THE OPTIMUM COMMUNICATIONS ARCHITECTURE FOR DEEP LEVEL GOLD MINING

by

Mark Henry Bruce Miller

Submitted in partial fulfilment of the requirements for the degree Master of Engineering (Electrical) in the Faculty of Engineering UNIVERSITY OF PRETORIA

March 2000

© University of Pretoria
SYNOPSIS

"THE OPTIMUM COMMUNICATIONS ARCHITECTURE FOR DEEP LEVEL GOLD MINING"

BY: Mark Henry Bruce Miller*

SUPERVISORS: Prof. G. Hancke*, Prof. M.W. Pretorius**

* Dept. of Electrical and Electronic Engineering.
** Dept. of Engineering and Technology Management.

UNIVERSITY OF PRETORIA: Faculty of Engineering

DEGREE: Master of Engineering (Electrical)

March 2000

KEYWORDS: Communications, Mining, Information-Technology (IT), Fieldbus, LAN, Video, Data, Radio, Control, Technology Management, Technology Framework,

If systems for multi media communication are implemented haphazardly in a business then one can end up with a ‘patchwork’ of communication systems, difficult and expensive to maintain and expand. The objective of the dissertation was to develop the vision or generic models for future communication systems in deep level gold mines, and to identify and define the more important engineering and technology practices necessary for the implementation of this vision.

APPROACH

The approach taken is best summarised by the flowchart below where the needs of the business were analysed and applicable technologies available investigated. These combined led to the concept of ‘domains’ which was developed and defined in order to rationalise the number of communication systems required. Technology trends were investigated further and finally appropriate models were developed for classified types of mines. Additionally the more important practices and measures were also defined.
The cost of communication systems was found to be significant and appropriate engineering is required to reduce the total cost of ownership. The profit opportunity enabled through communication systems is also enormous, and therefore 'downtime' is of major significance.

This emphasised the need for generic design guideline models, and the development of critical measures or practices to be adhered to within the business.

Three classes of mines ('Long', 'Medium' and 'Short Term') were identified in preparation for the technology models, primarily differentiated on the basis of automation requirements, expected life, and how much of the envisaged communications infrastructure was already in place. Four communications domains were identified as necessary for the 'Medium Term' mines, but with the possibility of reducing this for the 'Long Term' mines.

Models were developed for use as a guideline or vision for the long and medium term mines, and a set of criteria developed for the use as a guideline for technology choice of short term mines.

A number of measures were identified as necessary for the optimum management of communication system type issues and are listed as follows:

- Firstly the systems must be documented as they are, and planned with future need in mind.
• In the radio domain a 'Code of Practice Guideline' was developed primarily to control frequency spectrum use and critical aspect to radio systems

• The concept of 'Best Practice Reviews' was developed and implemented in order to maximise the benefits available with the professional resources deployed in the business units, and to recognise the dynamic and sometimes volatile nature of the technologies dealt with in the communications field. This is intended to be used, together with the proposed tailored project management process, as a solution for comprehensive 'Communication Systems Life Cycle Management'.

CONCLUSIONS

It is believed that if the mines use these models as a guideline for the choice and engineering of their future communications systems, together with the methods developed during the dissertation, then the optimum benefit available from communications technology will be obtained.
ACKNOWLEDGEMENTS

This is to acknowledge and thank the following people for their assistance and contributions in the writing of this dissertation.

Professor Gerhard Hancke, my study leader, for his overall guidance and assistance. Especially with the “Africon 99” conference and journal paper aspects to this dissertation.

Professor Tinus Pretorius, for his guidance in the technology management aspects of the dissertation.

Your assistance is warmly appreciated.
CONTENTS

SYNOPSIS I
ACKNOWLEDGEMENTS IV

1 INTRODUCTION 1

2 BACKGROUND 3
2.1 An Overview of Literature and Work Done 3

3 NEEDS ANALYSIS 5
3.1 Macro Process Description 5
3.2 Micro Process Description 7
  3.2.1 Rock Breaking 7
  3.2.2 Horizontal Transport 9
  3.2.3 Vertical Transport 12
3.3 Communication Domains Defined 12
  3.3.1 Shaft Barrel 13
  3.3.2 Process Control Domain 13
  3.3.3 Remote Production and Environmental Monitoring 14
  3.3.4 Mobile Communications Domain 14
3.4 Specific Need Areas 15
  3.4.1 Video 15
  3.4.2 Voice 16
  3.4.3 Data 16

4 ENGINEERING MANAGEMENT ISSUES 18
4.1 Return on Investment Evaluation 18
  4.1.1 Total Cost of Ownership 18
  4.1.2 Benefits Analysis 19
  4.1.3 Factors Affecting Cost of Ownership 20
  4.1.4 Factors Affecting Benefit Delivery 21
4.2 Project Management of Communications System Projects 22
  4.2.1 Needs Determination 23
  4.2.2 Conceptual Design 23
  4.2.3 Technology Forecast Review 23
  4.2.4 Master Plan Fit 23
  4.2.5 Tender Specification and Adjudication 23
  4.2.6 Installation and Commissioning 24
  4.2.7 System Handover 24
4.3 Technology Management Strategy for Anglogold Communication 24
  4.3.1 Existing Problems 24
  4.3.2 Communications Plans for Domains – the Key 25
  4.3.3 CIC Best Practice reviews 25
4.4 Communication System Life Cycle Management 26

5 TECHNOLOGY ANALYSIS 28
5.1 Review of Automation Approach Trends Internationally 28
5.2 Key Characteristics of Market Technologies 30
  5.2.1 Determinism 30
  5.2.2 Redundancy 30
  5.2.3 Bandwidth 30