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TMS Compact

Compact Multi-aggregate Transport Management System

Highlights

- Flexible architecture supports 10 voice or data circuits in a compact shelf, or up to 58 circuits when deployed with up to three expansion shelves.
- Supports SNMP traps (GTS Version 5.1.0. and later)
- Aggregate rates to 4.096 Mbps.
- Provides secure, cost-effective "single-service" transport of voice and data to any network site.
- Supports high-speed digital DDS, channelized FT1, FE1, T1, and E1 services.
- Supports all leased line (dedicated) interfaces (V.35, 422, 423, T1/D4, G703, etc.).
- Supports satellite aggregate communications links with minimum delay.
- Bit-interleaved multiplexing maximizes bandwidth utilization.
- Supports analog or digital PBX with high efficiency multiplexing.
- Supports redundancy for power provisioning, common logic, and any aggregate interface modules.
- Self-healing routing and disaster recovery ensures maximum availability.
- When deployed with GDC multiplexers (OCM-2000 or MiniMux), the TMSC concentrates branch office traffic from hundreds of locations.
- Easily tailored to point-to-point, delta, star, or fully meshed topologies to support any size organization.
- All components are modular and hot-swappable, for flexible sparing, easy upgrading, and future-proof scalability throughout the backbone network, without disruption of services.
- When equipped with Plus-series cards (ESCC-Plus, ACC-Plus, and UVC-Plus), TMS Compact provides heightened capabilities for critical SCADA application networks.
- GDC TMS Software (GTS) provides end-to-end management for configuration, control, alarm reporting, and diagnostics from up to six controller locations, as well as LAN-based access.

System Overview

TMS Compact (TMSC) transports critical multi-service communications over a single, private homogeneous network. A scaled down version of the TMS-3000, TMSC has fewer aggregate and channel capacities and a more compact footprint, providing full TMS node functionality for low density applications.

TMSC uses the same common cards (RCC, ESCC, ACC, etc.) and the same channel cards (UVC, UDC, TID-III, etc.) as the TMS-3000. TMSC can also use the "plus" series cards (ESCC-Plus, ACC-Plus, and UVC-Plus) to interoperate seamlessly in the TMS-OCM network. This modularity and flexibility allows for the constantly evolving private and public data and voice services to any nodal and remote sites in the network.

For both carriers and end users, the application of appropriate technology provides the means to rapidly deploy new services without costly "forklift" upgrades, greatly reduces the need for spare parts, and eliminates the need for technical training on more than one platform.

For applications that require full period availability with low/fixed delay, TMSC delivers high efficiency and circuit multiplexing, circuit routing, and standards-based access and termination. All services are delivered across wide areas via standard circuit switching techniques for the most efficient use of bandwidth, equipment, space, and human resources. ***Figure 1*** shows the TMSC Shelf with 10 channel modules. ***Figure 4*** shows the TMSC in an expansion shelf arrangement that can support up to 58 channel modules.

Figure 1: TMS Compact Shelf

Compatible & Modular

The TMS Compact is fully compatible with GDC's TMS family of products, including the TMS-3000, OCM-2000, and MiniMux TDM. As with all TMS node types, the TMS Compact is highly modular, requiring only one (optionally redundant) common logic module and one redundancy control module. The scalable TMS network may consist of a single TMS Compact node with only one installed channel module, or hundreds of nodes with many thousands of installed modules. As network requirements grow and change, TMS modules and TMS nodes may be added at any time without disruption to the production network.

The modular, scalable design allows for exceptionally easy field upgrades to hardware and software with minimal service interruption. This flexibility and interoperability allows incremental integration of state-of-the-art features and capabilities for the life of a TMS network.

TMS nodes require the least number of channel cards in the industry to provide for total transparent data and voice support. The TMS system makes maximum use of a "Universal" module approach to reduce the need for on-site spares, and to allow maximum flexibility. For example, a single Universal Data Channel (UDC) module is configurable on-site for many types of interfaces and rates. This provides a significant level of efficiency for support of data applications due to the wide range of configuration possibilities afforded by one card. UDC cards support speeds ranging from 75 bps to 2.048 Mbps which are software selectable from the Network Management System.

