Connections in Central America

CLARA Network Engineering Group

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This document presents the NEG recommendations for the setup of the new connections from Central American NRENs to RedCLARA's backbone.

CLARA/NEG/2005-0011
Version – 3.0

VERSION MANAGEMENT

This guide outlines the NEG recommendations for the new connections in Central America to the backbone of RedCLARA network. When new procedures are required or other changes made, it will be updated accordingly, and the new version release will be recorded in the table below.

Version	Modification description	Date	Reviewed by
preliminary	First draft	16-May-2005	Eriko Porto
1.0	Corrections and changes	20-May-2005	Eriko Porto
2.0	Corrections and changes	24-Jun-2005	Eriko Porto
3.0	Corrections and changes	01-Jan-2006	Eriko Porto

Summary

1. Introduction

The CLARA organization has concluded the tender process to choose the service provider for the connections from Costa Rica, Nicaragua, Guatemala and El Salvador in Central America. This document describes the CLARA NEG technical recommendations for the setup of these new connections. The purpose of these recommendations is to describe the hardware, protocols and configurations to be used for the connections from these new clients to the CLARA network backbone.

2. Scenario for the NRENs connections

The current proposal for these new connections with the technology availability is depicted in Figure 1. The bandwidth available for the NRENs is up to 10 Mbps.

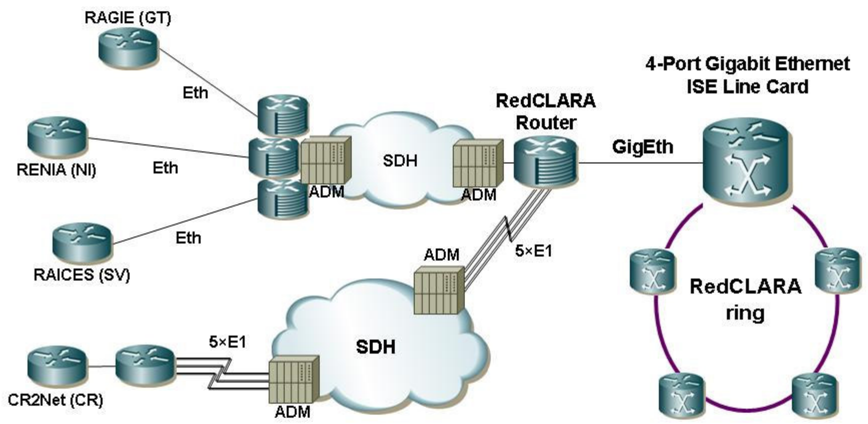

Figure 1: Technology availability

The routers attached to the NRENs, as represented in Figure 1, characterize the edge routers from their networks, which supply the adequate interfaces to receive the connections from the provider, and give access for the NRENs clients (universities and other R&E institutions) to the CLARA network.

The Layer 2 access for the NRENs uses Ethernet technology, and each one will receive 10 Mbps of available bandwidth. The traffic of these connections will be carried over the provider's SDH network, with the NRENs from GT, NI and SV sharing an E3 channel, which assure the 10 Mbps bandwidth for each one of the three NRENs, and the NREN from CR using an independent connection of 5 multiplexed E1 channels, in order to assure the 10 Mbps bandwidth.

Each NREN will provide a router (or other Layer 3 equipment) with the appropriate interfaces to establish the connection with RedCLARA through the provider. The Layer 3 equipment from the NREN must support full BGP and IPv6. The IPv4 addresses for configure the interfaces and establish the BGP peering sessions are provided by CLARA (see *CLARA/NEG/2004-0001 – IPv4 addressing and routing plan for CLARA network* and *CLARA/NEG/2005-0010 – DNS naming and IPv4 allocation* documents)

3. Connections requirements

3.1. Connections from GT, SV and NI

Figure 2 depicts the details of the provider access network and the proposed configuration for carry the Layer 3 traffic from the NRENs of GT, SV and NI to the CLARA router at Telnort PoP.

