Implementing A STAR Network Using Comtech EF Data's IP-Enabled Satellite Modems

(To Replace A Frame Relay Satellite Network)

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1 Introduction

There are many instances where customers require a STAR network to provide a number of real-time and non real-time services including voice, data and video. Currently many networks use frame relay as the underlying transport due to its ability to assign different levels of service to the different flows.

A typical STAR network has a central site (Hub) that transmits the aggregate carrier consisting of all frame-relay circuits to all the remotes. The remotes receive this aggregate carrier and demultiplex the circuits of interest to them. Each remote also transmits a simplex carrier for all its frame relay circuits going back to the central site.

Each frame relay circuit is typically assigned a Committed Circuit Rate and a maximum burstable rate depending on the application. e.g. a voice circuit may have a CIR or 32 kbit/s with maximum rate also set to 32 kbit/s, whereas for email and other non-real time data transfer, the CIR for the circuit could be set to 0 (or some other low value) with maximum rate set to say 64 kbit/s, allowing email transfers when ever bandwidth is available.

For a satellite network, in addition to the satellite modems and the RF equipment, a frame relay solution also requires Frame Relay Access Devices (FRADs) at each site, which could add significantly to the capital cost.

Comtech EF Data has recently introduced IP-enabled satellite modems that integrate IP networking and satellite modem into a single 1 RU package. With support for Quality of Service (QoS) and ability to multiplex several flows at the link layer (a concept similar to frame relay DLCI), it provides a much better alternative to a frame relay solution. The alternative solution based on C*i*M-550 and C*i*M-300L is not only lower cost but also reduces network complexity by reducing the number of components in the system.

This white paper presents the alternative solution.

2 Network Requirements

Lets consider a hypothetical case where a financial services company would like to connect its 4 remote locations to the Headquarters (HQ) for Intranet (email, ERP traffic etc), voice/fax (VoIP) connectivity between the sites and also to the PSTN, Internet access and occasional video applications. In addition to that, HQ would also like to transmit multiple channels of streaming audio and video to some (or all) the remotes on as needed basis. It also transmits a stock ticker to all the remote sites.

The ERP and VoIP traffic have priority over all other traffic. If needed, they can interrupt the audio and video broadcasts. The stock ticker is transmitted at a constant data rate and cannot be interrupted. Internet access has the least priority.

Only 1 public IP address (200.1.1.1) is available to the company for connecting to the Internet.

3 Proposed Solution

After traffic analysis, it was determined that total traffic from the HQ to the 4 remote sites is 2 Mbit/s. Total traffic from Remote 1 to HQ is 192 kbit/s, from Remote 2 to HQ is 256 kbit/s, Remote 3 to HQ is 128 kbit/s and Remote 4 to HQ is 384 kbit/s respectively.

This allows use of C*i*M-550 (which support up to 2.048 Mbit/s) at the HQ and either C*i*M-550 or C*i*M-300L (which supports up to 4.375 Mbit/s) at the remotes. C*i*M-300L provides a much more cost-effective solution for the remotes as it uses low cost BUC (Block Up Converter) and LNB (Low-Noise Block Down Converter) instead of an expensive RF Terminal.

The proposed solution will use C*i*M-550 at the Hub and C*i*M-300L at the remotes. If required, optional turbo codecs can be used to further optimize the space segment utilization.

As only 1 public IP address is available, private IP addresses will be used throughout the network. A router (running NAT) at the HQ will provide connectivity to the Internet. NAT will provide translation between public and private IP address space. A VoIP gateway will provide connection to the PSTN for outgoing and incoming calls. An H.323 Gatekeeper will be used for endpoint registration and symbolic to numeric address translation for the zone.

3.1 IP Addressing

Private IP addresses are used at the HQ and the Remote sites. The IP addressing scheme is summarized below:

S. No.	Site/Network	IP Address
1	HQ LAN	10.10.0.0/16
2	Remote Office 1 LAN	192.168.1.0/24
3	Remote Office 2 LAN	192.168.2.0/24
4	Remote Office 3 LAN	192.168.3.0/24
5	Remote Office 4 LAN	192.168.4.0/24
6	Satellite WAN	10.11.1.0/28
7	GW Router - Public IP	200.1.1.1

In addition, the HQ transmits 5 multicast streams to the remotes:

S. No.	IP Address	Comment
1	225.1.1.1	Audio channel 1
2	225.1.1.2	Audio channel 2
3	225.1.1.3	Video channel 1
4	225.1.1.4	Video channel 2
5	225.1.1.5	Stock ticker

3.2 Network Overview

The HQ site consists of 4 C*i*M-550:

- One of them transmits the aggregate carrier (2 Mbit/s) to all the remote sites and also receives the return carrier (192 kbit/s) from Remote 1
- The remaining three C*i*M-550 receive the return carrier from the three remotes - 256 kbit/s, 128 kbit/s and 384 kbit/s respectively

Each remote site has 1 C*i*M-300L that receives the aggregate carrier from the HQ (2 Mbit/s) and transmits the return carrier to the HQ (192 kbit/s, 256 kbit/s, 128 kbit/s and 384 kbit/s respectively)

A schematic of the network is given in Figure 1.

