Final Report

TRANSMISSION DEVELOPMENT PLAN 2014-2015

Volume III

System Operations

JULY 2016

NGCP

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PROGRAM SUMMARY

Developmental Objectives

The development plan for the SCADA, telecom and protection components of the Power Grid is characterized by the need to cope with the market-driven demand for consolidation of enterprise and operations applications in our energy management systems, subsequent necessity for bandwidth and interoperability in the communications network and indispensability of redundancy (i.e., "N-1") in our protection systems. The importance of integrating embedded renewable sources of energy into the Grid has also made it a point to provision readiness in both our SCADA-EMS and telecom systems for addressing connectivity and data organization and for our protection system to be able to handle the peculiar power quality management issues.

Following are the objectives of our developmental program for the 2016–2025 planning horizon and the respective major CAPEX issues of interest.

1. Migration to Efficient Technologies

   a. Shift to IP-based transport/network
   b. Completion of optical telecom backbone
   c. Adoption of Smart Grid model; implementation of IEC 61850 standard
   d. Use of hybrid power supplies
   e. Supervision/monitoring functions employing public infra

2. Sustenance of Systems to Maximize Economic Lives

   a. Stagger the retirement/replacement of systems running through obsolescence;
   b. Technological prudence: specified functions and upgradability should be realized within expected service life;
   c. Manage maintenance and replenishment of battery banks;
   d. Employ remote fiber monitoring systems for quick detection of damaging factors

3. Prioritization of Infra Expansion/Upgrade to Areas of Most Benefits at Least Cost

   a. Enhanced EMS applications, with emphasis on VRE management
   b. OPGW retrofitting to enable access to bandwidth
   c. Upgrade of power supply systems and other support infra
   d. Compliance with data center standards
   e. Cyber security

4. Address Deficiencies that Prevent Optimized Network Performance

   a. Completion of network synchronization system
   b. Retrofitting of submarine T/L with fiber
   c. Integration of telecom network management systems
   d. Securing RCC interfacing to HVDC control system
   e. Equipping RTU's with IP interfaces

5. Compliance with Grid Code and Regulatory Directions

   a. Monitoring and control of embedded generators
   b. VRE forecasting
   c. Consistency with Protection Philosophy
   d. Meeting power quality and system availability requirements

Situational Analysis

1. Telecoms. Because the pace of development vis-à-vis geographic peculiarities of the electricity Grids in Luzon, Visayas and Mindanao varies significantly, the characteristics of the respective telecom systems and facilities differ appreciably among each other. As far as the telecom infra-building is concerned: while Luzon's attention is most on establishing manageability and maintaining security of existing links, Mindanao is more concerned on building network infrastructure as well as putting up almost-the-most-basic communication access among it substations. Visayas, on the other hand, is midway—aiming to interconnect non-contiguous optical segments to build a more reliable backbone.

   From the register of our existing telecom facilities, we define:

   a. The need to replace part of the installed base already without spare parts support as well as the program for replenishments of equipment upon obsolescence;
   b. Required upgrades or replacements to address capacity/bandwidth issues resulting from a particular element's deficiency; and
   c. Additional facilities that will provide element and path redundancy in compliance with our N-1 philosophy.

   On a network level: as the open market integrates, the respective characteristics of the telecom networks in Luzon, Visayas and Mindanao become more similar as common performance parameters are adopted and the same operating philosophies are shared. Further, the requirement for more backbone bandwidth (and the subsequent need to reinforce synchronization of the high-speed transport network) is nonetheless increasingly and universally felt, catering to the demands of the now-mainly-IP-based applications. The 2016–2025 CAPEX projects identified in this volume reflect this trend as an integrated NGCP telecom network develops over the course of the planning horizon.

2. SCADA-EMS. The entry into the Electricity Market of Visayas and Mindanao has resulted in significantly more complex operations in the regions. The need for comprehensive SCADA/EMS coverage has also been made more difficult by the rapid changes in Grid configuration brought about by the integration of new players.

   The major issues for improvement of the existing SCADA/EMS arrangement are characterized below:

   a. The existence of different SCADA systems and schemes adopted in Luzon, Visayas and Mindanao—which has resulted in non-uniform O&M practices and procedures, spares management plans and personnel skills requirements—has not yet been fully addressed;
   b. Inadequacies in support facilities for some of the control centers have caused unreliable SCADA operations and accelerated equipment ageing and failure.
   c. There is scarce infrastructure reach to readily address supervision of embedded generators.

   The development of the Grid in response to Market demand in terms of capacity growth, geographic expansion and challenges in dispatching generators of renewable energy has manifested itself in our SCADA/EMS system through the consolidation and standardization of data collection and management processes and the employment of specialized modeling and analytical applications as part of EMS. The 2016–2025 CAPEX projects are in line with this development trend.

3. Protection Systems. A resilient Power Grid made possible through an effective protection system is a requisite for the realization of the Smart Grid environment. However, the existing protection facilities are significantly lagging in terms of compliance with the Protection Philosophy, especially in Mindanao where complementary telecom facilities to support path redundancy requirements are still under development.

   The challenges presently faced by the existing protection system are described by the following needs:

   a. Replacement of obsolete relay equipment and NDME's—which has no more manufacturer support and lacks modern communication features—have to be accelerated to minimize equipment failures as well as to consolidate (remote) management and maintenance.
   b. Redundancy requirements to meet the N-1 objective necessitate addition of relay equipment where no Main 2's are present and upgrade of existing relays where the required philosophies governing Main 1 and Main 2 modes have not been realized.
   c. Present state of stability still requires continued employment of SIPS in strategic areas of the Grid.

While substation upgrades programmed in Volume 2 addresses the above needs through the accompanying upgrading-also of the secondary equipment attributed to the transmission lines (radiating from the substation), such substation upgrades would not significantly cover the deficiencies in due time given the respective implementation schedules. Thus, our 2016–2025 CAPEX for protection builds up on relay and NDME equipment the lack of which compromises our performance objectives.

4. Infrastructure and "SOME." The program also covers the establishment of complementary infrastructure established through procurement of civil works (e.g., buildings, outside plant structures and telecom towers) as well as pertinent IT equipment for the handling of S.O. business processes—herein termed "S.O. Managed Equipment" or SOME—not addressed by the three (3) function-related categories above.

Summary of CAPEX Costs

CAPEX COSTS 2016–2025 (In Million Pesos)

CAPEX Proportion by Function

FUNCTION	REPLENISHMENTS	REHAB/UPGRADES	EXPANSIONS	TOTAL
TELECOMS	1,984	1,256	3,104	6,344
SCADA	1,281	0	2,372	3,653
PROTECTION*	308	215	429	952
INFRA/SOME	240	551	342	1,133
TOTAL	**3,813**	**2,022**	**6,247**	**12,081**

* NDME and PQA requirements. CAPEX for Protection is covered in Volume 2 (O&M).

CAPEX Proportion by Region

REGION	REPLENISHMENTS	REHAB/UPGRADES	EXPANSIONS	TOTAL
LUZON	1,294	990	2,503	4,787
VISAYAS	1,178	499	1,814	3,491
MINDANAO	1,341	532	1,929	3,803
TOTAL	**3,813**	**2,022**	**6,247**	**12,081**

Telecom Projects According To Nature of Facilities

TELECOM FACILITIES	LUZON	VISAYAS	MINDANAO	TOTAL
FIBER OPTICS & OPGW	1,235	705	567	2,507
MICROWAVE RADIO	430	253	320	1,003
NETWORK MANAGEMENT & SYNCHRONIZATION	321	313	241	875
PLC/PSE	79	119	121	319
WAN & ACCESS EQUIPMENT	167	197	157	521
POWER SUPPLY & AUXILIARY	233	261	319	813
MOBILE RADIO NETWORK	82	48	10	140
TEST EQUIPMENT	57	30	78	165
TOTAL	**2,604**	**1,927**	**1,813**	**6,344**

SCADA/EMS Projects Categorized by Component Function

SCADA/EMS COMPONENT	LUZON	VISAYAS	MINDANAO	TOTAL
SCADA	667	501	685	1,853
EMS APPLICATIONS	126	126	107	359
CYBER SECURITY	0	0	322	322
WAMS	373	373	373	1,119
TOTAL	**1,166**	**1,000**	**1,487**	**3,653**

STRATEGIES

1. <u>Sustenance of Assets Against Technology Shifts</u>. System Operations' primary asset management objective—and the main CAPEX driver—is to optimize the serviceability of its existing facilities, i.e., maximizing service lives up to the extent that the costs of ownership vis-à-vis strategic benefits justify continued maintenance. Therefore, given SO's dependence on software and electronics, rapid technological advances in either field increases the need for frequent reassessment of the relevance of such assets to SO's functional objectives. Technologies and applications approaching obsolescence should be retired—albeit on an optimized schedule—and replaced with the more efficient ones for the sake of improved performance and economics. Thus, we are reducing and eventually ending acquisition of spares and maintenance support for the assets due for retirement and investing on their replacements, as follows:

DECREASING FUNCTIONALITY	CURRENT PARADIGM
1) Power Line Carriers (PLC's) cannot be used to provide *differential* line protection and cannot be used as a redundant backbone access channel given the bandwidth requirements of current business and operations applications. PLC is also quite expensive for stations which have ready access to fiber-embedded transmission lines.	Fiber is the preferred media for line protection offering both the best bandwidth and reliability. All new transmission lines are already embedded with fiber and existing lines continue to be retrofitted with OPGW. Optical terminals are cheaper to acquire and maintain and protection relays can be outfitted with optical transceivers enabling "direct fiber" line protection setups.
2) Microwave radio shall be limited to spur link applications and backup routes where no transmission lines can be used to establish optical transport.	Retrofitted fiber is much cheaper in addressing backbone needs given the exponential bandwidth growth.
3) There would be less use of TDM channel multiplexers as service access is shifted to IP.	Routers and Ethernet switches shall begin to displace TDM multiplexers along the service access points as applications migrate towards IP communication.
4) PABX equipment shall be totally phased out.	Telephony and other multimedia services shall run through the IP network not unlike other applications using networked servers.
5) RTU's for Power Grid SCADA shall become less relevant as automation and data communication is integrated into substation and power plant design.	Remote data collection requirements shall be reduced to compliance with supervisory and communication protocol and hardware limited to intermediary access terminal for security purpose.
6) Use of distance relays shall be limited only to areas where differential protection cannot be applied on account of bandwidth limitations	Differential relays (with direct-fiber interfaces) shall displace more and more distance relays as fast communication interfaces through fiber and radio become pervasive.

2. Timing of Projects. Given the interdependence of technology and infrastructure—as well as the role of organizational evolution resulting from market trends—in defining developmental direction, we find the need to outline below the implementation sequence of our major projects for the purpose of validation and prioritization. It is also the purpose of this development plan to make rescheduling of projects convenient when faced with limited budget or implementation resources. Optimization demands that just enough infra is ready to accommodate the applications as they come and that right applications are chosen to take advantage of the minimum infra components in place at the time of need.

ANALYSIS OF SYSTEM OPERATIONS 2016-2025 CAPEX

NETWORK COMPONENT		TDP YEAR ('16 '17 '18 '19 '20 '21 '22 '23 '24 '25)	COST (PhP M)	
INFRA BUILDUP	BACKBONE	853 kms of OPGW in Luzon	735	17%
		25 kms Submarine Luzon-Visayas	320	
		630 kms of OPGW in Visayas	640	
		453 kms of OPGW in Mindanao	405	
	ACCESS	20 M/W Radio Hops in Luzon	158	3%
		19 M/W Radio Hops in Visayas	123	
		14 M/W Radio Hops in Mindanao	92	
MANAGEMENT INTEGRATION	ADMINISTRATION	Integrated NMS	137	21%
		150 FMS/BMS/RFMS for Telecom Stations	266	
		~100 RTU for IPPs /Monitoring of Embeddeds: ~70 Nodes	317	
		WAMS: 132 PMU's	1119	
		26 NDMEs / 247 PQAs	429	
		Added Monitoring Terminals	223	
	SYNC & PROTOCOL	70 Substation Clocks	163	2%
		Shift to TCP/IP	66	
		IEC 61850 Compliance	(Vol.2)	
SUPPORT FACILITIES	SECURITY	Cyber Security	322	6%
		Data Center/Building Extensions	374	
APPLICATIONS	ENHANCED APPS	VRE Forecasting/Dispatching	167	3%
		VVD (VOLTAGE-VAR DISPATCH)	54	
		Specialized Online Analysis Tools	138	
SUSTENANCE	TELECOMS	9,000 Fiber Kilometers, 250 Radio Hops	2266	19%
	SCADA SYSTEM	19 Control Centers	750	6%
		330 Remotes	(Vol.2)	
	SUPPORT	260 Network Nodes	2819	23%

3. CAPEX Priorities. As shown in the above schedule, 48% of projected CAPEX is allocated for sustenance of existing facilities and the rest for programs to address current deficiencies and new requirements. This does not mean that the same apportionment would be observed in case of budget constraints. While sustenance would ideally be the priority, we would note that new facilities are also meant to address deficiencies in existing service areas. (We note that since the start of regulation, through NGCP's stewardship of transmission and system operation assets, telecom and SCADA needs have not yet been fully met.) Should CAPEX limits be apparent as a result of regulatory determination, prevailing demand for pertinent applications at the moment shall be prioritized in the agenda.

   As an example, EMS enhancements for the purpose of improving SO response to Grid dynamics and maximizing access to energy sources according to market conduct are lined up for implementation through the 3rd and 4th regulatory periods. Projects for either infra reinforcement or sustenance/upgrade programs would hence depend on the relative significance of the affected network elements or sections in support of said EMS applications. Prominent in this respect are the VRE forecasting and modeling applications.

   Imperative also during the early years is putting in place the pertinent synchronization mechanisms and enforcing communication protocols which govern the building blocks of our automation and control systems. These projects, which cost only around 2% of the estimated total CAPEX, are first priority.

   Also, given the increasing dependence of SO on IT and communications systems, amid the growing pervasiveness of the internet in the business environment, the need to protect our operations against cyber threats has manifested itself as an indispensable determinant in our development planning and engineering design.

   Finally, among the new telecom infra projects listed—notwithstanding the need to address early the telecom network elements significant to the realization of our EMS objectives as mentioned above—we aim to complete the submarine link between Luzon and Visayas as soon as possible. Taking into account ongoing transmission line projects, the Samar-Sorsogon would be the only remaining submarine transmission line without a fiber optic complement. Integration of Grid control (and market operation) would be out of sight with an incomplete telecom network in the horizon.

TELECOMS

2016–2025

1.0 INTRODUCTION

Most significant among the System Operations (SO) assets is the NGCP telecom network—representing about 70% of present asset value (which also includes the SCADA/EMS system, network protection supervisory and test facilities, Grid operations tools and civil infrastructure).

NGCP's private telecom network exists to meet operational needs mainly in the absence of responsive public infrastructure around its areas of operation and has proven to be the most secure—yet most economical—means of servicing various mission-critical applications throughout the lives of its transmission line assets. Among other services, the NGCP telecom network provides communication facilities for line protection, SCADA/EMS, telephony, MIS/office automation and metering and billing applications.

Because the pace of development vis-à-vis geographic peculiarities of the electricity Grids in Luzon, Visayas, and Mindanao varied significantly, the characteristics of the respective telecom systems and facilities differ appreciably among each other. While Luzon's attention is more on ensuring capacity from and integrity of existing links, Mindanao is more concerned on yet putting up almost-the-most-basic communication access among it substations. Visayas, on the other hand, is midway—aiming to interconnect non-contiguous optical segments to build a more reliable backbone.

As the open market integrates, the respective characteristics of the telecom networks in Luzon, Visayas and Mindanao become more similar as common performance parameters are adopted and the same operating philosophies are shared. The 2016–2025 CAPEX projects identified in this volume reflect this trend as an integrated NGCP telecom network develops over the course of the study period.

1.1 Objective

a. Plan telecom network development within the next 10 years to support continuity of Grid operations and associated businesses;
b. Program addition, replacement, reconfiguration and retirement of telecom facilities in line with said network plan but excluding those telecom facilities programmed as complement for new T/L projects outlined in Volume 1.

1.2 Credible Basis

a. Power demand forecast and corporate thrusts defined in Volume 1, consistent with ERC references and guidelines;
b. Philippine Grid Code;
c. ERC-defined asset lives of telecom network elements and pertinent qualifications by NGCP on current applications.

2.0 ASSESSMENT

2.1 System Profile

2.1.1 Luzon Existing Telecom Facilities

In Luzon, majority of the nodes in the telecom backbone is operating at a capacity of 2.5 Gb/s (STM-16) while a fair number of nodes operate at 622 Mb/s (STM-4) and 155 Mb/s (STM-1). A combination of optical paths (embedded along the transmission lines) and microwave radio hops forms the said backbone, which also connects Luzon to Visayas and Mindanao via two (2) routes—through Mindoro in the West and via Bicol in the East. Substations and offices which are not located along the backbone route are connected through spur links. Existing microwave radio spur links range in capacity from 8 Mb/s (4E1) to 2x155 Mb/s (2xSTM-1). There are also substation-to-substation narrow-band power line carriers (PLC) mainly to carry line protection signaling but which also provide low speed data or voice communication when there are no other cost-effective means to deliver such basic services (e.g., when the substation or power plant is located in difficult terrain).

Bandwidth is optimized through the use of traffic managers such as the circuit-switched PABX systems (for “legacy” telephony and modem connections) and routers (for the modern IP-based applications). Operations and maintenance are organized through the use of network management systems and other remote sensing and supervision facilities; performance monitors ensure that the right quality of service is delivered.

As an ultimate backup system, SO operates and maintains a UHF radio network in Luzon which also serves as mobile dispatch system for O&M in its transmission line maintenance activities.

NGCP also maintains telecom infrastructure in the form of the outside plant for the (transmission-line-embedded) optical links and PLC’s, telecom antenna towers and radio “repeater” buildings.

Table 2.1.1 lists the major elements in the Luzon Grid telecom network indicating their respective conditions against current issues of concern.

Figure 2.1.1: Luzon Telecom Network

Table 2.1.1.a: Existing Telecom Facilities, Luzon (Part 1 of 3)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
MW Radio	15 yrs (ERC)	SDH	45 hops	0	For the PDH microwave radio, 63% of those within the ERC 15-year life are without spares support and phased replacement/upgrading needs to be timely programmed. Some PDH spur links are also filled to capacity and must be upgraded to accommodate additional applications through the service access points. In 2014, 10 of those PDH radio links were upgraded into SDH, 7 links of which has a capacity of STM-1 and the other 3 links has a capacity of 2xSTM-1. In line with the intention of extending the fiber optic network reach to each and every NGCP facility (consistent with the direct fiber connection protection policy), retirement of some microwave links/stations can now be optioned. It is anticipated that there will be additional radio links to be commissioned by 2015 onwards as complement to the transmission line projects of P&E, substation upgrading projects of O&M and entry of new power plants in Luzon Grid.
		PDH	32 hops	9 hops	
OPGW	50 yrs (ERC)	≥24 cores	2,055 kms	0	Most of the installed OPGW is the result of the retrofitting done during the 2005-concluded NCC Project; henceforth, new T/L's were embedded with optical fibers. However, 47% of OPGW links still use flat-ring loops that do not have alternate path protection--OPGW would have to be retrofitted in old T/L's to accelerate provisioning of (1+1) path protection. In 2014, around 115km of OPGW were added to the network as complement to the 2 wind farms in Northern Luzon and to the coal-fired power plant in Batangas. There will be an additional 238km of 36-core OPGW expected to be completed in 2015 as complement to the Santiago-Tuguegarao and Laoag-San Esteban T/L projects of P&E. Another additional 107km of 24-core OPGW is also expected in 2015 with the completion of Tayabas-Dasmariñas OPGW retrofitting project of SO.
		<24 cores	411 kms	0	

<table>
<tr><td rowspan="3">OLTE</td><td rowspan="3">10 yrs†</td><td>STM-16</td><td>18 nodes</td><td>0</td><td rowspan="3">System Operations has just concluded the replacement and upgrading project for the OLTE's in Luzon with the completion of the 4th and last stage of the OLTE upgrading program. Luzon is now operating the full-optical STM-16 backbone while STM-4's and STM-1's are employed to extend the backbone further to the north (Ilocos & Cagayan) and south (Bicol).

Although we do not foresee expansion of the STM-16 optical backbone in the 4th regulatory period, there would be expansion for sure in the STM-4 and STM-1 reach with the anticipated completion of T/L projects of P&E, as well as the entry of new power plants.</td></tr>
<tr><td>STM-4</td><td>34 nodes</td><td>0</td></tr>
<tr><td>STM-1</td><td>12 nodes</td><td>1 node</td></tr>
<tr><td>IP Telephony Server</td><td>5 yrs†</td><td>VOIP Server</td><td>2 sets</td><td>0</td><td>IP Telephony servers are programmed to replace the Legacy PABX Systems. These servers were installed in 2012 at Diliman and Mexico.</td></tr>
<tr><td rowspan="2">PLC/PSE</td><td rowspan="2">18 yrs*</td><td>PLC</td><td>61 links</td><td>22 links</td><td rowspan="2">PLC's with their associated PSE's are now almost solely used for T/L protection. (PSE's are also used independently for interfacing protection relays with other media such as optical fiber and radio.) With the emergence of direct fiber connected line protection systems replacing PLC transmission functions (i.e. Main1 line protection), phased retirement of installed based PLCs is now being initiated. Meanwhile, stand-alone PSE's will still be continuously utilized in other teleprotection applications via fiber optics and/or microwave transmissions.</td></tr>
<tr><td>PSE</td><td>39 links</td><td>20 links</td></tr>
</table>

† OLTE and IP Telephony Servers are not included in the ERC asset lives assessment--calculated economic service lives are based on actual operational performance.

* PLC/PSE 18-year economic life pertains to that of terminal equipment only.

Table 2.1.1.b: Existing Telecom Facilities, Luzon (Part 2 of 3)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
Access Multiplexer	10 yrs†	—	68 nodes	125 nodes	The access multiplexers serve as the service access points to the telecom backbone mostly for low order TDM-based applications. The 44% of installed base which are beyond economic life cannot meet present IP-application needs and other data-com requirements. For NGCP, IP-based traffic is being foreseen to replace most of TDM applications (e.g. telephony, SCADA) in the near future; hence, phased retirement of such low order TDM-based multiplexers is being initiated. Multi-Service Application Platforms (MSAP) compliant multiplexers are being considered as replacements.
Router	8 yrs†	—	43 nodes	4 nodes	Routers are the traffic management nodes for various IP traffic. 9% of the installed base are beyond economic life and no longer has the benefit of manufacturer support. Aside from replacement of outdated routers, necessary strengthening of the existing network (through restructuring and upgrades) should also be timely implemented in response to the fast-emerging and demanding IP-based technology driven applications (e.g. VoIP, Video). Remarkable increase in NGCP's IP Traffic is being foreseen within the next 5 years.
Mobile Network UHF Repeaters	12 yrs†	—	12 units	10 units	Over 45% of UHF radios in mobile network repeater systems have exceeded economic life. Not all spare parts are now available in the market and equipment have to be progressively retired to provide source of spare parts for remaining installed base.
UHF Subscriber Radio Stations	8 yrs†	Mobile Network	7 units	0	The UHF radio network is our backup communication facility for grid supervision and control in case the backbone fails; it also serves as the dispatch facility for O&M T/L maintenance activities.
PABX	8 yrs†	—	4 nodes	50 nodes	Around 93% of PABX equipment have exceeded their economic lives; while obsolescence may be addressed by retiring part of the installed base (to source spares), replacements of telephony equipment will be in line with our IP migration program.

† Access Mux, Routers, UHF radio, PABX and DC supplies are not included in the ERC asset lives assessment--calculated economic service lives are based on actual operational performance.

Table 2.1.1.c: Existing Telecom Facilities, Luzon (Part 3 of 3)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
48VDC Power Supply/ Charger	12 yrs†	—	135	54	Telecom equipment depends on reliable DC systems. The 29% of chargers which are beyond the effective service lives should be addressed by a timely replenishment program to avoid traffic downtimes resulting from interrupted power supply systems.
48VDC Battery Bank	8 yrs††	—	156	33	Replacements for battery banks which have exceeded their respective design lives should be on hand at the instant that measured capacity have degraded below efficiency thresholds. There is around 17% of the installed base that should be addressed under this category.
Generator Set	6 yrs†	—	21	23	Generators are necessary as AC backup systems where there is no substation service backup power as in repeater stations. The 52% over their natural service lives are programmed to be replaced or rehabilitated, depending on the extent of effect of depreciation.
Infrastructure	50 yrs (ERC)	Antenna Tower	63	0	Retrofitting works are conducted on existing telecom towers when additional load (i.e., antenna systems) will be installed.
		Repeater Bldg.	36	0	Expansion work is required in cases where additional equipment has to be housed on account of network reconfigurations or extensions.
Network Management System (NMS)	5 yrs*	Integrated	1	0	INMS is an integrated telecom network management system coordinating the different element managers into a single MMI. System upgrading is necessary to cope with software maintenance and applications development chores.
		Element Managers	6	5	Fault management is done remotely through proprietary element managers which are dependent on manufacturer support for the respective network elements involved.
		FMS	14	0	Facilities Management System (FMS) extends the network management capabilities to cover the online monitoring of the power supply system and associated components, video surveillance capability and environmental conditions such as temperature and humidity. FMS also handles the monitoring of unmanaged legacy/non-legacy telecom equipment installed at various microwave relay stations.

		BMS	23	0	BMS are employed to remotely monitor battery parameters and to enable early detection of battery faults and abnormalities. This will help minimize any unplanned traffic outages due to power supply failure and proper preemptive battery management can be undertaken.
		RFMS	0	3	Online optical fiber monitoring systems are presently installed to determine location of fiber breaks as soon as they occur so that corrective and security measures may be implemented as soon as possible. All of the installed base remote sensing equipment however are already outdated—the replacement and upgrading program is anticipated to be completed in 2015 to cover all fiber optic network in Luzon.
Sync Clock Source	8 yrs†	Clock Source	1	4	NGCP Telecom Network catering for high speed and reliable channel services like teleprotection, IS/IT, voice, and SCADA requires accurate clock synchronization for correct operation. Primary reference clocks based on GPS are strategically deployed network-wide to serve as highly accurate synchronization clock sources. In 2012, NGCP Management instructed SO to establish a single source of clock/time for all equipment in the substation. Hence, SO implemented stage 1 of the project that involves deployment of synchronization clock sources in 16 substations. Stage 1 is expected to be completed by 2016. In addition to SO's programmed implementation in the coming years, P&E's new substation projects and O&M's substation upgrading program should already include the sync timing requirements of the substations.

† Generators and Sync Clock Sources are not included in the ERC asset lives assessment--calculated economic service lives are based on actual operational performance.

†† Battery life is based on average design lives of installed battery banks.

* Network Management Systems 5-year economic life pertains to that of hardware/electronics only.

2.1.2 Visayas Existing Telecom Facilities

Visayas' telecom backbone operates at a bandwidth of 622 Mb/s (STM-4) and 155 Mb/s (STM-1). A combination of optical paths (i.e. OPGW along the HV transmission lines) and microwave radio hops forms the said backbone, interconnecting the island sub-grids of Leyte, Cebu, Negros, Panay, and Bohol. The backbone links Luzon via Panay in the West and via Leyte in the East; Mindanao is connected from Negros through the island of Siquijor at the Southernmost tip of Visayas. Substations and offices which are not located along the backbone route are connected through spur links. Existing microwave radio spur links in Visayas range in capacity from 34 Mb/s (16E1) to 2x155 Mb/s (2xSTM-1). There are also substation-to-substation narrow-band power line carriers (PLC) mainly to carry line protection signaling but which also provide low speed data or voice communication when no other cost-effective means to deliver such basic services (e.g., when the substation or power plant is located in difficult terrain) are available.

Bandwidth is optimized through the use of traffic managers such as the circuit-switched PABX systems (for "legacy" telephony and modem connections) and routers (for the modern IP-based applications, which now include VOIP and SCADA/EMS communications). Operations and maintenance are organized through the use of network management systems (NMS) and other remote sensing and supervision facilities; performance monitors ensure that the right quality of service is delivered.

NGCP also maintains telecom infrastructure in the form of the outside plant for the (transmission-line-embedded) optical links and PLC's, telecom antenna towers and radio "repeater" buildings.

Table 2.1.2 lists the major elements in the Visayas Grid telecom network indicating their respective conditions against current issues of concern.

VISAYAS TELECOM NETWORK

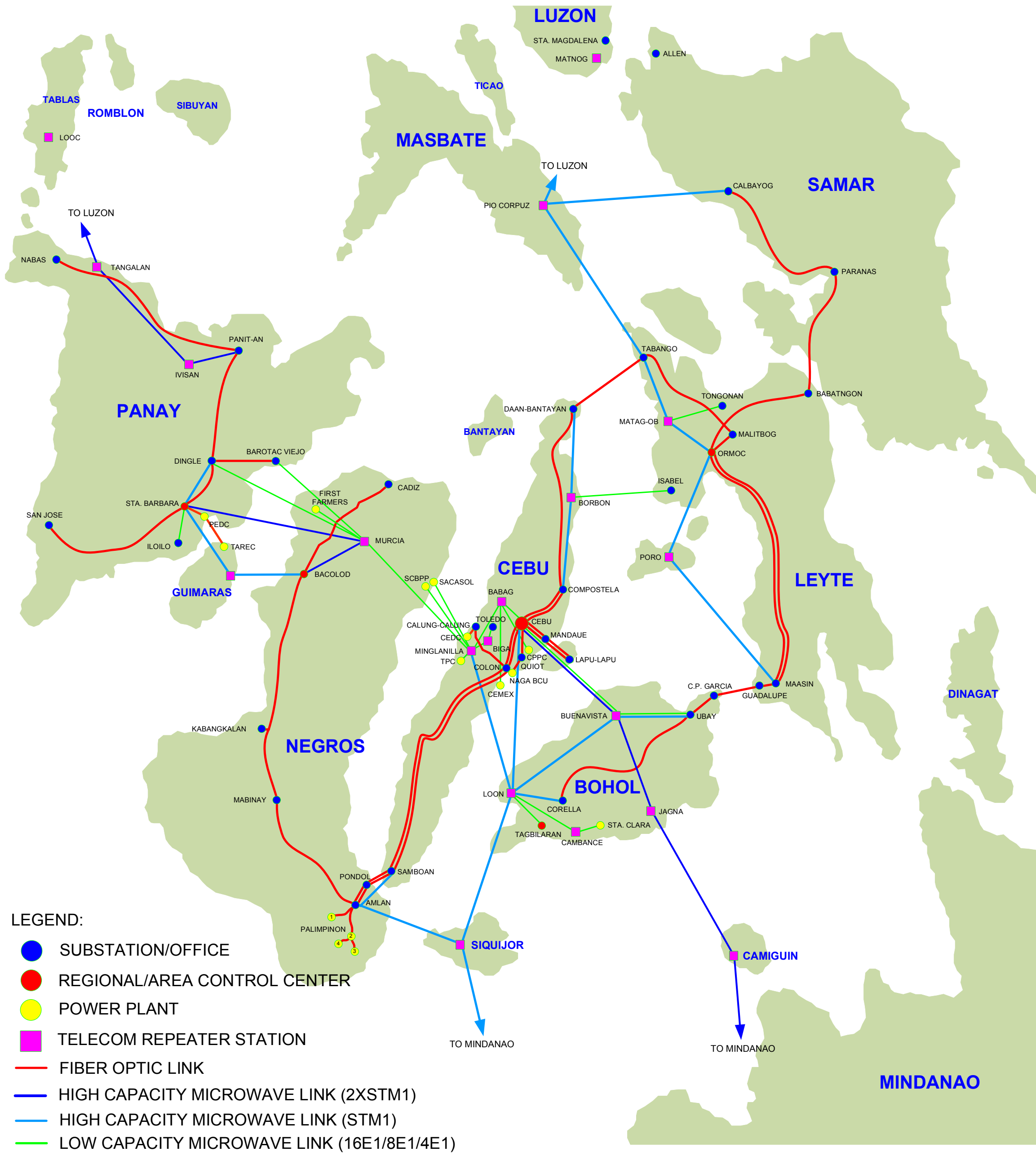


Figure 2.1.2: Visayas Telecom Network

Table 2.1.2.a: Existing Telecom Facilities, Visayas (Part 1 of 3)

NETWORK ELEMENT	ECO. LIFE	CLASS	<u><</u>E.L.	>E.L.	OUTLOOK
MW Radio	15 yrs (ERC)	SDH	24 hops	0	While SDH radios deployed in the backbone are below the ERC economic life of 15 years, some no longer have spare-parts support. Redundancy (1+1) protection is not available for some links due to lack of spares. Part of the installed base thus needs to be retired yearly to provide source of spares for the rest, taking into account the age of the retired equipment does not exceed the prescribed economic life. As for the PDH, most of the links are obsolete and under-capacity and need to be replaced.
		PDH	24 hops	0	
OPGW / Fiber Optic Infra	50 yrs (ERC)	<u>></u>24 cores	1,288 kms	0	Not all transmission lines in Visayas have OPGW system. Aside from the programmed T/L projects by P&E which already include OPGW component, the following HV lines are recommended for installation of OPGW to complete the optical backbone: OPGW Expansion under SO: Bacolod-Cadiz, Allen-Calbayog, Mabinay-Kabankalan-Bacolod L2, Ormoc-Tongonan-Isabel, Amlan-Mabinay L2, Cebu-Quiot-Colon L2.
		<24 cores	217 kms	0	
IP Telephony Server	5 yrs	VOIP Server	3 sets	0	IP Telephony servers are programmed to replace the Legacy PABX Systems. These servers were installed starting in 2010 at Cebu, Ormoc, and Bacolod.
PLC/PSE	18 yrs*	PLC	27 links	0	PLCs with their associated PSEs are now almost solely used for T/L protection except for sites where there are no other telecom media. Stand-alone PSEs are also used independently for interfacing protection relays with other media (such as optical fiber and radio). While ERC lists their economic life as 35 years, the practical serviceability of the terminal equipment depends on reliability and security of operations—significantly affected by degradation of their electronics over time. Thus, to sustain performance targets and ensure grid security, service lives of PLC/PSE are limited to within their peak operating condition.
		PSE	24 links	0	

† IP Telephony Servers are not included in the ERC asset lives assessment—calculated economic service lives are based on actual operational performance.

* PLC/PSE 18-year economic life pertains to that of terminal equipment only.

Table 2.1.2.b: Existing Telecom Facilities, Visayas (Part 2 of 3)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
Multiplexer	10 yrs†	Transport	27 nodes	0	Transport multiplexers were progressively replaced starting in 2010. The total number of access multiplexers installed is 27 nodes. Access multiplexers serve as the service access points to the telecom backbone. Some have transport capability and may be configured as SDH (backbone) nodes. Since its installation in 2003, 31% of these multiplexers are already beyond economic life.
		Access	59 nodes	26 nodes	
Router	8 yrs†	—	52 nodes	0	Presently, there are 52 IP routers in support of Corporate MIS, line protection transient recorders, VoIP and video-con services. The number and size of router equipment shall be dimensioned to support physical separation between the SCADA and the corporate MIS WAN networks. "Open Systems" OSPF routing protocol shall be implemented to optimize functionality of telecom complement and a replenishment program to address obsolescence shall be observed.
VHF Repeater Systems	12 yrs†	Circuit-Switched	0	9 nodes	All VHF network repeater systems have exceeded their economic life. Not all spare parts are available in the market and equipment have to be progressively retired to provide source of spare parts for remaining installed base.
48VDC Power Supply/ Charger	12 yrs†	—	56	13	DC systems are normally configured with only one battery charger and one battery bank. About 19% of the battery chargers are beyond their economic lives—no longer supported by the manufacturer. Because spare parts are no longer available, gradual replacement of these obsolete chargers is necessary to sustain availability. Also, upgrading to redundant (1+1) systems in key stations (backbone repeater stations) must be done to improve reliability, especially where security of fault clearance systems is paramount. The importance of a reliable power supply system should be emphasized, hence the need to provide additional chargers to implement the appropriate requirement.

† Multiplexer, Router, VHF repeater systems and power supply equipment are not included in the ERC asset lives assessment—calculated economic service lives are based on actual operational performance.

Table 2.1.2.c: Existing Telecom Facilities, Visayas (Part 3 of 3)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
48VDC Battery Bank	8 yrs[††]	—	57	3	5% of the battery banks are beyond their respective economic lives. Batteries whose capacities fall below 80% should be replaced because they are no longer reliable. Monitoring and periodic replacement of battery banks is necessary to maintain continuity of telecom service during commercial AC power interruption. A 2C+2B configuration for MW repeater stations along the backbone route shall be established. Improvement of reliability and availability of backbone telecom equipment is imperative considering that the Visayas network links Luzon and Mindanao telecom networks.
Generator Set	6 yrs[†]	—	11	7	Generator sets provide backup AC during commercial power failures. 39% of these gen sets are beyond service lives and may no longer be repaired in case of breakdown due to off-production of spares. Replacement of these gen sets is necessary to ensure continuous and reliable power supply. Additional gen sets are also required for redundancy at remote repeater sites to improve availability of the radio stations.
Infrastructure	50 yrs (ERC)	Antenna Tower	36	0	Periodic repainting of the tower and retightening of bolts are being done to prolong the life span of these structures. Some towers will be retrofitted to accommodate additional load when necessary.
		Repeater Bldg.	18	0	Periodic rehab is being done to ensure the security of telecom equipment and to prolong usage of these shelters. Repainting, waterproofing and rehab of dilapidated building structures should be done to maintain the functionality of the buildings.
Network Management System (NMS)	5 yrs*	Element Managers	9	0	Fault management is done remotely through proprietary element managers which are dependent on manufacturer support for the respective network elements involved. There are element managers for the radios, OLTE, multiplexers and SNMP elements. Performance/quality management systems measure and control network conditions that affect quality of service. The E1 performance monitoring system is one of these.

		FMS	10	0	Facilities Management System (FMS) extends the network management capabilities to cover the online monitoring of the power supply system and associated components, video surveillance capability and environmental conditions such as temperature and humidity. FMS also handles the monitoring of unmanaged legacy/non-legacy telecom equipment installed at various microwave relay stations.
		BMS	22	0	Battery Monitoring Systems (BMS) monitor battery cell parameters such as cell voltage, impedance, cell temperature, ambient temperature, and humidity in real time mode. They are aimed at optimizing the useful life of expensive stationary battery banks thru timely detection of signs of cell deterioration which can be corrected at their early stage.
		RFMS	6	0	Online optical fiber monitoring systems are presently installed to determine location of fiber breaks as soon as they occur so that corrective and security measures may be implemented as soon as possible.
Sync Clock Source	8 yrs†	Clock Source	4	1	NGCP Telecom Network catering for high speed and reliable channel services like Teleprotection, IS/IT, voice and SCADA requires accurate clock synchronization for correct operation. Primary reference clocks based on GPS are strategically deployed network-wide to serve as highly accurate synchronization clock sources. The recommended deployment is one (1) source per major Island in Visayas namely: Cebu, Leyte, Samar, Bohol, Negros, and Panay. Timing requirement for SCADA and Teleprotection applications shall also be provided by these primary clock sources.

† Generators and Sync Clock Sources are not included in the ERC asset lives assessment--calculated economic service lives are based on actual operational performance.

†† Battery life is based on average design lives of installed battery banks.

* Network Management Systems 5-year economic life pertains to that of hardware/electronics only.

2.1.3 Mindanao Existing Telecom Facilities

The recent implementation of the CAPEX Programs under the 3rd Regulatory period brought substantial improvement to the Mindanao telecommunications infrastructure. The retrofitting of existing transmission lines with optical power ground wires (OPGW) provided the Mindanao Grid the enhanced reliability of the communication system catering various operations-critical applications.

Mindanao's major telecom backbone have been upgraded from the low capacity 16xE1 (32Mbps) microwave links to the combination of fiber optics and high capacity microwave radio links that operates at capacities of STM-4 (622Mbps) and STM-1 (155Mbps) respectively. However, the low capacity 16xE1 (32Mbps) backbone going to the Zamboanga area are still for replacement and upgrading.

The inter-island backbone (going to Visayas) comprises of two (2) high capacity microwave routes–east and west. The western route passes through the island of Siquijor towards Negros while the eastern route passes through the island of Camiguin towards the island of Bohol. The capacity of the eastern route is STM-1 (155Mbps) while the western route is 2xSTM-1 (2x155Mbps).

The fiber optic backbone network has been overlaid along the 138KV high voltage transmission lines covering major substations in the Mindanao Grid. Stations and offices which are not located along the backbone route are connected through spur links. Still, considerable quantity of the existing microwave radio spur links are at a capacity from 2xE1 (4Mbps) and 16xE1 (32Mbps) and have been optimized beyond their operational life.

Mindanao Grid's teleprotection systems are being catered by the combination of fiber optics (direct-connect), microwave and power line carrier (PLC) systems for both main protections (Main 1 & Main 2). System Integrity Protection Systems (SIPs) are deployed utilizing the stand-alone protection signaling equipment (PSE) either via fiber optics or microwave carrier systems.

Recently deployed telecom systems and components have been equipped with associated management systems. These management systems provided enhancements in as far as operational efficiency is concerned. Bandwidth optimization has been successfully achieved through the use of these management systems. Provisioning of services became simpler and effective as well.

Rehabilitation and upgrading of the existing data (wide area network – WAN) infrastructure is ongoing gearing towards achieving a migrated system based on IP or packet technology catering both legacy and IP based applications. Migration has been ongoing particularly on the voice communication aspect – from the legacy circuit-switched to packet-switched (VoIP) technology.

On the associated auxiliary systems, replacement and rehabilitation of the telecom 48VDC systems has been a continuing program for Mindanao. The program aims to provide the required reliability on the operational status of the telecom equipment – provide continuous and uninterruptible power supply for the telecom equipment.

Furthermore, to support the day-to-day operation of the Mindanao Grid, System Operation is also operating and maintaining a VHF radio network in Mindanao as backup communication for the dispatch as well as field maintenance personnel.

NGCP also maintains telecom infrastructure in the form of the outside plant for the (transmission-line-embedded) optical links and PLC's, telecom antenna towers and radio "repeater" buildings.

Table 2.1.3 lists the major elements in the Mindanao Grid telecom network indicating their respective conditions against current issues of concern.

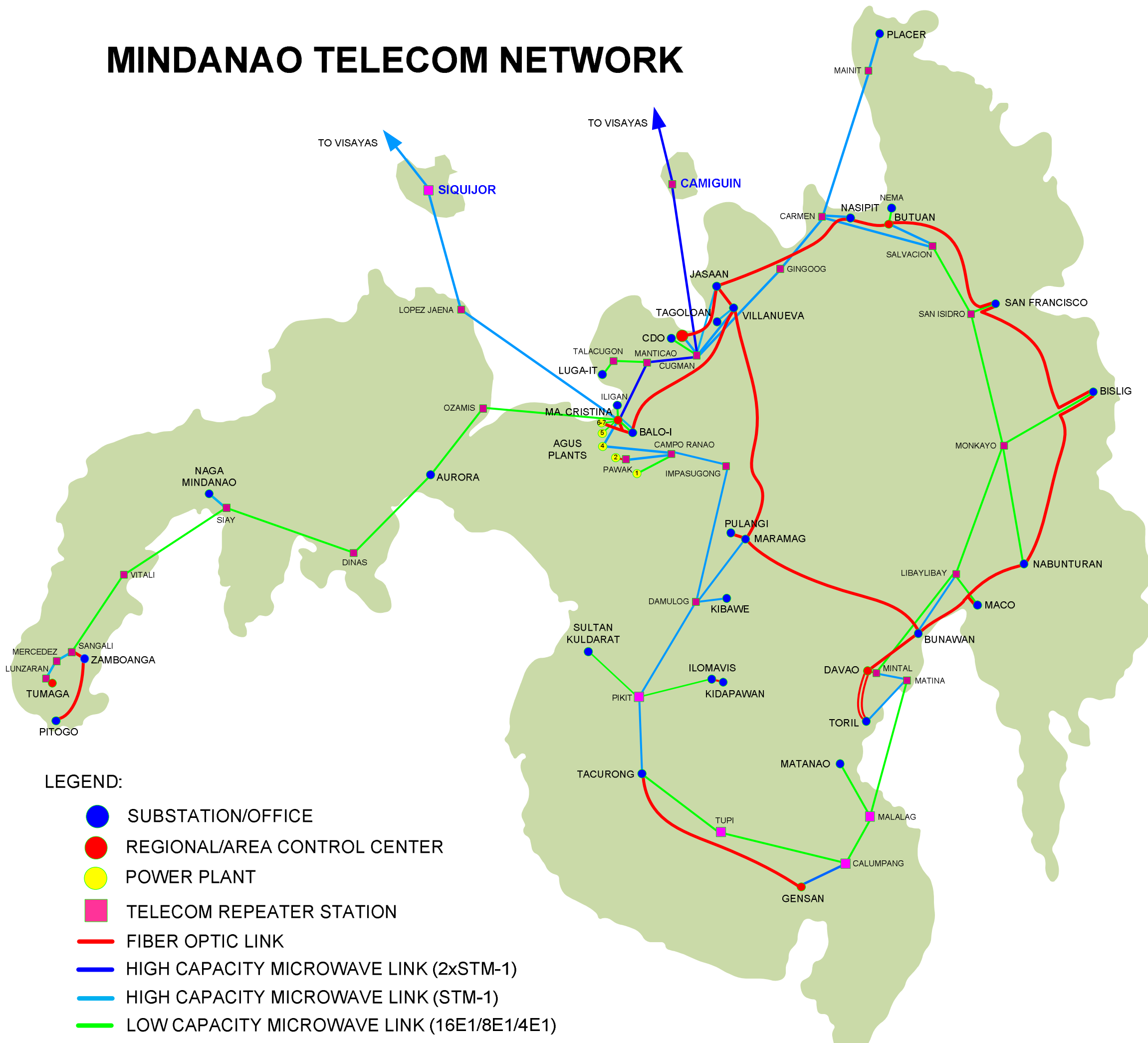


Figure 2.1.3: Mindanao Telecom Network

Table 2.1.3.a: Existing Telecom Facilities, Mindanao (Part 1 of 2)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
MW Radio	15 yrs (ERC)	SDH	27 hops	0	While some of the PDH radios deployed in the backbone are below the ERC economic life of 15 years, 48% no longer have spare-parts support. Redundancy (1+1) protection is no longer available for some links due to lack of spares. Part of the installed base thus needs to be retired yearly to provide source of spares for the rest. In 2013, additional 19 SDH and 1 PDH links were added to the network; however, these are all operating in parallel with the existing microwave links. PDH spur links are also filled to capacity and must be upgraded to accommodate additional applications through the service access points. Some links which still operate within the government-reallocated 2GHz frequency (for CMTS) must be replaced to avoid interference—there are still 16 microwave links operating at 2GHz band and in 2013.
		PDH	24 hops	20 hops	
OPGW / Fiber Optic Infra	50 yrs (ERC)	≥24 cores	1,046 kms	0	Majority of the transmission lines in Mindanao have already been retrofitted with OPGW. Aside from the programmed T/L projects by P&E which already include OPGW component, the following HV lines are still recommended to be retrofitted with OPGW to complete the optical backbone: OPGW Expansion: • Baloi–Aurora–NagaMin–Zamboanga • Matanao–Kidapawan
		<24 cores	0	0	
OLTE	10 yrs†	—	79 nodes	0	Optical Line Terminal Equipment (OLTE) are relatively young as they were installed only recently as part of the establishment of the fiber optic network in Mindanao.
IP Telephony Server	5 yrs	VOIP Server	2 sets	0	IP Telephony servers are programmed to replace the Legacy PABX Systems. These servers were installed starting in 2011 at Iligan BRCC and at Carmen MRCC in Cagayan de Oro City

PLC/PSE	18 yrs*	PLC	31 links	18 links	With the exception of a few voice and SCADA channels, PLC's with their associated PSE's are now mainly used for T/L protection. (PSE's are also used independently for interfacing protection relays with other media such as optical fiber and radio.) While ERC lists PLC economic life as 35 years, we understand that the assessment pertains mainly to outside plant, i.e., wave traps, T/L coupling capacitors, line matching units and cable; further, the practical service life depends on reliability and security of operations—performance measures which are significantly affected by degradation of electronics over time. Thus, to sustain performance targets and ensure grid security, service lives of PLC/PSE's are limited to within their peak operating condition. There are still 7 double-circuit transmission lines in Mindanao Power Grid sharing the same PLC for both lines 1 & 2.
		PSE	53 links	0	
Access Multiplexer	10 yrs†	—	16 nodes	62 nodes	The access multiplexers serve as the service access points to the telecom backbone. Almost 80% of the installed base which is beyond economic life cannot meet present IP-application needs and other data-com requirements. Such are beyond upgrade and must be replaced to be responsive to current and future demands.
Router	8 yrs†	—	8 nodes	0	The routers are the traffic management nodes for IP traffic. There are only 8 routers installed in Mindanao which are barely enough to meet present requirements. Expansion of these routers is programmed in 2017 to meet the expected growth in IP and bandwidth demands.
VHF Radios	12 yrs†	—	6	6	For dispatch: the most reliable and fastest means of communication in the region. However, the mode of communication is broadcasted; hence, there is no privacy. This is most effective in times of emergency such as grid blackout, power restoration & coordination purposes. 42% of VHF repeater radios were only upgraded starting in 2010 while the remaining units are already beyond service life—most of these radios are operating below performance level due to degradation of electronic parts. Spares are no longer available in the market/out-of-production.

