




TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 1 of 62

OASyS PCS LAN Specification

E354086-00000-271-078-0002

REV. 01

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TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 2 of 62

DOCUMENT CHANGE HISTORY:

Date	Previous Rev No.	New Rev No.	Details of Revision
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This table summarises what has been changed in the document so that it is easy to keep track of the effected changes.



TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 3 of 62

TABLE OF CONTENTS

1 INTRODUCTION5
1.1 Purpose5
1.2 Scope5
1.2.1 Requirements Included..... 5
1.2.2 Requirements Excluded 6
1.2.3 Document Directives 6
1.3 Terms and Definitions6
1.3.1 Abbreviations..... 6
1.3.2 Station Abbreviations and Numbers..... 8
1.3.3 DEFINITIONS 9
2 APPLICABLE DOCUMENTS 11
2.1 TPL Applicable Specifications and Standards 11
2.2 Other Applicable Specifications and Standards 12
2.3 Reference Documentation 12
3 PROCESS CONTROL NETWORK SPECIFICATIONS 14
3.1 Network Overview 14
3.1.1 Physical Network..... 14
3.1.2 Logical Network 15
3.2 Virtual LAN Definition 16
3.2.1 Functional descriptions of each VLAN 17
3.3 Quality of Service (QoS) 19
3.4 Network Devices..... 19
3.4.1 Station Network 20
3.4.2 Master Control Centre Network 20
3.5 Switch Port Allocation 22
3.5.1 Station Network Core Ports..... 22
3.5.2 MCC Ports 23
3.5.3 DMZ Network Ports 24
3.6 Routing Protocols and Routing Tables 25
3.7 Device Addressing Schemes 27
3.7.1 Device IP Assignments 28
3.8 Centralised Network Management..... 40
3.9 Network Monitoring and Alarming 40
4 CYBER SECURITY 41
4.1 NETWORK SECURITY 41
4.2 DEMILITARISED ZONE..... 41
5 PHYSICAL MEDIA SPECIFICATION 42
5.1 Cable Specifications 42
5.1.1 Copper Cables 42
5.1.2 Fibre Optic Cables 42
5.1.3 Cable Identification 42

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 4 of 62

5.1.4

Communications Cable Routing

42

5.2

Colour Specifications

42

5.2.1

Colour Differentiation per Function

42

5.2.2

Ethernet Connector Core Colour Sequence

43

6


APPENDIX 1

45

7

APPENDIX 2

54

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 5 of 62

1 INTRODUCTION

This specification defines the PCS network for the Crude Oil PCS Upgrade Project. The Process Control System specified for the upgrade project is the Schneider Electric M580 ePAC redundant PLCs, the OASyS DNA SCADA and the SimSuite Leak Detection system. Process Control System requirements will be followed to ensure safe and continual service.

1.1 Purpose

This specification defines the high-level requirements for the process control network to be implemented, including:

- The background information required to understand concepts defined herein;
- Overall design – the various layers that form the basis of the network;
- The definition of the VLANs to be implemented;
- The definition of the IP addressing scheme including the subnet to area mapping and the IP subnet to VLAN mapping;
- The cable, connector requirements – pertaining to copper and fibre connections for the PCS, remote I/O and data cabinet uplink(s) to the WAN interface devices;


This document's target audience is the technicians, specialists, engineers and service providers that will be directly involved in the design, implementation and configuration of the Process Control Network required for every station including the MCC, SCC and the School of Pipelines Training Centre. A firm understanding and knowledge of any related or referenced documents are essential.

1.2 Scope

1.2.1 Requirements Included

This document defines the requirements and responsibilities of any person, company or contractor that is involved in the connection of devices to the process control network, and includes:

- The uplink cables (copper CAT6A SFPs will be used unless explicitly specified otherwise) to be connected to the WAN interface devices (connection to the TPL existing WAN);
- Network OSI L2 and L3 switches;
- PLC CPU / eNOC / CRA cards;
- PLC Remote I/O;
- Variable Speed Drives;
- Flow Computers;
- Host virtual servers;
- PCS Operator workstations;
- UPS network monitoring cards;
- KVM;
- Printers;

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 6 of 62

- Firewalls;
- GPS Network Timeserver;

NOTE: GLC-TE SFP for the LAN to WAN connection is compatible with the ASR920, ONS15454 M6/M12 and Catalyst 2960

1.2.2 Requirements Excluded

The following is outside the scope of this document

- The direct configuration of Wide Area Network devices;
- Corporate connections (physical cabling);
- Detailed design of Network Security, Unified Threat Management and Intrusion Prevention System/Intrusion detection systems will be covered in the OASyS PCS Security Specification.

1.2.3 Document Directives

This document conveys the specifications and/or configuration design principles of equipment and procedures to be provided.

1.3 Terms and Definitions

Identify any acronyms, abbreviations or specialized terms used in this procedure and they should be stated in full

1.3.1 Abbreviations

Item	Description
BGP	Border Gateway Protocol
COMMS	Communications
COP	Crude Oil Pipeline
CVLAN	Control VLAN
CRP	Control ring peripherals
DSCP	Differentiated Services Code Point
DWP	Durban Witwatersrand Pipeline (Crude Oil Pipeline)
EDMS	Electronic Document Management System
EIGRP	Enhanced Interior Gateway Routing Protocol
eNOC	PLC Ethernet communication module
ESD	Electro-static discharge
FBS	Facility Breakdown Structure
FDS	Functional Design Specification

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 7 of 62

Item	Description
FEED	Front End Engineering & Design
FOC	Fibre Optic Cable
GBps	Gigabytes per second
Gbps	Gigabits per second
HA	High availability
HMI	Human Machine Interface
IMM	Integrated Management Module
I/O	System Input/Output
IGP	Interior Gateway Protocol
IO	A general reference to Input, output paths
IPS	Intrusion Prevention System
IPUP	Inter-process and unicast processes
IS-IS	Intermediate System to Intermediate System
LAN	Local Area Network
MBps	Megabytes per second
Mbps	Megabits per second
MCC	Master Control Centre
NAS	Network Attached Storage
NIC	Network Interface Card
OSPF	Open Shortest Path First
PBB	Provider Backbone Bridging
PBT	Provider Backbone Transport
PCS	Process Control System
PLC	Programmable Logic Controller
PtP	Point to Point
PUR	Polyurethane
PVC	Polyvinyl Chloride
QoS	Quality of Service
SCADA	Supervisory Control & Data Acquisition
SCC	Secondary Control Centre
SFP	Small Form-factor Pluggable

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 8 of 62


Item	Description
SFTP	Shielded and Foiled Twisted Pair
S/FTP	Shielded Unshielded Twisted Pair
SIF	Safety Instrumented Function
TBC	To Be Confirmed
TBD	To Be Determined
TPL	Transnet Pipelines
URS	User Requirement Specification
UTM	Unified Threat Management
VM	Virtual Machine
VLAN	Virtual Local Area Network
WAN	Wide Area Network

1.3.2 Station Abbreviations and Numbers



The table below provides a list of station numbers, names, abbreviations, station types and WAN connections pertaining to the PCS upgrade project.

FBS	Station Name	Abbr	Type	WAN type & Speed
1	Fynnlands COP	FYN	Intake Station	DWDM Fibre – 1Gbps
4	Hillcrest DWP	HLR	Pump Station	STM1 – 90MB
8	Howick DWP	HWR	Pump Station	DWDM Fibre – 1Gbps
10	Ladysmith DWP	LAY	Pump Station	STM1 – 90MB
17	Coalbrook COP	CBK	Delivery Station	STM1 – 90MB
28	Newcastle DWP	NCS	Pump Station	STM1 – 90MB
35	Quaggasnek COP	QGA	Pump Station	STM1 – 90MB
38	Mngeni COP	MGN	Booster Pump Station	STM1 – 90MB
39	Duzi COP	DUZ	Booster Pump Station	DWDM Fibre – 1Gbps
40	Mooi River COP	MRR	Booster Pump Station	DWDM Fibre – 1Gbps
41	Fort Mistake COP	FTM	Booster Pump Station	STM1 – 90MB
42	Wilge COP	WIL	Booster Pump Station	STM1 – 90MB
95	School of Pipelines	TRN	Training Centre	N/A
98	Secondary Control Centre	SCC	Secondary Control Centre – 202 Anton Lembede Street, Durban	DWDM Fibre – 1Gbps
99	Master Control Centre	MCC	Central Operations	DWDM Fibre – 1Gbps

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 9 of 62

1.3.3 DEFINITIONS

1.3.3.1 *Access Layer*

Is defined as the entry point for end-users, general devices or services. The access layer connects to the distribution layer.

1.3.3.2 *Backbone*

Is defined as the devices that form the core of a network and the transit between these devices; in a building or specific site. A backbone is split into multiple logical (virtual) tiers, each providing a dedicated service to the network. An end-user or service, therefore, does not directly connect to the backbone of a network, mostly for security reasons, but also due to connection speeds and the types of services required to operate that portion of the network.