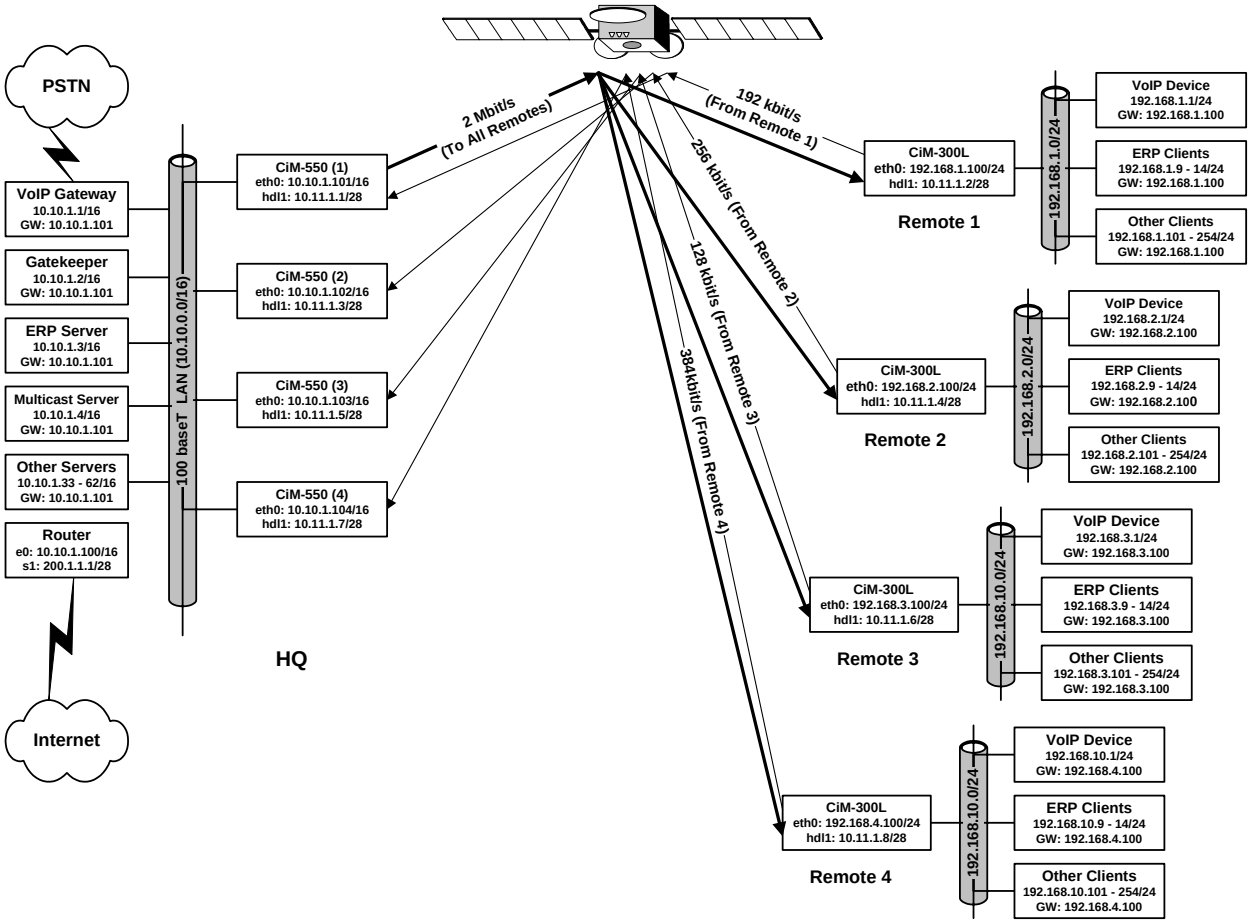

Figure 1. Network Schematic

3.3 Detailed Configuration

3.3.1 HQ Site

3.3.1.1 IP Addresses

IP addresses for application servers; gateway router and the C*i*M-550 are as follows:

