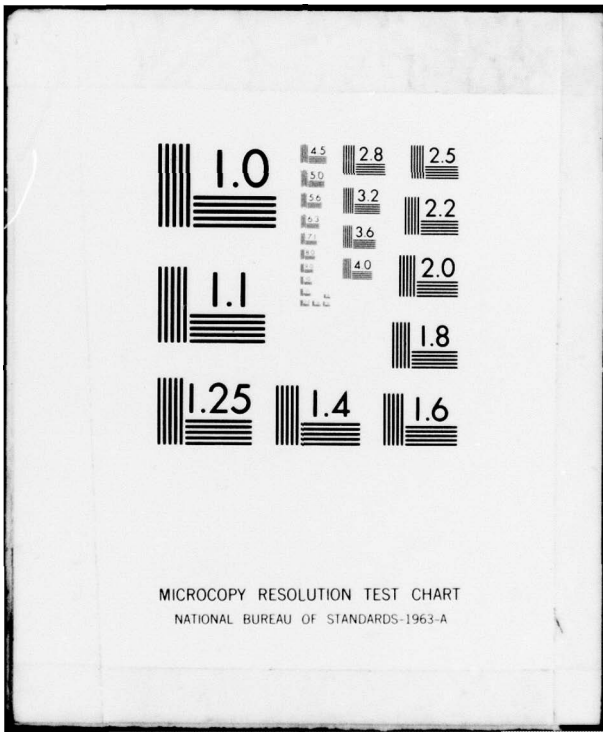
AD-A078 927 COMPUTER SCIENCES CORP FALLS CHURCH VA F/G 17/2
THE DEFENSE COMMUNICATIONS SYSTEM AND THE TACTICAL ACCESS AREA:--ETC(U)
SEP 79 C SCHULTZ , R SAVAGE DCA100-78-C-0053
UNCLASSIFIED SDIE-AD-E100 316 NL

1 OF 2
AD
A078927




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD E100316

THE DEFENSE COMMUNICATIONS SYSTEM AND THE LEVEL III TACTICAL ACCESS AREA: LIKELY CONFIGURATIONS OF INTEROPERATION

AD A078927

DDC RECEIVED JAN 8 1980 E

Prepared for

DEFENSE COMMUNICATIONS ENGINEERING CENTER
1860 Wiehle Avenue
Reston, Virginia 22090

Under

CONTRACT DCA 100-78-C-0053

SEPTEMBER 1979

DDC FILE COPY

This document has been approved for public release and sale; its distribution is unlimited.

COMPUTER SCIENCES CORPORATION

6565 Arlington Boulevard

Falls Church, Virginia 22046

Major Offices and Facilities Throughout the World

79 22 5 041

THE DEFENSE COMMUNICATIONS SYSTEM

AND THE

TACTICAL ACCESS AREA:

LIKELY CONFIGURATIONS OF

INTEROPERATION

DDC
RECEIVED
JAN 8 1980
E

Prepared for

DEFENSE COMMUNICATIONS ENGINEERING CENTER
1860 Wiehle Avenue
Reston, Virginia 22090

Under

CONTRACT DCA 100-78-C-0053

SEPTEMBER 1979

This document has been approved for public release and sale; its distribution is unlimited.

COMPUTER SCIENCES CORPORATION

6565 Arlington Boulevard

Falls Church, Virginia 22046

Major Offices and Facilities Throughout the World

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER (6)

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER (9)

4. TITLE (and Subtitle) THE DEFENSE COMMUNICATIONS SYSTEM AND THE TACTICAL ACCESS AREA: LIKELY CONFIGURATION OF INTEROPERATION

5. TYPE OF REPORT & PERIOD COVERED (13) Final Report Sep 78 — Sep 79

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s) (10) C. Shultz, R. Savage

8. CONTRACT OR GRANT NUMBER(s) (15) Contract # DCA 100-78-C-0053

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Computer Sciences Corporation
6565 Arlington Boulevard
Falls Church, Virginia 22046

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS (11)
Defense Communications Engineering Center/R710
1860 Wiehle Avenue
Reston, Virginia 22090

12. REPORT DATE
Sept [redacted]79

13. NUMBER OF PAGES
98

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 106
N/A

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
N/A

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release: Distribution unlimited

(18) SBIE (19) AD-E100 316

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
N/A

18. SUPPLEMENTARY NOTES
N/A

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Interoperation	Transmission	WWMCCS
Tactical	Subscriber	DEB
Reconstitution	System Engineering	TRI-TAC
Restoral	DCS	
Switching	JMTSS	

405 717 JSW

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report presents likely configurations of interoperation between DCS strategic assets and tactical communications systems. In light of current efforts to define the Joint Multichannel Transmission and Switching System (JMTSS), this report is intended to promote thought, discussion, and a common approach to developing a flexible and responsive military communications network.

For each configuration identified, the report addresses the features and functional services that will be provided as well as electrical interoperability.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Number 20 Continued:

The report addresses two general classes of interoperation. First there is the situation wherein tactical networks directly access the DCS to communicate with a DCS subscriber and/or to interoperate with a DCS switched network on a functionally segregated (access area) basis, referred to as DCS-Tactical Access. The second situation is one in which DCS and tactical assets are functionally integrated to provide one "system". Tactical assets (switches, transmission, subsystems, user devices, etc.) will supplement, extend and reconstitute the DCS and vice versa during crisis/contingencies. The JMTSS is the current conceptual development of this situation, referred to as DCS-Tactical Integrated.

The report concludes with discussion of how/where to focus design efforts to insure compatible DCS/Tactical interfaces and to achieve some degree of system integration.

Accession For
NTIS GRA&I
DDC TAB
Unannounced
Justification
By
Distribution/
Availability
Dist | Avail and/or special
A

TABLE OF CONTENTS

		Page
Executive Summary		1
ES 1	Introduction	1
ES 2	Purpose	2
ES 3	Report Organization	2
ES 4	DCS-Tactical Access	3
ES 5	DCS-Tactical Integrated	4
ES 6	Conclusions	4
Section 1 - Introduction		6
Section 2 - Purpose		8
Section 3 - Report Organization		9
Section 4 - DCS-Tactical Access		12
4.1	General	12
4.2	Configurations for Interoperation	13
4.2.1	Dedicated DCS Subscriber to Tactical Subscriber	13
4.2.2	Direct DCS Switched Service	27
4.2.3	DCS Switched to Tactical Switch Network	39
Section 5 - DCS-Tactical Integration		48
5.1	General	56
5.2	Configurations of Interoperation	61
5.2.1	DCS Extended by Tactical and Vice Versa	61
5.2.2	DCS Switch Reconstitution	61
5.2.3	DCS Reconstitution	72
Section 6 - Conclusions		90
Appendix A - Acronyms		92
Appendix B - Reference Documents		96

LIST OF ILLUSTRATIONS (Cont'd)

Figure

1	Digital European Backbone Network	10
2	Dedicated Point-to-Point Service	12
3	DCS Switched Service Direct to Tactical Subscriber	13
4	Interoperation of DCS and Tactical Switched Service	13
5	Dedicated DCS Subscriber to Tactical Subscriber	14
6	FKV/DEB I Equipment Interoperation with Old Tactical Equipment (TRC-97A)	16
7	DEB II-IV/PDP (DRAMA) Equipment Interoperation with GMF Satellite Terminal Equipment (TSC-85)	17
8	DEB II-IV/PDP (DRAMA) Equipment Interoperation with TRI-TAC Equipment (TRC-170)	18
9	Secure Voice (Unlike End Crypto Equipment)	21
10	Direct DCS Switched Service to Tactical Network Subscriber	28
11	AUTOVON Service VF Interface	30
12	AUTODIN Service Interface	33
13	AUTOSEVOCOM Wideband Service Interface (50 kbps)	36
14	AUTOSEVOCOM Narrowband Service Interface (2.4 kbps)	38
15	DCS AUTOVON Service Interconnected to TTC-39	40
16	DCS AUTODIN to TRI-TAC TTC-39 Interface	43
17	DCS AUTOSEVOCOM to TRI-TAC TTC-39 Interface	47
18	Tactical Interconnect at Remote DCS DEB I/KVF Repeater Site Equipped with TDM	50
19	Tactical Interconnect at Remote DCS DEB II-IV Repeater Site Equipped with TDM	51
20	Tactical Interconnect at Remote DCS DEB II-IV Repeater Site Unequipped with TDM	52
21	DCS Extended by Tactical Equipment (One Interface)	56
22	DCS Extended by Tactical Equipment (Two Interfaces)	57
23	Tactical Extended by DCS	57
24	DCS Switch Replaced by Tactical Switch	58
25	Tactical Microwave Reconstituting DCS Microwave	58
26	Tactical Equipment Positioning to Replace Destroyed DCS Site	59
27	Tactical TROPO Reconstituting DCS Microwave	59

LIST OF ILLUSTRATIONS (cont'd)

Figure

28	Tactical Satellite Reconstituting DCS Microwave	60
29	Tactical TROPO or Satellite Reconstituting DCS TROPO	60
30	TTC-39 Acting as AUTOVON Switch	62
31	TTC-39 Acting as AUTODIN Switch	68
32	TTC-39 Acting as AUTOSEVOCOM Switch	71
33	DCS and Tactical MUX Commonality	74
34	Potential DCS Tactical MUX Interoperation	75
35	Existing FKV System and Planned EWCS SLIP	78
36	FKV System with Unmanned FRC-162 Repeater Reconstituted by TRC-97A	79
37	Technical Interface Characteristics of HY-12/12A and GCC-6	80
38	FKV System with Unmanned FRC-162 Repeater Reconstituted by SHF Tactical GMF Satellite Terminals	83
39	Technical Interface Characteristics for HY-12/12A and TD-660/1065	84
40	FKV System with Unmanned FRC-162 Repeater Reconstituted by TRI-TAC TRC-170	86
41	Technical Interface Characteristics for HY-12/12A and TRI-TAC LGM	87
42	FCC-98/LSTDM Interfacing LGM/USM	88

LIST OF TABLES

Tables

1	Interface Features	19
2	Secure Voice Interface Features (Analog)	22
3	Secure Voice Interface Features (Digital)	23
4	Secure Data Interface Features (Quasi-analog)	24
5	Secure Data Interface Features (Digital)	25
6	AUTOVON VF Interface Features	29
7	AUTODIN VF Interface Features	31
8	AUTODIN Digital Interface Features	32
9	AUTOSEVOCOM 50-kbps Interface Features	35
10	AUTOSEVOCOM VF Interface Features	37
11	AUTOVON to TTC-39 VF Interface Features	41
12	AUTODIN to TCC-39 VF Interface Features	44
13	Type I Contingency Package	53
14	Type IA Contingency Package	54
15	Type II Contingency Package	55
16	Interface Features for TTC-39 Acting as AUTOVON Switch	67
17	Interface Features for TTC-39 Acting as AUTODIN Switch	70
18	Interface Functional Services	76
19	VF Interface Technical Considerations	76
20	Digital Interface Technical Considerations	77

EXECUTIVE SUMMARY

ES 1. INTRODUCTION

The Defense Communications System (DCS) was originally conceived as a "strategic" communications system designed and installed to provide DOD long-haul communications. "Tactical" systems were considered to be those systems, usually mobile, used to support air, ground, and naval tactical operations. Subsequent events have shown a narrowing of this separation and a need for the interoperability of the so called tactical and strategic communications systems. Not only have events such as the Vietnam war shown that there is a need for interoperability of the DCS and tactical systems, but also catastrophic events, such as destruction by fire of a DCS repeater station, indicate that tactical equipment could, if it were interoperable, be deployed to reconstitute the damaged DCS in appreciably less time than fixed assets could (even if available) be deployed and installed.

The DCS is evolving toward a digital system under the management control of the Defense Communications Agency (DCA). Concurrently, new tactical communications equipment is being developed by the Joint Tactical Communications Office, which is also digital in nature. However, the philosophies of DCA and TRI-TAC are not necessarily the same; thus, the equipment that results will not be interoperable without black boxes or equipment modifications. To further compound the problem, the U.S. Army Satellite Communications Agency is developing tactical satellite terminals which will not interoperate with TRI-TAC's tactical equipment. Finally, there are large numbers of old DCS and tactical equipment presently in the inventory which will probably be in use during the lifetime of DCS II (mid-1980s).

Now, there is the JMTSS which is in the conceptual stage. Here, we may expect a system of both old and new integrated DCS and tactical communications equipment. Problems of interoperation of DCS and tactical equipment

will abound and must be solved if JMTSS is to become viable. Now is an appropriate time for the TRI-TAC and JMTSS procurement programs to be reviewed, specifically to ensure that the equipment procured will be interoperable with the DCS.

ES 2. PURPOSE

The purpose of this report is to develop likely configurations of interoperation of DCS II and the tactical access area. (Appendix A defines the acronyms used in this report.) Two general configurations will be developed: first, there is the situation wherein tactical networks directly access the DCS to communicate with a DCS subscriber and/or to interoperate with a DCS switched network on a functionally segregated (access area) basis, including DCS connectivity to tactical forces via satellite communications. This situation will be referred to hereinafter as DCS-Tactical Access.

The second situation is one in which DCS and tactical assets are functionally integrated to provide one system. Tactical assets (switches, transmission subsystems, user devices, etc.) will supplement, extend, and reconstitute the DCS and vice versa during crisis. The Vietnam operation was the forerunner of such situations, and the JMTSS is the current conceptual development of future situations. This situation will be referred to hereinafter as DCS-Tactical Integrated.

ES 3. REPORT ORGANIZATION

Europe will serve as the generic basis for developing DCS-tactical communication interoperability configurations. However, the configurations are equally applicable worldwide.

This report will address interoperational configurations with representative older tactical equipment, and new DCS and TRI-TAC equipment with emphasis on the TRI-TAC equipment as the tactical assets to interoperate with the DCS. Configurations of DCS-Tactical Access will be addressed and

an older tactical equipment will be used to interface with DCS II (mid-1980s). Functional services such as signaling and preemption will be addressed. The same procedure will be followed using tactical satellite terminal and then TRI-TAC equipment.

Configurations of DCS-Tactical Integrated will be covered in the same order as for DCS-Tactical Access, again emphasizing transmission equipment interfaces.

Note that interoperational situations may be presented in this report which subsequent detailed investigations will show are not practical. Inclusion of such situations in this report serves only to indicate that there could be a requirement for the interoperation of the subsystem and/or equipment as shown.

ES 4. DCS-TACTICAL ACCESS

The DCS-Tactical Access areas are summarized as follows:

1. Dedicated Point-to-Point Service
2. DCS Switched Service Direct to Tactical Subscribers
3. Interoperation of DCS and Tactical Switched Services.

The services with which we will be concerned are:

1. Clear Voice
2. Secure Voice
3. Teletype
4. Data
5. Facsimile/Graphics
6. Imagery

Some technical considerations that are of concern are:

1. Bandwidth
2. Frequency Response

3. Impedance
4. Signal Level
5. Balanced or Unbalanced
6. Conditioning
7. 2-wire or 4-wire.

Section 4 of the report will describe the interface requirements and the figures contained therein will depict typical configurations to satisfy the requirements. Specific parameters will not be given because of the multiplicity of equipment possibilities. Also many have not been specified and a partial listing is available in DRAFT MIL-STD-187-320.

ES 5. DCS TACTICAL INTEGRATED

The DCS tactical integrated interoperability requirements are summarized as follows:

1. DCS extended by tactical equipment (one interface)
2. DCS extended by tactical equipment (two interfaces)
3. Tactical extended by DCS
4. DCS switch replaced by tactical switch
5. Tactical microwave reconstituting DCS microwave
6. Tactical equipment positioning to replace destroyed DCS site
7. Tactical satellite reconstituting DCS microwave
8. Tactical TROPO or satellite reconstituting DCS TROPO.

Technical considerations, services concerned, typical reconstitution packages and figures depicting typical configurations as well as in-depth explanations of the need and method used to satisfy these interoperability requirements are contained in Section 5 of the report.

ES 6. CONCLUSIONS

Section 6 of this report describes the conclusions reached after the presentation of the various interoperational configurations. Considerable

investigation and testing will be required to ensure that TRI-TAC and JMTSS will indeed satisfy the interoperability requirements.

SECTION 1 - INTRODUCTION

There has always been a requirement for interoperation of DCS and tactical communication equipment, the degree of which has been dictated by particular operations and situations. Problems of interoperation are not new, whether tactical to tactical, DCS to DCS, or DCS to tactical. The situation in Vietnam was a case in point. Here the solution was to declare most of the existing communication system a part of the DCS, under the operational direction and management control of DCA. This action improved conditions, but interoperation problems continued because of the inherent design features of the many different types of equipment in use.

Now, there is the JMTSS which is in the conceptual stage. Here, we may expect a system of integrated DCS and tactical communication equipment, both old and new. Problems of interoperation of DCS and tactical equipment will abound and must be solved if JMTSS is to become viable.

Prior to examining the various systems, it is necessary to define interoperability. JCS PUB 1 provides the following definition:

> "Interoperability - the ability of systems, units or forces to provide services to and accept services from other systems, units or forces and to use the services so exchanged to enable them to operate effectively together."

Unfortunately, this definition provides only limited aspects of the scope of interoperability as applied to communications. Interoperability can be achieved at various levels depending upon specific needs. DCS-tactical system interoperability exists today in varying degrees of interconnectivity, exchange, and commonality of systems. For example, interoperability can be:

1. Manually assisted interconnects.
2. Limited automatic interconnect using interface boxes for signaling and protocol mode conversion.

3. Fully automatic interconnect with full protocol, signaling, and numbering plan commonality.

The last one, while most difficult to achieve, is the most desirable, since the first two are time and resource sensitive. However, if the needs for interoperability are not specified in the beginning, then modifications or interface boxes become necessary.

SECTION 2 - PURPOSE

Concepts and needs for DCS-tactical communication interoperation are largely unstated today. In fact, there are some who say that no requirement exists. Others say that all interoperation will take place through a few "gateways." However, if JMTSS is to become a reality, and it must if for no other reason than for economic considerations, then likely configurations of interoperation of DCS and tactical communications must be identified, features must be cataloged, and the functional services that will be provided must be addressed. The purpose of this report is to identify and discuss these areas. It should be noted that in a reconstitution configuration it is not the intent nor do we imply total reconstitution but only restoral of service within the limits of capability of available equipment.

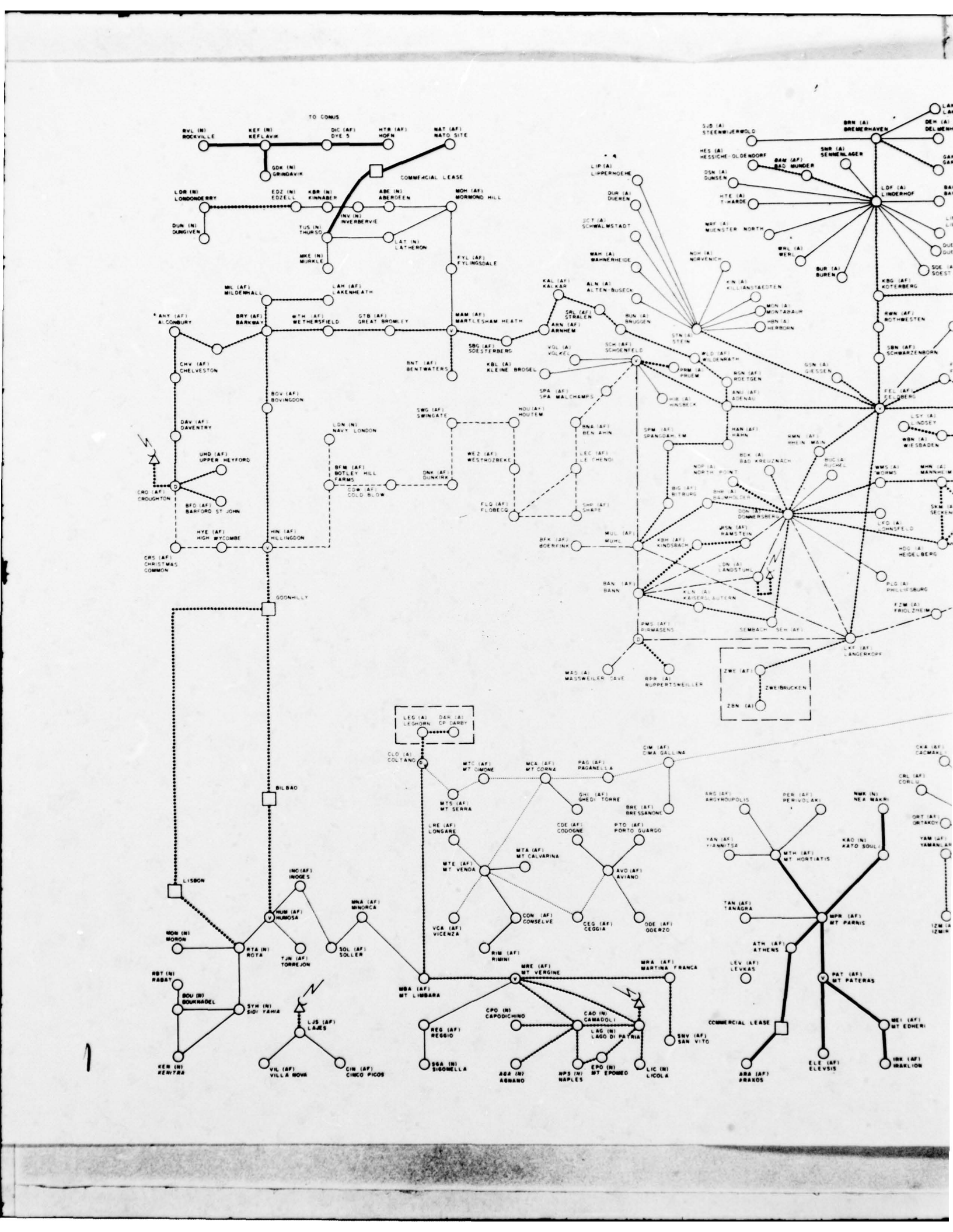
SECTION 3 - REPORT ORGANIZATION

Europe will serve as the basis for developing DCS-tactical communication interoperability configurations. However, the configurations are equally applicable worldwide. For this report, it is assumed that the European DCS is configured as shown in Figure 1. The backbone system is basically digital, and is composed of FKV-DEB I and DRAMA equipment. Satellite communications and leased services are also used as a part of the system. Tails are primarily older FDM/FM equipment. There are a few cases of older equipment being continued in backbone use such as in the United Kingdom, Spain, and Humosa to Mt. Limbara. The DCS-Tactical Access and DCS-Tactical Integrated situations will be developed using the European DCS-1985 (shown in Figure 1) as the baseline. However, the configurations will not be addressed in terms of specific geographical locations.

Although the Army has PCM equipment in use, much of the present tactical equipment inventory is FDM/FM. Usually, interfaces must be accomplished at the VF level, with the problems basically of levels, impedance, and signaling. These problems can be resolved. If data must be transmitted over the older systems, then D/A conversion must occur and the transmission must be quasi-analog. The D/A conversion could take place either at the DCS-tactical equipment interface or at each terminating end of the circuit.

In any event, since the problems with older equipment are basically the same, this report will address interoperational configurations only with a representative older tactical equipment. New DCS and TRI-TAC equipment will be covered. As stated in the task order, TRI-TAC equipment will be emphasized as the tactical assets to interoperate with the DCS.