1.3.3.3 *Backhaul*

Is defined as the interconnection and/or media of smaller subnetworks typically between data centres or data nodes by the aggregation of multiple networked services. These data centres or data node are typically distributed over a wide area ranging from a couple of meters to hundreds of kilometres. Backhaul typically links different buildings or metropolises together and interlinks many backbone networks. No service (server, application, PCS, etc.) on the network directly connects to the backhaul, as it uses specialised and dedicated equipment.


This document uses the term *backhaul* to refer to the *WAN* network as defined in TPL PL703.

1.3.3.4 *CIDR Notation*

IPv4 consists of 4 bytes, or octets, separated by a full stop between each byte. Since inception, the IPv4 address range was split into smaller groups or classes. The subnet mask is then used with Boolean logic to determine whether an IP falls into a specific range and if the host should respond. Three distinct classes were identified for general use and the others were reserved for later usage; three major subnet ranges were identified, an A-class, B-class and C-class. This way, by matching the IP address to the subnet mask you could identify what class of network it is.

In modern networks, these subnet classes have been replaced by Classless Inter-Domain Routing (CIDR). The only difference between the conventions is the classes fell away and the subnet bytes are now added together to give a bit count. This bit count tells the user what network it belongs to. Therefore an IP address of 192.168.1.1 with a subnet mask of 255.255.255.0 is now written shorthand as 192.168.1.1/24.

This specification will only use CIDR notation for all IP addresses. A good understanding of how IP addressing works and what distinguishes the network portion and the host

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 10 of 62

portion of the network is a necessity. Further deliberation on this topic is outside the scope of this document.

1.3.3.5 *Differentiated Service (Computer Networks)*

Differentiated services is an architecture that specifies a simple and scalable mechanism for classifying and managing network traffic and providing Quality of Service (QoS) on modern IP networks. Differentiated services use a 6-bit Differentiated Services Code Point (DSCP) in the 8-bit differentiated services field (DS field) in the IP header for packet classification purposes.


NOTE: For this specification, the term "LAN" is too elaborate and comprises of several layers that form the "network". For the various network layers, undesired network behaviour may occur using the incorrect network layer.

1.3.3.6 *Distribution Layer*

The distribution layer of a network defines the interconnection of access switches with the backbone. For example, physical / virtual network switches.

1.3.3.7 *Virtual LAN*

A Virtual LAN (VLAN) is defined as a LAN that is isolated from all other network traffic and is not on the same broadcast domain. Therefore, the sole purpose of a VLAN is to serve as a place holder in the addressing architecture and to give an islanded network a name or description. It should not be confused with hierarchical VLANs (HVLAN), Q-in-Q (802.11ad), PBB (802.11ah) or PBT standards. This term is used only in the scope of this specification and any system described herein that conforms to the requirements thereof.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 11 of 62

2 APPLICABLE DOCUMENTS

All documents of the exact revision cited in the Applicable Documents form part of this specification to the extent specified. In the event of a conflict between the text of this specification and the documents invoked herein, the text of this specification shall take precedence.

However, nothing in this specification supersedes applicable laws and regulations.

2.1 TPL Applicable Specifications and Standards

No. and Title	Doc. No.	Rev.
[1] Transnet Pipelines WAN – Crude Oil Pipeline Automation Systems LAN ICD	H354086-00000-276-242-0001	0
[2] PL703 Process Control Network Standard	PL703	2.0
[3] Pipeline Network Design Criteria	2684358-J-A00-CS-SP-001	04
[4] PCE – Framework for Minimum Controls for Security	TPL TECH MC&I STD PCE-006	2.0
[5] Control – Vulnerability and Firewall Configuration Management	TPL-TECH-C-WI-001	01
[6] Computer Naming Standard	2684358-S-A00-IS-ST-001	04
[7] PLC System/LAN Architectures	E354086-00000-271-256-0003, 0004, 0005, 0006	Latest
[8] SCADA System Architecture	E354086-00000-271-256-0002	Latest
[9] SCADA Functional Design Specification	E354086-00000-271-078-0018	Latest
[10] PLC Functional Design Specification	E354086-00000-271-078-0005	Latest
[11] SCADA/PLC Communication Plan	E354086-00000-271-078-0012	Latest
[12] LDS Functional Design Specification	E354086-00000-271-078-0007	Latest
[13] Metering Functional Design Specification	E354086-00000-271-078-0020	Latest
[14] Process Control System User Requirement Specification	TPL-TECH-I-C-SPEC-012	03
[15] Custody Metering System User Requirement Specification	TPL-TECH-I-M-SPEC-011B	04

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 12 of 62

No. and Title	Doc. No.	Rev.
[16] Leak Detection System User Requirement Specification	H354086-00000-270-078-0004	0
[17] Alarm Configuration Database	H354086-00000-271-060-0001	0
[18] OASyS PCS Diagnostic Functional Design Specification	E354086-00000-271-078-0027	Latest

2.2 Other Applicable Specifications and Standards

The following national and international standards are required to be complied with and shall be read in conjunction with this Specification.

No. and Title	Doc. No.	Rev.
[19] Quality Management Systems	SABS ISO 9000	2015
[20] The Classification of hazardous locations and the selection of electrical apparatus for use in such locations	SANS 10108	2014
[21] The wiring of premises – Part 1: Low-voltage installations	SANS 10142-1	2012
[22] Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test	IEC 61000-4-2	2008
[23] Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	IEC 61000-4-3	2006
[24] Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	IEC 61000-4-4	2012

2.3 Reference Documentation

The documents included in this section do not form part of the specification but are included for background and context.


No.	Doc. No.	Rev.
[25] Standard for Information Technology – Software Lifecycle Processes	IEEE 12207.0	1996
[26] Drawing Standards	PL100	03
[27] Plant & Equipment Tag Numbering Standards	PL101	03
[28] Equipment, Instrument & Electrical Symbolology Standards	PL102	01
[29] Internet Subnets	IETF RFC917	1984

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 13 of 62

No.	Doc. No.	Rev.
[30] Internet Standard Subnetting Procedure	IETF RFC950 & IETF RFC6918	1985 / 2013
[31] Variable Length Subnet Table For IPv4	IETF RFC1878	1995

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 14 of 62

3 PROCESS CONTROL NETWORK SPECIFICATIONS

3.1 Network Overview

The OASyS PCS network is physically and logically (software-based or by function) layered to allow configuration and segregation of the various devices. The stacked switches in each site will function as network switches and local routers and will be connected to the WAN interconnect devices via two cables.

The network shall be designed and implemented to conform to the TPL performance specification required by the SCADA system.

3.1.1 Physical Network

All stations, including the MCC, SCC and the training centre, have the same base system design.

Due to unforeseen limitations by existing TPL equipment, the following transpired:




- Contractual imposed limitations between TPL and their service provider monitoring the WAN, has an impact on the port speed.
- The active port count available to the PCS network.
- The fact that some sites only have one device to connect to.
- The type of devices the OASyS PCS network connects to differs significantly in functional capabilities.



A decision was made, between all parties concerned, to configure two ports for the PCS network on the WAN equipment regardless of device type or device count. The deciding factor was the design requirements of the OASyS PCS network, that requires 2 connections and the overall nature of the redundancy of the system. However, one port will be kept "administratively down". This means that if the primary port fails, the TPL service provider can remotely enable the secondary port and the station will be reconnected to the WAN.

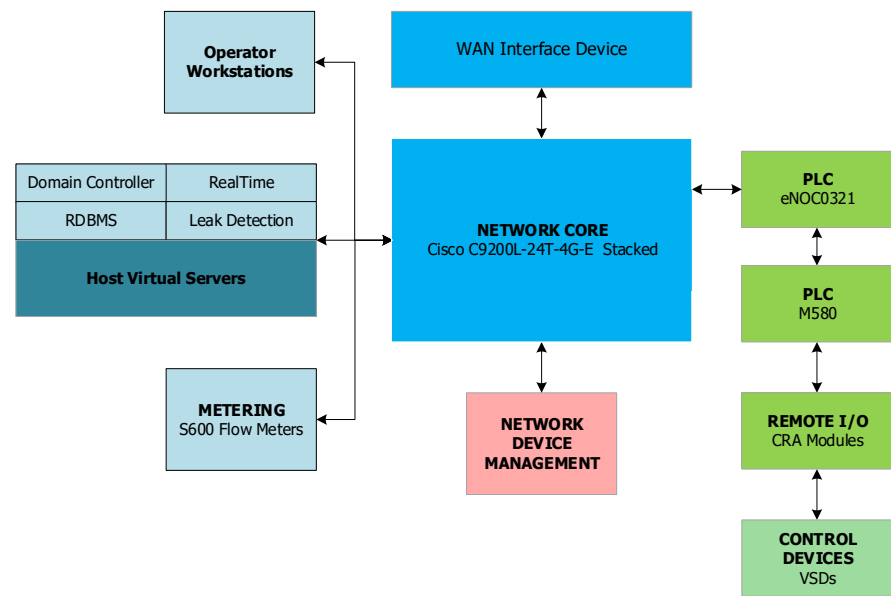



All connections within all sites are connected in a full mesh configuration to minimise single point of failures. Therefore, there always is two, or more, ports configured for each associated network service.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 15 of 62

3.1.2 Logical Network

This illustrates the logical network design, grouped by function and/or device.



TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 16 of 62

3.2 Virtual LAN Definition

The OASyS PCS network will be segregated into VLANs based on the table below, derived from the "TVDA How can I implement an M580 Redundant System v2 of 2017". The main focus of the segmentation (VLANing) is to break up packet broadcast domains, in order to protect all devices on the associated network, against unwanted traffic. It should be noted that Schneider Electric recommends a network/subnet/segment traffic load to never exceed the 20% mark. This is to allow (not limited to) extra room for occasional traffic spikes to not negatively impact the process and to honour built-in watchdog timers. These timers protect the M580 CPU against field bus failure etc. This allows for multi-layer in-system protection; preventing any single accidental network failure to not be the root cause of control system unreliable behaviour.

The remote I/O ring and external network (external to the PLC's direct Ethernet bus located in the PLC backplane) will be split on OSI layer 3 as the eNOC0321 card functions as an OSI model layer3 router. VLANs with associated subnets are preferred technology over stand-alone subnets or flat networks(as per Cisco CCNA / CCNE modules, Gartner, Network+). The VLAN configuration is performed on the central network devices shielding the PLC programmer/maintenance from it. This should provide sufficient isolation to prevent one PLC from taking over another's IO although they are on the same VLAN.

In the event of a network switch failure, there will be no impact on remote IO (CRA modules) as the PLC CPU controls the IO cycle.

The switches performing the routing for the VLANs on each location will connect to the WAN interconnect devices using two cables, with two of the switch ports configured as uplink ports. As the subnet is routed, the implicit configuration of trunk ports for uplink purposes will not be used. All VLANs will be locally configured per location only and splits the network primarily by function.

Several limitations were imposed by Vendors after upgrading their firmware of their devices and others simply shipping the latest firmware. Some of these changes (or original intended design limitations) by Vendors had a knock-on effect on how this specification matured. Therefore this specification is written on the tested and validated configuration as currently installed prior to iFAT.

The Vendors, issues and currently configured/tested/functioning correctly/working well are the major forces dictating the changes and can be found in the comments resolution section of this document.

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 17 of 62

The following VLANs will be configured on the stations:

#	Network Designation	Configured by	Virtual LANs	Routing		Location	Recom. WAN Bandwidth ⁵	
			Name (ID)	Ext. ¹	Int. ²		STM1 Sabre	DWDM
1	Default	Cisco	Default (1)	No	N/A	All	N/A	N/A
2	Management ³	TPL	mgmt-vlan (200)	Yes	No	All	5Mbps 5Mbps	100Mbps
3	SCADA ⁴	TPL	scada-vlan (210)	Yes	Yes	All	65Mbps 155Mbps	700Mbps
4	SCADA to eNOC	TPL	scada-enoc-vlan (220)	Yes	Yes	Stations	20Mbps 20Mbps	200Mbps
5	Flow Computers	TPL	fc-primary-vlan (221)	Yes	Yes	Intake / Outlet	N/A	N/A
6			fc-secondary-vlan (222)	No	No			
7	Uplinks	TPL	uplink-vlan (300) (310 for MCC DMZ)	Yes ⁶	No	All	90Mbps 190Mbps	1Gbps

- 1- External routing: VLAN is routed to the MCC;
- 2- Internal routing: VLAN can be locally routed to other VLANs within the station;
- 3- Proposed service list;

- Network devices
- Server IMM
- Hypervisor management
- SAN management

- 4- SCADA system intra-communications; real-time to historical, domain controllers, etc. and Flow Computers;
- 5- This originally showed total bandwidth for STM1 that is limited to around 90Mbps. Bandwidth is dynamically assigned by the weighted queue in the switches;
- 6- This is purely for uplinks;

3.2.1 Functional descriptions of each VLAN


1. **default:** Not used. All ports, by default, are configured to participate in this vlan.
2. **mgmt-vlan:** Used for the management and monitoring of the Host Servers. It will be routed and available on the *scada-cvlan* BUS.
3. **scada-vlan:** Used for communication between the SCADA servers and flow computers. When the SCADA servers need to talk to the PLC, they are routed to the *scada-enoc-cvlan*. The SCADA virtual servers will be connected to this network.

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 18 of 62

4. **scada-enoc-vlan:** PLC and other devices directly associated with PLC comms are connected to this bus. Routed to the *scada-cvlan* BUS for SCADA communications.
5. **fc-primary-vlan:** Used for communication between the Flow Computers and anything else.
6. **fc-secondary-vlan:** reserved for future use.
7. **uplink-vlan:** Used for intersite communication.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 19 of 62

3.3 Quality of Service (QoS)



QoS is primarily done on the WAN connections already and the need for additional QoS was proved not to be required for this project. Should we identify issues proving this requirement of urgent need, we will implement this section.

QoS will primarily function on service level and on a secondary level be implemented using QoS-queues in the switches. Differentiated services (DSCP) and type-of-service (TOS) values assigned to the required field in the TCP packet header will be implemented as required in 4 levels.

QoS will be configured to prioritise data traffic (from high to low priority):

1. SCADA system real-time data and control;
2. Replication data for SQL and AD data;
3. Remote access (RDP);
4. All other unmarked traffic as bulk;

On the SCADA-eNOC VLAN, weighted bandwidth management will be used. This will give a higher preference to the SCADA-eNOC-VLAN should the local server be unavailable. It will be configured to mark packets in the core switches at each location.



Exact values assigned to the DSCP values will have to be finalised using traffic engineering using specialised packet capture tools. The current state of the development system does never allow for this.



Network performance analysis and conformity obtained from the production network will be the input to the above section.


3.4 Network Devices

Cisco switch stack configuration binds the two or more switches to act as one device, sharing system resources (switch ports, processors, memory and ASICs). Should one switch fail, the master switch will reload and transfer its configuration, IOS and bootloader to the new switch as soon as the stack is re-established. This is performed without network downtime.

For sites with one switch stack (current design for all TPL sites), the stack will automatically be implemented as the root primary.

For sites with multiple stacked switches (not current design for any TPL sites), the stacks are to forward frames on the same network segment, and the one switch will be configured as a root primary and the other as root secondary. This interlink between the two switch stacks will be fibre optic cables and two cables will be used and cross-linked. To ensure network services do not suffer the effects of a spanning-tree topology change; the "spanning-tree" "portfast" feature will be enabled on each switch port.

For correct operation of the SCADA system, multicast mode must be enabled. In multicast mode, switches distribute a given packet to all hosts that have signalled they want to receive the material. Note that Internet Group Management Protocol (IGMP) Snooping

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 20 of 62

contradicts this mode by setting up dedicated paths between requesting and broadcasting stations and must be disabled to allow the proper operation of the SCADA LAN.

To prevent network loops (where a network cable connects two ports on the same network segment) the use of the Spanning-tree protocol will be implemented. In addition, the Spanning Tree algorithm, which is used to detect changes to IP addresses associated with a given port, must be set to FAST. This ensures that as IP addresses move (for example when a failover occurs), the switches will be able to detect this within 5 seconds. Note that the SLOW setting can take a minute to detect IP address/port mapping changes. Like the above IGMP problem, having Spanning Tree set to SLOW can mean an XOS machine will take a minute or more before it will track a failover.

Note: Network Loop i.e. Spanning-tree configuration and functionality to be tested in detail in phase 3.

3.4.1 Station Network

3.4.1.1 Network Edge

Station networks connect via cables using the appropriate SFP module(s), to existing WAN interface devices. Firewalls will not be implemented between the MCC or SCC and the stations.

3.4.1.2 Network Core

Two Cisco C9200L-24T-4G-E or latest and equivalent switches will be installed in a stack setup. SFP ports 1 to 4 will be used for the network edge connections. On sites where flow computers are to be installed, they will form part of the SCADA VLAN.

3.4.1.3 Metering

On metering sites, the meters will be connected to the main core switches.

3.4.1.4 Flow Computers

The existing TPL flow computers will have two Ethernet connections:


- One will be used for SCADA communications via the core network switches
- The second port will be spare

3.4.1.5 ModbusTCP to VSD and PLC Remote IO

TPL existing VSD drives will be connected to the PLC's service port communicating with the PLC using Modbus TCP through a Profibus to Modbus converter.

3.4.2 Master Control Centre Network


This section describes the differences in network design between the stations and the MCC.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 21 of 62

3.4.2.1 *Network Edge*

Firewall devices will be installed to segregate the OASyS control network from the corporate network, the SetLSX LDS network, the Decision Support network and the internet. Services between the networks will be made available only via DMZ hosted servers/services and secured by AD-based user/service authentication and firewall filter rules. The logical layer (defined as the software or services running in the DMZ) is outside the scope of this document. The VPN connections for remote support will come from the internet firewall.