- The Universal Data Channel card supports synchronous, asynchronous, isochronous and transition-encoded data.
- The Universal Voice Channel card supports FXS, FXO and E&M voice applications.

Legacy Support and Future Proof

TMS Compact allows users to accommodate legacy network requirements efficiently and economically while supporting the enhanced performance features required in mission critical networks.

When equipped with "Plus" series modules (ESCC-Plus, ACC-Plus, and UVC-Plus), a TMS system can provide heightened features, standards and rate capabilities required in mission critical networks.

The enhanced performance features in the "Plus" common cards allow the TMS to continuously monitor performance of primary and alternate aggregate links, and employs confidence factors to comparatively measure error rates, regardless of disparate data rates. The ESCC-Plus, the ACC-Plus, and the GTS Controller Version 6.x or higher are required to achieve the "Plus" capabilities.

Voice & Data

The TMS Compact system enables the combining of virtually all possible data and voice traffic into a common backbone. By applying the appropriate technology to any given networking task, the TMS Compact can be configured and used as a multiplexer, a voice compression device, a data compressor, or a T1/E1 cross-connect. Through the combination of these capabilities, the TMS family supports the widest possible set of network applications. For example, a single TMS Compact node:

- Combines low speed and high speed data channels and compressed voice channels, into physical aggregates, or logical sub-aggregates, using High Efficiency Multiplexing (HEM).
- Concentrates the connections from hundreds of remote branch office routers into a managed transport system.
- Compresses the voice channels from a digital PBX and delivers them in either analog or digital form.
- Delivers Data traffic in public data format for termination on GDC or on non-GDC devices.

Bit Transfer Mode

The TMS architecture supports bit mode data transfers between modules in the system. Bit mode supports maximum granularity of channel and aggregate data rates. Bit mode transfers data between TMS modules with the lowest possible delay at 16+ Mbps rate. Subrate and superate multiplexing and switching is also provided. A single TMS Compact node can be configured for up to 16+ Mbps of full duplex Bit Mode capacity.

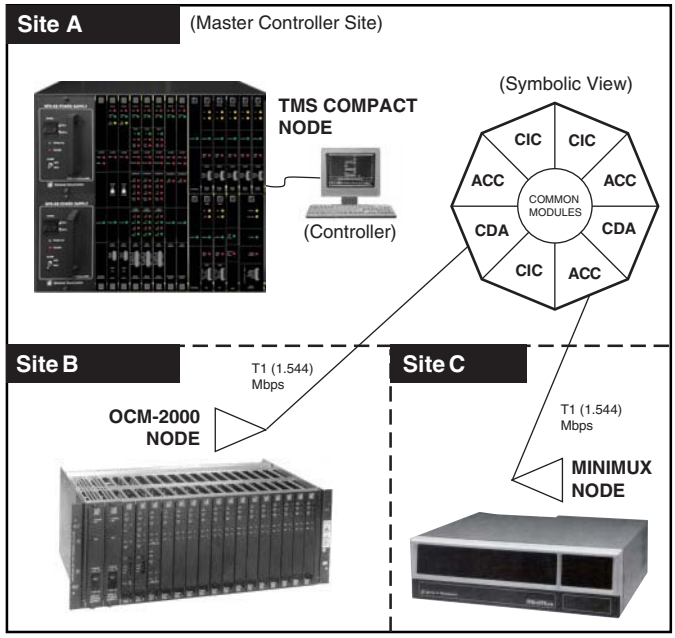


Figure 2: Typical Network Detail

Voice Compression

Standard voice traffic is passed through the POTS network at 64 Kbps. TMS Compact provides compression rates ranging from 32 Kbps to 4.8 Kbps by using a variety of high quality compression algorithms such as Adaptive Differential Pulse Code Modulation (ADPCM) and Codebook Excited Linear Predictive (CELP). The CS-ACELP voice compression algorithm reduces the bandwidth required for voice traffic to 8 Kbps while maintaining the quality of a 32 Kbps ADPCM call. This compression leads to extensive reductions in the amount of bandwidth required to transmit information across the backbone, as well as savings in infrastructure costs. TMS Compact can further compress voice channels automatically in the event of network failure or congestion. This adaptive downspeeding means that network managers can adjust voice quality rather than allow abnormal conditions to deny service to users.