Configurations of DCS-Tactical Access will be addressed, and a representative old tactical equipment will be used to interface with DCS II (mid-1980's). The features of the configuration, including functional services (signaling,


TO CONUS
RVL (N) ROCKVILLE
KEF (N) KEFLAVIK
DIC (AF) DYE 5
HTR (AF) HOFN
NAT (AF) NATO SITE
GDK (N) GRINDAVIK
COMMERCIAL LEASE
LDR (N) LONDONDERRY
EDZ (N) EDZELL
KBR (N) KINNAIRD
ABE (N) ABERDEEN
MOH (AF) MORMOND HILL
INV (N) INVERBERVIE
DUN (N) DUNGIVEN
TUS (N) THURSO
LAT (N) LATHERON
MKE (N) MURKLE
FYL (AF) FYLINGSDALE
MIL (AF) MILDENHALL
LAK (AF) LAKENHEATH
ANY (AF) ALCONBURY
BRY (AF) BARKWAY
WTH (AF) WETHERSFIELD
GTB (AF) GREAT BROMLEY
MAM (AF) MARTLESHAM HEATH
SBG (AF) SDESTERBERG
ARN (AF) ARNHEM
KAL (AF) KALKAR
SRL (AF) STRALEN
ALN (A) ALTEN-BUSECK
BUN (A) BRUGGEN
LIP (A) LIPPERNOEHE
DUR (A) DUEREN
SCT (A) SCHWALMSTADT
WAH (A) WAHNERHEIDE
NOH (A) NORVENICH
KLN (A) KILLIANSTAEDTEN
MON (A) MONTABAUR
HBN (A) HERBORN
STN (A) STEIN
SUD (A) STEENBERGERWOLD
BRN (A) BREMERHAVEN
HES (A) HESSICHE-OLDENDORF
SNR (A) SENNELAGER
BAN (AF) BAD MUNDER
DSN (A) DUNSEN
HTE (A) T-HARDE
LDF (A) LINDERHOF
MRF (A) MUENSTER NORTH
WRL (A) WERL
BUR (A) BUREN
SOE (A) SOEST
KBG (AF) KOTERBERG
RWN (AF) ROTHWESTEN
SBN (AF) SCHWARZENBORN
GSN (A) GIESSEN
FEL (AF) FELDBERG
LSY (A) LINDSEY
WBN (A) WIESBADEN
CHV (AF) CHELVESTON
BOV (AF) BOVINGDON
DAV (AF) DAVENTRY
UHD (AF) UPPER HEYFORD
CRO (AF) CROUGHTON
BFD (AF) BARFORD ST JOHN
HYE (AF) HIGH WYCOMBE
HIN (AF) HILLINGDON
CRS (AF) CHRISTMAS COMMON
SCH (AF) SCHOENFELD
VGL (A) VOLKEL
KBL (A) KLEINE BROGEL
BNT (AF) BENTWATERS
SPA (AF) SPA MALCHAMPS
HIR (A) HINSBECK
PRM (A) PRUEM
WLD (AF) WILDENRATH
RGN (AF) ROETGEN
ANC (AF) ADENAU
SWG (AF) SWINGATE
HOU (AF) HOUTEM
WEZ (AF) WESTHOZBEKE
DNK (AF) DUNKIRK
BFM (AF) BOTLEY HILL FARMS
CDK (AF) COLD BLOW
LON (N) NAVY LONDON
FLO (AF) FLOBECQ
HNA (AF) BEN AHIN
LEC (AF) LE CHENO
SHF (AF) SHARE
SPM (AF) SPANGDAHLEM
HAN (AF) HAHN
RMN (AF) RHEIN MAIN
BEK (A) BAD KREUZNACH
NOR (A) NORTH POINT
BUCKA BUCHEL
BIG (AF) BITBURG
BNR (A) BAD NEUNDORF
DON (A) DONNERSBERG
WMS (A) WORMS
MHN (A) MANNHEIM
LKD (A) LANDSTUHL
RMS (AF) RAMSTEIN
KBH (AF) KINDSBACH
BFK (AF) BOERFINK
MUL (AF) MUHL
LDN (A) LANDSTUHL
HDG (A) HEIDELBERG
PLG (A) PHILLIPSBURG
BAN (AF) BANN
KLN (A) KAISERSLAUTERN
FZM (A) FRIDLZHEIM
PMS (AF) PIRMASENS
SEMBACH SEH (AF)
LKF (AF) LANGERKOPF
MAS (A) MASSWEILER DAVE
RPR (A) RUPPERTSWEILER
ZWE (AF)
ZWEIBRUCKEN
ZBN (A)
GOOSEHILLY
BILBAO
LISBON
LEG (A) LEGHORN
DAR (A) CP DARBY
CLO (A) COLTANO
MTC (AF) MT CIMONE
MCA (AF) MT CORNA
PAG (AF) PAGANELLA
CIM (AF) CIMA GALLINA
MTS (AF) MT SERRA
GHE (AF) GHEDI TORRE
BRE (AF) BRESSANONE
LRE (AF) LONGARE
CDE (AF) CODOGNE
PTO (AF) PORTO GUARDO
MTE (AF) MT VENDA
MTA (AF) MT CALVARINA
AVO (AF) AVIANO
VCA (AF) VICENZA
CON (AF) CONSELVE
CEG (AF) CEGGIA
ODE (AF) ODERZO
RIM (AF) RIMINI
MRE (AF) MT VERGINE
MRA (AF) MARTINA FRANCA
MGA (AF) MT LIMBARA
REG (AF) REGGIO
SGA (N) SIGONELLA
CPO (N) CAPODICHINO
CAO (N) CAMADOLI
LAG (N) LAGO DI PATRIA
SNV (AF) SAN VITO
AGA (N) AGNANO
NPS (N) NAPLES
EPO (N) MT EPOMEO
LIC (N) LICOLA
ARG (AF) ARGYROUPOLIS
PER (AF) PERIVOLAKI
NMK (N) NEA MAKRI
YAN (AF) YIANNITSA
MTH (AF) MT HORTIATIS
KAO (N) KATO SOULI
TAN (AF) TANAGRA
MPR (AF) MT PARNIS
ATH (AF) ATHENS
LEV (AF) LEVKAS
PAT (AF) MT PATERAS
COMMERCIAL LEASE
MEI (AF) MT EDHERI
ARA (AF) PRAKOS
ELE (AF) ELEVSIS
IRK (AF) IRAKLION
CKA (AF) CACMAK
CRL (AF) CORLU
ORT (AF) ORTAKOY
YAM (AF) YAMANLAR
IZM (A) IZMIR
INO (AF) INOGES
HUM (AF) HUMOSA
MNA (AF) MINORCA
MON (N) MORON
RTA (N) ROTA
TJN (AF) TORREJON
SOL (AF) SOLLER
RBT (N) RABAT
BOU (N) BOUKHADEL
SYH (N) SIDI YAHIA
KEN (N) KENITRA
LJS (AF) LAJES
VIL (AF) VILLA NOVA
CIN (AF) CINCO PICOS

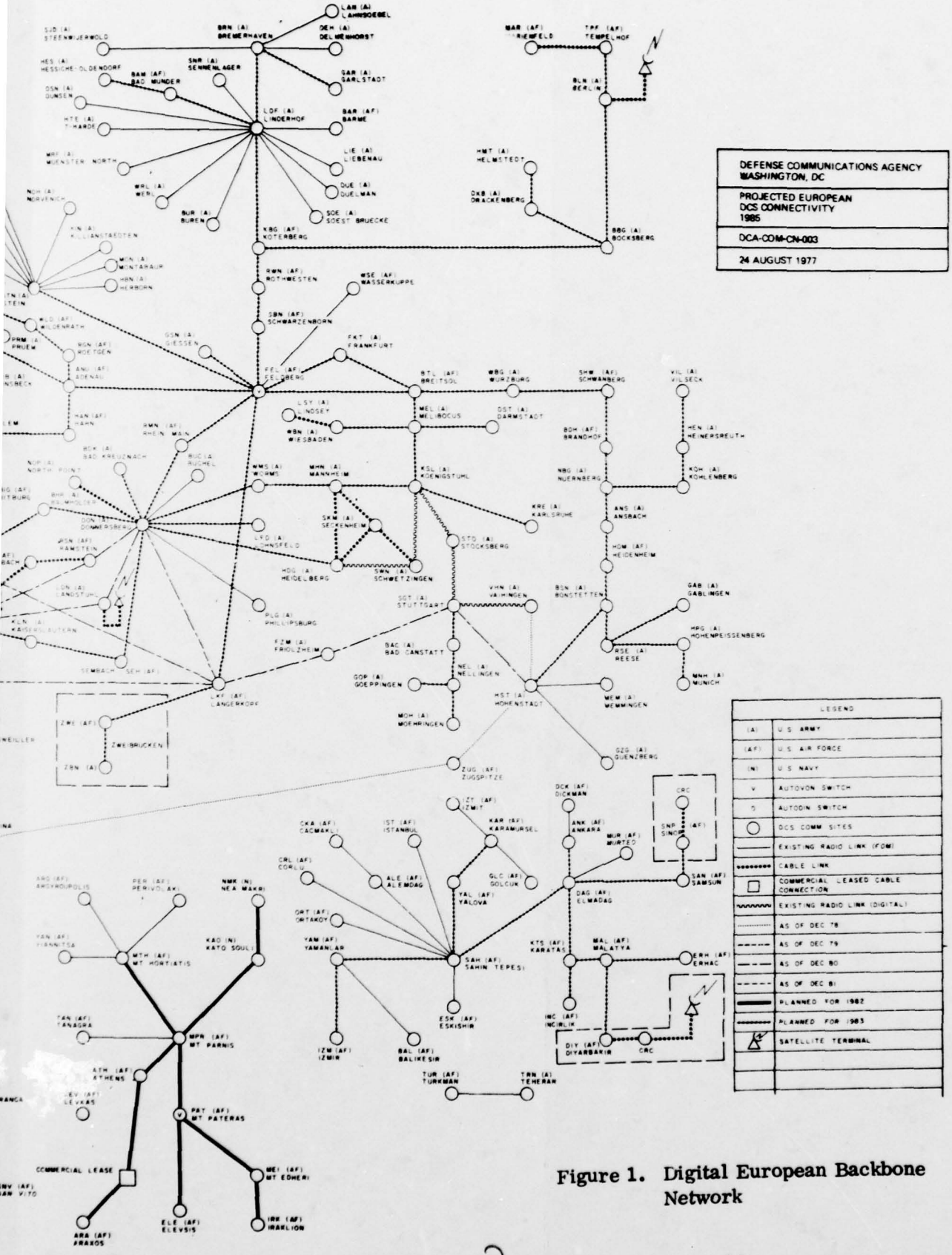


Figure 1. Digital European Backbone Network

preemption, etc.), will be addressed. The same procedure will be followed using tactical satellite terminals and then TRI-TAC equipment. Emphasis in this preliminary report will be placed on transmission equipment interfaces.

Configurations of DCS-Tactical Integrated will be covered in the same order as for DCS-Tactical Access, again emphasizing transmission equipment interfaces.

The report will then provide conclusions. Note that interoperational situations may be presented in this report which subsequent detailed investigations will show are not practical. Inclusion of such situations in this report serves only to indicate that there could be a requirement for the interoperation of the subsystem and/or equipment as shown.

SECTION 4 - DCS-TACTICAL ACCESS

4.1 GENERAL

The general situation is that tactical networks need to access the DCS in order for a tactical subscriber to communicate with a DCS subscriber or to interoperate with a DCS switched network. Additionally, use of satellite communications for these same purposes is required.

The DCS-Tactical Access area is characterized by single interfaces, whereas there may be more than one interface in the DCS-Tactical Integrated area. It should be noted that the DEB network is designed to accommodate VF and digital interface at all sites.

Likely configurations of DCS-Tactical Access interoperations are summarized below and discussed in detail in Paragraph 4.2.

1. A subscriber served by a tactical network requires dedicated service to a subscriber served by the DCS. Service required could be clear voice, secure voice, teletype, data, facsimile/graphics, or imagery. The requirement might be for a simple point-to-point circuit or for a complex multipoint circuit. Either one or all types of DCS and tactical transmission media could be involved. Figure 2 depicts this interoperational configuration.

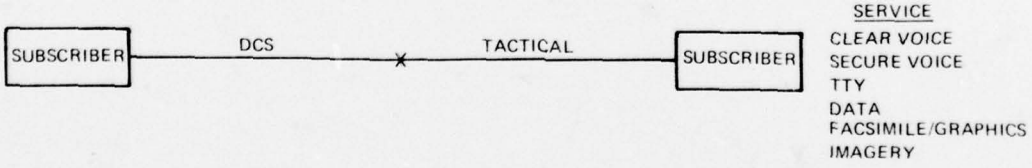


Figure 2. Dedicated Point-to-point Service

2. A subscriber served by a tactical network requires interoperation with a DCS switched network. The tactical subscriber is not served by a tactical switch. Service required could be clear voice,

secure voice, teletype, data, facsimile/graphics, or imagery. Either one or all types of DCS tactical transmission media could be employed. Figure 3 shows this situation.

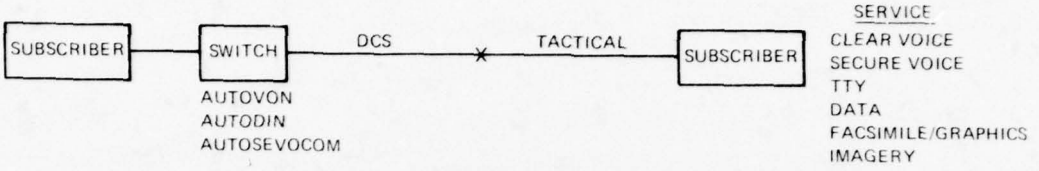


Figure 3. DCS Switched Service Direct to Tactical Subscriber

3. A subscriber served by a tactical switch and communication network requires interoperation with a DCS switched network. Service required could be clear voice, secure voice, teletype, data, facsimile/graphics, or imagery. A mixture of all types of DCS and tactical transmission media might be required to provide the service. Figure 4 portrays such a configuration.

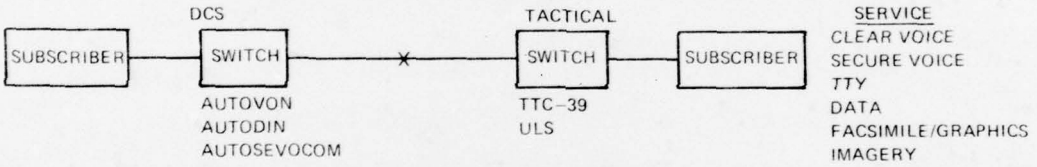


Figure 4. Interoperation of DCS and Tactical Switched Service

4.2 CONFIGURATIONS FOR INTEROPERATION

This paragraph will address details of likely configurations for interoperation, including features and functional services that will be provided through the interface point.

4.2.1 Dedicated DCS Subscriber to Tactical Subscriber

Figure 5 depicts a configuration wherein a tactical network interoperates with the DCS in order to provide dedicated service between a tactical subscriber and a DCS subscriber. The various services that might be required are shown in Figure 5 and are discussed in the following paragraphs. For the single circuit that this situation depicts, control requirements would be met by use

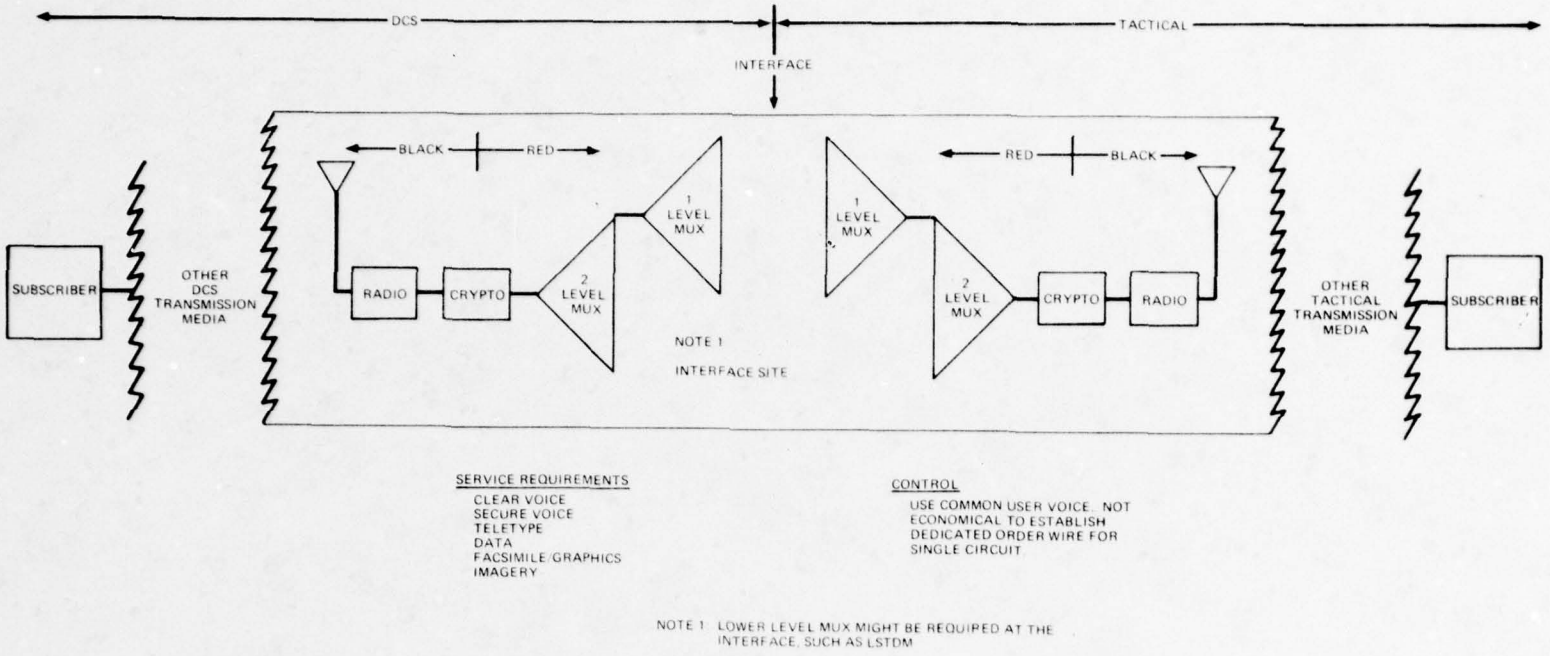


Figure 5. Dedicated DCS Subscriber to Tactical Subscriber

of a common user telephone. Under normal circumstances, it is neither practical nor economical to establish a dedicated orderwire. If such a requirement exists or arises, it can be satisfied on a patch basis or by use of the link orderwire. Many types of equipment could be employed in this interoperational situation. Examples are:

1. DCS. Present equipment, FKV/DEB I subsystem (FRC-162, FCC-97, TSEC/CY-104), DRAMA (FRC-163, FCC-98, KG-81, FCC-99), DSCS, leased commercial satellite, leased submarine cable, leased terrestrial service, etc.

2. Tactical. Present equipment, TRI-TAC family (TRC-170, SRWBR, Trunk Group Mux, Loop Group Mux, KG-81), the GMF satellite family (TSC-85, TSC-93, TD-754, TD-660), etc.

Figures 6, 7, and 8 show these configurations of DCS equipment interoperation with old, satellite, and TRI-TAC tactical equipment, respectively. The features of these interfaces are discussed in detail in the following paragraphs. In all cases, for the purpose of these examples, compatible terminal equipment (end instrument) is assumed. In a real life situation, the end equipment compatibility and availability would have to be confirmed.

4.2.1.1 Clear Voice

Clear voice is perhaps the simplest of the interfaces in a dedicated service situation. Features of the interface are shown in Table 1. This configuration provides clear voice only. Signaling and supervision are necessary in order to advise subscribers when to go on-hook and off-hook. A range of basic parameters of communication systems must be accommodated, with the interface providing the missing elements needed to effect interoperability. Irrespective of the exact levels at which interfaces are accomplished, there are certain operating characteristics or design parameters which must be satisfied to ensure successful operation between the two entities being interfaced.

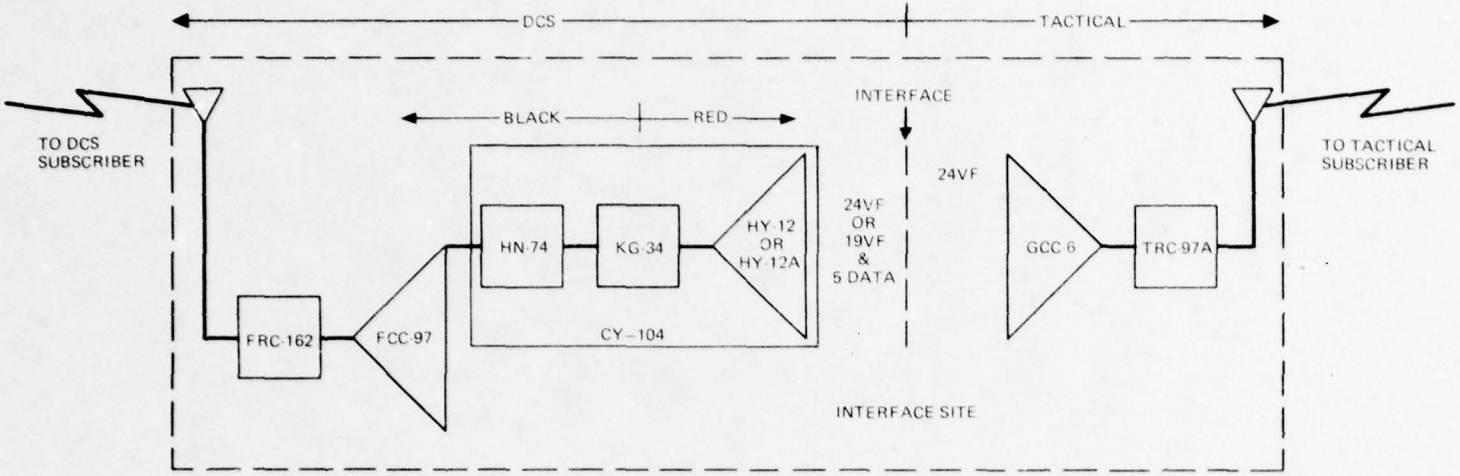


Figure 6. FKV/DEB I Equipment Interoperation with Old Tactical Equipment (TRC-97A)

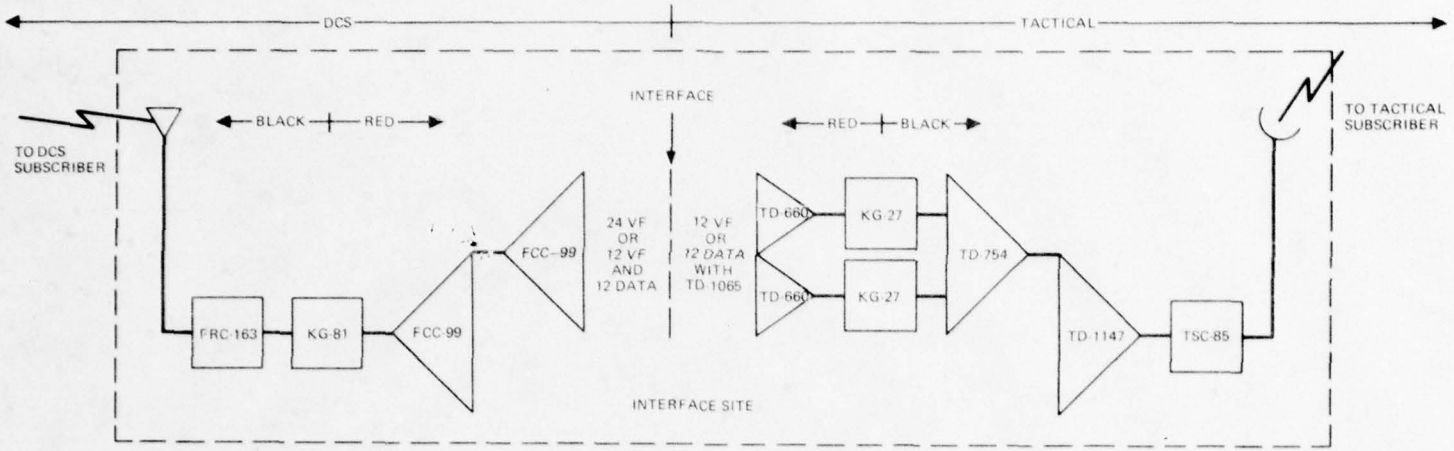


Figure 7. DEB II-IV/PDP (DRA MA) Equipment Interoperation with GMF Satellite Terminal Equipment (TSC-85)

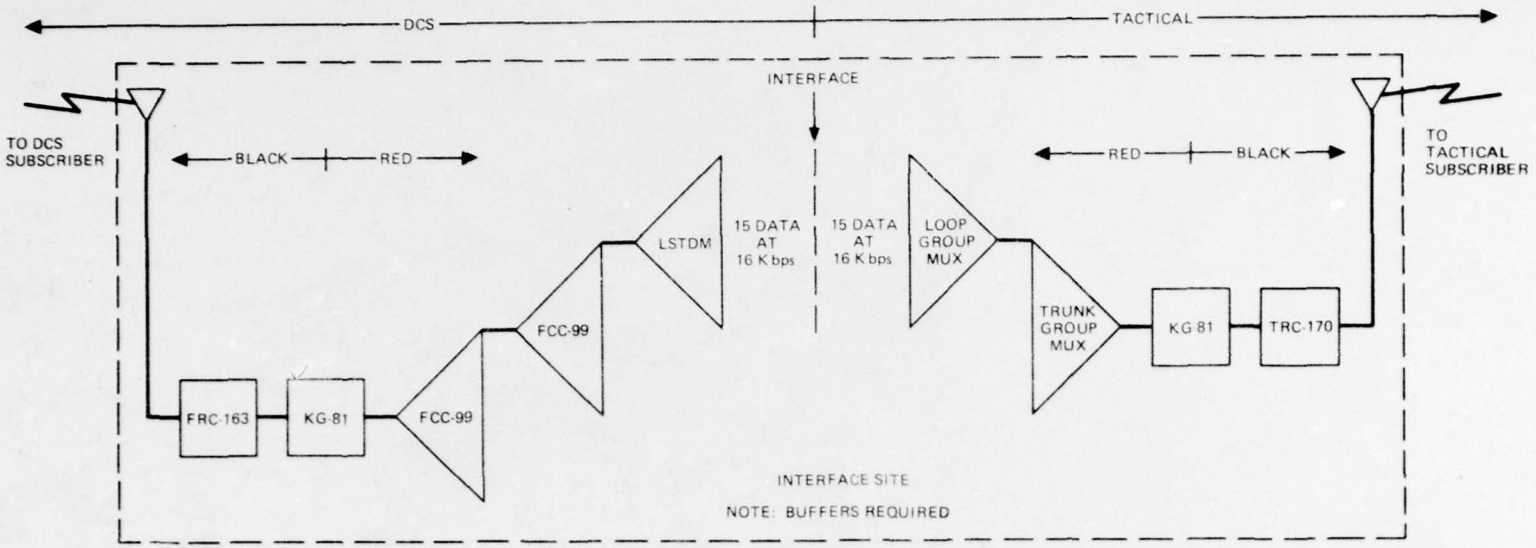


Figure 8. DEB II-IV/PDP (DRAMA) Equipment Interoperation with TRI-TAC Equipment (TRC-170)

Table 1. Interface Features

Functional services:	
Clear voice	
Signaling	
Supervision	
Technical considerations	Minimum requirements
Bandwidth	3Khz
Frequency response	300-3000 Hz - 3 to + 8dB loss
Impedance	600Ω ±10%
Signal level	0 ± 3dB
Noise level	35dbmØ distance dependent
Balanced or unbalanced	Balanced
Conditioning	Not required
2-wire or 4-wire	4-wire

The influence of standardization efforts over a considerable time period has produced fairly common electrical characteristics for an extensive set of equipment parameters prevailing in analog communication systems. Specifically, voice channel parameters of these transmission systems are in general agreement in terms of frequency response, frequency translation level, and delay distortion, which permit system cross-connects at voice channel levels at patching or multiplexing facilities.