The network core in the MCC and SCC will be responsible for the routing of the PCN network.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 22 of 62

3.5 Switch Port Allocation

3.5.1 Station Network Core Ports



Physical Port Number	Logical Port Number		Switch Port Type	VLAN ID	Designation
	Switch 1	Switch 2			
01 – 02	G1/0/01	G2/0/01	Trunk	210	Server dual-port NIC
	–	–			
	G1/0/02	G2/0/02			
03	G1/0/03	G2/0/03	Access	200	Backup Management
04 – 08	G1/0/04	G2/0/04	Access	210	Operator workstations
	–	–			
	G1/0/08	G2/0/08			
09	G1/0/09	G2/0/09			Printers
10 – 15	G1/0/10		Access	221	Flow Computers Primary
	–				
	G1/0/15				
		G2/0/10	Access	222	Flow-Computers Secondary
		–			
		G2/0/15			
16 – 20	G1/0/16	G2/0/16	Access	220	SCADA to eNOC
	–	–			
	G1/0/20	G2/0/20			
21	G1/0/21	G2/0/21	Access	200	Server IMM
22	G1/0/22	G2/0/22			SAN Management
23	G1/0/23	G2/0/23			Device Management/KVM
24	G1/0/24	G2/0/24			Engineering laptop
G1 – 4	G1/0/1	G2/1/1	Access	300	Uplink Ports
	–	–			
	G1/1/4	G2/1/4			

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 23 of 62

3.5.2 MCC Ports

Physical Port Number	Logical Port Number		Switch Port Type	VLAN ID	Designation
	Switch 1	Switch 2			
01 – 06	G1/0/01	G2/0/01	Trunk ¹	210	Server dual port NIC
	–	–			
	G1/0/06	G2/0/06			
07	G1/0/07	G2/0/07	Access	200	NAS Storage Devices (Backup)
08	G1/0/08	G2/0/08	Access	210	Domain Controller
09 – 14	G1/0/09	G2/0/09	Access	210	Operator workstations
	–	–			
	G1/0/14	G2/0/14			
15	G1/0/15	G2/0/15			Printers
16 – 18	G1/0/16	G2/0/16	Access	200	Server IMM
	–	–			
	G1/0/18	G2/0/18			
19 – 20	G1/0/19	G2/0/19			SAN Management
	–	–			
	G1/0/20	G2/0/20			
21	G1/0/21	G2/0/21			GPS Clock
22 – 23	G1/0/22	G2/0/22			Manage Engine
	–	–			
	G1/0/23	G2/0/23			
24	G1/0/24	G2/0/24			Maintenance Laptop
G1	G1/1/1	G2/1/1	Access	300	WAN Uplink Ports
G2	G1/1/2	G2/1/2	Access	1	Spare
G3 – G4	G1/1/3	G2/1/3	Access (LACP)	310	DMZ Uplink
	–	–			
	G1/1/4	G2/1/4			

- 1- The Operating System management is on VLAN 200 and is set in Hyper-V – Virtual Switch Manager. All VMs running on this server will automatically communicate on VLAN 210 as defined by the “trunk native vlan 210” setting in the network switch.

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 24 of 62

3.5.3 DMZ Network Ports


Physical Port Number/ Name	Logical Port Number/ Name	Port Type	Designation
DMZ	Not used	Physical Interface	Factory defined DMZ
MGMT	Not used	Physical Interface	Factory defined Management
WAN1	Not used	Physical Interface	Factory defined WAN 1
WAN2	Not used	Physical Interface	Factory defined WAN 2
HA1	HA1	Physical Interface	Factory defined HA connection 1
HA1	HA2	Physical Interface	Factory defined HA connection 2
1 – 4	DSS	Hardware Switch	DMZ switch ports
5 – 6	PRD	802.3ad Aggregate	Production uplink
7 – 8	SetLSX	Hardware Switch	SetLSX/Atmos interface
9 – 10	CORP	Hardware Switch	Corporate network interface
11 – 12	INT	Hardware Switch	Internet interface
13 – 14	PCS7	Hardware Switch	PCS7/Siemens system interface
15 – 20	Not Used	Physical Interface	Spare ports

Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 25 of 62

3.6 Routing Protocols and Routing Tables

The MCC and SCC will use dynamic routing protocols to automatically update its routing table and handle automatic network path failover. As the SCC is unmanned and the designated DRS, only the network switches will be active and will, therefore, be configured as the backup routers for the network (details to be confirmed). Routing will happen between MCC and stations, and not directly between stations themselves as the switches in the stations will only route local traffic. The manual creation, update or removal of routing table entries will not be required after the initial routing protocol setup.


Criteria	OSPF*	IS-IS	EIGRP	BGP
Scalability	2 tier, less scalable	2 tier, less scalable	Multiple tiers, scalable	Most scalable
Mesh topology	Well with mesh group	Well with mesh group	Poor, no mesh group	Works poorly, but RR removes req.
Ring topology	Ok	Ok	Not good	Good with RR
Hub and Spoke topology	Poor, require tuning	Bad, require tuning	Very well, minimum tuning	Very well with RR
Suitable for WAN	Yes	Yes	Yes	Yes, but in very large or where policy required
Suitable for Datacenter	Datacenter is a full mesh, no	Datacenter is a full mesh, no	Datacenter is a full mesh, no	Yes in large scale Datacenter
Security	Less secure	More secure	Less secure	Secure as it runs on TCP
Enterprise IGP	Yes	No, no IPSec	Yes	Not exactly, very large enterprise only
Service Provider IGP	Yes	Definitely	No, no support for traffic-eng.	Maybe in Datacenter, not as IGP
Complexity	Easy	Easy	Easy	Complex
Resources	Requires more CPU	Requires more CPU	Dual does not need much power	A lot of RAM and decent CPU
Extendibility	Not good	Good	Good	Very good
Training cost	Cheap	Cheap	Cheap	Moderate
Troubleshooting	Easy	Very easy	Easy	Moderate
Routing loops	Good	Good	Open to a race condition	Good

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 26 of 62

- EIGRP is limited to Cisco only, makes it less prone to be used in hybrid networks, thus staff experience may be limited
- IS-IS has no IPSec and has very limited Hub and Spoke support. Only Cisco and Juniper currently supports this IGP
- OSPF one of the oldest protocols and support by many devices. Easy to configure and troubleshoot
- BGP is the most widely used protocol in use by Internet Providers but may prove to be a challenge for most new network engineers

*OSPF will be used as IGP in ***point-to-multipoint broadcast*** mode. In this mode OSPF auto-configures itself thus to replace a defective device is much easier. Priority assignments will be configured to ensure that no multiple DRs is running on the network. We will also use a single IP subnet for this purpose and OSPF easily translates into MPLS.

**To-do: remove this sample config and add appendix showing full switch configuration with small breakdown.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 27 of 62

3.7 Device Addressing Schemes

For ease of identification, the current and familiar IP address structure (as per the PL703) will be altered to conform to the following IETF RFC documents and the current TVDA document:

- RFC917 – Internet Subnets
- RFC950 – Internet Standard Subnetting Procedure
- RFC1878 – Variable Length Subnet Table for IPv4

Using principles in the above documents the network uses a Class-A network as a starting point, which is then divided (subnetted) further to contain the FBS number of the location where the subnetwork will reside. A value of 100 will be added to the FBS number to ensure the new network range is easily identifiable and to eliminate duplicated IP ranges. The third part (or octet) of the address is further subnetted to allow all devices to have the same host IP regardless of physical location; refer to the table below. Following sections include the default IP addresses used by the OASyS configuration program. Several servers will be installed in various locations and not using this scheme will introduce duplicate IP addresses. The new PCS network is separated from other networks using firewalls.


The address structure is defined as 10.site.network.host/CIDR

i.e. 10.101.0.1/20

X (site) – will be the FBS number as specified in section 3.7.1.6 later on in this document, with the value of 100 added to it

Y (network) – will be split into the following separate functions:

Y#	Designation	CIDR	Address Space
000	Management and general devices	24	254
001 – 009	PLCs	24	254
010	SCADA	24	254
011	eNOC Cards	24	254
012	Flow Computers	24	254
013			254
016	PtP Uplinks	24	254
014 – 015 017 – 254	Spare	N/A	N/A

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 28 of 62

3.7.1 Device IP Assignments

3.7.1.1 PLC Address Assignment

The table below describes the IP assignments of a large system such as the CBK or JMP station(s).

