“All history and honest observation will show that the Red Man is a skulking coward and a windy braggart, who strikes without warning – usually from an ambush or under cover of night, and nearly always bringing a force of about five or six to one against his enemy; kills helpless women and little children, and massacres the men in their beds; and then brags about it as long as he lives, and his son and his grandson and great-grandson after him glorify it among the ‘heroic deeds of their ancestors.’ A regiment of Fenians will fill the whole world with the noise of it when they are getting ready invade Canada; but when the Red Man declares war, the first intimation his friend the white man whom he supped with at twilight has of it, is when the war-whoop rings in his ears and tomahawk sinks into his brain...”

---- Quote from The Noble Red Man, by Mark Twain. There has recently been talk of removing the words “nigger” and “Indian” from some of Mark Twain’s books in our public schools. Some have even said Mark Twain himself would have supported this overt act of censorship. Somehow I doubt it...

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Introduction
This book is intended to serve as a guide for telephone company planners and network suppliers in implementing DigiPLUS-based networks. Such networks form compatible stepping stones to the Integrated Services Digital Network (ISDN) and, beyond that, to Universal Information Services (UIS).

DigiPLUS is a flexible, cost effective network architecture that uses a family of AT&T products to support all private line digital and analog data services. This includes digital point-to-point and multipoint services at synchronous rates of 2.4, 4.8, 9.6 and 56 kb/s. It can be integrated with analog special services networks. DigiPLUS is a hubbed architecture that provides the benefits of reduced margin requirements, increased facility fills and greater flexibility to accommodate uncertainties in interoffice traffic forecasts. DigiPLUS provides for centralized control of Operations, Administration and Maintenance (OAM&M) as well as for high degrees of customer control. The latter capability opens the door to new service offerings and revenues.

The DigiPLUS architecture makes use of some familiar circuit elements such as D4/DS Channel Banks and DACS/SRDC plus some new circuit elements such as D4 Digital Data Banks, DACS Remote Units, Customer Network Controllers and improved Synchronization Distribution Expanders. All of these are compatible with both ISDN and UIS standards and will continue to perform their assigned functions as the network is gracefully expanded.

Market Perspective
According to reliable industry forecasts, the transmission of data over digital facilities is increasing at a rate of 20% to 30% per year. By 1990 it is expected to bring in three to four times as much revenue to the telephone companies as it does today with private line data network revenues forecast to approach one billion dollars annually by 1990. The data transmission market is technology driven. Business, as well as the public, perceives digital as state-of-the-art and analog as a dying technology. They equate digital with accuracy and reliability as a natural way of transmission that does not require modems to convert their binary digits to and from analog wave shapes to permit passage through the telephone network. They believe that digital provides greater through-put, faster response and more rapid service restoration. The transmission of data over analog circuits is not expected to increase significantly in the future and appears to be passing through its peak at this time. Indeed, lower cost is about the only thing that still drives this market.

Digital Data System
The reader will note from the above that the DigiPLUS-based network bears close resemblance to the Digital Data System (DDS) over which premium quality Dataphone Digital Service is provided. Like DDS, the DigiPLUS-based network is totally synchronized to AT&T’s master atomic clock in Hillsboro, Missouri and uses the same stratum of slaved clocks for local synchronization. It performs all of the functions of the highly specialized DDS equipment units but at a far lower cost.

A little background history on the DDS may be useful. Nationwide end-to-end digital transmission of binary data over 4-wire private lines was first introduced to American business at the dawn of the information age in January, 1974 when AT&T announced its Dataphone Digital Service. This was a premium offering designed to meet customer needs for very high quality data transmission and was the first in the world to offer all-digital transmission between widely separated sending and receiving computers and terminals. The DDS (DDS) over which the service is provided, is a network incorporating state-of-the-art network operation technologies, ranging from business machine interfaces to long haul facilities. Among these are the network synchronization technology, digital loop transmission techniques, central office multiplexing, T1 Carrier trunking, test access arrangements and in-service performance monitoring. Dataphone Digital Service offered full duplex, point-to-point and multipoint transmission of synchronous data at rates of 2.4, 4.8, 9.6 and 56 kb/s.
DigiPLUS OVERVIEW

The new premium service began modestly with only a few 1.544
Mb/s Data-Under-Voice circuits on TD-2 and TH-3 microwave
radio interconnecting Boston,
New York, Chicago and Washing-
ton, DC. Since then, the initial
plan to gradually expand the ser-
vice into 96 major metropolitan
areas has been fully implemented.
Today, Dataphone Digital Service
is available in over 100 American
cities, 82 Canadian cities (through
Canada's "Dataroute Interna-
tional") and in England and
Australia. The service has been
immensely successful and has
made significant inroads into the
previously exclusive use of analog
facilities for the transmission of
private line digital data. The sys-
tem is extremely accurate and reli-
able and eliminates the need for
modems and the many digital/
analog and analog/digital conver-
sions that tend to impair the data
signal.

Most data today are still trans-
mitted over the telephone network
on analog circuits but since the
advent of Dataphone Digital Ser-
cice there has been a consistent
trend toward end-to-end digital
transmission. The reasons are
many. Digital transmission has
established a proven track record
of superior accuracy, reliability
and circuit availability. It is char-
acterized by low error rate, greater
compatibility with computers and
terminals, faster response time,
easier maintenance, quicker serv-
vice restoration, freedom from digi-
tal/analog conversion impair-
ments, and compatibility with
customer network control
schemes.

There are a number of major dif-
fences between the DDS and
DigiPLUS network architectures:

- DDS relies heavily on the use of
highly specialized equipment
having little "shareability" with
other services. Its operation and
maintenance require the serv-
ces of highly trained special-
ists. The DigiPLUS-type network
uses mostly familiar and readily
available equipment such as
D4 Channel Banks whose func-
tions can be shared with other
services.

- DDS routes all circuits through
the hub office for testing and
multipoint bridging, with sub-
rate multiplexing being per-
formed only in higher traffic end
or collection offices. This reduces
the amount of expensive special-
ized equipment required. The
DigiPLUS architecture, relying
as it does on the use of famili-
are and lower cost equip-
ment, provides a cost advan-
tage over DDS that makes it eco-
nomical to establish large and
small service nodes at strategi-
cally located central offices. The
large service node carries suffi-
cient traffic to support a DACS/
SRDC for test access and multi-
point bridging. The small service
node has sufficient traffic to sup-
port Switched Access Remote
Test System (SARTS) testing
using the D4 Digital Data Bank.

- DDS requires many more equip-
ment units at the hub to perform
the test access, multipoint bridg-
ing, subrate multiplexing, per-
formance monitoring and OA&M
functions than the DigiPLUS
architecture requires for the
same functions at its service
nodes. This is largely due to the
extraordinary capabilities of the
DACS/SRDC to provide these
functions and to AT&T's new D4
Digital Data Bank (D4 DDB).
The D4 DDB can be configured
to perform the DDS Office Chan-
nel Unit function (D4 DDB OC),
the DDS Multipoint Function
Unit function (D4 DDB M3U)
or the DDS Subrate Data Mul-
tiplexer Unit function (D4 DDB
SRMX). It uses a portion of the
existing D4 Channel Bank com-
mon plug-ins plus one newly
designed plug-in for each of
these applications. The D4 DDB
can be configured in dedicated
arrangements that utilize the
total bank space or in split
bank arrangements that use one
half of the D4 Bank as a DDB
and the other half for normal
D4 applications or as a different
function D4 DDB.

- DDS, with its relatively high cost
for equipment and maintenance,
has significantly impacted on,
but not conquered, the data
market segment served by less
expensive analog networks. Digi-
PLUS, with the same ability to
support high quality data trans-
mission as DDS, can provide
Dataphone Digital Service and
similar non-DDS services at a
cost truly competitive with the
competing analog services.
Integrated Services Digital Network (ISDN)

In recognition of the need to provide efficient digital voice and data communication service to all segments of the population in the information age, the International Telecommunication Union (ITU) has recommended that its member nations establish within their borders an Integrated Services Digital Network (ISDN). The ISDN will provide end-to-end connectivity to support a wide variety of services to which users have access by a limited number of standard multipurpose customer interfaces. It is to evolve from the existing integrated digital telephone network and will have the following characteristics:

- End-to-end digital connectivity
- Integrated access to both circuit and packet switching networks
- Integrated services (i.e. voice and data) via the same interface
- Customer control of service features
- A limited set of standardized user-network interfaces
- Upward compatibility of network features

AT&T was the first entity in North America to announce support of the CCITT ISDN standards. We are actively developing the hardware and software needed by network providers to make ISDN a reality. We have already announced powerful new software features for our 5ESS™ switch that provide integrated voice and data access compatible with the ISDN standards. In addition, loop and trunk plug-ins will be made available to provide ISDN access. New SLC™ carrier plug-ins will also be compatible with the ISDN features on the 5ESS switch.

