May 2016)

- Gross exports by industry and partner economy e.g. to determine if there was a change in exports between Chinese Taipei and an MRA TEL partner economy before and after signing;
- Foreign value added share of gross exports, which is a measure of the import content of exports, a backward linkage measure which provides insights into which economies provide components or parts for products exported by Chinese Taipei. An initial review of these data has shown that, as expected, there is limited contribution by the TEL MRA economies to telecommunications products manufactured in Chinese Taipei and then exported; and
- Domestic services value add in gross exports which, while potentially attractive as a source of information in the role of services to manufacturing, appears to have little data.

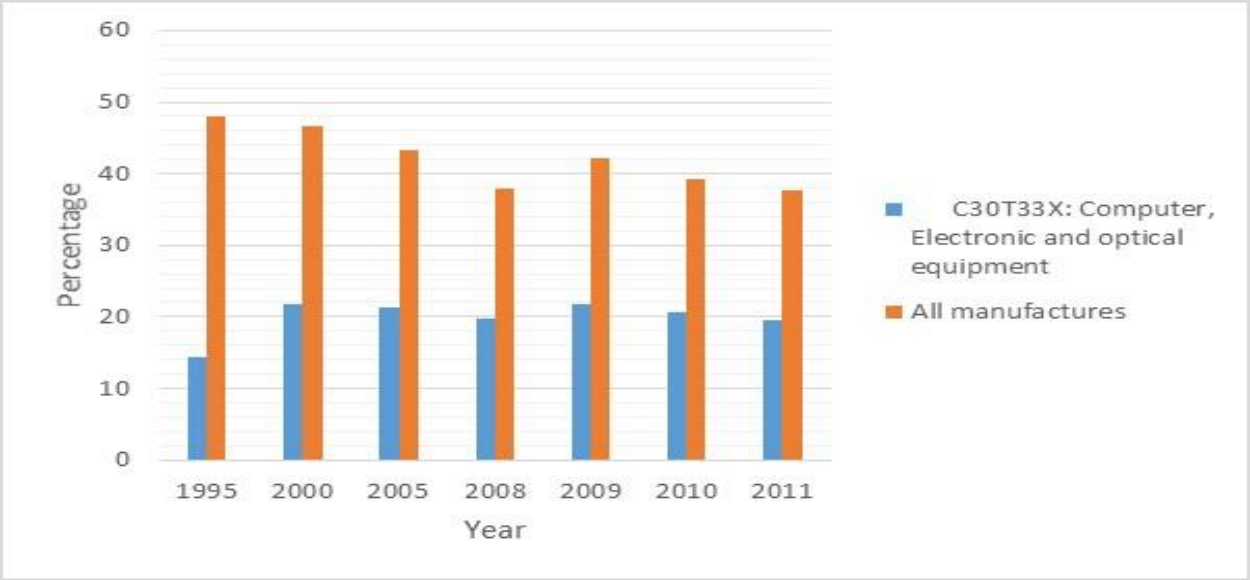
The limitation of the TiVA data set is that it does not use the same classification as the International Trade Centre and the most relevant class is Computer, Electrical and Optical Equipment (C30T33). Data from 1995 through to 2015 was examined to identify trends in exports and value-add in this sector, with the APEC TEL MRA trading partners. No particular trends were observed e.g. the graph of gross exports of computer, electrical and optical equipment to the five economies with which Chinese Taipei has a TEL MRA agreement show initial positive trends for the United States but a fall which is likely to be due to the Asian Financial Crisis in the period 2008-2009 (Figure 8) Figure 1. During this period, however, the percentage of domestic value add to the computer electrical and optical equipment manufacturing rose, while at the same time overall the percentage of domestic value add for all manufactures was falling (Figure 9).