† OLTE, Access Mux, Routers and VHF are not included in the ERC asset lives assessment--calculated economic service lives are based on actual operational performance.

* PLC/PSE 18-year economic life pertains to that of terminal equipment only.

Table 2.1.3.b: Existing Telecom Facilities, Mindanao (Part 2 of 2)

NETWORK ELEMENT	ECO. LIFE	CLASS	≤E.L.	>E.L.	OUTLOOK
PABX	8 yrs†	—	5 nodes	16 nodes	A major component in Mindanao's telecom system is the telephony or voice communication network. With the expansion of the nationwide IP network and the move towards an IP-based telephony system, this "legacy" equipment would be gradually replaced to take advantage of a more optimized bandwidth utilization realized from IP transport systems—at present, there were already around 350 units IP phones deployed in Mindanao Grid.
48VDC Power Supply/ Charger	12 yrs†	—	69	17	DC systems are normally configured with only one battery charger and one battery bank. 20% of the battery chargers are beyond their economic lives—no longer supported by the manufacturer. Because spare parts are no longer available, gradual replacement of these obsolete chargers is necessary to sustain availability. Also, upgrading to redundant (1+1) systems in key stations (backbone repeater stations) must be done to improve reliability, especially where security of fault clearance systems is paramount. The importance of a reliable power supply system should be emphasized, hence the need to provide additional chargers to implement the appropriate requirement.
48VDC Battery Bank	8 yrs††	—	72	3	Only 4% of the battery banks are beyond their respective economic lives. Batteries whose capacities fall below 80% should be replaced because they are no longer reliable. Monitoring and periodic replacement of battery banks is necessary to maintain continuity of telecom service during commercial AC power interruption. A 2C+2B configuration for MW repeater stations along the backbone route shall be established.
Generator Set	6 yrs†	—	18	18	Gen sets provide back-up AC power supply during AC commercial power failure. Eighteen (18) out of the 36 installed gensets are beyond its service life and spares are already out of production.
Infrastructure	50 yrs (ERC)	Antenna Tower	58	0	Periodic repainting of the tower and retightening of bolts are being done to prolong the life span of these structures. Some towers will be retrofitted to accommodate additional load when necessary.

		Repeater Bldg.	31	0	Repeater buildings are mainly made of concrete but still deteriorate with time. Since they are mostly installed in elevated locations, the buildings deteriorate faster due to constant exposure to extremes in weather conditions. Insect infestations also cause accelerated deterioration of wooden structures. Regular maintenance is necessary to sustain satisfactory building condition, ensuring sufficient protection for the telecom equipment housed therein.
Network Management System (NMS)	5 yrs*	Element Managers	5	0	Fault management is done remotely through proprietary element managers which are dependent on manufacturer support for the respective network elements, as follows: Netviewer for Nokia MW Radio and Multiplexers; T31 for ZTE MW Radio; R31 for ZTE Add-Drop Multiplexers; CeraView for Ceragon MW Radios; and, Pasolink for NEC MW Radios.
		NMS	0	1	Lone NMS is used to manage proprietary PDH radios and multiplexers. Although the system is still operational, the hardware is already prone to occasional shutdowns and the software needs to be upgraded to address compatibility issues with newer versions of network elements.
		BMS	25	0	BMS are employed to remotely monitor battery parameters and to enable early detection of battery faults and abnormalities. This will help minimize any unplanned traffic outages due to power supply failure and proper preemptive battery management can be undertaken.
Sync Clock Source	8 yrs†	Clock Source	3	0	NGCP Telecom Network catering for high speed and reliable channel services like Teleprotection, IS/IT, voice and SCADA requires accurate clock synchronization for correct operation. Highly accurate primary reference clocks (GPS) are strategically deployed network-wide to serve as highly accurate synchronization clock sources. Timing requirement for SCADA and Teleprotection applications shall also be provided by these primary clock sources.

† PABX, Sync Clock Sources, power supply, and generators are not included in the ERC asset lives assessment--calculated economic service lives are based on actual operational performance.

* Network Management Systems 5-year economic life pertains to that of hardware/electronics only.

3.0 REQUIREMENTS ANALYSIS

Grid expansion, current business demand, technology direction and the need to replenish equipment to sustain operations are the bases for which we have determined our requirements within the course of the study period 2016–2025.

3.1 Transmission Grid Extension

a. Telecom requirements as a result of transmission grid extension are addressed through the telecom components of transmission line projects defined in Volume 1.

b. There are, however, deficiencies in existing telecom facilities which were a result of under-programming of the necessary telecom complements in previous or current transmission line expansion projects—the appropriate adjustments to reverse such deficiencies shall be included as among the requirements in this program.

c. This volume does not include provisions for interconnections of new customers—anticipated or not—given that the program for such "customer-specific" facilities are governed by a separate mechanics.

3.2 Corporate Business Needs

Current business requirements vis-à-vis the state of pertinent telecom facilities are assessed in the following tables. The telecom elements are further analyzed according to four (4) basic parameters of the service: capacity (or bandwidth), route protection (or security), network reach and traffic management.

Table 3.2.a: Network Protection Needs versus Telecom System

RESPONSIVENESS OF EXISTING TELECOM SYSTEM			
BANDWIDTH/CAPACITY	ROUTE PROTECTION	NETWORK REACH	TRAFFIC MANAGEMENT
64 kb/s station-to-station links require minimum bandwidth and occupy the least backbone space; but use of PLC-only to connect some stations preclude of differential protection.	Multiple routes and media are required—to comply with Protection Philosophy.	Tele-protection links are generally put in place as requisite to Grid extension or connection; but there is need for direct optical links for differential relays in line with Protection Philosophy.	No traffic management is required since point-to-point connection is sensitive to dynamic rerouting.
INADEQUATE	INADEQUATE	INADEQUATE	GOOD TILL 2025

Table 3.2.b: SCADA/EMS Needs versus Telecom System

RESPONSIVENESS OF EXISTING TELECOM SYSTEM			
BANDWIDTH/CAPACITY	ROUTE PROTECTION	NETWORK REACH	TRAFFIC MANAGEMENT
Some RTU links still use PLC routes, especially in Mindanao—need to set up more backbone links to address bandwidth requirements.	Need to implement mesh connectivity to increase datacom accessibility and thus ensure data sufficiency.	SCADA extensions are provisioned in programmed Grid expansions as well as in interconnection of new customers.	Need to shift to IP-based traffic management systems—hand-in-hand with more pervasive use of IP datacoms.
INADEQUATE	INADEQUATE	GOOD TILL 2025	INADEQUATE

Table 3.2.c: Telephony Needs versus Telecom System

RESPONSIVENESS OF EXISTING TELECOM SYSTEM			
BANDWIDTH/CAPACITY	ROUTE PROTECTION	NETWORK REACH	TRAFFIC MANAGEMENT
Growth in bandwidth requirements is expected to flatten as use of IP telephony makes more efficient use of backbone capacity.	Because some of the nodes—including major substations and regulating plants—are connected only to the network by radio spur links or radial optical (flat-ring) connections, path redundancy is not complete.	As with teleprotection and SCADA, telephony links are standard facilities put in place upon Grid connection.	Need to shift to IP-based traffic management systems (versus circuit-switched PABX systems)—to complement migration to IP telephony.
GOOD TILL 2025	INADEQUATE	GOOD TILL 2025	INADEQUATE

Table 3.2.d: MIS, Office Automation, Billing and Metering Needs versus Telecom System

RESPONSIVENESS OF EXISTING TELECOM SYSTEM			
BANDWIDTH/CAPACITY	ROUTE PROTECTION	NETWORK REACH	TRAFFIC MANAGEMENT
Need to increase spur link capacity to ease bottlenecks at service access points (4E1's and 8E1's are not enough).	Alternate WAN routes are required—to optimize backbone utilization for high – bandwidth but less-priority applications.	Need to extend IP connectivity for business and automation applications to all stations.	Traffic management functionality is built into transport and access facilities; only lookout is the need to replenish end-of-life network elements.
INADEQUATE	INADEQUATE	INADEQUATE	GOOD TILL 2025

Table 3.2.e: O&M Mobile Dispatch Needs versus Telecom System

RESPONSIVENESS OF EXISTING TELECOM SYSTEM			
BANDWIDTH/CAPACITY	ROUTE PROTECTION	NETWORK REACH	TRAFFIC MANAGEMENT
O&M dispatch requirements are voice only and use minimal backbone bandwidth as mobile traffic is mostly local.	Duplex traffic are RF broadcast and does not involve multiple routes for protection.	There are still significant blind spots in network coverage.	Subscriber base per operation area is low-density class only and does not require special traffic managers or multiplexers.
GOOD TILL 2025	GOOD TILL 2025	INADEQUATE	GOOD TILL 2025

Following is the applications-versus-requirements responsiveness matrix, summarizing the above assessments.

TABLE 3.2.f: Summary, Business Application Needs versus Telecom System

APPLICATIONS	TELECOM REQUIREMENTS 2016–2025			
	BANDWIDTH/ CAPACITY	ROUTE/PATH PROTECTION	NETWORK REACH	TRAFFIC MANAGEMENT
TELEPROTECTION	INADEQUATE	INADEQUATE	INADEQUATE	GOOD TILL 2025
SCADA/EMS	INADEQUATE	INADEQUATE	GOOD TILL 2025	INADEQUATE
TELEPHONY	GOOD TILL 2025	INADEQUATE	GOOD TILL 2025	INADEQUATE
MIS/OFFICE AUTOMATION, BILLING, METERING	INADEQUATE	INADEQUATE	INADEQUATE	GOOD TILL 2025
O&M MOBILE DISPATCH	GOOD TILL 2025	GOOD TILL 2025	INADEQUATE	GOOD TILL 2025

From the above table, our present assessment of the NGCP telecom network is that:

a. bandwidth of the transmission system is insufficient to carry all telecom traffic,
b. path protection—i.e., *network security*—is significantly inadequate,
c. there is need to extend service access points to some key applications and
d. the shift in the nature transport mechanism (i.e., from TDM to IP) necessitate new traffic management systems to optimize backbone bandwidth.

It is apparent from the following graph that the capacity of the existing *backbone* is just enough to meet current NGCP applications demand but there is a need to expand within the next 5 years. (That is: there is no over-capacity in NGCP's backbone.)

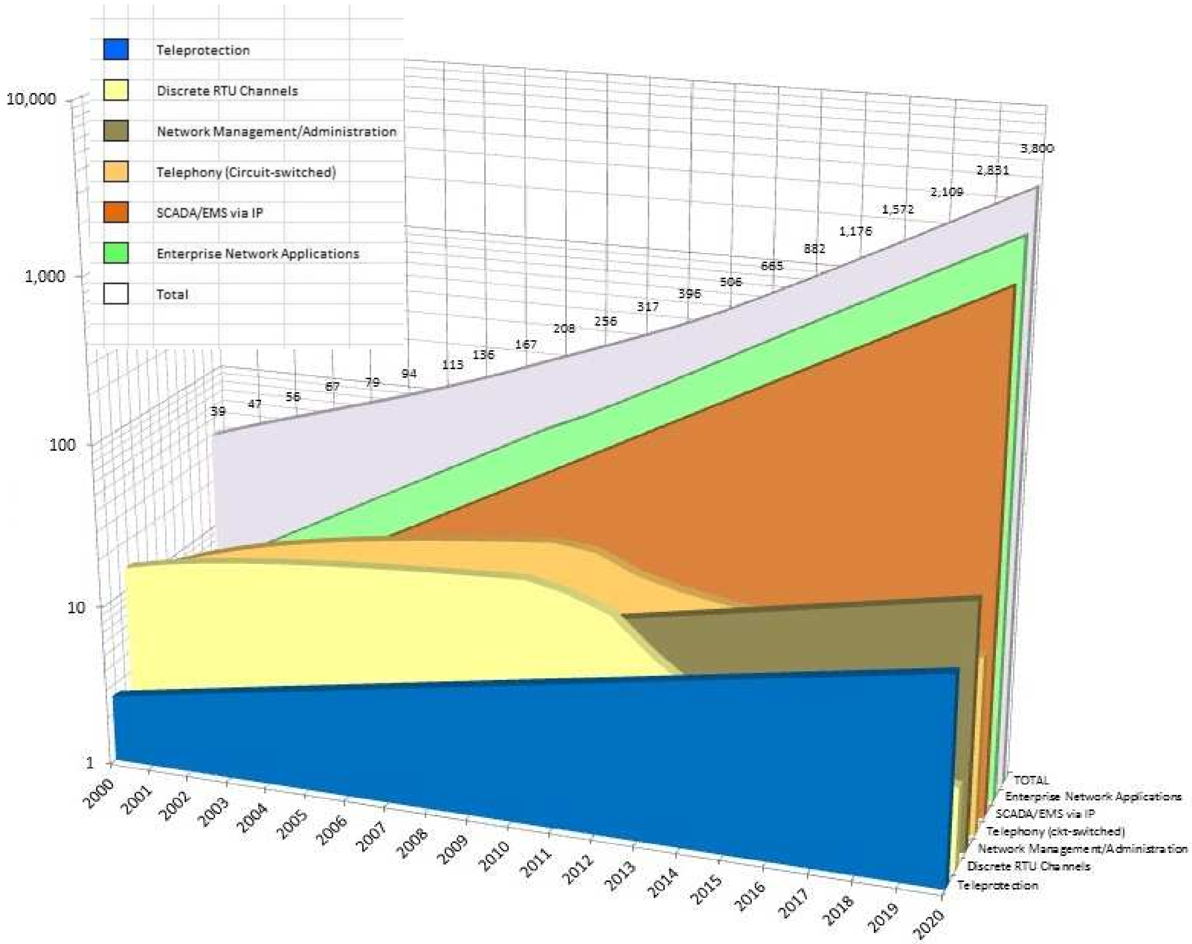


Figure 3.2.a: Telecom Demand Analysis, 2000-2020

Further, as discussed above, *bottlenecks* in the existing service access points—i.e., network connections to the plants/substations—prevent remote nodes from optimizing use of the backbone bandwidth. Thus, in ensuring adequacy of capacity of the network to carry applications demand, continuity of the desired bandwidth should be established by providing the appropriately-sized *spur links*.

As much as the need to provide sufficient bandwidth, the need for alternate (1+1) physical paths for important network nodes should also be addressed in establishing a resilient-enough telecom transmission system. In NGCP's SDH network, a general deficiency in this area is manifested in the absence of physical ring protection—mainly because of the need to still retrofit OPGW in old transmission lines—intended to prevent traffic loss in case of single-point failures (e.g., cut OPGW, power supply outage in a common node).

Following is an illustration of a non-protected versus ring or 1+1 protected optical network connection.

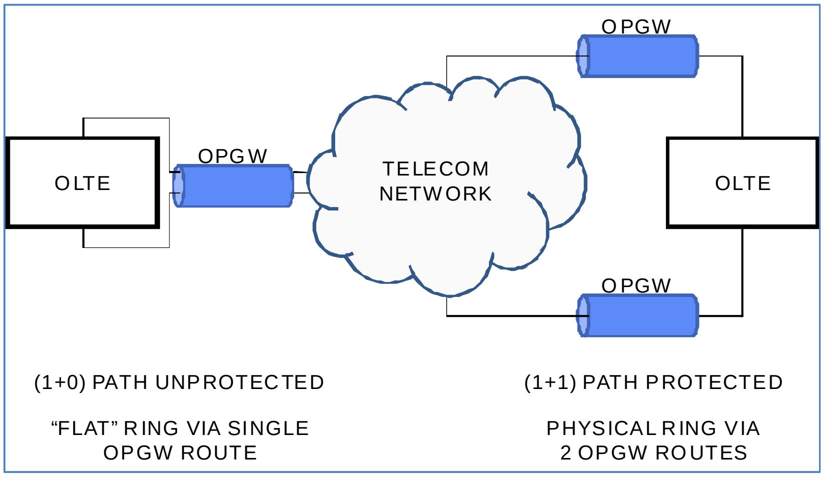


Fig. 3.2.b: Non-protected versus Protected Telecom Paths

3.3 Technology Evolution

Consideration of the effects of technology trends in programming facilities to meet applications demand is important in our effort to optimize returns by availing of the most efficient technology which will deliver the required services, avoiding early obsolescence, selecting which standards and policies to adopt and determining how to adapt existing processes with the anticipated changes in the business environment.

Table 3.3.a: Technology Direction versus Telecom Developmental Plan

TECHNOLOGY DIRECTION	TELECOM REQUIREMENTS 2016–2025
1. Use of IP for Bandwidth Efficiency and Traffic Management convenience	- Migration to IP-based Telephony - Use of IP-based SCADA (RTU) Datacoms - Use of IP-based Protection Management System (PMS)
2. Decreasing Manufacturing Cost, thus cheaper costs of Replacements – tendency for functions to be optimized according to near-term needs.	- Decentralization of Processing and Control Functions – Use of Distributed Architecture - Modularization
3. Convergence through Standardization	- Integration of Routing Functions in Telecom Equipment - Incorporation of Access Points and Mux Functions into SDH nodes
4. Cheaper cost of employing Hybrid Power Supply Systems	- Design of Power Supply Systems less dependent on Commercial Power Service

3.4 Equipment Replacement

Determining the optimum point to replace a facility or equipment should be given due consideration in programming plant acquisitions in order to maximize asset service lives. Diligence in regularly assessing the responsiveness of existing facilities against service requirements—vis-à-vis industry standards as well as market and manufacturing trends—is necessary to ensure that future acquisitions are optimized (service lives are maximized and values of features are realized).

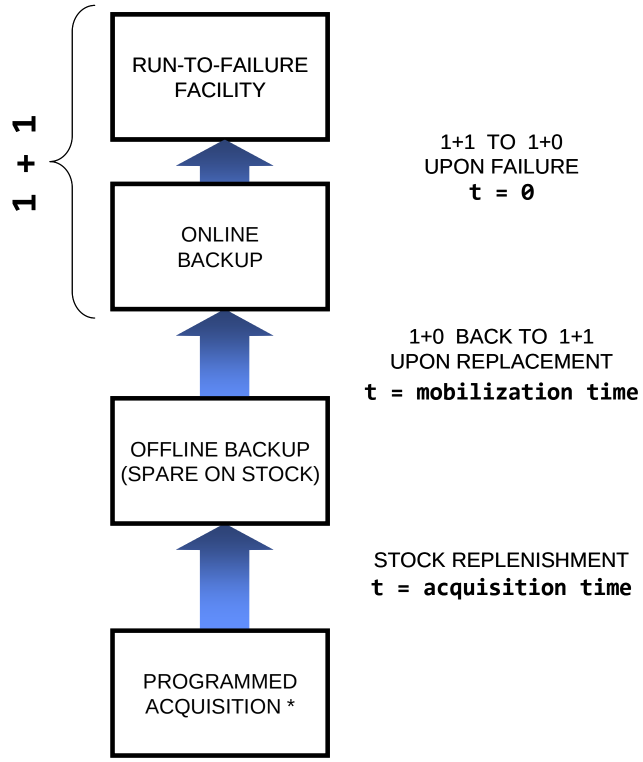
Table 3.4.a: Equipment Replacement in Telecom Developmental Plan

CAUSE FOR REPLACEMENT	TELECOM REQUIREMENTS 2016–2025
1. Economics – Cost of continued ownership has exceeded Cost of Replacement.	- Retirement of Obsolete MUX and Radio Equipment whose cost of spare parts and/or Upgrades are too expensive.
2. No Spare Parts support.	- Phased replacements of Radios, OLTEs and MUX equipment to provide source of spares for remaining installed base.
3. Significant degradation of Performance.	- Replacements of PLCs and Power Supply components exceeding programmed effective (peak-performance) service life.
4. Under–capacity.	- Replacements/Upgrades of M/W Radio spur links that are bottlenecks in the delivery of Bandwidth to Access Points.
5. No capability to address Standard/ Prevalent Protocols (Technology Obsolescence).	- Replacements of Access MUX Equipment without IP-application Ports. - Update of Test Equipment support to address new pervasive Datacom Protocols and Diagnostic/Measurement methods.

3.4.1 Spare Parts

Spare parts are *offline* backups for run-to-failure components. At present, some equipment have no ready spare parts because of either insufficiency of current stock or non-availability of spare parts in the market. In either case, spares stocking should be programmed on the basis of expected turnover rates and—for those equipment *nearing* obsolescence—vis-à-vis phased retirements of the existing installed base (which will be used as source of off-production spare parts). Inventory planning and facility retirement are therefore based on forecasted failure rates and *anticipated* end of product support.

Following is an illustration of the role of offline backups in the event of run-to-failure of a 1+1 protected telecom facility. (t= time for backup to assume primary role.)



*** Stock may be sourced instead via phased retirement in case of obsolete equipment.**

Figure 3.4.1: Role of Offline Backups

4.0 DEVELOPMENTAL PROGRAMS

Implementation of the facilities plan requires that the most efficient mode and scale of asset acquisition be established as basis for the CAPEX program. Both new projects and replenishments involve planning for service lives of assets according to anticipated optimum generated values from the depreciation, with due consideration to established factors of safety.

4.1 Planning Criteria

The facilities program meant to meet needs identified in our requirements analysis above shall be governed by the following philosophies and policies consistent with corporate mandate.

4.1.1 Technology Philosophy

a. Decision to adapt to technology directions should be weighed against impact on core business vis-à-vis economics.
b. Reliability and security precedes functionality.
c. Adopt open-systems standards in management, traffic processing and interfacing to increase flexibility to technology shifts and changes in organizational models as well as to optimize access to best of breed.
d. Prefer "green" technology as part of corporate social commitment.

4.1.2 Technology Development Route

a. Network infra shall continue to accommodate and prioritize real-time channels allocated for grid protection signaling.
b. To optimize bandwidth, IP-based traffic management facilities shall be established and switched-circuit traffic managers shall be gradually retired.
c. IP telephony shall be implemented hand-in-hand with the shift in traffic management paradigm to optimize infra utilization.
d. Routing protocol shall be migrated from proprietary to open systems to take advantage of the increasing prevalence of routing functionality in modern telecom facilities.
e. The energy-efficient (and generally cheaper) split-type radio technology shall be adopted where feasible (e.g., for up to STM-1 radio links) to optimize radio transmitter power, eliminate waveguide-caused problems and minimize dependence on air-conditioning requirements (and reduce failure rates resulting from lack thereof).
f. ADM (add-drop-multiplexing) and terminal functionality—as well as application access capability—shall be incorporated in new SDH nodes to limit failure points and maximize manageability.

4.1.3 Policies

a. Philippine Grid Code
b. Protection Philosophy
c. Spare Parts Management Policy
d. Government regulatory policies on use of radio frequency spectrum
f. Network security policy: physical separation of SCADA and protection networks from admin/MIS network

4.1.4 Guidelines

a. Infrastructure components shall be dimensioned to meet expected growth in requirements up to the end of expected economic lives.
b. Facilities shall be dimensioned according to an 85% fill of expected maximum capacity for contingency.
c. Replacements of operational network components shall be phased such that there is minimum traffic interruption.
d. Turnkey implementation (i.e., through Work Orders) shall be employed where:

    1) Projects cannot be carried out using existing resources, or
    2) There is a need for technology transfer.

e. Replenishments/ upgrades of network components that have exceeded economic lives shall be implemented using in-house engineering resources (i.e., shall be procured as GPE) to minimize implementation time and synchronize construction with operational priorities.
f. For purposes of depreciation programming, CAPEX projects shall be classified as:

1) Expansion	:	New Asset
2) Upgrade/Rehab	:	Add Value to Existing Asset
3) Replacement/Replenishment	:	Replace (Depreciated) Asset

4.1.5 Economic Analysis

a. Purpose: since telecom projects of NGCP are indirectly productive (i.e., with no definitive marketable outputs), economic analysis aims to establish the least-cost option in delivering the required services.
b. Alternatives from which to determine optimum allocation of resources are defined according to the following aspects:

1) Method of project implementation—i.e., turnkey or in-house;
2) Means of establishing and sustaining facilities—i.e., lease or own;
3) Distribution of benefits; e.g., which technology offers the flexibility to accommodate the most applications and satisfy the most operational objectives using shared infrastructure.

4.1.6 Safety and Security Concerns

a. For maximum security, physically separate networks shall be provided for both teleprotection and SCADA applications.
b. Repeater station security systems shall be reinforced to protect telecom backbone integrity.
c. Long-haul optical links shall preferably employ the use of the more physically-secure transmission line-embedded fibers, such as in OPGW and OPPC, over ADSS (given current experience in ADSS maintenance).
d. Telecom towers shall be constructed with utmost consideration in the safety of maintenance personnel; retrofitting of safety facilities shall be addressed where necessary among existing towers.

4.1.7 Specifications Program (General Principles)

Table 4.1.7: Specifications of Major Network Elements, 2016–2025

ELEMENT	2016	2025	RATIONALE
1. Backbone Capacity	STM-1 (155Mb/s)	STM-16 (16x155Mb/s)	Forecasted demand by end of 2013 is already about 400Mb/s only – especially with the completion with the SCADA/EMS upgrade and impending full implementation of the Data Acquisition project and the Wide Area Measurement System (WAMS) project by 2025; higher capacity implementation in Fiber Optic segments – which comprise significant portions of the backbone – is already necessary.
2. OPGW for New T/L	24 Cores	36 Cores	Only about 4 cores max allotted for dedicated relay communication but rapidly decreasing difference in installed cost of higher-density OPGW warrants increase in fiber cores; mechanical and electrical parameters limit size variance, though.
3. OPGW Retrofitting for Old T/L	24 Cores	24 Cores	Outer diameter of the OPGW increases as the number of fiber optic cores embedded in it increases – this would translate into much heavier cable. Studies show that the optimum number of cores that NGCP's existing tower can withstand is only 24 cores.

4. M/W Radio Spur Links	4E1~E3	E3~STM1	Primarily because of the need for separate SCADA, admin and protection IP networks, higher capacity tributaries are needed.
5. SDH Topology	Flat Ring	Physical Ring	Physically redundant (1+1) paths would provide required telecom backbone security.
6. Sync System	GPS	GPS	GPS was the original choice for synchronization because of its relatively cheap cost of implementation and maintenance vis-à-vis the proven reliability.
7. WAN Topology	Partial Mesh	Hierarchical-Mesh	Notwithstanding the need to organize routing, IP Path redundancy would optimize access to SCADA, protection and MIS nodes by avoiding single points of failure.
8. IP Bandwidth Management	Shared Network	Physically separate networks	SO-SCADA and Admin/MIS (enterprise) WAN's shall have physically distinct networks for optimum security.
9. PABX/ Telephony	Circuit-switched	IP	Legacy telephony switches will be gradually replaced by IP-based systems to maximize bandwidth efficiency and simplify traffic management.
10. Protection Signaling Equipment	Priority-coded	Simultaneous independent commands	To ensure integrity of discrete protection signals and simplify analysis of events, new PSE shall be specified with independent signal processing per port.
11. IP Routing	Proprietary (CISCO)	Open Systems	Migration from EIGRP to OSPF would optimize utility of telecom facilities (equipped with routing function), simplify (hierarchical) network management and reduce costs of ownership.

4.1.13 Yearly Network Development Map

The following are diagrams for the 2016–2025 programmed additions for Fiber Optic and Microwave Radio Networks:

