Symmetricom

NGN SERIES

Synchronization for Next Generation Networks:

Deploying Reliable DOCSIS Synchronization

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Included Topics

This document provides a guide for cable operators to deploy the DOCSIS Timing Interface in their networks. The guide covers the following topics:

- What is a DTI Server?
- What do Root and Slave DTI Servers do
- How to balance economics, scalability and reliability
- Deployment guidelines for:
  - an initial (small) site
  - a growing site
  - a large site
- What reliability can be achieved with DTI

Introduction

It is critical to maintain good synchronization in a DOCSIS network. Cable modems (CMs) use synchronization to determine when to transmit. Without good synchronization CMs will transmit at the wrong time, causing complete loss of transmission of not only the errant CM, but also the CMs it transmits over. M-CMTS specifications include the DOCSIS Timing Interface (DTI) to ensure highly accurate and reliable synchronization of the entire DOCSIS network. For an overview of the DOCSIS Timing Interface and Synchronization please refer to the list of documents at the end of this white paper.

DTI Root and Slave Servers

The cornerstone of DTI is a Root DTI Server. The Root Server controls the synchronization for an entire hub or headend. All M-CMTS devices including the CMTS, EdgeQAMs and Upstream Receivers synchronize either directly connect to the Root Server or through a subtending Slave Server. Since the Root Server is central to the operation of the DOCSIS network, the CableLabs DTI specifications suggest that a Root Server be extremely reliable. Symmetricom's TimeCreator 1000 has been designed with five nines or better reliability. The TimeCreator 1000 has a passive backplane architecture to eliminate single point of failure active components. It can be configured with redundant clock cards (IOCs) and redundant power supplies to protect all of the active signals. Essentially, the TimeCreator 1000 with redundant cards is like having two Root Servers in a single shelf. This type of architecture has been part of the Symmetricom products deployed in 70% of the world's telecommunication networks for over 30 years.

Initial Installation

DTI deployment is a balance of economics, scalability and reliability. A Root Server can be deployed without redundancy, although this creates a single point of failure in the network. DTI should be deployed using two connections between a DTI Server and the M-CMTS device (primary & secondary inputs). A typical initial deployment would consist of a single Root DTI Server with two connections to each M-CMTS device (Figure 1). The suggested configuration is a TimeCreator 1000 with redundant power supplies and clock cards. When using this initial architecture, the operator should consider leaving two to four ports on the Root Server free to connect future Slave Servers without needing to re-cable existing connections.

GPS may be used in DTI deployments to enable support for T1/E1 circuit emulation for Business Services. GPS may also be used in advanced M-CMTS architectures where the M-CMTS Core and EdgeQAM are not co-located in the same site. In this advanced architecture, GPS is needed to allow both sites to use the same time, in the case of the typical deployment described above, the GPS Time-Of-Day. GPS should be strongly considered for initial deployment if an advanced architecture or Business Services are in the strategy. Adding GPS to an operational DOCSIS network requires a brief outage to re-align the network to GPS time. An NTP Server may also be added to the Root DTI Server to support IP applications, OCAP, PacketCable, CM registration and other applications needing NTP.

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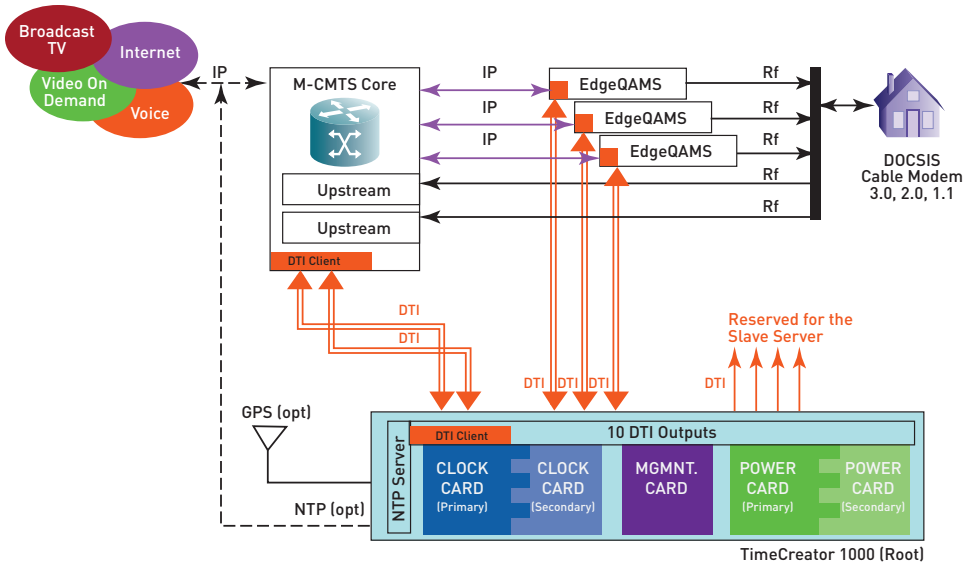

