PTD, Myanmar – Executive Summary

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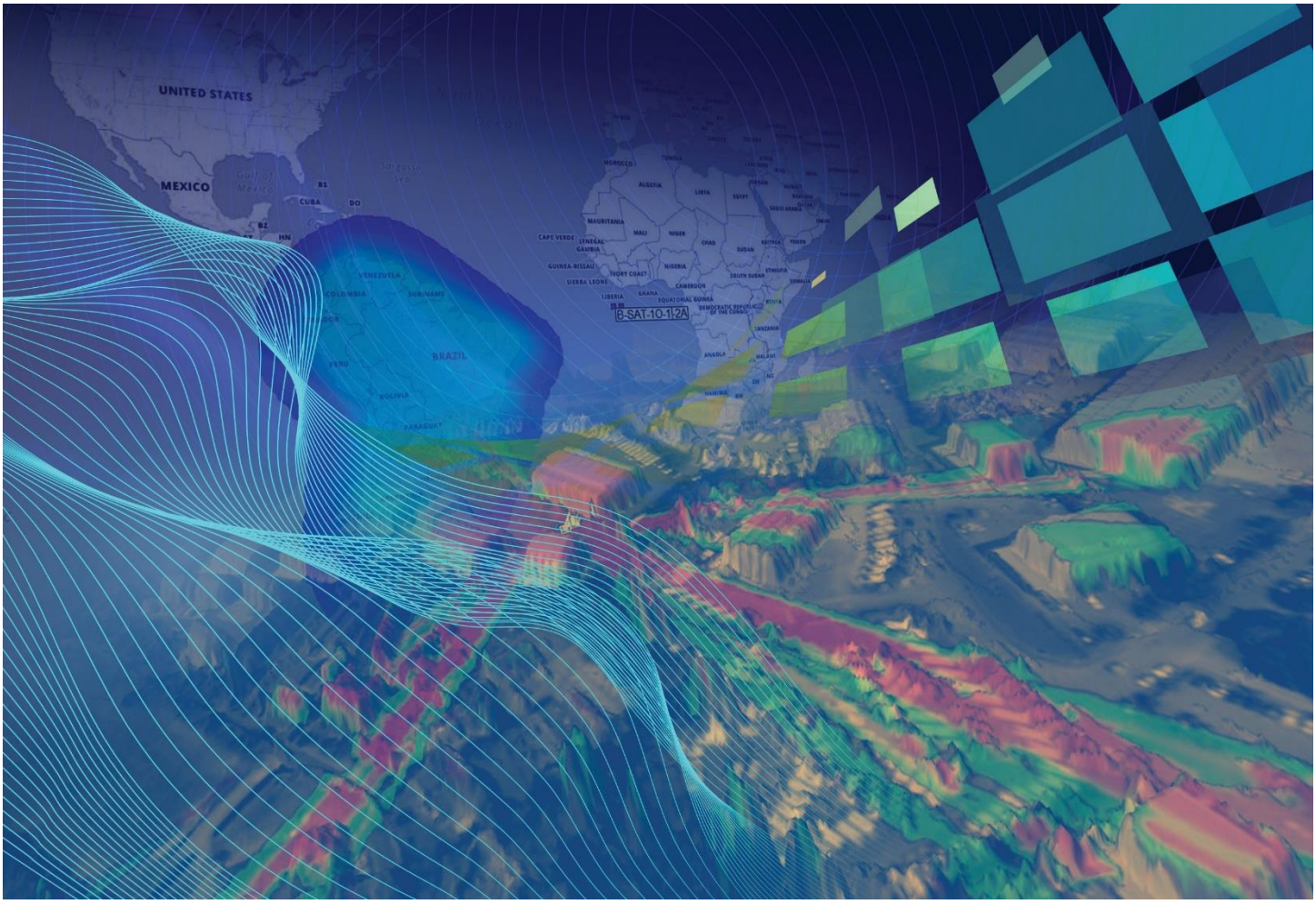
AUTHOR The Spectrum Center-Comit-A1 Joint Venture

SPECTRUM CENTER



Contact information:
Gilles Missud
Managing Director
SPECTRUM CENTER, LTD
gmissud@spectrum.center| t: +44 1293 522052 | m: +33 7 72 04 42 22

Tuan Bui
Managing Director
COMIT Telecom Co. Ltd
Tuan.bui@comitcorp.com | t: +95 1 535 669 | m: +95 925 424 8800