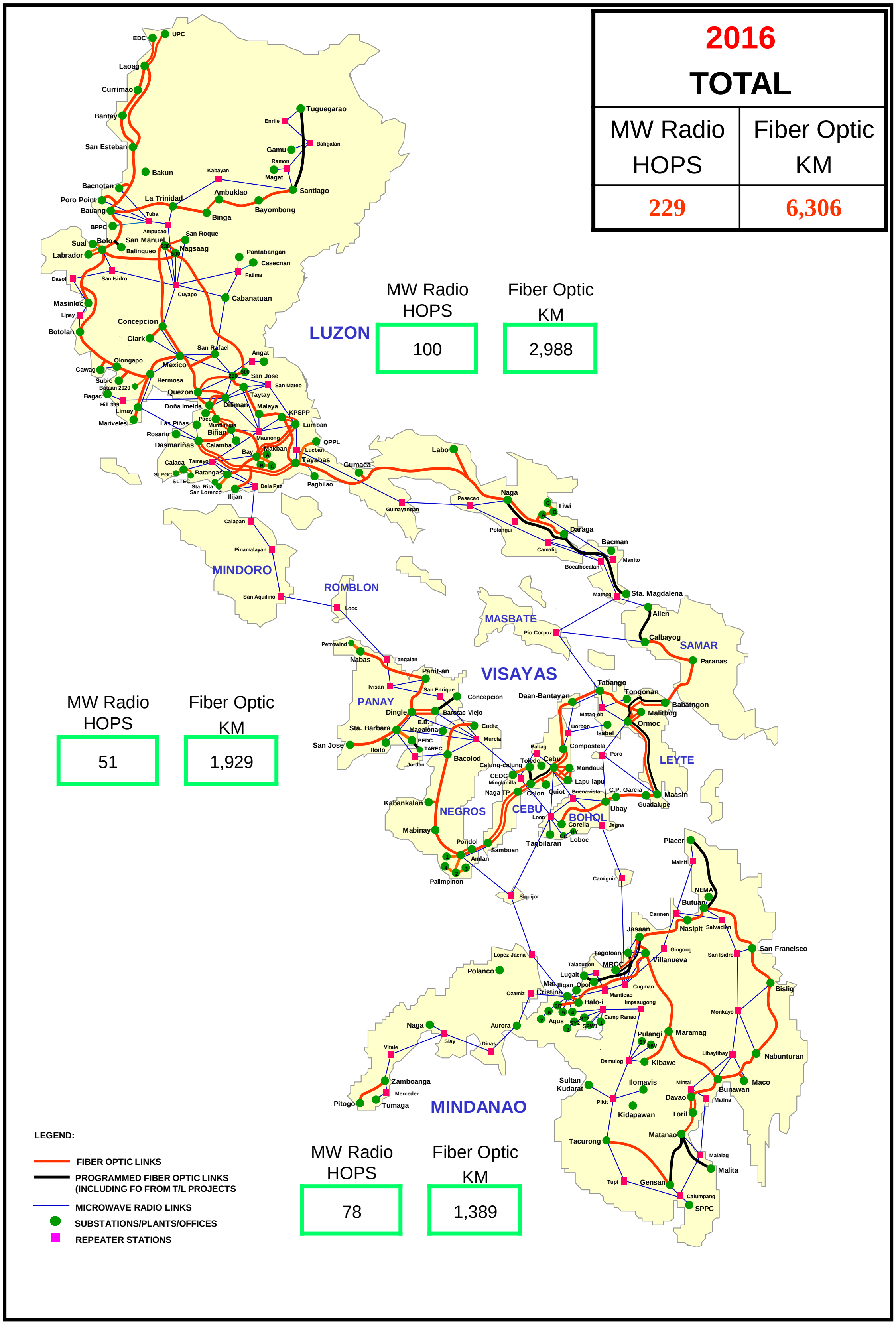


Fig. 4.1.8.a: NGCP Telecom Network – 2016

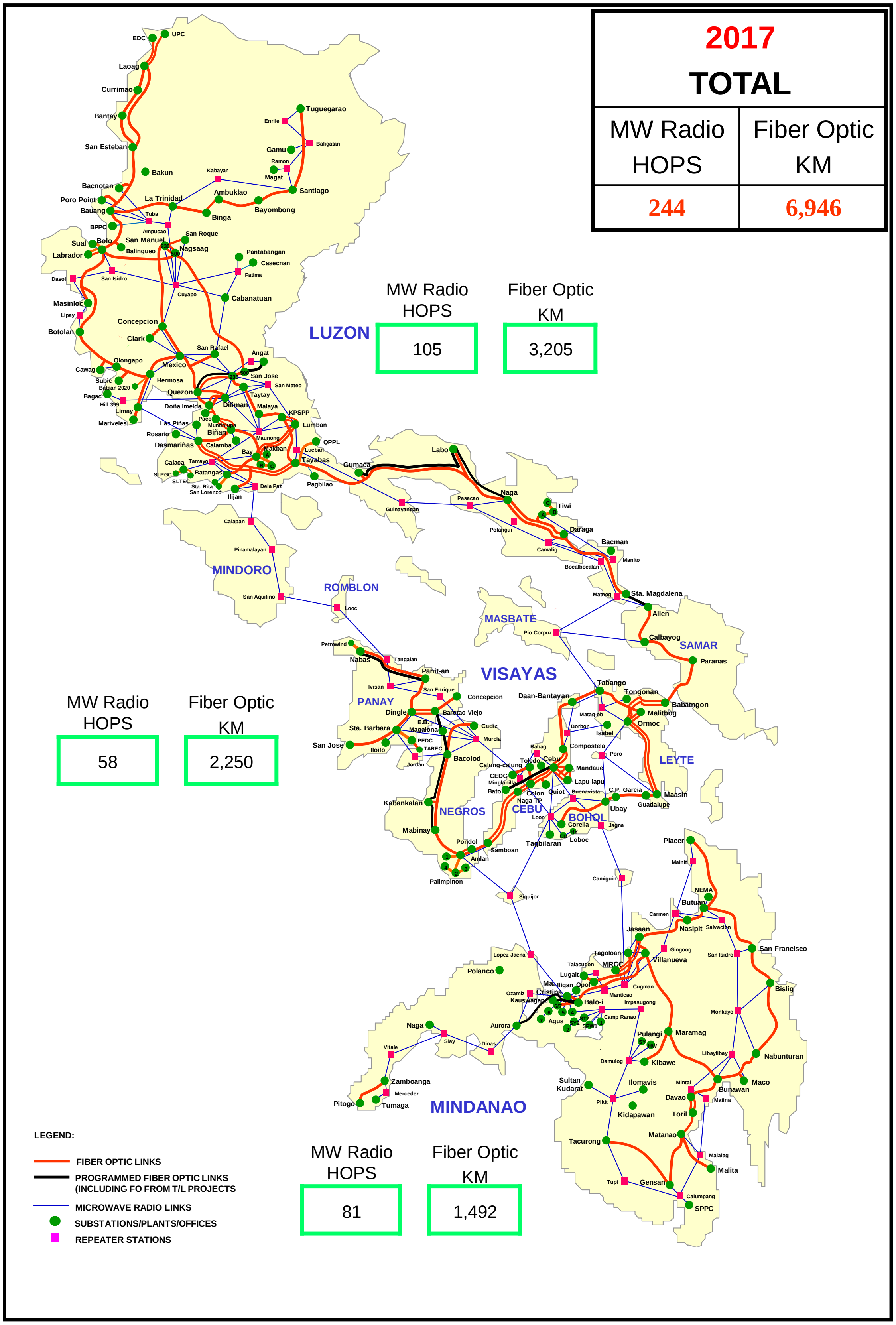


Fig. 4.1.8.b: NGCP Telecom Network – 2017

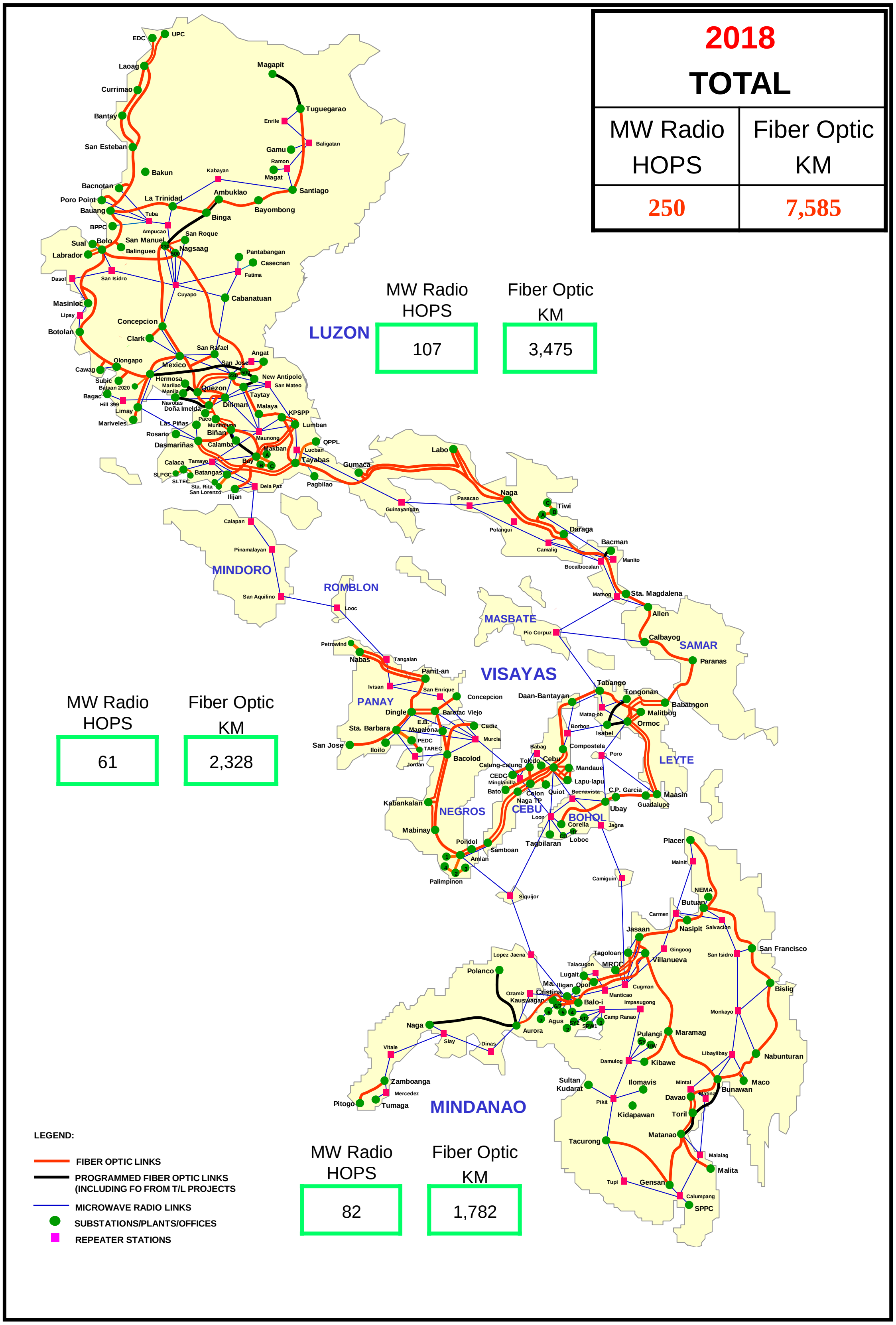


Fig. 4.1.8.c: NGCP Telecom Network – 2018

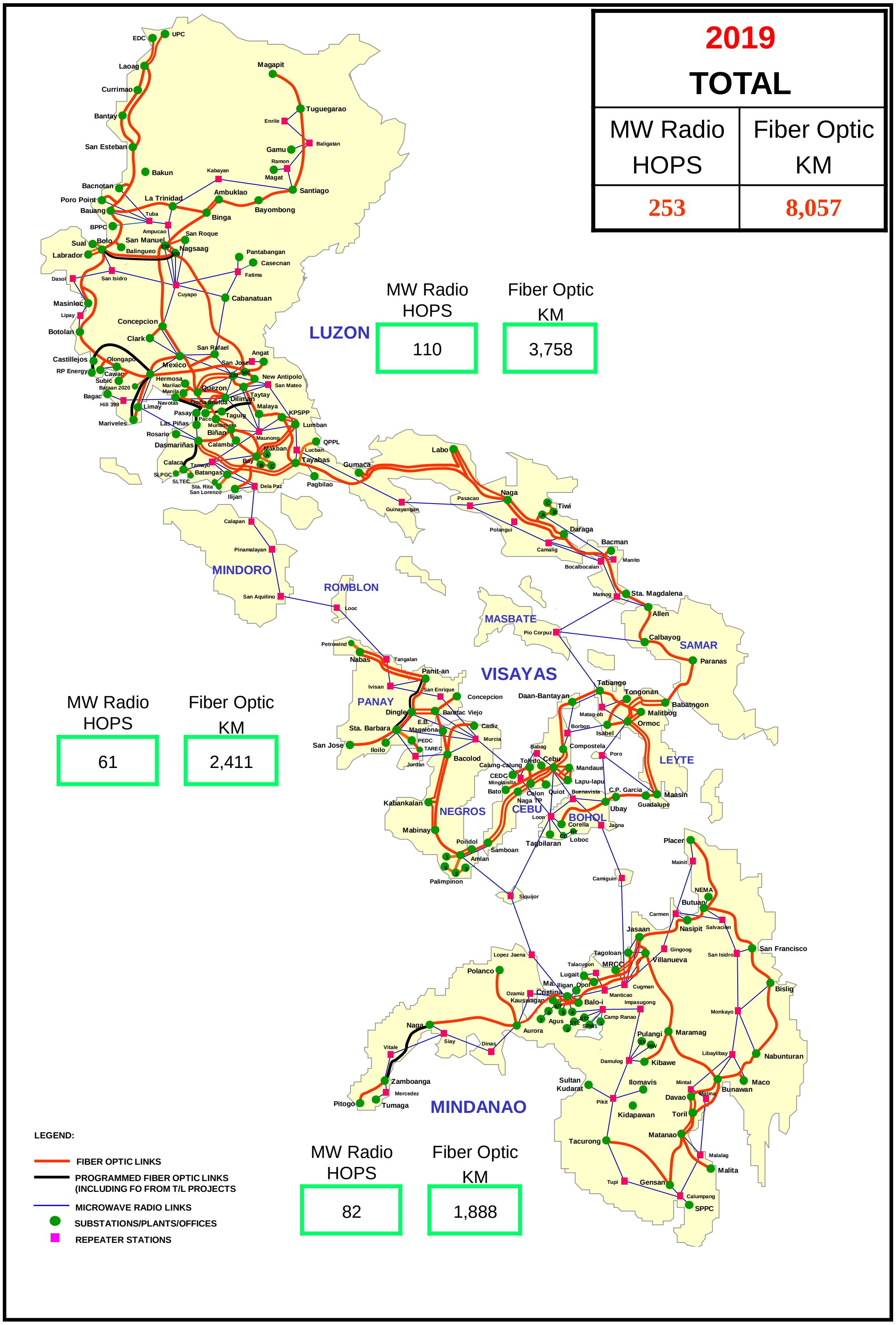


Fig. 4.1.8.d: NGCP Telecom Network – 2019

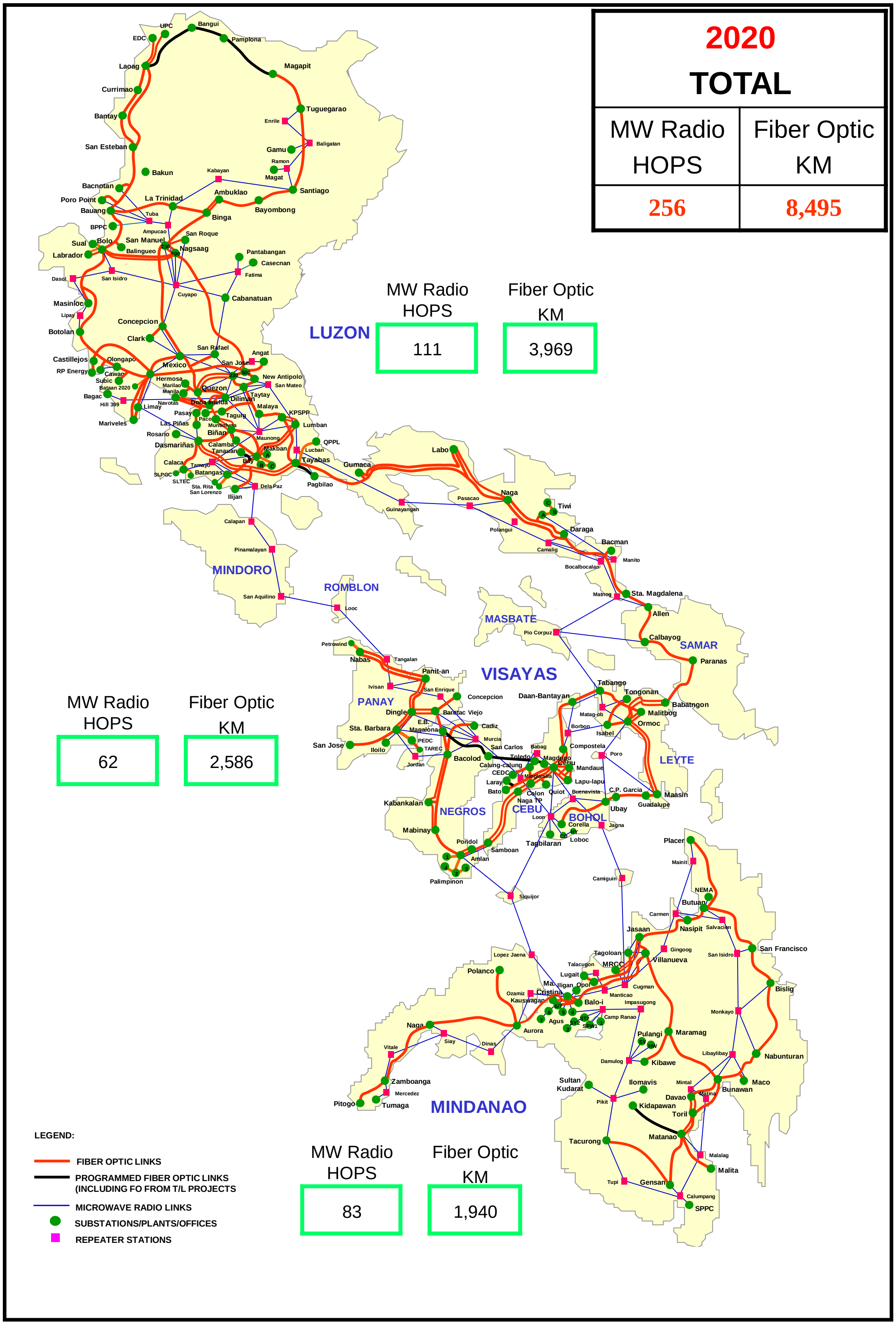


Fig. 4.1.8.e: NGCP Telecom Network – 2020

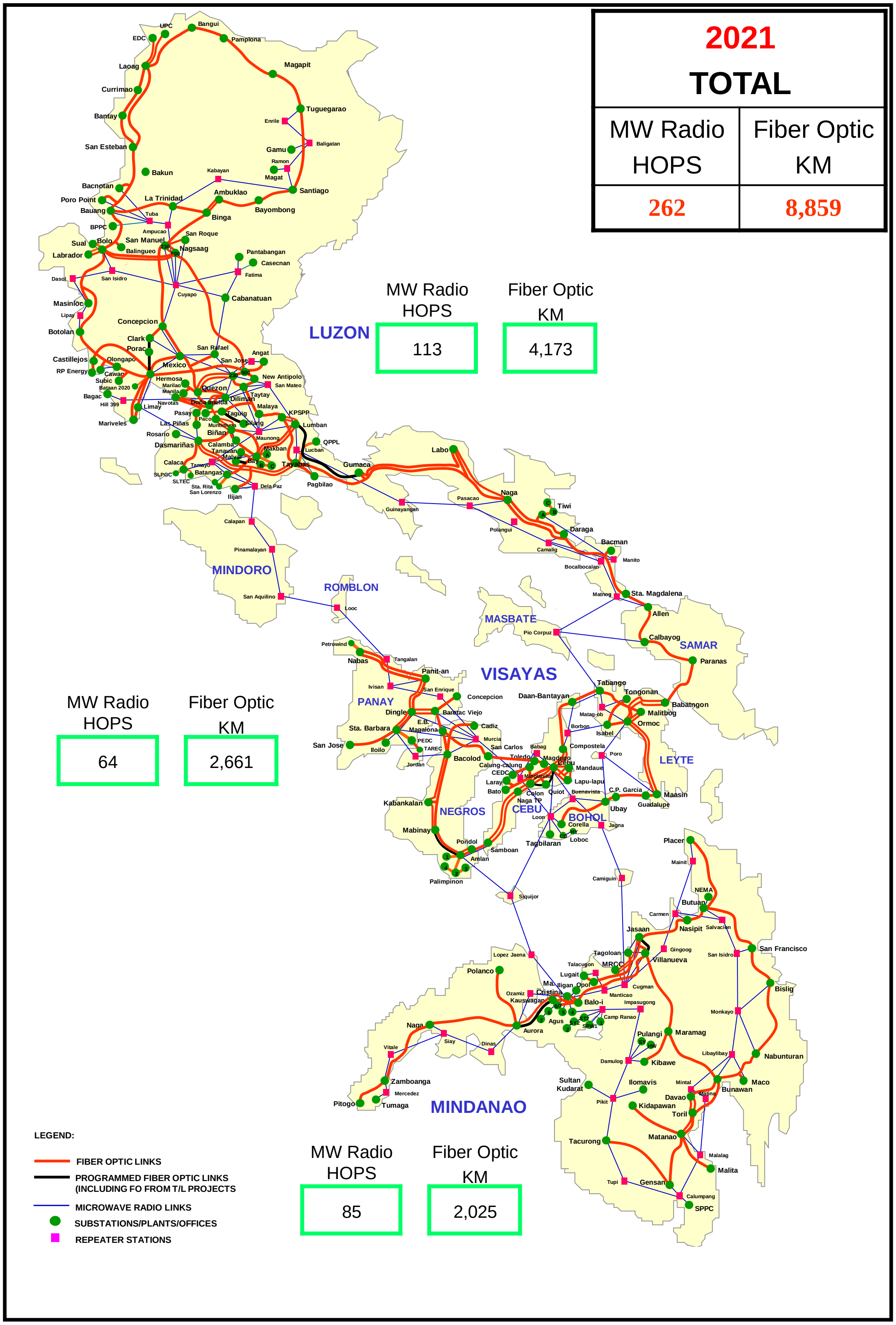


Fig. 4.1.8.f: NGCP Telecom Network – 2021

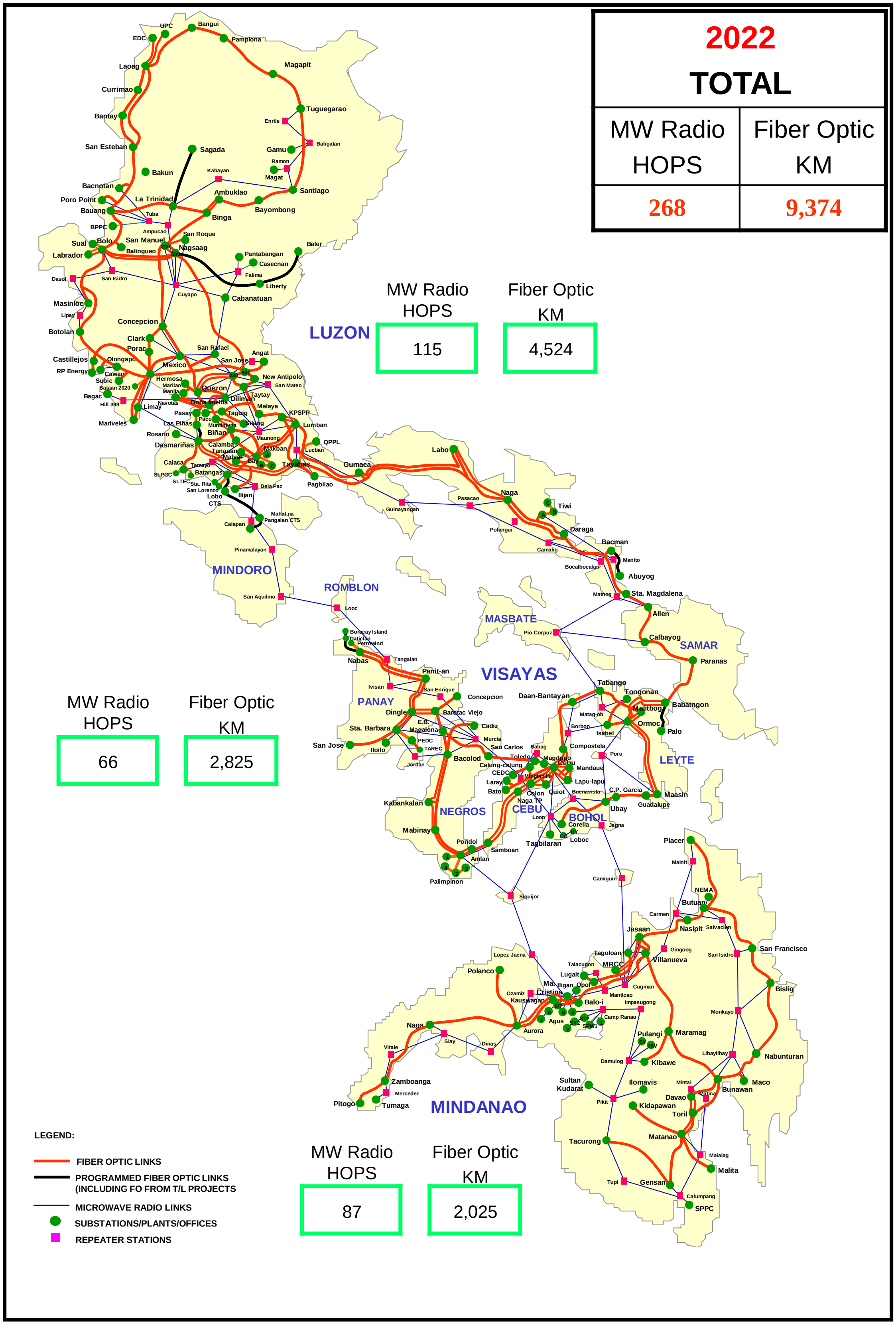


Fig. 4.1.8.g: NGCP Telecom Network – 2022

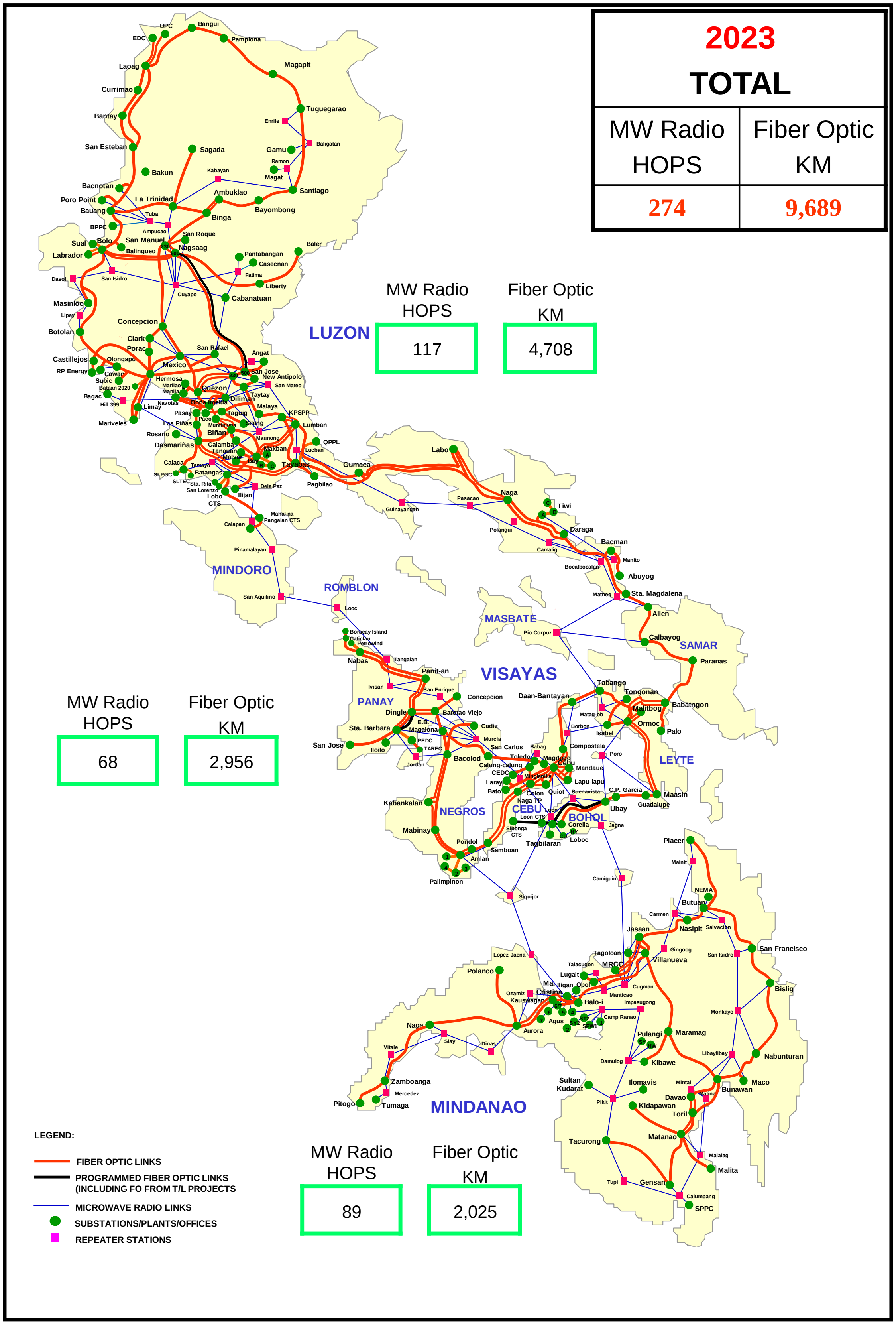


Fig. 4.1.8.h: NGCP Telecom Network – 2023

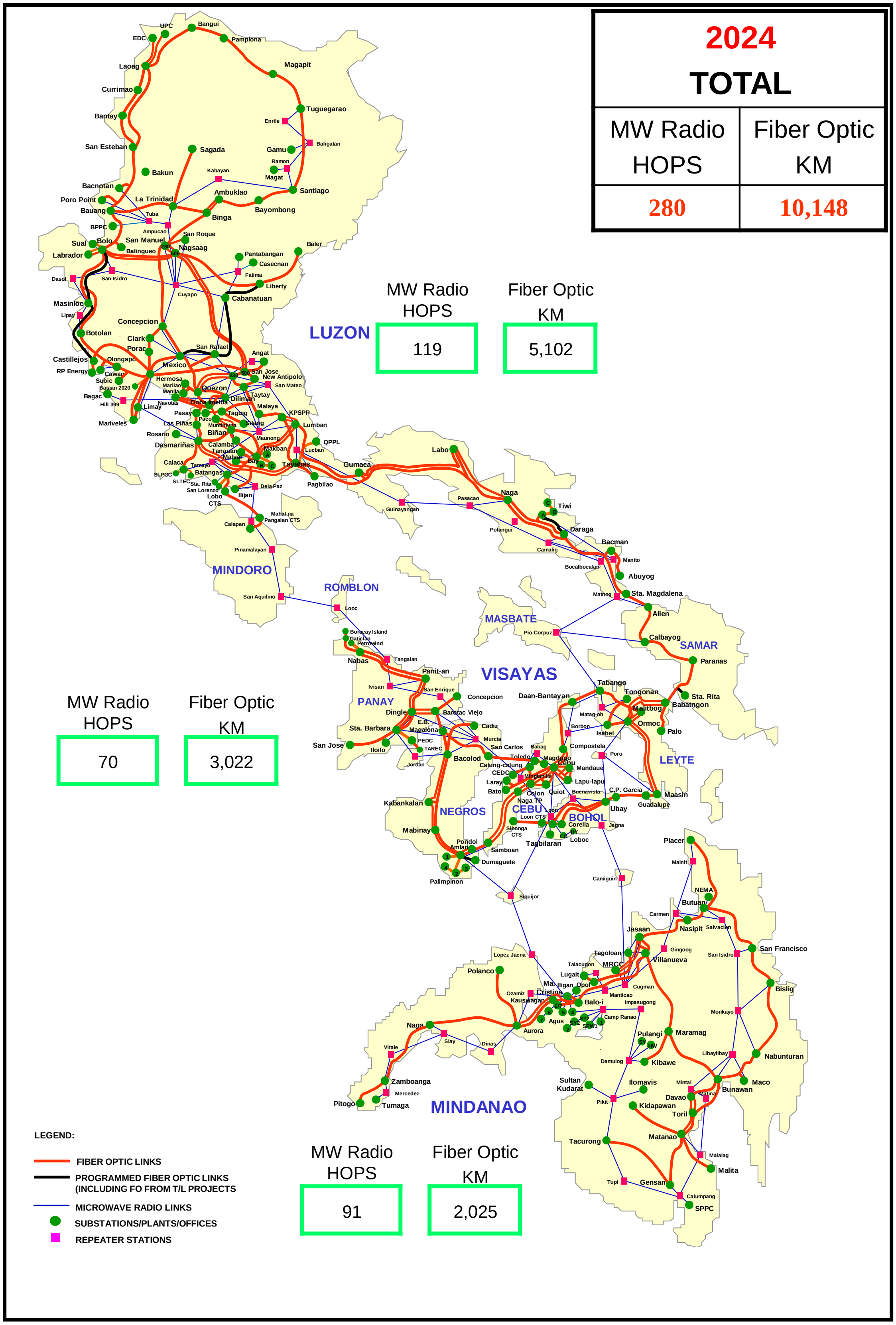


Fig. 4.1.8.i: NGCP Telecom Network – 2024

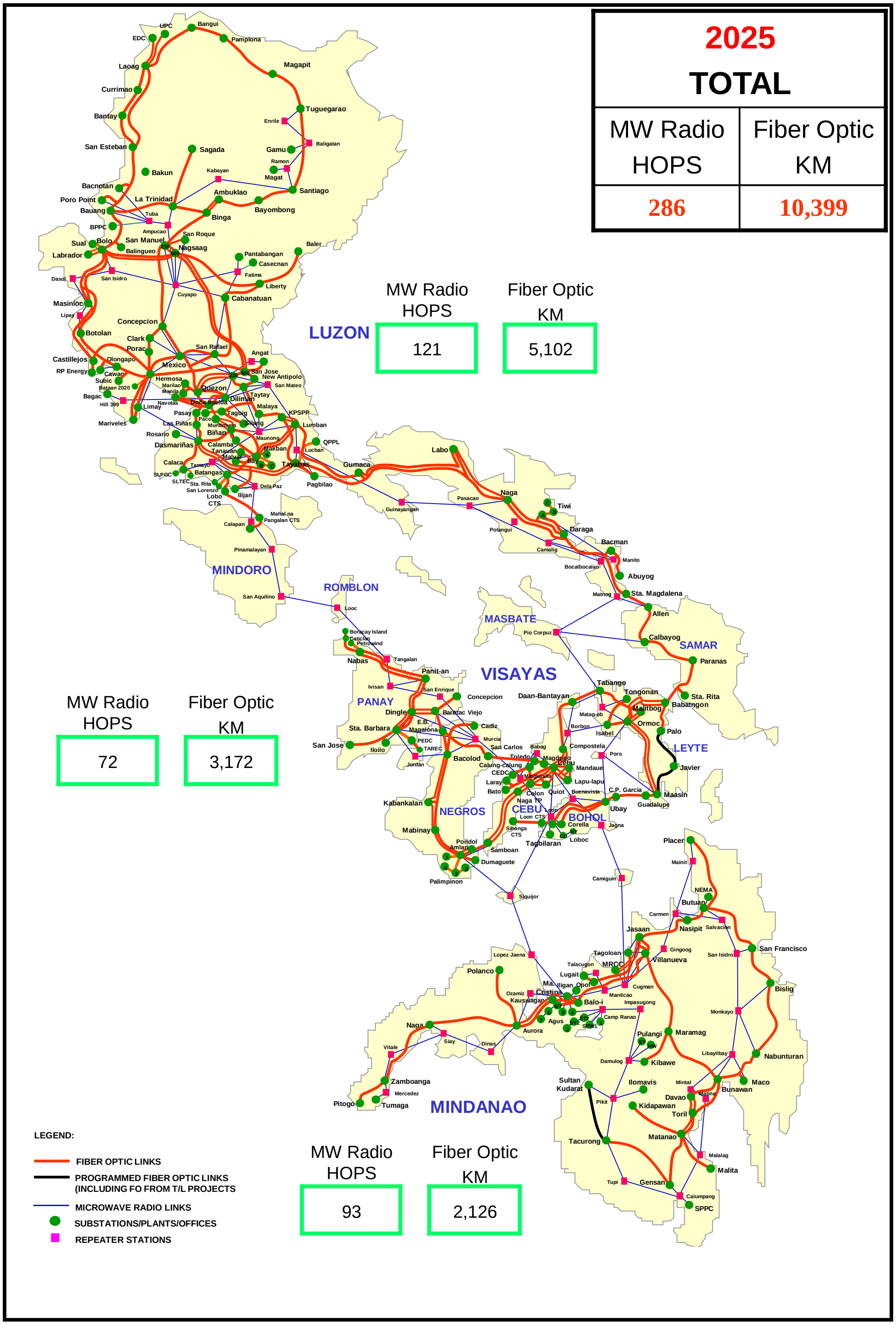


Fig. 4.1.8.j: NGCP Telecom Network – 2025

4.2 CAPEX Schedule (in Million Php)

Table 4.2.a: Luzon Telecom Projects

REPLACEMENTS AND REPLENISHMENTS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	3.00	10.00	7.00	3.00	19.00	3.00	7.00	3.00	15.00	3.00	73.00
1.1 STM-1/STM-4 Terminal Equipment		3			12				8		23.00
		2 nodes			8 nodes				8 nodes		18 nodes
1.2 OLTE/ADM Modules Replenishment	3	3	3	3	3	3	3	3	3	3	30.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
1.3 Fiber Optic Cable Replenishment		4	4		4		4		4		20.00
		5 reels	5 reels		5 reels		5 reels		5 reels		25 reels
2. MICROWAVE COMMUNICATION SYSTEM	5.00	16.30	5.50	15.00	16.30	6.50	5.00	6.50	5.00	6.50	87.60
2.1 Low Capacity Microwave Radios for IPPs		10		10	10						30.00
		2 links		2 links	2 links						6 links
2.2 Dehydrators			0.5			0.2		0.2		0.2	1.10
			5 units			2 units		2 units		2 units	11 units
2.3 Microwave Radio Modules Replenishment	5	5	5	5	5	5	5	5	5	5	50.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
2.4 Elliptical Waveguide Replenishment		1.3			1.3	1.3		1.3		1.3	6.50
		300 m.			300 m.	300 m.		300 m.		300 m.	1500 m.
3. ACCESS MULTIPLEXERS	3.00	9.00	9.00	3.00	9.00	10.00	10.00	10.00	10.00	10.00	83.00
3.1 Access Multiplexers for IPPs		6	6		6	6	6	6	6	6	48.00
		2 nodes	2 nodes		2 nodes	3 nodes	3 nodes	3 nodes	3 nodes	3 nodes	21 nodes
3.2 Low Order Multiplexer Modules Replenishment						1	1	1	1	1	5.00
						1 lot	1 lot	1 lot	1 lot	1 lot	5 lots

3.3 Multiplexer Modules Replenishment	3	3	3	3	3	3	3	3	3	3	30.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
4. NETWORK SYNCHRONIZATION SYSTEM	0.00	0.00	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	10.00
4.1 Sync Modules Replenishment						2	2	2	2	2	10.00
						1 lot	1 lot	1 lot	1 lot	1 lot	5 lots
5. LAND MOBILE RADIO SYSTEM	0.00	2.00	3.00	15.00	6.00	2.00	0.00	8.00	0.00	2.00	38.00
5.1 UHF Point-to-Point Radio			3								3.00
			4 sets								4 sets
5.2 Migration from Analog to Digital LMR/Mesh Radio System				10	5			5			20.00
				3 sets	2 sets			2 sets			7 sets
5.3 Portable Radio Components				3	1			1			5.00
				30 units	10 units			10 units			50 units
5.4 UHF Repeater Modules Replenishment		2		2		2		2		2	10.00
		1 lot		1 lot		1 lot		1 lot		1 lot	5 lots
6. TELEPROTECTION SYSTEM	20.00	10.00	31.80	0.00	0.00	8.80	7.00	0.80	0.00	0.80	79.20
6.1 Power Line Carrier	10	5	25								40.00
	2 links	1 link	5 links								8 links
6.2 Protection Signaling Equipment	10	5	6			8	7				36.00
	10 links	5 links	6 links			8 links	7 links				36 links
6.3 Optical-to-Electrical Converters			0.8			0.8		0.8		0.8	3.20
			8 sets			8 sets		8 sets		8 sets	32 sets
7. POWER SUPPLY AND AUXILIARY SYSTEM	6.20	20.65	9.85	20.38	11.80	12.70	14.95	14.20	14.70	16.95	142.38
7.1 48VDC Rectifier/Chargers		6.25	6.25	4.68	6.25	3.2	3.2	3.2	3.2	3.2	39.43
		8 sets	8 sets	6 sets	8 sets	4 sets	4 sets	4 sets	4 sets	4 sets	50 sets
7.2 48VDC Battery Banks	5.2	3.9	2.6	5.2	4.55	3	3.75	4.5	6	3.75	42.45
	15 banks	6 banks	4 banks	8 banks	8 banks	4 banks	5 banks	6 banks	8 banks	5 banks	69 banks

7.3 Generator Sets		4.5		4.5		3	3	3	3	3	24.00
		3 units		3 units		2 units	2 units	2 units	2 units	2 units	16 units
7.4. 48VDC Charger Modules Replenishment		5		5		2.5	5	2.5	2.5	5	27.50
		1 lot		1 lot		1 lot	1 lot	1 lot	1 lot	1 lot	7 lots
7.5. Generator Set Replenishment	1		1		1	1		1		1	6.00
	1 lot		1 lot		1 lot	1 lot		1 lot		1 lot	6 lots
7.6. Hybrid Power Supply Modules Replenishment		1		1						1	3.00
		1 lot		1 lot						1 lot	3 lots
8. SYSTEM TOOLS AND TEST EQUIPMENT	2.00	1.50	6.00	6.00	0.00	5.00	2.10	1.50	3.00	8.00	35.10
8.1 Test Instruments for Fiber Optic Applications			3	3						5	11.00
			3 sets	3 sets						8 sets	14 sets
8.2 Test Instruments for MW/UHF Radio Systems			3	3		5			3	3	17.00
			1 set	1 set		3 sets			1 set	1 set	7 sets
8.3 Test Instruments for Datacom and IP Applications	2						2.1				4.10
	2 sets						3 sets				5 sets
8.4 Test Instruments for PLC/PSE		1.5						1.5			3.00
		2 sets						2 sets			4 sets
TOTAL	**39.20**	**69.45**	**72.15**	**62.38**	**62.10**	**50.00**	**48.05**	**46.00**	**49.70**	**49.25**	**548.28**

REHABILITATIONS AND UPGRADES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	0.00	0.00	3.00	0.00	37.00	0.00	30.00	16.50	9.00	12.00	107.50
1.1 STM-4/16 to STM-16/64 Terminal Equipment					33		30				63.00
					11 nodes		15 nodes				26 nodes
1.2 STM-1/4 to STM-4/16 Terminal Equipment					4			16.5			20.50
					2 nodes			10 nodes			12 nodes
1.3 Low to High Capacity Terminal Equipment			3						9		12.00
			2 nodes						7 nodes		9 nodes
1.4 Remote Fiber Monitoring System										12	12.00
										13 nodes	13 nodes
2. MICROWAVE COMMUNICATION SYSTEM	5.00	42.00	25.00	12.00	0.00	30.00	30.00	30.00	30.00	30.00	234.00
2.1 Upgrade of Microwave Radios to NxSTM-1		22									22.00
		9 links									9 links
2.2 Low to High Capacity Microwave Radios	5	20	25	12		30	30	30	30	30	212.00
	1 links	4 links	5 links	2 links		6 links	6 links	6 links	6 links	6 links	42 links
3. WIDE AREA NETWORK	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	45.00
3.1 System Upgrade and Rehabilitation			20							25	45.00
			1 lot							1 lot	2 lots
4. TELEPHONY	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	10.00	0.00	20.00
4.1 System Upgrade and Rehabilitation			10						10		20.00
			1 lot						1 lot		2 lots
5. NETWORK MANAGEMENT SYSTEM	10.00	10.00	0.00	10.00	0.00	22.00	4.00	4.00	10.00	10.00	80.00
5.1 Upgrading of Synchronization System NMS		10					4	4	10		28.00
		1 lot					1 lot	1 lot	1 lot		4 lots

5.2 Upgrading of NMS/EMS	10					22					32.00
	1 lot					2 lots					3 lots
5.3 Upgrading of Facilities Management System				10						10	20.00
				1 lot						1 lot	2 lots
6. LAND MOBILE RADIO SYSTEM	0.00	3.00	3.00	0.00	0.00	3.00	0.50	3.00	0.50	0.00	13.00
6.1 UHF Repeater Radios		2.5	2.5			2.5		2.5			10.00
		2 sets	2 sets			2 sets		2 sets			8 sets
6.2 UHF Antenna System		0.5	0.5			0.5	0.5	0.5	0.5		3.00
		150 m	150 m			150 m	150 m	150 m	150 m		900 m
7. POWER SUPPLY AND AUXILIARY SYSTEM	16.50	1.00	1.50	0.50	3.50	7.05	2.00	2.00	3.00	2.00	39.05
7.1 Lightning, Grounding and Surge Protection	15	1	1		3	2	1	2	2	2	29.00
	18 stns	1 stn	1 stn		3 stns	2 stns	1 stn	2 stns	2 stns	2 stns	32 stns
7.2 Distribution Panel	1		0.5	0.5	0.5		1		1		4.50
	6 sets		3 sets	3 sets	3 sets		3 sets		3 sets		21 sets
7.3 Inverter/Water Distilling System	0.5					3.5					4.00
	1 lot					2 lots					3 lots
7.4 Tower Lights						0.8					0.80
						10 units					10 units
7.5 Air-conditioning Units						0.75					0.75
						10 units					10 units
8.FACILTIES MANAGEMENT SYSTEM	0.00	0.00	0.00	0.00	10.00	10.00	10.00	10.00	10.00	0.00	50.00
8.1 FMS Upgrade (Additional Monitoring Elements)					10	10	10	10	10		50.00
					1 lot	1 lot	1 lot	1 lot	1 lot		5 lots
TOTAL	**31.50**	**56.00**	**62.50**	**22.50**	**50.50**	**72.05**	**76.50**	**65.50**	**72.50**	**79.00**	**588.55**
***TOTAL**	**31.80**	**82.05**	**71.15**	**33.60**	**51.60**	**73.25**	**81.80**	**66.70**	**77.70**	**92.50**	**662.15**

*New total with addition of Power Supply and Auxiliary redundancy requirements under Expansion.

EXPANSION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	206.00	254.00	118.00	163.00	0.00	95.00	0.00	144.00	75.00	0.00	1,055.00
1.1 OPGW Retrofitting	186	146	18	63		95		144	75		727.00
	173 km	155 km	20 km	70 km		95 km		160 km	75 km		748 km
1.2 OLTE Components for OPGW Projects		8									8.00
		3 nodes									3 nodes
1.3 Submarine Fiber Optic Cable	20	100	100	100							320.00
		25 km									25 km
2. MICROWAVE COMMUNICATION SYSTEM	0.00	24.00	9.00	25.50	0.00	10.50	9.00	10.50	9.00	10.50	108.00
2.1 High Capacity Microwave Radios				15							15.00
				3 links							3 links
2.2 Microwave Radios for Incoming IPPs		22.5	9	9		9	9	9	9	9	85.50
		5 links	2 links	2 links		2 links	2 links	2 links	2 links	2 links	19 links
2.3 Low Capacity Radios (IP) for NGCP Field Offices		1.5		1.5		1.5		1.5		1.5	7.50
		2 links		2 links		2 links		2 links		2 links	10 links
3. ACCESS MULTIPLEXERS	0.00	5.00	2.00	2.00	0.00	2.00	2.00	2.00	2.00	2.00	19.00
3.1 Access Multiplexers for IPPs		5	2	2		2	2	2	2	2	19.00
		10 sets	4 sets	4 sets		4 sets	4 sets	4 sets	4 sets	4 sets	38 sets
4. NETWORK SYNCHRONIZATION SYSTEM	14.40	14.40	16.20	0.00	0.00	0.00	10.00	10.00	10.00	10.00	85.00
4.1 Substation Grid Clocks	14.4	14.4	16.2				10	10	10	10	85.00
	8 nodes	8 nodes	9 nodes				5 nodes	5 nodes	5 nodes	5 nodes	45 nodes
5. NETWORK MANAGEMENT SYSTEM	0.00	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00
5.1 INMS Expansion and Back-Up System		10									10.00
		1 lot									1 lot

6. FACILITIES MANAGEMENT SYSTEM	**0.00**	**11.50**	**15.50**	**15.50**	**19.50**	**5.00**	**5.00**	**5.00**	**5.00**	**4.00**	**86.00**
6.1 Facilities Management System		7.5	7.5	7.5	7.5						30.00
		5 units	5 units	5 units	5 units						20 units
6.2 Remote Fiber Monitoring System					4					4	8.00
					2 nodes					2 nodes	4 nodes
6.3 Battery Monitoring System		4	8	8	8	5	5	5	5		48.00
		8 banks	16 banks	16 banks	16 banks	8 banks	8 banks	8 banks	8 banks		88 banks
7. POWER SUPPLY AND AUXILIARY SYSTEM	**0.00**	**15.40**	**8.65**	**9.10**	**0.10**	**1.20**	**5.30**	**1.20**	**5.20**	**5.30**	**51.45**
7.1 Renewable Power Supply		12	8	8			4		4	4	40.00
		2 sets	2 sets	2 sets			1 set		1 set	1 set	7 sets
7.2 Low Capacity 48Vdc Chargers for IPPs (2C)		1.8	0.3	0.6		0.6	0.6	0.6	0.6	0.6	5.70
		12 sets	2 sets	4 sets		4 sets	4 sets	4 sets	4 sets	4 sets	38 sets
7.3 Low Capacity 48Vdc Battery Banks for IPPs (1B)		1.5	0.25	0.5		0.6	0.6	0.6	0.6	0.6	5.25
		1 bank	1 bank	2 banks		2 banks	2 banks	2 banks	2 banks	2 banks	19 banks
7.4 Transformer		0.1	0.1		0.1		0.1			0.1	0.50
		1 unit	1 unit		1 unit		1 unit			1 unit	5 units
8. SYSTEM TOOLS AND TEST EQUIPMENT	**0.30**	**10.65**	**0.00**	**2.00**	**1.00**	**0.00**	**0.00**	**0.00**	**0.00**	**8.20**	**22.15**
8.1 Test Instruments for Fiber Optic Applications					1					1	2.00
					1 set					1 set	2 sets
8.2 Test Instruments for MW/UHF/VHF Radio System		7									7.00
		2 sets									2 sets
8.3 Test Instruments for Datacom and IP Applications				2						2	4.00
				1 set						1 set	2 sets
8.4 Test Instruments for Electrical Installations	0.3	3.65								5.20	9.15
	4 sets	9 sets								10 sets	23 sets

9. DISASTER COMMUNICATION SYSTEM	15.473	0.00	0.00	0.00	0.00	0.00	15.473	0.00	0.00	0.00	30.95
9.1 Disaster Communication System	15						15				30.00
	1 lot						1 lot				2 lots
9.2 Satellite Phones	0.473						0.473				0.946
	11 units						11 units				22 units
TOTAL	**236.173**	**344.95**	**169.35**	**217.10**	**20.60**	**113.70**	**46.773**	**172.70**	**106.20**	**40.00**	**1,467.55**
***TOTAL**	**235.87**	**318.90**	**160.70**	**206.00**	**19.50**	**112.50**	**41.47**	**171.50**	**101.00**	**26.50**	**1,393.95**

*New total less Power Supply and Auxiliary redundancy requirements transferred to Rehab/Upgrade.

Table 4.2.b: Visayas Telecom Projects

REPLACEMENTS AND REPLENISHMENTS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	3.00	4.00	5.00	6.00	2.00	5.00	0.00	0.00	3.00	7.00	35.00
2.1. STM-N Terminal Equipment		4	5	3	2	5				7	26.00
		4 nodes	5 nodes	3 nodes	2 nodes	5 nodes				7 nodes	26 nodes
1.2 Fiber Optic Cable Replenishment	3			3					3		9.00
	10 km			10 km					10 km		30 km
2. MICROWAVE COMMUNICATION SYSTEM	15.00	15.00	15.00	14.00	15.00	3.00	3.00	12.00	12.00	12.00	116.00
2.1 High Capacity Microwave Radios	12	12	12	11	12			9	9	9	86.00
	4 links	4 links	4 links	2 links	2 links			3 links	3 links	3 links	25 links
2.2 Microwave Radio Modules Replenishments	3	3	3	3	3	3	3	3	3	3	30.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
3. ACCESS MULTIPLEXERS	6.00	5.00	6.00	5.00	5.00	6.00	6.00	5.00	5.00	5.00	54.00
3.1 Access Multiplexers	5	5	5	5	4	5	5	4	4	4	46.00
	5 nodes	5 nodes	5 nodes	5 nodes	4 nodes	5 nodes	5 nodes	4 nodes	4 nodes	4 nodes	46 nodes
3.2 Multiplexer Modules Replenishments	1		1		1	1	1	1	1	1	8.00
	1 lot		1 lot		1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	8 lots
4. WIDE AREA NETWORK	2.50	1.50	2.50	2.00	2.50	6.50	0.50	0.50	2.50	1.50	22.50
4.1 Routers	2	1	2	1.5	2	6			2	1	17.50
	4 sets	2 sets	4 sets	3 sets	4 sets	12 sets			4 sets	2 sets	35 sets
4.2 Router and Switch Modules Replenishment	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	5.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots

5. IP TELEPHONY	**3.50**	**2.00**	**0.00**	**0.00**	**0.00**	**6.00**	**2.00**	**0.00**	**0.00**	**0.00**	**13.50**
5.1 IP Telephony Server and Voice Logger System	3.5	2				6	2				13.50
	2 sets	1 set				3 set	1 set				7 sets
6. NETWORK SYNCHRONIZATION SYSTEM	**2.00**	**10.00**	**10.20**	**10.00**	**2.00**	**1.00**	**6.00**	**1.00**	**1.00**	**1.00**	**44.20**
6.1 Telecom Synchronization System Units (SSU)		8	8.2	8			5				29.20
		1 set	1 set	1 set			1 set				4 sets
6.2 SSU Modules Replenishment	2	2	2	2	2	1	1	1	1	1	15.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
7. NETWORK MANAGEMENT SYSTEM	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**30.00**
7.1 Network Management Systems Replenishment	3	3	3	3	3	3	3	3	3	3	30.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
8.LAND MOBILE RADIO SYSTEM	**0.00**	**9.60**	**10.00**	**2.40**	**0.40**	**7.00**	**4.50**	**7.00**	**2.50**	**5.00**	**48.40**
8.1 VHF Repeater Radios		3	5			2		2		2	14.00
		2 sets	2 sets			1set		1set		1set	7 sets
8.2 VHF Repeater Stations		6	4	2		4	4	4	2	2	28.00
		3 sets	2 sets	1 set		2 sets	2 sets	2 sets	1 set	1 set	14 sets
8.3 VHF Repeater Radio Modules Replenishment		0.6	1	0.4	0.4	1	0.5	1	0.5	1	6.40
		1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	9 lots
9. TELEPROTECTION SYSTEM	**8.00**	**12.00**	**21.00**	**10.00**	**14.00**	**14.00**	**8.00**	**10.00**	**8.00**	**4.00**	**109.00**
9.1 Power Line Carrier Equipment (PLC)	4	8	14	6	10	10	6	6	6		70.00
	2 link	4 links	7 links	3 links	5 links	5 links	3 links	3 links	3 links		35 links
9.2 Protection Signaling Equipment (PSE)	2	2	5	2	2	2		2		2	19.00
	2 sets	2 sets	5 sets	2 sets	2 sets	2 sets		2 sets		2 sets	19 sets
9.3 PLC Spare Modules Replenishment	1	1	1	1	1	1	1	1	1	1	10.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots

9.4 PSE Spare Modules Replenishment	1	1	1	1	1	1	1	1	1	1	10.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
10. POWER SUPPLY AND AUXILIARY SYSTEM	10.40	14.90	16.40	16.60	15.60	18.80	19.00	18.30	18.80	15.50	164.30
10.1 48VDC Power Supply System	1.2	3.1	2.1	2.1	3	6	7.2	6.5	6.5	5.2	42.90
	2 stns	4 stns	3 stns	4 stns	3 stns	7 stns	7 stns	5 stns	5 stns	4 stns	44 stns
10.2 MTD-Maintained 48VDC Power Supply System	6	8	6	6	4	6	6	6	6	4	58.00
	3 stns	4 stns	3 stns	3 stns	2 stns	3 stns	3 stns	3 stns	3 stns	2 stns	29 stns
10.3 Generator Sets	1.8	1.9	5.9	5.9	6	4	4	4	4	4	41.50
	1 set	1 set	3 sets	3 sets	3 sets	2 sets	2 sets	2 sets	2 sets	2 sets	21 sets
10.4 Air Conditioning Units	0.3	0.3	0.7	0.8	0.8	0.4	0.4	0.4	0.4	0.4	4.90
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
10.5 48VDC Charger Modules Replenishment	0.5	1	1	1	1	1.5	0.5	0.5	1	1	9.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
10.6 Generator Set Replenishment	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	4.30
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
10.7 Battery Monitoring System Replenishment	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	3.70
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
11. SYSTEM TOOLS AND TEST EQUIPMENT	7.50	1.00	8.00	4.50	3.00	6.00	0.00	0.00	0.00	0.00	30.00
11.1 Test Instruments for Fiber Optic Applications	2.5		3			2					7.50
	3 sets		1 set			2 sets					6 sets
11.2 Test Instruments for MW/UHF/VHF Radio System	3		3	3.5		2					11.50
	3 sets		1 set	1 set		2 sets					7 sets
11.3 Test Instruments for Datacom and IP Applications	2		2	1	2	2					9.00
	1 set		1 set	1 set	1 set	2 sets					6 sets
11.4 Test Instruments for Electrical Installations		1			1						2.00
		1 set			8 sets						9 sets
TOTAL	**60.90**	**78.00**	**97.10**	**73.50**	**62.50**	**76.30**	**52.00**	**56.80**	**55.80**	**54.00**	**666.90**

REHABILITATIONS AND UPGRADES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	1.00	1.00	1.00	1.00	1.00	3.00	3.00	3.00	3.00	3.00	20.00
1.1 Upgrade of OLTE to STM-N	1	1	1	1	1	3	3	3	3	3	20.00
	1 node	1 node	1 node	1 node	1 node	3 nodes	3 nodes	3 nodes	3 nodes	3 nodes	11 nodes
2. MICROWAVE COMMUNICATION SYSTEM	0.00	5.00	0.00	5.00	0.00	8.00	4.00	4.00	5.00	10.00	41.00
2.1 Upgrade of SDH/PDH MW Radio to N x STM-1		5		5		8	4	4	5	10	41.00
		2 links		2 links		8 links	4 links	4 links	2 links	4 links	26 links
3. ACCESS MULTIPLEXERS	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	20.00
3.1 Access Multiplexer Upgrade (Software, Firmware, Capacity, etc.)	2	2	2	2	2	2	2	2	2	2	20.00
	2 nodes	2 nodes	2 nodes	2 nodes	2 nodes	4 nodes	4 nodes	4 nodes	4 nodes	2 nodes	22 nodes
4. WIDE AREA NETWORK	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	11.00
4.1 WAN System Upgrade (Software, Firmware, Capacity, etc.)	1	1	1	1	1	1	1	1	1	2	11.00
	1 set	1 set	1 set	1 set	1 set	1 set	1 set	1 set	1 set	2 sets	11 sets
5. IP TELEPHONY	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	8.00
5.1 Call Manager	1	1	1	1	1		1	1	1		8.00
	1 set	1 set	1 set	1 set	1 set		1 set	1 set	1 set		8 sets
6. NETWORK SYNCHRONIZATION SYSTEM	0.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	8.00
6.1 SSU Modules Upgrade		2	1	1	1	1	1	1			8.00
		1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot			7 lots
7. NETWORK MANAGEMENT SYSTEM	0	5	10	10	5	5	0	0	15	10	60.00
7.1 Upgrading of Multiplexer Network Management System	15							10			25.00
	1 lot							1 lot			2 lots

7.2 Upgrading of Facilities Management System			10							10	20.00
			1 lot							1 lot	2 lots
7.3 Upgrading of Fiber Monitoring System				5							5.00
				1 lot							1 lot
7.4 Upgrading of Integrated Network Management System					5						5.00
					1 lot						1 lot
7.5 Upgrading of NMS Center						5					5.00
						1 lot					1 lot
8. FACILITIES MANAGEMENT SYSTEM	1.30	1.60	1.60	1.60	2.00	2.00	1.50	0.00	2.00	0.00	13.60
8.1 Battery Monitoring System Upgrade (SNMP & Sensors)	1.3	1.6	1.6	1.6	2	2	1.5		2		13.60
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot		1 lot		8 lots
9. TELEPROTECTION SYSTEM	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	10.00
9.1 Upgrade of Protection Signaling Equipment (Firmware, Software, Capacity, Quantity of Commands, Communication Medium, Etc.)	1	1	1	1	1	1	1	1	1	1	10.00
	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets	20 sets
10. POWER SUPPLY AND AUXILIARY SYSTEM	7.30	9.70	5.00	6.00	9.50	6.62	10.35	6.35	8.35	4.30	73.47
10.1 48VDC Power Supply System	1	4.5	2.5	3.5	7	4.1	8	4	6	4	44.60
	1 stn	5 stns	3 stns	4 stns	3 stns	4 stns	8 stns	4 stns	6 stns	4 stns	42 stns
10.2 Renewable Power Supply	5	1.5									6.50
	1 set	1 set									2 sets
10.3 Lightning Protection System		2.4									2.40
		2 stns									2 stns
10.4 Grounding System Upgrade of Microwave R/S	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	3.00
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
10.5 Microwave Tower Lighting System Upgrade	1	1	2.2	2.2	2.2	1.2	1.2	1.2	1.2		13.40
	3 sites	3 sites	3 sites	3 sites	3 sites	3 sites	3 sites	3 sites	3 sites		27 sites

10.6 Distribution Panel						1.02	0.85	0.85	0.85		3.57
						6 sites	5 sites	5 sites	5 sites		21 sites
TOTAL	**29.60**	**24.30**	**23.60**	**24.60**	**23.50**	**29.62**	**24.85**	**29.35**	**23.35**	**32.30**	**265.07**
***TOTAL**	**29.60**	**27.05**	**27.65**	**28.10**	**24.05**	**34.22**	**25.95**	**33.95**	**24.45**	**33.40**	**288.42**

*New total with addition of Power Supply and Auxiliary redundancy requirements under Expansion.

EXPANSION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	80.00	106.00	82.00	87.00	0.00	77.00	62.00	62.00	32.00	62.00	650.00
1.1 OPGW Retrofitting	78	106	78	83		75	60	60	30	60	630.00
	78 km	106 km	78 km	83 km		75 km	60 km	60 km	30 km	60km	630 km
1.2 Optical Line Terminal Equipment	2		4	4		2	2	2	2	2	20.00
	2 nodes		4 nodes	4 nodes		2 nodes	2 nodes	2 nodes	2 nodes	2 nodes	20 nodes
2. MICROWAVE COMMUNICATION SYSTEM	10.00	26.50	9.50	0.00	4.50	9.00	9.00	9.00	9.00	9.00	95.50
2.1 High Capacity Microwave Radios	6	8	5								19.00
	1 link	2 links	1 link								4 links
2.2 Microwave Radios for Incoming IPPs	4.0	18.5	4.5		4.5	9	9	9	9	9	76.50
	2 links	5 links	1 link		1 link	2 links	2 links	2 links	2 links	2 links	19 links
3. ACCESS MULTIPLEXERS	4.00	1.00	1.00	0.00	1.00	2.00	2.00	2.00	2.00	2.00	17.00
3.1 Access Multiplexers	4	1	1		1	2	2	2	2	2	17.00
	8 nodes	2 nodes	2 nodes		2 nodes	4 nodes	4 nodes	4 nodes	4 nodes	4 nodes	34 nodes
4. WIDE AREA NETWORK	6.00	8.00	5.00	2.00	0.00	6.00	6.00	6.00	6.00	0.00	45.00
4.1 Routers	3	5	2	1		4	4	4	4		27.00
	9 sets	7 sets	6 sets	3 sets		8 sets	8 sets	8 sets	8 sets		57 sets
4.2 POE Layer 2/Layer 3 Switches	3	3	3	1		2	2	2	2		18.00
	6 sets	6 sets	6 sets	2 sets		4 sets	4 sets	4 sets	4 sets		36 sets
5. TELEPHONY	1.50	0.50	0.50	0.50	0.50	1.00	0.50	0.50	0.50	0.50	6.50
5.1 IP Phones	1.5	0.5	0.5	0.5	0.5	1	0.5	0.5	0.5	0.5	6.50
	150 units	20 units	20 units	20 units	20 units	100 units	20 units	20 units	20 units	20 units	410 units
6. NETWORK SYNCHRONIZATION SYSTEM	0.00	7.60	7.60	0.00	0.00	0.00	7.00	7.00	7.00	0.00	36.20

6.1 Telecom Synchronization System Units (SSU)		7.6	7.6				7	7	7		36.20
		1 node	1 node				1 node	1 node	1 node		5 nodes
6.2 Substation Grid Clock						4	4	4	4	4	20.00
						2 nodes	2 nodes	2 nodes	2 nodes	2 nodes	10 nodes
7. NETWORK MANAGEMENT SYSTEM	10.00	4.00	4.00	0.00	4.00	0.00	0.00	0.00	4.00	0.00	26.00
7.1 Telecom Network Resource Management System					4				4		8.00
					1 lot				1 lot		2 lots
7.2 WAN Performance Management System	10	4	4								18.00
	1 lot	1 lot	1 lot								3 lots
8. FACILITIES MANAGEMENT SYSTEM	10.50	10.50	10.50	6.00	10.50	10.50	10.50	12.00	12.67	2.00	95.67
8.1 Facilities Management System	4.5	4.5	4.5		4.5	4.5	4.5	6	6		39.00
	3 sites	3 sites	3 sites		3 sites	3 sites	3 sites	4 sites	4 sites		26 sites
8.2 Remote Fiber Monitoring System	4	4	4	4	4	2	2	2	2	2	30.00
	2 nodes	2 nodes	2 nodes	2 nodes	2 nodes	1 node	1 node	1 node	1 node	1 node	15 nodes
8.3 Battery Monitoring System	2	2	2	2	2	4	4	4	4.67		26.67
	3 sets	3 sets	3 sets	3 sets	3 sets	6 sets	6 sets	6 sets	7 sets		40 sets
9. POWER SUPPLY AND AUXILIARY SYSTEM	0.00	2.75	4.05	3.50	0.55	4.60	1.10	4.60	1.10	1.10	23.35
9.1 Renewable Power Supply			3.5	3.5		3.5		3.5			14.00
			1 set	1 set		1 set		1 set			4 sets
9.2 Low Capacity 48Vdc Chargers for IPPs (2C)		1.5	0.3		0.3	0.6	0.6	0.6	0.6	0.6	5.10
		10 sets	2 sets		2 sets	4 sets	4 sets	4 sets	4 sets	4 sets	34 sets
9.3 Low Capacity 48Vdc Battery Bank for IPPs (1B)		1.25	0.25		0.25	0.5	0.5	0.5	0.5	0.5	4.25
		5 banks	1 bank		1 bank	2 banks	2 banks	2 banks	2 banks	2 banks	17 banks
TOTAL	**122.00**	**166.85**	**124.15**	**99.00**	**21.05**	**110.10**	**98.10**	**103.10**	**74.27**	**76.60**	**995.22**
***TOTAL**	**122.00**	**164.10**	**120.10**	**95.50**	**20.50**	**105.50**	**97.00**	**98.50**	**73.17**	**75.50**	**971.87**

*New total less Power Supply and Auxiliary redundancy requirements transferred to Rehab/Upgrade.