Figure 8: Gross Exports of Computer and Related Products from Chinese Taipei 1995-2011



Source: TiVA database. Note the five yearly intervals between the first three columns and then from 2008 the data are annual

Figure 9: Percentage Contribution of Domestic Value Add to Manufactures, 1995-2011



Source: TiVA database. Note the five yearly intervals between the first three columns and then from 2008 the data are annual

Finally, the UNCTAD makes available national level trade (both import and export) data by year, partner economy and commodity. There are 4-5 commodity classifications at the 3-digit level that are relevant to telecommunications. An analysis was completed of the United States-Chinese Taipei trade from 1995-2000 to see if the reported importance of printed circuit board exports from the US to Chinese Taipei could be identified (see page 17 for discussion on supply side barriers), but the data are too aggregated to pick up this particular trend with any confidence).

ANNEX 3 – TYPES AND SCOPE OF TESTING

This Annex summarises the different types of testing for which Chinese Taipei CABs can be accredited, and the scope of testing for which they are certified. The number of CAB agreements outline in this section is based on the information available from the National Communications Commission, Chinese Taipei.

Customer Premises Equipment (Australia only)

Customer premises equipment (CPE) is telephone or other telecommunication hardware that is installed or located on the customer's physical premises e.g. telephone handsets, cable TV set-top boxes, VoIP base stations, or Digital Subscriber Line routers.[79]

Table 9: Australian Telecommunications Standards

Standard	Definition
TS001 – 1997	Safety Requirements for Customer Equipment
TS002 – 1997	Analogue Interworking and Non-Interference Requirements
TS003 – 1997	Customer Switching Systems Connected to Public Switched Telephone Network (PSTN)
TS004 – 1997	Voice Frequency Performance Requirements for Customer Equipment
TS005 – 1997	Mobile Station for AMPS Analogue Cellular Mobile Telecommunications System
TS014 – 1997	General Requirements for Customer Equipment Connected to an ISDN Primary Rate Interface
TS018 – 1997	GSM Customer Equipment
TS019 – 1997	Customer Equipment for use with CT2 CA1 Cordless Telecommunications Systems
TS031 – 1997	Requirements for ISDN Basic Access Interface
TS038 – 1997	Requirements for ISDN Primary Rate Access Interface

Source: Australian Communications and Media Authority see http://www.acma.gov.au/

EMC (Australia and US)

EMC is focused on ensuring the correct operation of different telecommunication equipment within a standard electromagnetic system. This is specifically related to avoiding damage to equipment through unintentional generation and reception of electromagnetic energy.

[79] TechTarget (2010): Customer Premises Equipment, Available from: http://searchnetworking.techtarget.com/definition/customer-premises-equipment (Accessed May 2016)

Table 10: Australian EMC Standards

Standard	Definition
AS/NZS 1044 – 1995	Limits and methods of measurement of radio disturbance characteristics of electrical motor-operated and thermal appliances for household and similar purposes, electric tools and similar electric apparatus
AS/NZS 1053	Limits and methods of measurement of radio interference characteristics of sound and television broadcast receivers and associated equipment
AS/NZS 2064 ½ - 1997	Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radiofrequency equipment
AS/NZS 3548 – 1995	Limits and methods of measurement of radio disturbance characteristics of information technology equipment
AS/NZS 4251 – 1999	Electromagnetic compatibility (EMC) Generic emissions standard Series
AS/NZS 4051 – 1998	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
AS/NZS 4052 – 1992	Guidance on the use of the substitution method for measurements of radiation from microwave ovens for frequencies above 1 GHz
AS/ACIF S002	Applies to customer equipment that is designed or intended for connection with an analogue public switched telephone network two-wire service
AS/ACIF S043-1	Requirements for Customer Equipment for connection to a metallic local loop interface of a Telecommunications Network (Part 1 – General)
AS/ACIF S043-2	Requirements for Customer Equipment for connection to a metallic local loop interface of a Telecommunications Network (Part 2 – Broadband)

