INFRASTRUCTURE

Guidelines for developing countries ON ESTABLISHING CONFORMITY ASSESSMENT TEST LABS IN DIFFERENT REGIONS

Report

MAY 2012
Telecommunication Development Sector

Guidelines for developing countries on establishing conformity assessment test labs in different regions

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Foreword

For countries to participate meaningfully in the global digital economy they require robust, secure and dependable ICT platforms, the development of which is best supported by market access regimes that are well-defined, well-managed, non-discriminatory and transparent.

Driven by a variety of concerns, ranging from the quality of service to the performance and safety of equipment, many developing countries are now adopting more robust market access controls for the ICT equipment and systems deployed in their countries or regions.

The results of ITU consultations and surveys have borne out the magnitude and complexity of non-interoperability and non-compliance and the impact these have on service levels, frustration of users and service providers, loss of business and general economic loss. Indeed, Resolutions from four of the highest decision-making bodies of the International Telecommunication Union call for action on conformance and interoperability: WTSA Resolution 76 (Johannesburg 2008), WTDC Resolution 47 (Rev. Hyderabad 2010) and PP Resolution 177 (Guadalajara 2010), Resolution 62 (RA-12).

It is therefore with considerable pleasure that I present this series of guidelines which will facilitate efforts to design and implement the conformity assessment programmes necessary for effective controls.

The guidelines, which comprise both a framework and substantive recommendations regarding such elements as test-lab accreditation and certification, test equipment needs and cost boundaries, and test-lab operational procedures, have been prepared by ITU experts selected for their in-depth knowledge and experience of test-lab design and implementation, the development of standards, the formulation of telecommunication policy and regulations, as well as of capacity building activities in developing countries and the negotiation and oversight of international treaties. Their production has drawn on close collaboration with the staff of both the Telecommunication Development Bureau and the Telecommunication Standardization Bureau of the ITU.

These guidelines present the many elements necessary for the establishment of robust technical verification systems. They also, and no less importantly, address the need for human capacity building, a need which has been underlined by ITU Member States, regulatory agencies, and operators. Their implementation will greatly facilitate the harmonious and efficient development of globally interconnected networks.

Brahima Sanou

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1 Background

Major concerns raised at the World Telecommunication Standardization Assembly (WTSA-08) were the lack of conformance and interoperability of equipment being placed on the market, the need for capacity building and the absence of conformance and interoperability testing centres especially in developing countries. The resulting WTSA-08 Resolution 76, (studies related to conformance and interoperability testing, assistance to developing countries, and a possible future ITU Mark programme) has received a lot of attention over the last three years. In particular the World Telecommunication Development Conference 2010 (WTDC 2010) gave specific recognition to Resolution 76, approving WTDC 2010 Resolution 47 endorsing collaborative work with ITU-T on implementation of Resolution 76 including activities in capacity building, training, and development of guidelines in conformance and interoperability testing. Resolution 47 also identified specific responsibilities to conduct a field study on the economic feasibility of and need for creating regional laboratories for conformance and interoperability testing thereby assisting developing countries to become self-sufficient in meeting their own needs in this important area. This is an important objective underlying the creation of this set of guidelines. This guidelines are available electronically at www.itu.int/ITU-D/tech/ConformanceInteroperability/index.html

The ITU Telecommunication Standardization Bureau held an initial two day consultation meeting in Geneva, 21-22 July 2009 at which the opening session reviewed the resolutions adopted by WTSA-08 that addressed issues concerning developing countries. In particular it considered Resolution 76, including the actions required to be undertaken by the ITU-T Study Groups in developing test suites for recommendations and by the ITU-T in assisting developing countries in collaboration with the ITU-D in capacity building and establishment of regional and national test centres. As a result ITU established the Conformity and Interoperability Programme (C&I Programme) which draws upon the expertise and resources from all three Bureaux. The ITU webpage on the C&I Programme can be found at www.itu.int/net/ITU-T/cdb/Default.aspx with hyperlinks to a wide range of excellent and detailed information on the programme, the database of products claiming conformity to ITU Recommendations, and electronic copies of the forms to be used for submission of a conformity claim by an equipment supplier or their agent. Consultations were also held in 2009, 2010 and 2011 with the CTOs of major telecommunication equipment manufacturers and service providers to both update them on progress on implementation of the C&I Programme and to seek their advice and endorsement www.itu.int/net/pressoffice/press_releases/2010/CM09.aspx.

Following the July 2009 consultations, progress in implementing WTSA-08 Resolution 76 was reported at ITU Council in October 2009. This progress report was backed up by a comprehensive set of documents, including the report of the first consultation meeting, draft legal opinion on marking, comprehensive overview of interoperability issues experienced in the world regions, and other material. Document references may be found at: www.itu.int/ITU-T/worksem/wtsa-08/res76/200907/index.html.

Council 2009 endorsed the TSB Director's proposals for action summarized in the following recommendations:

- Implementation of the proposed conformity assessment programme
- Implementation of the proposed interoperability events programme
- Implementation of the proposed human resources capacity building
- Implementation of the proposed recommendations to assist establishment of test facilities in developing countries

This report proposes guidelines for the establishment of test facilities in developing countries in response to the fourth bullet above. Collaborative efforts by TSB/BDT have already included an ITU Regional

Seminar for the Africa Region on Conformance and Interoperability Testing Centre(s)[1] **held in** Accra, Ghana, 4-6 July 2011 and the ITU Forum on Conformance and Interoperability Testing in CIS and Europe Regions[2], Moscow (Russian Federation), 9-11 November 2011 www.itu.int/ITU-D/tech/ConformanceInteroperability/CI_Events.html.

Additional consultations and discussions were held at the April 2010 meeting of Council, at the ITU-T TSAG meeting in February 2010, at various meetings of the ITU-T Joint Coordination Activity on Conformance and Interoperability Testing (JCA-CIT), at WTDC 2010 (resulting in Resolution 47), at the BDT workshop on NGN and creation of test labs, 2-4 August 2010, Nairobi, and at the following four regional ITU consultation meetings on conformance assessment and interoperability (www.itu.int/ITU-T/worksem/past.html) Quito, 8 July 2010; Nairobi, 30-31 July 2010; Sydney, 16-17 September 2010; and Pune, India 14-17 December 2010. In support of the C&I Programme the ITU Plenipotentiary Conference in October 2010 produced Resolution 177 which essentially endorsed WTSA 2008 Resolution 76 and advocated urgent action on implementation of the Conformance and Interoperability Programme.

During 2010 and 2011, various briefings on the C&I Programme have been given by ITU staff and consultants taking advantage of regional standards meetings of bodies such as the Asia Pacific Telecommunity Standardization Program (APT/ASTAP), InterAmerican Telecommunications Commission Permanent Consultative Committee 1 (CITEL PCC.I) and other forums.

Preparation of a business plan for the long-term implementation of the full C&I Programme is currently underway.

2 Situation in regions: Results from BDT Questionnaire on the status of conformance and interoperability of equipment and systems

Following the Regional ITU Consultation on Conformance Assessment and Interoperability for the Africa Region[3], Nairobi, Kenya, 30-31 July 2010, and the Workshop on NGN Conformance and Interoperability Testing[4], Nairobi, 2-4 August 2010, a survey on conformance and interoperability testing and capacity building was carried out with a questionnaire being sent out to the ITU Membership[5].

The purpose of the questionnaire was to collect information from ITU Members on the status of conformance and interoperability of equipment and systems and to solicit expressions of interest in establishment of test centres, training and capacity building programmes.

Some 35 responses were received by the June 2011 deadline, many with detailed answers to the questions posed. Three groups of respondents were identified:

- **Group 1** where no equipment types are listed in the responses, and where service provision is largely or completely provided by a single service provider;
- **Group 2** where the responders tended to have a dominant equipment supplier and a few service providers; and
- **Group 3** where there was a wide mix of equipment suppliers and a number of service providers.

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1 www.itu.int/ITU-T/worksem/citc/201107/index.html

2 www.itu.int/ITU-D/tech/ConformanceInteroperability/CI_Events.html

3 www.itu.int/ITU-T/worksem/wtsa-08/res76/index.html#events

4 www.itu.int/ITU-D/tech/events/2010/NGNCenter_Kenya_Aug10/NGNTestingCenter_Nairobi_Program.html

5 The questionnaire can be found at: www.itu.int/ITU-D/CDS/gq/generic/questionnaire.asp?ProjectID=193.

Expressions of interest in training and capacity building, including a general interest in establishing national, sub-regional and regional test centres are captured in Table 1:

Table 1: Expressions of interest in training and capacity building

Interest and capacity	Group 1	Group 2	Group 3
Interested in follow-up training/capacity building related to WTDC 2010 Resolution 47, WTSA 2008 Resolution 76, PP-10 Resolution 177	Yes	Yes	Yes
Would participate in development of regional programme in capacity building and expert tutorials	Yes	Yes	Yes
Interested in opportunities to establish national, sub-regional and regional test centres	Yes	Yes	Yes
ICT Labs capable of hosting test events or ITU activities available	No	No	Yes

In all responses, except one from a Member State which already has excellent access to test centres of surrounding Member States, there were expressions of interest in opportunities to establish test centres in their country or region.

Subsections 2.1 and 2.2 provide input from respondents who were asked to list the main conformance and interoperability problems experienced on their fixed and mobile networks, and secondly to state the impact of these conformance and interoperability problems on, for example quality of services, network modifications, competitiveness, company image, additional costs to solve problems, etc.

The responses underscore the important role that a test centre could play in permitting pre-deployment assessment of connectivity and compliance through testing and test bed evaluation.

2.1 Conformance and interoperability problems (Quotes from survey responses)

- Legacy IN signalling (legacy/Intelligent Network signalling interoperability problems) services behaviour when replacing equipment, signalling in mobile network (access, core, SMS).
- Lack of conformity and interoperability between equipment from different vendors.
- Equipment from different manufacturers, due to application of non-standardized interfaces or protocols (for example: integration of IPTV system with IMS solutions, integration of NGN international softswitch and other manufacturer IMS elements, integration of 3G-WLAN controller into the network, incompatibility of IMS solutions and SIP clients, etc.).
- Equipment from one manufacturer, but with different software revisions resulting in incompatible SIP clients.
- Conformity of STB equipment of different IPTV middleware manufacturers.
- Bandwidth: Capacity of transmission of voice, data and video when users add much to our network.
- Complexity of networks to achieve interoperability through integration of networks and devices is necessary to hire a third party who is knowledgeable in various brands of equipment.
- There are services that were launched with some providers do not provide infrastructure and support teams to enable interoperability with other operators.
- Defining the methodology for adopting standards, especially on equipment owned a supplier and you can also use proprietary interfaces.
- During the process of achieving interoperability between networks are affected important statistics such as: Completion of inbound calls to the mobile network carrier to interference ratio, etc.

- Loss of independence of the network, little robustness and low speed to emergency response.
- The management of the CDR for billing.
- Implementation of new features and services on all platforms.
- See the presentations related to Egypt in the following URL, which lists the problems experienced www.itu.int/ITU-T/worksem/wtsa-08/res76/201007/Africa/programme.html.
- As the interoperability of the networks is required of the service providers, the technical problems are averted during the interconnection procedures.
- Since every fixed and mobile communications networks in our Member State should follow the procedures on conformity assessment and obligatory certification, so up to the present moment any problems weren't observed with conformity or interoperability.
- Different charging model, IMS does not support IN triggering and etc.
- New technology cannot interoperate with legacy equipment.
- No testing centres and facilities.
- Lack of trained personnel to undertake.
- In our Member State we have established a type approval regime since many years so we don't have conformance and interoperability problems except for the informal market on which is dumped non-type approved equipment.
- IP MSAN with Softswitch.
- CPEs/routers with DSLAM and IP routers.
- MSAN – Softswitch conformity problems.
- Soft switch (A vendor) & IMS core (B vendor) problems.
- ISDN support problems.
- User terminal problems both for IMS and SSW cores.
- In general conformity and interoperability issues are based on software features that are provided by vendors. For example new release software may cause interoperability issues with other vendor equipment or services in the network. It is also even possible to come across compatibility/interoperability issues between different versions of the same equipment from the same vendor.
- One other issue may be interoperability issues between services and terminal equipment that customers use.
- Main interoperability issues are due to proprietary and non-standard interfaces of Vendors. Because of the market and regulatory requirements and some service requirements we are using some proprietary extensions on signalling systems and some proprietary protocols.
- In our Member State in general Mobile system interoperability works well and in fixed systems there is no problem with conformance to the standards. However regarding IP phone service, there have been complaints from consumers about the case of connecting terminals that have no function for emergency reporting.

2.2 Impact of conformance and interoperability problems

- Loss of quality
- Additional costs to solve problems, quality of services

- Impact of conformance and interoperability problems on the technical aspects:
  - Inability to introduce attractive services promptly, to integrate existing and new services;
  - Inability to ensure and monitor QoS and service availability (lack of compatibility with operational support systems does not allow reduction of unnecessary administrative activities);
  - Frequent need for software modifications and/or addition of new elements;
  - Introduction of one new element or its software update causes hardware/software updates of other integrated elements;
  - Discrepancy of operators' expectations and real implementation possibilities, especially in relation to integration with existing elements.
- Impact of conformance and interoperability problems on the economical aspects:
  - Hardware/software updates require additional investments, since they are usually not included in contracts;
  - Inability to introduce attractive services reflects negatively on operator's competitiveness;
  - Inadequate quality of services undermines in the long run company's reputation;
  - Conformance and interoperability problems negatively impact income of the company.
- Adjusting prices of telecommunication services available to the public by poor service quality.
- Consolidation of continuous service, while maintaining access to the service and applications.
- The criteria for decision making, Service Availability, Customer Service and Quality.
- The participation and market positioning and has required establishing partnerships with integrators and solution providers at additional cost.
- Costs increase because you have to use many resources to make the desired changes.
- See the presentations related to Egypt in the following URL, which lists the problems experienced: www.itu.int/ITU-T/worksem/wtsa-08/res76/201007/Africa/programme.html.
- We have managed it with full cooperation from the vendors and network operators.
- We are unaware of the magnitude of such impact. Because of the costs of testing the smaller service providers find that the bigger operators make impossible the use of the required equipment in general. This may cause competition problem as well, however the secure operation and the maintenance of an adequate service quality are the primary considerations even in such cases.
- Longer and more pricy integration, some exceptions appears in new services, more complex new services delivery and etc.
- It became costly for the general public to buy new devices as old devices cannot access the new technology, e.g. with the 3G technology, some of the services offered by the telecom operators on 3G cannot accessed on old handsets.
- Poor Quality of services if the operators use a different model of equipment which does not conform to the standards.
- Sometimes, having bought an equipment which is not interoperable with the existing network, operators are required to modify the network in cases when they want to upgrade their

networks, this can cause QoS to be compromised and also may be costly which in the end affects the end user.

- Supply of poor quality equipment and systems.
- Dangerous equipment.
- Not conforming to standards.
- No interoperability even within one supplier's equipment.
- Counterfeit equipment.
- The impact due to Interoperability problems in the service in turn will affect the customer experience and the service provider might end up losing the customers.
- Additional costs to solve problems.
- Company image damaged.
- Quality of Services network modifications.
- Additional time to fix the problems.
- Project schedule, scope change.
- The answer for our country's mobile networks:
  - For all of the items mentioned in the question, the actual impact is based on where, when and how the problem occurred. The result may be from a simple alarm to an actual outage of the service resulting in commercial, quality and end user experienced problems.
- Delay of the projects, multi-vendor implications, extra costs for upgrades, extra test needs after upgrades.

The above responses provide a good idea of the kind of non-interoperability problems and their impacts being experienced in practice. They provide food for thought as to what areas ITU, within its scope and mandate, can provide assistance and relief especially as regards establishment of test centres. It is clear that capacity building and access to expertise is an essential ingredient as well as other initiatives to promote the use of global testable standards, product implementations tested for compliance and connectivity in system interoperability test events, and development of the capabilities to do local and regional testing for compliance and interoperability.

3 Needs of developing countries for test labs

3.1 Fundamentals of an orderly telecom equipment marketplace

There are many factors that underlie creation of an orderly marketplace in telecommunication products and services. A primary requirement is the establishment of robust technical requirements for products entering the marketplace. Such requirements address safety of personnel, both the user community and the network service provider personnel, and the establishment of an interference free environment for telecommunication services.

Interference free services – wireless and wireline – are implicated in the economic development of a society as participation in the global digital economy demands robust, secure and dependable telecommunication platforms over which the economic activity takes place. Furthermore a market access regime that is well defined, well managed, non-discriminatory and transparent inspires trust and confidence in equipment suppliers, service providers and people in general. Such a regime backed up by an appropriate legislative framework is a fundamental building block to deliver the requisite quality of

national and international connectivity crucial to participation in the global digital economy. In fact in a very real way it reflects the priorities and values of a society.

3.2 Implementation alternatives for an orderly telecom equipment marketplace

In many developing countries there are no basic requirements established in law for telecommunication apparatus importation and deployment in the marketplace. Such decisions may be left entirely to service providers which are often local branches of international service providers. Therefore the starting point for countries intending to introduce guidelines and requirements to address problems, or even chaos in the marketplace, can vary widely. In some countries, there may be no technical standards or requirements, in others technical requirements may exist for some product types such as cell phones but where, at the same time, no market surveillance, audit or testing capability exist to check for compliance or enforce conformance.

Example 1 – Adoption of an existing regime

This example is based on the process adopted by several countries with no established indigenous technical requirements for marketplace entry for telecommunication equipment. It is driven by an urgent need to redress problems of interference, network harm and safety issues but where the expertise or financial resources are insufficient to establish national requirements. It is based on placing trust in one or more national requirements from other developed countries, using their compliance marking and technical requirements as evidence of adequate quality of products for importation and deployment by service providers and users. In some countries the scarce resources that are available are put into inspection and follow up with regards to deployed telecommunication equipment, rather than the larger task of establishment a national system. The two most popular markings adopted for recognition and acceptance are those of the United States Federal Communications Commission (FCC Mark) and the European Community (EC Mark). Clearly there are many shortcomings of such an approach, including maintaining up to date information on approved products, changes and versions, but testimonials from officials with oversight responsibility from such countries report a market improvement in compliance–related incidents. Nevertheless they view such an approach as an interim solution until they are able to establish their own regime.

Example 2 – Fully fledged national system

This example is based on the type of market entry and deployment requirements of developed countries based on the regulatory frameworks of developed countries, such as the USA and the Members of the European Community. In all cases the requirements begin with a robust legal framework for market entry with assessed penalties for non-compliance. The legal framework reflects the overall policy for dealing with telecommunication products legitimately placed on the market, and is interpreted in regulations which add the necessary details regarding technical specifications and standards, processes for accreditation, testing, certification and marking, and assessed penalties for infractions. They may also include various authorities and procedures for inspection, ticketing, post market surveillance and audit. The technical specifications generally cover the following areas of product and activity:

- wireless and wireline apparatus;
- EMC requirements;
- SAR limits;
- broadcast equipment.

In practice implementation alternatives for an orderly telecom equipment marketplace often include a mix of the activities and procedures outlined in the two examples. The important thing is to recognize the nature of problems being encountered in a specific country, prioritizing them and dealing with them on that basis as resources permit.

4 Status of needs in developing countries

Many developing countries are moving quickly from uncontrolled market access for telecommunication equipment to controlled access driven by a variety of concerns. These include concerns about health effects of non-ionizing radiation, quality of service, performance of equipment and safety.

Many are already using the adoption method described in the example above or a mix of the processes described in both examples to improve orderliness in the telecom marketplace, and many more have moved already to explore the costs and requirements to implement test labs, accreditation and certification systems.

Others are actively seeking financial assistance from funding agencies, training sources, developed country experts and ITU to establish test centres and improve quality, performance and interoperability of systems including interoperation with legacy systems. Consultations and surveys have borne out the magnitude and complexity of non-interoperability and noncompliance and the impact these have on service levels, frustration of users and service providers, loss of business and general economic loss.

In concert with the desire on everyone's part to have the basic expertise and tools to assess compliance and deal with non-interoperability there is also a growing recognition of a potential business opportunity associated with having test lab(s), expertise and facilities which could lead to becoming a test lab(s) of choice for regional needs. This model has already been proven in the Mutual Recognition Agreements/Arrangements (MRAs) on conformity assessment that exist amongst the European Community, Americas region and Asian region countries. MRAs permit the recognition of competence of MRA partners to carry out each other's conformity assessment procedures including production of test reports, certification and marking. Thus a test lab recognised in an MRA partner country with competitively priced services could potentially capture a major share of the conformity assessment business amongst the parties.

4.1 Interoperability testing issues

Interoperability testing is at another level of complexity beyond regulatory type approval testing. It deals with fully understanding complex communication protocols, their implementation and interactions between and among complete devices – i.e. system testing. It is complementary to conformance testing but has a much greater requirement for programming language and computer science expertise and expertise in test suite languages, formal description languages, and operation of sophisticated software test tools.

Type approval test lab expertise however can ease the transition to interoperability testing. Therefore there may be merit for some developing countries transitioning through the establishment and operation of testing related to mandatory requirements such as spectrum masks, signal power levels and safety requirements before attempting complex interoperability testing. Furthermore, gaining familiarity with test set-ups, test equipment, test methodologies and procedures for type approvals would be helpful in establishing the expertise base needed to move on to more complex tasks. Table 2 gives some examples from the University of New Hampshire InterOperability Laboratory (UNH-IOL)[6] and illustrates some of the complex protocols being tested.

[6] www.iol.unh.edu/

Table 2: Example of UNH-IOL areas of testing

Protocols	Testing
IP	– IPv6 Routing – IPv4 Routing – USGv6 Testing – IPv6 Ready Program
Open Fabrics – Open Source	– Storage – SAS –Stats Analysis – SATA – Computer Bus I/face – Fibre Channel – iSCSI – small computer i/face
TR-069 Test Consortium Tools	
VoIP	
Wireless LAN	– 802.11 a, b, g, n
Ethernet	– 10BASE-T Ethernet – Gigabit Ethernet – 10 Gigabit Ethernet – Fast Ethernet – Power over Ethernet
Backplane	
Bridging	– Data Centre Bridging – MACsec – VLAN – Spanning Tree
DLNA ICV – Certification Pgm	– DHN (Digital Home Networking)
DSL	
MIPI – Music Industry	

5 Existing test labs and scopes of activities (see Appendix 3)

Many test labs exist on a global basis offering testing services in the telecommunication field which include testing for product compliance to mandatory standards, and also for interoperability testing of products and systems. Such labs advertise their services, scopes and fees and compete for the global testing market which is substantial. De facto standards development forums and consortia also cooperate in testing activities in support of their memberships and will often offer these services also to non-members at a premium price.

Appendix 3 provides a list of worldwide test labs which offer telecommunication testing services and provides the hyperlinks to their respective websites. More test lab websites are appearing on the web on a regular basis and it is therefore recommended to check for new sites on a regular basis.

6 Opportunities to establish test labs for type approval

6.1 What is type approval?

Type approval simply means that the product is certified to meet certain requirements for its ***type***, whatever that may be, for example cell phones operating in a certain frequency band. Type approval is granted to a product that meets a minimum set of regulatory, technical and safety requirements. The type approval is based on test results derived from a representative sample of the product. The

certification or subsequent declaration of conformity is contingent upon continued compliance for all production runs of that type and is usually subject to spot checks and audit for compliance throughout the life of the type. Compliance to type approval requirements is often denoted by a marking on the product or packaging. Formal assertion of claims of compliance may also be indicated by a declaration of conformity, supplier declaration of conformity (SDoC), or certification of compliance issued by a competent body.

6.2 Basic concepts in type approval

Principal concerns addressed in type approvals are network harm, interference and safety of life issues. Compliance to performance measures, particularly in mature markets, is usually left to marketplace players (customers) and mandatory requirements are kept to a minimum.

Type approval schemes normally embody the concept of "family of products" approvals, which means that products which are electrically and functionally identical or similar, but differ for example in colour or packaging, can be type approved based on test results from one representative sample from the family. Compliant products receive an approval mark from the approval authority. Such a mark carries, or points to, key data for regulatory authorities and marketplace surveillance activities to identify the product and if necessary retrieve and review the test results based on which it received its type approval. Approval authorities in general charge a fee for the type approval service and this may be in the form of a labelling fee per product, or a listing fee for publicizing the product on an official list or database of approved products. Database listing of all compliant products has become the norm for telecommunication products which can be legally deployed in the specific country marketplace.

Establishment of a fee schedule and changes to fees can be a somewhat onerous process requiring in some cases governmental approval and being tied to service level agreements involving penalties in reduced fees when service levels are not met. Such service level agreements for example may specify a certain turnaround time for responding to a request for certification or other service offered by the laboratory.

6.3 Why type approval?

A type approval system with well published requirements promotes transparency in market access and assures and maintains the confidence of suppliers, importers, end users and new technology developers. It stands in stark contrast to non-transparent conformity assessment procedures or no procedures at all, which can become effective protectionist tools, potentially frustrating creation of a fair and open marketplace and risking retaliatory action by trading partners. Therefore it is in the interest of equipment suppliers, network operators and end users to encourage well publicised and readily available requirements for market access in all jurisdictions to avoid unfair and capricious practices regarding market access.

Ideally every economy should have or recognise a type approval system or equivalent transparent process for market access in place.

6.4 When a type approval test lab is needed

There are a number of indicators which can signify that all is not well in a telecommunication marketplace and that there is a need for intervention to restore order and balance. Among these indicators are rising vocal concerns, dissatisfaction, complaints and frustration amongst the telecommunication equipment and services user community driven by their experience of increased incidences of interference and non-performance of terminal devices. Furthermore public concerns about potential health risks, such as from exposure to non-ionizing electromagnetic radiation from cell phone use or from communications transmission towers, demands action from authorities. An increasingly educated public demands to know what standards have been set, what limits are safe and what assurances are being provided. Suspicion of

dumping of sub-standard products in the marketplace which have failed testing in other countries is a further cause of concern as is the importation and deployment of counterfeit products. A key component of the answer to such concerns is to have a robust type approval regime and test lab working from a set of technical standards, a testing regime and testing capability to approve and monitor communications technologies which are being deployed on the marketplace, backed up by surveillance, audit and enforcement. If there are no established technical requirements, type approval regime and test labs available to a country or region then the marketplace is left largely unprotected.

The good news is that there are standards available and under development to define the technical requirements for products legitimately deployed in the marketplace. However adopting and adapting these standards for national systems requires a depth of expertise that many countries do not presently have. Furthermore institutional arrangements, legislation and regulatory regimes need to be established to give force to mandatory requirements and to provide the authorizations needed for marketplace intervention, surveillance and enforcement by proper authorities.

6.5 The importance of standards

Technical standards, especially at key interfaces and points of interconnection are crucially important to the interoperability of equipment and networks. Compatible and interoperable implementation of these standards requires that test suites and test methodologies are available with the natural language form of the standard to ensure uniform interpretation of the specifications. Use of standards rather than proprietary specifications also reduces the risks of confinement to a particular technology and to ultimate supplier lock-in. Standards ensure that legitimate objectives such as safety and non-interference are met and contribute to the process of regional integration and to market aggregation, competitiveness and trade. The standards development process itself also provides the opportunity for all interested parties to have a voice although the costs of participation can prove to be a barrier where financial resources are limited.

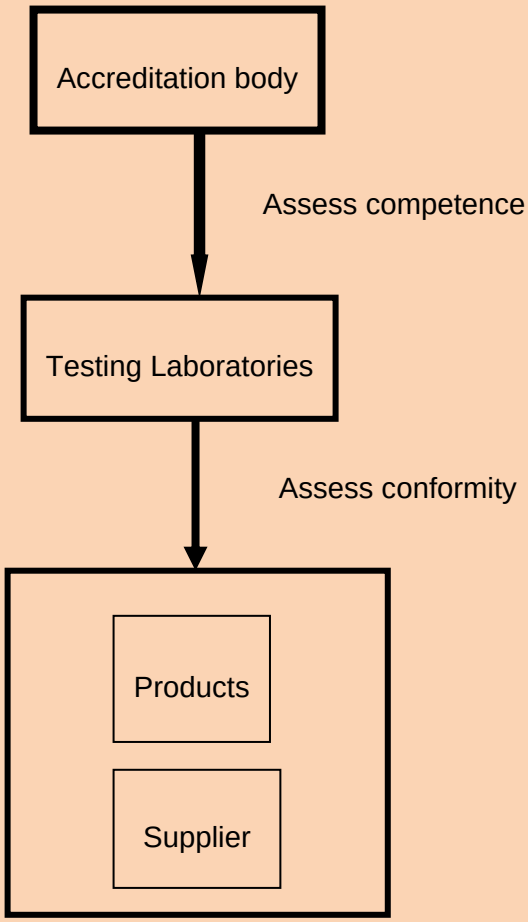
Appendix 2 provides a listing of important international and regional standards development bodies, both de jure and de facto.

7 Criteria to establish accreditation bodies and testing laboratories for type approval

Figure 1 shows the hierarchy of the approval process which results in a product being ready for the marketplace with a robust set of credentials asserting its compliance.

In the regulated sector, the regulators set specifications and standards for interfaces and equipment which telecommunication products have to meet before they can be sold or used in the regulator's territory. Similarly in the private sector, service providers and users set specifications and standards for the telecommunication equipment they are going to procure while manufacturers set specifications and standards for the telecommunication equipment they are going to produce.

Figure 1: Conformance testing



Source: ISO CASCO

In both the regulated and private sectors, the interested parties require evidence and proofs that the telecommunication equipment meet the specifications and standards set by the regulators and the service providers and users.

7.1 Conformity assessment and conformance testing

Conformity assessment is the name given to the processes that are used to demonstrate that a product (tangible) or a service or a management system or body meets specified requirements.

Internationally these requirements are developed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). The processes that need to be followed to be able to demonstrate that they meet the requirements are also developed by ISO/IEC.

The ISO committee on Conformity Assessment (CASCO)[7], develops standards and guides for conformity assessment and these documents are referred to the CASCO toolbox which contains the following conformity assessment topics:

[7] www.iso.org/iso/casco_toolbox

- Vocabulary and general principles of conformity assessment
- The development of technical specifications suitable for use in conformity assessment
- Code of good practice for conformity assessment
- Operation of testing and calibration laboratories and activities
- Proficiency testing by interlaboratory comparisons
- Inspection bodies and activities
- Supplier's declaration of conformity (SDoC)
- Product certification bodies and activities
- Management system audit and certification bodies and activities
- Personnel certification bodies and activities
- Marks of conformity
- Accreditation
- Peer assessment
- Mutual recognition of conformity assessment results.

The following CASCO toolbox standards and guides are of interest to the telecommunication sector.