Table 4.2.c: Mindanao Telecom Projects

REPLACEMENTS AND REPLENISHMENTS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	1.40	0.00	3.00	3.00	6.00	3.00	15.00	22.00	10.50	7.00	70.90
1.1 STM-n Terminal Equipment				3	6		12	15	7.5		43.50
				2 nodes	4 nodes		8 nodes	10 nodes	5 nodes		29 nodes
1.2 OLTE/ADM Modules Replenishment	0.4					3	3	3	3	3	15.40
	1 lot					1 lot	1 lot	1 lot	1 lot	1 lot	6 lots
1.3 Fiber Optic Cable Replenishment	1		3					4		4	12.00
	1 reel		3 reels					4 reels		4 reels	12 reels
2. MICROWAVE COMMUNICATION SYSTEM	47.00	28.00	22.10	0.00	0.00	27.00	30.70	27.00	27.00	29.10	237.90
2.1 Microwave Radio Equipment	44	28	20			24	24	24	24	24	212.00
	11 links	7 links	5 links			6 links	6 links	6 links	6 links	6 links	53 links
2.2 IP Radios for NGCP Field Offices	2						1.6				3.60
	5 links						4 links				9 links
2.3 Antenna and Radome Replenishment			2.1				2.1			2.1	6.30
			1 lot				1 lot			1 lot	3 lots
2.4 Microwave Radio Modules Replenishment	1					3	3	3	3	3	16.00
	1 lot					1 lot	1 lot	1 lot	1 lot	1 lot	6 lots
3. ACCESS MULTIPLEXERS	10.00	8.00	5.00	0.00	2.00	3.00	5.00	3.00	5.00	3.00	44.00
3.1 Access Multiplexers	10	6	3			3	3	3	3	3	34.00
	10 nodes	6 nodes	3 nodes			3 nodes	3 nodes	3 nodes	3 nodes	3 nodes	34 nodes
3.2 Multiplexer Modules Replenishment		2	2		2		2		2		10.00
		1 lot	1 lot		1 lot		1 lot		1 lot		5 lots

4. WIDE AREA NETWORK	0.50	11.00	7.00	0.50	1.00	0.50	0.50	1.00	16.00	0.50	38.50
4.1 Routers		10	6						16		32.00
		6sets	2 sets						8 sets		16 sets
4.2 Switches		1	0.5	0.5	0.5	0.5	0.5	0.5			4.00
		4 sets	2 sets	2 sets	2 sets	2 sets	2 sets	2 sets			16 sets
4.3 Router Modules Replenishment	0.5		0.5		0.5			0.5		0.5	2.50
	1 lot		1 lot		1 lot			1 lot		1 lot	5 lots
5. TELEPHONY	0.00	0.40	0.40	0.00	0.00	10.50	0.00	0.50	0.00	0.50	12.30
5.1 VOIP Telephony (Call Manager)						10					10.00
						2 sets					2 sets
5.2 IP Telephony Modules Replenishment		0.4	0.4			0.5		0.5		0.5	2.30
		1 lot	1 lot			1 lot		1 lot		1 lot	5 lots
6. NETWORK SYNCHRONIZATION SYSTEM	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	3.00
6.1 SSU Modules Replenishment	1			1			1				3.00
	1 lot			1 lot			1 lot				3 lots
7. LAND MOBILE RADIO SYSTEM	0.30	0.00	1.15	0.90	1.10	1.65	1.65	1.65	1.20	0.30	9.90
7.1 VHF Radio Repeaters			0.8	0.8	0.8	1.2	1.2	1.2	0.8		6.80
			2 units	2 units	2 units	3 set	3 sets	3 sets	2 sets		17 sets
7.2 VHF Antenna System			0.1	0.1	0.1	0.15	0.15	0.15	0.1		0.85
			2 sets	2 sets	2 sets	3 sets	3 sets	3 sets	2 sets		17 sets
7.3 VHF Radio Modules Replenishment	0.2		0.2		0.2	0.3	0.3	0.3	0.3	0.3	2.10
	1 lot		1 lot		1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	8 lots
7.4 VHF Radio Base Replenishment	0.1		0.05								0.15
	4 units		2 units								6 units

8. TELEPROTECTION SYSTEM	29.00	24.00	27.00	18.00	14.00	0.00	0.00	0.00	0.00	9.00	121.00
8.1 Power Line Carrier Equipment (PLC)	20	12	12								44.00
	5 links	3 links	3 links								11 links
8.2 Protection Signaling Equipment (PSE)		12	12	12	11						47.00
		12 links	12 links	12 links	11 links						47 links
8.3 PLC Modules Replenishment	3			3						3	9.00
	1 lot			1 lot						1 lot	3 lots
8.4 PSE Modules Replenishment	3			3						3	9.00
	1 lot			1 lot						1 lot	3 lots
8.5 PLC Accessories Replacements (LMU, Coax and HF Cables)	3		3		3					3	12.00
	1 lot		1 lot		1 lot					1 lot	4 lots
9. BATTERY MONITORING SYSTEM	0.50	0.50	0.50	0.50	0.50	0.60	0.60	0.60	0.60	0.60	5.50
9.1 Battery Monitoring System Replenishment	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	5.50
	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	10 lots
10. POWER SUPPLY AND AUXILIARY SYSTEM	23.40	11.50	15.60	12.60	13.60	31.20	16.40	20.10	18.60	15.00	178.00
10.1 48VDC Rectifier/Chargers	10	5	5.5	5.5	5.5	10.2		6	6	6.6	60.30
	10 sets	10 sets	11 sets	11 sets	11 sets	17 sets		10 sets	10 sets	11 sets	101 sets
10.2 48VDC Battery Banks	4.4	3.2	2.8	2.4	3.6	8	6	5.5	4	4	43.90
	11 banks	8 banks	7 banks	6 banks	9 banks	17 banks	16 banks	10 banks	8 banks	8 banks	100 banks
10.3 Generator Sets	4.5	2.8	2.8	4.2		7.2	5.4	3.6	3.6		34.10
	4 sets	4 sets	4 sets	5 sets		8 sets	6 sets	4 sets	4 sets		39 sets
10.4 Air-Conditioning Units	1.5	0.5	0.5	0.5	0.5	1.4	0.6	0.6	0.6		6.70
	20 units	10 units	10 units	10 units	10 units	20 units	10 units	10 units	10 units		110 units
10.5 48VDC Charger Modules Replenishment	2		2.5		2.5	2.7	2.7	2.7	2.7	2.7	20.50
	1 lot		1 lot		1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	8 lots
10.6 Generator Set Replenishment	1		1.5		1.5	1.7	1.7	1.7	1.7	1.7	12.50
	1 lot		1 lot		1 lot	1 lot	1 lot	1 lot	1 lot	1 lot	8 lots

11. SYSTEM TOOLS AND TEST EQUIPMENT	6.00	2.30	5.00	4.90	4.00	10.90	6.50	8.50	0.00	0.00	48.10
11.1 Test Instruments for Fiber Optic Applications			2.4			2.4					4.80
			10 sets			10 sets					20 sets
11.2 Test Instruments for MW/UHF/VHF Radio Systems			2.6	1	2	3.1	1	3.1			12.80
			5 sets	1 set	1 set	6 sets	1 set	6 sets			20 sets
11.3 Test Instruments for Datacom and IP Applications	1	2		1		2	1	2			9.00
	1 set	3 sets		1 set		3 sets	1 set	3 sets			12 sets
11.4 Test Instruments for PLC/PSE	3			1	2	3	3	3			15.00
	4 sets			2 sets	2 sets	2 sets	4 sets	2 sets			16 sets
11.5 Test Instruments for Electrical Installations	2	0.3		1.9		0.4	1.5	0.4			6.50
	2 sets	6 sets		8 sets		6 sets	2 sets	6 sets			30 sets
TOTAL	**119.10**	**85.70**	**86.75**	**41.40**	**42.20**	**88.35**	**77.35**	**84.35**	**78.90**	**65.00**	**769.10**

REHABILITATIONS AND UPGRADES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	3.50	0.00	0.00	0.00	0.00	77.00	10.50	0.00	0.00	0.00	91.00
1.1 OPGW Rehabilitation						77					77.00
						77 km					77km
1.2 STM-n Terminal Equipment	3.5						10.5				14.00
	7 nodes						7 nodes				14 nodes
2. MICROWAVE COMMUNICATION SYSTEM	0.00	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
2.1 High Capacity Microwave Radio Links		6									6.00
		2 links									2 links
3. IP TELEPHONY	0.00	5.00	0.00	0.00	0.00	0.00	0.00	5.00	5.00	0.00	15.00
3.1 Upgrading to IP Telephony System		5						5	5		15.00
		2 nodes						2 nodes	2 nodes		6 nodes
4. WIDE AREA NETWORK	15.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00
4.1 Restructuring and Reconfiguration (Migration to MPLS Technology)	15	3									18.00
	phase 2	phase 3									2 phases
5. POWER SUPPLY AND AUXILIARY SYSTEM	15.65	16.55	15.95	6.15	6.35	11.30	18.90	10.90	11.55	10.80	124.10
5.1 Renewable Power Supply	2	3				2.4	3.6	3.6	3.6	3.6	21.80
	2 sets	3 sets				2 sets	3 sets	3 sets	3 sets	3 sets	19 sets
5.2 Grounding System Resistance Improvement	3.5	5.6	5.6	4.9	5.6	8	8				41.20
	13 stns	8 stns	8 stns	7 stns	8 stns	9 stns	9 stns				62 stns

5.3 Lightning Protection System (Installation of Early Streamer Emission)	8	7.2	9.6				6.4	6.4	6.4	7.2	51.20
	10 stns	9 stns	12 stns				8 stns	8 stns	8 stns	9 stns	64 stns
5.4 Lightning Protection System (Rehabilitation of Early Streamer Emission)	0.75	0.75	0.75	0.75	0.75	0.9	0.9	0.9	0.9		7.35
	3 stns	3 stns	3 stns	3 stns	3 stns	3 stns	3 stns	3 stns	3 stns		27 stns
5.5 Rehabilitation of the 13.8VDC Power Supply System	0.5			0.5					0.65		1.65
	1 lot			1 lot					1 lot		3 lots
5.6 Rehabilitation of AC Distribution Line for MW Repeaters	0.9										0.90
	1 stn										1 stn
6. NETWORK MANAGEMENT SYSTEM		5.00									
6.1 Rehabilitation and Upgrading of MRCC NOC		5									
		1 lot									
TOTAL	**34.15**	**35.55**	**15.95**	**6.15**	**6.35**	**88.30**	**29.40**	**15.90**	**16.55**	**10.80**	**259.10**
***TOTAL**	**36.70**	**40.35**	**21.50**	**9.15**	**6.90**	**89.40**	**30.50**	**40.00**	**17.65**	**13.60**	**305.75**

*Total with addition of Power Supply and Auxiliary redundancy requirements under Expansion.

EXPANSION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
1. FIBER OPTIC COMMUNICATION SYSTEM	10.00	98.00	127.00	112.00	58.00	0.00	0.00	0.00	0.00	0.00	420.00
1.1 OPGW Retrofitting	10	92	124	106	52						384.00
	34 km	92 km	124km	106 km	52km						374 km
1.2 OLTE Component for OPGW Projects		6	3	6	6						21.00
		2 nodes	1 node	2 nodes	2 nodes						7 nodes
2. MICROWAVE COMMUNICATION SYSTEM	0.00	15.50	5.50	1.00	5.50	9.00	9.00	9.00	11.00	11.00	31.50
2.1 Provision for incoming IPPs		13.5	4.5		4.5	9	9	9	9	9	67.50
		3 links	1 link		1 link	2 links	2 links	2 links	2 links	2 links	15 links
2.2 Low Capacity Radios (IP) for NGCP Field Offices		2	1	1	1				2	2	9.00
		2 links	1 link	1 link	1 link				2 links	2 links	9 links
3. ACCESS MULTIPLEXERS	0.00	3.00	1.00	0.00	1.00	2.00	2.00	2.00	2.00	2.00	15.00
3.1 Access Multiplexers for Incoming IPPs		3	1		1	2	2	2	2	2	15.00
		6 nodes	2 nodes		2 nodes	4 nodes	4 nodes	4 nodes	4 nodes	4 nodes	30 nodes
4. WIDE AREA NETWORK	0.00	11.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.75
4.1 Routers		5.75									5.75
		18 sets									18 sets
4.2 POE Switches		6									6.00
		12 sets									12 sets
5. TELEPHONY	0.50	0.65	0.65	0.15	0.00	0.00	0.00	0.15	0.15	0.15	2.40
5.1 IP Phones		0.15	0.15	0.15				0.15	0.15	0.15	0.90
		10 units	10 units	10 units				10 units	10 units	10 units	60 units
5.2 Migration from Legacy to IP Telephony	0.5	0.5	0.5								1.50
	1 lot	1 lot	1 lot								3 lots

6. NETWORK SYNCHRONIZATION SYSTEM	16.00	0.00	11.25	0.00	0.00	0.00	15.00	0.00	0.00	0.00	42.25
6.1 Substation Grid Clock	16		11.25				15				42.25
	8 nodes		6 nodes				8 nodes				22 nodes
7. NETWORK MANAGEMENT SYSTEM	3.00	0.00	40.00	1.00	1.00	51.00	1.00	2.00	1.00	1.00	101.00
7.1 NMS for New Network Elements	3			1	1	1	1	2	1	1	11.00
	1 set			1 set	1 set	1 set	1 set	2 sets	1 set	1 set	9 sets
7.2 Integrated Management System			40								40.00
			1 lot								1 lot
7.3 Establishment of NOC DR Site						50					50.00
						1 lot					1 lot
8. FACILITIES MANAGEMENT SYSTEM	17.60	13.70	14.10	16.60	8.40	2.40	6.40	2.40	2.40	0.00	84.00
8.1 Facilities Management System	12	10.5	10.5	9	6						48.00
	7 stns	7 stns	7 stns	6 stns	4 stns						31 stns
8.2 Remote Fiber Monitoring System	2			6			4				12.00
	1 node			3 nodes			2 nodes				6 nodes
8.3 Battery Monitoring System	3.6	3.2	3.6	1.6	2.4	2.4	2.4	2.4	2.4		24.00
	8 stns	8 stns	8 stns	4 stns	6 stns	6 stns	6 stns	6 stns	6 stns		58 stns
9. POWER SUPPLY AND AUXILIARY SYSTEM	0.55	4.10	3.55	3.00	0.55	1.10	1.10	1.10	1.10	1.10	17.25
9.1 Renewable Power Supply		3	3	3							9.00
		3 stns	3 stns	3 stns							9 stns
9.2 Low Capacity 48Vdc Chargers for IPPs (2C)	0.3	0.6	0.3		0.3	0.6	0.6	0.6	0.6	0.6	4.50
	2 sets	4 sets	2 sets		2 sets	4 sets	4 sets	4 sets	4 sets	4 sets	30 sets
9.3 Low Capacity 48Vdc Battery Banks for IPPs (1B)	0.25	0.5	0.25		0.25	0.5	0.5	0.5	0.5	0.5	3.75
	1 bank	2 banks	1 bank		1 bank	2 banks	2 banks	2 banks	2 banks	2 banks	15 banks

10. SYSTEM TOOLS AND TEST EQUIPMENT	2.00	0.70	2.00	0.00	0.00	0.00	0.00	23.00	0.00	1.70	29.40
10.1 Fiber Optic System								3			3.00
								2 sets			2 sets
10.2 Wide Area (Data) Network			2					20			22.00
			1 set					1 set			2 sets
10.3 Auxiliary System	2	0.7								1.7	4.40
	4 sets	2 sets								4 sets	10 sets
TOTAL	**49.65**	**147.40**	**205.05**	**133.75**	**74.45**	**65.50**	**34.50**	**39.65**	**17.65**	**16.95**	**784.55**
***TOTAL**	**47.10**	**142.60**	**199.50**	**130.75**	**73.90**	**64.40**	**33.40**	**15.55**	**16.55**	**14.15**	**737.90**

*New total less Power Supply and Auxiliary redundancy requirements transferred to Rehab/Upgrade.

Table 4.2.d: Summary of Cost of CAPEX Projects, 2016–2025 (in Million Php)

TELECOM PROJECTS	LUZON	VISAYAS	MINDANAO	TOTAL
REPLENISHMENTS/ REPLACEMENTS	548.28	666.90	769.10	1,984.28
REHABILITATIONS/ UPGRADES	662.15	288.42	305.75	1,256.32
EXPANSIONS	1,393.95	971.87	737.90	3,103.72
TOTAL	**2,604.38**	**1,927.19**	**1,812.75**	**6,344.32**

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SCADA/EMS

2016-2025

1.0 INTRODUCTION

As the Philippine power grid continues to expand rapidly to meet the increasing need for reliable electricity, the country also moves forward to implement various reforms for the power industry, introducing additional considerations in system operations. Operating the electricity network becomes very complex in view of ever changing technical and regulatory environment, not to mention strict operational performance requirements for which the dispatch engineers need to comply.

NGCP has employed SCADA systems as indispensable tools for safely and securely operating the Philippine grid, and to ensure that technical and regulatory requirements are satisfactorily complied with.

Real-time information from the remote stations as presented by SCADA provide instantaneous picture of the ever-changing conditions of the power system. Data acquisition equipment installed in power plants and substations not only continuously feed data to the control centers, but provide remote control capabilities to devices installed in the field, thus enabling the system operators to make timely decisions and actions.

1.1 NGCP SCADA Infrastructure

NGCP SCADA systems consist of SCADA and EMS installed at control centers and substations automation systems as tool for a fully coordinated, safe and secure power grid operations. These are of varying ages and are in various conditions ranging from obsolete to newly installed systems.

SCADA/EMS equipment consists of master station hardware and software, and data acquisition equipment installed at power plants and substations in the entire country.

1.1.1 Control Center Hierarchy

NGCP established a hierarchy of control centers to support operations of the Philippine transmission system with the dispatch of all generation facilities to the grid.

The top-most level control centers are equipped with Supervisory Control and Data Acquisition (SCADA) and Energy Management Systems (EMS). The lowest levels have either basic SCADA systems or remote consoles only from the EMS.

This hierarchy consists of three (3) levels:

a. <u>National Control Center</u>. The National Control Center (NCC) in Diliman, Quezon City coordinates all high-voltage transmission operations (350kV HVDC, 500kV, 230kV and 138kV circuits) and dispatches all generation.

   A Backup National Control Center (BNCC) has been established in Cebu City.

b. Regional Control Centers. The RCCs are responsible for monitoring and control of 230 kV and 138 kV transmission systems in each of the three power grids: Luzon, Visayas and Mindanao.

The Luzon RCC is co-located with the NCC, and the Visayas RCC with the BNCC. The Mindanao RCC is responsible for the operation of the Mindanao grid.

c. Area Control Centers. Area Control Centers were established all over Luzon, Visayas and Mindanao to supervise other parts of the transmission network not managed by the RCCs and to coordinate directly with the customers in their respective areas of responsibility.

1.1.2 Control Centers Locations

Table 1.1.2: Control Centers Locations

Control Level	Control Centers	Location	System
National & Luzon Region	NCC and LRCC	Diliman, Quezon City	NARI OPEN 3000
Luzon RCC Back-up	Emergency Back-up NCC-ACC	Mexico, Pampanga	NARI OPEN 3000
Luzon ACCs	South Tagalog ACC	Biñan, Laguna	NARI OPEN 3000
	Northern Luzon ACC	La Trinidad, Benguet	
	Southern Luzon ACC	Naga, Camarines Sur	
Visayas Region	Visayas RCC	Cebu City	NARI OPEN 3000
Visayas Back-up	Back-up RCC	Mandaue City	Realflex RFLink
Visayas ACCs	Leyte-Samar ACC	Ormoc City, Leyte	NARI OPEN 3000
	Bohol ACC	Tagbilaran, Bohol	NARI OPEN 3000
	Negros ACC	Bacolod	Realflex
	Panay ACC	Sta. Barbara	Realflex
Mindanao Regional	RCC	Cagayan De Oro	NARI OPEN 3000
Mindanao RCC Back-Up	Back-up RCC/Iligan ACC	Iligan	Siemens PowerCC
Mindanao ACCs	Butuan ACC	Butuan	NARI OPEN 3000
	Davao ACC	Davao	NARI OPEN 3000
	Gen. Santos ACC	Gen. Santos	Siemens PowerCC
	Zamboanga ACC	Zamboanga	Siemens PowerCC

1.2 Content Overview

This section describes the development plans of NGCP to maintain and develop the necessary SCADA facilities and functionalities, in line with the grid expansion and other developments in the power industry affecting the way NGCP operates the grid for the period 2016–2025. These programs are referred in this section as SCADA TDP programs.

1.2.1 SCADA Program Objectives

The SCADA programs for 2016–2025 have been developed with the following objectives:

a. To sustain the performance and reliability of installed data acquisition and control center systems, including the updating of system software.
b. To expand the functionality and capability of the SCADA system and its associated Advanced Application Software in order to meet new requirements of the grid and electricity market system.
c. To enhance installed system to support increasing stringent corporate performance targets.
d. To improve reliable delivery of services thru security, reliability, availability and efficiency of electrical grid.
e. To address deficiencies that prevents optimized SCADA network performance.

The programs identified in this TDP are geared towards the continuing effort to maintain performance levels of existing SCADA systems and facilities through regular maintenance, planned replacement of failed, obsolete and unsuitable facilities, and acquisition of new facilities to support requirements for operations and address performance deficiencies and new functionalities.

2.0 ASSESSMENT

2.1 SCADA Existing Profile

Table 2.1.a: SCADA Systems

SCADA Systems	Luzon	Visayas	Mindanao	Total
Control Centers	6	6	7	19
NCC/RCC	1	1	1	3
Back-up RCC	1	1	1	3
Remote Consoles at ACC's	4	4	5	13
ACC	4	4	5	13

The SCADA/Energy Management System of NGCP's Regional Control Centers for Luzon, Visayas, and Mindanao are all new and are now of the same brand and manufacturer. However, except for Luzon, the backup system of Visayas and Mindanao are different from that of their regional control centers. Their systems in its Area Control Centers are also different being installed at different periods.

Data from substations and plants are collected through remote terminal units. Several substation automation systems, also referred to as Microcomputer-based Substation Control (MBSC) systems, are currently set-up in substations all over the Philippine grid.

Table 2.1.b: Monitored and Controlled Stations

Monitored and Controlled Stations	Luzon	Visayas	Mindanao	Total
Power Plants	60	36	25	121
Directly-connected	38	25	16	79
Embedded	22	11	9	42
Substations	54	33	29	116
Legacy (RTU-based)	26	15	19	60
Computer-based Control	28	18	10	56
Total	**114**	**69**	**54**	**237**

2.1.1 Regional Control Center EMS Profile

The Regional Control Center for Luzon, Visayas, and Mindanao were upgraded and replaced with Nanjing Automation Research Institute Technology (NARI-TECH) OPEN 3000 EMS. This included a full backup system (BLRCC) for Luzon. The upgrading for Luzon and Visayas were completed in the first quarter of 2012 while Mindanao completed its upgrading in the last quarter of 2011. The upgraded system is equipped with powerful hardware that can handle NGCP's SCADA/EMS performance requirements, and reasonably sized database that can readily accommodate and support increasing volume of data from power system growth and expansion. The OPEN 3000 EMS has advance application functions that are useful tools for the dispatchers in effectively managing the grid as well as market functions essential to the operation of the Market System.

A full backup system complete with all the functionalities available to the main system is now established in Mexico, Pampanga making the Luzon setup more stable and reliable. In addition, a Dispatcher's Training Simulator (DTS) is also available for the regions in order to enhance dispatcher's knowledge and skill in effective grid management.

Other advanced applications are envisioned to be added to the new system in the next few years to further enhance its capability.

2.1.2 ACC SCADA Systems Profile

The four (4) ACCs in Luzon use remote consoles that connect not only to the NCC EMS but also to the newly established backup system in Mexico, Pampanga. This current capability of the remote consoles to connect either to the NCC or BLRCC is more stable than the old setup wherein the console connects only to NCC system. The availability of these ACCs is still dependent on the EMS and the communication links between NCC/BLRCC and the ACCs.

Likewise, the Visayas grid also has four (4) ACCs. The Panay and Negros ACCs use Realflex SCADA system software which have been installed in the nineties and have undergone a series of software and hardware upgrades. Upgrade for the replacement of obsolete hardware was completed in 2010. The Ormoc and Bohol ACC SCADA Systems were replaced in 2013 with the NARI OPEN 3000 System.

Mindanao's five ACCs have stand-alone Siemens Spectrum PowerCC SCADA systems installed about six years ago. These are non-redundant units with the SCADA applications and HMI running under a single hardware. It only has basic SCADA functions and does not have advanced application capabilities. The Davao and Butuan ACC SCADA Systems were replaced in 2014 with the NARI OPEN 3000 System.

2.1.3 Data Acquisition Equipment Profile

Most of the remote terminal units in Luzon use the General Electric (GE) D20 Remote Terminal Units (RTUs) to provide data collection and remote control capabilities in the substations and power plants.

The RTUs have been upgraded in 2006 to support new protocols. A few RTUs still use analog communications link with bandwidth as low as 1200 baud but most of them uses 9600 baud to 19.2 kbaud. With the upgraded EMS system, all Remote Terminal Units (RTUs) and Substation Automation System (SAS) now use DNP 3.0 protocol in the exchange of data between the remote and Master Stations.

Like Luzon, almost all RTUs in Visayas are GE D20 RTUs, mostly installed during the early nineties. The main board and some peripheral boards were upgraded in 2006 for higher performance and to support modern communications protocols.

Telegyr Station Manager RTUs are used mostly in Mindanao. These RTUs have been upgraded in 2008 for additional communication ports to new master stations and support DNP V3.0 protocol. A few GE D20s have been installed in some power plants. These RTUs only support serial connections to the master stations.

Originally, transducers were installed in the nineties for providing power system information to the RTUs. Since 2004, transducers are being replaced with Intelligent Electronic Devices (IEDs).

To take advantage of the Ethernet network's high performance and reliable communication features, a program to migrate from the legacy RS232 serial interface to TCP/IP based Data Acquisition Network was established in Luzon, Visayas and Mindanao.

2.1.4 Substation Automation Systems (SAS) Profile

Since the late 1990's, substation automation systems (also MBSCs) have been installed in Luzon substations. These systems were supplied by different manufacturers making maintenance difficult. Since these MBSCs were old and some of its components were non-functional already, NGCP implemented upgrading/replacement of these MBSCs. At present, Luzon has completed the upgrading of eight major MBSC/stations and acquired new MBSCs for three new stations. With the coming of IEC 61850 standards for Substation Automation, NGCP management direction is to embrace and take full advantage of its benefits. Hence, NGCP will be implementing more MBSCs/Substation Automation projects in the future.

To resolve the issues and problems encountered due to the different vendors and different brands of MBSC system installed/acquired during TransCo time, NGCP aims to standardize the requirements and configurations. This shall be the guide in NGCP's acquisition of SCADA and Automation systems.

Visayas has SAS supplied by ABB, Siemens, Areva, NARI, Sifang and a couple of systems based on GE D20 RTUs, DAP servers and Realflex SCADA.

There are only six (6) substation automation systems in operations in Mindanao at present. Pitogo Substation uses an ABB system, the Maramag Substation uses an Areva system, Balo-i Substation uses the NARI NS3000, Villanueva NARI NS3000, Toril uses NARI NS3000, and Davao SIFANG CSC2000.

Other substation automation systems are being installed in connection with transmission lines and substations being constructed by NGCP.

2.1.5 Auxiliary Equipment Profile

Luzon operations of SCADA equipment are dependent on auxiliary equipment like UPS, batteries and emergency generators. All servers and workstations in all control centers are supplied by UPS. To ensure continuous operation of these critical equipment, acquisition of redundant UPS system for the Master stations (NCC/LRCC and BLRCC) including the four (4) Area Control Centers (ACCs) has been carried out in 2011 and in 2012. Precision Air-conditioning units have been installed in areas where these delicate equipment are installed in order to satisfy the environmental requirements for installations of this nature and safeguard these equipment from early deterioration.

Operation of SCADA equipment in Visayas and Mindanao are likewise dependent on auxiliary equipment like UPS, DC power supply, batteries, and emergency generators. Precision air-conditioning units are also installed to satisfy data center environmental requirements.

2.2 Features

The new OPEN 3000 SCADA/EMS system of Luzon, Visayas and Mindanao from NARI-Tech of China is a new generation of Automation System for power dispatching and is based on advanced IT Technologies and Standardized Platform. It runs on any hardware and is compatible with any Operating System, thus making it an open and flexible system. It is designed to support not only basic SCADA functions but also advanced power system applications like State Estimation, Contingency Analysis, Dispatcher's Power Flow, and Load Forecasting. It is also equipped with a Dispatcher's Training Simulator (DTS) for the enhancement of knowledge and skills of our power dispatchers. It is also designed to cope with future grid expansion in the next 8 to 10 years.

The OPEN 3000 of NARI also supports remote control capabilities to control the circuit breakers at the substations. It is also equipped with Automatic Generation Control (AGC) to control the output of the power plants that opt to offer ancillary service to regulate the system frequency.

A new backup system with all the features and capabilities of the main system is now available in Mexico, Pampanga. This system is ready to take over the dispatch function of the Luzon grid in case of NCC failure.

Luzon ACCs are provided with NARI OPEN 3000 remote consoles that are capable to connect/acquire information not only to NCC EMS but also to the backup system in Mexico. This new capability strengthens the reliability of the remote consoles in the ACCs although its availability is still dependent on the availability of the EMS in NCC or BLRCC and the communication link between them and the ACCs. Likewise, Mindanao is also provided with NARI OPEN 3000 remote console for all ACCs.

Luzon RTUs and substation automation systems report directly to three control centers, NCC, BNCC and BLRCC EMS. Mindanao RTUs and SAS are directly reporting to Mindanao RCC, Back-Up RCC and the ACCs.

2.3 Problems and Issues

With the recent acquisition of SCADA/EMS system for Luzon, Visayas and Mindanao, problems related to hardware limitation, sizing, as well as software capabilities were resolved. However, the Area Control Centers and some Back-up Regional Control Centers have a number of problems and issues that hampers their respective performance.

2.3.1 Hardware Limitations

a. Limited Operating Life of Hardware

SCADA systems rely on computer equipment. Computers have short service lives compared to other power system equipment.

In a normal office environment, computers typically have service lives of five (5) years. However, in the environment where these equipment are used in SCADA systems, actual operating life is usually shortened to about three (3) years due to continuous and heavy demand on the processing power of these equipment, and the harsh operating environment, especially for computers used in substation automation.

b. Fast Obsolescence of Computer Hardware

The rapid pace of development in the computer industry also rendered older models obsolete in a shorter period of time. Thus, after a few years, replacement parts or even equipment are no longer available because these hardware are already not manufactured. To make matters worse, new hardware models are usually not compatible with other old equipment.

2.3.2 Insufficient System Capacity and Functionality

Accelerated growth in the volume of real-time power system data as a consequence of rapid power system expansion can easily outstrip SCADA system capacity. This becomes more pronounced with the new and unique requirements of market operations.

2.3.3 Legacy Systems

Interconnecting legacy systems to new systems is becoming more difficult if not impossible due to a myriad of compatibility issues. This is compounded by rapid product development in the realm of information technology. The newer the model, the more pronounced is the compatibility issue with legacy systems.

2.3.4 Proprietary Systems

Various proprietary systems present different operating and maintenance requirements. This diversity creates compatibility issues that hamper system performance and makes system maintenance more complicated.

2.3.5 Luzon

Presently, only few advanced applications are integrated to the SCADA/EMS. There is a need to acquire additional advanced applications to efficiently and effectively manage the whole grid of Luzon. There is also the need to fine-tune the power system data for both Luzon and Visayas in the system model.

Luzon ACCs only use remote consoles from the NCC EMS. This makes the ACC systems dependent on the EMS and availability of the communication link.

Communications capabilities for the existing RTUs are limited to direct serial connection. This limits the compatibility of these RTUs to new communication links using IP networks.

2.3.6 Visayas

The Automatic Generation Control function was not fully utilized due to limited generation capacity and limited availability of appropriate generator type for regulation.

The back-up system for Visayas has only basic SCADA functions and is a platform different from the VRCC EMS. This curtails its utility as back-up to the VRCC EMS. Visayas RTUs and substation automation systems do not have the capability to communicate to IP networks directly. Special converters are needed to communicate with IP networks.

2.3.7 Mindanao

The back-up system for Mindanao is different from the MRCC EMS. New network configuration brought about by substation expansion, new transmission lines, and additional generators already reflected in the MRCC EMS cannot be readily imported to the back-up system. Moreover, it has only basic SCADA functions of monitoring and control and does not have advanced applications. It's hardware capability is limited. Integrating additional substations and plant RTU/SAS increases the risk of system malfunction. The back-up system was the emergency SCADA system commissioned as temporary replacement to the MRCC SCADA/EMS that was destroyed by the fire that razed MRCC on May 2009.

Similarly situated are the SCADA in the ACC's of Mindanao. Hardware limitations make the system incapable of supporting rapid power system expansion in the ACC's area of responsibility. More importantly, the hardware model is no longer supported by the manufacturer. In the event of hardware breakdown, spare parts will be difficult if not impossible to secure.

RTU's and substation automation systems in Mindanao, like its counterpart in Visayas and Luzon, do not support communication through TCP/IP.

3.0 REQUIREMENTS ANALYSIS

3.1 Demand

Additional SCADA/EMS requirements result from transmission grid extensions and power plant additions. As identified in Volume 1 of the Transmission Development Plan, several transmission expansion programs are identified in the period 2016–2025.

Major SCADA requirements for new stations are usually incorporated in the design of these new stations. However, this only addresses the SCADA requirements for remote sites. Corresponding equipment additions and capability expansions required at the master stations are usually not included in the scope of these projects.

The accumulated expansion requirements may reach the point where the required master station capacity can no longer be supported by the existing system.

Small scale substation expansions are implemented in-house by NGCP. This could be additional circuit breakers, etc. These expansions require only additional RTU boards for new I/O points and database space in the master station for the new points.

3.2 Technology Direction

The use of power system equipment employing new technology has introduced interface requirements to legacy SCADA systems and equipment, resulting in complicated schemes which could not fully utilize the advanced capabilities of newly developed technologies. To require new equipment to stick to legacy solutions would be restrictive, uneconomical and limit NGCP's chance of taking advantage of superior products.

Technological development has resulted to significant requirements for SCADA/EMS. Equipment installed in new installations are the products of new technology and standards.

The following technological development has necessitated planning for requirements that are essential due to the following trend:

a. The move towards IP-based telecom network requiring migration to IP-based equipment for efficient data exchange. This necessitates migration of SCADA data communication set-up to IP-based network.
b. New communication and data standards require upgrading of existing systems to support standards like IEC60870-104, IEC61850 and IEC61970.
c. Smart Grid

3.2.1 Obsolete Equipment

Some equipment still within their service life have already exhibited degraded functionality and performance. This is due to limited hardware capability and the fact that the equipment cannot be interconnected with other equipment in the system.

Expansion or upgrade options are no longer viable because these models are no longer supported by the original manufacturer.

3.3 Reliability and Performance

3.3.1 Equipment Exceeding Service Life

Significant issues in cost, performance, and reliability arise as the equipment approaches the end of its service life. These become more evident if the equipment is operated beyond its service life.

a. Cost. Continued operation of the equipment become more expensive as parts replacement and servicing become frequent.
b. Performance and Reliability. These equipment suffer serious performance degradation because of their advanced service life. Additionally, probabilities of sudden failure for this equipment are high with grave repercussion to total system reliability.

Restoration is difficult due to unavailability of spare parts. For systems, troubleshooting and maintenance will be complicated as manufacturers phase out support for the product. In this context, it becomes more economical to replace the equipment.

3.4 Policy Considerations

NGCP's commitment towards complying with the following applicable regulatory requirements is one of the major drivers for the SCADA CAPEX programs:

a. Philippine Grid Code (PGC),
b. Open Access Transmission Service (OATS),
c. Wholesale Electricity Spot Market Rules (WESM Rules) and,
d. Directives from the Department of Energy (DOE), Energy Regulatory Commission (ERC) and other government agencies.

In addition to this, the SCADA requirements must be consistent with NGCP adopted policies, standards and operating philosophies.

The government's aggressive promotion of renewable energy and efforts to include embedded generators in the electricity market are also prime inputs to the SCADA programs to be undertaken in the next few years.

Regulatory agencies of the government have stringent requirements on the power industry. These necessitated SCADA capabilities ranging from sophisticated automation functionality to plain data archiving to support the generation of reports required by regulatory directives.

Awareness of international practices and technological development in this area is essential so as to be able to identify the most suitable set up that can effectively cater to these needs.

3.4.1 Corporate Business Needs

3.4.1.1 Corporate Performance Targets

The Energy Regulatory Commission (ERC) sets performance level requirements for NGCP to ensure that service rendered to the public are maintained at satisfactory levels at all times. The most critical of these targets are those referring to power quality (FLC, VLC, SA) and reliability of service.

With performance targets becoming more stringent each year, monitoring and control facilities become very critical to ensure that NGCP's operations comply with the performance level requirements.

3.4.1.2 Regulatory Reporting Requirements

NGCP is committed to comply with the strict performance requirements set by ERC as specified in pertinent provisions of the Philippine Grid Code. SCADA systems automatically collect power system information and archive operational data as basis of regular and mandatory reports to the ERC and other government mandated agencies.

4.0 DEVELOPMENTAL PROGRAMS

4.1 Planning Criteria

4.1.1 Economic Considerations

SCADA/EMS CAPEX requirements are primarily cost items and do not provide direct revenues for NGCP. However, such facilities are essential infrastructure for the successful and sustained operation of the grid. Hence, it could be said that effectiveness of the SCADA/EMS affects cost-efficiency of grid operations.

4.1.1.1 Cost-Benefit analysis

The economic analysis of SCADA CAPEX requirements can be reduced to making least-cost decisions from among alternatives presented by available technology and configuration options.

4*.1.1.2 Total Cost of Ownership*

Different alternatives ultimately require differing levels of operating and maintenance expenses of installed system. Therefore, decisions on CAPEX requirements should not only focus on acquisition costs but should consider as well all required expenditures relative to the asset over its service life. This total cost of ownership approach considers the impact of such assets on the operating requirements as well as in maintenance expense requirements, including cost of maintaining competent personnel to service the equipment.

4.1.2 Technological Alternatives

The selection of a specific solution takes into account the balance between technological maturity and the equipment's product life cycle. Systems employing cutting edge technology usually carry risks associated, while equipment approaching the end of its life cycle.

The choice of a technological alternative could have impact on the total cost of ownership. While newly developed technology usually costs higher, considerations for the selection of appropriate technology should consider which alternative is better suited for future technological development. CAPEX investments can be better safeguarded against accelerated obsolescence if various technologies are evaluated against project technology trends and even against unanticipated developments.

4.1.3 Adoption of Open Systems against Proprietary Designs

New products have adopted open system design and are moving away from proprietary designs. Systems have moved towards being platform independent in hardware, operating system and software resulting in interchangeability, ease of application and maintenance.

4.1.4 Safety and Security Concerns

Safety and security considerations influence the development of SCADA projects identified in this TDP. An in-depth evaluation on the impact of these factors on the physical operation and information security are made in the planning of CAPEX requirements.

4.1.4.1 Operations Continuity

Operations continuity guarantees the availability of facilities to ensure continuous operations of SCADA system and equipment in the event of contingencies and during project implementation. Properly managed implementation ensures that operations are not adversely affected during equipment upgrade or replacement. High availability design, redundant facilities and provision of a back-up SCADA system safeguard against loss of control center facilities or functions.

4.1.4.2 Physical Considerations

Technical specifications in the CAPEX requirements are included that address physical protection of facilities, systems and equipment. Standard design specifies enclosed metal cabinets with equipment securely installed, to protect and limit physical access to interface wiring and equipment. Features are also incorporated in control room facilities and other SCADA installation requirements to protect SCADA assets from fire and other physical hazards.

In addition to this, design criteria are established that ensures safe conditions for personnel operating and maintaining these equipment.

4.1.4.3 SCADA Cyber-Security

SCADA CAPEX projects have been selected to ensure that SCADA/EMS network are at all times separate and not connected directly to the Corporate LAN and other external networks. Where connectivity is required for data exchange, the connection point may be provided with equipment and special provisions to ensure that only authorized traffic is permitted in the connection.

4.1.5 CAPEX Classification

SCADA/EMS TDP CAPEX requirements are classified accordingly as:

a. Expansion/New. These refer to system additions and new equipment needed to service increased SCADA requirements due to new installations and/or required functionalities.
b. Rehabilitation/Upgrade. These refer to works or enhancements intended to extend service life, improve performance or increase capability of installed systems or equipment.
c. Replacement/Replenishment. These refer to systems and equipment intended to replace existing systems that are no longer economical to operate or unable to deliver the function or purpose they were originally intended to provide.

Criteria had been developed to optimize choice in selection of projects and guide towards consistent approach in implementation of identified requirements.

4.1.6 System and Equipment Sizing

New systems are designed and equipped with enough for anticipated system changes within the TDP period. The system is further provided with 10% spare capacity and is capable to be expanded up to 30% of the design capacity without the need for major refurbishment or upgrade.

System sizing and capabilities were selected to provide 30% CPU loading at normal operating conditions and meet functional requirements during the expected economic life. This CPU loading level provides adequate contingency capability to service increased requirements during high system activity conditions.

4.1.7 Implementation

Implementation of requirements are scheduled such that disruption to the existing system is avoided or minimized, taking into consideration the existing manpower that will be involved in the activities.

Most expansion requirements are planned for turnkey implementation (work orders that cover complete works) where these projects cannot be carried out using existing resources or manpower, or beyond the technical capabilities of SCADA personnel.

Upgrades of network components that have exceeded economic life shall be implemented using in-house engineering capabilities.

4.2 Regional Considerations

The Luzon Grid accounts for more than seventy percent of the Philippine Grid demand. Being very extensive and involving a large number of stations and plants, Luzon requires more EMS functionalities for them to effectively manage the Luzon Grid. The electricity market, which has already been operating in Luzon for five years, imposes additional functionality requirements for Luzon EMS systems. Presently, all Luzon ACCs are using only remote consoles unlike Visayas and Mindanao. Luzon ACCs need to establish stand-alone SCADA systems for a more reliable and independent SCADA operations. Luzon stations were the first ones to be installed with substation automation systems.

There are a number of substation automation systems that require upgrading or replacement due to their age.

The Visayas Grid contains various embedded generators which are presently not monitored at the Visayas RCC. The combined capacities of these plants are significant enough to impact the demand behavior. The inability of VRCC to monitor these plants affects the capability of the dispatch engineers and planning engineers to forecast the system demand accurately and control the system effectively. The Visayas RCC back-up SCADA is of a different system from the main EMS thus requiring the dispatch engineers to be familiar with different systems. In addition to this, the back-up SCADA does not have advanced power system applications. The electricity market in the Visayas has just recently been introduced. Although the basic data requirements for Market Operations is already being provided, there is a need to prepare to support future requirements which the electricity market may impose the development of other market features.

The Mindanao Grid has the least number of substation automation systems in operations. More systems will be constructed in the next few years. Only few embedded generators are presently monitored from Mindanao RCC. The combined capacities of these plants provide a significant impact on the demand behavior on the grid. The inability of MRCC to monitor these plants affects the capability of the dispatch engineers as well as planning engineers to forecast the system demand accurately and control the system effectively. The Mindanao RCC back-up SCADA is of a different system from the main EMS thus requiring the dispatch engineers to be familiar with different systems. In addition to this, the back-up SCADA does not have advanced power system applications and was already obsolete. The electricity market does not operate yet in Mindanao. However, the government has plans to implement the market in Mindanao in the near future.

Table 4.2.a: SCADA Systems by 2025

SCADA Systems	Luzon	Visayas	Mindanao	Total
Control Centers	6	6	7	19
NCC/RCC	1	1	1	3
Back-up	1	1	1	3
Remote Consoles at ACC's	4	4	5	13
ACC	4	4	5	13

Table 4.2.b: Monitored and Controlled Stations by 2025

Monitored and Controlled Stations	Luzon	Visayas	Mindanao	Total
Power Plants	137	74	84	295
Directly-connected	57	34	28	119
Embedded	80	40	56	176
Substations	77	42	33	152
Legacy (RTU-based)	22	12	14	48
Computer-based Control	55	30	19	104
Total	**214**	**116**	**117**	**447**

4.3 CAPEX Schedule (in Million Php)

4.3.1 Luzon SCADA Programs

SCADA/EMS ENHANCEMENTS (RCC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 0: FIELD EQUIPMENT											60.75
AGC Controller and Other Related Devices	2	2	-	-	-	-	5	5	5	-	19.00
Weather Monitoring for Renewable Energy	-	3	3	3	-	-	-	-	-	-	9.00
Water Elevation Sensor	-	3.5	-	-	-	-	-	-	-	-	3.50
Upgrade of IEDs with Energy and THD for Generators, Lines and Feeders	8.25	-	-	-	-	-	5	5	5	-	23.25
Upgrade of DAC Devices for IPPs and Embedded Generators	-	3	3	-	-	-	-	-	-	-	6.00
LEVEL 1: RTU and SAS											148.00
Data Acquisition Network	25	-	-	-	-	10	10	10	10	-	65.00
RTU for New Renewable Energy and Embedded Generators	-	10	10	10	4	1	4	4	3	4	50.00
Equipping Existing RTU with IP Interface for IPPs and Embedded Generators	-	3	-	-	-	-	-	-	-	-	3.00
RTU Interface for Protection Relay	-	2	2	-	-	-	-	-	-	-	4.00
RTU and DAC Network IP Migration	26										26.00
Substation Upgrade to IEC 61850 Compliance (Refer to TDP Vol. 2)	-	-	-	-	-	-	-	-	-	-	-
New Substations (Refer to TDP Vol. 1)	-	-	-	-	-	-	-	-	-	-	-
LEVEL 2: SCADA HARDWARE and SOFTWARE											2.00
Enterprise SMS Server	2	-	-	-	-	-	-	-	-	-	2.00

LEVEL 3: AUTOMATED OPERATION											28.00
Automatic Voltage Control (AVC) and Volts/VAR Optimization	-	9	9	-	-	-	-	-	-	-	18.00
RE Real-time Dispatch	-	10	-	-	-	-	-	-	-	-	10.00
LEVEL 4: ENHANCED OPERATION											85.00
Network Equivalent (NE) / MATLAB	-	5	6	-	-	-	-	-	-	-	11.00
Short Circuit Analysis (SCA)	-	5	6	-	-	-	-	-	-	-	11.00
Availability Transmission Capacity (AVT)	-	-	-	5	6	-	-	-	-	-	11.00
VRE Short and Long Term Forecasting	30	-	-	-	-	-	-	-	-	-	30.00
VRE Security Constrained and Unit Commitment	-	5	6	-	-	-	-	-	-	-	11.00
VRE Security Constrained Economic Dispatch (SCED)	-	5	6	-	-	-	-	-	-	-	11.00
LEVEL 5: OPTIMIZED OPERATION											13.00
Optimization Analysis	-	-	-	-	-	-	8	-	-	-	8.00
Business System Integration	-	-	-	-	-	-	5	-	-	-	5.00
POWER SUPPLY and AUXILIARIES											2.00
Structured Grounding System	2	-	-	-	-	-	-	-	-	-	2.00
TOTAL	**95.25**	**65.50**	**51.00**	**18.00**	**10.00**	**11.00**	**37.00**	**24.00**	**23.00**	**4.00**	**338.75**

SCADA ENHANCEMENTS (BRCC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 2: SCADA HARDWARE and SOFTWARE											8.00
Data Historian	8	-	-	-	-	-	-	-	-	-	8.00
POWER SUPPLY and AUXILIARIES											2.00
Active Power Conditioner	-	2	-	-	-	-	-	-	-	-	2.00
TOTAL	**8.00**	**2.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**10.00**

SCADA ENHANCEMENTS (ACC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
POWER SUPPLY and AUXILIARIES											6.00
Active Power Conditioner	-	2	4	-	-	-	-	-	-	-	6.00
TOTAL	**0.00**	**2.00**	**4.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**6.00**

SCADA ENHANCEMENTS (WAMS)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 0: FIELD EQUIPMENT											0.00
CT and PT (refer to TDP Vol. 2)	-	-	-	-	-	-	-	-	-	-	-
LEVEL 1: PMU, DC and CABINET											100.00
Phasor Measurement Unit	-	-	-	-	20	15	20	-	-	-	55.00
Phasor Data Concentrator	-	-	-	-	10	5	10	-	-	-	25.00
Data Storage	-	-	-	-	10	10	-	-	-	-	20.00
LEVEL 2: SCADA HARDWARE and SOFTWARE											33.00
WAMS HMI (Server, Data Concentrator, Software, Network and Databases, etc.)	-	-	-	-	-	25	8	-	-	-	33.00
LEVEL 3: REAL-TIME and PLANNING APPLICATION TOOLS											240.00
Real Time Application											
Wide Area Situational Awareness	-	-	-	-	8	8	-	-	-	-	16.00
Frequency Stability Monitoring and Trending	-	-	-	-	8	8	-	-	-	-	16.00
Power Oscillation Monitoring	-	-	-	-	8	8	-	-	-	-	16.00
Alarming and Setting System Operating Limits, Event Detection and Avoidance	-	-	-	-	8	8	-	-	-	-	16.00
Resource Integration	-	-	-	-	-	-	8	8	-	-	16.00
State Estimation	-	-	-	-	-	-	8	8	-	-	16.00
Dynamic Line Ratings and Congestion Management	-	-	-	-	-	-	8	8	-	-	16.00
Outage Restoration	-	-	-	-	-	-	8	8	-	-	16.00
Operations Planning	-	-	-	-	-	-	8	8	-	-	16.00
Planning and Off-line Applications											
Base-Lining Power System Performance	-	-	-	-	-	-	8	8	-	-	16.00
Event Analysis	-	-	-	-	-	-	8	8	-	-	16.00

Static System Model Calibration and Validation	-	-	-	-	-	-	8	8	-	-	16.00
Dynamic System Model Calibration and Validation	-	-	-	-	-	-	8	8	-	-	16.00
Power Plant Model Validation	-	-	-	-	-		4	4	-	-	8.00
Load Characterization	-	-	-	-	-	-	4	4	-	-	8.00
Special Protection Scheme and Islanding	-	-	-	-	-	-	4	4	-	-	8.00
Primary Frequency (Governing) Response	-	-	-	-	-	-	4	4	-	-	8.00
LEVEL 5: OPTIMIZED OPERATION											0.00
Business System Integration	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**0.00**	**0.00**	**0.00**	**0.00**	**97.00**	**70.00**	**118.00**	**88.00**	**0.00**	**0.00**	**373.00**

SCADA REPLENISHMENT/REPLACEMENT	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
SYSTEMS AND APPLICATIONS											135.00
SCADA/EMS Replacement (RCC)	-	-	-	-	-	-	40	35	-	-	75.00
SCADA/EMS Replacement (BRCC)	-	-	-	-	-	-	30	30	-	-	60.00
SCADA System Replacement (ACC)	-	-	-	-	-	-	-	-	-	-	-
RCC/BRCC/ACC AUXILIARY FACILITIES											136.50
Redundant UPS System / Redundant Station Service Transformer	-	-	-	15	-	-	-	-	7	17	39.00
Data Center Cooling Systems	-	-	-	10	-	-	-	-	-	7.5	17.50
UPS Battery Banks	-	-	-	10	-	-	-	-	-	-	10.00
Emergency Generator Set	-	-	-	-	-	-	-	-	10	10	20.00
Video Projection System	-	-	-	-	-	40	-	-	5	5	50.00
SPARES											167.00
RCC and ACC (Power Supply/Auxiliary Spares)	-	-	-	-	-	2	2	2	2	2	10.00
BRCC (SCADA/EMS Hardware & Infra/Data Center)	5	-	-	5	-	1	-	-	1	-	12.00
RCC and ACC (SCADA Hardware & Infra/Data Center)	9	-	-	10	8	3	3	3	3	3	42.00
Data Acquisition and Control System	20	7	7	7	7	8	8	8	8	8	88.00
Tools and Test Equipment	1	1	1	1	1	2	2	2	2	2	15.00
TOTAL	**35.00**	**8.00**	**8.00**	**58.00**	**16.00**	**56.00**	**85.00**	**80.00**	**38.50**	**54.50**	**438.50**

4.3.2 Visayas SCADA Programs

SCADA/EMS ENHANCEMENTS (RCC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 0: FIELD EQUIPMENT											25.00
AGC Controller and Other Related Devices	-	2	-	-	-	-	-	-	-	-	2.00
Weather Monitoring for Renewable Energy	-	3	3	3	-	-	-	-	-	-	9.00
Capacitor Bank/Shunt Reactor Monitoring & Control	-	1	1	-	-	-	-	-	-	-	2.00
Upgrade of IEDs with Energy and THD for Generators, Lines and Feeders	-	3	3	-	-	-	-	-	-	-	6.00
Upgrade of DAC Devices for IPPs and Embedded Generators	-	3	3	-	-	-	-	-	-	-	6.00
LEVEL 1: RTU and SAS											53.00
Data Acquisition Network	-	6	-	-	-	-	-	-	-	-	6.00
RTU for New Renewable Energy and Embedded Generators	-	10	7	4	4	1	4	4	3	4	41.00
Equipping Existing RTU with IP Interface for IPPs and Embedded Generators	-	2	-	-	-	-	-	-	-	-	2.00
RTU Interface to Protection Relay	-	2	2	-	-	-	-	-	-	-	4.00
Substation Upgrade to IEC 61850 Compliance (Refer to TDP Vol. 2)	-	-	-	-	-	-	-	-	-	-	-
New Substations (Refer to TDP Vol. 1)	-	-	-	-	-	-	-	-	-	-	-
LEVEL 2: SCADA HARDWARE and SOFTWARE											18.00
Secured Interface for VPN Connected Stations	-	-	-	3	-	-	-	-	-	-	3.00
Data Diode for Data Historian	10	-	-	-	-	-	-	-	-	-	10.00
Extension of DTS Workstation for ACC	-	5	-	-	-	-	-	-	-	-	5.00

LEVEL 3: AUTOMATED OPERATION											28.00
Automatic Voltage Control (AVC) and Volts/VAR Optimization	-	9	9	-	-	-	-	-	-	-	18.00
RE Real-time Dispatch	-	10	-	-	-	-	-	-	-	-	10.00
LEVEL 4: ENHANCED OPERATION											85.00
Network Equivalent (NE) / MATLAB	-	5	6	-	-	-	-	-	-	-	11.00
Short Circuit Analysis (SCA)	-	5	6	-	-	-	-	-	-	-	11.00
Availability Transmission Capacity (AVT)	-	-	-	5	6	-	-	-	-	-	11.00
RE Short and Long Term Forecasting	30	-	-	-	-	-	-	-	-	-	30.00
RE Security Constrained and Unit Commitment	-	5	6	-	-	-	-	-	-	-	11.00
RE Security Constrained Economic Dispatch (SCED)	-	5	6	-	-	-	-	-	-	-	11.00
LEVEL 5: OPTIMIZED OPERATION											13.00
Optimization Analysis	-	-	-	-	-	-	8	-	-	-	8.00
Business System Integration	-	-	-	-	-	-	5	-	-	-	5.00
POWER SUPPLY and AUXILIARIES											2.00
Temperature and Humidity Monitoring for SCADA Data Centers	2	-	-	-	-	-	-	-	-	-	2.00
TOTAL	**42.00**	**76.00**	**52.00**	**15.00**	**10.00**	**1.00**	**17.00**	**4.00**	**3.00**	**4.00**	**224.00**

SCADA ENHANCEMENTS (CYBER SECURITY)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
*Budget covered under Mindanao.											

