Ethernet Routing Switch 8800 Series

Hirschmann™ Industrial Ethernet Switches

Engineering

>Ethernet Routing Switch 8800 Series with Hirschmann™ Industrial Ethernet Switches Technical Configuration Guide

Avaya Networking

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Abstract

This Technical Configuration Guide describes a solution comprised of Avaya Ethernet Routing Switch 8800 Series switches and Hirschmann™ Industrial Ethernet switches. During interoperability testing, connectivity was established between the Avaya and Hirschmann™ switches, and tests that simulated network failures were successfully completed.

Information in this Technical Configuration Guide has been obtained through Avaya Networking interoperability testing and additional technical discussions. Testing was conducted at the Avaya Networking Test Lab.

Acronym Key

Throughout this guide the following acronyms will be used:

- DIN: Deutsches Institut für Normung (in English - German Institute for Standardization)
- EMI: Electromagnetic Interference
- IE: Industrial Ethernet
- IGMP: Internet Group Management Protocol
- LACP: Link Aggregation Control Protocol
- MICE: Mechanical, Ingress, Climatic/Chemical and Electromagnetic
- MLT: MultiLink Trunking
- NEMA: National Electrical Manufacturer Association
- RSTP: Rapid Spanning Tree Protocol
- SMLT: Split MultiLink Trunking
- STP: Spanning Tree Protocol
- VRRP: Virtual Router Redundancy Protocol

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Conventions

This section describes the text, image, and command conventions used in this document.

Symbols

Tip – Highlights a configuration or technical tip.

Note – Highlights important information to the reader.

Warning – Highlights important information about an action that may result in equipment damage, configuration or data loss.

Text

Bold text indicates emphasis.

Italic text in a Courier New font indicates text the user must enter or select in a menu item, button or command:

```
ERS5520-48T# show running-config
```

Output examples from Avaya devices are displayed in a Lucida Console font:

```
ERS5520-48T# show sys-info

Operation Mode:          Switch
MAC Address:             00-12-83-93-B0-00
PoE Module FW:           6370.4
Reset Count:             83
Last Reset Type:         Management Factory Reset
Power Status:            Primary Power
Autotopology:            Enabled
Pluggable Port 45:       None
Pluggable Port 46:       None
Pluggable Port 47:       None
Pluggable Port 48:       None
Base Unit Selection:     Non-base unit using rear-panel switch
sysDescr:                Ethernet Routing Switch 5520-48T-PWR
                         HW:02       FW:6.0.0.10  SW:v6.2.0.009
                         Mfg Date:12042004    HW Dev:H/W rev.02
```

1. Introduction: Industrial Ethernet

Harsh environments require robust solutions.

The Avaya-Belden Industrial Ethernet (IE) solution can stand up to environmental settings that have wide temperature ranges, excessively dirty areas, high EMI, or areas where it is not always feasible or possible to use a NEMA-rated enclosure to protect the Ethernet switching equipment. Examples of this include:

- Manufacturing
- Military
- Mining
- Civil communications infrastructures
- Railway networks

In the manufacturing environment, Industrial Ethernet will soon completely replace proprietary BUS-systems (fieldbus, Profibus, etc.) that are connecting industrial robots and other manufacturing components. This migration to Ethernet is being driven by the ubiquitous availability and price points of Ethernet. Most, if not all, manufacturing environments already have some form of Ethernet in place – handling the office/backend networks. The ability to leverage this, along with the continually lowering price of Ethernet makes this very attractive as a replacement for the plant floor network.

Avaya and Belden are working together to offer a joint solution of an industrial switching infrastructure that ensures the interoperability and integration between the equipment offered by the two vendors. The Avaya-Belden total solution now encompasses not only the IE network, but also the data center and backend office infrastructure.

2. Avaya-Hirschmann™ Ethernet Switches interoperability testing

This document provides the details of the interoperability testing between the Avaya Ethernet Routing Switches and the Hirschmann™ Industrial Switches. The various network design scenarios and test cases are also detailed in this document.

The interoperability testing focused primarily on verifying throughput under normal conditions and then simulating various fault conditions to test high availability. The following sections describe the Avaya and Hirschmann™ switches used in these tests.

2.1 Avaya Ethernet switching components

The following Avaya Ethernet switches are part of this solution:

- Avaya Ethernet Routing Switch 8800
- Avaya Ethernet Routing Switch 5650

2.1.1 Ethernet Routing Switch 8800

The Avaya Ethernet Routing Switch 8800 (ERS 8800) systems are typically deployed in Switch Clusters to deliver true end-to-end reliability and always-on application access. Available in a wide range of models, these systems are specifically designed to address the critical enterprise requirements of reliability, efficiency, and scalability. The ERS 8800 is also a key component of the Avaya Virtual Enterprise Network Architecture, supporting full-featured network virtualization capabilities for campus cores and data center applications.

As a Layer 2/3 routing switch, the ERS 8800 provides flexibility in many network designs as it can be utilized as a closet switch, aggregation switch, or core switch. The ERS 8800 supports Switch Clustering by using Split Multilink Trunking (SMLT) for active/active uplink connectivity without using any form of spanning tree. However, the ERS 8800 also supports the IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) for those environments where spanning tree is desired.

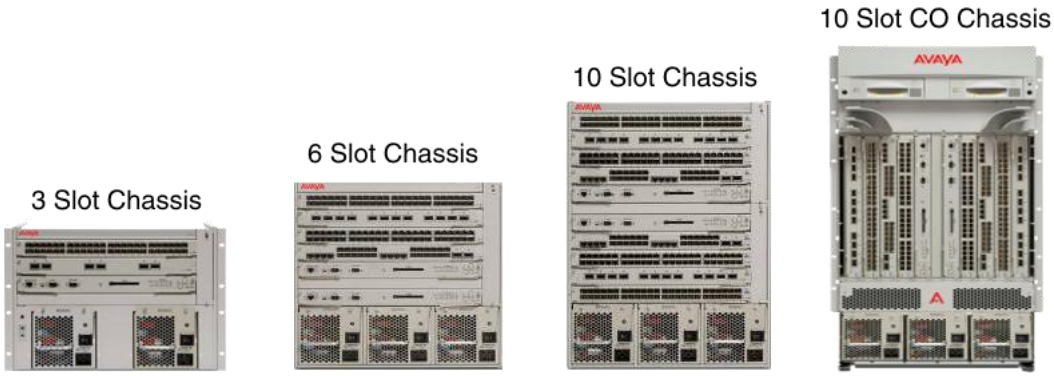


Figure 1 – Avaya ERS 8800

2.1.1.1 High Availability

The ERS 8800 supports High Availability (HA) mode within a single chassis when two Switch Fabric/CPU (SF/CPU) modules are installed. With HA enabled, both CPUs are active. The CPUs exchange topology data, so in the event of an SF/CPU failure, the functioning SF/CPU can continue passing traffic with sub-second recovery. In the event of a failure of the master CPU, the backup CPU takes over system control with sub-second convergence and minimal or no interruption to user applications/traffic.

2.1.1.2 Switch Clustering – Split MultiLink Trunking (SMLT)

Switch Clustering using Split MultiLink Trunking (SMLT) provides industry-leading performance for resiliency. Providing redundant active-active links without using Spanning Tree allows the ultimate design in a converged environment. Sub-second failover and the simplicity of a network without Spanning Tree reduces TCO and ensures converged applications will function flawlessly. A vital feature of Switch Clustering is its ability to work with any end device (3rd party switch, servers, etc.) that supports a form of link aggregation.

Switch Clustering also provides the ability to perform virtual hitless upgrades of the core switches (cluster). With all connections to the cluster dually attached, a single core switch can be taken out of service without interrupting end user traffic. This switch then can be upgraded and brought back into service. By performing the same function on the other switch, after the upgraded switch is back online, the entire cluster has been upgraded without taking a service outage and with minimal interruption to traffic flows on the network.

2.1.1.3 VRRP with Backup Master

To allow both VRRP switches to route traffic, Avaya created the Backup Master extension to VRRP, which creates an active-active environment for default routing. With Backup Master enabled on the backup routing switch, the backup router no longer switches traffic to the VRRP Master. Instead the Backup Master routes all traffic received on the Backup Master IP interface according to the switch routing table. This prevents the edge switch traffic from being unnecessarily switched to the other switch in the cluster.

VRRP provides redundancy for end users' default gateway and should be utilized for each VLAN configured that hosts end stations. This VRRP default gateway is for workstations or any edge clients in the edge VLAN, not for the firewall. Along with VRRP, Backup Master should be enabled on the Switch Cluster to provide active-active routing and forwarding of traffic.

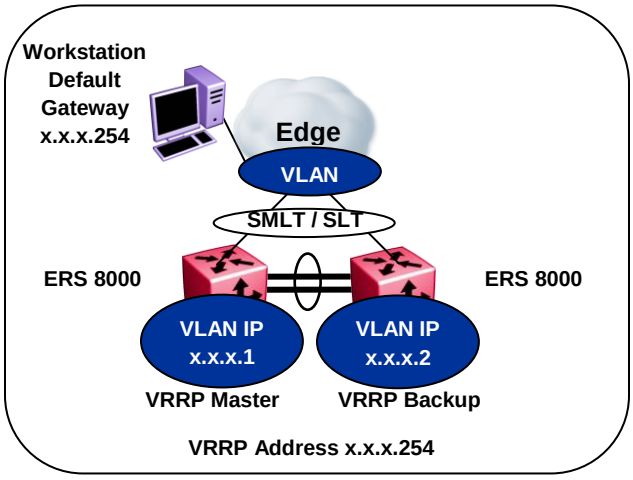


Figure 2 – Avaya ERS 8800 with VRRP Backup Master

2.1.2 Ethernet Routing Switch 5650

The Ethernet Routing Switch 5600 (ERS 5600) is a family of stackable Ethernet Layer 2/3 routing switches. For the Avaya-Belden Industrial Ethernet (IE) solution, the Avaya Networking Test Lab used the ERS 5650 in their tests. Like all of the ERS 5600 models, the ERS 5650 provides direct end station connectivity, aggregation for closet connectivity, as well as for servers, network appliances, and other devices. The ERS 5650 provides flexibility in many network designs as it can be utilized as a closet switch, aggregation switch, or as a core switch.

The ERS 5650 supports Switch Clustering by using Split Multilink Trunking (SMLT) for active/active uplink connectivity without the use of any form of spanning tree. However, the ERS 5650 also supports the IEEE 802.1w Rapid Spanning Tree Protocol (RSTP) for those environments where spanning tree is desired.

In the Avaya-Belden Industrial Ethernet (IE) solution, the ERS 8800s perform all of the Layer 3 functions. The ERS 5650s perform the Layer 2 switching to the ERS 8800s *only*. However, the ERS 5650 is perfectly suited to providing the high-performance and highly available connectivity solution in the wiring closet. It has 48 ports of 10/100/1000 plus two 10 Gbps XFP ports. You can combine the ERS 5650 switches into a single stack with each ERS 5650 unit providing two 10GbE XFP ports for high-capacity uplinks to the core of the network.

Figure 3 – ERS 5650

2.2 Hirschmann™ Ethernet switching components

The following Hirschmann™ Ethernet switches are part of this solution:

- Hirschmann™ MACH1040
- Hirschmann™ RS30
- Hirschmann™ MS30

2.2.1 Hirschmann™ Ruggedized Switch MACH1040

Hirschmann™ Ruggedized Switches are designed for high network availability and operational safety in the harshest conditions. The Hirschmann™ MACH1040_Gigabit Ethernet Switch operates in the temperature range of -40 to +70 °C, and it has high resistance to shock, vibration, electrical discharge, and magnetic fields. The MACH 1040 also uses the latest energy-saving chip technology, providing an extremely low thermal footprint despite being fan-less.

The MACH1000 is also available in an all-Gigabit version, offering 16 10/100/1000 RJ45/SFP combo ports to provide countless copper/ fiber combinations. These switches are available with Layer 2 or Layer 3 capabilities. The fan-less design and extremely efficient components are optimized for minimal heat generation and high MTBF (mean time between failure). The switches offer sub-10 second boot times and offer PTP IEEE 1588V2 with BC and TC, precision 30ns.

Hirschmann's ruggedized MACH1040 switches provide outstanding performance under extreme conditions with great flexibility. They have been specially designed to handle demanding requirements in applications such as military, power generation and distribution, as well as transportation. The series supports RSTP, MRP, link aggregation, Fast-HIPER-ring, redundant network/ring coupling and many security features.

The Avaya Networking Test Lab used MACH1040 switches in all Layer-2 based test scenarios.

Figure 4 – MACH1040

2.2.2 Hirschmann™ Rail Switch RS30

The Hirschmann™ Rail Switch (RS30) is a compact, managed OpenRail switch that comes in a small footprint. The RS30 is a Layer 2 switch that provides high port-density with speeds up to 1 Gigabit. The switch is Class 1 Div 2 rated, has a redundant media/ring, redundant power inputs, and DIN rail mounts. It also comes with extensive security options and alarming to ensure network integrity.

Figure 5 – RS30

2.2.3 Hirschmann™ Modular MICE Switches

MICE refers to the Mechanical, Ingress, Climatic/Chemical and Electromagnetic noise environment where the switch is going to be installed. The Modular Switch (MS30) offers you maximum flexibility due to the huge variety of media modules and therefore perfectly prepared for the growing network demands of the future. The MS30 is a Layer 2 switch that supports high port-density with speeds up to 1 Gigabit. The switch is Class 1 Div 2 rated, has a redundant media/ring, redundant power inputs, and DIN rail mounts. It comes with extensive security options and alarming to ensure network integrity. The MS30 also supports RSTP 802.1w as well as HIPER-ring, and redundant network/ring coupling.

The Avaya Networking Test Lab used an MS30 switch in all Layer-2 based test scenarios.

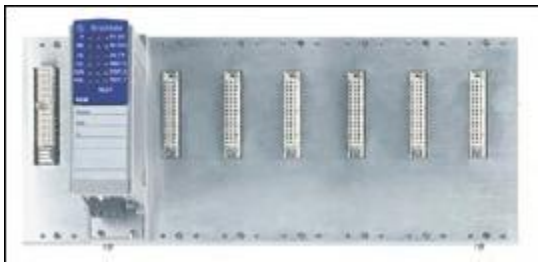


Figure 6 – MS30

3. Equipment and software validated

The following equipment and software were used for the sample configuration provided:

Equipment	Software
Avaya Ethernet Switches • Avaya Ethernet Routing Switch 8800 • Avaya Ethernet Routing Switch 5650	 • Software Release 7.1.3 • Software Release 6.2.1
Hirschmann™ Ethernet Switches • MACH1040 • RS30 • MS30	 • Software Release 06.0.02 • Software Release 06.0.02 • Software Release 06.0.02

4. Testing methodology

The Avaya Networking Test Lab conducted comprehensive tests using a methodology that verified connectivity under normal conditions and under various fault conditions. The testing consisted of using PCs connected to the Hirschmann™ switches (100Mbps Ethernet) and a PC connected to an ERS 5650 (100Mbps Ethernet). Pings were run between all the PCs in both directions. This ensured network connectivity to and through the core of the network.

A steady-state environment was tested where all devices were properly configured and connected as shown in each of the network topology figures. From this steady state, links and switches were failed to simulate network outages. These links and switches were then recovered simulating the restoration of the network. The results of each of these tests are detailed in the tables for each section. Please note that all tests were done simulating a single point of failure in the network. Multiple, simultaneous failures are out of the scope of these tests.

Avaya tested the solution under different scenarios, which are described in the following sections:

- ERS 8800 single connection to Hirschmann™ switches
- ERS 8800 MLT connection to Hirschmann™ Switches
- ERS 8800 switch cluster connection to Hirschmann™ Switch

5. ERS 8800 single connection to Hirschmann™ switches

The objective of this test is to establish connectivity between the ERS 8800 and the Hirschmann™ switches used in this testing.

