DEVELOPMENT OF DISTRIBUTION OUTAGE AND INTERRUPTION REPORTING SYSTEM ON THE INTRANET TO FACILITATE ASSET MANAGEMENT

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ABSTRACT

Tenaga Nasional Berhad (TNB) embarked on a project to review the existing distribution outage and interruption reporting system on the intranet (known as TOMS – TNB Outage Management System) with the view to include the following major attributes/objectives:

1) To align reporting methods and terms used to international standards.
2) To make use of utility-wide databases on assets, customer billing and information as the sources for identifying affected components and customer counts.
3) To improve customer service and supply reliability in the light of evolving industry drivers that include performance-based regulation, guaranteed service levels, e-business economy, deregulation, competition, highly publicized outage events and enhanced customer awareness.
4) To apply the asset management concepts of FMECA/FMEA in identifying outage modes and causes.
5) To review reliability index calculations in line with internationally accepted standards.
6) To establish applications of the outage database for reliability-based and risk-based network planning.

Index Terms - Outage and Interruption Reporting, Asset Performance, Reliability Index, Outage Statistics.

1.0 INTRODUCTION

Main inputs to planning of transmission and distribution (T&D) asset development are:

1) Forecast of future sources of supply, demand and energy.
2) Regulatory changes including reliability standards.
3) Operational performance.

The focus of this paper is the third input, that is, network operational performance usually revealed from the utility’s outage and interruption reporting system.

Realising the importance of operational performance as inputs to asset development planning, TNB, in mid 2006 embarked on a project to review the existing distribution outage and interruption reporting system known as LGBNet. The main objectives of the review of the LGBNet system are:

1) To ensure accurate and consistent recording of outage and interruption events so that the resulting performance figures could be effectively used as inputs to asset planning and development.
2) To apply recording methods in-line with international practices to allow for meaningful comparison of performance with other utilities.
3) To make use of existing asset, customers, metering and operational databases as sources of information and thus avoiding any duplication of data entries.
4) To measure service level performance in terms of SAIDI etc. and its subsequent reporting to the industry regulator.
5) To improve reliability management program based on accurate reliability performance of systems and components.

In particular, the paper will describe how the concepts of FMECA/FMEA have been applied to ensure outage modes and causes are clearly identified and these two elements are selectable based on the affected components. One major revision carried out was on reliability index calculations in which based customer count is taken as on the day of reporting rather than using annual average in the previous version or as specified in typical international standards.

2.0 PREVIOUS OUTAGE AND INTERRUPTION REPORTING SYSTEM

LGBNet System is an intranet-based application used by the utility Distribution Division to record system and component outage events planned and forced in the distribution system and to perform various analysis and reporting functions. LGBNet system was developed by the utility internal experts in 1994/1995 and continuous updating carried out over the past years. Together with TCS (Trouble Call System), LGBNet has been used for more than 10 years to manage and record network events involving component outages and supply interruptions.

In particular, LGBNet enables operational staff at area and branch levels to record events and track network and supply restoration performance in terms of SAIDI, SAIFI, CAIDI and ASAI. Operational staff also used LGBNet to identify problem areas in the network including recurring outages, poor performance feeders, quality of materials and equipment and take necessary actions to improve performance.
Figure 1 below illustrates the data inputs flows into the previous LGBNet system.

![Diagram](image)

**Figure 1: Data input flows to the previous LGBNet**

### 3.0 REVIEW PROCESS AND FINDINGS

The review process carried out included various site visits, workshops and discussions with the users of the LGBNet and the management of the utility. The following were major issues associated with the previous system that were identified:

1) **General:**
   - Inadequate definitions of common terms used.
   - Insufficient details and guidelines contained in the manuals.
   - Unclear ownership of the system for maintenance and updates.

2) **Data Inputs:**
   - Inconsistent terms used in TCS and LGBNet.
   - Large number of ‘unknown’ or ‘others’ provided as inputs for cause of outage with inconsistent terms used.
   - Use of old network database that has now been replaced by SAP-based ERMS (Enterprise Resources Management System) system.
   - Causes and modes of outages are inconsistently reported.

3) **Applications:**
   - Mainly used for monitoring of SAIDI, SAIFI and CAIDI.
   - Performance analysis applied by Area/Branch operation not consistent throughout the utility.
   - Lack of planning/design applications.
   - Component details are not consistently recorded for useful asset management applications.