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1. OVERVIEW OF THE PROPOSED SPECTRUM MANAGEMENT SYSTEM

Managing the radio spectrum in accordance to Telecommunications Law, 2013 is a key task of the Post and Telecommunications Department (PTD), Myanmar. In order to gain the greatest value from the spectrum a new Spectrum Management System (SMS) is required to achieve this goal. The Spectrum Center-Comit-A1 Joint Venture proposes a fully compliant and cost-effective spectrum management software solution to meet PTD's objectives. Once implemented proposed SMS will allow the PTD the following two key advantages:

- The necessary functionality and automation capability to allow to optimize the reduction in time necessary for processing incoming license requests and generate the corresponding fee calculations and invoices;
- A sufficiently flexible that allows a dedicated, local support team to continue to enhance and mature the SMS over time to meet current as well as future needs of the PTD for spectrum management;
- Implemented a mature, efficient, consolidated, centralized and accurate repository of all the information related to the licenses and fees issued to the public of Myanmar for the use of spectrum;

The proposed SMS from Spectrum Center, Inc. known as Spectrum-E© is the only commercialized web application for spectrum management available on the market today. The proposed SMS includes the following key modules that with appropriate adaptations will cover all the PTD's functional requirements:

- **e-Licensing**: Allows for the processing of frequency license/authorization requests. This module will be integrated with a localized, public facing web portal hosted on PTD premises. This module contains the features for performing ITU coordination and generating WISFAT compatible ITU notification files.

  The e-Licensing Module includes custom report template creation capabilities as well as workflow management features useful to the PTD system administrators. This will increase the accuracy and speed in issuing new licenses. The e-Licensing Module includes a highly evolved Business Rule Engine (BRE) that has been matured over the past 9 years with several deliveries to major telecommunications authorities in the United States, Brazil, Mexico, Argentina and more. The BRE includes spectrum management specific rules related to input fields for license requests that help aid in the automated validation of an incoming license request from an operator. The BRE is accessible through Spectrum-E©'s API.

- **Technical Analysis**: The Spectrum-E© Technical Analysis Module performs a variety of automated spectrum engineering workflows based on nationally and internationally recognized standards and recommendations. This includes, but is not limited to, the following: Propagation analysis, interference analysis, electromagnetic compatibility analysis, frequency plan management, frequency nomination/assignment, population covered analysis, and much more. The Technical Analysis Module of Spectrum-E© includes several automated frequency coordination features related to common to a spectrum manager. The Technical Analysis Module also includes a GIS Module that includes all the digital cartographic data used to reference radio station and radio network locations. The Spectrum-E Technical Analysis Module includes a GIS module designed to be compatible with the Quad Tile method popularized by Google Earth and is compatible with any Web Map Service provider. Today, the Technical Analysis Module does not have any need or dependency on legacy tools for performing any spectrum engineering related task.

- **Remote Monitoring**: The Remote Monitoring Module of Spectrum-E© allows users to perform remote spectrum monitoring tasks by submitting requests to launch spectrum monitoring measurement campaigns to the spectrum monitoring system's software interface or, in some cases, directly to the monitoring equipment itself via a socket layer connection.

These three modules are fully integrated, allowing authorized users to move between modules without needing to launch separate software applications. It should be noted that Spectrum Center is one of only two SMS vendors in the world to have developed a full integration with the Scorpio system of TCI for deliveries to several large regulators such as IFT of Mexico, MinTIC of Colombia amongst others. This integration includes the ability to perform Automatic Violation Detection with TCI measurement data and imported Tx lists from the SMS database as well as auto-generate ITU compliant measurement reports.

In Spectrum Center's extensive experience delivering SMS systems to spectrum authorities around the world, we have determined it is far less likely for a spectrum management administration to change its internal processes and much more likely to require the SMS vendor to adapt its product to comply with the pre-existing internal processes for executing spectrum management related tasks such as licensing and billing. Consequently, the SMS database needs to be highly customized and adapted with every delivery. It is important to note that Spectrum-E© contains the core of its functionality through its BRE and API, as it is only the functionality of an SMS that can be matured and evolved as a COTS delivery. How data related to the processing of licensing requests and how fees are calculated and invoiced can vary substantially from one administration to the next. So, by not being completely fixed to a pre-existing database architecture, the proposed SMS has the unique capability of being highly customizable even to the point of being database format agnostic. While we can offer our experience and understanding at developing spectrum management databases, and even reuse some of the databases we have created in the past, we understand that the database that will be supplied to the PTD will have to be adapted to accommodate how the PTD does business today in the most efficient manner possible. The Spectrum Center-Comit-A1 Joint Venture is not proposing to force the PTD to retrofit its data into generic data fields of a 500+ table legacy data model that is nearly incomprehensible by human beings.

