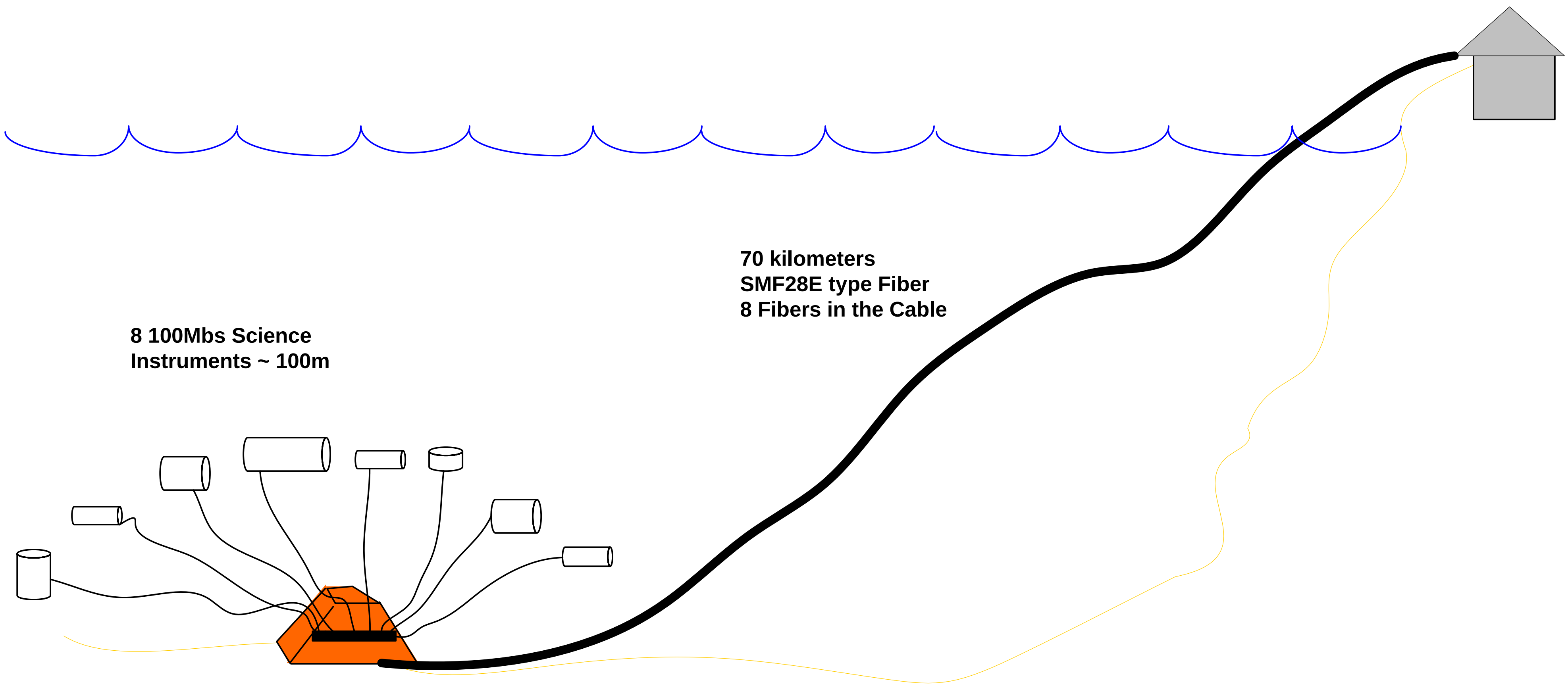
DCS Operations - Overview

This manual should provide sufficient material for an operator of the MARS subsea network system to maintain and control the system. When possible consult the included vendor manuals and data sheets for pertinent equipment.

The MARS DCS (Data Communications Subsystem) consists of a submarine node which provides 8x100Mbs Copper Ethernet ports to external science instruments, and an assembly of shore equipment which communicates the data from the node to the internet and MBARI Intranet. The science ports also provide 400VDC and 48VDC power and 1pps timing signals to the instrument. The communications connecting the sea to the shore is a DWDM optical system running 4 gigabit Ethernet channesl over 4 fibers. (4 additional fibers provide out of band control.)

The basic premise for the DCS operation is that electrical Ethernet data is sent from the science equipment to the subsea DCS node. Here it is converted to an optical signal. This signal is sent to the shore where it is reconverted to electrical Ethernet and send to science servers.



DCS and OBC FIBERS and Channels

Shown below is a summary of the fiber usage for the DCS and OBC (out-of-band-control) systems. Each Pair of DCS fibers carries 2 wavelengths of 1G data each for a total of 2 G per pair. The CISCO routers are capable of switching the traffic so that if a fiber pair or individual wavelength fails data can continue to flow.

DCS CHANNELS

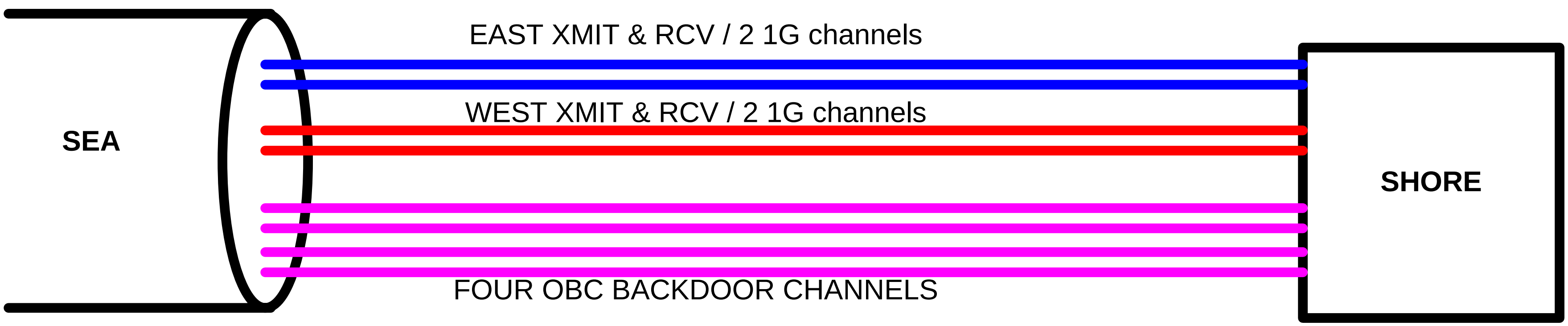
DWDM Optical Channels
2 Wavelenghts on Each Fiber Pair
Each Wavelength 1 Gigbit Ethernet