ISO/IEC 17000:2004 Conformity assessment –Vocabulary and general principles
ISO/IEC 17011:2004 Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies
ISO/IEC 17020:1998 General criteria for the operation of various types of bodies performing inspection
ISO/IEC 17021:2011 Conformity assessment – Requirements for bodies providing audit and certification of management systems
ISO/IEC 17024:2003 Conformity assessment – General requirements for bodies operating certification of persons
ISO/IEC 17025:2005/Cor 1:2006 General requirements for the competence of testing and calibration laboratories
ISO/IEC 17030:2003 Conformity assessment – General requirements for third-party marks of conformity
ISO/IEC 17040:2005 Conformity assessment – General requirements for peer assessment of conformity assessment bodies and accreditation
ISO/IEC 17043:2009 Conformity assessment – General requirements for proficiency testing
ISO/IEC 17050:2004 Conformity assessment – Supplier’s declaration of conformity
ISO/IEC Guide 65:1996 General requirements for bodies operating product certification systems
ISO/IEC Guide 67:2004 Conformity assessment – Fundamentals of product certification
ISO/IEC Guide 68:2002 Arrangements for the recognition and acceptance of conformity assessment results

Conformance testing is an important step to demonstrate that the telecommunication equipment meet its specific requirements. Conformance testing is performed by testing laboratories. In order to ensure that the testing laboratories are competent to perform their tasks, the testing laboratories have to be accredited to meet ISO/IEC 17025 – "General requirements for the competence of testing and calibration laboratories" [8].

Testing laboratories are accredited by accreditation bodies which in turn have to meet ISO/IEC 17011: 2004 – "Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies"[9].

Section 7.2 provides a summary of the requirements for ISO/IEC 17025: 2005 compliant testing laboratories, and ISO/IEC17011: 2004 compliant accreditation bodies are dealt with in Section 7.3.

Section 7.4 gives an update on the status, responsibilities and coordination mechanism of national and international bodies responsible for accreditation of testing laboratories.

7.2 Requirements for ISO/IEC 17025: 2005 compliant testing laboratories

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ISO/IEC 17025:2005/Cor1:2006 "General requirements for the competence of testing and calibration laboratories"

ISO/IEC 17025:2005 was updated to bring its quality system requirements more in line with ISO 9001:2000 – "Quality Management Systems – Requirements", www.iso.org/iso/catalogue_detail?csnumber=46486. It addresses both management system elements and technical competence in a systemic and consistent way. There are two main requirements sections, namely management requirements and technical requirements.

ISO/IEC 17025 is applicable to all organizations performing tests and/or calibrations including first-, second- and third-party laboratories. Such tests may be required to demonstrate the fulfilment of regulatory, safety or contractual requirements.

ISO/IEC 17025 addresses both management system elements and technical competence in a systemic and consistent way. There are two main requirements sections, namely management requirements and technical requirements.

7.2.1 Management requirements

7.2.1.1 Organization

The laboratory or the organization of which it is part shall be an entity that can be held legally responsible. In carrying out its activities, the laboratory is responsible for meeting the requirements of ISO/IEC 17025; the needs of its clients; the regulatory authorities and the organizations providing recognition.

The management system shall cover work at the laboratory's permanent facilities; at sites away from its permanent facilities; or in associated temporary or mobile facilities.

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[8] This document can be purchased at www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39883.

[9] This document can be purchased at www.iso.org/iso/catalogue_detail?csnumber=29332.

If the laboratory is involved in activities other than testing and/or calibration, its organizational arrangement shall be such to ensure that key personnel do not have a conflict of interest and their responsibilities are clearly defined.

7.2.1.2 Laboratory requirements

The laboratory shall have managerial and technical personnel with authorities and resources needed to carry out their duties including implementation, maintenance and improvement of the management system.

There shall be arrangements to ensure management and personnel are free from undue internal and external pressures and influences that may adversely affect the quality of their work.

There shall be policies and procedures for the protection of client's confidential information and proprietary rights including electronic storage and transmission of results.

There shall be policies and procedures to avoid involvement in activities that would diminish confidence in the laboratory's competence and integrity.

Organization and management structure of the laboratory shall be defined including its relationship within a larger organization; relationships between quality management, technical operations and support services.

The responsibility, authority and inter-relationship of personnel involved in management, performance or verification of work affecting the quality of tests and/or calibrations shall be defined.

There shall be adequate supervision of testing and calibration staff including trainees.

The laboratory shall have technical management with overall responsibility for technical operations and the provision of resources needed to meet the quality of laboratory operations.

The laboratory shall:

- have an appointed quality manager with the access to the highest level of management;
- have deputies for key personnel; and
- ensure its personnel are aware of the importance of their activities and how they contribute to the objectives of the quality system.

7.2.1.3 Management system

The laboratory shall establish, implement and maintain a management system appropriate to the laboratory's scope of activities with documented policies, procedures and instructions.

The quality policy shall be defined in a quality manual and issued under the authority of top management. The quality objectives must be measurable.

Top management shall provide evidence of its commitment to the development, implementation and improvement of the management system.

The roles and responsibilities of technical management and quality manager shall be defined in the quality manual.

The integrity of the management system shall be maintained when changes in management system are made.

7.2.1.4 Document control

7.2.1.4.1 General

The laboratory shall have procedures to control all documents as part of its management system including internally generated and from external sources.

7.2.1.4.2 Document approval and issue

Documents shall be reviewed and approved by authorized personnel.

A master list shall be established and be readily available.

Authorized editions of documents shall be available at all locations where operations essential to effective functioning of the laboratory is performed.

Documents shall be reviewed periodically for continuing suitability and compliance.

Documents which are invalid or obsolete shall be promptly removed and those which are retained shall be identified with suitable marking to guard against unintended use.

Document shall be uniquely identified with date of issue, page numbers or mark indicating end and issuing authority.

7.2.1.4.3 Document changes

Changes to documents shall be reviewed and approved by original function that performed the original review.

Altered or new text shall be identified where practicable.

There shall be procedures for describing how changes in documents maintained in computerized systems are made and controlled.

If hand written amendments are allowed, pending the re-issue of a document, the procedures and authorities for such amendments shall be defined.

7.2.1.5 Review of requests, tenders and contracts

The laboratory shall have procedures for reviews of requests, tenders and contracts to ensure that:

- requirements, including methods to be used are adequately documented and understood;
- it has resources and capabilities to meet the requirements;
- the appropriate tests or calibrations are selected and are capable of meeting the customer's requirements.

Any differences between the request or tender and the contract shall be resolved before commencing work and each contract shall be acceptable to the laboratory and its customer.

Records of the review shall be maintained and clients shall be informed of any deviation from the contracts.

The review shall cover any work that is subcontracted by the laboratory.

The same subcontracting work shall be repeated for any amendments after work has started.

7.2.1.6 Subcontracting

Subcontracting work shall be placed with competent laboratories (e.g. those which meet the requirement of ISO/IEC 17025).

The laboratory shall in writing, advise the customers of the subcontracting test and where appropriate obtain their approval.

The laboratory is responsible to the customer for the subcontractor's work, except in the case where the customer or a regulatory authority specifies which subcontractor is to be used.

The laboratory shall maintain a register of all subcontractors used and a record of ISO/IEC 17025 compliance for the work in question.

7.2.1.7 Purchasing services and supplies

The laboratory shall have procedures for selecting and purchasing of services and supplies affecting quality of work.

Purchased services and supplies shall not be used until they have verified as complying with requirements.

Purchasing documents shall adequately describe the services and products ordered and they shall be reviewed and approved for technical contents before being released.

Suppliers shall be evaluated by the laboratory before used and a list of approved suppliers shall be maintained.

7.2.1.8 Service to customer

The laboratory shall be willing to cooperate with customers or their representatives to clarify requests and monitor its performance in relation to the work, while ensuring confidentiality to other customers.

The laboratory shall seek feedback both positive and negative from customers and feedbacks from customers shall be analysed for improvement.

7.2.1.9 Complaints

The laboratory shall have a policy and procedures for the resolution of customer complaints.

The laboratory shall maintain records of complaints and investigations and corrective actions taken.

7.2.1.10 Control of nonconforming testing

The laboratory shall have a policy and procedures that shall be implemented in the case of the testing does not conform to its own procedures or customer requirements. The policy and procedures shall ensure that:

- there is an evaluation of significance of nonconforming work;
- corrective action is taken immediately including the decision about the acceptability of the nonconforming work;
- responsibilities and authority for taking action are designated;
- where necessary the customer is notified and work is recalled;
- the authority for resumption of work is defined;
- where the evaluation points to the possibility of recurrence of the nonconforming work, corrective action shall be taken in accordance with ISO/IEC 17025.

7.2.1.11 Improvement

The laboratory shall continually improve the effectiveness of its management system through the use of the audit results, analysis of data, corrective and preventive actions and management review.

7.2.1.12 Corrective action

The laboratory shall have policies and procedures for corrective action and shall designate appropriate authorities for the implementation of corrective actions.

Corrective actions procedures shall include root cause analysis and selection and implementation of corrective actions.

The laboratory shall monitor the results of corrective actions to ensure their effectiveness.

Additional audits shall be taken when compliance with the laboratory's own policies or the requirements of ISO/IEC 17025 are in doubt.

7.2.1.13 Preventive action

Needed improvements and sources of potential nonconformities shall be identified.

If there are identified improvement opportunities or required preventive actions, plans shall be developed, implemented and monitored to reduce the likelihood of non-conformities.

7.2.1.14 Control of records

The laboratory shall have procedures for the identification, collection, indexing, access, filing, maintenance and disposal of quality and technical records.

Records shall be readily retrievable and stored in a manner to prevent damage and loss. Retention times shall be specified.

Records shall be confidential and be held in a secure place.

The laboratory shall have a policy and procedures for back up of records stored electronically and to prevent unauthorized access to or amendment of these records.

The laboratory shall retain for a defined period of time:

- original observations;
- derived data;
- sufficient information to establish an audit trail;
- calibration records;
- staff records;
- a copy of each test report or calibration certificate issued.

Test or calibration records shall contain sufficient information enabling:

- identification of factors contributing to measurement uncertainty;
- tests to be repeated under conditions as close as possible to the original tests;
- identification of personnel responsible for the sampling, performance and checking of results.

Observation, data and calibration must be identifiable to specific tasks.

Mistakes in records shall be crossed through but be still legible with the correction entered next to the original information.

Each alteration shall be signed or initialled by the person making the correction.

7.2.1.15 Internal audits

Internal audits shall be conducted periodically and within a predetermined schedule and procedure.

All elements of management system shall be covered including testing activities.

The quality manager is responsible for planning and carrying out internal audits.

Auditors shall be trained and qualified personnel who are, where resources permit, independent of the activity to be audited.

Where audit findings cast doubt on the effectiveness of the laboratory's operation, the laboratory shall:

- take timely corrective action.
- shall notify customers in writing if investigations show that the laboratory results may have been affected.

The area of activities audited, the audit findings and corrective action shall be recorded.

There shall be follow-up to the audit to verify and record the implementation and the effectiveness of corrective actions taken.

7.2.1.16 Management reviews

Management reviews shall be conducted periodically (typically once per year) in accordance with a predetermined schedule and procedure to:

- review the effectiveness and suitability of the laboratory's management system and its test or calibration activities;
- introduce necessary changes or improvements.

Management review shall cover:

- the suitability of policies and procedures;
- reports from managerial and supervisory personnel;
- the outcome of recent internal audits;
- corrective and preventive actions;
- assessment by external bodies;
- the results of inter-laboratory comparisons or proficiency tests;
- changes in the volume or type of work;
- customer feedback;
- complaints;
- recommendations for improvements;
- other relevant factors such as quality control activities, resources and staff training.

7.2.2 Technical requirements

7.2.2.1 General

Factors determining the correctness and reliability of the tests include:

- human, environmental conditions, test methods and method validation;
- equipment, measurement traceability, sampling and handling of test items.

The laboratory shall take these factors into account when developing tests, procedures, training and qualification of personnel and selection of equipment.

7.2.2.2 Personnel

The laboratory shall:

- ensure the competence of all who operate equipment, perform tests, evaluate and sign test reports and calibrate certificates;
- set goals related to education, training and skills of its personnel;
- have policies and procedures for training programmes and evaluation of their effectiveness.

The laboratory shall maintain job descriptions for managerial, technical and support staff.

Management shall authorize specific personnel to:

- perform particular types of sampling and testing;
- issue test reports and calibration certificates;
- operate specific types of equipment;
- give opinions or interpretations.

The laboratory shall maintain records of relevant authorizations, competence, qualifications and experience, including those under contract.

7.2.2.3 Accommodation and environmental conditions

Laboratory facilities (including energy source, lighting, environmental) shall be suitable for performing tests correctly. Special care shall be taken when tests are performed at a location other than the laboratory's permanent facility.

Technical requirements for accommodation and environmental conditions that can affect results shall be documented.

Environmental conditions shall be monitored, controlled and recorded.

Testing shall be stopped when conditions jeopardize test results

There shall be effective separation between incompatible activities.

Measures shall be taken to avoid cross-contamination.

Access to and use of areas affecting quality of testing shall be controlled. The laboratory shall determine what is necessary based on its particular circumstances.

The laboratory shall practise good housekeeping.

7.2.2.4 Test and calibration methods and method validation

The laboratory shall use appropriate methods and procedures for all tests in its scope.

The laboratory shall have instruction on the use and operation of all relevant equipment and on the preparation and handling of all test items where the absence of such information might jeopardize the tests. All information shall be kept up-to-date and made readily available to personnel.

Any deviations from test methods shall be documented, justified, authorized and shall be accepted by the customer.

The introduction of laboratory developed methods shall be a planned activity and shall be assigned to qualified personnel with adequate resources.

Plans shall be updated as development proceeds and shall be communicated to all involved personnel.

The use of non-standard method shall:

- be subject to agreement with the customer;

- include a clear specification of the customer's requirements and the purpose of the test or calibration;
- be validated before use.

7.2.2.4.1 Validation of methods

The laboratory shall validate non-standard methods, laboratory-designed/developed methods, standard methods used outside their intended scope to confirm that the methods are fit for the intended use.

The laboratory shall record the results, the procedures used for validation and a statement on whether the method is fit for the intended use. The range and accuracy of values obtained shall be relevant to the customer's needs.

7.2.2.4.2 Estimation of uncertainty of measurement

The laboratory shall have procedures for estimation of uncertainty for types of tests and calibrations.

Where the test method may preclude rigorous analysis, the laboratory shall at least:

- attempt to identify all components of uncertainty;
- make a reasonable estimation based on knowledge of the performance of the method and on the measurement scope;
- ensure that the form of reporting does not give a wrong impression of uncertainty.

7.2.2.4.3 Control of data

Calculation of data transfer shall be subject to appropriate checks.

Computer software shall be suitably validated.

The laboratory shall have procedures for protecting data, integrity and confidentiality of data collection, data storage, data transmission and data processing.

The computers and automated equipment shall be cared for as required to ensure proper functioning and maintenance of integrity of the test data.

7.2.2.5 Equipment

The laboratory shall be furnished with test equipment for correct performance of tests.

When it is necessary to use equipment outside of its control, the laboratory shall ensure that all applicable requirements of ISO/IEC 17025 are met.

Equipment shall be calibrated or checked to ensure that it meets the laboratory's specifications before being put into use.

Equipment shall be operated by authorized personnel.

Up-to-date instructions shall be readily available to the laboratory's personnel.

Equipment shall be uniquely identified.

Records of equipment shall be maintained relevant to the tests performed.

The laboratory shall have procedure for safe handling, transport and storage of equipment to ensure its proper functioning and to avoid cross-contamination.

Equipment shall be marked or indicated if it is defective or outside specified limit.

Equipment shall be labelled with calibration status.

Equipment which has been subject to mishandling or found to be defective shall be:

- taken out of service;
- isolated or clearly marked to indicate that it is out of service until repaired and calibrated.

An investigation shall be conducted to determine if the defective equipment has had any impact on previous results and appropriate corrective action shall be taken.

Whenever equipment has been out of the laboratory's control for whatever reason, the function and calibration status shall be checked before it is returned to service.

Where intermediate checks are required, these checks shall be performed in accordance with defined procedures.

Where calibration gives rise to correction factors, the laboratory shall ensure that these factors are correctly updated.

Equipment shall be safeguarded from adjustments which would invalidate test or calibration results.

7.2.2.6 Measurement traceability

All equipment having a significant effect on test results shall be calibrated.

The laboratory shall have an established programme and procedures for calibration of its equipment.

Calibration of equipment shall be traceable to SI (*Système international d'unités*) units through a series of unbroken calibrations or comparisons linked to relevant primary standards, typically through national metrology institutes.

7.2.2.7 Reference standards and reference materials

Where applicable, the laboratory shall have a programme and procedure for the calibration of its reference standards and access to appropriate reference materials.

Reference standards and materials shall be traceability to SI units of measurement, or to certified reference materials.

Checks needed to maintain confidence in the calibration status of reference, primary, transfer or working standards and reference materials shall be carried out according to defined procedures and schedules, including transportation and storage.

7.2.2.8 Sampling

The laboratory shall have a sampling plan and procedures when it carries out sampling.

Records with appropriate sampling data shall be kept when there are any deviations, additions or exclusions to the sampling requirements.

Records shall include the sampling procedures, identification of the sampler, environmental conditions, diagrams and where necessary statistics upon which sampling is based.

7.2.2.9 Handling of test and calibration items

The laboratory shall have procedures for the identification, transportation, handling, storage, retention or disposal of test items.

Identification of test items shall be retained throughout their life in the laboratory.

Abnormalities or departure from normal or specified conditions when received by the laboratory shall be recorded.

Where there is doubt about the suitability of an item for test, or the test or calibration is not adequately described, the customer shall be consulted before proceeding.

The laboratory shall have procedures and facilities to avoid deterioration and loss and to protect the integrity of the test items.

7.2.2.10 Assuring the quality of test and calibration results

The laboratory shall have procedures for monitoring validity of tests undertaken.

7.2.2.11 Reporting the results

The laboratory shall report results accurately, clearly, objectively and in accordance with any specific instruction in the test methods.

The test report shall include information requested by the customer and necessary for the interpretation of the test results.

Simplified test reports may be prepared for test conducted internally or by agreement with a customer, provided that any information required in a full report shall be readily available in the laboratory where the tests or calibrations were performed.

Tests performed by subcontractors shall be clearly identified in the reports.

7.2.2.11.1 Test reports and calibration certificates

Test reports shall as a minimum contain the following:

- a title (e.g. “Test Report” or “Calibration Certificate”);
- name and address of the laboratory and location where tests/calibration were performed;
- a unique identification (such as a serial number) of the test report/calibration certificate;
- identification of the test report on each test page;
- indication of number of pages or end of report;
- name and address of customer;
- identification of test method used;
- description of condition and clear identification of test item;
- date of receipt of test item where this is critical to the validity and application of the results;
- date of test or calibration;
- reference to sampling plan and procedures used by the laboratory or other bodies where relevant to validity or application of the results;
- test or calibration results where appropriate, with units of measurement;
- name(s), function(s), signature(s) of person(s) authorizing certificates or test reports;
- statements, where relevant that test results relate only to the item used.

7.2.2.11.2 Test reports

Test reports shall contain where necessary for test result interpretation:

- any deviation from, addition to or exclusion from the test method;
- information on test conditions such as environmental conditions;
- a statement of compliance/non-compliance where relevant;

- where applicable a statement on the estimated uncertainty of measurement. The statement is applicable when required for validity or application of results when the customer requires it or when it affects compliance with specified limits;
- where appropriate opinions and interpretations;
- other information that may be required by specific methods or by the customer.

In addition, if sampling is used the report shall include:

- date of sampling;
- clear identification of samples;
- location of sampling (e.g. when the sample is taken as part of a product or artefact);
- reference to the sampling plan and procedures used;
- details of any environmental conditions during sampling that might affect results;
- any standard or specification for the sampling method or procedure;
- any deviation, addition to or exclusion from the procedure.

7.2.2.11.3 Calibration certificates

Calibration certificates shall also contain:

- environmental conditions;
- measurement uncertainty statements;
- evidence that measurements are traceable.

7.2.2.11.4 Opinions and interpretations

When opinions and interpretations are included, the laboratory shall:

- document the basis on which they are made;
- clearly identify them as such in the test report.

7.2.2.11.5 Testing and calibration results obtained from subcontractors

When a test report includes results from a subcontractor, these results shall be clearly identified in the report. The laboratory is still responsible for the work it has subcontracted.

7.2.2.11.6 Electronic transmission of results

When the laboratory transmits test results electronically, it has to meet all applicable ISO/IEC 17025 requirements.

7.2.2.11.7 Amendments to test reports and calibration certificates

Once a test report or calibration certificate has been issued, material changes or amendments shall be only in the form of a further document or data transfer containing the following statement:

- “Supplement to test reports (or calibration certificate) number [serial number] (or as otherwise identified)” or equivalent wording.
- If it is necessary to issue a new report, it shall have a unique identification and shall refer to the report it replaces.

7.3 Requirements for accreditation bodies: ISO/IEC 17011 – "Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies".

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7.3.1 Accreditation body

7.3.1.1 Legal responsibility

The accreditation body shall be a registered legal entity.

7.3.1.2 Structure

The accreditation body shall have the authority (generally derived from government) and shall be responsible for decisions made on accreditation.

The duties, responsibilities and authorities of the senior management shall be documented including:

- Decisions on accreditation
- Contractual arrangements
- Finance
- Policies

The accreditation body shall have access to expertise related to accreditation.

The accreditation body shall have rules for appointment, terms of reference and operation of committees.

7.3.1.3 Impartiality

The accreditation body shall be organized and operated so as to safeguard the objectivity and impartiality of its activities.

The accreditation body shall have balanced representation of interested parties.

It shall have non-discriminatory policies and procedures.

Its personnel and committees shall be free from undue commercial, financial and other pressures.

The assessors shall not make decisions on accreditation

It shall not offer conformity assessment services or consultancy.

Legal entities linked by common ownership or contractual arrangements with the accreditation body can offer consultancy or conformity assessment services.

7.3.1.4 Confidentiality

The accreditation body shall have arrangement to safeguard the confidentiality of the information gathered in the process of accreditation.

7.3.1.5 Liability and financing

The accreditation body shall have arrangement to cover the liabilities arising from its activities and shall have financial resources required for the operation of its activities.

7.3.1.6 Accreditation activities

The accreditation body shall describe it accreditation activities and refer to the relevant international standards and guides.

It shall have procedures for extending its activities

7.3.2 Management

7.3.2.1 Management system

The accreditation body's top management shall define and document policies and objectives including a quality policy.

Its top management shall appoint staff to establish management system.

7.3.2.2 Document control

The accreditation body shall have procedures to control all documents and the procedures shall define controls needed to:

- Approve documents
- Review, and update and re-approve documents
- Ensure that changes and versions of documents are identified
- Ensure relevant documents are available to all involved in accreditation
- Safeguard the confidentiality of documents.

7.3.2.3 Records

The accreditation body shall have procedures to identify, collect, index, access, file, maintain and dispose records.

It shall also have procedures to retain records consistent with its contractual and legal obligations.

7.3.2.4 Nonconformities and corrective actions

The accreditation body shall have procedures to identify and manage nonconformities including:

- Identification of nonconformities
- Determination of causes of nonconformities
- Correction actions
- Records of results of corrective actions.
- Review of effectiveness of corrective actions

7.3.2.5 Preventive actions

The accreditation body shall have procedures to identify opportunities for improvement and to take preventive actions which include:

- Identifying potential nonconformities and causes
- Implementing preventive actions
- Recording results of action taken
- Reviewing the effectiveness of corrective actions.

7.3.2.6 Internal audits

The accreditation body shall have procedures for internal audit to verify conformity to ISO/IEC 17011.

Internal audits shall be taken at least once a year.

Internal audits shall be conducted by qualified personnel and who did not perform activities to be audited.

7.3.2.7 Management review

The top management of the accreditation body shall review the management system at least once a year.

Reviews shall include:

- Results of audits
- Results of peer evaluation
- Feedback from interested parties
- Participation in international activities
- New areas of accreditation
- Trends in nonconformities
- Status of preventive and corrective actions
- Follow-up actions from earlier management reviews
- Fulfilment of objectives
- Appeals
- Analysis of complaints

Outputs of management review shall include:

- Improvement of management system
- Improvement of services and accreditation process
- Need for resources
- Definition or redefinition of policies and objectives

7.3.2.8 Complaints

The accreditation body shall have procedures to deal with complaints. It shall:

- Decide on validity of complaints
- Ensure that complaints concerning an accredited CAB are first addressed by the CAB
- Take appropriate actions
- Record all complaints and actions taken
- Respond to the complainant.

7.3.3 Human resources

7.3.3.1 Personnel associated with the accreditation body

The personnel of the accreditation body shall have:

- Competence with necessary education, training, technical knowledge, skills and experience

- Access to assessors
- Commitment to comply with rules

7.3.3.2 Personnel involved in the accreditation process

The accreditation body shall describe the following activities:

- The qualification, experience and competence required
- Initial and on-going training required.

It shall establish the procedures for selecting, training and approving assessors and experts.

It shall identify the specific scopes in which each assessor has demonstrated competence to assess.

It shall ensure the assessors:

- Are familiar with the accreditation procedures and criteria
- Have undergone accreditation assessor training
- Have thorough knowledge of assessment methods
- Are able to communicate effectively in writing and orally.
- Have appropriate personal attributes.

7.3.3.3 Monitoring

The accreditation body shall have procedures to monitor the performance and competence of its staff.

It shall evaluate the performance of assessors. On-site observation shall be done every three years.

7.3.3.4 Personnel records

The accreditation body shall maintain records of qualifications, training, experience and competence of each staff.

It shall maintain up-to-date records on assessors and experts.

7.3.4 Accreditation process

7.3.4.1 Accreditation criteria and information

The criteria for accreditation of CABs shall be those set out in international standards and guides.

It shall make publicly available the following:

- Information on its assessment and accreditation processes.
- Document containing the requirements for accreditation
- Information on fees
- A description of the rights and obligations of CABs.
- Information on accredited CABs.
- Information on lodging and handling of complaints and appeals
- Information about the authority under which the accreditation programme operates.
- A description of its rights and duties
- Information on financial support
- Information about its activities and limitations under which it operates.

- Information about the related bodies

7.3.4.2 Application for accreditation

The CAB which applies for accreditation shall provide:

- General features including name, address, legal status and human and technical resources,
- Information on its activities, relationship in a larger entity if applicable and addresses of it physical locations,
- Requested scope of accreditation,
- An agreement to fulfil the requirements of accreditation.

The CAB shall provide to the accreditation body prior to commencement of assessment:

- A description of the conformity assessment services it provides and a list of standards, methods or procedures for which it seeks accreditation.
- A copy of its quality manual

The accreditation body shall review for adequacy in the information supplied by the CAB.

7.3.4.3 Resource review

The accreditation body shall review its ability to carry out the assessment

It shall review its ability to carry out initial assessment in a timely manner.

7.3.4.4 Subcontracting the assessment

The accreditation body shall not subcontract the decision-making.

Contracting of external individual assessors is not subcontracting.

The accreditation body shall take full responsibility of all subcontracted assessments.

It shall maintain responsibility for granting, maintaining, extending, reducing, suspending or withdrawing accreditation.

It shall ensure the subcontractors are competent and comply with ISO/IEC 17011.

It shall obtain written consent of the CAB to use a particular subcontractor.

7.3.4.5 Preparation for assessment

The accreditation body may conduct a preliminary visit with agreement of the CAB.

It shall appoint an assessment team with a lead assessor.

Assessment team members cannot provide consultancy to the CAB

The accreditation body shall the names of the team members to the CAB in advance to allow the CAB to object the appointments of the assessors.

The assessment team reviews the document provided by the CAB and conducts the on-site assessment.

The assessment team shall witness a representative number of samples where the scope of the CAB covers a variety of conformity assessment services.

For initial assessments, the assessment team shall visit all premises of the CAB from which key activities are performed.

The accreditation body shall agree with the CAB and the assessment team to the date and schedule of the assessment.

7.3.4.6 Document and record review

The assessment team shall review all documents and records provided by the CAB.

If nonconformities are found during the reviews, on-site visit may not go ahead and the nonconformities are reported to the CAB.

7.3.4.7 On-site assessment

The assessment team shall have an opening meeting to define the purpose of assessment and accreditation criteria and to confirm schedule and scope of assessment.

The assessment team shall conduct assessment at premises from which one or more keys activities are performed.

The assessment team shall witness the performance of a representative number of staff of the CAB.

7.3.4.8 Analysis of findings and assessment report

The assessment team shall analyse information and evidence gathered during document review and on-site assessment to determine competence and conformity of the CAB with requirements of accreditation.

It the assessment team cannot reach a conclusion, it shall refer back to the accreditation body for clarification.

The assessment team shall meet with the CAB prior to leaving the site to provide a written and/or report on its findings. The CAB shall be invited to respond to the assessment report.

The accreditation body shall remain responsible for the content of the assessment report.

The assessment team shall provide detail report on the assessment to the accreditation decision-maker(s).

7.3.4.9 Decision-making and granting accreditation

The accreditation body shall be satisfied with the assessment report before it makes the decision.

It can use the results of an assessment already made by another accreditation body as long as that accreditation body is ISO/IEC 17011 compliant.

It shall provide an accreditation certificate to the accredited CAB.

7.3.4.10 Appeals

The accreditation body shall have procedures to address appeals by the CABs.

It shall appoint competent and independent persons to investigate the appeals

7.3.4.11 Reassessment and surveillance

Reassessment is similar to initial assessment.

Surveillance is to monitor the continued fulfilment of the accredited CAB of its requirements of accreditation, including surveillance on-site assessments and other surveillance activities such as enquires, review of declarations of the CAB on its scope and request to CAB for documents and records.

The accreditation body shall have procedures for periodic surveillance on-site assessments.

It shall design plans for reassessment and surveillance for each accredited CAB.

It shall employ reassessment alone or a combination of reassessment and surveillance. If reassessment is employed alone, the reassessment shall be conducted at least once every two year. If a combination of

reassessment and surveillance is employed, the reassessment shall be conducted at least once every five years and surveillance on-site assessment shall be conducted once every two years.

First surveillance on-site assessment shall be conducted no later than 12 months from initial accreditation.

7.3.4.12 Extending accreditation

Extension of scope of accreditation may require reassessment.

7.3.4.13 Suspending, withdrawing or reducing accreditation

The accreditation body can suspend, withdraw or reduce the scope of accreditation if the CAB persistently failed to meet the requirements of accreditation or to abide by the rules of accreditation.

7.3.4.14 Records of CABs

The accreditation body shall keep records of CABs including copies of accreditation certificates, assessment records and reports, accreditation decisions and correspondences securely to ensure confidentiality.

7.3.4.15 Proficiency testing and other comparisons for laboratories

The accreditation body shall maintain a list of appropriate proficiency testing and other comparison programmes. Such proficiency testing programmes should operate in accordance with the requirements of ISO/IEC 17043:2009, Conformity assessment – General requirements for proficiency testing.

It shall ensure that its accredited CABs participate in proficiency testing as appropriate.

7.3.4.16 Responsibilities of the accreditation body and the CAB

7.3.4.16.1 Obligations of the CAB

The accreditation body shall require the CAB to conform to:

- Fulfil continually the requirements for accreditation
- Cooperate with accreditation body to verify fulfilment of requirements of accreditation.
- Arrange witnessing of CAB services when requested.
- Pay fees as determined by the accreditation body.
- Inform accreditation body of changes relevant to tis accreditation

7.3.4.16.2 Obligations of the accreditation body

The accreditation body shall give notice of changes to its requirements for accreditation.