2. DELIVERY SCHEDULE FOR GOODS AND SERVICES

The Spectrum Center-Comit-A1 Joint Venture possesses the necessary combination of experience, dedication and skill sets and know how to implement the required goods and services in the most efficient amount of time possible. Spectrum Center has deployed complete spectrum management systems with the Spectrum-E platform in as little as 6 weeks. After reviewing the entirety of the PTD's requirements for computer hardware, GIS data, data migration, site specific goods (furniture, A/C, LAN cabling, etc.) and related services (installation, refurbishing, training, acceptance testing, propagation model optimization), the team was able to propose a very competitive delivery timeframe of approximately 3 months for the goods and a little over 5 months for the services.

3. COMPLIANCE WITH TECHNICAL SPECIFICATIONS

The proposed SMS is completely compliant with all the technical requirements described by the PTD in the BDS tender documentation phase 1. The proposed offer includes the option to install the Spectrum Center Commercial Off-the-Shelf (COTS) SMS on premises at PTD offices and integrate the SMS with on-premise infrastructure to be supplied by the Spectrum Center-Comit-A1 team.

The Spectrum Center-Comit-A1 Joint Venture solution complies with the PTD requirement:

1. Equipping the PTD with the required computing server hardware and end-user computers as well as firewall and routing hardware. The proposed COTS SMS is designed to leverage the available computing resources as much as any other COTS SMS on the market today if not much more so by a factor of 2-10.
2. Equipping the PTD with the required GIS mapping data.
3. The Spectrum Center-Comit-A1 Joint Venture understands that there is no such thing as a "one-size fits all" SMS database. Delivering legacy 500+ table SMS databases and compromising what can be retained from the source databases is not acceptable by current spectrum management administrations. The team

proposes to deliver the most efficient spectrum database to the PTD that ensures no data loss and captures all the fields that the PTD wishes to retain from their source databases. Detailed data dictionaries and E-R diagrams are supplied in the technical proposal and with the supplemental documentation however, this is just a "sketch" of the proposed spectrum management database as the final version will be appropriately adapted to contain the licensing and billing information as well as technical parameters for the radio networks in a manner that is most optimal for performing spectrum management related tasks.

4. Possesses successful past performance managing the delivery of software adaptations of a commercial off-the-shelf software application utilizing Agile Sprint system implementation methodology.
5. Equipping the PTD with the most mature, modern and flexible spectrum management solution on the market today.
    - Optimized engineering functionality covering all the requirements in the BDS tender document as well as the ability to reduce computation times with a calculation engine that offers true multi-thread/multi-core support. The Spectrum-E© Technical Analysis Module is the most powerful spectrum engineering tool on the market, with the ability to perform exhaustive technical analyses such as frequency assignment for large radio networks (>10,000 incumbent stations/links) in less than a couple minutes. Spectrum Center has complete ownership of the code of the Spectrum-E© Technical Analysis Module so it can modify/adapt the calculation engine as needed.
    - Dedicated administrative function to support the issue of new licenses, renewals, modifications and surrender or revocation of existing licenses.
    - Optimizing processing time for spectrum licensing process with built-in automation capabilities that allow end-users to reduce the processing time for a license request to less than a 10-minutes. A detailed example of how the spectrum licensing process including technical analyses is performed with the Spectrum-E© platform is covered in the technical proposal (pages 30-36) as well as supplemental documentation included with the proposal (e-Licensing User Guide).
    - Automation of licensing and frequency planning workflows through open, easily configurable State Chart XML files.
    - Fully compliant fee calculation and invoicing capability that includes an e-Payment capability and an ability to track payments.
    - Support for the latest ITU recommendations for spectrum management, radio propagation, interference and frequency coordination as well as ability to import ITU BRIFIC databases.
    - Compatibility with PTD's existing monitoring system to allow the monitoring and enforcement of spectrum regulation in Myanmar. A detailed "sketch" of the proposed SMS data dictionary as well as E-R diagrams that describe how licensing data would be stored in the proposed SMS is included in the detailed technical proposal and supplemental documentation. A detailed example of how Tx lists are sent from Spectrum-E to the Scorpio system for performing Automatic Violation Detection are also covered in the technical proposal and Spectrum-E Reference Guide document.
    - Unique flexibility of the proposed SMS web application architecture for adapting to the ever-evolving spectrum landscape.
    - Production of consistent data outputs to advise on spectrum use across Myanmar, to support the prioritization of spectrum policy decisions.
6. The Spectrum Center-Comit-A1 Joint Venture will provide the necessary dedicated local technical services necessary to support inspections and tests that are to be performed by PTD personnel.
7. The Spectrum Center-Comit-A1 Joint Venture possesses the necessary experience, knowledge and dedicated personnel to supply the required services for installing the required goods, performing the necessary data migration and acceptance testing, remote and on-site training, propagation model optimization and maintenance services.