OBC Channels

Half Duplex
9600 Baud Asynch

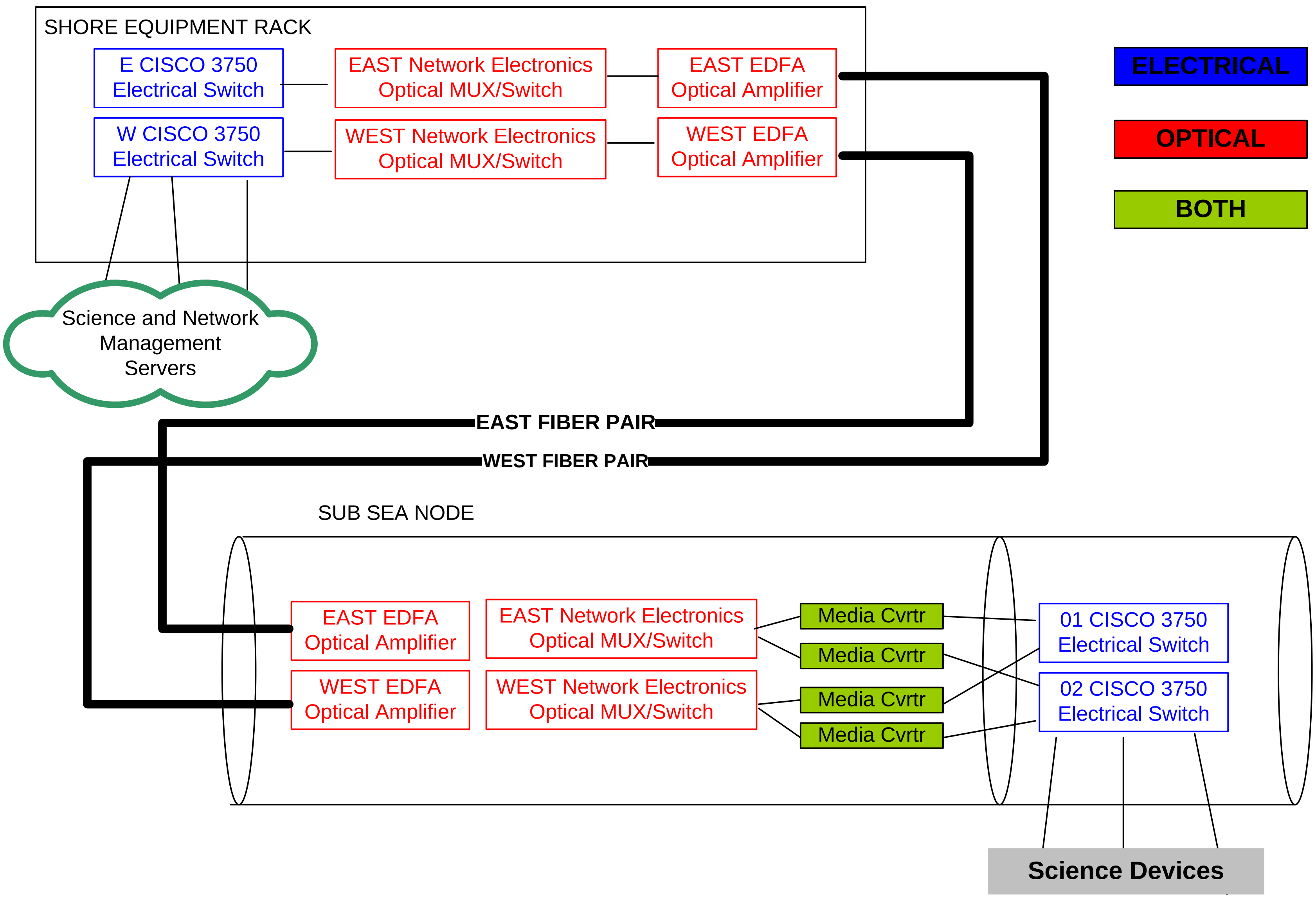
8 Fibers in the Cable

1 -DCS East Transmit
2 -DCS East Receive
3 -DCS West Transmit
4 -DCS West Receive
5 -OBC East A Channel
6 -OBC East B Channel
7 -OBC West A Channel
8 -OBC West B Channel



ARCHITECTURE - DCS

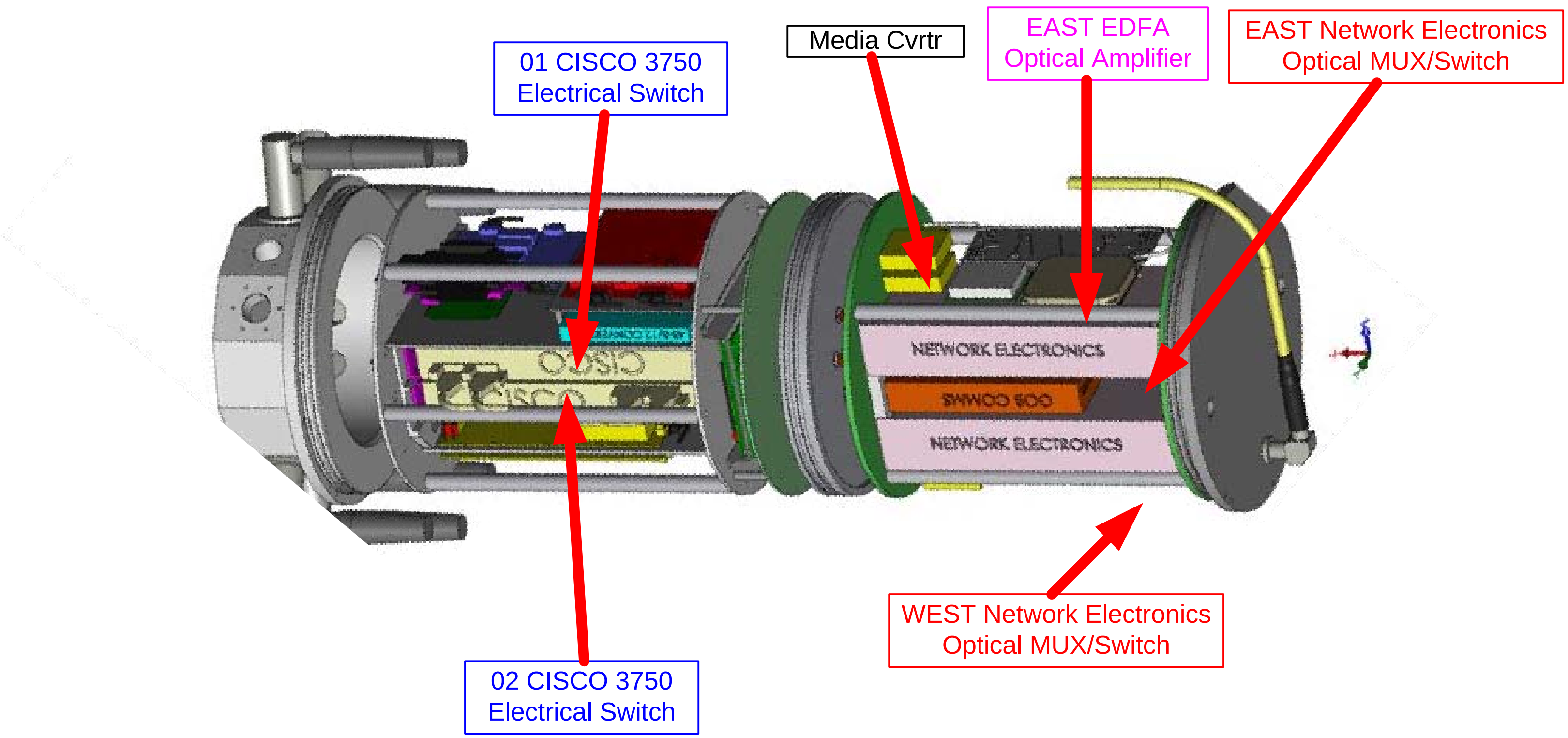
Internally the node consists of 2 complete assemblies of equipment to implement redundancy. Optical assemblies are labeled "east" and "west". The subsea CISCO switches are labeled 01 and 02 since they go to both the East and West sides. Shown below is a logical diagram fo tthe DCS elements. The next page shows a cartoon of the actual physical layout



NODE CHASSIS DESIGN

"WET" SIDE FILLED
WITH FLUORINERT
FC77

DRY SIDE
AIR COOLED
~ 88 watts



ARCHITECTURE – DCS COMPONENTS

The components of the MARS node and Shore Station are as follows:

4 CISCO 3750G-TS routing/switches in stackwise mode. These switches have 24 copper ports and 4 optical ports. 2 optical ports are used on each shore switch. The subsea switches do not utilize their optical ports since they are submerged in Fluorinert coolling liquid. The optical ports on the CISCO routers are called SFPs and do the optical to electrical conversion for the shore side. The electrical ethernet signals can then be utilized by science servers.

The CISCO switches have a 4 link Etherchannel configured bwtween sea and shore, two links terminating in each switch of the pair

4 Network Electronics (NE) optical mux units. These convert multiple channels of 1310nm signals to DWDM 15xx.xx levels and then multiplex them into the a single optical siagnal which leaves the shore or sea. The NE units also receive an incoming signal an pass it to the DeMux where it is split back into component wavelengths. The 1310/15xx converters are termed MRTR-d by the vendor. The unti accomidates 4 cards for 4 separate wavelengths. We use only 2 for our optical channels and a 3rd for a “passthrough” channel described later. The NE swtiches include a GYDA control card which will report the signal into the converters.

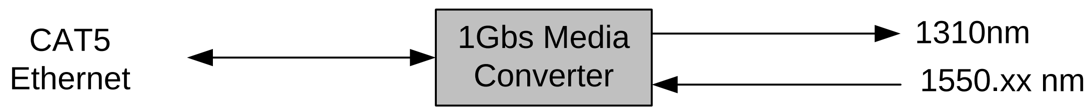
4 EDFA (Erbium Doped Fiber Amplifiers) by Bookham/Nortel. These receive an optical signal and boost it by up to 17dB. The amplifers have a serial interface where the boost level can be set. The MARS target is to have a 0dBm signal at the recevier.

4 GbE 4371 Media Converters by Omintron. These are in the subsea node only, since we do not do optical to electrical conversion using SFPs in the Cisco Routers described above. They have a CAT5 port on one side and a transmit and recieve 1310nm port on the other side.