SCADA ENHANCEMENTS (WAMS)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 0: FIELD EQUIPMENT											0.00
CT and PT (refer to TDP Vol. 2)	-	-	-	-	-	-	-	-	-	-	-
LEVEL 1: PMU, DC and CABINET											100.00
Phasor Measurement Unit	-	-	-	-	20	15	20	-	-	-	55.00
Phasor Data Concentrator	-	-	-	-	10	5	10	-	-	-	25.00
Data Storage	-	-	-	-	10	10	-	-	-	-	20.00
LEVEL 2: SCADA HARDWARE and SOFTWARE											33.00
WAMS HMI (Server, Data Concentrator, Software, Network and Databases, etc.)	-	-	-	-	-	25	8	-	-	-	33.00
LEVEL 3: REAL-TIME and PLANNING APPLICATION TOOLS											240.00
Real Time Application											
Wide Area Situational Awareness	-	-	-	-	8	8	-	-	-	-	16.00
Frequency Stability Monitoring and Trending	-	-	-	-	8	8	-	-	-	-	16.00
Power Oscillation Monitoring	-	-	-	-	8	8	-	-	-	-	16.00
Alarming and Setting System Operating Limits, Event Detection and Avoidance	-	-	-	-	8	8	-	-	-	-	16.00
Resource Integration	-	-	-	-	-	-	8	8	-	-	16.00
State Estimation	-	-	-	-	-	-	8	8	-	-	16.00
Dynamic Line Ratings and Congestion Management	-	-	-	-	-	-	8	8	-	-	16.00
Outage Restoration	-	-	-	-	-	-	8	8	-	-	16.00
Operations Planning	-	-	-	-	-	-	8	8	-	-	16.00
Planning and Off-line Applications											
Base-Lining Power System Performance	-	-	-	-	-	-	8	8	-	-	16.00
Event Analysis	-	-	-	-	-	-	8	8	-	-	16.00

Static System Model Calibration and Validation	-	-	-	-	-	-	8	8	-	-	16.00
Dynamic System Model Calibration and Validation	-	-	-	-	-	-	8	8	-	-	16.00
Power Plant Model Validation	-	-	-	-	-		4	4	-	-	8.00
Load Characterization	-	-	-	-	-	-	4	4	-	-	8.00
Special Protection Scheme and Islanding	-	-	-	-	-	-	4	4	-	-	8.00
Primary Frequency (Governing) Response	-	-	-	-	-	-	4	4	-	-	8.00
LEVEL 5: OPTIMIZED OPERATION											0.00
Business System Integration	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**0.00**	**0.00**	**0.00**	**0.00**	**97.00**	**70.00**	**118.00**	**88.00**	**0.00**	**0.00**	**373.00**

SCADA REPLENISHMENT/REPLACEMENT	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
SYSTEMS AND APPLICATIONS											205.00
SCADA/EMS Replacement (RCC)	-	-	-	-	-	-	40	35	-	-	75.00
SCADA/EMS Replacement (BRCC)	-	50	50	-	-	-	-	-	-	-	100.00
SCADA System Replacement (ACC)	-	30	-	-	-	-	-	-	-	-	30.00
RCC/BRCC/ACC AUXILIARY FACILITIES											82.20
Redundant UPS System / Redundant Station Service Transformer	-	-	-	15	-	-	-	-	-	-	15.00
Data Center Cooling Systems	0.2	-	-	10	-	-	-	-	-	-	10.20
UPS Battery Banks	1	4	-	10	-	-	-	-	-	-	15.00
Emergency Generator Set	-	-	-	-	-	-	-	-	10	10	20.00
Active Power Conditioner	-	-	-	12	-	-	-	-	-	-	12.00
Video Projection System	-	-	-	-	-	-	-	-	5	5	10.00
SPARES											115.42
RCC and ACC (Power Supply/Auxiliary Spares)	-	-	-	-	-	2	2	2	2	2	10.00
BRCC (SCADA/EMS Hardware & Infra/Data Center)	7	-	-	-	-	1	-	-	1	-	9.00
RCC and ACC (SCADA Hardware & Infra/Data Center)	-	5	-	5	8	3	3	3	3	3	33.00
Data Acquisition and Control System	-	5	5	5	5	5	5	5	5	5	45.00
Tools and Test Equipment	0.42	2	2	2	2	2	2	2	2	2	18.42
TOTAL	**8.62**	**96.00**	**57.00**	**59.00**	**15.00**	**13.00**	**52.00**	**47.00**	**28.00**	**27.00**	**402.62**

4.3.3 Mindanao SCADA Programs

SCADA/EMS ENHANCEMENTS (RCC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 0: FIELD EQUIPMENT											41.00
AGC Controller and other related Devices	-	4	-	-	-	-	-	-	-	-	4.00
Weather Monitoring for Renewable Energy	-	6	3	3	-	-	-	-	-	-	12.00
Water Elevation Sensor	-	7	-	-	-	-	-	-	-	-	7.00
Upgrade of IEDs with Energy and THD for Generators, Lines and Feeders	-	6	3	-	-	-	-	-	-	-	9.00
Upgrade of DAC Devices for IPPs and Embedded Generators	-	6	3	-	-	-	-	-	-	-	9.00
LEVEL 1: RTU and SAS											116.00
Data Acquisition Network	-	6	6	-	-	-	-	-	-	-	12.00
RTU for New Renewable Energy and Embedded Generators	-	14	13	13	12	5	8	8	6	4	83.00
Equipping Existing RTU with IP Interface for IPPs and Embedded Generators	10	-	-	-	-	-	-	-	-	-	10.00
RTU Interface to Protection Relay	-	4	2	-	-	-	-	-	-	-	6.00
Business System Integration	5	-	-	-	-	-	-	-	-	-	5.00
Substation Upgrade to IEC 61850 Compliance (Refer to TDP Vol. 2)	-	-	-	-	-	-	-	-	-	-	-
New Substations (Refer to TDP Vol. 1)	-	-	-	-	-	-	-	-	-	-	-
LEVEL 2: SCADA HARDWARE and SOFTWARE											20.00
SCADA Software Modification/ Enhancement	-	2	2	2	2	2	2	-	-	-	12.00
Upgrading of EMS Workstation OS to Linux	3	-	-	-	-	-	-	-	-	-	3.00
Extension of DTS Workstation for ACC	5	-	-	-	-	-	-	-	-	-	5.00

LEVEL 3: AUTOMATED OPERATION											28.00
Automatic Voltage Control (AVC) and Volts/VAR Optimization	-	9	9	-	-	-	-	-	-	-	18.00
RE Real-time Dispatch	-	10	-	-	-	-	-	-	-	-	10.00
LEVEL 4: ENHANCED OPERATION											66.00
Network Equivalent (NE) / MATLAB	-	5	6	-	-	-	-	-	-	-	11.00
Short Circuit Analysis (SCA)	-	5	6	-	-	-	-	-	-	-	11.00
Availability Transmission Capacity (AVT)	-	-	-	5	6	-	-	-	-	-	11.00
RE Short and Long Term Forecasting	-	11	-	-	-	-	-	-	-	-	11.00
RE Security Constrained and Unit Commitment	-	5	6	-	-	-	-	-	-	-	11.00
RE Security Constrained Economic Dispatch (SCED)	-	5	6	-	-	-	-	-	-	-	11.00
LEVEL 5: OPTIMIZED OPERATION											13.00
Optimization Analysis	-	-	-	-	-	-	8	-	-	-	8.00
Business System Integration	-	-	-	-	-	-	5	-	-	-	5.00
POWER SUPPLY and AUXILIARIES											19.00
Video Wall System	7	-	-	-	-	-	-	-	-	-	7.00
UPS and Battery Monitoring System	-	-	-	4	-	-	-	-	4	-	8.00
Active Power Conditioner	-	4	-	-	-	-	-	-	-	-	4.00
TOTAL	**30.00**	**109.00**	**65.00**	**27.00**	**20.00**	**7.00**	**23.00**	**8.00**	**10.00**	**4.00**	**303.00**

SCADA ENHANCEMENTS (BRCC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 2: SCADA HARDWARE and SOFTWARE											10.00
SCADA Software Modification/ Enhancement	-	2	2	2	2	2	-	-	-	-	10.00
POWER SUPPLY and AUXILIARIES											23.00
Integrated Power and Environment Monitoring System	-	3	-	-	-	-	-	-	-	-	3.00
Weather Monitoring System	-	2	-	-	-	2	-	-	-	-	4.00
Video Wall System	-	4	-	-	-	-	4	-	-	-	8.00
UPS and Battery Monitoring System	-	2	-	-	-	4	-	-	-	-	6.00
Active Power Conditioner	-	-	2	-	-	-	-	-	-	-	2.00
TOTAL	**0.00**	**13.00**	**4.00**	**2.00**	**2.00**	**8.00**	**4.00**	**0.00**	**0.00**	**0.00**	**33.00**

SCADA ENHANCEMENTS (ACC)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 2: SCADA HARDWARE and SOFTWARE											32.00
SCADA Software Modification/ Enhancement	-	4	2	2	2	2	-	-	-	-	12.00
SCADA Hardware Modification/ Enhancement	-	-	-	6	-	-	-	-	6	-	12.00
Data Historian	-	-	-	2	-	-	-	-	2	-	4.00
Extension of DTS Workstation for ACC	-	-	-	-	4	-	-	-	-	-	4.00
POWER SUPPLY and AUXILIARIES											22.00
Integrated Power and Environment Monitoring System	-	-	-	2	-	-	-	-	2	-	4.00

Weather Monitoring System	-	2	-	-	2	-	-	-	2	-	6.00
Video Wall System	-	-	2	-	-	-	-	2	-	-	4.00
UPS and Battery Monitoring System	-	-	-	-	-	2	-	-	-	-	2.00
Active Power Conditioner	-	-	2	4	-	-	-	-	-	-	6.00
TOTAL	**0.00**	**6.00**	**6.00**	**16.00**	**8.00**	**4.00**	**0.00**	**2.00**	**12.00**	**0.00**	**54.00**

SCADA/EMS ENHANCEMENTS (*CYBER SECURITY)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
PHASE 1 and 2											9.37
Training for System Admin and Users	3.65	4.20	1.52	-	-	-	-	-	-	-	9.37
PHASE 3											309.85
Perimeter Defenses	40	20	-	-	-	-	-	-	-	-	60.00
Network Defenses	38.39	3.12	-	-	-	-	-	-	-	-	41.50
Endpoint Defenses	2.35	0.04	-	-	-	-	-	-	-	-	2.39
Application Defenses	8.80	4.20	-	-	-	-	-	-	-	-	13.00
Data Defenses	-	36.66	-	-	-	-	-	-	-	-	36.66
Monitoring	-	44.20	64.50	-	-	-	-	-	-	-	108.70
Backup and Restore	-	12	-	-	-	-	-	-	-	-	12.00
Engineering	10	0.80	-	-	-	-	-	-	-	-	10.80
Contingency	-	-	24.80	-	-	-	-	-	-	-	24.80
PHASE 4											2.76
Certification and Audit	1.82	0.47	0.47	-	-	-	-	-	-	-	2.76
TOTAL	**105.00**	**125.68**	**91.29**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**321.97**

*The Cyber Security budget for Mindanao also covers the requirements for Luzon and Visayas.

SCADA ENHANCEMENTS (WAMS)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LEVEL 0: FIELD EQUIPMENT											0.00
CT and PT (refer to TDP Vol. 2)	-	-	-	-	-	-	-	-	-	-	-
LEVEL 1: PMU, DC and CABINET											100.00
Phasor Measurement Unit	-	-	-	-	20	15	20	-	-	-	55.00
Phasor Data Concentrator	-	-	-	-	10	5	10	-	-	-	25.00
Data Storage	-	-	-	-	10	10	-	-	-	-	20.00
LEVEL 2: SCADA HARDWARE and SOFTWARE											33.00
WAMS HMI (Server, Data Concentrator, Software, Network and Databases, etc.)	-	-	-	-	25	8	-	-	-	-	33.00
LEVEL 3: REAL-TIME and PLANNING APPLICATION TOOLS											240.00
Real Time Application											
Wide Area Situational Awareness	-	-	-	-	8	8	-	-	-	-	16.00
Frequency Stability Monitoring and Trending	-	-	-	-	8	8	-	-	-	-	16.00
Power Oscillation Monitoring	-	-	-	-	8	8	-	-	-	-	16.00
Alarming and Setting System Operating Limits, Event Detection and Avoidance	-	-	-	-	8	8	-	-	-	-	16.00
Resource Integration	-	-	-	-	-	-	8	8	-	-	16.00
State Estimation	-	-	-	-	-	-	8	8	-	-	16.00
Dynamic Line Ratings and Congestion Management	-	-	-	-	-	-	8	8	-	-	16.00
Outage Restoration	-	-	-	-	-	-	8	8	-	-	16.00
Operations Planning	-	-	-	-	-	-	8	8	-	-	16.00
Planning and Off-line Applications											
Base-Lining Power System Performance	-	-	-	-	-	-	8	8	-	-	16.00
Event Analysis	-	-	-	-	-	-	8	8	-	-	16.00

Static System Model Calibration and Validation	-	-	-	-	-	-	8	8	-	-	16.00
Dynamic System Model Calibration and Validation	-	-	-	-	-	-	8	8	-	-	16.00
Power Plant Model Validation	-	-	-	-	-		4	4	-	-	8.00
Load Characterization	-	-	-	-	-	-	4	4	-	-	8.00
Special Protection Scheme and Islanding	-	-	-	-	-	-	4	4	-	-	8.00
Primary Frequency (Governing) Response	-	-	-	-	-	-	4	4	-	-	8.00
LEVEL 5: OPTIMIZED OPERATION											0.00
Business System Integration	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**0.00**	**0.00**	**0.00**	**0.00**	**97.00**	**70.00**	**118.00**	**88.00**	**0.00**	**0.00**	**373.00**

SCADA REPLENISHMENT/REPLACEMENT	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
SYSTEMS AND APPLICATIONS											220.00
SCADA/EMS Replacement (RCC)	-	-	-	-	-	-	40	35	-	-	75.00
SCADA/EMS Replacement (BRCC)	-	50	50	-	-	-	-	-	-	-	100.00
SCADA System Replacement (ACC)	-	45	-	-	-	-	-	-	-	-	45.00
RCC/BRCC/ACC AUXILIARY FACILITIES											55.50
Redundant UPS System / Redundant Station Service Transformer	-	-	-	15	-	-	-	-	-	-	15.00
Data Center Cooling Systems	-	-	-	10	-	-	-	-	-	-	10.00
Emergency Generator Set	-	-	-	-	-	-	-	-	10	10	20.00
Active Power Conditioner	0.5	-	-	-	-	-	-	-	-	-	0.50
Video Projection System	-	-	-	-	-	-	-	-	5	5	10.00
SPARES											126.40
RCC and ACC (Power Supply/Auxiliary Spares)	4.71	-	-	-	-	2	2	2	2	2	14.71
BRCC (SCADA/EMS Hardware & Infra/Data Center)	-	-	-	-	-	1	-	-	1	-	2.00
RCC and ACC (SCADA Hardware & Infra/Data Center)	9.74	-	-	5	8	3	3	3	3	3	37.74
Data Acquisition and Control System	11.60	5	5	5	5	5	5	5	5	5	56.60
Tools and Test Equipment	1.35	-	-	2	2	2	2	2	2	2	15.35
TOTAL	**27.90**	**100.00**	**55.00**	**37.00**	**15.00**	**13.00**	**52.00**	**47.00**	**28.00**	**27.00**	**401.90**

4.3.4 SCADA Total

SCADA COMPONENT	LUZON	VISAYAS	MINDANAO	TOTAL
SCADA	667.25	500.62	684.90	1,852.77
EMS	126.00	126.00	107.00	359.00
CYBER SECURITY	0.00	0.00	321.97	321.97
WAMS	373.00	373.00	373.00	1,119.00
TOTAL	**1,166.25**	**999.62**	**1,486.87**	**3,652.74**

CATEGORY	LUZON	VISAYAS	MINDANAO	TOTAL
NEW	717.75	597.00	1,056.97	2,371.72
REPLACEMENT	448.50	402.62	429.90	1,281.02
TOTAL	**1,166.25**	**999.62**	**1,486.87**	**3,652.74**

PROTECTION

2016-2025

1.0 INTRODUCTION

1.1 NGCP Protection System

As part of its mandate, NGCP is continually extending and strengthening the country's power transmission facilities with the support of advances in technology—aiming to improve its operation and maintenance to achieve the highest degree of safety and security.

The fault clearance system (or network protection system) directly impacts the operation of NGCP's power system by isolating or "tripping" transmission lines with faults in order to protect life and property. Whenever a protective relay trips, there is always a corresponding unserved energy due to the outage of affected transmission line. But the revenue loss on account of the unserved energy for a section of the grid would be a small cost to pay in exchange for the protection of the power grid as a whole.

Thus, NGCP plans to undertake a network protection upgrade program that will involve replacement of outdated, obsolete and inappropriate protection and fault monitoring equipment in order to comply with network protection standards within a 10-year timeframe. All engineering projects under TDP Volume 1 and substation upgrading projects under TDP Volume 2 also take this program into account.

To ensure continuous operation of network protection system and disturbance monitoring equipment, the procurement for spares, accessories and GPE's are also included in this program.

1.2 Content Overview

2016–2025 TDP planning includes upgrading of all protective relays for transmission line, bus, transformer, reactor, capacitor and breaker fail, disturbance monitoring equipment and protection management system based on the TDP guidelines approved on May 2012. In general, the upgrade of the protection system shall be carried out on a per-Substation basis, inclusive of protection elements at the other end of the substation's peripheral lines.

Planning considerations include compliance with the Grid Code, prioritization of critical lines/substations, coping with obsolescence, alignment with the Smart Grid model and the adoption of an updated Network Protection Philosophy.

Advances in technology continue to produce new protection relays with more capabilities and features than existing equipment. Application of these new devices should result in system protection which is more secure, dependable and communicable. In any case, all the new protection systems design shall conform to NGCP's protection philosophy and SMART Grid applications.

ERC's prescribed 15-year economic lives for protection equipment have been adopted.

2.0 ASSESSMENT

2.1 Existing Profile

NGCP is divided into three major grids—the Luzon, Visayas and Mindanao Grids. These consist of a network of 500 kV, 230 kV and 115 kV lines for Luzon and 230 kV, 138 kV and 69 kV lines for Visayas and Mindanao. The lines are secured by redundant Main 1 and Main 2 protection schemes which may be any among a combination of differential-with-differential, differential-with-distance and distance-with-distance relays. Present combinations, however, do not necessarily conform to the new Network Protection Philosophy and realization of desired features requires upgrade or replacements of existing relays.

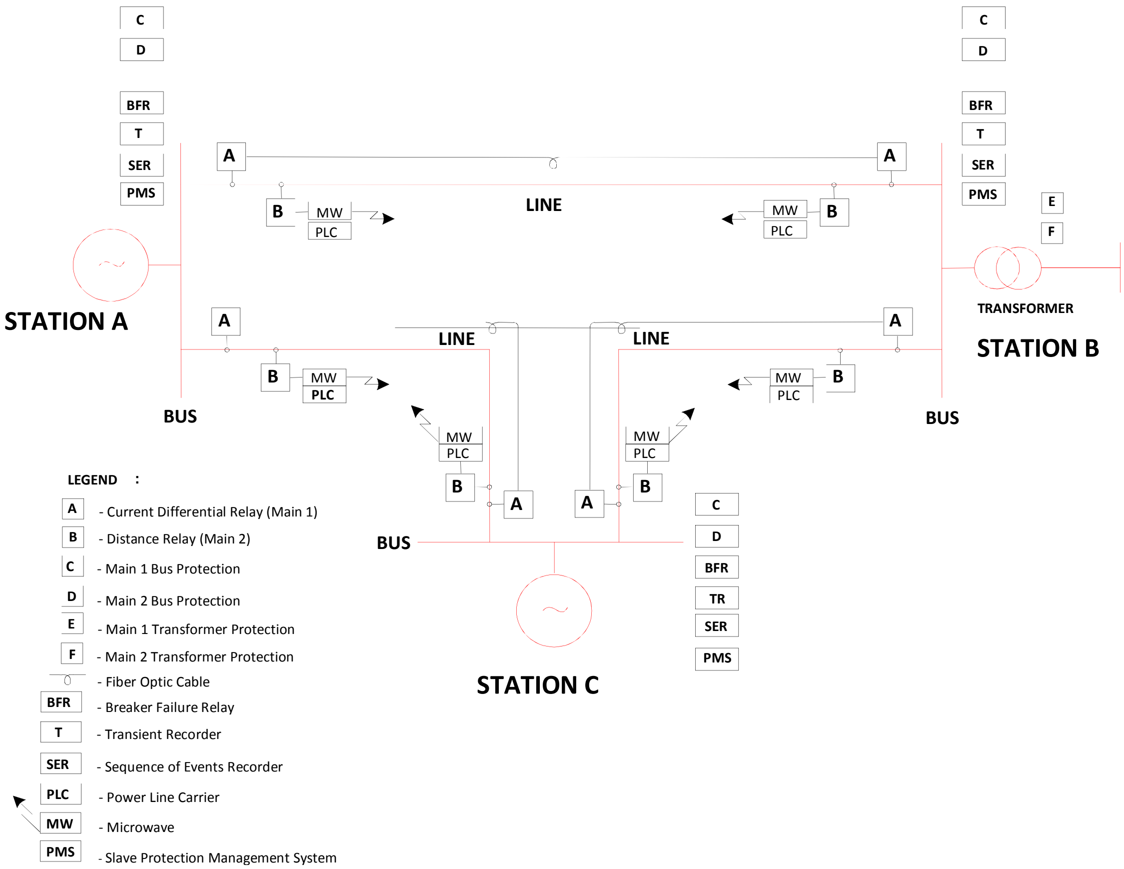
Most substation breakers are equipped with breaker fail relays as local back-up protection whenever the primary protections fail to interrupt the fault current within the prescribed fault clearance time as mandated by the Philippine Grid Code (PGC). At present, most of these back-up protection systems are either outdated or obsolete and some substations have none.

Most Transformers & Buses are protected by Main 1 Protection equipment only and most of these are already beyond economic life.

For the communication media, Main 1 and Main 2 are being coordinated using combinations of optical fibers, microwave radios and power line carriers (PLC). In some transmission lines which still benefit only from communication via PLC, both Main 1 and Main 2 are able to carry distance protection signals only.

System disturbances are being monitored through transient recorders. These equipment are installed for post analysis to verify protection and circuit breaker operations, fault clearance time, distance to fault and power system stability. Sequence of events recorders are used to monitor protective relays and other secondary devices within the substation in order to verify or confirm correctness of their operation.

Shown below is the typical configuration of Line Protection and Monitoring Equipment in the Luzon, Visayas and Mindanao Grids.



2.2 Features

2.2.1 Luzon

Table 2.2.1a: Protection Equipment

Network Element	Economic Life	Class	Less than Economic Life	More Than Economic Life	Outlook
Distance Relay	15 years (ERC)	Electro Mechanical		4	Most of the installed relays are beyond the economic life of 15 years with less capabilities and eighteen (18%) of the protection that are below the set economic life have no spare parts support or are declared obsolete. Based on the approved Protection Philosophy, both Main 1 and Main 2 primary protections should be replaced by differential relays for lines installed with fiber optic and alternate communication path via fiber optic or microwave. Replaced distance relays will become spares for the remaining operating distance relays. Replacement of old and defective relays with new numerical relays compliant to our Protection Philosophy will increase the reliability and security of Protection System. As for the electro mechanical relays, immediate replacement is necessary.
		Static		60	
		Numerical	119	117	
Line Differential Relay	15 years (ERC)	Electro Mechanical			
		Static		17	
		Numerical	159	54	
Directional Over Current Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical	2		
Current Comparison Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical			
Phase Comparison Relay	15 years (ERC)	Electro Mechanical			
		Static		2	
		Numerical			
Directional Power Relay	15 years (ERC)	Electro Mechanical			These relays are utilized by the System Integrity Protection Schemes (SIPS). Most of the existing units are below the 15 yrs. economic life. However, additional requirement will depend on the system needs for SIPS. The use of Directional Power Relays for our SIPS will serve as contingency measure for "N-2" or Multiple outages of Transmission Line or Equipment thus power delivery or dispatch will be maximized.
		Static	23		
		Numerical			

Under Frequency Relay	15 years (ERC)	Electro Mechanical			These relays are utilized by the ALD Schemes. All of the installed units are obsolete and beyond economic life and are subject for replacement. New model of UFR with enhanced functionality to maximize reliability and security are favorable.
		Static			
		Numerical		53	
Breaker Failure Relay	15 years (ERC)	Electro Mechanical		37	Ninety-four percent (94%) of the Substations throughout Luzon were equipped with the BFR and most of these units are beyond its economic life and are obsolete.
		Static		128	
		Numerical	298	92	
Bus Differential Relay	15 years (ERC)	Electro Mechanical		2	Only Fifty-eight percent (58%) of the total numbers of buses have Main 2 protections. Most bus protections are electro-mechanical and static type and obsolete.
		Static		20	
		Numerical	80	85	
Transformer Differential Relay	15 years (ERC)	Electro Mechanical		0	Seventy-one percent (71%) of the total numbers of Transformers have Main 2 protections. Most Transformer protections are electro-mechanical, static and numerical type and obsolete.
		Static		28	
		Numerical	120	81	

Table 2.2.1b: Network Disturbance Monitoring Equipment

Network Element	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Transient Recorders	15 years	Digital	3	18	Around 20% of the installed transient recorders are already beyond the economic life set by ERC for protection equipment. Although the manufacturer still supports the spare requirements, the cost is too prohibitive; thus, procuring new units is a better alternative. The replaced operational parts and modules will be a source of spares for the obsolete units until all these are replaced.
		Multi-Function	137	18	
Sequence of Events Recorders	15 years	Digital	20	43	68% sequence of events recorders are already beyond the economic life set by ERC for protection equipment. Although the manufacturer still supports the spare requirements, the cost is too prohibitive thus procuring new units is a better alternative. The replaced operational parts and modules will be a source of spares for the old units until all these are upgraded.
Power Quality Analyzer	15 years	Fixed	9		PQA's are necessary to monitor/record the power quality in the transmission system as required in the Philippine Grid Code. Procurement of Power Quality equipment will enable us to monitor compliance to Philippine Grid Code power quality requirement.
		Portable	1		

Tab*l*e 2.2.1c: Test Instruments

Equipment	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Power System Simulator	10 years	Three Phase	1	5	Additional and replacement program of these instruments are necessary to maintain the reliability and integrity of the network protection system. These also include the equipment calibration.
		Single Phase	2	4	
Real Time Digital Simulator	15 years	Digital	1		The present capability of the RTDS is limited to a maximum of 2 distance relays facing each other. To enhance the testing of protection systems (Main 1 and Main 2), upgrading is necessary.

2.2.2 Visayas

Table 2.2.2a: Protection Equipment

Equipment	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Distance Relay	15 years (ERC)	Electro Mechanical			Thirty-four (34) distance relays beyond economic life are installed as Main 1 protection. Ten (10) line differential relays are offline due to relay and teleprotection problems. Some directional overcurrent relays are used as Main 2 line protection. While others are used for System Integrity Protection Schemes (SIPS). Based on the approved Protection Philosophy, both Main 1 and Main 2 primary protections should be replaced by differential relays for lines installed with fiber optic and alternate communication path via fiber optic or microwave links.
		Static			
		Numerical	97	49	
Line Differential Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical	50		
Directional Over Current Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical	32		
Directional Power Relay	15 years (ERC)	Electro Mechanical			Directional power relays are used in SIPS. Additional requirements will depend on the need for SIPS to maintain system stability during multiple outages or overloading of transmission lines or equipment.
		Static			
		Numerical	3		
Under Frequency Relay	15 years (ERC)	Electro Mechanical			These relays are utilized in Automatic Load Dropping Schemes and all of them are already beyond economic life.
		Static		15	
		Numerical		15	
Breaker Failure Relay	15 years (ERC)	Electro Mechanical		15	Out of 27 substations in the Visayas that require breaker fail protections, only Toledo Substation is not equipped with BFR.
		Static		45	
		Numerical	166	18	
Bus Differential Relay	15 years (ERC)	Electro Mechanical	2	2	Only four buses have Main 2 protections. Twenty-seven percent (27%) of the existing bus protections are already obsolete.
		Static	3	10	
		Numerical	250		
Transformer Differential Relay	15 years (ERC)	Electro Mechanical		3	Only eleven (11) transformers have Main 2 protections. Eighteen (18%) percent of the existing transformer protections are already beyond economic life.
		Static	1	4	
		Numerical	49	4	

Table 2.2.2b: Network Disturbance Monitoring Equipment

Network Element	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Transient Recorders	15 years	Digital	8	12	Out of 33 stations considered for monitoring in the Visayas region, only 26 have installed TR. Of the 26 stations with installed TR, only 17 stations have functional recorders. All installed recorders in nine (9) stations are defective. Of the 70 TR installed in 33 stations, 32 are defective including the six (6) recorders that are already beyond economic life.
		Multi-Function	50		
Sequence of Events Recorders	15 years	Digital	29	9	Of the 33 stations, only 17 have installed SER. Out of the 38 SER installed in 17 stations, 15 SER are already defective. Although the manufacturer still supports the spare requirements, the cost is too prohibitive. Thus procuring new units is a better alternative. The operational parts and modules of the replaced SER will be the source of spares until all are upgraded.

Table 2.2.2c: Test Instruments

Equipment	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Power System Simulator	10 years	Three Phase	1		All of these instruments are working. Twelve (12) power quality analyzers are due for calibration. PQAs are necessary to monitor compliance to Philippine Grid Code power quality requirements.
		Single Phase			
Real Time Digital Simulator	15 years	Digital			
Power Multi Meter	5 years	Multi-function	1	3	
Portable Power Quality Analyzer	10 years	A			
		B	18		

2.2.3 Mindanao

Table 2.2.3a: Protection Equipment

Equipment	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Distance Relay	15 years (ERC)	Electro Mechanical			Thirty Eight percent (38%) of the protection that are below the set economic life has no more spare parts available. The new protection philosophy states that Main 1 and Main 2 line protection should be differential relays; therefore, replacement of all distance relays with differential relays is a must. However, this is only possible if a fiber optic medium of communication is already in place in that line.
		Static			
		Numerical	171	55	
Line Differential Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical	16		
Directional Over Current Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical	6		
Current Comparison Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical			
Phase Comparison Relay	15 years (ERC)	Electro Mechanical			
		Static			
		Numerical			
Directional Power Relay	15 years (ERC)	Electro Mechanical			These relays are utilized for System Integrity Protection Schemes (SIPS). Additional requirement (MFR Specifications) will depend on system studies.
		Static			
		Numerical	6		
Under Frequency Relay	15 years (ERC)	Electro Mechanical			Studies suggest that one UFR for one feeder is more manageable in terms of change of scheme for ALD-UFLS. We need 10 more UFR (MFR Specifications) to implement this plan. Also, 5 MFR's are recommended per year for replacement and spares.
		Static			
		Numerical	47		
Breaker Failure Relay	15 years (ERC)	Electro Mechanical			Some installed BFRs which are still for commissioning are already becoming obsolete and non-compliant to philosophy.
		Static			
		Numerical	254		

Table 2.2.3b: Network Disturbance Monitoring Equipment

Network Element	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Transient Recorders	15 years	Digital			Some MFRs cannot be connected remotely. Upgrading to NDME that can be integrated to PMS is already programmed in the next regulatory period.
		Multi-Function	61		
Sequence of Events Recorders	15 years	Digital	4		NDMEs are already programmed in the next regulatory period to address monitoring deficiencies.

Table 2.2.3c: Test Instruments

Equipment	Economic Life	Class	Less Than Economic Life	More Than Economic Life	Outlook
Power System Simulator	10 years	Three Phase	1		Acquisition of additional Power System Simulators is being considered.
		Single Phase			
Power Multimeter	5 years	Multi-function			No existing multimeter in Mindanao Grid.
Power Quality Analyzer	10 years	Fixed			PQAs are necessary to monitor compliance to the Philippine Grid Code power quality requirements.
		Portable	6		

2.3 Problems and Issues

2.3.1 Luzon

Undesired tripping of transmission lines and high voltage equipment in the grid are due to various misoperation, non-operation or malfunction of protective relays which are part of the Fault Clearance System (FCS). Many of these are attributed to obsolete relays and some were due to inappropriate relays installed in the system in the past. Quite a number of protection systems presently installed do not yet conform to current Network Protection Philosophy.

Aggravating the situation is the lack of immediate access to or non-availability of complete fault data due to obsolete and defective network disturbance monitoring equipment. This hampers analysis of system disturbances delaying resolution of network deficiencies and correction of defective protection systems. We would note also that there is no facility for remote access to the relay; hence, retrieval of fault data from numerical relays could not be done on demand. To date only manual (local) retrieval of fault data and relay setting configurations can be performed.

2.3.2 Visayas

One major problem in the Visayas is the deferral of the replacement of the defective Main 2 protections in some critical transmission lines. The lack of appropriate protective devices could cause cascading and widespread power outages.

A serious problem which adversely affects the analysis of system disturbances is the delay in retrieval of fault data. This is primarily due to the lack of adequate protection management system that would facilitate the immediate and remote retrieval of disturbance records from protective relays. In addition, several network disturbance monitoring equipment are already obsolete and defective.

A big setback in the existing protection system is the non-compliance to the Network Protection Philosophy. Some line protections and many substation protections do not yet conform to the N-1 contingency.

2.3.3 Mindanao

Considering the problem of peace and order in Mindanao, remote data retrieval is of vital importance for data analysis during system disturbance. The lack of remote capability of our transient recorders is a big hindrance for data gathering. Several undesired tripping of transmission lines and high voltage equipment in the Mindanao grid are due to various misoperation, non-operation or malfunction of protective relays and other connected equipment of the fault clearance system. Many of these are attributed to obsolete relays and equipment. Some installed breaker failure relays which are still for commissioning are already now becoming obsolete and not compliant to the new Protection Philosophy. Transformer and bus protection are still not covered with Main 2 protection. Line protection using differential protection is in level one because not all lines have fiber optic as medium of communication.

Moreover, Mindanao recently experienced two major power blackouts and the root cause mostly started from power plant protection problems. Issues on cross-ownership especially on protection equipment should be resolved. Appropriate protection relays facing generator plants should be installed plus another backup protection to ensure immediate isolation of plants should they encounter faults that may trigger prolonged downtimes affecting the Grid. Upgrading of substation to MBSC plus secondary protection must also include protection management system that can be connected to the MRCC master station. For substation upgrading, fault clearing system must include redundant battery system and if possible, to include the replacement of old power circuit breakers.

3.0 REQUIREMENTS ANALYSIS

3.1 Demand

Table 3.1: Demand – Corporate Needs versus Protection Requirements

Corporate Needs	Protection Requirements
1. Line Protection a. Main 1 Line Protection b. Main 2 Line Protection	- Line Differential Relay with Backup Distance Function - Line Differential Relay with Backup Distance Function
2. Substation Protection	- Main 1 Bus Differential Relay - Main 2 Bus Differential Relay - Main 1 Transformer Protection - Main 2 Transformer Protection - Breaker Failure Relay
3. System Protection a. System Integrity Protection Schemes b. Automatic Load Dropping	- Directional Power or Overcurrent Relay - Under Frequency Relay
4. Local and Remote Retrieval of System Disturbances Fault Records for Analysis	- Network Disturbance Monitoring Equipment - Mobile and Workstation Data Retriever/Computer - Established Equipment Remote Communication
5. Reliability of the Fault Clearance System	- Testing Equipment & other GPE's, Air Conditioning Units, Spares - Real Time Digital Simulator
6. Setting of Line Protection Relays, Load Flow, Dynamics, Electro Magnetic Simulation and Fault Analysis	- Various Power System Simulation Software - Software Maintenance and Support - Real Time Digital Simulator
7. Power Quality Analysis of Voltage and Frequency Variation, Harmonic Distortion, and Transient Over Voltage	- Power Quality Analyzer - Network Disturbance Monitoring Equipment
8. Simulations Testing of Relay Operations for Relay Selection and Accreditation	- Additional racks and amplifiers for the existing real time digital simulator
9. Protection Management System	- Dedicated Wide Area Network infrastructure for Protection equipment - Data concentrator and server

10. Monitoring of Status and Operational Alarms of Protection Relays, Disturbance Recorders and SIPS	- SCADA to provide necessary interface equipment
11. Telecom/IS/IT a. Tele-Protection Requirements b. Network Communication Requirements	 - Direct Fiber Optic for Main 1 and Main 2 Line Differential Relays - PSE via PLC a. Command 1 & 2 for Main 2 Distance Relay and Directional Earth Fault b. Command 3 for BFR Direct Transfer Trip - Additional Protection Signaling Equipment for SIPS - Dedicated communication link for LAN/WAN Scheme for Protection Relays and Monitoring Equipment

3.2 Technology Direction

Table 3.2: Technology Direction – Corporate Needs versus Protection Requirements

Corporate Needs	Protection Requirements
1. Remote Retrieval of Fault Data and Annunciation from Line Protection	- New Relays with IP based communication for Remote Access of Line Protection through Wide Area Network. - Requires various Switches, Routers, Firewalls, Network converters and Modem
2. Time Synchronization of Protection and Monitoring Equipment	- Integration of different Protocols - Global Positioning Satellite Time Synchronization Device
3. Compliance with the Reliability and Power Quality Standards	- Installation of Power Quality Analyzer

3.3 Policy Considerations

Table 3.3: Policy Considerations – Corporate Needs versus Protection Requirements

Corporate Needs	Protection Requirements
1. The cost of Operation and Maintenance exceeds the Replacement Cost	- Retirement of obsolete monitoring and Protection where cost of Spare Parts and Upgrades are too expensive
2. No Spare Parts support	- Phased replacements of Line Protection and Monitoring Equipment to provide source of spare for the remaining installed base
3. No capability to address Standards/Prevalent Protocols	- Replacement of Protection and Monitoring Equipment without applicable protocol
4. Worst Case condition of the Power System	- Replacement of obsolete and inappropriate protection system
5. Compliance with New Protection Philosophy	- Replacement of existing Protection System with Main 1 and Main 2 Line Differential Protections progressively to comply with the new Protection Philosophy
6. Compliance with Smart Grid	- Replacement of the existing Protection System with State of the Art Protection System to enhance the fault disturbance monitoring, communicability and interface ability
7. Compliance with Reliability and Power Quality Standards	- Installation of Power Quality Analyzer, Recloser & Breaker Failure Relay

4.0 DEVELOPMENTAL PROGRAMS

4.1 Planning Criteria

a. Decision to adapt to technology directions should be weighed against economics.
b. Reliability and Security precedes Functionality.
c. Adopt Open-System Standards in Protection Management and Interfacing to increase flexibility to technology shifts as well as to enable access to best of breed.
d. Prefer “Green” Technology as part of corporate commitment.
e. Protection Network Infrastructure shall be upgraded in order to adapt with new technology for the purpose of greater interoperability, accessibility, reliability and security, towards the fulfillment of Regulatory Requirements.
f. To optimize features/functionality of Protection Equipment in addressing corporate mandates.
g. Taking into account the embedding of fiber optics along transmission lines, the existing Distance Main 1 and Main 2 Protections shall be upgraded to Differential Protection in a progressive manner to comply with the Protection Philosophy.
h. Network Protection Management System shall be developed and established to ensure that the availability and functionality of the Protection Equipment (Relays and Recorders) are monitored all the time.
i. Network Disturbance Monitoring Equipment shall have power quality logger capability.
j. Priority protection requirements not covered by substation upgrading projects shall be implemented to ensure the stability and security of the protection system.

4.2 Regional Considerations

4.2.1 Luzon

Installation of back-up protection (Main 2) and replacement of Protection systems that have reached obsolescence shall be implemented. Likewise, inappropriate relays installed in critical substations are included in the replacement schedules to ensure secure and reliable operations. Aligned with the Smart Grid model, protective relays with enhanced communication systems and more interfacing options shall be procured. Upgrades/replacements of the protection system undertaken to comply with the NGCP Protection Philosophy shall include protection for transmission line, transformer, bus, breaker-fail, system integrity protection schemes (SIPS), disturbance monitoring equipment and protection management system (PMS).

Following are the protection developmental targets for Luzon:

Table 4.2.1: Protection Developmental Targets – Luzon

PROTECTION ELEMENT	CY 2016	CY 2025
LINE PROTECTION		
w/ MAIN 1 + MAIN 2	100%	100%
MAIN 1 AS DIFFERENTIAL	75%	100%
TRANSFORMER PROTECTION		
w/ MAIN 1 + MAIN 2	95%	100%
FOR CRITICAL SUBSTATION	100%	100%
BREAKER FAIL PROTECTION		
COMPLIANT TO PHILOSOPHY	45%	100%
BUS PROTECTION		
w/ MAIN 1 + MAIN 2	78%	100%
NDME		
STANDARDS-COMPLIANT	75%	100%
PMS	33%	100%
INSTALLED SIPS	12	7

4.2.2 Visayas

The fault clearance system shall be enhanced through the replacement and/or upgrading of obsolete and defective protective devices and equipment as well as the installation of new protection systems in order to ensure the security and reliability of the power system. Line, transformer, bus, breaker-fail, system integrity protection schemes (SIPS), network disturbance monitoring equipment and protection management system (PMS) shall comply with the Network Protection Philosophy and support Smart Grid requirements.

Following are the protection developmental targets for Visayas:

Table 4.2.2: Protection Developmental Targets – Visayas

PROTECTION ELEMENT	CY 2016	CY 2025
LINE PROTECTION		
w/ MAIN 1 + MAIN 2	100%	100%
MAIN 1 AS DIFFERENTIAL	55%	100%
TRANSFORMER PROTECTION		
w/ MAIN 1 + MAIN 2	34%	100%
FOR CRITICAL SUBSTATION	67%	100%

BREAKER FAIL PROTECTION		
COMPLIANT TO PHILOSOPHY	38%	100%
BUS PROTECTION		
w/ MAIN 1 + MAIN 2	25%	100%
NDME		
STANDARDS-COMPLIANT	65%	100%
PMS	21%	100%
INSTALLED SIPS	10	10

4.2.3 Mindanao

Protection upgrading in Mindanao shall be based on compliance with our new protection philosophy and shall be synchronized with upgrade plans of the Mindanao Operation & Maintenance (O&M) group. According to the per-substation upgrade plan of O&M, all protection systems in a particular substation shall be replaced in bulk (and still-appropriate units shall be deployed where appropriate). Upgrading would address protection requirements for lines, buses, transformers, feeders, and breaker-fails as well as auxiliary equipment used in the fault clearance system such as station batteries, grounding, lightning arresters and current and potential transformers. Line protection equipment for the adjacent substations shall also upgraded/replaced in line with our protection philosophy.

Line Differential Protection implementation as a compliance to our protection philosophy will depend on the completion of the upgrading of the telecom backbone using fiber optic medium of communication. Realization of targets in this regard will be synchronized with the telecom projects.

Protection Management System (PMS) Server in MRCC Cagayan del Oro City was already operational and in every substation therefore should have a remote communication through PMS slave system. Monitoring the state and health of relays, relay setting and relay actuations during system disturbance were done through PMS.

Network Disturbance Monitoring Equipment (NDME) is also an essential part of the upgrading of a substation and this will also through the interconnection of PMS.