The following figure represents the topology for this test:

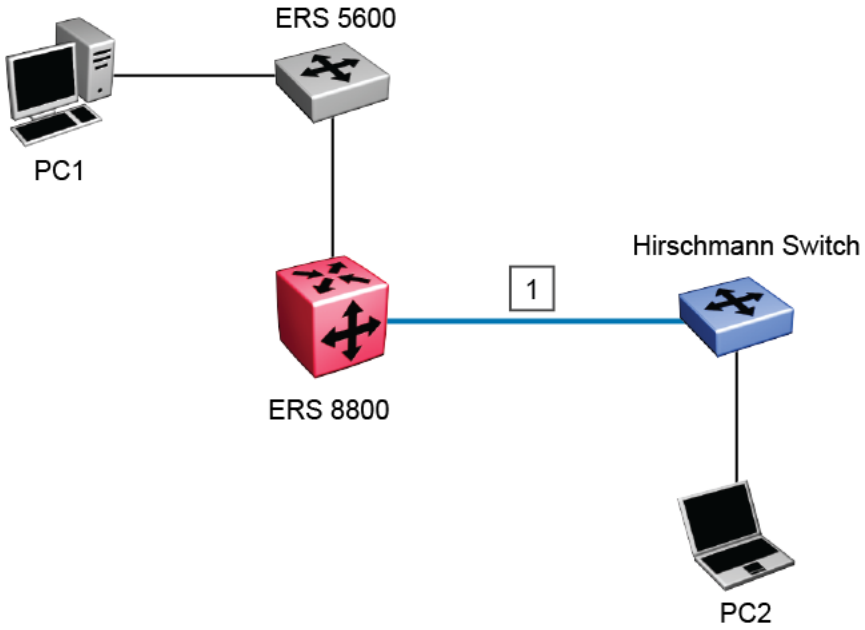


Figure 7 – ERS 8800 Single Connection to Hirschmann™ Switches

5.1 Procedure steps

1. Set up a single connection between the ERS 8800 and the Hirschmann™ MACH1040.
2. Test basic interoperability of link auto-negotiation (half/full duplex and 10/100/1000 Mbps).
3. Test on both copper and fiber ports.
4. Connect the ERS 8800 to the Hirschmann™ RS30 and repeat steps 2 and 3.
5. Connect the ERS 8800 to the Hirschmann™ MS30 and repeat steps 2 and 3.

Note: This test uses Port 2/13 as the connection to the Hirschmann™ switches. It also uses only one VLAN (VLAN 1000).

5.2 Test results

The following table shows the test results:

Test Cases	Test Results		
	MACH1040	RS30	MS30
Autonegotiation ERS8800 → Hirschmann™ (copper)	Pass	Pass	Pass
No Autonegotiation ERS8800 → Hirschmann™ (copper)	Pass	Pass	Pass
Ping PC1 ↔ PC2 (both directions, copper)	Pass	Pass	Pass
Fail Link 1 (remove cable from port)	Pass	Pass	Pass
Recover Link 1 (plug cable back into port)	Pass	Pass	Pass
ERS8800 → Hirschmann™ (fiber)	Pass	Pass	Pass
Ping PC1 ↔ PC2 (both directions, fiber)	Pass	Pass	Pass
Fail Link 1 (remove fiber from port)	Pass	Pass	Pass
Recover Link 1 (plug fiber back into port)	Pass	Pass	Pass

Multicast Test Cases for MACH1040 only	Test Results
Multicast stream from PC1 to PC2, IGMPv1	Pass[1]
Multicast stream from PC1 to PC2, IGMPv2	Pass[1]
Multicast stream from PC1 to PC2, IGMPv3	Pass[1]

Table 1 ERS 8800 Switch Single Connection to Hirschmann™ Switches

Note

1. The IGMP Querier that's active on the Hirschmann™ MACH switch allows only the system interface to be the querier. Therefore, for Multicast test cases, Active Querier and IGMP Snooping is enabled on the ERS 8800.

5.3 ACLI configuration

The following configuration shows how to configure the ERS 8800 with the ACLI:

1 Enter *Interface Configuration* mode for port 2/13:

```
8800(config)#interface FastEthernet 2/13
```

2 Disable Autonegotiation on port 2/13:

```
8800(config-if)#speed 100
8800(config-if)#duplex full
```

3 Enable Autonegotiation on port 2/13:

```
8800(config-if)#speed auto
8800(config-if)#duplex auto
```

4 Enable IGMPv1 on VLAN 1000:

```
8800(config)#interface vlan 1000
8800(config-if)#ip igmp
8800(config-if)#ip igmp snooping
8800(config-if)#ip igmp version 1
8800(config-if)#ip igmp mrouter 2/13
```

5 Enable IGMPv2 on VLAN 1000:

```
8800(config-if)#ip igmp version 2
```

6 Enable IGMPv3 on VLAN 1000:

```
8800(config-if)#ip igmp version 3
```

7 Enter *Global Configuration mode*:

```
8800(config-if)#exit
```

8 Configure SSM globally:

```
8800(config)# ip pim mode ssm
```

9 Configure an SSM channel:

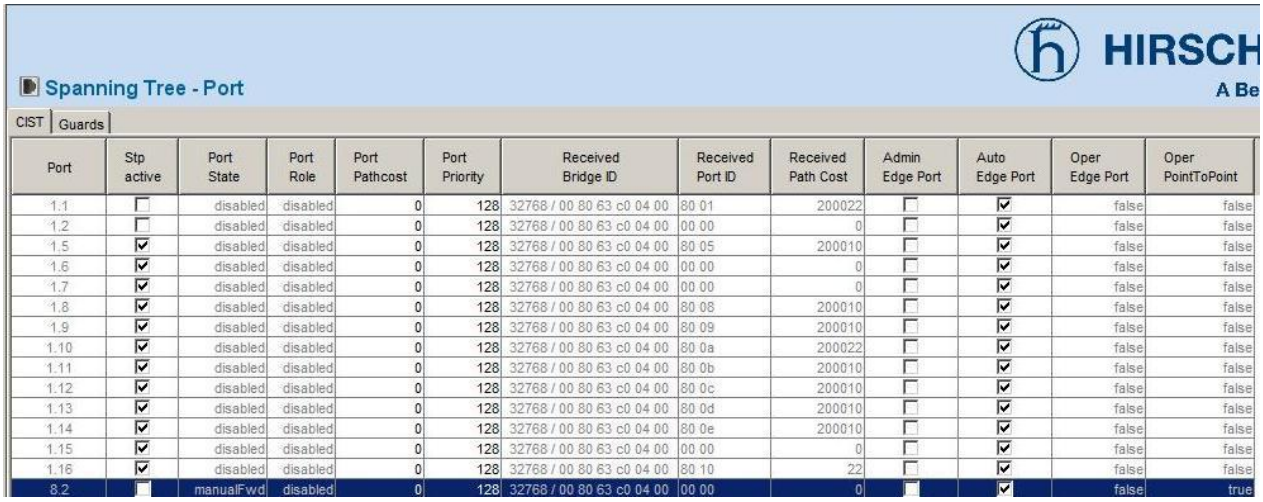
```
8800(config)# ip igmp ssm-map all
```

5.4 GUI configuration

The following sections show how to configure the MACH1040 and the ERS 8800 with the GUI.

5.4.1 Configuring the MACH1040

1 Disable Spanning Tree on the MACH1040:

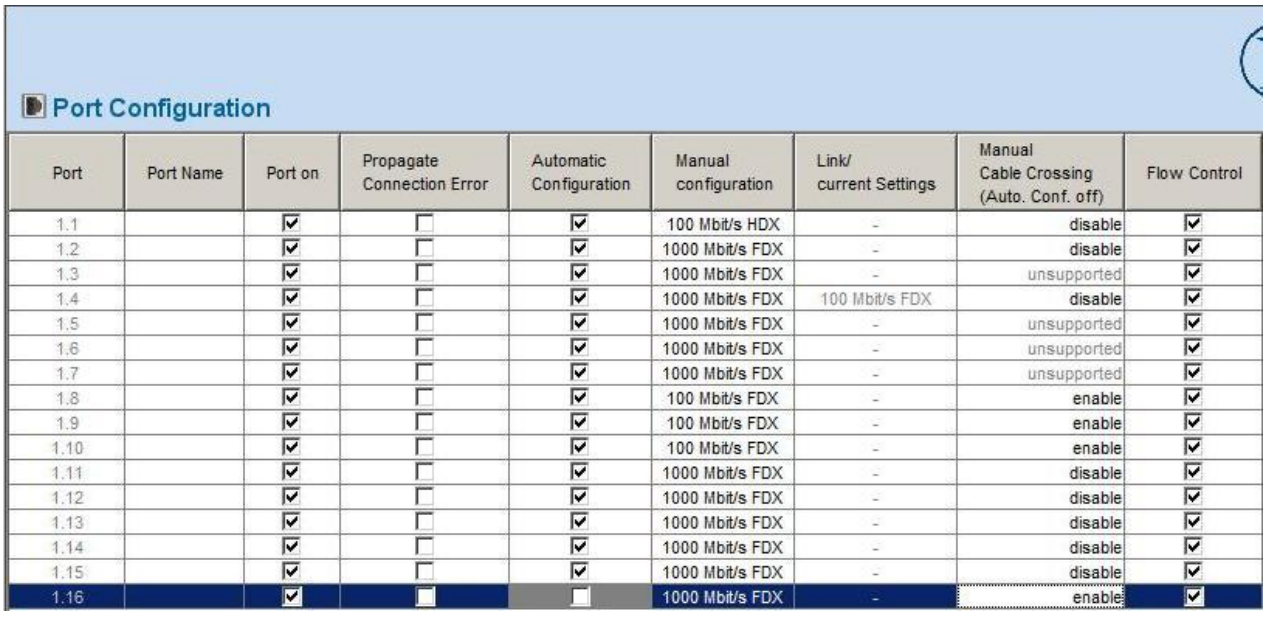


Spanning Tree - Port

CIST | Guards

Port	Stp active	Port State	Port Role	Port Pathcost	Port Priority	Received Bridge ID	Received Port ID	Received Path Cost	Admin Edge Port	Auto Edge Port	Oper Edge Port	Oper PointToPoint
1.1	☐	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 01	200022	☐	☑	false	false
1.2	☐	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	00 00	0	☐	☑	false	false
1.5	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 05	200010	☐	☑	false	false
1.6	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	00 00	0	☐	☑	false	false
1.7	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	00 00	0	☐	☑	false	false
1.8	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 08	200010	☐	☑	false	false
1.9	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 09	200010	☐	☑	false	false
1.10	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 0a	200022	☐	☑	false	false
1.11	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 0b	200010	☐	☑	false	false
1.12	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 0c	200010	☐	☑	false	false
1.13	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 0d	200010	☐	☑	false	false
1.14	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 0e	200010	☐	☑	false	false
1.15	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	00 00	0	☐	☑	false	false
1.16	☑	disabled	disabled	0	128	32768 / 00 80 63 c0 04 00	80 10	22	☐	☑	false	false
8.2	☐	manualFwd	disabled	0	128	32768 / 00 80 63 c0 04 00	00 00	0	☐	☑	false	true

2 Disable Autonegotiation on the MACH1040:



Port Configuration

Port	Port Name	Port on	Propagate Connection Error	Automatic Configuration	Manual configuration	Link/ current Settings	Manual Cable Crossing (Auto. Conf. off)	Flow Control
1.1		☑	☐	☑	100 Mbit/s HDX	-	disable	☑
1.2		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.3		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.4		☑	☐	☑	1000 Mbit/s FDX	100 Mbit/s FDX	disable	☑
1.5		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.6		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.7		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.8		☑	☐	☑	100 Mbit/s FDX	-	enable	☑
1.9		☑	☐	☑	100 Mbit/s FDX	-	enable	☑
1.10		☑	☐	☑	100 Mbit/s FDX	-	enable	☑
1.11		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.12		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.13		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.14		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.15		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.16		☑	☐	☐	1000 Mbit/s FDX	-	enable	☑

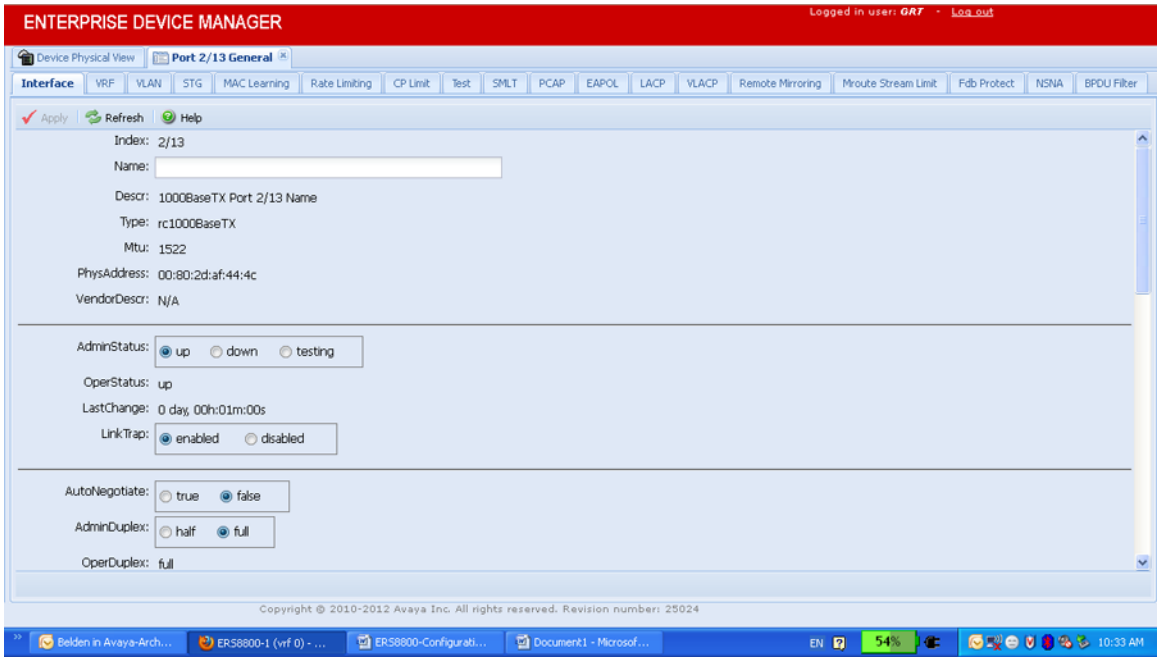
3 Enable Autonegotiation on the MACH1040:

Port Configuration

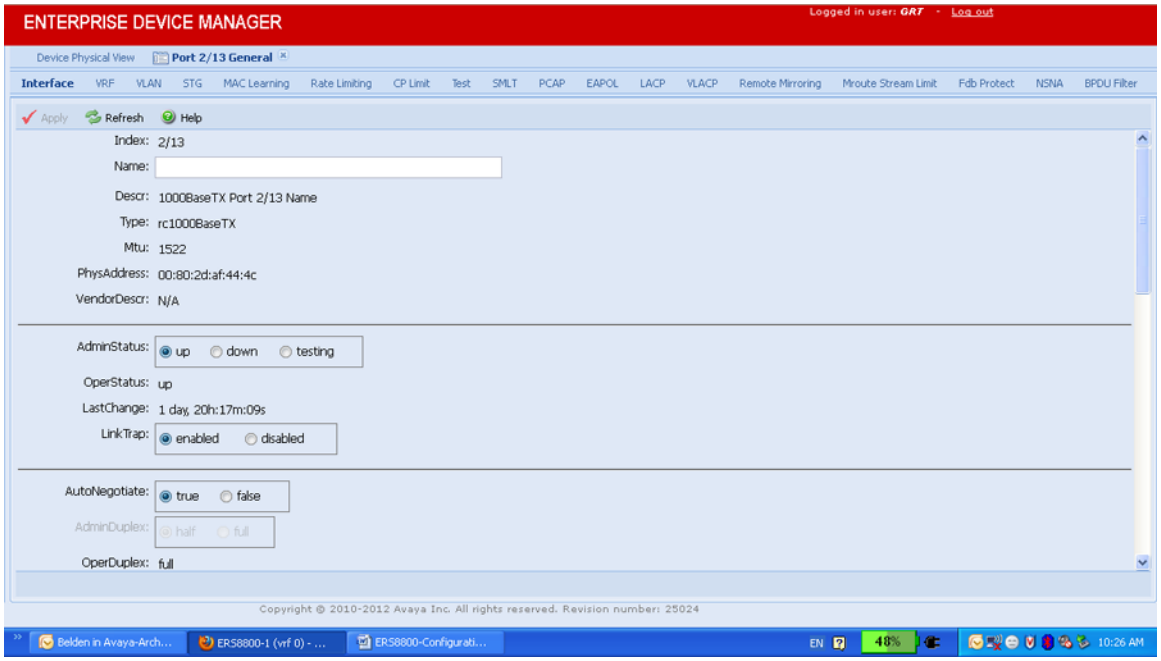
Port	Port Name	Port on	Propagate Connection Error	Automatic Configuration	Manual configuration	Link/ current Settings	Manual Cable Crossing (Auto. Conf. off)	Flow Control
1.1		☑	☐	☑	100 Mbit/s HDX	-	disable	☑
1.2		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.3		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.4		☑	☐	☑	1000 Mbit/s FDX	100 Mbit/s FDX	disable	☑
1.5		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.6		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.7		☑	☐	☑	1000 Mbit/s FDX	-	unsupported	☑
1.8		☑	☐	☑	100 Mbit/s FDX	-	enable	☑
1.9		☑	☐	☑	100 Mbit/s FDX	-	enable	☑
1.10		☑	☐	☑	100 Mbit/s FDX	-	enable	☑
1.11		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.12		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.13		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.14		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.15		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑
1.16		☑	☐	☑	1000 Mbit/s FDX	-	disable	☑