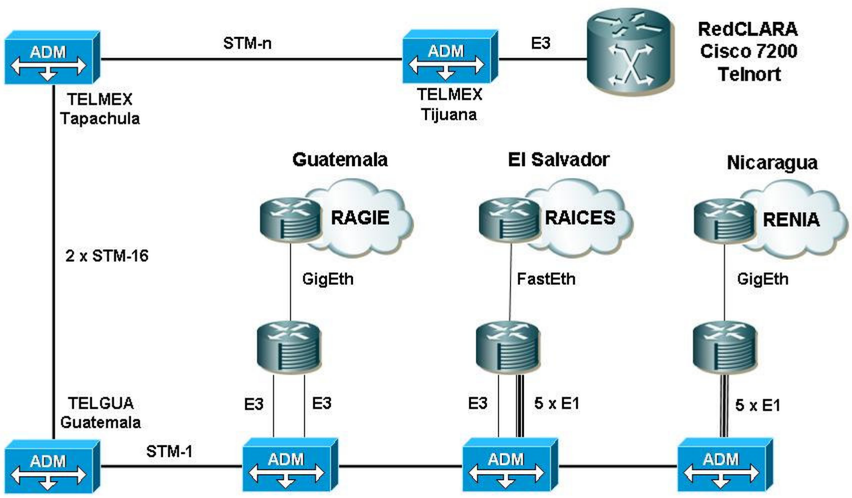

Figure 2: Provider access network

Hardware requirements:

- The routers must support standard 802.1pQ VLANs.
- The routers must provide non blocking architecture, or must be limited in the total use of ports in order to avoid contention in the backplane.
- The routers must support tools for traffic shaping and traffic policing.
- The routers must be configured to isolate the traffics from the different VLANs and schedule the traffic in order to guarantee the required bandwidth for each NREN.

Bandwidth requirements:

- The SDH circuit from NI to SV must provide bandwidth no less than 10 Mbps.
- The SDH circuit from SV to GT must provide bandwidth no less than 20 Mbps.

3.2. Configuration for the MPLS transport network

In order to avoid the overhead from ATM virtual circuits and do a better use of the E3 clear-channel between the provider router in GT and the CLARA router in **Telnort** (MX), the configuration for this circuit will use Ethernet over MPLS solution based on the IETF draft-martini proposal (draft-martini-l2circuit-trans-mpls-16 and draft-martini-l2circuit-encap-mpls-09). Both routers are Cisco 7200 series routers and must support the Cisco AToM – Any Transport over MPLS – solution.

This configuration will create an Ethernet Virtual LAN (VLAN) that will span over geographically separated sites, and will allow for transport of Ethernet traffic (unicast, broadcast, and multicast) from a source 802.1Q VLAN to a destination 802.1Q VLAN over a core MPLS network, by mapping these VLANs to MPLS LSPs. Ethernet over MPLS uses the Label Distribution Protocol (LDP) to dynamically set up and tear down LSPs over the core MPLS network for dynamic service provisioning. For this configuration the LSPs will be set up manually between the two routers. Figure 3 shows the proposed configuration for the MPLS transport network, configuration templates are provided in Annex C.