Following are the protection developmental targets for Mindanao:

Table 4.2.3: Protection Developmental Targets – Mindanao

PROTECTION ELEMENT	CY 2016	CY 2025
LINE PROTECTION		
w/ MAIN 1 + MAIN 2	100%	100%
MAIN 1 AS DIFFERENTIAL	50%	95%
TRANSFORMER PROTECTION		
w/ MAIN 1 + MAIN 2	95%	100%
FOR CRITICAL SUBSTATION	0%	100%
BREAKER FAIL PROTECTION		
COMPLIANT TO PHILOSOPHY	40%	81%
BUS PROTECTION		
w/ MAIN 1 + MAIN 2	100%	100%
NDME		
STANDARDS-COMPLIANT	75%	100%
PMS	20%	85%
INSTALLED SIPS	6	4

4.2.4 Overall (Luzon, Visayas and Mindanao)

Following are the overall protection developmental targets for the three regions:

Table 4.2.4: Protection Developmental Targets – Overall

PROTECTION ELEMENT	CY 2016	CY 2025
LINE PROTECTION		
w/ MAIN 1 + MAIN 2	100%	100%
MAIN 1 AS DIFFERENTIAL	48%	72%
TRANSFORMER PROTECTION		
w/ MAIN 1 + MAIN 2	71%	100%
FOR CRITICAL SUBSTATION	89%	100%
BREAKER FAIL PROTECTION		
COMPLIANT TO PHILOSOPHY	44%	94%
BUS PROTECTION		
w/ MAIN 1 + MAIN 2	64%	100%
NDME		
STANDARDS-COMPLIANT	73%	100%
PMS	25%	80%
INSTALLED SIPS	28	21

4.3 Identification of Deficiencies in Protection and Assessment of Priorities based on Criticality of the Equipment being Protected

4.3.1 Protection Relay Replacement Program

4.3.1.1 Luzon

In Luzon, there is a significant increase in the number of protection deficiencies that have been identified in the current year as compare to the previous year, from 964 to 1045; wherein 480 or 46% were non-compliant to the protection philosophy and another 480 or 46% have no spares support, while the remaining 9% or 97 have no redundancy and protection. The first priorities for replacement program are the 7 BFRs and 1 Bus Protection in the identified critical transmission lines to ensure the security and reliability of the grid.

Table 4.3.1.1: Priority Table for Relay Replacement Program in Luzon

Category of Replacement	Line Protection		Transformer Protection		Bus Protection		Breaker Fail Protection		Total
	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	
No Protection	0	0	0	0	1	1	7	7	16
Not Redundant	0	0	0	30	13	26	0	0	69
Not Standard	82	36	16	35	17	37	65	192	480
No Spares Support	82	36	16	35	17	37	65	192	480

4.3.1.2 Visayas

In Visayas, there were 339 total deficiencies in protection that have been identified which comparably smaller than previous year with 408 deficiencies. These comprises of; 53% or 179 protection equipment that are non-compliant to the protection philosophy, 26% or 87 have no redundancy, 20% or 68 have no spares support and the remaining 2% or 6 still have no BFR protection. The installation of 6 BFRs in the critical substation should be prioritized to mitigate occurrence of undesired relay tripping due to the failure of the said breakers.

Table 4.3.1.2: Priority Table for Relay Replacement Program in Visayas

Category of Replacement	Line Protection		Transformer Protection		Bus Protection		Breaker Fail Protection		Total
	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	
No Protection	0	0	0	0	0	0	6	0	6
Not Redundant	10	6	11	24	28	8	0	0	87
Not Standard	0	0	0	0	1	0	47* 99**	11* 21**	179
No Spares Support	40	12	4	4	8	0	0	0	68

***Obsolete Relays/ Non-Compliant to Protection Philosophy. **Non-Compliant to Protection Philosophy.**

4.3.1.3 Mindanao

In Mindanao, there were 418 total deficiencies in protection that have been identified; wherein 147 or 35% have no protection, 130 or 31.10% were non-compliant to the protection philosophy, 86 or 20.57% have no redundancy and 55 or 13.16% have no spares support. The table 4.3.3 also shows that installation of 104 BFRs and 1 Line Protection have to be prioritized for replacement due to its criticality in the system grid.

Table 4.3.3: Priority Table for Relay Replacement Program in Mindanao

Category of Replacement	Line Protection		Transformer Protection		Bus Protection		Breaker Fail Protection		Total
	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	
No Protection	0	0	0	0	0	0	104	43	147
Not Redundant	1	5	17	10	31	22	0	0	86
Not Standard	0	3	0	0	0	0	88	39	130
No Spares Support	19	29	5	2	0	0	0	0	55

LEGEND:

- 1st Priority for Replacement Program
- 2nd Priority for Replacement Program
- 3rd Priority for Replacement Program
- 4th Priority for Replacement Program

4.3.1.4 Summary (Luzon, Visayas and Mindanao)

On the table below, the total number of deficiencies in the whole grid is equivalent to 1683 protection relays. The table 4.3.4.1 shows the total number of deficiencies according to the criticality of equipment. It can be observed that BFR protections have the highest number of deficiencies wherein 382 are critical and 484 are non-critical.

Table 4.3.1.4: Priority Table for Relay Replacement Program in Luzon, Visayas and Mindanao

Category of Replacement	Line Protection		Transformer Protection		Bus Protection		Breaker Fail Protection		Total
	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	Critical	Non-Critical	
No Protection	0	0	0	0	1	1	117	50	169
Not Redundant	11	11	28	64	72	56	0	0	242
Not Standard	82	39	16	35	18	37	200	242	669
No Spares Support	141	77	25	41	25	37	65	192	603
Total:	**234**	**127**	**69**	**140**	**116**	**131**	**382**	**484**	**1,683**

Moreover, table 4.3.4.2 will show the total deficiencies on protective relays in the whole grid according to category of replacement. As can be seen in this figure; 669 or 40% were non-standard, 603 or 36% have no spares support, 242 or 14% have no redundancy and the remaining 169 or 10% had been identified no protection.

Table 4.3.4.2: Total Deficiencies on Protective Relays in Luzon, Visayas and Mindanao

Category of Replacement	Line Protection	Transformer Protection	Bus Protection	Breaker Protection	Total
No Protection	0	0	2	167	169
Not Redundant	22	92	128	0	242
Not Standard	121	51	55	442	669
No Spares Support	218	66	62	257	603
Total:	**361**	**209**	**247**	**866**	**1,683**

4.3.2 Network Disturbance Monitoring Equipment and Power Quality Analyzer Program

4.3.2.1 Luzon

At present, 79 units or 33% of the 239 units installed NDME's are already beyond the 15-year economic life prescribed by ERC for protection equipment. All of these equipment are no longer benefit from manufacturer support, resulting in difficult maintenance.

Likewise, there are only 10 PQA's installed throughout Luzon. These are of course not sufficient to cater to the power quality monitoring requirements of the whole region.

Power quality issues are prevalent in some critical substations with installed capacitors which are connected to large non-linear time-varying loads (e.g., steel mills). For instance, in Mexico substation wherein one of its major loads is a steel mill, this type of load contributes several power quality problems in the power system such as generating current/voltage harmonics beyond power system network limits, voltage imbalance and fluctuation. The use of capacitors also introduces “harmonic resonance” resulting in overvoltage and overcurrent spells—possibly damaging some electrical network elements, especially transformers. These power quality problems can be resolved and mitigated by the installation of adequate PQA equipment, particularly in substations where there are identified power quality issues (e.g., in Mexico).

4.3.2.2 Visayas

At present, 21 units or 19% of the 108 units installed NDME’s are already beyond the 15 years economic life set by ERC for protection equipment, all of which are considered phased-out. The cost of repair and maintenance is too high as to warrant procuring new units instead. The still-operational parts and modules of the retired obsolete equipment will then be used as source of spares for the retained functional units, until all of the former have been totally replaced.

Likewise, there are 18 PQA’s installed in the region, all of which are still within expected economic lives. But considering the geographical condition of Visayas, these would not be sufficient to cater the power quality requirements in the region.

Power quality issues, particularly voltage problems in major substations, will be addressed by acquiring more units of PQA’s.

4.3.2.3 Mindanao

At present, most of the NDME’s are newly installed however, there are some major lines and substations that have deficiencies in monitoring equipment; some are already problematic while still within their life span. Aside from this, there is a need for additional NDME’s along the 69kV transmission lines. Considering the peace and order problem in Mindanao, remote data retrieval is of vital importance for data analysis during system disturbances. The lack of remote access capability to transient recorders is a significant hindrance for data gathering. Therefore, the installation of remotely accessible NDME’s in such areas of deficiency must be prioritized in order to maintain a secure and reliable operation of the power system network in Mindanao.

Mindanao power system network is relatively more stable in the northern part of the island in terms of voltage and frequency variation even during disturbances. However, the eastern areas are more frequently subjected to a combination of high and low voltages during peak or off-peak load conditions. The low voltage in some substations during peak condition can be attributed to the long 138 kV transmission lines and limited local power supply generation. Low voltages can also be experienced at the far end of the 69 kV systems during peak conditions. Currently, power quality monitoring requirements are not being fully implemented since only 6 PQA's are installed throughout Mindanao grid.

4.3.2.4 Overall (Luzon, Visayas and Mindanao)

The delay in the resolution of the cause of network failure and subsequent correction of network deficiencies is on account of the non-availability of fault data due to the lack of functional NDME's. Obsolescence and degradation as a result of age have lessened the effectiveness of existing NDME's.

Table 2.1 shows the age profile of installed NDME and PQA facilities on a per-Region basis.

Table 4.3.2.4: Existing NDMEs and PQAs

NDMEs Replacement	ERC Service Life		Luzon		Visayas		Mindanao		Total	
			All	Beyond S. L.	All	Beyond S. L.	All	Beyond S. L.	All	Beyond S. L.
Transient Recorders	15	Qty.	176	36	70	12	61	0	307	48
		%		20%		17%		0		16%
Sequence of Events Recorders	15	Qty.	63	43	38	9	4	0	105	52
		%		68%		24%		0		50%
Power Quality Analyzer	15	Qty.	10	0	18	0	6	0	34	0
		%		0		0		0		0

4.4 Protection Compliance Strategy

O&M's substation upgrading program (Vol. 2) is aimed at addressing the identified potential deficiencies by rehabilitating prioritized substations and updating or upgrading pertinent secondary equipment. Relays and other line protection equipment in adjacent stations are also covered among the upgraded components. P&E's new transmission lines and substation projects (Vol. 1) would also address some of the deficiencies since the new network assets most often require complementary adjustments/upgrades in connecting substations.

But the wholescale substation projects alone cannot cover all the identified deficiencies which need immediate action to ensure network performance within the mandated thresholds. The recourse would be to ensure that the spares stock should be enough to address both the remaining deficiencies as well as expected run-to-failures of equipment operating beyond normal service lives.

In planning the spares stocks level, we would note, too, that for those equipment without spares support, staggered replacement of installed base will be carried out to provide source of spares for remaining online equipment. The objective is to optimize returns even on already “obsolete” but still functional equipment.

4.5 CAPEX Schedule (in Million Php)

4.5.1 Luzon NDME and PQA Programs

REPLACEMENTS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	7.00	21.00	19.25	15.75	8.75	0.00	0.00	0.00	0.00	0.00	71.75
	4 nodes	12 nodes	11 nodes	9 nodes	5 nodes						41 nodes
SPARES	5.00	8.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	93.00
NDME	3	6	6	6	6	6	6	6	6	6	57.00
PQA	2	2	4	4	4	4	4	4	4	4	36.00
TOTAL	**12.00**	**29.00**	**29.25**	**25.75**	**18.75**	**10.00**	**10.00**	**10.00**	**10.00**	**10.00**	**164.75**

UPGRADES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	0.00	10.44	12.18	6.96	6.96	0.00	0.00	0.00	0.00	0.00	36.54
		6 nodes	7 nodes	4 nodes	4 nodes						21 nodes
TOTAL	**0.00**	**10.44**	**12.18**	**6.96**	**6.96**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**36.54**

NEW	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	0.00	0.00	2.90	5.80	8.70	0.00	0.00	0.00	0.00	0.00	17.40
			1 node	2 nodes	3 nodes						6 nodes
POWER QUALITY ANALYZER	8.00	42.00	30.00	28.00	24.00	14.00	12.00	12.00	12.00	10.00	192.00
	8 nodes	40 nodes	27 nodes	25 nodes	21 nodes	14 nodes	11 nodes	11 nodes	12 nodes	10 nodes	179 nodes
TOTAL	**8.00**	**42.00**	**32.90**	**33.80**	**32.70**	**14.00**	**12.00**	**12.00**	**12.00**	**10.00**	**209.40**

4.5.2 Visayas NDME and PQA Programs

REPLACEMENTS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	8.00	8.00	12.00	6.00	12.00	0.00	0.00	0.00	0.00	0.00	46.00
	4 nodes	4 nodes	6 nodes	3 nodes	6 nodes						23 nodes
SPARES	7.54	2.52	4.47	2.52	2.22	2.32	2.02	2.32	2.02	2.32	30.23
NDME	7.54	2.52	4.47	2.52	2.22	2.32	2.02	2.32	2.02	2.32	30.23
TOTAL	**15.54**	**10.52**	**16.47**	**8.52**	**14.22**	**2.32**	**2.02**	**2.32**	**2.02**	**2.32**	**76.23**

UPGRADES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	0.00	4.00	4.00	6.00	6.00	4.00	6.00	6.00	4.00	0.00	40.00
		2 nodes	2 nodes	3 nodes	3 nodes	2 nodes	3 nodes	3 nodes	2 nodes		20 nodes
TOTAL	**0.00**	**4.00**	**4.00**	**6.00**	**6.00**	**4.00**	**6.00**	**6.00**	**4.00**	**0.00**	**40.00**

NEW	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	0.00	14.00	6.00	8.00	12.00	0.00	0.00	0.00	0.00	0.00	40.00
		7 nodes	3 node	4 nodes	6 nodes						20 nodes
POWER QUALITY ANALYZER	5.00	10.00	10.00	10.00	10.00	7.50	5.00	5.00	5.00	5.00	72.50
	2 nodes	4 nodes	4 nodes	4 nodes	4 nodes	3 nodes	2 nodes	2 nodes	2 nodes	2 nodes	29 nodes
TOTAL	**8.00**	**42.00**	**32.90**	**33.80**	**32.70**	**14.00**	**12.00**	**12.00**	**12.00**	**10.00**	**209.40**

4.5.3 Mindanao NDME and PQA Programs

REPLACEMENTS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	0.00	22.00	18.00	10.00	6.00	0.00	0.00	0.00	0.00	0.00	56.00
		11 nodes	9 nodes	5 nodes	3 nodes						28 nodes
SPARES	1.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	2.00	0.00	9.00
NDME	1		1		1		1		1		5.00
PQA			1		1		1		1		4.00
TOTAL	**1.00**	**22.00**	**20.00**	**10.00**	**8.00**	**0.00**	**2.00**	**0.00**	**2.00**	**0.00**	**65.00**

UPGRADES	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
NETWORK DISTURBANCE MONITORING EQUIPMENT	20.00	30.00	30.00	28.00	30.00	0.00	0.00	0.00	0.00	0.00	138.00
	10 nodes	15 nodes	15 nodes	14 nodes	15 nodes						69 nodes
TOTAL	**0.00**	**10.44**	**12.18**	**6.96**	**6.96**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**36.54**

NEW	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
POWER QUALITY ANALYZER	4.20	18.90	21.00	16.80	23.10	23.10	0.00	0.00	0.00	0.00	107.10
	2 nodes	9 nodes	10 nodes	8 nodes	11 nodes	11 nodes					51 nodes
TOTAL	**4.20**	**18.90**	**21.00**	**16.80**	**23.10**	**23.10**	**0.00**	**0.00**	**0.00**	**0.00**	**107.10**

4.5.4 CAPEX Summary

COMPONENT	LUZON	VISAYAS	MINDANAO	TOTAL
NDME	182.69	158.23	199.00	539.92
PQA	228.00	72.50	111.10	411.60
TOTAL	**410.69**	**230.73**	**310.10**	**951.52**

CATEGORY	LUZON	VISAYAS	MINDANAO	TOTAL
REPLACEMENT	164.75	78.23	65.00	307.98
UPGRADE	36.54	40.00	138.00	214.54
NEW	209.40	112.50	107.10	429.00
TOTAL	**410.69**	**230.73**	**310.10**	**951.52**

INFRASTRUCTURE

2016–2025

1.0 INTRODUCTION

1.1 System Operations Network Infrastructure Overview

The mandate of SO in managing the various power sources and transmission facilities in the Philippine Grid is to provide central dispatch based on market demand while ensuring reliability of the Grid.

These are not only on a medium-term basis, but also on the more detailed hourly dispatch of power generating and transmission facilities planned and performed. To carry out this mandate, SO determines the proper loading of generating plants, transmission lines and facilities support in order to achieve a secure and reliable power system. It also determines the appropriate configuration of the existing transmission network and other related transmission facilities at all times.

System Operations has 3 Regional Control Centers, various Area Control Centers and new Backup Control Centers strategically located in different areas in Luzon, Visayas and Mindanao.

Figure 1.1.a: Luzon Regional Control Center (NCC Building, Diliman, Quezon City)

Figure 1.1.b: Visayas Regional Control Center (Cebu City)

Figure 1.1.c: Mindanao Regional Control Center (Carmen, Cagayan de Oro)

Geographical map and locations of the SO RCCs, Backup RCCs & ACCs:

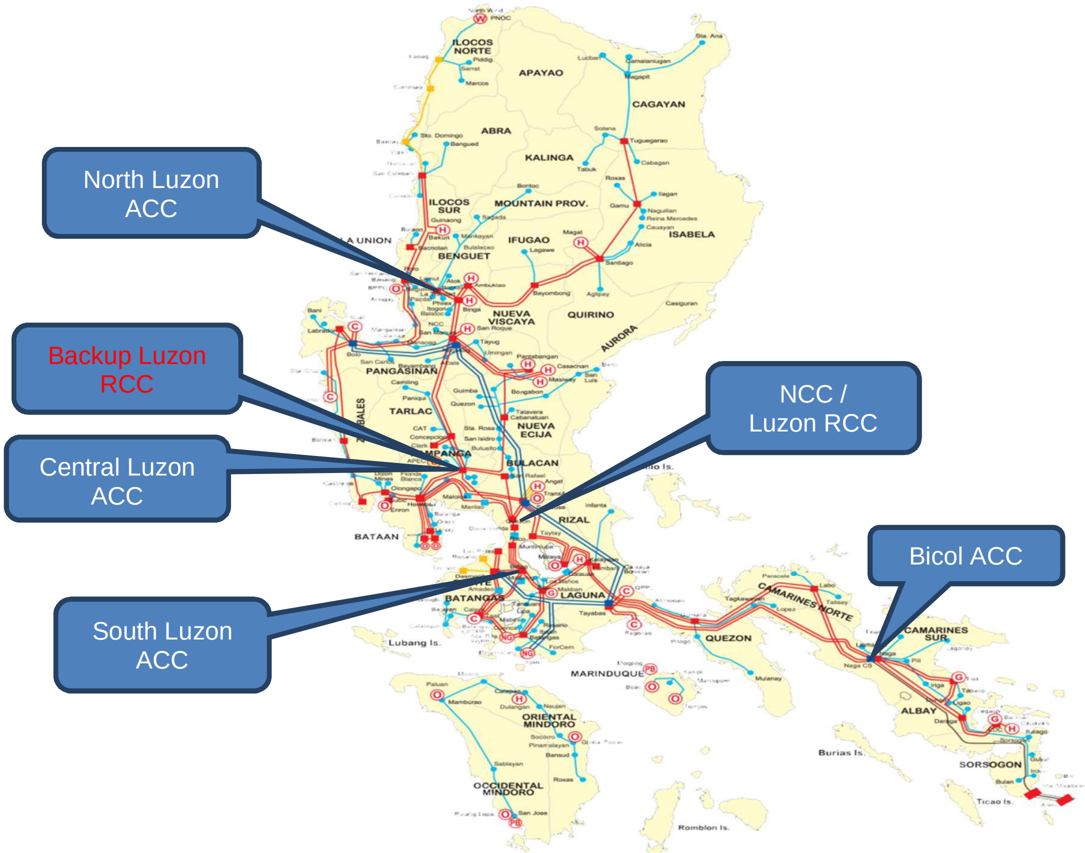


Figure 1.1.d: Luzon Grid

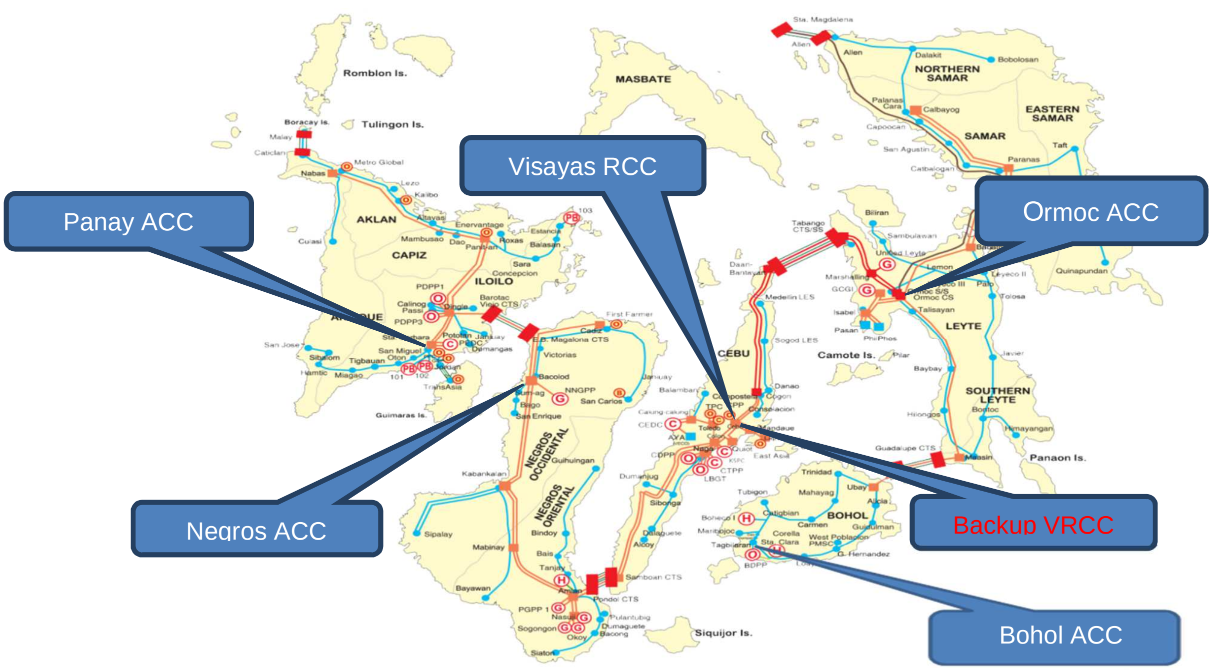


Figure 1.1.e: Visayas Grid

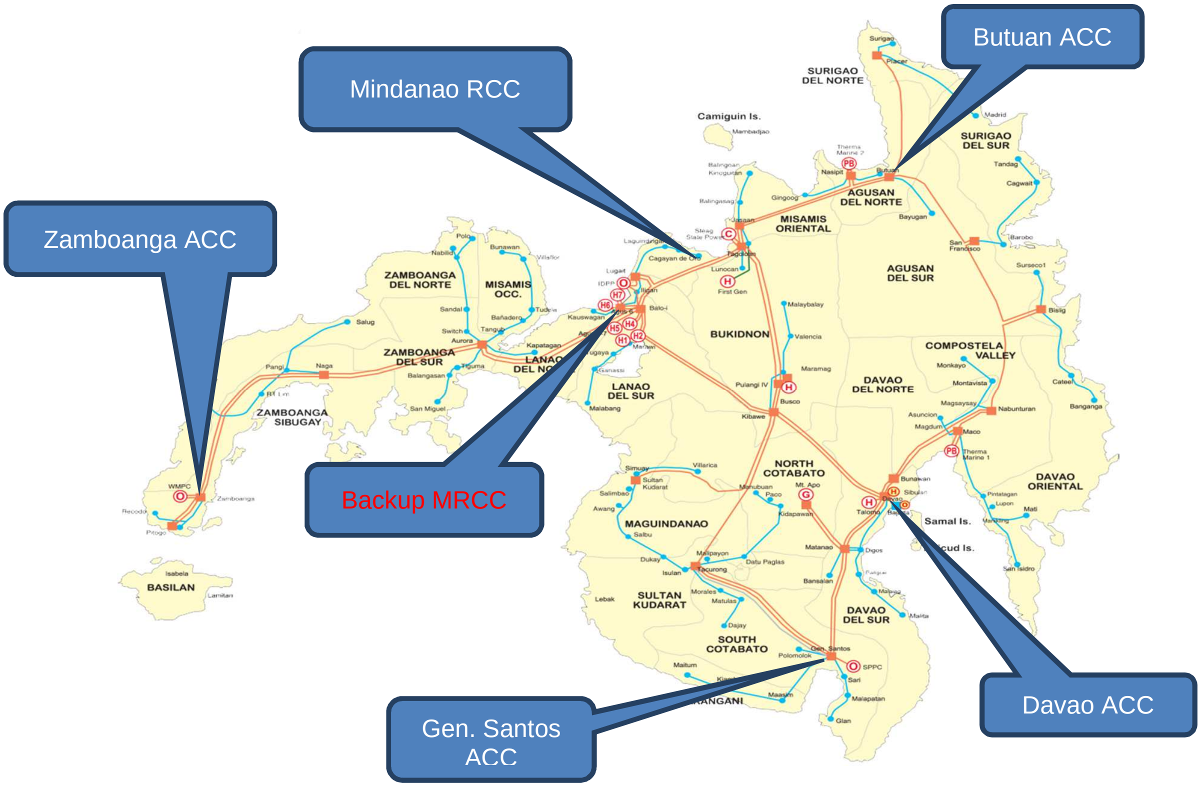


Figure 1.1.f: Mindanao Grid

These Area Control Centers (ACCs) are equipped with new SCADA systems to provide the ACCs dispatchers with real-time view of the power system situation in their respective areas of responsibilities.

The SCADA/EMS System provides monitoring and control of the Luzon, Visayas and Mindanao Power Grid and collecting Power system data via Remote Terminal Units (RTUs) installed at various plants and substations; the data are transmitted to the master stations (Luzon, Visayas and Mindanao Regional Control Centers) for processing into graphical and tabular displays. The mode of transmission of these data is via fiber optic, microwave and/or PLC communication system. It is operated and maintained by SO. Thus, real time power system data are readily available to the grid dispatchers as basis for operational decisions. But due to fast pace of the technology evolution and the increasing failure due to age factor and obsolescence of parts of installed equipment; warrants the needs to upgrade and enhance these equipment to be able to cope up with the modernization requirement of the system.

1.1.1 Luzon System Operations Overview

The Luzon System Operations (LSO) is responsible for the safe, stable, economic, efficient and effective control of the Generating Units, Transmission and Distribution System in maintaining continuous supply of Electrical Energy within normal and tolerable limits of System Voltage and Frequency. Assuring the security and reliability of the grid at all times in compliance with the provisions of the Security and Reliability guidelines to meet the specified standards in maintaining the Power Quality in the Luzon Grid.

a. The Luzon Regional Control Center is located in Diliman, Quezon City and commissioned on March 2001.

Figure 1.1.1.a1: Luzon Regional Control Center

In addition, the Backup Luzon Regional Control Center (BLRCC) in Mexico, Pampanga will serve as a backup for the Regional Control Center. The project started last February 2011 and the inauguration and completion of the BLRCC building was on October 2012.

The existing Central Luzon Area Control Center (CLACC) office and personnel that are presently co-located with the O&M office building will transfer to the BLRCC building.

Figure 1.1.1.a2: Backup Luzon Regional Control Center

These are the following Area Control Centers in Luzon:

b. The Central Luzon Area Control Center is located in Mexico, Pampanga and co-located with O&M Building.

Figure 1.1.1.b: Central Luzon Area Control Center

c. The Southern Tagalog Area Control Center is located in Biñan, Laguna and commissioned on June 1994.

Figure 1.1.1.c: Southern Tagalog Area Control Center

d. The Bicol Area Control Center is located in Naga City, Camarines Sur and commissioned on May 1994.

Figure 1.1.1.d: Bicol Area Control Center

e. The North Luzon Area Control Center is located in La Trinidad, Benguet and commissioned on April 1994

Figure 1.2.1.d: Northern Luzon Area Control Center

1.1.1.1 Luzon Telecom Repeater Stations

There are various Telecom Microwave Repeater Stations (R/S) facilities installed and operational in different regions in Luzon. They are an essential communication component of the Luzon Power Grid which provides the telecommunication channels critical to operation, maintenance and protection of the power transmission lines and substation as in the Supervisory Control and Data Acquisition (SCADA) and line protection meant to minimize/eliminate electricity power outages and interruptions.

The Microwave R/S and Telecom facilities being maintained by Luzon System Operations are as follows:

Table 1.1.1.1: Luzon Telecom Repeater Stations

Item #	Name of R/S Facility	Location of facility	Year Constructed
REGION 1			
1	Dasol (Hill 144)	Brgy. Alilaw, Dasol, Pangasinan	1998
2	San Isidro	Brgy. San Isidro, Labrador, Pangasinan	1998
CAR			
3	Ampucao	Brgy. Ampucao, Itogon, Benguet	1980
4	Tuba (Cabuyao)	Brgy. Cabuyao, Tuba, Benguet	1998
REGION 2			
5	Ramon (Magat RS)	Brgy. Gen. Aguinaldo, Magat, Isabela	2003
6	Enrile (Roma Norte)	Roma Norte, Enrile, Cagayan	2003
7	Baligatan (Ilagan)	Ilagan S/S, Ilagan, Isabela	2003
REGION 3			
8	Cuyapo	Brgy. Landik, Cuyapo, Nueva Ecija	1998
9	Banawag (Hill 399)	Brgy. Banawag, Morong, Bataan	1998
10	Lipay (Palauig)	Brgy. Lipay, Palauig, Zambales	2003
11	Fatima (Pantabangan RS)	Brgy. Sampaloc, Pantabangan, Nueva Ecija	2004
REGION 4A			
12	Haligue Silangan (De La Paz)	Brgy. Haligue Silangan, Batangas City	2000
13	Tamayo	Brgy. Tamayo., Calaca, Batangas	1986
14	Lewin (Kalayaan RS)	Kalayaan Substation, Bgy. Lewin, Lumban,	2004
15	Maunong	Brgy. Maunong. Calamba, Laguna	1998
16	Guinayangan	Brgy. Ermita, Guinayangan, Quezon	1998
17	Lucban	Brgy. Palola, Lucban, Quezon	1991
18	San Mateo (Mataba)	Brgy. Malanday, San Mateo, Rizal	1998

REGION 4B			
19	Calapan	Calapan City, Oriental Mindoro	2003
20	Pinamalayan	Brgy. Calingag, Pinamalayan, Oriental Mindoro	2003
21	San Aquilino	Brgy. San Aquilino, Roxas, Oriental Mindoro	2003
22	Looc	Brgy. Limon Norte, Looc, Romblon	2003
REGION 5			
23	Pasacao	Brgy. Macad, Pasacao, Camarines Sur	1991
24	Polangui (San Roque)	Brgy. San Roque, Polangui, Albay	2003
25	Camalig	Brgy. Kitwinan, Camalig, Albay	1986
26	Manito (Bacman RS)	Manito, Sorsogon	
27	Bocalbocalan (New Bacman)	Brgy. Bocalbocalan, Sorsogon	2003
28	Matnog	Brgy. Pangue, Matnog, Sorsogon	1998

1.1.2 Visayas System Operations Overview

The Visayas System Operations is headquartered at the Visayas Regional Control Center which also serves as Backup National Control Center and is located at Visayas Power Complex in Nasipit, Talamban, Cebu City. It houses the Visayas Dispatching Arena, the SCADA Master Station, Telecom Network Management System, Network Protection, Network Planning and the Regional Office.

It is linked through the Telecom Network with the four (4) Area Control Centers in the Visayas namely: Bohol Area Control Center, Leyte-Samar Area Control Center, Negros Area Control Center and Panay Area Control Center. Visayas presently has seventeen (17) Microwave Repeater Stations in its telecom network; including the newly constructed Microwave Repeater Stations in Jagna, Bohol and Guimaras Island, Panay. In addition, there is one Microwave Repeater Station that will be put-up in Barangay Badiangan, Ajuy, Iloilo to replace the damaged Caniapasan Repeater Station during the onslaught of Typhoon Yolanda in November 2013.

1.1.2.1 Description of Facilities

a. Visayas Regional Control Center

Figure 1.1.2.1a: Visayas Regional Control Center (VRCC)

The VRCC building and its power facilities were constructed and installed in 2001. The following are major dispatching equipment inside the facility:

1. 1.5MVA, 13.8kV/460V Transformer
2. 2 x 150kW UPS for continuous regulated power at 230Vac, 60Hz
3. 205 kVA Emergency Generator. As designed, provides only power to the UPS.
4. 6 kVA Back-up UPS supplies power only to Back-up Realflex System
5. 10 kVA Back-up UPS supplies power for the VSO web, market (WESM) and Video Conferencing Servers.
6. 1 unit Fire Suppression System

b. Bohol Area Control Center

Figure 1.1.2.1b: Bohol Area Control Center

The Bohol Area Control Center at Dampas District, Tagbilaran City was used to be located inside the compound of Salcon Island Power Corporation, formerly owned by NPC-Bohol Diesel Power Plant (BDPP). It is responsible for the dispatching of the entire Bohol Grid. A two-storey ACC building with a total floor area of 217 sq. meters was completed and put into operation in 2011. Co-located inside the said building is District II's S/S Control Room.

The following are major dispatching equipment inside the facility:

1. 2 units 7.5 kVA UPS with Battery Banks
2. 2 units SCADA Realflex System
3. 1 unit Large Format Display
4. 2 sets Desktop Computers
5. 4 units Split Type Air-conditioning Units
6. 5 units Window Type Air-conditioning Units
7. 1 set 90 KVA Back-up Generator
8. 1 unit Fire Suppression System
9. 1 Data Center (equipped with Fire Suppression and Air-conditioning System)
10. 1 set Surge Protection Device

c. Leyte-Samar Area Control Center

Figure 1.1.2.1c: Leyte-Samar Area Control Center

The Leyte-Samar Area Control Center at Milagro, Ormoc City is located inside the Ormoc Substation Compound together with the Operation & Maintenance facilities. It is responsible in the dispatching of the Leyte-Samar Grid. It has a 2-storey building approximately 152.44 sq. meters which was constructed in April 2008 to house the following major dispatching equipment:

1. 2 units 7.5 kVA UPS with Battery Banks
2. 2 units SCADA Realflex System
3. 1 unit Large Format Display
4. 3 sets Desktop Computers
5. 8 units Split Type Air-Conditioning Equipment.
6. 1 unit Window Type Air-conditioning
7. 1 unit Fire Suppression System
8. 1 Data Center (equipped with Fire Suppression and Air-conditioning System)
9. 1 set 90 kVA Standby Generator Set

d. Negros Area Control Center

Figure 1.1.2.1d: Negros Area Control Center

The Negros Area Control Center at Mansilingan District, Bacolod City is located inside the Bacolod Substation. It is responsible in the dispatching of the entire Negros Grid. The new two-storey ACC building was completed on July 5, 2013 and has an area of approximately 266.5 sq. meters. Negros ACC dispatch operations officially transferred to this building on July 17, 2013.

The following are major dispatching equipment inside the facility:

1. 2 units 7.5 kVA UPS with Battery Banks
2. 1 unit SCADA Realflex System
3. 1 unit Large Format Display
4. 3 units LCD Monitors (24")
5. 4 sets Desktop Computers
6. 1 unit VHF Base Radio with Antenna
7. 12 units Split Type Air-conditioning Equipment
8. 1 unit Air Cleaner
9. 1 set of Addressable Fire Detection/Alarm System (FDAS)
10. 2 sets of FM200 Fire Suppression System
11. 3 units Surge Suppression Device with Enhanced Grounding System
12. 1 Data Center (equipped with Fire Suppression and Air-conditioning System)

e. Panay Area Control Center

Figure 1.1.2.1e: Panay Area Control Center

The Panay Area Control Center at Sta. Barbara, Iloilo was used to be located inside the Sta. Barbara Substation Compound co-located with the Operation and Maintenance Office. It is responsible in the dispatching of the Panay Area. In 2014, a new ACC building was constructed under the Panay South Backbone Project.

The following are major dispatching equipment inside the facility:

1. 2 units 7.5 kVA UPS with Battery Banks
2. 2 units SCADA Realflex System
3. 1 unit Large Format Display
4. 3 sets Desktop Computers
5. 5 units Window Type Air-conditioning Equipment

1.1.2.2 Visayas Telecom Microwave Repeater Stations

These telecom microwave radio facilities are situated in various locations in Visayas, as described below. They are an essential communication component of NGCP's telecom network, necessary for the interconnection of the plants and substations within the Visayas Power Grid. The telecommunication channels provided by these repeater stations are critical to operation, maintenance and protection of the power transmission lines and substations, carrying signals for Supervisory Control and Data Acquisition (SCADA) as well as for line protection meant to limit outages/interruptions. The Microwave Repeater Stations and telecom facilities being maintained by Visayas System Operations are as follows:

Table 1.1.2.2: Visayas Telecom Repeater Stations

Name of Facility	Location of Facility	Date Constructed	Building Type	Antenna Tower Height, m.
CEBU AREA				
1. Babag (Busay)	Brgy. Babag I, Cebu City	1995	Type A	60
2. Poro (Camotes)	Alta Vista, Poro, Camotes, Cebu	2004	Type A	24
3. Minglanilla (Majic)	Camp 7, Minglanilla, Cebu	1995	Type A	40
4. Borbon (Muagao)	Brgy. Tagnucan, Borbon, Cebu	2000	Container Van	85
5. Compostela RS	Compostela, Cebu	2000	Container Van	110
6. Daan-Bantayan RS (Talisay)	Talisay CTS, Daan-Bantayan, Cebu	Co-located with Talisay CTS	S/S Relay Room	55
7. Samboan RS (Suba)	Suba, Samboan, Cebu	Co-located with Suba CTS	Relay Room	25
NEGROS AREA				
8. Murcia (Canlandog)	Brgy. Canlandog, Murcia, Negros Occidental	1995	Type A	35
9. Bacolod RS	Bacolod S/S, Mansiligan District, Bacolod city	Co-located with Bacolod S/S	Relay Room	15
10. Amlan	Amlan, Negros Oriental	1995	Type A	30
11. Siquijor	Brgy. Canlasong, Larena, Siquijor	1995	Type A	21 40
PANAY AREA				
12. San Enrique (Caniapasan – To be retired.)	Brgy. Mapili, San Enrique, Iloilo City	2003	Type A	66
13. Ivisan	Mt. Supo, Ilaya, Ivisan, Capiz	2003	Type A	27
14. Tangalan (Jawili)	Brgy. Jawili, Tangalan, Aklan	2003	Type A	33
15. Panit-an	Panit-an DPP, Panit-an, Capiz	2003	Type B	27
16. Sta. Barbara RS	Sta. Barbara, Iloilo City	Co-located with Sta. Barbara S/S	Telecom Equipment Room	30
17. WVA RS	Brgy. Obrero, Iloilo City	Co-located with WVA office	Telecom Equipment Room	35
18. Jordan RS (Guimaras)	Brgy. Jordan, Guimaras	2013	Type A	50

Name of Facility	Location of Facility	Date Constructed	Building Type	Antenna Tower Height, m.
LEYTE AREA				
19. Matag-ob (Palompon)	Brgy. Sta. Rosa, Matag-ob, Leyte	1995	Type A	10
20. Tabango RS	Tabango, Leyte	Co-located with CTS	Telecom Equipment Room	60
21. Tongonan	Kananga, Leyte	1995		10
22. Ormoc RS	Milagro, Ormoc City	Co-located with Ormoc S/S	Telecom Equipment Room	18
23. Maasin RS	Maasin So. Leyte, Maasin City	Co-located with Maasin CTS	Telecom Equipment Room	50
BOHOL AREA				
24. Buenavista	Brgy. Lusong, Buenavista, Bohol	2002	Type A	50
25. Loon	Brgy. Cabadog, Loon, Bohol	1995	Type A	60
26. Ubay RS	Ubay CTS, Ubay, Bohol	Co-located with Ubay CTS	Relay Room	50
27. Jagna	Brgy. Mayana, Jagna, Bohol	2012	Type A	40
MASBATE AREA				
28. Pio Corpus	Brgy. Labigan, Pio V. Corpus, Masbate	1995	Type A	35 48

1.1.3 Mindanao System Operations Overview

The Mindanao System Operations (MSO) manages the power system facilities of the Mindanao Grid covering the whole island. From the generation side of various plants to substations, transmission lines and load-end customers, MSO coordinates, manages and monitors their operation for a safe, efficient and reliable system. Notwithstanding system deficiencies aggravated by cultural peculiarities, MSO strives to enforce Grid Code compliance to all Grid users.

Having most of the generation facilities located at the north-central end, MSO is continually challenged with balancing access to the southern portion of the Mindanao Island where the greater load is currently located. The situation is aggravated by damage to stretches of the transmission lines inflicted from time to time by still-lingering secessionist elements in the region. To meet the needs therefore of the impending integration into the open electricity market, Mindanao has to accelerate building infrastructure support for SO's fault clearance systems, telecom network and SCADA/EMS facilities.

1.1.3.1 Mindanao Regional Control Center Building

NGCP has recently inaugurated the new Mindanao Regional Control Center Building at Carmen, Cagayan de Oro City. In tandem, the new NARI Open 3000 SCADA/EMS System was also commissioned.

Subsequently, the former MRCC Building and its Siemens Power CC located at Ma. Cristina, Iligan City, has been converted into a Back-up Regional Control Center. This Back-up Regional Control Center also serves as the Office of the Iligan Area Control Center (IACC)—originally located at Tagoloan Substation in Misamis Oriental, this Area Control Center was transferred to Iligan City upon establishment of the new MRCC Building at Carmen.

Figure 1.1.3.1: Mindanao Regional Control Center

1.1.3.2 Mindanao Area Control Centers

There are five Area Control Centers (ACCs) strategically located in Mindanao. Siemens Spectrum Power CC SCADA system has been installed in all of these ACCs. The SCADA system will provide the ACC dispatchers with a real-time view of the power system situation in their respective areas of responsibility.

The existing Area Control Centers are as follows:

a. Butuan Area Control Center

Location	-	Bonbon, Butuan City
Building Completed	-	February 2006
SCADA System Commissioned	-	February 20, 2008

b. Davao Area Control Center

Location	-	New Loon, Tugbok District, Davao City
Building Completed	-	December 2005
SCADA System Commissioned	-	August 11, 2008

c. General Santos Area Control Center

Location	-	Klinan 5, Brgy. Mabuhay, General Santos City
Building Completed	-	November 2006
SCADA System Commissioned	-	August 12, 2008

d. Zamboanga Area Control Center

Location	-	Sun St., Tumaga, Zamboanga City
Building Completed	-	February 2005
SCADA System Commissioned	-	October 2008

e. Iligan Area Control Center

Location	-	Ma. Cristina, Iligan City
Building Completed	-	October 2010
SCADA System Commissioned	-	October 2010
Effectivity of IACC Operation	-	May 24, 2012

Figure 1.1.3.2a: Butuan Area Control Center

Figure 1.1.3.2b: Davao Area Control Center

Figure 1.1.3.2c: General Santos Area Control Center

Figure 1.1.3.2d: Zamboanga Area Control Center

Figure 1.1.3.2e: Cagayan Area Control Center (co-location with Tagoloan Substation)

Figure 1.1.3.2f: MSO Annex Building

1.1.3.3 Mindanao Telecom Repeater Stations

There are 23 repeater stations spread across at strategic spots all over the Mindanao Island serving as telecommunication backbone links. Expansions and rehabilitations are necessary at some locations to address necessary capacity and configuration issues.

SO Facility Infrastructure Profile
As of June 2015

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
Region: Luzon System Operations					
1	National Control Center (NCC/LRCC) Building	Diliman	2001	This houses the NOD personnel responsible for the system dispatching and housing of SCADA and Telecom equipment and office of LSO personnel.	Poor cooling system of the Battery/UPS System.
2	Luzon Regional Control Center (LRCC/NCC)	Diliman	2001	Regional dispatching center.	No existing quarters for NOD dispatcher's shifting personnel.
3	PMC Building	Diliman	1989	LSO regional office and housing of Telecom, SCADA and Protection Test equipment.	Centralized air-conditioning System is due for rehabilitation/replacement.
4	Various Luzon Repeater Stations (Enclosure of Various LSO Telecom Equipment)	Luzon	-	To provide shelter of Telecom equipment from decay and protect the life of the equipment and personnel working.	No enclosure which expose the Telecom equipment to security threat.
5	National Control Center (Battery/UPS Room)	Luzon	-	To provide adequate cooling system requirement of the Battery/UPS equipment to prolong its lifespan.	Existing room temperature at the Battery/UPS room is beyond the manufacturer recommendation.
6	Luzon System Operation Regional Office Laboratory	Luzon	-	To provide in-house support for the repair and maintenance of various LSO equipment.	No existing workshop to conduct in-house maintenance and repair works of various LSO equipment.

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
7	Luzon System Operation Regional Office Simulation Laboratory	Luzon	-	To provide NPD laboratory for simulation/evaluation of the integrity of the protective relay equipment.	Existing Laboratory for expansion and improvement.
8	Pinamalayan R/S	Brgy. Calingag, Pinamalayan, Oriental Mindoro	2003	Rehabilitation of MW to strengthen communication facilities/system.	Existing structures needs to be reinforced to prevent misalignment of antenna and/or damage.
9	San Aquilino R/S	Brgy. San Aquilino, Roxas, Oriental Mindoro	2003	Rehabilitation of MW to strengthen communication facilities/system.	For the necessary retrofitting and repainting of existing telecom towers to maintain structural stability.
10	Calapan R/S	Calapan City, Oriental Mindoro	2003	Rehabilitation of MW to strengthen communication facilities/system.	For the necessary retrofitting and repainting of existing telecom towers to maintain structural stability.
11	Matnog R/S	Brgy. Pangue, Matnog, Sorsogon	1998	Rehabilitation of MW to strengthen communication facilities/system for building structures.	For the maintenance and improvements of MW building structures to ensure optimal working conditions for Telecom and associated auxiliary equipment.
12	Bocalbocalan R/S (New Bacman)	Brgy. Bocalbocalan, Sorsogon	2003	Rehabilitation of MW to strengthen communication facilities/system for building structures.	For the maintenance and improvements of MW building structures to ensure optimal working conditions for Telecom and associated auxiliary equipment.
13	Tuba R/S (Cabuyao)	Brgy. Cabuyao, Tuba, Benguet	1998	Rehabilitation of MW to strengthen communication facilities/system for Perimeter structures.	For the maintenance and improvements on perimeter security of existing infrastructure.
14	Ampucao R/S	Brgy. Ampucao, Itogon, Benguet	1980	Rehabilitation of MW to strengthen communication facilities/system for Access Roads.	For the necessary maintenance and improvements of access roads to ensure accessibility of MW repeater stations for O&M purposes.

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
15	Lucban R/S	Brgy. Palola, Lucban, Quezon	1991	Rehabilitation of MW to strengthen communication facilities/system for AC Power Lines.	For the necessary maintenance of AC power lines to ensure reliability of power supply for the equipment located at various MW repeater stations.
16	San Mateo R/S (Mataba)	Brgy. Malanday, San Mateo, Rizal	1998	Rehabilitation of MW to strengthen communication facilities.	For backup route of Telecom traffic from Diliman to North and South Luzon.
17	Various Microwave Towers	Luzon	-	To strengthen communication facilities/system.	Existing structures needs to be reinforced to prevent misalignment of antenna and/or damage.
18	Expansion of Various RF Building	Luzon	-	To strengthen communication facilities/system.	Existing structures needs to be reinforced to prevent misalignment of antenna and/or damage.
19	Various Repeater Stations	Luzon	-	To comply with DENR environmental laws and IMS requirements.	No existing haz-waste shelter and Oil catchment basin. On-going projects for Magat and Roma Norte RS.
20	NCC SCADA Server Room	Luzon	-	To be used by NCC dispatchers in case of NCC system failure.	Expansion of the server room necessary to accommodate installation of new equipment for the upgrade.
21	STACC	Biñan	1994	This house the STACC responsible for the system dispatching of Southern Tagalog Area.	No existing quarters for STACC dispatcher's shifting personnel.
22	BLRCC	Mexico	2012	BLRCC will serve as back-up to RCC	No seclusion fence.
Region: Visayas System Operations					
1	Visayas Regional Control Center	Visayas Power Complex, Nasipit, Talamban, Cebu	2001	This building houses the Visayas Regional Control Center dispatching and Visayas SO Regional Office.	The space is no longer enough to accommodate the additional equipment of Telecom & SCADA and Office for personnel. The capacity of the existing generator cannot carry the present building load requirements.