Some parameters are adjustable (e.g., level), while others are inherent features that result from equipment design (e.g., frequency response and delay distortion). Any variations of the latter type usually result in some performance degradation which, depending on the extent of the difference and the length of the circuits, may limit interconnectivity. Extensions of these discussions apply in a similar fashion to group and supergroup interfaces in FDM systems.

Problems which may be encountered in such situations generally can be resolved at an interface point by means of hardware manipulations, such as the addition of hybrids and other types of conditioning equipment; judicious deployment of equipment, such as RF or multiplexers to ensure compatibility at

link ends; and A/D or D/A conversion equipment in cases where analog and digital systems will be interfaced.

Of greater significance and complexity are the areas involving such system operating parameters as signaling/supervision, network numbering and routing schemes, line protocols and message formats, etc. In these instances a variety of remedial techniques, including both hardware and software implementations, must be applied to effect the interface.

This is an area in which it is difficult to cite an example. Circumstances will dictate the appropriate action, and the decision taken at that time will depend upon whether the requirement is for reconstitution of a digital switch, access to a digital switch from a tactical subscriber, restoral of a segment of a DCS System with tactical equipment or some other requirement. To be effective, TRI-TAC equipment must be available for all contingencies and the operating parameter requirements must be known and satisfied at the time of deployment.

In the case of clear voice, the features of the interface are basically the same irrespective of the type of equipment that is involved. This is true because of the VF capability that is provided by both DCS and tactical equipment.

4.2.1.2 Secure Voice

The secure voice situations described here are dedicated point-to-point service. In other words, no switches are involved in this configuration. Several types of cryptographic equipment could be employed. For example, both the DCS and tactical subscribers could use PARKHILL or the NBST of AUTOSEVOCOM. In either case, end-to-end encryption would be employed. Wideband (50 kbps) service might be desired, thus requiring a group or six voice channels in an FDM system if a digital USC-26 operating in half-group mode is used. Here again, end-to-end encryption would be provided; possibly, both DCS and tactical subscribers would be equipped with a TRI-TAC DSVT.

All of the preceding situations have called out like terminal and cryptographic equipment for both users. However, there could be the situation where the DCS subscriber uses an NBST and the tactical subscriber uses a PARKHILL. In this case, additional equipment would be required at the point of interface--an NBST on the DCS side and a PARKHILL on the tactical side. A red/maroon interface would be necessary in order to provide end-to-end security, but end-to-end encryption would not be provided. This situation is depicted in Figure 9. Quality, however, will probably be unsatisfactory, so the circuit may not be usable.

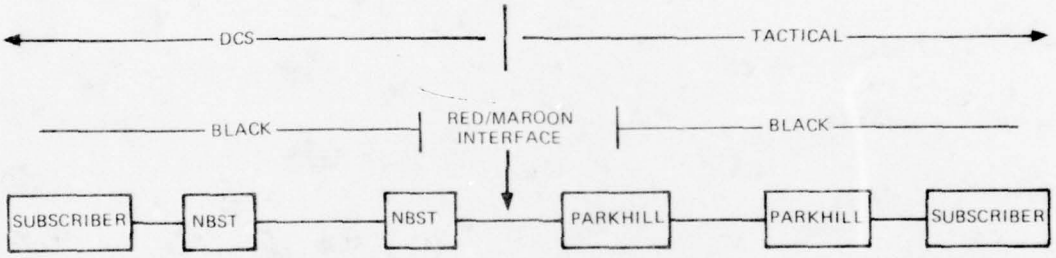


Figure 9. Secure Voice (Unlike End Crypto Equipment)

The interface features of the preceding dedicated secure voice situations are generally the same when the interface is at VF level, except that a red/maroon interface is required when using the NBST on one side and the PARKHILL on the other, for example. Features of the interface are shown in Table 2.

Table 2. Secure Voice Interface Features (Analog)

Functional services:		
Secure voice		
Signaling		
Supervision		
Technical considerations		Minimum requirements
Bandwidth	–	3kHz
Frequency response	–	300Hz - 3000Hz -1 to +3dB loss
Impedance	–	600Ω ±10%
Signal level	–	0dB ± 3dB (equipment conscious
Noise level	–	35dB (distance dependent)
Balanced or unbalanced	–	Balanced
Conditioning	–	to DCS S-3 specifications

In some cases the secure voice interface could be digital. For example, both the DCS subscriber and the tactical subscriber could use the DSVT, with transmission taking place over both DCS digital and TRI-TAC digital facilities. In such a case, the features of the interface would be like that in Table 3.

Plans indicate that the NBST equipment presently in use will be replaced by the DCS Varient Secure Telephone Unit (STU-II). This unit has the capability to operate at 2.4 kbps LPC-10, 9.6 kbps APC-4, and 16 kbps (by use of an external 16-kbps modem). When this plan is completed, the number of STU-IIs installed will make it unlikely that normal DCS secure voice subscribers will possess Parkhill or DSVT.

End-to-end, point-to-point encryption will still be possible with the DCS subscriber using a 16-kbps STU-II and the tactical subscriber, a DSVT. This is possible since the TRI-TAC subscriber will be able to force the DSVT to the 16-kbps rate.

End-to-end security without end-to-end encryption in a tandem configuration is achievable between the STU-II and the DSVT. According to recent Digital Voice Processor Consortium test results, tandems from

9.6 to 32 kbps, 2.4 kbps to 32 kbps and 9.6 kbps to 16 kbps can be accomplished with acceptable quality. A 2.4 to 16 kbps is possible, but quality is sacrificed. An interface point must exist that can make the necessary back-to-back connections between the STU-II and the DSVT.

Table 3. Secure Voice Interface Features (Digital)

Functional services:		
Secure voice		
Signaling		
Supervision		
Timing		
Technical considerations		Minimum Requirements
Data Rate	–	2.4 9.6 16 kbps
Serial or Parallel	–	Serial
Clocking	–	Station Clock transmit - Slaved or Data Recovery Receive
Error Rate	–	As specified for transmission media
Signal Level	–	Media conscious
Balanced-Unbalanced	–	IAW MIL STD 188-114
Conditioning	–	To DCS D1 Specifications

4.2.1.3 Teletype

The requirement is for a tactical communication network subscriber that will exchange secure teletype traffic with a subscriber to the DCS. End terminal equipment is compatible including crypto devices. Teletype signals are inherently digital, so the discussion of data in Paragraph 4.2.1.4 applies to teletype equipment.

4.2.1.4 Data

This configuration involves the need for a tactical network subscriber to exchange secure data with a subscriber served by the DCS. Obviously, the

end terminals should be compatible. The KG-13 crypto equipment would probably be used. Equipment that provides the transmission path will dictate the method of accomplishing this service. For example, modems could be used for D/A and A/D conversion, with the data being transmitted as quasi-analog. Although a data rate of 9.6 kbps might be possible over a single voice channel, in practice a rate of 4.8 kbps would probably be the limit. If higher data rates were required, then multiple voice channels (as used for wideband AUTOSEVOCOM) would be necessary.

If the transmission media were DCS DRAMA and TRI-TAC or GMF SATCOM, then end-to-end digital transmission could take place. The constraints here would be the data rates at which DRAMA and TRI-TAC are designed to interoperate (i.e., 16, 32, 256, and 512 kbps). At 16 and 32 kbps, the interface would be between the DRAMA submultiplexer and the TRI-TAC Loop Group Mux. At 256 and 512 kbps, the interface would be between the DRAMA FCC-98, and the TRI-TAC TGM. At present, there is no planned common data rate higher than 512 kbps.

If the data were transmitted as quasi-analog, the interface features would be the same as given in Table 4.

Table 4. Secure Data Interface Features (Quasi-analog)

Functional services:
Secure data
Signaling
Supervision
Timing
Technical considerations:
Bandwidth
Frequency response
Type of modulation
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning
Clocking

If digital transmission takes place, then the interface features would be as shown in Table 5.

Table 5. Secure Data Interface Features (Digital)

Functional services:
Secure data
Signaling
Supervision
Timing
Technical considerations:
Data rate
Serial or parallel
Signal format
Error rate
Logic sense
Transmitter signal level
Transmitter source impedence
Transmitter waveshape
Receiver input impedence
Receiver input capacitance
Receiver sensitivity
Clocking

4.2.1.5 Facsimile/Graphics

Facsimile/graphics consists basically of analog data. The scanned information is an analog signal which may be digitized for preprocessing (usually for bandwidth reduction), for encryption, and for noise resistance. Low-speed facsimile is commonly transmitted by analog modulation over conventional voice circuits, especially in the case of meteorological data (i.e., weather maps).

TRI-TAC now has the lightweight TDF (AN/UXC-4 ( ) (V)) under development. The TDF will operate on channels with data rates of 1.2 to 32 kbps. It can also be used over voice circuits using modems. The TDF will also be compatible with standard meteorological transmissions through a special interface module.

Thus, the transmission of facsimile/graphics on a dedicated basis appears much the same as for clear or secure voice or secure data, depending on the transmission media employed. If analog is transmitted in the clear, then the DCS-tactical interface features would be as shown in Table 1. If analog transmission is secured, the DCS-tactical interface features would be as shown in Table 3, since A/D and D/A conversion would be necessary for encryption.

If the new TDF is used over DCS and tactical digital transmission media, then the interface features would be as shown in Table 5, except that secure facsimile/graphics would be provided.

4.2.1.6 Imagery

Imagery is basically analog data that is characterized by wide bandwidth requirements such as the 4.2 MHz needed by commercial television. High-resolution video transmission may require even greater bandwidth. As in facsimile, the scanned information (an analog signal) may be digitized for preprocessing (usually for bandwidth reduction), for encryption, and for noise resistance. Transmission of imagery will usually be limited to paired-user devices and normally will take place over dedicated paths.

Due to the bandwidth requirements, imagery transmission over much of the present DCS and tactical equipment suffers severe limitations, especially for TROPO equipment. New digital equipment will remove many of these limitations.

Imagery transmission on a dedicated basis appears much the same as clear or secure voice or secure data, depending on the transmission media used. If clear analog is used, then the DCS-tactical interface features would be as shown in Table 1. Table 3 represents the features of secure analog. Table 5 shows the DCS-tactical interface features if imagery was transmitted over digital DCS and tactical systems.

Broadband requirements to support imagery (including conferencing) will be extremely demanding on shared facilities because of unidirectional and conference needs. Broadband loops to imagery users may well be tailored for alternate functions, including the necessary network control functions. Control schemes which flexibly interleave imagery transmission with standard trunking support will provide added flexibility. However, support of imagery transmission under the JMTSS concept poses severe problems.

4.2.2 Direct DCS Switched Service

Figure 10 shows a configuration where a tactical network provides a tactical network subscriber with direct access to a DCS switched network (AUTOVON, AUTODIN, or AUTOSEVOCOM). Control requirements would be provided through common user telephone. Various types of transmission equipment could be employed, examples of which are listed in Paragraph 4.2.1. Figures 6, 7, and 8 represent some equipment configurations that might be used (connectivity to a switch rather than from subscriber to subscriber as shown). Features of these interfaces are discussed in detail below.

4.2.2.1 AUTOVON

This configuration involves the need of a clear voice subscriber, served by a tactical network, for direct access to a DCS AUTOVON switch. There can be many configurations of equipment to provide such service. For practical purposes, however, an interface can be accomplished only at the VF level.

Using the equipment configuration shown in Figure 6 and assuming that the tactical subscriber accesses on an analog basis, the interface is accomplished at the VF level. The DCS FKV and DRAMA equipments provide flexibility to interface at the VF level or digitally. The old tactical equipment provides a VF capability only. Under these conditions, the features of the interface would be as shown in Table 6.

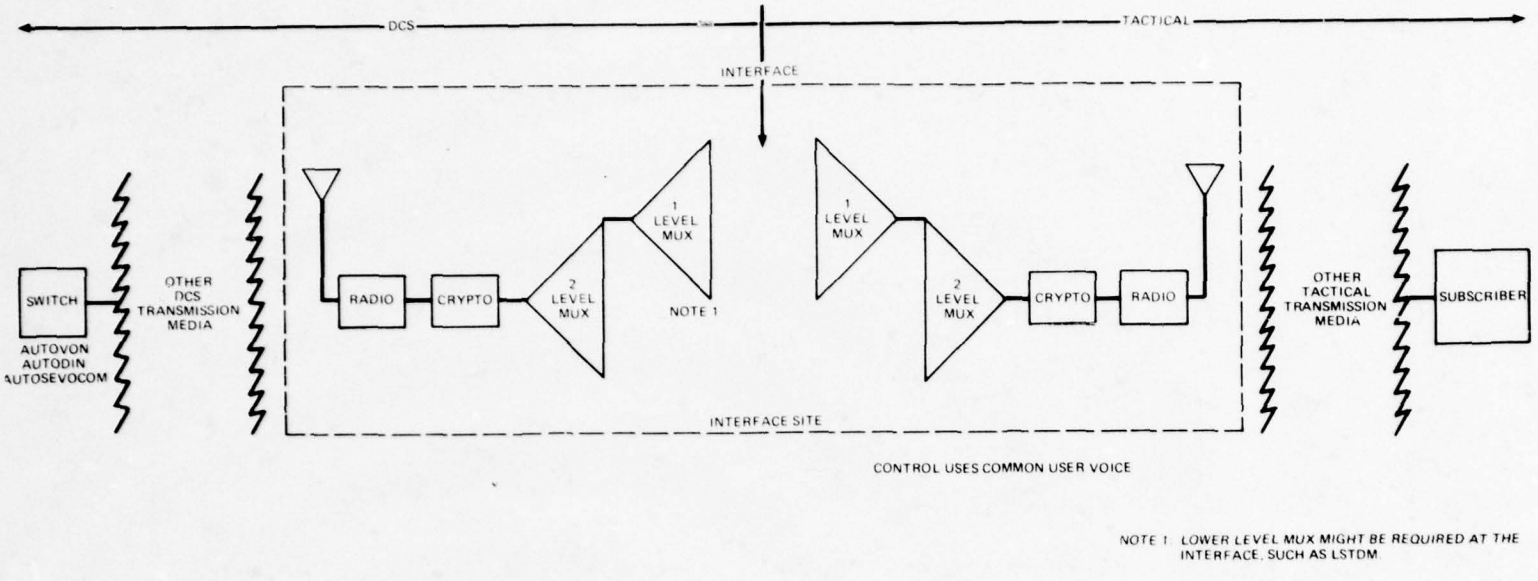


Figure 10. Direct DCS Switched Service to Tactical Network Subscriber

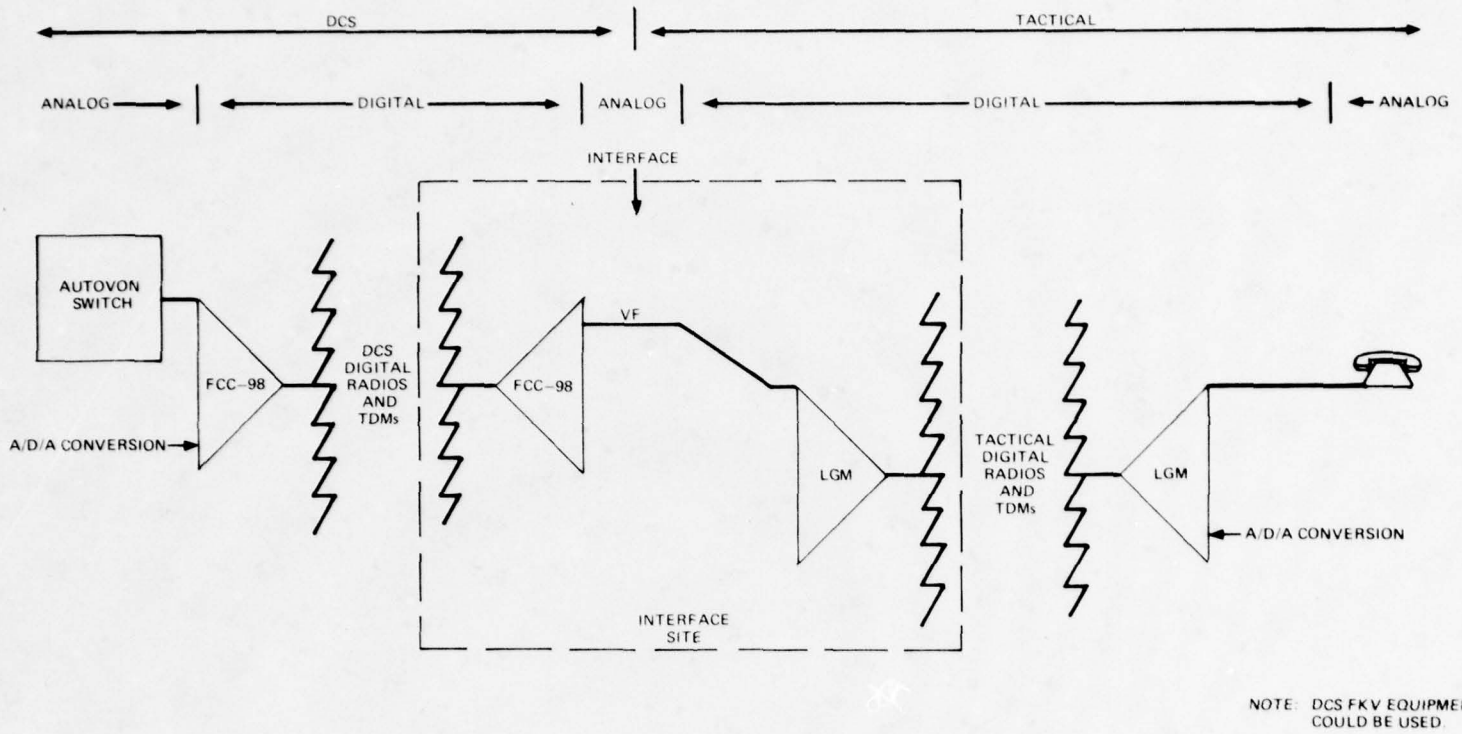
Table 6. AUTOVON VF Interface Features

Functional services:
Clear voice
Signaling
Supervision
Precedence
Preemption
Ringing
Power
Technical considerations:
Bandwidth
Frequency response
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning

AUTOVON compatible clear voice would be provided over this interface. Signaling is required for transmitting addresses. Supervision is required for indicating on-hook, off-hook, and disconnect. Precedence is required to indicate the priority level of a call, and preemption is necessary in case a higher priority call requires access to the circuit. Power is required if common battery is employed, but this condition is not probable in this configuration.

Under conditions where the interface occurs between DRAMA or FKV equipment and tactical satellite equipment, VF level would be used (Figure 7). Note that the tactical subscriber's AUTOVON Telephone set could access the TSC-85 directly if PCM is provided in the TSC-85 as either GFE or procured as part of the buy. If the TRI-TAC DGM should be downstream from the terminal, an Analogue Applique Unit (AAU) would be required to interface with the DGM. The AAU is used within an LGM. This is true because the AAU is the only unit that will accept a 4-KHz, 4-wire, full-duplex analog loog (the other TRI-TAC multiplexers are confined to digital channels). The interface at VF level will have the same features as shown in Table 6. The interface for AUTOVON service to a tactical subscriber could take place between DRAMA

Figure 11. AUTOVON Service VF Interface



or FKV and TRI-TAC digital equipment (Figure 8). Here, again, the AAU would be necessary before the subscriber could access the network. The interface would be at the VF level, and the TRI-TAC LGM would need Analog Applique Units (AAU). Figure 11 depicts this situation. The interface features would be the same as shown in Table 6.

4.2.2.2 AUTODIN

A subscriber of a tactical network requires access to DCS AUTODIN. Assume that the tactical subscriber has an AUTODIN approved compatible terminal which is secured by a KG-13 crypto device. As in most configurations, varied types of DCS and tactical communication equipment could provide the transmission media. AUTODIN traffic originates as digital data, which are then encrypted by a key generator (KG-13). In most cases today, a modem accomplishes conversion to quasi-analog, and transmission takes place over VF circuits. This could be the mode of operation in the DCS-tactical interoperation, especially for older equipment. In this case, the interface would probably be at the VF level, basically as shown for AUTOVON in Figure 11, except that modems would be required on each end. Features of the interface are shown in Table 7.

Table 7. AUTODIN VF Interface Features

Functional services:
Secure data
Signaling
Supervision
Precedence
Timing
Control
Error detection and retransmission
Language media format
Technical considerations:
Bandwidth
Frequency response
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning

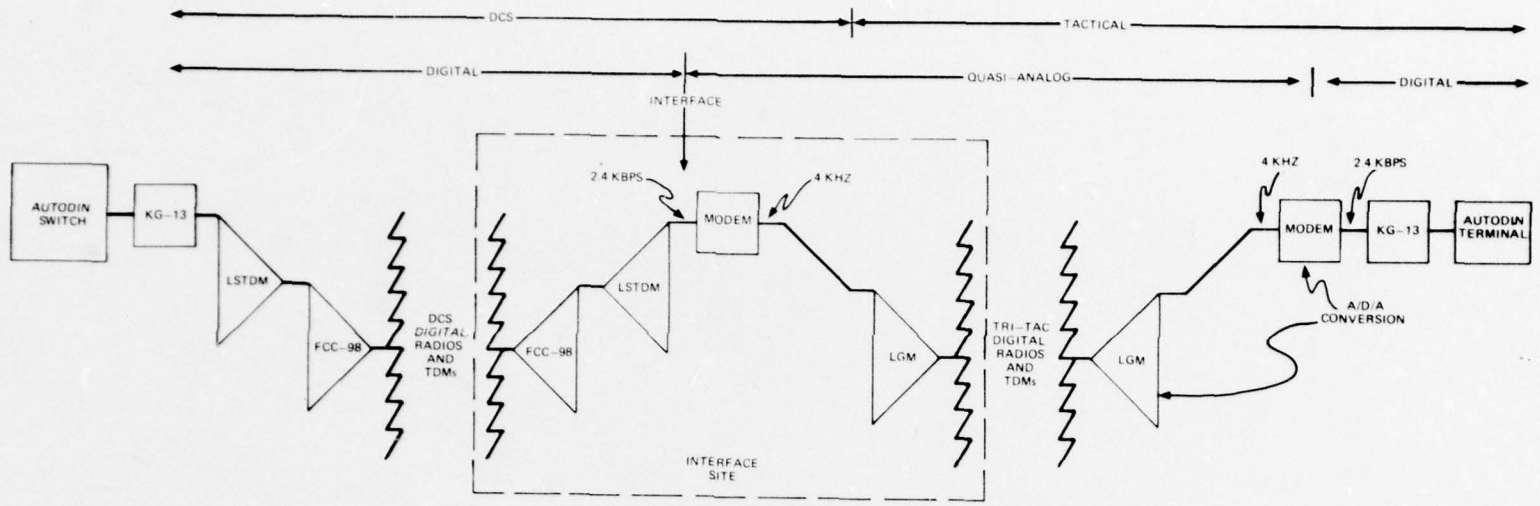
The required mode is 2.4 kbps when interfacing the TRI-TAC equipment. The LGM with AAU would be used, and a modem would be required at the data terminal and switch ends of the circuit (assuming a 2400-baud rate). This configuration would be portrayed in Figure 12. The features of an AUTODIN digital interface are shown in Table 8.

Table 8. AUTODIN Digital Interface Features

Functional services:
Secure data
Signaling
Supervision
Precedence
Timing
Control
Error detection and retransmission
Language media format
Technical considerations:
Data rate
Serial or parallel
Signal format
Error rate
Logic sense
Transmitter signal level
Transmitter source impedance
Transmitter waveshape
Receiver input impedance
Receiver input capacitance
Receiver sensitivity
Clocking

There is the possibility that either of the two types of data adapters being developed by TRI-TAC could be modified for use on such a circuit. A primary function of the data adapter is to match the data terminal's baud rate to the TRI-TAC loop transmission rate. Thus, a modified data adapter might be employed to match a data terminal's 2400-baud rate to a 16/32 kbps TRI-TAC transmission rate and to interface the LGM. In addition, rate converters

Figure 12 AUTODIN Service Interface



NOTE: DCS FKV EQUIPMENT COULD BE USED

could be used. In these cases, modems and the USM at the terminal end would not be necessary. The transmission would be from digital terminal to switch. As previously noted, however, the feasibility of modifying a TRI-TAC data adapter is not known at this time.

4.2.2.3 AUTOSEVOCOM

In this situation, a subscriber to a tactical network requires switched AUTOSEVOCOM service, which could be wideband or narrowband. If narrowband, service is usually provided by homing an NBST on an AUTOVON switch. In some cases, however, NBSTs are homed on SECORDs (manual, cord-board type switch). Wideband subscriber terminals are homed on FTC-31's, WECO 758's, or SECORDs. Wideband trunking (50 kbps) is used to provide high-quality, secure voice service. The FTC-31 provides wideband direct-dial service to local subscribers, long-haul direct-dial wideband service via interswitch wideband trunks, and operator-controlled interconnection to narrowband (2.4 and 9.6 kbps) trunks. The 758C provides essentially the same service as the FTC-31. The SECORD provides manual switching between local WBSTs, NBSTs in some cases, and long-haul transmission via narrowband or wideband trunks. The AUTOVON switch treats the NBST as it does any other voice subscriber, with the call being placed in the clear and then encrypted upon completion of the connection. Secure voice calls using AUTOVON (including narrowband interswitch trunking) are transmitted as quasi-analog signals.

