NEC

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INCORPORATED IN VICTORIA

Systems Integration
BND

BANDWIDTH UTILIZATION TEST REPORT

TITLE:

BANDWIDTH UTILIZATION BY NEC IPS2000 PABX'S AND CISCO 3660 ROUTER OVER ISDN, FRAME RELAY, ATM AND ETHERNET WAN TECHNOLOGY.

TESTING ENGINEERS:

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Classification:	☒	Final	☐	Preliminary	☐	
Distribution:	☒	General	☒	Customer	☐	New Zealand
Technical Level:	☐	Low	☐	Low – Medium	☐	Medium
	☒	Medium – High	☐	High	☐	

ADDITIONAL INFORMATION:

Compiled:	**Approved:**	**Authorized:**	**Document Number:**
H.KUMAR I.HAMEED			**Issue:**
			Released:
Date: 27-3-2002	**Date:**	**Date:**	**Date:**

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

The results provided in this test report indicate bandwidth utilized by IPS2000's Virtual IP trunk and Peer-to-Peer IP Dterm using different wan technology ISDN, ATM, Ethernet and Frame Relay.

Bandwidth utilized by per call with different voice compression such as G711 a-law, G729, G723a were tested successfully. Few issues were encountered during testing, that are related to "ip rtp header-compression" on different wan link and Dterm rtp self port number for the "rtp header-compression".

The testing scenarios and bandwidth utilized by single call over the different wan technology are included in this bandwidth utilization test report, however this only covers phase one testing. The following phases of testing will include testing for Dterm/IP PAD rtp self port number, IP rtp header-compression issues on Wan link and survivability (SRS) testing.

The NEAX2000 IPS configurations are documented in Technical information bulletin (TIB) **XXXX**. For further information regarding document TIB **XXXX** contact the authors (Mr. Ibrahim Hameed) of this document.

2.0 INTRODUCTION

This document outlines the bandwidth utilization and results using NEC NEAX2000 IPS PABX's and Cisco 3660 series routers using ATM, Frame-Relay, ISDN (BRI) and Ethernet.

3.0 OBJECTIVES

- To test the bandwidth utilization by NEC NEAX 2000 IPS PABX's over ISDN, ATM, Frame relay and Ethernet wan technology.

- To test the bandwidth utilization by the following technology.
  - Virtual IP trunk (4/8 Trunks) with voice compression G711 a-law, G729, G723a
  - Dterm Peer-to-Peer with voice compression G711 a-law, G729, G723a
  - NEC Soft Phone 1.7 (Peer-to-Peer) with voice compression G711 a-law, G729, G723a

4.0 SCOPE

This document cover the bandwidth utilization testing that includes the bandwidth utilization by single call over the Virtual trunk and IP peer-to-peer topology. Testing also include the test of hardware interfaces, NEC IPS Virtual Trunk, NEC Peer-to-Peer and basic feature testing.

Additional testing for the issue of IP rtp header-compression and IP Dterm and IP PAD's rtp Self-Port will be covered in the following phases of bandwidth utilization testing.

5.0 GENERAL EQUIPMENT REQUIREMENTS

The following tables detail the equipment used to perform the bandwidth utilization tests.

VENDOR: NEC AUSTRALIA

ITEM DESCRIPTION	PART NUMBER	H/W	S/W	F/W	QUANTITY	COMMENTS
IPS2000	SN 1557 PIMM-B				2	
CPU (Virtual trunk)	PN-CP24-A	2A	D2 4.04		1	Includes Virtual Trunk
IP-PAD	PN-32IPLA	4A		0.26	2	Register Card
Digital Telephone	Dterm 75				4	Dterm 75 also suitable
VCT Card	PN-16VCTA	3A			1	ICS 140 Software
IP Adapter	IPW-2UA				1	IMX 240 Software
IPS MAT Program	Version 4.5.0					

VENDOR: CISCO SYSTEMS

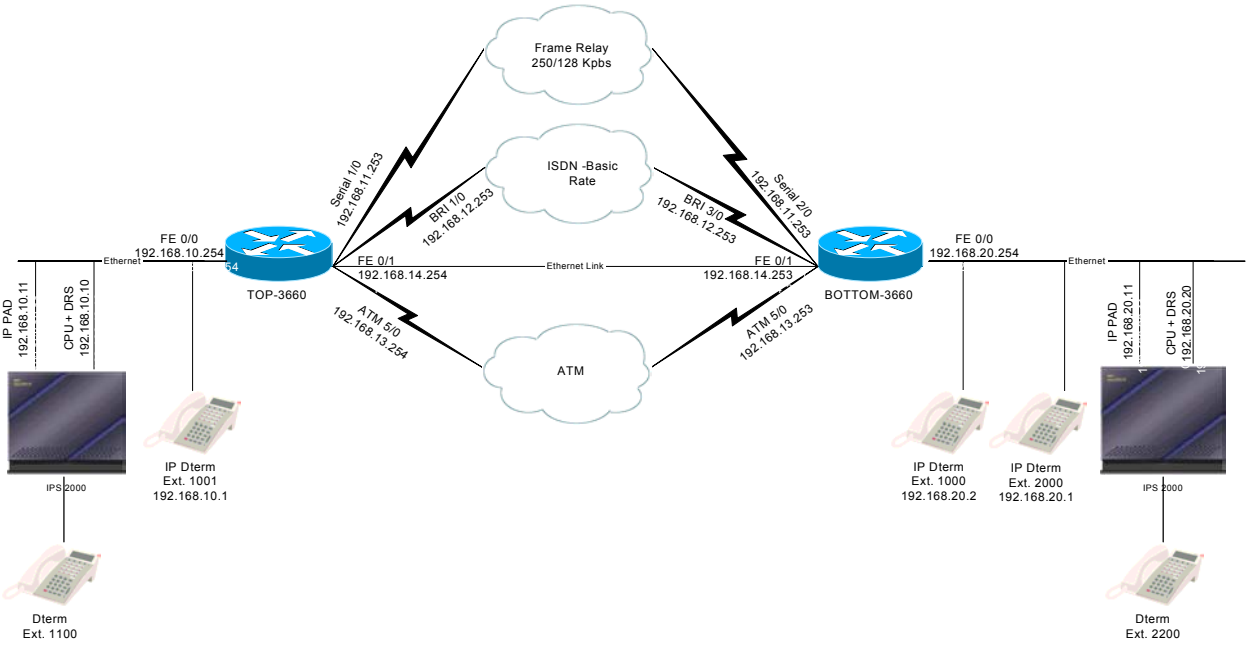
ITEM DESCRIPTION	PART NUMBER	QUANTITY	COMMENTS
Cisco 3660 Router	Cisco3660-MB-2FE	2	
WAN interface cards	WIC-1T	2	Serial Wan interface module
ATM Network Module	ATM-1A-OC3MM	2	ATM Multimode Network Module
ISDN Bri WIC	WIC-1B-S/T	2	ISDN Bri Wan interface module
3660 Cisco IOS Software	Version 12.1(5)T	2	Minimum Required IOS Software Version.
32MB Flash Memory	-	2	
64MB DRAM Memory	-	2	

VENDOR: RADCOM

ITEM DESCRIPTION	PART NUMBER	QUANTITY	COMMENTS
RADCOM Prism Lite	-	1	RADCOM Prism Lite Protocol Analyzer
BRI Card	ISDN-BRI-S/T	1	
ATM Module	OC-3C-STM-1	1	
LAN Module	-	1	
MTYP	-	1	
RADCOM Prism Lite s/w	Version 6.63	1	

6.0 NETWORK CONFIGURATION

The network configuration diagram for bandwidth analysis testing is as follows



7.0 SOFTWARE CONFIGURATION

The following sections indicate the required software versions for the Cisco routers and the NEC NEAX2000 IPS PABX. The Cisco router programming and the NEC NEAX2000 IPS programming is documented in the TIB number **XXXX**. Further information on TIB **XXXX** can be obtained from the ITR **XXXX**'s authors.

7.1 CISCO 3660 ROUTER CONFIGURATION REQUIREMENTS

7.1.1 ROUTER TOP-3660 VERSION INFORMATION

```
Top-3660#show ver
Cisco Internetwork Operating System Software
IOS (tm) 3600 Software (C3660-IS-M), Version 12.1(5)T,  RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2000 by cisco Systems, Inc.
Compiled Sat 11-Nov-00 10:05 by ccai
Image text-base: 0x60008960, data-base: 0x61140000

ROM: System Bootstrap, Version 12.0(6r)T, RELEASE SOFTWARE (fc1)
ROM: 3600 Software (C3660-IS-M), Version 12.2(6), RELEASE SOFTWARE (fc2)

Top-3660 uptime is 6 days, 6 hours, 24 minutes
System returned to ROM by reload
System image file is "flash:c3660-is-mz.121-5.t.bin"

cisco c3660 (R527x) processor (revision C0) with 120832K/10240K bytes of memory.
Processor board ID JAB0436C0TR
R527x CPU at 225Mhz, Implementation 40, Rev 10.0, 2048KB L2 Cache
Channelized E1, Version 1.0.
Bridging software.
X.25 software, Version 3.0.0.
SuperLAT software (copyright 1990 by Meridian Technology Corp).
Primary Rate ISDN software, Version 1.1.
Basic Rate ISDN software, Version 1.1.


3660 Chassis type: ENTERPRISE
2 FastEthernet/IEEE 802.3 interface(s)
1 Serial network interface(s)
1 ISDN Basic Rate interface(s)
1 ATM network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
125K bytes of non-volatile configuration memory.
32768K bytes of processor board System flash (Read/Write)

Configuration register is 0x2102

Top-3660#
```

7.1.2 ROUTER TOP-3660 CONFIGURATION

Router TOP-3660 configuration information.

```
Top-3660#show run
Building configuration...

Current configuration : 3435 bytes
!
version 12.1
no service single-slot-reload-enable
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Top-3660
!
boot system flash c3660-is-mz.121-5.t.bin
logging rate-limit console 10 except errors
enable password cisco
!
ip subnet-zero
!
!
no ip finger
no ip domain-lookup
!
!
class-map match-any VOIP
  match access-group 101
class-map match-any RTP
  match access-group 100
!
!
policy-map POLICY
  class RTP
    priority 100
  class VOIP
   bandwidth 10
!
frame-relay switching
isdn switch-type basic-net3
!
!
!
interface FastEthernet0/0
 ip address 192.168.10.254 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 duplex auto
 speed auto
 no cdp enable
!
interface FastEthernet0/1
 ip address 192.168.14.254 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 load-interval 30
 no keepalive
 duplex auto
 speed auto
 no cdp enable
!
interface BRI1/0
 no ip address
 encapsulation ppp
 load-interval 30
 dialer pool-member 1
 isdn switch-type basic-net3
 no cdp enable
!
interface Serial1/0
 bandwidth 256
 ip address 192.168.11.254 255.255.255.0
 encapsulation frame-relay
 no ip route-cache
```

```
 no ip mroute-cache
 load-interval 30
 no keepalive
 clockrate 250000
 frame-relay class FR
 frame-relay map ip 192.168.11.253 100 broadcast
 frame-relay ip rtp header-compression
!
interface ATM5/0
 bandwidth 250000
 ip address 192.168.13.254 255.255.255.0
 no atm scrambling cell-payload
 no atm ilmi-keepalive
 pvc atm1 8/38
  encapsulation aal5snap
 !
!
interface Virtual-Template1
 no ip address
 ppp multilink
 ppp multilink interleave
!
interface Dialer1
 ip address 192.168.12.254 255.255.255.0
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 load-interval 30
 dialer pool 1
 dialer idle-timeout 300 either
 dialer string 95453322
 dialer load-threshold 1 either
 dialer-group 1
 no cdp enable
 ppp multilink
!
ip classless
ip route 192.168.20.0 255.255.255.0 192.168.14.253
no ip http server
!
!
map-class frame-relay FR
 frame-relay fragment 320
 no frame-relay adaptive-shaping
 frame-relay cir 256000
 frame-relay bc 2560
 frame-relay mincir 256000
 !
access-list 100 permit ip any any precedence critical
access-list 100 permit ip any any dscp ef
access-list 101 permit ip any any precedence network
access-list 101 permit ip any any dscp ef
dialer-list 1 protocol ip permit
no cdp run
!
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 exec-timeout 0 0
 password cisco
 login
!
end

Top-3660#
```