5.4.2 Configuring the ERS 8800

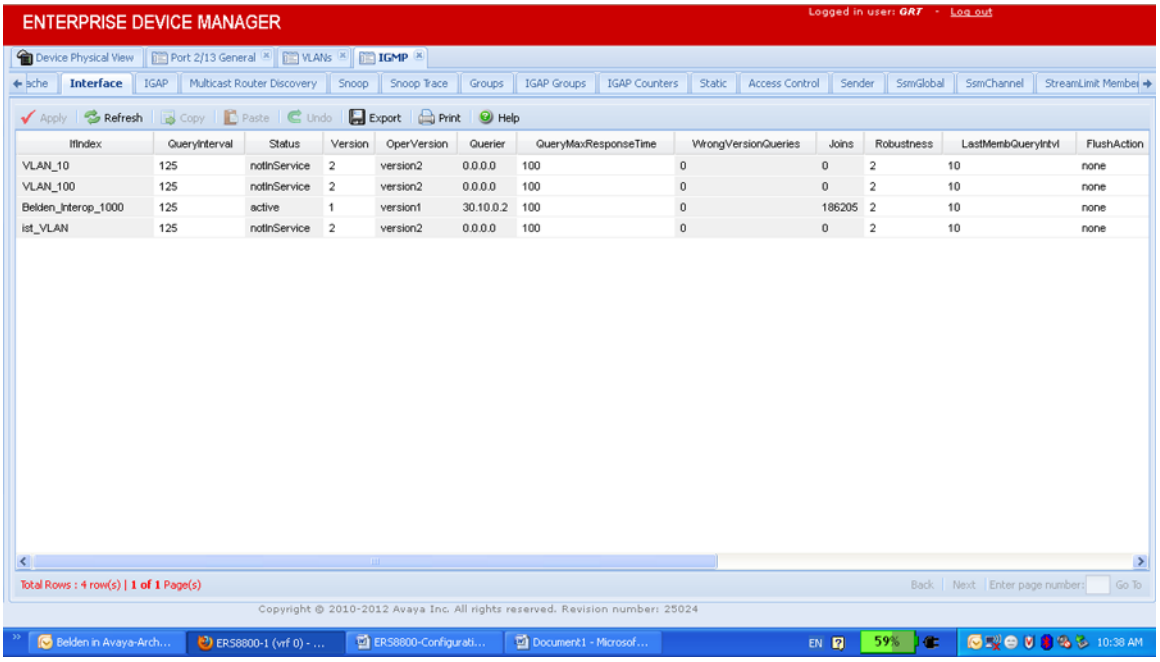
1 Disable Autonegotiation on port 2/13 from Edit > Port > General > Interface:



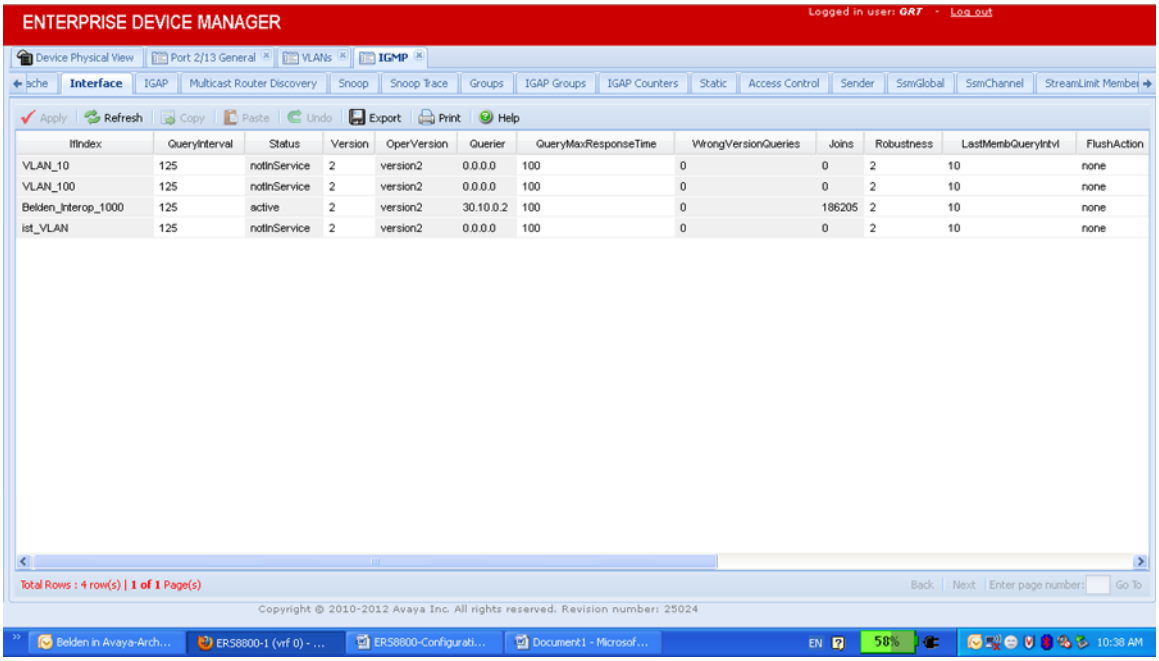
2 Enable Autonegotiation on port 2/13 from Edit > Port > General > Interface:



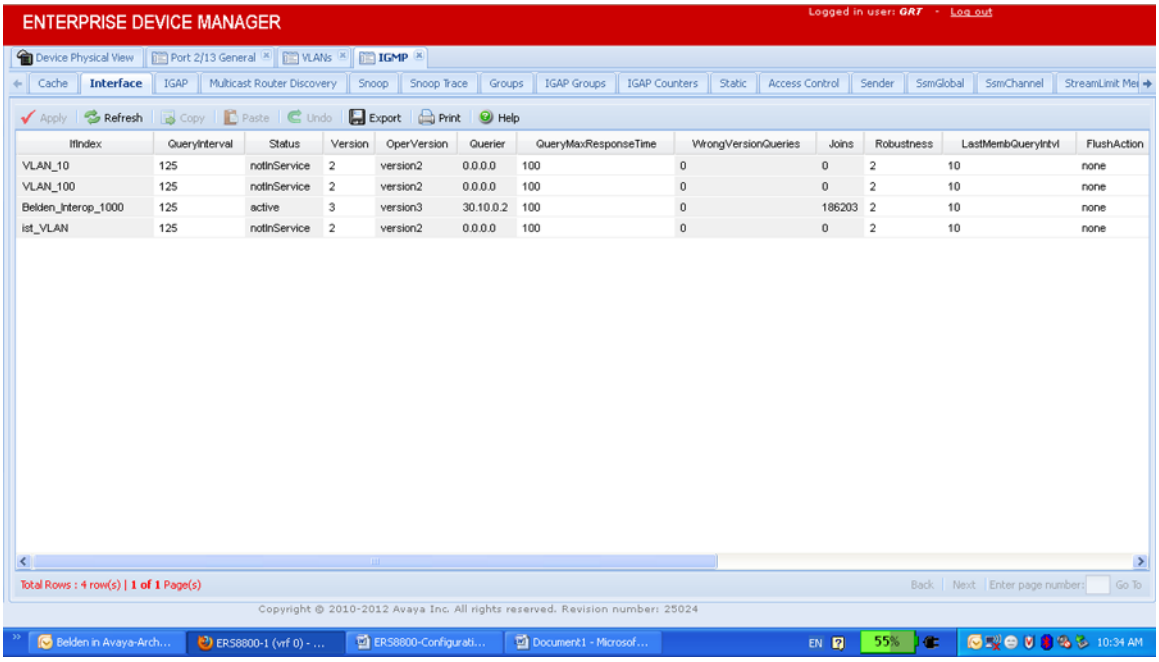
3 Enable IGMPv1 on VLAN 1000 from IP > IGMP > Interface:



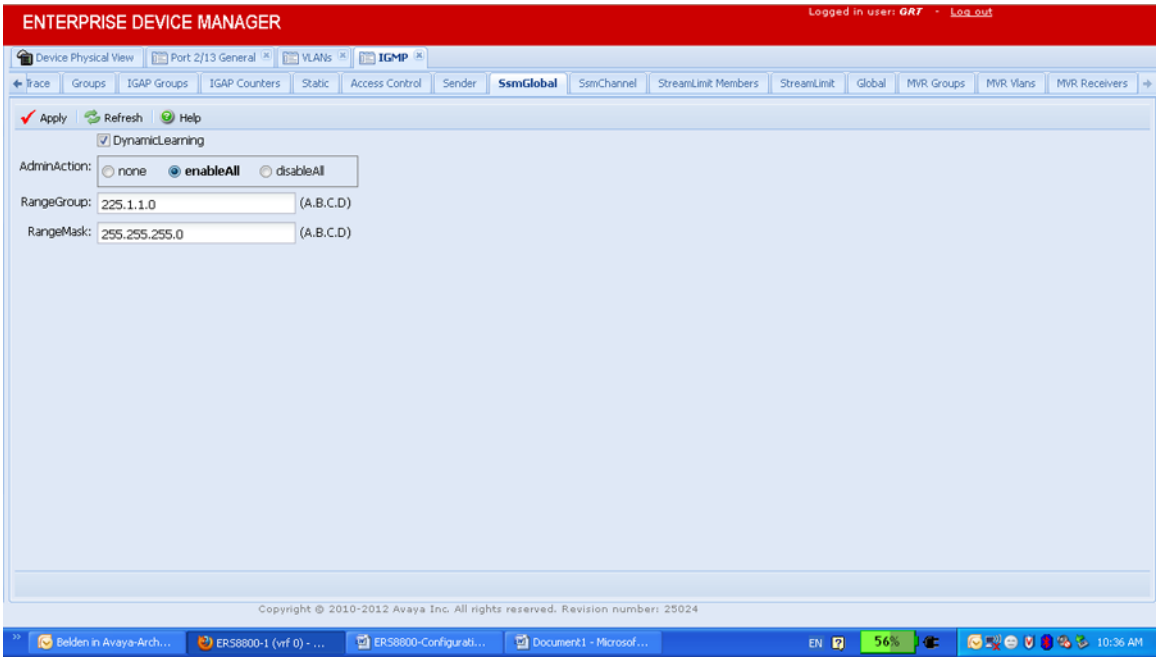
4 Enable IGMPv2 on VLAN 1000 from IP > IGMP > Interface:



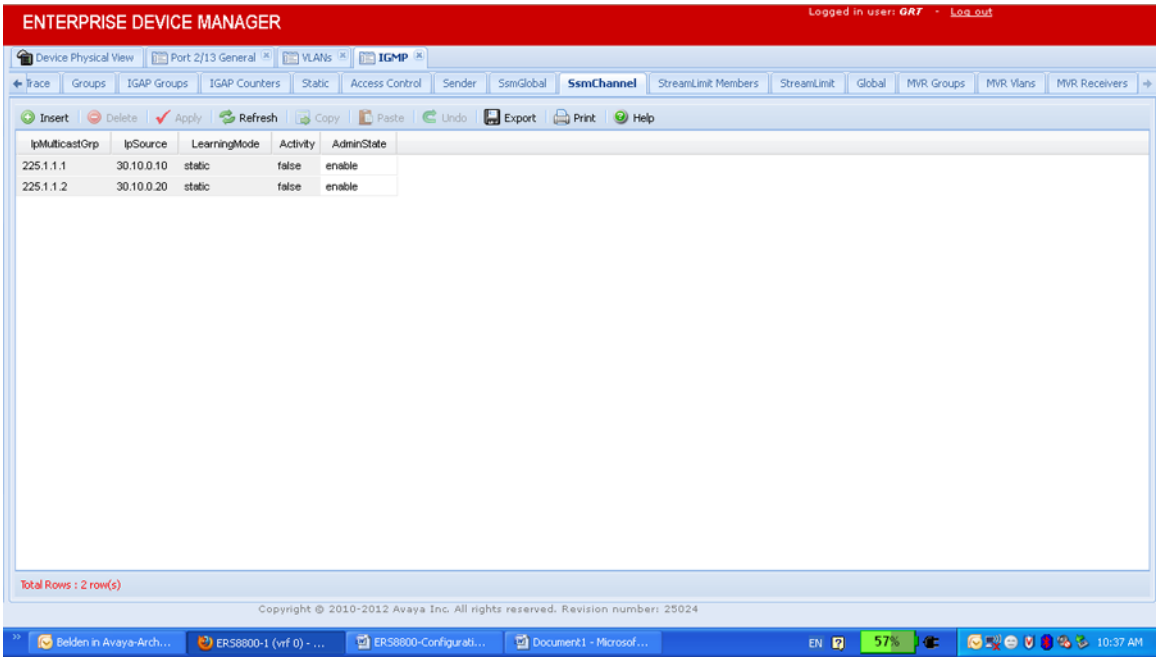
5 Enable IGMPv3 on VLAN 1000 from IP > IGMP > Interface:



6 Configure SSM globally from IP > IGMP > Ssm Global:



7 Configure an SSM channel from IP > IGMP > Ssm Channel:



6. ERS 8800 MLT connection to Hirschmann™ Switches

The objective of this test is to establish advanced Switch-to-Switch multiple connections using MLT. The connections are between the ERS 8800 and the Hirschmann™ MACH1040 and RS30 switches.

Note: The Hirschmann™ MICE switch (MS30) does not support Link Aggregation.

The following figure represents the topology for this test.

