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BELLSOUTH
LOOP TECHNOLOGY
DEPLOYMENT GUIDELINE

SEPTEMBER 1989

File Code: 240.0220

November 13, 1989

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FROM: J. V. Jackson, Operations Manager - Technology Deployment Strategy (BSS)

SUBJECT: 1989 BellSouth Loop Technology Deployment Guideline

Attached is an approved copy of the 1989 BellSouth Loop Technology Deployment Guideline, RL:89-08-095SV. BSS - Documentation has been provided with a set of originals to provide library and reference copies. Distributions to requested organizations via coded distribution lists may be arranged by contacting Margaret Capley on 205-977-8913 prior to December 1. In addition, one set of originals is being sent with this letter to the headquarters staff of each of the operating companies and to the BSS Distribution Training staff for appropriate distributions.

Please ensure that all members of your organization, or area/district organizations that you support, that are involved in outside plant planning and LATA/integrated planning issues are supplied with copies of this document. Also, please ensure that all previous issues or preliminary/draft copies are disposed of properly, preferably shredded. Your help in assisting in a proper distribution is greatly appreciated.

Thank you for all the comments and input from your organizations that contributed to the completion of this issue. We look forward to continuing to work with you in the development and refinement of regional loop deployment recommendations. If you have any questions or comments, please call me on 205-977-5032 or Stan Fory on 205-977-7158.

Jim

Attachment

F02B01Z 08282

BellSouth Services
A BELLSOUTH Company

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from: Executive Vice President - Marketing, Network and Planning

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This letter introduces the 1989 issue of the BellSouth Loop Technology Deployment Guideline. This fourth issue reflects the effects of recent significant increases in the cost of copper cable and the introduction of a new, more economical, vendor product line of digital loop carrier. These two new factors have resulted in a more aggressive deployment recommendation than the previous issue of the guideline (RL 88-09-030SV), particularly for certain arrangements of integrated digital loop carrier.

The objective of the BellSouth Loop Technology Deployment Guideline continues to be to provide methods for selecting the most economical means of providing required loop network capabilities consistent with corporate assumptions concerning market and technological issues. The use of these methods can significantly reduce or eliminate the need for local economic studies. Deployment plans should be reviewed to ensure that they are consistent with the recommendations contained in this guideline.

Some important highlights of the 1989 issue include:

1. When new cable facilities are required to support digital span lines for digital loop carrier and other DS1 requirements in the feeder network, place fiber cable and associated electronics. No economic study is required except for total ten year demands of less than twelve DS1s.

2. Studies continue to support the placement and termination of metallic feeder cables to serve areas with feeder lengths less than the recommended crossover points, except where significant expenditures for conduit placements can be deferred.

3. Remote switch units are generally not economical as loop relief alternatives when compared to digital loop carrier.

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4. Integration is the economical choice over universal carrier arrangements, even at very low utilization rates for the digital loop carrier. In addition, the hairpin/sidedoor feature available on some switches for use with integrated digital loop carrier should be considered as an economical alternative to dedicated systems for non-switched or non-locally switched special services.

5. Digital switch and carrier system components to provide integrated access for basic access ISDN will not be available until the 1991-1992 timeframe. For areas that are likely candidates for narrowband ISDN services, deployment of digital loop carrier closer than 12 kft is not recommended when significant early demand is forecasted or when universal carrier must be used. Deployments should follow those for POTS when integrated carrier components become available.

This guideline will be updated as required to reflect the availability of new products and technologies and changes in costs and/or cost trends projections. Questions from your staffs regarding this guideline should be directed to Mr. J. V. Jackson on 205-977-5032 or Mr. S. R. Fory on 205-977-7158.

Executive Vice President -
Marketing, Network and Planning, BSS

BELLSOUTH
LOOP TECHNOLOGY DEPLOYMENT GUIDELINE
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* Denotes sections with major revisions over previous issue.

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1. BELLSOUTH
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4. SUMMARY OF RECOMMENDATIONS

5. Carrier/Cable Crossover Point (Section 2.0):

6. Universal Carrier
7. Integrated Carrier (5ESS)
8. Integrated Carrier (DMS-100)

Feeder Cable (Section 2.2):

Terminate metallic feeder cables to serve areas at less than the recommended crossover points, except where significant expenditures are required for structure placements (see Section 2.3)

Structures (Section 2.3)

Place no underground conduit except that justified by detailed cost studies.

Digital Loop Carrier Deployment (Section 2.4.1)

Digital switch and carrier system components to provide integrated access for basic access ISDN will not be available until the 1991-1992 timeframe. For areas that are likely candidates for significant narrowband ISDN services, deployment of digital loop carrier closer than 12 kft is not recommended when significant early demand is forecasted or when universal carrier must be used. Deployments should follow those for POTS when integrated carrier can be used.

Digital Span Line (Section 2.4.2)

The first choice for providing the digital span line for carrier is the use of existing metallic facilities. Where existing cable pairs cannot be conditioned to provide the 3-5 year demand for digital lines, place a new digital line facility (see Section 2.5).

Conditioning Costs/Extraordinary Expenditures (Section 2.4.3)

If extraordinary expenditures associated with providing the digital line on existing cable exceed $65 per DS1-kft, consider fiber cable (See Att.6). Place fiber to potential hub locations with growth of more than 20 DS1s per year.

1. BELLSOUTH
2. LOOP TECHNOLOGY DEPLOYMENT GUIDELINE
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4. SUMMARY OF RECOMMENDATIONS
5. (Continued)

6. Product Selection (Section 2.4.5)

7. Primary product recommendations for carrier providing primarily POTS include:

8. Universal Carrier:
9. Integrated carrier: ;
See the Product Selection Table on page 6 for more detail.

Housing Requirements (Section 2.4.7)

Cabinets are generally more economical than huts and CEVs.

Relief Intervals Section (2.4.8)

Channel Bank Assemblies in huts and CEVs	1 year requirement
RT Cabinet e/w Channel Banks	2 year requirement
Channel Unit Plug-ins	
(Less than 24 lns/yr)	1 year requirement
(greater than 24 lns/yr)	6 month requirement
(Use PIPSO if applicable)	

Integration (Section 2.4.9)

Digital loop carrier should generally be integrated into the switch. Place integrated digital loop carrier using the hairpin/sidedoor feature of the DMS-100 for all single system sites serving both switched and non-switched (NS) or non-locally switched (NLS) special services and for all multi-system sites where less than 24 NS/NLS special services are forecasted for the site.

New Facilities for Digital Span Line (Section 2.5)

In general, when new cable facilities are required to support digital span lines for digital loop carrier and other DS1 requirements, place fiber cable and associated electronics. For total ten year demand of 12 DS1s or less, provide study.

Lightwave Multiplexing Equipment (Section 2.6)

Generally, place 90 Mbps systems. Provide one year requirement.

SUMMARY OF RECOMMENDATIONS
(Continued)

Fiber Cable (Section 2.7)

Size fiber cable placements for the ten year requirement based on the most economical lightwave system (see Section 2.6). **Provide six fibers (four active and two spare) per lightwave system.**

Distribution Cable (Section 2.8)

Distribution cables **should be down gauged** when served entirely by carrier.

Remote Switching (Section 4.4)

Remote switch units are not economical as relief loop alternatives to digital loop carrier in single carrier serving area (CSA) applications serving primarily POTS. However, RSUs may be the only practical facility capable of satisfying large volumes of early ISDN demand beyond 18 kilofeet from the serving central office.

BELLSOUTH
LOOP TECHNOLOGY DEPLOYMENT GUIDELINE
SEPTEMBER 1989

1.0 INTRODUCTION

1.1 Background

The first BellSouth Loop Technology Deployment Strategy was published in October 1985. This strategy defined capital deployment planning assumptions and outlined regional implementation guidelines consistent with those assumptions. Its purpose was to assure the consistent application of technical assumptions in the development of capital deployment plans and to promote the integration of the market planning and capital deployment processes.

This publication of the BellSouth Loop Technology Guideline represents the fourth issue of loop deployment implementation guideline, which was originally published as one part of the BellSouth Loop Technology Deployment Strategy in October 1985. Other issues addressed by that publication will be discussed here, but they are to be primarily addressed by other deliverables.

1.2 Purpose

The purpose of this guideline is to assure the consistent regional application of technical assumptions in the development of capital deployment plans and **to economically position the network to competitively serve both existing and future customer demands in an increasingly competitive market.**

1.3 Objective

The objective of the BellSouth Loop Technology Deployment Guideline is to provide the methods for selecting the most economical means of providing required loop network capabilities consistent with market and technological assumptions. Although these guidelines provide a screening process for selecting the most economical deployment solution, they should not be used rigidly to justify an unreasonable plan. Always use sound engineering judgement and common sense.

The application of this Guideline should significantly reduce or eliminate the need for local studies to determine economic deployment alternatives. The Guideline may be used as input to existing mechanized planning tools for the development of area specific deployment plans.

Changes in the Guideline over the previous issue are highlighted in bold print and affected sections are indicated in the Table of Contents.

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2.0 IMPLEMENTATION GUIDELINES

The results of associated economic studies are summarized below and should be used as a screening tool for selecting the most economical technology deployment solution for feeder facilities to provide POTS and limited demand for locally switched special services (<10%). For larger switched special service demands, similar crossover points are applicable for universal carrier or carrier integrated with a 5ESS. For carrier integrated with a DMS-100, see the graphs on Attachments 7 and 8 for results with 50% switched specials.

	Carrier / Office Type	Feeder Length	CSA Deployment Solution
	For Constant Growth Pattern (All Except High First Period Growth):		
	Universal		Place Metallic Cable
	Universal		See Graph on Attachment 1
	Universal		Place Universal Carrier
	Integrated / 5ESS		Place Metallic Cable
	Integrated / 5ESS		See Graph on Attachment 2
	Integrated / 5ESS		Place Integrated Carrier
*	Integrated / DMS-100		Place Metallic Cable
*	Integrated / DMS-100		See Graph on Attachment 3
*	Integrated / DMS-100		Place Integrated Carrier
	For High First Period Growth Only:		
	Universal		Place Metallic Cable
	Universal		See Graph on Attachment 4
	Universal		Place Universal Carrier
	Integrated / 5ESS		Place Metallic Cable
	Integrated / 5ESS		See Graph on Attachment 5
	Integrated / 5ESS		Place Integrated Carrier
*	Integrated / DMS-100		Place Metallic Cable
*	Integrated / DMS-100		See Graph on Attachment 6
*	Integrated / DMS-100		Place Integrated Carrier

* NOTE: For carrier systems other than DMS-1 Urban integrated into the DMS-100 switch, use the 5ESS crossover data.