	Address	Device Type	IP	CIDR	Gateway
	Reserved / Wasted	N/A	10.1xx.11.001 – 10.1xx.11.010	N/A	N/A
eNOC on PLC 1	Primary Main IP Address	eNOC0321	10.1xx.11.011	24	10.1xx.11.254
	Standby IP Address	eNOC0321	10.1xx.11.012		
	Spare	N/A	10.1xx.11.013 – 10.1xx.11.020		
eNOC on PLC 2	Primary Main IP Address	eNOC0321	10.1xx.11.021		
	Standby IP Address	eNOC0321	10.1xx.11.022		
	Spare	N/A	10.1xx.11.023 – 10.1xx.11.030		
eNOC on PLC 3	Primary Main IP Address	eNOC0321	10.1xx.11.031		
	Standby IP Address	eNOC0321	10.1xx.11.032		
	Spare	N/A	10.1xx.11.033 – 10.1xx.11.040		
eNOC on PLC 4	Primary Main IP Address	eNOC0321	10.1xx.11.041		
	Standby IP Address	eNOC0321	10.1xx.11.042		
	Spare	N/A	10.1xx.11.043 – 10.1xx.11.050		

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 29 of 62

	Address	Device Type	IP	CTDR	Gateway
eNOC on PLC 5	Primary Main IP Address	eNOC0321	10.1xx.11.051	24	10.1xx.11.254
	Standby IP Address	eNOC0321	10.1xx.11.052		
	Spare	N/A	10.1xx.11.053 – 10.1xx.11.060		
eNOC on PLC 6	Primary Main IP Address	eNOC0321	10.1xx.11.061		
	Standby IP Address	eNOC0321	10.1xx.11.062		
	Spare	N/A	10.1xx.11.063 – 10.1xx.11.070		
PLC System 1	Primary IP Address	M580	10.1xx.1.001	24	10.1xx.1.254
	Standby IP Address	M580	10.1xx.1.002		
	CPU-A	M580	10.1xx.1.003		
	CPU-B	M580	10.1xx.1.004		
	BMECRA_XXX	M580	10.1xx.1.010 – 10.1xx.1.050		
	Spare / Wasted	N/A	10.1xx.1.051 – 10.1xx.1.253		
	Fieldbus Network	eNOC0321	10.1xx.1.254	24	N/A
PLC System 2	Primary IP Address	M580	10.1xx.2.001	24	10.1xx.2.254
	Standby IP Address	M580	10.1xx.2.002		
	CPU-A	M580	10.1xx.2.003		
	CPU-B	M580	10.1xx.2.004		
	BMECRA_XXX	M580	10.1xx.2.010 – 10.1xx.2.050		
	Spare / Wasted	N/A	10.1xx.2.051 – 10.1xx.2.253		
	Fieldbus Network	eNOC0321	10.1xx.2.254	24	N/A

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 30 of 62

	Address	Device Type	IP	CIDR	Gateway
PLC System 3	Primary IP Address	M580	10.1xx.3.001	24	10.1xx.3.254
	Standby IP Address	M580	10.1xx.3.002		
	CPU-A	M580	10.1xx.3.003		
	CPU-B	M580	10.1xx.3.004		
	BMECRA_XXX	M580	10.1xx.3.010 – 10.1xx.3.050		
	Spare / Wasted	N/A	10.1xx.3.051 – 10.1xx.3.253		
	Fieldbus Network	eNOC0321	10.1xx.3.254	24	N/A
PLC System 4	Primary IP Address	M580	10.1xx.4.001	24	10.1xx.4.254
	Standby IP Address	M580	10.1xx.4.002		
	CPU-A	M580	10.1xx.4.003		
	CPU-B	M580	10.1xx.4.004		
	BMECRA_XXX	M580	10.1xx.4.010 – 10.1xx.4.050		
	Spare / Wasted	N/A	10.1xx.4.051 – 10.1xx.4.253		
	Fieldbus Network	eNOC0321	10.1xx.4.254	24	N/A
PLC System 5	Primary IP Address	M580	10.1xx.5.001	24	10.1xx.5.254
	Standby IP Address	M580	10.1xx.5.002		
	CPU-A	M580	10.1xx.5.003		
	CPU-B	M580	10.1xx.5.004		
	BMECRA_XXX	M580	10.1xx.5.010 – 10.1xx.5.050		
	Spare / Wasted	N/A	10.1xx.5.051 – 10.1xx.5.253		
	Fieldbus Network	eNOC0321	10.1xx.5.254	24	N/A


TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 31 of 62

	Address	Device Type	IP	CTDR	Gateway
PLC System 6	Primary IP Address	M580	10.1xx.6.001	24	10.1xx.6.254
	Standby IP Address	M580	10.1xx.6.002		
	CPU-A	M580	10.1xx.6.003		
	CPU-B	M580	10.1xx.6.004		
	BMECRA_XXX	M580	10.1xx.6.010 – 10.1xx.6.050		
	Spare / Wasted	N/A	10.1xx.6.051 – 10.1xx.6.253		
	Fieldbus Network	eNOC0321	10.1xx.6.254	24	N/A

In order for any external device to talk to the PLC additional routes has to be added to the network switches that essentially works the same as the default route. However, you do not have to have these routes for the SCADA to access the PLC variables using the Modbus Protocol.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 32 of 62

3.7.1.2 Station Address Assignment

	Designation	Device Type	IP	CTDR	Default Gateway
Physical Devices	Core Switches ¹	Cisco Switch	10.1xx.00.001 – 10.1xx.00.004	27	N/A
	Storage Devices	Backup Management	10.1xx.00.007	27	10.1xx.00.001
	Server 1 IMM	Physical Server	10.1xx.00.011	27	
	Server 2 IMM	Physical Server	10.1xx.00.012	27	
	SAN Management P1 P2	Storage Array	10.1xx.00.015	27	
			10.1xx.00.016	27	
	Host Virtual Server 1	Windows Server	10.1xx.00.020	27	
	Host Virtual Server 2	Windows Server	10.1xx.00.021	27	
	KVM Switch	KVM	10.1xx.00.023	27	
	Flow Computers	S600 SCADA	10.1xx.12.001 – 10.1xx.12.200	24	10.1xx.12.254
		S600 Printing	10.1xx.13.001 – 10.1xx.13.200	24	10.1xx.13.254
	Printers	Printers	10.1xx.10.020 – 10.1xx.10.024	24	10.1xx.10.254
	Operator Workstations	Workstation Computer	10.1xx.10.025 – 10.1xx.10.030	24	

1. 1 x IP address per stack

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 33 of 62

Virtual Servers	Domain Controller 1	VM	10.1xx.10.031	24	10.1xx.10.254
	Domain Controller 2	VM	10.1xx.10.032	24	
	Support Server	VM	10.1xx.10.033	24	
	Database Server 1	VM	10.1xx.10.035	24	
	Database Server 2	VM	10.1xx.10.036	24	
	SCADA Server 1	VM	10.1xx.10.041	24	
	SCADA Server 2	VM	10.1xx.10.042	24	
	OASyS Services	Application Service	10.1xx.10.043 – 10.1xx.10.050	24	
	PLC Engineering Station	VM	10.1xx.10.100	24	

3.7.1.3 Master Control Centre Address Assignment


	Designation	Device Type	IP	CIDR	Default Gateway
Physical Devices	Network Switches	Cisco Switch	10.199.00.001 – 10.199.00.004	27	N/A
	Storage Devices	NAS Storage Devices (Backup)	10.199.00.007	27	10.199.00.001
	GPS Network Time Server	GPS	10.199.00.010	27	
	Server 1 IMM	Physical Server	10.199.00.011	27	
	Server 2 IMM	Physical Server	10.199.00.012	27	
	Server 3 IMM	Physical Server	10.199.00.013	27	
	DCS Server IMM	Physical Server	10.199.00.014	27	
	SAN Management P1 P2	Storage Array	10.199.00.015 10.199.00.016	27 27	
	Host Virtual Server 1	Windows Server	10.199.00.020	27	

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 34 of 62


	Designation	Device Type	IP	CIDR	Default Gateway
Virtual Servers	Host Virtual Server 2	Windows Server	10.199.00.021	27	
	Host Virtual Server 3	Windows Server	10.199.00.022	27	
	Printers	Network Printer	10.199.10.020 – 10.199.10.024	24	
	Operator Workstations	Workstation Computer	10.199.10.025 – 10.199.10.030	24	
	Domain Controller 1	Physical Server	10.199.10.031	24	
	Domain Controller 2	VM	10.199.10.032	24	10.199.10.254
	Primary Support Server	VM	10.199.10.033	24	
	Database Server 1	VM	10.199.10.035	24	
	Database Server 2	VM	10.199.10.036	24	
	SCADA Server 1	VM	10.199.10.041	24	
	SCADA Server 2	VM	10.199.10.042	24	
	OASyS Services	Application Service	10.199.10.043 – 10.199.10.050	24	
	Deployment Server	VM	10.199.10.037	24	
	Remote Access Server	VM	10.199.10.038	24	
	Leak Detection Server 1	VM	10.199.10.071	24	
	Leak Detection Server 2	VM	10.199.10.072	24	
	Secondary Support Server 1	VM	10.199.10.110	24	
	Secondary Support Server 2	VM	10.199.10.111	24	

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 35 of 62

3.7.1.4 DMZ

The DMZ is a subnetwork of the MCC. To keep addressing the same as previous sections, here we use the subnet and add 10 to the 3rd octet.

