iDirect Star-Mesh Broadband IP VSAT System
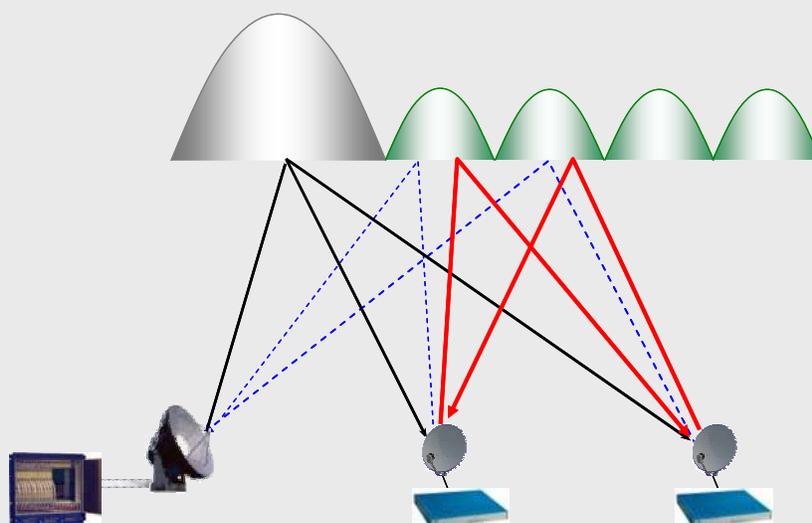
Sasmith Reddi
Director - Systems Engineering
iDirect Technologies
10803 Parkridge Blvd.
Reston, VA 20191

703 648 8000
703 648 8014 fax
sreddi@idirect-tech.com

www.idirect-tech.com

Table of Contents

Introduction

The iDirect Broadband VSAT network is a complete turn-key solution for broadband IP connectivity over satellite. The iDirect network combines the industry's fastest data rates with the leading satellite access technology to provide the most reliable and bandwidth efficient solutions for voice, video, and data transmission needs. iDirect networking solution can be implemented irrespective of the topology requirements of an application i.e., point-to-point, star or mesh.

The purpose of this document is describe the operation and advantages of adding a mesh network overlay on top of the current iDirect star network to allow direct connectivity between remote terminals with a single trip over the satellite. iDirect will implement this solution in a phased manner. Initial phase of this solution will be available in Mid-2005.

Theory of Operation

The iDirect Star/Mesh solution combines the centralized hub benefits of the star network topology with the direct single-hop remote-to-remote connection of the mesh network. In a star network all remote terminals have direct connectivity with the hub which is ideal for applications that terminate into a common point such as the internet, public telephone network, or corporate data centers. In a mesh network, the remote terminals are able to send IP packets directly to other remote terminals based on the destination IP address. The star/mesh remote IDU's use the star return channel and forward channel for mesh control messages. The iDirect mesh solution is a TDMA mesh that uses the same return carriers that are implemented for star connectivity.
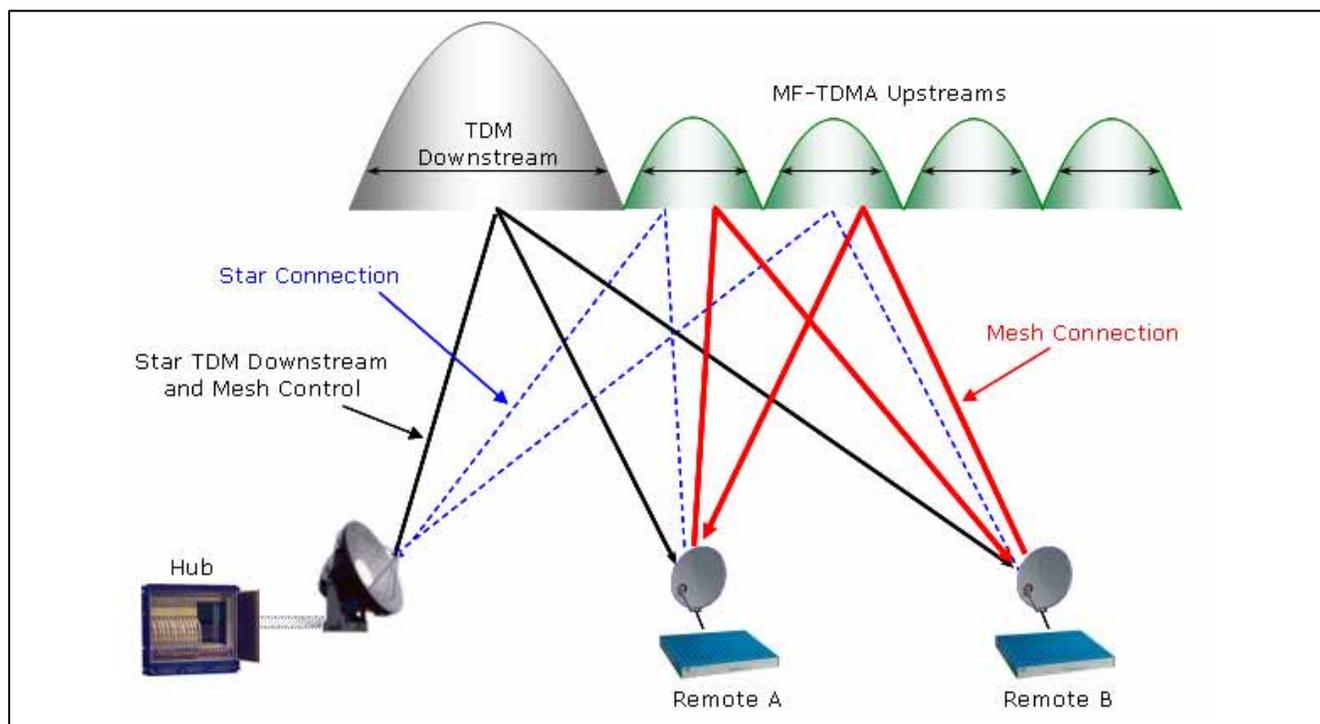