"Constant Growth" includes 10% of the total ten year demand each year. Other growth patterns, such as a bell shaped growth pattern, yielded similar results in the associated economic studies. "High First Period Growth" includes approximately 75 % of the total ten year demand during the first two years. For growth situations that may be in between these patterns, an interpolation of the carrier/cable crossover points must be made by the loop planner. Total Ten Year Demand is the number of lines that will be added to the CSA during the ten year study period, either by growth or transfer, that will require placement of new loop facilities.

The following sections provide details and discuss other important considerations for various network components.

2.1 Load Coils

Avoid the use of load coils in new plant construction. The intent of this guideline is to avoid not only the cost of load coils, but also the limitations they impose on both existing and future digital services. This guideline effectively requires the use of digital loop carrier or remote switching devices to serve loops longer than 18 kft of total loop length.

Load coil placements are permitted on distribution facilities in areas served by loaded feeder pairs or where Expanded Carrier Serving Areas (ECSAs) utilize distribution lengths in excess of 12 kft to maintain high utilization of digital loop carrier facilities. However, the goal of feeder and distribution design should be the elimination of the use of load coils entirely, consistent with good engineering judgement and economic sense.

2.2 Feeder Cable

The chart at the beginning of Section 2.0 provides a screening tool for selecting the most economical technology deployment solution for feeder facilities providing primarily POTS. Termination of metallic feeder cables to serve areas at less than the crossover points indicated will generally be more economical than the placement of digital loop carrier, except where significant expenditures are required for structure placements (see Section 2.3). Although some calculated crossover points are beyond 12 kft, particularly for high first period growth or for very high total demand, some other factors must be considered before deploying metallic feeder cable beyond 12 kft.

a. Typical distribution lengths (3 kft was assumed for the studies) could dictate the use of load coils. For many business applications, such as PBX trunks, loading is often appropriate for metallic loops longer than 15 kft (total length). The placement of load coils presents an impediment to the provisioning of existing and future digital services.

b. For total loop lengths beyond 15 kft, coarse gauge cable is introduced not only into the feeder network, but also into the distribution. An 18 kft loop (total length) requires a minimum of 6 kft of 24 gauge cable. Deployment of metallic feeder facilities will restrict most distribution cable placements to coarse gauge, whereas with the deployment of carrier, distribution cables may be down-gauged to 26 gauge, consistent with standard CSA design. This is particularly true for high growth development areas which also require large expenditures for distribution cables. See Section 2.8 for guidelines on distribution cables.

c. Using digital loop carrier and standard CSA design, many voice frequency special services may be "de-specialized", providing savings in special service provisioning costs. Although no service provisioning costs or revenues are reflected in the study results and corresponding graphs of crossover points, the impact of special services must be assessed for the area being considered for feeder relief.

d. Placement of metallic feeder cable beyond the limits of this guideline should be avoided except where required to fully utilize existing metallic pairs by filling short gaps in the existing feeder network.

2.3 Structures

Place no underground conduit except that justified by detailed cost studies. In existing conduit routes where fiber cable and innerduct have not been established, reserve the last available duct, besides maintenance duct (may include air pipe), for future innerduct and fiber cable placement.

See Section 2.4.3 for guidelines on auxiliary manhole placements associated with the deployment of digital loop carrier.

2.4 Digital Loop Carrier

2.4.1 Deployment

The chart at the beginning of Section 2.0 provides a screening tool for selecting the most economical technology deployment solution for feeder facilities providing primarily POTS. Although some calculated crossover points are closer than 12 kft, particularly for low total demand or for integrated carrier, some other factors must be considered before deploying digital loop carrier at distances less than 12 kft.

a. **For analog central offices, consider the placement of digital loop carrier consistent with crossover and product recommendations for integrated carrier only when an equipment order has been placed with a vendor for a digital switch replacement.** See Section 2.4.9 for more details on integration issues.

b. For areas with low total ten year demands, the lower limit of the carrier versus cable crossover point is based on a cable plan which includes a separate sheath to that area. This is generally impractical for such low demands.

c. For total loop lengths less than 9 kft, some penalty in special service provisioning may be incurred with digital loop carrier. For these loops, most voice frequency special services can be provided over metallic cable pairs with no electronic treatment, such as MFTs, at the central office. In addition, these loops require no special service design procedures, provided that appropriate assignment procedures have been initiated to designate areas that qualify under standard CSA design rules, with or without the presence of carrier. However, with digital loop carrier, channel unit plug-in costs for these special services are significantly higher than those for POTS. Costs for MFTs and channel unit plug-ins are reflected in the associated economic studies and recommended crossover points.

d. Universal carrier arrangements for providing narrowband ISDN have significantly low utilization of the hardwired carrier components. In addition, costs for plug-ins are significantly higher than for POTS. Integrated carrier arrangements will allow more efficient use of hardwired components as well as eliminate the central office terminal and the Digital Subscriber Line (DSL) plug-ins that interface with the digital switch. However, digital switch and carrier system components to provide integrated access for basic access ISDN will not be available before the 1991-1992 timeframe. (See Section 4.1 for more information on

ISDN and Section 2.4.5 for specific product information.) Estimated costs for providing a basic access ISDN circuit (2B+D) on integrated digital loop carrier versus metallic cable pairs and DSL plug-ins have a similar economic comparison as that for POTS and yield approximately the same crossover point. Therefore, for areas that are likely candidates for significant narrowband ISDN services, the deployment of digital loop carrier closer than 12 kft is not recommended when significant early demand is forecasted or when universal carrier must be used and deployments should follow those for POTS when integrated carrier can be used.

2.4.2 Digital Span Line

The first choice for providing the digital span line for carrier is the use of existing metallic facilities. The second choice is to fill gaps of inadequate metallic facilities with new cable. Generally, a "gap" should not exceed the length of an identified feeder section. **Costs for filling any "gaps" should be included with other "extraordinary expenditures" for span line development of, existing facilities (See Section 2.4.3).** A digital line plan should be developed as described in BSP-901-350-201 to meet digital line requirements on a planned systematic basis. Where existing cable pairs cannot be conditioned to provide the 3-5 year demand for digital lines, then placement of a new cable facility should be considered to provide the digital span lines. See Section 2.5 for guidelines addressing new digital line facility selection.

2.4.3 Conditioning Costs/Extraordinary Expenditures

Extraordinary expenditures include those for auxiliary manholes, additional cable stubbing required for auxiliary manholes, unusual cable pair rearrangements, and any other extraordinary costs associated with providing the digital line on existing cable, other than the placement and splicing of apparatus cases, the unloading of cable pairs, and the testing of the digital span line. **Generally, if extraordinary expenditures are estimated to exceed $65 per DS1-kft over the length of an equivalent fiber cable plan during a ten year period, the route may be a candidate for fiber cable placement. The graph in Attachment 9 provides a more complete screening for selecting the most economical digital line plan for a particular route. In general, placement of fiber facilities beyond 8 kft is more economical than conditioning existing metallic facilities for carrier serving areas or potential hub locations that are forecasted to grow at least 20 DS1s per year.**

2.4.4 Carrier Serving Areas

Continue to utilize the Carrier Serving Area (CSA) design as described in BSP-901-350-201 with distribution limits of 9 kft of 26 gauge or 12 kft of 24 or 22 gauge cable. Expanded CSAs, designed on the drop limit of digital loop carrier **(most POTS channel unit plug-ins have a drop limit of 900 ohms)**, may be utilized in rural areas to maintain high utilization of carrier facilities. Division of the expanded CSA to form standard CSAs should be considered when demand prompts the placement of additional carrier systems. **See Section 2.8.2 for distribution cable design criteria.**

2.4.5 Product Selection

The following chart provides a screening tool for selecting the most economical system type to be deployed for POTS and limited demand for locally switched special services (<10%). The selection of carrier system types is based on the use of the most economical housing for each carrier type. See Section 2.4.8 for guidelines on housing selections. **It should be noted that the product selection table is easily affected by the relative costs of the various vendor products. Material price changes by any or all of the vendors could produce significant modifications to these recommendations.**

Central Office Type	Unv. or Int.	Met. or Fbr.	Total 10 Yr. Demand	Economical System	Notes
For Constant Growth Pattern (All Except High First Period Growth):					
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Met.**			
•					
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Fbr.**			
Any	**Unv.**	**Fbr.**			
5ESS	**Int.**	**Both**			
5ESS	**Int.**	**Both**			
DMS-100	**Int.**	**Both**			
• DMS-100	**Int.**	**Both**			
For High First Period Growth Pattern Only:					
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Met.**			
Any	**Unv.**	**Fbr.**			
Any	**Unv.**	**Fbr.**			
Any	**Unv.**	**Fbr.**			
No.5ESS	**Int.**	**Both**			
No.5ESS	**Int.**	**Both**			
No.5ESS	**Int.**	**Both**			
DMS-100	**Int.**	**Both**			
• DMS-100	**Int.**	**Both**			
•					

The following sections provide specific product information which should also be considered in selecting the most appropriate carrier system.

2.4.5 Product Selection (System Notes)

The following notes provide specific product information, including equipment configurations, service capabilities, and future enhancements, which should be used in conjunction with the previous table to select the most appropriate carrier system. The ability of a system to provide intelligent network features, such as remote provisioning, enhanced self-diagnostic tests, remote inventory functions, and traffic monitoring, should also be considered. These notes are not intended to endorse the selection of a particular system nor the deployment of components prior to product approval.

It should also be noted that the carrier versus cable crossover points documented in Section 2.0 and Attachments 1-8 are based on the selection of the most economical carrier system and housing. The selection of alternate systems and/or housings may affect the carrier versus cable crossover point.

a. Integrated Carrier Versus Universal Carrier

<u>For analog central offices, consider the placement of digital loop carrier consistent with product and crossover recommendations for integrated carrier only when an equipment order has been placed with a vendor for a digital switch replacement.</u> See Section 2.4.9 for more details on integration issues.

b. Fujitsu Digital Loop Carrier (FDLC)

Fujitsu Digital Loop Carrier (FDLC) is now available but quantities may be limited in some areas during the short term. When FDLC is not available, DMS-1 Urban is generally the most economical alternative as a substitute for FDLC in universal configurations. SLC-96 Mode 2 is generally the most economical alternative as a substitute for FDLC in 5ESS integrated configurations.