It shall make public information on the current status of the accreditations it has granted to CABs including names and addresses, dates of accreditation and the scopes of accreditation.

It shall provide information about international arrangements in which it is involved.

7.4 National and international bodies responsible for Accrediting conformity assessment bodies

Accreditation is the third party attestation related to a conformity assessment body (e.g. a testing laboratory) conveying formal demonstration of its competence to carry out specific conformity assessment tasks (e.g. testing). The requirement for a testing laboratory is in ISO/IEC 17025.

Accreditation is performed by accreditation bodies which should comply with ISO/IEC 17011.

7.4.1 National accreditation bodies

The first comprehensive laboratory accreditation programme was established in Australia in 1947 by the National Association of Testing Laboratory (NATA), www.nata.asn.au/aboutnata. Similar programmes were established in the United Kingdom, United States, France, Canada, Denmark, Sweden and Germany in the 1980s.

National accreditation bodies are often recognised by national governments.

Fulfilment of ISO/IEC 17011 requirements demonstrates that an accreditation body is competent to perform its accreditation tasks. In the conformity assessment structure (Figure 1), there is no higher level body above the accreditation that has the role of confirming that an accreditation body fulfils ISO/IEC 17011 requirements.

To address this issue, peer assessment mechanisms have been created at the regional and international levels between accreditation bodies to ensure they are operating in accordance with ISO/IEC 17011.

7.4.2 International organizations

7.4.2.1 International Laboratory Accreditation Cooperation (ILAC)[10]

ILAC was started in 1977 as a conference and it became a formal cooperation with a charter to establish a network of mutual recognition arrangements among accreditation bodies in 1996.

On November 2, 2000, 36 accreditation bodies, full members of ILAC, from 28 countries worldwide signed the "ILAC Mutual Recognition Arrangement", which is often referred to as the ILAC Arrangement.

As of 2010, the ILAC Arrangement has 72 accreditation body signatories (full members) from 59 countries.

The purpose of the ILAC Arrangement is to develop a global network of accredited testing and calibration laboratories that are assessed and recognized as being competent by ILAC Arrangement signatory accreditation bodies.

The signatories have been peer-assessed and shown to meet ILAC's criteria for competence.

Each signatory to the ILAC Arrangement agrees to:

- maintain conformance with the current version of ISO/IEC 17011, related ILAC guidance documents and a few but very important supplementary requirements; and
- ensure that all accredited laboratories comply with ISO/IEC 17025 or ISO 15189 (for medical testing laboratories) and related ILAC policy and guidance documents.

Peer evaluation of signatories involves a team of peers who are generally senior staff of experienced accreditation bodies. The evaluations include:

- time spent at the headquarters office of the applicant accreditation body to determine compliance with ISO/IEC 17011;
- the evaluators witness the performance of the applicant accreditation body's assessors during actual assessments/reassessments to determine if the laboratories are in compliance with ISO/IEC 17025.

In addition to individual membership of accreditation bodies, ILAC has formally established Regional Accreditation Cooperations with regional accreditation bodies. These regional bodies have objectives

[10] www.ilac.org/

similar to and compatible with ILAC and they are committed to the obligations of the ILAC Mutual Recognition Arrangement. These bodies shall have formally nominated representatives of accreditation interests from at least four countries.

ILAC has three Recognized Regional Cooperation Bodies whose regional mutual recognition arrangements have been successfully peer-evaluated by ILAC and they are:

- Asia Pacific Laboratory Accreditation Cooperation (APLAC)[11];
- European co-operation for Accreditation (EA)[12];
- Inter-American Accreditation Cooperation (IAAC)[13].

The Recognized Regional Cooperation Bodies are re-assessed by ILAC every four years.

The Southern African Development Community in Accreditation Service (SADCAS)[14] is preparing to join the ILAC MRA. It is in the process of developing their MRA evaluation processes for recognition and approval by ILAC.

7.4.2.2 International Accreditation Forum (IAF)[15]

The prime purposes of IAF are:

- to ensure that its accreditation body members only accredit bodies that are competent to do the work they undertake;
- to establish mutual recognition arrangements known as Multilateral Recognition Arrangements (MLA), between its accreditation body members.

The scopes of the MLA include certification/registration of quality systems, products, services, personnel, environmental management systems.

Accreditation body members of IAF are admitted to the IAF MLA after evaluation of their operations by an IAF peer evaluation team which is charged to ensure that the applicant accreditation bodies comply fully both with ISO/IEC 17011 and IAF requirements.

IAF had evaluated and accepted the process and outcomes of three regional accreditation groups:

- The European co-operation for Accreditation (EA).
- The Pacific Accreditation Cooperation (PAC)[16] .
- The Inter-American Accreditation Cooperation (IAAC).

The regional accreditation groups are evaluated every for years by IAF.

Membership of the IAF MLA is recognized as being satisfied by membership of any of the EA MLA, the PAC MLA or the IAAC MLA within the appropriate scope.

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11 www.aplac.org/

12 www.european-accreditation.org/content/home/home.htm

13 www.iaac.org.mx/English/Index.php

14 www.sadcas.org/news003.php

15 www.iaf.nu/

16 www.apec-pac.org/pac.php

The IAF MLA signatories at the end of November, 2010, are as follows:

- Main scope of ISO/IEC 17021 and the sub-scope of ISO 9001: three regional accreditation groups (EA, PAC and IAAC) and 46 accreditation bodies.
- Main scope of ISO/IEC 17021[17] and the sub-scope of ISO 14001: two regional accreditation groups (EA and PAC) and 41 accreditation bodies.
- Main scope of ISO/IEC Guide 65[18]: two regional accreditation groups (EA and PAC) and 38 accreditation bodies.

7.4.3 Regional accreditation bodies

It is costly and time consuming to set up a national accreditation body. In addition to start-up costs, there are operational costs which may not be recovered entirely by accreditation fees.

Some regions are considering establishing regional accreditation bodies. In order to set up a regional accreditation body, the countries within the region have to agree on the following:

- the organizational form and statuses of the Regional Accreditation Body;
- the registration of the Regional Accreditation Body in one of the country in the region and its governance structures and professional liability;
- the joint short-term and long-term funding mechanisms;
- the recognition of the Regional Accreditation Body as equivalent to a national accreditation body especially in the administration of technical regulations;
- the acceptance of the Regional Accreditation Body as representing the individual country in the international accreditation forums;
- the Regional Accreditation Body as a signatory of the mutual recognition arrangements of ILAC and IAF.

8 Technical and economic steps to be followed to build ISO/IEC 17025 compliant testing laboratories

ISO/IEC 17025 has two main sets of requirements, namely management requirements and technical requirements. To be compliant with ISO/IEC 17025, a testing laboratory has to meet these requirements (section 7.2).

This section outlines the basic components of an ISO/IEC 17025 compliant testing laboratory. The scope of accreditation (that is the testing scope) will add additional elements to the basic components.

8.1 Legal status/legal entity

The testing laboratory has to be established as an entity that can be held legally responsible for its activities.

[17] www.iso.org/iso/catalogue_detail?csnumber=56676

[18] www.iso.org/iso/catalogue_detail.htm?csnumber=26796

8.2 Financial policy

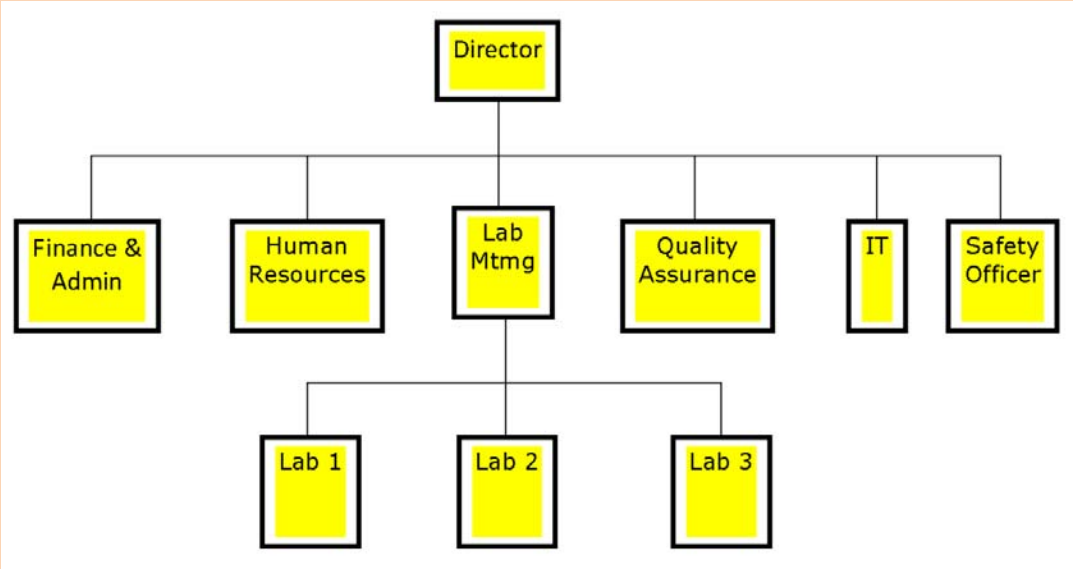
Start-up cost includes building, infrastructure development, and procurement of equipment. It is difficult especially in developing countries to cover operating costs from earned income. One of the important tasks will be to develop plans to secure both medium and long term funding for the testing laboratories. One potential source of funding is from government. A commitment from government especially in developing countries to provide long term financial support is a prerequisite in the effort to building a testing laboratory.

See Appendix 4 for possible funding sources.

8.3 Management structure

There is a need to establish a procedure to ensure that departments of a testing laboratory with conflicting interests do not adversely influence compliance with ISO/IEC 17025. In Figure 2, the finance, administration, quality assurance, IT, the safety officer, and human resources departments do not report to the laboratory management department.

Figure 2: A typical management structure



Source: Labcompliance, ISO/IEC 17025 Accreditation Package, 2009.
If the testing laboratory is part of a larger organization, responsibilities of key personnel will have to be well defined in order to identify potential conflicts of interest.

8.4 Personnel

It is essential to recruit staff members who have both theoretical training and adequate practical experience. It may be necessary to deploy staff for an extended period of time in a working laboratory in order to gain experience and to maintain their necessary skill set.

Remuneration of staff is an important financial issue. The testing laboratory should have adequate funds in its budget to ensure that fully trained staff is paid well enough in order to keep them in the organization.

8.5 Training system

Training is an important part of the laboratory's plan and programme. A training programme has to be put in place to train new staff and to keep staff up to date with technological change andevolution.

8.6 Premises

There are a number of tasks in the planning and development of the laboratory premises, including:

- The selection of test site location is an important issue to be considered. For example an Open Area Test Site (OATS) should be located in an electronic "quiet" area in order to minimize electronic interference.
- One of the important tasks in the planning and development of the laboratory premises is the effective separation between neighbouring areas where the activities of these areas are incompatible.
- An example is the separation of wire line and wireless test stations. Another example is the separation of office and laboratory spaces.
- Access to test and calibration areas shall be strictly controlled and limited to authorized personnel. An example of access control is the use of ID cards.
- The location of windows of the building housing the laboratory is an important factor in the design of the building. Proper orientation of the windows of the building is necessary to avoid direct sunlight in order to protect sensitive test equipment. For example in the northern hemisphere, the windows should be located on the north side of the building.
- Environmental control is an important factor. There should be a long term plan for environmental control. For example for the testing of telecommunication equipment, the building temperature should be kept between 15 to 30 degrees Celsius and the relative humidity should be less than 70 per cent.
- Continuity of electricity supply has to be maintained. Uninterrupted power supplies have to be deployed if necessary. Electricity supply variance can affect test equipment and thereby have effects on test results. Voltage stabilizers are required if the voltage variance is greater or less than 5 per cent.

8.7 Equipment

Test equipment is an important tool and asset of the laboratory. It is important that proper studies and decisions are made before the purchasing of test equipment which has to conform to specifications relevant to the tests being offered by the laboratory.

The availability of maintenance and technical support from the supplier/manufacturer of the equipment is an important issue to be considered in the process to select the suppliers for the equipment.

Price is not the only deciding factor to be considered when buying test equipment. It is much better to buy a slightly more expensive equipment for which maintenance is available than a less expensive option for which there is no technical support, in the country or in neighbouring countries.

The criteria to be considered when selecting an equipment vendor include:

- the vendor's equipment meets the required specifications;
- the vendor has a leading position in the market place;
- the design, development and manufacture of the equipment take place in a quality system environment such as ISO 9001;

- the vendor provides installation, familiarization and training services; and
- the vendor provides phone and on-site support in local language.

The following steps are necessary in the installation and documentation of equipment:

1. Verify that the location where the equipment is being installed meets the environmental specifications as defined by the equipment vendor.
2. Install the equipment hardware according to the vendor's specifications.
3. Install software and start-up according to the vendor's specifications.
4. Document the hardware and software being installed including vendor's name, model number, serial number and location of installation.

After installation, equipment should be tested for calibration and for performance verification and the steps to be followed include:

1. Develop test procedures and test protocols.
2. Define acceptance criteria based on documented specifications.
3. Ensure that the test engineers have the appropriate qualifications.
4. Perform tests and document test results.
5. Label equipment with status, dates of last and next calibration.
6. Maintain records of calibration and checks.

8.8 Steps towards ISO/IEC 17025 accreditation

An important task in the building of a testing laboratory compliant with ISO/IEC 17025 is to obtain accreditation of the laboratory to meet ISO/IEC 17025 by an accreditation body which is compliant with ISO/IEC 17011.

The criteria to be considered in the selection of an accreditation body include:

- language;
- proximity to the country if an in-country accreditation body is not available;
- accreditation cost which can vary between different accreditation bodies. The cost will also depend on the assessors employed for the accreditation and the scope of the accreditation;
- accreditation body is a signatory to ILAC MRA or a member of regional cooperation bodies recognized by ILAC.

The laboratory should create a team with a team leader to:

- define the scope of accreditation;
- learn the ISO/IEC 17025 requirements;
- conduct gap analysis and subsequently prepare a task list to resolve the deficiencies.
- estimate costs;
- obtain management decision.

Once decision is made to go ahead, the laboratory should create a team to obtain accreditation and the steps include:

1. The selection of an accreditation body.
2. The development of documentation for the accreditation process.

3. Training of staff.
4. Internal audit and corrections.
5. Pre-assessment and corrections.
6. Accreditation audit.

Long term financial and managerial support is necessary to maintain accreditation and the laboratory should have the necessary processes in place to obtain and maintain financial and managerial support.

9 Potential roles of MRAs

Mutual Recognition Agreements/Arrangements (MRAs) can play a number of useful roles in the ITU Conformance and Interoperability(C&I) testing programme.

In the context of regulatory systems MRAs can provide for the recognition of competence of third parties to carry out national regulatory/type approval processes such as testing and certification. MRAs can help avoid the cost of duplicative testing – once in the exporting country and again in the importing country – and promote transparency in the approval process by having the processes and procedures of the participating bodies exposed to discussion during the MRA negotiations. They streamline market access to foreign markets by saving time to market, production costs, especially in the conformance testing cycle, and in many cases saving costs in the reduced requirement for personnel in foreign marketplaces to handle local interfacing with the testing and certification organizations. MRAs also help in circumventing predatory practices and market entry roadblocks such as import licensing and re-testing which can be used to place local suppliers in an anti-competitive position compared with a foreign supplier. Experience shows that MRAs, by virtue of sharing ideas and observing best practices of other authorities, also reduce diversity of procedures and methods for compliance assurance thereby producing additional cost savings especially for equipment suppliers to diverse foreign markets. MRAs are in fact a significant step towards achievement of the ultimate goal of the supplier community, namely, “one test, done once, valid worldwide”. It is also worth noting that the World Trade Organization (WTO) Agreement on Technical Barriers[19] to Trade strongly encourages WTO Members to engage in such agreements.

9.1 Regulatory sector

ITU Member States which have regulatory policies, regulations and specifications for telecommunication equipment, will require that the equipment imported or deployed in their countries meet their regulations and specifications. Conformance testing, certification and marking are methods employed to demonstrate that equipment meets requirements. Equipment tested or certified in an exporting Member State meeting the requirements of an importing Member State may not be accepted by the importing Member State and the equipment may have to be tested or certified again in the importing Member State before it can be deployed in the importing Member State.

To expedite the trade of telecommunication equipment between Member States, the Member States can negotiate and implement a bilateral MRA on conformity assessment. With this MRA in place the parties to the MRA will mutually recognize each other’s conformity assessment bodies and mutually accept the conformity assessment results prepared by these recognized conformity assessment bodies. The results of the implementation of the MRA would be the elimination of double testing and certification thus reducing the costs of the equipment and reducing the time to bring the equipment to market.

One of the lessons learned from experience with MRAs in the regulatory sector is that often existing national legislation is inadequate to address all aspects of the MRA process. For example delegation of

[19] www.wto.org/english/tratop_e/tbt_e/tbt_e.htm

various authorities to foreign MRA partners is often found to be ”ultra-virus” requiring legislative changes which at best are time consuming to achieve and can delay engagement in an MRA for periods as much as a few years. Furthermore legislative authority is often found to be vested in a variety of legal instruments under different governmental jurisdictions, therefore requiring sensitive negotiation with the implicated legal authorities which may not have a strong interest in telecommunication and undertaking the required changes. An example of this is found in legislative authorities responsible for calibration. Calibration per se applies to a large range of products and services varying from health systems and equipment to military and environmental protection areas. Since the basic tenet of an MRA is to be able to export to partner countries without trans-national audits it is crucially important that the competence of MRA partners in regards to calibration of equipment which is subject to the MRA process is accepted without question. This becomes very important if test results are in dispute between a regulatory authority and an equipment supplier and a judicial process is entered into to resolve the dispute. Tracing calibration of equipment to an indisputable source becomes key to validation of test results, along with the test methodology used. Therefore legislation which permits acceptance of foreign MRA partner competence in calibration is an essential ingredient of preparation for engagement in an MRA.

In a regional group such as in the African region, if there are a number of Member States which intend to implement an MRA with neighbouring countries, it would be more efficient for the group to develop a framework MRA similar to the Asia Pacific Economic Cooperation (APEC) MRA and the Inter-American Telecommunication Commission (CITEL) of the Organization of American States (OAS) MRA (APEC TEL MRA[20] or the Inter-American MRA[21]) (see also section 10 below). In this way the Member States agree to the principle and the framework of the MRA. They will develop and implement bilateral MRAs with their partners based on the framework. A multilateral MRA (one which is agreed to by a number of partners) will enable the development of a consistent set of bilateral MRAs within a region and reduce the time and resources required to develop and manage the individual bilateral MRAs.

9.2 Voluntary sector

Internationally recognised accreditation bodies have to be ISO/IEC 17011 compliant. Peer assessment by other accreditation bodies is the process developed internationally to demonstrate ISO/IEC 17011 compliance. There are two international groups and at least three regional groups of accreditation bodies which have implemented MRAs for compliance with ISO/IEC 17011.

Accreditation bodies for testing laboratories can join the International Laboratory Accreditation Cooperation (ILAC) MRA as signatories on the basis of them being peer assessed as fulfilling the requirements of ISO/IEC 17011.

Accreditation bodies for certification bodies can join the International Accreditation Forum (IAF) MLA as signatories on the basis of them being peer assessed as fulfilling the requirements of ISO/IEC 17011.

Accreditation bodies for testing laboratories can also join regional groups such as the Asia Pacific Laboratory Accreditation Cooperation (APLAC), the European co-operation for Accreditation (EA) and Inter American Accreditation Cooperation (IAAC) as signatories to their MRAs.

Accreditation bodies for certification bodies can also join the European co-operation for Accreditation (EA), the Pacific Accreditation Cooperation (PAC) and the Inter American Accreditation Cooperation (IAAC) as signatories to their MRAs.

Individual conformity assessment bodies can also implement peer assessment and mutual recognition of conformity assessment results between themselves directly.

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[20] http://publications.apec.org/publication-detail.php?pub_id=1104

[21] www.ic.gc.ca/eic/site/mra-arm.nsf/eng/nj00020.html

9.3 Institutional arrangements to support MRAs

One of the lessons of experience with MRAs is that often national legislation is inadequate to the process. For example delegation of various authorities to foreign MRA partners is often found to be *ultra virus* requiring legislative changes which at best are time consuming to achieve and can delay engagement in an MRA for periods as much as a few years. Furthermore legislative authority is often found to be vested in a variety of legal instruments under different governmental jurisdictions, therefore requiring sensitive negotiation with the implicated legal authorities which may not have a strong interest in telecommunication and undertaking the required changes. An example of this is found in legislative authorities responsible for calibration. Calibration per se applies to a large range of products and services varying from health systems and equipment to military and environmental protection areas. Since the basic tenet of an MRA is to be able to export to partner countries without trans-national audits it is crucially important that the competence of MRA partners in regards to calibration of equipment which is subject to the MRA process is accepted without question. This becomes very important if test results are in dispute between a regulatory authority and an equipment supplier and a judicial process is entered into to resolve the dispute. Tracing calibration of equipment to an indisputable source becomes key to validation of test results, along with the test methodology used. Therefore legislation which permits acceptance of foreign MRA partner competence in calibration is an essential ingredient of preparation for engagement in an MRA.

In order to manage the MRA process say for a Pan-Regional MRA a trusted organization is required to host the MRA database of signatories and scopes and other details e.g. an organization such as CITEL in the Americas; APEC TEL in the Asia-Pacific region; EC in Europe. The MRA also needs an oversight committee consisting of principals from the signatory countries. Such a committee, known as a joint committee, of MRA partners oversees on-going developments such as changes to scope and contact points and deals with problems such as non-compliance matters and performance of bodies implicated in the MRA processes. Processes and procedures are also needed for engagement and confidence building, operation, problem resolution, and withdrawal from the MRA.

Further guidance on the establishment and operation of MRAs can be found in ISO/IEC Guide 68: 2002: *Arrangements for the recognition and acceptance of conformity assessment results*.

10 Mutual recognition agreements/arrangements (MRA) frameworks

10.1 Background

This overview is being presented in the context of recent developments in various forums of ITU with particular focus on conformity and interoperability issues relevant to the work of the ITU Telecommunication Standardization Sector (ITU-T) and the Telecommunication Development Sector (ITU-D). These matters have been raised principally by developing countries and are related to building needed expertise worldwide (capacity building) in telecommunications, solving problems with interoperability and conformity testing of products and systems, establishing the case for setting up regional and sub-regional test laboratories including capabilities to perform type approval testing and interoperability testing, advancing work in ITU-T Study Groups towards establishing testable Recommendations replete with test suites, and contributing to bridging the standardization gap. Resolutions of the 2008 World Telecommunication Standardization Assembly (WTSA), the 2010 World Telecommunication Development Conference (WTDC), and the 2010 Plenipotentiary Conference (PP-10) are demanding action on these topics and there has been much discussion at related events such as the Telecommunication Standards Advisory Group (TSAG) meetings, as well as meetings of the TSB Director with prominent sector member CTO's, various workshops, study groups, and regional consultation meetings.

WTSA 2008 Resolution 76, WTDC 2010 Resolution 47 and PP-10 Resolution 177 (Guadalajara, 2010) are complementary Resolutions mutually supportive of dealing with the issues mentioned above and

providing guidance and instruction to ITU to proceed in conducting studies, developing an action plan and initiating actions to address these matters as a matter of some urgency. Mutual recognition agreements/arrangements (MRAs) could play a role in this work, creating a collaboration framework for mutually recognizing the competence of testing laboratories, certification and accreditation bodies amongst participating MRA signatory organizations and countries, and providing operational efficiencies and cost savings in delivering products to the marketplace which are compliant with ITU Recommendations and other relevant standards.

This section provides an overview of MRAs, the benefits of MRAs, types of MRAs and an example of an MRA on conformity assessment of telecommunication equipment.

10.2 Overview of an MRA

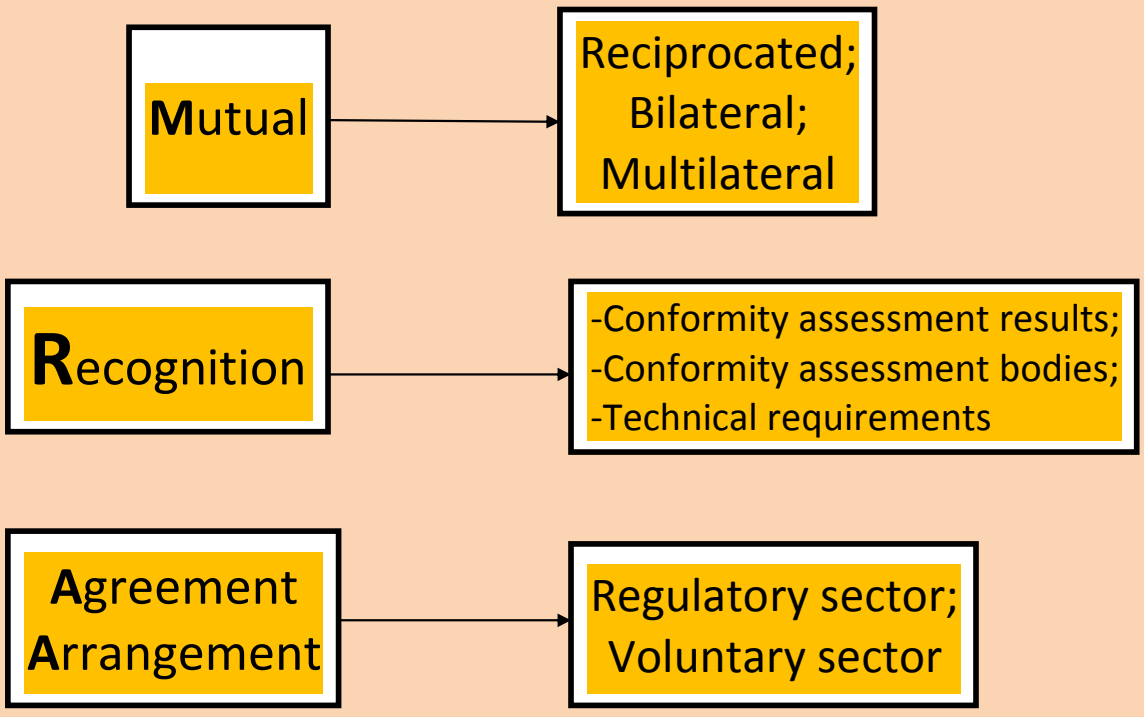
An MRA is an agreement or arrangement between two or more parties to recognize each other's expertise and competence to carry out tasks and procedures on behalf of the other party or parties on a mutual basis and for the purpose of this report, the parties to an MRA mutually recognize each other's conformity assessment bodies (CABs) and the conformity assessment results produced by these CABs.

An MRA is reciprocated among parties and it can be bilateral (two parties) or multilateral (more than two parties).

The parties to the MRA may be in the regulatory sector which includes sovereign states, government institutions and agencies. The parties to the MRA may also be in the voluntary sector which includes private and semi-private organizations such as test laboratories, certification bodies and accreditation bodies.

Two kinds of MRAs are in common use today – mutual recognition agreements and mutual recognition arrangements. These two similar sounding terms embody *significantly different* legal interpretations.

Figure 3: Understanding MRAs



Source: Andrew Kwan.

In general, an agreement is deemed to be a legally binding instrument which has similar status and force as a treaty and therefore requires a high level of approval and ratification.

A mutual recognition agreement between countries may therefore require approval by the highest legislative authorities in each country and for example in a parliamentary democracy would require approval of Parliament. Other types of governance structures would have appropriate bodies vested with such authority and may have more or less onerous approval procedures depending on the individual situation and sensitivity of the subject matter of the MRA.

A mutual recognition arrangement is deemed to be less formal depending on the coverage and sensitivity of issues involved and approval and ratification procedures may be vested with lower level agencies and officials and therefore can generally be established much faster.

In recent years many countries have gone exclusively to mutual recognition agreements for formal commitments between themselves and other countries[22]. The arguments in favour of this include the consideration that agreements between countries should be vetted by representatives of the whole citizenry, i.e. not just the political party in power at that time. This therefore requires going beyond merely obtaining departmental head or even cabinet approval, and requires obtaining full government approval.

10.3 Benefits of MRAs

A number of important benefits accrue from MRAs. Primarily MRAs on conformity assessment are intended to streamline the flow of products amongst participating signatory bodies which may include Member States, government agencies and departments, private sector organizations such as test labs and accreditation bodies. MRAs have the potential to reduce the cost of carrying out testing and/or certification due to facilitating integrated manufacturing, testing and marking for target markets, which in addition can significantly reduce time to market. In the regulatory sector they permit obtaining the required national certificates for products locally by manufacturers, avoid rejection of consignments and eliminate redundant procedures.

A further benefit of MRAs is that they promote transparency in market access. For example in MRAs dealing with regulated products they constrain the parties to follow the agreement which spells out in detail the procedures for market access. This has a major impact on removal of predatory and non-transparent procedures which may favour national industries and deny national treatment to importers thereby damaging the competitive edge of the exporting party. Estimates of savings obtained through MRAs are based on the removal of re-testing, re-shipment to destination marketplaces for certification and marking, and removal of the need for local staff in the destination importing marketplace to handle the interface with test labs, accreditation and certification bodies.

MRAs dealing with regulated products have most meaning when there is a regulatory system in place in the marketplaces of the signatories, specifying among other things technical requirements and procedures. Therefore an additional side benefit of such MRAs is to raise the awareness of the need for and benefits of a regulatory system which prevents harmful interference amongst deployed systems and prevents both network harm and harm to personnel working with telecommunication products and systems. Such regulatory systems may also be said to reflect the value system of the society in which they are deployed since they specifically address safety of life and interference-free service delivery.

It is important to note that regulatory requirements have no interoperability objectives per se nor does meeting them advance the likelihood of interoperability in a particular marketplace.

[22] This comment applies only to MRAs between Member States.

10.4 Types of MRAs relevant to the conformity assessment of telecommunication equipment

This section focuses on MRAs on conformity assessment of telecommunication equipment and related procedures with emphasis on accreditation, testing and certification. Two MRA regimes are discussed in this section:

1. MRAs on conformity assessment which deal with products in the regulatory sector, and
2. MRAs dealing with products in the voluntary or unregulated product sector.

The formal foundational basis for MRAs has already been the object of many years of work in committees of the International Organization for Standardization (ISO) in collaboration with the International Electro-technical Commission (IEC) and other bodies. This collaboration now embraces ITU as well under the World Standards Cooperation (WSC) umbrella which underpins the spirit of collaboration among the three international de jure standards bodies, ITU, ISO and IEC, with responsibilities in the ICT sector.

The early recognition of globalization of trade in products and services saw the formation of the ISO Committee on Conformity Assessment (CASCO), which has developed the ISO/CASCO TOOLBOX of international guides and standards. This TOOLBOX contains a suite of about 30 documents as of early 2010 which cover conformity assessment, accreditation, testing, peer assessments, MRAs, and many other important elements which form a foundation for regulatory and voluntary testing with trusted credentials (see section 8).

10.4.1 Voluntary sector

10.4.1.1 IECEE CB scheme[23]

Conformity assessment bodies dealing with the safety of electrical and electronic equipment had organized the IECEE Certification Bodies (CB) scheme.

