

MPLS on the Cisco Catalyst 8540 MSR Enhanced ARM (ARM 2) Using PVPs

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Introduction

This document provides a sample configuration for the Multiprotocol Layer Switching (MPLS) on the Catalyst 8540 Enhanced ATM Router module (ARM). The ARM module's main function is to increase the capability in connecting two different worlds – packet/switching (which is frame based) and ATM (which is cell based). This functionality could be extended to the MPLS as well. The Catalyst 8540 MSR with an Enhanced ARM can be installed at the edge of a packet and cell based network with both MPLS modes enabled in the same chassis. The Enhanced ARM (ARM2) on the Catalyst 8540 MSR is required for Label Edge Routing (LER) functionality on ATM interfaces – it acts as the proxy interface for every incoming and outgoing ATM interface in the Label Switch Path (LSP) to do the MPLS packet processing. The Catalyst 8540 is ideally suited for cell–mode to frame–mode MPLS integration (accomplished by deploying the Enhanced ATM router module). Up to two ARM2 cards can be used in a single chassis.

This document provides examples of two different configurations that explain the usage of the ARM 2.

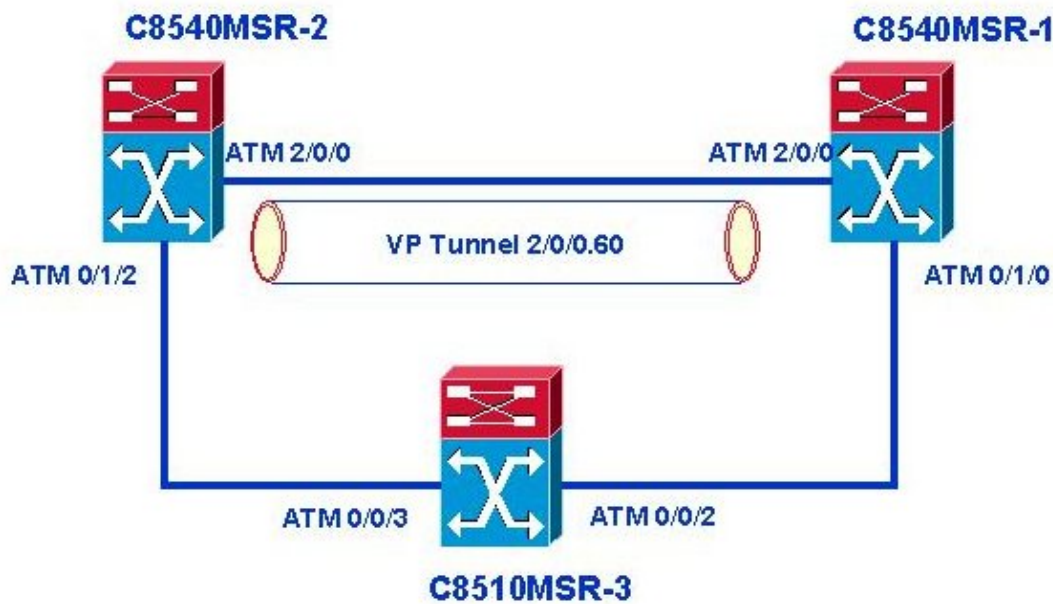
- Using the Enhanced ARM for cell mode (terminating cell mode MPLS on the ARM 2)
- Using the Enhanced ARM for frame mode MPLS over ATM over ATM VP tunnel.

Configure

In this section, you are presented with the information to configure the features described in this document. The OSPF was used as an internal routing protocol.

Network Diagram

This document uses the network setup shown in the diagram below:



The diagram above is used for the following scenarios:

- Using the Enhanced ARM for cell mode (terminating cell mode MPLS on the ARM 2)
- Using the Enhanced ARM for frame mode MPLS over ATM over ATM VP tunnel.

Notice that the configuration for the cell mode uses the path C8540MSR-2 to C8510MSR-3 to C8540MSR-1, while the configurations described in this document for frame mode uses the VP Tunnel to connect C8540MSR-2 and C8540MSR-1.

Components Used

The configurations described in this document were developed and tested using the software and hardware versions below.