The task is not easily accomplished. The ISDN standards require the use of 64 kb/s channels with clear channel capability (64 CCC). This eliminates all restrictions on the content or format of the customer’s information signal and means that no signaling or supervisory information can be carried within the customer’s 64 kb/s CCC channel. Also, the channel must not be constrained by the “1’s” density requirement now used to ensure proper timing recovery in T1 repeaters. The former requirement can be met by using an extended framing format (Fe) that provides a 2 kb/s channel for signaling and frame identification, or by carrying the signaling and supervisory information on a separate channel. The second requirement can be accommodated by encoding techniques such as Bipolar-with-0-Zero-Substitution (B8ZS) that replace strings of consecutive zeros with fixed sets of 1s and 0s recognized by the receiver. Today’s network systems do not conform to the 64 CCC standard.

Anticipating these difficulties in implementing ISDN, AT&T began some years ago to incorporate the 64 CCC and B8ZS features as options in many of its new equipment designs. Some of these are:

- DACS/SRDC
- DDM 1000
- D5 Digital Terminal System
- BCM32000
- SLC Series 5 Carrier System

These units can be used in today’s digital networks without fear of their becoming obsolete in the future ISDN and UIS environment. AT&T is committed to total support of the ISDN and UIS concepts and intends to make all of its future network products compatible with them.
DigiPLUS OVERVIEW

DigiPLUS – The Vital Link
To meet the increasing demand for end-to-end private line digital data transmission services within a LATA while providing a compatible stepping stone to the ISDN at a cost truly competitive with equivalent analog data services, AT&T has developed an equally high quality but lower cost private line digital data network architecture called “DigiPLUS” as an alternative to the present DDS architecture. DigiPLUS includes new applications of the familiar and ubiquitous D4 Channel Bank which are made possible by the use of three new D4 plug-in units – an Office Channel Unit, Multipoint Junction Unit and a Subrate Multiplexer. When used in any of these three applications, the D4 Channel Bank becomes a D4 Digital Data Bank (D4 DDB) whose high speed output is one or more DS0 signals. Together, these three configurations of the D4 DDB are capable of carrying out all of the central office functions now performed by the following DDS equipment units:
- BCPA (Bay Clock, Power and Alarm circuit)
- OCU (Office Channel Unit)
- ISMX (Integrated Subrate Multiplexer)
- SRDM (Subrate Data Multiplexer)
- TIDM (T1 Data Multiplexer)
- TIWB5 (T1 Wideband Data/Voice Multiplexer)
- SRDPM (Subrate Data Multiplexer Performance Monitor)
- TIDM-PM (T1 Data Multiplexer Performance Monitor)
- MJU (Multipoint Junction Unit)
- 5V-PSS (5V Power Supply)
- OCU PWR (OCU Power Supply)
plus 65 DDS PLUG-IN CODES.

DigiPLUS Enhancements
At the outset, it was realized that the significant economic benefits provided by the DigiPLUS architecture could be vastly enhanced by operating the new network in conjunction with one or more DACS hubbing centers equipped with the optional Subrate Data Cross-connect capability (SRDC) and with smaller centers equipped with DACS Remote Units (DRUs). The synergy between the D4 Digital Data Bank and DACS/SRDC provides a uniquely cost effective network architecture that:
- Supports all digital data services
- Provides point-to-point and multipoint circuits
- Includes hubbing offices that reduce interoffice data transport costs and enhance network flexibility
- Can be integrated with analog special service networks
- Provides many opportunities for new services and revenues through customer control, secondary channel and other features.

As you read through this book, you will see that DigiPLUS is fully compatible with the developing Integrated Services Digital Network and with the future Universal Information Services. It will meet the needs of your data customers and generate new and increasing revenues for your company for years to come.
# DATAPORTS

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DATAPORTS

Background
Dataports are D3 and D4 Channel Bank plug-in channel units introduced by AT&T in the late seventies as a means of providing economical access to the Digital Data System for telephone company customers located in low traffic end-office areas. By using existing channel banks and T1 carrier lines, Dataports offer short interval procurement and fast turn-up of service with a small investment. Initially they were available in separate versions for each DDS speed, four OCU DP s for interfacing with the customer’s loop at the end office and two DS0 DP s for use in the hub or intermediate offices. In the latest versions, all four DDS speeds are switch-selectable in a single all-rate OCU DP and a single all-rate DS0 DP. Both are low power types with selectable error correction for each speed. They are shown in Figure 1.

Figure 1
In the DDS end-office, the OCU DP performs the byte-stuffing and control functions otherwise performed by the DDS Office Channel Unit. The D4 Bank maps the internal DS0 signal from the Dataport directly into the outgoing D1 bit stream and transmits it to the hub office. The T1 Data or T1 Data/Voice Multiplexer (T1DM or TIWBS) used in the larger DDS end-offices is not used. As a result, the Dataport end-office requires no investment in these units. In the hub office, the DS0 Dataport recovers the DS0 signal from the incoming T1 or T1C, T1D, lightwave bit stream and inserts the customer’s return DS0 into the return bit stream. A SLC 96 Carrier-compatible all-rate OCU Dataport is also available. In the D4 DDB, the OCU DP function is performed by an “OCU” plug-in that looks like a D4 OCU DP but does not say DP on its faceplate. It is an “HA” unit that contains most, but not all, of the circuits of an OCU DP. The use of D4 Dataports and D4 DDB OCUs is fundamental to the Digiplus architecture.

Features and Benefits
AT&T Bell Laboratories has maintained an ongoing program of Dataport improvement and innovation. The new all-rate D4 units include features not available on earlier versions and provide greater economic benefits:
- Short interval procurement
- and plug-in convenience assure quick turn-up of service
- The all-rate OCU DP with switch-selectable 2.4, 4.8, 9.6 or 56 kb/s speed and the all-rate DS0 DP simplify bank administration efforts and lower costs
- Greatly reduces sparring requirements and lowers investment costs
- Reduces craft training costs
- Reduces circuit set-up time
- Error correction for each DDS rate maintains an effective Bit Error Rate of 10^-8 even when the digital line degrades to 10^-9. This simplifies administration and increases flexibility.
- End-to-end compatibility with D3 and D5 Channel Bank Dataports allows economical use in existing plant
- Low power consumption
- Modular circuit-at-a-time growth capability keeps investment at a minimum
- CMOS technology provides highest-quality, maintenance-free reliability
- All-rate units include all current Dataport features
- New latching loopback feature is compatible with SARTS, DIGITEST, ABATS, KS test sets and provides improved maintenance capability
- Unique secondary channel feature provides new revenue opportunities through enhanced customer network control and diagnostic capabilities

Figure 1 – D4 All-rate Dataports.
New 325A Power Converter Unit provides increased power at no increase in cost. Accommodates up to 48 low power or all-rate Dataports per D4 Channel Bank or D4 DDB. Allows more efficient use of D4 bays and improved administration.

- Competitively priced
- An increased design range of 34dB is possible on 56 kb/s circuits using the new all-rate Dataports.

**Applications**

As mentioned above, the Dataport capacity of new and existing D4 Channel Banks has been significantly increased through the use of a new Power Converter Unit which is a direct replacement for the earlier unit. It allows unrestricted use of up to 48 low power Dataports in either the D4 Channel Bank or D4 Digital Data Bank. Figure 2 illustrates typical applications of D4 Dataports and D4 DDB SRMxs in the DigiPLUS network architecture. Here a small service node has been established by using a D4 DDB whose DS0 outputs are accessible for testing by the Switched Access Remote Test System (SARTS) through Remote Test System 5A, or with the local use of KS test sets. In the large service node, test access is provided through the SRDC. In DDS networks, all of the circuits would have had to be routed to the hub office in order to gain test access to the customer’s DS0A signals. This can result in miles of unnecessary transmission, particularly for intra-office circuits.

Where economically justified, the small and large service nodes can also provide Multipoint Junction Unit and Subrate Multiplexing functions through D4 DDBs. In addition, the large service node can provide customer control through a Customer Network Controller on its DACS/SRDC.

Note that while the D4 Channel Bank can be used alone in any office because its high speed digital output allows it to interface directly with T1, T1C, T2 or lightweight lines, the D4 DDB’s DS0 outputs require that it be used in conjunction with DS0 Dataports in a D4 Channel Bank where its signals must be transmitted to/from another office. There are two ways of accomplishing this. The D4 DDB may be used in a fully dedicated arrangement with up to 48 OCUs (or in dedicated MJU or Subrate Multiplexer arrangements to be described later) with its DS0 signals outputted to a separate D4 Channel Bank. A second method is to configure the D4 in a split-bank arrangement in which one half of the bank is dedicated to the DDB function while the other half is used as a standard D4 Channel Bank digroup for transmitting voice, voiceband data and other special services. In the split bank arrangements, all of the standard D4 common units needed for interfacing with the high frequency digital line, such as the Transmit, Receive and Line Interface Units, are retained.