The IECEE CB scheme is the international system for mutual acceptance of test reports and certificates dealing with the safety of electrical and electronic components, equipment and products. It is a multilateral agreement among participating countries and certification organizations. A manufacturer utilizing a CB test certificate issued by one of the accepted national certification bodies (NCBs) can obtain certification marks of the latter, within their scope of adherence, in the countries where the accepted NCBs are located.

10.4.1.2 International Laboratory Accreditation Cooperation (ILAC) MRA

The International Laboratory Accreditation Cooperation (ILAC) MRA was formalized and signed by 36 accreditation bodies from 28 countries in 2000. The purpose of the ILAC MRA is to develop a global network of accredited testing and calibration laboratories that are assessed and recognized as being competent by ILAC MRA signatory accreditation bodies (see section 8).

10.4.1.3 International Accreditation Forum (IAF) MLA

The IAF establishes mutual recognition arrangements known as Multilateral Recognition Arrangement (MLA). The scope of the MLA includes certification bodies, registration of quality systems, products and services. Accreditation body members of IAF are admitted to the IAF MLA after evaluation of their operations by a peer evaluation team which is charged to ensure that the applicant member complies fully with both the international standards and IAF requirements (see section 8).

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[23] www.iecee.org/html/AboutIECEE.htm. IECEE stands for "The IEC System for Conformity Testing and Certification of Electrical and Electronic Components, Equipment and Products".

10.4.2 Regulatory sector

A number of countries and regions have concluded a number of MRAs on conformity assessment of telecommunication equipment. These are bilateral agreements and most of them are binding.

The following is an example of existing MRAs in conformity assessment of telecommunication equipment:

- United States – European Union
- United States – EFTA countries
- United States – Japan
- United States – Vietnam
- United States – Canada
- Canada – European Union
- Canada – Switzerland
- Canada – EFTA countries
- United States – Mexico
- Canada – Israel (in advanced stage of ratification)
- Canada – Mexico (in advanced stage of ratification)

In addition, two regional groups, namely the Asia Pacific Economic Cooperation (APEC) and the Inter-American Telecommunication Commission (CITEL) of the Organization of American States (OAS) had developed two MRAs which provide the framework for its members to develop bilateral MRAs. The APEC TEL MRA covers 21 economies of APEC and the Inter-American MRA covers 34 Member States of the OAS. Economies of APEC and Member States of CITEL are implementing bilateral MRAs based on either the APEC TEL MRA or the Inter-American MRA.

10.5 An example of the framework and contents of a mutual recognition arrangement for conformity assessment of telecommunication equipment

Framework

- Scope: Equipment subject to mandatory telecommunication requirements
- Coverage: Telecom, EMC and Electrical Safety
- Phases:
  - Phase I – acceptance of test results
  - Phase II – acceptance of equipment certification
- Conformity Assessment Bodies (CABs):
  - Testing laboratories
  - Certification bodies
- Competence of CABs: Determined using ISO/IEC Standards 17011, 17025, Guide 65 plus appropriate technical regulations

Contents

- Preamble
- Purpose of the agreement
- General Provisions

- Definitions and Interpretations
- Scope
- Designating Authorities
- Designation of CABs and Appointment of Accreditation Bodies (ABs)
- Recognition of CABs and Mutual Acceptance of the Results of Conformity Assessment (CA) Procedures
- Verification of CABs
- Commencing the Agreement and Initiating Participation in Phase I or Phase II Procedures
- Information Exchange
- Joint Committee
- Additional Provisions
- Confidentiality
- Preservation of Regulatory Authority
- Fees
- Amendment and Termination of Agreement
- Final Provisions
- Appendix A
  - Common Requirements
  - Designation of Testing Laboratories
  - Designation of Certification Bodies
- Appendix B – Phase I procedures for mutual recognition of testing laboratories as CABs and mutual acceptance of test results
  - Scope
  - Designation and Recognition of CABs
  - Participation in Phase I Procedures
  - Transition Periods
  - Mutual Acceptance of Test Reports
  - Processing of Applications
  - Suspension of Mutual Recognition and Acceptance Obligations
- Appendix C – Phase II procedures for mutual recognition of certification bodies as CABs and mutual acceptance of equipment certifications
  - Same as Appendix B above, except change Phase I to Phase II and testing to certification
- Annexes I – Annexes IV

  Annex I – List of the Technical Regulations for Each Participating Country

  Annex II – List of Name and Address of Each Designating Authority and Accreditation Body for Each Participating Country

  Annex III – List of Name and Address of Each CAB Designated by Each Participating Country

Annex IV – List of Name and Address of Each CAB or MRAs by AB Recognized by Each Participating Country

Contents (by paragraph)

- Preamble.
- Trade facilitation measure in support of the WTO Agreement on Technical Barriers to Trade (TBT) obligations.
- The agreement is not legally binding; however, it does imply certain rights and responsibilities for participating countries.
- Parties may exchange letters if useful.

1. Purpose of Agreement
   - To provide for the mutual acceptance of other parties' CA results for a wide range of telecommunication equipment subject to mandatory requirements.
2. General Provisions
   - Introduces and brings into the agreement the designating and monitoring procedures in Appendices A, B and C.
3. Definitions and Interpretations
   - Introduces ISO/IEC Guide definitions and key definitions.
   - Technical regulations – means mandatory requirements.
4. Scope
   - Arrangement applies to the Technical Regulations listed by each participating party in ANNEX I – applies to network terminal attachment and other telecommunication equipment. Coverage includes Telecom equipment, EMC and Electrical Safety.
5. Designating Authority (DA)
   - A government entity that designates, lists, verifies competence of, limits and withdraws designation of Conformity Assessment Bodies (CABs) within its jurisdiction.
   - An independent accreditation body may be appointed to determine competence of CABs. The DAs and ABs will be listed in ANNEX II by each party.
6. Designation of CABs and Appointment of ABs
   - Each DA (listed in ANNEX II) may designate CABs to perform conformity assessment activities to the other party's requirements.
   - Designations must follow the procedures in Appendix A.
   - Mutual recognition agreements between accrediting bodies may be used, provided they follow Appendix A.
7. Recognition of CABs and Mutual Acceptance of the Results of Conformity Assessment Procedures
   - Under the procedures specified for Phase I and Phase II, a party (Regulatory Authority) will recognize CABs and accept the results performed by those CABs.
8. Verification of CABs
   - Parties have the right to contest a CABs technical competence following due process procedures.
   - The Joint Committee may become involved to assist in resolving the differences.

9. Commencing the Agreement and Initiating Participation in Phase I or Phase II Procedures
    - Commencement date.
    - Each party must provide the other parties with certain information. (Some countries may accomplish this through an exchange of letters.)
10. Information Exchange
    - Technical regulations are listed in Annex I for each party. Changes to regulations must be publicly available.
    - DA and AB (Annex II), designated CABs (Annex III), recognized CABs (Annex IV) must be kept current.
11. Joint Committee
    - Joint party established consisting of representatives from each party.
12. Additional Provisions
    - Each party will endeavour to use international standards as a basis for its technical regulations.
13. Confidentiality
    - A party, in accordance with applicable laws, will protect proprietary information.
14. Preservation of Regulatory Authority
    - Each party retains all authority under its laws to interpret and enforce its technical regulations governing equipment covered by this Agreement.
15. Fees
    - The parties will ensure that any fees charged will be non-discriminatory, transparent, and reasonable.
16. Amendment and Termination of Agreement
    - May be amended by mutual written consent of the participating parties.
    - A party may terminate its participation by giving 6 months' notice.
17. Final Provisions
    - Agreement is inclusion of Appendices A-C and Annexes I-IV, with appendices taking precedence in cases of inconsistencies.

Appendix A – Designation and Monitoring Requirements for CABs

- Specifies designation and monitoring rules for testing labs and certification bodies.

A. Common Requirements
    - DA may appoint Accreditation Bodies (AB) provided certain conditions are met, which includes the use of the relevant international standards/guides; i.e. ISO/IEC 17011, 17025 and Guide 65.
    - DAs encouraged to harmonize designation procedures.
    - ABs encouraged to participate in agreements between accreditation bodies.

B. Designation of Testing Laboratories (TL)

- A party may use one or more Designating Authorities or Accrediting Bodies to determine the competence of a laboratory to test equipment to the other party's technical regulations.
- The DA or AB must be capable of meeting of ISO/IEC 17011.
- The TL must be accredited to ISO/IEC 17025 to the appropriate scope and technical regulations.
- The DA may require the TL to demonstrate competence through: Regional AB MRA, peer evaluations, proficiency testing or comparison between testing laboratories.
- Each TL will have a 6 character identifier.

C. Designation of Certification Bodies (CB)

- A party may use one or more Designating Authorities or Accrediting Bodies to determine the competence of a body to certify equipment to the other party's technical regulations.
- The DA or AB must be capable of meeting of ISO/IEC 17011.
- The CB must be accredited to ISO/IEC Guide 65 to the appropriate scope and technical regulations using a team of technical experts to determine competence for each type of equipment and discipline.
- The CB must also be accredited to ISO/IEC 17025 and be capable of testing equipment for which it approves.
- Sub-contracting per Guide 65 permitted.
- CB must establish an acceptable market surveillance programme in accordance with Guide 65.
- Each CB will have a 6 character identifier established by the DA.

Appendix B – Phase I Procedures for Mutual Recognition of Test Labs and Mutual Acceptance of Test Reports

1. Scope

- Specifies the procedure for mutual recognition of TLs and the acceptance of test reports relating to the technical regulations identified in ANNEX I for Phase I for each party.

2. Designation and Recognition of CAB

- The DA of the exporting party accredits and designates CABs as being competent to test equipment subject to the technical requirements of the importing party listed in ANNEX I.
- The importing party (RA) upon receipt of the exporting parties' designation will evaluate and recognize CABs in a fair and transparent manner. The Joint Committee may be used for the review process in cases of dispute.
- Consistent with paragraph 5.3 of the MRA, an exporting party may appoint an AB which has entered into a MRA with other ABs to accredit CABs.

3. Participation in Phase I Procedures

- Details the appropriate ANNEXES that each party needs to complete.

4. Transition Periods

- Establishes a procedure to build confidence with the aid of familiarization and training among participating parties.

5. Mutual Acceptance of Test Reports
    - Establishes a procedure for the fair and transparent handling of test reports by recognized CABs.
6. Processing of Applications
    - Establishes timetable for processing applications.
7. Suspension of Mutual Recognition and Acceptance Obligations
    - Establishes procedure for suspension of MRA.

Appendix C – Phase II Procedures for Mutual Recognition of CBs and Mutual Acceptance of Equipment Certifications

1. Scope
    - Specifies the procedure for mutual recognition of CBs and the acceptance of approval of equipment meeting the technical regulations identified in ANNEX I for Phase I for each party.
2. Designation and Recognition of CABs
    - The DA of the exporting party accredits and designates CBs as being competent to approve equipment subject to the technical requirements of the importing party listed in ANNEX I. Consistent with paragraph 5.3 of the MRA, the DA may appoint an AB to accredit the CB for the procedures in Appendix A.
    - The importing party (RA) upon receipt of the exporting parties' designation will evaluate and recognize the CB in a fair and transparent manner. The Joint Committee may be used for the review process in cases of dispute.
3. Participation in Phase II procedures
    - Details the appropriate ANNEXES that each party needs to complete.
4. Transition Periods
    - Establishes a procedure to build confidence with the aid of familiarization and training among participating parties.
5. Mutual Acceptance of Equipment Certifications
    - Establishes a procedure for the fair and transparent handling of equipment certification produced by recognized CBs.
6. Suspension of Mutual Recognition and Acceptance Obligations
    - Establishes procedure for suspension of MRA.

11 Lessons learned in creation of international test centres

This section describes some of the lessons learned in the creation of international or regional test centres.

11.1 Background

11.1.1 Test centres

The purpose of test centres is to:

- Conduct conformance testing of equipment to meet specific standards and specifications as specified by vendors, manufacturers, service providers and network operators.

- Conduct interoperability testing of equipment on specific networks.
- Conduct testing and evaluation of equipment which employs new technologies before deployment in networks.

There are different types of test centres including:

- Private test centres belonging to manufacturers and testing laboratories (see Appendix 3 of main report) with test equipment belonging to the manufacturers or equipment specified by the customers.
- Test centres which serve a specific community such as "*Technische und betriebliche Fragen der Numbmerierung und Netzzusammenschaltung*" with test equipment of interest to the specific community.
- Test centres and services operating at the international or regional levels such as the ETSI Plugtests, and the test centre established by the Central Scientific – Research Institute of Communication (ZNIIS) of the Russian Federation which tests equipment to meet international standards (ISO) and Recommendations (ITU).

11.1.2 Network operators and service providers

When network operators plan for new networks or improvement to their existing networks, they develop requirements on interfaces and protocols which are mostly based on international standards such as ITU Recommendations. These requirements will also be based on proprietary or private standards, interfaces or protocols in order to meet the requirements of the existing networks.

Similarly when service providers plan for new services or improvements to existing services, they will develop requirements for the provisioning of these services. These requirements will mostly be based on international standards such as ITU Recommendations. These requirements may also include proprietary or private standards in order to meet the requirements of the existing services.

The requirements created by the network operators and service providers will typically be formulated in a number of requests for proposals (RFPs) as the first step towards acquisition of products and systems.

11.1.3 Vendors and manufacturers

In response to the RFPs, equipment vendors and manufacturers will develop equipment (hardware and software) to meet the RFPs based on their own product lines and the portfolios of the services their equipment supports.

The vendors and manufacturers will test their equipment for conformity to the requirements specified in the RFPs before delivering the equipment to their clients. These tests are specialized tests used by the vendors to test their own equipment in a simulated environment.

11.1.4 Equipment installation, conformance and interoperability testing

The vendor selected by the network operators and service providers delivers the equipment to the client's site and along with the client (network operator or service provider) conducts conformance and interoperability testing using one or more network configurations specified by the client. These tests will be conducted using a combination of test procedures specially developed for this test and standardized test suites. Since the networks operated by the network operators may connect to different networks, the conformance and interoperability tests will have to be repeated for the various network configurations.

11.2 Results of conformance and interoperability tests

A number of regional and international test centres have been established to conduct conformance and interoperability tests. Their experiences are summarized in the following:

- It is costly to conduct the specialized conformance and interoperability tests and return on investment is questionable in the short and medium time frames.
- Since the tests involve proprietary interfaces and protocols, the results of the tests cannot be shared with other clients of the test centres.
- A common set of test procedures is not available and sometimes not possible to formulate resulting in a highly inefficient testing environment.

11.3 Optimum strategies to establish test centres

The experience gained and lessons learned from the establishment and operation of regional test centres has led to the following proposed optimum strategies to establish test centres.

- The four stakeholders involved in the development and testing of telecommunication equipment, namely, the vendors of telecommunication equipment; the standard development bodies such as ITU and ETSI; the network operators and service providers and the test centres should cooperate closely in the development of standardized test suites and procedures during the development of the standards and specifications.
- Test centres should be established on a regional basis to take advantage of the similar networks with common infrastructures and shared common interfaces deployed by the regional network operators.
- Development of model networks based on regional requirements which can perform a common set of tests such as:
  - conformance and interoperability tests on equipment implementing international standards;
  - testing of special parameters implemented by network operators;
  - testing of equipment under payload;
  - testing of new services;
  - testing of systems (equipment, network solutions) under simulated error conditions;
  - testing of protocols and interfaces;
  - QoS testing;
  - metrology testing

12 Test suite development and selection for conformance and interoperability testing

Test specifications come in different forms and from various sources. ITU is the primary source for specifying the technologies and producing the standards for which conformance and interoperability testing is planned. Due to the breadth of ITU leading-edge ICT standards development, ITU has a large catalogue of standards available for conformance testing. A review is currently under way to determine the optimal set of standards to become candidates for new test suite development. This chapter looks at the test specification development process and the identification and availability of test suites for future conformance and interoperability testing.

12.1 Technologies, standards, and test specifications

ITU has a long history and experience with the development of test specifications, detailing the requirements and options within its standards and facilitating conformance testing. When addressing the needs of developing countries, it is important to consider technologies currently deployed as well as technologies anticipated for future introduction. To address conformance and interoperability testing in various regions, there is a need to support test specifications for legacy standards as well as the most current, leading-edge ICT standards.

12.1.1 ITU-T test specifications

ITU-T Recommendations cover a very wide range of protocols, architectures, services, and systems. They also define complex systems, services and applications on multiple platforms, legacy/IP-based network convergence, and wireline/wireless convergence.

ITU-T technologies under study within its various Study Groups include:

- NGN Architecture and Services
- Fixed-Mobile Convergence
- Optical Networks
- Broadband Cable
- Multimedia, IPTV
- ISDN
- QoS, QoE
- Security

ITU-T has a catalogue of more than 3000 Recommendations. Not all Recommendations specify technologies that are suitable for conformance testing. In its development of the Conformity Database project, ITU-T has identified about 400 Recommendations deployed in products and candidates that are suitable for testing. Most ITU-T Recommendations, including the majority of the candidate conformity Recommendations, have no associated test specifications (e.g. PICS, Test Suites). There are fewer than 150 Recommendations that include test specifications as of March 2012.

12.1.2 Technologies for conformance testing

The primary factor for determining conformance testing in a regional test centre will be the technologies currently deployed and technologies envisioned for future deployment. In addition to the legacy technologies for which ITU-T has developed standards over many years, there is also a focus on evolving, emerging, and future technologies.

ITU participates in Global Standards Collaboration (GSC) meetings with regional SDOs that are major contributors to ITU standardization efforts (including standardization of test specifications). GSC brings together senior representatives of ITU with the Association of Radio Industries and Businesses (ARIB) and the Telecommunication Technology Committee (TTC) of Japan, the Alliance for Telecommunications Industry Solutions (ATIS) and Telecommunications Industry Association (TIA) of the USA, the China Communications Standards Association (CCSA), the European Telecommunications Standards Institute (ETSI), the ICT Standards Advisory Council of Canada (ISACC), and the Telecommunications Technology Association (TTA) of Korea. Technology discussions are focused on high interest subjects that include:

- NGN Architecture and Services
- Fixed-Mobile Convergence
- Mobile Multimedia Broadcast/Multicast
- *Interoperability*
- Optical Networks
- Multimedia and IPTV
- QoS, QoE
- Security and Identity Management
- Emergency Communications
- Intelligent Transportation Systems
- Smart Grid
- Machine-to-Machine Communications
- Cloud Computing

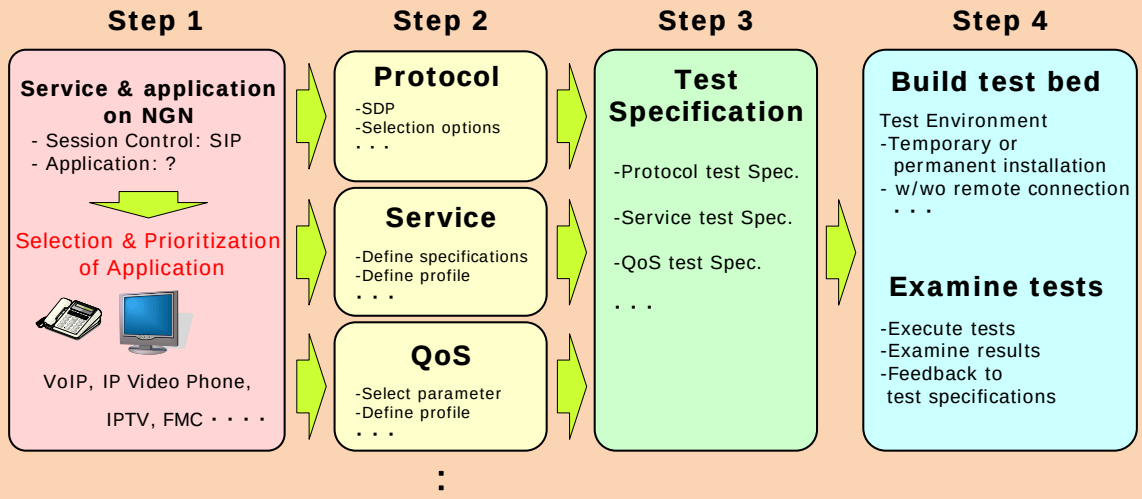
12.2 Test specification development

Test specifications come in various forms and from various sources. A significant number of test scripts and test specifications are created in association with the product development or certification process. Product or service-specific test specifications may be created by manufacturers, network or service providers, or industry associations. Standards development organizations may create test scripts according to standardized methodologies or on an ad hoc basis for various types of testing events.

Development of methodologies and guidelines for test specifications continues in ITU-T. The following diagram depicts a high level process for developing test specifications for services and applications on NGN.

Formal test specification techniques include: Protocol Implementation Conformance Statements (PICS), PICS Proforma, Test Suites, Test Suite Structure and Test Purposes (TSS and TP), Protocol Implementation eXtra Information for Testing (PIXIT), and Abstract Test Suites (ATS). These formal techniques have been utilized within ITU-T and will be discussed briefly.

Figure 4: Typical NGN conformance and interoperability test specification process



Source: "Handbook on Testing", ITU-T, 2011

12.2.1 Protocol Implementation Conformance Statement (PICS)

PICS Proforma – A document, presented in the form of a questionnaire that systematically reviews all requirements of a given standard. In particular, it lists all cases, conditions, and options for the protocol messages and requires an indication of the support of each within a particular implementation. PICS Proforma include Status Notations and Support Declarations:

- Status notations – Each condition, option, response, etc. is reflected by a status designation (e.g. mandatory, optional, prohibited, conditional)
- Support declarations: Indication of the support status (yes, no, not applicable) for each of the items in the questionnaire for the specific implementation under review

PICS – The PICS is the completed questionnaire of the PICS Proforma document and contains all information regarding a specific implementation under study.

PICS Proforma and PICS can be utilized for standards other than strictly protocol standards (ICS Proforma, ICS).

12.2.2 Test suite structure (TSS) and test purpose (TP)

Test purpose – Each test purpose focuses on a single conformance requirement.

Test suite – A collection of test cases, one for each test purpose. A test case verifies conformance/interoperability for a particular requirement or option according to the test purpose.

Test suite structure – A test suite must ensure coverage of all conformance requirements. This is facilitated by creating a hierarchical structure for different categories of tests. For example: Basic interconnection tests, mandatory features, optional features, data transfer, variation of parameters. The logical construction of a test suite and test purposes optimizes test case coverage and minimizes test duplication.

12.2.3 Abstract test suite (ATS)

Abstract test suite (ATS) – A test suite is composed of abstract test cases and written in test notation (e.g. TTCN-3) that defines: test suite structure, test suite architecture, test methods and port definitions, design principles, assumptions, simulator interfaces, parameter and data values.

12.2.4 Protocol implementation eXtra information for testing (PIXIT)

PIXIT Proforma – Supplementary questionnaire (supplementary to the PICS Proforma) requesting additional specific information regarding the implementation to be tested (implementation under test (IUT)). The PIXIT Proforma contains requests for information on the IUT and the testing environment (e.g. configuration, parameters, timer values, procedures).

PIXIT – The completed questionnaire of the PIXIT Proforma document, containing additional information regarding the specific IUT

The full test specification methodology progresses from the completed PICS to the design of test cases and a test suite. The test suite is then converted into a set of abstract test cases, written in test notation.

12.2.5 Testing and test control notation (TTCN-3)

TTCN-3 is the latest version the standardized TTCN programming/scripting language used for protocol and software conformance testing. TTCN-3 is widely used by standards development organizations (SDOs), vendors, and test labs to test conformance to standards and product specifications. TTCN-3 is implementation technology and operating system independent.

Test cases from a variety of standards (e.g. ISDN, IPv6, 3G IMS, VoIP) have been written in TTCN to verify that protocol implementations in products (e.g. network elements, mobile phones) meet the requirements of those standards. Test cases from test suites are written in TTCN-3, enabling automated test execution[24].

12.3 Test specification availability

ITU has produced more than 100 test specifications for a wide range of protocols, architectures, services, and systems utilizing formal methodologies, but other sources also exist. Other SDOs also have experience in creating test specifications. For example, ATIS, CableLabs, CCSA, ETSI, IEEE, IETF, ISO/IEC, OMA, 3GPP/3GPP2, TIA, TTA, and TTC have developed test specifications for many technologies.

Producing test specifications within an ITTC and/or contracting to produce specifications would be costly and time-consuming. Although the existence of test specifications does not necessarily mean they are

[24] See www.itu.int/ITU-T/studygroups/com07/ttcn.html and www.etsi.org/WebSite/technologies/ttcn3.aspx)

readily available to an ITTC, a system must be in place to identify and obtain the required test specifications.

12.3.1 ITU-T test specifications

The following is a short list of ITU-T Recommendations which are examples of test specifications, test suites, test purposes, PIXITs, and abstract test suites developed for various signalling, networking, and IP-based standards[25].

- **Q.765bis** – SS7 Application transport mechanism: **Test suite structure** and **test purposes** (TSS and TP)
- **Q.780** – Signalling System No. 7 **test specification** – General description
- **Q.784** – ISUP basic call test specification
- **Q.784.2** – ISUP basic call test specification: **Abstract test suite** for ISUP'92 basic call control procedures
- **Q.784.3** – ISUP basic call test specification: ISUP '97 basic call control procedures – **Test suite structure** and **test purposes** (TSS and TP)
- **Q.788** – User-network-interface to user-network-interface compatibility **test specifications** for ISDN, non-ISDN and undetermined accesses interworking over international ISUP
- **Q.1912.5** – Interworking between SIP and BICC or ISUP: Part 5 (**Abstract test suite** and **PIXIT**)
- **Q.3940** – NGN **Interconnection Testing**
- **Q.3941.1** – **Network Integration Testing** between SIP and ISDN/PSTN network signalling protocol. Part 1 **TSS and TP**
- **Q.3941.2** – Network Integration Testing between SIP and ISDN/PSTN network signalling protocols. Part 2: **PIXIT and ATS**
- **Q.3948** – VoIP **services testing** at NGN UNI

12.3.2 Other sources

The following is a short list of technology areas where standards and standardization of test specifications are addressed by other SDOs. A list of test specifications and interoperability agreements, developed by other SDOs and applicable to ITU-T Recommendations can also be found in Appendix 6.

ETSI – ETSI has created various PICS, TSS/TP, and ATS documents with TTCN-3 Code. Test specifications for the following standards are publicly available:

- IP Multimedia Subsystem (IMS)
- VoIP (SIP)
- IPv6 (IETF)
- WiMax (802.16 – IEEE)

OMA (Open Mobile Alliance) – OMA has developed a series of Service Enabler test specifications to support its testing program. Specifications exist for various services, including: mobile broadcast services, presence, and multimedia messaging service (MMS).

[25] A more complete list can be found in Appendix 6.

IETF (Internet Engineering Task Force) – The IETF has produced various Internet protocol tests (e.g. SIP, Email protocols).

12.4 Selection and development of new ITU-T test specifications

ITU-T already has completed a number of test specifications covering, for example, ISDN protocols/interworking and optical fibre/components. Test suite development continues for these technologies. ITU-T has also begun work on test specifications for IPTV, VoIP services, NGN interworking, IMS, and NGN supplementary services.

During the 2011 comprehensive review of its published standards, ITU-T has already identified about 400 Recommendations deployed in products and candidates that are suitable for testing. Since the majority of these standards have no accompanying ITU-T test specifications, this is also represents the first list of candidates for test specification development. Many of these Recommendations deal with legacy technologies, and for many of these, test suites that do not exist in ITU-T catalogue may well already exist in the industry since these technologies have also been tested many times for many implementations.

ITU should focus future test suite development for its current leading-edge technologies. In addition to protocol specifications for new protocols, ITU is encouraging the development of test suites and interoperability events for complex systems and services. ITU plans to expand its test suite creation programme to support its focus on conformance and interoperability testing, in order to accelerate ITU standards-based product deployment. Feedback from interoperability testing is also extremely useful to improve standards development and verify conformance.

When addressing the needs of developing countries, it is important to consider technologies currently deployed as well as technologies anticipated for future introduction. Regional priorities should dictate the catalogue available to regional ITTCs and Regional ITTCs should take steps to obtain test suites from all available sources.

13 Role and scope of international telecommunication test centres

International telecommunication test centres (ITTCs) are designed to provide testing services that are otherwise unavailable or sub-standard in a given Region. However, an ITTC is envisioned to not only provide conformity and interoperability testing services, but also to be a centre of excellence for test methodologies, training, and capacity building for the Region. This chapter explores the role and scope of ITTCs, describing the various testing functions required as well as its associated and complementary functions.

13.1 Scope and purpose of regional ITTCs

The main purpose for establishing regional test centres is to address the specific testing needs of different regions. Testing needs differ based on technologies, services, and equipment deployed in regional networks and the availability of testing expertise also varies by region. Testing programmes offered should be developed to address certification practices, technologies implemented and technology trends of the region. In particular, experience gained in performing complex networking tests could lead to recommendations for optimized network solutions, decreased time-to-market for new technologies, and improved quality of service (QoS). Since ITTCs are to be deployed across a regional domain, potentially including many different and interconnected networks and service providers, regional testing centres could stimulate interest in new and existing vendors in the region to demonstrate interoperability and networking solutions across the region.

ITTCs should also focus on capacity building and training programmes. Capacity building efforts benefit from the concentration of experts present at the ITTC and the specialized equipment available to test the latest applications and services at a single location. Given the accumulated experience with testing current and evolving technologies in the region, the ITTC is in a position to share knowledge and host expert tutorials on these testing methodologies and technologies. (For additional resources for training, see Appendix 5 for a listing of examples of training organizations in various regions and training courses for a variety of technologies.)

As a centre of excellence for testing, the ITTC should foster interaction and cooperation with similar lab environments and research projects of other organizations. For example, the ITTC should collaborate with operators, vendors, scientific institutions, and universities that support their own research and testing labs and new technology and methodology development.

13.2 Functional capabilities of regional ITTCs

Depending upon the region, ITTC functional capabilities may include:

- configuring, calibrating, and testing appropriate telecommunication and measurement equipment;
- configuring a model network infrastructure for complex interoperability testing of systems and services;
- automating control systems and testing procedures (testing methods, testing protocols, etc.);
- establishing training courses on testing procedures and new technologies;
- coordinating with other conformance and interoperability organizations in support of a knowledge database.

13.3 Testing programmes for an ITTC

New technologies create new challenges for testing methodologies. Complex NGN and IMS functional architectures give rise to a host of NGN implementations. Interoperability testing of services deployed on NGN platforms not only requires specific service and feature definition, but also network element and traffic flow parameters and access terminal characteristics. Testing of complex systems under simulated network load conditions is also critical in QoS/QoE testing.

ITTC testing programmes offered should be developed to address certification practices, technologies implemented and technology trends of the region. This implies that test centres will require the methodologies, labs and equipment to perform:

- Type Approval Testing for a wide range of wireline, wireless, and network equipment;
- Conformance Testing that is broad enough in scope to cover the broad range of technology standards deployed; and
- Interoperability Testing, complementary to conformance testing that is capable of handling complex protocols, architectures and services.

A regional centre can potentially provide better control over the scope of the region's testing programmes and consistency across all testing (e.g. test bed improvements, code updates, and release management).