Configurations for the Fujitsu system include Mode 1 (non-concentrated), Mode 2 (concentrated), and Mode 3 (special services), similar to SLC-96. Mode 1 has been approved for use in the universal arrangement. Mode 1 and Mode 2 have been approved for use in the integrated arrangement with both the 5ESS and DMS-100 (with BCS-26 or later software). Approval for the use of Mode 2 in the universal configuration is awaiting release of the Traffic Monitor Unit (TMU) for testing. Testing for the use of SLC-96 COTs (for POTS, SPOTS, and coin) with FDLC RTs for both Mode 1 and Mode 2 is underway. Mode 3 has not yet been tested or approved.

A full range of services can be provided by FDLC channel unit plug-ins, including POTS, coin, locally switched specials (UVC1), non-locally switched 2-wire specials (UVC2, one line each), 4-wire specials, and DDS (DP). Dataport (DP) channel units can be configured for various rates from the system controller, which is required to provision services other than those provided by POTS, coin, or UVC1 plug-ins. Provisioning of these services in the Mode 1, Mode 2, or Mode 3 should have similar restrictions to those for SLC-96 as discussed in Note d. Locally switched specials cannot be provided using a Mode 2 system equipped with a UVC1 plug-in when the system is integrated with a 5ESS switch.

FDLC components to provide standard integrated ISDN and compatibility with TR-303 are scheduled for general availability in 1992 and will allow a total of 192 ISDN circuits per dual channel bank. See Sections 4.1 and 4.2 for more information on ISDN and TR-303.

c. DMS-1 Urban Digital Loop Carrier

DMS-1 Urban should only be utilized for areas requiring predominantly POTS. This system does not currently provide many of the intelligent network features that may be available with other systems.

The associated economic studies included four DS1s for each DMS-1 Urban system, in accordance with the BellSouth Digital Loop Carrier Integration Guidelines. However, the number of DS1s used may vary from two to eight and may have some effect on its economic viability. The presence of switched specials or other high usage business lines will affect the traffic capabilities of the system and may require additional DS1s.

Locally switched two-wire special services such as PBX trunks can now be provided using an FXB channel unit only in a DMS-100 office. FXB channel units occupy twice the space per channel as POTS channel units. A reduction in system channel capacity for large special service demands can result in significantly different economic crossover points compared to those for POTS (See Section 2.0). Anticipated demand for a system equipped for 544 channels should not include more than 120 FXB units if the system is equipped with a 35 amp power plant; with a 25 amp power plant, more severe restrictions apply. Appropriate reductions in the maximum number of special services must be made when the maximum number of DS1 lines is not provided.

The Special Service Module (SSM), which uses DE-4 channel units to provide non-locally switched specials is not approved for use in BellSouth. Special service plug-ins to provide non-switched specials directly with the DMS-1 Urban are being evaluated. Currently to provide services requiring other than a POTS or FXB channel unit, an alternate or dedicated carrier system must be deployed or metallic cable pairs must be used.

Standard ISDN channel units that use three dedicated time slots per ISDN circuit, compatible with TR-397, will be available in late 1990 for use with universal carrier. These will require the use of DS1 tandem channel units at the COT to interface with another vendor's COT channel bank and ISDN channel units. Each DMS-1 Urban line card carrier which can provide eight POTS lines will be able to provide four ISDN circuits. ISDN system capacity will be limited by the total number of timeslots available on the DS1 trunks for the system (maximum capacity equals 96 ISDN lines assuming 12 DS1 trunks). Components to provide integrated standard ISDN and compatibility with TR-397 and TR-303 are scheduled for general availability in 1992 (See Sections 4.1 and 4.2). System capacities will be similar to that for POTS.

A smaller configuration of the DMS-1 Urban which provides a capacity of 112 POTS lines is available (96 lines when integrated). Although this system does not appear to be economical for general deployment, its minimal trunk requirements of two DS1s may be attractive in situations where existing trunks are extremely limited and the costs of additional DS1 development are excessive. The use of this configuration should be justified on a case by case basis with the appropriate economic study.

d. SLC-96 Digital Loop Carrier

SLC-96 Mode 1 (non-concentrated) should be utilized for areas with high usage business lines (such as PBX trunks), anticipated ISDN services, or secondary derived channel services on the primary loop.

SLC-96 Mode 2 (concentrated) should be utilized for areas requiring predominantly POTS. Anticipated demand to be served by each 48 channel group should not include more than eight high usage business or special service circuits. Presently proposed architectures for most ISDN services and secondary derived channel services cannot be served on SLC-96 Mode 2. D4 channel units must be used instead of SPOTS channel units to provide locally switched specials when a Mode 2 system is integrated with a 5ESS switch.

SLC-96 Mode 3 (special services) may be utilized for high concentrations of non-switched special services.

Limited available space in existing housings or difficulty in acquiring sufficient site(s) for a practical housing arrangement may require the use of some other system, such as SLC-Series 5, although the results of economic studies may indicate that SLC-96 may also be an economical alternative even with additional housings. In addition, SLC-96 does not provide many of the intelligent network features that may be available with other systems.

Channel units to provide pre-standard basic access narrowband ISDN (2B+D) are currently available for use in a universal Mode 1 system. However, these channel units utilize three dedicated time slots and a total of only 32 ISDN circuits can be provided per system. Standard ISDN channel units using a similar configuration compatible with TR-397 will be available in late 1990. There are no plans to provide components for integrated ISDN in any SLC-96 configuration nor for TR-303 compatibility (See Sections 4.1 and 4.2).

e. SLC-Series 5 Digital Loop Carrier (SLC-5)

SLC-5 Feature Package B (FPB) may be used when existing SLC-96 central office terminals can be utilized or when the system can be integrated with a No.5ESS switch.

SLC-5 Feature Package C (FPC) may be used for high concentrations of non-switched specials, similar to SLC-96 Mode 3. SLC-5 FPC allows the use of ESPOTS plug-ins (two lines each) for two-wire non-switched special services, a smaller assortment of plug-ins than for SLC-96 Mode 3, and POTS channel units. SLC-5 FPC cannot be integrated.

SLC-5 Feature Package D (FPD) can provide the same sort of T-1 line savings as SLC-96 Mode 2, by using Adaptive Differential Pulse Code Modulation (ADPCM) which eliminates the need for concentration. SLC-5 FPD cannot be integrated and other configurations should be considered first.

SLC-5 Enhanced Feature Package B (FPB+) will be available for testing at the end of 1989. This configuration is planned to provide full compatibility with the TR-008 standard and allow integration with switches other than the No.5ESS. It is also planned to incorporate many of the features of FPC and will allow optional concentration similar to SLC-96 Mode 2. FPB+ is intended to become the standard configuration for SLC-5 deployment and trade-in offers may make conversion of existing FPC and FPD systems attractive.

Standard ISDN channel units that use three dedicated time slots per ISDN circuit, compatible with TR-397, will be available in late 1990 for use with universal carrier. A total of only 64 ISDN circuits can be provided per dual channel bank. Integrated SLC-Series 5 systems compatible with TR-397 and TR-303 will be available in 1992 and will provide a total of 192 ISDN circuits per dual channel bank. (See Sections 4.1 and 4.2)

f. Other Digital Switches

Other digital switches may also have capabilities for integration of some carrier systems. However, system capacities and other features may be affected. For example, the capacity of a SLC-96 system is reduced to 90 lines when integrated with a Stromberg-Carlson switch.

2.4.6 Relief Strategy

The growth strategy is the preferred method for relief but may not always be applicable.

a. Growth Strategy (Preferred)

When a majority of the short-term growth can be identified with new construction or specific demand, digital loop carrier systems should be positioned at or near the location of that new construction or specific demand to serve growth and minimize rearrangements for route relief.

b. Cutover Strategy

Wholesale cutover of existing lines from cable to carrier at one site to provide cable facilities for identified growth at locations closer to the central office generally should not be proposed, particularly for relief of areas located closer than the crossover point for carrier. However, the following situations may warrant consideration of a cutover strategy:

1) Excess capacity of lightwave multiplexers and/or remote housings at the "cutover" area can be effectively utilized without increasing expenditures for these items during the five year planning period.

2) Forecasted growth is small and cannot be identified with specific demand or construction activity or when growth is scattered, such as along a rural route.

Furthermore, the cutover strategy should only be used where <u>all</u> of the following conditions are met:

1) The feeder length associated with the area to be relieved with physical facilities derived from cutover activities is greater than the appropriate carrier/cable crossover point for that area (See Section 2.0 and Attachments 1-8). Study results indicate that even when fiber facilities are considered to be free, the effect on the carrier/cable crossover point is negligible and that when lightwave multiplexers are considered to be free (not a totally reasonable assumption), the carrier/crossover point is typically only reduced by one kft or less.

2) Existing facilities, or those placed to provide for growth in the "cutover" area only, can be utilized for digital span line requirements. Use of the cutover strategy should not trigger the placement of new fiber or metallic facilities, or increase the size of placements for growth, to provide additional digital span lines during the five year planning period. In addition, use of the cutover strategy should not trigger placement of new or additional lightwave multiplexers during the five year planning period.

3) The relieved feeder pairs can be economically and practically reused to serve other areas of the route. This does not preclude the placement of short sections of cable (where economical) to serve additional areas of the route. These rearrangements should be on a planned basis and should provide adequate relief so that the entry of

splices more than once in the five year planning period is avoided and additional cable stubbing is minimized.

4) Use of the cutover strategy should not trigger the placement of a new hut or CEV or the establishment of a new remote terminal site for cabinets in the "cutover" area during the five year planning period. The cutover strategy becomes more attractive when existing remote terminal housings, or those placed to provide for growth in the "cutover" area only, can be utilized for the additional systems.

Use of this strategy does not imply that fiber should be placed to the end of the route. See Sections 2.5 and 2.6 for guidelines addressing the placement of a new cable facility to provide the digital span line.

Furthermore, the cutover strategy should not be utilized on a wholesale basis to achieve arbitrary utilization levels for switch interface components. See the BellSouth Digital Loop Carrier Integration Guidelines for appropriate coordination procedures involving the administration of integrated digital loop carrier.

c. Facility Replacements

When significantly long cable replacements are triggered by road moves or by deteriorated sections of cable which cannot be maintained (as substantiated by documented trouble history), then the placement of digital loop carrier may be an economic alternative. Factors include the number of sites to be established and the placement of digital span line facilities. The cable length that can be justified by replacement with carrier should be equal to or greater than the crossover length. When applying the crossover length, demand should be considered as a "high first period growth pattern" and cable placements as incremental pairs (see Notes for Attachments 1-8). If carrier is used to replace the feeder facilities, then cable pairs may be made available for use in areas closer to the central office.

2.4.7 Housing Requirements

The following chart provides a screening tool for selecting the most economical housing for each carrier type.