In the end-office shown in Figure 2, a customer is being served by an OCU DP in a D4 Channel Bank. In the small service node office, there are sufficient circuits to justify use of a dedicated D4 DDB for subrate multiplexing. It shares the use of an external D4 Channel Bank. The large service node is equipped with a DACS/SRDC that provides test access and electronically cross-connects DS0 channels to the desired T-Carrier lines. It uses a D4 DDB SRMX to efficiently load locally terminated circuits onto the SRDC. In the SLC 96 Carrier application, the customer loop is terminated in an OCU DP at the Remote Terminal while a DS0 DP is used in a D4 Channel Bank at the central office to recover the DS0 signal and transmit it to the large service node for testing.
NETWORK SYNCHRONIZATION

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Synchronization Distribution Expander (SDE) .................................. 13
A Requirement for Accuracy

Digital pulses do not propagate with the same velocity in all transmission media. T-Carrier cables, coaxial cable and lightguide fibers have different propagation velocities and these can vary between the temperature extremes of winter and summer. Microwave radio propagates at yet a different rate. The result is to slow down or speed up the rate of arrival of data pulses causing pileups or slippages at various receiving points along the transmission path. By far the best way of averaging out the overall rate of data flow is to precisely synchronize the entire transmission network to a highly accurate master clock, provide adequate buffering at each receiving terminal, and accept only customer data signals which have been synchronized to the same clock. This allows all DDS data signals to be written in at the sending ends at the same average rate that they are read out at the receiving ends. Total synchronization of the network and customer signals is a cornerstone of the Digital Data System and of the DigiPLUS network architecture.

In the Digital Data System, precision network timing is derived from AT&T's atomic reference clock located in Hillsboro, Missouri. It provides the AT&T Basic Synchronization Reference Frequency which is used to synchronize a DDS master timing supply located in a hub office in nearby St. Louis. The master clock in turn synchronizes all of the DDS equipment and DDS transmission facilities terminating in that office. The timing information is then carried within the synchronized bit streams of outgoing T-Carrier, coaxial cable, lightwave and microwave facilities to downstream offices which successively retransmit it until the farthest end offices are reached.

The timing network is an open tree-like affair with no closed loops. Each receiving office recovers the embedded timing signal from the DDS-timed bit stream and uses it to synchronize its own nodal, secondary or local DDS timing supply. The timing signal is usually delivered to end offices over a T1 carrier line selected for its freedom from impulse noise and similar impairments. Many offices use the AT&T Synchronization Distribution Expander (SDE) unit to distribute the timing signal down to the T4 Bay and Bank levels. Figure 3 illustrates the basic DDS timing network.

New Synchronization Distribution Expander with Enhanced Features

Because of the critical importance of timing to the performance and reliability of the Digital Data System, AT&T has developed an enhanced Synchronization Distribution Expander unit containing many new features in addition to those included in the current unit. This enhanced SDE provides a highly accurate, reliable and economical timing source with expanded capacity to accommodate D4 Digital Data Banks, D4 Channel Banks with Dataports, DACS/SRDC and other digital equipment in an office. The basic SDE unit is modular with 10 output timing signals. It can be expanded by 10 additional outputs at a time (to a maximum of 40 outputs) to provide for orderly, flexible growth. As shown in Figure 4, the SDE is small in size and can be miscellaneousely mounted close to the timed equipment to reduce cabling requirements (300 ft. maximum) and installation costs.

The enhanced SDE includes several new and important features specifically designed to guard against loss of the DDS timing signal:

1. Automatic 1:1 T1 Protection Switching circuitry detects loss of signal on the working T1 line carrying the embedded DDS timing and automatically switches to the alternate T1 DDS timing line to prevent loss of timing, or faulty timing, from affecting the office's DDS timing supply.

---

**Figure 3** – Stratum Levels
NETWORK SYNCHRONIZATION

- Switch selection of either standard D4 or clear channel Fe frame format and detection of out-of-frame condition for selected format. Out-of-frame condition forces a switch to the alternate T1 line.

- Improved free-running capability allows the SDE to act as a near Stratum 3 timing source in a part of the network which has lost its normal DDS timing. If, for example, both SDE DDS DS1 input timing signals are lost, a memory circuit in the SDE will immediately initiate a switch to the hold-over mode. This mode allows the SDE to "store" the timing information extracted from the last good DS1 input and allows the SDE to continue supplying its output composite clock.

The SDE also has an option for composite clock input. If both clock inputs fail, the SDE has the capability to switch to a free run mode of operation to continue supplying its output composite clock. The free run option can also be used in a stand-alone network. This application allows the SDE to be used as a master timing supply in a local data network. These added features make the Synchronization Distribution Expander even more flexible and valuable in the DDS office. They increase the already high reliability of Dataphone Digital Service that your customers have come to expect.
D4 DIGITAL DATA BANK (D4 DDB)

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### Limitations of DDS

Early in the implementation phase of the Digital Data System, telephone companies established geographical Digital Serving Areas (DSAs) designed to provide service to a maximum number of business customers in the major metropolitan areas using the existing loop plant. The lower subrates such as 2.4 kb/s could be transmitted farthest, but long 56 kb/s loops often required 56 kb/s repeaters. Off-net service to customers beyond the DSA was offered using L- or N-Carrier group band facilities between the customer's location and the off-net end office. End-office traffic was traditionally sent to a hub office where the DS0A circuits could be accessed for testing and multipoint bridging. Many of the hubs were outgrowths of the earlier Serving Test Centers. In some cases, DDS Traffic was gathered at a collection office where sub-rate multiplexing provided for more efficient transmission to and from the hub. This traditional DDS serving arrangement is illustrated in Figure 5.

Admittedly, there were a number of shortcomings in the DSA scheme of providing Dataphone Digital Service. Because the DSAs rarely encompassed all the area within a LATA, service was often unavailable to smaller businesses outside the DSA which could not afford the off-net service. Even when demand developed in such areas, response to it was often slow because of the high startup costs involved in equipping new end-offices with the specialized DDS equipment required. This equipment required an investment fully dedicated to the provision of Dataphone Digital Service since it did not possess the type of flexibility needed to share its use with other services. Another shortcoming was the necessity to route all customer signals through a hub office in order to gain test and bridging access even when both ends of the circuit terminated in the same end-office. Frequently, this resulted in increasing circuit lengths and significantly driving up the tariffed costs to the end user. Many of these initial shortcomings, however, were greatly lessened with the introduction of D3 and D4 Dataports at the end of the last decade.

As pointed out earlier, Dataports are channel unit plug-ins for D3 and D4 Channel Banks that permit the use of existing channel banks and T-Carrier lines to provide rapid and economical access to the DDS system in almost any central office. A typical application of D4 Dataports in today's DDS is illustrated in Figure 6. In City B, the customer's 2.4 kb/s data signal is transmitted over the local loop at the Dataphone...
Digital Service rate and is terminated in a D4 OCU DP at the serving central office. The high speed output from the D4 Bank is routed over a single facility channel to a hub office where testing, performance monitoring, and any required multipoint bridging and cross-connecting is done for the digital circuits having end points within its serving area. At the hub, the Automated Bit Access Test System (ABATS) provides reduced test time and allows rapid detection and verification of circuit problems. Also at the hub, a Multipoint Junction Unit (MJU) is used to branch the control station’s signal into two identical outputs. These are transmitted over two facility channels to City A where each branch is sent over a different local loop to serve two company locations.

**D4 Digital Data Bank Concept**

The concept of the D4 Digital Data Bank (D4 DDB) was carefully developed to overcome the shortcomings of both the existing DDS network architecture with its limited Digital Serving Areas and the Dataport network architecture with its lack of end-office test capability and inefficient use of DS0 channels. The extent to which we were successful is indicated in Figure 7 which shows the DDS equipment units that can be displaced by the use of D4 Channel Banks, D4 Dataports, and only three new types of D4 DDS plug-in units. Not only can the various configurations of the D4 DDB duplicate all of the functions performed by the DDS units, but can do it at a fraction of the cost using existing D4 Channel Banks. The extended frame (Fe) format and secondary channel feature are standard and can be switched in or out as required.

Figure 7—The D4 Digital Data Bank Concept

Figure 8 shows how D4 Digital Data Banks can be used to provide the same service as shown in Figure 6 but without the need for routing via a hub office. In Figure 8, the former hub office functions are performed in the City A end-office. There, a D4 DDS Substrate Multiplexer (SRMX) can combine up to 20 separate 2.4 kb/s data signals into a single DS0 channel for efficient transmission, and a D4 DDS Multipoint Junction Unit performs the multipoint branching function for the two business locations in City A. Only a single facility channel is needed to carry this traffic between City A and City B. Compare this to the two facility channels required with DDS as shown in Figure 6.

In City A, the Switched Access Remote Test System (SARGT) provides test access to the T & R and T1. R1 leads via stand-alone SMAS Connectors or those in Unitized D4 Bays. Used in conjunction with RTS-5A (Remote Test System), error rates, loopback and all standard DDS tests can be performed at the City A office. DDS timing can be provided by a DDS clock in either office, or the D4s can be loop-timed from other...
D4 DIGITAL DATA BANK (D4 DDB)

offices. Thus, all of the DDS functions formerly performed at the hub office are now available at the end-office level through the use of D4 Digital Data Banks. As a result, the circuit length is significantly reduced and fewer facility channels are required.