S. No.	Device	IP Address(es)	Default Gateway
1	VoIP Gateway	10.10.1.1/16	10.10.1.101
2	H.323 Gatekeeper	10.10.1.2/16	10.10.1.101
3	ERP Server	10.10.1.3/16	10.10.1.101
4	Multicast Server	10.10.1.4/16	10.10.1.101
5	Other Servers	10.10.1.33/16 to 10.10.1.62/16	10.10.1.101
6	Gateway Router	10.10.1.100/16 (e0) 200.1.1.1/28 (s0)	-
7	C*i*M-550 (1)	10.10.1.101/16 (eth0) 10.11.1.1/28 (hdl1)	-
8	C*i*M-550 (2)	10.10.1.102/16 (eth0) 10.11.1.3/28 (hdl1)	-
9	C*i*M-550 (3)	10.10.1.103/16 (eth0) 10.11.1.5/28 (hdl1)	-
10	C*i*M-550 (4)	10.10.1.104/16 (eth0) 10.11.1.7/28 (hdl1)	-

Note:

1. Each C*i*M-550 has 2 IP addresses - one for the Ethernet interface (eth0) and one for the HDLC interface (hdl1), i.e. the satellite interface.

3.3.1.2 Routing, QoS & DES Configuration

3.3.1.2.1 Router

The gateway router has the following routes configured:

S. No.	Destination	Destination Address	Next Hop IP Address
1	Remote Site 1	192.168.1.0/24	10.10.1.101
2	Remote Site 2	192.168.2.0/24	10.10.1.101
3	Remote Site 3	192.168.3.0/24	10.10.1.101
4	Remote Site 4	192.168.4.0/24	10.10.1.101
5	Internet	0.0.0.0/0	200.1.1.1

i.e. all traffic to remotes is routed to the first *CiM*-550.

3.3.1.2.2 C*i*M-550 (1)

The C*i*M-550 (1) is configured as follows:

S. No.	Destination IP Address	Next Hop IP Address	QoS (Min)	QoS (Max)	DES Key	Comments
1	192.168.1.1/32	10.11.1.2	32 kbit/s	96 kbit/s	Key 1	For VoIP traffic to Remote 1. Guarantees a minimum bandwidth of 32 kbit/s with ability to burst up to 96 kbit/s (if available) to allow for fax and/or multiple voice calls. Key 1 is used for encrypting the route.
2	192.168.1.8/29	10.11.1.2	128 kbit/s	256 kbit/s	Key 2	For ERP traffic to Remote 1.
3	192.168.1.0/24	10.11.1.2	0 kbit/s	192 kbit/s	None	For Internet and other application traffic to Remote 1. No guaranteed minimum. Ability to burst up to 192 kbit/s if available. No encryption.
4	192.168.2.1/32	10.11.1.4	64 kbit/s	128 kbit/s	Key 1	For VoIP traffic to Remote 2.
5	192.168.2.8/29	10.11.1.4	128 kbit/s	256 kbit/s	Key 2	For ERP traffic to Remote 2.
6	192.168.2.0/24	10.11.1.4	0 kbit/s	256 kbit/s	None	For Internet and other application traffic to Remote 2.
7	192.168.3.1/32	10.11.1.6	32 kbit/s	64 kbit/s	Key 1	For VoIP traffic to Remote 3.
8	192.168.3.8/29	10.11.1.6	96 kbit/s	128 kbit/s	Key 2	For ERP traffic to Remote 3.
9	192.168.3.0/24	10.11.1.6	0 kbit/s	128 kbit/s	None	For Internet and other application traffic to Remote 3.
10	192.168.4.1/32	10.11.1.8	128 kbit/s	192 kbit/s	Key 1	For VoIP traffic to Remote 4.
11	192.168.4.8/29	10.11.1.8	256 kbit/s	384 kbit/s	Key 2	For ERP traffic to Remote 4.
12	192.168.4.0/24	10.11.1.8	0 kbit/s	384 kbit/s	None	For Internet and other application traffic to Remote 4.
13	0.0.0.0/0	10.10.1.100	NA	NA	NA	Default route for Internet access.
14	225.1.1.1/32	NA	0 kbit/s	96 kbit/s	None	Multicast audio to remotes.
15	225.1.1.2/32	NA	0 kbit/s	96 kbit/s	None	Multicast audio to remotes.
16	225.1.1.3/32	NA	0 kbit/s	512 kbit/s	None	Multicast video to remotes.
17	225.1.1.4/32	NA	0 kbit/s	512 kbit/s	None	Multicast video to remotes.
18	225.1.1.5/32	NA	48 kbit/s	48 kbit/s	None	Stock ticker to remotes.