TMS Compact supports digital and analog voice interfaces, and offers complete flexibility for individual voice channel routing. Voice channels from a digital PBX can be compressed and then transported to different destinations in a network, such as an analog interface or another digital interface. Voice channels can also be converted between A-law and Mu-law and then compressed and transported between T1 and E1 networks.

The voice compression algorithm contains an integrated 16 millisecond, configurable G.165 compliant echo canceller and a non-linear echo suppressor. The echo canceller prevents echoes that may be present on analog loops from being transmitted to the other end of the network. The echo canceller can eliminate near end echoes for telephone terminations within the allowable 9,000 foot loop length.

Fax Bypass Option

The Fax Bypass option allows the transparent bypass of fax signals at the full Group III rate of 9.6 Kbps.

Rapid Recovery (IAR)

Link failures are the major cause of downtime in critical communications networks. In the event of a transmission facility failure, TMS Compact dynamically applies Intelligent Automatic Rerouting (IAR) to route circuits around failed network resources according to AutoPath parameters defined at the controller.

Designated circuits, such as voice, can be automatically downspeeded in order to maintain service to as many users as possible during the failure. IAR occurs well within the time-out thresholds of front end processor sessions.

Thus, voice, data and other protocols designated towards a failed circuit are transported without additional delays along an alternate path during the link failure. IAR speed combined with automatic downspeeding guarantees minimal - if any - disruption to users on the network.

Disaster Recovery Re-Routing (DDR)

Creating a mesh network topology and defining a backup nodal site provides alternate traffic routes in the event of a a disaster situation at a nodal location (i.e., fire, flood, etc.). In such conditions, the TMS Compact will automatically redirect the end points of the circuits from the failed primary site to the designated back-up site. Non-critical circuits can be dropped according to circuit profiling to conserve bandwidth. TMS Compact ensures the integrity of application requirements is maintained during DRR by matching each circuit's profile with aggregate profiles.

Reliable Non-Stop Operation

TMS systems are designed to minimize component count and power consumption, reducing the potential for equipment failure. Built-in redundancy and recovery features further ensure non-stop power provisioning, common logic operation and line interface module operation, for maximum reliability throughout the system.

Non-Disruptive Updates

From one single location, the TMS operating software and/or configuration parameters can be downloaded to the entire network without disrupting communications. Downloads occur in the background and are stored in each network node until commanded active. Even after activation, the previous software is retained in each node, making it possible to instantly switch back to the previous software upon command. This capability adds new features and reduces downtime by eliminating costly truck-rolls to remote sites to change PROMs.

Figure 3: GDC's TMS Management System, "GTS"

Fail-Safe Redundancy

TMSC provides non-stop inter-networking through integral redundancy. Any module supporting more than one channel can be made redundant without adding costly shelves or bulky external cables. TMSC initially configured without redundancy can be easily upgraded for redundancy by simply installing additional modules. TMSC can be configured with one-to-N redundant common logic aggregates, and one-to-one power supply redundancy.

All redundant cards and power supplies will immediately and automatically switch to their redundant counterparts in the event of a module failure. The switch over will occur with minimal, if any, disruption of service. This is accomplished by processing all functions simultaneously in both the primary and the secondary stand-by modules. In the event of a power supply module failure, the remaining modules will provide power for the TMS node. Power supplies, like all TMS modules, are "hot swappable", eliminating the need to remove primary power before replacement.

Cost of Ownership

Reliability, Redundancy, and Maintainability are hallmarks of the TMS design. Through careful design, the TMS Compact has lowered the cost of ownership by:

- maintaining high reliability
- providing high bandwidth utilization efficiencies
- maintaining operation through redundancy under conditions of equipment failure
- providing rapid fault isolation
- providing single channel per module options
- minimum requirement for spare parts

Robust Clocking

TMS Compact supports comprehensive fallback clock sourcing. The system may be locked to any aggregate or channel, internal or external clock source, backed up by similar clock sources at any network node. The network operator defines a master clock node and clock stability levels. Should a clock failure occur, TMS Compact automatically reverts to the next lower (or equal) level clock source at the master node or the closest node. This fallback occurs without service interruption if the fallback clock is closely matched to the original clock source. Clock restoral is also independent of rerouting and inter-nodal trunk failures.