Advantages of the D4 DDB
- Extremely cost-effective, especially for small applications
- Provides low risk, low investment way to serve new customers
- Improves network efficiency through multiplexing of substrate signals into a single DS0 channel
- Easy to share with other regular D4 voice, voiceband data, program etc., special services
- As easy to install and maintain as D4 Channel Banks
- D4 is very familiar to craft throughout the country

D4 DDB Dedicated and Split-Bank Arrangements

The D4 DDB utilizes existing D4 shelves and standard common equipment plug-ins without modification. D4 DDB also makes use of standard low power or all-rate D4 Dataports as well as three new D4 DDB plug-ins that condition the bank to perform its three DDS functions:
- Office Channel Unit
- Multipoint Junction Unit
- Substrate Multiplexer

Office Channel Unit
D4 DDB OCU

Figure 9 is a simplified block diagram of the D4 DDB in its Office Channel Unit version. It depicts only one of a possible 48 DDB OCUs that can be accommodated in a complete D4 frame, or 24 in the split bank arrangement discussed below. Note that there is no DS1 signal in the D4 DDB OCU, only the customer's 4-wire loop signals and the byte-stuffed DS0A signals. Together, these essentially constitute an 8-wire interface with the loop providing access to the T, R, T1 and R1 transmission leads and the DS0A signals appearing on the E&M leads. The loop leads can provide metallic access to check for foreign voltages while the E&M leads can be used for loopback tests through SMAS connectors. In Unitized D4 Bays, the built-in SMAS accesses only the transmission leads so that access to the E&M leads must be provided externally.

The dedicated OCU arrangement of the D4 DDB is shown in Figure 10. Blacked out areas indicate common equipment plug-ins which are not used in the dedicated configuration. Up to 40 OCUs can be accommodated in
the arrangement using the (up to now) standard D4 Power Converter Unit but up to 48 can be used with the new standard 325A Power Unit. The dedicated arrangement must be used with a separate D4 Bank which provides the plug-ins needed to generate the high frequency digital line signal (T1, TIC, T2, lightweight FT2) and interface it to the line.

The Split Bank Arrangement of the D4 DDB OCU is shown in Figure 11. This arrangement dedicates the 24 channels of the A side in the bottom two shelves to the DDB OCU function and the 24 channels of the B side in the top two shelves to normal D4 Channel Bank services. The split bank arrangement lends itself ideally to shared DDS and other D4 applications because it includes all of the plug-ins needed to interface the D4 Digital Data Bank to the carrier line through the channel bank portion.

Alternatively, the upper half of the bank can also be used for a second DDB function such as MJU or SRMX but this again requires connection to an external D4 Bank to provide the interface with the carrier line.

Figure 12 is a photograph of the D4 DDB Office Channel Unit. Although it looks much like a D4 OCU D6 note that the DDB OCU does not include the letters DP on its faceplate. It is electrically different and not interchangeable with the D4 OCU Dataport.

A standard 11/6" bay equipped with six D4 Banks in a fully dedicated DDB OCU arrangement accommodates 288 all-rate OCUs while a similar bay accommodates 80 DDS HL220 OCUs. A price comparison based on material price differences is shown in Figure 13. It graphically illustrates
the substantial cost advantage of the D4 Digital Data Bank in providing the Office Channel Unit function. The low price per channel for the D4 DDB OCU reduces your risk if the anticipated demand does not materialize. Material savings alone are large enough to warrant consideration of providing the test access feature in DDS end-offices where it was previously considered uneconomical.

**Multipoint Junction Unit**

**D4 DDB MJU**

Multipoint service provides two-way data transmission of any subrate signal between a control station and two or more remote terminals operating at the same DDS rate. The Control Station—usually a computer—addresses one or more of the remote stations, transmits information to them and may direct them to send back information one at a time. A Multipoint Junction Unit (MJU) with a single 2-way port on its control side accepts the Control Station's DS0A data signal, regenerates and retimes it, and then branches it into 2 to 4 identical outputs for transmission over different routes. If more than four branches are required, any output can be used as an input to another MJU in the same office or in a distant office to derive additional branches. In the reverse direction, one Remote Station at a time is permitted to transmit data back while the other Remote Stations transmit either an idle code or "all-1's" signal. The MJU regenerates and retransmits only the input containing data.

Figure 14 shows a simplified block diagram of the D4 DDB Multipoint Junction Unit. It includes a Quad Multipoint Junction Unit (QMJu) that provides digital processing for up to four MJUs independently, each operating at any selected subrate and each providing up to four branches. The QMJu is compatible with existing DDS multipoint circuits and automated test systems.

It is also compatible with the secondary channel feature and provides branch blocking and MJU loopback. The MJUs can be tested locally using DDS portable test sets. Note that the D4 DDB MJU can simultaneously provide both loop and DS0A interfaces. It can therefore perform multipoint branching right at the central office serving the branch locations. Multiple facility channels are not needed to carry the branched signals to and from a hub office as is done for DDS signals.

In Figure 14, one D4 Dataport provides the interface between the control station signal and the MJU and up to four others provide the interfaces for the individual branches. The Dataport will be a D4 OCU DP type if it interfaces with a 4-wire loop. It will be a D4 DS0 DP type if it connects to other DDS equipment or provides DS0A test access via SMAS connectors. The D4 DDB MJU allows multipoint branching to be performed at the most economically advantageous points in the customer's network to minimize transmission costs.

A photograph of the Quad Multipoint Junction Unit is shown in Figure 15.

As with the D4 DDB OCU, the D4 DDB MJU can also be configured in fully dedicated or split bank arrangements. The dedicated arrangement is shown in Figure 16. The D4 frame is divided into two halves, each containing a D4 DDB QMJu plug-in that can provide up to 4 control legs (i.e., 4 MJUs) and 16 branches. The entire D4 DDB MJU therefore provides a maximum capacity of 8 control legs and 32 branches.

In the split bank arrangement shown in Figure 17, either the upper or lower two shelves can be equipped with a D4 QMJu to pro-
vide four MJUs. The other two shelves are used as a one-digroup D4 Channel Bank terminating a digital facility. The wide availability of D4 shelves in practically all telephone companies makes the split bank arrangement of MJUs especially attractive because it provides almost unlimited capability to branch your customer’s signal at the point in his network that is most economically favorable. This helps your telephone company sell multipoint Dataphone Digital Service.

A comparison of material prices for a traditional DDS MJU bay and the new D4 DDB MJU bay is shown in the graph of Figure 18.
**D4 DIGITAL DATA BANK (D4 DDB)**

The high startup cost of the traditional MJU as opposed to the new is easily seen at the left of the graph. This area also shows the economic advantage of the D4 DDB MJU when the number of branches required is relatively small. When the flexibility to locate the D4 DDB MJU at the most advantageous point is taken into account, its benefits are even more apparent.

**Substrate Multiplexer**

D4 DDB SRMX

The third new function that can be performed by the D4 Digital Data Bank is substrate multiplexing. In the present Digital Data System, this function is provided by the Substrate Data Multiplexer (SRDM) in hub and large end offices and by the Integrated Substrate Multiplexer (ISMX) in smaller local offices. The 2.4 kb/s SRDM multiplexes up to twenty 2.4 kb/s DS0A signals into a fully packed DS0B channel; the 4.8 kb/s SRDM multiplexes any mix of up to ten 2.4 and 4.8 kb/s channels; the 9.6 kb/s SRDM multiplexes any mix of five substrate channels. The less expensive 5-channel ISMX multiplexes five DS0A signals of any one substrate into one DS0B channel; the 10-channel ISMX multiplexes ten 2.4 kb/s signals, or ten 4.8 signals, or five of each, into one DS0B channel. This packing of 64 kb/s DS0B channels with as many substrate signals as it can fit in provides greatly increased transmission efficiency. A single T1 Carri er line, for example, can carry as many as 460 2.4 kb/s data signals compared to the 24 that Dataports permit.

A simplified block diagram of the D4 DDB SRMX is shown in Figure 19. It illustrates only one of several flexible subrate multiplexing capabilities the SRMX can provide. The substrate channel signals to the five D4 Dataports shown at the left side of the diagram come either from customer loops into OCU DPs, or as DS0A signals from other equipment (such as DDS SRDMs) into DS0 DPs. Thus, both loop and DS0A interfaces can be provided simultaneously within the same multiplexer. The multiplexed output from the Substrate Multiplexer Unit is a single DS0B channel. Of course, all of these circuits are 2-way with both multiplexing and demultiplexing functions proceeding simultaneously.
The D4 DDB SRMU performs all of the multiplexing and alarm control functions for one half of the D4 Bank. The channels associated with an SRMU can be arranged in the following combinations:

- Four 5-channel mixes of 2.4, 4.8 and 9.6 kb/s signals
- or Two 10-channel mixes of 2.4 and 4.8 kb/s signals
- or Two 5-channel mixes of 2.4, 4.8, 9.6 kb/s signals plus one 10-channel mix of 2.4 and 4.8 kb/s signals
- or One 20-channel fill of 2.4 kb/s signals

It should be noted from the last item above that the D4 DDB SRMX offers a 20-channel ISMX capability which is not available with 5 and 10-channel DDS ISMX's.