The coordination work with CMC/TCS redevelopment focused on the following:

- Sharing of the same databases between CMC/TCS and LGBNet.
- To ensure consistent inputs at TCS Level for use in LGBNet.
- To share the same ‘ERMS-PM Data’ used by LGBNet for TCS.
- To coordinate work schedule and integration to meet target launching of TOMS.

### 4.0 DATA RECORDING APPROACH

To ensure efficient data input into LGBNet, the following approaches have been adopted:

1) All outages and interruptions reports will be received by CMC (Call Management Centre) and reported into the TCS (Trouble Call System) used at the Supply Restoration Centre. This ensures that the shared databases of TCS and LGBNet are consistently updated.

2) Outage without interruption will be allowed to be reported through LGBNet.

3) Scheduled outage (with or without interruption) will be allowed to be reported through LGBNet.

4) The RCC will also have access to both TCS and LGBNet to enable control personnel to provide inputs on restoration stage, switches/breaker operations and protection operation.

In August 2006, concepts of the revised LGBNet were presented and discussed at various forums using the ‘Mock-Up System’. From September 2006 through December 2006, the LGBNet 2006 was redeveloped and the following sections describes important aspects of the system in particular its functions to facilitate asset management.

### 5.0 OUTAGE MODES AND CAUSES

In order to provide a systematic approach to identify the possible cause(s) of each outage, the revised LGBNet has implemented the concept of failure modes, effects and causes based on the subjects of:

1) FMEA (Failure Mode and Effect Analysis) and
2) FMECA (Failure Mode, Effect and Criticality Analysis).

FMEA/FMECA are methodologies designed to identify potential failure modes for a product or process, to assess the risk associated with those failure modes, to rank the issues in terms of importance and to identify and carry out corrective actions to address the most serious concerns [1]. Although FMEA/FMECA is applied for identifying potential failure modes when designing of products or process, it can also be used when analyzing failures of an existing process, product or services such as analyzing failures or outages in the electric distribution network.
Failure cause could be identified based on failure mode(s),
effect(s) and failure analysis as illustrated in a relationship
in Figure 2. Since ‘Failure Modes’ are based on observable
effects and detection, without the need to ascertain the
cause yet (which may require ‘Failure Cause Analysis’), it
would be expected that reporting would be conducted
without prejudice, pre-judgment or bias.

Failure modes must have observable evidence of failures
from the failure effect and must include: item or component
affected, component function, outage detection and part(s)
damaged. As an example, the possible failure modes for
Medium Voltage Underground Cables are combinations of
fault detection/indication and damage part or component
could be:

1) Insulation failure (tripping and puncture).
2) Overload (tripping and re-energise ok).
3) Insulation failure by third party intrusion (tripping,
   insulation burnt and dug-up).
4) Insulation defect/failure (tripping, burnt and dried
   oil).

Failure cause could be defined as ‘the physical or chemical
process, design defects, part misapplication (through human
error, human inaction, bad workmanship), quality defects,
or other processes that are the basic reason for failure or
which initiate the physical process by which deterioration
proceeds to failure’. Based on the above definition of failure
cause, the generic categories of failure causes include:

1) Methods – installation, tests, techniques, fabrication,
   mounting, etc.
2) People – workmanship, lack of training, lack of skill,
   careless, failure to follow procedures, etc.
3) Materials – defects, sub-standards, not according to
   specification, etc.
4) Equipment – under-specified, under-rated, deficient
   design.
5) Measurements – SCADA, load readings & calculations.
6) Environment – always in combination with 1) – 5)
7) Weather – always in combination 1) – 5)

Causes must therefore contain elements that are controllable
and actionable. However, in some cases, it may include
unavoidable elements beyond controllable. Outage modes

and effects must contain elements that are ‘observable’ and
outage causes must contain elements that are ‘controllable’.

6.0 RELIABILITY INDEX CALCULATIONS

Reliability indices can be calculated based on the domain of
a basic service area or any meaningful combinations of
these service areas based on the utility and national
administrations. A station, to serve an area needs to
maintain an electric distribution network (called Network)
and the Network supplies electricity energy to a number of
customers of different categories. The base domain of
reliability indices is the service area. However, for the
purpose of analysis, the indices can also be calculated based
domains of the MV feeders.