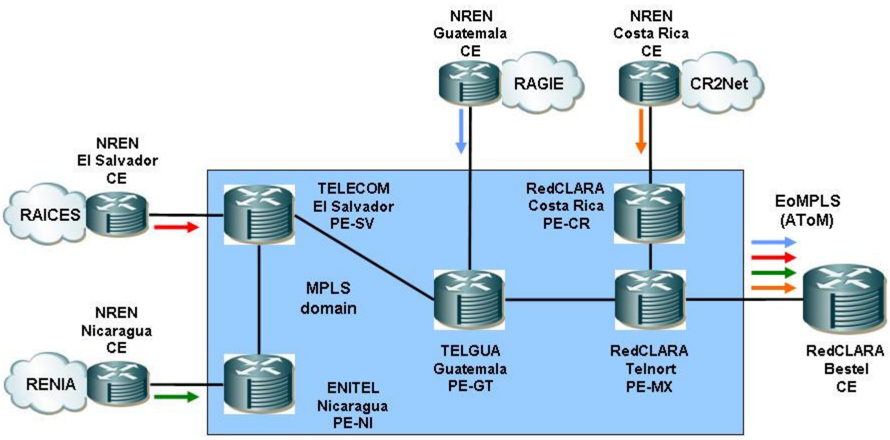

Figure 3: EoMPLS configuration

3.3. Connection from CR

The connection from the NREN from CR will use Multilink PPP between both PE routers, standardized in RFC1990. This technique sends packets across the individual links in a round robin fashion, and adds three significant capabilities. First, because multilink PPP works at the link layer, it makes an NxE1 bundle appear as one logical link to the upper layer protocols in the router. Thus, only one network address needs to be configured for the entire bundle. Second, Multilink PPP keeps track of packet sequencing and buffers packets that arrive early. With this ability, Multilink PPP preserves packet order across the entire NxE1 bundle. Third, packet fragmentation can be enabled to split large data packets into smaller packet fragments that are individually transmitted across the links. In many circumstances fragmentation can increase the efficiency of the NxE1 link. Figure 4 shows a diagram of the solution.

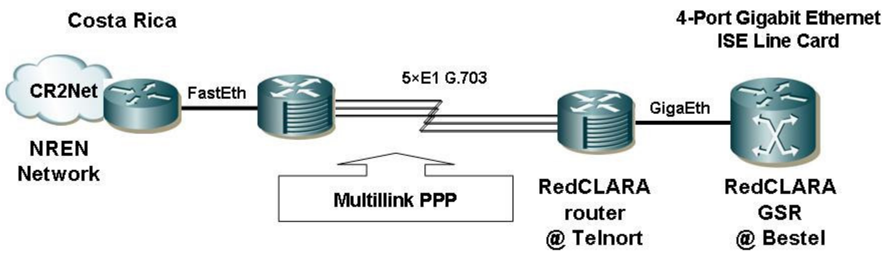

Figure 4: Multilink PPP configuration

Multilink PPP also offers significant link manageability. If an individual link fails, Multilink PPP can automatically detect the failure and remove that link from the bundle. As long as one link of the bundle is working the logical interface representing the bundle is up. By using keep alive signals, Multilink PPP can detect when a previously failed link comes back up and then reinsert that link into the bundle.

Additionally, when more bandwidth is needed, additional links can be added to the bundle by simply configuring them as a member of the bundle. No reconfiguration at the network layer is needed.

4. Infrastructure between Telnort and Bestel PoPs

Figure 5 shows the details for the connections between the PoPs at Telnort and Bestel in Tijuana city (Mexico). The new connections will use the present fiber infrastructure between the buildings, which was developed for the connection between CUDI and CLARA network.

The connections from the NRENs; MPLS PVCs multiplexed in the E3 clear channel and the NxE1 bundle from CR, come to the CLARA router placed at Telnort, and all connections share the 1 Gbps link between Telnort and Bestel through the CLARA switch at Telnort and the CUDI switch placed at Bestel.