Carrier Type	Total 10 Yr. Demand	Housing Selection
For Constant Growth Pattern (All Except High First Period Growth):		
SLC-96		36-Type Cabinet (Max.3)
SLC-96		80-Type Cabinet (Max.4)
SLC-96		Hut or CEV
SLC-5		51-Type Cabinet (Max.3)
SLC-5		80-Type Cabinet (Max.3)
SLC-5		Hut or CEV
Fujitsu		6200 Type Cabinet (Max.2)
Fujitsu		Hut or CEV
DMS-1 Urban		600 Series Cabinet (Max.6)
DMS-1 Urban		Hut or CEV
For High First Period Growth Only:		
SLC-96		36-Type Cabinet (Max.2)
SLC-96		80-Type Cabinet (Max.2)
SLC-96		Hut or CEV
SLC-5		51-Type Cabinet (Max.2)
SLC-5		80-Type Cabinet (Max.2)
SLC-5		Hut or CEV
Fujitsu		6200 Type Cabinet (Max.2)
Fujitsu		Hut or CEV
DMS-1 Urban		600 Series Cabinet (Max.4)
DMS-1 Urban		Hut or CEV

Although huts and CEVs may be slightly more economical for large demands, large capacity housings, such as the 80-type cabinets, may remain viable economic options.

While the results of these economic studies indicate that large capacity cabinets are the most economical housing for many values of ten year demand, this does not imply that a proliferation of cabinets on the same site is necessarily appropriate. However, some advanced planning, particularly in developing areas, could lead to the placement of several large cabinets on separate sites instead of one large enclosure. This could be of particular benefit when providing facilities to large "phased" developments. Such a plan would be deferring housing expenditures for portions of the development for which completion dates are often uncertain. In addition, consideration must be given to the nature of the area being served. For example, 51-type cabinets may be aesthetically unsuitable for some urban and suburban areas. A redefinition of CSA boundaries may be appropriate when multiple cabinets are proposed. In these cases, RT cabinets at multiple sites that can be served from the same repeater point or lightwave multiplexer may continue to be administered in the same CSA.

Land acquisition and site preparation costs are also a primary consideration in housing selections. Cabinets, as well as CEVs, may often be placed on public right-of-way at minimal site acquisition costs, while huts often require purchased sites. The following chart shows the land acquisition and site preparation costs used in the associated economic studies. These costs are in addition to the costs associated with actual placement of the housing and associated equipment or cabling. Situations which require significantly different costs may require local analysis.

Structure Type	Land Acq.	Site Prep.
Cabinet		
CEV - 6x16		
CEV - 6x24		
Hut - 10x14		
Hut - 12x20		

2.4.8 Relief Intervals

This section is intended to furnish guidance on the minimum size of placements for digital loop carrier sites. It is not intended to influence in any way the product selection detailed in Section 2.4.5. In some cases, placement of the economical carrier system as recommended may provide channel bank or housing capacity which exceeds the minimum provisioning intervals specified below.

Channel Banks Assemblies (in huts and vaults)	1 year requirement
Remote Terminal Cabinet equipped with channel banks	2 year requirement
Channel Unit Plug-ins	
Less than or equal to 24 lns/yr	1 year requirement
Greater than 24 lns/yr	6 month requirement

When using the cutover strategy, provide additional equipment in accordance with Section 2.4.6.

Many areas of the operating companies have or will soon implement Plug-In Provisioning on a Service Order basis (PIPSO) as documented in RL-87-06-009SV. For those areas, PIPSO guidelines should be followed for channel unit provisioning. Channel units may still be provided by job authorities when such provisioning can avoid field visits by installation personnel. For example, providing facilities for an apartment complex may include installation of the feeder/distribution jumper wires and channel unit plug-ins on the job authority.

2.4.9 Integration

Digital loop carrier systems used exclusively for POTS and other locally switched circuits, such as PBX trunks, may be readily and economically integrated with current technologies. Economic analysis indicates that integration is the least cost alternative to universal carrier arrangements for a wide range of situations. Furthermore, study results suggest that even at very low utilization rates for the digital loop carrier, integration is the economical choice. Only in those cases where utilization rates for both the digital loop carrier and the associated switch peripheral equipment remained low for the entire ten year study period did integration appear to lose its economic advantage. The utilization rate for digital loop carrier equals the number of channels assigned or used divided by the number of channels available. The utilization rate for the switch peripheral equipment equals the number of carrier systems terminated (or DS1s used) divided by the maximum number of systems (or DS1s) allowed. This is not to be confused with the utilization rate shown by demand and facility (D & F) charts.

Therefore, digital loop carrier should generally be integrated into the switch. Significant unused capacity in the switch and the size of new equipment placements may affect the economic viability of integration in a specific situation. The tables in Attachment 10 should be used only for those cases where low utilization rates are expected over a long period of time for the digital loop carrier and the associated switch peripherals. However, for the vast majority of cases, the long term utilization for the switch peripherals is not expected to remain low.

Digital switch components capable of full integration with digital loop carrier systems, including "Nail-up" and "Hairpin" or "Sidedoor" features for handling non-switched (NS) or non-locally switched (NLS) special services, are available for the DMS-100 switch with BCS-24 or later software (See Section 4.2 for more information on both the DMS-100 and 5ESS switches). The hairpin/sidedoor feature has been successfully trialed and its use with integrated digital loop carrier should be considered as an economic alternative to dedicated systems for NS/NLS special services. Where the forecast for all services at one customer or RT site can be served by one digital loop carrier system, then a dedicated system for NS/NLS specials is probably not cost effective if any number of services are locally switched. Where the forecast exceeds one system at an RT site, consideration should be given to placement of a dedicated system for NS/NLS specials. The obvious exception is where all the NS/NLS special services could be served by excess capacity on the systems required for switched services.

In general, therefore, place integrated digital loop carrier using the hairpin/sidedoor feature of the DMS-100 for all single system sites serving both switched and NS/NLS special services and for all multi-system sites where less than 24 NS/NLS special services are forecasted for the site during the three year planning period. This does not imply that all NS/NLS special services need to be served by the same carrier system.

For analog central offices, consider the placement of digital loop carrier consistent with the crossover and product recommendations for integrated carrier only when an equipment order has been placed with a vendor for a digital switch replacement. For information on the replacement of analog switches, see the Analog ESS Economic Study Guideline (RL-88-10-032SV).

2.5 New Facilities for Digital Span Line

2.5.1 New Facilities versus Existing Metallic Facilities

As stated in Section 2.4.2, the preferred method of providing DS1 facilities for subscriber carrier is via existing metallic cable. A lack of existing metallic facilities suitable for DS1 development may lead to consideration of a new cable to provide the digital span lines for digital loop carrier and other services. Conditions which may make the existing metallic facilities unsuitable should be documented and may include:

a. A history of high trouble rates.

b. Excessive cable rearrangements to acquire suitable pairs or other extraordinary expenditures (see Section 2.4.3).

c. Unacceptable results of preconditioning tests which cannot be reasonably or practically corrected.

d. Excessive cutover of existing lines, particularly for high growth rates (see Section 2.4.6)

2.5.2 New Fiber Cable versus New Metallic Cable

In general, when new cable facilities are required to support digital span lines for digital loop carrier and other DS1 requirements, place fiber cable and associated electronics. Where lightwave multiplexing arrangements can utilize significant equipment capacities, placement of a fiber cable and associated multiplexing equipment is more economical than the placement of a new metallic cable and DS1 repeater equipment. However, for low demands, the low utilization of multiplexing equipment may favor the deployment of metallic cable. Proposals for the placement of a new digital line facility (fiber or metallic cable) to serve a total ten year demand of 12 DS1s or less should be justified with an economic study which assesses the impact of future broadband requirements. Other factors which may affect cable selection include:

a. Limited structure space. Do not place a metallic cable for digital span lines in the last available duct. Place innerduct and fiber cable instead.

b. Demand for broadband services such as LightGate.

c. Placement of interoffice trunk cable. Joint loop and interoffice fiber cables should be considered if both have requirement triggers and their respective service dates are within two years of each other.

d. Excessive repeater manhole placements and other unusual expenditures related to providing the digital span line.

2.6 Lightwave Multiplexing Equipment

2.6.1 Product Selection

The graphs on Attachment 11 provide a screening tool for selecting the most economical lightwave system type for each value of total ten year demand, growth pattern, and distance from the central office. While a high speed lightwave system may appear to be the most economical arrangement for a limited number of situations, the anticipation of the introduction of SONET compatible multiplexers may lead to consideration of a lower speed system (<=180 Mbps), particularly if the five year demand can be satisfied (see Section 4.3). Consideration of the fiber hub plan for the route and remote terminal housing arrangements may also influence the selection of the appropriate lightwave system (Also see Section 2.7.1). Where current plans include optical extensions from hub locations, a currently available 150Mbps system which provides DS3 add/drop capability should be considered. It is particularly suitable to cabinet installations due to its small size. Methods and procedures for the deployment of this system are currently being developed.

2.6.2 Housing Requirements

Presently the only lightwave systems which may be installed in a remote cabinet have transmission rates of 90 to 180 Mbps. Lightwave systems with transmission rates greater than 180 Mbps must be installed in a controlled environment available in huts, CEVs, and customer premise locations. "Hardened" versions of these systems may be available in the near future. See Section 2.4.8 for selection of equipment housings.

2.6.3 Relief Intervals

Provisioning intervals for lightwave multiplexing equipment should be as follows:

a. Place the number of lightwave transmit/receive units and high speed (DS3 and above) multiplexing plug-ins to meet only the one year requirement.

b. For fiber hubs utilizing 90/180 Mbps systems, if the ten year demand is less than 56 DS1s, place the 90 Mbps version. Otherwise, place the 180 Mbps version.

c. For fiber hubs utilizing 560 Mbps systems, if the one year requirement is less than or equal to 28 equivalent DS1s, consideration should be given to placing a DS3 lightwave system which can be converted at a later date to an electrical multiplexer for higher bit rate systems. If the two year requirement is greater than 28 DS1s, also provide the hardwired shelves for the higher bit rate system.

d. Provide hardwired shelves for low speed multiplexing (less than DS3) for the one year requirement.

e. Provide plug-ins for low speed multiplexing (less than DS3) for the one year requirement, except as required by tariff provisions for services such as Lightgate.

2.7 Fiber Cable

2.7.1 Fiber Hub Design

Fiber hub design should be considered in developing an optimum fiber plan. A fiber hub is a location in a fiber cable route from which one or more Carrier Serving Areas (CSAs) can be economically supported. The fiber hub is generally a location at which the bit stream is multiplexed from a lower to a higher bit rate. This permits more efficient use of fiber between the central office and fiber hub. Facilities provided by this method are then extended as DS1 lines on metallic facilities to various CSAs or at lower bit rates on fiber cable to various CSAs or other fiber hubs. This arrangement may avoid the high costs associated with the under utilization of both fiber and multiplexers which may be experienced if fiber is extended to each individual CSA or customer location.