- *Two Cisco C8540 MSRs, Cisco IOS® version 12.1(10)EY (256 MB DRAM)*
- *Cisco C8510 MSR, IOS version Version 12.1(7a)EY1 (64 MB DRAM)*
- *C8540-ARM2 (Enhanced ATM Router module)*
- *WAI-OC3-4MM (4 port OC-3 line card)*
- *C85MS-4F-OC12MM (4 port OC-12 line card)*

The information presented in this document was created from devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If you are working in a live network, ensure that you understand the potential impact of any command before using it.

Using the Enhanced ARM for Cell Mode MPLS

On the Catalyst 8540 MSR cell-mode MPLS is supported on all ATM interfaces and works in parallel with ATM signaling (such as ILMI) and ATM routing (PNNI). The cell-mode MPLS is enabled by adding the **mpls ip** interface command (or **tag-switching ip** in older IOS versions) and requires establishment of one unidirectional Label Virtual Circuit (LVC), or a Tag Virtual Circuit (TVC) for each Forwarding Equivalent Class (FEC) or an IP destination. Label virtual circuits are known as **head-end** LVC at the originator LER, **tail-end** LVC at the destination LER, and **transit** LVC at the LSR. In case a Cat8540 MSR acts as a pure ATM LSR (MPLS P router), the CPU does not establish head-end LVC for the routes learned in the ATM

core. The traffic that originates from the CPU and is destined to a remote LSR is sent over the MPLS control VC. An ATM interface could be linked to an ARM2 port and the LVC will terminate on the ARM2 port if that is the case. In fact, when linking an ATM interface to an ARM2 port, the ARM2 acts as an ATM LER (MPLS PE router) and will initiate head-end LVC (terminating LVC) for the routes learned in the ATM core.

ATM interfaces, ATM VP and hierarchical VP tunnels can be configured to terminate on the ARM2 port (available on 8540 MSR platform only). For load balancing purposes, ATM interfaces can be linked to either of the two ports of an Enhanced ARM . To terminate cell mode MPLS on an ARM2 port, use the **mpls-forwarding interface ATMx/y/z** interface configuration command, where ATMx/y/z is the Enhanced ARM port). That command applies to the main interface only.

Configurations

- C8540MSR-2
- C8510MSR-3

```

C8540MSR-2 (Catalyst 8540MSR)
C8540MSR-2#show hardware

C8540 named c8540MSR-2, Date: 04:46:41 UTC Mon Feb 10 2003

Slot  Ctrlr-Type      Part No.  Rev  Ser No  Mfg Date  RMA No.  Hw Vrs  Tst  EEP
-----
 0/* Super Cam       73-2739-03 B0  03170SXG Apr 27 99 0           3.0
 0/1 155MM PAM       73-1496-03 A0  09006167 Aug 01 95 00-00-00 3.1    0    2
 2/* OCM Board       73-2833-06 A0  03210XWB May 26 99 0           6.0
 2/0 QUAD 622 Gen    73-2852-05 A0  03210YN8 May 26 99 0           5.0
 9/* ETHERNET PAM    73-3754-05 A0  03374A9K Mar 17 99 0           4.1
12/* CMPM Card       73-3944-05 A0  04209EX0 Aug 29 00 0           5.0
12/0 ARM2 PAM       73-5533-01 A0  0424A160 Aug 29 00 0           5.1
12/1 ARM2 PAM       73-5533-01 A0  0424A183 Aug 29 00 0           5.1

C8540MSR-2#conf t

Enter configuration commands, one per line.  End with CNTL/Z.

C8540MSR-2(config)#int atm 0/1/2
C8540MSR-2(config-if)#mpls ip
! Cell mode MPLS enabled
C8540MSR-2(config-if)#ip add 10.254.14.237 255.255.255.252
C8540MSR-2(config-if)#mpls label protocol ldp
! LDP enabled on the interface
C8540MSR-2(config-if)#end

C8540MSR-2#show atm vc int atm 0/1/2
      Interface          VPI  VCI  Type  X-Interface      X-VPI X-VCI Encap  Status
ATM0/1/2                0    5    PVC   ATM0             0     57   QSAAL  UP
ATM0/1/2                0   16    PVC   ATM0             0     37   ILMI   UP
ATM0/1/2                0   18    PVC   ATM0             0    202   PNNI   UP
ATM0/1/2                0   32    PVC   ATM0           0    256   SNAP  UP

C8540MSR-2#show mpls int atm 0/1/2

Interface          IP          Tunnel  Operational
ATM0/1/2          Yes (ldp)   No      Yes          (ATM labels)

C8540MSR-2#show mpls int atm 0/1/2 det