13.3.1 Type approval testing

Type approval testing (see Chapter 6) provides independent verification that equipment will perform adequately within mandatory requirements related to network harm, interference and safety – and function within the published specifications of the manufacturer and/or relevant mandatory or voluntary

industry standards. Type approval is granted to a product that meets a minimum set of regulatory, technical and safety requirements. Based on regional needs, type approval should be offered as well as conformance and interoperability testing. Type approval testing can also be useful in determining the root causes of some perceived network interoperability issues – cases where network interoperability issues do not arise from a failure to conform to service/system standards or a failure in implementing network parameters, but actually arise due to some equipment components operating outside specified norms.

Type approval testing lab sub-units typically include: calibration lab, wireless test lab, wireline test lab, EM shielded room, anechoic chamber, EMC test lab, SAR test systems, environmental chamber, Open Area Test Site (OATS).

13.3.2 Conformance testing

Conformance testing demonstrates that telecommunication equipment meets its specific standards or requirements (see Chapter 7). ITTC support for conformance testing should be broad enough in scope to cover multiple technologies and prioritized according to Regional technologies supported and network evolution plans.

Depending on the technologies deployed or planned for a region, the ITTC must support the relevant test methodologies and obtain the relevant test specifications for performing conformance tests. For example, ITU-T has identified more than 400 of its Recommendations, representing various technologies, suitable for testing. Test specifications (i.e. PICS, test suites) have been published for approximately one-third of these standards (see Chapter 12 and Appendix 6). Other SDOs have published test specifications for additional technologies. The ITTC must have procedures in place to obtain to identify and obtain the required test specifications.

13.3.3 Interoperability testing

Interoperability testing is complementary to conformance testing and results may help resolve conformance issues. Interoperability testing must support complex systems and services deployed across next generation networks. Experience gained in performing complex networking tests could lead to a unified set of equipment requirements, unified network solutions, and improved QoS/QoE.

ITU-T has introduced the concept of *model networks* as an instrument for testing new technologies. For complex systems and services, it is insufficient to conduct tests on individual network components or between single network links. In order to test the true system functioning and compatibility, it is necessary to perform tests on networks supporting services under load and stress conditions.

Service testing of new technologies poses some difficult challenges. Especially regarding services, conformance testing is most often insufficient to guarantee interoperability due sometimes to the lack of specificity in the service description and most often due to varying implementations of the same service in different networks. To address this problem, ITU-T is developing a new approach to the testing of telecommunication services (draft Recommendation Q.3915). This methodology is being applied to a wide range of service types: basic and supplementary services, streaming services, multimedia services. The goal is to specify all aspects of the service parameters and network implementation for testing purposes. These service aspects include:[26]

- service definition and features from the operator side and customer side, including service control features (activation, configuration, removal, billing);
- network capabilities for support of services including number format, identification, authentication;

[26] See “Handbook on Testing”, ITU-T, 2011

- network architecture and functional requirements of network elements;
- access network and terminal types;
- scenarios for service assignment;
- traffic flow characteristics;
- protocol and interface types;
- interworking with non-NGN networks;
- interworking with other services

Testing for quality of service (QoS) and quality of experience (QoE) also needs to be addressed in interoperability testing. The ITU-T Q.3920-series Recommendations are being developed to address QoS/QoE testing under unloaded and loaded conditions. This testing accounts for QoS parameters (e.g. IP packet delay, packet loss rate, packet error rate) as well as various traffic types (e.g. best effort, speech, and video).

The model networks test labs, modelling NGN networks and services, require a diverse inventory of network components, servers and simulators to accommodate a variety of network configurations. Figures 8 and 9 in Chapter 14 depict components required for model network configurations of terminal equipment and NGN testing. Model network labs typically require components for service and terminal access, networking and signalling, media access and control, applications, services, and network management. A list of these components can be found in Section 15.2.5.

13.3.4 Virtual testing

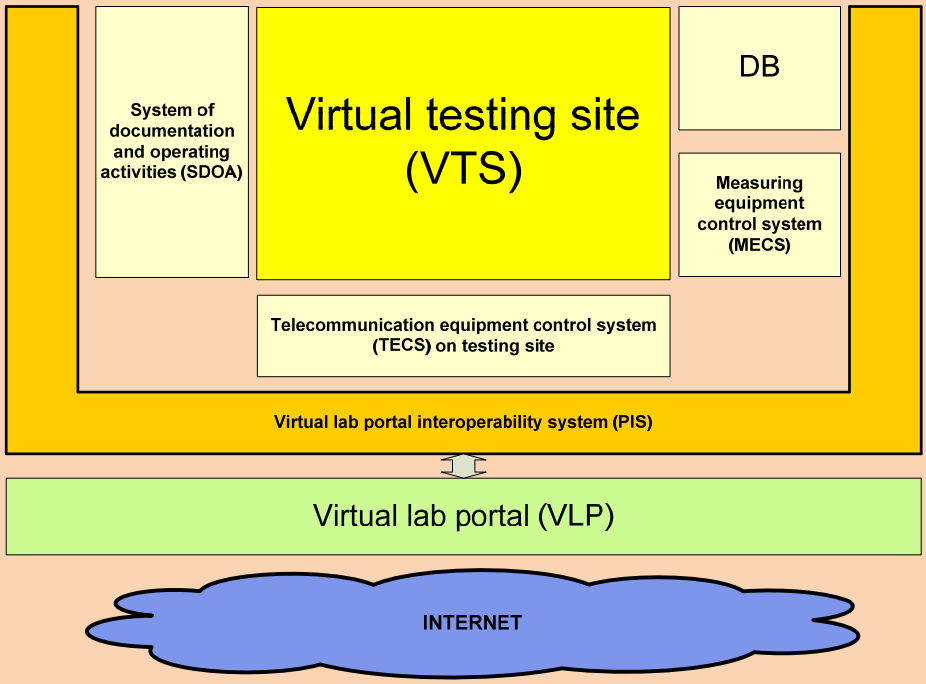
An additional testing functionality is currently being developed in ITU-T that could become a powerful testing and training tool for regional test centres. The objective is to provide remote access to an NGN model network for testing new technology equipment and services. The virtual test lab would be equipped with a model NGN network that could be configured at the request of the remote user and provide measurement and test parameter capabilities while connected to remote equipment. The virtual testing site (VTS) will provide the simulation of NGN packet switching traffic loads for testing purposes.

The virtual lab provides access to testing services and simulations and can serve as a training tool in regions where it may be impractical for certain individuals to travel to the ITTC or transport equipment. The virtual lab, while limited in scope from actual on-site testing programmes, has certain inherent advantages by virtue of remote access and also enjoys some of the advantages that the ITTC can provide:

- reduced test preparation time (model infrastructure architecture defined);
- availability and use of expensive test equipment via a remote interface;
- automation of testing procedures requiring minimal participation personnel;
- remote testing without mandatory physical presence of testing experts;
- use of testing systems utilizing the latest testing language (TTCN-3);
- reduced testing costs expected to be much lower than on-site equipment set-up and testing.

Figure 5 shows the basic Virtual Lab structure:

Figure 5: Virtual lab block diagram



Source: "Handbook on Testing", ITU-T, 2011

Functional capabilities of the VTS will include:

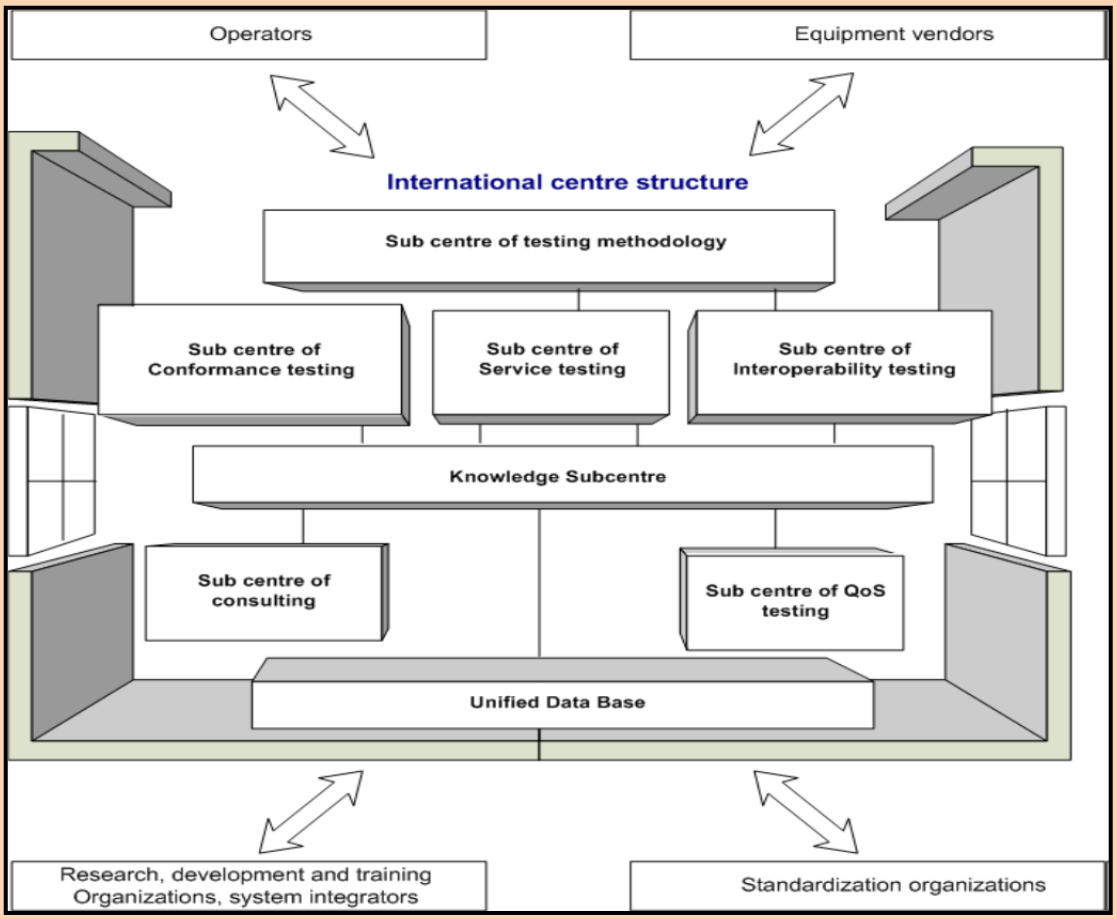
- control of the model network infrastructure;
- telecommunication and measurement equipment configuration;
- database support and interoperability;
- design support for test procedures and automated control systems;
- communication with laboratory experts.

Virtual testing adds a unique and leading edge service ITTC's complement of testing programmes. Along with type approval, conformance, and interoperability testing programmes, the ITTC is capable of servicing the varied and unique needs of its clients.

14 Operational procedures for ITTCs

ITTC operations must include business procedures, certification procedures, and test programme operations. Operational components to support the ITTC functions include lab management, IT, finance, administration, quality assurance, and human resources. ITTC operations must have both an internal and external focus in order to manage the relationships with the ecosystem of organizations involved in conformance and interoperability testing.

Figure 6: ITTC technology-related functional units and external interactions

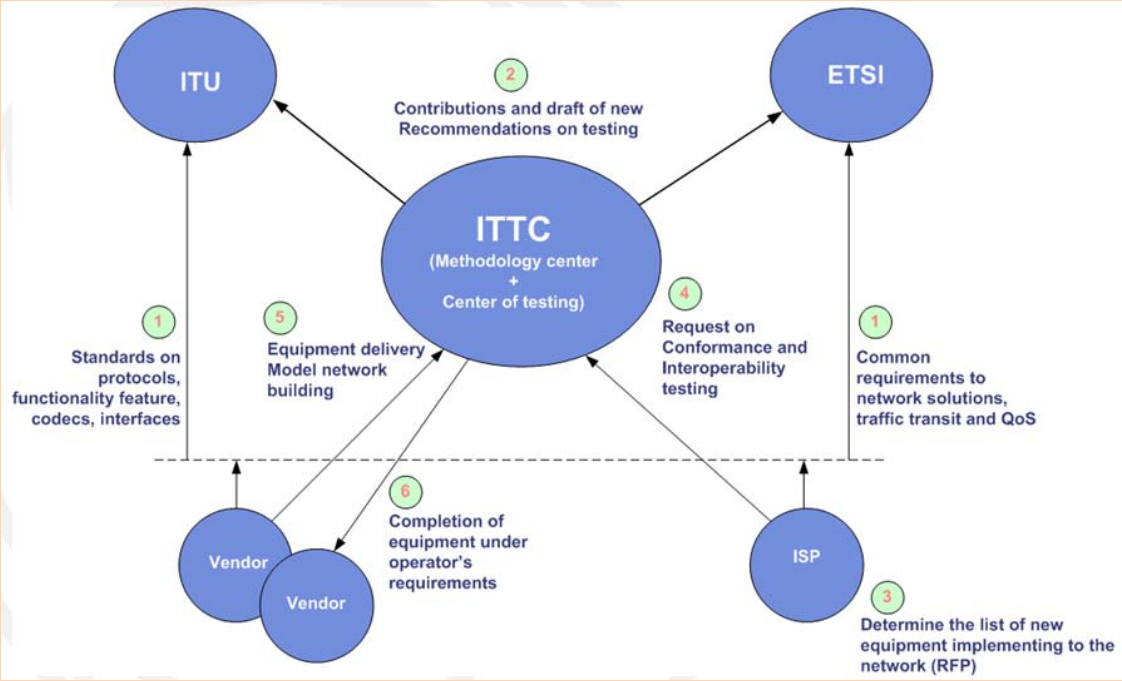


Source: ZNIIS Lab; ITU Seminar, S3-5; (Moscow, November 2011)

As depicted in Figure 6, a testing centre will typically consist of various functional units. These units include test labs for conformance and interoperability testing as well as the capabilities to address testing methodology, service platform testing and QoS testing. Supporting the test labs, there must be database support for the test data and a knowledge database for the storage of accumulated related data on testing, implementations, standards, and training. To perform its basic functions as an operating testing centre, there also needs to be interactions with the larger conformance and interoperability ecosystem that includes other related organizations such as vendors (for equipment purchases and testing), operators (for network implementations and interoperability testing), R&D organizations (for advances in technology and test methodology), training organizations (for course offerings and capacity building), and SDOs (for conformance testing and test specifications).

The following diagram (from the ITU-T "Handbook on Testing") represents the typical operational relationships of an ITTC. It focuses on the ITTC as the centre for testing and test methodologies and depicts SDO-based standards utilized as inputs for conformance and interoperability testing, vendor equipment being tested and used to build model networks for testing, and the outputs of test results, feedback for improving standards development, and creation of common or uniform requirements for network deployments of systems and services.

Figure 7: Typical ITTC operational procedures



Source: "Handbook on Testing", ITU-T, 2011

14.1 Business operations

The ITTC's chief function is the test lab operations, but the ITTC also is a business and must function accordingly. A number of concepts were introduced in Chapter 7 regarding the requirements for setting up a certified test lab. Business operations should include:

- customer interface (marketing, reception, etc.);
- financial operations and billing systems;
  - funding (e.g. consortium, government participation)
  - income stream (e.g. testing contracts, training programmes)
- human resources (hiring staff, attracting experts);
- data base/document filing system;
- training programmes (training new staff, training staff for new technologies);
- shipping and receiving.

14.2 Accreditation and certification procedures

Accreditation of a test lab to meet international standards (i.e., ISO/IEC 17025) is crucially important to establishing a successful, trusted testing laboratory. Internationally recognized credentials for the individual test lab units as well as robust equipment calibration, inspection, and maintenance procedures are also essential ingredients. Details of the accreditation and certification processes can be found in Chapters 7 and 8. It is important to note that if accreditation is relied upon to recognise the competence of testing laboratories, then the accreditation body should fulfil the requirements of ISO/IEC 17011 and also be a signatory to the ILAC MRA and relevant regional MRA.

14.3 Testing programme operations

Laboratory operations require the following set of administrative procedures:

- lab operations (Lab unit supervision and management);
- equipment (vendor criteria, purchase, installation, calibration, documentation, training, maintenance);
- security:
  - Access to laboratories and sensitive equipment;
  - Access to data, documents, data bases;
- environmental control of labs;
- power supply, backup, surge protection, voltage stabilization;

Test programme operations should include:

- test lab operations (e.g. model network lab, wireless test lab, wireline test lab);
- component testing (conformance testing, functional testing, load and stress testing);
- comprehensive network and services testing for complex systems (interoperability testing, functional testing, interconnect testing, service testing, end-to-end testing, QoS testing, mobility and roaming testing);
- participation in standardization activities (feedback from conformance and interoperability test results to improve standards).

Type approval labs:

Test lab modules typically include:

- wireless test lab;
- wireline test lab;
- EM shielded room;
- anechoic chamber;
- EMC test lab;
- SAR test systems;
- environmental chamber;
- Open Area Test Site (OATS);
- mechanical test lab (e.g. vibration effects);
- calibration lab.

  [Note: Calibration lab costs are generally high due to the high standards that must be maintained for calibration equipment. It is often more cost effective to contract for these services]

Interoperability labs

Interoperability test labs are designed to test specific network implementations according to the model network concepts described in Chapter 13. Figures 8 and 9 depict model network physical architectures for terminal and NGN testing, respectively.

Model network architectures are used to test equipment and network solutions under various traffic and load conditions. Conformance and interoperability testing of compliance with standards is the primary goal. Test programmes also typically include the testing of special parameters for operators, testing of new services, protocols, and interfaces, and QoS testing.

Technologies to be tested may vary greatly by region. Interoperability labs must be equipped to test the set of architectures, systems and services most relevant. For example, Chapter 4 detailed some of the technologies being tested at the University of New Hampshire Lab (USA). These include IPv6 routing, VoIP, Wireless LAN, Ethernet, and Home Networking – among others. Another example is the Orange Testing Labs in Poland which supports tests for networks and multimedia, terminal equipment to test software applications, NGN-IMS, optical network transport, IPTV, and DWDM – among other technologies.

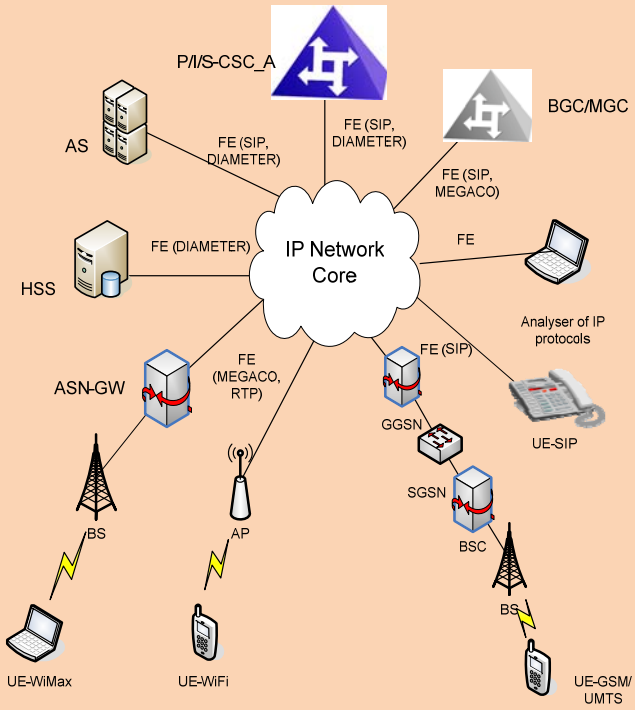
The physical configurations of the model networks will vary based on the technologies and services tested. However, operation of a model network interoperability lab requires that sufficient network infrastructure equipment and components are available to create the model network architectures. Figures 8 and 9 depict model network configurations for terminal testing and NGN testing, respectively. As shown in the figures, modelling NGN networks and services, typically require: Media Gateway Controllers (MGC), Proxy Servers SIP (PS), IP Multimedia Subsystem (IMS), Media Gateways (GW), Signaling Gateways (SG), Transport Network Environment (TNE), Application Servers (AS), Media servers (MS), Messaging Servers (MeS), Management System (MS), Billing system (BS), NGN Access Devices (NGN-AD), Media Gateway for Legacy Terminal Equipment (GW-LTE).

The model network test bed should have the capability to perform conformance testing, functional testing, and load/stress testing on NGN components. Network tests should include functional testing; interconnect testing, service testing, end-to-end testing, QoS testing, and mobility/roaming testing.

Other architectures tested may require additional or different components. For example, ZNIIS Labs (Moscow) supports model network architectures and recommends the following infrastructures:

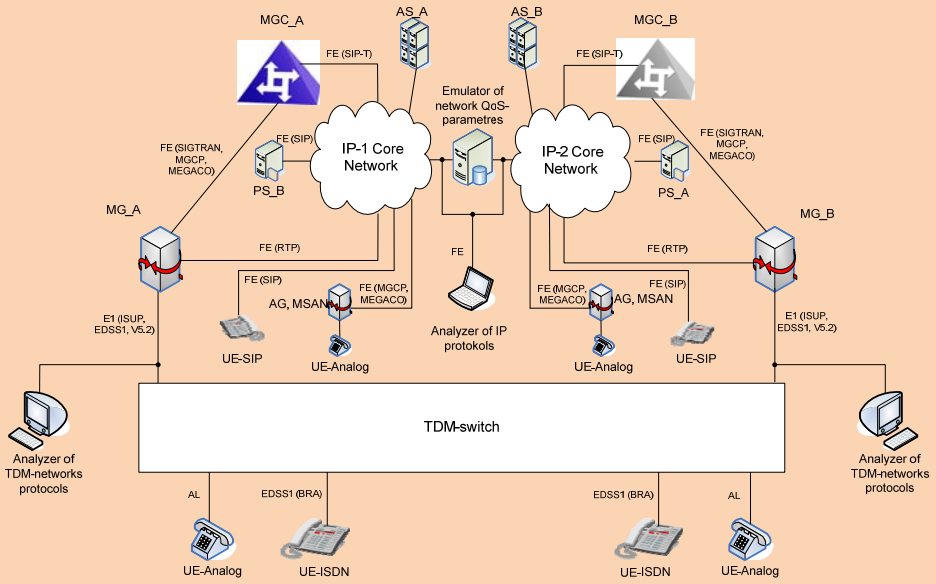
- optical transport infrastructure for xWDM and SDH technologies;
- packet switch transport infrastructure based on IP/MPLS technologies with at least three autonomous systems;
- access infrastructure: MSAN, xPON, xDSL, FTTx, WiFi, WiMAX, Ethernet;
- call control infrastructure with the capability to emulate at least five nodes;
- application stratum emulation for providing supplementary services, TV services and converged services;
- OSS/BSS systems;
- network control stratum emulation;
- terminal equipment include wireline and wireless terminal equipment;
- database infrastructure with capabilities for storage, analysis and preview;
- LAN model network.

Figure 8: The model network configuration for terminal testing



Source: "Handbook on Testing", ITU-T, 2011

Figure 9: The model network configuration for NGN testing



Source: "Handbook on Testing", ITU-T, 2011

15 Equipment requirements for ITTC testing programmes

As discussed previously (Chapter 13), ITTC testing programmes should be tailored to the specific current and future needs of the Region. ITTC test equipment requirements will depend on the Regional technologies supported and network evolution plans. This chapter reviews the testing programmes recommended for an ITTC and details the equipment and components required to outfit the various lab units to provide the required tests.

15.1 ITTC testing programmes

15.1.1 Type approval testing

Type approval testing involves testing of a variety of equipment types, since equipment requiring type approval testing is representative of all the various technologies deployed in the region and also may be utilized in test lab architectures for those technologies. Wireline and wireless labs are required, as well as a number of specialized facilities such as EM shielded rooms, anechoic chambers, EMC test equipment, SAR test systems, Environmental chambers, and Open Area Test Sites (OATS), and vibration test equipment.

15.1.2 Conformance testing

Conformance testing must support testing of compliance to standards implemented in a variety of equipment types. Testing of compliance to standards and equipment specifications requires a methodical analysis of test cases. An automated test execution environment (utilizing TTCN-3) is encouraged.

15.1.3 Interoperability testing

Interoperability testing is complementary to conformance testing and must support complex system/service testing. This can be accomplished through the model network lab concept developed in ITU-T. The model network test lab needs to be flexible to address numerous test architectures and services (e.g. NGN, wireless terminals, IPTV). Equipment testing can be performed under load and stress conditions to identify the specific features of the tested equipment's functioning and compatibility.

15.2 Equipment for specialized test labs

A detailed list of equipment, components, and systems is provided in Appendix 7. Where available, cost figures are provided to give order-of-magnitude estimates for planning purposes.

15.2.1 Wireless test lab equipment

Equipment to consider:

- Antenna Tower
- Antennas (Loop, Biconical, Dipole, Monopole)
- Audio Analyzer
- Controller
- DC Power Supply
- Horn Antenna
- Hybrid Junction
- Line Impedance Stabilization Network (LISN)
- Multimeter
- Oscilloscope
- Power Divider
- Power Meter
- Power Sensor
- Preamplifier
- Radio Communications Analyzer
- Semi-Anechoic Chamber (SAC)
- Shielded Room

- Log Periodic Antenna
- Miscellaneous (attenuators, connectors, adapters)
- Modulation Analyzer
- Signal Generator
- Spectrum Analyzer
- Test Receiver
- Turntable

15.2.2 Wireline test lab

Equipment to consider:

- AC Power Source Analyzers
- Dielectric Withstand Tester
- Differential Probe
- DSLAM
- Feeding boxes
- Feeding Bridge
- Function Generators
- Function/Arbitrary Wave Form Generator
- HAC Probe-Axial
- HAC Probe-Radial
- Head and Torso Simulator (HATS)
- Robot and Mannequin body shapes for HATS
- Line Simulator
- Longitudinal Test Circuit
- Multimeters
- Surge and EFT Couple
- Surge Network
- Switch/Control System
- Transverse Balance Circuit Box
- Vector Signal Analyzers (VSA)

15.2.3 SAR test lab

Equipment to consider:

- Amplifiers
- Analog Signal Generator
- Attenuators (3 dB, 10 dB, 20 dB)
- Data Acquisition Electronics
- Dielectric Probe Kit
- Dual Directional Coupler
- Isotropic E-Field Probe
- Power Meter
- Power Sensors
- Radio Communication Analyzer
- Reference Dipole Antennas
- SAR Compliance Test System
- Signal Generators Tissues Simulating Liquid (TSL)

15.2.4 Safety/environmental/mechanical test labs

Equipment to consider:

- Electrostatic Discharge Simulator
- Electrodynamic shaker (ejecting force 10 000 N, shock force 25 000 N, frequency range 20-3000 Hz, acceleration 75 g, work load 160 kg
- Climatic chamber (temperature range –75º to +180º C; relative humidity 10-95 %
- Thermal oven (up to 350º C)
- Voltage depression/over-voltage simulators
- Disturbance simulators

15.2.5 Interoperability – model network lab

ITTC interoperability labs must be equipped to test the set of architectures, systems and services most relevant to the region. In Chapter 14, two representative architectures (NGN, terminal equipment interworking) were presented. Equipment to consider for NGN-related testing:

Call/ session control system

- Media Gateway Controller (MGC)
- Proxy server SIP (PS)
- IP Multimedia Subsystem (IMS)

Voice and signalling transmission system

- Media Gateway (GW)
- Signaling Gateway (SG)
- Transport Network Environment (TNE)

Application servers

- Application server (AS)
- Media server (MS)
- Messaging server (MeS)

Management and billing system

- Management system (MS)
- Billing system (BS)

Access environment

- NGN access devices (NGN-AD)
- Media Gateway for Legacy Terminal Equipment (GW-LTE)

Other architectures tested may require additional or different components. Examples include:

Transmission equipment

- PDH/SDH/WDM
- Metro/Global Ethernet
- Access networks transmission equipment
- Digital TV transmission (broadcasting) equipment

Access service network equipment

- xDSL/FTTH/Metro Ethernet/PON/GPON
- VoIP/SIP Phones
- PBX
- Call centre equipment

Radio network equipment

- Broadband wireless access networks equipment, including WiFi, WiMAX
- GSM/UMTS/HSPA/HSPA+/LTE BSS equipment
- Femto Cell equipment
- CDMA 2000/EVDO (IMT MC 450)/TETRA/DECT BSS equipment

Radio handset equipment

- GSM/UMTS/GSM-UMTS/LTE Handsets
- CDMA 1x (IMT MC 450) Handsets
- WiFi/WiMAX user equipment (CPE)

16 Economics and cost implications for ITTCs

16.1 Economics of a regional test centre

A regional testing centre, by its nature, is a focal point for conformance and interoperability testing and testing experts in the region. When an ITTC realizes its full potential, it becomes a centre of excellence for testing expertise and training. In the absence of sufficient testing capacity in a given region, it is assumed that an ITTC would be a larger and better equipped facility than individual, unassociated, ad hoc test labs throughout the region. Economies of scale will enable the ITTC to have the size and critical mass for a successful testing programme and enable focus and specialization of processes and tools that would otherwise be unavailable in the Region. A Regional Centre provides better control over the scope of the

testing programme and process consistency across all testing programmes (e.g. test bed improvements, code updates, and release management).

A major objective for the ITTC is to resolve interoperability issues in deployed networks by enabling operators and vendors to test equipment and services in advanced test centre simulations. The most direct benefit comes from solving interoperability problems through ITTC testing. Resolution of interoperability issues can have significant regional economic effects. Cost savings from eliminating corrective actions in the field (network equipment, software), reducing network downtime, and decreased time-to-market with service improvements should be realized by operators and users alike. Testing interoperability of network equipment and service deployments (and the international standards on which the services are based) will result in a valuable knowledge base for future network deployments and feedback into standards development.

Although there will be revenue generated from the ITTC testing services provided, there are also other benefits that have potential immediate or longer term economic benefit to the region. One of the roles envisioned for a regional test lab is for capacity building. Training of new experts via courses, participation in lab events, and remote access to virtual test lab facilities can have a lasting positive impact for the region. Access to an ITTC centre of excellence will assist in bridging the knowledge and training gap in the region. Capacity building efforts benefit from the concentration of experts with specialized equipment testing new applications and services at a single location. Relationship building and collaboration with universities can magnify this effect, as increasing numbers of students and professionals are exposed to the latest conformance and interoperability testing methodologies and ICT technologies. One of the expectations for establishing regional test centres is that the major stakeholders in the region (i.e. operators, governments, vendors) can come together and collaborate in mandatory and voluntary testing activities to accelerate the deployment of technologies in the region.

16.2 Cost implications of operations and testing programmes

ITTC funding is a major consideration in establishing an ITTC. The financial resources will ultimately determine the scope of testing operations. Although the ITTC testing operations will eventually be a source of income, this will not be immediate. Significant funds are needed prior to initiating operations – primarily for facilities and equipment. A cost analysis must be performed to provide the best estimates of the actual operating budget necessary to establish and operate the ITTC. The cost analysis must include both capital costs (e.g. facilities, equipment, vehicles) and operating costs (e.g. staff salaries, services, utilities). The complete financial analysis, taking into account current funding, projected income, capital costs, and operating costs, provides the constraints within which the ITTC must operate.