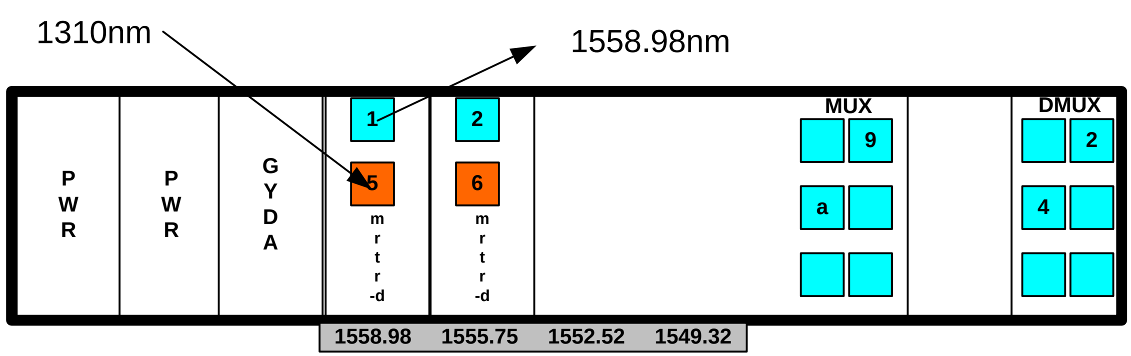
OPTICAL OPERATION – Media Converters, MRTRs

Optical transport is accomplished using electrical to optical media conversion and using DWDM transponders (known as MRTRs in Network Electronics terms) in the C band.

The converters take a 1 Gbs electrical Ethernet signal from the CISCO routers and convert it to a 1 Gbs optical Ethernet signal. The CAT5 copper connection is a two way xmit rcv connection. The converter splits it into a transmit and receive fiber optic signal. The converter transmits at 1310nm. The recieves from the shore a 1558.98 or 1555.75 nm signal which in converts back to electrical.

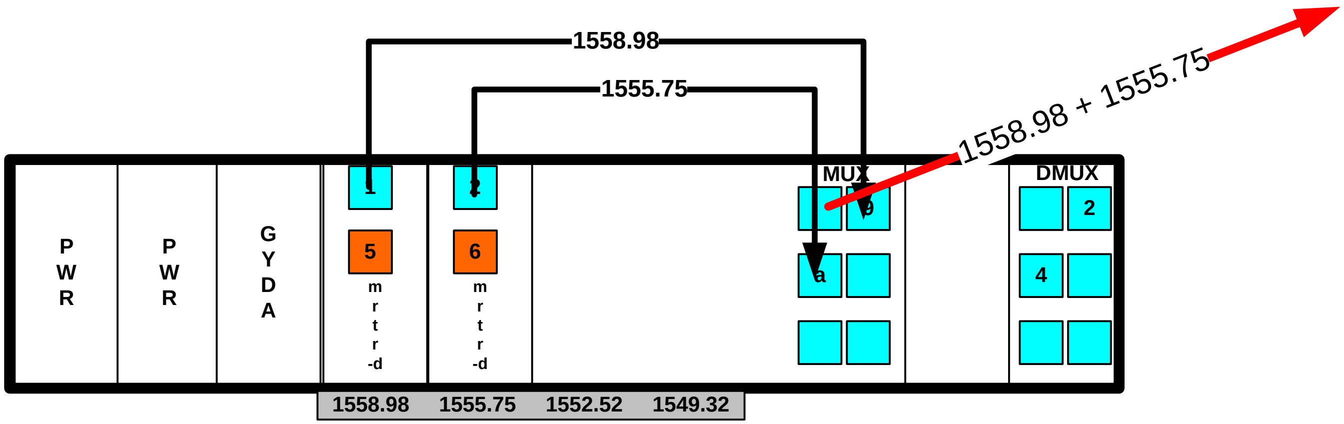


The 1310nm signal from the Media Converter must be shifted to an appropriate 1550.xx nm C band level. This is done by the Network Electronics (NE) optical mux/switch. Cards called MRTR cards convert from 1310 to 1550.xx. Each card is tuned for the specific C band frequency.

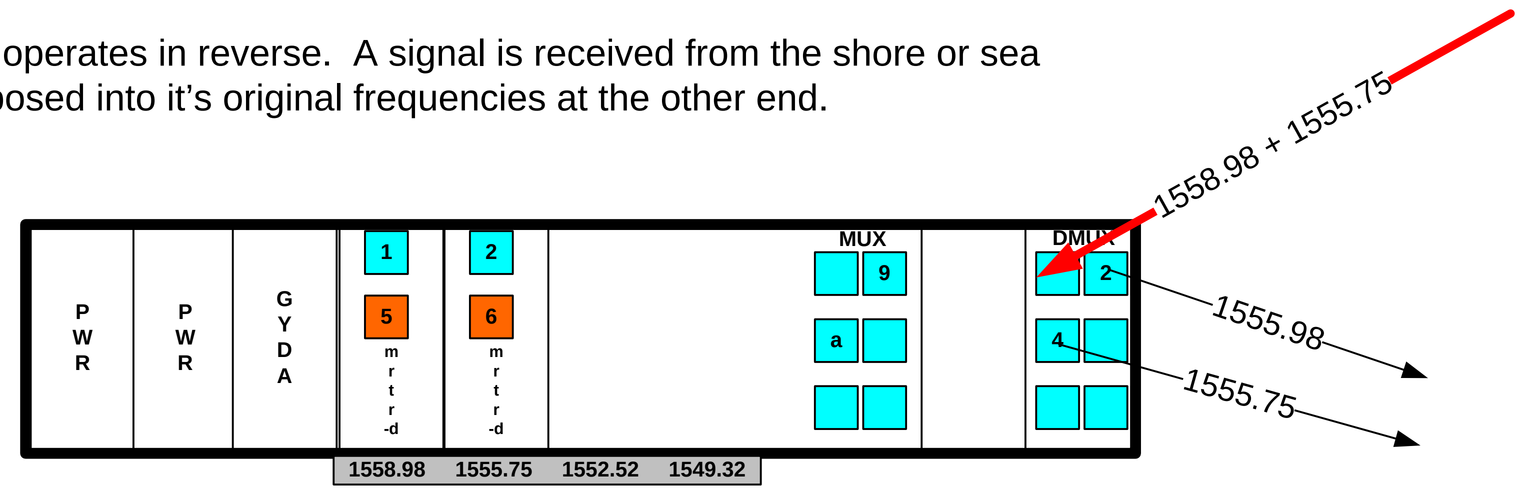


OPTICAL OPERATION - Muxing

Once the converted signals have been tuned to the proper C band frequency they are routed to the MUX portion of the NE switch where they are bundled up into one light stream. This is sent to the EDFA for amplification (west side only) and then sent to the shore. The East side goes directly to the shore where it is pre-amplified as an incoming signal.

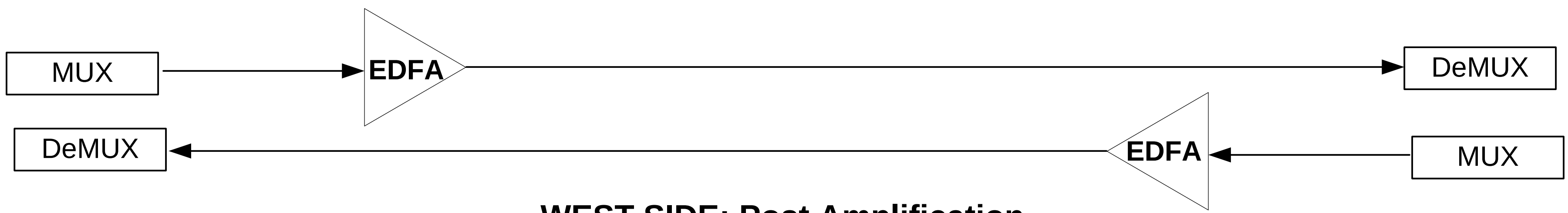


The Demux operates in reverse. A signal is received from the shore or sea and decomposed into it's original frequencies at the other end.

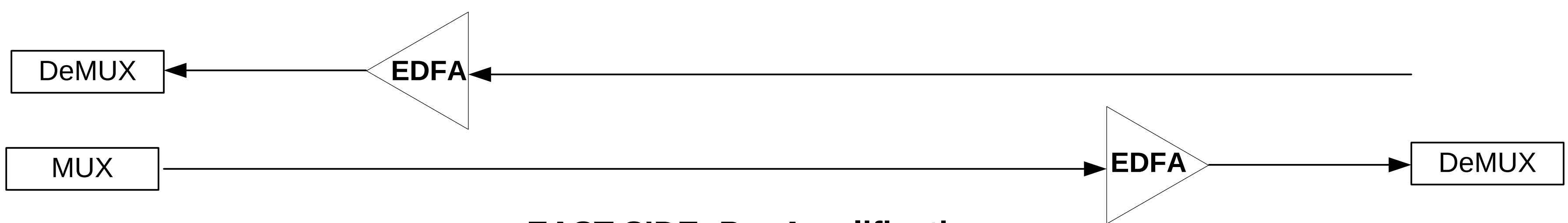


OPTICAL OPERATION - Amplification

One must be alert to an asymmetry built into MARS for testing purposes. This is the fact that the East side uses pre-amplification and the West side uses post amplification. The basic concept is shown below. The pre-amp mode has the added advantage that the reporting software in the EDFA can give the operator the level of optical signal arriving at the remote end.