Note:

1. QoS and DES are optional features.
2. If QoS is used, the sum of all minimums should not exceed the available bandwidth on the carrier or the results will be unpredictable.
3. Each C*i*M-550 supports up to 2 keys for encryption and up to 2 keys for decryption. A route can be configured to use Key 1 or Key 2 or Random (i.e. use Key 1 or Key 2 randomly on an IP datagram basis) or none (i.e. no encryption).
4. QoS and DES only applies to the WAN side (satellite).

In addition to the routing, QoS (optional) and DES (optional) configuration, HDLC IP address to layer 2 address mappings are defined in the ARP table of C*i*M-550 (1) as follows:

S. No.	IP Address	HDLC Address	Comments
1	10.11.1.2	0x0001	All traffic to Remote 1 is transmitted on HDLC channel 1
2	10.11.1.4	0x0002	All traffic to Remote 2 is transmitted on HDLC channel 2
3	10.11.1.6	0x0003	All traffic to Remote 3 is transmitted on HDLC channel 3
4	10.11.1.8	0x0004	All traffic to Remote 4 is transmitted on HDLC channel 4
5	225.1.1.1	0x0100	This multicast stream is transmitted on HDLC channel 0x0100. Only remotes receiving 0x0100 will receive this multicast stream.
6	225.1.1.2	0x0101	This multicast stream is transmitted on HDLC channel 0x0101. Only remotes receiving 0x0101 will receive this multicast stream.
7	225.1.1.3	0x0102	This multicast stream is transmitted on HDLC channel 0x0102. Only remotes receiving 0x0102 will receive this multicast stream.
8	225.1.1.4	0x0103	This multicast stream is transmitted on HDLC channel 0x0103. Only remotes receiving 0x0103 will receive this multicast stream.
9	225.1.1.5	0xFFFF	This multicast stream is transmitted on HDLC channel 0xFFFF. All the remotes will be able to receive this multicast stream.

Note:

1. On the transmit side, a C*i*M-550 supports 0x0000 through 0x00FE as HDLC channel addresses for unicast and 0x0000 through 0xFFFF as channel addresses for multicast.
2. Each C*i*M-550 can receive up to 4 user configured HDLC channels and the broadcast channel (0xFFFF).

C*i*M-550 (1) is also configured to receive HDLC channel 0x0001, i.e. the return transmission from Remote 1 and appropriate DES keys to decrypt Remote 1's transmission.

3.3.1.2.3 C*i*M-550 (2)

C*i*M-550's (2) route table is as follows:

S. No.	Destination	Destination Address	Next Hop IP Address	Comments
1	Remote Site 1	192.168.1.0/24	10.10.1.101	Traffic for Remote 1 is routed to C*i*M-550 (1).
2	Remote Site 3	192.168.3.0/24	10.10.1.101	Traffic for Remote 3 is routed to C*i*M-550 (1).
3	Remote Site 4	192.168.4.0/24	10.10.1.101	Traffic for Remote 4 is routed to C*i*M-550 (1).
4	Internet	0.0.0.0/0	10.10.1.100	Default route to Internet.

C*i*M-550 (2) is also configured to receive HDLC channel 0x0002, i.e. the return transmission from Remote 2 and appropriate DES keys to decrypt Remote 2's transmission.

Note:

1. Remote 2 can use HDLC channel 1 for transmission to HQ but using a separate HDLC channel from each remote ensures that each receiver at the HQ is receiving the right carrier.

3.3.1.2.4 C*i*M-550 (3)

CiM-550's (3) route table is as follows:

S. No.	Destination	Destination Address	Next Hop IP Address	Comments
1	Remote Site 1	192.168.1.0/24	10.10.1.101	Traffic for Remote 1 is routed to C*i*M-550 (1).
2	Remote Site 2	192.168.2.0/24	10.10.1.101	Traffic for Remote 2 is routed to C*i*M-550 (1).
3	Remote Site 4	192.168.4.0/24	10.10.1.101	Traffic for Remote 4 is routed to C*i*M-550 (1).
4	Internet	0.0.0.0/0	10.10.1.100	Default route to Internet.

C*i*M-550 (3) is also configured to receive HDLC channel 0x0003, i.e. the return transmission from Remote 3 and appropriate DES keys to decrypt Remote 3's transmission.