Figure 1: Star/Mesh Network High Level Architecture

The advantage of the iDirect mesh solution is that it operates in conjunction with MF-*TDMA,* Application QoS and the full iDirect RTTM feature set. This results in a significantly lower solution cost and ease of implementation,, while supporting critical business applications. Within an iDirect network a remote can communicate in both a star mode and a mesh mode at the same time, depending on the amount of bandwidth available. Since the iDirect platform has turbo product codes as a standard FEC, it also results in generally smaller ODUs.

Network Architecture

The star and mesh connectivity of this network solution are provided by two types of satellite channels and specialized remote terminal equipment. All networks consist of a single broadcast downstream channel and one or more TDMA channels.

Downstream Channel

The iDirect hub is the only node in the star/mesh network that transmits on the downstream channel. IP packets that need to be sent from the hub to remotes are sent on this shared broadcast channel that all remotes receive. Each remote terminal filters the incoming data stream for packets that are identified with a unique media access control (MAC) address and routes them to its LAN port. The downstream channel is also used to route network control information from the centralized network management system (NMS) and dynamic bandwidth allocation changes.

The downstream channel in a star/mesh network has the following advantages:
- **Dedicated bandwidth** – Typical applications for a star network have higher requirements for bandwidth from the hub to the remotes, such as internet, corporate datacenter, and public switched telephone network connections. Most of the dataflow in these applications goes from the hub towards the remotes.

- **Centralized Management** – the complete iDirect star/mesh network can be managed from a centralized network operations center (NOC) running the advanced iDirect NMS applications. The hub node in the network provides the ideal connectivity for this centralized management

- **Network Synchronization** – the iDirect TDMA channels are able to take advantage of significant bandwidth efficiency and performance enhancements because of the tight timing and frequency synchronization that the downstream channel provides. The centralized hub provides the frequency and timing references for the remote terminals via the downstream channel, which results in lower equipment costs for the remote terminals.

TDMA Upstream Channels

A star/mesh network consists of one or more deterministic time division multiple access (D-TDMA) channels, which are shared access channels that provide IP connectivity between remote terminals and from remotes back to the hub. The remote terminals are assigned transmit time slots on these channels based on the dynamic bandwidth allocation algorithms provided by the hub. The D-TDMA channels provide the following advantages:

- **Multiple Frequencies** – a typical network will contain multiple D-TDMA channels for remote-remote and remote-hub connectivity. Each terminal is able to quickly hop between these frequencies for to provide the same efficient bandwidth utilization as a single large TDMA channel, but without the high power output and large antenna requirements.

- **Dynamic Allocation** – bandwidth is only assigned to remote terminals that need to transmit data, and is taken away from terminals that are idle. These allocation decisions are made several times a second by the hub which is constantly monitoring the bandwidth demands of the remote terminals.