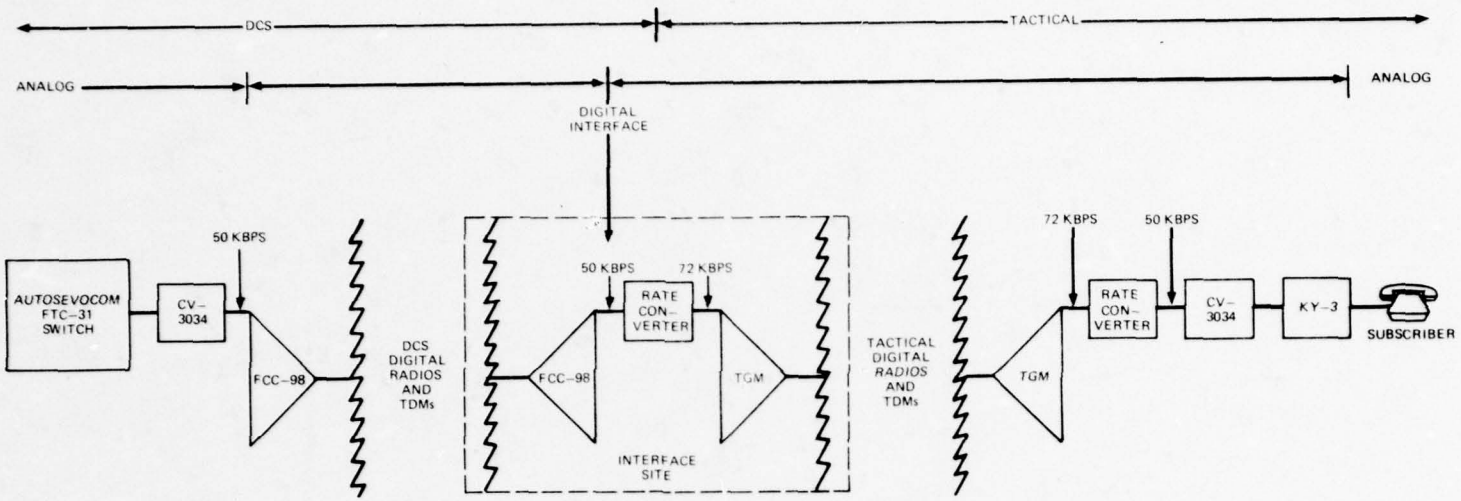
Two interoperational configurations will be discussed herein. In both cases, transmission will be over DCS DRAMA equipment (FKV could be used) and TRI-TAC digital equipment (depicted in Figure 8). The first configuration will cover wideband service via an FTC-31 switch. The second will discuss narrowband service through AUTOVON.

4.2.2.3.1 Wideband Via FTC-31 Switch

The requirement is for a tactical network subscriber that will be provided 50-kbps service from a WBST to an FTC-31 AUTOSEVOCOM switch and, thus, access to the network. The configuration would be as shown in Figure 13. Note that a rate converter would be required to match the rate of the WBST to that of the TRI-TAC TGM. The interface would be digital, and the features would be as shown in Table 9. Note that this configuration is provided by both DRAMA and TRI-TAC equipment. On the DCS side, FKV equipment could be used in lieu of the DRAMA equipment. However, providing this service over old tactical equipment or GMF tactical satellite terminals would require the USC-26 and 6 or 12 VF channels.

Table 9. AUTOSEVOCOM 50-kbps Interface Features

Functional services:
Secure voice
Signaling
Supervision
Precedence
Preemption
Ringing
Power
Timing
Technical considerations:
Data rate
Serial or parallel
Error rate
Transmitter signal level
Transmitter source impedance
Transmitter waveshape
Receiver input impedance
Receiver input capacitance
Receiver sensitivity
Clocking



NOTE: DSC FKV EQUIPMENT *COULD BE USED*

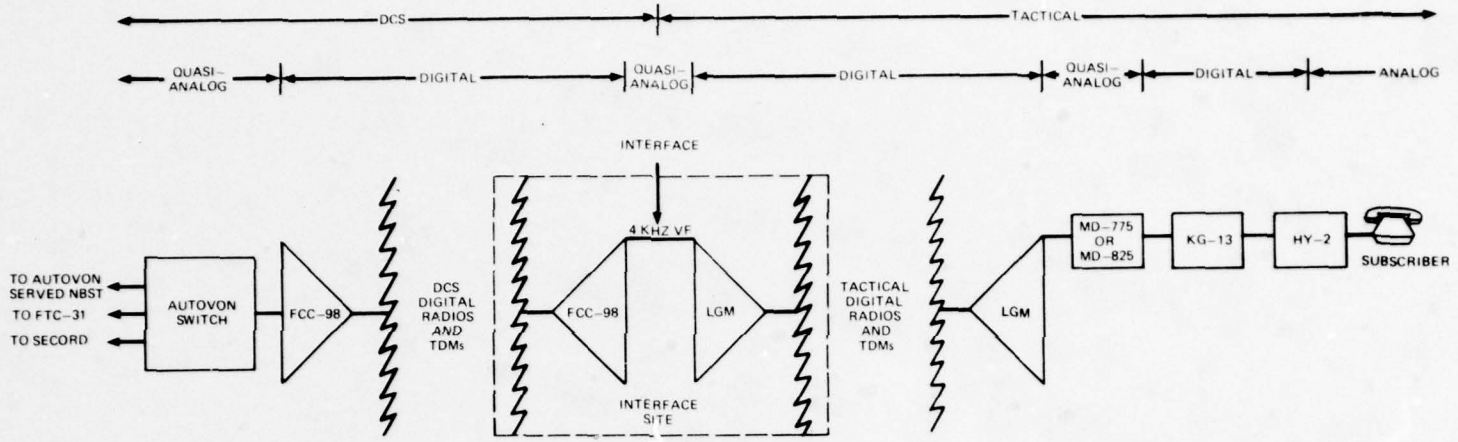
Figure 13. AUTOSEVCOM Wideband Service Interface (50 kbps)

4.2.2.3.2 Narrowband Via FTC-31 Switch

In this configuration, a tactical network subscriber requires 2.4-kbps service from an NBST to an AUTOVON switch for access to the AUTOSEVOCOM network. On the DCS side, service is provided by DRAMA (or FKV) equipment. TRI-TAC equipment is used on the tactical side. The configuration would appear as shown in Figure 14. An AAU would be required for the LGM. The interface takes place at the VF level (quasi-analog). In this case, since this is a VF circuit, old tactical equipment could provide the service. GMF satellite terminals could also provide the service. For example, if TSC-85's, 93's, or 94's were used, then the TD-660 MUX would be the entry device at the terminal and at the interface point. In all cases, the features of the interface would be as shown in Table 10.

Table 10. AUTOSEVOCOM VF Interface Features

Functional services:
Secure voice
Signaling
Supervision
Precedence
Preemption
Ringing
Power
Timing
Technical considerations:
Bandwidth
Frequency response
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning



NOTE: DCS FKV EQUIPMENT COULD BE USED

Figure 14. AUTOSEVCOM Narrowband Service Interface (2.4 kbps)

4.2.3 DCS Switched to Tactical Switched Network

The discussion of interoperation of DCS switched networks will consider AUTOVON, AUTODIN, and AUTOSEVOCOM interoperating with the TRI-TAC TTC-39, which is being developed with provisions for interoperation with the DCS switched networks.

4.2.3.1 AUTOVON

The TTC-39 is designed to act as either an AUTOVON switch or as a PBX interoperating with AUTOVON. In either case, trunks and/or access lines are terminated on the SDMX. Thus, traffic leaving the TTC-39 destined for an AUTOVON switch is in analog form. However, both TTC-39 analog and digital voice subscribers can access AUTOVON. Analog subscribers are homed on the SDMX and are connected to AUTOVON trunks and/or access lines upon dialing the precedence, route code, AUTOVON area code, and subscriber address. Subscribers must be class marked for AUTOVON access. The TTC-39 provides outgoing in-band DTMF signaling nonconfirmation with SF supervision.

Digital voice subscribers (DSVT or DNVT) are homed on the TDMX. If a digital subscriber is class marked for AUTOVON access, he gains access by dialing, as indicated for the analog subscriber. By means of internal interfaces, the TDMX switches the call to the SDMX (D/A conversion takes place), and the SDMX seizes an AUTOVON access line or trunk as the case may be. Again, the traffic is in analog form.

Assuming that transmission will take place over DCS DRAMA and TRI-TAC digital equipment, this interoperational configuration would appear as shown in Figure 15. For purposes of simplicity, the CNCE, which would probably be used at a TTC-39 site, has not been shown. Use of the TRI-TAC DGM hierarchy permits a clear depiction of the configuration interface. The features of an interface that provides interconnection between DCS AUTOVON and the TRI-TAC TTC-39 are given in Table 11.

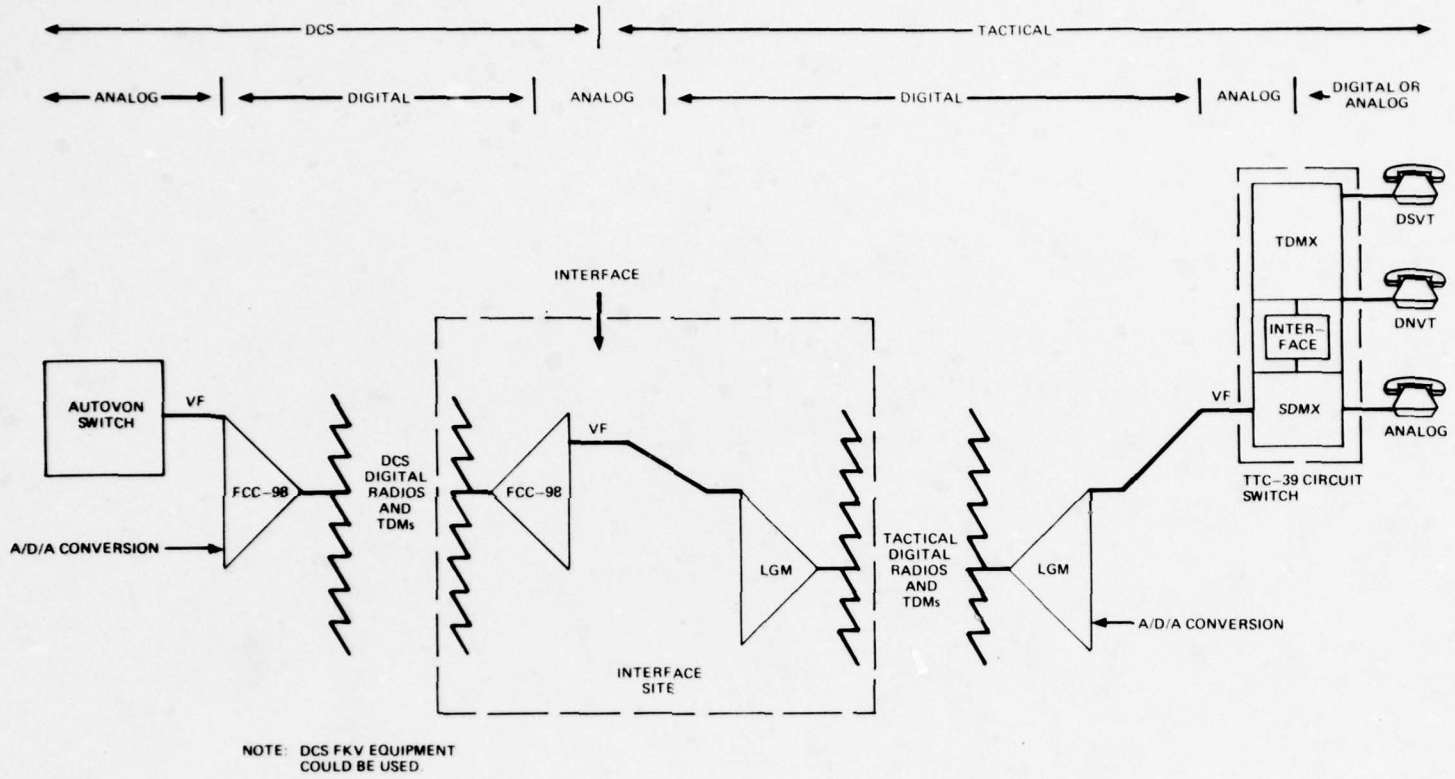


Figure 15. DCS AUTOVON Service Interface to TTC-39

Table 11. AUTOVON to TTC-39 VF Interface Features

Functional services:
Clear voice
Signaling
Supervision
Precedence
Preemption
Ringing
Technical considerations:
Bandwidth
Frequency response
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning

4.2.3.2 AUTODIN

The TRI-TAC developed switch has, in addition to its two circuit switch modules (TTC-39), a message switch (TYC-39) which provides functions and services related to the handling, processing, and switching of messages in a store and forward operation. It performs those functions required to ensure protection and security of message traffic which originates (1) at directly connected terminals, (2) on trunks to AUTODIN automatic switching centers, (3) on trunks to other message switching centers, and (4) at terminals or message switching centers connected to TYC-39 circuit switches. The message switching center can terminate all types of teletypewriters; paper tape readers; card readers; AUTODIN DSTE mobile data terminals; weather terminals; high-, medium-, and low-speed printers; and magnetic tape terminals. To accommodate some of the older terminals, TRI-TAC is developing DAs which compensate for differences in protocol and bit rates of the TRI-TAC switching and transmission equipment. A prime function of the DA is to match the baud rate of the terminal equipment to the TRI-TAC loop transmission rate (information exchange rate is not changed).

AUTODIN compatibility is provided through either dedicated or circuit-switched trunk interfaces to the TYC-39 message switch. These circuits are full-duplex, 4-wire trunk circuits capable of transmission rates of 75×2^N bps (N = 4 to 7) and 16 and 32 kbps. Compatible cryptos and modems are required at the switch when the interface is accomplished via an analog circuit. When message switch trunks are established via the TTC-39 circuit switch, they are marked with a FLASH precedence to inhibit preemption.

A likely configuration of AUTODIN to TRI-TAC switch interoperation is shown in Figure 16, where 2.4-kbps trunking is provided. The TRI-TAC switch could access the trunk from the message switch or from the circuit. Various data terminals would be homed on the TYC-39. The figure shows three methods of implementation: (1) data terminal through a DA and through a DSVT to the circuit switch, which would access the message switch through an interswitch trunk; (2) a data terminal through a DLED to the message switch; and (3) a data terminal via a DA through a DLED to the message switch. The DSVT configuration could also be homed on the message switch.

Since operation is in a store and forward mode, the data rate of terminals has no direct relation to the data rate of the AUTODIN to TYC-39 trunk. The basic problem here is the DCS II versus TRI-TAC data rates. As previously noted, the TYC-39 message switch will output a 2.4-kbps AUTODIN compatible signal. If transmitted over existing DCS and tactical equipment, it would be quasi-analog, with a modem and a crypto device required on each end. The interface would also be quasi-analog. Using DRAMA (or FKV) and TRI-TAC equipment, there are two options. The first would be as shown in Figure 12, except that the TYC-39 message switch would be the device on the right in lieu of the data terminal. The alternative would be as shown in Figure 16, which provides A/D/A conversion on each end and quasi-analog transmission. The interface features of this configuration are given in Table 12.

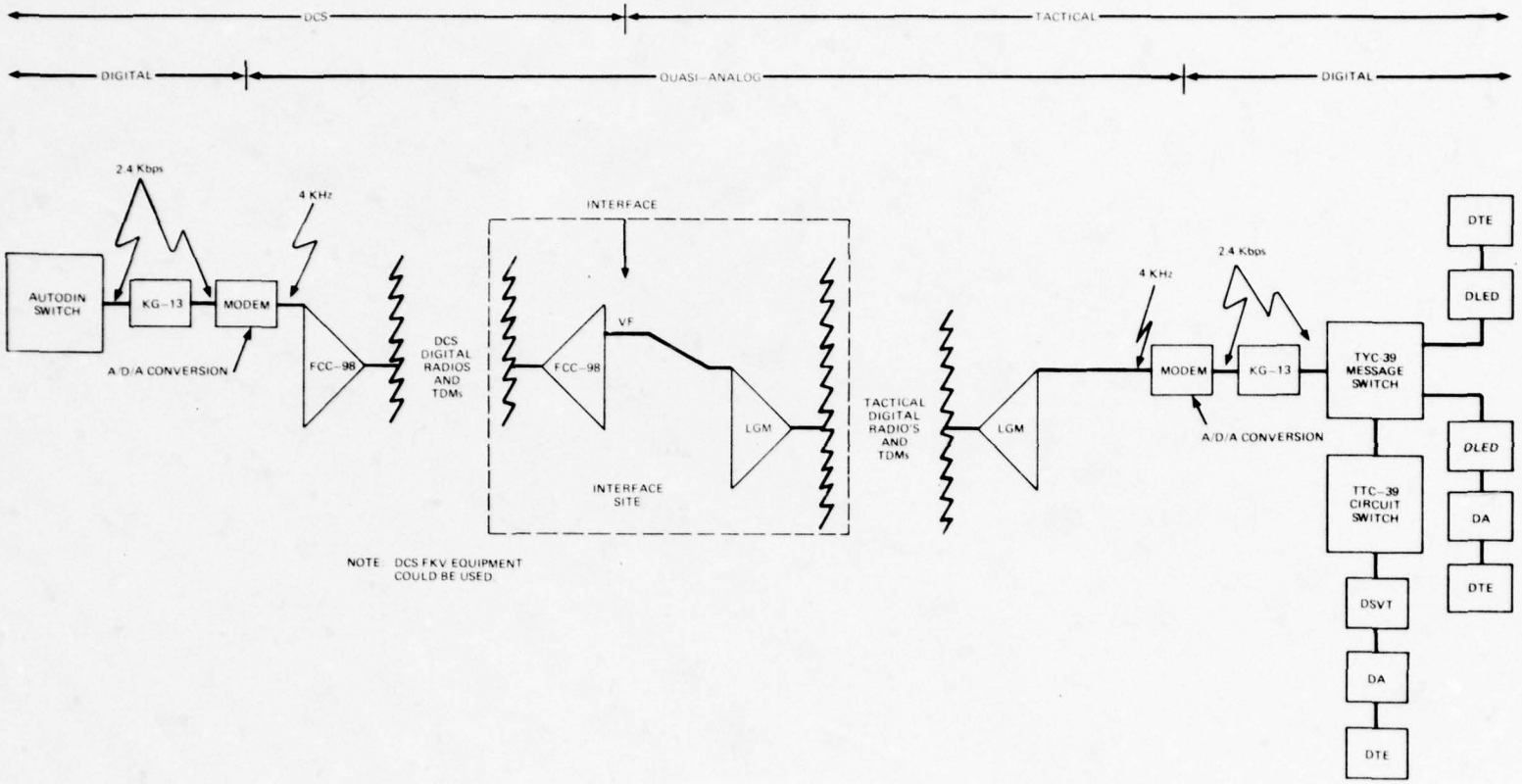


Figure 16. DCS AUTODIN to TRI-TAC-39 Interface

Table 12. AUTODIN to TYC-39 VF Interface

Functional services:
Secure data
Signaling
Supervision
Precedence
Timing
Control
Error detection and retransmission
Language media format
Technical considerations:
Bandwidth
Frequency response
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning

4.2.3.3 AUTOSEVOCOM

The AUTOSEVOCM II program has been changed to the Secure Voice Improvement Program (SVIP). The major changes which will take place are described on page 37. The AUTOVON System will be used as the primary transmission and switching medium. The following discussion addresses the requirement for interoperation between the TTC-39 and AUTOSEVOCOM as presently configured. In other words, the requirement is for a DSVT operating at 16/32 kbps and homed on a TTC-39 TDMX to interoperate with an AUTOSEVOCOM subscriber (either narrowband or wideband). The TTC-39 specification states essentially as follows:

The TTC-39 will be capable of interfacing with the automatic secure voice communication (AUTOSEVOCOM) network utilizing either of the two following procedures, which will be software selectable:

1. Utilizing intermatrix loop-around trunks to tandem (back-to-back) dissimilar voice encryption devices in any of the following combinations: HY-2/KY-3, HY-2/TRI-TAC digital, or KY-3/TRI-TAC digital. The loop-around trunk will be accessible in either direction. Bit stream sensing equipment will be provided for those equipments whose method of operation is to establish the call in the clear and then switch to encryption. When a bit stream is detected, the sensing equipment will switch in the encryption equipment in the loop-around trunk. The maximum number of secure voice type loop-arounds will be limited to 24 per circuit switch. At expanded nodes, up to 24 loop-arounds may be located at each component 600-line circuit switch.

2. By utilizing an interface device at the AUTOSEVOCOM switchboard, the TTC-39 will treat this type of call as a normal digital loop. The interface device will contain the necessary control switching supervisory indicators, dialing facilities, and COMSEC devices to allow the attendant at the AUTOSEVOCOM switchboard to receive and initiate calls, with a full set of subscriber features, into the tactical network and to cross-connect those calls to and from subscribers in the AUTOSEVOCOM network.

The preceding in (1) above is interpreted as follows. DVSTs are homed on the TTC-39 TDMX. NBSTs and WBSTs are homed on the TTC-39's SDMX. By use of loop-around trunks, sensing equipment will switch in appropriate crypto devices, and secure voice terminals with unlike crypto can communicate in a secure mode. Thus, an NBST can talk to a DVST; a WBST to a DVST; and an NBST to a WBST.

In (2) above, an interface device at the AUTOSEVOCOM switch will permit the operator to receive and initiate calls to the TTC-39 and to cross-connect those calls to and from subscribers in the AUTOSEVOCOM system. Thus, interoperation on an operator-controlled basis would be permitted.

In practice, it appears that the TTC-39 will normally interface AUTOSEVOCOM through AUTOVON. The loop-around trunk capability described above will permit the DSVT to communicate with AUTOSEVOCOM subscribers (either an NBST or a WBST). Whether the special interface capability described in (2) above will be provided in not known at this time. Of course, the AUTOSEVOCOM terminals (WBST and NBST) could be homed on the TTC-39 and connected into AUTOSEVOCOM.

The interoperational configuration of DCS AUTOSEVOCOM to TTC-39 would appear as shown in Figure 17. The features of the interface would be the same as those shown in Table 10.

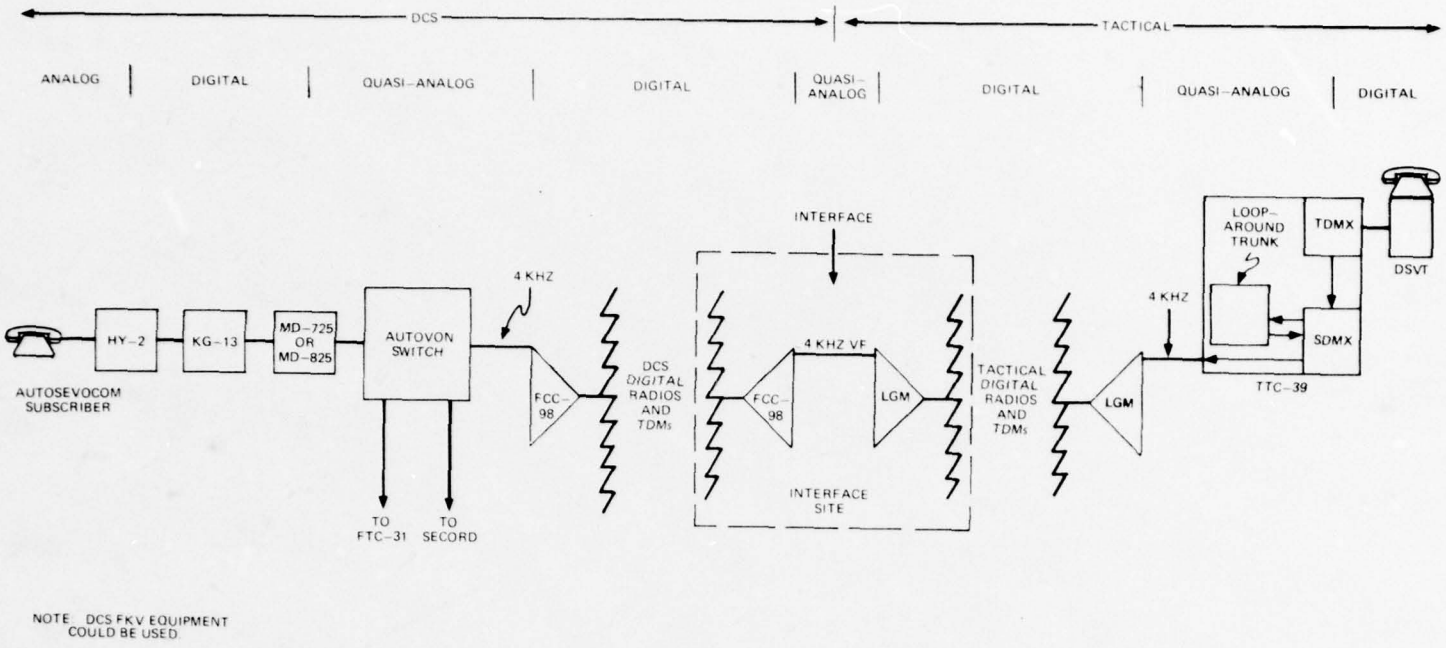


Figure 17. AUTOSEVCOM to TRI-TAC-39 Interface

SECTION 5 - DCS-TACTICAL INTEGRATED

The general situation is that DCS and tactical subsystems and/or equipment are integrated to form a single system. Tactical equipment might be used to expand, extend, or reconstitute the DCS or vice versa. A case in point is the JMTSS, where tactical assets are integrated functionally with DCS assets to reconstitute and extend the DCS under stress conditions.

The JMTSS now being planned for Europe and the Pacific pose large-scale interoperability problems between DCS and tactical communication equipment. Simply stated, JMTSS dictates that most tactical equipment, except low-level radio systems, will be capable of interoperation with most DCS equipment. Interoperational and interface problems must be resolved before JMTSS can become a reality.

JMTSS consists of a mix of DCS and tactical assets, and is a transmission and switching system which is designed to support various theater operational plans. Conceptual planning has been accomplished and assessment made of the availability of JCS contingency and tactical equipment. However, no detailed engineering has been accomplished; and, hence, no identification and examination of potential problems have taken place.