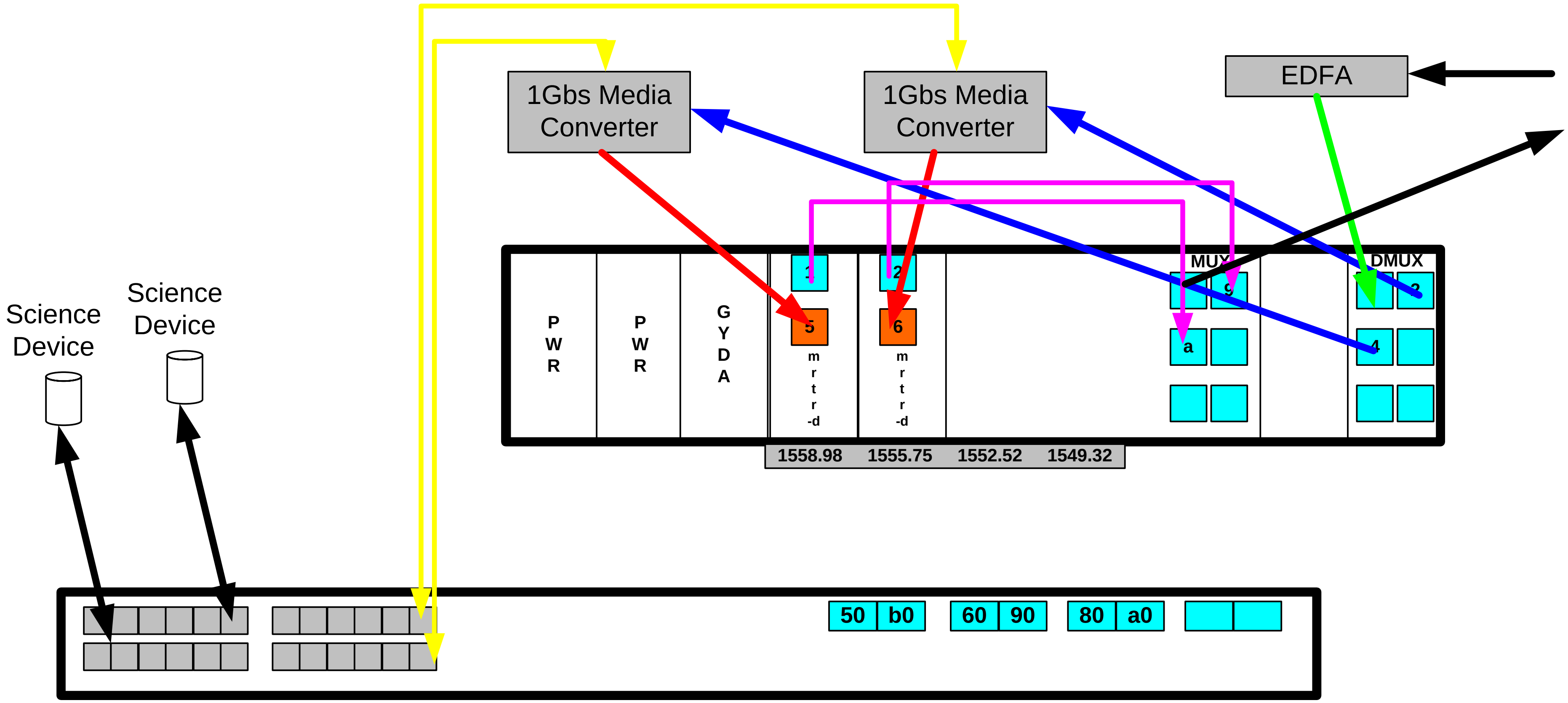
WEST SIDE: Post Amplification



EAST SIDE: Pre Amplification

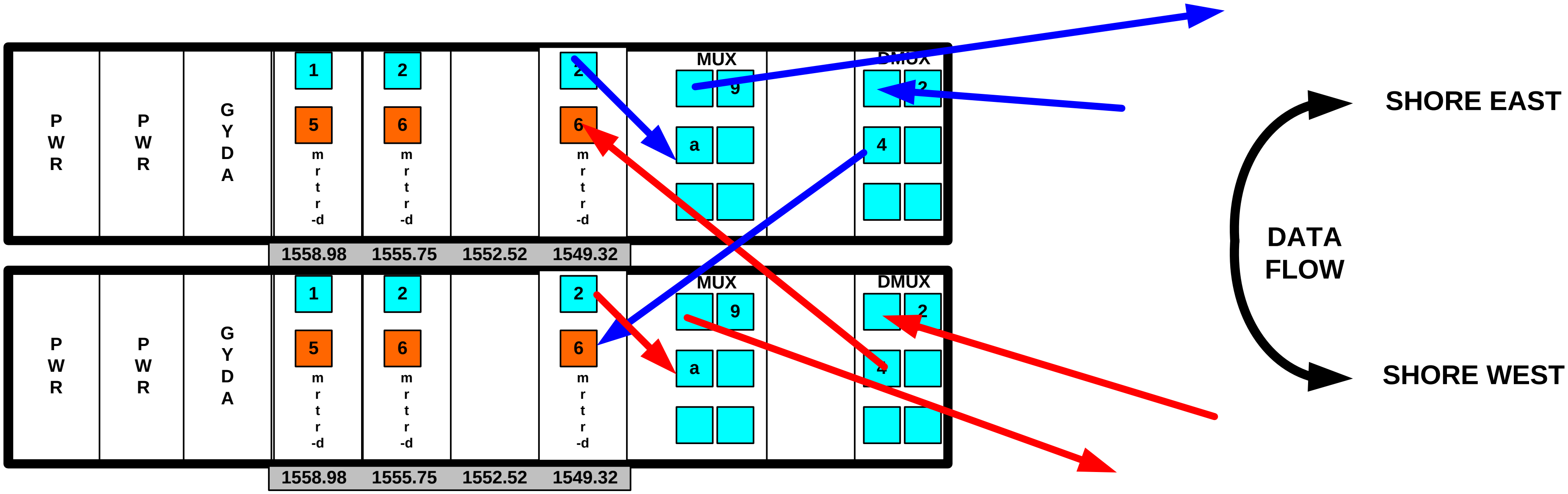
OPTICAL OPERATION - Summary

Here is a summary of the end-to-end operation of MARS. Shown here science devices are connected via an ocean wet connector to a CISCO router in the node.
There data is electrically multiplexed in the router with and sent out of the router into a 1Gbs media converter where it is converted to a 1310nm optical signal. (yellow arrow)
This signal is sent to one of the MRTR cards in the Network Electronics optical mux where it is shifted to 1558.98 or 1555.75 nm. (red arrow)
From the MRTR the signal is MUXed into one optical stream (magenta arrow) and then sent to the shore. (black arrow)
In the reverse mode an optical signal from the shore is received by the EDFA optical amplifier where it is boosted and then sent to the NE demux. (green arrow)
Here it is split into its component 1558.98 and 1555.75 optical signals and passed to the 1Gbs media converter. (blue arrows)
The converter changes the optical signal back to an electrical one where it is sent to the CISCO router. (yellow arrows)
The router uses the IP address in the signal data to send it to the appropriate science instrument (black arrows)