- **Single Hop** – data is able to traverse the network directly from a remote terminal to another remote terminal with a single trip over the satellite. This is critical for latency sensitive applications such as voice and video connections.
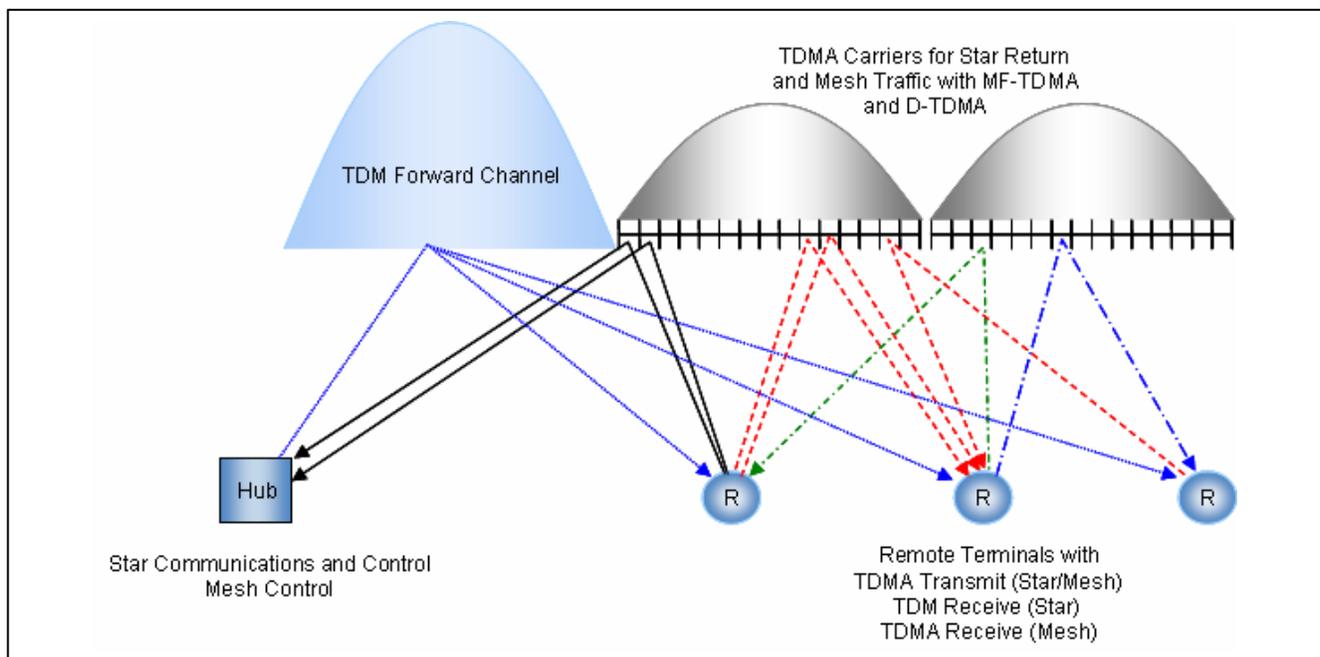

Figure 2: Star/Mesh Traffic and Control Architecture

Within the iDirect system the TDM forward channel is used for Star-topology traffic and control. In addition, the TDM forward channel is used for Mesh-topology control that includes carrier and slot allocation for remote-to-remote traffic. The TDMA return channels are used for both star-topology and mesh-topology traffic. Figure 2 provides a high-level traffic flow diagram.

Within the Mesh-topology all the iDirect features such as Application QoS (classification and prioritization), Voice Jitter handling, IP Routing, Encryption, TCP/HTTP acceleration and cRTP are still valid and available. The system will also respect and system QoS rules such as minimum information rate, committed information rate and maximum information rate.

Remote Terminal Equipment

In addition to the standard antenna, block up-converter (BUC), and low-noise block down-converter (LNB) outdoor unit (ODU) components, the iDirect star/mesh terminal consists of the following components that are all integrated into a single indoor unit (IDU) chassis:

- **Integrated Features –** IP Router, TCP Optimization, RTTM feature (Application and System QoS), cRTP, Encryption, MF-TDMA, D-TDMA, Automatic Uplink Power Control and Turbo Coding.

- **TDM Downstream Receiver –** This continuously demodulates the downstream carrier from the

hub and provides the filtered IP packets and network synchronization information. The downstream receiver connects to the antenna LNB via the L-band receive IFL cable. The down-converted satellite spectrum from the LNB is also provided to the D-TDMA receiver.

- **TDMA Satellite Transmitter** – The TDMA transmitter is responsible for sending data from the remote terminal to the satellite TDMA channels. All data that is destined for the Hub or for other remote terminals is sent via this transmitter.

- **TDMA Satellite Receiver** – The TDMA receiver is responsible for demodulating a TDMA carrier for providing remote-to-remote mesh connectivity. The receiver will tune to the carrier based on control information from the Hub.

Summary

The iDirect Star/Mesh solution provides a very efficient and cost-effective solution for those networks that need to provide a regular star topology for remote-to-hub and specific mesh topology for remote-to-remote communications. This solution supports most network requirements where typical traffic patterns are 95% star-topology and 5% mesh topology. With the iDirect solution an organization still has the benefits of many patent-pending features that include the iDirect RTTM feature set, Application QoS, System QoS, Network QoS, cRTP, TCP and HTTP Acceleration, IP Routing, and built-in AES or 3DES Encryption.

NOTE: iDirect will implement this solution in a phased manner. Initial phase of this solution will be available in Mid-2005.