Fractional E1 / T1

With Fractional E1/T1, end users and carriers have more options in designing high capacity digital networks. In providing for aggregate interfacing into the byte-oriented public network, the TMS Compact facilitates access to services provided by the DACS-based network, and also accepts direct PABX connections.

TMS Compact Architecture

The TMS Compact comprises one standalone shelf that can accommodate up to 10 voice or data channel cards. The channel card capacity can be increased by attaching one, two or three Expansion shelves by means of Flex Card connectors. Each Expansion shelf provides an addition 16 channel card slots to the node, for a total of 58 channels per node.

- ***Figure 1*** shows a TMSC node deployed without Expansion shelves.
- ***Figure 4*** shows a TMSC node deployed with Expansion shelves.
- ***Figure 5*** shows the logical components of a TMSC node.

With all of the power and capabilities of the TMS, surprisingly few modules are required. GDC's extensive use of a "universal" multi-functional approach to module design results in a lower complement of modules, which results in lower costs for spare parts.

TMS Compact modules include:

- Power Supplies (one to two)
- Combined Digital Aggregate (CDA)
- ADPCM Compression Module (ACM)
- Aggregate Control Card (ACC/ACC-Plus)
- Channel Interface Card (CIC)
- Enterprise System Control Card (ESCC/ESCC-Plus)
- Redundant Control Card (RCC)
- Up to 10 channel modules: (any combination of UDC, UVC/UVC-Plus and TID-III modules)
- Expansion Modules (one or two)

Expansion Shelf modules include:

- Expansion Modules (one or two)
- Up to 16 channel cards per shelf: (any combination of UDC, UVC/UVC-Plus and TID-III modules)
- One or more Sync Status Modules (SSM)