Additional unique advantages of the proposed Spectrum-E© SMS can be summarized below:

- Open source web application architecture allowing PTD total source-code level ownership on the entire Spectrum-E© web stack, including all customized features of the delivered system;
- Open platform that allows local resources to be able to implement unique adjustments to the platform that are specific to the PTD and don't lock the PTD to permanently relying on the continuous intervention of a foreign manufacturer;
- Advanced browser-based spectrum management solution, customized to meet the end user needs;
- The open architecture allows the local help desk support team greater latitude and control in resolving bugs and other errors related to the proposed SMS;
- Proprietary hybrid columnar storage method for databases that allows the end user to process millions of records in a database query in a matter of a few seconds via the Spectrum-E© GUI;
- Compatibility with PTD IT requirements:
    - Compatible with Microsoft Windows Server and SQL Server High Availability failover solutions;
    - Database formats: relational (Oracle, SQL), or non-relational document-based formats (or hybrid models) to allow compliance with any fixed delivery timeframe for data migration;
    - Ability to support multiple database schemas through the same datastore view in the system GUI;
    - Includes a mature and well documented API compatible with any integration mechanism (e.g. RESTful web services, etc.)

4. PROJECT TEAM

The Spectrum Center–Comit-A1 Joint Venture will be registered on award of this contract to comply with the requirements of this tender with the aim of supplying and supporting the proposed solution. This joint venture will be established by Spectrum Center, Inc., a spectrum management specialist and COMIT Telecom Co. Ltd (referred to as COMIT) and A1 Construction Co. ltd.

Spectrum Center, Inc. (formerly known as ATDI, Inc.) was established in 1999 in the United States of America. Today, Spectrum Center, Inc. is a financially strong, profitable, independent and fully US-owned corporation that specializes in supplying spectrum management and spectrum engineering software systems around the world. By leveraging an open, progressive cross-platform compatible software delivery model, Spectrum Center, Inc. has been able to adapt its commercial off-the-shelf Spectrum-E© spectrum management software solution for successful delivery to several regulatory and commercial clientele around the world. Spectrum Center, Inc. Spectrum-E© customers include over 20 national spectrum authorities, as well as thousands of authorized frequency coordinators, equipment manufacturers, system integrators, service providers, operators, independent consultants and more from all around the world.

COMIT Telecom Co. Ltd. was established in 2014 in the Republic of the Union of Myanmar. The COMIT group was established in 2003 in Vietnam and has since expanded its territories and market dominance in the Southeast Asia region. The organization has offices in Vietnam, Myanmar and the Philippines. COMIT are leading providers of innovative IT solutions and services focusing on providing support to the telecommunications industry. COMIT have a team of over 200 professionals across the region. COMIT works closely with communication regulators, service providers and manufacturers to supply state-of-the-art solutions and services and have a wealth of experience partnering with other suppliers to meet end-user needs. The pinnacle of their offering is their ability to offer a wide range of high-quality solutions and services at an affordable price. Over the past 15 years, their successes include the likes of Ericsson and Nokia. They offer dedicated customer-focused services, with the aim of continually assessing customer needs throughout the project lifecycle and onwards.

A1 Construction Co. ltd. was founded as a privately held construction company in 1990 together with the rise of demand in construction industry. Today A1 is proud to be recognized as one of the leading and largest construction companies in Myanmar.

Its outstanding reputations in the field of city and land development have been attributed to the company's dedication for excellence. It has been made possible by its workforce of professional and experienced administrative staff, engineers, architects, planners, and labor. As part of its commitment in providing high quality and advance engineering, the company personnel are constantly given training to keep up with the trends of modern technology and construction. In addition, A1 actively participates in engineering and technology societies, and contribute to those areas.
Its expertise has spanned from minor renovations to multimillion-dollar projects. For this, A1 has earned a strong trust from their various clients due to its ability to deliver quality construction, promptness in meeting deadlines, completion of projects, and customer satisfaction.