Fig 1 Initial Installation

A Growing Installation

Since there can be only one Root Server in each site, the DTI specification allows for Slave Servers to be directly connected to a Root Server to add capacity and support more sophisticated deployment architectures. With more than one DTI Server, the primary and secondary connection to the M-CMTS devices can be cabled in different ways. One way is to dual home each M-CMTS device to a single server where both primary and secondary inputs are connected to the Root or a Slave Server. A second way is to single home each M-CMTS device to two servers where the primary and secondary inputs are connected to different servers (traceable to the Root).

Single or dual homing the M-CMTS devices allows for several architectures, each with its advantages and disadvantages. Figure 2 shows one way to grow a DTI deployment by adding a single slave server to a site and dual homing the M-CMTS devices. In this architecture, the Slave Server is dual homed to the Root Server using a standard DTI connection. This ensures that the Slave Server has a reliable synchronization signal from the Root. Since each M-CMTS device is dual homed to either the Root or the Slave Server, each server should have redundant clock cards and power supplies. The advantages of this architecture are that it is the simplest way to grow and requires the fewest servers. The disadvantages are that if a server fails, it will cause the connected devices to fail and that this architecture can only scale to 60 outputs per site using the TimeCreator 1000. To avoid an outage, the Root Server and each Slave Server should have redundant cards.

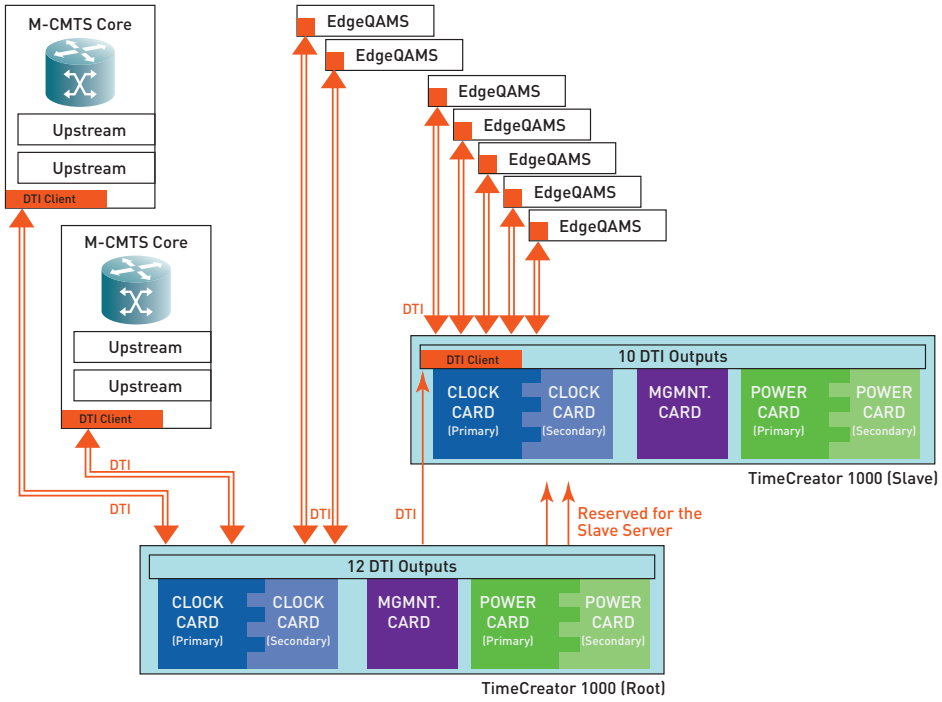

Fig 2 Growing Installation

Large Site Installation

Figure 3 shows a deployment where M-CMTS devices are single homed to two different servers. In this deployment Slave Servers are deployed in pairs and each M-CMTS device is single homed to each Slave Server in the pair. Each Slave Server does not need internal redundancy and is connected to the Root Server using a single DTI connection. This architecture provides each M-CMTS device two paths to the Root Server, but through different servers. The advantage of this architecture is that only the Root Server needs to have redundant clock and power cards. The Slave Servers do not require this, since they are deployed in pairs. This architecture has greater than five nines reliability and can scale to 132 outputs in a single site using the TimeCreator 1000. The disadvantage of this architecture is the higher upfront cost of deploying three servers, so it should typically only be deployed where higher capacity is needed.