Source: SAI Global, ACMA and the Australian Communications Industry Forum

Table 11: United States EMC Standards

Standard	Definition
47 CFR Part 18	Regulates industrial, scientific and medical (ISM) equipment that emits electromagnetic frequencies within the radio frequency spectrum
47 CFR Part 15	Regulates intentional, unintentional or incidental radiator operations without individual license Notes: also contains technical specifications, administrative requirements and conditions relating to part 15 devices

Source: Cornell University Law resources and the Electronic Code of Federal Regulations

Fixed Network Equipment (Hong Kong, China only)

Fixed network equipment broadly refers to a system that is connected by wires rather than a radio system. Fix network equipment refers to the equipment that support this this network. This can also include the PSTN, digital subscriber lines (DSL), and coaxial cable and fibre. Within a premises, other equipment can be included under this definition which assist in

extending the network to other devices. This includes by wires (such as an Ethernet) or wireless networks (such as Wi-Fi).[80]

Table 12: Hong Kong, China Fixed Network Equipment Standards

Standard	Definition
HKTA Specification 2014	Network connection specification for connection of CPE to the Public Telecommunications Network (PTN) in Hong Kong, China using ISDN Basic Rate Access (BRA) based on ITU-T recommendations
HKTA Specification 2015	Network connection specification for connection of CPE to the to the PTN in Hong Kong, China using ISDN Primary Rate Access (PRA) at 1544kbits/s based on ITU-T recommendations
HKTA Specification 2017	Network connection specification for connection of CPE to the PTN in Hong Kong, China over digital trunk at 1544kbits/s using DTMF signalling
HKTA Specification 2021 (formerly HKCA 2021)	Network connection specification for connection of CPE to the PTN in Hong Kong, China by ISDB BRA interface using metallic loops on the network
HKTA Specification 2023 (formerly HkCA 2023)	Network connection for the connection of CPE with voiceband operation to the private circuits provided by the Fixed Telecommunications Network Services (FTNS) operators in Hong Kong, China

Source: OFCA Hong Kong, China

Information Technology Equipment (Singapore only)

Information Technology Equipment (ITE) includes devices that collect, transfer, store or process data. Such devices generate a multiplicity of periodic pulsed, or binary, electrical waveforms. ITE equipment is generally low voltage in nature (600V or below). Examples of ITE equipment include computers, telecommunications equipment, monitors, keyboards, printers, servers, and computer drives.[81]

Table 13: Singapore ITE Standards

Standard	Definition
IEC/ISO CISPR 22	The standard cover limits and methods of measurement of radiated and conducted emissions from ITE.

Source: International Electrotechnical Commission

Low power R.F. equipment (Australia, Singapore, US)

Low-power, non-licensed RF transmitters are used virtually everywhere. Cordless phones, baby monitors, garage door openers, wireless home security systems, keyless automobile entry systems and hundreds of other types of common electronic equipment rely on such transmitters

[80] OECD (2012): Fixed and Mobile Networks: Substitution, Complementarity and Convergence, Working Party On Communication Infrastructures And Services Policy, Directorate for Science, Technology and Industry Committee for Information, Computer And Communications Policy DSTI/ICCP/CISP(2011)11/FINAL, 8 October 2012, page 9

[81] Compatible Electronics (2016): Information Technicality Equipment – ITE Equipment. Available from: http://www.celectronics.com/training/learning/product_family_standard/Information-Technology-Equipment-ITE.html (Accessed May 2016)

to function. At any time of day, most people are within a few meters of consumer products that use low-power, non-licensed transmitters.

Table 14: Australian Low Power RF Equipment Standards

Standard	Definition
AS/NZS 4268	Limits and methods of measurement for radio equipment and systems for short range devices
AS/NZS 4771	Standard for technical characteristics and test conditions for data transmission equipment operating in the 900MHz, 2.4 GHz and 5.8 GH bands and using spread spectrum modulation techniques

Source: SAI Global

Table 15: Singapore Low Power RF Equipment Standards

Standard	Definition
IDA TS SRD	This specification defines the minimum technical requirements for short-range device transmitters and receivers to operate in the authorized frequency bands or frequencies, and transmit within the corresponding output levels.