3.3.1.2.5 C*i*M-550 (4)

C*i*M-550's (4) route table is as follows:

S. No.	Destination	Destination Address	Next Hop IP Address	Comments
1	Remote Site 1	192.168.1.0/24	10.10.1.101	Traffic for Remote 1 is routed to C*i*M-550 (1).
2	Remote Site 2	192.168.2.0/24	10.10.1.101	Traffic for Remote 2 is routed to C*i*M-550 (1).
3	Remote Site 3	192.168.3.0/24	10.10.1.101	Traffic for Remote 3 is routed to C*i*M-550 (1).
4	Internet	0.0.0.0/0	10.10.1.100	Default route to Internet.

C*i*M-550 (4) is also configured to receive HDLC channel 0x0004, i.e. the return transmission from Remote 4 and appropriate DES keys to decrypt Remote 4's transmission.

3.3.2 Remote Site 1

IP addresses for application clients and the C*i*M-300L are as follows:

S. No.	Device	IP Address	Default Gateway
1	VoIP Device	192.168.1.1/24	192.168.1.100
2	ERP Clients	192.168.1.9/24 to 192.168.1.14/24	192.168.1.100
3	Other Clients	192.168.1.101/24 to 192.168.1.254/24	192.168.1.100
4	C*i*M-300L	192.168.1.100/24 (eth0) 10.11.1.2/28 (hdl1)	-

The C*i*M-300L at Remote 1 is configured as follows:

S. No.	Destination IP Address	Next Hop IP Address	QoS (Min)	QoS (Max)	DES* Key	Comments
1	10.10.1.0/30	10.11.1.1	32 kbit/s	96 kbit/s	Key 1	For VoIP traffic to HQ and Gatekeeper requests. Minimum 32 kbit/s with ability to burst up to 96 kbit/s if available.
2	10.10.1.3/32	10.11.1.1	96 kbit/s	128 kbit/s	Key 2	For ERP traffic to HQ.
3	10.10.1.32/26	10.11.1.1	16 kbit/s	192 kbit/s	Key 1	For other application traffic (e.g. email) to HQ. Minimum 8 kbit/s with ability to burst up to 192 kbit/s if available.
4	10.10.0.0/16	10.11.1.1	0 kbit/s	192 kbit/s	None	For all other traffic to HQ including Internet traffic. No guaranteed minimum. Maximum limited to 192 kbit/s (if available). This limits non-essential traffic to available bandwidth only.

In addition to the routing, QoS (optional) and DES (optional) configuration, HDLC IP address to layer 2 address mappings are defined in the ARP table of C*i*M-300L as follows:

S. No.	IP Address	HDLC Address	Comments
1	10.11.1.1	0x0001	All traffic to HQ is transmitted on HDLC channel 1

The C*i*M-300L is also configured to receive the following HDLC channels:

S. No.	HDLC Address	Comments
1	0x0001	Unicast traffic from HQ
2	0x0100	Audio channel 1 from HQ
3	0x0102	Video channel 1 from HQ

In the route table, also enable "Downlink Multicast" which allows any multicast traffic received on one of the configured HDLC channels (or the broadcast channel - 0xFFFF) to be transmitted to the LAN. An alternative would be to individually configure each multicast stream that needs to be routed from the satellite to the LAN on the receive side.

3.3.3 Remote Site 2

IP addresses for application clients and the C*i*M-300L are as follows:

S. No.	Device	IP Address	Default Gateway
1	VoIP Device	192.168.2.1/24	192.168.2.100
2	ERP Clients	192.168.2.9/24 to 192.168.2.14/24	192.168.2.100
3	Other Clients	192.168.2.101/24 to 192.168.2.254/24	192.168.2.100
4	C*i*M-300L	192.168.2.100/24 (eth0) 10.11.1.4/28 (hdl1)	-

* The keys can be different from the transmit keys used by the HQ and all other remotes.

The C*i*M-300L at Remote 2 is configured as follows:

S. No.	Destination IP Address	Next Hop IP Address	QoS (Min)	QoS (Max)	DES Key	Comments
1	10.10.1.0/30	10.11.1.3	64 kbit/s	128 kbit/s	Key 1	For VoIP traffic to HQ and Gatekeeper requests.
2	10.10.1.3/32	10.11.1.3	128 kbit/s	256 kbit/s	Key 2	For ERP traffic to HQ.
3	10.10.1.32/26	10.11.1.3	16 kbit/s	256 kbit/s	Key 1	For other application traffic (e.g. email) to HQ.
4	10.10.0.0/16	10.11.1.3	0 kbit/s	256 kbit/s	None	For all other traffic to HQ including Internet traffic.