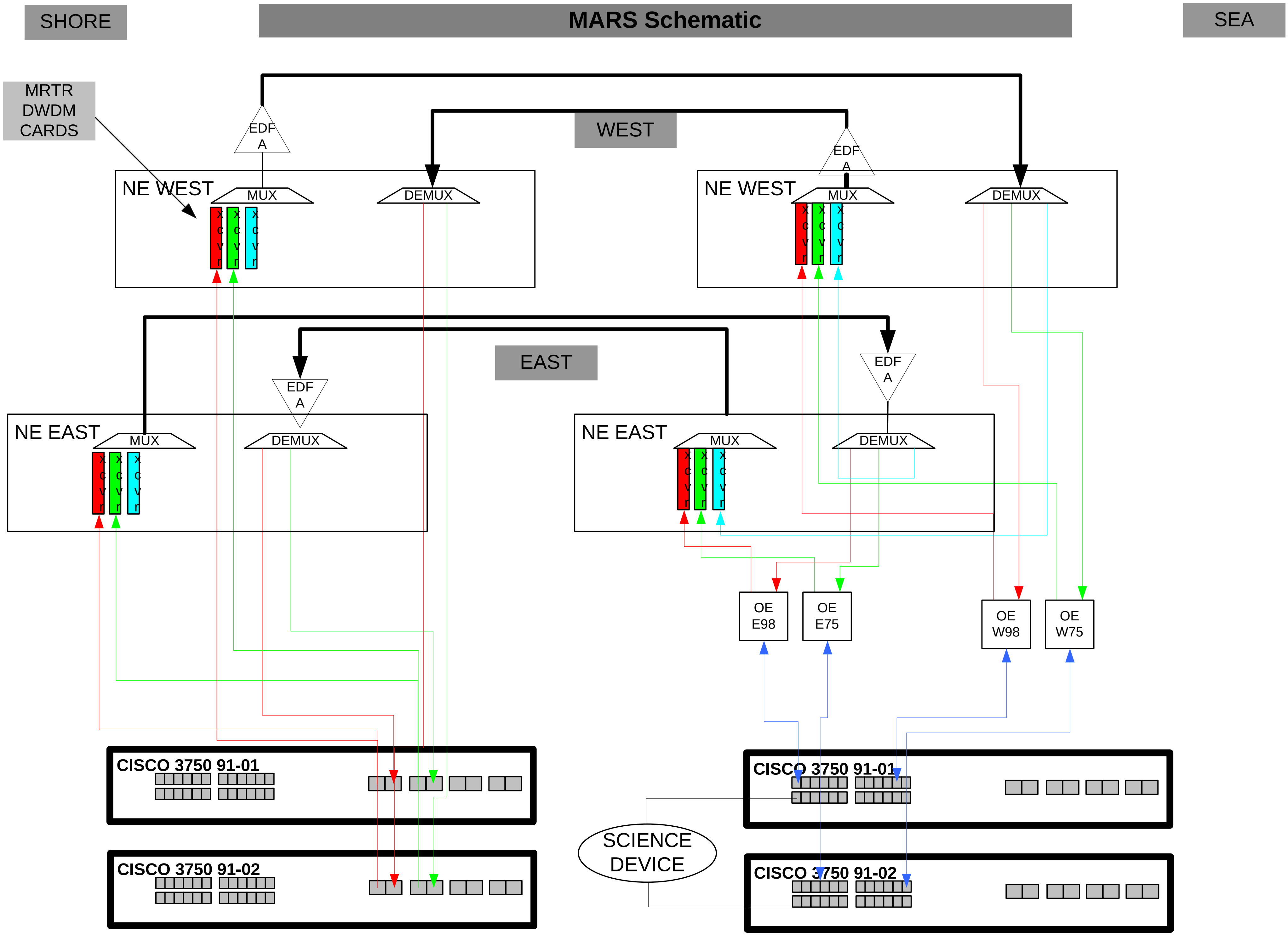


OPTICAL OPERATION – pass through channel

There is a 3rd channel which we have not mentioned yet- the "pass through" channel. This was added as an experiment for the future NEPTUNE project. This is simply a 3rd wavelength at 1549.32 nm. It does not couple with a media converter however. It simply takes a signal from the shore, and passes it to the second optcai switch in the node where it is sent back to shore. This will become clear when viewing the diagram:



The next diagram is a complete schematic showing the 2 data channels and pass-through channels for both the East and West sides of the DCS system. Pay particular attention to the EDFAs. The East side pre-amplifies the incoming signal. The West side post-amplifies the signal before it is transmitted from the node.


SHORE
MARS Schematic
SEA
MRTR DWDM CARDS
WEST
EDF A
NE WEST
MUX
DEMUX
xcvr
EAST
NE EAST
OE E98
OE E75
OE W98
OE W75
CISCO 3750 91-01
CISCO 3750 91-02
SCIENCE DEVICE

IP Network Engineering

The basic network provided by the MARS DCS system is an IP over Ethernet system. At the high level, the optical transport can be neglected and the system treated much as an ordinary copper network system.

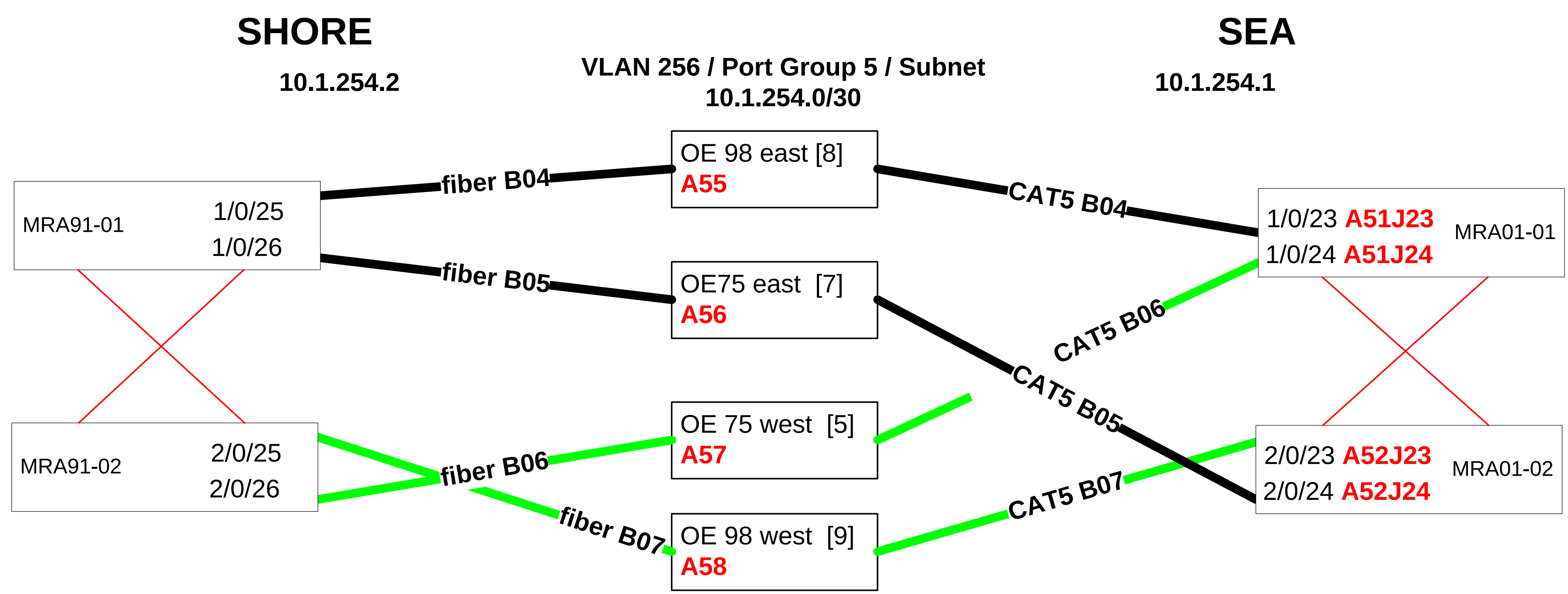
The basic backbone of MARS is the sea-shore connection. This consists of a 4 link Etherchannel with 1Gbs links. The routers on each end are paired into a stackwise configuration, the pairs representing themselves to the network as a single routing/switching entity.

For debugging purposes the below diagram is very useful. This shows the mapping of the EtherChannels from sea to shore, giving the individual router ports and the Media Converters involved.

Note the crossing of the connections on the sea side. This provides further redundancy to the system, so that if one router on each end fails, we still have a connection available.