The physical makeup of the D4 DDB SRMX corresponding to Figure 19 is shown in Figure 20. The SRMX can be partially equipped to provide, for example, only one of the two 5-channel mixes depicted in Figure 21. Besides providing a flexible substrate multiplexing capability equivalent to that of any DDS SRDM or ISMX, the SRMU is fully compatible with:

- Secondary channel feature
- Existing DDS substrate multiplexes and test systems

As with both the D4 DDM OCU and MJU, the D4 DDB SRMX can be configured in either a fully dedicated arrangement using two SRMUs, or in a split bank arrangement using only a single SRMU. With the latter arrangement, the second half of the D4 Bank can be used as a D4 DDB OCU, a D4 DDB MJU, or a standard D4 Channel Bank digroup. The only new plug-ins required are the two SRMUs as illustrated in Figure 21.

A photograph of the D4 DDB SRMU is shown in Figure 22. Note how easy it is to establish the desired multiplexing combinations by means of SW1 and SW2.
**D4 DIGITAL DATA BANK (D4 DDB)**

**Figure 22 – Subrate Multiplexer Unit**

SW1 sets the combinations for the upper shelf except that when it is set for 20 24-kb/s channels, it applies to the lower shelf as well. SW2 is used to select the combinations for the lower shelf.

To determine the economic advantage of the D4 DDB SRMX based on the lower cost of equipment price alone, the graphs of Figure 23 and 24 were plotted. Figure 23 compares the material costs of a standard local office DDS ISMX bay for a given number of DDSA channels vs. a functionally equivalent DDB ISMX bay configuration. Figure 24 makes a similar comparison of a DDS SRDM bay vs. the equivalent DDB SRMX bay. In both cases, the very pronounced economic advantages of the D4 Digital Data Bank are obvious, particularly at those offices having low subrate traffic.

Figure 23 shows that for the ISMX function, the D4 DDB SRMX saves over 50% in material costs even with the 80-subrate channels of a full DDS ISMX bay. The much lower start-up cost with the D4 DDB ISMX is evident at the left.

The comparison of the DDS SRDM bay prices with the D4 DDB SRMX in Figure 24 shows that the SRMX saves approximately 75% of material costs at 30 subrate channels and approximately 25% at 300 channels. When you also consider the transmission savings provided by multiplexing many subrate signals into each DS0 channel of the T Carrier line at the originating end-office instead of at the hub, the overall benefits of the D4 DDB SRMX are even more impressive.

**Figure 23 – D4 Digital Data Bank ISMX vs DDS ISMX - Material Price Comparison**

**Figure 24 – D4 Digital Data Bank vs DDS SRDM Bay (DS0A to DS0B Multiplex) - Material Price Comparison**
Reliability of the D4 DDB

The Digital Data System was designed to be the most reliable data network ever built because reliability was the very foundation of the premium Dataphone Digital Service carried over its lines. Every piece of DDS equipment was designed to the most rigid reliability standard to ensure that the service could meet its circuit availability objective of at least 99.90% station-to-station.

The D4 Digital Data Bank carries on this tradition of reliability. With the widespread use of Dataports, the D4 Channel Bank has been part of the DDS network and has established an enviable record of reliability in its own right. The three new D4 DDB plug-in units are designed to the same rigid standards. The DDB OCU, for example, has a predicted Mean Time Between Failure of 43 years and an average annual downtime of only 21 minutes. The D4 Digital Data Bank is fully compatible with the reliability objectives of the Digital Data System.

D4 DDB Reliability Considerations

- Based on the proven ten-year record of unsurpassed reliability of the D4 Channel Bank
- Short restoral time because technicians are already highly familiar with the D4 Bank and spare plug-ins are easily available
- Low relative cost of the D4 DDB and the simplified DigiPLUS network architecture lead to a large reduction in equipment and associated plug-in units in the transmission path. As a result, there is a concomitant decrease in the probability of circuit failure.
DIGITAL ACCESS AND CROSS-CONNECT SYSTEMS (DACS), DACS WITH SUBRATE DATA CROSS-CONNECT (DACS/SRDC)

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DACS
The microprocessor-controlled Digital Access and Cross-connect System (DACS) was introduced in 1981 to provide a means of electronically crossconnecting individual 64 kbps DS0 channels embedded in T1 Carrier bit streams and to provide test access to those channels. This allows DACS to collect channels having a common destination from different bit streams, assign them to the desired outgoing bit streams, and electronically cross-connect them. This eliminates the need to demultiplex the T1 bit streams and bring their individual DS0 signals to rows of jack fields for manual cross-connecting and testing via patch cords. On command from a local or remote TTY terminal, DACS can electronically cross-connect any DS0 channel, or multiples of up to 24 of them, to any other facility terminating on it. It can provision and rearrange circuits the same way. This makes it possible for telephone companies to quickly reassign circuits so as to maintain high fills of their T1 lines for maximum utilization and efficiency. It also makes it possible for telephone companies to offer their customers real control of their own network through a Telco-owned Customer Network Controller. This microcomputer-controlled device provides a software interface that allows Telco customers to access and control the DACS cross-connections of their own networks.

Another feature of DACS is that it can be equipped with a Digital Multipoint Bridge that permits voice conference circuits and broadcast-type voiceband data networks to be electronically programmed and established on command. An economical DACS Remote Unit (DRU) that brings the advantages and benefits of electronic DS0 cross-connecting to small offices is also available from AT&T Network Systems. The DRU is described in a later section.

DACS/SRDC
To extend the benefits of electronic cross-connecting to subrate data channels of 2.4, 4.8 and 9.6 kh/s, a Subrate Data Cross-connect capability (SRDC) can now be ordered with new DACS frames or retrofitted into existing DACS machines equipped with A2-type frames. These subrate are those of the Digital Data System, but the SRDC accommodates non-DDS data signals at these rates as well. For Dataphone Digital Service, DACS/SRDC replaces a large amount of DDS equipment otherwise required in hub offices and provides opportunities for greater revenues through new digital data service offerings. It offers point-to-point and multipoint services. DACS/SRDC is also fully compatible with the secondary channel feature that gives your customers an auxiliary data channel for control or communications applications. In addition, future enhancements to the Customer Network Controller will permit...
DIGITAL ACCESS AND CROSS-CONNECT SYSTEMS (DACS), DACS WITH SUBRATE DATA CROSS-CONNECT (DACS/SRDC)

customers control of their own subrate digital facilities terminating on the DACS/SRDC.

The DACS frame layout and functional block design are shown in Figure 25. It is a double bay arrangement 6'6" wide by 7'0" high and containing a Controller and four Units. Each Unit contains 4 Dual Multiplexers and up to 32 Digroup Circuit Packs providing a total frame capacity of 128 Digroups. One Digroup is dedicated to test access, leaving 127 to perform electronic cross-connections. This allows a total of 1524 cross-connections to be made between 3048 DS0 channels.

The Hub in Today's DDS

The DDS hub office plays a vital role in helping to hold down the costs of Dataphone Digital Service. Hubbing allows efficient utilization of interoffice T Carrier lines and avoids the need for duplicating DDS equipment in many offices. It allows the readjustment of interoffice channel capacities to meet shifting demands more rapidly and economically than constructing new facilities.

The primary functions of the DDS hub office are:
- Multiplexing DS0 channels to/from DS1 or T1 lines and subrate multiplexing of DS0A channels to/from the DS0B level
- Cross-connecting DS0 channels and cross-connecting DS1 lines
- Providing multipoint service through Multipoint Junction Units
- Provide Dataport terminations for T Carrier lines containing Dataport channels
- Performance monitoring of facilities
- Testing

The arrangement of the equipment used to perform the above functions in the traditional DDS hub office is illustrated in Figure 26.

The Hub with DACS/SRDC

DACS/SRDC is designed to perform all of the hub office functions listed above. To show how DACS/SRDC can replace the many DDS units used in the traditional hub office, Figure 26 has been redrawn (Figure 27) to show the startling differences. All of the DDS equipment units and crossconnect bays shown within the shaded area of Figure 26 have been replaced by DACS/SRDC. Compare the two figures. The reduced amount of equipment with DACS/SRDC equates to higher reliability and lower costs.

The DACS/SRDC hub arrangement shown supports point-to-point, multipoint and data transport services for DDS, Digitnet and others at subrates of 2.4, 4.8, 9.6 kb/s and 56 kb/s. It provides error correction for Dataport circuits and is compatible with the secondary channel feature.

Outside the shaded area, the use of D4 DDB SRMXs to terminate
local loops and the use of D4 or D5 Channel Banks to provide multiplexing to the DS1 level is far simpler and more economical than installing specialized DDS equipment such as Office Channel Unit bays, Subrate Multiplexers, T1 Data Multiplexers, Digital Transmission Surveillance System for performance monitoring, and Digital System Access Units for test access. In addition, the D4 DDB can be shared by digitized analog signals such as voice and voiceband data. The widespread use of VLSI circuitry in the DACS/SRDC ensures very high reliability and superior performance.