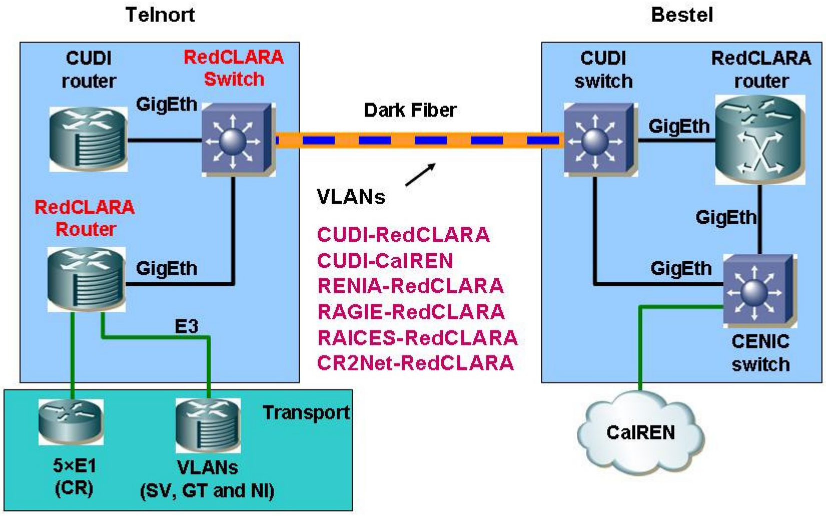

Figure 5: Telnort and Bestel connection

This topology altogether with the configurations proposed maintains the philosophy that the international connections end on RedCLARA equipment. Bandwidth growth is possible in the future using more lambdas between Telnort and Bestel.

The provider will supply housing for the equipment at Telnort PoP with adequate rack space, ventilation and electrical power feed. The requirements are detailed in the Annex A.

The provider will also supply a dial-in leased line for out-of-band access to the auxiliary port of the RedCLARA router placed at Telnort PoP. This out-of-band access will allow remote configuration and monitoring of the equipment placed at Telnort by the CLARA NOC group, mainly in the case of failure in the main access through the CLARA network.

The PSTN line will be used exclusively to dial-in to the router auxiliary port using an external modem, also supplied by CLARA, and this configuration will be used for dial backup in the event of losing the primary connection through the service links of the network.

Annex A – Hardware configuration and requirements

Table 1 lists the hardware configurations for the router and the switch provided by CLARA for these connections. The provider will supply housing for the equipment at the PoP of Telnort.

Table 1: Hardware configuration

Item	Item Quant.	Quant.	Part Number	Description
Cisco 7206 – Telnort Router (1)				
1	1	1	7206VXR/NPE-G1	7206VXR with NPE-G1 includes 3GigE/FE/E Ports and IP SW
		1	PWR-7200-DC+	Cisco 7200 DC (24V-60V) Power Supply Option
		1	PWR-7200/2-DC+	Cisco 7200 Redundant DC (24V-60V) Power Supply Option
		1	S72A-12401	Cisco 7200 Series IOS ENTERPRISE
		1	MEM-NPE-G1-512MB	Two 256MB mem modules (512MB total) for NPE-G1 in 7200
		1	MEM-NPE-G1-FLD128	Cisco 7200 Compact Flash Disk for NPE-G1, 128 MB Option
		2	WS-G5484	1000BASE-SX Short Wavelength GBIC (Multimode only)
		1	WS-G5486	1000BASE-LX/LH long haul GBIC (singlemode or multimode)
		2	PA-4E1G/75	4-Port E1 G.703 Serial Port Adapter (75ohm/Unbalanced)
		1	PA-2E3	2 Port E3 Serial Port Adapter with E3 DSUs
		2	PA-4E1G/75	4-Port E1 G.703 Serial Port Adapter (75ohm/Unbalanced)
		1	PA-A6-E3	1Port Enh ATM E3 Port Adapter (8k VCs)
		16	CAB-E1-BNC	E1 Cable BNC 75ohm/Unbal 5m
		1	CON-OSP-7206	CISCO7206 On-Site Premium Maintenance
Catalyst 3750 Metro – LAN Switch (2)				
2	1	1	ME-C3750-24TE-M	ME C3750 24 10/100+2SFP+2SFP ES Prt (no-pwr): Std ME SW Img
		1	ME3750-IPBASE-LIC	IP BASE FEATURE LICENSE FOR CATALYST 3750 METRO
		1	PWR-ME3750-DC	Configurable ME-C3750 DC Power Supply
		1	PWR-ME3750-DC-R	Metro Catalyst 3750 redundant DC power supply (configurable)
		2	GLC-LH-SM	GE SFP, LC connector LX/LH transceiver
		2	GLC-SX-MM	GE SFP, LC connector SX transceiver
		2	GLC-T	Cisco 1000BASE-T SFP

Tables 2 to 4 list the hardware requirements for the router and the switch provided by CLARA for these connections.