Source: Infocomm Development Authority of Singapore see http://www.ida.gov.sg

Table 16: United States Low Power RF Equipment Standards

Standard	Definition
47 CFR Subpart 15B	This subpart regulates unintentional radiator operations without an individual license
47 CFR Subpart 15C	This subpart regulates intentional radiator operations without an individual license
47 CFR Subpart 15E	This subpart sets out the regulations for unlicensed National Information Infrastructure (U-NII) devices operating in the 5.15-5.35 GHz, 5.47-5.725 GHz and 5.725-5.825 GHz bands.
47 CFR Part 18	Regulates ISM equipment that emits electromagnetic frequencies within the radio frequency spectrum to prevent harmful interference with authorised radio communication services

Source: SAI Global and Cornell University law resources

Mobile/base station for GSM communication/digital communication system (DCS) (Australia; Hong Kong, China)

The GSM is an open, digital cellular technology used for transmitting voice and data services. GSM is a circuit-switched system that divides each 200kHz channel into eight 25kHz time slots. The data transfer speeds supported by GSM enables the transmission of basic data services, such as SMS. GSM has international roaming capabilities which allow users to access the same services abroad and in their home economies.[82]

Table 17: Australian GSM/DCS Standards

Standard	Definition
TS018 – 1997	GSM Customer Equipment

Source: Australian Communications and Media Authority see http://www.acma.gov.au/

[82] University of Colorado Boulder (2016): GSM Tutorial. Available from: http://ecee.colorado.edu/~ecen4242/gsm/index.htm (Accessed May 2016)

Table 18: Hong Kong, China GSM/DCS Standards

Standard	Definition
HKTA Standard 1033	Performance specification for mobile stations and portable equipment for use in the global system for mobile communications (GSM) 900 and 1800 MHz bands

Source: Office of the Communications Authority (Hong Kong, China) see http://www.ofca.gov.hk/

Radio Communications Device (Australia only)

A radio communications device is a transmitter designed for the purpose of radio communication. This includes anything designed to, or intended for, the use of communication through transition and reception of radio signal. Relevant standards specify the essential operational and marking requirements and required radiofrequency characteristics for operation within certain radiofrequency spectrum arrangements.

Table 19: Australian Radio Communications Device Standards

Standard	Definition
AS 4295 – 1995	Analogue speech (angle modulated) equipment operating in land mobile and fixed services bands in the frequency range 29.7 MHz to 1 GHz
AS/NZS 4255 – 1995	Radiocommunications equipment used in the handphone and citizen band radio services operating a t frequencies not exceeding 30 MHz
AS/NZS 4281 – 1995	Radiocommunications requirements for cordless telephones operating in the 1.7MHz and between 30 and 41MHz frequency band
AS/NZS 4365 – 1996	Radiocommunications equipment used in the UHF citizen band and personal radio service
AS/NZS 4415 – 1996	Radiotelephone transmitters and receivers for the maritime mobile service operation VHF bands – technical characteristics and methods or measure

Source: Australian Communications and Media Authority see http://www.acma.gov.au/

Radio Equipment (Hong Kong, China; and Singapore)

Radio equipment is any equipment or interconnected system or subsystem of equipment that is used to communicate over a distance by modulating and radiating electromagnetic waves in space without an artificial guide. This includes both transmitting and receiving.