**DACS/SRDC Deployment Strategy**

An economic study of the savings provided by the use of DACS/SRDC vs. the use of traditional DDS equipment for different numbers of stations was made to determine the approximate point at which the DACS/SRDC proves in. The results are given in the graph of Figure 28.

Figure 28 shows that DACS/SRDC begins to pay for itself when the number of DDS station signals (i.e., computer or terminal) terminated on it exceeds approximately 300. At that point, the savings generated by use of the DACS/SRDC goes up very rapidly as the number of stations increases. The graph begins to level off to a peak savings of 50% when the number of stations approaches about 1000. Since virtually all DDS hubs terminate in excess of 300 circuits, DACS/SRDC can provide substantial savings to telephone companies when used to replace the DDS equipment in traditional hubs or used as original equipment in new DigiPLUS service nodes. Existing DACS machines with A2-type framework can be retrofitted with the Subrate

**Data Cross-connect capability.**

The use of DACS/SRDC to electronically groom circuits prior to cutover of digital switching machines is another money saving application.

The recommended DACS/SRDC deployment strategy is summarized below:

- Use in existing hubs
- Adjacent new hubs
- Modernization cutover grooming

**Description of DACS/SRDC**

Figure 25 shows that all of the space in the DACS frame is used to provide terminations for 128 DS1 digroups. To provide space for the Subrate Data Cross-connect capability, it is necessary to replace either one or two of the DACS.
**DIGITAL ACCESS AND CROSS-CONNECT SYSTEMS (DACS), DACS WITH SUBRATE DATA CROSS-CONNECT (DACS/SRDC)**

"Units" with SRDC "Units" depending on the number of subrate cross-connections required. For each DACS "Unit" replaced by an SRDC "Unit," the 128 digroup capacity of the DACS is diminished by 32 DS1s. Each SRDC Unit can cross-connect 768 (i.e. 32 x 24) DS0 channels containing subrate data.

The remaining DACS capacity can be shared between digital and "analog" cross-connects. Figure 29 illustrates the functional split in the DACS when the SRDC capability is added.

The DACS and SRDC sections each have their own Microprocessor Systems (MS). However, note that the interface for all Operations Systems (OS) and for the local terminal is provided by the DACS MS allowing an integrated OS network supporting both analog and digital services.

The DACS/SRDC frame layout used for shared analog and digital services is illustrated in Figure 30. Only DACS Unit 4 has been replaced by an SRDC unit. This arrangement provides terminations for 96 DS1s with 1152 (i.e. 96 x 24 - 2) cross-connections between its 2304 DS0 channels. Of these 2304 DS0 channels, the SRDC further demultiplexes 768 of them (i.e. 32 x 24) to the DS0A level where it can cross-connect a maximum of 7680 (i.e. 768 x 20) max = 2 for 2.4 kb/s rates where 20 customer signals can be multiplexed into 1 DS0 channel) of them before they are returned to the DS0 channels in the DACS section.

When maximum subrate capacity is required, two DACS "Units" (Nos. 3 and 4) are replaced by SRDC "Units." The frame layout is then as shown in Figure 31. This arrangement provides terminations for 64 DS1s with 1536 DS0

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**Figure 30 – DACS/SRDC Frame Layout - Shared Analog and Data Services**

**Figure 31 – DACS/SRDC Frame Layout Maximum Subrate Capacity**
channels and 768 cross-connects. With the maximum substrate capacity arrangement, all 1536 DS0 channels can be cross-connected at the DS8A level in the SRDC section up to a maximum of 15,360 (i.e. 1536 x 20 max.) for 2.4 kb/s rates where 20 customer signals can be multiplexed into 1 DS8 channel cross-connects.

An example of how a single 9.6 kb/s signal is cross-connected within the DACS/SRDC is shown in Figure 32.

Here a 9.6 kb/s DS8A signal in DS0 Channel 3 of customer No. 4(B) on the left, one of possibly five such customer signals that Channel 3 might contain, is to be cross-connected to a 9.6 kb/s channel within DS0 Channel 23 of customer No. 1(C) on the right. In the DACS section, Channel 3 is cross-connected to the SRDC section where the individual customer signals can be cross-connected. The 9.6 kb/s signal from Channel 3 customer B is then electronically cross-connected to the appropriate outgoing channel in customer position No. 1. DACS inserts this multiplexed signal into Channel 23 of customer No. 1(C) on the right to complete the cross-connection. The identical action is performed in the reverse direction of the 2-way signal but is not shown in the diagram for reasons of clarity.

**DACS/SRDC Multipoint Circuit Arrangements**

Figure 33 illustrates how eight Multipoint Junction Units can be cascaded in a DACS/SRDC to provide up to 25 branches. The multipoint circuits are realized by the basic SRDC architecture: no additional circuits are required. The Multipoint Junction Unit is fundamentally different from the DACS Digital Multipoint Bridge (DMB) which is used to provide full duplex conference call connections in a variety of voice and data combinations between as many as 220 locations.

**DACS/SRDC - Gives You Long Term Features**

Many unique features have been included in the DACS/SRDC to ensure its compatibility with existing and future operational environments. Some of the broad categories of its features are listed below but each feature will be described in greater detail in later paragraphs:

- Includes many Operations Support features that are compatible with the latest Telco plans for centralized and automated Operations, Administration and Maintenance environments.
- Equipped with enhanced digital group circuit options that allow compatibility with all current and anticipated facility and
DIGITAL ACCESS AND CROSS-CONNECT SYSTEMS (DACS), DACS WITH SUBRATE DATA CROSS-CONNECT (DACS/SRDC)

frame formats. Also provides many facility maintenance features.
- Includes state-of-the-art technology for self-testing, self diagnostics and automatic message generation for remote surveillance.
- Built-in interfaces to administrative links that permit remote control of the DACS/SRDC, remote access and testing of DS1, DS0 and DS0A signals and remote insertion of multipoint loopback, branch and block line codes.
- Built in DACS and SRDC Unit memories, non-volatile bubble memory backup, and a high speed 4800 baud interface for an administrative data link to a direct memory backup system for quick rebooting.

Operations Support Features
Centralized remote control of all facets of operation, administration and maintenance of the DACS/SRDC system is of paramount importance when evaluating its benefits. The DACS/SRDC provides interfaces to five administrative links to local or remote TTY terminals or OS systems. These permit complete control of all DACS and SRDC functions and programming from either a collocated TTY terminal or from a remote centralized Operations Center such as an NTEC/SCC (Network Terminal Equipment Center/Switching Control Center). From these locations each DACS DS1 channel can be programmed to accept line and facility signals of specific formats. Facility alarms and performance monitoring/alarm reporting thresholds can also be remotely established and selected to meet the requirements of the Facility Maintenance and Administration Center. Self-monitoring of critical circuits helps DACS/SRDC determine the appropriate center to which it should report specific types of troubles. The DACS/SRDC provides DS1, DS0 and DS0A test access for SARTS, DIGITEST, ARATS and other automated test systems, and permits complete automated OAM&M except for physical replacement of circuit packs.

Enhanced Digroup Circuit (AMM 180)
Many of the unique capabilities of the DACS/SRDC are due to its use of enhanced digroup circuits that allow a number of options and parameters to be programmed and selected from a local or remote TTY terminal. For example, it can be programmed to accept a specific facility signal format including D4, Fe extended frame or DDS. This capability is planned to be extended to include SLC Carrier and Digital Multiplex Interface (DMI) formats in the future. The enhanced digroup also allows pre-programming of the specific line format (8B/2ZS, No Zero Suppression, or Digital Transmission Surveillance System) to be accepted by each DACS digroup. Facility alarms and reporting thresholds are remotely programmable and selectable. The enhanced circuitry also provides a special data channel mapping feature. In addition to its programmable options, the enhanced digroup circuit provides numerous facility maintenance features that can assist in detecting deteriorating facilities before they fail and in isolating trouble when they do fail. The circuit includes many performance indicators and generates alarm and performance messages when the programmed thresholds are exceeded. These features are employed in the interface between Remote Measurement System - Digital 1 and DACS/SRDC as described in a later chapter.

A variety of framing formats can be found terminated on almost every DACS frame but the performance indications generated by the enhanced digroup circuit are the same for all of them. The indicators can be periodically polled to provide near real-time performance information for the Facility Maintenance Center and for use by RMS-D1.

Equipment Maintenance Features
The maintenance features built into the DACS/SRDC equipment follow the modern design philosophy that complex electronic machines must be able to diagnose their own illnesses, pinpoint the cause, and prescribe the action to be taken. The DACS/SRDC follows a program of continuous self-checking that will almost instantly detect any internal circuit malfunction and generate an appropriate alarm or diagnostic message. In keeping with long-standing AT&T maintenance philosophy, all equipment units that handle 24 or more channels are duplicated, with the standby unit automatically switched into service when the working unit fails. The sophisticated trouble analysis program of the DACS/SRDC isolates any fault down to a few circuit packs, usually one or two. With its many VLSI circuits and redundant circuitry, AT&T's DACS/SRDC has been designed and built for easy maintenance.
Circuit Testing Features

Since one of the primary functions of a hub or service node office is to provide centralized test access to private line special service circuits, the extent to which DACS/ SRDC fulfills this function is of extreme importance. The quality and reliability of tariffed services rely heavily on the ability to access and test circuits rapidly, to sectionalize and isolate trouble rapidly and to initiate corrective action rapidly. Responsibility for these functions is assigned to various specialized centers in the modern operational environment. DACS/SRDC's job is to provide ready test access to the DS1, DS0, DS0A and DS0B signals terminated on it.