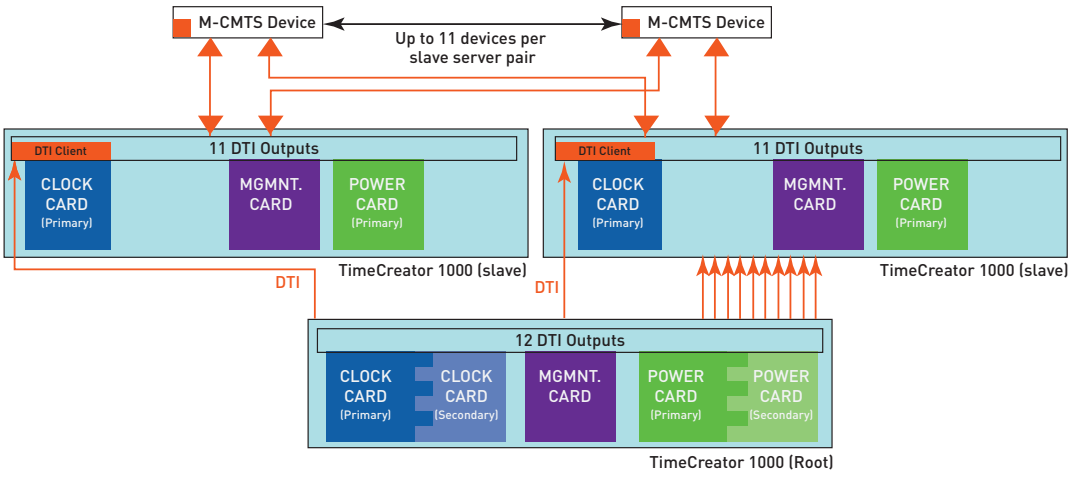

Fig 3 Large Site Installation

Alternative Architecture for a Growing Installation

Figure 4 shows a single homed architecture using a single Slave Server and a Root Server. The advantage of this architecture is that it does not require redundant cards in the Slave Server. The disadvantage is that it only scales to 11 outputs. Once there are no more outputs left on the Root Server, this architecture must be migrated to an architecture similar to Figure 2 or Figure 3.

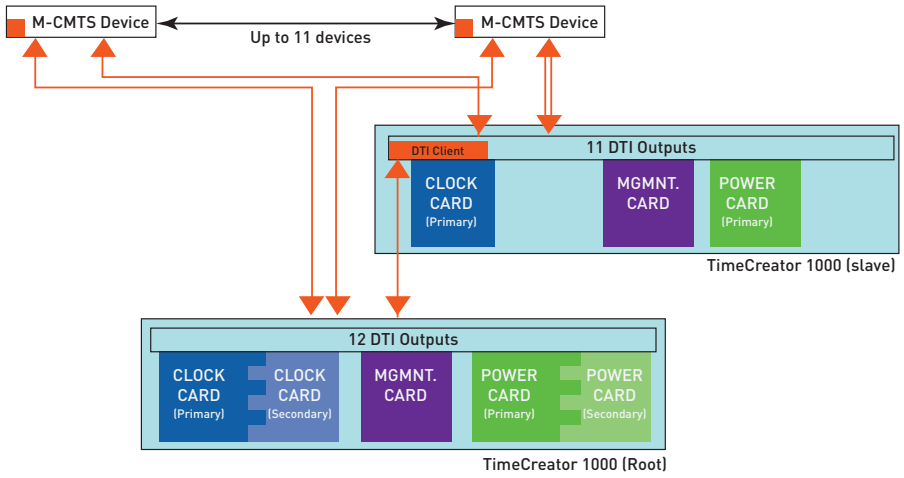

Fig 4 Alternate Growing Site Installation

Meeting the Need for Better Than Five Nines Reliability

All of the architectures described above rely on a reliable Root Server. Symmetricom's TimeCreator has been designed with this in mind. It provides over five nines of reliability and is fully compliant to the CableLabs specification.

However, in some installations five nines reliability for a Root Server may not be enough for some operators, especially in large deployments. The CableLabs specification did not foresee this requirement and does not consider the corner case where a Root Server is taken off-line or fails. If this were to happen and M-CMTS devices are dual homed, there would be a failure in the network. If the M-CMTS devices are single homed, then there is no immediate impact. In Figure 3, both Slave Servers will go into holdover, but remain in normal output mode. In Figure 4, the M-CMTS devices will hitlessly switch to the Slave Server. In both cases there will be an issue when the Root Server re-starts and conveys the new DOCSIS timestamp. The DOCSIS timestamp is derived from GPS or NTP, or set by the user. In all of these cases, the new timestamp will not be within 5ns of the timestamp being used by the Slave Servers, which is required for normal operation. This will cause the Slave Servers and M-CMTS devices to re-sync and may cause cable modems to re-range.