If one disconnects a fiber on the shore side or CAT5 on the sea side, the corresponding light on the router port at the opposite end will go out. (WARNING-at this time a known bug in Cisco IOS makes this pattern indeterminate)

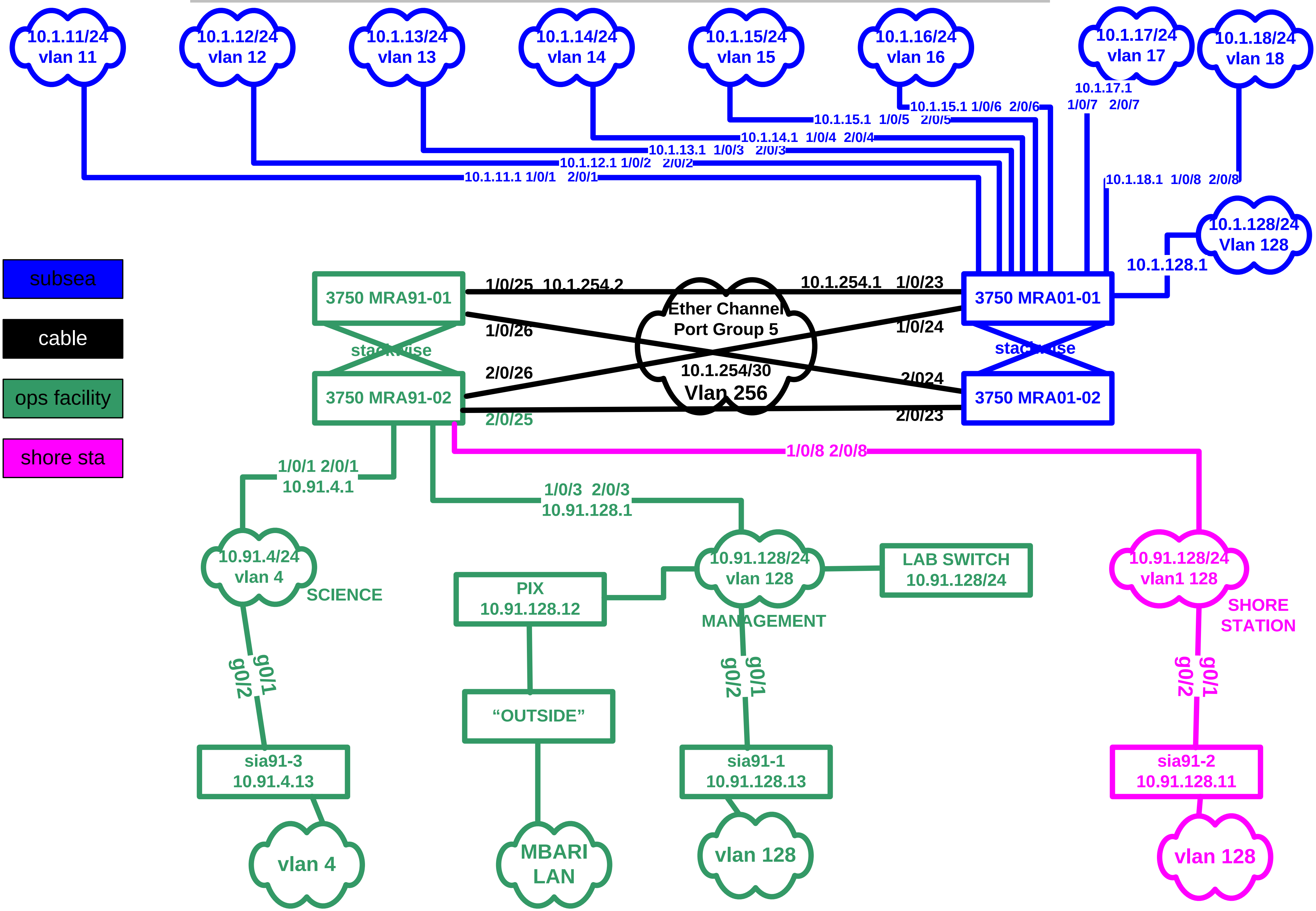
BACKBONE-mapping of ethernet channels from sea to shore



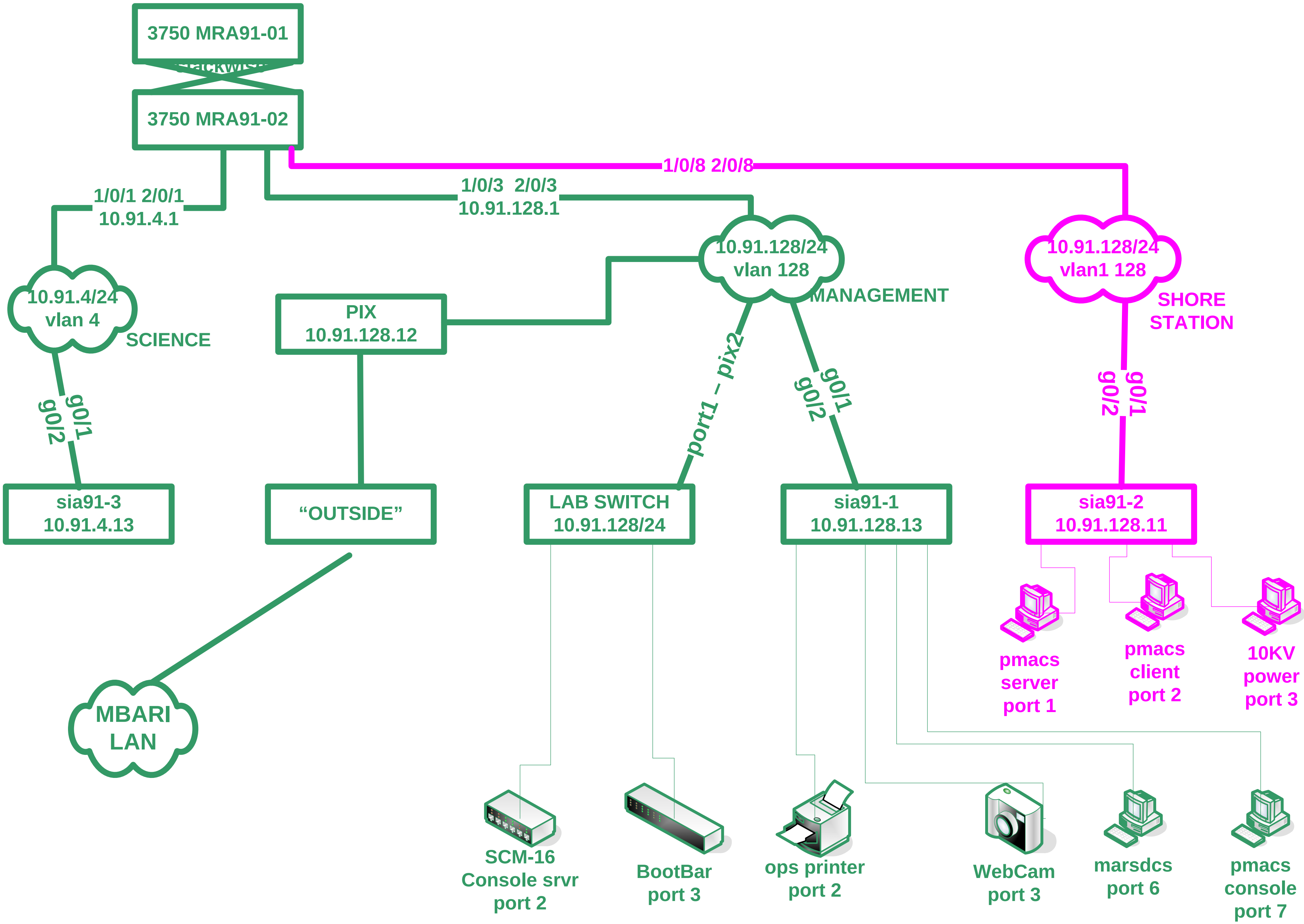
IP Network Engineering

Shown on the next page is the complete IP network for MARS. It can be described as follows:
The backbone, as mentioned on the prior page, is a 4Gbs EtherChannel backbone connecting the Sea and Shore CISCO stacks. The backbone is placed in subnet 10.1.254.0/30
The Sea is subnet 10.1.0.0 and the Shore is subnet 10.91.0.0
These subnets are further partitioned into management subnets of 10.1.128.0/24 and 10.91.128.0/24.
The MARS network contains 3 ancillary switches in addition to the 3750 backbone switches:
sia91-1 is a managment switch, into which the various network managment servers are connected
sia91-3 is a science server, to which the science data servers are attached. Its ports are placed in subnet 10.91.4.0/24
sia91-2 is the shore station switch.