A regional test centre may also be the best and perhaps only solution in a region where there is no single entity with the resources to establish a multi-functional ITTC. The consortium model has been discussed in this context as a means for funding an ITTC. Although it is entirely feasible for a single entity (e.g. government, regional organization, operator) to finance the creation of the test centre, a consortium provides several advantages. The first advantage is the division of costs for establishing the ITTC. In addition to providing financing for the ITTC, a consortium of stakeholders provides more critical mass for participation in ITTC activities and enhances the probability of success. It also becomes a source for expertise to support testing functions and defines a stakeholder group that is committed to come together to test and mutually solve interoperability problems. As an example, the University of New Hampshire Lab discussed in Chapter 4 is 100 per cent funded by a consortium of more than 150 telecommunication industry companies.

ITTC Facility

Cost estimates for the ITTC facility depend on the many variables involved in establishing and operating an ITTC. ITTC location and size are two major factors that can greatly influence costs, since costs vary by region. An ITTC facility and testing programme to adequately address the full scope of type approval, conformance and interoperability testing could cost as much as USD 20-30 million. In addition, annual

upgrades for software and equipment for such a large laboratory could easily reach USD 0.5-1 million. Facility space at some of the large testing facilities can be 30 000-50 000 sq.ft. (2 800-3 700 sq. meters). For example, the University of New Hampshire Lab has a 32 000 sq. ft. testing facility with a full-time staff of 20 and 100 university student employees. Major vendors with their own test facilities employ 30-50 test engineers for product testing.

An ITTC facility of this magnitude may or may not be practical for a given region, although the ITTC rollout plan may call for a modest start-up operation with a phased approach to building and equipping facilities in a future expansion (see Chapter 17). The modular nature of some of the test labs and systems enables flexibility for initial facility design, expansion decisions, and costs. There are type approval labs in North America, Europe, and North Africa that have been built for approximately USD 5 million and an equipment inventory of USD 3-5 million.

As an illustrative example, Table 3 provides a more average size facility that would still be effective to support a wide range of testing programmes. The table shows a facility designed for 20-30 staff members with an available space of 12 000 sq ft (1100 sq m) for both business and testing operations (e.g. Wireless Lab, Wireline Lab, Model Network Lab, Anechoic Chamber).

Table 3

ITTC Facility	Area (sq ft)	Area (sq meters)
Entry Foyer	1000	93
Reception	300	28
Director's office	180	17
Staff offices for 24 people	2400	223
Conference room	500	47
Model Network testing	600	56
Wireless testing	400	37
Wireline testing	400	37
Calibration	400	37
SAR lab	400	37
Shielded room	400	37
Anechoic chamber	900	84
Environmental chamber	150	14
Storage for test gear	1000	93
LAN server room	400	37
Finance and admin space	300	28
Filing room	900	84
Shipping and receiving	300	28
Garage for vans	1000	93
Washrooms	300	28
TOTALS	12,230	1,138

Equipment

In order to operate effectively, ITTC testing lab modules must have the appropriate test equipment. In addition to the cost of equipment, there are the initial costs of calibration and maintenance. Calibration can be accomplished internally, if a calibration lab is part of the test centre plan. Calibration lab costs are generally high due to the high standards that must be maintained for calibration equipment. It is often more cost effective to contract for these services.

Equipment costs vary for the various testing labs, but equipment costs are significant. A detailed list of equipment, components, and systems is provided in Appendix 7. Where available, cost figures are provided to give order-of-magnitude estimates for planning purposes. It is clear a selection of components from the list of equipment could easily cost USD 500-750 000, without the special facilities such as SAR, Dosimetric Assessment System, Environmental Test Chamber, Semi-Anechoic Chamber, and OATS. These special facilities alone would cost an additional USD 2.5 – 4 million. There also will be significant additional costs for equipping an interoperability test lab with model network components such as call/session/application/media/messaging servers, signalling/media gateways, management/billing systems, transmission equipment, radio network equipment, and terminal equipment.

Business operations

In addition to the significant costs of the testing operations and lab equipment and facilities to be purchased and maintained, the ITTC must operate as a business. Once the ITTC is operating, there are ongoing expenses for ITTC personnel and all business and administrative processes (e.g., financial operations, quality assurance (including accreditation and certification), marketing, data systems, training, shipping/receiving).

Test specifications

Producing test specifications within the ITTC and/or contracting to produce specifications could be costly and time-consuming. The existence of test specifications does not necessarily mean they are readily available to an ITTC. Although some specifications are available free of charge, other documentation is available only to organization members, test event participants, or product/service customers. Some documentation may be available through negotiation of confidentiality agreements or specific contracts. Funds need to be allocated and a system must be in place to identify and obtain the required test specifications.

17 Roadmap for ITTC and services rollout

Developing plans and committing resources to establish an ITTC is a large undertaking, requiring analysis of Regional technology deployment and plans, market factors, funding sources, testing expertise, accreditation experience, and many other factors. A roadmap provides a methodical means of considering all the parameters associated with establishing a Regional test centre. This chapter provides some high-level guidance in addressing the factors necessary to plan such a facility and its programmes.

17.1 Roadmap for regional ITTC rollout

From ITTC project conception to final recommendations and execution, the evaluation and decision process should follow a logical set of steps based on the overall objectives and constraints. A roadmap is useful to point the way toward a successful rollout of a viable ITTC.

The roadmap defines the methodical steps in the ITTC feasibility study from concept to rollout.

The rollout specifies the recommended action plan for obtaining test centre facilities, preparing the test centre for business and lab operations, and initiating testing services.

In most cases the rollout will include several phases. Even in the situation where funding is available for all facilities and test programmes, there will normally be a start-up period defined for bringing systems on-line and for lab accreditations. In the case where extensive construction or expansion is required, there may be a period where some test programmes are offered while others are waiting to be brought on-line.

17.1.1 Technology evaluation

The primary consideration for establishing an ITTC is the analysis of technologies deployed in and planned for the region. A market evaluation of regional technologies deployed and their relative market shares and trends are critical in predicting the relevance and success of ITTC testing programmes. In particular, for interoperability testing, regional input is necessary to determine the potential network architectures and service scenarios to be tested among the broad scope of standards already in force. Given the assumption that there is a need for a regional test centre, due to the existence of regional factors such as scarce testing resources, lack of sufficient testing expertise, or delayed market introduction of new technologies due to interoperability issues, an analysis must be made to determine what technologies will be tested.

The technology evaluation determines the scope of the testing programme and the testing programme influences the design of the facilities required to accomplish the ITTC testing objectives. For a thorough analysis, it is necessary to identify technologies currently in use as well as new and planned technologies and services in order to account for future ITTC growth and expansion.

There are a number of ways arrive at the final proposal for the ITTC rollout plan. It is recommended that a full technology analysis be completed first – taking into account as much information as possible. It is then possible to apply constraints (e.g. financial, facility, timeframe, regulatory) in order to determine priorities for the ITTC rollout.

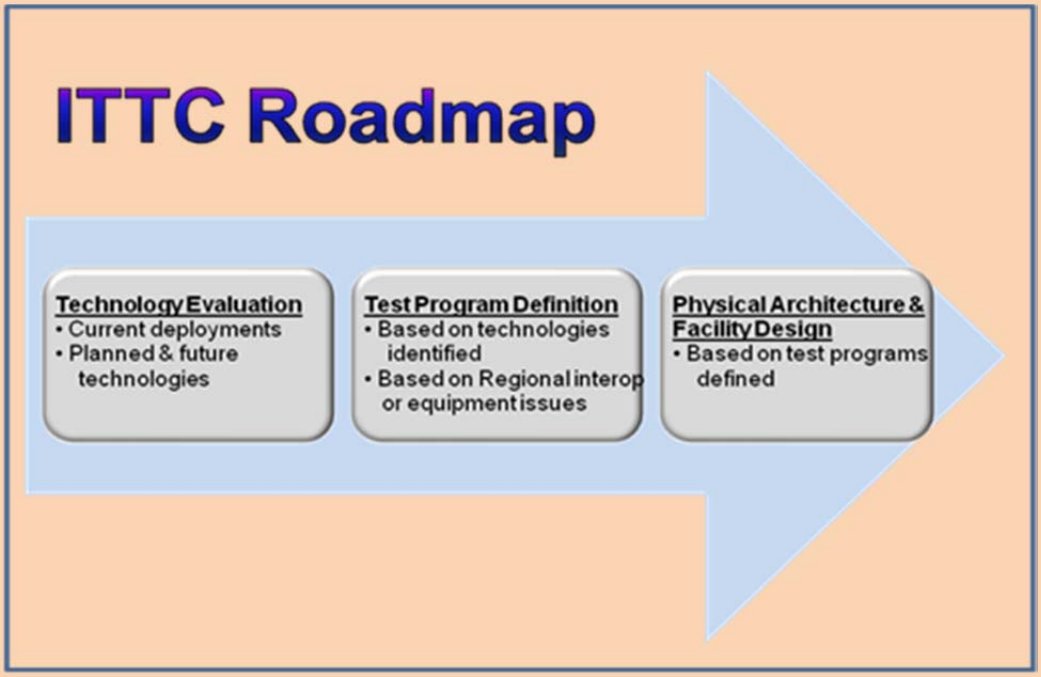
17.1.2 Facilities assessment

The assumptions for testing programmes will determine the ultimate facility (i.e. building, total floor space, lab space, office space, and operations space) required for ITTC operations. For a regional testing centre, some attention should be paid to its location relative to the customer base and the ecosystem of stakeholders to be involved. Location may also be influenced by the availability of land for construction, existing facilities available for purchase, expansion, or lease. Facility planning must take into account not only the space requirements but also the special nature of the space and testing requirements. Special attention should be given to the need and space requirements for special-purpose test facilities (e.g. OATS, Anechoic or Semi Anechoic Chamber), for special physical requirements (shielded rooms, avoidance of vibrations, noise, heat), and for special resources (power supply (capacity, stability), water supply). Also, facility planning should take into account future plans for expanding services and operations.

17.1.3 Financial analysis

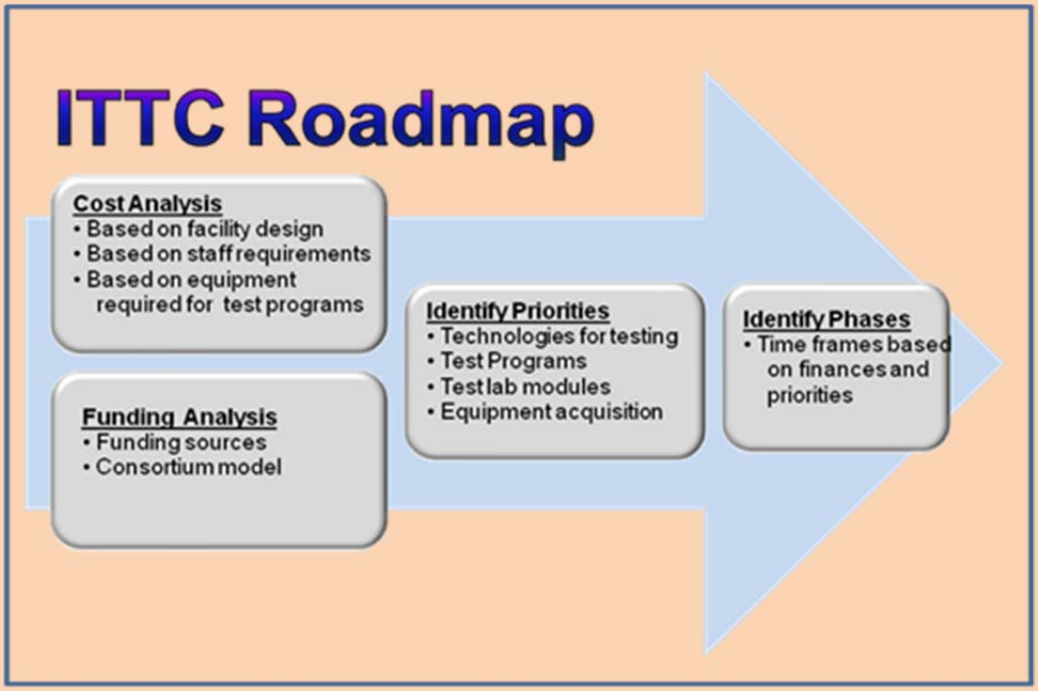
The other major consideration for establishing an ITTC is the availability of funding. The financial resources will ultimately determine the scope of operations and the pace of the ITTC rollout. Based on the technology analysis and the resulting ITTC testing objectives, the full scope of ITTC operations is determined. Although the ITTC testing operations will eventually be a source of income, this will not be immediate. Significant funds are needed prior to initiating operations – primarily for facilities and equipment. A cost analysis must be performed to provide the best estimates of the actual operating budget necessary to establish and operate the ITTC. The cost analysis must include both capital costs (e.g. facilities, equipment, vehicles) and operating costs (e.g. staff salaries, services, utilities). The complete financial analysis, taking into account current funding, projected income, capital costs, and operating costs, provides the constraints within which the ITTC must operate.

Figure 10: ITTC Roadmap (1 of 2)



Source: Adapted from ITTC

Figure 11: ITTC Roadmap (2 of 2)



Source: Adapted from ITTC

17.1.4 Priority identification

Assuming the total ITTC operational plan (including envisioned future expansion) cannot be supported immediately, the technology and test programme priorities will drive the development of phases for the rollout plan. In previous chapters, the various dimensions of the ITTC operations were explored – testing programmes (type approval, conformance, interoperability), test labs (e.g. wireless, wireline, SAR, model network) and other activities (e.g. training, capacity building, standards development). These operational aspects all fit within the context of technologies identified for the region. Prioritizing the operations and technologies will facilitate the ITTC rollout plan – as a progression from highest regional priorities to lower priorities. These operational priorities, in combination with the financial analysis, facilitate the creation of phases in the rollout plan.

17.2 Case study –Tanzania Test Lab: feasibility analysis

The following is a short summary of a feasibility study and analysis which Sintesio, a Slovenia-based test lab, performed for the establishment of a type approval test lab in Tanzania[27]. Although the scope of the Sintesio case study was limited to type approval testing, the analysis includes the same parameters required to assess the feasibility of an ITTC. The Sintesio study indicated that there was a strong probability of non-interoperable areas of the Tanzania due to the existence of sub-standard products in the market (thus justifying the need for type approval testing). Also, equipment and services targeted for testing represented a wide variety of technologies, which may ultimately benefit from improved interoperability as a direct outcome from the creation of this test centre:

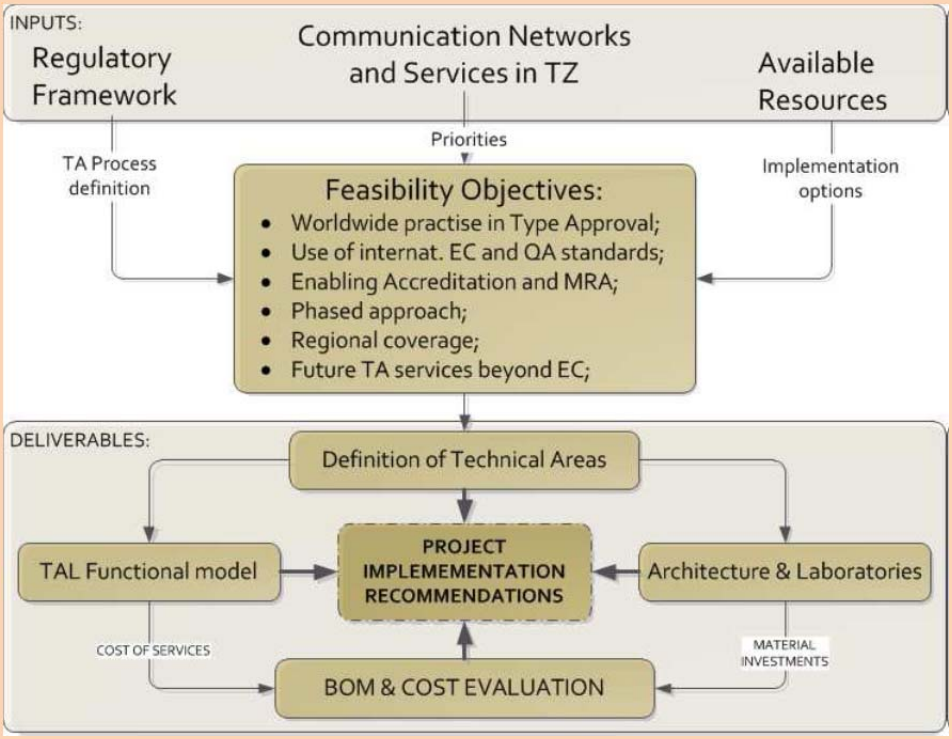
- Mobile voice and data network and services, fixed broadband (xDSL, FTTx, USB, cable) user equipment, IP-based Interconnection and transmission equipment (SDH, PDH, ...), legacy to IP-based (NGN) network interworking equipment, fixed narrowband user equipment (POTS, PSTN, ISDN)

But rather than focusing on the specifics of this case study, it is instructive to focus on the analysis itself.

Figure 12 summarizes the feasibility considerations for the Tanzania (TZ) lab and indicates that information regarding the TZ regulatory framework, the networks and services deployed, and type approval processes required as well as implementation options were inputs to the feasibility analysis. Once the feasibility objectives were determined (e.g. develop a phased approach, regional coverage) the deliverables were defined within the constraints of test functions to be performed, physical lab parameters, cost information, and technologies to be supported. In the Tanzania case study, a phased approach was chosen after prioritizing technologies and testing functions. Table 4 is a partial summary of the recommendations for a phased introduction of testing services. The table indicates that all technologies are planned to be phased in for type approval testing after three years, beginning with the high market volume and new technologies (digital broadcast, mobile services and fixed wireless), then emerging market and network interconnections (fixed broadband, NGN/IP-based interworking), and finally mature technologies (fixed legacy). Figure 12: Feasibility considerations for establishing a type approval lab (Sintesio)

[27] Sintesio Labs – Slovenia, ITU Regional Seminar for the Africa Region on Conformance and Interoperability Testing Centres, Accra (Ghana), 4-6 July 2011.

Figure 12: Feasibility Considerations for Establishing a Type Approval Lab (Sintesio)



Source: Sintesio Labs

Table 4: Phased approach for TZ Type Approval Lab (Sintesio)

Type approval procedures	Phase 1 Year 1-2	Phase 2 Year 2-3	Phase 3 Year 3-4
Digital Broadcasting	Conformance (DVB-T/T2 Receivers and transmitters)	EMC (Emission), Health and Safety, Conformance (DVBC, S/S2 receivers; Analogue, FM, T-DAB transmitters; quality)	EMC (Immunity)
Mobile and Fixed Wireless	Efficient Use of RF Spectrum, Conformance (User equipment)	EMC (Emission), Health and Safety	EMC (Immunity), Efficient Use of RF Spectrum, Conformance (Base stations, network equipment)
Fixed narrowband equipment		EMC (Emission), Health and Safety, Conformance (User equipment)	EMC (Immunity), Conformance (Network equipment)
Fixed broadband equipment		EMC (Emission), Health and Safety, Conformance (User equipment)	EMC (Immunity), Conformance (Network equipment)
Network Transmission and Interconnection/ interworking equipment		EMC (Emission), Health and Safety, Conformance (IP-based Network Including NGN equipment)	EMC (Immunity), Conformance (Legacy Network equipment)

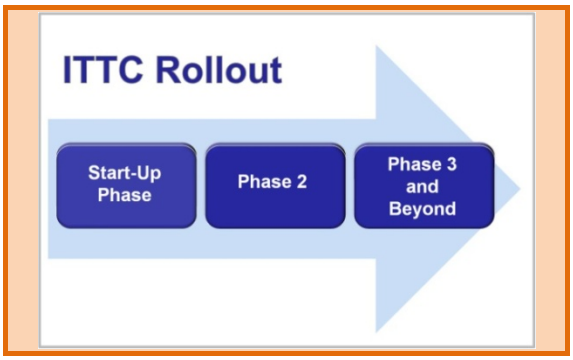
17.3 Regional ITTC rollout plan

Once the technology and operational priorities have been determined in concert with the financial constraints, the rollout plan can be constructed. Since most details of the rollout plan are region-specific, the following guidelines provide an example of the processes involved.

As discussed earlier, the rollout plan can be separated into phases and represents both a logical and practical means of establishing the ITTC facility and initiating operations. There certainly will be a start-up phase, regardless of any other constraints. Subsequent phases are determined from the priority and financial analyses.

17.3.1 Start-up phase

It is assumed that decisions have already been made in the financial analysis regarding the facility and the initial complement of testing labs and services. (For example, the facilities acquired may be larger than initially required or expandable in the future, but only partially utilized at start-up. A subset of test labs may be initially available and a subset of technologies (e.g. wireless) initially available for testing). The initial services and operations are determined by the highest priorities identified.



Facility

Decisions have already been made regarding the location of the regional test centre and facility space has been acquired in an appropriately electronically quiet environment to permit sensitive EMC and EMI testing. Whether the chosen facility has been purchased, leased, constructed, or expanded from existing facilities the potential for future expansion of services and operations has been taken into account. Special facility requirements have already been addressed. For example, special requirements for sensitive equipment (e.g. shielding from environmental factors such as temperature, noise, vibration), special power requirements are met. Additional special requirements have been identified that could affect the building shape, height and even foundational strengths depending on such considerations as whether a 14 meter or 3 meter anechoic chamber is required for anticipated EMC business or mandatory testing needs. Space has been allocated for business operations (reception, offices, shipping/receiving), and test labs.

Equipment

According to the priorities determined, lab modules to be available at start-up have the required test equipment. All equipment must be made operational and calibrated. Calibration can be accomplished internally, if a calibration lab is part of the test centre plan. Of course, for start-up, the calibration lab equipment would also need to be calibrated and certified. Calibration lab costs are generally high due to the high standards that must be maintained for calibration equipment. It is often more cost effective to contract for these services.

Business operations

Decisions have been made regarding staff size and expertise required to provide the services identified. Personnel has been hired and all business and administrative processes (e.g. financial operations, marketing, data systems, shipping/receiving).

Lab accreditation

Once all start-up processes, personnel, and lab modules are in place, the ITTC must be accredited. As discussed in Chapter 7, accreditation not only involves the actual test lab modules and equipment, but also includes requirements for lab management practices, testing procedures, environmental factors, data management, and personnel.

Testing services

Based on the technology and priority assessments for the Region, the specific testing services have been identified and associated test labs are in place. The modular nature of the test labs, especially in the case of type approval labs, enables flexibility in equipping for start-up functionality and expanding in subsequent phases.

Testing services will generally be introduced based on the relative priority in the region. Highest priority services will be introduced first. In the case study in section 17.2, the highest priority technologies were those with high market volume and new technologies. (There may be situations where an ITTC is unable to introduce testing services from its highest priorities first, but these would be exceptional cases. For example, there may be anticipated delays in obtaining particular equipment or completing construction, so another service is substituted to enable earlier start-up).

17.3.2 Phase 2 and subsequent phases

After start-up it is assumed that the ITTC is accredited and performing testing functions for at least some of its highest priority technologies. The ITTC may also have initiated capacity building and training services, utilizing the expertise of the ITTC staff. These are also elements important to Phase 2 and beyond. Regardless of the phase, there must be periodic calibration and maintenance of the lab equipment.

Beginning with Phase 2, testing services offered and lab facilities are most likely scheduled to expand. Any high priority technologies not initiated at start-up will be offered in subsequent phases. Test labs not available during the start-up phase will be completed, accredited, and functional until the ITTC's full testing programme is realized.

Now that the ITTC is operational, attention must also be focused on the business operations. Marketing of the ITTC services are important to maintain and increase the customer base as well advertising new services and training offered as they are phased in. Relationships should be cultivated with the stakeholders in the conformance and interoperability testing ecosystem, including government agencies, operators, vendors, standards organizations, and universities.

Rollout phases should be defined at start-up and become the business goals for future years of operation. As in most businesses, conditions change over years of operation and the content of the initial rollout phases may evolve over time. This is normal and the ITTC should review its business goals periodically, identify changes in economics or technology trends, and be ready to respond.

18 Funding sources (see Appendix 4)

There are many potentially available sources of funding for initiatives such as building infrastructure in developing countries, and telecommunication test centres appears to fit well with the type of infrastructure which would qualify. Appendix 4 provides a listing of such organizations with brief statements of their basic operating focus and contact details. This listing does not imply any special endorsement from ITU.

Some of these are region specific or community specific, others truly international, and at least one is specifically focused on assistance to establish regulatory frameworks, of which test centres form an important part, as part of overall economic assistance.

Furthermore as can be seen in their brief descriptions, the services provided range from grants and loans, including technical assistance, to training and consulting services.

In the case of international organizations such as UNIDO, and many others, it must be borne in mind that in general large sums of money are not readily available and in fact the modus operandi for qualified recipients is more likely for them to receive seed funding, the remaining funds being provided by other partnerships and the originators of the funding requests. In addition it seems that applications for funding need to be very convincing and robust as regards details of what is being proposed, with business planning details, co-funders and sponsors identified and a well laid out plan for future year activities. Funding in general is provided on a competitive basis as there will normally be many more requests than funds available.

It is also necessary to factor a sufficient amount of time into the funding request process as this can take a considerable amount of time and effort and needs to be included in the planning and scheduling activities.

Due to recent developments in the financial market worldwide some of the references may no longer be valid or may have changed as regards contact persons so this must be borne in mind when referring to Appendix 4 although as many as possible sources have been checked and in some cases up to date contacts supplied.

19 Training sources (see Appendix 5)

There are multiple choices for training courses in telecommunication, readily available for review on their Internet websites. A simple browser search using the words “telecommunication training courses” is sufficient to identify many excellent sources of training, ranging from fully and partially subsidized courses from industry and governments to commercially available courses delivered by professional institutes.

Among the options are targeted courses for subjects such as Conformity Assessment and Type Approval, training with hands-on experience working in an operational lab with experts, and sponsored courses with fully funded travel, accommodation and instruction. In addition there are partially sponsored courses with on-site living expenses paid, but travel funds required and private sector “for profit” courses with fully loaded fees including fees for instructors.

Company sponsored training is another option where telecommunication product suppliers will provide hands-on laboratory facilities dealing largely or exclusively with promotion of their technologies but nevertheless providing quality training specific to their commercial goals.

ITU also has a Human Capacity Building Programme which is carried out through regular ITU-D programme activities involving special projects, ITU Centres of Excellence, Internet training centres and on-request advisory and consulting services. Furthermore the BDT has an ITU Academy initiative, delivered in cooperation with partners and providing an extensive curriculum. The ITU Academy supports both face-to-face and distance learning methods of training[28].

The ITU Centres of Excellence programme provides regional focal points for training and education. It is supported by donors and other partners and is operating in Africa, the Americas, Arab States, Asia-Pacific, CIS countries, Caribbean and Europe. This programme is now being merged into a global training network of shared resources providing a worldwide service in training and education in telecommunication and related subject matter. This is complemented by the ITU Internet Training Centres (ITCs) which focus on creation and enhancement of ICT and related skills. In this initiative BDT works through partnerships with university and training bodies to set up ITCs which provide access to affordable quality training using face-

[28] The ITU Academy portal may be viewed at http://academy.itu.int/

to-face and distance learning. ITCs complement technical training with soft skills such as entrepreneurial skills to facilitate self-employment[29].

Excellent training and education programmes are available through the auspices of ITU-D.

Training is also widely available for both telecommunication senior management and technical staff through private and semi-private organizations with excellent credentials and experience. Training programmes are very up to date covering the latest topics in technology and services. Numerous funding organizations exist which are interested in financing telecommunication programmes and providing training courses and assistance in cooperation with ITU.

Appendix 5 provides examples of such courses from four typical organizations in this business to provide a reference point for readers. It should be noted that the issue of language used in training is an important one, since trainers and trainees need to be able to engage in a rich level of communication. So as one example, in Russian speaking countries there are companies offering a wide variety of telecommunication training in Russian such as the JSC Scientific Technical Centre "KOMSET" and other bodies. These examples do not imply any special endorsement from ITU.

20 Recommendations

It is recommended that:

1. Members advise ITU of interoperability problems, their mitigation, successful procedures that were helpful, the impacts of the interoperability problems and any questions and answers they may also wish to contribute. The new Standards Q&A webpage on the ITU-T website, at http://groups.itu.int/itu-t/StandardsQA.aspx, has a section on conformance and interoperability which provides a readymade place to record such experiences for the benefit of all.
2. Members establish market access requirements for telecommunication equipment to avoid interference, network harm and safety of life issues in their marketplace.
3. Members examine their existing legislation and regulations to ensure that they enable participation in MRAs on conformity assessment and testing with foreign partners, and provide appropriate powers to deal with non-compliance of telecommunication equipment in the marketplace.
4. Members currently with no requirements for market access for telecommunication products consider establishing them, and examine first such requirements and procedures as are already established in developed economies for both potential guidance and possible adoption.
5. Members prioritize areas of concern related to telecommunication products and systems in preparation for dealing with these through establishment of technical requirements, testing and compliance assessment, and market surveillance and audit. Consideration should also be given to establishing tools aimed at discouraging non-compliance, such as assessment of penalties.
6. Members consider potential opportunities to establish test facilities and testing services to serve the needs of their country and possibly their region.
7. Members take advantage of training offered by ITU and private training organizations in order to accelerate the building of expertise and capacity in the telecommunication area.
8. Members seek opportunities, in collaboration with ITU, for hands-on, in-house training in conformity assessment laboratories and test centres already established in other countries, and especially in developed countries and regions, to accelerate their rate of development of expertise and possible acquisition of credentials in testing practice.

[29] More information may be viewed at http://academy.itu.int/events/item/34-itu-academy-activities-in-the-regions

9. To demonstrate that the accreditation bodies are ISO/IEC 17011 compliant, the accreditation bodies should become signatories of the ILAC MRA or the IAF MLA.

10. In regions where there are no MRAs on conformity assessment, regional groups such as in the African region, develop a framework MRA similar to the APEC TEL MRA or the Inter-American MRA. A Pan African body such as the African Telecommunications Union (ATU) could possibly initiate and lead such an effort for the Africa region.

11. If there is an absence of accreditation bodies within a region, a regional accreditation body is established by Member States of the region to facilitate the timely and efficient accreditation of conformity assessment bodies within that region

12. The four stakeholders involved in the development and testing of telecommunication equipment, namely, the vendors of telecommunication equipment; the standard development bodies such as ITU and ETSI; the network operators and service providers and the test centres cooperate closely in the development of standardized test suites and procedures during the development of the standards and specifications.

13. Test centres be established on a regional basis to take advantage of the similar networks in a region with common infrastructures and shared common interfaces deployed by the regional network operators.

14. Focus on the ITTC as a Centre of Excellence. In addition to offering a variety of technology testing services otherwise not available in the region, the ITTC should take advantage of its concentration of experts and specialized equipment to also be a centre of excellence for test methodologies, training, and capacity building

15. Interoperability testing should utilize the model network concept under development in ITU-T. For complex systems and services, it is insufficient to conduct tests on individual network components or between single network links. In order to test the true system functioning and compatibility, it is necessary to perform tests on networks supporting services under load and stress conditions.

16. Consideration of a consortium model for establishing an ITTC and formulation of a memorandum of understanding (MoU) framework for engagement of the parties. In addition to providing financing for the ITTC, a consortium of stakeholders provides more critical mass for participation in ITTC activities and enhances the probability of success.