7.1.3 ROUTER BOTTOM-3660 VERSION INFORMATION

```
Bottom-3660#show ver
Cisco Internetwork Operating System Software
IOS (tm) 3600 Software (C3660-IS-M), Version 12.2(6), RELEASE SOFTWARE (fc2)
Copyright (c) 1986-2001 by cisco Systems, Inc.
Compiled Wed 07-Nov-01 16:59 by pwade
Image text-base: 0x600089C0, data-base: 0x61200000

ROM: System Bootstrap, Version 12.0(6r)T, RELEASE SOFTWARE (fc1)

Bottom-3660 uptime is 5 days, 1 hour, 54 minutes
System returned to ROM by reload
System image file is "flash:c3660-is-mz.122-6.bin"

cisco 3660 (R527x) processor (revision 1.0) with 54272K/11264K bytes of memory.
Processor board ID JAB041289GL
R527x CPU at 225Mhz, Implementation 40, Rev 10.0, 2048KB L2 Cache
Channelized E1, Version 1.0.
Bridging software.
X.25 software, Version 3.0.0.
SuperLAT software (copyright 1990 by Meridian Technology Corp).
Primary Rate ISDN software, Version 1.1.
Basic Rate ISDN software, Version 1.1.


3660 Chassis type: ENTERPRISE
2 FastEthernet/IEEE 802.3 interface(s)
4 Serial network interface(s)
1 ISDN Basic Rate interface(s)
1 ATM network interface(s)
DRAM configuration is 64 bits wide with parity disabled.
125K bytes of non-volatile configuration memory.
32768K bytes of processor board System flash (Read/Write)

Configuration register is 0x2102
```

7.1.4 ROUTER B CONFIGURATION

Router BOTTOM-3660 configuration information.

```
Bottom-3660#show run
Building configuration...

Current configuration : 3904 bytes
!
version 12.1
no service single-slot-reload-enable
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname Bottom-3660
!
boot system flash c3660-is-mz.121-5.t.bin
logging rate-limit console 10 except errors
enable password cisco
!
ip subnet-zero
!
!
no ip finger
no ip domain-lookup
!
!
class-map match-any VOIP
  match access-group 101
class-map match-any RTP
  match access-group 100
!
!
policy-map POLICY
```

```
  class RTP
    priority 100
  class VOIP
   bandwidth 10
!
isdn switch-type basic-net3
!
!
interface FastEthernet0/0
 ip address 192.168.20.254 255.255.255.0
 duplex auto
 speed auto
 no cdp enable
!
interface FastEthernet0/1
 ip address 192.168.14.253 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 load-interval 30
 no keepalive
 duplex auto
 speed auto
 no cdp enable
!
interface Serial2/0
 bandwidth 256
 ip address 192.168.11.253 255.255.255.0
 encapsulation frame-relay
 no ip route-cache
 no ip mroute-cache
 load-interval 30
 no keepalive
 frame-relay class FR
 frame-relay traffic-shaping
 frame-relay map ip 192.168.11.254 100 broadcast
 frame-relay local-dlci 100
 frame-relay ip rtp header-compression
!
interface BRI3/0
 no ip address
 encapsulation ppp
 load-interval 30
 dialer pool-member 1
 isdn switch-type basic-net3
 no cdp enable
 ppp multilink
!
interface ATM5/0
 ip address 192.168.13.253 255.255.255.0
 no atm scrambling cell-payload
 no atm ilmi-keepalive
 pvc atm1 7/37
  encapsulation aal5snap
 !
!
interface Dialer1
 ip address 192.168.12.253 255.255.255.0
 encapsulation ppp
 no ip route-cache
 no ip mroute-cache
 load-interval 30
 dialer pool 1
 dialer idle-timeout 300 either
 dialer string 95600849
 dialer load-threshold 1 either
 dialer-group 1
 no cdp enable
 ppp multilink
!
ip classless
ip route 192.168.10.0 255.255.255.0 192.168.14.254
no ip http server
!
!
map-class frame-relay FR
 frame-relay fragment 320
 no frame-relay adaptive-shaping
```

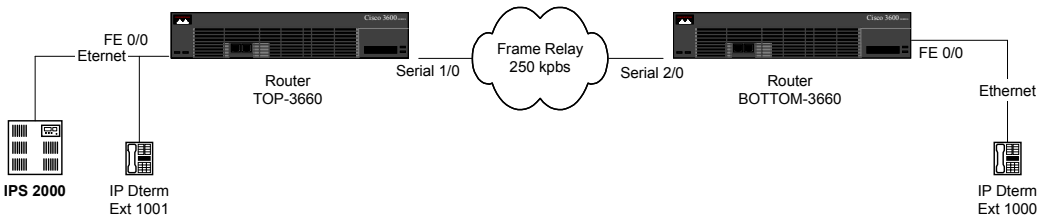
```
 frame-relay cir 256000
 frame-relay bc 2560
 frame-relay mincir 256000
access-list 100 permit ip any any precedence critical
access-list 100 permit ip any any dscp ef
access-list 101 permit ip any any precedence network
access-list 101 permit ip any any dscp ef
dialer-list 1 protocol ip permit
no cdp run
!
!
!
!
!
line con 0
 exec-timeout 0 0
 transport input none
line aux 0
line vty 0 4
 exec-timeout 0 0
 password cisco
 login
!
end

Bottom-3660#
```

7.2 NEC 7400 PABX CONFIGURATION REQUIREMENTS

Refer to TIB number **XXXX** for NEC NEAX2000 IPS PABX configuration information.

8.0 APPENDIX A – FRAME-RELAY

8.1 TEST SCENARIO 1 – PEER TO PEER



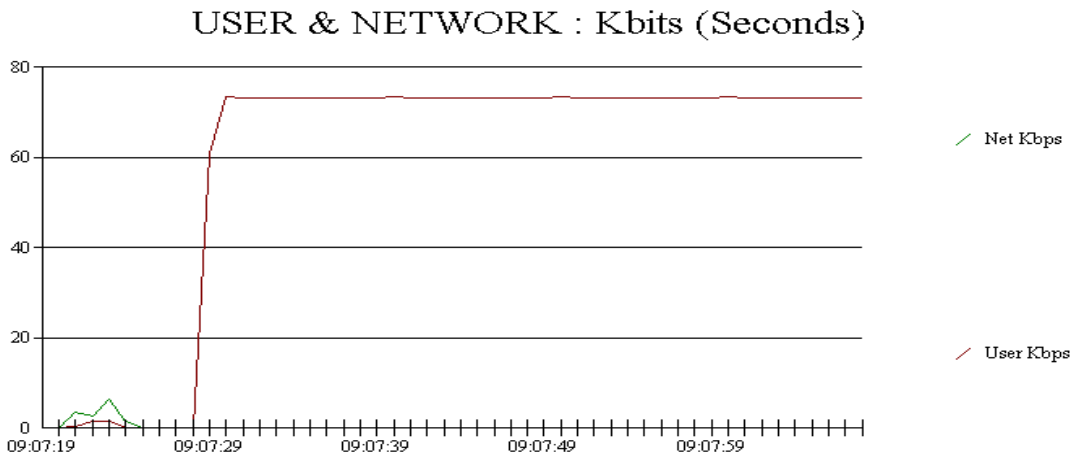
8.1.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

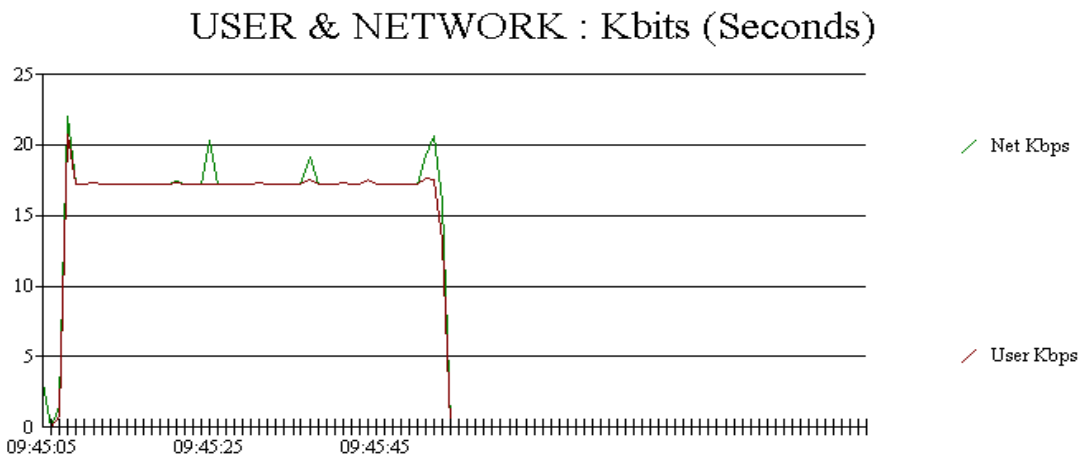
- No compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- Frame relay

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	40	Frame Relay	73.2 Kbps
G729	8	40	25	40	Frame Relay	17.2 Kbps
G723A	6.3	30 (Default)	33.33	40	Frame Relay	19.04 Kbps

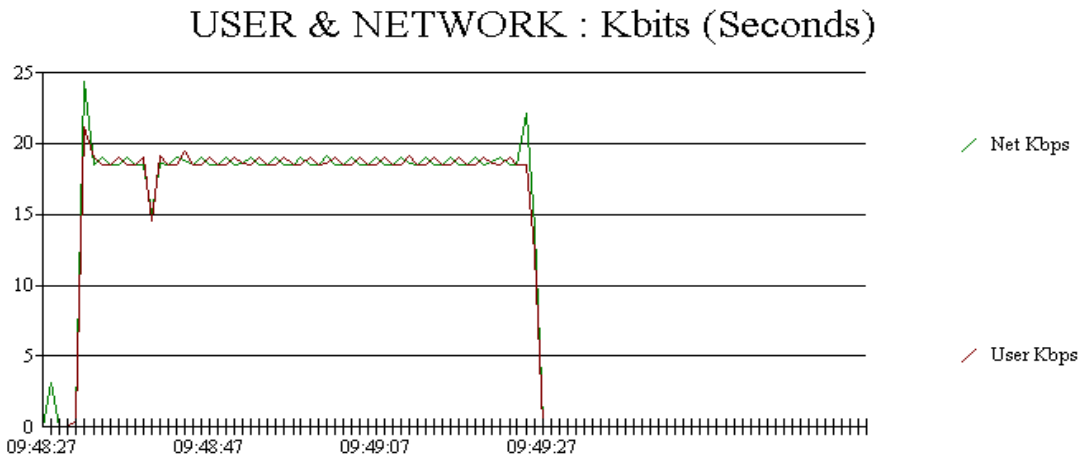
1. Bandwidth Graph for G711 without compression. Bandwidth utilized 73.2 Kbps.



2. Bandwidth Graph for G729 without compression. Bandwidth utilized 17.2 Kbps.



3. Bandwidth Graph for G723 without compression. Bandwidth utilized 19.04 Kbps.



8.1.2 PEER TO PEER CONNECTION WITH IP RTP HEADER-COMPRESSION ON THE ROUTERS

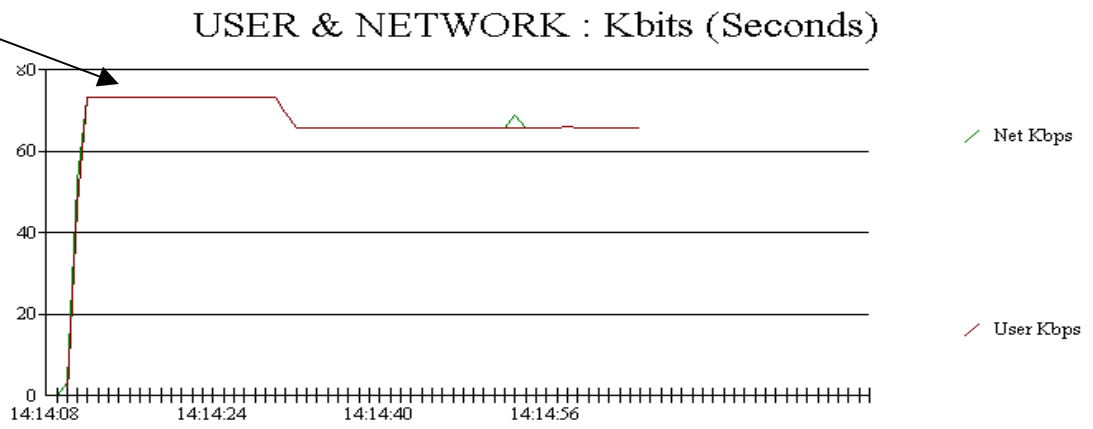
In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced some issues. IP RTP Header-compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- IP RTP Header-compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- Frame relay