Table 2: Dimensions and power requirements for the Catalyst switch

Cisco Catalyst 3750 Metro switch	
Physical Dimensions	
Dimensions (H x W x D)	1.73 x 17.5 x 14.68 in. (4.39 x 44.5 x 37.3 cm)
Weight	12.1 lb (5.49 kg) (Cisco Catalyst 3750 Metro 24-AC or DC)
Power	
Power consumption	110W (maximum), 374 BTUs per hour (Cisco Catalyst 3750 Metro 24-AC or DC Switch)
AC input voltage and frequency	100 to 127/200 to 240 VAC (autoranging), 50 to 60 Hz (Cisco Catalyst 3750 Metro 24-AC)
DC input voltage	-36 to 72 VDC @ 3A (Cisco Catalyst 3750 Metro 24-DC)

Table 3: Dimensions of the Cisco router

	Cisco 7204VXR	Cisco 7206VXR
Height	5.25 in. (13.34 cm)	5.25 in. (13.34 cm)
Width	16.8 in. (42.67 cm)	16.8 in. (42.67 cm)
Depth	17 in. (43.18 cm)	17 in. (43.18 cm)
Weight	Chassis is fully configured with a network processing engine, I/O controller, four port adapters, two power supplies, and a fan tray: ~50 lb (22.7 kg)	Chassis is fully configured with a network processing engine, I/O controller, six port adapters, two power supplies, and a fan tray: ~50 lb (22.7 kg)

Table 4: Power requirements for the Cisco router

	Cisco 7204VXR/ Cisco 7206VXR
DC-output power	280W max. (single or dual power supply configuration)
DC-input power	370W max. (single or dual power supply configuration)
DC-input voltage rating	-24 to -60 VDC for global DC power requirements
DC-input current rating	Not to exceed 13A max. at -48 VDC (370W/-48 VDC = 7.7A typical draw) Not to exceed 8A max. at -60 VDC (370W/-60 VDC = 6.2A typical draw)
DC voltages supplied and maximum steady-state current ratings	+5.2V at 360A +12.2V at 9A -12.0V at 1.5A +3.5V at 13A
DC-input cable	14 AWG recommended minimum, with at least 3 conductors rated for at least 140° F (60° C)
Frequency	50/60 Hz
Airflow	~80 cfm
Power dissipation	~370W max. configuration
Heat dissipation	370W (1262 BTUs)

For the implementation of the EoMPLS solution it is necessary to provide a underlying layer-3 infrastructure, with active routing protocol in order to transport the layer-2 connections (Ethernet VLANs), and enable the virtual circuits between the NRENs and RedCLARA.

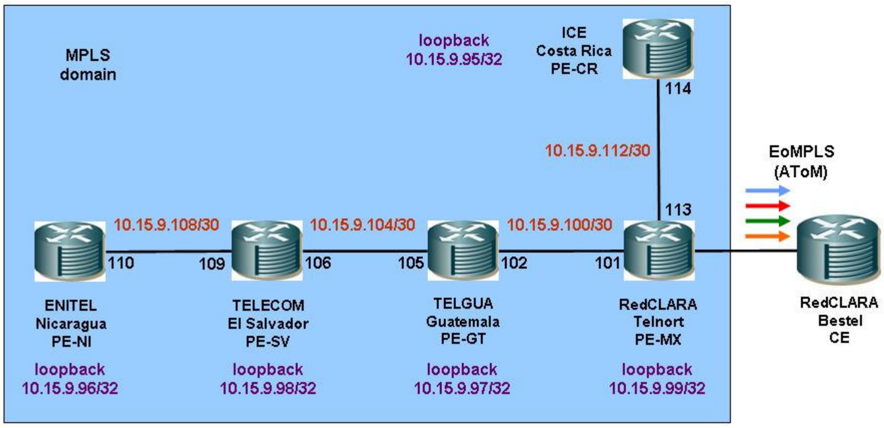

Figure 6: IP configuration

Figure 6 and Table 5 provides the IP configuration of the underlying MPLS domain, which will be implemented as a transport network for the layer-2 virtual circuits.