In addition to the routing, QoS (optional) and DES (optional) configuration, HDLC IP address to layer 2 address mappings are defined in the ARP table of C*i*M-300L as follows:

S. No.	IP Address	HDLC Address	Comments
1	10.11.1.3	0x0002	All traffic to HQ is transmitted on HDLC channel 2

The C*i*M-300L is also configured to receive the following HDLC channels:

S. No.	HDLC Address	Comments
1	0x0001	Unicast traffic from HQ
2	0x0100	Audio channel 1 from HQ
3	0x0102	Video channel 1 from HQ

In the route table, also enable "Downlink Multicast".

3.3.4 Remote Site 3

IP addresses for application clients and the C*i*M-300L are as follows:

S. No.	Device	IP Address	Default Gateway
1	VoIP Device	192.168.3.1/24	192.168.3.100
2	ERP Clients	192.168.3.9/24 to 192.168.3.14/24	192.168.3.100
3	Other Clients	192.168.3.101/24 to 192.168.3.254/24	192.168.3.100
4	C*i*M-300L	192.168.3.100/24 (eth0) 10.11.1.6/28 (hdl1)	-

The C*i*M-300L at Remote 3 is configured as follows:

S. No.	Destination IP Address	Next Hop IP Address	QoS (Min)	QoS (Max)	DES Key	Comment
1	10.10.1.0/30	10.11.1.5	32 kbit/s	64 kbit/s	Key 1	For VoIP traffic to HQ and Gatekeeper requests.
2	10.10.1.3/32	10.11.1.5	64 kbit/s	128 kbit/s	Key 2	For ERP traffic to HQ.
3	10.10.1.32/26	10.11.1.5	8 kbit/s	128 kbit/s	Key 1	For other application traffic (e.g. email) to HQ.
4	10.10.0.0/16	10.11.1.5	0 kbit/s	128 kbit/s	None	For all other traffic to HQ including Internet traffic.

In addition to the routing, QoS (optional) and DES (optional) configuration, HDLC IP address to layer 2 address mappings are defined in the ARP table of C*i*M-300L as follows:

S. No.	IP Address	HDLC Address	Comments
1	10.11.1.5	0x0003	All traffic to HQ is transmitted on HDLC channel 3

The C*i*M-300L is also configured to receive the following HDLC channels:

S. No.	HDLC Address	Comments
1	0x0001	Unicast traffic from HQ
2	0x0101	Audio channel 2 from HQ
3	0x0103	Video channel 2 from HQ

In the route table, also enable "Downlink Multicast".

3.3.5 Remote Site 4

IP addresses for application clients and the C*i*M-300L are as follows:

S. No.	Device	IP Address	Default Gateway
1	VoIP Device	192.168.4.1/24	192.168.4.100
2	ERP Clients	192.168.4.9/24 to 192.168.4.14/24	192.168.4.100
3	Other Clients	192.168.4.101/24 to 192.168.4.254/24	192.168.4.100
4	C*i*M-300L	192.168.4.100/24 (eth0) 10.11.1.6/28 (hdl1)	-

The C*i*M-300L at Remote 4 is configured as follows:

S. No.	Destination IP Address	Next Hop IP Address	QoS (Min)	QoS (Max)	DES Key	Comment
1	10.10.1.0/30	10.11.1.7	128 kbit/s	192 kbit/s	Key 1	For VoIP traffic to HQ and Gatekeeper requests.
2	10.10.1.3/32	10.11.1.7	192 kbit/s	384 kbit/s	Key 2	For ERP traffic to HQ.
3	10.10.1.32/26	10.11.1.7	8 kbit/s	384 kbit/s	Key 1	For other application traffic (e.g. email) to HQ.
4	10.10.0.0/16	10.11.1.7	0 kbit/s	384 kbit/s	None	For all other traffic to HQ including Internet traffic.

In addition to the routing, QoS (optional) and DES (optional) configuration, HDLC IP address to layer 2 address mappings are defined in the ARP table of C*i*M-300L as follows:

S. No.	IP Address	HDLC Address	Comments
1	10.11.1.7	0x0004	All traffic to HQ is transmitted on HDLC channel 3

The C*i*M-300L is also configured to receive the following HDLC channels:

S. No.	HDLC Address	Comments
1	0x0001	Unicast traffic from HQ
2	0x0101	Audio channel 2 from HQ
3	0x0103	Video channel 2 from HQ

In the route table, also enable "Downlink Multicast".