Table 20: Hong Kong, China Radio Equipment Standards

Standard	Definition
HKTA Standard 1002	Performance specifications for short range devices operating in the 433MHz band
HKTA Standard 1004	Performance specifications for VHF transmitters and receivers for use in the public paging service
HKTA Standard 1005	Performance specification for angle modulated VHF maritime band radio equipment for voluntary fitting in small craft
HKTA Standard 1006	Performance specification for cordless telephone operating in the 1.7MHz and 47MHz bands
HKTA Standard 1007	Performance specification for the limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment
HKTA Standard 1008	Performance specification for low power radio microphones, including associated receiving equipment
HKTA Standard 1009	Type acceptance criteria for base station equipment of 2.3GHz E-UTRA TDD network
HKTA Standard 1015	Performance specification for cordless telephone operating in the 864.1 to 868.1 MHz band
HKTA Standard 1016	Performance requirements for radio equipment for use as repeater, base and mobile stations in 800 MHz trunk systems
HKTA Standard 1020	Performance requirements for Base Station System and repeater equipment for use in the public mobile communications service employing GSM (900 MHz band) or Personal Communications Services (1800 MHz band).
HKTA Standard 1022	Performance requirements for CB radio transceivers operation in the frequency band 26.96 – 27.41 MHz for voice communications.
HKTA Standard 1026	Performance specification for cordless telephones operation in the 46 MHz and 49 MHz Bands

Source: Office of the Communications Authority (Hong Kong, China) see http://www.ofca.gov.hk/

Table 21: Singapore Radio Equipment Standards

Standard	Definition
IDA TS SRD	This specification defines the minimum technical requirements for short range device transmitters and receivers to operate in the authorized frequency bands or frequencies, and transmit within the corresponding output levels.

Source: Infocomm Development Authority of Singapore see http://www.ida.gov.sg

Sound and television broadcast receivers and associated equipment (Singapore)

Sound and television broadcast receivers and associated equipment includes any device designed to receive television pictures that are simultaneously broadcast with sound on the television channels.[83]

[83] Legal Information Institute (2016): TV broadcast receivers, Cornell University Law School, Available from: https://www.law.cornell.edu/cfr/text/47/15.117 (Accessed June 2016)

Table 22: Singapore Sound and Television Broadcast Receivers Standards

Standard	Definition
IDA/MDA TS DVB-T2 IRD	Defines requirements for the Integrated Receiver Decoder (IRD) functionality that may be incorporated as a standalone module such as receiver box, an Integrated Digital Television (IDTV) or any other similar device intended for use with the second generation Digital Terrestrial Television Broadcasting System (DVB-T2).

Source: Infocomm Development Authority of Singapore see http://www.ida.gov.sg

Telecommunication Terminal Equipment (Australia, Canada, US)

Telecommunication terminal equipment (TTE) functions at either end of a communications link within a public telecommunication network. It provides sending and receiving functions for subscribers.

Table 23: Australian TTE Standards

Standard	Definition
AS/ACIF S002	Specifies the technical requirements for Customer Equipment (CE) and in the case of compound CE the parts of the compound CE that are designed or intended for connection to an analogue PSTN two-wire service
AS/ACIF S003	Applies to CE that is designed with multiple parts (local or network) that provides or is intended to provide access (gateway functions) to a Telecommunications Network, and capable of switching, storage, processing, conversion, integration, line isolation/coupling or multiplexing of analogue or digital voice or voice equivalent communication
AS/ACIF S041	Specifies the technical requirements for CE or the parts of the CE that are designed or intended for connection to a DSL service that shares the metallic local loop with an analogue PSTN two-wire service.
AS/ACIF S043-1	Requirements for Customer Equipment for connection to a metallic local loop interface of a Telecommunications Network (Part 1 – General)
AS/ACIF S043-2	Requirements for Customer Equipment for connection to a metallic local loop interface of a Telecommunications Network (Part 2 – Broadband)
AS/ACIF S041	Requirements for DSL Customer Equipment of connection to the Public Switched Telephone Network

Source: Australian Communications Authority and Standards Australia see http://www.commsalliance.com.au/