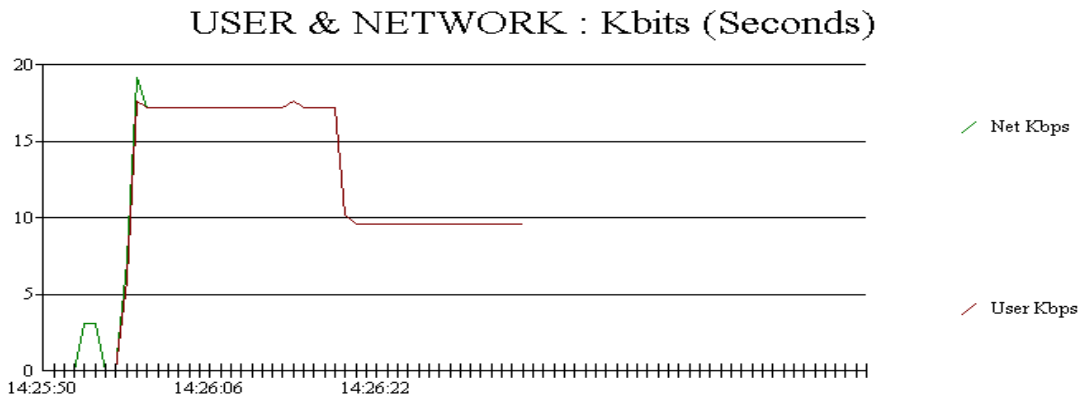
Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	cRTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	2	Frame Relay	65.6 Kbps
G729	8	40	25	2	Frame Relay	9.6 Kbps
G723A	6.3	30 (Default)	33.33	2	Frame Relay	8.7 Kbps

1. Bandwidth Graph for G711 with compression enabled. Bandwidth utilized 65.6 Kbps.

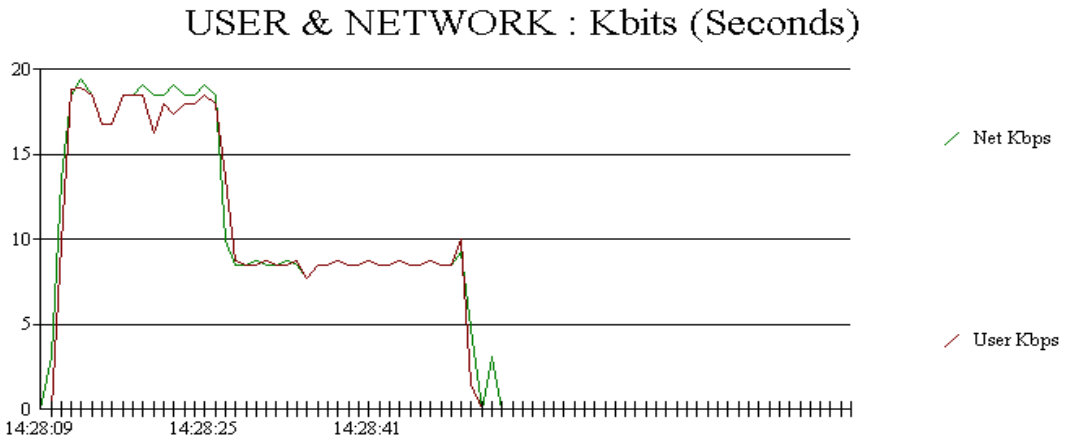
Issue 1



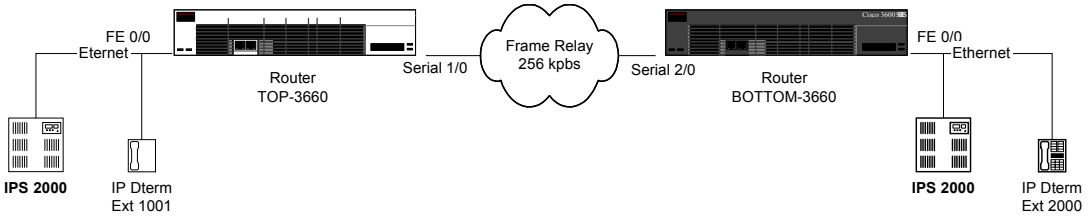
2. Bandwidth Graph for G729 with compression enabled. Bandwidth utilized 9.6 Kbps.



3. Bandwidth Graph for G723a with compression enabled. Bandwidth utilized 8.7 Kbps.



8.2 VIRTUAL TRUNK



8.2.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

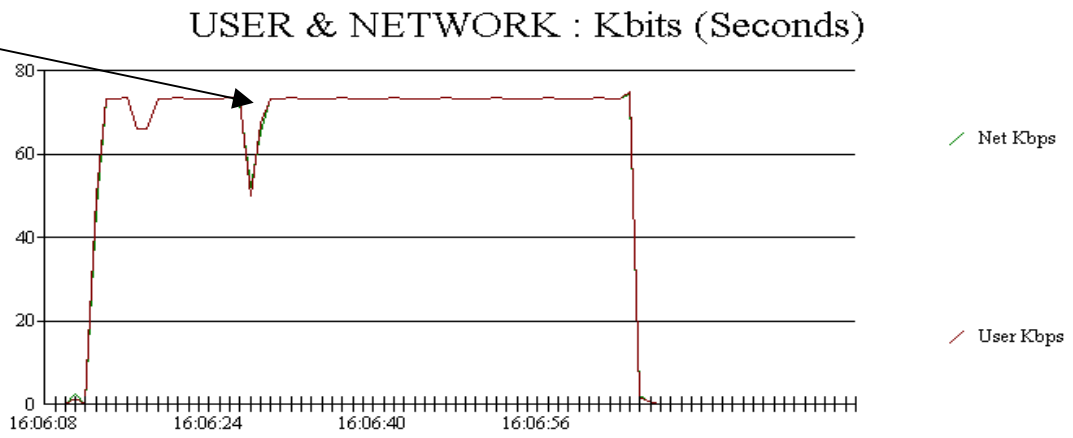
In this scenario the call was made from IP Dterm (ext. 1001) to IP Dterm (ext. 2000) via IP virtual trunk. The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- No compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- Frame Relay

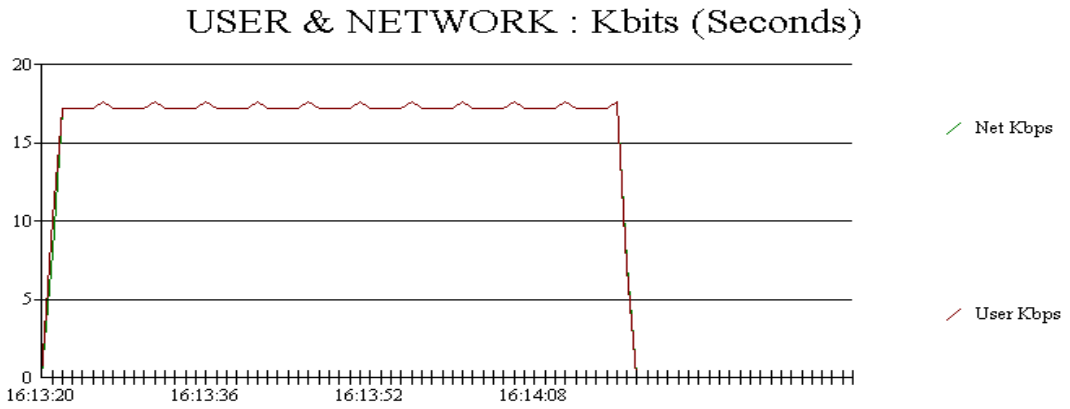
Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Virtual Trunk
G711 a-law	64	40	25	40	Frame Relay	73.56 Kbps
G729	8	40	25	40	Frame Relay	17.5 Kbps
G723A	6.3	30 (Default)	33.33	40	Frame Relay	19.04 Kbps

1. Bandwidth Graph for G711 with no compression . Bandwidth utilized 73.56 kbps.

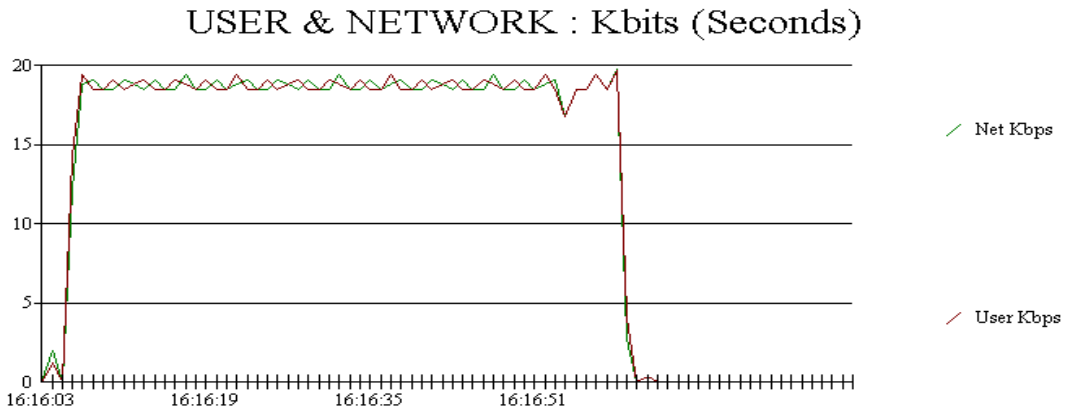
Issue 3



2. Bandwidth Graph for G729 with no compression. Bandwidth utilized 17.5 Kbps.



3. Bandwidth Graph for G723a with no compression. Bandwidth utilized 19.04 Kbps.



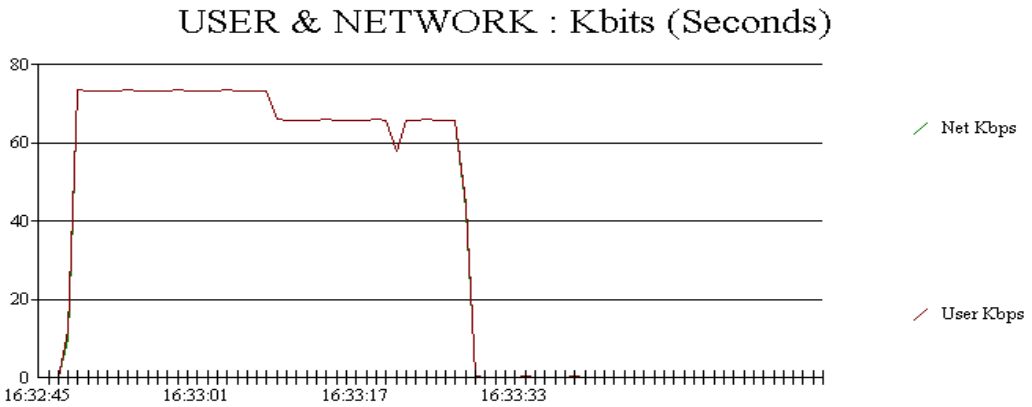
8.2.2 CONNECTION WITH IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from IP Dterm (ext. 1001) to IP Dterm (ext. 2000) via IP virtual trunk. The test scenario experienced some issues, IP rtp header-compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

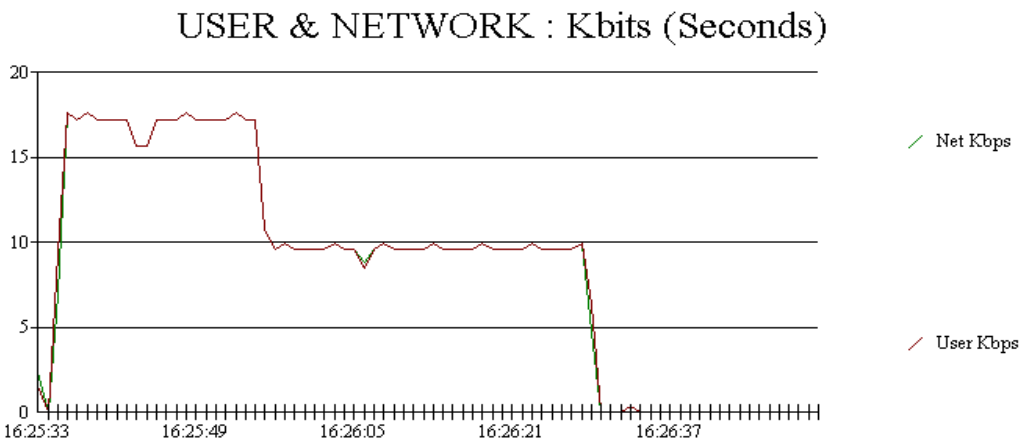
- Compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- Frame Relay

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Virtual Trunk
G711 a-law	64	40	25	2	Frame Relay	65.96 Kbps
G729	8	40	25	2	Frame Relay	9.96 Kbps
G723A	6.3	30 (Default)	33.33	2	Frame Relay	9.07 Kbps

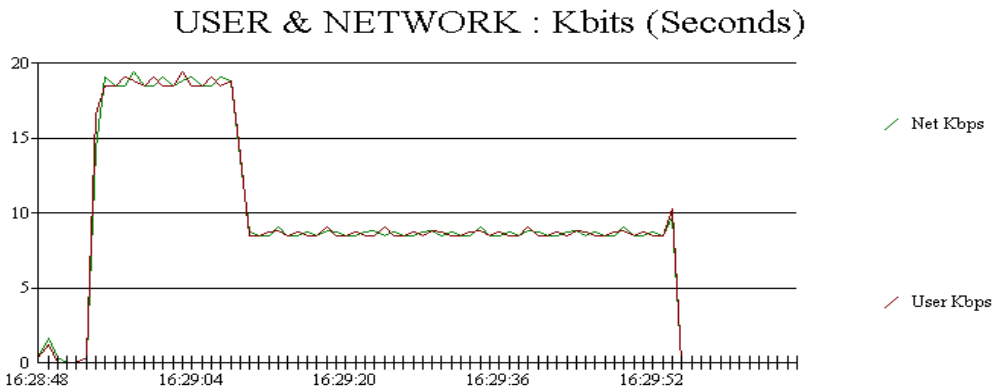
1. Bandwidth Graph for G711 with compression enabled. Bandwidth utilized 65.96 kbps.