However, the use of back-to-back lightwave multiplexers at the hub site may not be an economical alternative. Lightwave multiplexers which allow lightwave extensions as an integrated part of the high speed system without the addition of separate hardwire shelves and common plug-ins may provide a more attractive hubbing alternative. The introduction of synchronous lightwave multiplexers with DS1 add/drop capability consistent with SONET standards will greatly enhance the viability of fiber hubbing and the entire fiber network (See Section 4.3). Although long term fiber plans should consider the impact of SONET on future fiber requirements, the uneconomical placement of asynchronous multiplexer equipment, either back-to-back or integrated, to meet short term demand at a hub site should not be justified on the basis of a temporary substitute for SONET equipment, but rather as an economically justified alternative to dedicated point-to-point systems.

The following general guidelines should be considered when establishing a fiber hub:

a. Remote terminal sites requiring a hut or vault installation should be the primary choice for fiber hub installations. "Hardened" lightwave systems may also be placed in remote cabinets when significant utilization can be achieved by serving other nearby cabinets.

b. A fiber hub should generally serve one (1) to five (5) CSAs and should be located at a major taper point or large planned installation.

c. Existing metallic cable should be fully utilized, where practical, for extensions from a fiber hub to a remote terminal site. Short sections of metallic cable may be placed for extensions or to fill gaps in the existing network.

d. In general, no DS1 protection line should be provided for carrier systems collocated with a lightwave multiplexer. However, the provisioning of a DS1 protection line may be used to provide an added margin of safety for service continuity for a system serving particularly high traffic levels or particularly sensitive or important services.

e. In general, the DS1 protection line should be routed through the lightwave multiplexer when the carrier system is supported by metallic DS1 extensions. When expected service demands include DDS and/or other data lines, consideration should be given to placement of a SLIM to terminate the DS1 protection line for TR-008 systems at the lightwave multiplexer site to ensure satisfactory transmission.

2.7.2 Mode Selection

Only single mode fiber should be used for new installations. Multimode fiber may be used only to extend an existing multimode fiber cable, either by direct splicing or cross-connecting.

2.7.3 Fiber Sizing - Singlemode

As specified in Section 2.6.1, the graphs on Attachment 11 provide a screening tool for selecting the most economical lightwave system type. After selecting the appropriate system type to meet the total ten year demand, singlemode fiber cables should generally be sized for the ten year requirement as follows:

a. Provide four fibers for each lightwave system to be placed during the ten year period. The number of systems to be placed during the ten year period equals the total ten year demand for DS1s divided by the capacity of the selected system type. The chart on Attachment 12 lists the equivalent capacities for various transmission rates.

b. Provide two spare fibers (in addition to protection fibers) for each lightwave system to be placed during the ten year period. This will provide a minimum of two spare fibers at each hub for unforeseen demand and will allow the use of standard fiber cable sizes in multiples of six (6) fibers.

c. Fiber cable terminating hardware should be sized as a minimum to match the fiber cables placed at the remote equipment sites. Recommendations for fiber cable terminations are being formulated by the Fiber Termination Product Team.

d. Fiber cable terminating hardware placed at the central office should be sized for all fiber cables placed during the central office engineering interval.

Although the introduction of SONET lightwave multiplexers may impact the sizing of fiber cables, vendor products for the full range of SONET capabilities are not yet available and costs are unknown (see Section 4.3). SONET architectures will include add/drop chains, hubs, and rings, as well as point-to-point systems. Because of the unknowns regarding costs and specific product configurations, guidelines to identify the most economical SONET architecture for a given situation are not fully developed. Therefore, the effects of these architectures on the sizing of currently planned fiber cable placements cannot be determined at this time.

While economic study results favor the placement of fiber cables sized for the ten year demand, a five year sizing period often yields only a marginal long term cost penalty and may be appropriate when large fiber cable placements are being generated by large demands in the last five years of the ten year study period. Also see previous comments regarding the effects of SONET.

2.8 Distribution Cable

2.8.1 LROPP

Long Range Outside Plant Planning (LROPP), BSP 901-350-201, establishes design criteria for distribution plant based on ultimate design points of each area. Although these criteria simplify feeder administration and distribution design, they may result in significant overgauging of the distribution plant in those areas that are to be served primarily by digital loop carrier facilities.

2.8.2 Design Criteria

a. Digital Loop Carrier

For loops served by digital loop carrier, do not exceed a 900 ohm drop limit or 5db loss, including bridged tap. Although some channel units may be available with drop limits which exceed 900 ohms, "on hook" transmission capabilities may not be supported by these units. The table on Attachment 12 lists the loss and resistance data for loaded and non-loaded cable pairs.

b. Load Coils

As stated in Section 2.1, avoid the use of load coils in new plant construction since loading is unsuitable for digital services. However, loading may be necessary in expanded carrier serving areas beyond rural remote terminal sites (see Section 2.4.4).

c. Metallic Facilities

Appropriate resistance design rules or long route design rules should be utilized for loops served by metallic feeder pairs. The table on Attachment 12 lists the loss and resistance data for loaded and non-loaded cable pairs.

2.8.3 Application of Design Criteria

a. Digital Loop Carrier Only

Consider only the design criteria that apply to digital loop carrier for areas that meet one of the following conditions:

1) The area is within a carrier serving area served entirely by digital loop carrier facilities (no voice frequency feeder pairs available).

2) All available voice frequency facilities are committed to other areas within the carrier serving area, all growth in the CSA is being served by digital loop carrier facilities, and the area being considered is served entirely by digital loop carrier.

This may allow the placement of finer gauge distribution cable than would be placed under resistance or long route design rules, particularly in areas with well defined ultimate distribution lengths such as SAC areas or well developed business areas. Caution should be exercised in placing fine gauge cable in sparsely developed areas with ultimate distribution lengths that are not yet well defined.

b. Metallic Facilities and Digital Loop Carrier

For areas served by both metallic facilities and digital loop carrier, apply both the resistance or long route design criteria and the digital loop carrier design criteria. Choose the coarser distribution gauging plan in order to satisfy both sets of criteria. In some cases the resistance or long route design will dictate a coarser gauge than will digital loop carrier. In other cases, particularly for long distribution lengths associated with expanded carrier serving areas and rural allocation areas, digital loop carrier design criteria may dictate the coarser gauge. If this is the case, a re-examination of the outside plant sectionalization process may reveal a more appropriate gauging plan.

c. Metallic Facilities Only

For areas served entirely by metallic facilities, the eventual placement of digital loop carrier for relief or replacement of existing feeder facilities should be considered when designing the distribution plant. Therefore, distribution gauging plans should be developed as described in paragraph b.

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3.0 MARKET CONSIDERATIONS

3.1 Market Potential

A basic consideration in a loop technology deployment strategy is the market potential for existing and new digital services that cannot be provided technologically and/or economically by the conventional metallic based network. This market potential affects the effective life of newly placed metallic facilities as well as the expected migration from voice frequency to digital based services. Since services such as customer controlled private line networks often require conversion to a digital format at the switch, there are already technological reasons for moving from a voice frequency network to a digital network, while increasing penetrations and complexities of digital requirements lead from a metallic based network to a fiber based network.

It should be noted that there are no narrowband services that cannot be provided over non-loaded metallic loop lengths (less than 18 kft of total loop length). Broadband services, on the other hand, will require the placement of fiber based facilities all the way to the customer interface and represent a market potential which cannot be satisfied either by a conventional metallic cable network or by a conventional digital loop carrier feeder network, whether metallic or fiber based. Although the placement of fiber cable provides increased future network capabilities, the uneconomical deployment of digital loop carrier provides no additional positioning for any existing or future services, including broadband, and can provide no additional revenues. Furthermore, changes in the cost of fiber have a negligible effect on the carrier/cable crossover point, even when its cost is assumed to be zero.

Assessment of market potential and its effect on network investments will be more fully developed by market and network programs currently under development. Identification of potential service demands and required network capabilities for particular market areas will allow development of a more precise deployment strategy tailored to meet specific market area demands.

3.2 Geographic Flexibility

Since metallic cable facilities are tied to a specific geography and a limited range of services, a major shift in service demand by even a single large customer to other locations or to other services such as Lightgate may render significant metallic capacity and large capital investments useless. Where existing digital loop carrier systems and other electronics may not meet future service needs or may no longer be required at a particular location, the bulk of the investment may be moved to meet service demands at other locations.

3.3 Effective Service Life

An effective service life of ten years was used for all metallic cable placements in the economic studies. It is appropriate for this life to equal that specified for current generation electronic systems, since with the recommended deployment guideline, both technologies are equally capable of providing existing analog and digital services and have equal potential for obsolescence by technologies which will provide broadband and/or video services as well as narrowband services.

4.0 TECHNOLOGY CONSIDERATIONS

This section summarizes some of the continuing issues or general assumptions concerning technology development and applications. Deployment recommendations concerning approved products and technologies are contained in Section 2.

4.1 Integrated Services Digital Network (ISDN)

Standards for ISDN basic access circuits (2B+D, two 64 kbps data or voice channels and one 16 kbps data circuit) have been largely completed and can be provided over common non-loaded two-wire metallic loops out to 18 kft (total loop length including bridged tap). Some development of digital loop carrier architectures to provide ISDN basic access has already been completed and further work is continuing. TR-397 contains standards for transport of ISDN circuits over digital loop carrier, either with dedicated or dynamically assigned time slots.

Current and proposed universal carrier arrangements for providing narrowband ISDN utilizes three time slots dedicated to each ISDN circuit which results in significantly low utilization of the hardwired carrier components. In addition, costs for plug-ins are significantly higher than for POTS. Proposed integrated carrier arrangements utilize dynamically assigned time slots for "B" channels with multiplexed full time "D" channels. This will allow the more efficient use of hardwired components as well as eliminate the central office terminal and the Digital Subscriber Line (DSL) plug-ins that interface with the digital switch. Digital loop carrier and digital switch components to provide integrated access will not be available until the 1991-1992 timeframe (See Sections 2.4.1 and 2.4.5).