Besides the normal DS1 and DS0 test access provided by DACS, the SRDC section provides both monitoring and splitting access to DS0A and DS0B signals and presents a DS0A signal to the remote test device. This access can be established from a remotely located NTEC/SCC via administrative data links or via a link to a distant Special Service Center (SSC) through the hub office's Remote Test System or Remote Measurement System-Digital. These links can also be used to set up test port loopbacks and to check facility and equipment status. The DACS/SRDC provides a method for checking the operation of the data links.

Additional tests can be performed on substrate signals by applying specific line codes from an external source to the circuit via the SRDC test access point. One specific line code establishes a multipoint loopback while another sets up a branch and block test.

Memory Administration Features

Every function, operation and cross-connect performed in and by the DACS/SRDC machine is activated electronically at the command of specific control signals. There are no patch cords. The DACS and SRDC sections have separate non-volatile bubble memories that provide backup for the memories in their Units' Cross-connect Modules. This backup prevents the loss of any operation program or cross-connect data which could be catastrophic to the networks terminated on the DACS/SRDC. The DACS and SRDC bubble memories, in turn, can be backed up by storage in a Remote Memory Administration System (RAMAS).

In the improbable event of loss of data, the DACS/SRDC provides an interface for a 4800 baud high speed data link to the direct memory backup to allow the system to be rebooted in a minimum of time.

Operational Support for DACS/SRDC

NTEC/SCC

The operational support environment most likely to be in effect during the deployment of DACS/ SRDC, at least over the short term, is shown in Figure 34. For purposes of assigning responsibility, the DACS/SRDC machine is considered to be a facility terminal and responsibility for its operation and maintenance is assigned to the Network Terminal Equipment Center/ Switching Control Center (NTEC/SCC). This center is primarily an SCC except that when its responsibility and work volume is high, an NTEC may be collocated with it to assume responsibility for all terminal equipment in the area. This includes responsibility for digital and analog channel banks, MFT, DACS/ SRDC etc. The SCC's primary mechanized support is furnished by a 2 Switching Control Center System (2SCCS). This system communicates with the DACS/ SRDC over an administrative data link.

Figure 34 – DACS/SRDC Operational Support
DIGITAL ACCESS AND CROSS-CONNECT SYSTEMS (DACS), DACS WITH SUBRATE DATA CROSS-CONNECT (DACS/SRDC)

A link that also enables the technicians at the NTEC/SCC to remotely monitor and control the complete operation of the DACS/SRDC. They can also receive alarms, run diagnostics, provision circuits and obtain information to make dispatch decisions.

FMAC/TCAS
The Facility Maintenance and Administration Center (FMAC) has overall responsibility for the T-Carrier facilities that terminate on the DACS/SRDC. The FMAC is supported in this by a T-Carrier Administration System (TCAS). The 2SCCS forwards DACS/SRDC facility alarms to the FMAC.

SSC
The Special Service Center (SSC) is responsible for overall installation and maintenance of the SARTS-testable special service circuits terminating on the DACS/SRDC. The SSC is supported by the Switched Access Remote Test System (SARTS). This system accesses circuits in distant offices and directs their testing by commands to the distant office's Remote Test Systems-5A. In the short term, SARTS/RTS-5A is expected to be supplemented by AT&T's new DIGITEST/RMS-D1, an enhanced digital test system to be described later in this book. For the long term, SARTS/RMS-D1 will support all the testing needs of the DACS and DACS/SRDC.

CPC
In the upper right of Figure 34 is the Circuit Provisioning Center (CPC) supported by the Trunks Integrated Record Keeping System (TIRKS). The CPC is responsible for circuit and facility design and for equipment assignment. TIRKS communicates its information to DACS/SRDC over an administrative data link.

A Summary of DACS/SRDC Features
Below is a summary of the DACS/SRDC features described in the preceding paragraphs of this section:

- Efficient equipment arrangement packs vast networking capability into small amounts of floor space
- Use can be shared by voice and digital services
- Provides enhanced operational capabilities
  - Automated provisioning
  - Automated testing
  - Automated Memory Administration
  - Performance Monitoring
  - Advanced equipment and facility maintenance features
- Secondary channel capability
- Improved network flexibility
- Building block for advanced DigiPLUS network architecture
- ISDN and UIS compatible
Overview

The most difficult construction aspect of the "Scotty's Spectrum Analyzer" project by Scotty Sprowls is making the first IF 1013.3 MHz cavity bandpass filter. After having a bit of bad luck trying to construct one of these units using the copper pipe and brass plate method, I looked into trying to adapt a 800/900 MHz mobile duplexer for the filter. This appears to have turned out quite well, and the final filter was fairly easy to construct.

The filter shown here will be made from a Celwave Model No. 20−1224A19 duplexer which was originally tuned for 928.5 MHz (low) and 952.5 MHz (high). These duplexers are available for very low cost on eBay from the user "helpinghams." Be sure to purchase the 4−cavity model duplexer and try to get one that isn't painted. The stock duplexer was labeled "Celwave UHF Duplexer 840–960 MHz 4−Cavity" in the eBay description.

The coupling loop dimensions and spacings from the original cavity filter design on Scotty's website will be used here. They could probably be tweaked a little bit to increase the filter's final bandpass characteristics, but everything worked here as shown. The final 3 dB bandwidth of the filter is 4 MHz, which is a little wide, but it's the 1034.7 MHz image rejection measurement that we're really after. The filter's insertion loss is around 5 to 8 dB, but that's not very important here.

Pictures & Construction Notes

Stock Celwave Model No. 20−1224A19 duplexer internal view.

The stock RF connectors and bits of hardline coax will need to be removed. The connectors are riveted to the base assembly, so you'll have to drill those out. Use a heat gun to heat the pieces of hardline coax and they'll slip right out.
Closeup of the four main tuning posts inside the duplexer.

They are 2.5 inches long and 0.34 inches in diameter. Four stainless steel #6–32 screws hold each of the posts to the main base assembly.

The duplexer's stock coupling loops will need to be unsoldered or trimmed off of the tuning posts, as they will not be used here. Be sure not to lose the little white Teflon caps on each of the posts.
Top plate of the duplexer showing the four brass tuning screws which fit inside the Teflon caps on the tuning posts.

This will require no modification.

Taking the duplexer apart.

Be sure not to damage the silver plating on the main tuning posts.
Drilling a 1/8 inch hole through the four cavities for the new coupling loops.

The hole is 0.7 inches from the base, as per the original filter design.

Using a 1/8 inch hole held the bits of Teflon dielectric from the UT−141 hardline coax a little better.

Be sure the drill bit doesn’t wander as it passes through the side of each cavity.
The duplexer's base assembly.

You should mark the internal sides of cavity with a scriber before disassembling the duplexer.

Note that there are three small holes near where the tuning post attached. Only two of these holes were used originally, and we’ll be using the unused hole for the new coupling loops.

Drill four #56 sized holes 0.06 inches from the inside of the cavity which you marked with a scribe. This will be for the new coupling loops on the otherside of the cavity.
Construct the internal coupling loops from bits of scrap UT–141 hardline coax as per the original cavity filter design.

This will be much easier to do since the sides of the cavity are square.
Since the duplexer's cavity is made from aluminum, we won't be able to solder the input and output connections like in the original cavity filter design.

To overcome this, we'll be using panel−mount SMA jacks with pigtailed made from scraps of UT−141 coax.
Soldering the main tuning stubs to the base assembly.

The stock duplexer held the main tuning stubs using only screws. Since this connection is fairly critical, we’ll add a bit of silver solder to the base of the tuning stubs to prevent them from coming loose.

This is optional, but probably very helpful.
Putting everything back together.

Since the cavity is held together using screws, you can easily take it apart and tweak the coupling loop spacing.

Add a bit of Loctite to the screws to help secure the final filter design.
Bottom of the base assembly showing the solder connections.

A few solder "blobs" cover up those unused holes.

You'll have to solder quickly to prevent the solder connection on the SMA connectors from coming undone.
The duplexer originally had solder access holes in the sides of the cavity. They are plugged using a rubber stopper.

We'll use these access holes to add a dab of Remington MoistureGuard grease into each cavity. When this grease evaporates, it coats the sides of the cavity to prevent any oxidation from taking place.

You can find Remington MoistureGuard at most gun stores.
Final 1013.3 MHz bandpass cavity filter overview.

I don't have a spectrum sweep of the bandpass response, but it does appear to work or at least is a very good starting point.

The filter in symmetrical, so either SMA jack can be used for the RF input or output.
10.7 MHz IF / 30 kHz BW Resolution Filter

Overview

This is a 10.7 MHz narrowband (approximately 30 kHz) resolution filter for the GBPPR 1 GHz RF Spectrum Analyzer project. This filter will allow the spectrum analyzer to display the RF signal(s) it's receiving in more detail than the stock 300 kHz filter.