```

```

Interface ATM0/1/2:
  IP labeling enabled (ldp)
  LSP Tunnel labeling not enabled
  MPLS operational          MTU = 4470
  ATM tagging: Label VPI = 1
  Label VCI range = 33 - 65535
  Control VC = 0/32

```

```
C8540MSR-2#conf t
```

Enter configuration commands, one per line. End with CNTL/Z.

```

C8540MSR-2(config)#int atm 0/1/2
C8540MSR-2(config-if)#mpls-forwarding int atm 12/0/1
! Terminate Cell mode MPLS on ARM2
C8540MSR-2(config-if)#end

```

```
C8540MSR-2#show atm vc int atm 0/1/2
```

Interface	VPI	VCI	Type	X-Interface	X-VPI	X-VCI	Encap	Status
ATM0/1/2	0	5	PVC	ATM0	0	57	QSAAL	UP
ATM0/1/2	0	16	PVC	ATM0	0	37	ILMI	UP
ATM0/1/2	0	18	PVC	ATM0	0	202	PNNI	UP
ATM0/1/2	0	32	PVC	ATM12/0/1	2	120	SNAP	UP
ATM0/1/2	1	35	TVC(O)	ATM12/0/1	2	121	MUX	UP
ATM0/1/2	1	36	TVC(O)	ATM12/0/1	2	122	MUX	UP
ATM0/1/2	1	37	TVC(O)	ATM12/0/1	2	123	MUX	UP
ATM0/1/2	1	41	TVC(O)	ATM12/0/1	2	124	MUX	UP

```
C8540MSR-2#show mpls int
```

Interface	IP	Tunnel	Operational
FastEthernet9/0/0	Yes (ldp)	No	Yes
ATM0/1/2	Yes (ldp)	No	Yes (ATM labels)
<i>! Note: ATM labels -> Cell mode</i>			
ATM12/0/0.60	Yes (ldp)	No	Yes

Note: The same configuration procedure shown above should be used on the second 8540 MSR (C8540MSR-1). This configuration is not shown here because the same steps are required to get the MPLS up and running.

C8510MSR-3 (Catalyst 8510MSR)

```

C8510MSR-1#show running-config
Building configuration...

!
interface Loopback0
 ip address 10.254.231.1 255.255.255.255
!
interface ATM0/0/2
 ip address 10.254.14.245 255.255.255.252
 logging event subif-link-status
 no atm ilmi-keepalive
 mpls label protocol ldp
 tag-switching ip
!
interface ATM0/0/3
 ip address 10.254.14.238 255.255.255.252
 logging event subif-link-status
 load-interval 30
 no atm ilmi-keepalive
 mpls label protocol ldp
 tag-switching ip

```

```

!
router ospf 1
 log-adjacency-changes
 network 10.0.0.0 0.255.255.255 area 0.0.0.0

```

Using the Enhanced ARM for Frame Mode MPLS over ATM VP Tunnel

The Catalyst 8540 MSR with an Enhanced ARM line card can also run frame mode MPLS over ATM. In order to illustrate usage of the Enhanced ARM in the frame mode MPLS, view the "Using the Enhanced ARM for Frame Mode MPLS over ATM Tunnels" configuration example located in this document. ATM VP tunnels are sometimes used to connect two sites. Instead of configuring individual VCs, the large "pipe" VP tunnel can be used. In order to illustrate this option, which is normally used by companies that need a large number of VCs between the remote sites, the VP tunnel was created between C8540MSR-1 and C8540MSR-2. Two 8540MSR's are directly connected through the ATM2/0/0 (OC-12, an hierarchical VP tunnel ATM2/0/0.60 has been used). Both Enhanced ARM modules run frame mode MPLS on an ATM subinterface. For that reason, a data PVC/aal5snap has been configured.

The table below displays the steps performed in C8540MSR-1 to configure the Enhanced ARM for Frame Mode MPLS over ATM VP Tunnel.