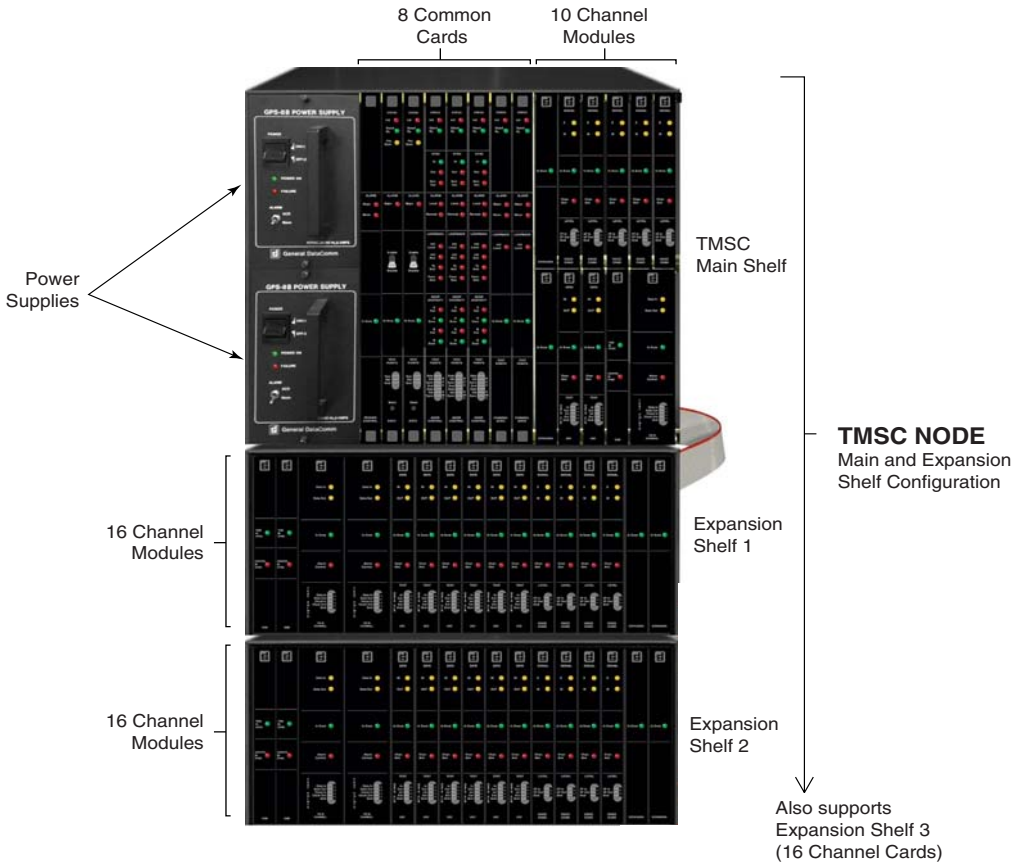
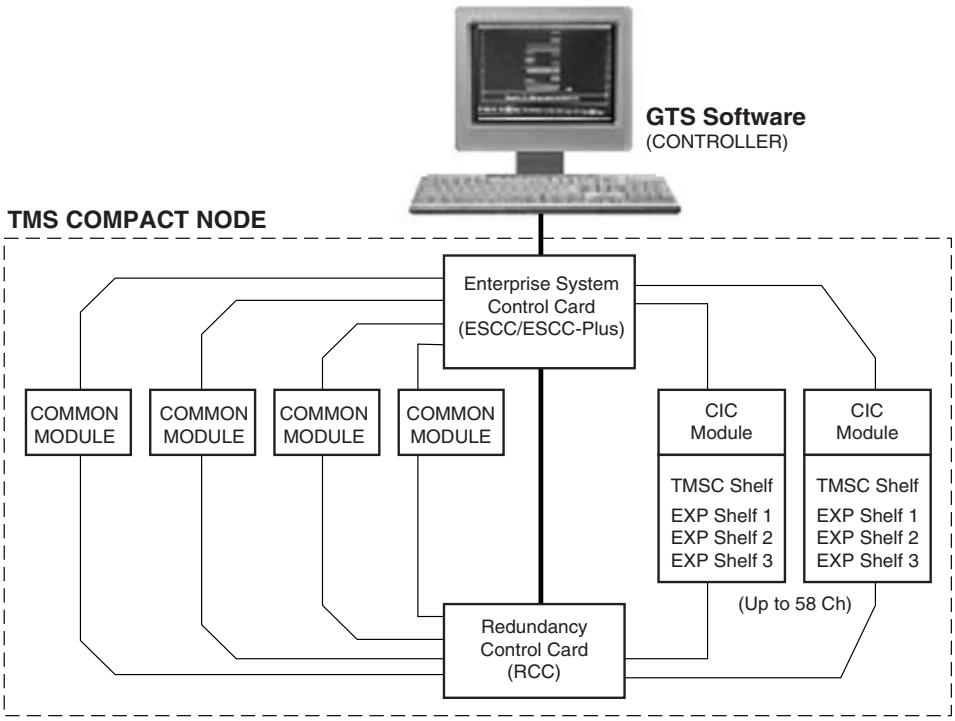


Figure 4: TMSC with Expansion Shelves



Note: Common Modules in the in the TMS Compact Shelf can be ACM, ACC/ACC-Plus, CDA, or CIC modules.

Figure 5: TMSC Logical Components

TMS Modules Overview

Common Logic Modules

Enterprise System Control (ESCC/ESCC-Plus)

The ESCC module monitors and controls the activities of all the other cards and modules in that shelf. The ESCC stores configuration information for the local TMS node and provides permanent storage of software programs for all of the common logic cards in the TMS system. It also communicates with a local controller, with other ESCCs in the TMS network. The ESCC controls downloads, clocking and redundancy of common cards.

Aggregate Control Card (ACC/ACC-Plus)

ACC controls transfer of data across an aggregate trunk to another TMSC, TMS-3000, OCM-2000 or MINIMUX node. Data is derived from CIC, ACC or CDA modules via the Common Equipment Bus, assembled into an aggregate bit stream, and transmitted across the aggregate trunk. Data received from the aggregate trunk is de-multiplexed and distributed to either ACC, ACM, CIC or CDA modules at up to 4.096 Mbps.