The filter is made using four commercially available 10.7 MHz monolithic crystal filters from ECS. These ECS−10.7−15B filters can be purchased from Digi−Key or Mouser and each "4−pole" package will include two matched filters, so you'll need to order two of these packages for a total of four crystals. There is not enough stopband attenuation when using only two crystals and this can lead to spurious images on the analyzer's display.

Each of the crystals is marked with a black phasing dot on its case and this should be taken into account when making the final circuit. The crystals have a input/output impedance of around 3,000 ohms, so a simple inductor/capacitor L−network will be used to transform this to 50 ohms.

Note that these particular crystal filters are not really designed for RF test equipment use, so they will have a fair amount of ripple in their passband. This ripple can be adjusted slightly by adding a few low−value trimmer capacitors on the input/output of the crystals.

You can sometimes find commercial 10.7 MHz IF filters at hamfests. Keep an eye out for these, as they will have much better passband and out−of−band attenuation characteristics.

Pictures & Construction Notes

Overview of the finished 10.7 MHz narrowband resolution filter.

It's built onto the lid of a salvaged Bud CU−124 case for ease of removal for modification or tuning.
Alternate view.

The input and outputs are symmetrical, and you can see the variable inductors (orange) used in the 3,000 ohm to 50 ohm matching section.

Little bits of copper PC board material are used to improve shielding between each of the crystals.

The RF connectors are TNC jacks.
Another view.

The two 2–10 pF trimmer capacitors can be used to slightly improve the filter’s passband ripple characteristics.

Note the black phasing dots on the each of the crystals.
10.7 MHz narrowband resolution filter spectrum sweep.

Center displayed frequency is 10.7 MHz.

The settings are 10 dB per vertical division and 5 kHz per horizontal division.

Note the large amount of ripple in the passband.

The final passband may vary slightly with each crystal.
10.7 MHz narrowband resolution filter spectrum sweep.

Center displayed frequency is 10.7 MHz.

The settings are 10 dB per vertical division and 20 kHz per horizontal division.
10.7 MHz narrowband resolution filter spectrum sweep.

Center displayed frequency is 10.7 MHz.

The settings are 10 dB per vertical division and 1 MHz per horizontal division.

Note the fairly poor out-of-band rejection above 10.7 MHz, probably leakage from the impedance matching sections.

The final tuned filter has an insertion loss of around 9 dB. You'll want to add a resistive attenuator to the other filter(s) used in your spectrum analyzer so they all have close to the same insertion loss.
View of the out-of-band peak at around 14 MHz.

10.7 MHz is on the left.

The settings are 10 dB per vertical division and 1 MHz per horizontal division.
10.7 MHz IF / 30 kHz Resolution Filter

X = ECS-10.7-15B Monolithic Crystal Filter (Digi-Key X704-ND)

Note these packages come with two matched crystals, so you’ll need to order two.

The input/output impedance of the crystal filters is 3,000 ohms.

Be sure to note the crystal’s phasing dots when constructing the circuit.
by "Connecticut2600"

In 1987, a small group of hackers affiliated with 2600 Magazine had their first meeting in New York City. As the New York meeting grew in popularity, they expanded into other cities. The Connecticut hacker group IIRG decided in the early 1990s to host one, and that was the start of the CT2600 meetings. After having the meetings for about a year, they decided to stop hosting them. The rising stupidity of the younger generation of hackers resulted in a fake bomb threat being called into the meeting location by one of the attendees, resulting in his arrest. Connecticut had other meeting locations hosted by various other groups over the years, but every meeting attempt to date has ended in failure because the stupidity level of the local hacker scene goes higher and higher as the years drag on.

Fast forward to the last decade. An old−school hacker decided to start the meetings up again on the Connecticut shoreline. CT2600 meetings were always held in the center of the state because hackers with a clue on the extreme ends always went to either the New York or Boston meetings, given the lameness of the Connecticut hacker scene at large. These meetings broke apart when the host was sued for DCMA violations over hosting the DeCSS code, and when it was found out that he was screwing the local scene whores. The surviving attendees tried to get their act together, but were unsuccessful. It wasn’t until recently that a group managed to get their act together enough to set up a meeting location.

This CT2600 group was a continuing decline of the ones who screwed−up the original 2600 meetings in the state. It consisted of wannabes, scene whores, and generic criminal types who had a reputation for shitting where they eat, and screwing over their fellow "hackers." I observed their meetings at Paneria Bread in Newington several times. They were technically inept, very cliquish, rude, and hostile to newcomers. When a different group of hackers in the state created a hackerspace, they proceeded to create a website with a similar name to draw potential members away from the other group and to their group. They were not good ambassadors to the local hacker community, and as a target they were irresistible.

A Gmail account and website "Connecticut2600" was created, and an email was sent to 2600 Magazine in July, 2010 stating that the CT2600 meetings had moved to a new location and website. It received the usual automated response from 2600. For two or three months, an email was sent dutifully to 2600 saying how great the new meeting location was. Sure enough, when the Autumn 2010 issue came out, the "new" meeting location and webpage was listed. During this time period, the original group of lamers continued meeting at the "old" location, unaware that their meeting was moved. When they finally did discover the move in November of 2010, what did they do? The nominal meeting organizer at ctgeeks.org posted up this blog entry: "Due to circumstances beyond my personal control, the location for the meetings has changed to the food court of the Brass City Mall in Waterbury, Connecticut. Hope to see everyone there this coming first Friday." This is the response I would expect from a herd animal and not a hacker.
I have not been to a CT2600 meeting, after having seen their stupidity in action way too many times, and decided to do something about it. 2600, at least in this state, continues to attract the absolute worst of the local hacking community. I think that's because 2600 has since sometime in the 1990s dropped to presenting the lowest common denominator of the hacking community. This is obvious in the way they conducted no real follow-up with the originator of the email notifying them of the location and website change, or apparently with the party who had started the Newington meeting. This complacency and lackadaisical attitude allowed them to be taken advantage of by someone who put in a minimal effort at social engineering.

I was hoping that by covertly changing the meeting location it would perhaps give a new generation of hackers a means to meet for a while before having to deal with the human trash that continue to wreck the hacking scene in this state. It is rather sad that most novice hackers receive their introduction to hacking by way of a rag such as 2600, but I guess you work with what you have. Being that a few months went by before the switch was noticed by the CT2600/CTGeeks sheep, maybe I was successful. If you are a hacker and live in Connecticut, avoid the CT2600 meetings and 2600 in general. Unfortunately, the last decent hacker group in this state maintains a very low, almost covert, profile, and has their own internal problems, but they at least have a web site up and running with good information. They are the International Information Retrieval Guild (IIRG), and their web site is at www.iirg.org. Maybe they will start their zine Phantasy again. If you are looking for a real hacker zine, download GBPPR Zine at www.gbppr.org. It's free and has real information in it.
Hey, that's just great.
Listen kid, before we can make you an official offer, you've got to make the place more "average internet user friendly", you know what I mean?

Yeah, heh...

Mr. Zweischist will be pleased!
you're gonna be rich, kid!

Later...

/b/new/ - News
Text Boards: /freefall/ & /politic/
End of Issue #82

Any Questions?

Editorial and Rants

Ever wonder why the faggots on /b/ support Jewlian Assange’s WikiLeaks website, but bitched and moaned for /new/ to be shut down?

Well, now you know...

So much for "freedom of speech," or "fighting censorship," or whatever bullshit the kiddies are always screaming about.
Pictures from a Martin Luther King, Jr. holiday rally on January 17, 2011 sponsored by the South Carolina NAACP which drew more than 1,200 to the State House in Columbia, South Carolina.

Note how they purposely blocked the statue of George Washington! Wake up White man!
During the 2010 election campaign for Russ Feingold, he was running around saying he wasn’t working for any “special interest” groups. That’s funny... as I found a few on his official website before it was taken down.

"Finally, there has been no justice for the thousands of Jews, like those aboard the German vessel the St. Louis, who sought refuge from hostile Nazi treatment but were callously turned away at America’s shores.

A second commission created by this bill will review the treatment by the U.S. government of Jewish refugees who were fleeing Nazi persecution and genocide. We must review the facts here as well and determine how restrictive immigration policies failed to provide adequate safe harbor to Jewish refugees fleeing the persecution of Nazi Germany. It is a horrible truth that the United States turned away thousands of refugees, delivering many refugees to their deaths at the hands of the Nazi regime."

feingold.senate.gov/record.cfm?id=309632

How is it that a U.S. Senator can get away with putting Jews in a special category for U.S. Congressional protection?

Good thing he didn't get away with it, as he was voted out.

Think about it... Wisconsin Senator Russ Feingold was putting Jews in a special protected category and using U.S. taxpayer money for a commission to “investigate” those trying to prevent Jews from illegally entering the U.S. during WWII. Feingold has to realize the United States was founded as a White Nation, by White men, and Jews are not any part of its identity.

Well, at least there’s one less Jewish supremacist in the Senate.