2. Bandwidth Graph for G729 with compression enabled. Bandwidth utilized 9.96 Kbps.

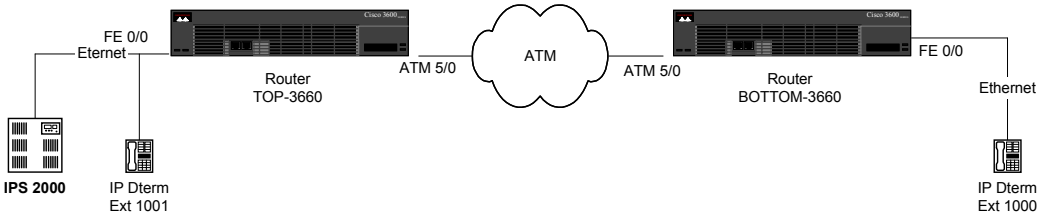


3. Bandwidth Graph for G723 with compression enabled. Bandwidth utilized 9.07 Kbps.



9.0 APPENDIX B – ATM

9.1 TEST SCENARIO 1 – PEER TO PEER



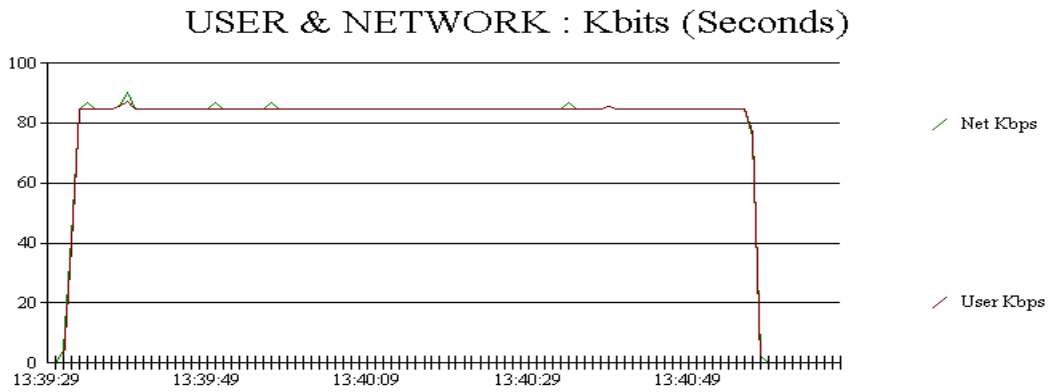
9.1.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

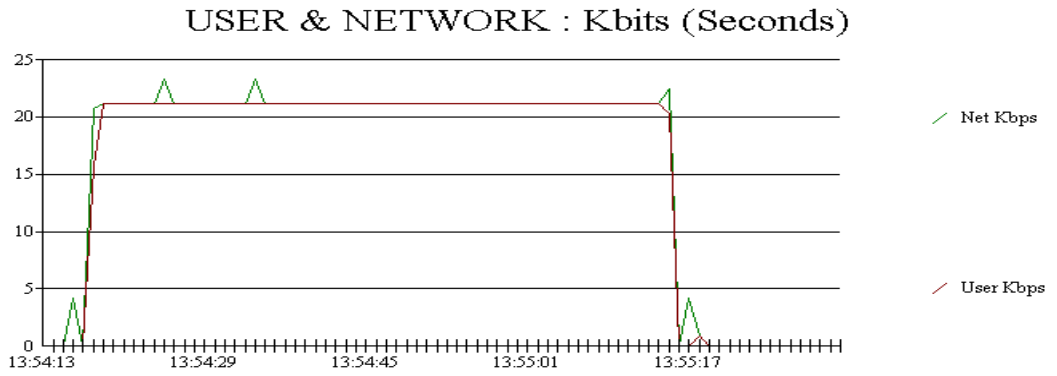
- No compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- ATM (encapsulation: aal5snap)

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	40	ATM	84.8 Kbps
G729	8	40	25	40	ATM	21.2 Kbps
G723A	6.3	30 (Default)	33.33	40	ATM	28.84 Kbps

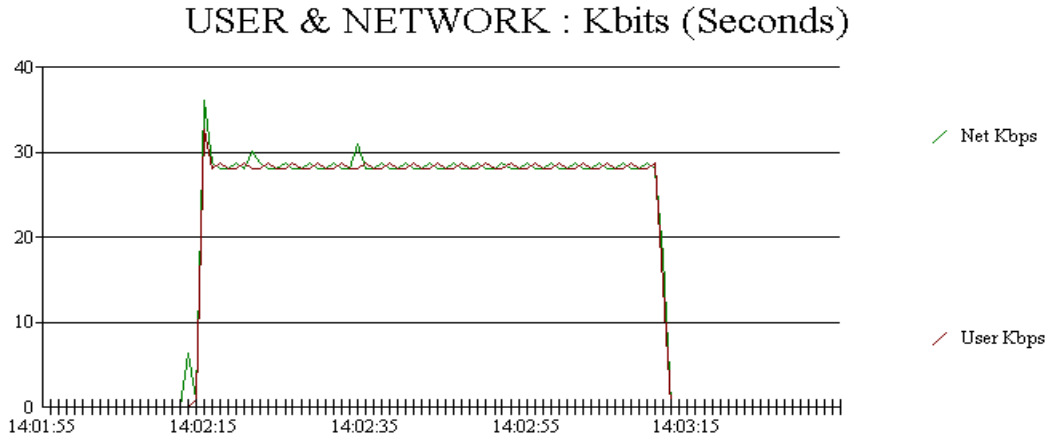
1. Bandwidth Graph for G711 without compression. Bandwidth utilized 84.8 Kbps



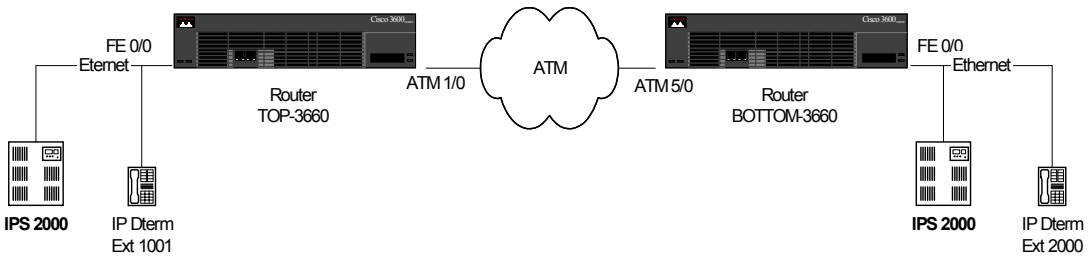
2. Bandwidth Graph for G729 without compression. Bandwidth utilized 21.2 Kbps



3. Bandwidth Graph for G729 without compression. Bandwidth utilized 28.84 Kbps



9.2 TEST SCENARIO 2 – VIRTUAL TRUNK



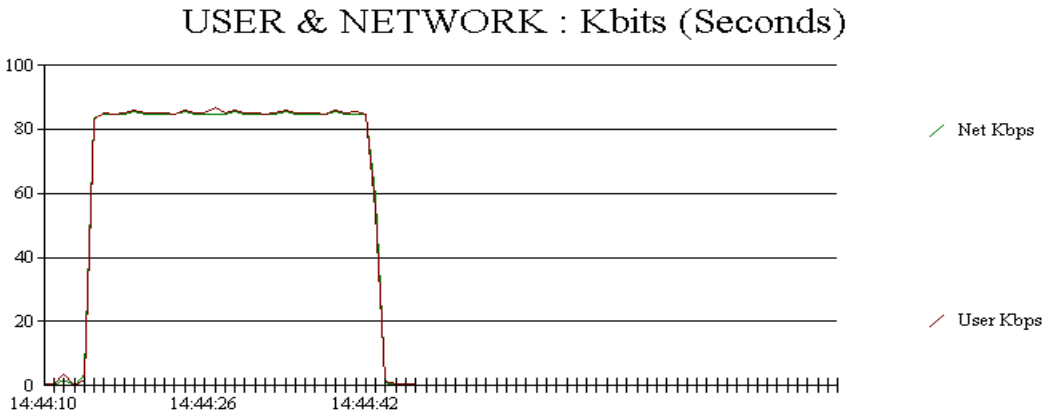
9.2.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from Dterm (ext. 1001) to IP Dterm (ext. 2000) via IP virtual Trunk. The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

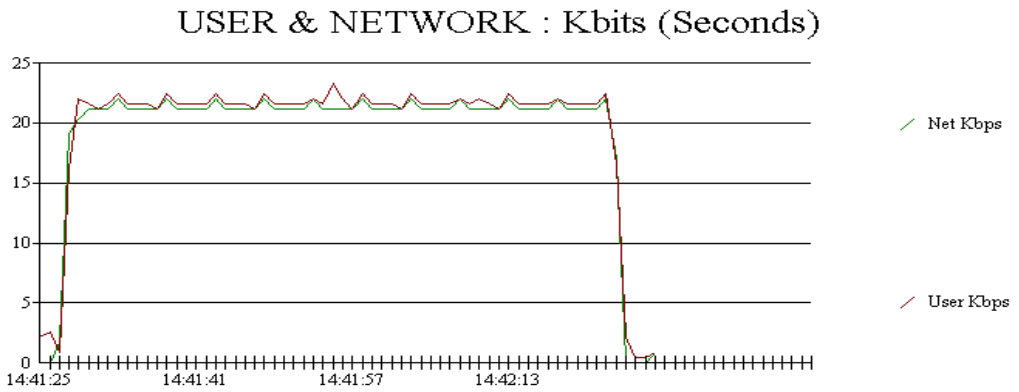
- No compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- ATM (encapsulation aal5snap)

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Virtual Trunk
G711 a-law	64	40	25	40	ATM	84.8 Kbps
G729	8	40	25	40	ATM	21.6 Kbps
G723A	6.3	30 (Default)	33.33	40	ATM	28.84 Kbps

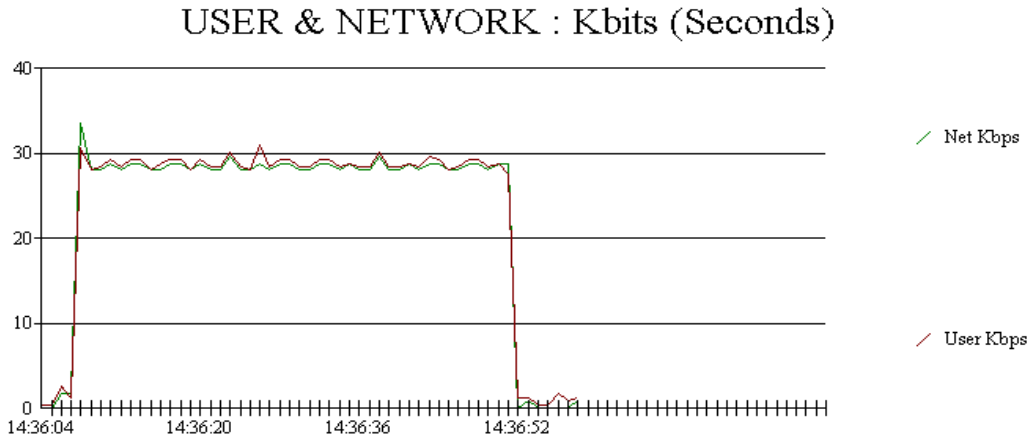
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 84.8 Kbps