4.2 Carrier/Switch Integration

Digital switch components capable of full integration with digital loop carrier systems, including "Nail-up" and "Hairpin" or "Sidedoor" features for handling non-switched special services, are available for the DMS-100 switch. "Nail-up" allows permanent circuit connections through the switch. "Hairpin" or "Sidedoor" allow the grooming of individual DS0 circuits from a digital bit stream for alternate routing while the other circuits continue to be routed to the switch. Hairpin provides intra-unit grooming between carrier systems served by the same switch peripheral, while sidedoor provides inter-unit grooming via DS1 links from the switch peripheral to another device, such as a digital crossconnect unit or D4 channel bank. However, enhancements to operational support systems have not yet been completed to allow efficient administration of all these capabilities. Until enhancements are complete, use of nail-up capabilities should be restricted to specific cases. The hairpin/sidedoor feature in the Subscriber Carrier Module (SCM) of the DMS-100 switch has been successfully field trialed and should be considered as an economic alternative (See Section 2.4.9).

The nail-up feature in the Digital Carrier Line Unit (DCLU) of the 5ESS is currently under study and is being scheduled for field trial. A new switch interface is planned to provide full integration capabilities for carrier.

The use of digital access and cross connect devices and/or the use of separate systems at the remote terminal site may make the integration of non-switched special services uneconomical during the short term. Digital loop carrier systems used exclusively for POTS and other locally switched circuits, such as PBX trunks, may be readily and economically integrated with current technologies.

Integration capabilities will be greatly enhanced when digital loop carrier and switch components compatible with TR-303 become available in the 1991-1992 timeframe. Some vendor plans include enhancements to existing carrier systems to provide TR-303 compatibility (see Section 2.4.5). TR-303 contains requirements for a generic interface for integrated digital loop carrier systems. This generic interface will allow multiple vendors' remote carrier terminals to interface with multiple vendors' digital switches. TR-303 also defines remote terminal functionality, including concentration of switched services through dynamic time slot assignment, grooming of special services, and remote access for operations, administration, and maintenance functions. TR-303 carrier systems may have 2 to 28 DS1s serving 48 to 2048 channels.

4.3 Lightwave Multiplexing/SONET

There is currently a proliferation of lightwave multiplexing products available. A 90 Mbps integrated lightwave system was chosen as the "low-speed" lightwave system to be used by this guideline because of its price and capacity advantage over currently marketed 45 Mbps systems. For demands that exceed the capacity of one 90 Mbps system, the 180 Mbps option was also considered by the associated economic studies. A 565 Mbps system is used as a representative "high-speed" system to compare with the 90 Mbps system. A 45 Mbps system is used only as an electrical "low-speed" multiplexer for the representative "high-speed" system.

The introduction of add/drop synchronous multiplexer capabilities will increase the economic viability of fiber optic facilities. Some products are available today with limited add/drop synchronous capabilities, but general deployments should be based on the Synchronous Optical NETwork. SONET will provide the following network capabilities:

a. A family of standard optical interfaces that will allow compatibility of multiple vendor equipment.

b. Integrated operational and administrative functions that will allow remote provisioning, remote bandwidth management, and remote maintenance.

c. Modular multiplexing so that higher order signals are simply multiples of lower order signals. This allows identification of DS1/DS3 signals which permits efficient add/drop capabilities without demultiplexing.

d. Accommodation of existing asynchronous signals, such as DS1 and DS3, as well as future broadband signals.

Although SONET interfaces will be defined for digital loop carrier remote terminals and switch interfaces, most digital loop carrier systems will most likely be fed by Add/Drop Multiplexers (ADMs) arranged in chains or rings. Point-to-point multiplexer arrangements may still be viable applications where demand is large.

Currently defined SONET standards (Phase 1) are sufficient to allow transport between different manufacturer's systems, but the full benefit of SONET cannot be realized until standards are completed on data communications for operational support capabilities (Phase 2). Otherwise, communications between operational support systems and network elements will follow proprietary schemes. Although Phase 1 products may be offered by some vendors, general deployment of SONET network elements should not begin until Phase 2 equipment is available. There are two reasons for this recommendation. First, Phase 2 equipment is expected to be available in mid-1991. Second, the risk is high that upgrades to Phase 2 will require hardware replacements.

4.4 Remote Switching

The Remote Switch/Digital Loop Carrier analysis indicates that remote switch units are not economical as relief alternatives to digital loop carrier in single carrier serving area (CSA) applications serving primarily POTS. Other remote switch applications such as new wire centers, CDO replacements, or combinations of multiple high growth CSAs that do not dictate significant metallic cable placements may require a detailed study by the lata/fundamental planners. Due to the excessive cost to provide pre-standard ISDN over universal digital loop carrier, RSUs may be the only practical facility capable of satisfying large volumes of early ISDN demand beyond 18 kilofeet from the serving central office. The relative projected economics of standard ISDN components are estimated to impact RSU and integrated DLC technologies comparatively the same, suggesting a result similar to that of the existing analysis. (See Section 4.1 for ISDN considerations.)

4.5 Special Service Provisioning Costs

When considering the effects of special service demands on loop technology deployments, the following assumptions should be made about the costs of provisioning special services (usually non-switched or non-locally switched circuits):

a. Voice Frequency Special Services

   For voice frequency special services on loops greater than 8 kft (total loop length), the circuit provisioning costs on metallic cable and digital loop carrier are approximately equal. For loops less than 8 kft (total loop length), no MFT (metallic facility terminal) is required for most voice frequency special services served on metallic cable, resulting in much lower costs than on digital loop carrier.

b. Subrate DDS

   For subrate DDS (less than 56 kbps), the circuit provisioning costs on metallic cable and digital loop carrier are approximately equal for non-loaded loops. For total loop lengths greater than 18 kft, subrate DDS would require non-loaded metallic facilities, while voice frequency services require loading, resulting in additional expenditures to condition and administer separate metallic facilities.

c. DDS 56 kbps

For 56 kbps DDS on loops less than 12 kft (total loop length), the circuit provisioning costs on metallic cable and digital loop carrier are approximately equal. For loops longer than 12 kft (total loop length), field repeaters are usually required for 56 kbps DDS on metallic facilities, resulting in significant expenditures. Additional conditioning expenditures are required to provide non-loaded metallic facilities for loops longer than 18 kft (total loop length).

4.6 Fiber Distribution Networks

Currently, deployment of fiber distribution networks using currently available products is not economical for providing narrowband services compared to conventional metallic distribution facilities. Furthermore, the forecast of available revenues from identified potential broadband services is not sufficient to justify the additional cost of placing broadband electronics on an existing fiber distribution facility.

Several architectures have been proposed and are under consideration for this "last mile" application of fiber technology. A variety of vendor products are under development, some of which utilize adaptations of existing digital loop carrier products or similar devices at the remote terminal site, and some of which propose radically new designs. Although architectures which utilize active electronics at the curb appear to be the most economical fiber alternative, issues such as powering still must be resolved prior to general deployment.

Residential areas which are forecasted to have a significant penetration of customers with more than two lines present the most advantageous opportunity for the deployment of fiber distribution networks because conventional distribution facilities are often designed for more than two pairs per living unit. However, the regional forecast for these types of developments is small compared to total growth of new developments. Furthermore, the introduction of standard narrowband ISDN products, which is expected in the 1991-1992 timeframe, will readily allow the efficient provisioning of multiple circuits on each metallic cable pair, making designs of more than two pairs per living unit unnecessary.

Business areas, particularly business parks, where significant demand is expected at each customer location may present opportunities for the deployment of electronics and fiber directly to the customer location, even with conventional products. Studies are continuing and all proposals should be justified with an economic study.

5.0 GUIDELINE UPDATES

The BellSouth Loop Technology Deployment Guidelines will be updated periodically to reflect the development of new study tools and methods, the refinement of market analysis, the introduction of new technologies, and the adjustment of price relationships. These issues are discussed in more detail in the following sections.

5.1 Mechanized Study Tools

The Economic Study Module (ESM) of the LEIS™ System was utilized in the economic studies conducted to develop this guideline. Other mechanized study tools, such as the Current PLANning Module (PLAN) of LEIS™ and the Network Planning System - Distribution (NPS-D) are now available and will enhance our ability to assess the impact of new technologies, market demands, special service provisioning costs, and other factors on the technology deployment process. These study tools contain headquarters cost files that will be periodically updated to assure ongoing consistency with changes in the Guideline. Additional information on these mechanized study tools can be found in the following practices:

ESM/PLAN: BR 901-600-005 through BR 901-600-013 and 916-100-017SV

NPS-D: BR 781-210-210

5.2 Market Analysis

As discussed in Section 3.1, the assessment of market potential and its effect on network investments will be more fully developed by market and network programs currently under development. Identification of potential service demands and required network capabilities for particular market areas will allow development of a more precise deployment strategy tailored to meet specific market area demands.

5.3 New Technologies

As new technologies are introduced to meet existing and new market demands, these guidelines will be updated to reflect those that are approved for use in the loop network.

5.4 Changing Costs

As the cost relationships of various technology alternatives continue to change, these guidelines will be updated to reflect the new cost relationships.

NOTES FOR ATTACHMENTS 1 - 8

These graphs should be used as a screening tool to select the most economical technology deployment solution for feeder facilities to each CSA, based on total ten year demand, growth pattern, distance from the central office, and other considerations. See Section 2.2 and 2.4 for other considerations when deploying metallic feeder cable and digital loop carrier, respectively.

Attachments 1-3 should be used when considering CSAs with all growth patterns except high first period growth. **These results are based on a constant growth pattern and other growth patterns, such as a bell shaped growth pattern, yielded similar results in the associated economic studies. "Constant Growth" includes 10% of the total ten year demand each year. Attachment 7 is similar, but for demands with 50% switched specials which can be served by integrated carrier in a DMS-100 office.**

Attachments 4-6 should be used when considering CSAs with high first period growth only. High first period growth patterns include approximately 75 % of the total ten year demand during the first two years. **Attachment 8 is similar, but for demands with 50% switched specials which can be served by integrated carrier in a DMS-100 office.**

For growth situations in between these patterns, an interpolation of the carrier crossover points must be made by the local loop planner.