C8540MSR-1 (Catalyst 8540MSR)										
C8540MSR-1#show hardware										
C8540 named c8540-r6-1, Date: 04:46:41 UTC Mon Feb 10 2003										
Slot	Ctrlr-Type	Part No.	Rev	Ser No	Mfg Date	RMA No.	Hw Vrs	Tst	EEP	
0/*	Super Cam	73-2739-03	B0	03170SUQ	Apr 27 99	0	3.0			
0/1	155MM PAM	73-1496-03	A6	03199939	Aug 01 95	00-00-00	3.1	0	2	
2/*	OCM Board	73-2833-06	A0	03210XWB	May 26 99	0	6.0			
2/0	QUAD 622 Gen	73-2852-05	A0	03210YN8	May 26 99	0	5.0			
9/*	ETHERNET PAM	73-3754-05	A0	031111EO	Mar 17 99	0	4.1			
11/*	CMPM Card	73-3944-05	A0	04209F5E	Aug 29 00	0	5.0			
11/0	ARM2 PAM	73-5533-01	A0	0424A162	Aug 29 00	0	5.1			
11/1	ARM2 PAM	73-5533-01	A0	0424A17C	Aug 29 00	0	5.1			
C8540MSR-1#conf t										
Enter configuration commands, one per line. End with CNTL/Z.										
C8540MSR-1(config)#atm hierarchical-tunnel										
C8540MSR-1(config)#atm connection-traffic-table-row index 60 cbr pbr 120000										
C8540MSR-1(config)#int atm 2/0/0										
C8540MSR-1(config-if)#atm pvp 6 hierarchical rx-cttr 60 tx-cttr 60										
C8540MSR-1(config-if)#int atm 2/0/0.60										
C8540MSR-1(config-subif)#exit										
C8540MSR-1(config)#int atm 11/0/0.60 point-to-point										
C8540MSR-1(config-subif)#ip address 10.254.14.10 255.255.255.252										
C8540MSR-1(conf-sif)#atm pvc 2 60 pd on encap aal5snap int atm 2/0/0.60 60 60										
C8540MSR-1(config-subif)#mpls label protocol ldp										
C8540MSR-1(config-subif)#mpls ip										
C8540MSR-1(config-subif)#end										
C8540MSR-1#show atm vc int atm 11/0/0.60 include ATM2/										
ATM11/0/0		2	60	PVC	ATM2/0/0.60	60	60	SNAP	UP	
C8540MSR-1#show mpls int										
Interface		IP		Tunnel		Operational				
ATM0/0/1		Yes (ldp)		No		Yes		(ATM labels)		
ATM0/0/2		Yes		No		No		(ATM labels)		
FastEthernet9/0/4		Yes		No		No				
ATM0/1/0		Yes (ldp)		No		No		(ATM labels)		

ATM11/0/1	Yes	No	No
ATM11/0/0.5	Yes (tdp)	No	Yes
ATM11/0/0.60	Yes (ldp)	No	Yes

! Note: no ATM labels -> Frame mode

C8540MSR-1#show mpls int atm 11/0/0.60 det

```
Interface ATM11/0/0.60:
  IP labeling enabled (ldp)
  LSP Tunnel labeling not enabled
  MPLS operational
  MTU = 4470
```

C8540MSR-1#show atm vp

Interface	VPI	Type	X-Interface	X-VPI	Status
ATM2/0/0	60	PVP			HIE. TUNNEL

Configurations

The relevant parts of the MSR's configurations from the network diagram are shown below:

- C8540MSR-2
- C8540MSR-1
- C8510MSR-3 (Note that this configuration is the same as the one in Using the Enhanced ARM for Cell Mode MPLS above.)