Table 24: Canada TTE Standards

Standard	Definition
CS-03 Part I	Minimal technical requirement of terminal equipment (TE) and related access arrangements intended for direct connection to analog wireline facilities owned by Canadian Local Exchange Carriers (LEC)
CS-03 Part II	Specifies digital network interfaces that include: wide band channel which provide full 1.544 Mbps (DS-1) bandwidth facility channelized into 24 substrate channels of 64kbps interfaces, DS-1 channelised into 64kbps using signaling bits which may be decoded by the network, DS-1 channelised into 24 substrate channels of 64kbps having analog content which may be decoded by the network
CS-03 Part V	This part provides technical requirements for handset telephones to be hearing aid compatible.
CS-03 Part VI	This part sets the minimum network protection requirements for (ISDN TE intended for connection to common carrier provided facilities for both BRA and PRA
CS-03 Part VIII	Sets the minimum requirement for network protection for symmetrical and asymmetrical digital subscriber lines for ADSL, ADSL2, ADSL2+, READSL, HDSL2, SDSL, SHDSL, VDSL and VDSL2

Source: Innovation, Science and Economic Development Canada see http://www.ic.gc.ca/

Table 25: United States TTE Standards

Standard	Definition
47 CFR Part 68	Regulates terminal connection of telecommunications equipment and customer premises wiring with the public switched telephone network, and some private line services and the connection of private branch exchanges to telecommunications interfaces
TIA-968-A	Specifies technical criteria for terminal equipment approach in accordance with 47 CFR 68 for direct connection to the public switched telephone network, including private line services provided over wireline facilities owned by providers or wireline telecommunications

Source: American National Standards Institute see https://www.ansi.org/ and Cornell University Law School see https://www.law.cornell.edu/cfr/text/47/68.100

Terminal Attachment (Canada, Hong Kong, China; US)

Terminal Attachment refers to the technical requirement for the way that terminal equipment is attached to the facilities of telecommunications services providers.

The Canada Terminal Attachment standards are the same as those outlined in Table 24.

Table 26: Hong Kong, China TTE Standards

Standard	Definition
HKTA Specification 2011	Network connection specification for connection of (CPE to direct exchange lines (DEL) of the PSTN in Hong Kong, China

Source: Office of the Communications Authority (Hong Kong, China) see http://www.ofca.gov.hk/

Table 27: United States Terminal Attachment Standards

Standard	Definition
47 CFR Part 68	Regulates terminal connection of telecommunications equipment and customer premises wiring with the public switched telephone network, and some private line services and the connection of private branch exchanges to telecommunications interfaces
TIA-968-A	Specifies technical criteria for terminal equipment approach in accordance with 47 CFR 68 for direct connection to the public switched telephone network, including private line services provided over wireline facilities owned by providers or wireline telecommunications

Source: American National Standards Institute see https://www.ansi.org/ and Cornell University Law School see https://www.law.cornell.edu/cfr/text/47/68.100

ANNEX 4 – CHINESE TAIPEI CABS

Table 28 summarises the key members of the CAB industry in Chinese Taipei for which there was publically available information.

Table 28: Summary of CABs

Name of company	First ISO/IEC 17025 accredited	Owner	Accredited for	APEC TEL MRA Partners
A Test Lab Techno Corp.	2010	SME est. 2001	TTE, Low power RF equipment	Australia; Canada; United States
Aerospace Industrial Development Corporation EME Lab.	2005	Government-owned under Ministry of Economic Affairs from 1969	Low-powered RF equipment	United States
AnCert Certification Co., Ltd	2007	Est. 2009	EMC	United States. Canada; Australia; New Zealand
Audix Technology Corporation	2007	Audix Group, under Technique Services est. 1980	TTE	United States
Bay Area Compliance Laboratories Corp. (Chinese Taipei)		Subsidiary of BACL (United Stated) Est 1996	Low-powered RF equipment, EMC	United States; Canada; Singapore
BTL Inc.	1987 (FCC) 1997 (BSMI)	Est 1986 as Neutron Engineering, merged with BTL in 2005	Low-powered RF equipment, TTE	United States
Bureau Veritas Consumer Products Services (Hong Kong, China) and Taoyuan Branch	2003	Global conglomerate with subsidiaries in ~40 economies	Mobile/base station for GSM/DCS, Low power R.F. equipment, EMC, xDSL Terminal Equipment, Terminal Attachment	Australia; Canada; Hong Kong China; Singapore; United States
Central Research Technology Co.	2001	Est. 1997	Low-powered RF equipment	United States
Cerpass Technology Corporation	2005	Est. 2003, Chinese Taipei based company with labs in China	TTE	United States
Compliance Certification Services Inc.	2003		Low-powered RF equipment	United States
Communications Global Certification Services Inc.	2004	Chinese Taipei company, bought by HTC in 2007	TTE	United States
Electronics Testing Center, Chinese Taipei	2000	Est. 1982 as joint venture between ITRI and Electronic Manufacturers	CPE, EMC, Terminal Attachment, TTE, EMC	Australia; Canada; United States