Table 5: IP addresses allocation

EQUIPMENT	INTERFACE	IP	MASK
CSR-C007206-R1-CR	loopback 0	10.15.9.95	255.255.255.255
NIC-C007206-R1-NI	loopback 0	10.15.9.96	255.255.255.255
CEN-C007206-R1-GT	loopback 0	10.15.9.97	255.255.255.255
CEN-C007206-R1-SV	loopback 0	10.15.9.98	255.255.255.255
TIJ-C007206-R1-MX	loopback 0	10.15.9.99	255.255.255.255
TIJ-C007206-R1-MX	E3 MX-GT	10.15.9.100	255.255.255.252
CEN-C007206-R1-GT	E3 GT-MX	10.15.9.100	255.255.255.252
CEN-C007206-R1-GT	E3 GT-SV	10.15.9.104	255.255.255.252
CEN-C007206-R1-SV	E3 SV-GT	10.15.9.104	255.255.255.252
CEN-C007206-R1-SV	5xE1 SV-NI (multilink ppp)	10.15.9.108	255.255.255.252
NIC-C007206-R1-NI	5xE1 NI-SV (multilink ppp)	10.15.9.108	255.255.255.252
TIJ-C007206-R1-MX	5xE1 MX-CR (multilink ppp)	10.15.9.112	255.255.255.252
CSR-C007206-R1-CR	5xE1 CR-MX (multilink ppp)	10.15.9.112	255.255.255.252

Annex C – Routing and MPLS configuration templates

Below are provided the configuration templates for the OSPF routing protocol, Multilink PPP connections, and the EoMPLS VC connections.

OSPF configurations

```
TIJ-C007206-R1-MX
router ospf 200
 router-id 10.15.9.99
 log-adjacency-changes
 network 10.15.9.99 0.0.0.0 area 0
 network 10.15.9.100 0.0.0.3 area 0

CEN-C007206-R1-GT
router ospf 200
 router-id 10.15.9.97
 log-adjacency-changes
 network 10.15.9.97 0.0.0.0 area 0
 network 10.15.9.100 0.0.0.3 area 0
 network 10.15.9.104 0.0.0.3 area 0

CEN-C007206-R1-SV
router ospf 200
 router-id 10.15.9.98
 log-adjacency-changes
 network 10.15.9.98 0.0.0.0 area 0
 network 10.15.9.104 0.0.0.3 area 0
 network 10.15.9.108 0.0.0.3 area 0

NIC-C007206-R1-NI
router ospf 200
 router-id 10.15.9.96
 log-adjacency-changes
 network 10.15.9.96 0.0.0.0 area 0
 network 10.15.9.108 0.0.0.3 area 0

CSR-C007206-R1-CR
router ospf 200
 router-id 10.15.9.95
 log-adjacency-changes
 network 10.15.9.95 0.0.0.0 area 0
 network 10.15.9.112 0.0.0.3 area 0
```