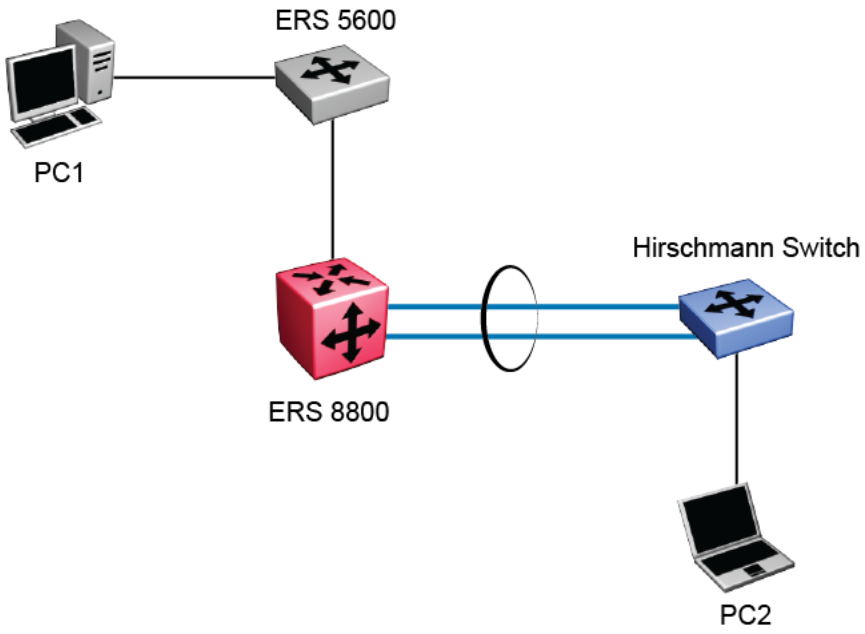


Figure 8 - ERS 8800 MLT and Hirschmann™ Link Aggregation

6.1 Procedure steps

1. Configure MLT ports on the ERS 8800.
2. Configure LACP on the Hirschmann™ switches.

6.2 Test results

The following table shows the test results:

Test Cases	Test Results	
	MACH1040	RS30
Autonegotiation ERS8800 → Hirschmann™ (copper)	Pass[2]	Pass[2]
No Autonegotiation ERS8800 → Hirschmann™ (copper)	Pass[2]	Pass[2]
Ping PC1 ↔PC2 (both directions, copper)	Pass	Pass
Partially fail MLT link (remove cable from port)	Pass	Pass
Recover the failed MLT link (plug cable back into port)	Pass	Pass
ERS8800 → Hirschmann™ (fiber)	Pass	Pass
Ping PC1 ↔ PC2 (both directions, fiber)	Pass	Pass
Partially fail MLT link (remove cable from port)	Pass	Pass
Recover the failed MLT link (plug cable back into port)	Pass	Pass

Multicast Test Cases for MACH1040 only	Test Results
Multicast stream from PC1 to PC2, IGMPv1	Pass[3]
Multicast stream from PC1 to PC2, IGMPv2	Pass[3]
Multicast stream from PC1 to PC2, IGMPv3	Pass[3]

Table 2 ERS 8800 Switch MLT and Hirschmann™ Link Aggregation

Notes

1. When configuring Link Aggregation on Hirschmann™ switches to interoperate with Avaya MLT, "Allow static link aggregation" must be enabled.

2. If the LAG configured on the Hirschmann™ MACH switch is not trunked (set 'U' for the trunk as the member of vlan 1000), and the MLT trunk on the ERS 8800 is not configured as 'access' mode, then you won't be able to connect to the network. You have to configure the trunk as 'tagged' mode on the switches on both sides to get connectivity.

3. The IGMP Querier that's active on the Hirschmann™ MACH switch allows only the system interface to be the querier. Therefore, for Multicast test cases, Active Querier and IGMP Snooping is enabled on the ERS 8800.

6.3 ACLI configuration

The following configuration shows how to configure the ERS 8800 with the ACLI:

Notes: This test uses two copper ports and two fiber ports.

- The copper MLT ports are 2/14 and 2/15.
- The fiber MLT ports are 7/14 and 7/15.
- The MLT name is MLT-20.
- Autonegotiation is always on the Fiber ports.

1 Enter *Interface Configuration* mode and disable Autonegotiation on Copper port 2/14:

```
8800(config)#interface FastEthernet 2/14
8800(config-if)#speed 100
8800(config-if)#duplex full
8800(config-if)#exit
```

2 Enter *Interface Configuration* mode and disable Autonegotiation on Copper port 2/15:

```
8800(config)#interface FastEthernet 2/15
8800(config-if)#speed 100
8800(config-if)#duplex full
8800(config-if)#exit
```

3 Create MLT-20 with Copper ports:

```
8800(config)#mlt 20 name "MLT-20" enable member 2/14-15 learning disable
```

4 Enter *Interface Configuration* mode and enable Autonegotiation on Copper port 2/14:

```
8800(config)#interface FastEthernet 2/14
8800(config-if)#speed auto
8800(config-if)#duplex auto
8800(config-if)#exit
```

5 Enter *Interface Configuration* mode and enable Autonegotiation on Copper port 2/15:

```
8800(config)#interface FastEthernet 2/15
8800(config-if)#speed auto
8800(config-if)#duplex auto
8800(config-if)#exit
```

6 Enter *Interface Configuration* mode and enable Autonegotiation on Fiber port 7/14:

```
8800(config)#interface GigabitEthernet 7/14
8800(config-if)#speed auto
8800(config-if)#duplex auto
8800(config-if)#exit
```

7 Enter *Interface Configuration* mode and enable Autonegotiation on Fiber port 7/15:

```
8800(config)#interface GigabitEthernet 7/15
8800(config-if)#speed auto
8800(config-if)#duplex auto
8800(config-if)#exit
```

8 Create MLT-20 with Fiber ports:

```
8800(config)#mlt 20 name "MLT-20" enable member 7/14-15 learning disable
```

9 Enable IGMPv1 on VLAN 1000:

```
8800(config)#interface vlan 1000
8800(config-if)#ip igmp
8800(config-if)#ip igmp snooping
8800(config-if)#ip igmp version 1
8800(config-if)#ip igmp mrouter 7/14-15
8800(config-if)#exit
```

10 Enable IGMPv2 on VLAN 1000:

```
8800(config)#interface vlan 1000
8800(config-if)#ip igmp version 2
8800(config-if)#exit
```

11 Enable IGMPv3 on VLAN 1000:

```
8800(config)#interface vlan 1000
8800(config-if)#ip igmp version 3
8800(config-if)#exit
```

12 Configure SSM globally:

```
8800(config)#ip pim mode ssm
```

13 Configure an SSM channel:

```
8800(config)# ip igmp ssm-map all
```

6.4 GUI configuration

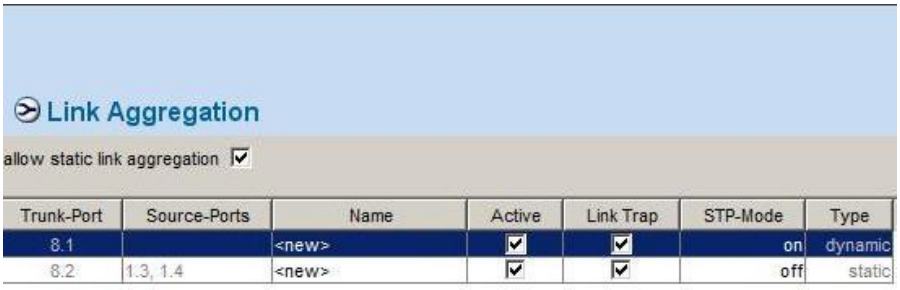
The following sections show how to configure the MACH1040 and the ERS 8800 with the GUI.

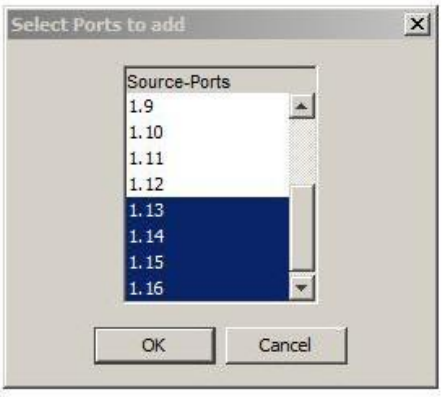
Note: This test uses four copper ports and four fiber ports.

- The copper MLT ports are 1/45-1/48.
- The fiber MLT ports are 2/1-2/4.
- MLT 1 is the Copper MLT.
- MLT 2 is the Fiber MLT.
- Autonegotiation is always on the Fiber ports.

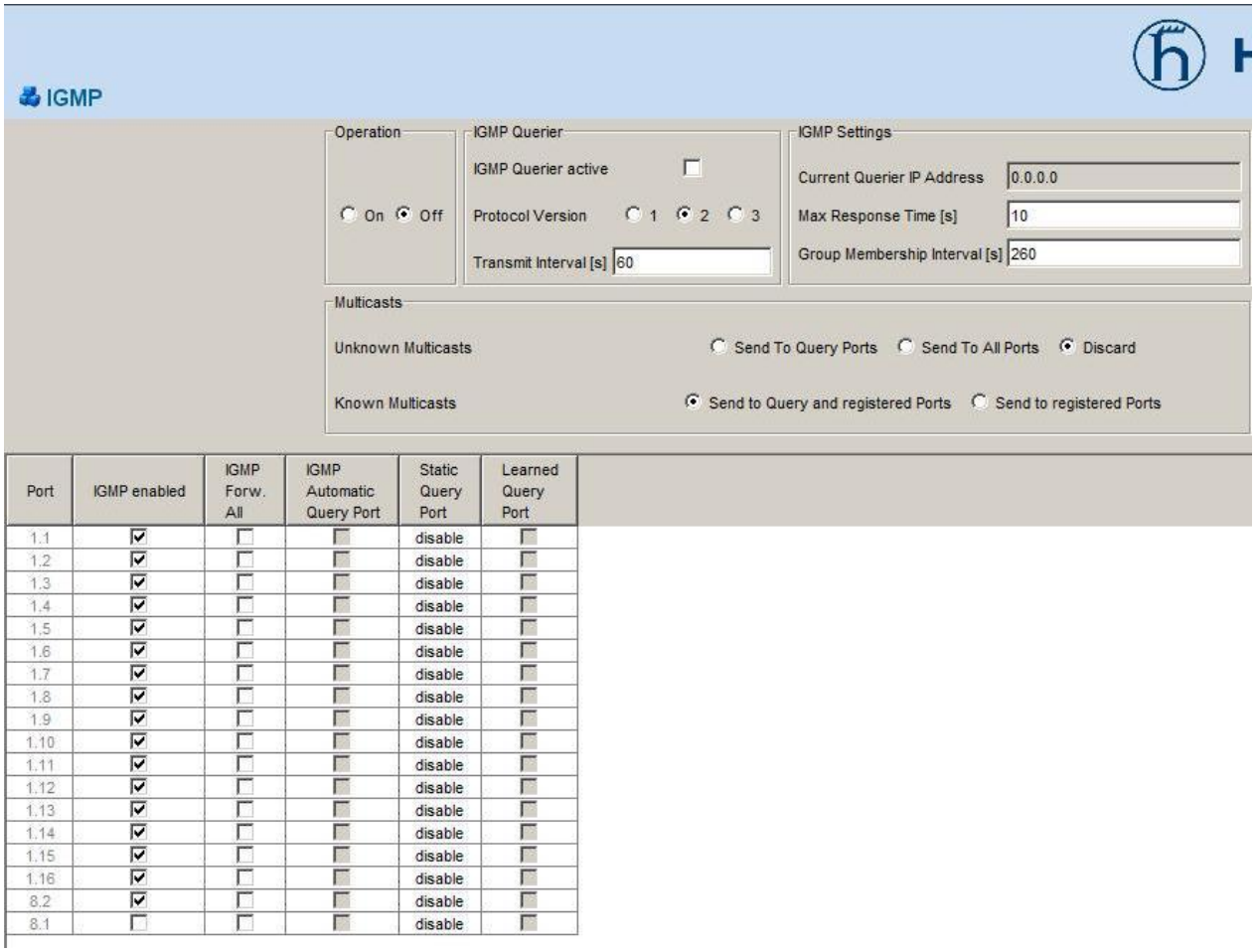
6.4.1 Configuring the MACH1040

1 Enable Link Aggregation on the MACH1040:





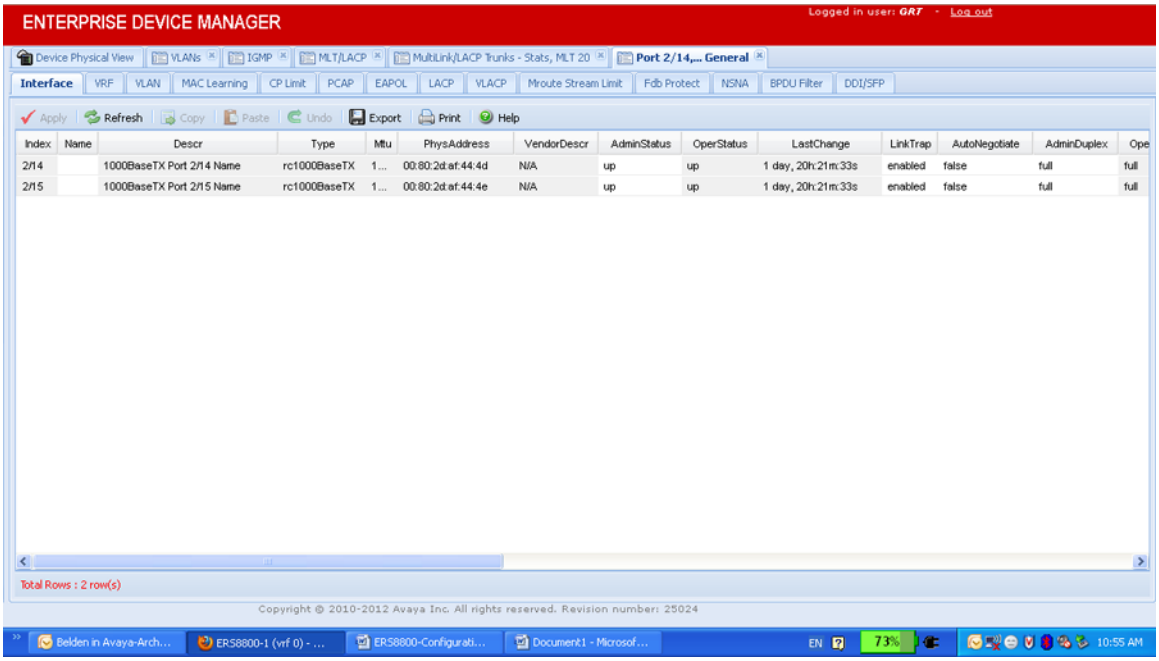
2 Disable IGMP on the MACH1040:



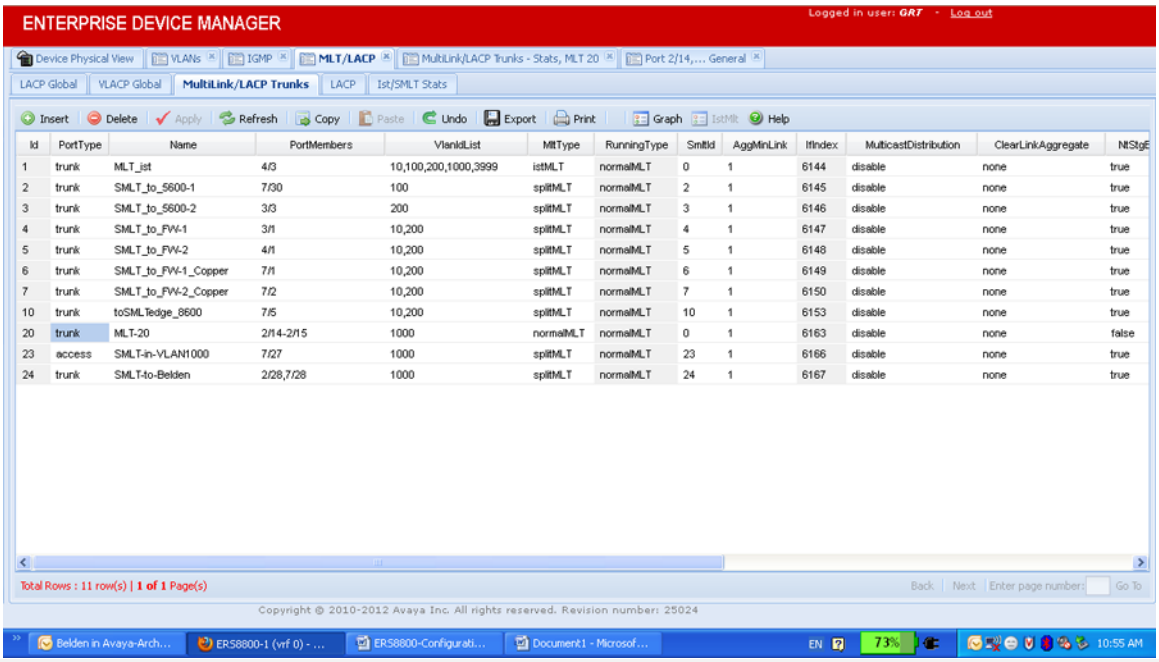
Port	IGMP enabled	IGMP Forw. All	IGMP Automatic Query Port	Static Query Port	Learned Query Port
1.1	☑	☐	☐	disable	☐
1.2	☑	☐	☐	disable	☐
1.3	☑	☐	☐	disable	☐
1.4	☑	☐	☐	disable	☐
1.5	☑	☐	☐	disable	☐
1.6	☑	☐	☐	disable	☐
1.7	☑	☐	☐	disable	☐
1.8	☑	☐	☐	disable	☐
1.9	☑	☐	☐	disable	☐
1.10	☑	☐	☐	disable	☐
1.11	☑	☐	☐	disable	☐
1.12	☑	☐	☐	disable	☐
1.13	☑	☐	☐	disable	☐
1.14	☑	☐	☐	disable	☐
1.15	☑	☐	☐	disable	☐
1.16	☑	☐	☐	disable	☐
8.2	☑	☐	☐	disable	☐
8.1	☐	☐	☐	disable	☐