		Association; 6 domestic locations		
Foxconn EMC Measurement Center	2005	Parent company Hon Hal Precision Industry Co., Ltd est. 1974	EMC	United States
Global Certification Corp.				United States
Global EMC Standard Tech. Corp	2011	Chinese Taipei company est. 1995	EMC, RF	United States
Hong An Technology EMC Laboratory		Hong An Technology Co. Ltd est. 1996	Low-powered RF equipment	United States
International Certification Corp.		Est. 2012	TTE, Low-powered RF equipment	United States
International Standards Laboratory	2003		TTE, low-powered RF equipment, base station RF equipment	United States
Interocean EMC Technology Corp.	1999	Chinese Taipei company. Est. 1999	Low-powered RF equipment	United States
Intertek Testing Services Taiwan Ltd.	2000	One of hundreds of subsidiaries owned by Intertek plc (UK)	EMC, Terminal Attachment TTE	Australia; Canada; Hong Kong China; United States
Inventec Corporation Taoyuan EMC Laboratory	2003	Inventec Corporation (stock exchange listed) est. 1975	EMC	Singapore
Max Light Technology Co., Ltd.	2011	SME est. 1996	Terminal attachment	Canada; United States
MITAC EMC LAB.		Owned by MITAC International Corporation, manufacturer est. 1982		
PTT Laboratory, TECO Imaging Systems	2009	Part of TECO Group (est. 1956), contract manufacturer. Parent in Chinese Taipei, operations in 30 economies	TTE	Canada; United States
QuieTek Corporation	2011	SME, est. 1998, four domestic locations	Low-powered RF	Australia; United States
SGS Taiwan Ltd.	2014	Owned by SGS group since 1952; 2,500 in Chinese Taipei, 85,000 worldwide	Low-powered RF, IT equipment	Singapore
Spectrum Research & Testing Lab., Inc.	2007	SME	Low-powered RF equipment	Australia; Canada; United States

SPORTON International Inc.	2009	Stock-exchange listed parent, business unit founded 2006	Low-powered RF equipment, TTE	United States
Telecommunications Equipment Testing Center, Telecom Laboratories/ Chung-wha Telecom Co., Ltd.	2000	Chung-wha Telecom	CPE, Radio communication devices, EMC, Terminal attachment equipment, radio equipment, fixed network equipment	Australia; Canada; Hong Kong, China; United States
Telecom Technology Center	2015	SME, est. 2004	Sound and TV receivers and broadcasting equipment	Singapore; United States
Training Research Co. Ltd	2000	SME est. 1994	EMC, TTE	Australia; United States
TUV Rheinland Taiwan Ltd		Global corporation est. 1872	Low-powered RF Equipment, TTE	United States
Wendell Co., Ltd	2001	Chinese Taipei company with subsidiaries in Australia; China; Korea; and Japan. Also contract manufacturer	EMC	United States
Worldwide Testing Services (Taiwan) Co., Ltd.	2006	SME est. 1995	Low-powered radio equipment	Singapore; United States

Source: NCC list of List of Domestic Recognized Telecommunication Equipment Testing Labs, supplemented by list from FCC