To address this omission in the DTI Specification, Symmetricom is adding a feature to TimeCreator 1000 that will ensure a graceful recovery of the network. With TimeCreator 1000 Release 1.1, when a Root Server is re-started, it will not reset the DOCSIS timestamp for the site. Instead, the Root will acquire time from GPS or use a dedicated connection to one of the Slave Servers to acquire the old DOCSIS timestamp being used by the Slave Servers in holdover. The Root will then convey the new DOCSIS timestamp to the Slave Servers. The Servers will then realign to the new time. During this entire process the network will operate in an extended operational state which should not impact performance of DOCSIS.

Using the TimeCreator 1000 from Symmetricom M-CMTS can be reliably deployed with a variety of architectures to meet the scalability and economic requirements of each cable operator. Symmetricom is committed to enabling synchronization for DOCSIS deployment and quality assurance for voice, video and data though our solutions. For more information visit www.symmetricom.com or e-mail cable@symmetricom.com

Related Documents

"Synchronization Requirements for High-Performance Cable Networks"
(http://ngn.symmetricom.com/pdf/application_notes/AB_Cable.pdf)

TimeCreator 1000 Manual

TimeCreator 1000 Quick Start Guide

"Time to Sync Up"
(http://www.cable360.net/ct/sections/columns/telephony/22840.html)

"Timing is Everything"
(http://www.cedmagazine.com/article.aspx?id=147013)

"Avoid a Timing Meltdown"
(http://www.cable360.net/ct/operations/bestpractices/22842.html)

CableLabs DTI Specification
(http://www.cablelabs.com/specifications/CM-SP-DTI-I04-061222.pdf)

CableLabs DTI Acceptance Test Procedure (CM-TP-DTI-ATP-I02-060825 available on DocZone)

Ordering Guide

TimeCreator 1000 Part Numbers

	Initial Site	Growing Site	Alternate Growing Site	Large Site
Suggested BOM				
TimeCreator 1000 - No redundancy				2
TimeCreator 1000 - Power Card redundancy			1	
TimeCreator 1000 - Clock & Power redundancy		1		
TimeCreator 1000 - Clock & Power redundancy with GPS				
TimeCreator 1000 - Clock & Power redundancy with GPS & NTP Server	1	1	1	1
Optional BOM				
TimeCreator 1000 - No redundancy				2
TimeCreator 1000 - Power Card redundancy			1	
TimeCreator 1000 - Clock & Power redundancy		1		
TimeCreator 1000 - Clock & Power redundancy with GPS	1	1	1	1
TimeCreator 1000 - Clock & Power redundancy with GPS & NTP Server				
Typical BOM				
TimeCreator 1000 - No redundancy				2
TimeCreator 1000 - Power Card redundancy			1	
TimeCreator 1000 - Clock & Power redundancy	1	2	1	1
TimeCreator 1000 - Clock & Power redundancy with GPS				
TimeCreator 1000 - Clock & Power redundancy with GPS & NTP Server				

Note: If ordering a unit with an EU power cable replace the -01 in the part number with -11.
If ordering a unit with an UK power cable replace the -01 in the part number with -21

Configuration Bills of Materials (BOMs)

Initial Installation (Figure 1)

- Suggested Configuration:
  TimeCreator 1000 Enhanced Root (quantity 1)
- Optional Configuration:
  TimeCreator 1000 Standard Root (quantity 1)
- Typical Configuration:
  TimeCreator 1000 Standard Slave (quantity 1)

Growing Installation (Figure 2)

- Suggested Configuration:
  TimeCreator 1000 Enhanced Root (quantity 1)
  TimeCreator 1000 Standard Slave (quantity 1)
- Optional Configuration:
  TimeCreator 1000 Standard Root (quantity 1)
  TimeCreator 1000 Standard Slave (quantity 1)
- Typical Configuration:
  TimeCreator 1000 Standard Slave (quantity 2)

Large Site Installation (Figure 3)

- Suggested Configuration:
  TimeCreator 1000 Enhanced Root (quantity 1)
  TimeCreator 1000 Basic Slave (quantity 2)
- Optional Configuration:
  TimeCreator 1000 Standard Root (quantity 1)
  TimeCreator 1000 Basic Slave (quantity 2)
- Typical Configuration:
  TimeCreator 1000 Standard Slave (quantity 1)
  TimeCreator 1000 Basic Slave (quantity 2)

Alternate Growing Site Installation (Figure 4)

- Suggested Configuration:
  TimeCreator 1000 Enhanced Root (quantity 1)
  TimeCreator 1000 Basic Slave (quantity 1)
- Optional Configuration:
  TimeCreator 1000 Standard Root (quantity 1)
  TimeCreator 1000 Basic Slave (quantity 1)
- Typical Configuration:
  TimeCreator 1000 Standard Slave (quantity 1)
  TimeCreator 1000 Basic Slave (quantity 1)

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