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
2	Leyte-Samar ACC	Ormoc	2007	This houses the Leyte-Samar ACC, responsible for the system dispatching of Leyte-Samar Area.	The building does not have a server/room data center. There is also a need to check and ensure proper grounding to protect the expensive equipment from lightning surge.
3	Negros ACC	Bacolod	2014	This building houses the Negros ACC, responsible for the system dispatching of Negros Area.	
4	Panay ACC	Sta. Barbara	2014	This building houses the Panay ACC, responsible for the system dispatching of Panay Area.	
5	Bohol ACC	Bohol	2011	This building houses the Bohol ACC, responsible for the system dispatching of Bohol Area.	Needs the construction of a dedicated server room/data center.
6	Permanent Backup Regional Control Center	Visayas	-	To provide backup operation during emergency cases for continued reliable power supply.	No existing permanent backup control center.
7	Borbon R/S (Muagao)	Cebu	2000	This Microwave Repeater Station houses the Telecom equipment and power supply system.	Needs periodic repainting of building and tower to restore these to original condition. Installation of tower platforms and ladder cage for the 85-meter tower is ongoing.
8	Poro R/S (Camotes)	Cebu	2004	This Microwave Repeater Station houses the Telecom equipment and power supply system.	Needs construction of haz-waste shelter and secondary containment. Also required periodic repainting of building and tower.
9	Minglanilla R/S (Majic)	Cebu	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired or rehabilitated. There is also a need to rehabilitate the perimeter fence. Periodic tower and building repainting is required to

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
					restore these to original condition. For safety compliance, platforms and ladder cage for the 40-meter tower was recently installed.
10	Buenavista R/S	Bohol	2002	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired or rehabilitated. Periodic tower and building repainting is required to restore these to original condition.
11	Loon R/S	Bohol	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The tower needs repainting. For safety compliance there is also a need to install platforms and ladder cage for the 60-meter tower.
12	Siquijor R/S	Siquijor	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated. Periodic repainting of building and tower will ensure restoration to original condition.
13	Babag R/S (Busay)	Cebu	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated. The same is true for the perimeter fence. The tower and building requires periodic repainting to restore these to original condition. Installation of tower platforms and ladder cage is substantially completed.
14	Panit-an R/S	Panay	2003	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired and rehabilitated. The tower and building also requires periodic repainting to restore these to original condition. For safety compliance there is also a need to install platforms and ladder cage for the 27-meter tower.

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
15	San Enrique R/S (Caniapasan)	Panay	2003	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated periodically. Project is currently being undertaken for haz-waste shelter facility and secondary containment on site to comply with DENR RA 6969.
16	Murcia R/S (Canlandog)	Negros Occidental	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired and expanded. There is no slope protection, haz-waste shelter facility and secondary containment on site to comply with DENR RA 6969. The tower needs repainting and reinforcement. For safety compliance there is also a need to install platforms and ladder cage for the 35-meter tower.
17	Ivisan R/S	Panay	2003	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated. There is no slope protection and the tower needs repainting. For safety compliance, there is also a need to install platforms and ladder cage for the 27-meter tower.
18	Tangalan R/S (Jawili)	Panay	2003	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated. There is no slope protection and the tower needs repainting. For safety compliance, platforms and ladder cage for the 33-meter tower were recently installed.
19	Matag-ob R/S (Palompon)	Leyte	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated. There is also a need for periodic repainting of tower and building to restore these to

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
					original condition. For safety compliance there is also a need to install ladder cage for the 10-meter tower. Project for rehabilitation is ongoing.
20	Amlan	Negros Oriental	2003	This Microwave Repeater Station houses the Telecom equipment and power supply system.	Repair of Telecom building and tower repainting.
21	Compostela	Cebu	2003	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The Telecom equipment van needs to be repaired/ rehabilitated.
22	Pio Corpus R/S (Masbate)	Masbate	1995	This Microwave Repeater Station houses the Telecom equipment and power supply system.	The building is dilapidated and needs to be repaired/ rehabilitated. The tower also needs repainting. For safety compliance there is also a need to install platforms for the 48-meter tower.
Region: Mindanao System Operations					
1	Iligan ACC and Backup MRCC	Iligan City	2010	A scaled down ACC with replicate technology to the RCC to serve as backup.	
2	Mindanao Regional Control Center (MRCC)	Cagayan de Oro City	2012	The main Regional Control Center with state of the art SCADA/EMS capability.	
3	Butuan ACC	Bonbon, Butuan City	2007	Mini Dispatching Center within a specific AOR during system blackout.	Needs additional haz-waste facility, server room and backup SCADA redundancy.
4	Davao ACC	New Loon, Davao City	2006	Mini Dispatching Center within a specific AOR during system blackout.	Needs additional haz-waste facility, server room and backup SCADA redundancy.
5	General Santos ACC	Klinan, Gen. Santos City	2007	Mini Dispatching Center within a	Needs additional haz-waste facility, server room

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
				specific AOR during system blackout.	and backup SCADA redundancy.
6	Zamboanga ACC	Lunzuran	2006	Mini Dispatching Center within a specific AOR during system blackout.	Needs additional haz-waste facility, server room and backup SCADA redundancy.
7	Power Management Center	Iligan City	1999	To house and protect generator equipment.	
8	System Operation Control Center	Iligan City	1998	To house and protect Telecom equipment.	Rehabilitation of shelter and repainting of antenna tower.
9	Talacogon R/S (Lugait Hill)	Misamis Oriental	1998	To house and protect Telecom equipment.	
10	Manticao R/S (Donque Hill)	Misamis Oriental	1998	To house and protect Telecom equipment.	
11	Cugman R/S (Langilanon)	Cagayan de Oro	1999	To house and protect Telecom equipment.	
12	Gingoog R/S (Haruhay)	Misamis Oriental	1999	To house and protect Telecom equipment.	
13	Carmen R/S (Rojales)	Agusan Norte	1999	To house and protect Telecom equipment.	
14	Mainit R/S (Silop)	Surigao Norte	1999	To house and protect Telecom equipment.	Newly painted tower and building but needs additional haz-waste facility.
15	Salvacion R/S (Josefa)	Butuan City	1999	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
16	San Isidro R/S (Magdiwata)	Agusan Sur	1999	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
17	Monkayo R/S (Pasian)	Compostela Valley	1999	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
18	Libay-libay R/S	Compostela Valley	1999	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
19	Mintal R/S (Davao)	Davao City	1998	To house and protect Telecom equipment.	
20	Matina R/S	Davao City	2008	To house and protect Telecom equipment.	Needs additional haz-waste facility.
21	Tupi R/S	South Cotabato	1999	To house and protect Telecom equipment.	Newly painted tower and building but needs additional haz-waste facility.
22	Malalag R/S	Davao Oriental	1999	To house and protect Telecom equipment.	Newly painted tower and building but needs additional haz-waste facility.
23	Calumpang R/S	General Santos City	2011	To house and protect Telecom equipment.	Will soon be shelved and replaced by a tower and building.
24	Pikit R/S (Batulawan)	North Cotabato	1999	To house and protect Telecom equipment.	Newly painted tower and building and haz-waste facility installed last 2013.
25	Damulog R/S (Panigsikan)	Bukidnon	1999	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
26	Impasugong R/S (Kitanglad)	Bukidnon	1999	To house and protect Telecom equipment.	Newly painted tower and building but needs additional haz-waste facility.
27	Camp Ranao R/S (Signal Hill)	Marawi City	1998	To house and protect Telecom equipment.	Needs painting of tower and building.
28	Dinas R/S (Buga)	Zamboanga Sur	1998	To house and protect Telecom equipment.	Needs painting of tower and building haz-waste facility completed last September 2013.
29	Lopez Jaena R/S(Ilihan Hill)	Misamis Occidental	1998	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
30	Siay R/S (Maligaya)	Zamboanga Sibugay	1998	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
31	Vitale R/S (Taguite)	Zamboanga City	1998	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.

Item No.	Infrastructure/ Description	Location	Year Constructed/ Installed	Operational Relevance	Problems/Concerns
32	Mercedez R/S	Zamboanga City	1998	To house and protect Telecom equipment.	Newly painted but needs additional haz-waste facility.
33	Tumaga S/S (Lunzuran)	Zamboanga City	1998	To house and protect Telecom equipment.	Needs painting of tower and building and needs additional haz-waste facility.
34	Catarman R/S (Camiguin)	Camiguin	2012	Newly established repeater station for additional traffic route from Visayas to Mindanao.	Newly constructed haz-waste facility completed last October 2013.
35	Agus 2 Van	Lanao Sur	1998	To house and protect Telecom equipment.	Newly painted but needs additional haz-waste facility.
36	Ozamis R/S (Bucagan Hill)	Ozamis City	1998	To house and protect Telecom equipment.	Needs painting but has haz-waste facility.
37	Zamboanga R/S (Sangali)	Zamboanga City	1998	To house and protect Telecom equipment.	Newly constructed but needs haz-waste facility and the previous van shelter shelved.

3.0 REQUIREMENTS ANALYSIS

3.1 Improvement and Expansion of Civil Infrastructure

Infrastructure development is necessary to address changing requirements brought about by Grid growth and regulatory mandate. As such, this involves implementing projects to establish new or to upgrade existing structures, which also involves putting in place the pertinent ancillary facilities/equipment.

3.2 Corporate Business Needs

Table 3.2: Corporate Business Needs

Applications	Infrastructure Requirements (2016–2025)		
	Work Area Capacity	Strategic Location	Remarks
1. Response to Regulatory Requirements	✓	✓	For compliance.
2. Manpower Requirements	✓	✓	To complement the workforce requirement.
3. Health, Safety and Environmental Conditions	✓	✓	To have safe and secure working areas.
4. Technology Evolution	✓	✓	To cope with Market Demand.

✓ Existing Facilities/Infra sufficient for the purpose up to 2025

3.3 Regulatory Compliance

Table 3.3: Regulatory Compliance

Technology Direction	Details
1. Telecom Upgrade and Expansion	- To house additional/new equipment required by the Grid. - Design power supply systems that are less dependent on commercial power service.
2. SCADA Upgrade	- To accommodate additional/new equipment installed for SCADA system monitoring.
3. Protection Upgrade	- Installation and Upgrading of Protection facilities.
4. Training & Developments and Technology Transfer	- Additional facilities for training and re-tooling of personnel.

3.4 Materials and Peripherals

Table 3.3: Materials and Peripherals

Requirements	Reasons
1. Air-Conditioning System	- Replacement of A/C units whose cost of spare parts and/or upgrades are too expensive and to do away with Ozone Depleting Substances (ODS).
2. Firefighting System and Controls	- Protection of our personnel, equipment and facilities from destruction against fire and other external forces.
3. Generator Set/UPS	- Back-up power in case of power failure.
4. Office Systems	- Provision of office tables, chairs, and cubicles, including electrical requirements for new facilities and expansions.
5. Spare Parts	- Replacement of worn-out/defective parts.

4.0 PROJECT DEVELOPMENT

4.1 Planning Criteria

4.1.1 Requirement Philosophy

a. Decision to respond to the requirements of the system against impact on core business vis-à-vis economics.
b. Reliability, security and safety link to grid compliance.
c. Increase flexibility to technology trends.
d. Support to climate change mandate.
e. Provision of the necessary infrastructure to sustain the Integrated Management System implementation.

4.1.2 Infrastructure Development Policy

a. Civil infrastructure shall continue to accommodate and prioritize those identified for the system improvement, enhancement and technology updates.
b. Materials and peripheral shall be acquired to coincide with the infrastructure requirements.
c. Various control measures shall be implemented in order to sustain the security, safety of the personnel, facilities and equipment.
d. The use of energy-efficient and environmentally compliant air-conditioning units, equipment and fire suppression agents shall be employed in all facilities.
e. Power grid requirements shall be prioritized to ensure reliable flow of deliverables.

4.1.3 Policies

a. Grid Code
b. Fire code and other Legal Statutory Requirements
c. Spare Parts Management Policy
d. Integrated Management System (IMS)
e. Security Policy

4.2 Guidelines

a. Infrastructure shall be programmed to meet expected growth in the requirements up to the end of expected economic life. All infra projects shall always be in pursuance and consistent with the mandate of System Operations.
b. Infrastructure shall meet all regulatory compliance requirements, taking into account market and organizational needs.

c. All materials and peripherals shall be provided, dimensioned and configured in accordance with the technology philosophy.
d. All infrastructure projects (expansion, rehabilitation and upgrade) shall be by contract or turnkey except when there are no competitive contractors available (e.g., in isolated remote locations).
e. CAPEX Projects shall be classified according to the following:

   1) Expansion - New asset
   2) Upgrade/Rehabilitation - Add value to existing asset
   3) Replacement - Replace (devalued) asset

4.3 Economic Analysis

a. Economic analysis in infrastructure aims to establish the least cost option and but should ensure compliance to government regulations and likewise optimize benefit to Grid operations.
b. Alternatives from which to determine optimum allocation of resources are defined according to the following aspects:

   1) Method of project implementation – turnkey or in-house.
   2) Means of establishing and sustaining the infra – lease or own.
   3) Distribution of benefits versus limitation of facilities, e.g., what option can accommodate the most applications and conditions with least infrastructure requirements.
   4) Expected assignment of budget limits – fixed on an annual basis.
   5) Capacity to implement the projects.

4.4 Security and Safety Concerns

a. All activities involved in implementing these infrastructure projects shall strictly comply with the Corporate Security Policy.
b. Involved parties are committed to the security of activities and safety of personnel.
c. Security and safety measures shall be implemented according to procedure including conduct of audit at different phases of the project to establish effectiveness of the control measures.

4.5 CAPEX Schedule (in Million Php)

4.5.1 Luzon

LUZON	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
EXPANSION	3.50	4.00	1.00	5.00	2.30	2.80	3.20	6.80	0.00	1.60	30.20
UPGRADE/ REHAB	105.54	38.66	26.80	14.80	15.80	14.40	20.40	19.40	18.40	17.40	291.60
REPLACEMENT											
TOTAL	**109.04**	**42.66**	**27.80**	**19.80**	**18.10**	**17.20**	**23.60**	**26.20**	**18.40**	**19.00**	**321.80**

4.5.2 Visayas

VISAYAS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
EXPANSION	0.00	53.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	103.00
UPGRADE/ REHAB	16.88	9.40	25.26	58.30	13.36	9.50	9.50	8.90	10.30	8.90	170.30
REPLACEMENT											
TOTAL	**16.88**	**62.40**	**75.26**	**58.30**	**13.36**	**9.50**	**9.50**	**8.90**	**10.30**	**8.90**	**273.30**

4.5.3 Mindanao

MINDANAO	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
EXPANSION	3.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	6.00
UPGRADE/ REHAB	0.00	23.52	0.48	2.33	0.48	17.28	15.65	12.18	9.42	7.40	88.74
REPLACEMENT											
TOTAL	**3.00**	**23.52**	**0.48**	**2.33**	**0.48**	**17.28**	**15.65**	**15.18**	**9.42**	**7.40**	**94.74**

4.5.4 Total

CATEGORY	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
EXPANSION	6.50	57.00	51.00	5.00	2.30	2.80	3.20	9.80	0.00	1.60	139.20
UPGRADE/ REHAB	122.43	71.58	52.54	75.43	29.64	41.18	45.55	40.48	38.12	33.70	550.64
REPLACEMENT											
TOTAL	**128.93**	**128.58**	**103.54**	**80.43**	**31.94**	**43.98**	**48.75**	**50.28**	**38.12**	**35.30**	**689.84**

4.5.5 System Operations Infrastructure Summary

CAPEX	DESCRIPTION	TOTAL COST		
		LUZON	VISAYAS	MINDANAO
1. EXPANSION	New assets proposed based on the planning criteria and needs of the existing infrastructure profile.	30.20	103.00	6.00
2. UPGRADE/ REHABILITATION	Improvement or rehabilitation projects to keep up with the requirements and prevent onset of asset deterioration.	291.60	170.30	88.74
3. REPLACEMENT	Replacement of totally depreciated or non-useful assets based on the planning criteria.	-	-	-

4.5.6 Summary of Regional CAPEX Schedule

REGION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
LUZON	109.04	42.66	27.80	19.80	18.10	17.20	23.60	26.20	18.40	19.00	321.80
VISAYAS	16.88	62.40	75.26	58.30	13.36	9.50	9.50	8.90	10.30	8.90	273.30
MINDANAO	3.00	23.52	0.48	2.33	0.48	17.28	15.65	15.18	9.42	7.40	94.74
TOTAL	**128.93**	**128.58**	**103.54**	**80.43**	**31.94**	**43.98**	**48.75**	**50.28**	**38.12**	**35.30**	**689.84**

4.5.7 CAPEX Program Schedule

4.5.7.1 LSO CAPEX Schedule Project Description – New

EXPANSION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Power and Environment Monitoring System for Control Center	-	3	-	-	-	-	-	-	-	-	3.00
Control Center/ Control Room Water Elevation Sensor	-	-	-	-	-	-	2	2	-	-	4.00
Control Center/Control Room Weather Monitoring/ Sensor	-	-	-	-	-	-	-	2	-	-	2.00
Enclosures for Telecom Equipment	-	1	1	-	1	1.6	-	1.6	-	1.6	7.80
Construction of Haz-waste Shelter & Oil Catchment Basin for Various Luzon Repeater Stations	3.5	-	-	-	1.3	1.2	1.2	1.2	-	-	8.40
Construction of Dispatchers' Quarters	-	-	-	5	-	-	-	-	-	-	5.00
TOTAL	**3.50**	**4.00**	**1.00**	**5.00**	**2.30**	**2.80**	**3.20**	**6.80**	**0.00**	**1.60**	**30.20**

4.5.7.2 LSO CAPEX Schedule Project Description – Rehabilitation/Upgrade

REHAB/UPGRADE	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Repeater Station Facilities Rehabilitation	14.00	5.27	21.80	6.80	15.80	8.40	18.40	9.40	16.40	9.40	125.67
Rehabilitation of Microwave Radio Facilities: Telecom Towers	8	-	4.8	4.8	4.8	4	4	4	4	4	42.40
Rehabilitation of Microwave Radio Facilities: Access Roads	-	-	4.8	-	4	-	4	-	4	-	16.80
Rehabilitation of Microwave Radio Facilities: Building Structures	-	-	5	-	4	-	3	3	3	3	21.00

Rehabilitation of Microwave Radio Facilities: Perimeter Structures	2	-	4	-	3	-	3	-	3	-	15.00
Rehabilitation of Microwave Radio Facilities: AC Power Lines	-	2	-	2	-	2	2	2	2	2	14.00
Installation of Platforms and Cage for Telecom Towers	4	2.27	2.2	-	-	2	2	-	-	-	12.47
Construction of Stainless Fuel Tanks for Repeater Stations	-	1	1	-	-	0.4	0.4	0.4	0.4	0.4	4.00
Control Center Building Facilities Improvements	89.74	23.39	0.00	0.00	0.00	2.00	2.00	2.00	2.00	2.00	129.13
Replacement of Centralized ACU System (NCC Building)	64.23	-	-	-	-	-	-	-	-	-	64.23
Replacement of Fire Protection Systems (LSO Building)	22.49	-	-	-	-	-	-	-	-	-	22.49
Replacement of Fire Protection Systems (NCC Building)	-	23.39	-	-	-	-	-	-	-	-	23.39
Redundant ACU System for LSO Data Center	1	-	-	-	-	-	-	-	-	-	1.00
460V/230V Distribution System	0.6	-	-	-	-	-	-	-	-	-	0.60
Fire Hydrant System at BLRCC	0.4	-	-	-	-	-	-	-	-	-	0.40
Steel Roll-up Doors & Windows at STACC	0.35	-	-	-	-	-	-	-	-	-	0.35
ACU System at LRCC and BACC	0.33	-	-	-	-	-	-	-	-	-	0.33
Storage Tank / Genset Storage at BACC	0.2	-	-	-	-	-	-	-	-	-	0.20
Water Purifier at NLACC	0.05	-	-	-	-	-	-	-	-	-	0.05
Binding/Dater Machine at LRCC	0.095	-	-	-	-	-	-	-	-	-	0.095
Control Center Building Rehab	-	-	-	-	-	3	-	-	-	3	6.00
Improvement of Grounding and Surge Protection System	-	-	-	-	-	2	2	2	2	2	10.00

Telecom, SCADA, Protection Room/Lab	1.80	10.00	5.00	8.00	0.00	1.00	0.00	8.00	0.00	3.00	36.80
Responding Mechanism Room	1.8	-	-	-	-	-	-	-	-	-	1.80
SCADA Accreditation/ Simulation Laboratory	-	10	5	5	-	-	-	5	-	-	25.00
Telecom NMS Facility for NOC Setup	-	-	-	3	-	-	-	3	-	3	9.00
NPD Laboratory for Relay Testing Facility	-	-	-	-	-	1	-	-	-	-	1.00
TOTAL	**105.5**	**38.66**	**26.80**	**14.80**	**15.80**	**14.40**	**20.40**	**19.40**	**18.40**	**17.40**	**291.60**

4.5.7.3 VSO CAPEX Schedule Project Description – New

EXPANSION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Construction of Back-up VSO Building	-	50	50	-	-	-	-	-	-	-	100.00
Expansion of Hazwaste Shelter, Provision of Secondary Containment for Genset and Day Tank, & Perimeter Fence	-	3	-	-	-	-	-	-	-	-	3.00
TOTAL	**0.00**	**53.00**	**50.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**103.00**

4.5.7.4 VSO CAPEX Schedule Project Description – Rehabilitation/Upgrade

REHAB/UPGRADE	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Repeater Station Facilities Rehabilitation	1.15	9.40	15.26	7.30	3.36	7.50	7.50	6.90	8.30	6.90	73.57
Rehabilitation of Microwave Radio Facilities: Telecom Tower, Building, Perimeter Fence, Haz-waste Shelter, Secondary Containment and Day Tank Shelter	-	3.6	13.6	7.3	3.3	5	5	4.4	5.8	4.4	52.40

Installation of Platforms and Cage for Telecom Towers	-	2.50	-	-	0.06	-	-	-	-	-	2.56
Upgrade of Tower Light Systems	-	-	-	-	-	1	1	1	1	1	5.00
Installation of Security Access Door Controllers at the Existing 16 Microwave R/S in Visayas	1.15	-	-	-	-	-	-	-	-	-	1.15
Construction of Safety Hand Rails and Seclusion Fence	-	1.5	-	-	-	-	-	-	-	-	1.50
Rehab of Equipment Van at Borbon RS	-	1.2	-	-	-	-	-	-	-	-	1.20
Expansion of Battery Room at Tabango RS	-	0.6	-	-	-	-	-	-	-	-	0.60
Construction of Permanent Shelter at Cross Dako	-	-	1.66	-	-	-	-	-	-	-	1.66
Repeater Station Improvements	-	-	-	-	-	1.5	1.5	1.5	1.5	1.5	7.50
Control Center Building Facilities Improvements	15.73	0.00	10.00	51.00	10.00	2.00	2.00	2.00	2.00	2.00	96.73
Installation of 90 kVA Capacity Generator and 90 kVA 460/230V Transformer and Generator Shelter at ACCs	4.63	-	-	-	-	-	-	-	-	-	4.63
BNCC ACU System (Installation of Inverter Type ACU and Rehab of ACU Ducting)	4	-	-	-	-	-	-	-	-	-	4.00
Motorized Roll-up Shutters and Glass Tinting for VRCC and ACCs	3	-	-	-	-	-	-	-	-	-	3.00
Fire Suppression System for VSO and ACCs	3.1	-	-	-	-	-	-	-	-	-	3.10
VSO Conference Room Rehab	1	-	-	-	-	-	-	-	-	-	1.00
Expansion of VRCC Building Left Wing for New Control Room (Including Office System, Structured Cabling, Fire Fighting	-	-	10	40	-	-	-	-	-	-	50.00

System, ACU System)											
VRCC Building Electrical and Switchgear Upgrade	-	-	-	6	-	-	-	-	-	-	6.00
Conversion of RCC Control Room to DTS Room and Server	-	-	-	5	10	-	-	-	-	-	15.00
Control Center Building Rehab	-	-	-	-	-	2	2	2	2	2	10.00
TOTAL	**16.88**	**9.40**	**25.26**	**58.30**	**13.36**	**9.50**	**9.50**	**8.90**	**10.30**	**8.90**	**170.30**

4.5.7.5 MSO CAPEX Schedule Project Description – New

EXPANSION	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Installation of Fire Detection, Fire Suppression and Evacuation Systems	3	-	-	-	-	-	-	3	-	-	6.00
TOTAL	**3.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.00**	**0.00**	**0.00**	**6.00**

4.5.7.6 MSO CAPEX Schedule Project Description – Rehabilitation/Upgrade

REHAB/UPGRADE	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	TOTAL
Repeater Station Facilities Rehabilitation	0.00	15.52	0.48	2.33	0.48	13.78	14.15	9.93	8.92	6.60	72.19
Rehabilitation of Microwave Radio Facilities: Building Structures	-	9.94	0.3	-	0.3	2.6	4.5	2.7	1.8	1.8	23.94
Rehabilitation of Microwave Radio Facilities: Telecom Towers	-	2.15	-	2.15	-	-	-	-	-	-	4.30
Rehabilitation of Microwave Radio Facilities: Access Pathways	-	2.33	0.18	0.18	0.18	3.8	0.17	1.63	0.6	0.6	9.67

Rehabilitation of Microwave Radio Facilities: Environmental Compliance Structures	-	1.1	-	-	-	0.65	0.9	0.6	0.65	0.1	4.00
Installation of Platforms and Cage for Telecom Towers	-	-	-	-	-	4.23	6.08	-	3.37	2.1	15.78
Microwave Repeater Stations Battery & Engine Room Expansion	-	-	-	-	-	2.5	2.5	3.5	2.5	2	13.00
Construction of Fencing and Shelter for Linabo Peak RS	-	-	-	-	-	-	-	1.5	-	-	1.50
Control Center Building Facilities Improvements	0.00	8.00	0.00	0.00	0.00	3.50	1.50	2.25	0.50	0.80	16.55
Building Grounding and Lightning Surge Protection System for BMRCC and ACCs	-	8	-	-	-	-	-	-	-	-	8.00
Ground Floor Canopy and Fuel Tank Shed for MRCC Generator Set	-	-	-	-	-	-	-	0.6	-	-	0.60
Roll-up Grills for MSO Building Electrical Room	-	-	-	-	-	-	-	0.55	-	-	0.55
MSO Storage Room	-	-	-	-	-	-	-	0.8	-	-	0.80
MRCC Bldg. Roofing Repair and Water Proofing	-	-	-	-	-	2	-	-	-	-	2.00
MRCC Building Rehabilitation and Improvement	-	-	-	-	-	-	1.5	-	0.5	0.8	2.80
MRCC Bldg. Conference Rooms, Dispatcher's View Deck and Office Enhancement	-	-	-	-	-	1.5	-	0.3	-	-	1.80
TOTAL	**0.00**	**23.52**	**0.48**	**2.33**	**0.48**	**17.28**	**15.65**	**12.18**	**9.42**	**7.40**	**88.74**

SOME

2016-2025

1.0 INTRODUCTION

1.1 The System Operations Management Equipment (SOME)

As part of the 2014–2015 Transmission Development Plan, continuous maintenance and upgrade of System Operation Management Equipment (SOME)—IT infrastructure is imperative to support the implementation, operation and improvement of the various power transmission processes in which security, availability and adequacy of accurate information is of major concern.

With the grid's increasing reliance on the information system and technology infrastructure and the coming of new generation and transmission projects, SOME infrastructure must expand to be able to meet the growing demands for operational data anywhere and anytime. These projects should be centered on the principles of Security, Availability and Scalability.

1.2 Content Overview

In System Operations (SO), where power dispatch is the core function and real-time data and communication are of great importance, SOME plays a significant role in ensuring continuous, reliable and efficient grid operations. Anent to the criticality and significance of its function, SO maintains its own Information system and technology infrastructure independent from that of the Corporate. It develops and maintains various office/database applications and continually innovates, creates and acquires software beneficial to power systems. It also maintains large data and manages its availability through its network storage solution. Adding to the growing operations database is the real-time exchange of data between SO and Market Operator for the Wholesale Electricity Spot Market.

Considering the importance of SO's information assets not only to its operations but also to regulating bodies and customers, SO continues to ensure the confidentiality, integrity and availability of information assets by selecting software and hardware that will minimize threats and risks associated with it. Moreover, SO is geared on establishing a secured network infrastructure that will effectively manage the security risks and vulnerability associated with SO's growing reliance on SOME.

Over the next decade, SOME CAPEX Program will provide tools to ensure the reliability, adequacy, security provision and stability of the nationwide transmission system. The program covers the SOME requirements of the three (3) Regional Control Centers, three (3) Back-up Regional Control Centers, and thirteen (13) Area Control Centers. These SO interrelated subsystems have to be at pace with the prevailing trend of information technology to keep up with the current and future requirements and live up to the expectations of NGCP's stakeholders.

2.0 ASSESSMENT

2.1 Existing Profile

2.1.1 Statistical Data

Table 2.1.1 shows that SO has a total of 408 desktops, 209 laptops, 121 printers and various related equipment distributed among the regional offices and Area Control Centers. Luzon SO maintains most of the SO Management Equipment. We would note that the proportion among the three Regions is on account of the size of information assets—and their respective expected growth rates— being maintained by the region concerned.

The Grid's increasing reliance on the information system and technology infrastructure prompted dynamic changes in the SO's data network. The demand for a more secure, reliable and scalable data channels necessitated the procurement of systems and equipment designed to efficiently complete the job. To date, SO operates and maintain routers, switches, firewall appliances and other network elements that are meant to ensure secure delivery of data and content to its end-users. Information management in this respect covers the exchange of real-time data with the Market Operator for the Wholesale Electricity Spot Market. Besides the in-house applications developed by SO ISIT personnel, SO maintains software/hardware that involve proprietary support through renewable maintenance service arrangements.

Table 2.1.1: ICT Inventory and Ageing

ICT Equipment		Existing				Age > 5 Years			
		LSO	VSO	MSO	Total	LSO	VSO	MSO	Total
PCs and Peripherals	Laptop	128	21	60	209	21	8	21	50
	Desktop	201	69	138	408	16	35	56	107
	Printer	65	17	39	121	5	8	19	32
	Projector	8	8	15	31	2	2	9	13
	Scanner	29	6	21	56	0	5	5	10
	Facsimile	22	8	16	46	0	6	13	19
Network Devices	Switch	34	23	25	82	6	4	15	25
	Wireless Router	14	11	5	30	0	7	1	8
	Firewall	12	7	6	25	0	3	0	3
Server	Database	8	4	6	18	2	0	1	3
	Web	4	2	3	9	1	1	0	2
	Application	4	6	5	15	1	2	2	5
	Text	3	2	0	5	0	0	0	0
	File	16	1	6	23	1	0	3	4
Data Storage Solution	Storage Area Network (SAN)	2	1	1	4	0	0	0	0
	Network Attached Storage (NAS)	1	0	2	3	0	0	0	0
IP Based	Videocon	16	3	4	23	0	0	1	1
	Voice Log	24	0	6	30	6	0	0	6

We would note that there is a significant number of laptops (second to desktops), majority of these are actually employed as mobile craft terminals for testing, diagnostics and configuration work on modern telecom, SCADA and protection equipment that can only be controlled through an external terminal.

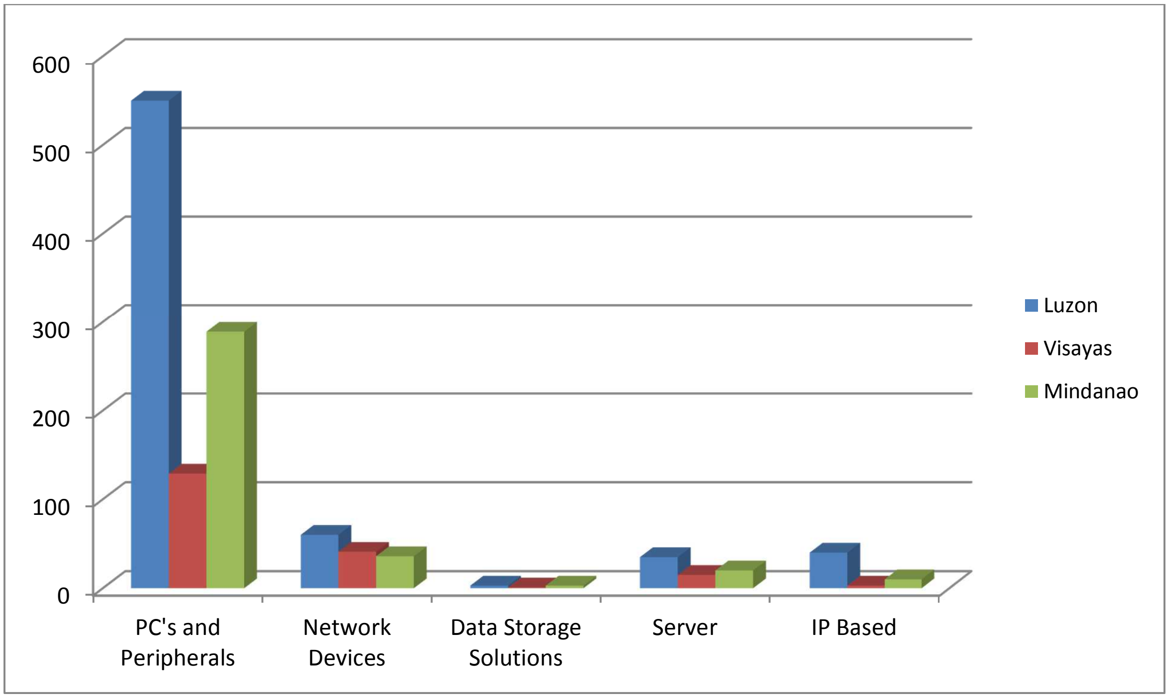


Figure 2.1.1: Regional Distribution of SOMEs

Around twenty three percent (23%) of SO's ICT equipment are beyond their expected useful/economic life of five (5) years—these are programmed for replacement as shown in Table 2.1.2, subject to respective serviceability assessments.

Table 2.1.2: Replacement Percentage Over Existing SOMEs

SOME	LSO		VSO		MSO		Total Existing	Age ≥ 5 Yrs	%
	Existing	Aged	Existing	Aged	Existing	Aged			
PC's & Peripherals	550	44	129	64	289	123	968	231	23.86
Network Devices	60	6	41	14	36	16	137	36	26.28
Data Storage Solutions	3	0	1	0	3	0	7	0	0.00
Server	35	5	15	3	20	6	70	14	20.00
IP Based	40	6	3	0	10	1	53	7	13.21
Total							**1,235**	**288**	**23.32**

With reference to the same table, SO maintains seventy (70) servers that provide various 24/7 services from database applications to network management. To complement such services, a data storage solution was established in each regional office.

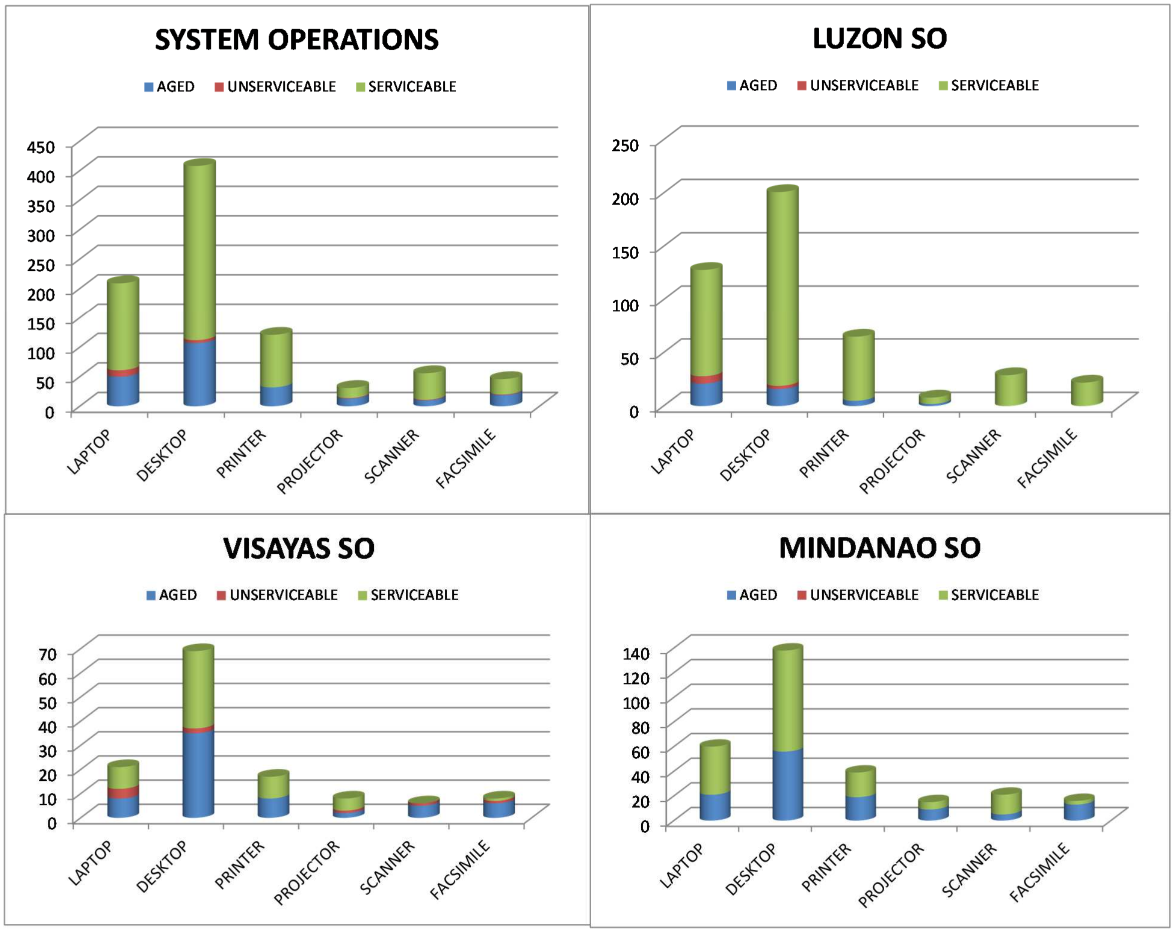


Figure 2.1.2: PCs and Peripherals Ageing Distribution

2.2 Features

Figures 2.2.1 to 2.2.9 show the present SO ISIT infrastructure from its database servers to LAN to videoconferencing system.