6.4.2 Configuring the ERS 8800

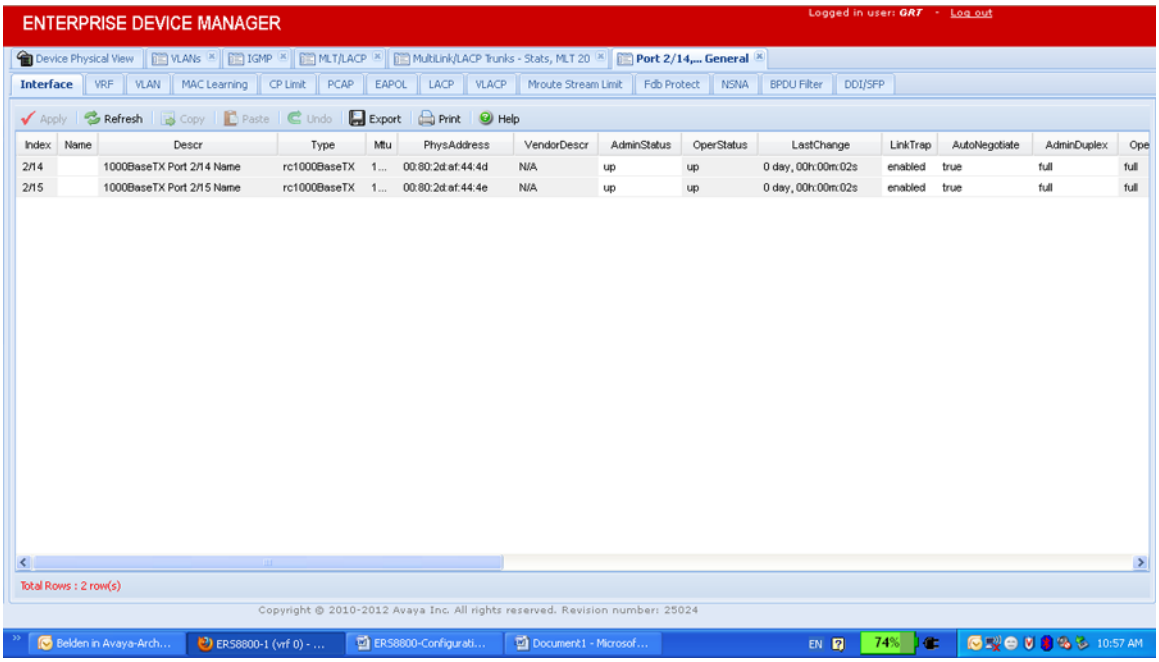
1 Disable Autonegotiation on ports 2/14 and 2/15 from Edit > Port > General > Interface:



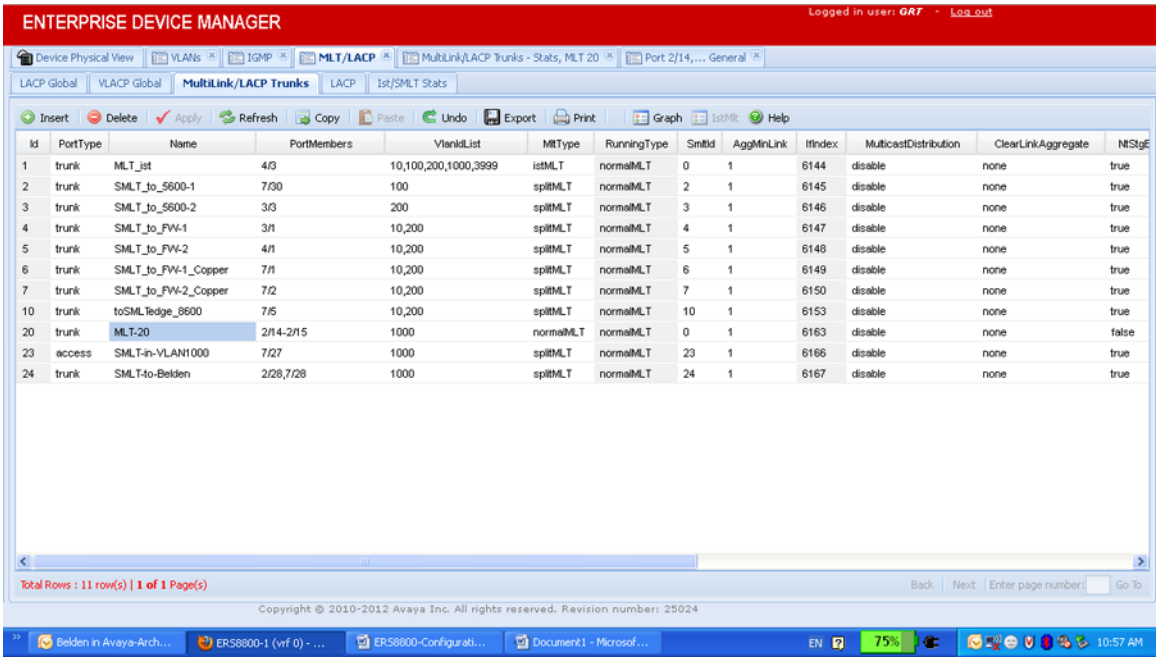
2 Create MLT-20 and add ports 2/14-15 from VLAN > MLT/LACP > MultiLink/LACP Trunks:



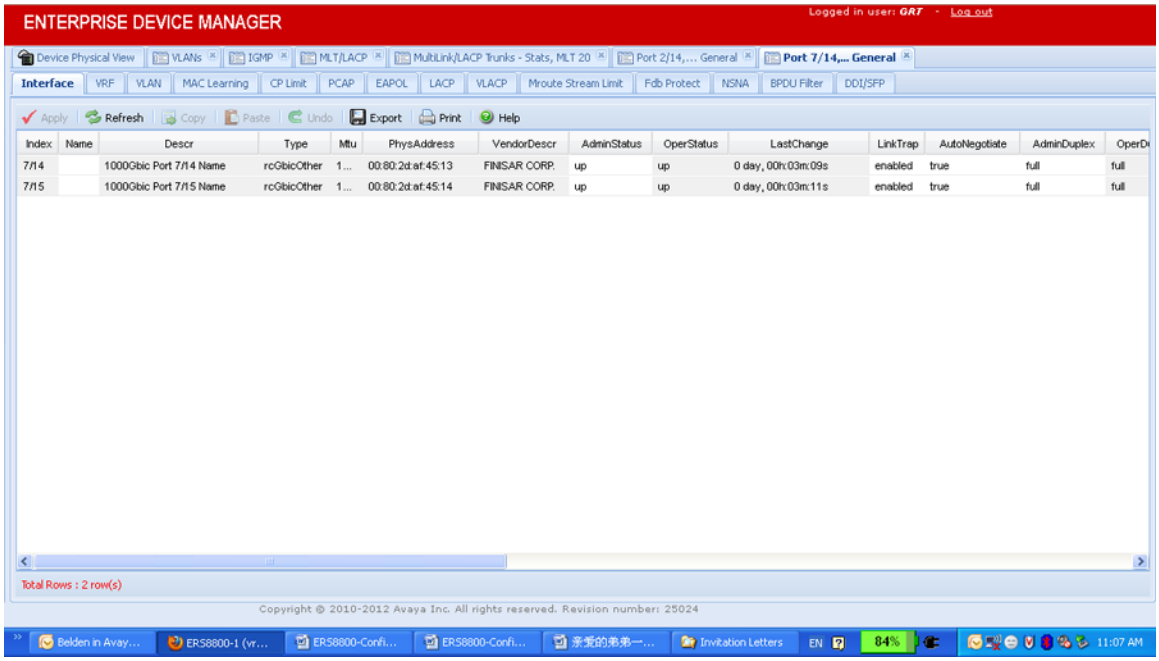
3 Enable Autonegotiation on ports 2/14 and 2/15 from Edit > Port > General > Interface:



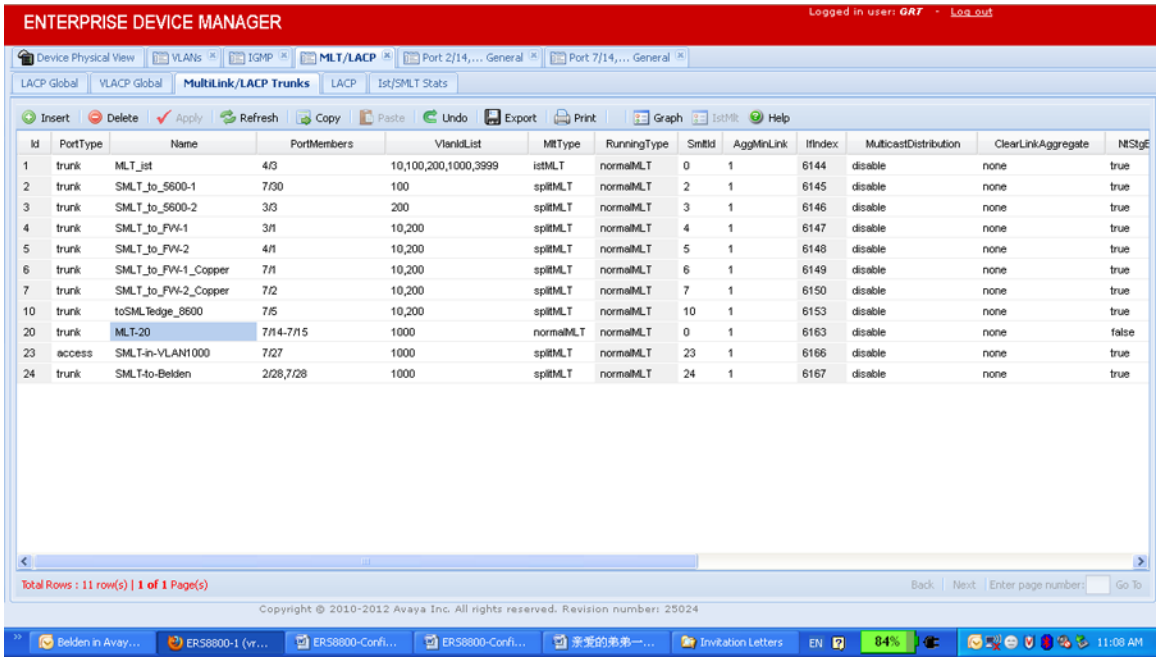
4 Enable Autonegotiation on MLT-20 from VLAN > MLT/LACP > MultiLink/LACP Trunks:



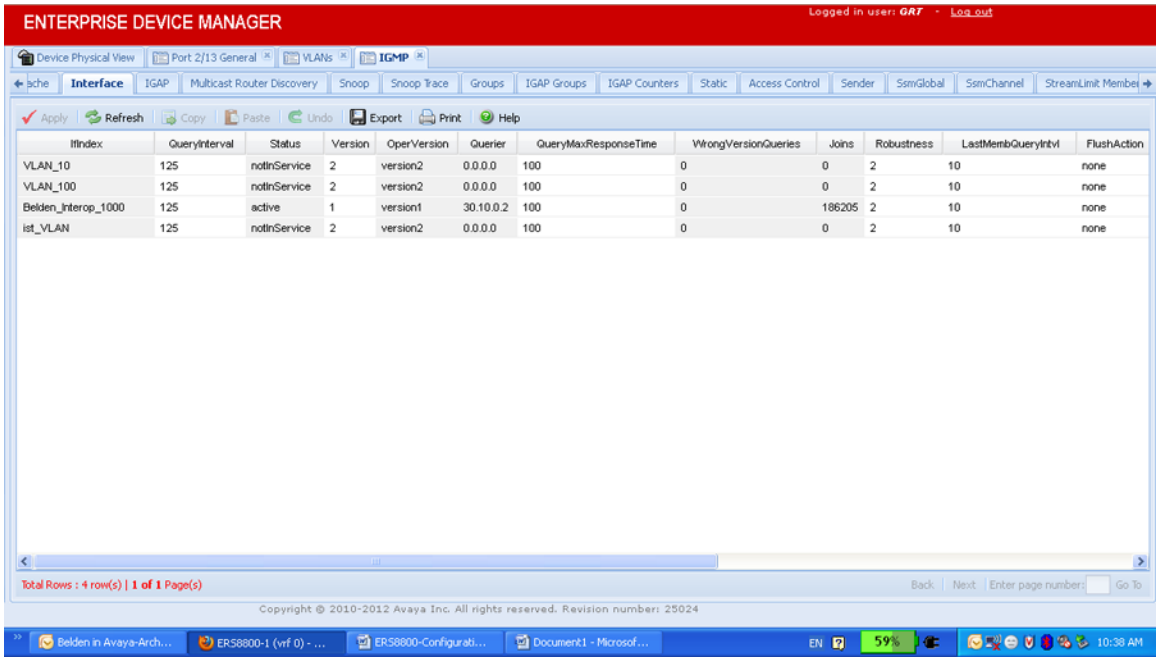
5 Enable Autonegotiation on fiber ports 7/14 and 7/15 from Edit > Port > General > Interface:



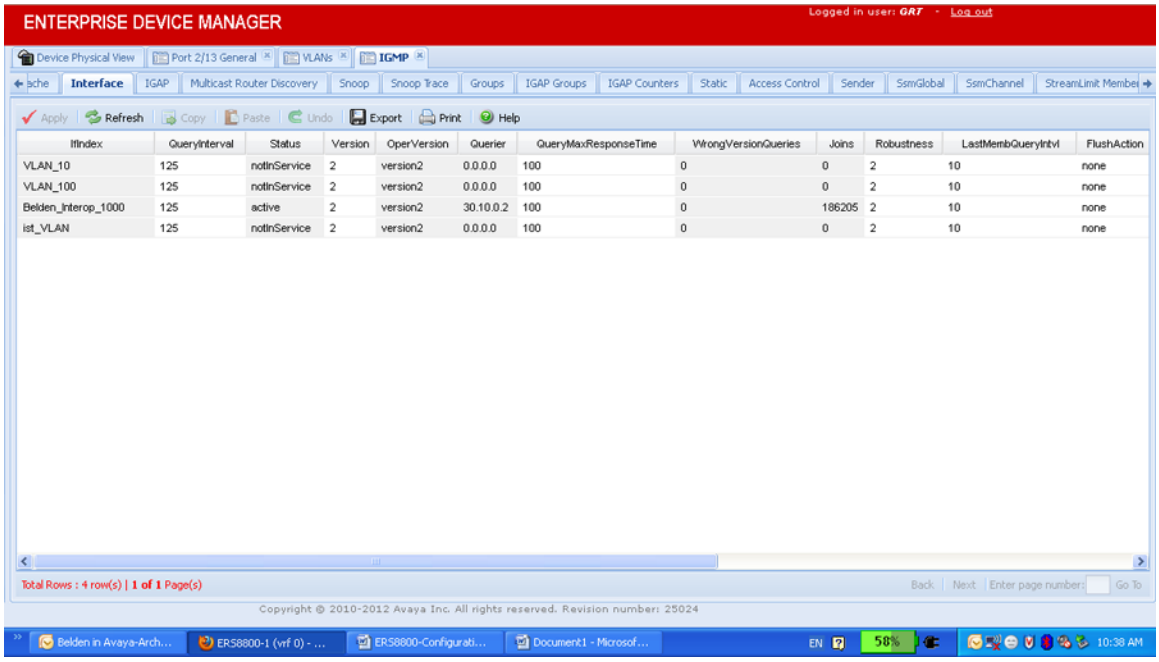
6 Enable Autonegotiation on MLT-20 with fiber ports from VLAN > MLT/LACP > MultiLink/LACP Trunks:



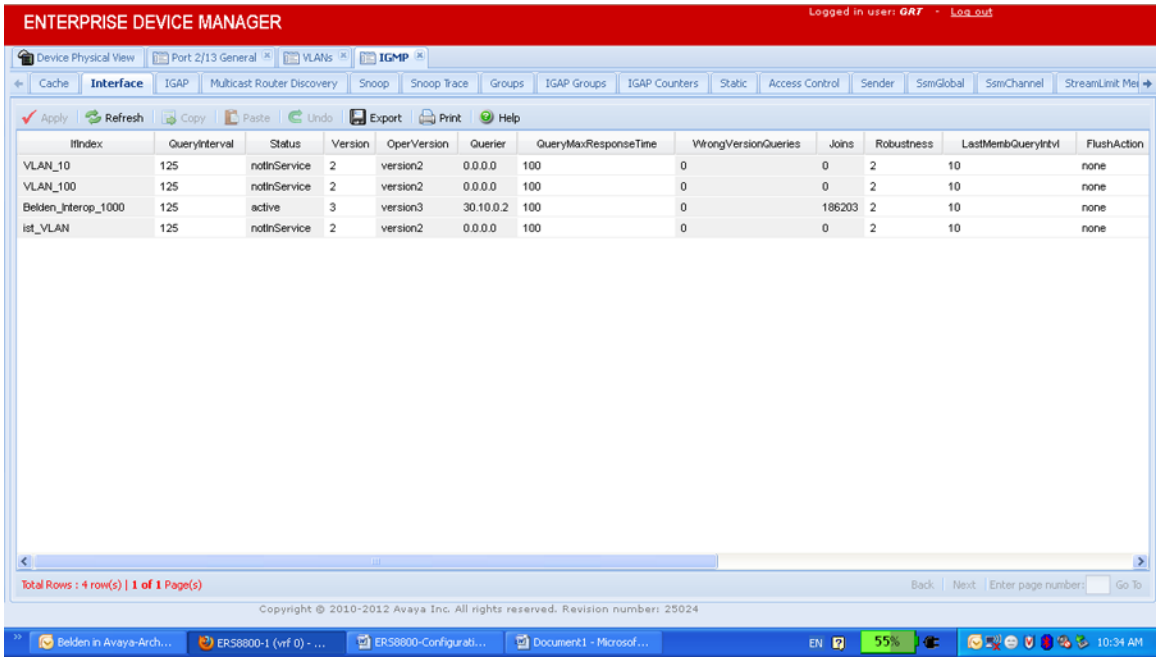
7 Enable IGMPv1 on VLAN 1000 from IP > IGMP > Interface:



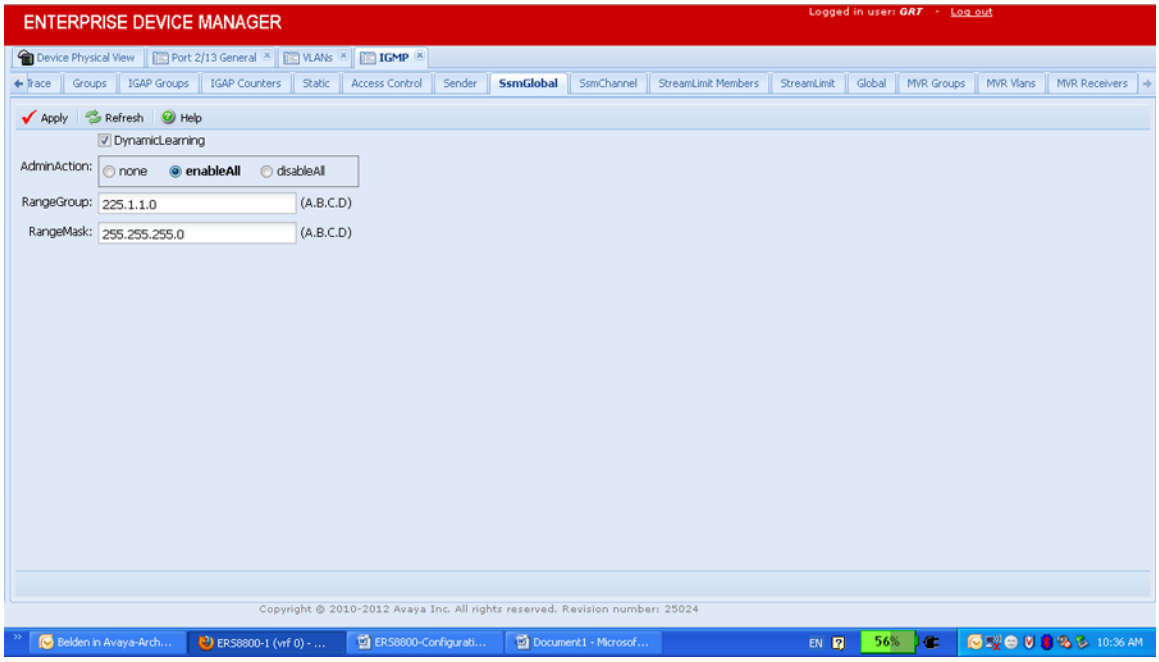
8 Enable IGMPv2 on VLAN 1000 from IP > IGMP > Interface:



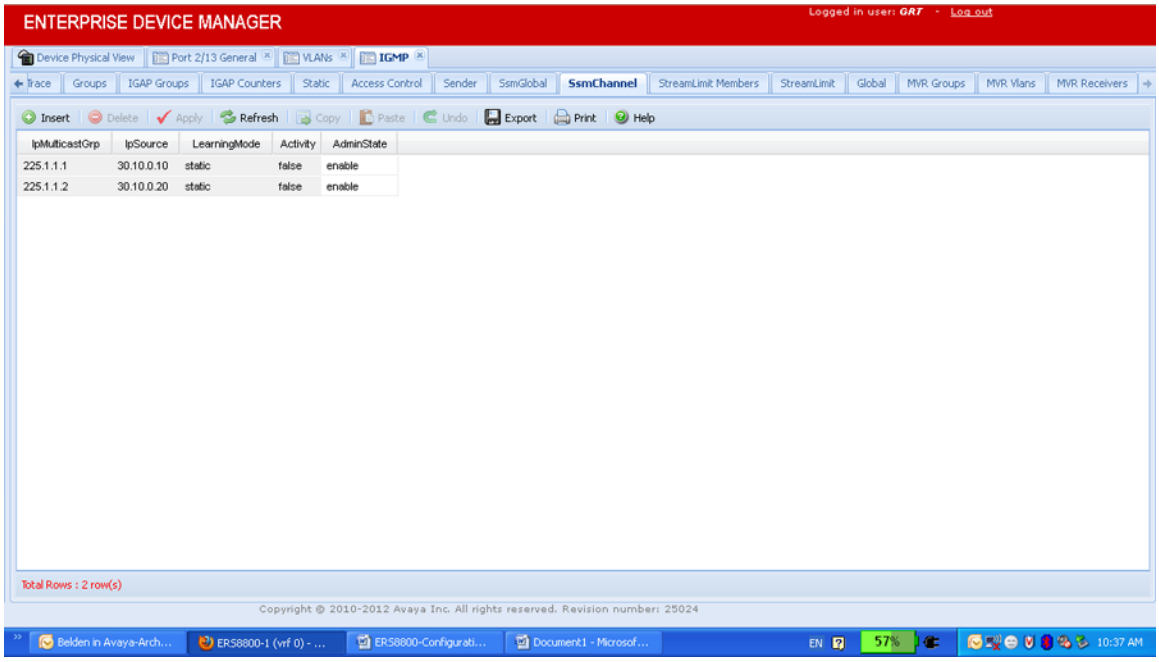
9 Enable IGMPv3 on VLAN 1000 from IP > IGMP > Interface:



10 Configure SSM globally from IP > IGMP > Ssm Global:



11 Configure an SSM channel from IP > IGMP > Ssm Channel:



7. ERS 8800 switch cluster connection to Hirschmann™ Switch

The objective of this test is to configure two ERS 8800s as a Layer 3 Switch Cluster that aggregates individual Hirschmann™ switches configured for 802.3ad link aggregation. The connections are between the ERS 8800s and the Hirschmann™ MACH1040 and RS30 switches.

Note: The Hirschmann™ MICE switch (MS30) does not support Link Aggregation.

The following figure represents the topology for this test.

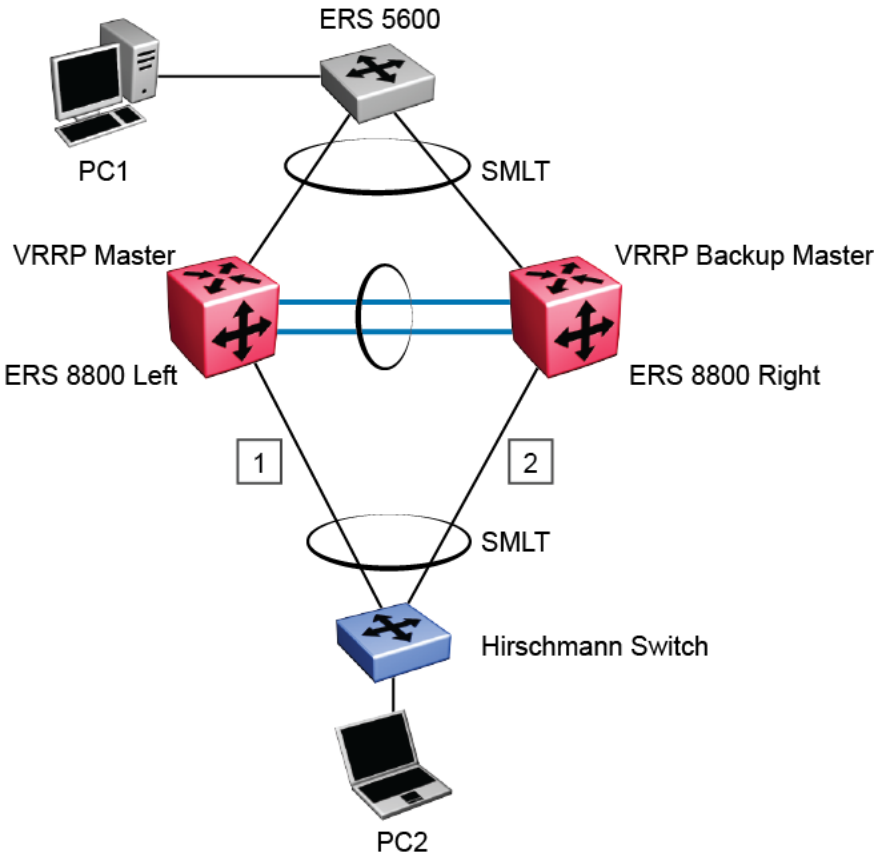


Figure 9 - ERS 8800 Switch Cluster to Individual Hirschmann™ Switches

7.1 Procedure steps

The third IE solution design utilized the aggregating individual Hirschmann™ switches configured for 802.3ad link aggregation (not supported on MICE). Test on both copper and fiber connections. The following represents the topology:

1. Configure the ERS 8800s as an L3 Switch Cluster.
2. Disable IGMP on the Hirschmann™ switches.
3. Enable LACP on the Hirschmann™ switches.

7.2 Test results

The following table shows the test results:

Test Cases	Test Result	
	MACH1040	RS30
Autonegotiation ERS8800 → Hirschmann™ (copper)	Pass	Pass
No Autonegotiation ERS8800 → Hirschmann™ (copper)	Pass	Pass
Ping PC1 ↔ PC2 (both directions, copper)	Pass	Pass
Fail link 1 (remove cable from port)	Pass: 1 ping lost	Pass: 1 ping lost
Recover link 1 (plug cable back into port)	Pass: 1 ping lost	Pass: 1 ping lost
Power off ERS8800 Left switch	Pass	Pass
Power on ERS8800 Left switch	Pass	Pass
Power off ERS8800 Right switch	Pass	Pass
Power on ERS8800 Right switch	Pass	Pass
ERS8800 → Hirschmann™ (fiber)	Pass	Pass
Ping PC1 ↔ PC2 (both directions, fiber)	Pass	Pass
Fail link 2 (remove cable from port)	Pass	Pass
Recover link 2 (plug cable back into port)	Pass	Pass
Power off ERS8800 Left switch	Pass: 1 ping lost	Pass: 1 ping lost
Power on ERS8800 Left switch	Pass	Pass
Power off ERS8800 Right switch	Pass	Pass
Power on ERS8800 Right switch	Pass	Pass

Multicast Test Cases for MACH only	Test Results
Multicast stream from PC1 to PC2, IGMPv1	Pass[1]
Multicast stream from PC1 to PC2, IGMPv2	Pass[1]
Multicast stream from PC1 to PC2, IGMPv3	Pass[1]

Table 3 ERS 8800 Switch Clustering and Hirschmann™ Link Aggregation

Note

1. The IGMP Querier that's active on the Hirschmann™ MACH switch allows only the system interface to be the querier. Therefore, for Multicast test cases, Active Querier and IGMP Snooping is enabled on the ERS 8800.

7.3 ACLI configuration

For these tests, there are three switches to configure: ERS 8800-Left, ERS 8800-Right, and the MACH1040.

7.3.1 ERS 8800-Left

Note: This test designates 8800A as ERS8800-Left.

- IST to 8800-Right is Copper MLT port 4/3, VLAN 3999
- SMLT to ERS 5650 Fiber MLT port 7/27, VLAN 1000
- SMLT to Hirschmann™ are Copper/Fiber MLT ports 2/28 and 7/28, VLAN 1000
- IP Routing is enabled
- VRRP is enabled

1 Enter *Configuration* mode and create IST VLAN 3999:

```
8800A (config)#vlan create 3999 name IstVlan type port
8800A (config)#vlan members remove 1 4/3
8800A (config)#vlan members add 3999 4/3
```

2 Create Access VLAN 1000

```
8800A (config)#vlan create 2 name To5650Vlan type port
8800A (config)#vlan members remove 1 7/27
8800A (config)#vlan members add 1000 7/27
/27
```

3 Create Trunk VLAN 1000

```
8800A (config)#vlan create 3 name ToHirschmannVlan type port
8800A (config)#vlan members remove 1 2/28,7/28
8800A (config)#vlan members add 1000 2/28,7/28
```

4 Create IST IP interface, IST MLT, and IST Peer

```
8800A (config)#interface vlan 3999
8800A (config-if)#ip address 12.12.12.2 255.255.255.252
8800A (config-if)#exit
8800A (config)#mlt 1 name IST enable member 4/3
8800A (config)#interface mlt 1
8800A (config-if)#ist enable peer-ip 12.12.12.1 vlan 3999
```

5 Create VLAN 1000 IP Interface

```
8800A (config)#interface vlan 1000
8800A (config-if)#ip address 2.2.2.2 255.255.255.0
```

6 Create SMLT-to-ERS5650 MLT

```
8800A (config)#mlt 23 name SMLT-to-ERS5650 enable member 7/27 learning disable
8800A (config)#interface mlt 23
8800A (config-if)#smlt 23
```

7 Create SMLT-to-Hirschmann MLT

```
8800A (config)#mlt 24 name SMLT-to-Hirschmann enable member 2/28,7/28 learning disable
8800A (config)#interface mlt 24
8800A (config-if)#smlt 24
```

8 Globally Enable IP Routing and VRRP

```
8800A (config)#ip routing
8800A (config)#router vrrp enable
```

9 Enable IP routing and create VRRP for VLAN 1000 IP Interface

```
8800A (config)#interface vlan 1000
8800A (config-if)#ip routing
8800A (config-if)#ip vrrp address 1000 2.2.2.1
8800A (config-if)#ip vrrp 1000 enable
8800A (config-if)#ip vrrp 1000 backup-master enable
```

10 Error message when enabling PIM with IST enabled

```
8800A (config)#ip pim enable
% Cannot modify settings
% PIM not supported on an IST enabled unit
```

7.3.2 ERS 8800-Right

Note: This test designates 8800A as ERS8800-Left.