2. Bandwidth Graph for G729 without compression. Bandwidth utilized 21.6 Kbps

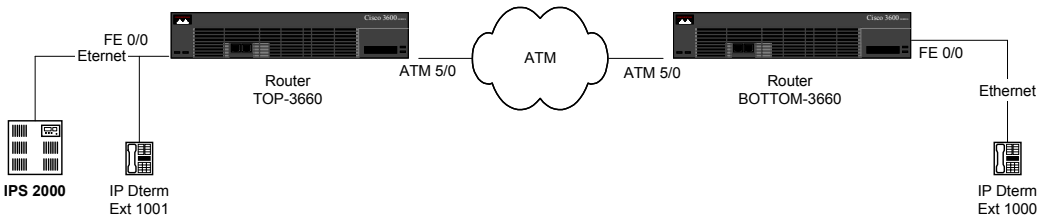


3. Bandwidth Graph for G723a without compression. Bandwidth utilized 28.84 Kbps



10.0 APPENDIX C – MPPP OVER ATM

10.1 TEST SCENARIO 1 – PEER TO PEER



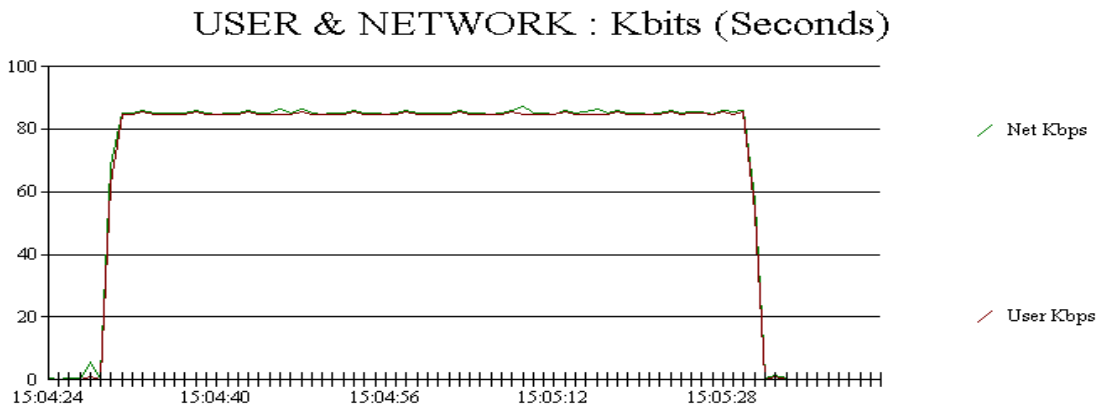
10.1.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

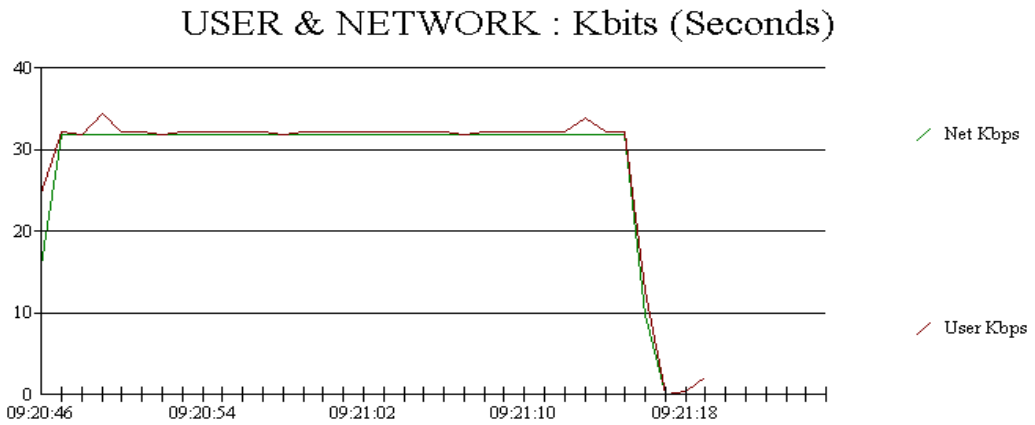
- No compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- PPP over ATM (encapsulation: aal5snap)

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	40	PPPoATM	86 Kbps
G729	8	40	25	40	PPPoATM	32.22 Kbps
G723A	6.3	30 (Default)	33.33	40	PPPoATM	29.25 Kbps

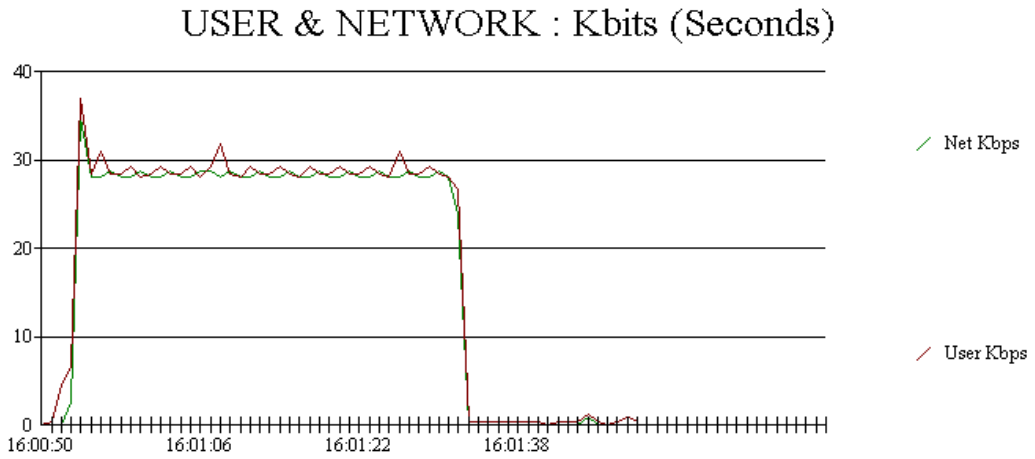
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 86 Kbps



2. Bandwidth Graph for G729 without compression. Bandwidth utilized 32.22 Kbps



3. Bandwidth Graph for G723a without compression. Bandwidth utilized 29.25 Kbps



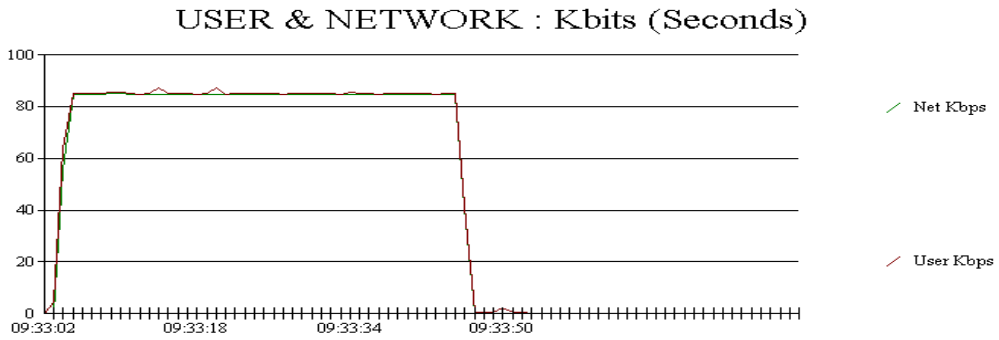
10.1.2 CONNECTION WITH IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- Compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- PPP over ATM (encapsulation: aal5snap)

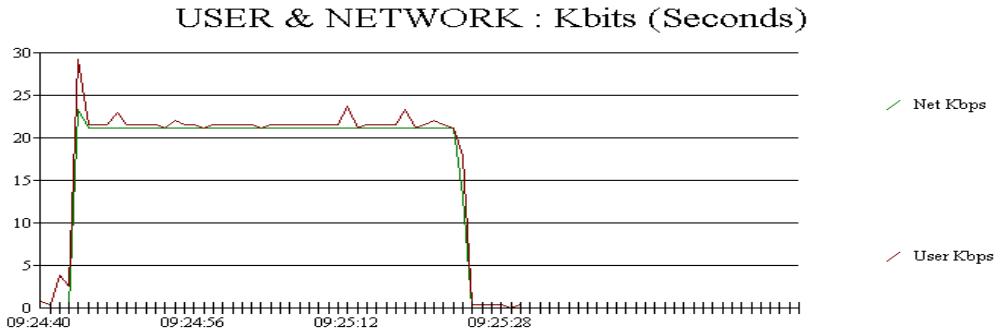
Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	2	PPPoATM	85.22 Kbps
G729	8	40	25	2	PPPoATM	21.6 Kbps
G723A	6.3	30 (Default)	33.33	2	PPPoATM	14.8 Kbps

1. **Bandwidth Graph for G711 with IP rtp compression. Bandwidth utilized 85.22**

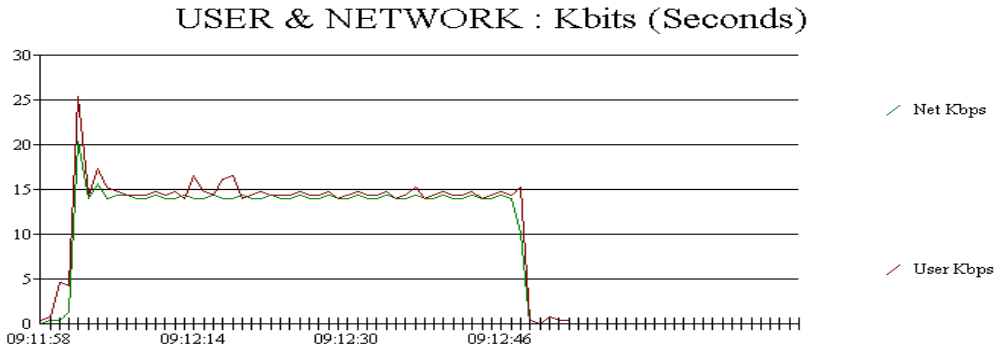


Kbps

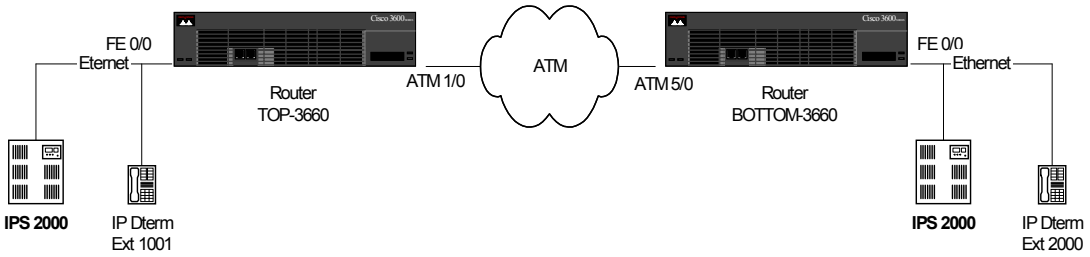
2. **Bandwidth Graph for G729 with IP rtp compression. Bandwidth utilized 21.6 Kbps**



3. **Bandwidth Graph for G723a with IP rtp compression. Bandwidth utilized 14.8 Kbps**



10.2 TEST SCENARIO 2 – VIRTUAL TRUNK



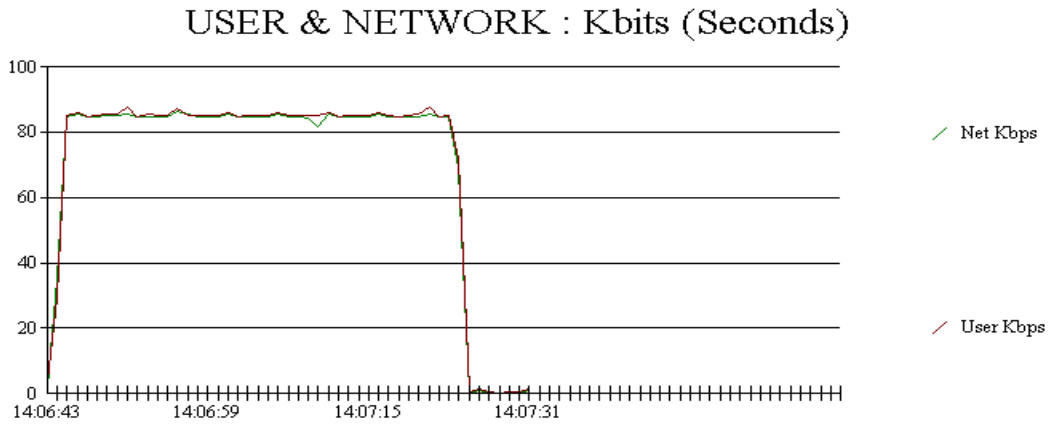
10.2.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from IP Dterm (ext. 1001) to IP Dterm (ext. 2000) via IP virtual trunk. The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

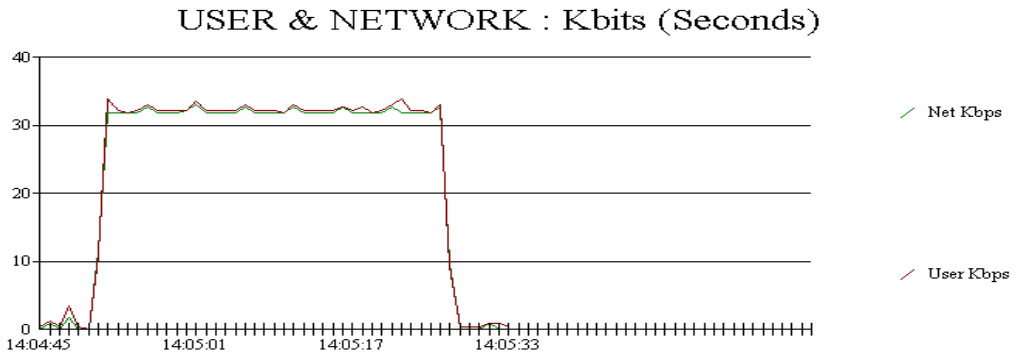
- No compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- PPP over ATM