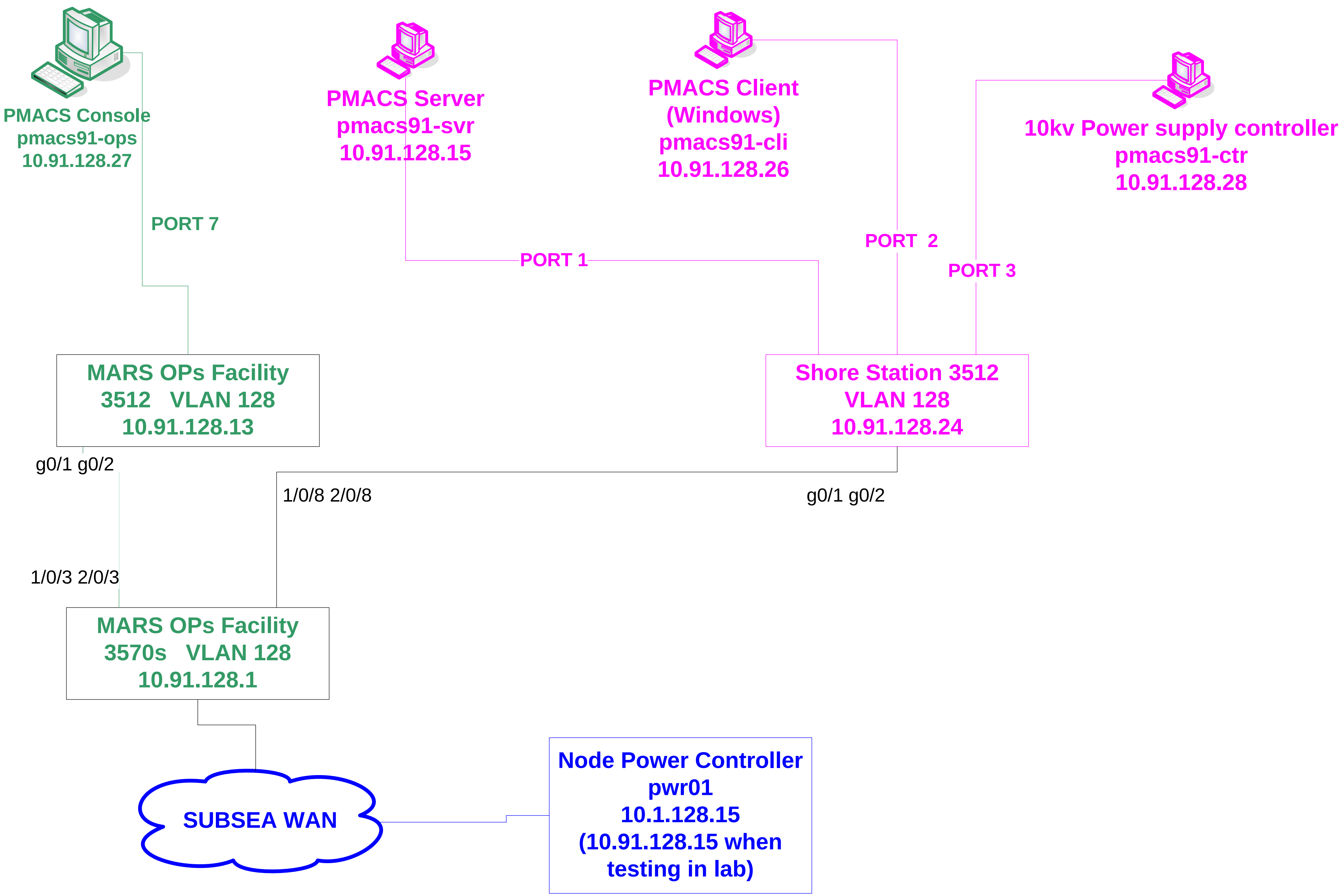
V02 – DCS Opened Node Validation (subnets)



V02 – DCS Opened Node Validation (detail of 10.91.128.0/24 subnet)



Network Diagram 4



Installing an Instrument

1) plug it's ethernet RJ45 into either the mra01-01 or mra01-02 router (both if you have a Y connector) using the port list below.

2) give the instrument an address of 10.1.xx.yyy where
   a) xx is 11 thru 18 from the chart below
   b) yyy is your choice, from 2 thru 254

3) Use a netmask of 255.255.255.0

4) give the instrument a gateway of 10.1.xx.1

5) On the shore routers you will need to connect your 'server' (or laptop). Use any of ports on mra91-02 from 3 thru 18. Give the server a gateway of 10.91.128.1/255.255.255.0

6) You probably will have to issue a “noshut” CISCO command to start the ports which were configured in the steps above.

At this point you should be able to ping the instrument from the server.
During our test phase you should let WHOI know when you add anything to the network. We can add it to our monitor list.

Switch Ports	IP Range	Gateway
1/0/1 2/0/1	10.1.11.xxx	10.1.11.1
1/0/2 2/0/2	10.1.12.xxx	10.1.12.1
1/0/3 2/0/3	10.1.13.xxx	10.1.13.1
1/0/4 2/0/4	10.1.14.xxx	10.1.14.1
1/0/5 2/0/5	10.1.15.xxx	10.1.15.1
1/0/6 2/0/6	10.1.16.xxx	10.1.16.1
1/0/7 2/0/7	10.1.17.xxx	10.1.17.1
1/0/8 2/0/8	10.1.18.xxx	10.1.18.1

V02 – DCS Opened Node Validation – ports for mra91-01 and mra91-02

01 SHORE 02

port	vlans	to	port	Desc
1/0/01	4T	Sia91-3	Gi0/1	Science switch
1/0/02	4			
1/0/03	128T	Sia91-1	Gi0/1	ops fac switch
1/0/04	128			
1/0/05	128	linksys	1	linksys
1/0/06	128			
1/0/07	128			
1/0/08	128T	sia91-2	Gi0/1	shore sta switch
1/0/09	128			
1/0/10	128			
1/0/11	128			
1/0/12	128			
1/0/13	128			
1/0/14	128	PIX		10.91.128.12
1/0/15	128	GYDA		10.91.128.14
1/0/16	128			
1/0/17	128	ntp		10.91.128.55
1/0/18	128			
1/0/19				
1/0/20				
1/0/21				
1/0/22				
1/0/23				
1/0/24				
1/0/25	256	Mra01-01	1/0/23	etherchannel
1/0/26	256	Mra01-02	2/0/24	etherchannel
1/0/27				
1/0/28				

port	vlans	to	port	Desc
2/0/01	4T	Sia91-3	Gi0/2	Science switch
2/0/02	4			
2/0/03	128T	Sia91-1	Gi0/2	ops fac switch
2/0/04	128			
2/0/05	128			
2/0/06	128			
2/0/07	128			
2/0/08	128T	sia91-2	Gi0/2	shore sta switch
2/0/09	128			
2/0/10	128			
2/0/11	128			
2/0/12	128			
2/0/13	128			
2/0/14	128			
2/0/15	128			
2/0/16	128			
2/0/17	128			
2/0/18	128			
2/0/19				
2/0/20				
2/0/21				
2/0/22				
2/0/23				
2/0/24				
2/0/25	256	Mra01-02	2/0/23	etherchannel
2/0/26	256	Mra01-01	1/0/24	etherchannel
2/0/27				
2/0/28				

V02 – DCS Opened Node Validation – ports for mra01-01 and mra01-02

01 (A51) SEA 02 (A52)

port	vlans	to	port	Desc
1/0/01	11	ADCP		science
1/0/02	12			science
1/0/03	13			science
1/0/04	14			science
1/0/05	15			science
1/0/06	16			science
1/0/07	17			science
1/0/08	18			science
1/0/09	128	Node pwr ctl		10.1.128.15
1/0/10	128			
1/0/11	128			
1/0/12	128			
1/0/13				
1/0/14				
1/0/15				
1/0/16				
1/0/17				
1/0/18				
1/0/19				
1/0/20				
1/0/21				
1/0/22				
1/0/23	256	Mra91-01	1/0/25	**A51J23 – B04**
1/0/24	256	Mra91-02	2/0/26	**A51J24 – B06**
1/0/25				
1/0/26				
1/0/27				
1/0/28				

port	vlans	to	port	Desc
2/0/01	11			science
2/0/02	12			science
2/0/03	13			science
2/0/04	14			science
2/0/05	15			science
2/0/06	16			
2/0/07	17			science
2/0/08	18			science
2/0/09	128	GYDA	**A52J09**	10.1.128.14 – B03
2/0/10	128			
2/0/11	128	cyclades	**A51J11**	10.1.128.20 – B02
2/0/12	128			
2/0/13				
2/0/14				
2/0/15				
2/0/16				
2/0/17				
2/0/18				
2/0/19				
2/0/20				
2/0/21				
2/0/22				
2/0/23	256	Mra91-02	2/0/25	**A52J23 – B07**
2/0/24	256	Mra91-01	1/0/26	**A52J24 – B05**
2/0/25				
2/0/26				
2/0/27				
2/0/28				