In Europe, JMTSS planning is for support of an OPLAN that covers a wide geographical area. It is assumed that JMTSS implementation cannot be accomplished until a conflict takes place. The assumption is then made that JCS contingency and tactical assets will be made available (from the time-phased force deployment list) from the CONUS and will arrive in a timely manner. The European DCS is used as the basic system from which JMTSS is developed, and DCA Europe is designated as the executive agency responsible for it. A scenario is used which says that certain DCS facilities are destroyed. The first action is to restore as many high-priority circuits as possible to surviving paths by using spare capability and by preempting lower

priority circuits. Reconstitution then takes place by using the JCS contingency and tactical assets delivered from CONUS. Mathematical calculations are given below to show the shortfalls of equipment.

This is straightforward comparison of microwave to microwave, TROPO to TROPO, etc. No real consideration is given to interoperability. For example, assume that an FRC-80 relay station in Germany is destroyed. The TRC-97 will be used for reconstitution. Is the TRC-97 interoperable with the FRC-80, or will four TRC-97's be required. If so, what are the interface problems? The planning was accomplished using here-and-now equipment. However, comments on the plan have brought out additional capabilities that will be provided by new systems and equipment. For example, DEB, which will be implemented in four phases, will overcome some of the shortfalls shown in the European JMTSS plan (by increasing channel capacity and by dual-homing some sites).

Each DEB site will have a tactical interface capability. In DEB I, this is 48 VF and four 1.544-Mbps channels at accessible sites, and 48 VF channels and one baseband channel (12.6 Mbps) at inaccessible sites. DEB II-IV sites will be the same as DEB I, except that a minimum of 24 and no more than 48 VF channels will be provided. (See Figures 18, 19, and 20.) Available also are equipped surge spare channels and a quantity of spare first-level multiplexers. Additionally, DCS contingency assets are being procured under the DEB program which will be capable of restoring a number of links (see Tables 13, 14, and 15.)

In the early 1980's, the GMF portion of DSCS will become available. In fact, some equipment is now under procurement, but production type hardware, including the control central, will not be available until 1981-1982 and thereafter. While this equipment will provide more reconstitution capability, it will also cause more problems. For example, the earth terminals (TSC-85, -93, -94) are equipped with the TD-660 48-kbps PCM A/D converter which

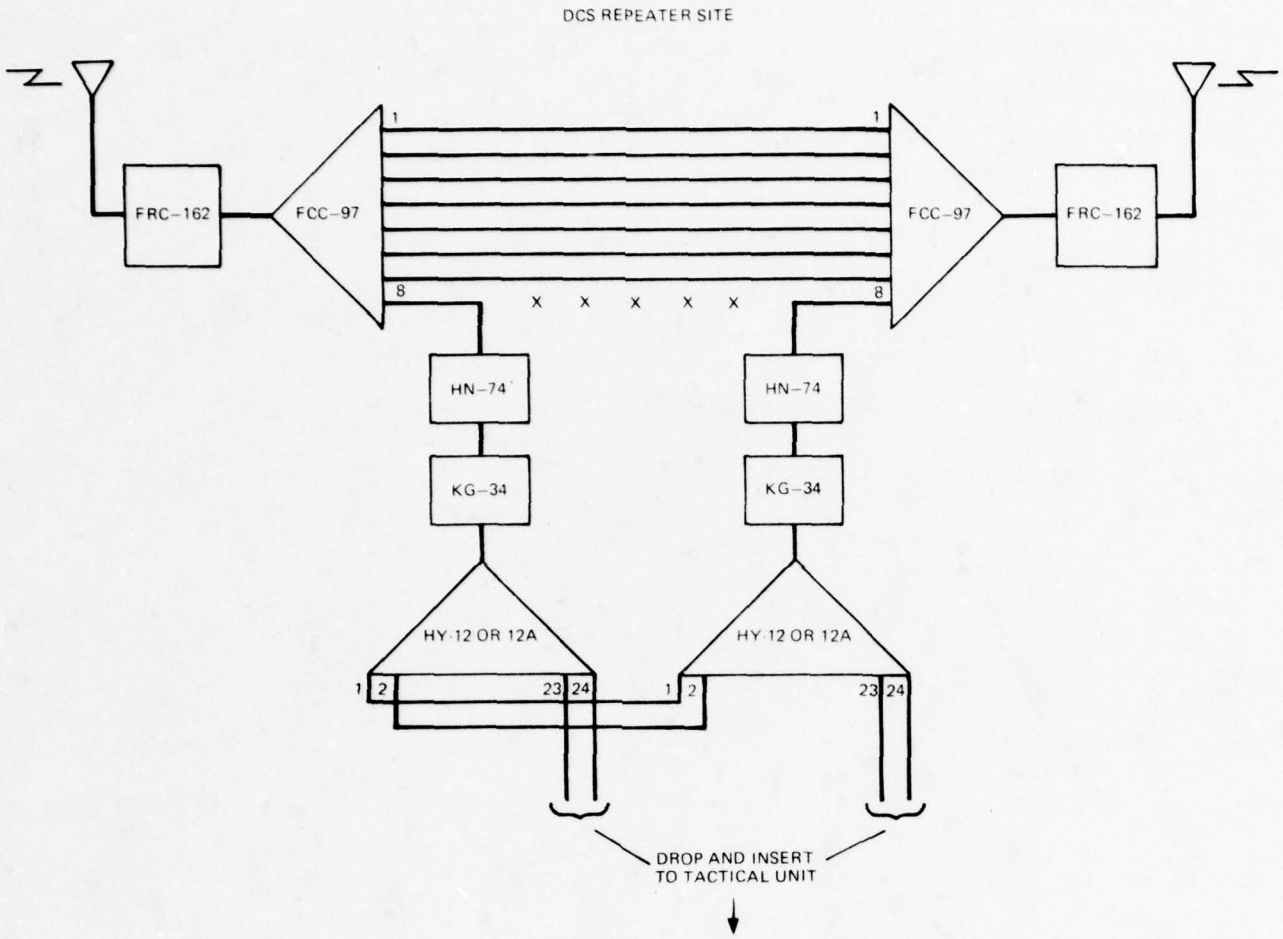


Figure 18. Tactical Interconnect at Remote DCS DEB I/KFV Repeater Site Equipped with TDM

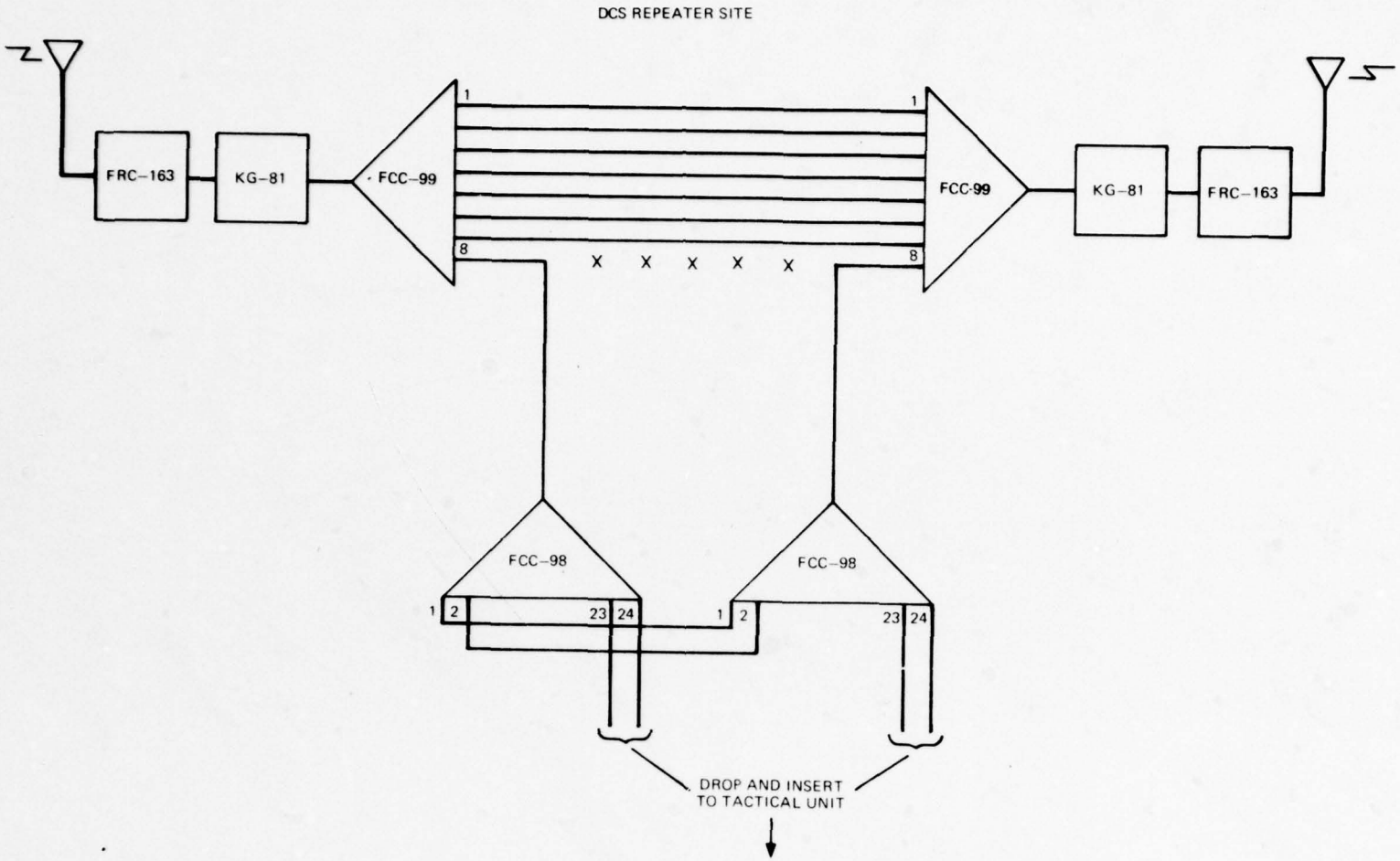


Figure 19. Tactical Interconnect at Remote DCS DEB II-IV Repeater Site Equipped with TDM

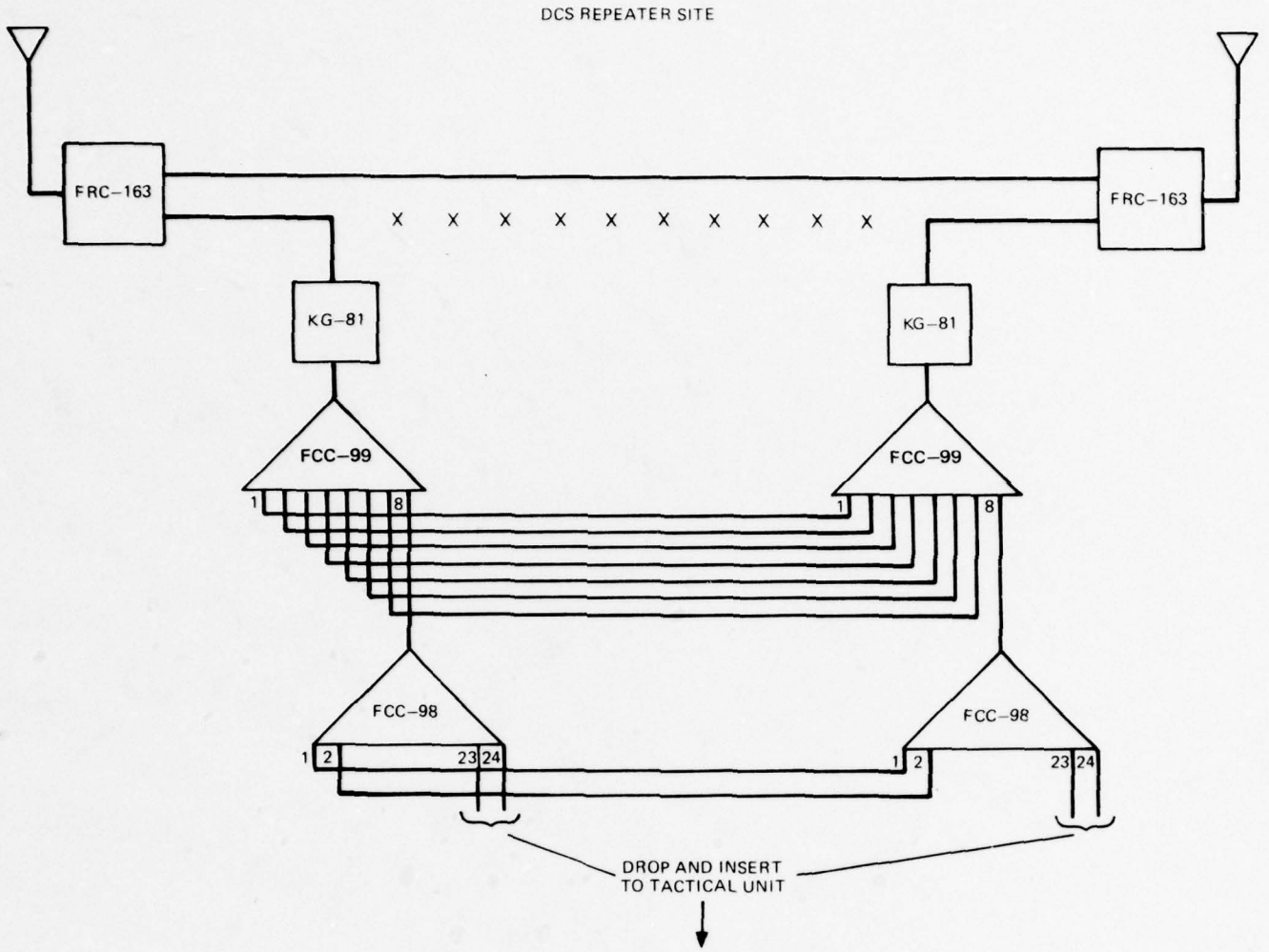


Figure 20. Tactical Interconnect at Remote DCS DEB II-IV Repeater Site Unequipped with TDM

Table 13. Type I Contingency Package

Prime equipment shelter:
Four CY-104A PCMs
Three T1-4000 TDMs
Two TCM-604B tunable radios
Two 5-watt amplifiers
FAS, OW, and VF, T-1, BB patch, patch for 96 4-wire VF circuits
Power subsystem: Two PU-405 A/M engine generators (15 kW) with synchronizer
Mast/antenna subsystem:
Modified tactical mast (102 feet)
Two remotely steerable 6-foot antennas
Eight GHz feeds and waveguide
Support documentation spares, tools, patch cords, test equipments, etc.

Table 14. Type IA Contingency Package

Man-transportable for inaccessible sites:

- Two Terracomm 604B tunable radios
- Two 2-watt power amplifiers
- Two antenna systems (tripod and feeds)
- Two 4-foot antennas
- Portable power system (1/2 kW)
- Non-Redundant FCC-97

All units transportable by one man except power system, which may require two men

Table 15. Type II Contingency Package

Prime equipment shelter:

- Two tunable (DRAMA compatible) radios (operation in both 4 and 8 GHz bands is required)
- Two 2.5-watt amplifiers
- Four FCC-99 8-port TDMs
- Two TSEC/CI-3 (with bypass)
- Six AN/FCC-98 PCM (a CY-104A may be added in addition to, or in place of, one FCC-98)
- FAS, OW, VF, T-1, MBS, BB patch

Power subsystem: TBD*

Mast/antenna subsystem: TBD*

Support documentation, spares, test equipment, tools, patch cords, etc.

*Will use type I equipment if possible.

poses problems in tandem end-to-end configurations. Its quantization standard is lower than the DCS 64-kbps PCM. Voice transmission will usually be satisfactory. However, transmission of quasi-analog data at 2.4 kbps is marginal. It is also marginal for in-band signaling and supervision. Further, as presently designed, the GMF satellite earth terminals are not compatible with TRI-TAC equipment, thus a buffer must be designed and produced to permit interoperation.

5.1 GENERAL

Likely configurations of DCS-Tactical Integrated interoperation are summarized below and covered in detail in Paragraph 5.2.

1. The DCS must be extended by tactical equipment to provide dedicated service between subscribers or to reconstitute existing dedicated service (or vice versa). Service could be clear voice, secure voice, teletype, data, facsimile/graphics, or imagery. A point-to-point or multipoint circuit could be required. Various types of DCS and tactical transmission media might be used. Figures 21, 22, and 23 depict three generalized configurations of this situation.

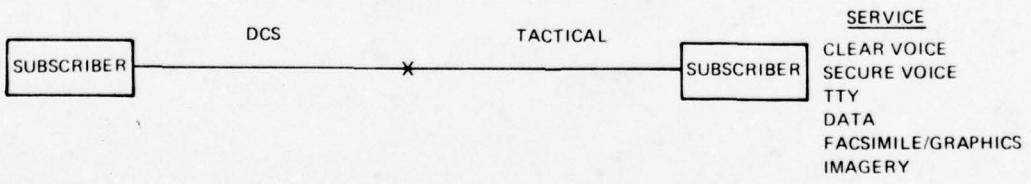


Figure 21. DCS Extended by Tactical Equipment (One Interface)

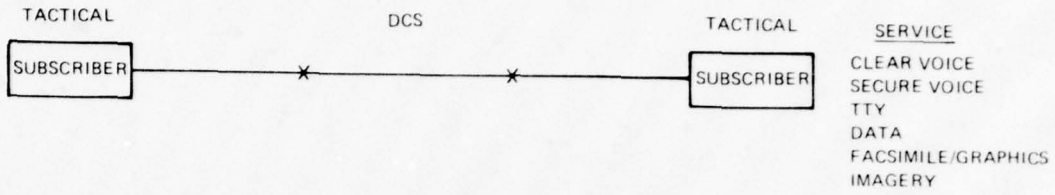


Figure 22. DCS Extended by Tactical Equipment (Two Interfaces)

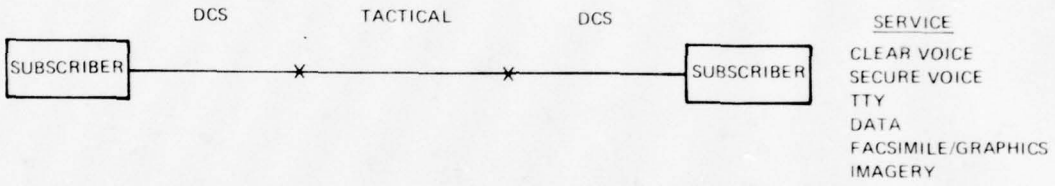


Figure 23. Tactical Extended by DCS

2. A switch of a DCS switched networked (AUTOVON, AUTODIN, or AUTOSEVOCOM) is destroyed and must be reconstituted by a tactical switch such as the TTC-39 or possibly the ULS. Service could be clear voice, secure voice, teletype, data, facsimile/graphics, or imagery. Various types of DCS and tactical equipment could be employed. Figure 24 provides an overview of this situation.

3. A JMTSS-type concept must be implemented, where a DCS baseline system has been partially destroyed and must be reconstituted by tactical assets (or vice versa). Note that extension or expansion of the DCS has been covered by the examples shown in Paragraphs 4.1 and 5.1 (1 and 2). In these situations, we are dealing primarily

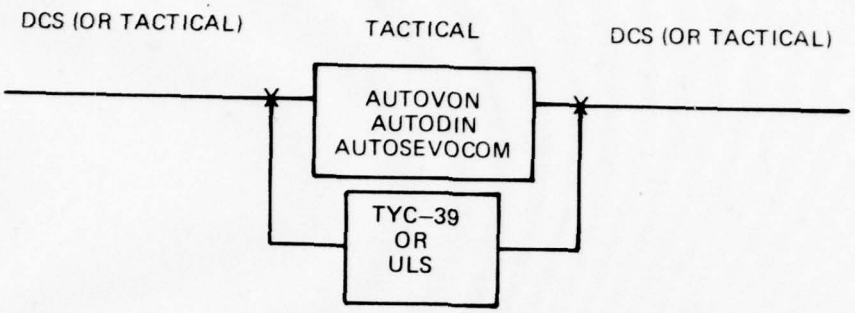


Figure 24. DCS Switch Replaced by Tactical Switch

with the functional interoperation of DCS and tactical equipments, where the transmission media can be a mix of all types. Figure 25 shows a configuration where a DCS microwave repeater site has been destroyed and is reconstituted by tactical microwave equipment.

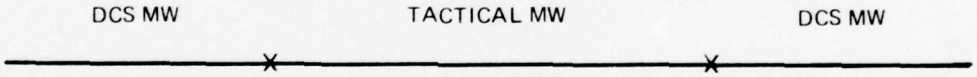


Figure 25. Tactical Microwave Reconstituting DCS Microwave

Note that, in all probability, tactical microwave equipment would be required at the destroyed repeater site and at the sites on either side of it, because there is little probability of the DCS and tactical microwave interoperating (Figure 26). Of course, two sets of DCS microwave equipment would be released for use elsewhere (assuming there are no frequency problems).

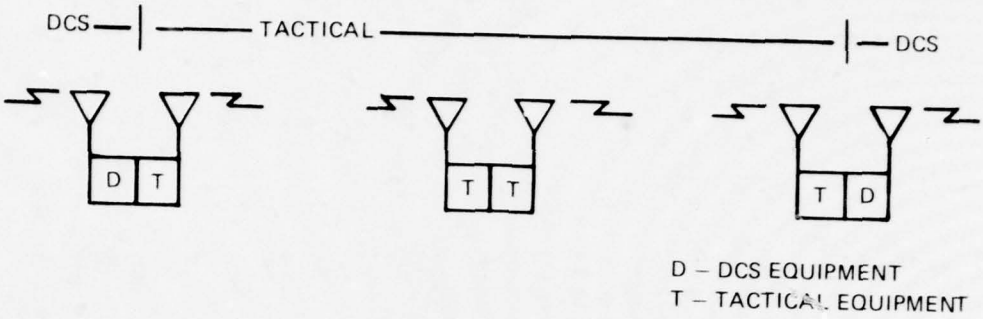


Figure 26. Tactical Equipment Positioning to Replace Destroyed DCS Site

4. Figure 27 shows a similar situation, except that tactical TROPO has been used to reconstitute a destroyed DCS microwave repeater site (assuming that there is no D&I need at the destroyed repeater site). The advantage here is the savings in tactical equipment needs, but this is probably offset by the limited channel capacity of the tactical TROPO equipment.

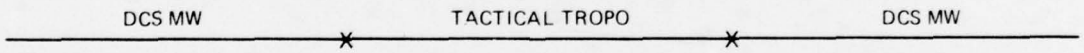


Figure 27. Tactical TROPO Reconstituting DCS Microwave

5. Figure 28 again shows a similar situation, except that GMF tactical satellite terminals have been used to reconstitute the destroyed DCS microwave repeater site. Here, tactical equipment is saved, but channel limitations probably override the savings.

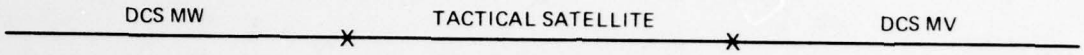


Figure 28. Tactical Satellite Reconstituting DCS Microwave

6. Another situation is that where a DCS TROPO site is destroyed and is reconstituted by a tactical TROPO or a GMF tactical satellite. Figure 29 depicts this configuration.

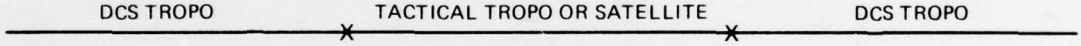


Figure 29. Tactical TROPO or Satellite Reconstituting DCS TROPO

7. There are many other situations where tactical equipment might be required to reconstitute DCS networks. Tactical satellite earth terminals might be used to reconstitute DSCS. Tactical equipment could be employed to reconstitute DCS systems using leased transmission service. Of course, in all cases, the converse is true: DCS assets might be used to reconstitute tactical networks, especially in the case of utilizing DEB contingency assets.

8. In some cases, the situations of DCS-Tactical Integrated will duplicate those of DCS-Tactical Access described in Paragraph 4. When this occurs, reference will be made to the appropriate paragraph instead of repeating the discussion.

5.2 CONFIGURATIONS OF INTEROPERATION

This paragraph will address the various configurations of interoperation for the DCS-Tactical Integrated situation.

5.2.1 DCS Extended by Tactical and Vice Versa

The first generalized configuration is that described by Paragraph 5.1(1). Since this configuration is basically the same as that covered in Paragraphs 4.2.1 through 4.2.6, it will not be repeated. Additionally, the interfaces will also be generally the same as those that will be addressed in Paragraph 5.2.3.

5.2.2 DCS Switch Reconstitution

Use of tactical switches to reconstitute destroyed DCS AUTOVON, AUTODIN, and AUTOSEVOCOM switches represents one of the more critical aspects of the JMTSS. Probably the only existing tactical switch with any potential utility in this situation is the Army's TTC-38, which is limited to use in the AUTOVON subsystem. Therefore, the TRI-TAC TTC-39/TYC-39 must be considered the prime means of DCS switch reconstitution. Use of the TTC-39/TYC-39 to replace destroyed AUTOVON, AUTODIN, and AUTOSEVOCOM FTC-31 switches will be discussed. The general configuration is portrayed in Figure 30. As the figure shows, trunks and access lines other than local to the TTC-39 are carried by six types of transmission media: DCS DRAMA, DCS FKV, DCS FDM/FM, GMF satellite, tactical FDM/FM, and TRI-TAC.