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Virtual Trunk
G711 a-law	64	40	25	40	PPPoATM	85.2
G729	8	40	25	40	PPPoATM	31.8
G723A	6.3	30 (Default)	33.33	40	PPPoATM	28.8

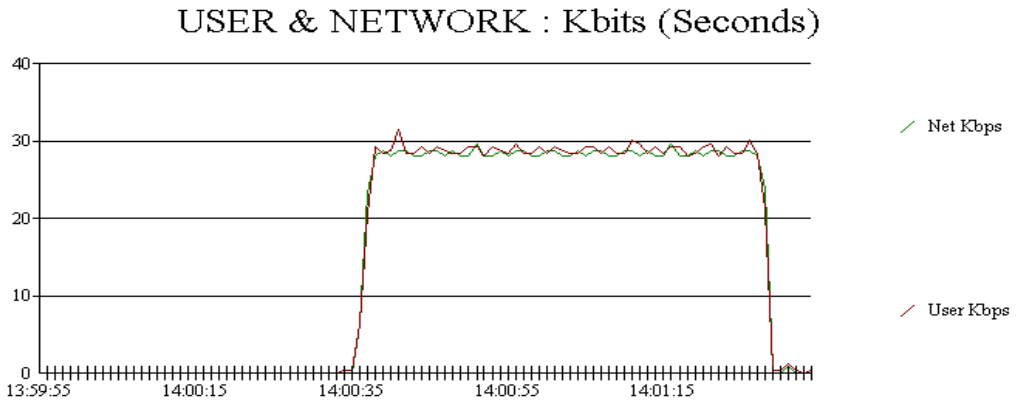
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 85.2 Kbps



2. Bandwidth Graph for G729 without compression. Bandwidth utilized 31.8 Kbps.



3. Bandwidth Graph for G723a without compression. Bandwidth utilized 28.8 Kbps.



10.2.2 CONNECTION WITH IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from IP Dterm (ext. 1001) to IP Dterm (ext. 2000) via IP virtual trunk. The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- Compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- PPP over ATM

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Virtual Trunk
G711 a-law	64	40	25	2	PPPoATM	85.2
G729	8	40	25	2	PPPoATM	21.6
G723A	6.3	30 (Default)	33.33	2	PPPoATM	14.8.8

1. Bandwidth Graph for G711 with compression enabled. Bandwidth utilized 85.2 Kbps

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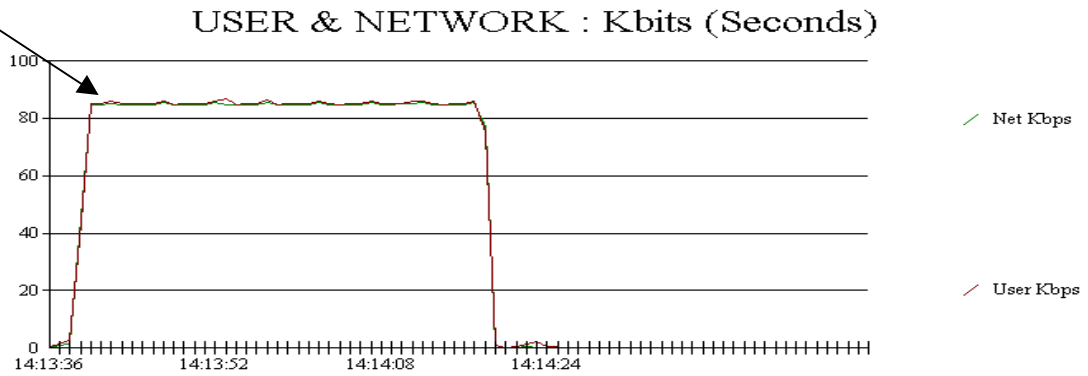
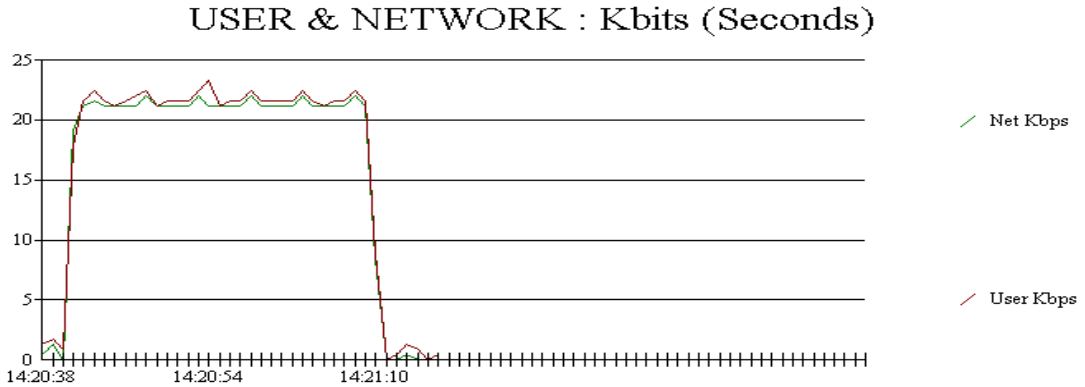
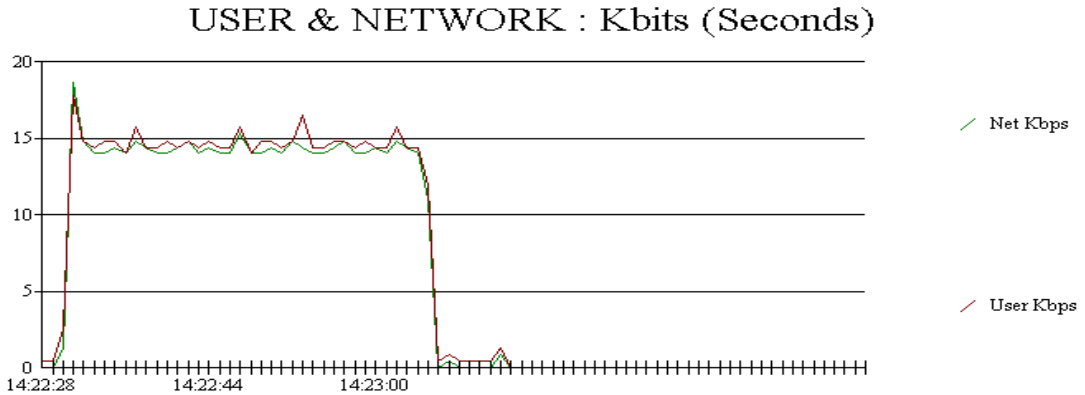


2. Bandwidth Graph for G729 with compression enabled. Bandwidth utilized 21.6 Kbps

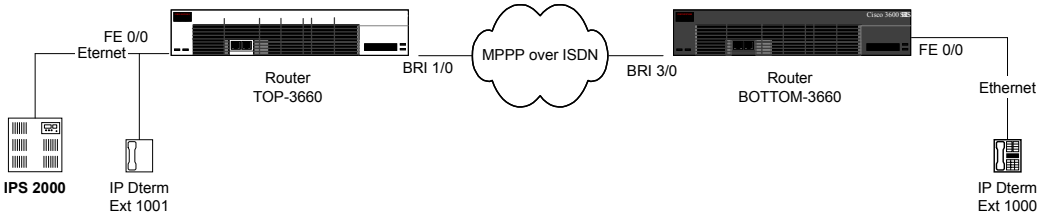


3. Bandwidth Graph for G723a with compression enabled. Bandwidth utilized 14.8 Kbps



10.0 APPENDIX D – MPPP OVER ISDN

10.1 TEST SCENARIO 1 – PEER TO PEER



10.1.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

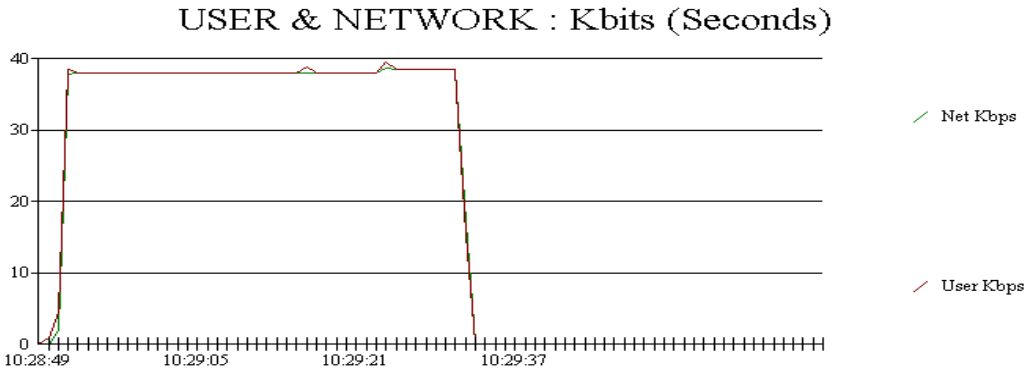
In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- No compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- MPPP over ISDN

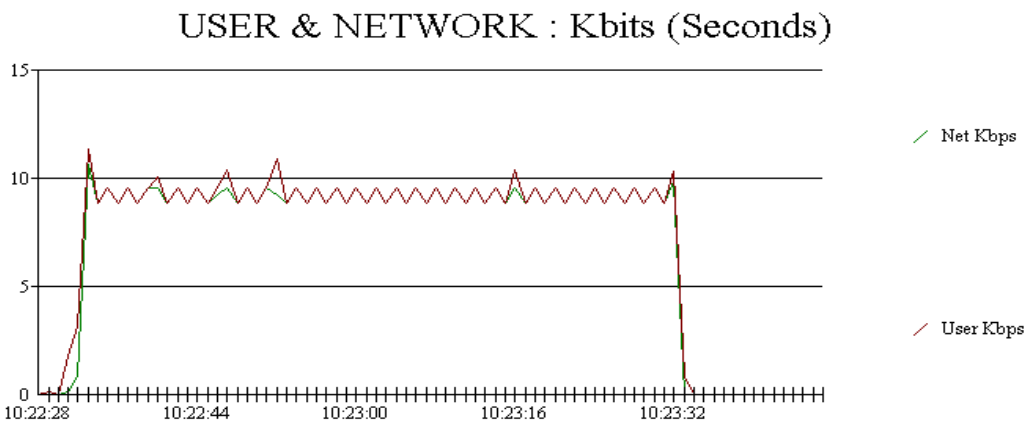
Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	40	MPPPoISDN	76.8 Kbps
G729	8	40	25	40	MPPPoISDN	20.1 Kbps
G723A	6.3	30 (Default)	33.33	40	MPPPoISDN	20.6 Kbps

NOTE: With RADCOM you can monitor only one channel at a time using MPPP. So the graphs shown below is showing bandwidth utilization of one channel. For total bandwidth utilization, multiply one channel bandwidth utilization by 2. e.g. 38.4 X 2 = 76.8 Kbps. Router distributing total bandwidth usage into channel equally.