17. The development of an ITTC roadmap and a rollout plan. From project conception to final recommendations and execution, the evaluation and decision process should follow a logical set of steps based on the overall objectives and constraints. Rollout phases should be well-defined at start-up and become the business goals for future years of operation.

APPENDIX 1

ACRONYMS

3GPP	3RD Generation Partnership Project
AB	Accreditation Body
APEC TEL	Asia Pacific Economic Cooperation Telecommunications and Information Working Group
APLAC	Asia Pacific Laboratory Accreditation Cooperation
APT	Asia Pacific Telecommunity
ARIB	Association of Radio Industries and Business (Japan)
AS	Application Server
ASTAP	Asia Pacific Telecommunity Standardization Program
ATIS	Alliance for Telecommunications Industry Solutions
ATS	Abstract Test Suite
ATU	African Telecommunications Union
BDT	Telecommunication Development Bureau of ITU
BGC	Border Gateway Controller
BICC	Bearer Independent Call Control
C&I	Conformance and Inter-operability
CAB	Conformity Assessment Body
CASCO	ISO committee on conformity assessment
CB	Certification Body
CCSA	China Communications Standards Association
CDR	Call Detail Recording
CIS	Commonwealth of Independent States
CISPR	Comite International Special des Pertubations Radioelectriques
CITEL	Inter-American Telecommunication Commission
CPE	Customer Premises Equipment
CTO	Chief Technology Officer
DA	Designation Authority
DLNA	Digital Living Network Alliance
DSL	Digital Subscriber Line
DWDM	Dense Wavelength Division Multiplexing
EA	European co-operation for accreditation
EC	European Commission
ECMA	European Computer Manufacturers Association

EFTA	European Free Trade Area
EMC	Electro Magnetic Compatibility
ETSI	European Telecommunications Standards Institute
FCC	Federal Communication Commission
GPON	Gigabit-capable Passive Optical Network
GS1	Global Standards 1
GSM	Global System for Communications
HAC	Hearing Aid Compatibility
HATS	Head and Torso Simulator
HSS	Home Subscriber Server
IAAC	InterAmerican Accreditation Cooperation
IAF	International Accreditation Forum
ICS	Implementation Conformance Statement
iCSi	Small Computer Interface
ICT	Information and Communications Technologies
IEC	International Electrotechnical Commission
IECEE CB	IEC System for conformity testing and certification of electrical and electronic components, equipment and products certification body
IEEE	Institute Electrical and Electronic Engineers
IETF	Internet Engineering Task Force
ILAC	International Laboratory Accreditation Cooperation
IMS	IP Multimedia Subsystem
IPMSAN	Internet Protocol Manager
IPTV	Internet Protocol Television
IPv6	Internet Protocol Version 6
ISACC	ICT Standards Advisory Council of Canada
ISDN	Integrated Services Digital Network
ISO	International Standardization Organization
ISUP	ISDN User Part
ITC	Information Technology Committee
ITTC	International Telecommunication Test Centre
ITU	International Telecommunication Union
IUT	Implementation Under Test
JCA-CIT	Joint Coordination Activity – Conformity and Interoperability Testing
LTE	Long Term Evolution
MACsec	Media Access Control security

MG	Media Gateway
MGC	Media Gateway Controller
MIDI	Musical Instrument Digital Interface
MPLS	Multi-Protocol Label Switching
MRA	Mutual Recognition Agreement/Arrangement
MS	Media Server
NATA	National Association of Testing Authorities
NCB	Network Control Block
NGN	Next Generation Network
NIST	National Institute of Standards and Technology
NUT	Network Under Test
OASIS	Organization for the Advancement of Structured Information Standards
OATS	Open Area Test Site
PAC	Pacific Accreditation Cooperation
PCC.I	Permanent Consultative Commission One
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation eXtra Information for Testing
PON	Passive Optical Network
PP	Plenipotentiary
PS	Proxy Server
PSTN	Public Switched Telephone Network
QoE	Quality of Experience
QoS	Quality of Service
RA	Remote Access
RFID	Radio Frequency Identification
RFP	Request for Proposal
SADCAS	South African Development Community Accreditation Service
SAR	Specific Absorption Rate
SAS	Statistical Analysis Software
SATA	South African Telecommunication Association
SDO	Standards Development Organization
SDOC	Supplier's Declaration of Conformity
SG	Study group
SG	Signalling Gateway
SIP	Session Initiation Protocol
SS7	Signalling System number 7

STB	Set Top Box
TA	Type Approval
TBT	Technical Barriers to Trade
TCP/IP	Transport Control Protocol/Internet Protocol
TETRA	TErrestrial TRunked RAdio
TIA	Telecommunications Industry Association
TL	Test Lab
TP	Test procedure/Test Procedure
TSAG	Telecommunication Standards Advisory group
TSB	Telecommunication Standardization Bureau of ITU
TSS	Telecommunication Suite Structure
TTA	Telecommunications Technology Association (Korea)
TTC	Telecommunication Technology Committee (Japan)
TTCN	Tree and Tabular Combined Notation /Testing and Test Control Notation
UMTS	Universal Mobile Telecommunications System
UNI	User to Network Interface
UNIDO	United Nations Industrial Development Organization
URL	Uniform Resource Locator
VLAN	Virtual Local Area Network
VOIP	Voice Over Internet Protocol
VSA	Vector Signal Analyzer
VTS	Virtual Testing Site
WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WTDC	World Telecommunication Development Conference
WTO	World Trade Organization
WTSA	World Telecommunication Standardization Assembly

APPENDIX 2

INTERNATIONAL AND PSEUDO-INTERNATIONAL STANDARDS ORGANIZATIONS

- ITU-T – ITU Telecommunication Sector
- ISO – International Organization for Standardization
- IEC – International Electrotechnical Commission
- IETF – Internet Engineering Task Force
- IEEE – Institute of Electrical and Electronics Engineers
- OASIS – Organization for the Advancement of Structured Information Standards
- W3C – World Wide Web Consortium
- CISPR – International Special Committee on Radio Interference
- 3GPP – 3rd Generation Partnership Project
- AIIM – Association for Information and Image Management
- CableLabs – Cable Television Laboratories
- Ecma International
- GS1 – Global supply chain standards (identification numbers, barcodes, electronic commerce transactions, RFID)

Regional Standards Organizations

Africa

- ARSO – African Regional Organization for Standardization
- SADCSTAN – Southern African Development Community (SADC) Cooperation in Standardization

Americas

- COPANT – Pan American Standards Commission
- AMN – MERCOSUR Standardization Association
- CROSQ – CARICOM Regional Organisation for Standards and Quality
- CITEL – Inter American Telecommunications Commission

Asia Pacific

- PASC – Pacific Area Standards Congress
- ACCSQ – ASEAN Consultative Committee for Standards and Quality
- APT Standardization Program (ASTAP)

Europe

- CEN – European Committee for Standardization
- CENELEC – European Committee for Electrotechnical Standardization
- ETSI – European Telecommunications Standards Institute

Middle East

- AICTO – Arab Information and Communication Technologies Organization

APPENDIX 3

WORLDWIDE TEST LABS

1. USA NIST

   http://ts.nist.gov/standards/scopes/programs.htm

   http://ts.nist.gov/standards/scopes/ect.htm

2. AUSTRALIA

   www.austest.com.au/about_us.php

3. European

   http://start.europadev.com/Home/consultancy-1

4. A4Labs

   www.at4wireless.com/testing-certification-services/accreditations.html

5. TUNISIA

   www.cert.nat.tn

6. FCC Q&A SITE

   www.bureauveritas.com/wps/wcm/connect/bv_com/group/home/news/did-you-know-that/fcc_faqs?presentationtemplate=bv_master/news_full_story_presentation

7. MIDDLE EAST

   www.uaelab.ae/UAELAB/about_UAELAB.htm

   www.goglobalcompliance.com/

   www.ntra.gov.eg/arabic/main.asp

   www.contractlaboratory.com/labclass/telecommunications.cfm

   www.intertek.com/it/

8. RUSSIAN FEDERATION

   http://zniis.ru/ITTC.html

9. SINTESIO LABORATORY SLOVENIA

   www.sintesio.org/about_us/

10. CANADA – INDUSTRY CANADA

    www.ic.gc.ca/eic/site/smt-gst.nsf/eng/home

11. AFRICA, CHINA, ASEAN, CIS, LATIN AMERICA TEST LABS (Link to ITU webpage)

    www.itu.int/dms_pub/itu-t/oth/06/24/T06240000010009MSWE.doc

APPENDIX 4

INTERNATIONAL FUNDING AGENCIES IN TELECOMS

This Annex is an edited extract from the publication **Financial Institutions Offering Resources for Telecommunication Projects and Technical Assistance in Developing Countries,** Fourth edition, 1999, copyright by the Telecommunication Development Bureau of the International Telecommunication Union (ITU). It should be noted that some contact details may be out of date.

www.itu.int/pub/D-FIN-FINI-1999

www.regency.org/t_in_act/pdf/english/annexa.pdf

MULTILATERAL AGENCIES

Funding agencies and contacts

UNIDO

UNIDO is a niche agency of the UN. It implements around USD 140 million worth of projects per year, a small amount compared to UNDP (USD 3.2 billion), the World Bank (USD 24 billion) and private sector capital flows to developing countries (c. USD 300 billion). Even doubling or tripling the volume of UNIDO's implementation would hardly produce significant changes in our visibility. Increasing the impact of what UNIDO does requires a different approach – one that involves something other than simply spending money.

UNIDO has some interesting programs and experiences in the area of test lab development and training and also offers assistance to Developing Countries to help them conform to International Standards: www.unido.org/index.php?id=o59143.

UNIDO Assistance for Testing Laboratories

Development assistance for laboratories (including those operated by various national standards bodies) has been a major segment of UNIDO support activities since its inception. Such development has, in many cases, been extended to include other support for laboratory operations, such as establishment of equipment maintenance, repair and calibration services.

Additionally, UNIDO has provided numerous training opportunities for laboratory personnel to achieve expertise in various testing disciplines and product sectors. Assistance has also included preparation of laboratories for accreditation through development of their capacity to comply with ISO/IEC 17025 and associated accreditation criteria. More recently, UNIDO has also been preparing guidance documents and training relevant to operation of proficiency testing programs and on the significance of certified reference materials and the various Guides on this subject produced by ISO REMCO.

A further laboratory-support initiative of UNIDO has been its contributions to the establishment of ***LABNET***. This is a web-based information source for laboratories, covering topics such as accreditation, reference materials, proficiency testing etc. It has been jointly supported by UNIDO and WAITRO, the World Association of Industrial and Technological Research Organizations. LABNET can be accessed at: www.labnetwork.org/en/success-stories/case-study-competence-of-laboratories-in-pakistan-/169-unido-assistance-for-testing-laboratories.

See also the website for UNIDO's LABNETWORK: www.labnetwork.org/en/about-labnetwork.

UNIDO Headquarters
Vienna International Centre
Wagramerstr. 5
P.O. Box 300
A-1400 Vienna
Austria
Tel: +43 (1) 26026-0
Fax: +43 (1) 2692669

UNIDO Geneva Office
Le Bocage, Pavillion I
Room 77-82
Palais des Nations
Avenue de la Paix 8-14
CH-1211 Geneva 10
Switzerland
Tel: +41 (22) 917 1423
Fax: +41 (22) 917 0059

African Development Bank (AfDB)
01 B.P. 1387
Joseph Anoma Street
Abidjan 01, Côte d'Ivoire
Tel: +225 204000/204444
Fax: +225 217753/204909/204927
Telex: 22202, 23263, 23498
Cable: AFDEV ABIDJAN

AfDB seeks to play a role in the private financing of telecommunication infrastructure within Africa, including build-operate-transfer schemes, and the provision of technical advice to governments on the development of the legal and regulatory framework.

Asian Development Bank (ADB)
P.O. Box 789
Mandaluyong City
0401 Metro Manila, Philippines
Tel: +63 2 632 44 44
Fax: +63 2 636 23 16
E-mail: adbhq@mail.asiandevbank.org
Website: www.asiandevbank.org
Contact: Günter Hecker, Manager, Transport and Communications Division (West)

ADB provides loans to finance telecommunication infrastructure projects and technical assistance grants to developing member countries in the Asia and Pacific region.

Banque Arabe pour le Développement Economique en Afrique (BADEA)
Abdel Rahman El-Mahdi Street
P.O. Box 2640
Khartoum
Sudan
Tel: +249 11 77 3646/3709/0498
Fax: +249 11 77 0600
Telex: 22739/22248/23098 BADEA SD
Contact: Programme, Projects and Technical Assistance Department

BADEA works with non-Arab members of the Organization of African Unity. About 5 per cent of BADEA's financing in 1995 was devoted to the telecommunication sector.

Banque Ouest Africaine de Développement (BOAD)
68 avenue de la Libération
P.O. Box 1172
Lomé
Togo
Tel: +228 21 0113
Fax: +228 21 7269
Contact: Boni Yayi, President

BOAD provides financing to African shareholding states for pre-investment studies, project preparation, costs and technical assistance in cooperation with the International Telecommunication Union. BOAD will also consider co-financing of a telecommunication project with other development institutions.

Caribbean Development Bank (CDB)
P.O. Box 408
Wildey
St. Michael
Barbados
West Indies
Tel: +1 246 431 1600
Fax: +1 246 426 7269
Cable: CARIBANK
Contact: Sir Neville V. Nicholls, President; Marius A. St.Rose,
Vice-President (Operations); Masie Plummer,
Vice-President (Corporate Services) and Bank Secretary

CDB finances telecommunication projects in Commonwealth Caribbean nations, and provides technical assistance related to projects it is financing (or may finance) and for purposes of general development. Loans are available to both private and public entities which are interested in investing in the Caribbean region.

East African Development Bank (EADB)
4 Nile Avenue
P.O. Box 7128
Kampala
Uganda
Tel: +256 41 230 021/5
Fax: +256 41 259 763
Telex: 61074 EADEVBANK
Contact: F.R. Tibeita, Director General; J.G. Nduati, Director of Operations

EADB provides financial assistance, promoting development and economic growth in Kenya, Tanzania and Uganda.

Telecommunication funding covers rehabilitation/modernization, expansion and acquisition of new equipment and services.

European Bank for Reconstruction and Development (EBRD)
One Exchange Square
London EC2A 2EH
UK
Tel: +44 171 338 6000
Fax: +44 171 338 6100
Telex: 8812161 EBRD L G
Website: www.ebrd.com
Contact: a member of the Telecommunication Team; the Project Enquiries Officer in London; or the local resident office

The EBRD provides project-specific direct financing. For private sector activities, it finances restructuring and privatization, or the infrastructure that supports these activities. Joint ventures have been major beneficiaries of Bank lending, particularly those with foreign sponsors. The EBRD also offers technical cooperation.

European Commission (EC)
200 rue de la Loi
1049 Brussels
Belgium
Tel: +32 2 291 111
Contact: J.F. Soupizet, Head of Sector, Directorate General XIII. Telecommunications, Information Market and Exploitation of Research

The EC gives priority to the establishment of a regulatory framework for private sector investment and a framework of technical standards which facilitates use of the available technologies. Support for telecommunications is not separate from economic cooperation or development aid.

European Investment Bank (EIB)
100 Boulevard Konrad Adenauer
2950 Luxembourg
Tel: +352 4379 1
Fax: +352 4377 04
Telex: +3530 bukeu lu
Contact: F. Carpenter, Secretary-General

The EIB is the European Union's financing institution. It finances investment in more than 130 countries outside the EU, within the framework of the Union's external cooperation policy.
Publications on EIB activities can be obtained on request.
Contact: EIB's Information Desk, Fax: +352 4379 3122.

Inter-American Development Bank (IADB)
Office of External Relations
1300 New York Avenue NW
Washington, DC 20577
USA
Tel: +1 202 623 1397
Fax: +1 202 623 1403
E-mail: pic@iadb.org
Contact: Daniel Martin, Chief, Public Information Section

The IADB makes loans for high-priority projects in the infrastructure, productive and social sectors, such as the improvement of existing networks, installation of rural services and emergency systems important for earthquake rehabilitation, in the developing member countries in Latin America and the Caribbean. Technical assistance is provided for pre-investment and institutional strengthening.

International Finance Corporation (IFC)

2121 Pennsylvania Avenue, NW
Washington, DC 20433, USA
Tel: +1 202 477 1234
Fax: +1 202 477 6391
E-mail: information@ifc.org
Telex: MCI 248423 (WORLDBANK)
Contact: Declan Duff, Manager, Telecommunications, Transportation and Utilities Department

IFC is the world's largest source of direct project financing for private investment in developing countries. In addition to providing finance, IFC acts as a catalyst, bringing in other lenders and shareholders and coordinating financing from foreign and local banks, export credit agencies and other institutions. IFC has been especially successful in mobilizing capital through financing loan syndications.

Islamic Development Bank (IsDB)

P.O. Box 5925
Jeddah 21432
Saudi Arabia
Tel: +966 2 636 1400
Fax: +966 2 636 6871
E-mail: archives@isdb.org.sa
Telex: 601137, 601407 ISDB SJ
Cable: BANKISLAMI JEDDAH
Website: www.isdb.org.sa
Contact: Dr. Ahmad Mohamed Ali, President

The objective of the IsDB is to foster the economic development and social progress of its 52 member countries and Muslim communities in non-member countries, in accordance with the principles of Islamic Shariah. Technical assistance for feasibility studies is financed through grants and/or interest-free loans. The IsDB encourages all development projects.

World Bank

1818 "H" Street, N.W.
Washington
DC 20433
USA
Tel: +1 202 458 4765
Fax: +1 202 522 3001
E-mail: eforestier@worldbank.org
Website: www.worldbank.org
Contact: Emmanuel Forestier, Manager, Telecommunications and Informatics Unit, Energy, Mining and Telecommunications Department

The **World Bank** Group comprises five agencies. From the viewpoint of financing, the main distinction among these agencies is as follows:

The **International Bank for Reconstruction and Development (IBRD)** provides long-term loans at market interest rates to governments, state enterprises or private companies with government guarantee, in countries that cannot adequately finance their development requirements from other sources on reasonable terms. IBRD also offers partial risk and credit guarantees to other lenders.

The **International Development Association (IDA)** provides credits similar to IBRD loans but interest free to countries that have a per capita income less than USD 905 (in 1995) and lack the financial ability to borrow from IBRD on market terms.

The **International Finance Corporation (IFC)** supports private enterprises without government guarantees through loans, loan syndications, equity investments, security underwritings and other financial instruments.

The **Multilateral Investment Guarantee Agency (MIGA)** provides insurance against certain types of non-commercial risk incurred by private-equity investors and lenders.

The **International Centre for Settlement of Investment Disputes (ICSID**) assists in the mediation or conciliation of investment disputes between governments and private foreign investors. To be eligible for an IBRD loan or IDA credit, the borrower must be a developing member country of IBRD or IDA, respectively. The Bank's telecommunication operations focus on creating conditions conducive to private participation in increasingly competitive market structures.

The Information for Development Program (*info*Dev), a global programme managed by the World Bank, provides expertise and grant financing to assist developing countries improve and enhance their social and economic development through information and communication technology.

WorldTel

9-11 rue de Varembé
1211 Geneva 20
Switzerland
Tel: +41 22 730 5401
Fax: +41 22 910 0506
Contact: Terrefe Ras-Work, Director Business Development

WorldTel is both a funding and an operating entity working with developing countries in Africa, the Americas, Asia and Eastern Europe. WorldTel focuses its attention on the provision of basic service infrastructure. The host country needs to become a member of the Assembly of Governors in order to have its projects considered.

BILATERAL AGENCIES

AUSTRALIA

Australian Agency for International Development (AusAID)

G.P.O. Box 887
Canberra ACT 2601
Australia
Tel: +61 2 6206 4580
Fax: +61 2 6206 4925

The principal objective of AusAID is to reduce poverty and build capacity in developing countries, with a special focus on south and East Asia, the South Pacific and southern Africa.

AUSTRIA

Development Cooperation Department (DCD)

Federal Ministry for Foreign Affairs
Minoritenplatz 9
1014 Vienna
Austria
Tel: +43 1 531 15
Fax: +43 1 531 85/270

DCD's funds are concentrated on low-income countries in sub-Saharan Africa. The different activities supported are multilateral development cooperation, bilateral technical development cooperation,

financial aspects of development cooperation, coordination and information, policy and planning, and evaluation. One important concern of Austria's development cooperation is measures to involve women in economic and social life. Other central topics are sustainable development and social justice.

BELGIUM

Belgian Administration for Development Cooperation (BADC)

6 rue Brederode
1000 Brussels
Belgium
Tel: +32 2 519 02 11
Fax: +32 2 519 05 85
Contact: Y. Cheyns

BADC operates at two levels: bilaterally (development projects, technical experts, co-financing non-governmental organizations, humanitarian aid, financial contributions to Belgian universities, study and training, grants, financial assistance, and so on) and multilaterally (contributions to different United Nations organizations, to the European Development Fund, and similar).

Belgian cooperation will be concentrated on a limited number of countries (about 20).

CANADA

Canadian International Development Agency (CIDA)

200 promenade du Portage
Hull, Quebec, KIA OG4, Canada
Tel: +1 819 953 4507
Fax: +1 819 997 1491
E-mail: isabelle.roy@acdi-cida.gc.ca
Contact: Isabelle Roy, Senior ICT Advisor;
For application information, contact your closest Canadian mission/embassy or CIDA directly.

A fundamental objective of Canadian assistance has been to improve the capacity of developing countries to communicate with their peoples, among themselves, and with the North.

Assistance is usually disbursed through three programmes: the bilateral programme, the multilateral programme and the Canadian Partnership programme, and goes to Africa and the Middle East, Asia, central and Eastern Europe, and Latin America.

International Development Research Centre (IDRC)

250 Albert Street
Ottawa, Ontario, K1G 3H9, Canada
Tel: +1 613 236 6163
Fax: +1 613 567 7749
E-mail: info@idrc.ca
Website: www.idrc.ca
Contact: Robert Valantin, Chief Scientist, Information and Communication

Two current programme initiatives work extensively in the field of telecommunication research: PAN Global Networking and the Acacia Initiative. PAN aims to promote access to the information resources available on the Internet. Special attention is given to research and development communities in Asia and Latin America. Acacia aims to empower sub-Saharan African communities with the ability to apply information and communication technologies to their own development. Acacia addresses applications, technology, infrastructure and policy issues.

IDRC generally supports research in the following areas: applications of information and communication technologies in problem solving, decision making and knowledge access and transfer; networking and the use of information and communication technologies to meet the needs of local communities and to promote equity in development; policies and practices that will increase the benefits and reduce the negative impacts of the evolving information infrastructure on developing countries and their people.

DENMARK

Danish International Development Agency (DANIDA)

2 Asiatisk Plads
1448 Copenhagen K, Denmark
Tel: +45 33 92 02 25
Fax: +45 33 92 07 90
Telex: 31 292 etr dk
Contact: Helene Ras Groen, Adviser, Infrastructure Division

DANIDA is currently providing bilateral assistance for telecommunication projects in Nepal, Zimbabwe and a few other countries where the assistance is being phased out.

Broad-sector support is presently planned for Malawi only.

FINLAND

Department for International Development Cooperation (DIDC)

Ministry for Foreign Affairs
Katajanokanlaituri 3
P.O. Box 176
00161 Helsinki, Finland
Tel: +358 9 1341 6212
Fax: +358 9 1341 6314
E-mail: heikki.tunnanen@formi.fi
Contact: Heikki Tunnanen, Deputy Director General

DIDC intervention is mainly in the form of training of personnel and institutional development, rural information and communication technology. Aid is channelled through bilateral cooperation, international organizations and development funds, humanitarian aid and non-governmental organizations.

FRANCE

Agence Française de Développement (AFD)

5 rue Roland Barthes
75598 Paris Cedex 12, France
Tel: +33 1 53 44 31 31
Fax: +33 1 44 87 99 39
Telex: 281871F
Website: www.afd.fr

AFD implements overseas development assistance, concentrating on francophone Africa, with increasing diversification into the rest of Africa, and Caribbean and Pacific countries.

Natexis (new name of Group Credit National – BFCE)

45 rue Saint Dominique
75700 Paris 07 SP, France

Tel: +33 1 48 00 48 00
Fax: +33 1 48 00 41 51
Contact: French Ministry of Economy, Finance and Industry

Natexis is responsible for activities in the implementation of overseas development assistance on behalf of the French Ministry of Economy, Finance and Industry.

The organization is operational in developing countries except those managed by the *Agence Française de Développement*.

GERMANY

Bundesministerium fur Wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)

40 Friedrich-Ebert-Allee
53113 Bonn
Germany
Tel: +49 228 535 3757
Fax: +49 228 535 3755
Contact: Georg Lührs, Deputy Head of Infrastructure Division

BMZ provides overseas development assistance to developing countries in Africa, the Arab States, Asia and the Pacific, Europe, and Latin America and the Caribbean.

Kreditanstalt fur Wiederaufbau (KfW)

5-9 Palmengartenstrasse
60325 Frankfurt am Main
Germany
Tel: +49 69 7431 0
Fax: +49 69 7431 2944
E-mail: jens.clausen@kfw.de
Website: www.kfw.de
Contact: Jens Clausen, Sector Economist, Sector Policy Department

KfW finances telecommunication infrastructure projects and project-related consulting services, particularly for countries prepared to implement sector reforms which will attract private capital and management. Assistance will primarily be dedicated to supporting the needs of commercial and administrative end-users.

IRELAND

Agency for Personal Service Overseas (APSO)

29-30 Fitzwilliam Square
Dublin 2
Ireland
Tel: +353 1 661 4411
Fax: +353 1 661 4202
E-mail: apso@iol.ie

APSO assists qualified Irish personnel primarily to train and transfer technical know-how to staff in telecommunication projects in the developing world. APSO funds only personnel, not projects.

ITALY

Direzione Generale per la Cooperazione allo Sviluppo (DGCS)

Ministry of Foreign Affairs
Piazza Della Farnesina
00194 Roma, Italy
Tel: +39 06 3235916

Telecommunications are not a priority for the DGCS, according to the guidelines approved in 1995 by the Inter-Ministerial Committee for Economic Planning. However, grant and loan demands for telecommunication projects should be addressed to the DGCS by authorities from developing countries in Africa, Asia and Latin America.

Mediocredito Centrale (MCC)

51 via Piemonte
00187 Rome
Italy
Tel: +39 06 47 91 777
Fax: +39 06 47 91 642
E-mail: project@mcc.it
Website: www.mcc.it
Contact: Valerio Bellamoli, Director, Project Finance Department

MCC was founded as a credit institute to provide loans to small and medium-sized business and to support export credits. MCC will finance telecommunication projects (cable, satellite, cellular and fixed networks) in developed and emerging markets.

JAPAN

Japan International Cooperation Agency (JICA)

Shinjuku Maynds Tower Building
2-1-1, Yoyogi, Shibuya-ku, Tokyo, Japan
Tel: +81 3 5352 5311 4
Fax: +81 3 5352 5032

JICA aims to promote economic and social development and thus improve living standards in developing countries. Economic infrastructure is one of the main sectors benefiting from Japanese aid, a sector including communications and transportation.

Ministry of Foreign Affairs (MOFA)

1-3-2 Kasumigaseki
Chiyoda-ku, Tokyo, Japan
Tel: +81 3 3580 3311 (ext. 2748)
Fax: +81 3 3593 8021
E-mail: koji.matsuoka@mofa.go.jp
Contact: Koji Matsuoka, Research and Planning Division, Economic Cooperation Bureau

MOFA finances the construction of basic information and communication infrastructure, and provides assistance to help transfer technology and train personnel necessary for the operation, maintenance and management of information and communication systems. For growing economies such as those of southeast Asia, it mainly provides loans. For poorer countries, it provides grants.

Overseas Economic Cooperation Fund (OECF)

4-1 Ohtemachi 1-Chome
Chiyoda-ku
Tokyo 100
Japan
Tel: +81 3 3215 1419
Fax: +81 3 3215 1307
E-mail: copr@oecf.go.jp
Website: www.oecf.go.jp
Contact: Takayuki Ohgai, Director, Public Relations Division, Coordination Department

OECF provides overseas development assistance loans to finance telecommunication infrastructure projects aimed at both expanding telecommunication capacity and improving quality of service by system modernization and the introduction of new technologies.

NETHERLANDS

Ministry of Foreign Affairs

P.O. Box 20061
2500 EB The Hague
Netherlands
Tel: +31 70 348 6186/5075
Fax: +31 70 348 4848/6167
Telex: 31326 Buza nl
Contact: J.P. Mout, Dept. DVN/CI

Ministry of Foreign Affairs-funded telecommunication projects are usually infrastructural projects. Special emphasis is laid on private participation. Assistance is focused on developing countries wishing to achieve connectivity to rapid developments in the field of innovative information and communication technologies.

NEW ZEALAND

Development Cooperation Division (DEV)

Ministry of Foreign Affairs and Trade
Private Bag 18-90
Wellington
New Zealand
Tel: +64 4 494 8500
Fax: +64 4 494 8515

New Zealand's DEV provides the Southeast Asian and South Pacific regions with financing for telecommunication projects, equipment, training and maintenance. Current themes of New Zealand's development cooperation are women in development and environmental enhancement.

NORWAY

Norwegian Post and Telecommunications Authority (NPT)

Revierstredet 2
P.O. Box 447 Sentrum
0104 Oslo, Norway
Tel: +47 22 82 46 00
Fax: +47 22 82 48 40
Telex: 79 544 NTRA N

E-mail: firmapost@npt.no
Website: www.npt.no
Contact: Oistein Iversen, Senior Adviser, Director's Staff;
Steinar Hagen, Infrastructure Division, Deputy Director, Technical Department, Economics Development Section, Norwegian Agency for International Development (NORAD)

NPT represents NORAD in the telecommunication sector. Norway provides grants to finance telecommunication infrastructure projects and technical assistance in developing countries. This support is mainly for the establishment of joint ventures, training courses and feasibility studies. Norway has a particular interest in Russian projects.

SWEDEN

Swedish International Development Authority (Sida)

S-105 25 Stockholm, Sweden
Tel: +46 8 698 50 00
Fax: +46 8 20 88 64
Telex: 11450 SIDA sithim
E-mail: lars.glimbert@sida.se
Website: www.sida.se
Contact: Lars Glimbert or Benst Oberger, Department for Infrastructure and Economic Cooperation

Sida provides resources to stimulate changes in policy which favour the commercialization and privatization of the sector, support the formation of international alliances, contribute to human resources and organizational development, and support innovative information technology projects in different sectors of society.

SWITZERLAND

Swiss Agency for Development and Cooperation (SDC)

Federal Department of Foreign Affairs
3003 Berne, Switzerland
Tel: +41 31 322 34 27
Fax: +41 31 324 16 91

The bulk of Swiss development cooperation in the field of communications takes the form of technical assistance, provided to countries in Africa, Asia and Latin America for projects including telecommunications. SDC's technical and financial assistance is deliberately concentrated on 19 countries.