Redundancy Control Card (RCC)

The RCC maintains a set of primary/secondary signals that are directed to each redundant pair of cards. The RCC determines if a card is present in each slot; if only one card of a redundant pair is present, that card remains in service.

ADPCM Compression Module (ACM)

The ACM compresses multiple voice channels for a substantial bandwidth savings over 64K PCM. This bandwidth savings can be used during disaster recovery and fall-back where the ACM can further compress voice channels to provide more active circuits. Available as T1 or E1 device.

Combined Digital Aggregate (CDA)

The CDA connects TMS nodes and multiplexers at remote locations. Each CDA exchanges data with other CDA, ACC, or CICs in the TMSC shelf via the TMS Fast Bus. The CDA-T1 module interfaces between the public T1 network and a TMS network. The CDA-E1 Module allows full duplex access to ITU-T structured public networks at 2.048 Mbps.

CIC Card

A CIC is the interface for up to 58 local channel cards. It multiplexes and demultiplexes data from channel cards onto a high-speed 16.896 MHz bus, allowing communication to all common cards installed in the node. The CIC is also responsible for frame calculation, channel control and communication with ESCCs and RCCs.

Data Channel Cards

The TMS system employs a universal module design for maximum flexibility reduced on-site spares. TMS modules may be added any time without disruption to the production network. TMS data and voice cards are compatible with the OCM-2000 and MiniMux TDM systems.

Universal Data Card (UDC)

The Universal Data Channel (UDC) module can be configured for a variety of interfaces types and rates from 75 bps to 2.048 Mbps. The UDC supports synchronous, asynchronous, isochronous and transition-encoded data.

When the UDC is equipped with the Hyper Plug-In Card option, data channels operate error free in the presence of up to 32 bits of frame jitter. This feature extends the receive buffer up to 64 bits.

Time-Independent Data Channel Card (TID-III)

TID-III Data Channel Module allows true isochronous/plesiochronous data communication in a TMS system. TID-III accepts RS-422 data and clock inputs at any one of 18 standard rates from 1.0 Kbps to 1.024 Mbps. TID-III is programmed to accommodate special rates or to automatically track variable rate input clocks up to a specified maximum.

Other Supported Modules

Sync Status Modules (SSM)

SSM modules install in any channel slot to detect out-of-sync conditions at the node.

- The SSM with Channel Alarm capability can detects fault conditions at data or voice channel modules.
- The SSM with Crypto In Sync capability is for high security TDM systems using cryptographic equipment to scramble aggregate data. When this model detects out-of-sync conditions at the primary ACC link, it uses its output signal to connect a dial backup link.

Aggregate Interface Plug-ins

Aggregate Interface devices plug into the ACC/ACC-Plus modules to convert aggregate data to a wide variety of signal standards required by a particular aggregate trunk.

Legacy TMS Modules

TMSC supports legacy modules in established networks.

TMS-Plus Systems

In this document, information referring to the classic ACC, ESCC, and UVC modules also refers to their "plus" version counterparts, e.g., ACC-plus, ESCC-Plus, and UVC-Plus, except where noted. If your TMS system includes legacy modules and devices from earlier releases of the TMS system, these devices may have limited availability and/or support. For information on the availability or interoperability of legacy devices in a TMS-Plus system, contact your GDC representative.

Voice Channel Cards

Universal Voice Card (UVC)

The analog Universal Voice Card provides full-duplex voice communication functions, with options for Pulse Code Modulation (PCM) and Adaptive Differential Pulse Code Modulation (ADPCM). One of two models of the UVC connects to the backplane of the TMS-3000 Channel Expansion shelf:

- Universal Voice Card (GDC 036P265-002) provides PCM voice encoding at a data rate of 64 Kbps.
- Universal Voice Card (GDC 036P265-003) provides ADPCM voice encoding at software controlled variable data rates of 16 Kbps, 24 Kbps, or 32 Kbps with a PCM fallback mode (PCM-T) at a 64 Kbps rate.
- When equipped with the Echo Canceller Piggyback card, UVC cards at both ends of the communication link can eliminate round trip delay echo.