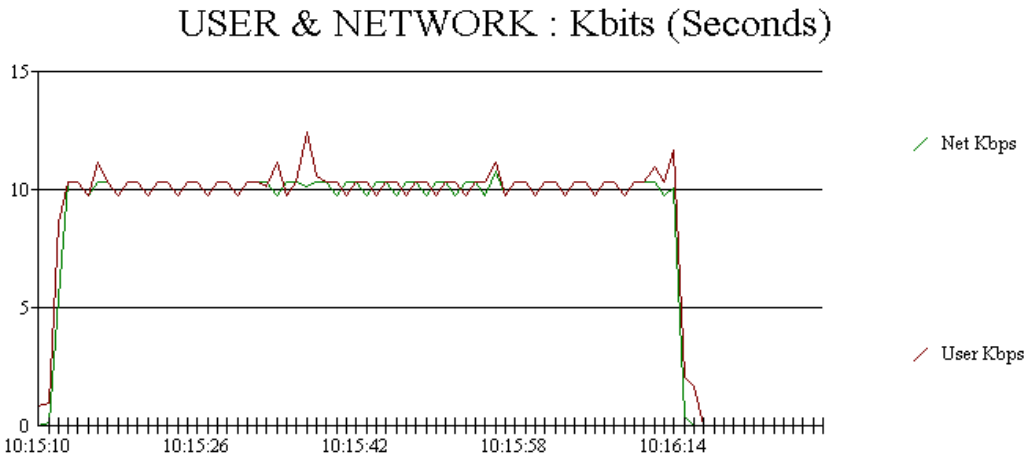
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 76.8 Kbps



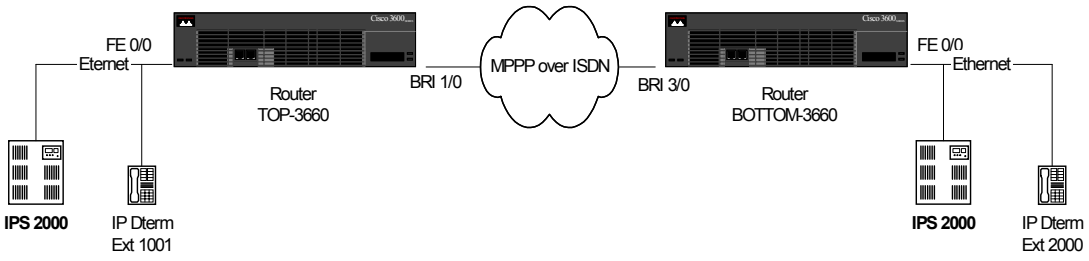
2. Bandwidth Graph for G729 without compression. Bandwidth utilized 20.1 Kbps



3. Bandwidth Graph for G723a without compression. Bandwidth utilized 20.6 Kbps



10.2 TEST SCENARIO 2 – VIRTUAL TRUNK



10.2.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from IP Dterm (ext. 1001) to IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured

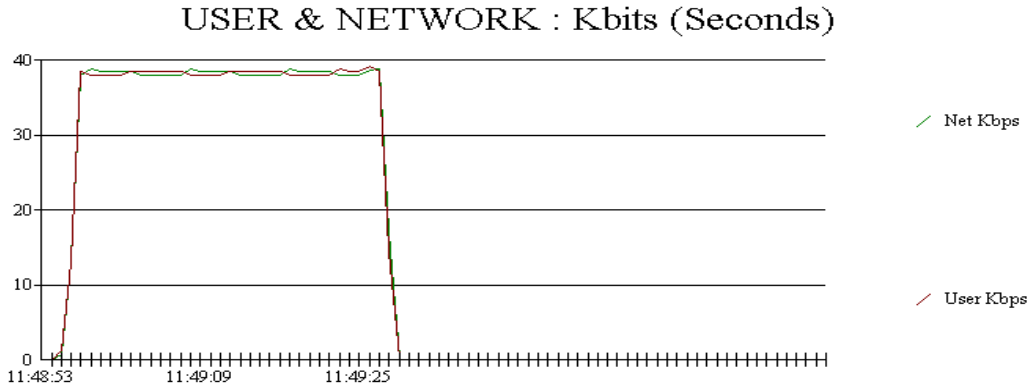
on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- No compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- MPPP over ISDN

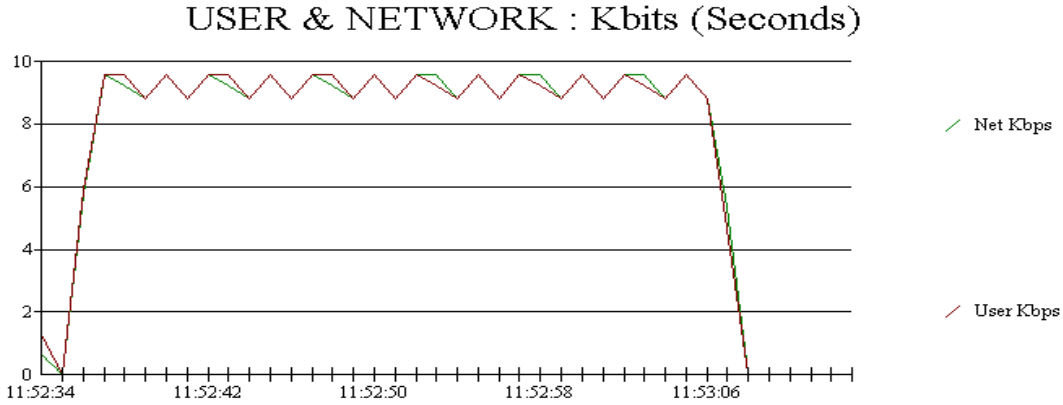
Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Virtual Trunk
G711 a-law	64	40	25	40	MPPPoISDN	76.8 Kbps
G729	8	40	25	40	MPPPoISDN	19 Kbps
G723A	6.3	30 (Default)	33.33	40	MPPPoISDN	20.6 Kbps

NOTE: With RADCOM you can monitor only one channel at a time using MPPP. So the graphs shown below is showing bandwidth utilization of one channel. For total bandwidth utilization, multiply one channel bandwidth utilization by 2. e.g. 38.4 X 2 = 76.8 Kbps. Router distributing total bandwidth usage into channel equally.

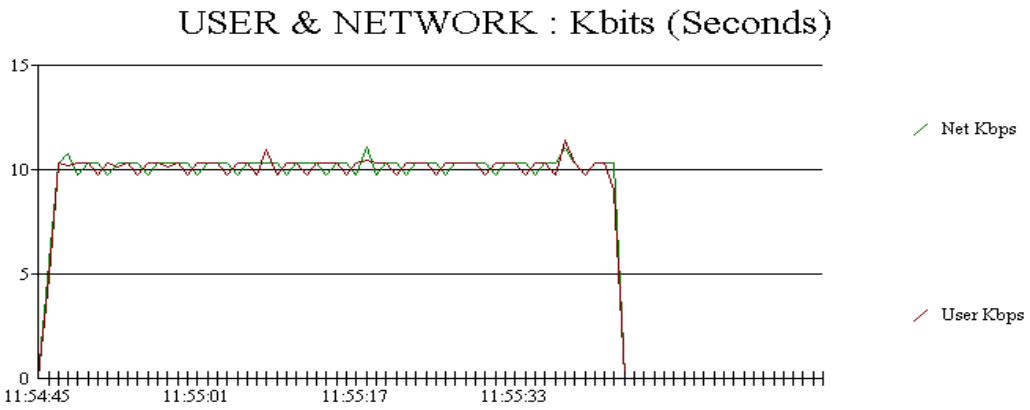
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 76.8 Kbps



2. Bandwidth Graph for G729 without compression. Bandwidth utilized 19 Kbps

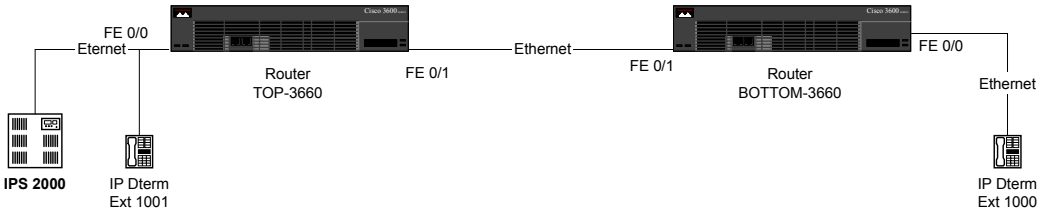


3. Bandwidth Graph for G723a without compression. Bandwidth utilized 20.6 Kbps



11.0 APPENDIX E – ETHERNET

11.1 TEST SCENARIO 1 – PEER TO PEER



10.1.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

In this scenario the call was made from Peer IP Dterm (ext. 1001) to Peer IP Dterm (ext. 1000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

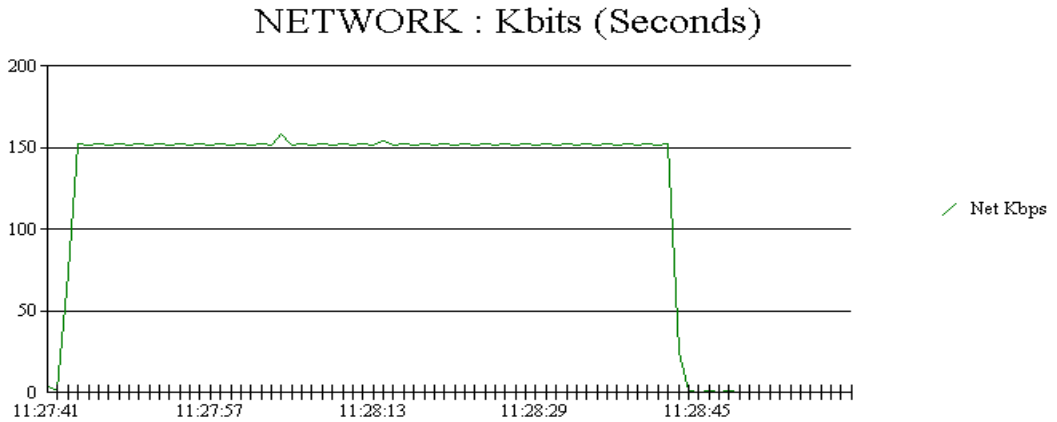
- No compression enabled on the routers.
- No VAD enabled
- Peer to Peer
- Ethernet

Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Peer to Peer
G711 a-law	64	40	25	40	Ethernet	75 Kbps
G729	8	40	25	40	Ethernet	20.1 Kbps
G723A	6.3	30 (Default)	33.33	40	Ethernet	19.6 Kbps

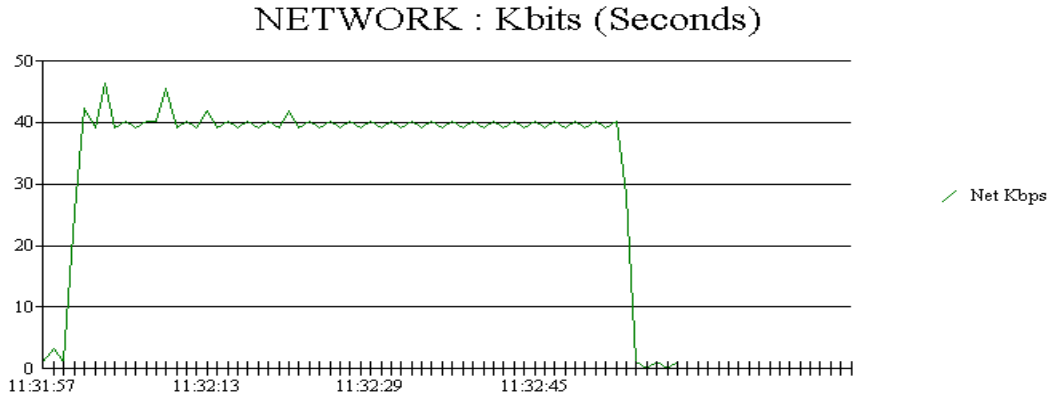
NOTE: With RADCOM you can monitor only half duplex at 10 Mbps ethernet connection. So the graphs shown below is showing double bandwidth utilization over ethernet link. For accurate bandwidth

utilization, divide half duplex bandwidth utilization by 2. e.g. 150/2 = 75 Kbps. Router FE0/1 is intensely configured as half duplex with 10 Mbps.

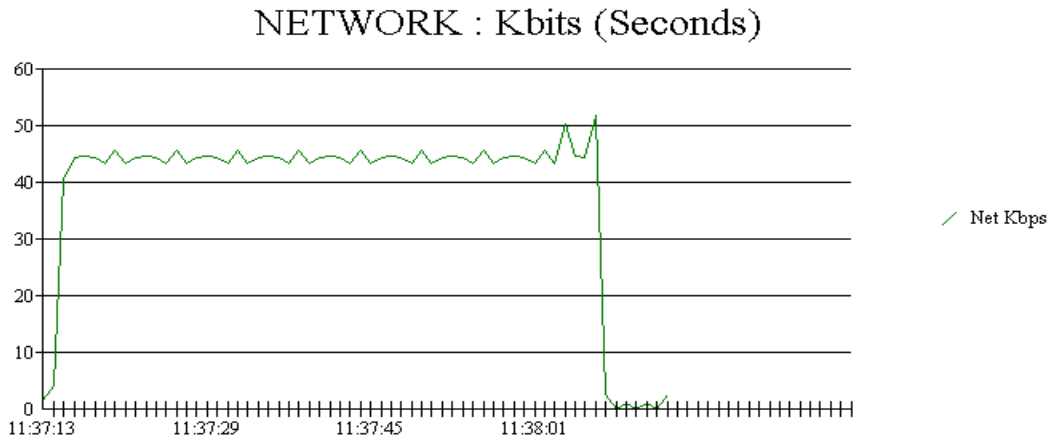
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 75 Kbps



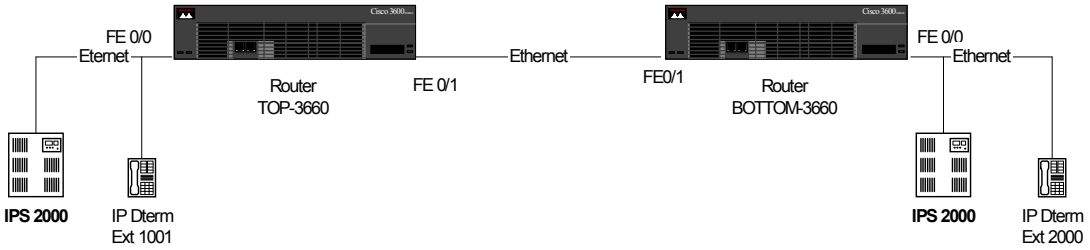
2. Bandwidth Graph for G729 without compression. Bandwidth utilized 20.1 Kbps