EoMPLS configurations

```
CEN-C007206-R1-GT
------------------
interface GigabitEthernet0/1
 description NREN-GT
 no ip address
 duplex auto
 speed auto
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/1.103
 description NREN-GT/RAGIE
 encapsulation dot1Q 103
 no snmp trap link-status
 no cdp enable
 xconnect 10.15.9.99 103 encapsulation mpls
!
CEN-C007206-R1-SV
------------------
interface GigabitEthernet0/1
 description NREN-SV
 no ip address
 duplex auto
 speed auto
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/1.104
 description NREN-SV/RAICES
 encapsulation dot1Q 104
 no snmp trap link-status
 no cdp enable
 xconnect 10.15.9.99 104 encapsulation mpls
!
NIC-C007206-R1-NI
------------------
interface FastEthernet0/1
 description NREN-NI
 no ip address
 duplex auto
 speed auto
!
interface FastEthernet0/1.102
 description NREN-NI/RENIA
 encapsulation dot1Q 102
 no snmp trap link-status
 no cdp enable
 mpls l2transport route 10.15.9.99 102
!
```

```
CSR-C007206-R1-CR
------------------
interface GigabitEthernet0/1
 description NREN-CR
 no ip address
 duplex auto
 speed auto
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/1.101
 description NREN-CR/CR2Net
 encapsulation dot1Q 101
 no snmp trap link-status
 no cdp enable
 xconnect 10.15.9.99 101 encapsulation mpls
!
TIJ-C007206-R1-MX
------------------
interface GigabitEthernet0/1
 description NRENs centro-america
 no ip address
 duplex auto
 speed auto
 media-type rj45
 negotiation auto
!
interface GigabitEthernet0/1.101
 description NREN-CR/CR2Net
 encapsulation dot1Q 101
 no cdp enable
 xconnect 10.15.9.95 101 encapsulation mpls
!
interface GigabitEthernet0/1.102
 description NREN-NI/RENIA
 encapsulation dot1Q 102
 no cdp enable
 xconnect 10.15.9.96 102 encapsulation mpls
!
interface GigabitEthernet0/1.103
 description NREN-GT/RAGIE
 encapsulation dot1Q 103
 no cdp enable
 xconnect 10.15.9.97 103 encapsulation mpls
!
interface GigabitEthernet0/1.104
 description NREN-SV/RAICES
 encapsulation dot1Q 104
 no cdp enable
 xconnect 10.15.9.98 104 encapsulation mpls
!
```

Multilink-PPP and MPLS configurations

```
CEN-C007206-R1-SV
------------------
ip cef
mpls label protocol ldp
!
!
interface Multilink1
 ip address 10.15.9.110 255.255.255.252
 tag-switching ip
 ppp multilink
 multilink-group 1
!
interface Serial<slot>/0
 no ip address
 ip route-cache distributed
 encapsulation ppp
 no fair-queue
 ppp multilink
 multilink-group 1
!
! repeat the same configuration for the other
! serial interfaces of the multilink bundle
!
NIC-C007206-R1-NI
------------------
ip cef
mpls label protocol ldp
!
!
interface Multilink1
 ip address 10.15.9.110 255.255.255.252
 tag-switching ip
 ppp multilink
 multilink-group 1
!
interface Serial<slot>/0
 no ip address
 ip route-cache distributed
 encapsulation ppp
 no fair-queue
 ppp multilink
 multilink-group 1
!
! repeat the same configuration for the other
! serial interfaces of the multilink bundle
!
```

Multilink-PPP and MPLS configurations

```
TIJ-C007206-R1-MX
------------------
ip cef
mpls label protocol ldp
!
!
interface Multilink1
 ip address 10.15.9.113 255.255.255.252
 tag-switching ip
 ppp multilink
 multilink-group 1
!
interface Serial<slot>/0
 no ip address
 ip route-cache distributed
 encapsulation ppp
 no fair-queue
 ppp multilink
 multilink-group 1
!
! repeat the same configuration for the other
! serial interfaces of the multilink bundle
!
CSR-C007206-R1-CR
------------------
ip cef
mpls label protocol ldp
!
!
interface Multilink1
 ip address 10.15.9.114 255.255.255.252
 tag-switching ip
 ppp multilink
 multilink-group 1
!
interface Serial<slot>/0
 no ip address
 ip route-cache distributed
 encapsulation ppp
 no fair-queue
 ppp multilink
 multilink-group 1
!
! repeat the same configuration for the other
! serial interfaces of the multilink bundle
!
```