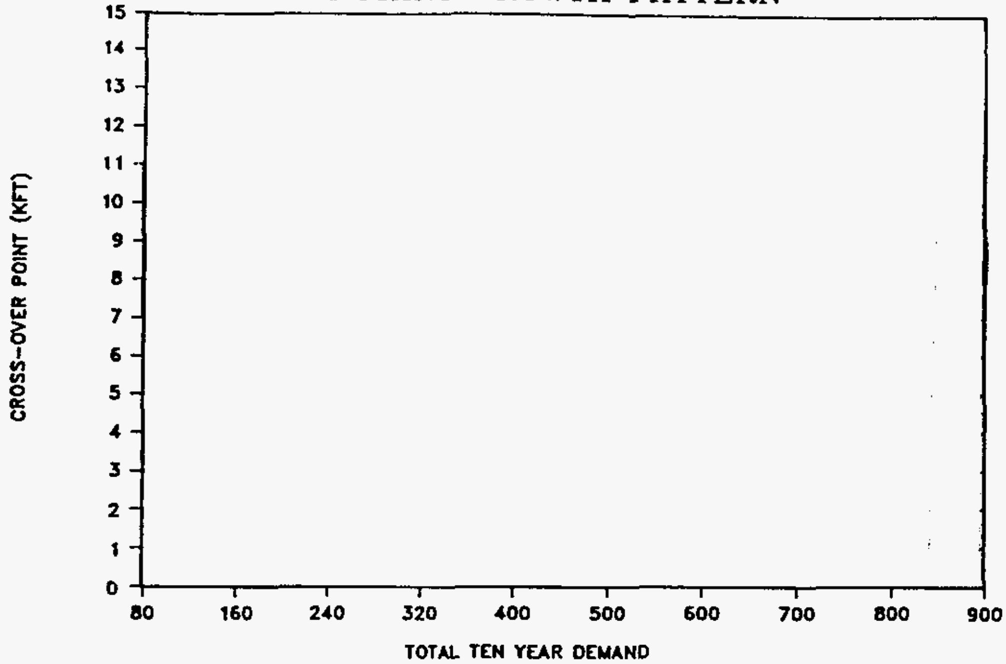
Total Ten Year Demand is the number of lines that will be added to the CSA during the ten year study period, either by growth or transfer, that will require placement of new loop facilities.

Each graph shows separate "bands" for the crossover points to be applied to situations utilizing universal carrier, carrier integrated with a 5ESS, or carrier integrated with a DMS-100. The bottom line of each band shows the crossover points for carrier versus a metallic cable with a unique sheath for that CSA and represents the closest distance that carrier could be the economical choice. The top line shows the crossover points for carrier versus incremental feeder pairs that may be added to other cable sheaths placed for growth closer to the central office and represents the farthest distance that metallic cable could be the economic choice. For values of total ten year demand and distance from the central office that fall above the appropriate band, carrier should be placed to provide feeder facilities. For values below the band, metallic feeder cable should be placed. Values of total ten year demand and distance from the central office that fall between these upper and lower limits represent the situations in which some other method must be used to determine the economic choice, **such as a field study or simply engineering judgement based on knowledge of demand and route conditions.** Primary consideration should be given to market factors and potential service demands that will be required during the planning period.

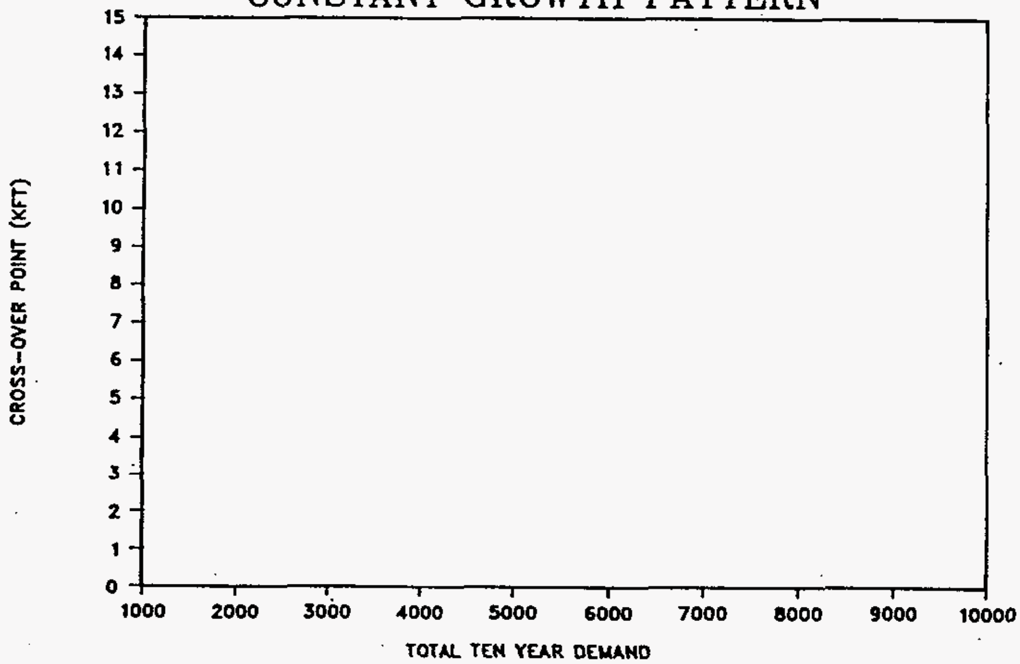
Although some calculated crossover points are beyond 12 kft, particularly for high first period growth or for very high total demand, the factors discussed in Section 2.2 should be considered before deploying metallic feeder cable beyond 12 kft. In addition, the factors discussed in Section 2.4 should be considered before deploying digital loop carrier at distances less than 12 kft.

ATTACHMENT 1

UNIVERSAL CARRIER
CONSTANT GROWTH PATTERN



UNIVERSAL CARRIER
CONSTANT GROWTH PATTERN



ATTACHMENT 2

INTEGRATED CARRIER – 5ESS CONSTANT GROWTH PATTERN

1

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

INTEGRATED CARRIER – 5ESS CONSTANT GROWTH PATTERN

2

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

INTEGRATED CARRIER – DMS–100 CONSTANT GROWTH PATTERN

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

INTEGRATED CARRIER – DMS–100 CONSTANT GROWTH PATTERN

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

ATTACHMENT 4

UNIVERSAL CARRIER
HIGH FIRST PERIOD GROWTH PATTERN

CROSS-OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

UNIVERSAL CARRIER
HIGH FIRST PERIOD GROWTH PATTERN

CROSS-OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

ATTACHMENT 5

INTEGRATED CARRIER – 5ESS
HIGH FIRST PERIOD GROWTH PATTERN

CROSS-OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

INTEGRATED CARRIER – 5ESS
HIGH FIRST PERIOD GROWTH PATTERN

CROSS-OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

ATTACHMENT 6

INTEGRATED CARRIER – DMS–100
HIGH FIRST PERIOD GROWTH PATTERN

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

INTEGRATED CARRIER – DMS–100
HIGH FIRST PERIOD GROWTH PATTERN

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

ATTACHMENT 7

INTEGRATED CARRIER – DMS–100
CONSTANT GROWTH PATTERN – 50% SW.SPEC.

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

INTEGRATED CARRIER – DMS–100
CONSTANT GROWTH PATTERN – 50% SW.SPEC.

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

ATTACHMENT 8

INTEGRATED CARRIER – DMS–100
HIGH FIRST PERIOD GROWTH PATTERN – 50% SW.SPEC.

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

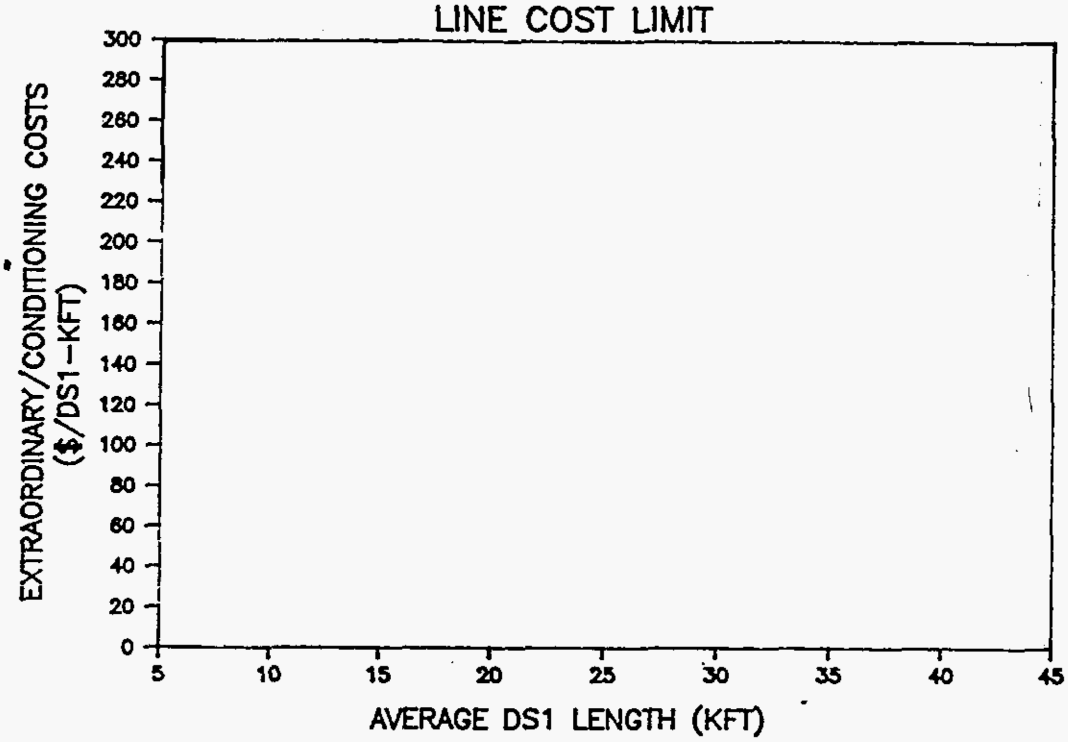
INTEGRATED CARRIER – DMS–100
HIGH FIRST PERIOD GROWTH PATTERN – 50% SW.SPEC.

CROSS–OVER POINT (KFT)

TOTAL TEN YEAR DEMAND

ATTACHMENT 9

EXTRAORDINARY T-1
LINE COST LIMIT



NOTES ON ATTACHMENT 9

1. Identify the total DS1-KFT which would be provided over the length of a potential fiber cable plan. Multiply each DS1 requirement by the portion of its length to be served by fiber facilities.

2. Average DS1 Length = the total DS1-KFT divided by the total no. of DS1s.

3. Mux Util. = the average utilization for all fiber multiplexer hardwire equipment (generally for the wire center or area).

4. The chart indicates the limit of conditioning costs and or extraordinary expenditures (per DS1-KFT) for that particular route. This unit value multiplied by the total DS1-KFT indicates the total cost limit for the route.