- IST to 8800-Right is Copper MLT port 4/3, VLAN 3999
- SMLT to ERS 5650 Fiber MLT port 7/27, VLAN 1000
- SMLT to Hirschmann™ are Copper/Fiber MLT ports 7/28 and 8/28, VLAN 1000
- IP Routing is enabled
- VRRP is enabled

1 Enter *Configuration* mode and create IST VLAN 3999:

```
8800A (config)#vlan create 3999 name IstVlan type port
8800A (config)#vlan members remove 1 4/3
8800A (config)#vlan members add 3999 4/3
```

2 Create Access VLAN 1000

```
8800A (config)#vlan create 2 name To5650Vlan type port
8800A (config)#vlan members remove 1 7/27
8800A (config)#vlan members add 1000 7/27
/27
```

3 Create Trunk VLAN 1000

```
8800A (config)#vlan create 3 name ToHirschmannVlan type port
8800A (config)#vlan members remove 1 2/28,7/28
8800A (config)#vlan members add 1000 2/28,7/28
```

4 Create IST IP interface, IST MLT, and IST Peer

```
8800A (config)#interface vlan 3999
8800A (config-if)#ip address 12.12.12.1 255.255.255.252
8800A (config-if)#exit
8800A (config)#mlt 1 name IST enable member 4/3
8800A (config)#interface mlt 1
8800A (config-if)#ist enable peer-ip 12.12.12.2 vlan 3999
```

5 Create VLAN 1000 IP Interface

```
8800A (config)#interface vlan 1000
8800A (config-if)#ip address 2.2.2.2 255.255.255.0
```

6 Create SMLT-to-ERS5650 MLT

```
8800A (config)#mlt 23 name SMLT-to-ERS5650 enable member 7/27 learning disable
8800A (config)#interface mlt 23
8800A (config-if)#smlt 23
```

7 Create SMLT-to-Hirschmann MLT

```
8800A (config)#mlt 24 name SMLT-to-Hirschmann enable member 2/28,7/28 learning disable
8800A (config)#interface mlt 24
8800A (config-if)#smlt 24
```

8 Globally Enable IP Routing and VRRP

```
8800A (config)#ip routing
8800A (config)#router vrrp enable
```

9 Enable IP routing and create VRRP for VLAN 1000 IP Interface

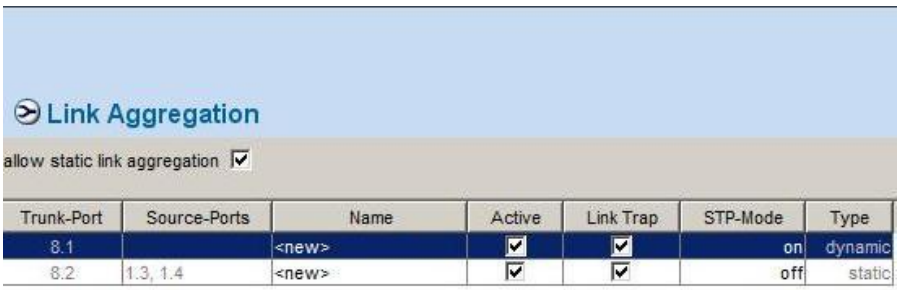
```
8800A (config)#interface vlan 1000
8800A (config-if)#ip routing
8800A (config-if)#ip vrrp address 1000 2.2.2.1
8800A (config-if)#ip vrrp 1000 enable
8800A (config-if)#ip vrrp 1000 backup-master enable
```

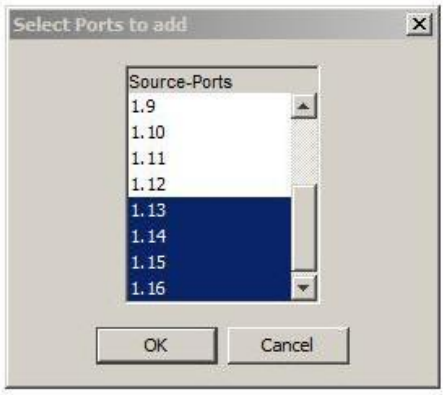
10 Error message when enabling PIM with IST enabled

```
8800A (config)#ip pim enable
% Cannot modify settings
% PIM not supported on an IST enabled unit
```

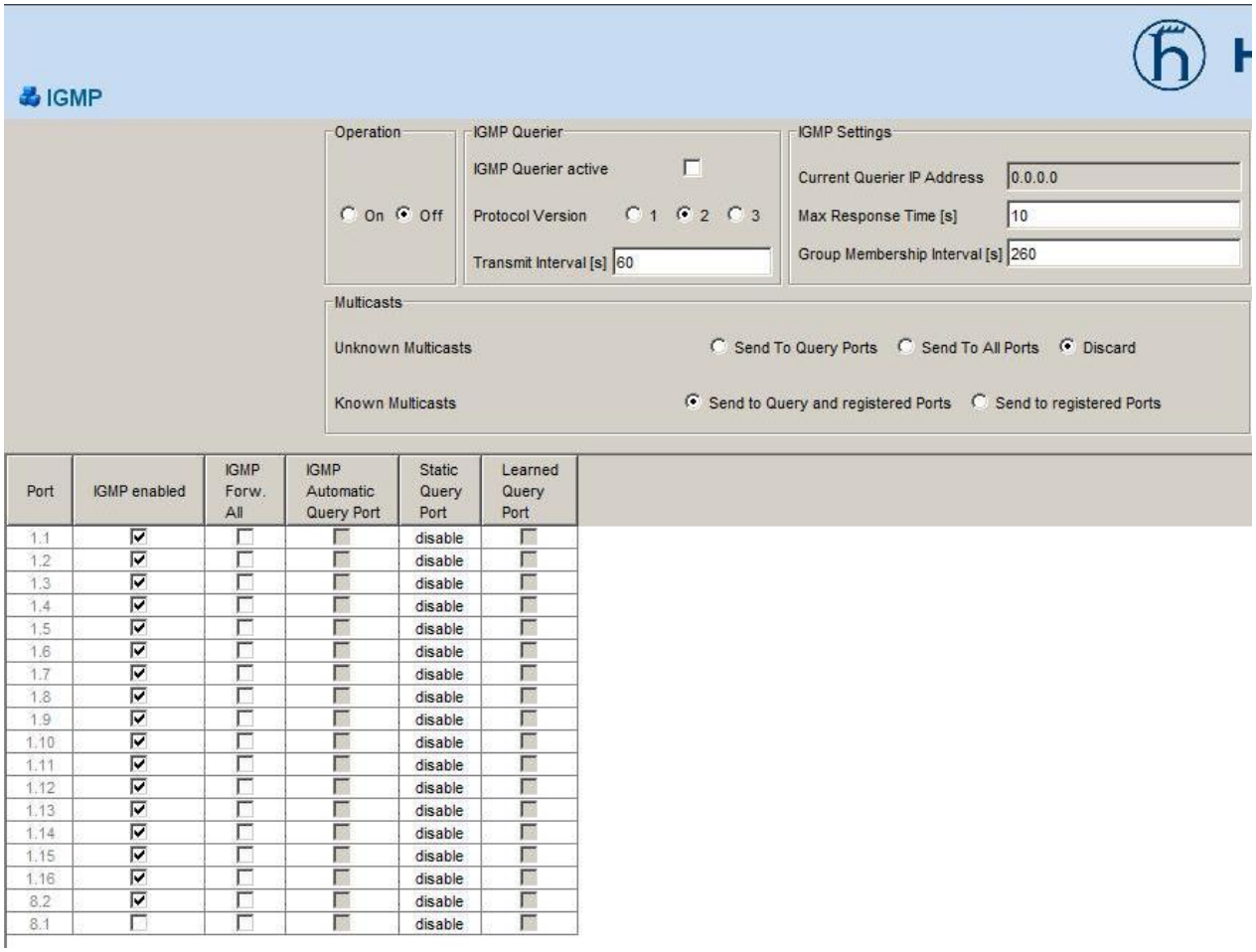
7.4 GUI configuration

1 Enable Link Aggregation on the MACH1040:





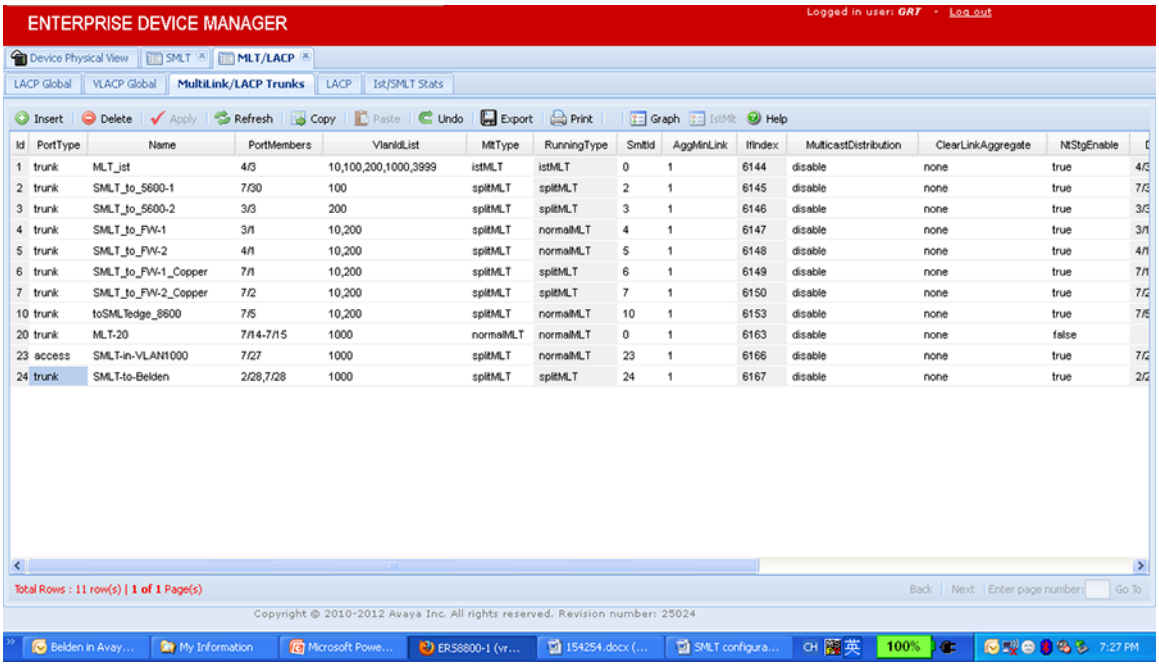
2 Disable IGMP on the MACH1040:



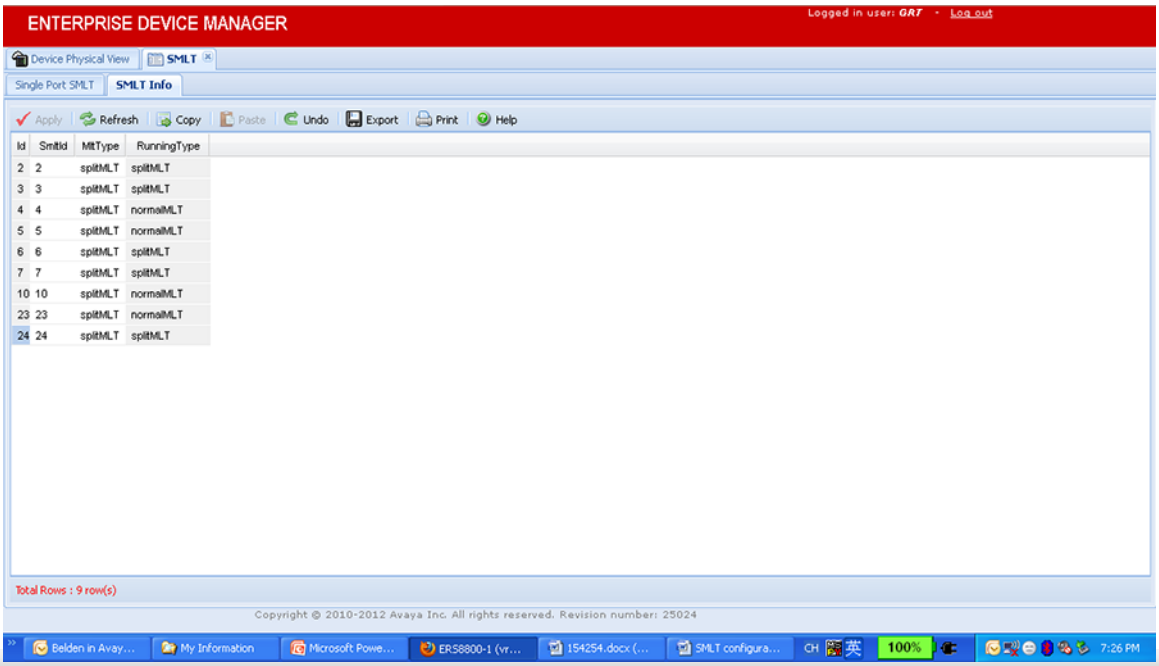
Port	IGMP enabled	IGMP Forw. All	IGMP Automatic Query Port	Static Query Port	Learned Query Port
1.1	☑	☐	☐	disable	☐
1.2	☑	☐	☐	disable	☐
1.3	☑	☐	☐	disable	☐
1.4	☑	☐	☐	disable	☐
1.5	☑	☐	☐	disable	☐
1.6	☑	☐	☐	disable	☐
1.7	☑	☐	☐	disable	☐
1.8	☑	☐	☐	disable	☐
1.9	☑	☐	☐	disable	☐
1.10	☑	☐	☐	disable	☐
1.11	☑	☐	☐	disable	☐
1.12	☑	☐	☐	disable	☐
1.13	☑	☐	☐	disable	☐
1.14	☑	☐	☐	disable	☐
1.15	☑	☐	☐	disable	☐
1.16	☑	☐	☐	disable	☐
8.2	☑	☐	☐	disable	☐
8.1	☐	☐	☐	disable	☐

7.5 Configuring the ERS 8800

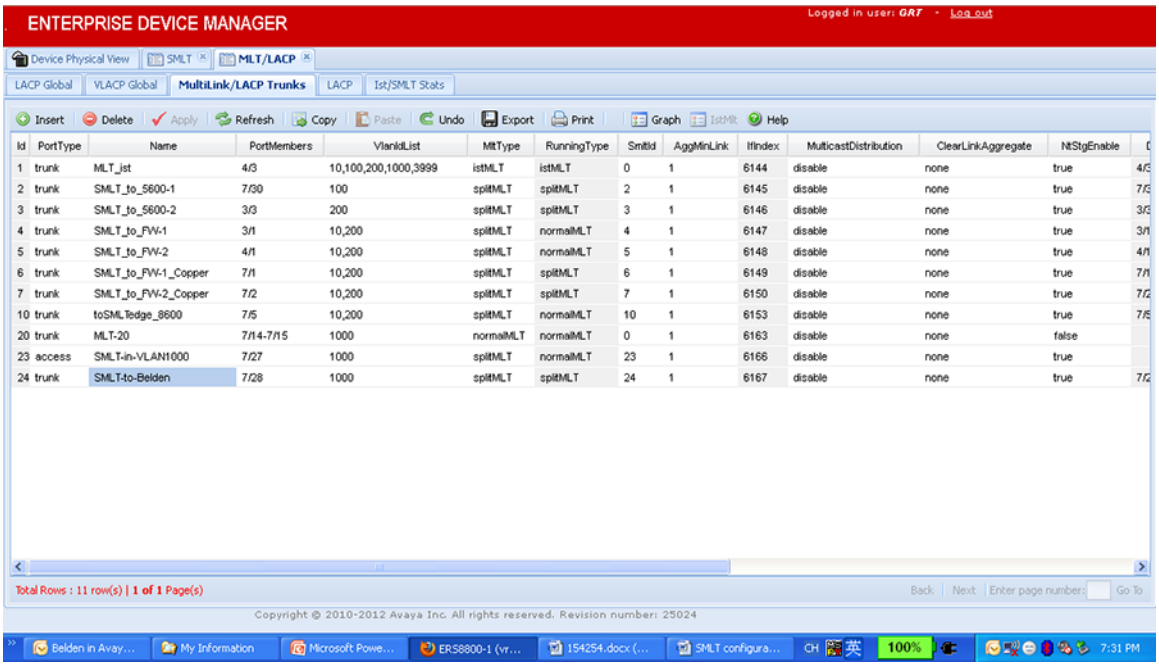
1 Create Copper Port SMLT-24 and add ports 2/28 and 7/28 from VLAN > MLT/LACP > MultiLink/LACP Trunks:



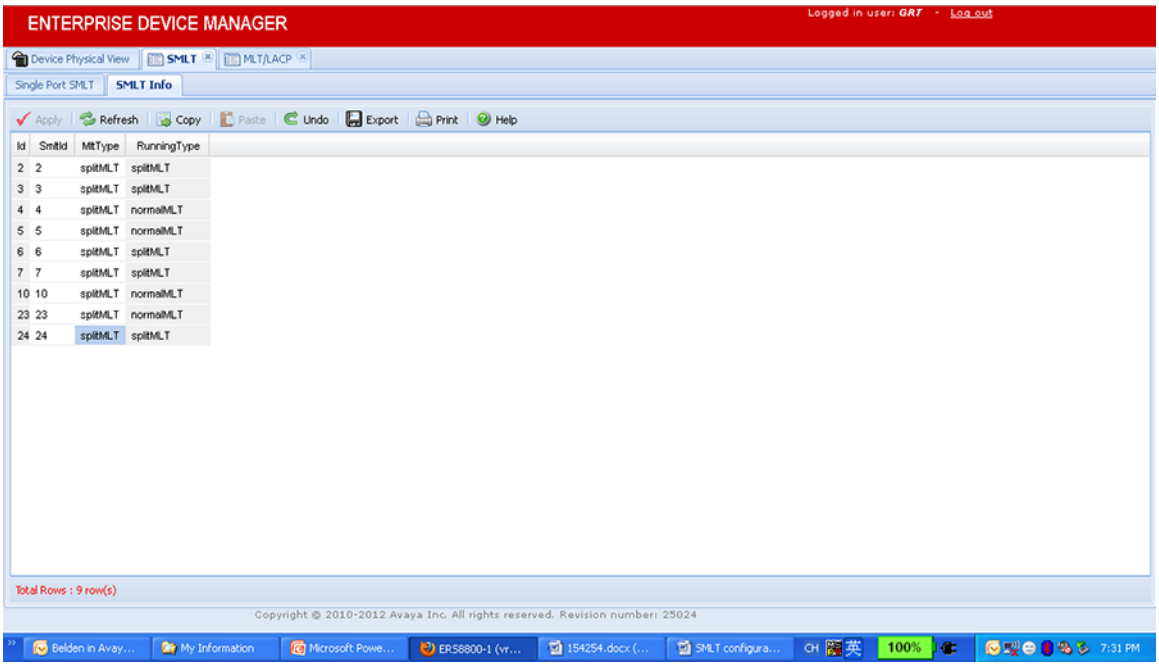
2 Verify the SMLT configuration from VLAN > SMLT > SMLT Info:



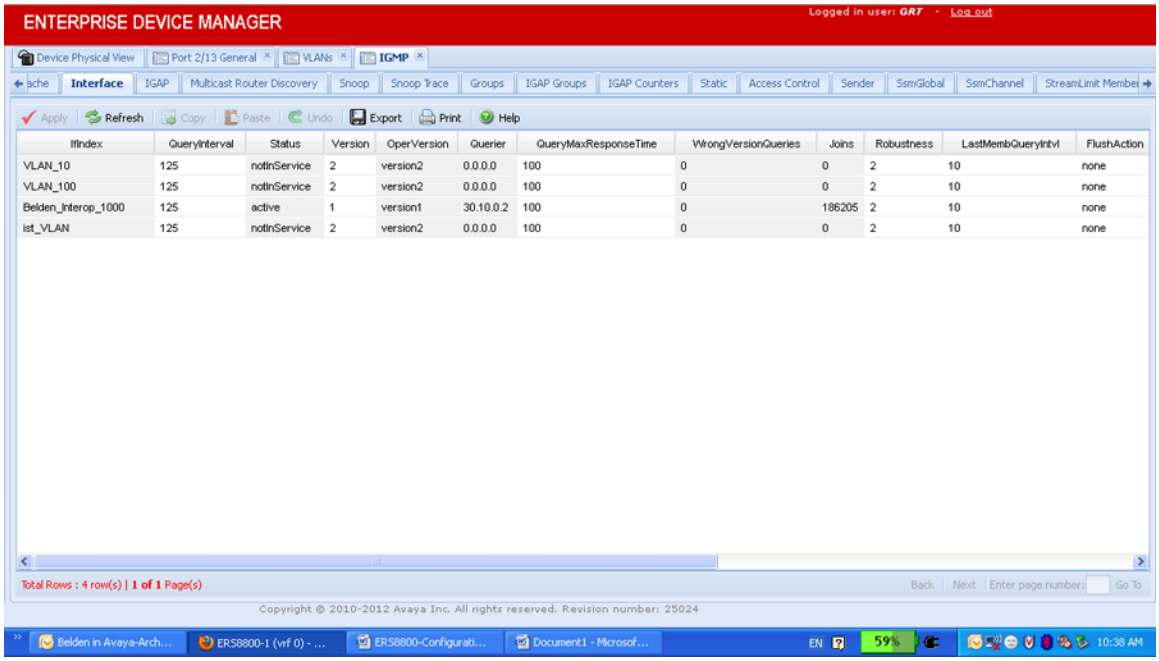
3 Create Fiber Port SMLT-24 and add port 7/28 from VLAN > MLT/LACP > MultiLink/LACP Trunks:



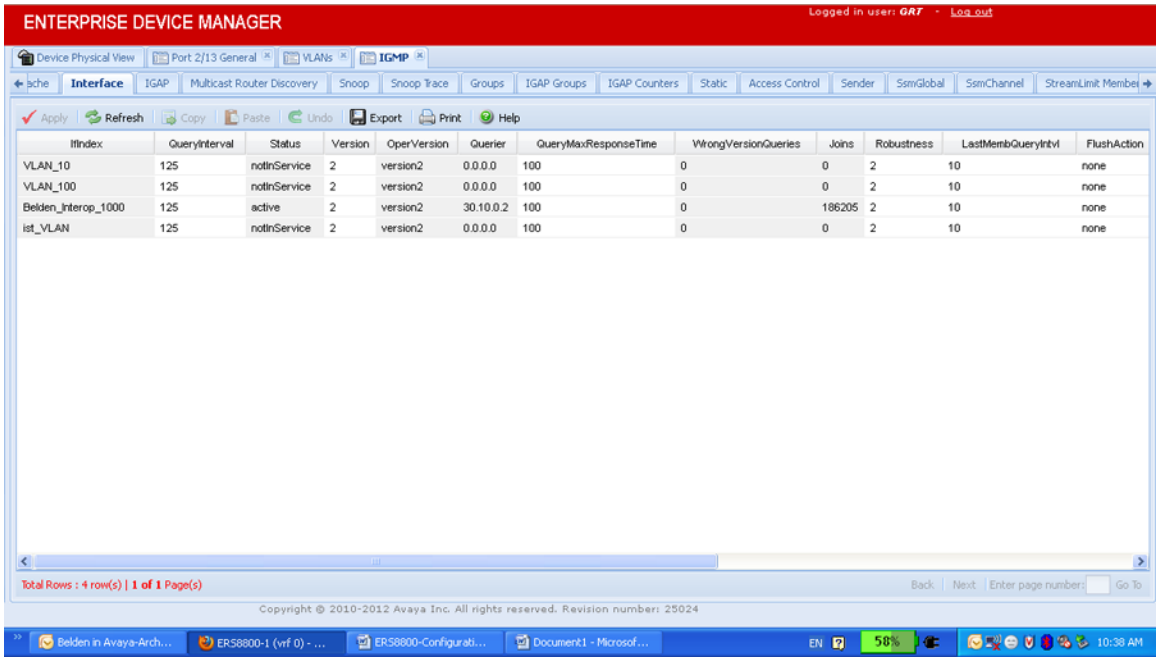
4 Verify the SMLT configuration from VLAN > SMLT > SMLT Info:



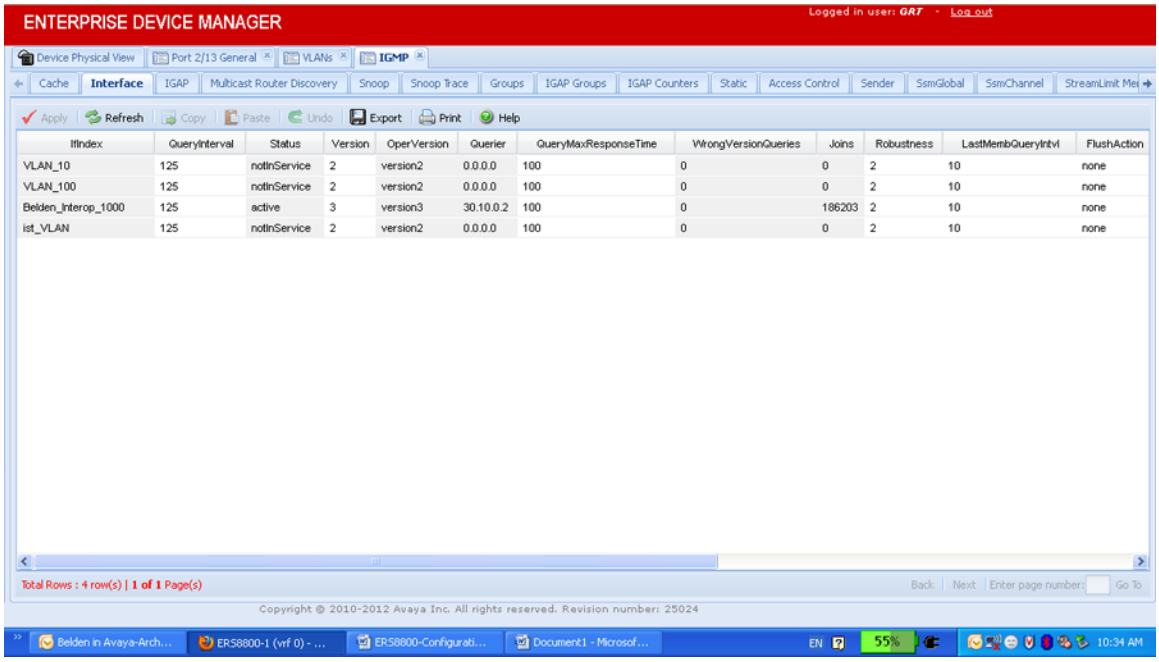
5 Enable IGMPv1 on VLAN 1000 from IP > IGMP > Interface:



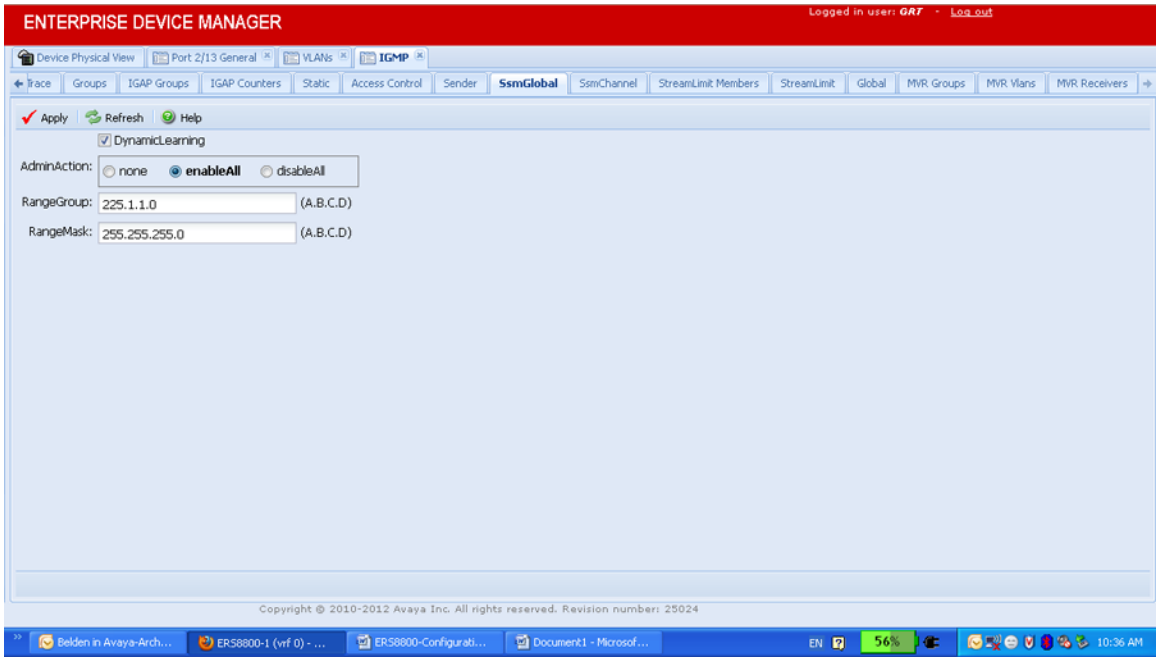
6 Enable IGMPv2 on VLAN 1000 from IP > IGMP > Interface:



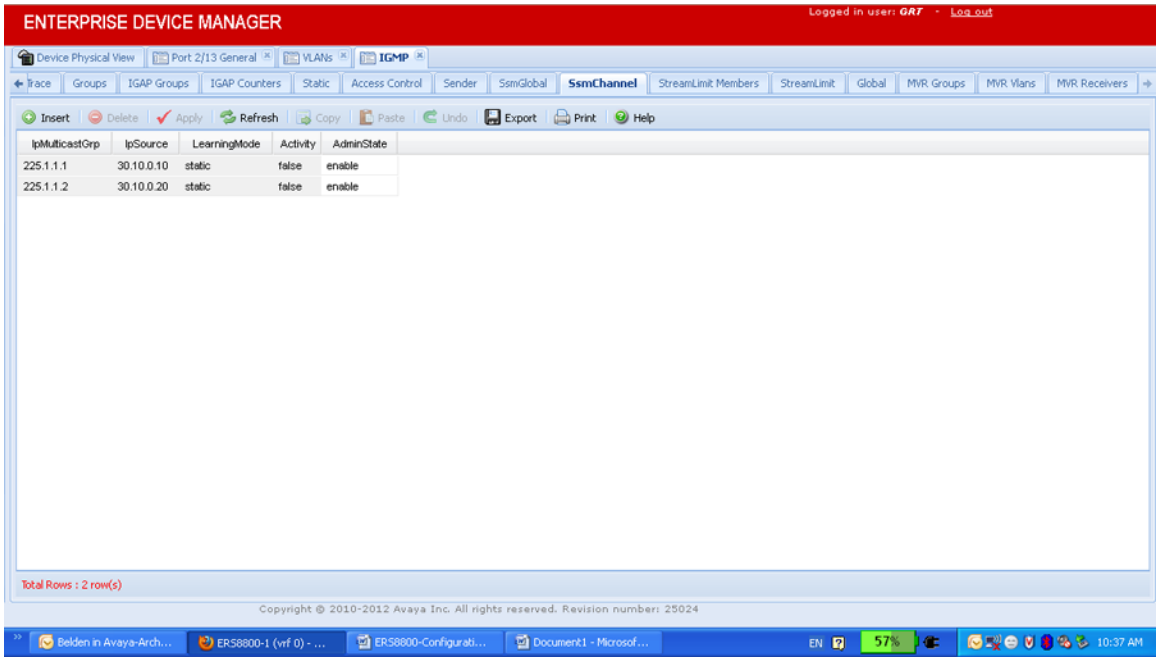
7 Enable IGMPv3 on VLAN 1000 from IP > IGMP > Interface:



8 Configure SSM globally from IP > IGMP > Ssm Global:



9 Configure an SSM channel from IP > IGMP > Ssm Channel:



8. Conclusion

The Avaya Networking Test Lab verified connectivity under normal conditions where all the devices were configured properly. From this steady-state environment, various tests simulated fault conditions with link and switch failures. These links and switches were then recovered simulating the restoration of the network.

The Avaya-Belden Industrial Ethernet (IE) solution passed all of these tests and confirmed that this solution meets Avaya's quality and interoperability standards.