3. Bandwidth Graph for G723a without compression. Bandwidth utilized 22.3 Kbps



11.2 TEST SCENARIO 2 – VIRTUAL TRUNK



11.2.1 CONNECTION WITHOUT IP RTP HEADER-COMPRESSION ON THE ROUTERS

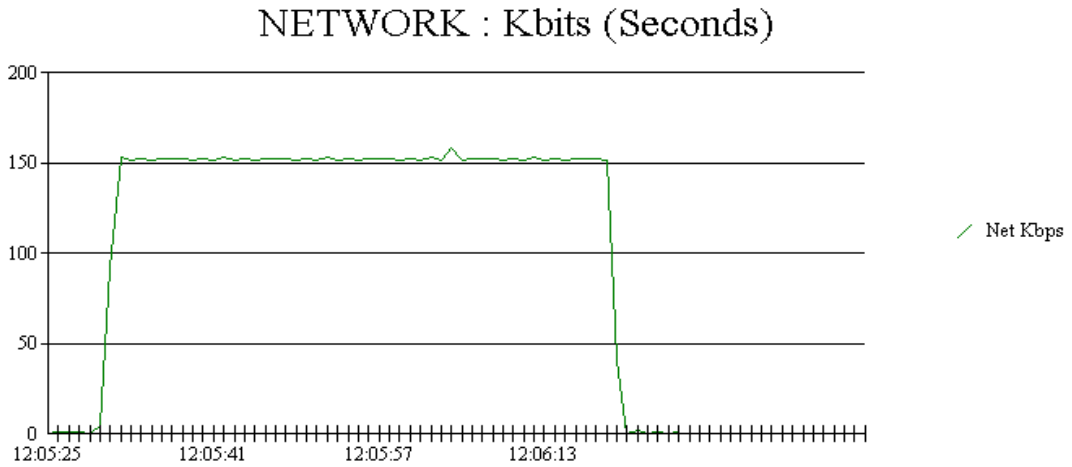
In this scenario the call was made from IP Dterm (ext. 1001) to IP Dterm (ext. 2000). The test scenario experienced no problems. No compression enabled on the router. Codec configured on the IPS2000 was G711 a-law, G729 and G723a. Voice sampling configured is 40 ms for G711 and G729. Voice sampling for G723 is 30 ms by default.

- No compression enabled on the routers.
- No VAD enabled
- Virtual Trunk
- Half Duplex, 10 Mbps Ethernet

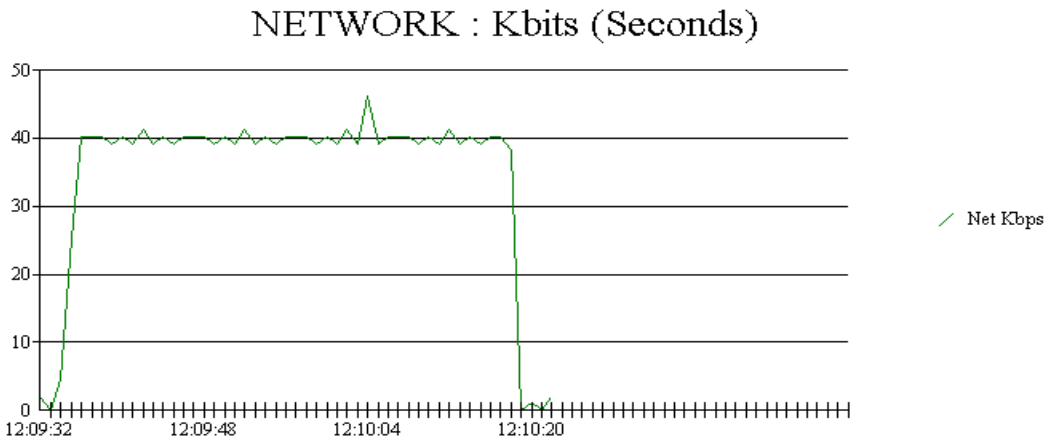
Voice CODEC	Bandwidth	Voice Sample (ms)	Packets /Sec	IP /UDP/RTP Header (Bytes)	Data Link Layer	IPS IP Dterm Virtual Trunk
G711 a-law	64	40	25	40	Ethernet	75 Kbps
G729	8	40	25	40	Ethernet	19.6 Kbps
G723A	6.3	30 (Default)	33.33	40	Ethernet	21.9 Kbps

NOTE: With RADCOM you can monitor only one channel at a time using MPPP. So the graphs shown below is showing bandwidth utilization of one channel. For total bandwidth utilization, multiply one channel bandwidth utilization by 2. e.g. 38.4 X 2 = 76.8 Kbps. Router distributing total bandwidth usage into channel equally.

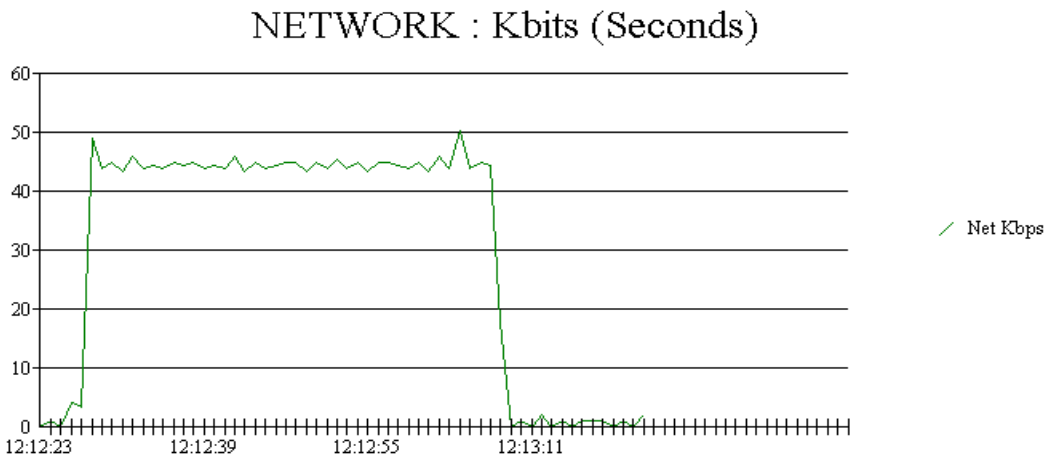
1. Bandwidth Graph for G711 a-law without compression. Bandwidth utilized 75 Kbps



2. Bandwidth Graph for G729 without compression. Bandwidth utilized 19.6 Kbps



3. Bandwidth Graph for G723a without compression. Bandwidth utilized 21.9 Kbps



12.0 SUMMERY

12.1 ISSUES EXPERIENCED:

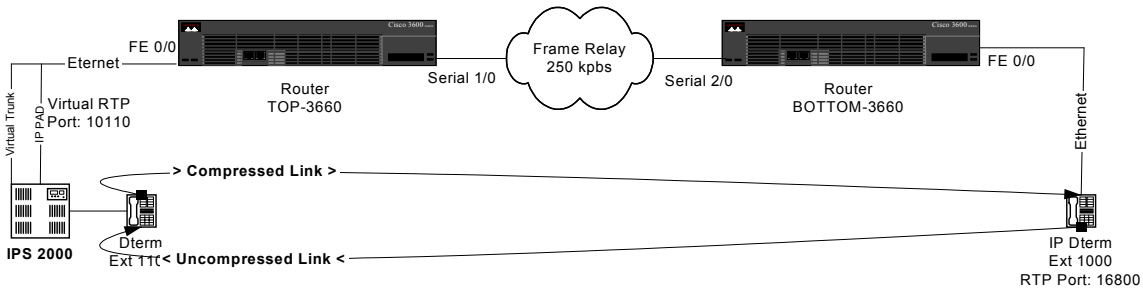
1. When IP rtp header-compression enabled on the WAN link of the routers for the Frame-relay. Compression doesn't start instantly when voice call start, router waits for 20 seconds and then start compressing the rtp header. That happens only on Frame-relay wan link.

2. RTP header-compression doesn't work on router if Dterm rtp self port is set to default value i.e. 3462. In order to compression work you it is required to set Dterm RTP self port between 16384 to 65536.

4. There is more than 20 kbps drop occasionally in the bandwidth utilization but doesn't effect the ongoing conversation.

5. Bandwidth doesn't compress on G711 even after enabling the IP rtp header-compression on the PPP over ATM link using aal5snap encapsulation.

6. Compression on frame-relay link doesn't work in both direction if call is made from normal Dterm (ext. 1100 rtp port 10110) to IP Dterm (ext. 1000 rtp port 16800) via IP PAD. Compression works only on the RTP session from normal Dterm to IP Dterm via PAD but not in opposite direction. See figure below.



12.2 BANDWIDTH UTILIZATION:

	Voice CODEC	Bandwidth (Kbps)	Voice Sample (ms)	Packets/sec	IP/UDP/RTP Header (bytes)	cRTP Header (bytes)	Data Link Layer	IPS IP Trunk	IPS Virtual Trunk	IPS IP Dterm (Peer-To-Peer)	SoftPhone
NEC Products	G.729	8	40	25	40		Ethernet	19.6 Kpbs	19.6 Kpbs	20.1 Kpbs	20.1 Kpbs
	G.729	8	40	25		2	Ethernet	X	X	X	X
	G.729	8	40	25	40		MPPP over ISDN	19 Kpbs	19 Kpbs	19 Kpbs	19 Kpbs
	G.729	8	40	25		2	MPPP over ISDN	X	X	X	X
	G.729	8	40	25	40		Frame Relay	17.2 Kpbs	17.2 Kpbs	17.2 Kpbs	17.2 Kpbs
	G.729	8	40	25		2	Frame Relay	10 Kpbs	10 Kpbs	10 Kpbs	10 Kpbs
	G.729	8	40	25	40		ATM	21.6 Kpbs	21.6 Kpbs	21.2 Kpbs	21.2 Kpbs
	G.729	8	40	25		2	ATM	X	X	X	X
	G.729	8	40	25	40		PPP over ATM	31.8 Kpbs	31.8 Kpbs	32.2 Kpbs	32.2 Kpbs
	G.729	8	40	25		2	PPP over ATM	21.6 Kpbs	21.6 Kpbs	21.6 Kpbs	21.6 Kpbs
	G.711	64	40	25	40		Ethernet	75 Kpbs	75 Kpbs	75 Kpbs	75 Kpbs
	G.711	64	40	25		2	Ethernet	X	X	X	X
	G.711	64	40	25	40		MPPP over ISDN	76.8 Kpbs	76.8	76.8 Kpbs	76.8 Kpbs
	G.711	64	40	25		2	MPPP over ISDN	X	X	X	X
	G.711	64	40	25	40		Frame Relay	73.6 Kpbs	73.56 Kpbs	73.2 Kpbs	73.2 Kpbs
	G.711	64	40	25		2	Frame Relay	66 Kpbs	66 Kpbs	66 Kpbs	66 Kpbs
	G.711	64	40	25	40		ATM	84.8 Kpbs	84.8 Kpbs	84.8 Kpbs	84.8 Kpbs
	G.711	64	40	25		2	ATM	X	X	X	X
	G.711	64	40	25	40		PPP over ATM	85.2 Kpbs	85.2 Kpbs	86 Kpbs	86 Kpbs
	G.711	64	40	25		2	PPP over ATM	85.2 Kpbs	85.2 Kpbs	85.22 Kpbs	85.22 Kpbs
	G.723A	6.3	30	33.3333333	40		Ethernet	21.9 Kpbs	21.9 Kpbs	22.3 Kpbs	19.6 Kpbs
	G.723A	6.3	30	33.3333333		2	Ethernet	X	X	X	X
	G.723A	6.3	30	33.3333333	40		MPPP over ISDN	20.6 Kpbs	20.6 Kpbs	20.6 Kpbs	20.6 Kpbs
	G.723A	6.3	30	33.3333333		2	MPPP over ISDN	X	X	X	X
	G.723A	6.3	30	33.3333333	40		Frame Relay	19.04 Kpbs	19.04 Kpbs	19.04 Kpbs	19.04 Kpbs

G.723A	6.3	30	33.3333333		2	Frame Relay	9.1 Kpbs	9.1 Kpbs	8.7 Kpbs	8.7 Kpbs
G.723A	6.3	30	33.3333333	40		ATM	28.8 Kpbs	28.8 Kpbs	28.8 Kpbs	28.8 Kpbs
G.723A	6.3	30	33.3333333		2	ATM	X	X	X	X
G.723A	6.3	30	33.3333333	40		PPP over ATM	28.8 Kpbs	28.8 Kpbs	29.3 Kpbs	29.3 Kpbs
G.723A	6.3	30	33.3333333		2	PPP over ATM	14.8 Kpbs	14.8 Kpbs	14.8 Kpbs	14.8 Kpbs