In each case, except TRI-TAC, the multiplex involved (DRAMA, such as FCC-98; FKV-HY-12; GMF satellite, such as TD-660; DCS FDM, such as UCC-4; and tactical FDM, such as GCC-6) provides a VF level output which

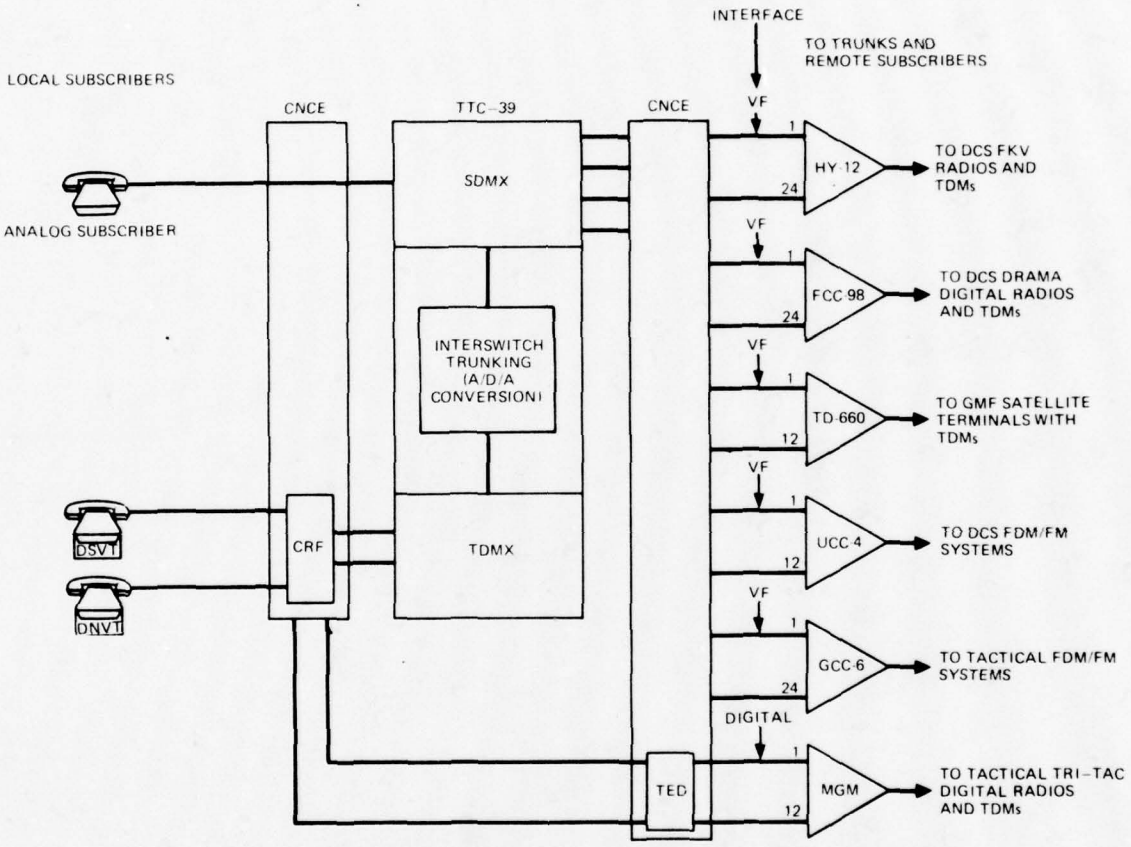


Figure 30. TTC-39 Acting as AUTOVON Switch

fits into the TTC-39 scheme for the AUTOVON interface. Interoperation with TRI-TAC DSVTs and DNVTs would be accomplished via the TDMX.

5.2.2.1 AUTOVON Switch Reconstitution

The TTC-39 is designed to act as an AUTOVON switch, with interface taking place via the SDMX of its circuit switch at a nominal 4-kHz VF. Analog subscribers would be homed on the SDMX, as would AUTOVON interswitch trunking. Tactical digital subscribers homed on the TDMX could access AUTOVON, if authorized, through the interswitch matrix where A/D/A conversion will be accomplished. DSVTs with data capability will be inhibited by the TTC-39 from placing a data call into AUTOVON.

5.2.2.1.1 AUTOVON Trunk Signaling

The signaling between the TTC-39, when operating as an AUTOVON switch, and other AUTOVON switches will be in accordance with the following description:

> The normal analog signaling to an AUTOVON trunk will be single-frequency (2600 Hz) supervision, will be multifrequency (MF two out of six) in-band confirmation or nonconfirmation signaling, and will be in accordance with DCAC 370-V185-7, dated October 1967. On outgoing calls to AUTOVON, the TTC-39 will seize a trunk by applying the appropriate conditions to the single-frequency unit (refer to Chapter 8 of DCAC 370-V185-7).

In the confirmation signaling mode, AUTOVON will respond by sending a key pulse (KP) signal. Upon receipt of the KP signal, the TTC-39 will outpulse KP. AUTOVON will respond with interdigit (ID). The TTC-39 will send the precedence digit, and AUTOVON will confirm by returning the precedence digit. The TTC-39 will send ID, and AUTOVON will confirm with ID. This sequence will continue through all the prefix and address digits which are

KP+P+R+NYX+XXXX. Route indication digit assignment and usage will be in accordance with DCAC 370-V185-7, Chapter 4, Paragraph 4. Upon receipt of the address digits from the TTC-39, the AUTOVON switch forwards the end of signaling (ST) digit to the TTC-39 which instructs the TTC-39 to drop its receiver/sender units after confirmation of the ST digit. The TTC-39 responds with an ST digit, and the AUTOVON switch sends interdigit to complete the sequence. (Refer to DCAC 370-V185-7, Figure 8-6, for a detailed description of sequence.) The TTC-39 takes no further action unless a busy, preemption, or release signal is initiated. AUTOVON will complete the routing of the call. The release cycle with AUTOVON is completed by applying the correct supervisory tone conditions to the trunk and marking the trunk idle.

If the TTC-39 receives the KP signal during the sequence of transmitting the address signals, it will reinitiate the signaling sequence, starting with the transmittal of KP. If the TTC-39, upon seizing an AUTOVON trunk, encounters a glare condition, it will drop its seizure within 2 seconds and attempt to seize any remaining trunk in the group prior to proceeding with the normal routing cycle. If the call encounters a busy condition, either line or trunk busy, the appropriate signal will be returned to the TTC-39, and the connections through the network will be released. If a line busy (LB) signal is received at the TTC-39, an LB indication is returned to the calling subscriber. If a trunk busy (TB) signal is received at the TTC-39, the TTC-39 would attempt to complete the call on an alternate route. If no alternate routes are available, a TB indication is returned to the calling subscriber.

In routing calls to AUTOVON that originate and are completed within the local AUTOVON area code, the TTC-39 will not be required to transmit the area code. In this case, the signaling will be KP+P+R+NNX+XXXX+ST. On incoming calls, the roles of the two switches defined above will be reversed. On outgoing calls, the TTC-39 will be capable of initiating the seize cycle before waiting for all the address digits. If it is unable to seize a trunk, it

will return the appropriate busy indication to the subscriber. The TTC-39 will recognize the preemption signals generated by AUTOVON as outlined in DCAC 370-V185-7, Chapter 8, Figure 8-2, and will generate like signals when preempting an AUTOVON trunk. The TTC-39 will make provisions for accepting and generating a route indication of the form R or RX, where R is defined in DCAC 370-V185-7 and X is any digit from 0 to 9. The X will not be employed until specific assignments are made.

It will be possible to program any trunk group for MF 2/6 nonconfirmation signaling. In this situation, the signaling sequence will start with a received wink start signal (140 to 240 milliseconds in duration). If the wink start signal is not received within 4 seconds after seizure of the trunk, a timeout will occur, and an attempt will be made to seize another trunk in the same route before proceeding with the normal hunting sequence. The switch will then transmit KP+P+R+NYX+XXXX+ST. As indicated previously, the NYX code is not required on calls which originate and are completed within a local AUTOVON area. The KP tones will be present for 100 $\pm$ 15 milliseconds; the digit pulse for 70 $\pm$ 15 milliseconds; and the ST digit pulse for 70 $\pm$ 15 milliseconds. The ID time will be 70 $\pm$ 15 milliseconds. The receiver will respond to a KP of not less than 55 milliseconds or to digits of not less than 27 milliseconds. The frequencies transmitted must be accurate within $\pm$ 1.5 percent. The receiver must recognize frequencies of $\pm$ 1.5 percent, $\pm$ 10 Hz of the nominal. The transmitted MF 2/6 signal tone power will be -6 $\pm$ 1 dBmO for each frequency, with a maximum difference between the two tones of 0.5 dB.

5.2.2.1.2 TTC-39 Acting as AUTOVON Switch

When the TTC-39 is used in a strategic network, it will have the capability of signaling to/from unattended and attended PBXs. Signaling from PBXs will be by any one of the following:

1. Dial pulse.
2. DTMF.
3. Dial pulse and DTMF.
4. Multifrequency (MF 2/6) nonconfirmation.

The receive start signal returned to the PBX to indicate that outpulsing may start for signaling modes (1) through (3) may be either a dial tone or a wink start signal. For MF 2/6 nonconfirmation, the start signal may be dial tone, wink signal, or KP tone. The TTC-39 will be capable of signaling to PBXs in any one of the following signaling modes:

1. Dial pulse.
2. Local terminating (manual operation).
3. MF 2/6 confirmation.

In the dial pulse mode, the TTC-39 will delete the R digit and have the capability to signal in the PNID and INID modes, depending on the class mark associated with the PBX trunk. In the local terminating mode, the TTC-39 sends single-frequency 2600-Hz alerting signals, either routing or precedence, in accordance with DCAC 370-V175-6 System Interface Criteria, Figures 5-3 and 5-4. The start send signals given by a PBX to a TTC-39 to indicate that the PBX is ready to receive the required digits are:

1. No signal (timed start).
2. Wink start.
3. KP tone start (used only with MF 2/6 nonconfirmation).

5.2.2.1.3 Interface Characteristics

As was previously noted, interface to the TTC-39 acting as an AUTOVON switch will be at the VF level, which is inherent in the design of the switch. Thus, the features of the interface, in all cases, are as given in Table 16.

Table 16. Interface Features for TTC-39 Acting as AUTOVON Switch

Functional services:
Clear voice
Signaling
Supervision
Precedence
Preemption
Ringing
Technical considerations:
Bandwidth
Frequency response (insertion loss)
Impedance (input/output)
Longitudinal balance
Envelope delay distortion
Harmonic distortion (single)
Intermodulation distortion (total)
Idle channel noise
Impulse noise
Crosstalk
Noise
Signal level
Balanced or unbalanced
Conditioning

5.2.2.2 AUTODIN Switch Reconstitution

The TYC-39 message switch is designed so that it could, in effect, act as an AUTODIN switch. It provides functions and services related to the handling, processing, and switching of messages in a store and forward mode of operation. It provides the circuits required to receive, process, route, and transmit teletype and data traffic. It performs the various bookkeeping and administrative functions to ensure protection and security of message traffic which originates (1) at users connected directly to the message switch, (2) on trunks connected to other message switching centers, and (3) at users or message switching centers connected to TTC-39 circuit switching centers. Figure 31 depicts a TYC-39 acting as AUTODIN switch.

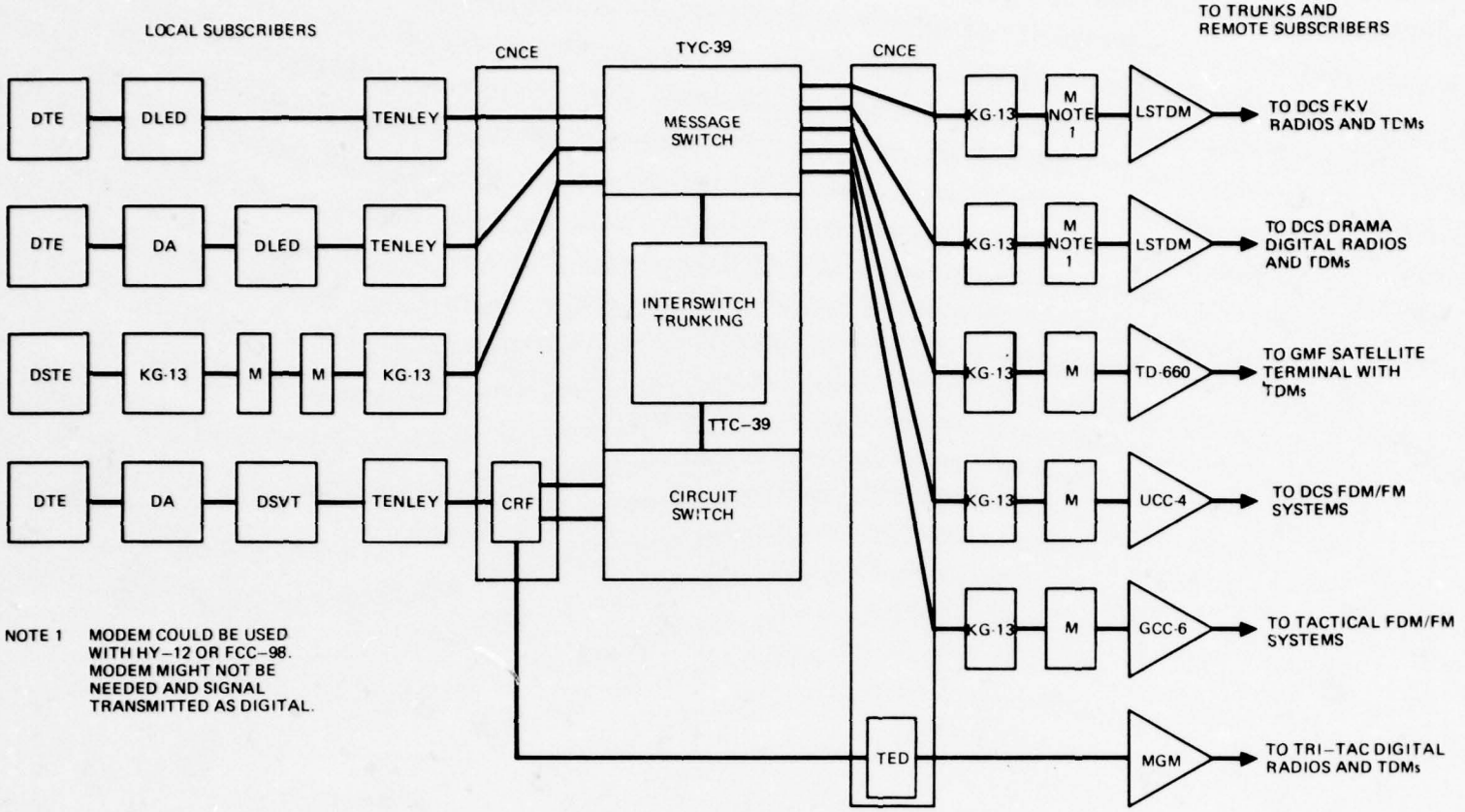


Figure 31. TTC-39 Acting as AUTODIN Switch

The switch can terminate either 25 or 50 lines or trunks. The switch will provide a throughput of up to 81 million characters per day, with a 1-second peak throughput of 9,000 characters. The maximum length of a single message is 44,000 characters. The terminals which interface with the switch may be any of three line types in AUTODIN Modes I through V using ITA No. 2 (BAUDOT) or ITA No. 5 (ASCII) at information rates up to 16 kilobauds. Message formats described in JANAP-128 or ACP-127 must be used. The terminals can include all types of teletypewriters; paper tape readers; card readers; AUTODIN DSTEs; mobile data terminals; weather terminals; high-, medium-, and low-speed printers; and magnetic tape terminals. A line Type IV termination with information rates up to 16 kilobauds is provided for use with DA configured terminals.

5.2.2.2.1 Interface Characteristics

The features of the interface of the TYC-39 acting as an AUTODIN switch are given in Table 17.

Table 17. Interface Features for TYC-39 Acting as AUTODIN Switch

Functional services:
Secure data
Signaling
Supervision
Precedence
Timing
Control
Error detection and retransmission
Language media format
Technical considerations:
Data rate
Serial or parallel
Error rate
Transmitter signal level
Transmitter source impedance
Transmitter waveshape
Receiver input impedance
Receiver input capacitance
Receiver sensitivity
Clocking

5.2.2.3 AUTOSEVOCOM Switch Reconstitution

The TYC-39 is not designed to act as an AUTOSEVOCOM switch, even though it was being considered for such a use. It is designed to terminate WBSTs and NBSTs, and to interoperate with AUTOSEVOCOM through AUTOVON as discussed in Paragraph 4.2.3.3. Thus, it would appear that the SDMX of the TTC-39 could be used to reconstitute an FTC-31. However, wideband trunking would not be possible. The discussion in Paragraph 4.2.3.3 covers the interoperation of the TTC-39 with AUTOSEVOCOM and will not be repeated. The configuration would be as shown in Figure 32. The features of the interface would be the same as those given in Table 10.

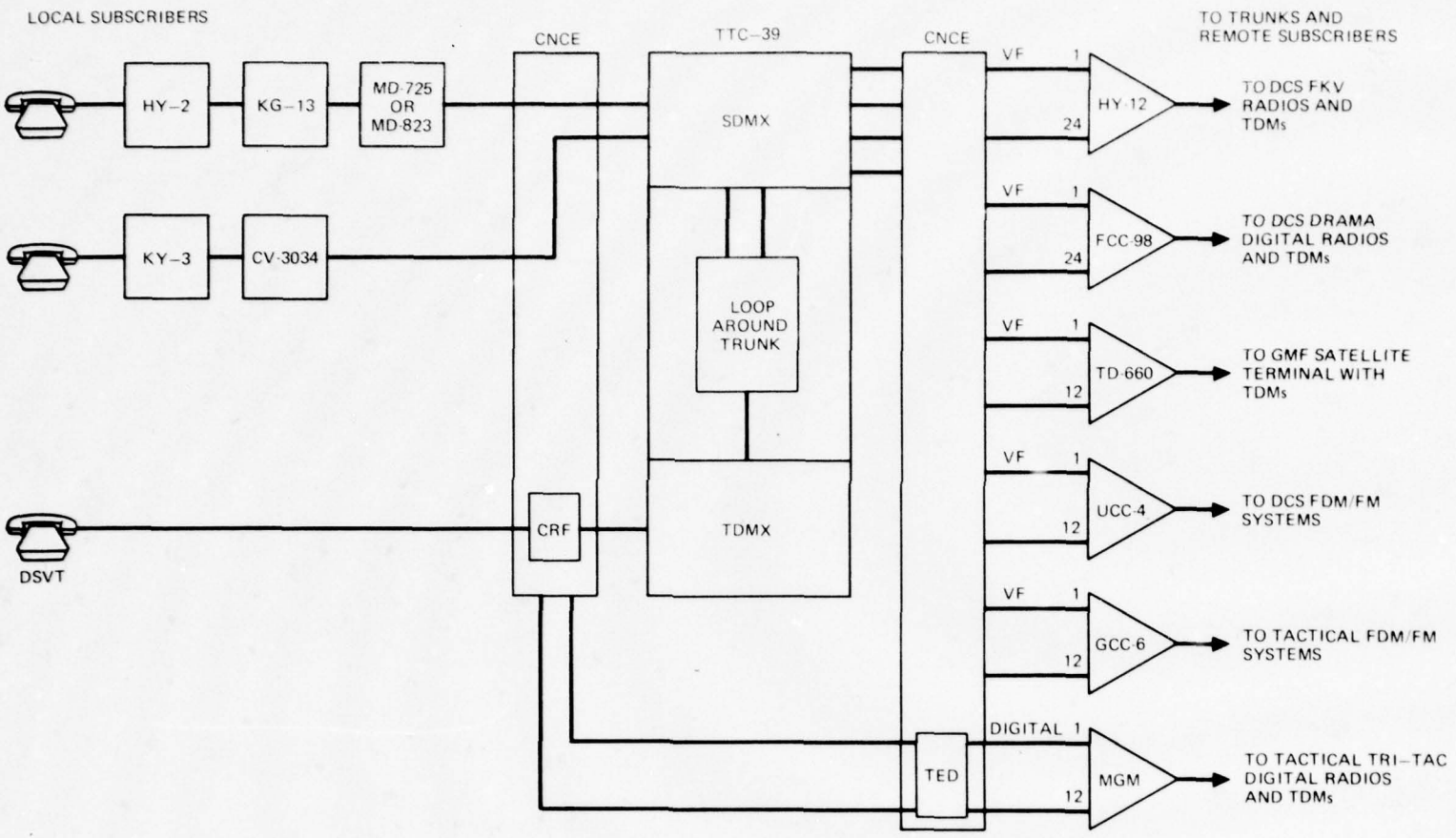


Figure 32. TTC-39 Acting as AUTOSEVOCOM Switch

5.2.3 DCS Reconstitution

This paragraph addresses reconstitution of the DCS by using tactical equipment in the context of the JMTSS. Thus, in effect, there would be an integrated system composed of DCS and tactical subsystems/equipment. Reconstitution of DCS switches has been addressed in Paragraph 5.2.2 and will not be further discussed. And in most respects, reconstitution is similar to DCS extension, as discussed in Paragraphs 5.2.1 and 4.2. However, reconstitution generally requires two interface sites since, in many cases, the tactical equipment would be inserted into a DCS subsystem or vice versa.

As previously noted, due to the inherent characteristics of older tactical equipment, interface with DCS FKV and DRAMA equipment will be at the VF level. There will be only a brief discussion of the use of old tactical equipment for reconstitution. Since the time frame under consideration is the mid-1980's, the discussions will center on FKV equipment being reconstituted by TRI-TAC and GMF satellite equipment. Due to the compatibility of the DRAMA and FKV first-level multiplexers (FCC-98 and HY-12 12A), the discussions will generally apply to DRAMA equipment.

5.2.3.1 Multiplex Commonality

The characteristics of the DCS and tactical multiplexers that generally represent the points of interface are described below. Some possible combinations for interface will be shown, but feasibility depends on the outcome of follow-on detailed investigations. Such problems as the TRI-TAC use of an overhead channel for framing and signaling versus the DCS use of in-baud techniques must be further investigated. Thus, the prime consideration in the following discussion is commonality of inputs/outputs of the low-speed side of the multiplexers. Although the USM is shown in the drawings that follow, this mux may not be procured.