3.4 Network Operation Overview

All the traffic to the 4 remotes is aggregated and transmitted by one C*i*M-550 at the HQ. Traffic flows within the aggregate carrier are identified by the HDLC address assigned to them. Each traffic flow is individually rate controlled based on the configured QoS parameters.

Each C*i*M-300L at the remote first filters the incoming traffic by HDLC address. This prevents traffic destined to one remote from being received by another remote. For traffic originating at the remote, each flow is again rate controlled based on the configured QoS.

If desired, encryption can be used on an IP route basis to protect sensitive traffic.

4 On Demand Single Hop Connectivity Option

Due to the STAR topology of the network, if some of the traffic from a remote is destined to another remote, it has to be retransmitted by the hub. This has 2 major disadvantages:

- The delay is more than doubled (remote to Hub and then Hub to remote)
- Bandwidth requirement is doubled (remote to Hub and then Hub to remote)

This may be tolerated for infrequent store and forward traffic such as email. However real time applications that require high throughput and low latency, such as VoIP and video-conferencing, a double hop connection is not acceptable.

This situation can be alleviated by using the On Demand Single Hop Connectivity Option from Comtech EF Data (availability – TBD). The optional solution consists of:

- additional receivers at the remotes and
- software application (a server/manager that generally resides at HQ and a client portion that resides on each C*i*M-550 or C*i*M-300L) that provides the dynamic control for on demand single hop links.

5 Other Key Features

C*i*M provides security via multi-level access control and access lists.

Access to management functions (via telnet, SNMP or http) is regulated via a 3 level access control mechanism:

- Administrator level, which has complete access to all management functions, including the ability to ftp the param files in and out
- Read/Write level, which has access to most of the management functions (excluding administrative functions)
- Read Only level, which has view only access to management functions (excluding administrative functions)

In addition, access lists can be used to restrict access to a specific set of IP addresses.

6 Advantages

Comtech EF Data's IP enabled satellite modems (C*i*M-550, C*i*M-300L etc) provide many advantages over traditional frame relay based satellite networks:

- Highly integrated (does not require a separate FRAD and modem), thereby reducing complexity, increasing reliability and maximizing space utilization on an equipment rack
- Lower cost
- QoS control by IP address, allowing a better control over bandwidth provisioning to different applications based on their delay and jitter tolerance
- Encryption on an IP route basis for data security
- Support for IP multicast
- Support for asymmetric circuits for Internet access and other applications that do not require symmetric connectivity
- With integrated L-band interface, C*i*M-300L provides an efficient and low-cost solution for single channel remote sites
- SNMP v2 for integrated network management
- Remote control and management via telnet, SNMP and web interface
- Firmware and software upgrade via ftp
- Feature upgrade via Comtech EF Data's FAST capability
- Ability to backup and restore IP configuration via ftp[*]
- Optional 1:1 Redundancy using CRS-100 switch to protect mission critical links (C*i*M-550 only)

6.1 On Demand Single Hop Connectivity Option

- Enables real-time applications that are delay and bandwidth sensitive (e.g. VoIP)
- Extremely efficient
  - Alleviates the need for twice the bandwidth for remote to remote connectivity
- Extremely cost efficient
  - One time equipment and software expense
  - No recurring expense - i.e. does not require additional bandwidth

[*] The CiM keeps 2 sets of configuration in ASCII format - param1 and param2. They can be ftp'ed out, edited using a text editor and ftp'ed back in.