UNITED KINGDOM

Commonwealth Development Corporation (CDC)

One Bessborough Gardens
London SW1V 2JQ
UK
Tel: +44 171 828 4488
Fax: +44 171 828 6505
E-mail: infrastruc@cdc.co.uk
Contact: Adrian Robinson, Manager, Telecoms

CDC helps finance telecom projects in developing countries, providing finance for private sector companies or public sector entities going through the privatization process. CDC also invests in small and medium-sized enterprises.

Department for International Development

(DFID)

94 Victoria Street
London SW1E 5JL
UK
Tel: +44 171 917 0116
Fax: +44 171 917 0072
Contact: John Hodges, Chief Engineering Adviser

Direct investment in telecommunication has low priority, but DFID gives some support for sector regulation and enabling legislation for private sector inputs. DFID does encourage private sector investment and public/private partnerships.

UNITED STATES of AMERICA

United States Agency for International Development (USAID)

Ronald Reagan Building
1300 Pennsylvania Avenue, NW
Washington DC 20523
USA

For financial data:

Contact: Mary Knox, PPC/DP
Tel: +1 202 712 0978
Fax: +1 202 216 3394
E-mail: mknox@usaid.gov

For information technology for development:

Contact: Paula Bagasao, PPC/SPG
Tel: +1 202 712 1062
Fax: +1 202 216 3124
E-mail: pbagasao@usaid.gov

USAID recognizes the importance of incorporating access to data and information and communication technology (including telecommunication-related development activities) across all sectors.

Abu Dhabi Fund for Development (ADFD)

P.O. Box 814
Abu Dhabi
United Arab Emirates
Tel: +971 2 72 5800
Fax: +971 2 72 8890
Telex: 22287 FUND EM
Cable: FUND ABU DHABI
Contact: H.E. Saeed Khalfan Al Rumaithi

ADFD provides assistance to African, Arab and Asian economies by promoting development projects. The softest terms for loans are given for infrastructural, rural development and telecommunication projects; the hardest, for industrial and tourism projects. Co-financing with other development finance institutions is encouraged.

Arab Fund for Economic and Social Development (AFESD)

P.O. Box 21923
Safat 13080
Kuwait
Tel: +965 484 4500
Fax: +965 481 5750/60/70
Telex: INMARABI 22143 KT
Cable: INMARABI KUWAIT
Contact: H.E. Abdlatif Yousef Al-Hamad, Director General/Chairman of the Board of Directors

AFESD is a regional development institution that finances projects for economic and social development, with emphasis on regional Arab projects. AFSD also provides grants for technical assistance for preparation of feasibility studies, institutional capacity building, research and seminars, and training.

Kuwait Fund for Arab Economic Development (KFAED)

P.O. Box 2921
Safat 13030
Kuwait
Tel: +965 246 8800
Fax: +965 241 9091
Telex: 22613 KFEAD KT
Cable: ALSUNDUK, Kuwait
Contact: Hesham Al-Waqayan, Deputy Director General (Operations and Disbursement);
Fawzi Yousef Al-Hunaif, Director of Operations

KFAED provides grants to all developing nations, to finance telecommunication activities including pre-investment studies, recruitment of experts and vocational training programmes.

Saudi Fund for Development (SFD)

P.O. Box 1887
Riyadh 11441
Saudi Arabia
Tel: +966 1 464 0292
Fax: +966 1 464 7450
Telex: 401744, 401145 SANDOQ SJ
Contact: H.E. Sheikh Mohammed A. Al-Sugair

SFD provides loans for development projects, in all sectors of developing countries in Africa, Asia, Latin America and Oceania, with a strong preference for infrastructure projects, in particular transport and communication. It may finance feasibility and engineering studies but it does not, as a general rule, make any technical assistance grants.

APPENDIX 5

TELECOMMUNICATIONS TRAINING COURSES

1.0 Commonwealth Telecommunications Organization (CTO) *WWW.CTO.INT*

- A professional training and capacity building programme covering telecommunications and ICT
- Offered to all parties – Ministries, regulators, operators and others
- The programme is funded through annual financial contributions from its members
- Lower fees for members – about 50% lower
- Visit CTO course schedules and fees at:

Sample of CTO courses and fees

WWW.CTO.INT/PDT/SCHEDULEDCOURSES/TABID/219/DEFAULT.ASPX

- ICT Tools for Management and Planning Nairobi, Kenya 17/05/2010 to 20/05/2010 GBP 699/ GBP 1 099
- Next Generation Networks Ndola, Zambia 14/06/2010 to 18/06/2010 GBP 799/ GBP 1 199
- Fibre Optic Access Networks Limbe, Cameroon 28/06/2010 to 02/07/2010 GBP 799/ GBP 1 199
- Convergence & Talent Management Botswana 05/07/2010 to 09/07/2010 GBP 799/ GBP 1 199
- IP Networking including Bandwidth Optimization & Expansion Suva, Fiji Islands 26/07/2010 to 30/07/2010 GBP 799/ GBP 1 199
- GSM Technologies (2G, 2.5G, EDGE, GPRS) Gaborone, Botswana 02/08/2010 to 06/08/2010 GBP 799/ GBP 1 199
- Frequency Planning & Spectrum Management* Bamenda, Cameroon 09/08/2010 to 13/08/2010 GBP 799/ GBP 1 199
- Internship in Marketing (exchange program)* South Africa 16/08/2010 to 20/08/2010 GBP 799/ GBP 1 199
- Internship on ADSL Technology* South Africa 16/08/2010 to 20/08/2010 GBP 799/GBP 1 199

2.0 Telecommunications Executive Management Institute of Canada (TEMIC) *WWW.TEMIC.CA*

- Non-profit organization based in Montreal (Canada)
- Mandate of assisting developing countries in expanding their telecommunication sector by improving the managerial abilities of senior telecommunication managers
- Holds seminars at various locations across Canada
- Supported by 35 different organizations from the Canadian telecommunication industry
- Special ties with other international associations such as the Commonwealth Telecommunications Organisation (CTO) and the Caribbean Telecommunications Union (CTU)
- Participation in TEMIC programmes is by invitation from the Institute

- Participants' living expenses during their stay in Canada are generally paid for by the Institute.

TEMIC SEMINARS:

- Telecommunications Senior Management
- Marketing and Customer Services Management in Telecommunications
- Rural Telecommunications Management
- Strategic Management in Telecommunications
- Telecommunications Policy, Regulation and Transition Management
- Telecommunications Management in the New Environment
- ICT Development and Management

3.0 LEVER TECHNOLOGY GROUP PLC info@lever.co.uk

Delivers a wide range of Wireline Telecoms training courses and Wireless courses covering the following technologies and more.

LTE Training Courses

UMTS Training Courses

WiMAX Forum® Training Courses

TCP/IP, IP and IPv6 Training Courses

VoIP Training Courses

Fixed Mobile Convergence (FMC) Training Courses

Telecoms Training Courses

Voice Telephony Training Courses

WiFi Wireless (WLAN) Training Courses

Certified Wireless Network Professional (CWNP) Training Courses

RF and Wireless Training Courses

TETRA Training Courses

Bluetooth and ZigBee Training Courses

Satellite Communications (VSAT) Training Courses

Billing Training Courses

Network Security Training Courses

Cisco Training Courses

SAMPLE OF LEVER COURSES

LTE Training Courses

4G and LTE – Non-Technical Appreciation training course

A 1-day LTE/4G training course – A Non-Technical Appreciation of the Next Generation of Mobile Communications.

LTE and 4G – Technical Overview training course

A 1-day LTE and 4G training course – A high-value seminar covering all aspects of LTE motivations, timescales, goals, technical features, and aspects of UMTS that will change to support LTE.

LTE (Long Term Evolution) – In-Depth training course

A 3-day LTE training course – A high-value training course covering all aspects of LTE, including environment, drivers, MIMO, CDMA, OFDM, air interface, architectural and core network changes.

Long Term Evolution (LTE) – RF Design™ Boot Camp training course

A 4-day LTE training course – The authoritative course for LTE RF network Planning and Design Engineers.

TCP/IP, IP and IPv6 Training Courses

Wireshark Boot Camp Training Course training course

A 1-day Wireshark training course – Learn Wireshark network monitoring, troubleshooting with Wireshark, Wireshark security monitoring, Wireshark protocol analysis, network diagnosis and support using Wireshark.

IPv4: Protocols, Implementation, Analysis, Troubleshooting and Support training course

A 3-day TCP/IP training course – A comprehensive hands-on practical TCP/IP training course covering TCP/IP protocols, IP network support, troubleshooting and optimisation using Wireshark.

IPv6: Protocols, Implementation and Migration training course

A 2-day IPv6 training course – Understand IPv6 in-depth with this comprehensive, hands-on practical IPv6 training course.

VoIP and Unified Communications (UC) training course

A 3-day VoIP training course – A comprehensive, authoritative and thoroughly hands-on practical coverage of the latest Voice over IP standards, IP telephony products and Unified Communications (UC).

Voice over Wi-Fi (VoFi/VoWLAN) training course

A 2-day Voice over WLAN training course – An advanced course covering voice over Wi-Fi technologies and VoWi-Fi network engineering.

MPLS Technology Essentials training course

A 3-day MPLS training course – Understand MPLS in depth with this comprehensive hands-on training course.

RF and Wireless Training Courses

Intro to Radio Planning for Mobile Networks training course

A 1-day Radio Planning training course – The What, Why and something of the How.

Fundamentals of Wireless Systems and Networks training course

A 5-day Wireless training course – A unique, high-value, fast-track coverage of today's current and emerging Wireless communications networks, systems and technologies: RF Fundamentals, LTE, UMTS, HSPA+, EDGE, GSM, GPRS, WiMAX, TETRA, Wi-Fi, ZigBee, Bluetooth.

Understanding Mobile and Wireless Communications training course

A 2-day Wireless training course – A complete and essential overview of all modern Mobile and Wireless communications technologies, for non-technical professionals.

Understanding Satellite Communications Systems training course

A 3-day VSAT training course – Understand Satellite Communications systems with this authoritative training course.

4.0 NEOTELIS *WWW.NEOTELIS.COM*

- Founded in 1997 and headquartered in Montreal, Canada,
- Assists telecommunication organizations worldwide in consulting and telecom training
- Clients in Africa, the Americas and the Caribbean, Asia, Europe, the Middle East and Oceania
- Has performed mandates in more than 100 countries around the world for operators, regulators, governments and policy-makers
- Offers a wide range of Training Programs in the key areas of the telecommunication sector: Strategy and Management, Marketing and Sales, Engineering Operations, Finance, Human Resources, Policies and Regulation and Information and Communications, Technologies for Development (ICT4D)

Sample of Neotelis courses

- Strategy & Management
- MGT-100E Mini MBA in Telecommunications

  11-22 July 2011 – Montreal, Canada (in English)
- MGT-101E Strategic Thinking & Planning in Telecommunications

  27 June – 1 July – London, United Kingdom
- MGT-104E Business Intelligence in Telecommunications

  25-29 July 2011 – Amsterdam, Netherlands
- Engineering, Networks & Technologies
- ENG-207E Next Generation Networks

  14-18 November 2011 – Miami, USA
- ENG-412E TCP/IP Network Fundamentals

  17-28 October 2011 – Montreal, Canada (in English)
- ENG-507E Fixed & Mobile WiMAX: Planning, Design & Deployment

  19-23 September 2011 – London, United Kingdom Policies & Regulations
- REG-100E Telecom Regulation Essentials

  26 September-7 October 2011 – Montreal, Canada (in English)
- REG-101E Management of Regulatory Affairs

  31 October-4 November 2011 – Cape Town, South Africa
- REG-106E Competition Issues in Telecommunications

  4-8 July 2011 – London, United Kingdom
- International IP Interconnection

- III-100E Transitioning International Voice Interconnections to IP

  4-5 April 2011 – Singapore, Singapore

  30-31 May 2011 – Montreal, Canada (in English)

  8-9 November 2011 – London, United Kingdom
- III-200E International IP Interconnection – Business Aspects

  27-29 September 2011 – Amsterdam, Netherlands
- III-301E International IP Interconnection – Technical Aspects

  6-8 April 2011 – Singapore, Singapore

  1-3 June 2011 – Montreal, Canada (in English)

  13-15 June 2011 – Paris, France (in English)

APPENDIX 6

AVAILABILITY OF TEST SPECIFICATIONS FROM ITU-T RECOMMENDATIONS

Recommendations for which ITU-T test specifications are available[30]

ITU-T Recommendations specifying test procedures are available for the following Recommendations:

Optical fibre cables:

- G.652 (2009-11) Characteristics of a single-mode optical fibre and cable
- G.653 (2010-07) Characteristics of a dispersion-shifted, single-mode optical fibre and cable
- G.654 (2010-07) Characteristics of a cut-off shifted, single-mode optical fibre and cable
- G.655 (2009-11) Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable
- G.656 (2010-07) Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport
- G.657 (2009-11) Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network

Characteristics of optical components and subsystems:

- G.662 (2005-07) Generic characteristics of optical amplifier devices and subsystems
- G.663 (2011-04) Application related aspects of optical amplifier devices and subsystems
- G.664 (2006-03) Optical safety procedures and requirements for optical transport systems
- G.665 (2005-01) Generic characteristics of Raman amplifiers and Raman amplified systems
- G.666 (2011-02) Characteristics of PMD compensators and PMD compensating receivers
- G.667 (2006-12) Characteristics of adaptive chromatic dispersion compensators

Optical fibre submarine cable systems:

- G.973 (2010-07) Characteristics of repeaterless optical fibre submarine cable systems
- G.974 (2007-07) Characteristics of regenerative optical fibre submarine cable systems
- G.975.1 (2004-02) Forward error correction for high bit-rate DWDM submarine systems
- G.977 (2011-04) Characteristics of optically amplified optical fibre submarine cable systems
- G.978 (2010-07) Characteristics of optical fibre submarine cables

Coding of voice and audio signals:

- G.711 (1988-11) Pulse code modulation (PCM) of voice frequencies
- G.722 (1988-11) 7 kHz audio-coding within 64 kbit/s

[30] ITU-T Conformity Database portal (www.itu.int/net/ITU-T/cdb/Test-Specifications.aspx).

- G.723.1 (2006-05) Dual rate speech coder for multimedia communications transmitting at 5.3 and 6.3 kbit/s
- G.726 (1990-12) 40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)
- G.727 (1990-12) 5-, 4-, 3- and 2-bit/sample embedded adaptive differential pulse code modulation (ADPCM)
- G.728 (1992-09) Coding of speech at 16 kbit/s using low-delay code excited linear prediction
- G.729 (2007-01) Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear prediction (CS-ACELP)

Optical fibre cables test methods:

The following G.Series specifications address testing methods:

- G.650.1 Definitions and test methods for linear, deterministic attributes of single-mode fibre and cable
- G.650.2 Definitions and test methods for statistical and non-linear related attributes of single-mode fibre and cable
- G.650.3 Test methods for installed single-mode optical fibre cable links
- G.661 Definitions and test methods for the relevant generic parameters of optical amplifier devices and subsystems
- G.976 Test methods applicable to optical fibre submarine cable systems
- G.996.1 Test procedures for digital subscriber line (DSL) transceivers
- G.996.2 Single-ended line testing for digital subscriber lines (DSL)
- G.Supplement 44 Test plan to verify B-PON interoperability
- G.Supplement 46 G-PON interoperability test plan between optical line terminations and optical network units

Coding of moving video:

- H.264 (2010-03) Advanced video coding for generic audiovisual services

Protection against interference – resistibility:

- K.20 (2008-04) Resistibility of telecommunication equipment installed in a telecommunication centre to overvoltages and overcurrents
- K.21 (2008-04) Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents
- K.45 (2008-04) Resistibility of telecommunication equipment installed in the access and trunk networks to overvoltages and overcurrents

Voice terminal characteristics:

- P.310 (2009-06) Transmission characteristics for narrow-band digital handset and headset telephones
- P.311 (2011-03) Transmission characteristics for wideband digital handset and headset telephones
- P.313 (2007-03) Transmission characteristics for cordless and mobile digital terminals

Integrated Services Digital Network (ISDN):

- Q.703 (1996-07) MTP signalling link
- Q.704 (1996-07) MTP Signalling network functions and messages
- Q.706 (1993-03) Message transfer part signalling performance
- Q.707 (1988-11) MTP Testing and maintenance
- Q.711 (2001-03) Functional description of the signalling connection control part
- Q.712 (1996-07) Definition and function of Signalling connection control part messages
- Q.713 (2001-03) Signalling connection control part formats and codes
- Q.714 (2001-05) Signalling connection control part procedures
- Q.721 (1988-11) Functional description of the Signalling System No. 7 Telephone User Part (TUP)
- Q.722 (1988-11) General function of telephone messages and signals
- Q.723 (1988-11) Telephone user part formats and codes
- Q.724 (1988-11) Telephone user part signalling procedures
- Q.730 (1988) ISUP supplementary services (1988 version covered by test specification – latest version of Q.730 1999-12)
- Q.761 (1999-12) SS7 ISDN User Part functional description
- Q.762 (1999-12) SS7 ISDN User Part general functions of messages and signals
- Q.763 (1999-12) SS7 ISDN User Part formats and codes
- Q.764 (1999-12) SS7 ISDN User Part signalling procedures
- Q.765 (2000-06) SS7 application transport mechanism
- Q.767 (1991-02) Application of the ISDN User Part of CCITT signalling system No. 7 for international ISDN interconnections
- Q.771 (1993) Functional description of transaction capabilities (93 version covered by test specification – latest version of Q.771 – Q.774 1997-06)
- Q.772 (1993) Transaction capabilities information element definitions
- Q.773 (1993) Transaction capabilities formats and encoding
- Q.774 (1993) Transaction capabilities procedures
- Q.921 (1997-09) ISDN user-network interface – Data link layer specification

ISDN protocol (SS7 and DSS1) associated test documentation:

- Q.765bis – SS7 Application transport mechanism: Test suite structure/test purposes (TSS & TP)
- Q.780 Signalling System No. 7 test specification – General description
- Q.781 MTP level 2 test specification
- Q.782 MTP level 3 test specification
- Q.783 TUP test specification
- Q.784 ISUP basic call test specification

- Q.784.1 ISUP basic call test specification: Validation and compatibility for ISUP'92 and Q.767 protocols
- Q.784.2 ISUP basic call test specification: Abstract test suite for ISUP'92 basic call control procedures
- Q.784.3 ISUP basic call test specification: ISUP '97 basic call control procedures – Test suite structure and test purposes (TSS & TP)
- Q.785 ISUP protocol test specification for supplementary services
- Q.785.2 ISUP'97 supplementary services – Test suite structure and test purposes (TSS & TP)
- Q.786 SCCP test specification
- Q.787 Transaction capabilities (TC) test specification
- Q.788 User-network-interface to user-network-interface compatibility test specifications for ISDN, non-ISDN and undetermined accesses interworking over international ISUP
- Q.921bis Abstract test suite for LAPD conformance testing
- Q.933bis Abstract test suite – Signalling specification for frame mode basic call control conformance testing for permanent virtual connections (PVCs)

SIP-ISDN interworking:

- Q.1912.5 (2004-03) Interworking between Session Initiation Protocol (SIP) and Bearer Independent Call Control protocol or ISDN User Part

Image compression – JPEG 2000:

- T.800 (2002-08) JPEG 2000 image coding system: Core coding system
- T.802 (2002-08) Motion JPEG-2000

Recommendations for which test specifications are available from other SDOs

Some test specifications and interoperability agreements that are applicable to ITU-T Recommendations are available as follows:

- H.262 (Generic coding of moving pictures and associated audio information: Video) – Conformance testing and software simulation are available in **ISO/IEC** 13818-4:2004 and **ISO/IEC** TR 13818-5:2005, respectively
- J-Series (Cable networks and transmission of television, sound programme and other multimedia signals) – the following ITU-T Recommendations are covered by the **CableLabs** certification scheme
  - J.83 Digital multi-programme systems for television, sound and data services for cable distribution
  - J.112 Transmission systems for interactive cable television services
  - J.122 Second-generation transmission systems for interactive cable television services – IP cable modems
  - J.125 Link privacy for cable modem implementations
  - J.126 Embedded Cable Modem device specification
  - J.127 Transmission protocol for multimedia webcasting over TCP/IP networks
  - J.128 Set-top gateway specification for transmission systems for interactive cable television services

- J.161 Audio and video codec requirements and usage for the provision of bidirectional audio services over cable television networks using cable modems
- J.162 Network call signalling protocol for the delivery of time-critical services over cable television networks using cable modems
- J.163 Dynamic quality of service for the provision of real-time services over cable television networks using cable modems
- J.164 Event message requirements for the support of real-time services over cable television networks using cable modems
- J.166 IPCablecom Management Information Base (MIB) framework
- J.167 Media terminal adapter (MTA) device provisioning requirements for the delivery of real-time services over cable television networks using cable modems
- J.170 IPCablecom security specification
- J.171.0 IPCablecom trunking gateway control protocol (TGCP): Profiles overview
- J.172 IPCablecom management event mechanism
- J.179 IPCablecom support for multimedia
- J.191 IP feature package to enhance cable modems
- J.192 A residential gateway to support the delivery of cable data services
- J.199 Battery backup for cable-based devices
- J.202 Harmonization of procedural content formats for interactive TV applications
- J.204 Metrics gathering specification
- J.210 Downstream RF interface for cable modem termination systems
- J.211 Timing interface for cable modem termination systems
- J.212 Downstream external Physical layer interface for modular cable modem termination systems
- J.215 Client digital programme insertion API
- J.222.1 Third-generation transmission systems for interactive cable television services – IP cable modems: Physical layer specification
- J.222.2 Third-generation transmission systems for interactive cable television services – IP cable modems: MAC and Upper Layer protocols
- J.222.3 Third-generation transmission systems for interactive cable television services – IP cable modems: Security services
- J.361 IPCablecom2 codec and media
- J.365 IPCablecom2 application manager interface
- J.366.0 IPCablecom2 IP Multimedia Subsystem (IMS): Delta Recommendations overview
- J.366.2 IPCablecom2 IP Multimedia Subsystem (IMS): Session handling – IM call model – Stage 2 specification
- J.366.3 IPCablecom2 IP Multimedia Subsystem (IMS): Stage 2 specification
- J.366.4 IPCablecom2 IP Multimedia Subsystem (IMS): Session Initiation Protocol (SIP) and Session Description Protocol (SDP) – Stage 3 specification
- J.366.7 IPCablecom2 IP Multimedia Subsystem (IMS): Access security for IP-based services

- J.366.8 IPCablecom2 IP Multimedia Subsystem (IMS): Network domain security specification
- J.366.9 IPCablecom2 IP Multimedia Subsystem (IMS): Generic authentication architecture specification (3GPP TS 33.220)
- J.368 IPCablecom2 quality of service specification
- J.369 IPCablecom2 E-UE provisioning framework specification
- J.370 IPCablecom2 embedded user equipment provisioning data model specification
- J.602 Network service operator's requirements for real-time transmission of exLSDI signals under parallel processing functionality

- The **Broadband Forum** has produced test specifications for the following ITU-T Recommendations:
  - G.991.2 Single-pair high-speed digital subscriber line (SHDSL) transceivers
  - G.992.1 Asymmetric digital subscriber line (ADSL) transceivers
  - G.992.2 Splitterless asymmetric digital subscriber line (ADSL) transceivers
  - G.992.3 Asymmetric digital subscriber line transceivers 2 (ADSL2)
  - G.992.5 Asymmetric digital subscriber line (ADSL) transceivers – Extended bandwidth ADSL2 (ADSL2plus)
  - G.993.2 Very high speed digital subscriber line transceivers 2 (VDSL2)
  - G.994.1 Handshake procedures for digital subscriber line (DSL) transceivers
  - G.997.1 Physical layer management for digital subscriber line (DSL) transceivers

APPENDIX 7

EQUIPMENT DATA AND ORDER-OF-MAGNITUDE COST FIGURES

Equipment	Description	Order-of-Magnitude Cost Figures (USD)
AMPLIFIERS:		
AMPLIFIER, RF	Frequency Range: 20 Hz to 20 KHz	7,000
AMPLIFIER, RF	Frequency Range: 100 KHz-26.5 GHz	41,000
AMPLIFIER, VERTICAL DUAL CHANNEL		3,000
AMPLIFIER, DISTRIBUTION HF		1,300 to 8,000
AMPLIFIER, BROADBAND		3,000 to 13,000
ANALYZERS:		
ANALYZER, RADIO COMMUNICATION	Frequency Range: 300 kHz to 3 GHz	17,000
ANALYZER, RADIO COMMUNICATION	Frequency Range: 30 MHz to 2.7 GHz	61,000
ANALYZER, AUDIO		77,000
ANALYZER, SPECTRUM	Frequency Range: 9 kHz to 6.5 GHz	38,000
ANALYZER, SPECTRUM	9 kHz to 40 GHz Portable Millimeter Wave Spectrum Analyzer	75,000
ANALYZER, SPECTRUM	Monitors RF, microwave, and millimeter-wave signals from 3 Hz to 50 GHz	115,000
ANALYZER, AC POWER	750 VA, 300 V, 6.5 A	10,000
ANALYZER, VECTOR NETWORK MICROWAVE	VSA with W-CDMA Capability, DC to 2.65 GHz	65,000
ANALYZER, VECTOR NETWORK MICROWAVE	Frequency Range: 10 MHz to 67 GHz	180,000
ANALYZER, SIGNAL	Frequency Range: 20 Hz-26.5 GHz	37,000
ANTENNAS:		
ANTENNA – Double-Ridged Waveguide Horn	Frequency Range: 1 GHz-18 GHz	5,000
ANTENNA – passive loop antenna	Frequency Range: 10 kHz-30 MHz	1,400
ANTENNA, DIPOLE	Frequency Range: 140-400 MHz	2,000
ANTENNA, DIPOLE – BROADBAND	Frequency Range: 1-6 GHz	12,000
ANTENNA, BICONICAL	Frequency Range: 30-300 MHz	2,700
ANTENNA, BICONICAL	Frequency Range: 26 MHz to 2 GHz	6,000
ANTENNA, DF	Frequency Range: 30 MHz to 1 GHz	5,000
ANTENNA, LOG PERIODIC	Frequency Range: 200 MHz to 2 GHz	3,500
ANTENNA, MICROWAVE		1,300
ANTENNA, MASS		19,000
ANTENNA TOWER		22,000

Equipment	Description	Order-of-Magnitude Cost Figures (USD)
CALIBRATORS:		
CALIBRATION UNIT, DC REF STANDARD	Frequency range: 100 kHz to 2600 MHz	3,500
MULTIFUNCTION CALIBRATOR	10 Hz to 30 MHz to cover to RF voltmeters	60,000
AM/FM CALIBRATOR	Frequency range: 150 kHz to 1300 MHz	10,000
COAXIAL DIOPOLE 1600 MHz		5,000
CONTROLLER		6,800
COUNTER, FREQUENCY		17,000
COUPLER, CONNECTING NETWORK		2,800
EXCITER – RADIO TRANSMITTER		20,000 to 55,000
FM TRANSMITTER SYSTEM		50,000
GENERATORS:		
RINGING GENERATOR, SIGNAL	Feeding bridge for analogue telephone measurements	15,000
MICROWAVE SIGNAL GENERATOR	Frequency Range: 10 MHz to 40 GHz	43,000
GENERATOR, SIGNAL RF	4 GHz RF Reference Source	46,000
GENERATOR, WAVEFORM		2,000 to 6,000
HIGH TEMPERATURE DIELECTRIC PROBE		9,200
HUB, LAN 10 BASE-2 ETHERNET		26,000
INVERTER		500
LABELLING MACHINE		500
MASK-TESTER & ADAPTER		9,000
MEASURING AMPLIFIER		20,000
METER, CURRENT		9,000
METER, FIELD STRENGTH		30,000
METER, P.D.		8,000 to 10,000
MILLIMETER, MIXTURE		28,000
MIXER, AUDIO VISUAL		6,000
MODULE, ELECTRONIC CAL.		6,000 to 11,000
MONOPOLE		4,000
MULTIMETERS:		
MULTIMETER	True-rms ac voltage and current – 100 kHz ac bandwidth	550
MULTIMETER	100 µA to 10 A current range	1,300
MULTIMETER	DC range from 200 mV to 1 Kv; Bandwidth for AC measurements extends to 1 MHz	21,000

Equipment	Description	Order-of-Magnitude Cost Figures (USD)
OSCILLOSCOPES:		
OSCILLOSCOPE	500 MHz Digital Storage Oscilloscope	23,000
OSCILLOSCOPE	2 GHz to 13 GHz real-time oscilloscope	120,000
POWER SUPPLY		1, 000 to 4,000
PREAMPLIFIER, MICROWAVE SYSTEM		3,000 to 14,000
PROBE, MAGNETIC FIELD		12,200
PROBE, ELECTRIC FIELD		5,000 to 10,000
PROBE, HIGH VOLTAGE		1,000 to 2,000
RADIO FILTER, BAND REJECT RF TUNABLE		2,500 to 5,000
RADIO FILTER, BANDPASS ELECTRONIC		1,200 to 2,000
RADIO, 2 WAY HAND HELD		180
MEASURING RECEIVER:		60 000 to 142,000
TEST RECEIVER	EMI Test Receiver, 20 Hz-40 GHz	142,000
TEST RECEIVER	EMI Receiver MODIFIER – 20 Hz-7 GHz	99,000
TEST RECEIVER	Frequency Range: 20 Hz to 26.5 GHz – For calibrating RF-level and analog modulation	60,000
RECEIVER, SENDER DIGITAL		3,000 to 10,000
RESISTOR, LOAD STANDARD		3,000 to 5,000
RF VECTOR NETWORK ANALYZER 30 KHz-3 GHz		48,000
SENSOR, POWER		2,000 to 6,000
SIMULATOR, WIRELINE xDLS		185,000
SIMULATOR, HEAD AND TORSO		31,000
SPLITTER		2,000 to 4,500
SWITCH, TELECOMMUNICATION		2000 to 4,500
TEST SET MEASURE		18,000 to 32,000
TEST SYSTEM, TELPHONE		17,000
TESTER		3,000
TRANSCEIVER		100 to 850
TRANSMITTERS:		
AM TRANSMITTER	Output Power: 5 W to 550 W – Frequency Range: 522 kHz to 1705 kHz	10,000
FM TRANSMITTER	Output Power: FM + HD Radio: 300 W to 700 W; Frequency Range: 87.5 MHz to 108 MHz, programmable in 10 kHz steps	15,000

Equipment	Description	Order-of-Magnitude Cost Figures (USD)
FIBER OPTIC TRANSMITTER	Max. Distance 50m; Operating Temp. –10°C to +70°C	5,600
TRIPOD		5,000 to 6,000
BRIDGE, POWER DIVIDER		1,600
OPTO-EXTENDER		1,650
SPECIAL FACILITIES/SYSTEMS:		
SAR		250,000
ISAR		135,000
DOSIMETRIC ASSESSMENT SYSTEM		240,000
ENVIRONMENTAL TEST CHAMBER		536,000
SEMI ANECHONIC CHAMBER	3 meter	420,000
SEMI ANECHONIC CHAMBER	10 meter	1,650,000
OPEN AREA TEST SITE (OATS)	Ground plane, basement, installation, construction	350,000

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05/2012