Figure 33 shows those DCS multiplexers on the left and tactical multiplexers on the right which have general areas of commonality. The DCS LSTDM, as presently specified, has a variety of data rate inputs, with 16/32 kbps being common with TRI-TAC and the GMF satellite terminal. The HY-12 provides 24 VF channels, while the HY-12A can accommodate the replacement of five VF channels by data channels. The FCC-98 provides 24 VF channels, or 12 VF and 12 data channels. The USM provides 18 VF channels, of which a limited number can be replaced by 16/32-kbps digital channels. The LCM has 18 data channels at 16/32 kbps. However, one channel is used for overhead (framing, signaling, and telemetry), and a recent change precludes accessing two channels. Thus, only 15 channels can be used for traffic. The TGM accepts up to four channels at 128/256/512 kbps. The TD-660 provides 12 VF channels and, when connected in parallel with the TD-1065, can provide 16/32-kbps data channels. Figure 34 portrays potential DCS-tactical multiplexer interoperations which are listed tabularly as follows:

VF

HY-12 . . . . . USM

FCC-98 . . . . . USM

FCC-98 . . . . . TD-660

HY-12 . . . . . TD-660

16/32 Kbps

LSTDM . . . . . USM

LSTDM . . . . . LGM

LSTDM TD-660/TD-1065

HY-12A . . . . . USM

HY-12A . . . . . LGM

HY-12A TD-660/TD-1065

128/256/512 kbps

FCC-98 . . . . . TGM

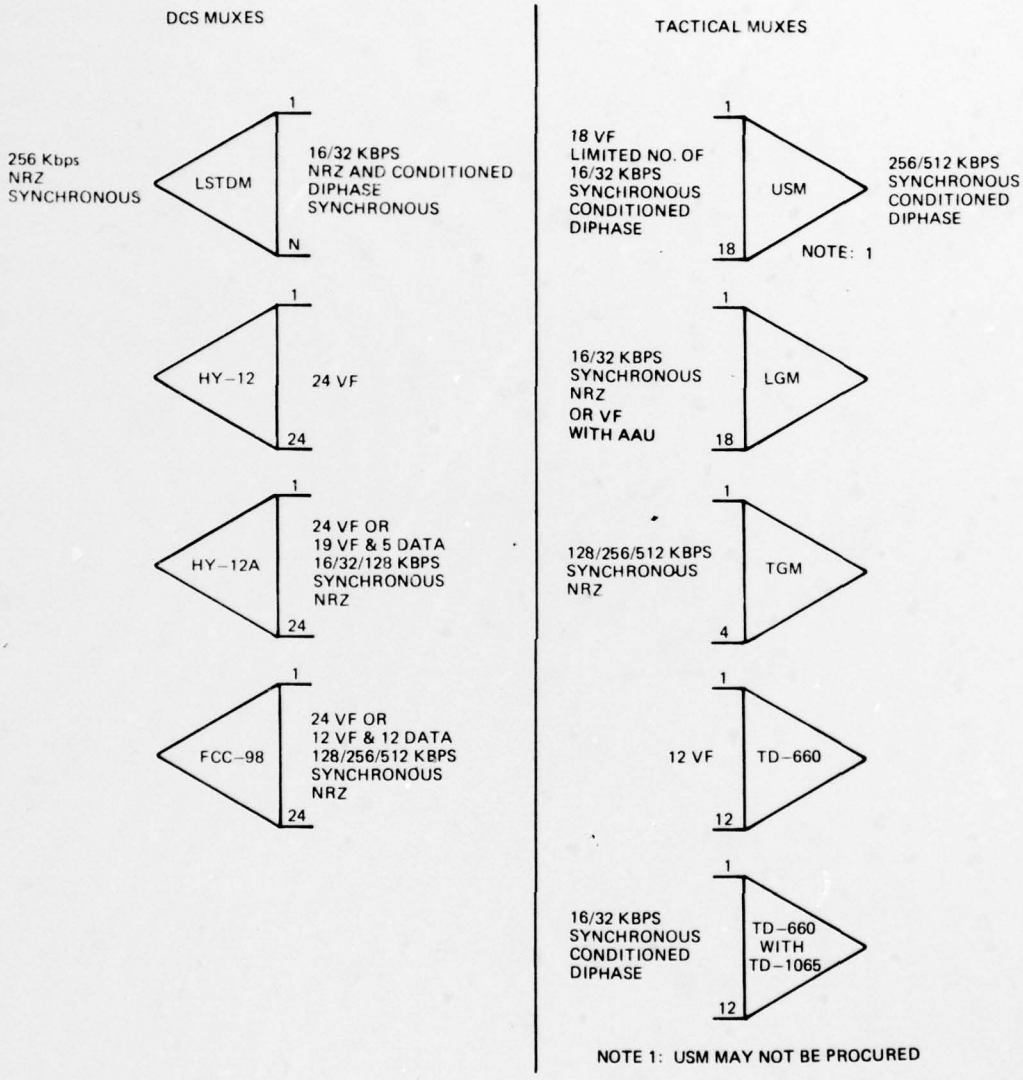


Figure 33. DCS and Tactical MUX Commonality

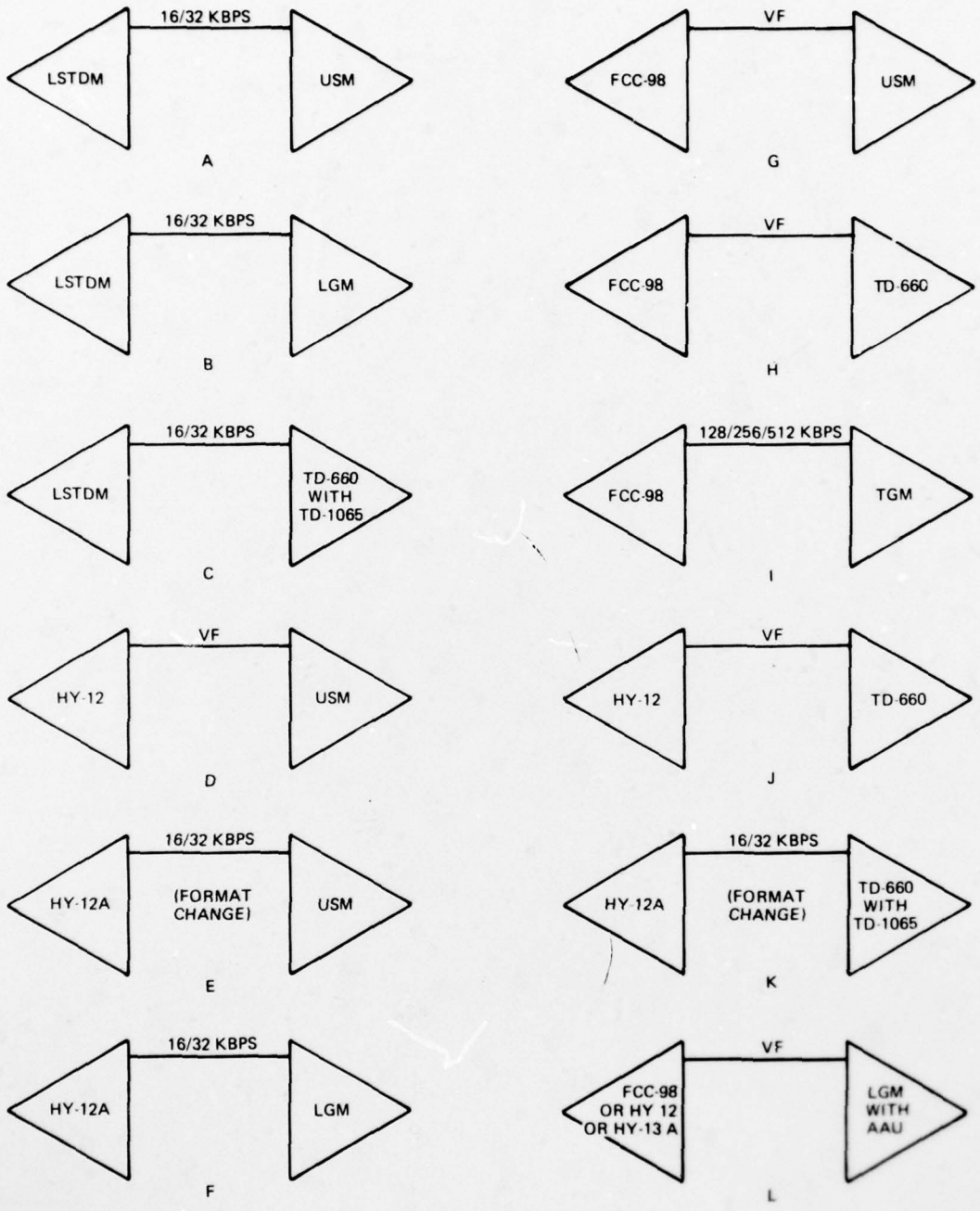


Figure 34. Potential DCS Tactical MUX Interoperation

Detailed investigations during follow-on work will determine the practicality of interoperation of the DCS and tactical multiplexers as shown.

5.2.3.2 Reconstitution Configurations

Use of tactical equipment to reconstitute DCS FKV and DRAMA equipment will be discussed. The functional services across the interface are given in Table 18 and will be dictated by the type of service to be provided.

Table 18. Interface Functional Services

Clear voice
Secure voice
Secure data
Secure TTY
Facsimile/graphics
Imagery
Signaling
Supervision
Precedence
Preemption
Ringing
Power
Timing
Control
Error detection and retransmission
Language media format

Technical considerations of a VF interface are given in Table 19.

Table 19. VF Interface Technical Considerations

Bandwidth
Frequency response
Impedance
Signal level
Noise level
Balanced or unbalanced
Conditioning

Technical considerations of a digital interface are given in Table 20.

Table 20. Digital Interface Technical Considerations

Data rate
Serial or parallel
Error rate
Transmitter signal level
Transmitter source impedance
Transmitter waveshape
Receiver input impedance
Receiver input capacitance
Receiver sensitivity
Clocking

5.2.3.2.1 FKV Reconstitution

The first situation involves the need to reconstitute an FKV, DEB I, or EWCS-SLIP unmanned repeater site with no drop and insert requirements by using tactical assets. Figure 35 shows the links configured before the need for reconstitution. Several different types of tactical equipment will be examined for use in reconstitution.

5.2.3.2.1.1 Use of TRC-97A

The TRC-97A LOS/TROPO equipment, although not new, will undoubtedly still be around in the mid-1980's and, thus, is a candidate for use, even though it can only replace 24 of the 192 VF channels in an FKV subsystem. The equipment used in this discussion is not a TRC-97A that has been modified to a digital radio. Figure 36 shows the reconstituted link using the TRC-97A operating in LOS. The TROPO mode from Site A to C might be employed if the path permits, thus saving equipment. However, this would not impact the interoperation problem under consideration, except that digital service over TROPO would probably suffer because of phase jitter.

As the DCS and tactical equipments are presently configured, interface is possible only at the VF level. Figure 37 shows the interface between the

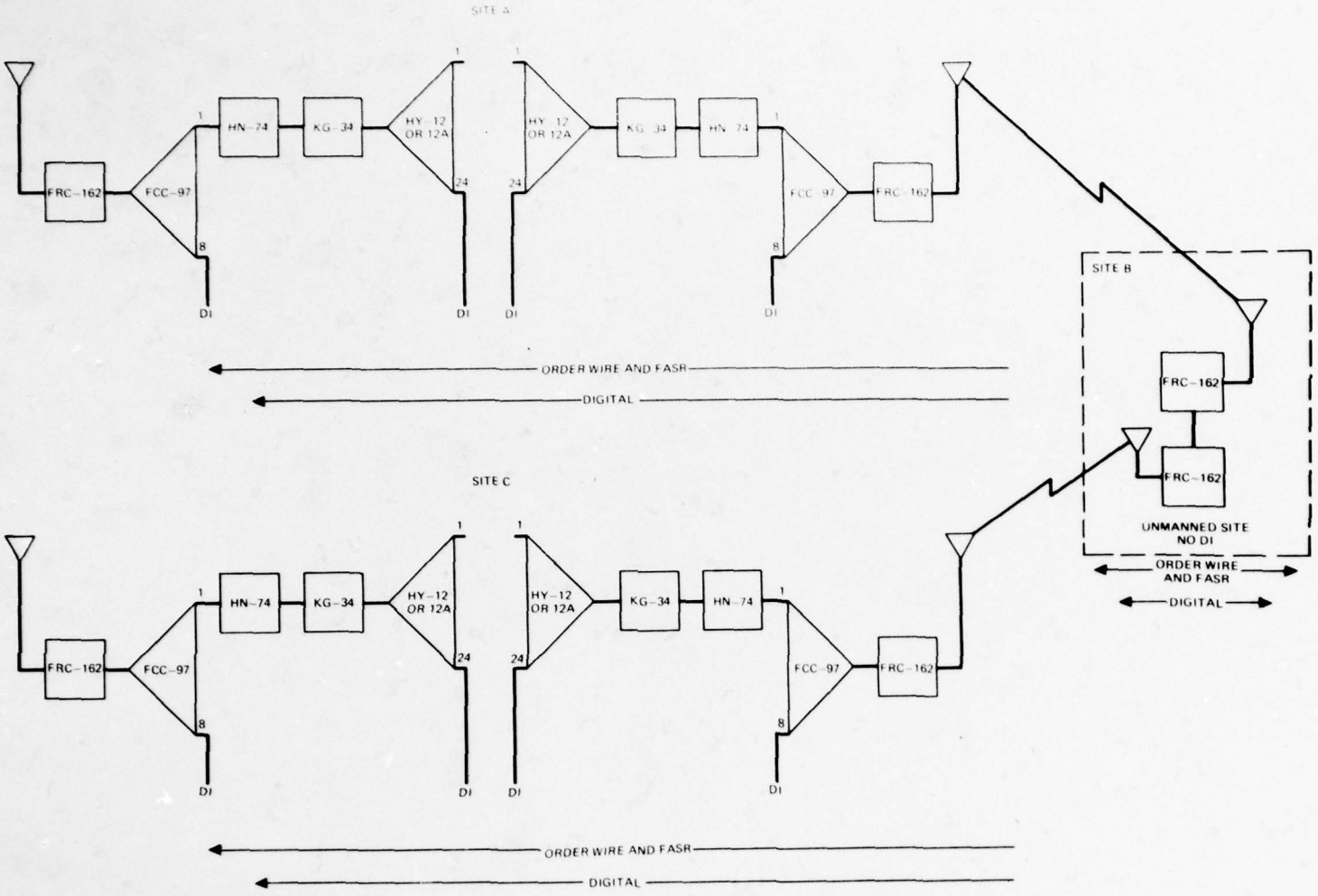


Figure 35. Existing FKV System and Planned EWCS SLIP

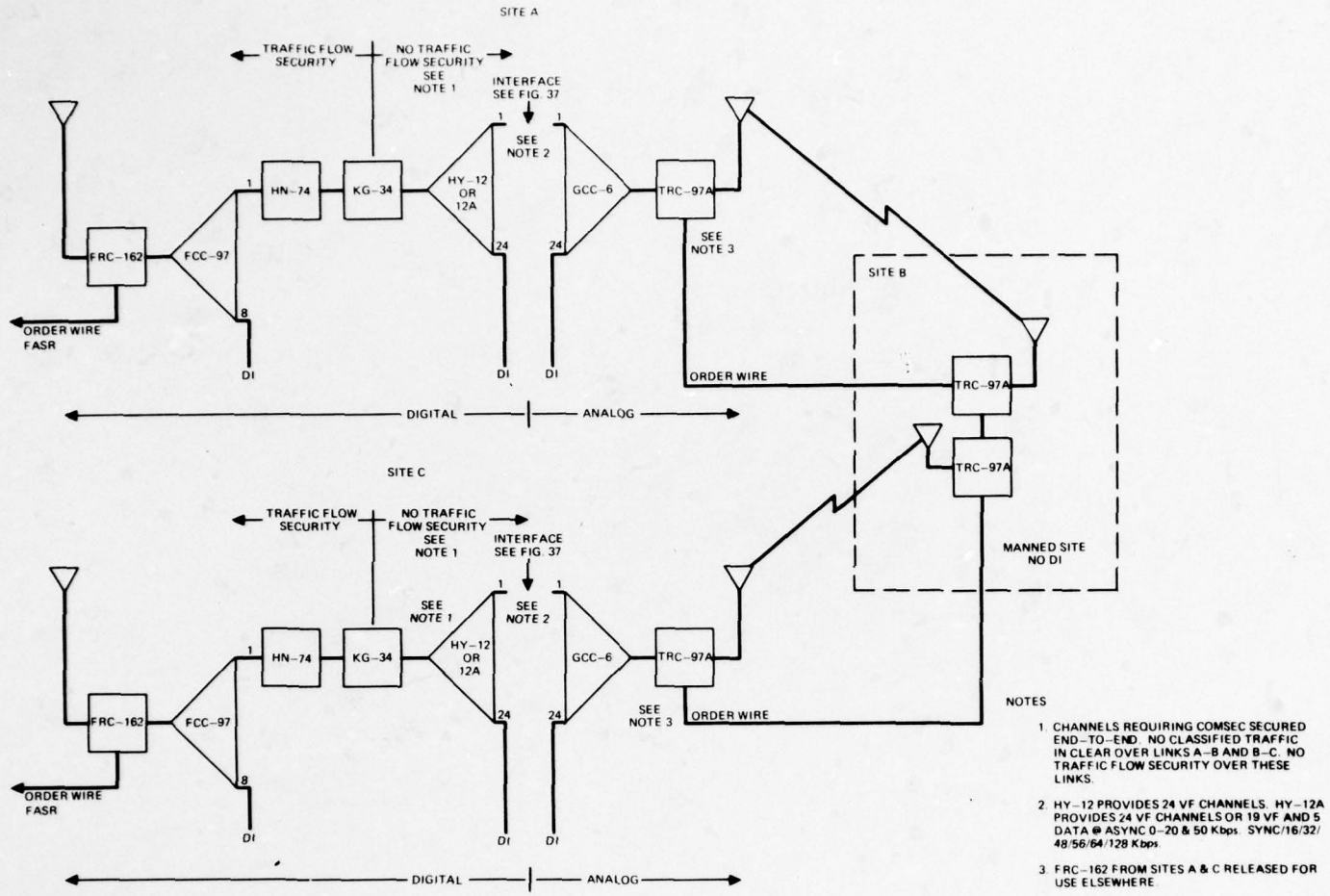


Figure 36. FKV System with Unmanned FRC-162 Repeater Reconstituted by TRC-97A

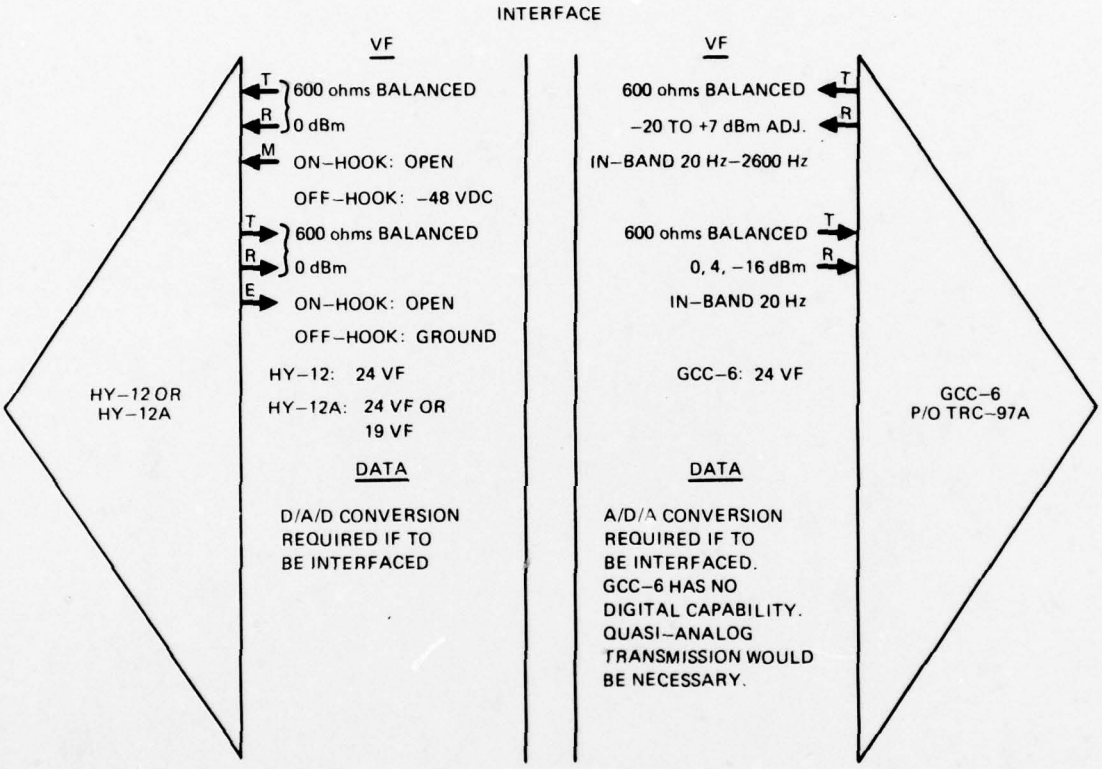


Figure 37. Technical Interface Characteristics of HY-12/12A and GCC-6

HY-12 or HY-12A of the FKV site and the GCC-6 of the TRC-97A. Note that impendance and levels are compatible, but that there is a signaling problem. The HY-12/12A uses E&M, and the GCC-6 uses 20/2600 Hz. Therefore, there is a problem in that an E&M to 20/2600 Hz converter is necessary to accomplish VF interoperation. However, if data are transmitted over the five channels in the HY-12A, then another problem exists. D/A conversion must be accomplished in order for the TRC-97A to accept the circuits as well as A/D conversion to reenter the FKV system. Use of modems for the conversion (at both interface points) is a possible solution. However, the data transmission rates go to 128 kbps. Thus, the TRC-97A can support only limited data traffic, with severe limitations imposed on its VF capability.

Another problem is security. Note in Figure 36 that the KG-34's will provide transmission flow security to either side of the two links reconstituted by the TRC-97A's. However, there is no transmission flow security on the two TRC-97A links. This may not be a problem, since those circuits requiring COMSEC may be secured on an end-to-end basis and thus are secured over the TRC-97A links. The absence of transmission flow security might be an acceptable risk under stress conditions.

Interfacing the order wire poses another problem. The TRC-97A has a 3-kHz order wire with 1600-Hz SF signaling. The FRC-162 provides a 0- to 4-kHz channel for a voice order wire, and a 4- to 8-kHz channel for transmitting alarm data from unattended sites. Site A can talk to Sites B and C over the TRC-97A order wire, and this should prove adequate without the need of interfacing to the FRC-162. However, remote alarm data cannot be passed to Sites A and C. This, plus its inherent design, probably dictates that the Site B TRC-97A be manned.

5.2.3.2.1.2 Use of GMF Satellite Terminal

The TSC-85 (also TSC-93 and -94) are still in development, with a low rate initial procurement underway primarily for test purposes. This equipment

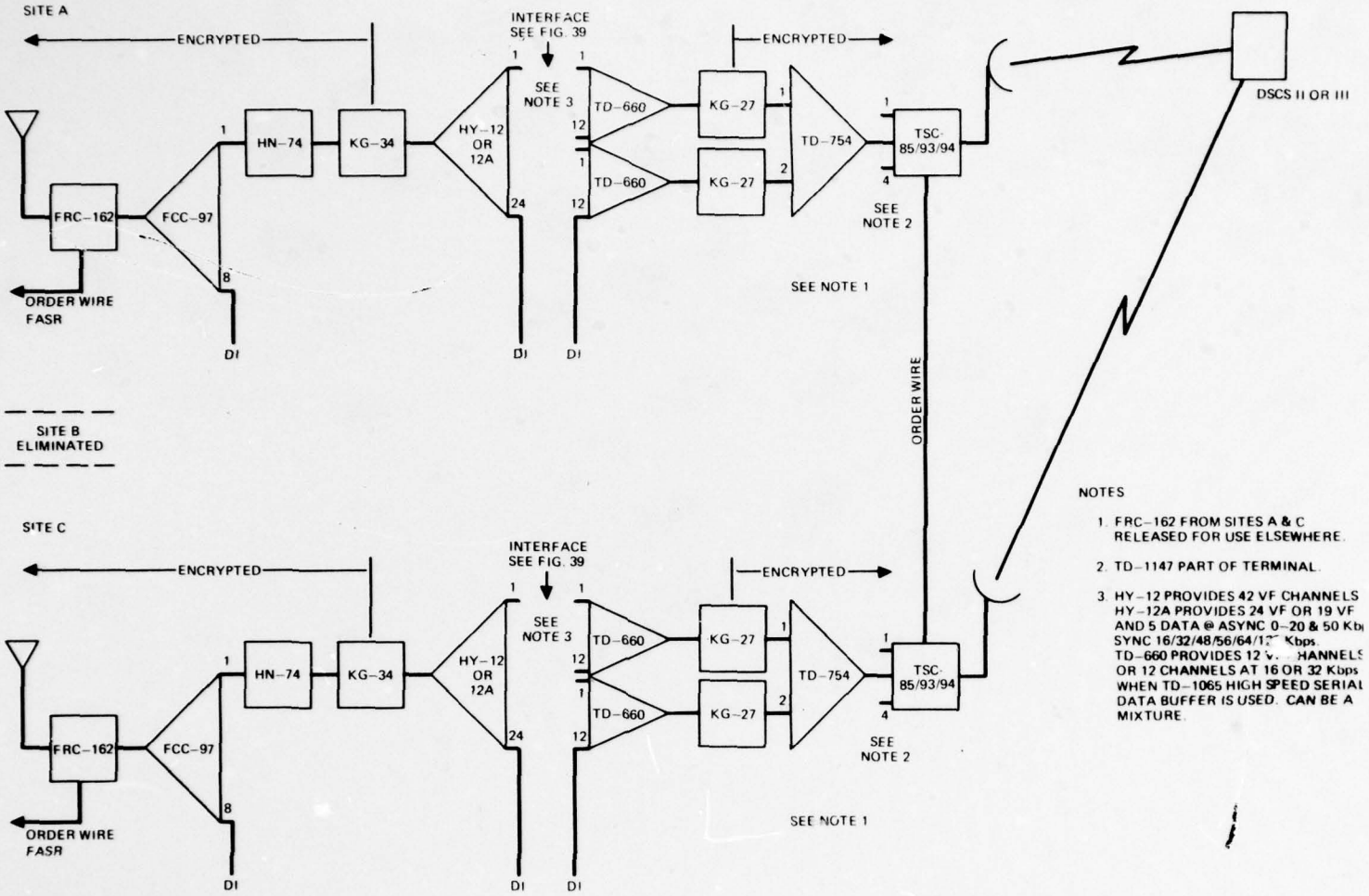
does provide a good potential for reconstitution of a DCS subsystem. Its inherent flexibility provides choices of where the satellite terminals could be placed, thus presenting the possibility of releasing DCS assets for use in other reconstitution actions. Figure 38 shows the reconstituted FKV link using the TSC-85 to bypass the destroyed site.

Figure 39 shows the HY-12 or HY-12A interface with the TD-660. Only impedance matching and an E&M to 1600-Hz in-band signaling conversion are required to accomplish a VF interface. Digital interfacing would be a problem, because of the differences in modulation schemes (NRZ for the HY-12 or 12A versus conditioned diphase for the TD-660). A possible solution is to use a device like the TRI-TAC conditioned diphase group modem that is modified for the proper data rate. Such a device accepts NRZ on one side and conditioned diphase on the other.

Another problem would be the order wire. The FKV radio (FRC-162) provides a 4-kHz order wire and a 4-kHz telemetry channel for fault alarms and controls. The TSC-85 provides only a voice order wire. However, the sites where the TSC-85's would be located would probably be manned and, thus, point-to-point order wire operations would probably suffice. Fault alarm data would be transmitted to controls on either side of the reconstituted wire. An alternative could be the use of a mission channel for telemetry.

5.2.3.2.1.3 Use of TRI-TAC TRC-170

The TRI-TAC TRC-170, operating in either an LOS or a TROPO mode, could be used to reconstitute a destroyed FKV-type site. Used in the LOS mode, the TRC-170 would provide the greatest number of channels and release two sets of FKV equipment for use elsewhere, but four TRC-170's would be required. In the TROPO mode, where the TRC-170 would release two sets of FKV equipment for use elsewhere, only two TRC-170's would be required, but there would probably be a reduced channel capacity, depending on the



NOTES

1. FRC-162 FROM SITES A & C RELEASED FOR USE ELSEWHERE.
2. TD-1147 PART OF TERMINAL.
3. HY-12 PROVIDES 42 VF CHANNELS HY-12A PROVIDES 24 VF OR 19 VF AND 5 DATA @ ASYNC 0-20 & 50 Kb SYNC 16/32/48/56/64/12[illegible] Kbps. TD-660 PROVIDES 12 V[illegible] HANNELS OR 12 CHANNELS AT 16 OR 32 Kbps WHEN TD-1065 HIGH SPEED SERIAL DATA BUFFER IS USED. CAN BE A MIXTURE.