	Designation	Device Type	IP	CIDR	Default Gateway
Physical Devices	Core Switch(es)	Cisco Switch	10.199.02.001 – 10.199.02.004	27	N/A
	Server 1 IMM	Physical Server	10.199.02.011	27	10.199.02.30
	Host Virtual Server 1	Windows Server	10.199.02.020	27	
Virtual Servers	Primary Support Server	VM	10.199.12.033	24	10.199.12.254
	OASyS Services	Application Service	10.199.12.043 – 10.199.12.050	24	
	Domain Controller	VM	10.199.12.031	24	
	Decision Support Server	VM	10.199.12.041	24	
Point to Point Links ¹	Firewall – DMZ to PCN	PtP Link	10.199.02.128	31	N/A
	Firewall – DMZ to Internet	PtP Link	41.162.56.034	29	41.162.56.33
	Firewall – DMZ to Corporate	PtP Link	10.144.50.254	24	N/A
	Firewall – DMZ to SetLXS LDS	PtP Link	10.144.54.001	23	N/A
	Firewall – DMZ to PCS7 Terminal Bus Scalance	PtP Link	10.001.99.208	24	N/A
	DMZ VPN IP Range	Address Range	10.199.02.161 – 10.199.02.189	27	10.199.2.190
	Firewall to Firewall internal connections	HA Link	10.199.02.136 10.199.02.138	31 31	N/A

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 36 of 62

This section does not have a default route as dynamic routing protocols will be used to perform the routing and firewall rules will assist in traffic management

3.7.1.5 Inter-site link Address Assignments (MCC Routing)

FBS	Station Name	Abbreviation	IP Address
1	Fynnlads COP	FYN	10.199.16.001
2	Durban	DNR	10.199.16.002
4	Hillcrest DWP	HLR	10.199.16.004
8	Howick DWP	HWR	10.199.16.008
10	Ladysmith DWP	LAY	10.199.16.010
11	Van Reenen	VRN	10.199.16.011
12	Bethlehem (TOP)	BHT	10.199.16.012
13	Bethlehem	BEM	10.199.16.013
14	Kroonstad	KRO	10.199.16.014
15	Magdala	MGA	10.199.16.015
16	Sasolburg	SBG	10.199.16.016
17	Coalbrook COP	CBK	10.199.16.017
18	Alrode	ALR	10.199.16.018
19	Potchefstroom	PCM	10.199.16.019
20	Klerksdorp	KRP	10.199.16.020
21	Airport	APT	10.199.16.021
22	Waltloo	WAO	10.199.16.022
23	Pretoria West	PWT	10.199.16.023
24	Langlaagte	LLA	10.199.16.024
25	Tarlton	TLR	10.199.16.025
26	Rustenburg	RTR	10.199.16.026
27	Witbank	WIR	10.199.16.027
28	Newcastle DWP	NCS	10.199.16.028
29	Volkstrust	VRR	10.199.16.029
30	Standerton	SNR	10.199.16.030
31	Secunda	SEC	10.199.16.031
32	Empangeni	EMG	10.199.16.032
33	Mahlabatini	MAT	10.199.16.033
34	Scheepersnek	SCN	10.199.16.034


TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 37 of 62

FBS	Station Name	Abbreviation	IP Address
35	Quaggasnek COP	QGA	10.199.16.035
36	Kendal	KEN	10.199.16.036
37	Meyerton	MTN	10.199.16.037
38	Mngeni COP	MGN	10.199.16.038
39	Duzi COP	DUZ	10.199.16.039
40	Mooi River COP	MRR	10.199.16.040
41	Fort Mistake COP	FTM	10.199.16.041
42	Wilge COP	WIL	10.199.16.042
43	Refractionator	IRP	10.199.16.043
44	Jameson Park	JMP	10.199.16.044
50	Island View (TM1)	IVW	10.199.16.050
51	Twini (PS1)	TNI	10.199.16.051
52	Umbumbulu (PS2)	UBB	10.199.16.052
53	Hilltop (PS3)	HTP	10.199.16.053
54	Lions River (PS4)	LRV	10.199.16.054
55	Mnambithi (PS5)	MBT	10.199.16.055
56	Van Reenen (PS6)	VNN	10.199.16.056
57	Warden (PS7)	WDN	10.199.16.057
58	Villiers (PS8)	VLR	10.199.16.058
59	Jameson Park (TM2)	JMP	10.199.16.059
95	School of Pipelines	TRN	10.199.16.095
96	JHB Railway Station	NSB	10.199.16.096
97	Durban Railway Station	DRS	10.199.16.097
98	Secondary Control Centre	SCC	10.199.16.098
99	Master Control Centre	MCC	10.199.16.099



TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 38 of 62

3.7.1.6 *Site Subnet Assignments*

The assignment of IP addresses is static and automatic IP address assignment mechanisms such as DHCP will not be used in the production environment.

Below is the list of subnet assignments for each network location. These IP Address allocations may be revised at a later stage of the project. However, the subnet ranges will need to be maintained to accommodate the M580 PLC reserved allocation space.


FBS	Station Name	Abbreviation	Subnet
1	Fynnlunds COP	FYN	10.101.00.00/19
2	Durban	DNR	10.102.00.00/19
4	Hillcrest DWP	HLR	10.104.00.00/19
8	Howick DWP	HWR	10.108.00.00/19
10	Ladysmith DWP	LAY	10.110.00.00/19
11	Van Reenen	VRN	10.111.00.00/19
12	Bethlehem (TOP)	BHT	10.112.00.00/19
13	Bethlehem	BEM	10.113.00.00/19
14	Kroonstad	KRO	10.114.00.00/19
15	Magdala	MGA	10.115.00.00/19
16	Sasolburg	SBG	10.116.00.00/19
17	Coalbrook COP	CBK	10.117.00.00/19
18	Alrode	ALR	10.118.00.00/19
19	Potchefstroom	PCM	10.119.00.00/19
20	Klerksdorp	KRP	10.120.00.00/19
21	Airport	APT	10.121.00.00/19
22	Waltloo	WAO	10.122.00.00/19
23	Pretoria West	PWT	10.123.00.00/19
24	Langlaagte	LLA	10.124.00.00/19
25	Tarlton	TLR	10.125.00.00/19
26	Rustenburg	RTR	10.126.00.00/19
27	Witbank	WIR	10.127.00.00/19
28	Newcastle DWP	NCS	10.128.00.00/19
29	Volksrust	VRR	10.129.00.00/19
30	Standerton	SNR	10.130.00.00/19
31	Secunda	SEC	10.131.00.00/19
32	Empangeni	EMG	10.132.00.00/19
33	Mahlabatini	MAT	10.133.00.00/19

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 39 of 62

FBS	Station Name	Abbreviation	Subnet
34	Scheepersnek	SCN	10.134.00.00/19
35	Quaggasnek COP	QGA	10.135.00.00/19
36	Kendal	KEN	10.136.00.00/19
37	Meyerton	MTN	10.137.00.00/19
38	Mngeni COP	MGN	10.138.00.00/19
39	Duzi COP	DUZ	10.139.00.00/19
40	Mooi River COP	MRR	10.140.00.00/19
41	Fort Mistake COP	FTM	10.141.00.00/19
42	Wilge COP	WIL	10.142.00.00/19
43	Refractionator	IRP	10.143.00.00/19
44	Jameson Park	JMP	10.144.00.00/19
50	Island View (TM1)	IVW	10.150.00.00/19
51	Twini (PS1)	TNI	10.151.00.00/19
52	Umbumbulu (PS2)	UBB	10.152.00.00/19
53	Hilltop (PS3)	HTP	10.153.00.00/19
54	Lions River (PS4)	LRV	10.154.00.00/19
55	Mnambithi (PS5)	MBT	10.155.00.00/19
56	Van Reenen (PS6)	VNN	10.156.00.00/19
57	Warden (PS7)	WDN	10.157.00.00/19
58	Villiers (PS8)	VLR	10.158.00.00/19
59	Jameson Park (TM2)	JMP	10.159.00.00/19
95	School of Pipelines	TRN	10.195.00.00/19
96	JHB Railway Station	NSB	10.196.00.00/19
97	Durban Railway Station	DRS	10.197.00.00/19
98	Secondary Control Centre	SCC	10.198.00.00/19
99	Master Control Centre	MCC	10.199.00.00/24 10.199.10.00/24
	Decision support & DMZ	DSS/DMZ	10.199.02.00/24 10.199.12.00/24
	Inter-site Uplink		10.199.16.00/24

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 40 of 62

3.7.1.7 *MCC PCS7 UPS interface*

The load-balanced UPS system, consisting of UPS 3 & 4, currently installed at the MCC/NOC; has an IP address of 10.1.99.205/24. The OASyS DNA system will have network agents installed to communicate with these UPSes in order to perform a controlled system shutdown.


3.8 Centralised Network Management

A central, maintenance and network management system will be installed in the MCC. This will keep a backup of all switch configurations and provide means to do the configuration of network equipment.

Detailed design and specific product modules to be finalised in Phase 3 of this project.

3.9 Network Monitoring and Alarming

Details are not in the scope of this document and are therefore contained in the network diagnostic FDS, document number: [18].

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 41 of 62

4 CYBER SECURITY


4.1 NETWORK SECURITY

LAN security must be taken into consideration during the design of the network. Network security is described in document name: OASyS PCS Network Security Specification, document number: E354086-00000-271-078-0024.

4.2 DEMILITARISED ZONE

Traffic will be allowed to flow according to the following matrix:

	PRD	DSS	CORP	INT	SetLSX	PCS7
PRD	-	Y	N	N	N	N
DSS	Y	-	Y	Y	Y	Y
CORP	N	Y	-	N	N	N
INT	N	Y	N	-	N	N
SetLSX	Y	N	N	N	-	N
PCS7	Y	Y	N	N	N	-

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 42 of 62

5 PHYSICAL MEDIA SPECIFICATION

TPL pipelines traverse several metropolitan and municipal areas. Permanent and dedicated network infrastructure, spanning the various pipelines and metropolises operated by TPL, has been established and acts as backhaul for all communication requirements between the sites and the MCC.