C8540MSR-2 (Catalyst 8540MSR)

```
C8540MSR-2#show running-config
Building configuration...
!
mpls label protocol ldp
atm hierarchical-tunnel
atm connection-traffic-table-row index 60 cbr pcr 120000

!
interface Loopback0
 ip address 10.254.225.1 255.255.255.255
!
interface ATM0/1/2
 description IP subnet 10.254.14.236
 ip address 10.254.14.237 255.255.255.252
 ip ospf cost 4
 no atm ilmi-keepalive
 mpls label protocol ldp
 tag-switching ip
 mpls-forwarding interface ATM12/0/1
! terminates cell mode MPLS on the ARM module
interface ATM2/0/0
 no ip address
 no atm ilmi-keepalive
 atm pvp 60 hierarchical rx-cttr 60 tx-cttr 60
!
interface ATM2/0/0.60 point-to-point
 description Hierarchical VP Tunnel for frame mode MPLS over ATM
!
interface FastEthernet9/0/0
 ip address 10.64.0.2 255.255.255.252
 load-interval 30
 duplex full
 speed 100
 tag-switching ip
 mpls-forwarding interface ATM12/0/0
```

```

! EPIF based FE line cards do not support MPLS natively
! link to ARM2 (ATM 12/0/0) enables MPLS on those cards

interface ATM12/0/0

description Enhanced ARM - ARM2

no ip address

!

interface ATM12/0/0.60 point-to-point

description ARM2 subinterface used for Frame mode MPLS over HVPT 60

ip address 10.254.14.9 255.255.255.252
atm pvc 2 60 pd on encap aal5snap interface ATM2/0/0.60 60 60
mpls label protocol ldp
tag-switching ip

! an ARM2 point-to-point subinterface (point-to-point) supported as of IOS
release 12.1(10)EY only

!
router ospf 1
router-id 10.254.225.1
log-adjacency-changes
network 10.0.0.0 0.255.255.255 area 0.0.0.0
!

```

C8540MSR-1 (Catalyst 8540MSR)

```

C8540MSR-1#show running-config
Building configuration...
sdm sram Label 32768
sdm sram Tag-Cos 32768

!
tag-switching tdp router-id Loopback0
!
atm hierarchical-tunnel
atm connection-traffic-table-row index 60 cbr pcr 120000
!
interface Loopback0
ip address 10.254.232.1 255.255.255.255
!
interface ATM0/1/0
ip address 10.254.14.246 255.255.255.252
ip ospf cost 100
logging event subif-link-status
no atm ilmi-keepalive
mpls label protocol ldp
tag-switching ip
mpls-forwarding interface ATM11/0/0
!
interface ATM2/0/0
no ip address
no atm ilmi-keepalive
atm pvp 60 hierarchical rx-cttr 60 tx-cttr 60
!
interface ATM2/0/0.60 point-to-point
no atm ilmi-keepalive

```

```

!
interface FastEthernet9/0/4
 ip address 10.177.1.1 255.255.255.252
 tag-switching ip
 mpls-forwarding interface ATM11/0/0
!
interface ATM11/0/0
 no ip address
!
interface ATM11/0/0.60 point-to-point
 ip address 10.254.14.10 255.255.255.252
 atm pvc 2 60 pd on encap aal5snap interface ATM2/0/0.60 60 60
 mpls label protocol ldp
 tag-switching ip
!

router ospf 1
 router-id 10.254.232.1
 log-adjacency-changes
 network 10.177.1.0 0.0.0.3 area 0.0.0.0
 network 10.254.0.0 0.0.255.255 area 0.0.0.0
!
end

```

Verify

Use the following commands to verify if the MPLS is up and working properly:

- **show mpls interfaces [detail]** – Verifies whether a label distribution protocol is running on the requested interface
- **show mpls ldp neighbors** – Displays the status of LDP sessions/neighbor connections
- **show mpls ldp discovery** – Determines the LDP identifier and LDP hello exchange status of the interfaces
- **show mpls forwarding-table** – Checks the MPLS Forwarding Information Base (FIB) table
- **show mpls ip binding** – Checks the MPLS IP Label Information Base (LIB) table

C8540MSR-1#show mpls interfaces

Interface	IP	Tunnel	Operational
ATM0/0/1	Yes (ldp)	No	Yes (ATM labels)
ATM0/1/0	Yes (ldp)	No	Yes (ATM labels)
ATM11/0/0.60	Yes (ldp)	No	Yes

C8540MSR-1#show mpls interfaces atm 0/1/0 detail

```

Interface ATM0/1/0:
  IP labeling enabled (ldp)
  LSP Tunnel labeling not enabled
  MPLS operational
  MTU = 4470
  ATM tagging: Label VPI = 1
                Label VCI range = 33 - 65535
                Control VC = 0/32