5. PAST PERFORMANCE

a. Spectrum Center

ITU Region 1 & 2 Spectrum Authorities

We maintain the spectrum management and/or technical analysis solution for the following national or regional telecommunications regulators or spectrum management organizations:

- Ministry of Communications of Israel (MoC)
- Communications Regulator of Ireland (ComReg)
- National Air Traffic Services (NATS)
- Civil Aviation Authority (CAA)
- National Allied Radio Frequency Association (NARFA) of the UK
- Telecommunications Regulatory Commission of the British Virgin Islands (TRC of BVI)
- National Telecommunications Agency for Brazil (ANATEL),
- National Spectrum Agency for Colombia (ANE),
- Public Services Authority of Panama (ASEP),
- Eastern Caribbean Telecommunications Authority (ECTEL)
- Spectrum Management Authority of Jamaica (SMA)
- National Communications Entity of Argentina (ENACOM),
- Federal Telecommunications Institute of Mexico (IFT),
- Ministry of Telecommunications of Information and Communications of Colombia (MinTIC)
- Undersecretary of Telecommunications of Chile (SUBTEL)
- Telecommunications and Electricity Management Oversight of El Salvador (SIGET)
- Regulatory Unit of Communications Services of Uruguay (URSEC),
- Many more...

משרד התקשורת MOC communications

Commission for Communications Regulation

ift INSTITUTO FEDERAL DE TELECOMUNICACIONES

ANATEL

ENACOM Ente Nacional de Comunicaciones

Spectrum MANAGEMENT AUTHORITY

These deliveries generally include enterprise MOTS implementations leveraging our commercial SMS platform Spectrum-E©.

US Federal Government

Over 31 current and past federal clients amongst 12 agencies.

- Department of Defense
  - US Air Force
  - US Army Research Laboratory
  - US Army Spectrum Management Office
  - US Army Aberdeen Proving Ground
  - US Army Fort Huachuca
  - US Defense Information Systems Agency - Joint Spectrum Center
  - US Naval Surface Warfare Center
- Department of Energy
  - HQ Spectrum Management Office
  - Bonneville Power Authority
  - National Nuclear Security Administration
  - Western Area Power Authority
- Department of the Interior
  - Office of the CIO/EID/National Radio and Spectrum Program Management Office
- Department of Homeland Security
  - Wireless Management Office
  - Immigration and Customs Enforcement
  - US Coast Guard HQ/LANT/PAC
  - US Customs and Border Patrol
- Department of Justice
  - Wireless Management Office
  - Drug Enforcement Agency
  - Federal Bureau of Investigation
- Department of the Treasury
  - Treasury Inspector General for Tax Administration/ Technical & Firearms Support Division
- Federal Aviation Administration
- Federal Communications Commission
- National Aeronautical Space Administration
  - Glenn Research Center
  - Kennedy Space Center
- National Security Agency
- National Telecommunications & Information Administration
- United States Postal Service

Authorized FCC Frequency Coordinators

Current customers

- APCO AFC
  - National Regional Planning Committee
- Enterprise Wireless Alliance
- Wireless Infrastructure Association
- Utilities Technology Council

State and Local Government organizations

- Alabama Regional Planning Office
- California Technology Agency
- Sacramento County, CA
- County of Riverside, CA
- County of Monterey, CA
- San Bernardino County, CA
- Georgia Technology Authority
- New York City Dept. of Information & Technology & Communications
- New York City Transit Authority
- New York City Police Department
- New York State Division of Homeland Security & Emergency Services
- New York State Police
- New York State Thruway Authority
- State of Connecticut
- State of Montana
- Westchester County, NY
- Washington Dept. of Transportation

b. COMIT & A1 (and his subsidiary) in Myanmar

No.	Year	Type of Project	Manufacture
1	2014/2015	3 x Mobile Monitoring Station	TCI Toyota
2	2016/2017	1 x Mobile Quality of Service Testing System	Keysight/Nemo
3	2016/2017	1 x Monitoring Control Center 2 x Monitoring Transportable 3 x Mobile Monitoring Station 6 x Fixed Monitoring Station (Yangon and Mandalay)	TCI Toyota
4	2018/2019	4 x Fixed Monitoring Station (Tamu, Kawthaung, tarchileik, Myawaddy)	TCI
5	2018/2019	2 x Mobile Quality of Service Testing System	Keysight/Nemo