7 Appendix - Sample Param File

The IP configuration is stored in an ASCII file (called param1 and param2) that can be retrieved via ftp, modified using a text editor and put back via ftp. This allows configuration to be backed up and restored and also allows offline configuration ability. A sample parameter file pertaining to C*i*M-550 (1) at the Hub is shown below:

```
Param File

Rt#0                = Remote-1-VoIP  192.168.1.1/32   10.11.1.2       N/A
Rt#1                = Remote-1-ERP   192.168.1.8/29   10.11.1.2       N/A
Rt#2                = Remote-1-Other 192.168.1.0/24   10.11.1.2       N/A
Rt#3                = Remote-2-VoIP  192.168.2.1/32   10.11.1.4       N/A
Rt#4                = Remote-2-ERP   192.168.2.8/29   10.11.1.4       N/A
Rt#5                = Remote-2-Other 192.168.2.0/24   10.11.1.4       N/A
Rt#6                = Remote-3-VoIP  192.168.3.1/32   10.11.1.6       N/A
Rt#7                = Remote-3-ERP   192.168.3.8/29   10.11.1.6       N/A
Rt#8                = Remote-3-Other 192.168.3.0/24   10.11.1.6       N/A
Rt#9                = Remote-4-VoIP  192.168.4.1/32   10.11.1.8       N/A
Rt#10               = Remote-4-ERP   192.168.4.8/29   10.11.1.8       N/A
Rt#11               = Remote-4-Other 192.168.4.0/24   10.11.1.8       N/A
Rt#12               = Audio-1        225.1.1.1/32     0.0.0.0         LAN->SAT
Rt#13               = Audio-2        225.1.1.2/32     0.0.0.0         LAN->SAT
Rt#14               = Video-1        225.1.1.3/32     0.0.0.0         LAN->SAT
Rt#15               = Video-2        225.1.1.4/32     0.0.0.0         LAN->SAT
Rt#16               = Stock-Ticker   225.1.1.5/32     0.0.0.0         LAN->SAT
Rt#17               = Default        0.0.0.0/0        10.10.1.100 N/A
GENERIC_DOWNLINK_MCAST#0 = Disabled
ADMIN_PWD#0         = admin/admin
READWRITE_PWD#2     = rw/rw
READONLY_PWD#1      = ro/ro
ACCESS_CLIENT#0     = 172.019.010.001/32
ACCESS_CLIENT#1     = NOT-DEFINED/NA
ACCESS_CLIENT#2     = NOT-DEFINED/NA
ACCESS_CLIENT#3     = NOT-DEFINED/NA
ACCESS_ENFORCEMENT_ENABLE#0 = Enabled
TRANS_DES_ENABLE#0  = Enabled
RECV_DES_ENABLE#0   = Enabled
IGMP_ENABLE#0       = Enabled
QOS_ENABLE#0        = Enabled
MULTICAST_ENABLE#0  = Enabled
PING_REPLY_ENABLE#0 = Enabled
SNMP_ENABLE#0       = Enabled
TELNETD_ENABLE#0    = Enabled
ENCRYPT_KEY#0       = 0123456789ABCDEF
ENCRYPT_KEY#1       = FEDCBA9876543210
DECRYPT_KEY#0       = 0011223344556677
DECRYPT_KEY#1       = 7766554433221100
ETHER_SPEED_MODE#0  = Auto
SATELLITE_IP_ADDR#0 = 10.11.1.1
SATELLITE_SUBNET_BITS#0 =  28
HSR_MODE#0          = Enabled
HST_MODE#0          = Enabled
BW#0                = Remote-1-VoIP      32            96             Key1
```

```
BW#1                = Remote-1-ERP        128           256            Key2
BW#2                = Remote-1-Other      0             192           Clear
BW#3                = Remote-2-VoIP       64            128            Key1
BW#4                = Remote-2-ERP        128           256            Key2
BW#5                = Remote-2-Other      0             256           Clear
BW#6                = Remote-3-VoIP       32            64             Key1
BW#7                = Remote-3-ERP        96            128            Key2
BW#8                = Remote-3-Other      0             128           Clear
BW#9                = Remote-4-VoIP       128           192            Key1
BW#10               = Remote-4-ERP        256           384            Key2
BW#11               = Remote-4-Other      0             384           Clear
BW#12               = Audio-1             0             96            Clear
BW#13               = Audio-2             0             96            Clear
BW#14               = Video-1             0             512           Clear
BW#15               = Video-2             0             512           Clear
BW#16               = Stock-Ticker        48            48            Clear
BW#17               = Default             0             0             Clear
BW#1046             = tech.html           0             0             Clear
SARP#0              = HDLC        10.11.1.2       0x0001
SARP#1              = HDLC        10.11.1.4       0x0002
SARP#2              = HDLC        10.11.1.6       0x0003
SARP#3              = HDLC        10.11.1.8       0x0004
SARP#4              = HDLC        225.1.1.1       0x0100
SARP#5              = HDLC        225.1.1.2       0x0101
SARP#6              = HDLC        225.1.1.3       0x0102
SARP#7              = HDLC        225.1.1.4       0x0103
SARP#8              = HDLC        225.1.1.5       0xffff
HSR_HDLC_CHAN#0     = 0x0001
HSR_HDLC_CHAN#1     = NOT-DEFINED
HSR_HDLC_CHAN#2     = NOT-DEFINED
HSR_HDLC_CHAN#3     = NOT-DEFINED
IGMP_ENABLE#0       = Yes
IGMP_QRYP#0         = 25
IGMP_MXRT#0         = 20
IGMP_MRP#0          = 3
IGMP_QUERIES#0      = Yes
IGMP_VERSION2#0     = V2
IGMP_ROUTERALERT_OPT#0 = No
IGMP_URI#0          = 25
```