```

C8540MSR-1#show mpls ldp neighbor

```

Peer LDP Ident: 10.254.225.1:0; Local LDP Ident 10.254.232.1:0
TCP connection: 10.254.225.1.646 - 10.254.232.1.11016
State: Oper; Msgs sent/rcvd: 106/93; Downstream
Up time: 00:56:36
LDP discovery sources:
  ATM11/0/0.60, Src IP addr: 10.254.14.9
Addresses bound to peer LDP Ident:
  2.2.2.1          10.64.4.190    10.254.225.1    1.254.8.1
  10.254.14.221   10.254.14.225   10.254.14.237   10.254.14.9

```

```

Peer LDP Ident: 10.254.231.1:4; Local LDP Ident 10.254.232.1:2
TCP connection: 10.254.14.245.646 - 10.254.14.246.11017
State: Oper; Msgs sent/rcvd: 45/45; Downstream on demand
Up time: 00:38:27
LDP discovery sources:
  ATM0/1/0, Src IP addr: 10.254.14.245

```

C8540MSR-1#show mpls ldp discovery

```

Local LDP Identifier:      10.254.232.1:0
Discovery Sources:
Interfaces:

```

```

      ATM0/1/0 (ldp): xmit/rcv          LDP Id: 10.254.231.1:4; IP addr:      10.254.14.245
      ATM11/0/0.60 (ldp): xmit/rcv     LDP Id: 10.254.225.1:0

```

C8540MSR-1#show mpls forwarding-table

Local tag	Outgoing tag or VC	Prefix or Tunnel Id	Bytes tag switched	Outgoing interface	Next Hop
16	Untagged	10.254.14.220/30	0	AT11/0/0.60	point2point
17	27	10.254.247.1/32	0	AT11/0/0.60	point2point
20	22	10.254.14.240/30	0	AT11/0/0.60	point2point
21	26	10.254.231.1/32	0	AT11/0/0.60	point2point
24	Untagged	10.254.14.224/30	0	AT11/0/0.60	point2point
25	24	10.254.227.1/32	0	AT11/0/0.60	point2point
26	Pop tag	10.254.14.236/30	0	AT11/0/0.60	point2point
33	Untagged	10.254.221.1/32	0	AT11/0/0.60	point2point
45	18	10.254.14.12/30	0	AT11/0/0.60	point2point

SORBRVC0(c8540-r6-1)#show mpls ip bind

```

...
10.254.221.1/32
  in label:      33
10.254.222.1/32
  in label:      36
  out vc label:  1/53      lsr: 10.254.233.1:2  ATM0/0/1
                    Active  ingress 4 hops (vcd 49)
10.254.223.1/32
  in label:      34
  out vc label:  1/54      lsr: 10.254.233.1:2  ATM0/0/1
                    Active  ingress 3 hops (vcd 43)
10.254.225.1/32
  in label:      28
  out label:     imp-null  lsr: 10.254.225.1:0
10.254.227.1/32
  in label:      25
  out label:     24      lsr: 10.254.225.1:0
10.254.232.1/32
  in label:      imp-null
  in vc label:   1/34      lsr: 10.254.233.1:2  ATM0/0/1
                    Active  egress (vcd 59)
  out label:     33      lsr: 10.254.225.1:0
10.254.233.1/32
  in label:      29
  out label:     34      lsr: 10.254.225.1:0
  out vc label:  1/60      lsr: 10.254.233.1:2  ATM0/0/1
                    Active  ingress 2 hops (vcd 38)
10.254.242.1/32
  in label:      19
  out vc label:  1/61      lsr: 10.254.233.1:2  ATM0/0/1
                    Active  ingress 5 hops (vcd 50)
10.254.247.1/32
  in label:      17
  out label:     27      lsr: 10.254.225.1:0

```

Troubleshoot

For additional information on MPLS troubleshooting, refer to the MPLS Troubleshooting general troubleshooting document which explains MPLS troubleshooting in detail.

Related Information

- [Configuring MPLS over RFC1483 PVCs on the Enhanced ATM Router Module \(ARM\)](#)
- [Configuring ATM Label Edge Routing on the Enhanced ATM Router Module \(ARM\)](#)
- [MPLS on CCO](#)

Additional Documentation

- [Troubleshooting Tag and MPLS Switching Connections](#)
- [Technical Support – Cisco Systems](#)
- [More ATM Information](#)
- [Tools and Utilities – Cisco Systems](#)

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