5.1 Cable Specifications

5.1.1 Copper Cables

All copper network cables provided will be CAT6A – 4pr – STP (Overall shielded, twisted pair).

5.1.2 Fibre Optic Cables

Single-mode fibre shall be used and shall be either steel wire armoured (SWA) or corrugated sheath tape (CST).

Patch leads shall be ruggedized unless routed within a single tier of a panel.

OTDR testing shall be performed on all cores for all fibre cable links with dB losses not exceeding a loss of 0.05 dB.

5.1.3 Cable Identification

Grafoplast Trasp Series 100 will be used.

5.1.4 Communications Cable Routing

Legrand mild steel trunking (110x63mm, powder coat colour: grey) will be installed underneath the false flooring running between the various panels and equipment. This trunking shall be used for reticulation of communication cabling and fibre cables. All cables routed from this trunking to the various panels shall be protected for the full length using 50 mm OD and 100mm OD St Sprague tubing.


Minimum bend radius will be complied with as stipulated in the cable specification section in this document.

5.2 Colour Specifications

5.2.1 Colour Differentiation per Function

Industrial Ethernet cable is manufactured by specialised companies and the outer sheath colour often is an indication of cable type. Identification of cable function will be provided by a clear indication on the RJ-45 connector in accordance with the table below and the manufacturer specification of said connection method.

The cable will be of a single colour on all sites. The method of identification/colouring will be finalised in Phase 3.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 43 of 62

The table below defines the network function associated with each colour:

Function	Colour Coding Device
PLC-A eNOC & SCADA system LAN subnet to switch 1	Blue
PLC-B eNOC & SCADA-system LAN subnet to switch 2	Blue
Operator Workstation Computers and server systems	Yellow
Flow Computers (S600)	Black
PLC remote IO ring	Green
PLC hot- / standby link	Red
PLC to an external device not defined	Orange
Switch to Host Virtual Server links	White
Switch to WAN interface device uplinks (in cases of RJ45)	Magenta

5.2.2 Ethernet Connector Core Colour Sequence

The T-568A wiring standard will be used for all network cable terminations and no cable cores will be crossed over with each other. Every connector will be identical to another.

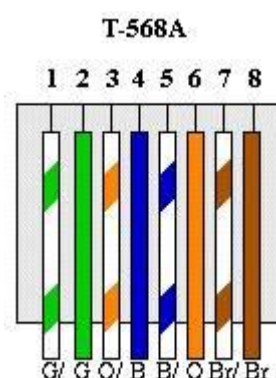



Figure 5-2-2: Connector Colour Coding

Note: The illustration above assumes the cable is held upright (connector in hand and cable hanging to the ground) with the bare copper connections facing forwards, and the quick-release clip is on the opposite (back) side


TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 44 of 62

The Harting connectors, the RJ45 plug Cat6, 8p IDC straight Connectors, IDC termination Part number: 09 45 151 1560, follows this exactly as illustrated by their installation image:



Figure 5-2-3: Connector Colour Coding on Sticker

Note: The illustration above may be confusing as there is a small PCB inside the connector ensuring the correct physical connection.

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 45 of 62

6 APPENDIX 1

This is the config file for MCC:

```

service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
service password-encryption

hostname MCCPRDNSW01

enable secret 9
$9$fIWIENffZ7uo6K$2nvLnkDodbyPlt013/3VAqX9hCmPnPjANTiP84.LS8M
enable password 7 1427134F48137A3920

ip routing
ip arp entry learn 255
ip gratuitous-arps

ip name-server 10.199.10.31 10.199.10.32
ip domain name pcsprd.tpl.com

no ip igmp snooping
login on-success log

spanning-tree mode rapid-pvst
spanning-tree extend system-id

username admin privilege 15 password 7 073F72585C59175603425A4D

redundancy
mode sso
main-cpu
standby console enable


interface Port-channel2
description Hyper-v Server 1 - PC
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate

interface Port-channel3
description Hyper-v Server 2 - PC
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate

interface Port-channel9
description "MCCPRDDCS01A LACP"
switchport access vlan 210
switchport mode access

interface Port-channel10
description "PRD <> DSS Failover channel 1"
switchport access vlan 310
switchport mode access
spanning-tree portfast

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 46 of 62

```

interface Port-channel11
description "PRD <> DSS Failover channel 2"
switchport access vlan 310
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet0/0
vrf forwarding Mgmt-vrf
no ip address
shutdown
negotiation auto

```

```

interface GigabitEthernet1/0/1
description Hyper-v Server 1 - NIC1
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 2 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```

interface GigabitEthernet1/0/2
description Hyper-v Server 2 - NIC1
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 3 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```

interface GigabitEthernet1/0/3
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet1/0/4
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet1/0/5
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```


interface GigabitEthernet1/0/6
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet1/0/7
switchport access vlan 200

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 47 of 62

```

switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet1/0/8
switchport access vlan 210
switchport mode access
channel-group 9 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```

interface GigabitEthernet1/0/9
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/10
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/11
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/12
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/13
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/14
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/15
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/16
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```


interface GigabitEthernet1/0/17
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/18

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 48 of 62

```

switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/19
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/20
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/21
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/22
switchport access vlan 200
switchport mode access

```

```

interface GigabitEthernet1/0/23

```

```

interface GigabitEthernet1/0/24

```

```

interface GigabitEthernet1/1/1
switchport access vlan 300
switchport trunk allowed vlan 300
switchport mode access
spanning-tree bpduguard enable

```

```

interface GigabitEthernet1/1/2
switchport access vlan 300
switchport mode access

```

```

interface GigabitEthernet1/1/3
switchport access vlan 310
switchport mode access
channel-protocol lacp
channel-group 10 mode active

```

```


interface GigabitEthernet1/1/4
switchport access vlan 310
switchport mode access
channel-protocol lacp
channel-group 11 mode active

```

```

interface GigabitEthernet2/0/1
description Hyper-v Server 1 - NIC2
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 2 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```


TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 49 of 62

```

interface GigabitEthernet2/0/2
description Hyper-v Server 2 - NIC2
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 3 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```

interface GigabitEthernet2/0/3
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet2/0/4
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet2/0/5
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet2/0/6
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet2/0/7
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
spanning-tree portfast

```

```

interface GigabitEthernet2/0/8
switchport access vlan 210
switchport mode access
channel-group 9 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```


interface GigabitEthernet2/0/9
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet2/0/10
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 50 of 62

```

interface GigabitEthernet2/0/11
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/12
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/13
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/14
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/15
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/16
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/17
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/18
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast


interface GigabitEthernet2/0/19
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/20
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast

interface GigabitEthernet2/0/21
  switchport access vlan 200
  switchport mode access

interface GigabitEthernet2/0/22
  switchport access vlan 200
  switchport mode access

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 51 of 62

```

interface GigabitEthernet2/0/23

interface GigabitEthernet2/0/24
 switchport access vlan 310
 switchport mode access
 channel-protocol lacp
 channel-group 10 mode active

interface GigabitEthernet2/1/1
 switchport access vlan 300
 switchport trunk allowed vlan 300
 switchport mode access
 spanning-tree bpdupfilter enable

interface GigabitEthernet2/1/2
 switchport access vlan 300
 switchport mode access

interface GigabitEthernet2/1/3
 switchport access vlan 310
 switchport mode access
 channel-protocol lacp
 channel-group 10 mode active

interface GigabitEthernet2/1/4
 switchport access vlan 310
 switchport mode access
 channel-protocol lacp
 channel-group 11 mode active

interface Vlan1
 description DEFAULT VLAN
 no ip address
 shutdown

interface Vlan200
 description MANAGEMENT VLAN
 ip address 10.199.0.1 255.255.255.224

interface Vlan210
 description SCADA VLAN
 ip address 10.199.10.254 255.255.255.0

interface Vlan300
 description UPLINK
 ip address 10.199.16.99 255.255.255.0
 ip ospf message-digest-key 1 md5 7
03090C23541D0848173A33211219051F11
 ip ospf dead-interval 40
 ip ospf priority 254

interface Vlan310
 description DMZDSS
 ip address 10.199.2.129 255.255.255.248

router ospf 1