Current standards on outage and interruption reporting such
as IEEE Std. 1366-2003 [2], recommends the use of average
number of customers over the year as the base. Previous
LGBNet determines this average number from the actual
number of customers of the previous year and the forecast
number for the next half year. However, presently the actual
number of customers in each domain, categories and in
some cases connection points could be obtained from the
electronic customer information and billing system (e-
CIBS). The number of customers may also change daily as
new connections and disconnections are made.

To reflect the actual performance, the TOMS-LGBNet has
adopted an approach to calculate reliability indices based on
the actual number of customers in the domain as contained
in the e-CIBS. Therefore, the traditional approach of
calculating reliability indices as and when required by user
through querying of number of customers affected and
restoration time from the database cannot be applied
anymore. In the TOMS-LGBNet, reliability indices of each
interruption record are calculated and stored as part of the
event record in the database. Therefore, the indices are
calculated based on the total number of customers at the
time of the event and will remain the same in the future.

7.0 OUTAGE STATISTICS

It must be recognized that the reliability indices such as
SAIDI calculated by a database system such as the LGBNet
are historical values because they are based on events that
have occurred. An operation engineer would use these
historical indices as the benchmark or measures and
employs operational improvement strategies available to
achieve better performance the next time an interruption
event occurs. However, options available to an operation
engineer to improve SAIDI, as for example, is limited and
may include the following approaches:

1) Better supervision of fault repair team.
2) Better communication facilities for fault repair team.
3) Close supervision of switching operation by authorized
   persons.
4) Better traveling options to different locations for the fault repair teams.
5) Better vegetation management.
6) Close supervision of maintenance and inspection works.

We take note that operation engineer has limited options and only within the domain of staff management and to some extent facilities. In practice, in order to make further significant improvement to reliability, it has to be part of future planning and asset development with focus on network configuration, management, component and automation.

A starting point of any plan is the past or historical performance and this would be provided by the outage and interruption reporting system like the LGBNNet. To evaluate a plan and its cost effectiveness, we need to evaluate the performance in the future such as reliability index, SAIDI.

Future reliability indices can be calculated based on average historical performance such failure rate ($\lambda$), mean time to switch (MTTS) and mean time to repair (MTTR) and these parameters are calculated for different types of components and their voltage level.

8.0 IMPROVED CUSTOMER SERVICE

TOMS system has demonstrated value to TNB by accelerating the resolution of customer service issues and providing the visibility to optimize infrastructure, customer support and field response teams. It also integrated customer care functions, billing system, network management, work and asset management and mobile field force automation (MFFA) with the capabilities of business intelligence tools, middleware and database technologies thus enabling TNB to adapt more nimbly to market deregulation, meet ever-evolving customer demands, and deliver on commitments to superior customer service. Figure 3 shows typical results for customer survey rating.

![Customer Survey Rating](image)

Figure 3: Customer Survey Rating

Chart above in Figure 3, shows the random survey results conducted via SMS on TNB customers especially relating to outage management.

TOMS system has provided a birds eye view with a very comprehensive database in regards to customer management and outage and interruption analysis.

9.0 CONCLUSIONS

In this paper we have described the development of outage and interruption reporting system that includes the following features to facilitate asset management and development:

1) The revised reporting system uses extensively the existing enterprise-wide databases belonging to the utility such as customer counts, component details, connectivity, asset counts, etc.
2) Reliability indices such as SAIDI and SAIFI are calculated based on the actual total number of customers obtained from e-CIBS (Electronic Customer Billing and Information System) and calculated and stored for each reported event. We believe that this approach should be adopted as the standard.
3) Outage performance figures for different types of components and at different voltage levels calculated by the system is useful information for use in planning that enables one to predict more accurately performance of planned system.
4) The applications of concepts of FMEA/FMECA have enabled the system to be designed to clearly identify outage modes and outage causes.
5) The system has been designed to generate performance figures up to the component and equipment levels that are useful for the purposes improving asset management aspects including specifications and quality assurance.
6) The system have positive responses and commitment from all levels of management and staff (front-liners).
7) The system has shown drastic improvement in customer service and crew management.
8) To establish applications of the outage database for reliability-based and risk-based network planning.
9) A more transparent, efficient, standardized and accurate outage & interruption event reporting system.

10. BIBLIOGRAPHY