LOGS are on /var/log/ciscl.log

V02 – DCS Opened Node Validation – ports for aux switches

sia91-1	10.91.128.13	MARS operations facility		
port	vlans	to	port	Desc
1/0/01	128	*broken port*		*dont use*
1/0/02	128	pmacs cons	na	10.91.128.27
1/0/03	128	mars printer	na	10.91.128.29
1/0/04	128	web cam	na	10.91.128.23
1/0/05	128	marsdcs	eth1	10.91.128.57
1/0/06	128			
1/0/07	128			
1/0/08	128			
1/0/09	128			
1/0/10	128			
1/0/11	128			
1/0/12	128			
g0/1	po2	mra91-01	g1/0/3	
g0/2	po2	mra91-02	g2/0/3	

sia91-3	10.91.4.13	science hosting switch		
port	vlans	to	port	Desc
1/0/01	4			
1/0/02	4			
1/0/03	4			
1/0/04	4			
1/0/05	4			
1/0/06	4			
1/0/07	4			
1/0/08	4			
1/0/09	4			
1/0/10	4			
1/0/11	4			
1/0/12	4			
g0/1	po1	mra91-01	g1/0/1	
g0/2	po1	mra91-02	g2/0/1	

sia91-2	10.91.128.24	shore station		
port	vlans	to	port	Desc
1/0/01	128	pmacs srvr		10.91.128.15
1/0/02	128	pmcas client	nic 1	10.91.128.26
1/0/03	128			
1/0/04	128			
1/0/05	128			
1/0/06	128			
1/0/07	128			
1/0/08	128			
1/0/09	128			
1/0/10	128			
1/0/11	128			
1/0/12	128			
g0/1	po3	mra91-01	g1/0/8	
g0/2	po3	mra91-02	g2/0/8	

PIX Firewall 10.91.128.12 / 134.89.42.12			
port	to	port	Desc
0	MBARI inet		
1	mra91-01	g1/0/14	
2	LAB SWITCH	1	
3			
4			
5			

LAB Switch			
port	to	port	Desc
01	PIX	2	
02	SCM16		10.91.128.17
03	Boot Bar		10.91.128.19
04			
05			
..... 16			

MARS – Subsea Cable FIbre Numbers

1	OBC EAST A
2	OBC WEST A
3	OBC EAST B
4	OBC WEST B
5	EAST EDFA INPUT
6	W EDFA OUTPUT
7	EAST MUX COMMON
8	W DeMUX COMMON

V02 – DCS Opened Node Validation

LINKSYS

Device	Start Port	End Port	Maps To IP	Maps To Port
Scm-web	na(8001)	8001	10.91.128.17	80
bootbar-web	8002	8002	10.91.128.19	80
GYDA	8003	8003	10.91.128.14	80
lanf gui	4002	4002	10.91.128.22	4002
scm-ssh	2222	2222	10.91.128.17	22
rmt-console	2201	2216	10.91.128.17	2001-16
marsdcs ssh	22	22	10.91.128.57	22
marsdcs http	80	80	10.91.128.57	80

PUBLIC ADDRESSES

Device	Maps To IP	Device	Maps To IP
PIX-int	10.91.128.12	SHR-mgr-int	10.91.128.101
PIX-ext	134.89.42.12	SHR-mgr-ext	134.89.42.101
scm-in			
scm-ext	134.89.42.11		
bootbar-int			
bootbar-ext	134.89.42.10		
webcam-int			
webcam-ext	134.89.42.20		

MBARI GW	134.89.42.1
MBARI DNS	134.89.2.12
MBARI MASK	255.255.254.0

CONSOLE SERVER

Port	Console Device	IP Port
1	not used	2201
2	mra91-02	2202
3	not used	2203
4	sia91-v128	2204
5	Ntp91-1	2205
6	sia91-v?	2206
7	edfa-west	2207
8	edfa-east	2208
9	not used	2209
10	not used	2210
11	mra91-01	2211
12	not used	2212
13	not used	2213
14	not used	2214
15	PIX	2215
16	boot bar	2216

POWER BAR

Port	Device
1	conosle server
2	PIX
3	ntp
4	linksys
5	
6	mra91-01
7	mra91-02
8	ne East
9	ne west
10	EDFAs
11	marsdcs
12	OBC East
13	sia91-3
14	sia91-1
15	OBC West
16	LAB Switch

PASSWORDS

Device	UID/PSW
linksys	netpune/neptune1
SCM Conosole	super/neptune1
sia91-11	neptune1/neptune1
sia91-128	neptune1/neptune1
Ntp91-1	root/endrun_1
EDFA	AD FFFF 1234
cyclades	root/neptune1
pwr-ctrllr	dcs/apl1013
switches telnent	neptune3
switches console	neptune1
switches enable	neptune1
GYDA	admin/password
lanforge	lanforge/lanforge
lanforge - root	root/lanforge
web camera	neptune1/neptune1
web camera2	neptune/neptune1
boot bar	

POWER Ports	
Port	Device
1	spare
2	spare
3	CISCO mra01-01
4	CISCO mra01-02
5	OE Converter W75
6	Cyclades
7	OE Converter E75
8	OE Converter E98
9	OE Converter W98
10	NE Switch West
11	EDFA West
12	spare
13	NE Switch East
14	EDFA East
15	OBC A
16	OBCB

Sensor Ports	
sensor	Device
1	Relative Humidity
2	NE Switch E75
3	NE Switch W75
4	Upper Temp
5	Lower Temp
6	spare
7	OE Converter E75
8	OE Converter W75

Power Controller Commands

logon/paswd dcs / apl1013
getv – read voltage on all internal buses
gets n – get the state of Load N
gets 0- list all power-port status
sets n 0|1 set switch for Load N (1-16) on (1) or off (0)
getsens – read all engineering sensors
getc n – read current for Load N
quit exit the program

PMACS Data
(via Steve's program)

http://128.95.97.153/power_obc/data/
http://128.95.97.153/power_obc/plots/

(via Mike's program)

pmacs.apl.washington.edu/altarchive/2005/06

V02 – DCS Opened Node Validation

CONNECTING VIA OBC

There are two ways to connect to the backdoor (serial xbar switch), either via in-band using the Cyclades comms controller or going directly through the out-of-band system using the obc_shore computer and sail. The first method uses ethernet, the second via a serial port interface.

1) In-Band using the Cyclades comms controller
Using a web-browser, enter the following url
    http://10.1.128.20/cgi-bin/obc_xbar

1 - N/C	**5 - EDFA-E**
2 - N/C	**6 - EDFA-W**
3 – CiscoA	**7 - PwrCtl**
4 – CiscoB	**8 - Loopback**

Select a port and then manually connect,
via telnet 10.1.128.20 7001

Note: the above can be done without a web-browser by running wget

```
wget -O /tmp/eraseme.txt -o/dev/null
    http://10.1.128.20/cgi-bin/obc_xbar?port=5
```

2) Using Sail Driver via ttyS0 connected to OBC

```
su root
cd /home/stevel/sail_driver
./sail -s#S01A -x5
```

Procedure for Diagnosis

1) For initial checkup, after connecting the East A&B and the West A&B shore fibers to their corresponding transponders in the sub-sea unit issue help commands to each device to check it's operation. Needless to say you wil need an RS232 connection to each port (East A,B and West A,B) on the shore stations.

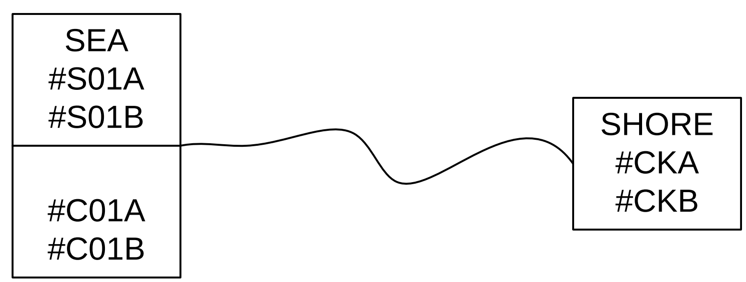
Check Shore East or West A side
###CKAH

Check Shore East or West B side
###CKBH

Sub-sea East or West A side
###S01AH

Sub-sea Esat or West B side
###S01BH

In the event or problems a simple optical test can be performed:
1) Insert an optical power meter (1550nm) at the fiber end which connects to a sub-sea transponder
2) From an ASCII terminal connected to the shore station send continiuous character strings
3) Expect about -35 to -45 dBm



PIX MAPS			
ALLOW	IN	MAP	Description
WHOI, APL	134.89.42.17	10.91.128.17	SCM-16
WHOI, APL	134.89.42.19	10.91.128.19	bootbar
WHOI, APL	134.89.42.19	10.91.128.23	webcam 1
WHOI, APL	134.89.42.19	10.91.128.30	webcam 2
WHOI, APL	134.89.42.57	10.91.128.57	marsdcs
WHOI, APL	134.89.42.59	10.91.128.59	LinkSys
WHOI, APL	134.89.42.114	10.1.128.14	sea GYDA
WHOI, APL	134.89.42.120	10.1.128.20	Cyclades

Shore Station Power Consumption			
Number	Device	Power (watts)	Total
2	EDFA	23	46
2	3750	120	240
2	3512	100	200
2	NE Mux	30	60
1	Lab Switch	??	
1	SCM-16	5	5
1	Endrun NTP	60	60
2	OBC Stations	15	30
1	marsdcs srvr	400	400
1	PIX	15	15
1	NetGear	8	8
TOTAL			1072