```

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 52 of 62

```
router-id 10.199.16.99
nsf cisco
area 0 authentication message-digest
summary-address 10.199.0.0 255.255.224.0
passive-interface default
no passive-interface Vlan300
network 10.199.2.128 0.0.0.1 area 0
network 10.199.16.254 0.0.0.0 area 0
network 10.199.0.0 0.0.31.255 area 0
default-information originate metric 10 metric-type 1

ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip route 10.1.99.0 255.255.255.0 10.199.2.130 permanent
ip route 10.144.50.0 255.255.254.0 10.199.2.130 permanent
ip route 10.144.54.0 255.255.254.0 10.199.2.130 permanent
ip route 10.199.2.0 255.255.255.224 10.199.2.130 permanent
ip route 10.199.12.0 255.255.255.0 10.199.2.130 permanent
ip ssh authentication-retries 4
ip ssh version 2
ip ssh pubkey-chain
  username EOH-ADM
    key-hash ssh-rsa 4D310253C9F1A7ABBC78D6758539BC8D
  username RaynoPADM
    key-hash ssh-rsa E115FCE4A62799825BFF1B47F5E9DCCC


ip prefix-list OSPF_Redist seq 10 permit 10.101.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 20 permit 10.104.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 30 permit 10.108.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 40 permit 10.110.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 50 permit 10.117.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 60 permit 10.128.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 70 permit 10.135.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 80 permit 10.138.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 90 permit 10.139.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 100 permit 10.140.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 110 permit 10.141.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 120 permit 10.142.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 200 permit 10.198.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 210 permit 10.199.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 500 deny 0.0.0.0/0 le 32

snmp-server community public RO

banner motd ^C
WELCOME to MCC

This is a secured site and access to sensitive systems are
prohibited. Your actions are monitored and will be used against
you. If you wonder if you are allowed in here, you probably am
not - LEAVE!

Any changes made to this system without prior knowledge of the
authorised personel may result in undesired system operation
and/or breakdowns.
```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 53 of 62


```

^C

line con 0
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  exec-timeout 120 0
  password 7 1427411F1E54247830786274
  login local
  transport input ssh
line vty 5 15
  exec-timeout 0 0
  password 7 08111F5A1B490B44065B5D45
  login

ntp server 10.199.0.10

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 54 of 62

7 APPENDIX 2

This is the config file for a typical station:

```

service timestamps debug datetime msec localtime
service timestamps log datetime msec localtime
service password-encryption

hostname CBKPRDNSW01

enable secret 9
$9$fIWIENffZ7uo6K$2nvLnkDodbyPlt013/3VAqX9hCmPnPjANTiP84.LS8M
enable password 7 133516564F1B54382F

ip routing
ip arp entry learn 255
ip gratuitous-arps

ip name-server 10.199.10.31 10.117.10.31
ip domain name pcsprd.tpl.com

no ip igmp snooping
login on-success log

spanning-tree mode rapid-pvst
spanning-tree extend system-id

username admin privilege 15 password 7 11394A110542055F107A7A65

redundancy
mode sso
main-cpu
standby console enable


interface Port-channel2
description Hyper-v Server 1 - PC
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate

interface Port-channel3
description Hyper-v Server 2 - PC
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate

interface GigabitEthernet0/0
vrf forwarding Mgmt-vrf
no ip address
shutdown
negotiation auto

interface GigabitEthernet1/0/1
description Hyper-v Server 1 - NIC1

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 55 of 62

```

switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 2 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```

interface GigabitEthernet1/0/2
description Hyper-v Server 2 - NIC1
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 3 mode active
spanning-tree portfast
spanning-tree bpduguard enable

```

```

interface GigabitEthernet1/0/3
switchport access vlan 200
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/4
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/5
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/6
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/7
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/8
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```


interface GigabitEthernet1/0/9
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

```

interface GigabitEthernet1/0/10
switchport access vlan 221
switchport mode access
spanning-tree portfast

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 56 of 62

```
interface GigabitEthernet1/0/11
  switchport access vlan 221
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/12
  switchport access vlan 221
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/13
  switchport access vlan 221
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/14
  switchport access vlan 221
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/15
  switchport access vlan 221
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/16
  switchport access vlan 220
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/17
  switchport access vlan 220
  switchport mode access
  spanning-tree portfast
```


```
interface GigabitEthernet1/0/18
  switchport access vlan 220
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/19
  switchport access vlan 220
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/20
  switchport access vlan 220
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/21
  switchport access vlan 200
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet1/0/22
```


TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 57 of 62

```

switchport access vlan 200
switchport mode access
spanning-tree portfast

interface GigabitEthernet1/0/23
switchport access vlan 200
switchport mode access
spanning-tree portfast

interface GigabitEthernet1/0/24
switchport access vlan 200
switchport mode access
spanning-tree portfast

interface GigabitEthernet1/1/1
switchport access vlan 300
switchport mode access
spanning-tree bpduguard enable

interface GigabitEthernet1/1/2
shutdown

interface GigabitEthernet1/1/3
shutdown

interface GigabitEthernet1/1/4
shutdown


interface GigabitEthernet2/0/1
description Hyper-v Server 1 - NIC2
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 2 mode active
spanning-tree portfast
spanning-tree bpduguard enable

interface GigabitEthernet2/0/2
description Hyper-v Server 2 - NIC2
switchport access vlan 200
switchport trunk native vlan 210
switchport mode trunk
switchport nonegotiate
channel-group 3 mode active
spanning-tree portfast
spanning-tree bpduguard enable

interface GigabitEthernet2/0/3
switchport access vlan 200
switchport mode access
spanning-tree portfast

interface GigabitEthernet2/0/4
switchport access vlan 210
switchport mode access
spanning-tree portfast

```

TRANSNET PIPELINES			
Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 58 of 62

```
interface GigabitEthernet2/0/5
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/6
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/7
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/8
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/9
  switchport access vlan 210
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/10
  switchport access vlan 222
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/11
  switchport access vlan 222
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/12
  switchport access vlan 222
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/13
  switchport access vlan 222
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/14
  switchport access vlan 222
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/15
  switchport access vlan 222
  switchport mode access
  spanning-tree portfast
```

```
interface GigabitEthernet2/0/16
```

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 59 of 62

```
switchport access vlan 220
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/17
switchport access vlan 220
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/18
switchport access vlan 220
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/19
switchport access vlan 220
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/20
switchport access vlan 220
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/21
switchport access vlan 200
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/22
switchport access vlan 200
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/23
switchport access vlan 200
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/0/24
switchport access vlan 200
switchport mode access
spanning-tree portfast
```

```
interface GigabitEthernet2/1/1
switchport access vlan 300
switchport mode access
spanning-tree bpduguard enable
```

```
interface GigabitEthernet2/1/2
shutdown
```

```
interface GigabitEthernet2/1/3
shutdown
```

```
interface GigabitEthernet2/1/4
shutdown
```

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 60 of 62

```
interface Vlan1
  description DEFAULT VLAN
  no ip address
  shutdown

interface Vlan200
  description MANAGEMENT VLAN
  ip address 10.117.0.1 255.255.255.224

interface Vlan210
  description SCADA VLAN
  ip address 10.117.10.254 255.255.255.0

interface Vlan220
  description PLC VLAN
  ip address 10.117.11.254 255.255.255.0

interface Vlan221
  description FC primary
  ip address 10.117.12.254 255.255.255.0

interface Vlan222
  description FC secondary
  ip address 10.117.13.254 255.255.255.0

interface Vlan300
  description UPLINK
  ip address 10.199.16.17 255.255.255.0
  ip ospf message-digest-key 1 md5 7
  141A45235E16032F7D1B19112718090516
  ip ospf dead-interval 40
  ip ospf priority 0

router ospf 1
  router-id 10.199.16.17
  nsf cisco
  area 0 authentication message-digest
  summary-address 10.117.0.0 255.255.224.0
  passive-interface default
  no passive-interface Vlan300
  network 10.117.0.0 0.0.31.255 area 0
  network 10.199.16.17 0.0.0.0 area 0
  distribute-list prefix OSPF_Redist in

ip forward-protocol nd
ip http server
ip http authentication local
ip http secure-server
ip route 10.117.1.0 255.255.255.0 10.117.11.11 permanent
ip route 10.117.2.0 255.255.255.0 10.117.11.21 permanent
ip route 10.117.3.0 255.255.255.0 10.117.11.31 permanent
ip ssh version 2
ip ssh pubkey-chain
  username EOH-ADM
  key-hash ssh-rsa 4D310253C9F1A7ABBC78D6758539BC8D
  username RaynoPADM
```

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 61 of 62

key-hash ssh-rsa E115FCE4A62799825BFF1B47F5E9DCCC

```
ip prefix-list OSPF_Redist seq 10 permit 10.101.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 20 permit 10.104.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 30 permit 10.108.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 40 permit 10.110.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 50 permit 10.117.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 60 permit 10.128.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 70 permit 10.135.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 80 permit 10.138.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 90 permit 10.139.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 100 permit 10.140.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 110 permit 10.141.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 120 permit 10.142.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 200 permit 10.198.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 210 permit 10.199.0.0/18 ge 19
ip prefix-list OSPF_Redist seq 500 deny 0.0.0.0/0 le 32
```

snmp-server community public RO

```
banner motd ^C
WELCOME to CBK
```

This is a secured site and access to sensitive systems are prohibited. Your actions are monitored and will be used against you. If you wonder if you are allowed in here, you probably am not - LEAVE!

Any changes made to this system without prior knowledge of the authorised personel may result in undesired system operation and/or breakdowns.
^C

```
line con 0
  stopbits 1
line aux 0
  stopbits 1
line vty 0 4
  exec-timeout 120 0
  password 7 053B551B331C405A0D554653
  login local
  transport input ssh
line vty 5 15
  exec-timeout 0 0
  password 7 06365C355E1E074A1147434A
  login
  transport input all
```

ntp server 10.199.16.

TRANSNET PIPELINES



Document Name	Document Number	Revision Number	Page
OASyS PCS LAN Specification	PRJ: E354086-00000-271-078-0002 TPL: TPL-XXXX-X-X-XXXX-XXXX	01 XX	Page 62 of 62