Universal Voice Card Plus (UVC-Plus)

The Analog Universal Voice Card Plus (036P235-013) is a single channel voice module that provides full-duplex voice communication capabilities and eliminates the requirements for external signal conversion equipment. The UVC-Plus card is capable of Pulse Code Modulation (PCM), Adaptive Differential Pulse Code Modulation (ADPCM) and Codebook Excited Linear Prediction (CELP).

The UVC-Plus utilizes an onboard microprocessor and supports E&M and 2-wire FXS/FXO on the same card, eliminating the need for external signaling and terminating equipment. Standards compliant UVC-Plus supports the following protocols:

- G.711 compliant PCM (64 Kbps)
- G.726 compliant ADPCM (16, 24, and 32 Kbps)
- G.729 compliant CELP (8 Kbps)

Voice Quality

Voice quality is highly subjective, however standardized quality testing such as DAM (Diagnostic Acceptability Measure), and MOS (Mean Opinion Score, CCITT P.80) indicates the relative quality of voice compression implementations. The TMS-3000 supports the highest quality voice compression techniques available.

The table below compares DAM and MOS voice quality scores of GDC voice compression techniques with competitive products and with standard PCM scores

GDC Compression Techniques	DAM Score	MOS Score
ADPCM 32 Kbps	69	3.8
ADPCM 24 Kbps	62.2	3.3
ADPCM 16 Kbps	53.6	2.7
CELP 9.6 Kbps	65	3.5
CELP 6.4 Kbps	61.4	3.3
CELP 4.8 Kbps	59.4	3.1
Compared with		
Competitive Product	57.6	3
Standard PCM 64Kbps	80.8	4.9

NOTE: Voice quality scores are of value only when compared to scores tested under identical conditions.

TMS-Plus Systems

If your TMSC includes legacy modules and devices from earlier releases of the TMS, e.g., Voice II, VLBRV/FAX, or CELP channel cards, these devices may have limited availability and/or support. For information on the availability or interoperability of legacy devices in a TMS-Plus system, contact your GDC representative.

Technical Specifications

Multiplexing Technique	Bit-interleaved, time division
Multiplexing Efficiency	Up to 99%, essentially unaffected by speed or mix of channels
Microcell Backplane Internal Data Throughput	Bit mode: 16.896 Mbps
Channel Capacity	Up to 58 channels of voice or data per node
Aggregate Interfaces	EIA/TIA-232-E/ITU-T V.28 ITU-T V.35 EIA RS-422 (ITU-T V.11) EIA RS-423 (ITU-T V.10) MIL-STD-188-114 T1 1.544 Mbps (non AT&T) ITU-T G.703 2.048 Mbps ITU-T G.704 2.048 Mbps
Aggregate Capacity	Up to 2 redundant aggregate trunks per node
Aggregate Rate	TMS Compact (w/classic ACC/ESCC): From 2400 bps to 2.048 Mbps TMS Compact (w/ ACC-Plus/ESCC-Plus): From 2400 bps to 4.096 Mbps. (See user manual for a listing of all standard rates.)
Operating Environment	For equipment mounted in customer-supplied cabinets: Temperature: 32 deg. F to 124 deg. F (0 deg. C to 50 deg. C), Derate operating temperature by 1 deg. C/1000 ft above sea level. 95% relative humidity non-condensing Altitude: 10,000 ft (3048 m)
Non-Operating Environment	- 4 deg. F to +186 deg. F (- 40 deg. C to + 85 deg. C) 95% relative humidity, non- condensing Altitude: 40,000 ft (12,192 m)
Standalone Shelf Dimensions	Height: 14 in. (355.6 mm) Width: 16.5 in. (419.1 mm) Depth: 16in. (406.4 mm)
Expansion Shelf Dimensions	Height: 7 in. (177.8 mm) Width: 16.5 in. (419.1 mm) Depth: 10 in. (254.0 mm)
Power Specifications	GPS-8B Universal AC Power Supplies (one or two) Input Voltage Range: 85-129 VAC; Fuses: 8 Amp 3AG Input Voltage Range: 204-264 VAC; Fuses: 5 Amp 5x20 mm Frequency 50/60 Hz Output Voltage and Current +5.1 V +3.0%, -2.5% at 8 to 105 amps
Management	GTS Network Management Software, Version 6.0 or higher

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