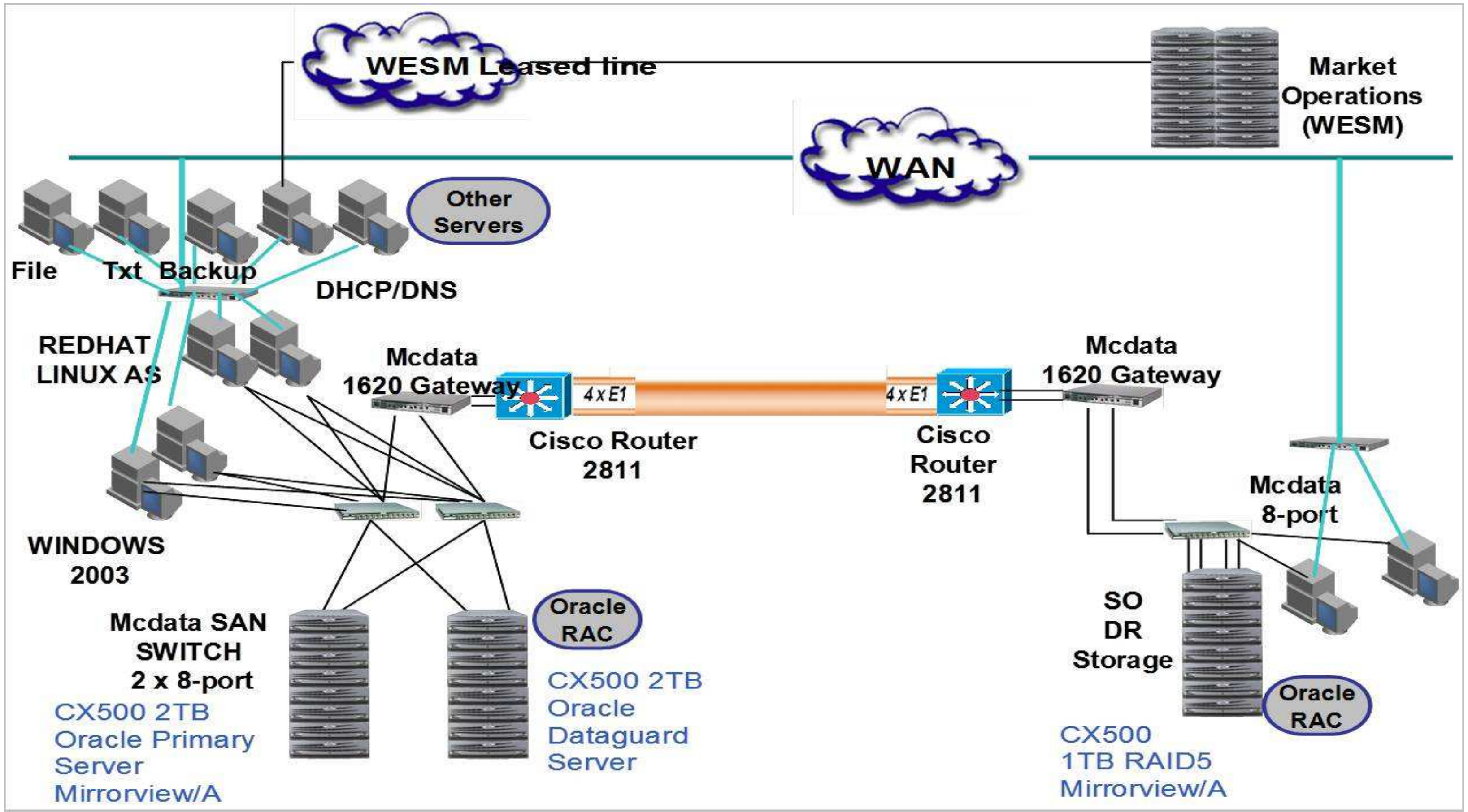


Figure 2.2.1: Existing LSO Database Servers

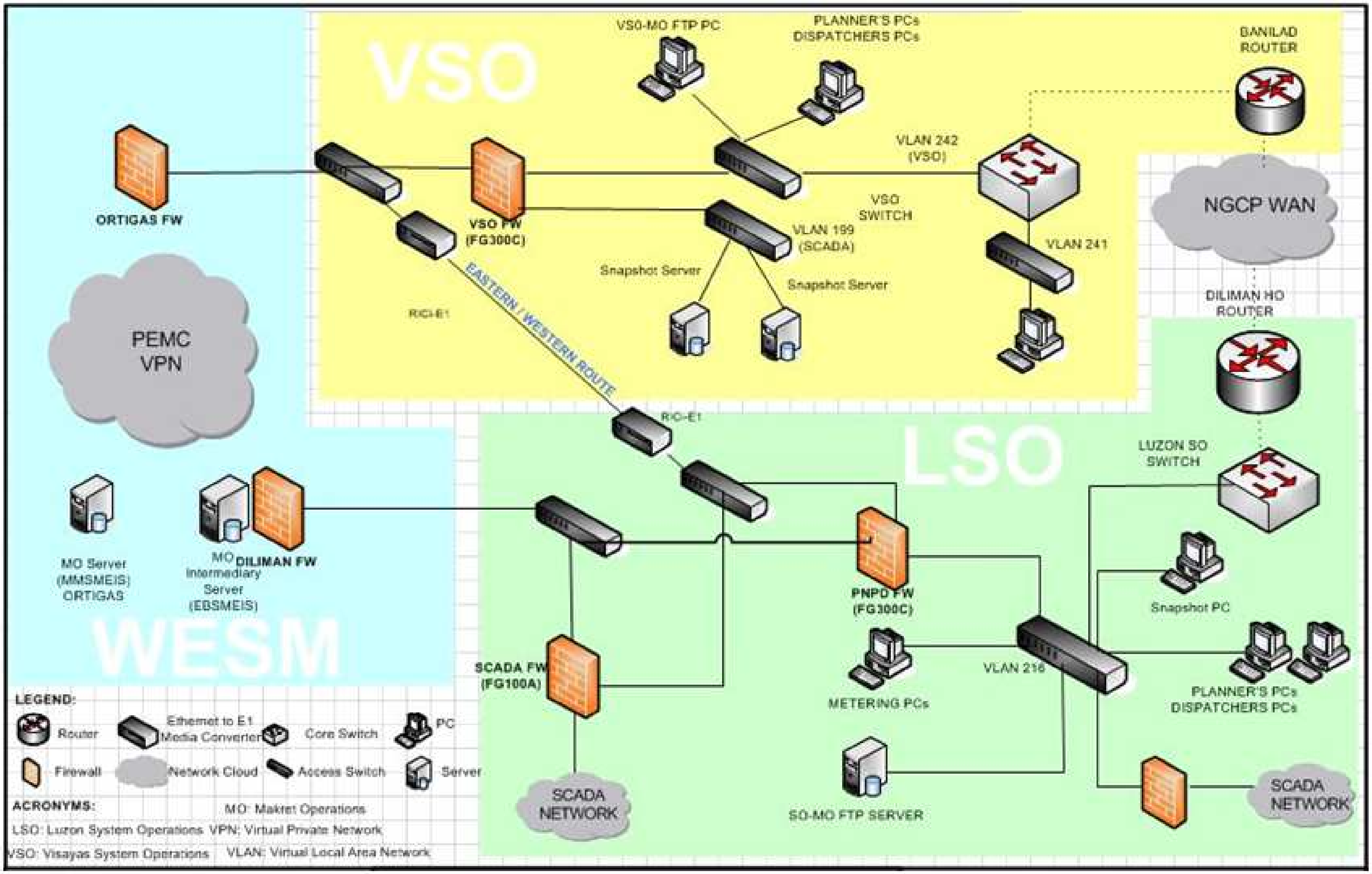


Figure 2.2.2: Existing SO-MO Data Interchange Interconnectivity

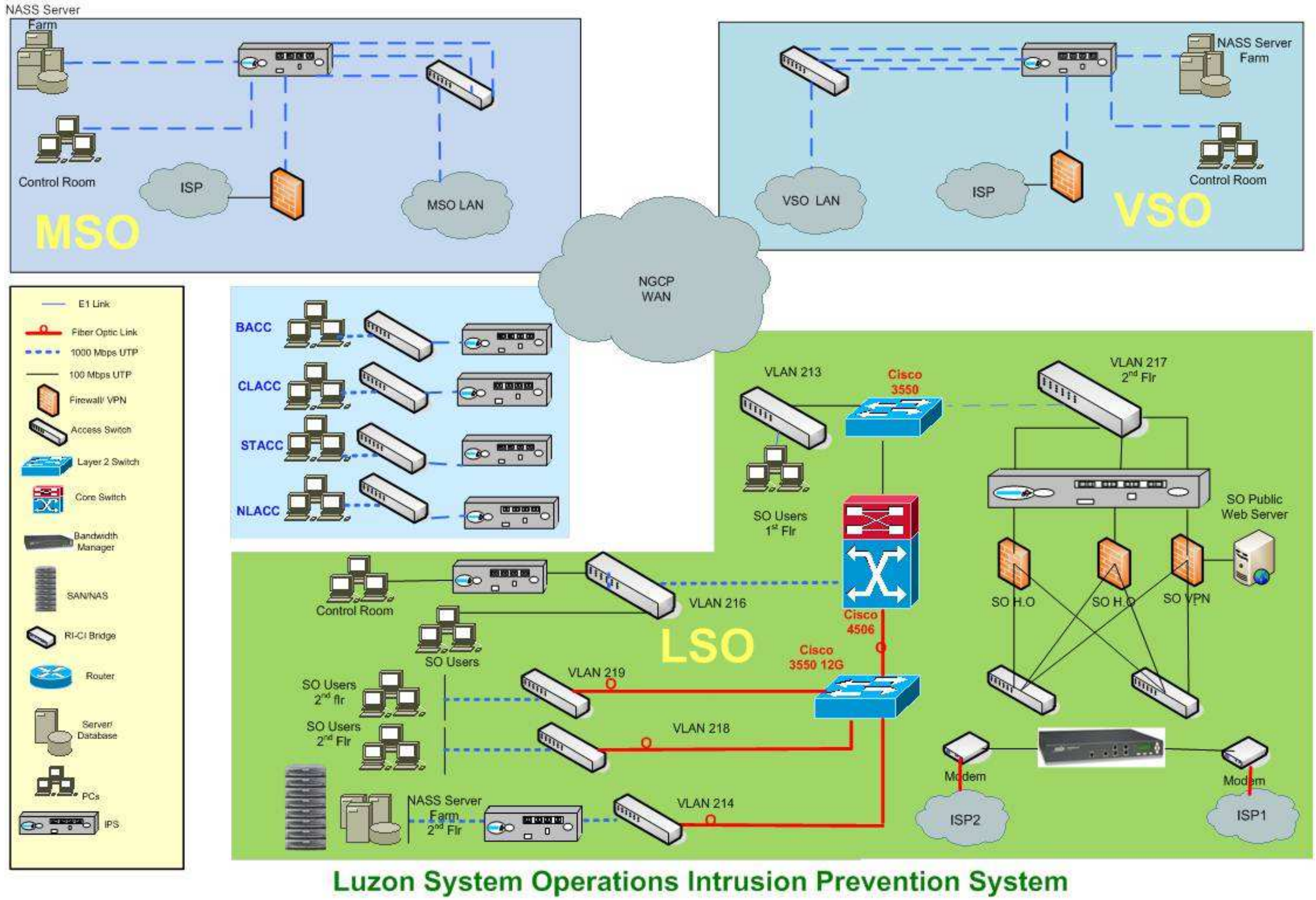


Figure 2.2.3: Intrusion Prevention System Implementation

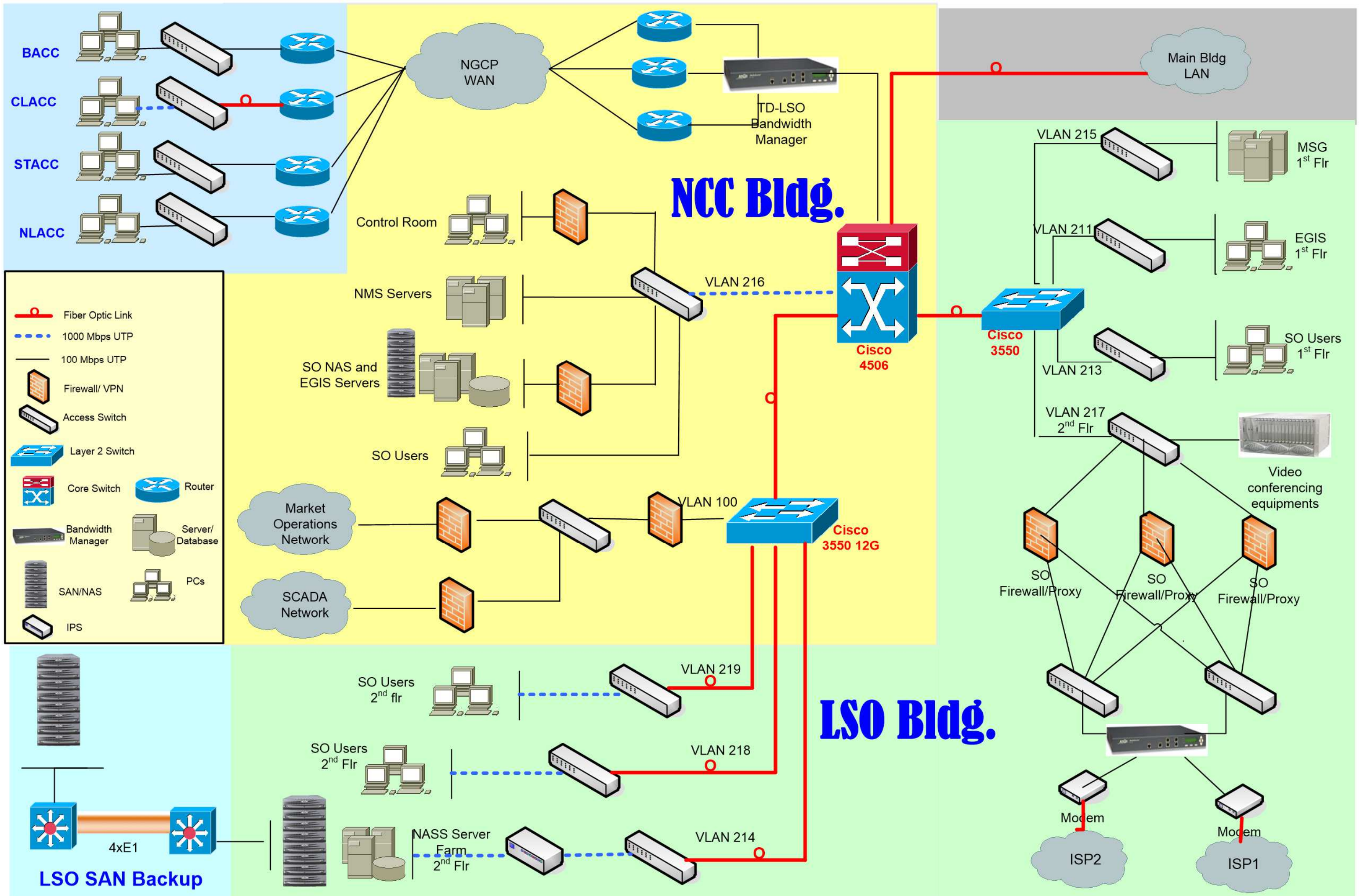


Figure 2.2.4: Existing LSO Local Area Networks

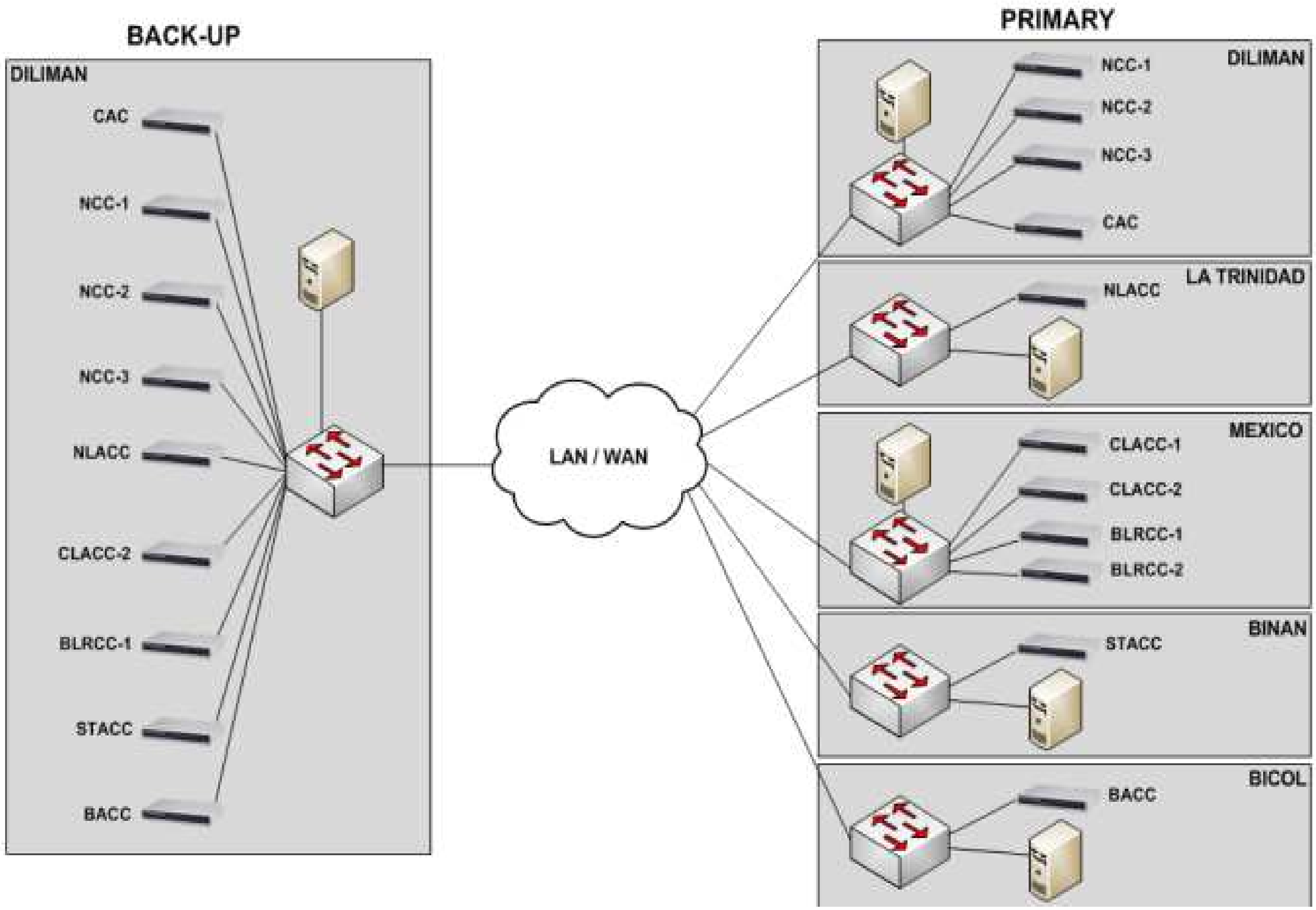


Figure 2.2.5: Existing Voice Logging System

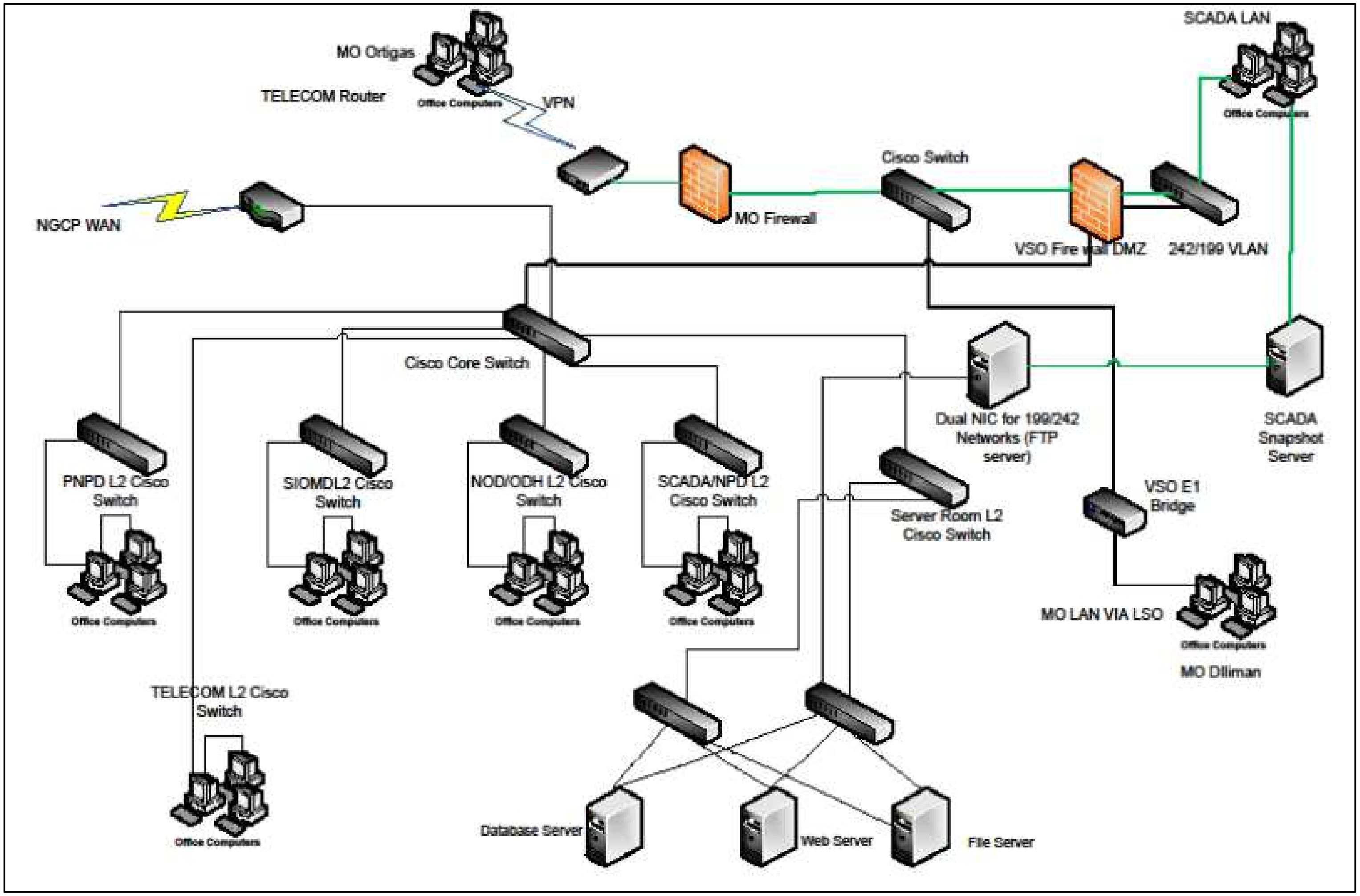


Figure 2.2.6: Existing VSO Local Area Networks

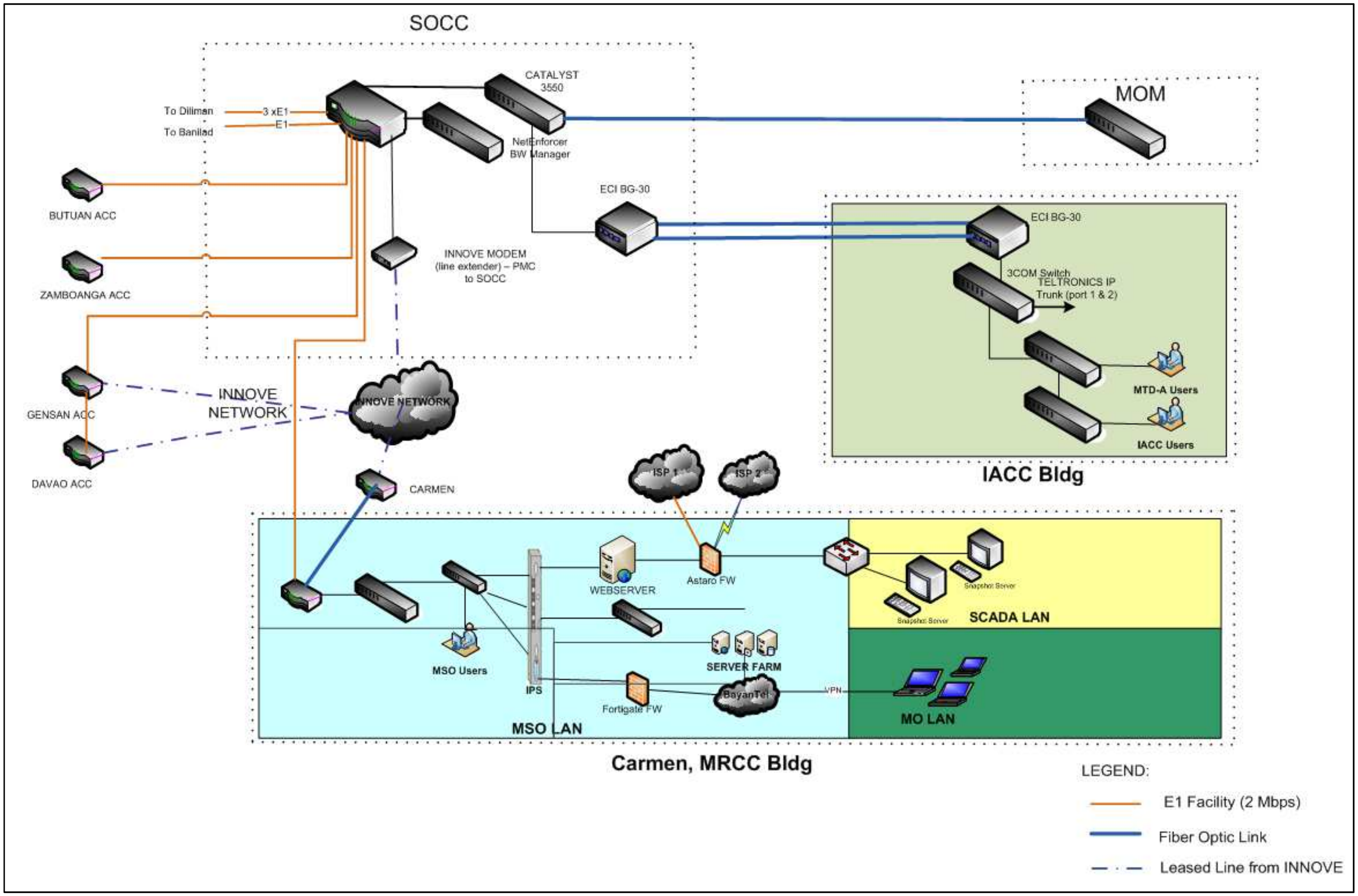
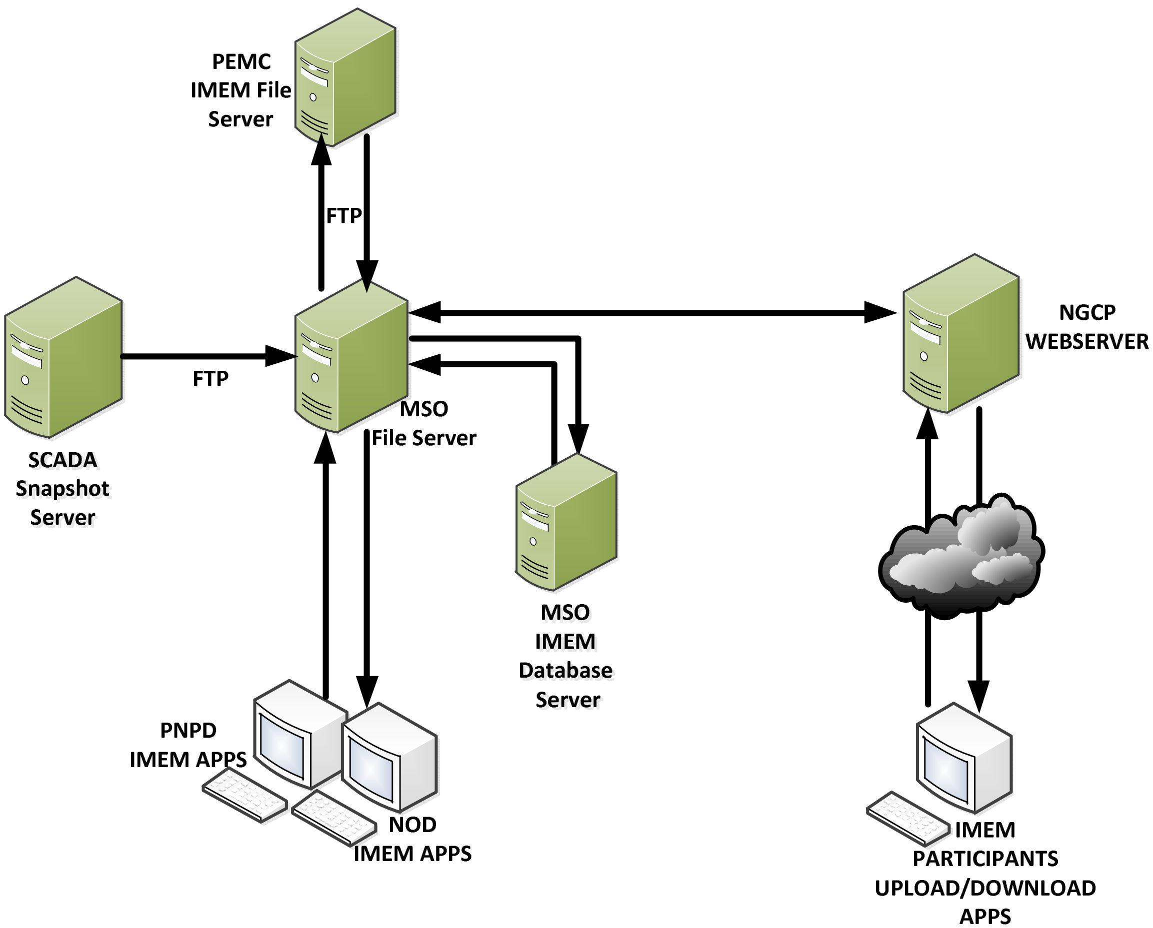


Figure 2.2.7: Existing MSO Local Area Networks



MSO-IMEM Data Interchange Data Flow

Figure 2.2.8: MSO-IMEM Data Interchange Data Flow

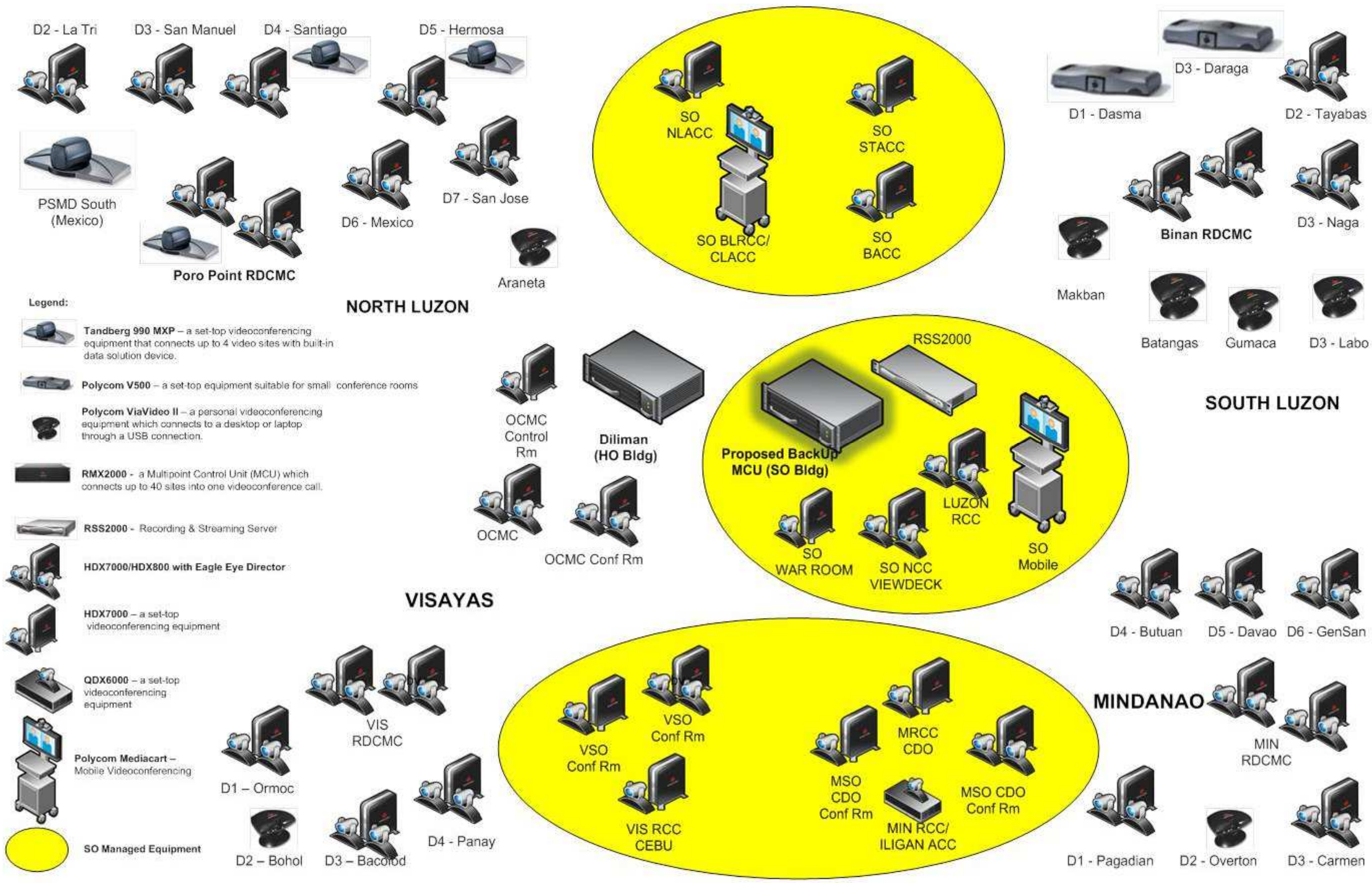


Figure 2.2.9: Existing Videoconferencing System

2.3 Problems and Issues

The rapid development of ISIT technologies is expected to cause some uncertainties in facilities programming through the 10-year SOME development plan. Given the fast pace of technology shift, ISIT equipment may suffer obsolescence before the anticipated end-of-lives. Also, upgrades in power system and office automation software may require corresponding adjustments in hardware specifications.

Considering the specialized nature of SO functions, it is unavoidable that some ISIT resources would be proprietary in nature, has limited sources or suppliers and, at the moment, mainly available only through the international market. The procurement process should be prepared for this situation to avoid implementation delay.

Occasional failures in the network links between SO and Market Operator may be noted at present as a minor problem; but solutions should be put in place as the same problem would present a major difficulty in the future on account of market growth.

3.0 REQUIREMENTS ANALYSIS

3.1 Demand

Inasmuch as Grid operation drives the development of ISIT applications, the programmed transmission line extensions through this TDP (outlined in Volume 1) should be complemented by additional ISIT infrastructures. An expanded Grid would require tools to manage and process an increased volume of data and a network able to deliver such data and processed information to the resulting increased number of end-users.

SO addresses the ISIT requirements of its work force by procuring desktop computers, printers and other peripherals aimed at maximizing productivity, and mobile/laptop computers that serve as control terminals for system administration, configuration and maintenance of telecom, SCADA and network protection equipment. Furthermore, improvement of the existing Local Area Network (LAN) is being undertaken to minimize bottlenecks/collisions brought about by the growing number of internet, email, and database application users connected through the network at the same time. SO also manages the videoconferencing services that quicken coordination among the regional and field offices and which has now minimized travel expenses.

Although SO develops in-house office/database/web applications, unavoidable use of proprietary software/hardware for specialized power system studies require outsourced maintenance services.

Since SO operates on a 24/7 basis, it requires servers and data storage solutions that can continuously provide ISIT-related services. Data centers have to be established to ensure integrity of the increasing volume of data.

Further, since the demand for operations data and processed information defines the information system and technology infrastructure, the need to secure real-time data interchange between SO and the Market Operator compels us to implement a continuing SOME infrastructure upgrade.

3.2 Technology Direction

The emergence of advanced technology has opened doors to more sophisticated options available to the Grid operator. SO aims to gear itself towards protecting its information assets through a network infrastructure strengthened by a security system that will effectively manage the risks associated with SO's growing reliance on ISIT. To ensure the business continuity of SO, disaster recovery solutions shall be adopted. As operations data increases through time, SO would need to incorporate additional data storage as well as employ specialized servers to handle real-time data transaction.

Early obsolescence due to technology shifts should also be considered in planning for SOME replacements. This includes updating software needed for power systems as well as office automation to suit current end-user needs. Notwithstanding the risks of shortened serviceability for such IT resources on account of technology developments, the need to ensure scalability remains a factor in procurement specifications to ensure optimum returns on investment and least interruption to operations.

3.3 Policy Considerations

The importance of SO's information assets is defined under Section 1.4, Chapter 1 of the Philippine Grid Code which specifies the need to ensure confidentiality, integrity and availability of data that are required in the planning, operation and maintenance of the Grid.

The development plan for SOME is governed by a Corporate Policy on the Procurement of and Optimization on the Use of ISIT resources. Per Circular No. 2010-0025, the five (5) years useful service life of ISIT equipment shall be strictly observed. Additional guidelines through Circular No. 2010-0050 were also issued regarding procurement of ISIT equipment. The subsequent Standard Technical Specifications for Hardware and Software Products is regularly updated to make sure that new equipment would be serviceable up to their programmed useful lives.

4.0 DEVELOPMENTAL PROGRAMS

4.1 Planning Criteria

4.1.1 Technology Philosophy

Technology molds the direction of development of the Grid—innovations that present the greatest opportunities for enhancing and ensuring continuous, reliable and efficient Grid operations shall be adopted. Real-time information is valuable and SOME shall be selected on the basis of technologies most useful for securing mission-critical data.

4.1.2 Technology Development Route

As technology continues to progress and plays a wider role in the development and operation of the Grid, SOME shall be selected and configured according to new standards in technology that are most beneficial to power transmission processes—only ISIT equipment that will increase the efficiency and productivity of SO's workforce shall be acquired. And SO shall continue to search for applications that would improve our capability to maintain the stability and reliability of the Grid.

4.2 Regional Considerations

As mentioned above, the difference in the nature and scale of SOME attributed each Region is mainly attributed to the volume of data being processed and maintained respectively. Thus, there would be no special regional considerations in developmental planning other than such dimensioning aspect.

However, to rationalize the planning and implementation of SOME projects, the following guidelines shall be observed uniformly and collectively by the Regional SO's (Luzon, Visayas and Mindanao):

a. All SOME projects shall always be in pursuant to or are consistent with the plans of System Operations.
b. All projects shall include provisions for ensuring the security and integrity of all data used and generated by the systems developed under the SOME project. Security and integrity shall also cover physical, network and system facilities.
c. Generally recognizing the criticality of the function of system operations, all SOME projects shall have a provision for backup and recovery procedures.
d. Given the rapid pace of ISIT development, SOME project shall take into consideration the risk of obsolescence of the technology adopted in the SOME project.

4.2.1 Economic Analysis

The economic analysis of SOME projects should consider the following factors:

a. Estimated typical benefit-cost ratio from the project.
b. Business processes that will be enhanced, enabled or improved as a result of the project.
c. Significance to other parties of the project.
d. Definitive references for possible revenues that may be generated, such as cost of data.

4.2.2 Safety and Security Concerns

All activities of SOME projects shall strictly comply with the Corporate Information Security Policy. Consequently, information security control and audit during the implementation of the project shall be conducted. Moreover, concerned parties shall be committed to the security of the network, integrity of data and safety of personnel and property.

4.2.3 Project Description Table

Programs under the development plan are categorized generally into the following:

Table 4.2.3: SOME Projects

Projects	Description
1. SOME Viability Replacement	Typically it involves the purchase of ISIT equipment such as PCs and its peripherals, network devices and other ISIT-related items whose economic life either was reached, overturned by new technology, or shortened due to declared unserviceable.
2. Local Area Network Expansion and Security	Involves the extension/upgrading of our local area network infrastructure as the grid expands and to meet the growing demands of a better and secured information highway.
3. Data Storage Solution Expansion and Availability	Consists of acquiring data storage solutions to meet the growing volume of operational data and to make sure that this data is available for consumption.
4. Videoconference System Upgrade and Expansion	Pertains to the upgrading of existing Videocon equipment, its features and extending the coverage of its scope. It will also entail equipment replacement that has reached its economic life or has become defective.
5. Information Systems Sustenance	Involves plans for the coming years for maintaining information systems that will be beneficial to the operation and data acquisition not only for NGCP in general, but as well as to our partners in the power industry.

4.3 CAPEX Schedule

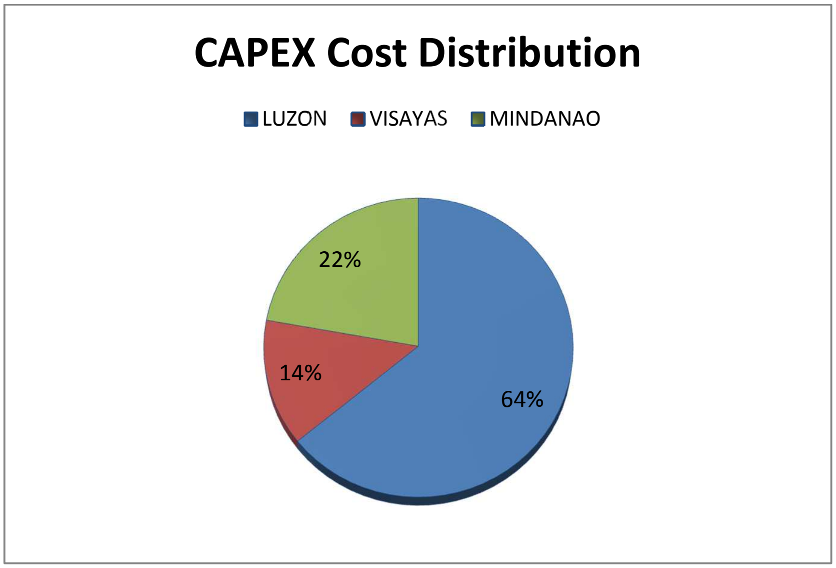


Figure 4.3.1: CAPEX Distribution by Cost

The total project cost for SOME programs for the next decade sums up to P443.05M (Table 4.3.a). This covers both the two major categories under SO's development plan. Luzon has a bigger share of the CAPEX at 64% while the remaining is shared by Visayas (14%) and Mindanao (22%) as shown on Figure 4.3.1. The large portion attributed to Luzon is on account of the centralized nature of our information systems data repository, headquartered in the area.

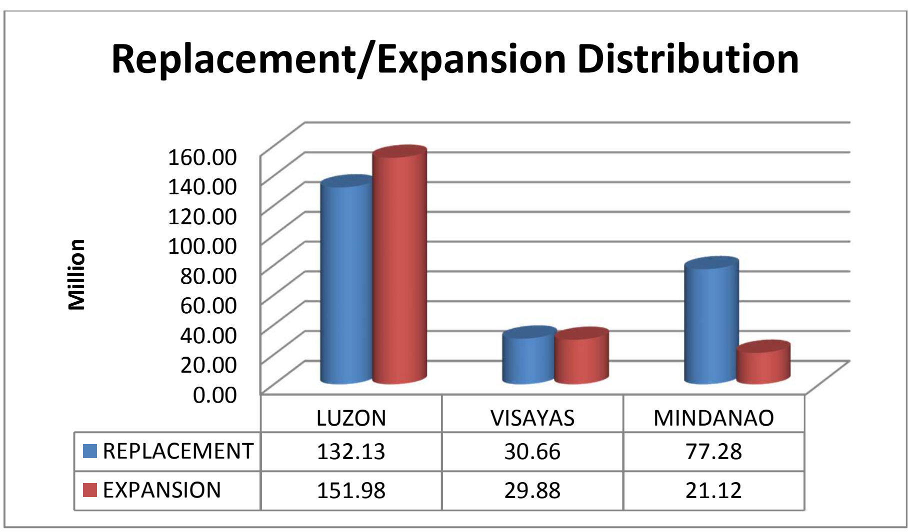


Figure 4.3.2: Equipment Replacement/Expansion Regional Distribution

The majority of the expenditures of SOME's program are for replacement projects with Luzon SO getting the biggest portion (52%), as shown in Figure 4.3.2.

Table 4.3.a: CAPEX Summary (In Million Php)

Project	Luzon	Visayas	Mindanao	Total
Replacement	132.13	30.66	77.28	**240.07**
Expansion	151.98	29.88	21.12	**202.98**
Total	**284.11**	**60.54**	**98.40**	**443.05**

Table 4.3.b: CAPEX Summary (In Quantity)

Project	Luzon	Visayas	Mindanao	Total
Replacement	668	314	470	**1,452**
Expansion	66	101	31	**198**
Total	**734**	**415**	**501**	**1,650**

4.3.1 ISIT Equipment Replacement

The sustenance program ensures reliable and uninterrupted equipment operation through the procurement of ISIT equipment—such as PCs and its peripherals, network devices—that have aged beyond their reliable and economic lives. It also covers the replacement of unserviceable/inoperable equipment whose reliable operations could no longer be guaranteed through parts replacement or repairs.

Table 4.3.1.a: CAPEX Schedule – Replacement in Cost

ICT Replacement Schedule, Cost (In Million Php)											
Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Luzon	27.80	10.12	2.94	11.02	19.18	34.07	10.12	2.94	11.02	2.94	132.13
Visayas	3.25	4.67	2.78	1.42	4.12	2.52	4.67	2.88	1.52	2.88	30.66
Mindanao	3.07	2.64	12.54	5.29	4.45	2.32	2.02	16.78	11.41	16.78	77.28
Total	**34.11**	**17.42**	**18.26**	**17.72**	**27.74**	**38.90**	**16.80**	**22.59**	**23.94**	**22.59**	**240.07**

Table 4.3.1.b: CAPEX Schedule – Replacement in Quantity

ICT Replacement Schedule, Quantity											
Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Luzon	23	88	45	97	60	80	88	45	97	45	668
Visayas	24	54	18	21	44	39	54	19	22	19	314
Mindanao	14	30	63	68	48	25	23	62	75	62	470
Total	**61**	**172**	**126**	**186**	**152**	**144**	**165**	**126**	**194**	**126**	**1,452**

Table 4.3.1.c: Luzon CAPEX Schedule – Replacement in Cost (in Million Php)

ICT Equipment		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PCs and Peripherals	Laptop	-	3.28	1.20	2.32	1.12	1.28	3.28	1.20	2.32	1.20
	Desktop		1.02	-	1.38	-	1.86	1.02	-	1.38	-
	Printer	0.35	0.14	0.14	0.42	0.63	0.70	0.14	0.14	0.42	0.14
	Projector	-	0.20	-	0.30	0.40	-	0.20	-	0.30	-
	Scanner	-	-	0.13	0.08	0.03	0.23	-	0.13	0.08	0.13
	Facsimile	-	0.08	0.03	0.06	0.03	-	0.08	0.03	0.06	0.03
Network Devices	Switch	-	0.60	0.60	0.36	0.24	-	0.60	0.60	0.36	0.60
	Switch (Layer 3)	-	0.80	0.80	-	-	-	0.80	0.80	-	0.80
	Wireless Router	-	-	0.05	-	0.04	-	-	0.05	-	0.05
	Firewall	-	-	-	3.00	1.50	-	-	-	3.00	-
	Bandwidth Manager	-	-	-	-	1.20	-	-	-	-	-
Server	Database	4.02	2.50	-	1.00	-	1.00	2.50	-	1.00	-
	Web	-	-	-	0.50	-	-	-	-	0.50	-
	Application	-	-	-	0.50	-	-	-	-	0.50	-
	Text	-	-	-	-	-	-	-	-	-	-
	File	-	0.50	-	0.50	-	-	0.50	-	0.50	-
Data Storage Solutions	Storage Area Network (with Tape Subsystem)	14.50	-	-	-	-	29.00	-	-	-	-
	Network Attached Storage	-	-	-	-	7.00	-	-	-	-	-
IP-Based Devices	Videocon	8.04	1.00	-	-	3.00	-	1.00	-	-	-
	Voice Log	-	-	-	0.60	-	-	-	-	0.60	-
	Time Server	0.45	-	-	-	1.00	-	-	-	-	-
	Network Access Control	-	-	-	-	2.50	-	-	-	-	-
	KVM Switch	0.45	-	-	-	0.50	-	-	-	-	-
Total		**27.80**	**10.12**	**2.94**	**11.02**	**19.18**	**34.07**	**10.12**	**2.94**	**11.02**	**2.94**
Grand Total											**132.13**

Table 4.3.1.d: Visayas CAPEX Schedule – Replacement in Cost (in Million Php)

ICT Equipment		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PCs and Peripherals	Laptop	-	0.60	0.40	0.40	0.40	0.30	0.60	0.40	0.40	0.40
	Desktop	1.35	1.44	-	0.12	1.62	0.84	1.44	-	0.12	-
	Printer	0.07	-	0.07	0.07	0.18	0.21	-	0.07	0.07	0.07
	Projector	0.10	0.10	-	0.10	0.40	0.20	0.10	0.10	0.20	0.10
	Scanner	-	0.03	0.03	0.03	-	0.03	0.03	0.03	0.03	0.03
	Monitor	0.50	-	-	-	0.02	-	-	-	-	-
	Document Camera	0.02	-	-	-	-	-	-	-	-	-
Network Devices	Switch	0.02	-	0.10	0.20	-	0.16	-	0.10	0.20	0.10
	Wireless Router	-	-	-	-	-	0.02	-	-	-	-
	Firewall	0.26	-	0.78	-	-	0.26	-	0.78	-	0.78
Server	Database	0.50	0.50	1.00	0.50	0.50	0.50	0.50	1.00	0.50	1.00
	Web	-	-	-	-	0.50	-	-	-	-	-
	File	-	-	-	-	0.50	-	-	-	-	-
IP-Based Devices	Videocon	-	0.40	0.40	-	-	-	0.40	0.40	-	0.40
	KVM Extender	0.43	-	-	-	-	-	-	-	-	-
Power	UPS Battery	-	1.60	-	-	-	-	1.60	-	-	-
Total		**3.25**	**4.67**	**2.78**	**1.42**	**4.12**	**2.52**	**4.67**	**2.88**	**1.52**	**2.88**
Grand Total											**30.66**

Table 4.3.1.e: Mindanao CAPEX Schedule – Replacement in Cost (in Millions Php)

ICT Equipment		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PCs and Peripherals	Laptop	0.30	0.30	0.90	0.30	0.50	0.10	0.30	0.30	0.30	0.30
	Desktop	0.68	0.30	0.36	1.50	1.02	0.72	0.30	0.30	0.30	0.30
	Printer	0.18	0.07	0.32	0.28	0.14	0.14	0.14	0.28	0.28	0.28
	Projector	0.17	-	0.60	0.10	0.20	0.10	0.10	0.10	0.10	0.10
	Scanner	-	-	0.03	-	0.05	-	0.08	0.08	0.08	0.08
	Monitor, LCD	-	-	0.18	-	-	-	0.07	-	-	-
	HDD, SATA	-	-	0.40	-	-	-	-	-	-	-
	Optical Drive, External	-	-	0.03	-	-	-	-	-	-	-
	Server Hard Disk (SAS)	-	0.04	0.12	0.24	-	0.04	-	0.04	0.04	0.04
	Video Camera	-	-	0.20	0.20	-	0.20	-	0.20	-	0.20
	Digital Camera	-	-	0.05	-	-	-	-	-	0.05	-
	Facsimile	-	0.11	0.11	0.06	0.06	0.02	0.03	0.03	0.03	0.03
Network Devices	Switch	-	0.04	-	-	0.04	-	-	-	0.04	-
	KVM Switch Over IP	-	0.25	0.50	-	0.25	-	-	-	0.25	-
	Wireless Router	-	0.03	0.01	0.01	0.03	-	-	-	0.28	-
	Firewall	0.75	0.26	-	-	0.26	-	-	-	0.26	-
Server	Database	1.00	-	0.50	-	-	-	0.50	-	-	-
	Web	-	0.50	-	-	-	0.50	-	-	-	-
	Application	-	-	-	-	-	-	-	-	-	-
	Text	-	-	-	-	-	-	-	-	-	-
	File	-	0.50	-	-	0.50	-	-	0.50	0.50	0.50
Data Storage Solution	Storage Area Network (SAN)	-	-	8.00	-	-	-	-	-	8.00	-
	Network Attached Storage	-	-	-	1.00	-	-	-	14.00	-	14.00
IP Based	Videocon	-	-	-	0.40	0.40	-	-	-	0.40	-
	Voice Logger	-	-	-	0.70	-	-	-	0.70	-	0.70
Power Management	UPS	-	0.25	0.25	0.50	1.00	0.50	0.25	0.25	0.25	0.25
	UPS Battery	-	-	-	-	-	-	0.25	-	0.25	-
Total		**3.07**	**2.64**	**12.54**	**5.29**	**4.45**	**2.32**	**2.02**	**16.78**	**11.41**	**16.78**
Grand Total											**77.28**

4.3.2 Local Area Network Expansion and Security

The Grid's increasing dependence on IP based solutions for its operations drives the need for a flexible, scalable and reliable data network. This entails the procurement of additional network ancillaries to accommodate the growing demand for its services, and provide redundant systems to ensure continuous operation. Furthermore the expanding data infrastructure requires additional security appliances to safeguard its operation from threats that would compromise confidentiality, integrity and availability of operational data as stipulated in Section 1.4, Chapter 1 of the Philippine Grid Code.

Table 4.3.2.a: CAPEX Schedule – Expansion in Cost

SOME Expansion Schedule, Cost (In Million Php)											
Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Luzon	12.31	3.00	1.60	15.60	12.27	11.90	58.00	28.50	4.40	4.40	151.98
Visayas	4.08	2.62	2.59	0.00	10.67	2.59	1.69	2.26	1.69	1.69	29.88
Mindanao	1.25	1.00	1.00	0.00	10.67	1.86	1.16	1.16	1.86	1.16	21.12
Total	**17.64**	**6.62**	**5.19**	**15.60**	**33.60**	**16.35**	**60.85**	**31.92**	**7.95**	**7.25**	**202.98**

Table 4.3.2.b: CAPEX Schedule – Expansion in Quantity

SOME Expansion Schedule, Quantity											
Region	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
Luzon	7	5	3	4	4	12	7	10	7	7	66
Visayas	1	3	7	0	1	7	26	4	26	26	101
Mindanao	2	2	2	0	1	6	4	4	6	4	31
Total	**10**	**10**	**12**	**4**	**6**	**25**	**37**	**18**	**39**	**37**	**198**

Table 4.3.2.c: Luzon CAPEX Schedule –Expansion in Cost (in Million Php)

Project	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Disaster Recovery Data Center	-	-	-	-	-	-	30.00	-	-	-
Network Cable Rack & Associated Equipment	0.09	-	0.10	-	0.10	0.10	0.10	0.10	0.10	0.10
Videoconference Endpoint	1.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Multipoint Control Unit	-	-	-	14.00	-	-	-	14.00	-	-
Storage Expansion	0.45	-	0.50	-	0.50	-	0.50	-	0.50	0.50
Server Expansion	0.45	0.50	-	0.50	-	0.50	-	0.50	-	-
Voice Logger Expansion	-	0.10	-	0.10	-	0.10	-	0.10	-	-
Consolidated Data Center	-	-	-	-	-	-	25.00	-	-	-
Network Monitoring Tool	-	-	-	-	-	6.00	-	-	-	-
LSO LAN Expansion	2.68	-	-	-	-	-	-	10.00	-	-
Intrusion Prevention System	3.57	1.40	-	-	-	4.20	1.40	2.80	2.80	2.80
Text Messaging Infra Expansion	1.52	-	-	-	-	-	-	-	-	-
Power Quality Analyzer	1.60	-	-	-	-	-	-	-	-	-
Security & Monitoring of SO IT Facilities	-	-	-	-	10.67	-	-	-	-	-
Total	**12.31**	**3.00**	**1.60**	**15.60**	**12.27**	**11.90**	**58.00**	**28.50**	**4.40**	**4.40**
Grand Total										**151.98**

Table 4.3.2.d: Visayas CAPEX Schedule – Expansion in Cost (in Million Php)

Project	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Stand-alone Videoconference Endpoint Set	-	1.50	-	-	-	-	-	-	-	-
Structured Cabling of Back-up VSO Building	-	-	-	-	-	-	-	-	-	-
ACC LAN Expansion	-	-	-	-	-	-	-	-	-	-
Storage Area Network	-	1.12	-	-	-	-	1.12	-	1.12	1.12
Network Cable Rack & Associated Equipment	0.38	-	0.38	-	-	0.38	-	-	-	-
Network Printer	-	-	0.03	-	-	0.03	0.03	-	0.03	0.03
Fiber Optic Transceiver	-	-	-	-	-	-	0.36	-	0.36	0.36
Desktop PCs for Additional Personnel/ Requirements	0.50	-	0.19	-	-	0.19	0.19	-	0.19	0.19
VSO LAN Expansion	-	-	2.00	-	-	2.00	-	2.00	-	-
Network Switch	-	-	-	-	-	-	-	0.26	-	-
Digisilent w/ License Hardware	0.50	-	-	-	-	-	-	-	-	-
PTI w/ License Hardware	0.30	-	-	-	-	-	-	-	-	-
Power Quality Analyzer	2.40	-	-	-	-	-	-	-	-	-
Security and Monitoring of SO IT Facilities	-	-	-	-	10.67	-	-	-	-	-
Total	**4.08**	**2.62**	**2.59**	**0.00**	**10.67**	**2.59**	**1.69**	**2.26**	**1.69**	**1.69**
Grand Total										**29.88**

Table 4.3.2.e: Mindanao CAPEX Schedule – Expansion in Cost (in Million Php)

Project	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PCs and Peripherals	-	-	-	-	-	0.06	0.06	0.06	0.06	0.06
Voice Logger	-	-	-	-	-	0.10	-	-	0.10	-
MSO LAN Expansion	-	-	-	-	-	0.10	-	-	0.10	-
Videoconference Endpoint	-	-	-	-	-	1.00	-	-	1.00	-
Storage Expansion	-	-	1.00	-	-	0.50	-	-	0.50	-
Server Expansion	-	1.00	-	-	-	-	1.00	1.00	-	1.00
Network Cable Rack & Associated Equipment	-	-	-	-	-	0.10	0.10	0.10	0.10	0.10
Power Quality Analyzer	1.00	-	-	-	-	-	-	-	-	-
BGA Rework Station	0.25	-	-	-	-	-	-	-	-	-
Security and Monitoring of SO IT Facilities	-	-	-	-	10.67	-	-	-	-	-
Total	**1.25**	**1.00**	**1.00**	**0.00**	**10.67**	**1.86**	**1.16**	**1.16**	**1.86**	**1.16**
Grand Total										**21.12**

4.3.3 Data Storage Expansion

The growing volume of operational data critical to the planning and operation of the Grid requires a stable and reliable data storage platform. SO's operational data is currently hosted by its server-based storage solutions put in place in each regional office. Steps are taken to provide adequate drive space, data availability, and business continuity. Regular review on the data volume growth model is conducted, and needs for hardware and software upgrades are constantly studied to address wear and tear of daily operation and obsolescence. Provisions for redundancy, backup and recovery are also integrated into the planning, implementation and operation of these systems.

Table 4.3.3: Database Annual Growth

Regions	Database Projected Annual Volume Growth, GB/Year
Luzon	69
Visayas	12
Mindanao	10
Total	**91**