1. ATTACHMENT 10

2. ECONOMICAL CARRIER
3. UTILIZATION FOR
4. INTEGRATION (5ESS)

	96-Line Carrier Systems Terminated per DCLU=					
	1	2	3	4	5	6
	DCLU Utilization = Sys. Terminated/Sys. Allowed					
5. Carrier System	17%	33%	50%	67%	83%	100%
6. For all Growth Patterns Except High First Period Growth:						
7. SLC-96 Mode 1						
8. SLC-96 Mode 2						
9. SLC-5 FPB						
10. Fujitsu Mode 1						
11. Fujitsu Mode 2						
12. DMS-1 Urban	/----- Not Integratable with 5ESS ---/					
13. For High First Period Growth:						
14. SLC-96 Mode 1						
15. SLC-96 Mode 2						
16. SLC-5 FPB						
17. Fujitsu Mode 1						
18. Fujitsu Mode 2						
DMS-1 Urban	/--- Not Integratable with 5ESS ---/					

A value of "NA" indicates that integration is not economical at that value of peripheral utilization. A value of ">=0%" indicates that integration is always economical for any value of carrier utilization.

"All Growth Patterns Except High First Period Growth" include constant growth and bell shaped growth patterns which yielded similar results in the associated economic studies. "High First Period Growth" includes approximately 75 % of the total ten year demand during the first two years. For growth situations that may be in between these patterns, an interpolation of the economical utilization rates must be made by the loop planner.

Carrier System Utilization = Channels Used/Maximum Channels Available, where Channels Available = Channel Capacity of RT Channel Bank, Not Channels Equipped

Utilization rates should be taken as an average for the ten year demand period where the total ten year demand is the number of lines that will be added to the CSA during the ten year study period, either by growth or transfer, that will require placement of new loop facilities.

1. ATTACHMENT 10

2. ECONOMICAL CARRIER — Carrier Systems Terminated per SCM-S (Note 1)=
3. UTILIZATION FOR — 1 2 3 4 5 6
4. INTEGRATION (DMS-100)
6. SCM-S Utilization = Sys. Terminated/Sys. Allowed
7. Carrier System — 17% 33% 50% 67% 83% 100%

8. For all Growth Patterns Except High First Period Growth:

9. SLC-96 Mode 2

10. Fujitsu Mode 2

11. For High First Period Growth:

12. SLC-96 Mode 2

13. Fujitsu Mode 2

14. ECONOMICAL CARRIER — Carrier Systems Terminated per SCM-S/U(Note 1,2)=
15. UTILIZATION FOR — 1 2 3 4
16. INTEGRATION (DMS-100)
17. SCM-S/U Utilization = Sys.Terminated/Sys.Allowed
18. Carrier System — 25% 50% 75% 100%

19. For all Growth Patterns Except High First Period Growth:

20. SLC-96 Mode 1

21. SLC-5 FPB

22. Fujitsu Mode 1

23. DMS-1 Urban

24. For High First Period Growth:

25. SLC-96 Mode 1

26. SLC-5 FPB

27. Fujitsu Mode 1

28. DMS-1 Urban

Note 1: Each SCM-S peripheral can terminate a maximum of 20 DS1s or six 96-line systems. Assume a maximum of 6 systems for SLC-96 Mode 2 and 4 systems for SLC-96 Mode 1.

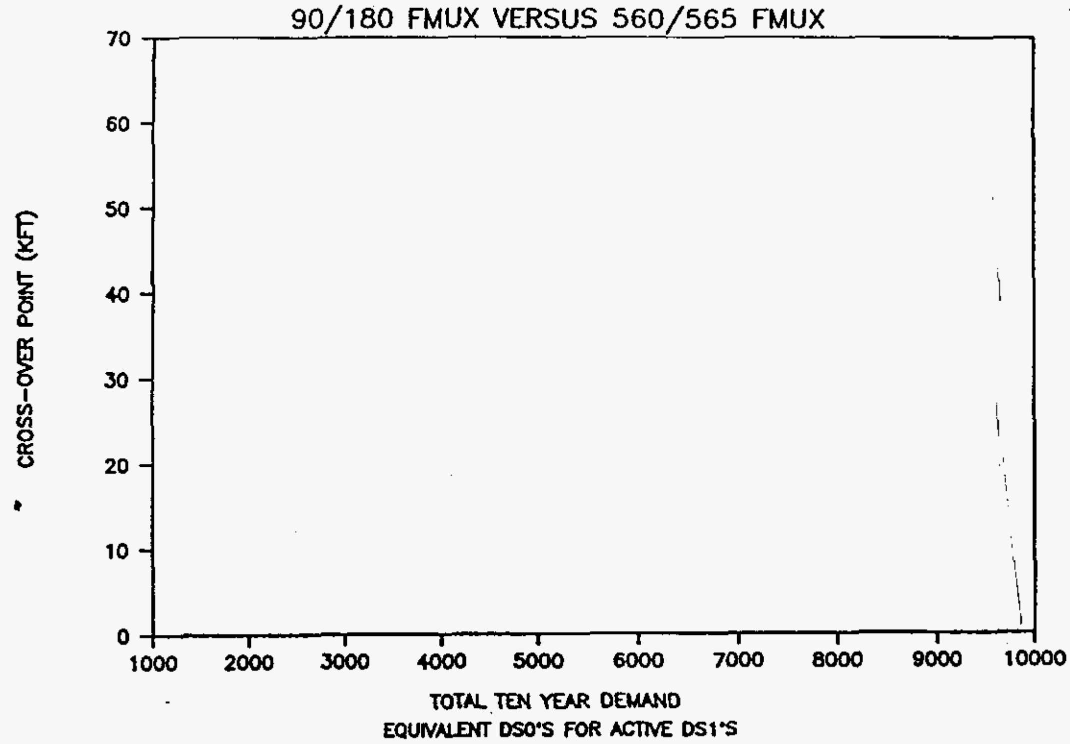
Note 2: Each SCM-U peripheral can terminate a maximum of 20 DS1s. Using 4 DS1s per DMS-1 Urban, assume a maximum of 4 systems.

Also see notes on page 1 of Attachment 10.

ATTACHMENT 11

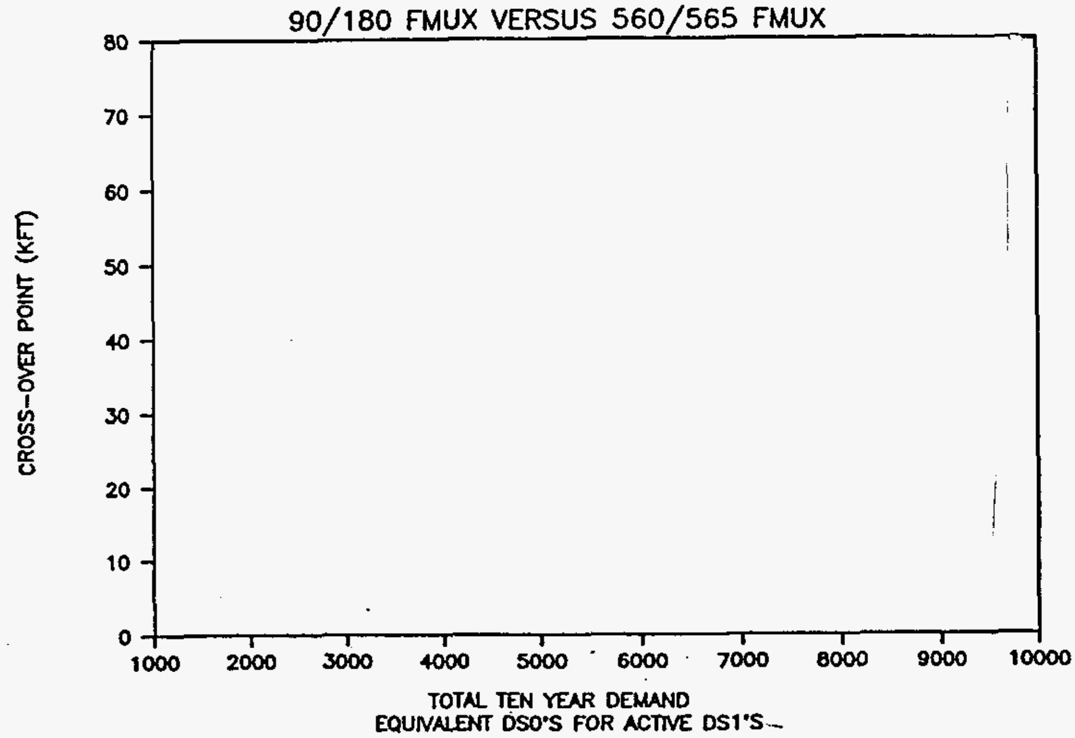
CONSTANT GROWTH

90/180 FMUX VERSUS 560/565 FMUX



HIGH FIRST PERIOD GROWTH

90/180 FMUX VERSUS 560/565 FMUX



ATTACHMENT 12

LIGHTWAVE SYSTEM CAPACITIES

Transmission		Equivalent Capacities		
Level	Bit Rate	DS3	DS1	Voice
DS1	1.5 Mbps	-	1	24
DS2	6.3 Mbps	-	4	96
DS3	45 Mbps	1	28	672
-	90 Mbps	2	56	1344
-	180 Mbps	4	112	2688
-	565 Mbps	12	336	8064

DISTRIBUTION DESIGN LIMITS

Distribution Area Location	From Cent.Off. Resist.	From Cent.Off. Loss	From RT Site Resist.	From RT Site Loss
1. Non-loaded Areas	1300 ohms	8db	900 ohms	5db
2. Loaded Areas within Supervision Limits				
Step-by-Step	1300 ohms	8db	900 ohms	5db
Other Offices	1500 ohms	8db	900 ohms	5db
3. Area Beyond Supervision Limits	2800 ohms	14db (E/W 6db Gain)	900 ohms	5db

DC RESISTANCE (OHMS/KFT)

Cable Gauge	Non-Loaded 68°F	Non-Loaded 100°F	Non-Loaded 140°F	H-88 Loaded 68°F	H-88 Loaded 100°F	H-88 Loaded 140°F
19	16.7	17.2	18.6	18.2	18.7	20.1
22	32.4	34.6	37.4	34.3	36.1	38.9
24	51.9	56.5	60.0	53.4	57.0	61.5
26	83.3	89.2	96.2	84.8	90.7	97.7

VF LOSS AT 1000 HZ (DB/KFT)

Cable Gauge	Non-Loaded 68°F	Non-Loaded 100°F	Non-Loaded 140°F	H-88 Loaded 68°F	H-88 Loaded 100°F	H-88 Loaded 140°F
19	.24	.25	.26	.08	.09	.10
22	.34	.36	.38	.15	.16	.18
24	.44	.46	.48	.23	.25	.28
26	.56	.57	.60	.34	.37	.41

Note: Add .25 db/kft for bridged tap.