Figure 38. FKV System with Unmanned FRC-162 Repeater Reconstituted by SHF Tactical GMF Satellite Terminals

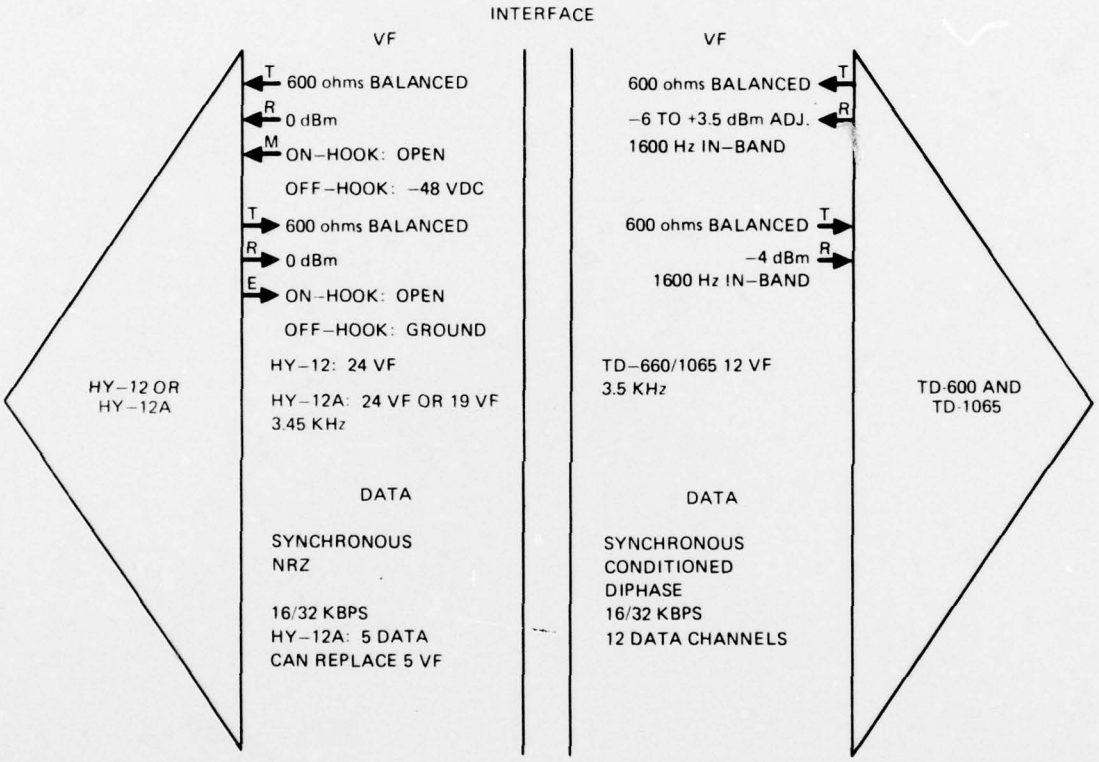


Figure 39. Technical Interface Characteristics for HY-12/12A and TD-660/1065

distance of the link. Figure 40 depicts the TRC-170 operating in the TROPO mode and reconstituting a destroyed FKV-type site. Figure 41 shows the HY-12 or 12A interfacing the TRI-TAC LGM. However, the LGM has no VF capability, the HY-12 is totally voice, and the HY-12A has only five possible data channels. Data interface on this limited basis does not appear to be a great problem.

To accomplish a VF interface, however, a TRI-TAC AAU would be required for the LGM.

The order wire interface would pose problems, since the FRC-162 provides a 4-kHz voice order wire and a 4-kHz telemetry channel. TRI-TAC equipment provides a 16-kbps digitized voice order wire and four 2-kbps data channels for telemetry. Point-to-point order wire operation appears satisfactory, assuming that TRC-170 sites would be manned.

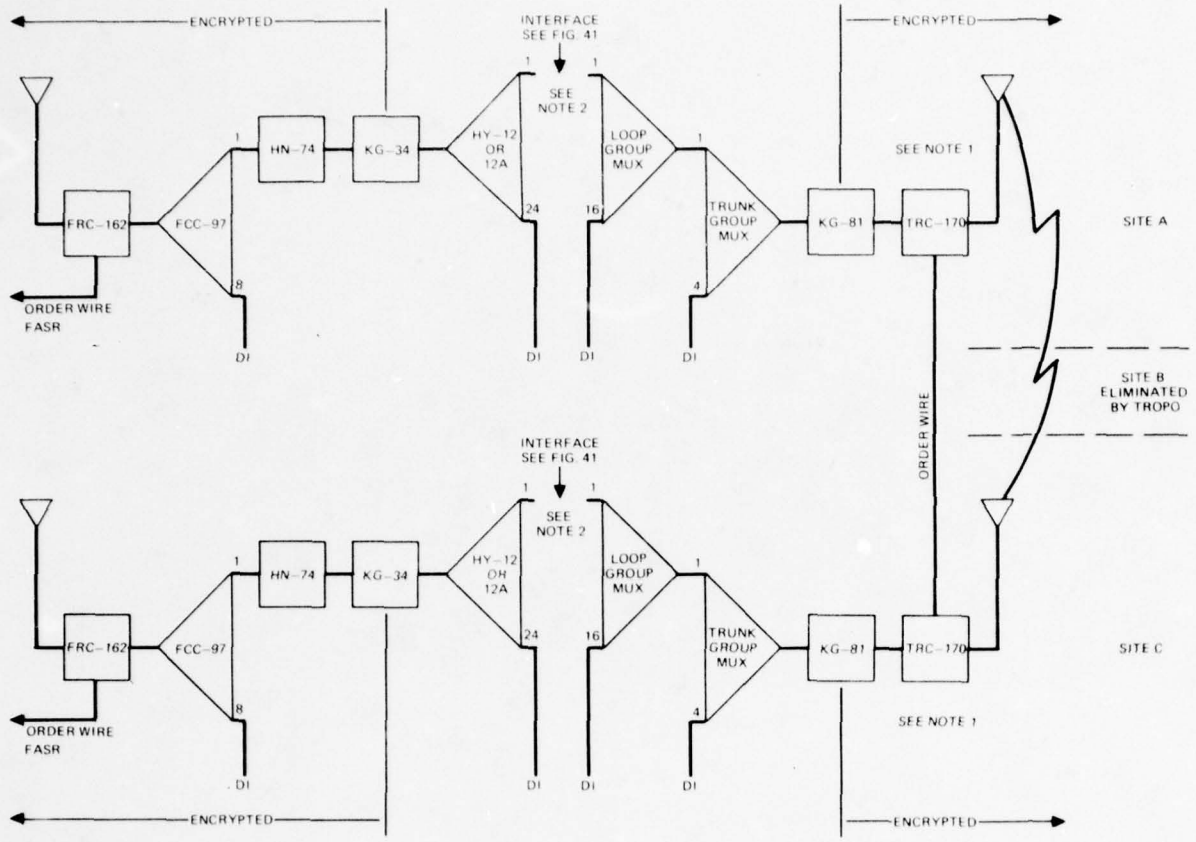
5.2.3.2.2 DRAMA Reconstitution

Due to the compatibility between FKV and DRAMA equipment, the discussion in this paragraph will be limited to those situations where major differences exist. Note that the prime differences between the HY-12/12A and FCC-98 are as follows:

	HY-12/12A	FCC-98
Data Channels	5	12
Data Rate (kbps)	16/32/48/56/64/128	56/64/128/256/512

5.2.3.2.2.1 Use of TRC-97A

Use of the TRC-97A to reconstitute a DRAMA link would impose the same considerations as those addressed for an FKV link in Paragraph 5.2.3.2.1.1.



NOTES:

1. FRC-162 FROM SITES A & C RELEASED FOR USE ELSEWHERE.
2. HY-12 PROVIDES 24 VF CHANNELS. HY-12A PROVIDES 24 VF OR 19 VF AND 5 DATA @ ASYNC 0-20 & 50 Kbps. SYNC 16/32/48/56/64/128 Kbps.
   LOOP GROUP MUX PROVIDES 8/16 CHANNELS AT 32 Kbps OR 9/18 CHANNELS AT 32 Kbps OR 8/16 CHANNELS AT 16 Kbps OR 9/18 CHANNELS AT 16 Kbps.

Figure 40. FKV System with Unmanned FRC-162 Repeater Reconstituted by TRI-TAC TRC-170

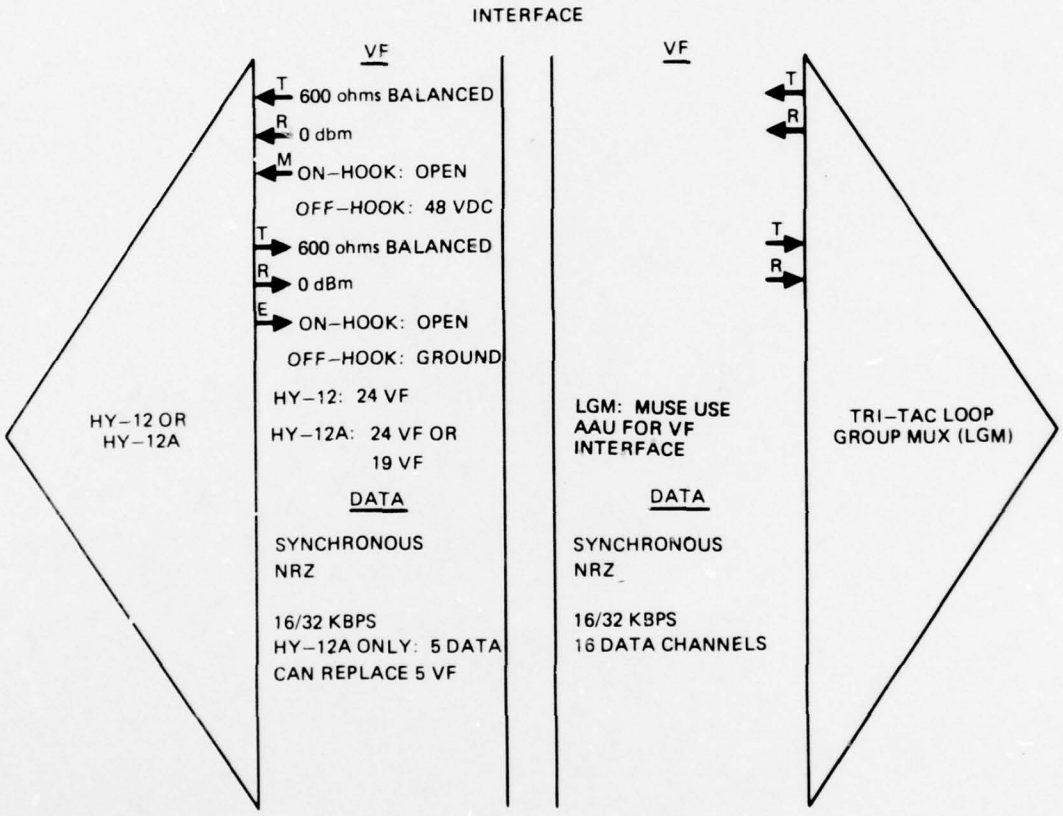


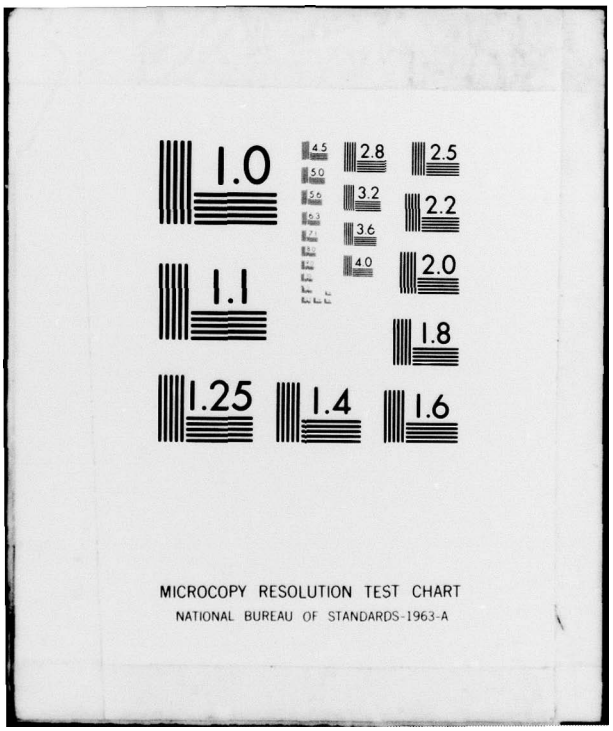
Figure 41. Technical Interface Characteristics for HY-12/12A and TRI-TAC LGM

AD-A078 927 COMPUTER SCIENCES CORP FALLS CHURCH VA F/G 17/2
THE DEFENSE COMMUNICATIONS SYSTEM AND THE TACTICAL ACCESS AREA:--ETC(U)
SEP 79 C SCHULTZ , R SAVAGE DCA100-78-C-0053
UNCLASSIFIED SBIE-AD-E100 316 NL

2 OF 2
AD
A078927



END
DATE
FILMED
1-80
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
7.1
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

5.2.3.2.2.2 Use of GMF Satellite Terminal

Interfacing the FCC-98 with the TD-660 at the VF level would be the same as discussed in Paragraph 5.2.3.2.1.2 for FKV equipment. Since the FCC-98 does not have compatible data rates, however, an LSTDM would be required for a digital interface at 16/32 kbps. This interface does not appear to pose any significant problems.

5.2.3.2.2.3 Use of TRI-TAC TRC-170

A VF interface between the DCS FCC-98 and the TRI-TAC LGM would require a AAU on the tactical side, as discussed for FKV equipment. An LSTDM would be required on the DCS to provide compatible data rates (16/32 kbps) to interface the TRI-TAC LGM. Figure 42 depicts this situation. While no major problems are anticipated, detailed investigations will determine if such is true. For example, the TRI-TAC use of an overhead channel for framing and signaling may be troublesome and must be looked into.

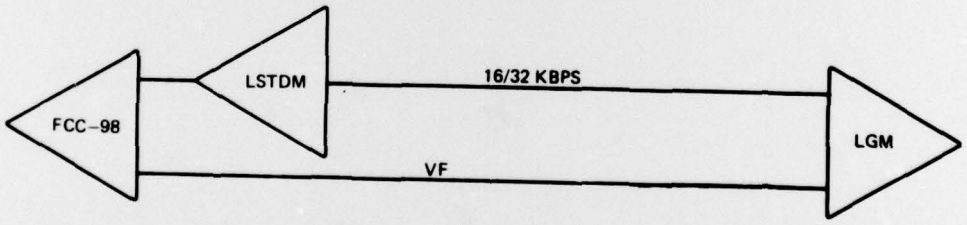


Figure 42. FCC-98 LSTDM Interfacing LGM/USM

5.2.3.2.2.4 DRAMA Order Wire

The DRAMA equipment uses the 3-channel version of the FCC-98 for a service channel MUX that normally provides two voice order wires and a data channel for fault alarms and control. Thus, to interface order wires with those of the tactical equipments previously discussed poses problems. One of the DRAMA voice order wires could probably be interfaced with the TRC-97A and

TSC-85, provided signaling converters and other minor modifications are undertaken. However, the TRC-170 interface poses different problems because of data rates. Because of the emergency nature of reconstitution situations, point-to-point order wire and fault alarm and control would temporarily suffice. This will be further investigated during follow-on work.

5.2.3.3 Interface at Higher Data Rates

There appears to be the potential for three configurations of interfacing DCS to tactical equipment at higher rates. The LSTDM output of 256 kbps might be input to a TRI-TAC TGM. Then the USM output of 256/512 kbps could possibly be input to the DCS FCC-98. In both these cases, however, there is the problem of conditioned diphase versus NRZ. A type of TRI-TAC conditioned diphase group modem might be used to resolve this problem.

The third potential connection might be to interface the FCC-98 to the TRI-TAC TGM at 128/256/512 kbps, such as shown in Block I of Figure 34. In general, this interface appears possible, but only a detailed study will provide its feasibility.

The problem that affects all these higher data rate interfaces is the TRI-TAC use of an overhead channel for framing and signaling. This precludes rearrangement of channels in the TRI-TAC MUX hierarchy. The impact of the overhead channel will be determined during the subsequent investigation of problems.

SECTION 6 - CONCLUSIONS

As work was started on this report concerning DCS and the tactical access area, past experiences of problems of interoperation of different subsystems/equipments were reviewed. Such experiences were primarily for the analog world, but they vividly demonstrate that interoperation almost always poses such problems as signaling, matching impedances, matching levels, etc. More recent experiences in the commercial world pertain to the interoperation of digital and analog subsystems and the transmission of data over these interoperating subsystems. Here, the problems indicated that data rates, interfaces, etc., had been adopted by various vendors and carriers without due consideration of interoperational needs.

Much the same is true of the DCS versus TRI-TAC needs for interoperation. The DCS adoption of the North American standard using PCM appears logical and in keeping with the needs of the future. The same is true of the TRI-TAC use of the 16/32-kbps data rate and CVSD. Although there have been efforts to determine new means of interoperation, the research conducted during the preparation of this report can only emphasize the magnitude of the problem, especially in a JMTSS environment.

Interoperability efforts appear to have been concentrated on the TRI-TAC switching equipment (principally TTC-39) and the CNCE of the TCCF. Various means will be provided in these equipments for interoperation with DCS, commercial, and NATO facilities. However, future investigations and interoperability testing will determine the degree of satisfaction of such needs. The capability of transmission systems to support interoperability appears to be the area requiring the most detailed examination and study.

In the case of JMTSS with tactical equipment reconstituting DCS equipment or vice versa, there may not be TTC-39s or CNCEs available. Thus, tactical equipment or DCS equipment, as the case may be, will be inserted in a

transmission route where a repeater site has been destroyed. If no drop and insert is required, then it would be desirable to "through-group" the mission streams at the highest possible level. Preliminary research indicates that this is not possible and that multiplexers must be provided to break out channels for interfacing. Again, future work will determine the extent of this problem.

System control of an integrated DCS-tactical system poses further problems. While point-to-point order wire and fault alarm and control can suffice temporarily, an interoperating system over the longer term requires interoperating system control. This does not appear practical in the time frame under consideration. Of course, the problem is further compounded, because the GMF satellite terminals have only a voice order wire.

Note that interoperation with the Navy has not been addressed in this preliminary report, mainly because the Navy states that all interoperation will be through a NAVCAMS or a NAVCOMSTA which will be configured with necessary devices to accomplish interoperation (automatic, semiautomatic, or manual). This same policy is stated by the Marine Corps. However, the GMF satellite, which will be used by the Marine Corps as well as by the Army and the Air Force, has been addressed.

APPENDIX A - ACRONYMS

This appendix provides definitions for the acronyms used in this report.

AAU	Analog Applique Unit (for A/D/A conversion)
A/D	Analog to digital
A/D/A	Analog to digital to analog conversion
AUTODIN	DCS Automatic Digital Network
AUTOVON	DCS Automatic Voice Network
AUTOSEVOCOM	DCS Automatic Secure Voice Communications
CNCE	TRI-TAC Communications Nodal Control Element (part of the TCCF)
COMSEC	Communication security
CONUS	Continental United States
CRF	Channel reassignment function
CVSD	Continuously variable slope delta modulation
DA	TRI-TAC data adapter
D/A	Digital to analog
DCA	Defense Communications Agency
DCAC	Defense Communications Agency circular
DCS	Defense Communications System
DCS II	Defense Communications System in the mid-1980's
DEB	Digital European backbone (being implemented in four phases)
DGM	TRI-TAC digital group multiplex (a family of time division multiplexers)
D&I	Drop and insert channels
DLED	TRI-TAC dedicated loop encryption device
DNVT	TRI-TAC digital nonsecure voice terminal
DRAMA	DCS digital radio and multiplex acquisition (FRC-163, FCC-98, FCC-99)
DSCS	Defense Satellite Communications System
DSSCS	Defense Special Security Communications System
DSVT	TRI-TAC digital subscriber voice terminal
DSTE	DCS AUTODIN digital subscriber terminal equipment
DTE	Digital terminal equipment

DTMF	Dual-tone multifrequency signaling
FASR	Fault alarm status reporting
FAX	Facsimile
FDM/FM	Frequency division multiplex/frequency modulation
FKV	DCS Frankfurt-Koenigstuhl-Vaihingen TDM communications system installed in 1975 using FRC-162, CY-104, FCC-97, and T1WB1
GMF	Ground mobile forces
ID	Interdigit
INID	Intercept network inward dialing
JCS	Joint Chiefs of Staff
JMTSS	Joint multichannel trunking and switching system
KP	Key pulse
LGM	TRI-TAC loop group multiplexer (first level MUX)
LOS	Line of sight
LSTDM	DCS low-speed time division multiplexer (sublevel multiplexer)
MCB	Message control block
MDT	Mobile data terminal
MF	Multiple frequency signaling
MGM	Master group multiplexer
MUX	Multiplex(er)
NATO	North Atlantic Treaty Organization
NAVCAMS	Naval Communications Area Master Station
NAVCOMSTA	Naval Communications Station
NBST	DCS AUTOSEVOCOM narrowband secure terminal
NRZ	Nonreturn to zero
OPLAN	Operational plan
OSD	Office of Secretary of Defense
PARKHILL	Narrowband encryption device
PBX	Private Branch Exchange

PCM	Pulse code modulation
PDP	DCS Pacific digitization program
PNID	Precedence network inward dialing
RF	Radio frequency
RI	Routing indicator
SATCOM	Satellite communications
SDMX	TRI-TAC AN/TTC-39 circuit switch space division matrix
SF	Single-frequency signaling
S&F	Store and forward
SRWBR	TRI-TAC short-range wideband radio
SVD	Subscriber
TCCF	TRI-TAC tactical communications control facilities
TDF	Tactical digital facsimile
TDM	Time division multiplex
TDMA	Time division multiple access
TDMX	TRI-TAC AN/TTC-39 circuit switch time division matrix
TED	Trunk encryption device
TENLEY	TRI-TAC encryption device
TGM	TRI-TAC trunk group multiplexer (second level MUX)
TRI-TAC	Joint Tactical Communications Office
TROPO	Tropospheric scatter radio
TTY	Teletype
ULS	TRI-TAC unit level switch (TTC-42 and SB-3865)
USM	TRI-TAC universal synchronous multiplexer (sublevel MUX)
VF	Voice frequency
WBST	DCS AUTOSEVOCOM wideband secure terminal (KY-3)

APPENDIX B - REFERENCE DOCUMENTS

This appendix identifies and lists those documents that were studied during the preparation of this report.

1. CCC-74049, Specification for Radio Set, AN/FRC-163 ( ), 1 March 1976 including Amendment 2, 16 July 1976.

2. CCC-74048, Specification for Multiplexer/Demultiplexer TD-1193 ( )/F, 1 March 1976 including Amendment 2, 16 July 1976.

3. CCC-74047, Specification for Multiplexer/Demultiplexer TD-1192 ( ) (P)/F, 20 August 1975 including Amendment 5, 20 April 1977.

4. TT-B1-1101-0001, Performance Specification, Central Office, Communications, Automatic AN/TTC-39 ( ) (V), TRI-TAC, 21 January 1972.

5. TT-B1-1101-0001A, Performance Specification, Central Office, Communications, Automatic AN/TTC-39 ( ) (V), TRI-TAC, 7 Jure 1974.

6. USAEPG-TP-868, Volume II, Joint Test of Central Office, Communications Automatic AN/TTC-39 ( ) (V), TRI-TAC, February 1975.

7. TT-B1-2202-013, Performance Specification for Digital Group Multiplex, TRI-TAC, 26 November 1974.

8. Martin Marietta Tactical Communications Control Facilities Applications Guide, March 1978.

9. TT-B1-1203-0033, Performance Specification for Tactical Unit Level Circuit Switch, TRI-TAC, 30 June 1975.

10. GMF Satellite Communications Program Memorandum, 12 January 1978 (SATCOMA).

11. TT-A3-9004-0019, Interface Specification of the TCCF and AN/TTC-39 ( ) (V), TRI-TAC, 31 December 1974.

12. "Integrated Switching of Voice and Non-Voice Traffic," Jerome Blackman, TRI-TAC, 1976.

13. Brochure on AN/TRC-170, Raytheon, 1978.

14. Brochure on Tactical Digital Facsimile, AN/UXC-4 ( ) (V), Datalog (Litton), 1978.

15. Brochure on Unit Level Circuit Switch (AN/TTC-42 and SB-3865), ITT Defense Communications Division, 1978.

16. DCEC EP 3-78, DCS Technical Control Engineering Criteria, May 1978.

17. Draft Proposed MIL-STD-187-320, Standards for Long Haul Communications, Transmission Planning Standards for the DCS, 14 November 1978.

18. MIL-STD-188-100, Common Long Haul and Tactical Communication System Technical Standards, 15 November 1972.

19. DCAC 370-D175-1, DCS AUTODIN Interface and Control Criteria, October 1970.

20. DCAC 370-V175-6, AUTOVON System Interface Criteria, February 1965.

21. DCAC 370-185-1, DCS Applications Engineering Manual, May 1968.

22. (C) TTO-ENG-031-76-ANC7, Architecture for Tactical Switched Communication Systems, Annex C7, Architecture for External Interface Subsystem (Phase 1 Implementation) (U), TRI-TAC, March 1976.

23. MIL-STD-188-114, Electrical Characteristics of Digital Interface Circuits, 24 March 1976.

24. (C) TTO-ENG-031-77-ANF4, Architecture for Tactical Switched Communication Systems, Annex F4, Signal and Supervision (U), TRI-TAC, June 1977.

25. MITRE WP-21220 Working Paper, External Access Characteristics of TRI-TAC Equipments, 31 March 1977.

26. DCEC TR 2-77, System Integration and Interface Transition Issues, April 1977.

27. DCEC TR 6-78, Digital Transmission in the Evolving DCS, May 1978.

28. DCEC TR 23-77, DCS II Timing Subsystem, December 1977.

29. DCEC TR 4-78, Technical Overview of the System Control Improvement Program, May 1978.